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The Sabin Center for Climate Change Law develops legal techniques to fight climate change, trains law students and lawyers in their use, and provides the legal profession and the public with up-to-date resources on key topics in climate law and regulation. It works closely with the scientists at Columbia University's Climate School and with a wide range of governmental, non-governmental and academic organizations.

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Conclusions

This report examines the legal issues relevant to the shipping of carbon dioxide captured at industrial facilities in Europe to the United States for permanent sequestration, most likely in facilities to be built in Texas or Louisiana near the Gulf of Mexico.

The purity of the carbon dioxide stream has particular legal significance. Excessive levels of impurities, especially of chemicals deemed hazardous, would subject the shipments to severe domestic and international legal restrictions that apply to the transportation, storage and disposal of hazardous waste. It is our understanding that the carbon dioxide captured in CCS operations typically has low levels of contaminants, but that would need to be verified on a facility-by-facility basis. The specific composition of transported carbon dioxide will vary depending on the carbon dioxide capture methodology and the source of the stream. Purity requirements for ships are likely to be more stringent than those for pipelines due to differences in temperature and pressure for shipping. The European Union recommendation for the purity of the carbon dioxide for storage in Europe is above 99.7% by volume. It would be very important not to add any contaminants to the captured carbon dioxide, or to allow contaminants to be introduced by, for example, using pipes or tanks that had previously been used for other chemicals and that had not been thoroughly cleaned.

Carbon capture and sequestration (CCS) is not explicitly referenced in either the United Nations Framework Convention on Climate Change of 1992 (UNFCCC) or the Paris Climate Agreement of 2015. The UNFCCC, among other things, requires each signatory country to report annually its greenhouse gas (GHG) emissions and removals by sinks. The Paris Climate Agreement, among other things, requires each signatory country to issue and to periodically strengthen a document called a Nationally Determined Contribution (NDC), which is its pledge for addressing climate change, including by reducing its GHG emissions and enhancing removals, among others. This report concludes that GHG emissions captured and sequestered as part of a CCS process at a point source would have to be separately reported in accordance with specific guidelines from the Intergovernmental Panel on Climate Change, but these captured emissions could be deducted from the total reported emissions of the source country to yield a lower level of net emissions. This lower level of net emissions would assist the country in meeting its NDC. The emissions from the ships and any leakage of carbon dioxide in the shipment process should be reflected in the accounting to yield the overall net emissions reductions. The country where the sequestration takes place (such as the U.S.) would not be able to take credit for this sequestration in meeting its own NDC; the relevant accounting rules prohibit double counting.

No international environmental treaty explicitly regulates the shipment of carbon dioxide. Certain ambiguities in the London Protocol arguably created challenges, but a 2009 amendment (and its provisional application) resolved those ambiguities in a manner favorable to such shipment. Beyond that, assuming that the carbon dioxide is not unduly contaminated, no treaties or other legal instruments pose significant barriers to the ocean shipment of carbon dioxide for sequestration. However, the existing patchwork of treaties does create ongoing confusion and uncertainties. This report describes the patchwork in detail.

The Paris Climate Agreement establishes several market-based mechanisms for the international trading of emission reduction credits and of units called Internationally Transferred Mitigation Outcomes (ITMOs). The report concludes that these trading mechanisms are not likely to be relevant to the international shipment of carbon dioxide. They are extremely complicated, would involve high transaction costs, and are subject to considerable uncertainties about the applicable rules, which are still being developed. Use of these market mechanisms in the shipment of carbon dioxide from the E.U. to the United States would yield no clear benefit. Moreover, neither the U.S. nor the E.U. has expressed interest in using the Paris market-based mechanisms to assist in their NDC compliance.

Therefore, the economics of the operation would instead be dominated by the payments the source country would make to the receiving country for providing the sequestration services. In the U.S., the substantial tax benefits provided by the Internal Revenue Code for CCS and the subsidies provided to CCS by the Infrastructure Investment and Jobs Act of 2021are not consequential for projects involving cross-border transportation of carbon dioxide. Analysis of these subsidies and the tax issues is beyond the scope of this report, but we note that the tax benefits for CCS provided by the Inflation Reduction Act of 2022 apply only to carbon dioxide captured and stored in the United States. Discussion of any applicable import tariffs is also beyond the scope of this report.

Construction and operation of the sequestration facilities in the U.S. would be subject to several federal and state laws, but those are beyond the scope of this report. This report did, however, look at the laws relevant to the transfer of the carbon dioxide from ships to the sequestration facility. If a new dock or pier needs to be built specifically to accommodate the ships carrying carbon dioxide, approvals would be required from the U.S. Army Corps of Engineers. Those approvals would be subject to review under the National Environmental Policy Act (NEPA), and an environmental impact statement might be required. This could be a lengthy process. NEPA would also be invoked if the carbon dioxide is to be stored below the ocean floor on the U.S. outer continental shelf, necessitating approvals from the U.S. Bureau of Ocean Energy Management. Construction of onshore pipelines and other onshore facilities at the receiving end would be subject to various federal and state laws, but none of them appear to pose serious impediments.

Accidents at sea or in port that lead to leakage of carbon dioxide, bunker fuel or other substances, or that cause injury to persons or damage to property, could expose the ship and associated entities and people to liability. However, these would be no different than the sorts of liability involved in any other kind of maritime accident. It would be advisable to negotiate allocation of risk and to closely examine relevant insurance policies to ensure they provide the needed coverage. If an accident leads to the release of a substantial amount of carbon dioxide, that would affect the emissions reductions that could be claimed by the country of origin.

Summary

A number of large facilities intended for the permanent sequestration of carbon dioxide are being developed in the United States. Several of them will be located in Texas and Louisiana on or near the coast of the Gulf of Mexico, making them easily accessible to ships. At the same time, there is substantial interest in Europe in installing equipment to capture carbon dioxide from certain industrial operations before it is emitted into the atmosphere, but currently there are inadequate facilities existing in Europe to sequester much of this carbon dioxide. Therefore, there is interest in the possibility of using ships to transport the carbon dioxide that has been captured in Europe to the United States for sequestration. This report examines the laws that could be applicable to this shipping. Much of the report would also be relevant to the shipping of carbon dioxide from other origins to other destinations, though domestic laws at either end of the trip may also be relevant.

This report is organized as follows. Chapter 1 introduces essential definitions and details the academic and practical interest in the cross-border shipping of carbon dioxide for permanent storage. Chapter 2 provides a technical overview of relevant issues involved in the different stages of carbon dioxide shipping. It also contextualizes CCS in the context of climate agreements. Chapter 3 zooms in the international treaties applicable to the cross-border transportation of carbon dioxide for permanent storage overseas. Chapter 4 pivots to how the international shipping of carbon dioxide from the European Union for permanent storage in the United States may fit under Nationally Determined Contributions (NDCs) and the market-based mechanisms of Article 6 of the Paris Agreement. Chapter 5 reviews the domestic legislation of the United States that may be applicable to the international shipping of carbon dioxide for permanent storage in the United States, whereas Chapter 6 presents the scope of environmental reviews that may apply under the National Environmental Policy Act (NEPA). Chapter 7 analyzes the liability regimes involved in such shipping.

Below are the main findings and pertinent recommendations when applicable of each chapter.

Chapter 2 provides a technical overview of relevant issues involved in the different stages of carbon dioxide shipping for permanent storage overseas. It highlights the current main challenges involved in the cross-border shipping of carbon dioxide, particularly regarding technology, scale, and commerciality. Captured carbon dioxide streams from point sources contain different impurities depending on both the specific point source and the carbon capture process used. This report also considered carbon dioxide streams from carbon dioxide removal (CDR) processes, such as direct air capture (DAC), which scrub carbon dioxide from the atmosphere.[1] Carbon

[1] Direct air capture (DAC) is considered among the most prominent engineered approaches to CDR, although the distinction between "engineered" and "natural" approaches may not be helpful. Ocean-based CDR methods, for instance, are particularly difficult to be characterized as natural or engineered. Christine Bertram & Christine Merk, *Public Perceptions of Ocean-Based Carbon Dioxide Removal: The Nature-Engineering Divide?* 2 FRONTIERS IN CLIMATE, Article 594194, 1, 5 (2020) (Highlighting that the distinction between natural and engineered approaches matters for public opinion acceptance, despite "the categorization of approaches into nature-based solutions and climate engineering seems somewhat arbitrary.").

streams produced from DAC typically yield higher purity levels than streams captured from point sources.[2] The purity of the carbon dioxide stream is consequential in several aspects of the carbon capture, transportation, and storage process. Despite the lack of established standards, it is clear that in the shipping process, impurities in the carbon dioxide stream affect its solubility in water, density, and pressure-temperature phase equilibria. Each of these shifts could impact safety and feasibility of transport. Excessive levels of contamination could subject the carbon dioxide waste streams to the severe restrictions imposed by various international and national laws on the transportation, storage and disposal of hazardous waste.

Another technical challenge refers to the different states of the carbon dioxide involved in the carbon capture and sequestration (CCS) chain. Carbon dioxide for shipping is usually brought into a liquid state through several cooling and compression steps in a process known as "liquefaction."[3] Carbon dioxide destined for geologic storage is typically first conditioned into a supercritical state rather than a liquefied one.[4] This supercritical carbon dioxide has a density that resembles a liquid but expands to fill space like a gas. These different states add complexity throughout the cross-border shipping of carbon dioxide for permanent storage abroad.

Chapter 2 also contextualizes CCS in the context of climate agreements, examining the United Nations Framework Convention on Climate Change[5] and, more recently, the Paris Agreement on Climate Change[6] and related international agreements signed under the Paris Agreements' umbrella, namely, the Glasgow Climate Pact and the Sharm el-Sheikh Implementation Plan.[7]

The Paris Agreement had little to say when it came to CCS, limiting itself to "removals" and the related need for parties to include these in their reporting.[8] Here, making a technical distinction between CCS and CDR is useful.

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[2] Purity levels among DAC technologies may vary considerably. *See* M. Fasihi et al., *Techno-economic assessment of CO_2 Direct Air Capture Plants,* 224 JOURNAL OF CLEANER PRODUCTION 957, 966 (2019) (Underscoring that, in general, DAC processes produce a high purity stream of carbon dioxide).

[3] *Id.*

[4] *See* WORLD RESOURCES INSTITUTE, GUIDELINES FOR CARBON DIOXIDE CAPTURE, TRANSPORT, AND STORAGE 42 (Sarah M. Forbes et al. eds., 2008). For completeness, a few technical points need inclusion. In the United States, carbon dioxide is currently moved in dense phase / super critical (90-120 bar); whereas in the European Union many are looking at moving it in gaseous phase. In the latter case, the density of the carbon dioxide is lower (requiring bigger pipes), and the carbon dioxide moves at lower pressures (20-50 bar). Less energy is required to maintain this lower pressure along a long pipeline which may result in lower costs. The capture process used might also impact the way in which carbon dioxide is transported. Amiens-based capture processes produce a gaseous carbon dioxide stream, whereas cryogenic-type capture technology results in a dense/liquid phase carbon dioxide. This, in some instances, will drive the decision as to the type of pipeline to use to transport the carbon dioxide. (Personal communication with Jasper Heikens, chief commercial officer of Ecolog Ltd. (Jan. 9, 2024)).

[5] The United Nations Framework Convention on Climate Change, Sep. 5, 1992, 1771 U.N.T.S. 107 [hereinafter UNFCCC].

[6] The United Nations Paris Agreement, Dec. 12, 2015, 54113 U.N.R.N. 88, [hereinafter Paris Agreement].

[7] Conference of the Parties Serving as the Meeting of the Parties to the Paris Agreement, *Report of the Conference of the Parties Serving as the Meeting of the Parties to the Paris Agreement on its Second Session, Held in Glasgow from 31 October to 12 November 2021. Addendum—United Nations Framework Convention on Climate Change* (Mar. 8, 2022), at https://perma.cc/9VD6-3PLY (Glasgow Climate Pact); UNFCCC, Decision-CP 27: Sharm el-Sheikh Implementation Plan (Advanced unedited version: Nov. 20, 2022), at https://perma.cc/F6JD-QPYY.

[8] Paris Agreement, *supra* note 6, Art. 4–5 and Art. 13, respectively.

As discussed, CCS refers to the removal of gas from an emissions stream before it reaches the ambient air, and then storing the carbon dioxide in such a way that it cannot reach the atmosphere.[9] The IPCC defines CDR as, "Anthropogenic activities removing CO_2 from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products. It includes existing and potential anthropogenic enhancement of biological or geochemical sinks and direct air capture and storage but excludes natural carbon dioxide uptake not directly caused by human activities."[10] In short, CCS removes the carbon dioxide from existing emissions streams before they reach the atmosphere; CDR removes the carbon dioxide from the atmosphere itself.

CCS, therefore, is not technically a removal activity, as it does not actually remove carbon dioxide from the atmosphere. Rather, CCS prevents the release of additional carbon dioxide into the ambient air. As a result, CCS is not part of the GHG removal set of climate interventions.[11] However, as a climate mitigation technology, CCS still aims at reducing anthropogenic CO_2 emissions.[12] In order to achieve its intended mitigation effect, the captured carbon dioxide from a CCS stream must be stored for indefinite time periods, but at minimum for several centuries.[13]

CCS has faced criticism and is no panacea. CCS is a mitigation action aimed at achieving overall GHG emission reductions, rather than as a replacement for the reductions themselves.[14] CCS is not in any way a replacement for emissions reductions through such measures as transitioning away from fossil fuels, which is the most important mitigation measure; CCS is merely a supplement to these actions. CDR can similarly be used as a complement to (but not a substitute for) emissions reductions. In the future, CDR may be used to counterbalance hard-to-abate residual emissions, and thus achieve net zero emissions.[15] Ultimately, CCS and CDR are

[9] Michael B. Gerrard, *Introduction and Overview, in* Climate Engineering and the Law: Regulation and Liability for Solar Radiation Management and Carbon Dioxide Removal 3 (Michael B. Gerrard & Tracy Hester eds., 2018).

[10] Intergovernmental Panel on Climate Change (IPCC), *Annex I: Glossary in* Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty (J. B. Robin Matthews ed., 2018).

[11] Nils Markusson et al., *Towards a Cultural Political Economy of Mitigation Deterrence by Negative Emissions Technologies (NETs),* Global Sustainability 1, 2 (2017), (Clarifying that bioenergy coupled with carbon capture and storage—BECCS is part of NETs. *Id.* at 2).

[12] Karl W. Bandilla, *Carbon Capture and Storage in* Future Energy: Improved, Sustainable and Clean Options for our Planet 669, 669, 681 (Trevor M. Letcher ed., 2020).

[13] *Id.* at 681.

[14] Key players include all Member States who are Parties of the IPCCC and the IPCCC reports and the IEA, for instance. For their seminal work on CCS, *see, e.g.,* IPCC, IPCC Special Report on Carbon Dioxide Capture and Storage Prepared by Working Group III of the Intergovernmental Panel on Climate Change 3 (Bert Metz et al. eds., 2005); and, more recently, International Energy Agency, *Net Zero by 2050: A Roadmap for the Global Energy Sector* 64–80, IEA (Oct. 2021).

[15] IPCC, Summary for Policymakers in Climate Change 2022: Mitigation of Climate Change: Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change 36–38 (Priyadarshi R. Shukla et al. eds., 2022).

components of portfolio of actions toward climate mitigation[16] because achieving global net zero GHG emissions is a requirement for stabilizing a GHG-induced global surface temperature increase.[17]

Chapter 3 narrows its scope of analysis to look solely at the international agreements that may affect the cross-border transportation of carbon dioxide for storage. It highlights how international agreements on what constitutes a hazardous or toxic substance are not always black and white. Global definitions of "hazardous" and "toxic" substances may be interpreted differently across domestic regulations. Similarly, there are often subtle distinctions between the movement of waste and dumping; while these two activities are not necessarily related, one may follow the other in practice.[18] Finally, the transboundary movement of carbon dioxide raises difficult questions on how to classify carbon dioxide under international treaties that were drafted prior to the development of CCS technologies.[19]

In such a context, Chapter 3 begins by examining the London Convention and Protocol,[20] which is arguably the most important legal framework to understand the regulation of cross-border carbon dioxide transportation and storage. The London Convention regulates the intentional dumping and incineration of wastes at sea from ships.[21] It defines dumping as "any deliberate disposal at sea of wastes or other matter from vessels, aircraft, platforms or other man-made structures at sea; and any deliberate disposal at sea of vessels, aircraft, platforms or other mandate structure at sea."[22]

The London Protocol expanded the Convention's definition of "dumping" to include (in addition to the above) "any storage of wastes or other matter in the seabed and the subsoil thereof from vessels, aircraft, platforms or other man-made structures at sea."[23] As such, the Protocol explicitly includes seabed storage activities as part

[16] IPCC, IPCC Special Report on Carbon Dioxide Capture and Storage Prepared by Working Group III of the Intergovernmental Panel on Climate Change 19 (Bert Metz et al. eds., 2005) (Placing CCS among other options in the portfolio of potential climate change mitigation measures).

[17] IPCC, Summary for Policymakers in Climate Change 2021: The Physical Science Basis: Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change 38–40, D.1.8, specifically (Valérie Masson-Delmotte et al. eds., 2021).

[18] André Nollkaemper, *Transboundary Movement of Hazardous Waste for the Purpose of Dumping at Sea*, 22 Marine Pollution Bulletin 377, 377 (1991).

[19] Andy Raine, *Transboundary Transportation of CO_2 Associated with CCS Projects,* 2 Carbon and Climate L. Rev. 353, 356 (2008).

[20] 1972 United Nations Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Dec. 29, 1972, (entered into force Aug. 30, 1975) 1046 U.N.T.S. 120 [hereinafter London Convention]; and 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Nov. 7, 1996 (entered into force Mar. 24, 2006), 36 I.L.M. 7 [hereinafter London Protocol].

[21] London Convention, *supra* note 20, Art. I–II. *See also* David Hunter et al., International Environmental Law and Policy 785 (2022).

[22] London Convention, *supra* note 20, Art. III, 1 (a), whereas Art. III, 1 (b) excludes from the scope of the London Convention the application of the MARPOL Convention; the placement of matter for a purpose other than the mere disposal thereof and as long as not this placement is not contrary to the goals of the Convention; and the disposal of wastes or other matter directly arising from, or related to the exploration, exploitation and associated off-shore processing of sea-bed mineral resources.

[23] London Protocol, *supra* note 20, Art. 1 (4) 3. *See also* IEAGHG, *The Status and Challenges of CO_2 Shipping Infrastructures*, 58 (James Craig ed., 2020), at https://perma.cc/URY6-48Y3.

of the definition of dumping.[24] Technically, carbon dioxide is included under the Protocol's definition of waste and other matters as a "material and substance of any kind, form or description."[25] Therefore, carbon dioxide for sub-seabed storage falls within the original scope of the Protocol's application, but this treaty has been subject to two amendments aiming to make this application more flexible. In 2006, Annex 1 of the London Protocol was amended to include carbon dioxide streams from carbon capture processes for storage, placing it among the specific authorized substances for dumping.[26] In 2009, an amendment of Article 6 of the London Protocol authorized the cross-border export of carbon dioxide for geological storage,[27] but this amendment has yet to enter into force.[28]

While there is no single international treaty that explicitly addresses the cross-border transportation of carbon dioxide for storage, the London Convention and Protocol system currently offers the strongest regulation potential, with the latter being the only treaty specifically allowing for offshore storage of carbon dioxide. The London Protocol regulates the export of carbon dioxide for offshore storage.[29] It also regulates the act of offshore storage in sub-seabed geologic formations. Notably, however, it does not regulate the carbon capture process, nor does it regulate onshore carbon storage.

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[24] London Protocol, *supra* note 20, Art. 1 (4) 1 (3). The London Protocol defines dumping to include both "deliberate disposal at sea of wastes or other matter from vessels, aircraft, platforms, or other man-made structures" and the "storage of wastes or other matter in the seabed and the subsoil thereof from vessels, aircraft, platforms or other man-made structures at sea." Meanwhile, the London Convention focuses on the "deliberate disposal [of waste] at sea." London Convention, *supra* note 20, Art. III, 1(a) (i).

[25] London Protocol, *supra* note 20, Art. 1 (8). This also applies to the London Convention. London Convention, *supra* note 20, Art. I. *See also* Ray Purdy & Richard Macrory, *Geological Carbon Sequestration: Critical Legal Issues*, Tydall Centre for Climate Change Research: Working Paper 45, 18–20 (2004).

[26] London Protocol, *supra* note 20, Annex 1: "Wastes and Other Matter that may be considered for Dumping: Paragraph 4: Carbon dioxide streams referred to in paragraph 1.8 may only be considered for dumping, if: (1) disposal is into a sub-seabed geological formation; (2) they consist overwhelmingly of carbon dioxide. They may contain incidental associated substances derived from the source material and the capture and sequestration processes used; and (3) no wastes or other matter are added for the purpose of disposing of those wastes or other matter."

[27] The 2009 amendment to Art. 6 reads as follows: "[t]he export of carbon dioxide streams for disposal in accordance with Annex 1 may occur, provided that an agreement or arrangement has been entered into by the countries concerned. Such an agreement or arrangement shall include: (2.1) confirmation and allocation of permitting responsibilities between the exporting and receiving countries, consistent with the provisions of this Protocol and other applicable international law; and (2.2) in the case of export to non-Contracting Parties, provisions at a minimum equivalent to those contained in this Protocol, including those relating to the issuance of permits and permit conditions for complying with the provisions of Annex 2, to ensure that the agreement or arrangement does not derogate from the obligations of Contracting Parties under this Protocol to protect and preserve the marine environment. A Contracting Party entering into such an agreement or arrangement shall notify it to the Organization." IMO, *CO_2 Export Amendment: Resolution LP.3(4)* (Adopted on 30 October 2009).

[28] The amendment has yet to enter into force because it has not been ratified by two-thirds of the London Protocol's parties. London Protocol, *supra* note 20, Art. 21 (requiring approval of two third of the contracting parties of the Protocol for an amendment to its main text to be valid). The London Protocol has currently fifty-three parties; thirty-six are needed. *See* IMO, The London Convention and Protocol, IMO (Jan. 6, 2023), at https://perma.cc/CQW4-V75Y.

[29] Because the London Protocol regulates export, it has implications for cross-border carbon dioxide transport. The Protocol does not directly regulate the act of transportation, however. For example, the Protocol does not establish detailed rules for the handling of carbon dioxide, nor specify how it must be transported.

While the London Protocol currently regulates the export of waste for offshore disposal and, as such carbon dioxide for offshore, sub-seabed storage stages of the CCS chain, the way in which it does so has changed over time. Nowadays, there is an overall agreement that the provisional application of the 2009 export amendment to Article 6 of the London Protocol removed the last significant international legal barrier to CCS, opening the door for countries to pursue cross-border transportation of carbon dioxide for offshore storage.

Chapter 3 also analyzes the Basel and Bamako Conventions, which concern the export and import of hazardous waste.[30] These Conventions are unlikely to apply to the cross-border transportation of carbon dioxide for storage, so long as purity levels of the carbon dioxide stream are high, and no prohibited co-components are added. In sum, these Conventions, while relevant, will likely not impede the movement of carbon dioxide across borders.

Following the more in-depth analysis of the above international treaties, chapter 3 then briefly outlines the potential implications of the following treaties and agreements on regulating transboundary carbon dioxide movement: UNCLOS (*United Nations Convention on the Law of the Sea*);[31] the High Seas Treaty or BBNJ (*United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction*);[32] MARPOL (*International Convention for the Prevention of Pollution from Ships*);[33] OSPAR (*Convention for the Protection of the Marine Environment of the North-East Atlantic*);[34] the HNS Convention (*International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea*);[35] the OECD Wastes Decision;[36] and specific U.S. bilateral treaties involving the transportation of hazardous waste.[37] While each of these treaties and agreements raises interesting considerations regarding the transport and storage of carbon dioxide, ultimately none pose significant barriers to the industry at this time.

Chapter 3 concludes that none of the international legal frameworks discussed contain provisions to authorize onshore storage, only covering cross-border transportation for offshore storage while not precluding onshore storage. This scenario is unlikely to be optimal if the international law community continues to consider CCS as

[30] The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal Mar. 22, 1989 (entered into force May 5, 1992), 1673 U.N.T.S. 57 [hereinafter Basel Convention]; and The Bamako Convention on the Ban of Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa, Jan. 30, 1991 (entered into force Apr. 22, 1998) 2101 U.N.T.S. 177 [hereinafter Bamako Convention].

[31] United Nations Convention on the Law of Sea, Dec. 10, 1982 (entered into force Nov. 16, 1994), 1833 U.N.T.S. 3 [hereinafter UNCLOS].

[32] The United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction [hereinafter The High Seas Treaty].

[33] The United Nations Convention for the Prevention of Pollution from Ships, Nov. 2, 1973, 12 I.L.M 319 [hereinafter MARPOL].

[34] The Convention for the Protection of the Marine Environment of the North-East Atlantic, Sep. 22, 1992 (entered into force on Mar. 25, 1998), 2454 U.N.T.S. 67 [hereinafter OSPAR].

[35] International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea 1996 and its Protocol of 2010 (adopted May 3, 1996, and Apr. 29, 2010, respectively, and not yet entered into force), 35 I.L.M. 1415 [hereinafter HNS Convention].

[36] OECD Legal Instruments, *Decision of the Council on the Control of Transboundary Movements of Wastes Destined for Recovery Operations*, Mar. 29, 1992 (amended Dec. 31, 2020) [hereinafter OECD Wastes Decision].

[37] These agreements and related references are detailed in Chapter 3.

having an important role as a part of a mitigation portfolio of activities needed to reduce GHG emissions, particularly for hard-to-abate sectors. There is, however, a general agreement regarding the role of international treaties in transboundary offshore carbon dioxide storage. The provisional application of the 2009 export amendment to Article 6 of the London Protocol, as mentioned above, removed the last significant international legal barrier to CCS, opening the door for countries to pursue cross-border transportation of carbon dioxide for offshore storage.[38]

Despite a general understanding that no international treaty poses significant barriers to CCS, actors still face a patchwork of international treaties that each have some level of uncertainty regarding their exact scope of their application. This patchwork international governance system is unlikely to be optimal if the international law community considers CCS as having an important role as a part of a mitigation portfolio of activities needed to reduce GHG emissions, particularly for hard-to-abate sectors.

Chapter 4 highlights the complexities involved in the integration of the cross-border shipping of carbon dioxide from Europe for permanent storage in the United States into both NDCs and the market-based mechanisms of the Paris Agreement. It concludes that the 2006 IPCC Guidelines specifically provide for the reporting of carbon dioxide captured in one country and exported to another one. These guidelines require the country exporting carbon dioxide and the country receiving it to report the exact amount of carbon dioxide exported and/or imported under their jurisdiction, including emissions generated by temporary storage and all fugitive emissions involved the process. For purposes of this report, therefore, CCS cross-border operations have specific and detailed rules under the emissions inventories and NDCs required for parties to the Paris Agreement. Carbon dioxide originating from DAC sources, however, has yet to be contemplated in the guidelines.

This chapter also concludes that incorporating the permanent storage of carbon dioxide into an NDC via the market mechanisms of Article 6 of the Paris Agreement could theoretically occur in two forms: (1) under Article 6.2's cooperative bilateral or multilateral approach, particularly through the use of internationally transferred mitigation outcomes (ITMOs) towards NDCs and to promote sustainable development and ensuring environmental integrity; or (2) under Article 6.4's Sustainable Development Mechanism (SDM), so long as emissions reductions resulting from this SDM are not used to demonstrate achievement by multiple parties' NDCs to preclude double counting of the same offset.

However, the market-based mechanisms of the Paris Agreement currently present significant challenges. While some of these challenges may be streamlined in the upcoming COPs, many uncertainties around these mechanisms remain, which ultimately does not incentivize member states of the European Union to utilize market-based mechanisms in connection with the cross-border shipping of carbon dioxide for permanent storage in the United States for the purposes of counting this activity towards their NDCs.

[38] IEAGHG, *Exporting CO_2 for Offshore Storage – The London Protocol's Export Amendment and Associated Guidelines and Guidance,* 2021 TR02, 9 (Apr. 2021), at https://perma.cc/J8NZ-UZZ8.

Neither the EU nor the US currently plan to make use of the Article 6 mechanisms. Whether future COPs can sufficiently clarify Article 6's operational uncertainties to the point that either party is interested in revising this stance remains to be seen.

Chapter 5 turns its attention to the shipping of carbon dioxide from Europe for permanent storage in the United States focusing on the domestic U.S. laws relevant to this operation. As such, it builds on our previous findings of the current existing requirements imposed under international law, which are discussed in Chapter 3. As this report focuses exclusively on international laws and any U.S. subnational laws that may inhibit international transport of carbon dioxide, a detailed analysis of U.S. law concerning reservoirs, pipelines, and the like is outside the scope of this research. That said, this report analyzes eventual requirements that current pipeline regulations may impose regarding purity standards and specifications for carbon dioxide streams.

This chapter discusses the main federal statutes regulating the cross-border transportation of carbon dioxide for storage, thus focusing on the Marine Protection, Research, and Sanctuaries Act (MPRSA),[39] the Hazardous Materials Transportation Act (HMTA),[40] and the Act to Prevent Pollution from Ships (APPS).[41] As for the storage component, Chapter 5 specifically discusses the Safe Drinking Water Act (SDWA),[42] the Resource Conservation and Recovery Act (RCRA),[43] and the Outer Continental Shelf Lands Act (OCSLA).[44] This chapter also outlines current state experiences in handling the transportation for permanent storage of carbon dioxide. It primarily focuses on how states have handled provisions under the Safe Drinking Water Act. For the purposes of this report, just four states are relevant to this analysis: North Dakota, Wyoming, Louisiana, and Texas.

While there is no comprehensive domestic legal framework regulating the cross-border transportation of carbon dioxide for permanent storage in the United States, the 2021 amendments under the Infrastructure Investment and Jobs Act (IIJA) were consequential for activities involving the transportation and permanent storage of carbon dioxide offshore. All the federal statutes and related regulations researched in Chapter 5 are unlikely to impose legal barriers for the import of carbon dioxide for permanent injection and storage in the United States. None of these acts impose important additional requirements beyond those currently in place under international law, which are mainly concerned with the purity levels of the carbon dioxide stream for storage and its sources. Nonetheless, a comprehensive domestic statutory framework could be helpful in facilitating carbon dioxide transportation for permanent storage, but it is not essential.

Chapter 6 discusses the applicability of the National Environmental Policy Act (NEPA),[45] and the scope of the NEPA review if it is triggered by discretionary federal approvals of the transport or receipt of carbon dioxide from ships. While several federal statutes and associated agencies including EPA, BOEM, DOT and PHMSA might be

[39] 33 USC §1401.
[40] 49 USC §§5101.
[41] 33 U.S.C. §§ 1901–1905.
[42] Safe Drinking Water Act of 1974, 42 USC §§ 300h et seq.
[43] 42 USC § 6922 (a) et seq.
[44] 43 USC §1301.
[45] 42 U.S.C.§§ 4321–4370e (As amended by the Builder Act, i.e., Title III, C, of the 2023 Fiscal Responsibility Act of May 28, 2023).

involved in the cross-border transportation of carbon dioxide for permanent storage, none but one of the statutes evaluated in this report are currently likely to trigger NEPA review: OCSLA. This statute currently provides that the Secretary of Interior may issue leases, easements, or right-of-way for activities that "provide for, support, or are directly related to the injection of a carbon dioxide stream into sub-seabed geologic formations for the purpose of long-term carbon sequestration."[46] Therefore, this lease, which will be within the purview of BOEM as it is the agency within the Department of the Interior that administers OCSLA,[47] would invoke NEPA. This is the case, as this lease may qualify as a "major federal action" under the revised NEPA.[48]

The final logistical step of transferring carbon dioxide from ship to shore would likely require some type of pier, jetty, or other similar structure. If a new pier or other structure needed to be built to accommodate the carbon dioxide-carrying ships, permits would be required from the Army Corps of Engineers, triggering the application of NEPA. It is possible that an environmental impact statement (EIS) would be required. The report discusses in detail the legal requirements that would be applicable to the contents of such an EIS if one needs to be prepared. Use of an existing pier, and minor modifications to the pier (especially if they did not involve construction in the water), would not require Army Corps permits or trigger NEPA. NEPA could also be invoked if the carbon dioxide is to be stored below the ocean floor on the United States OCS, necessitating approvals from the U.S. Bureau of Ocean Energy Management (BOEM).

Chapter 7 analyzes both the SOLAS Convention (*Convention for the Safety of Life at Sea*)[49] and MARPOL (*International Convention for the Prevention of Pollution from Ships*),[50] as both conventions provide for states' conduct to secure the safe transportation of goods. In addition to these regulatory conventions, the IMO has also established several liability conventions that may be relevant to the potential shipment of carbon dioxide. Therefore, the following international treaties focusing on carriers' liability are examined: the LLMC Convention (*Convention on Limitation of Liability for Maritime Claims*),[51] the HNS Convention (*International Convention on*

[46] 43 USC §1337 paragraph (1), which determines that: "In general: The Secretary, in consultation with the Secretary of the Department in which the Coast Guard is operating and other relevant departments and agencies of the Federal Government, may grant a lease, easement, or right-of-way on the Outer Continental Shelf for activities not otherwise authorized in this subchapter, the Deepwater Port Act of 1974 (33 U.S.C. 1501 et seq.), the Ocean Thermal Energy Conversion Act of 1980 (42 U.S.C. 9101 et seq.), or other applicable law, if those activities . . . (E) provide for, support, or are directly related to the injection of a carbon dioxide stream into sub-seabed geologic formations for the purpose of long-term carbon sequestration."

[47] Department of Interior (DOI), *Interior Department Completes the Reorganization of the Former MMS* (Sep. 30, 2011), at https://perma.cc/4LBY-3872.

[48] 42 U.S.C. § 4336e (10) (A): "The term 'major Federal action' means an action that the agency carrying out such action determines is subject to substantial Federal control and responsibility." (Defining now this term as amended by the Fiscal Responsibility Act of 2023 (May 28, 2023), § 111 (Definitions), at 91.

[49] International Convention for the Safety of Life at Sea, Nov. 1, 1974 (entered into force on May 25, 1980), 1184 U.N.T.S. 279 [hereinafter SOLAS].

[50] The United Nations Convention for the Prevention of Pollution from Ships, Nov. 2, 1973, 12 I.L.M 319 [hereinafter MARPOL].

[51] Convention on Limitation of Liability for Maritime Claims, Nov. 16, 1976 (entered into force on Dec. 1, 1986), 1456 U.N.T.S. 221 [hereinafter LLMC].

Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea),[52] and the Bunkers Convention (*International Convention on Liability for Bunker Oil Pollution Damage*).[53]

In addition to being a regulatory matter in international conventions, the carriage of goods by sea is also a contractual subject matter. As such, this chapter highlights the main issues regarding contractual liability in the cross-border shipping of carbon dioxide for storage. It also discusses the United Nations Convention on the Law of the Sea (UNCLOS)[54] as well as its consequences for the liability regimes analyzed. Chapter 7 further discusses the jurisdiction over liability claims.

We conclude that, subject to the international and national frameworks on liability and their applicable limitations, it is expected that the agreement between the parties will establish when liability passes over at the delivery point to the ship owner or operator, as well as when liability passes over at re-delivery. Federal courts have extensive admiralty and maritime jurisdiction, including cases arising out of an injury to persons or damage to property connected to a vessel in navigation on navigable waters during the course of traditional maritime activity with the potential to affect maritime commerce. Moreover, torts that occur in the exclusive economic zone (EEZ), which extends out to 200 nautical miles from shore, as well as contractual claims are likely to be included within federal courts' admiralty and maritime jurisdiction in the United States.

[52] International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea 1996 and its Protocol of 2010 (adopted May 3, 1996, and Apr. 29, 2010, respectively, and not yet entered into force), 35 I.L.M. 1415 [hereinafter HNS Convention].

[53] The International Convention on Civil Liability for Bunker Oil Pollution Damage, Mar. 23, 2001 (entered into force on Nov. 11, 2008), 1456 U.N.T.S. 221 [hereinafter Bunkers].

[54] United Nations Convention on the Law of Sea, Dec. 10, 1982 (entered into force Nov. 16, 1994), 1833 U.N.T.S. 3 [hereinafter UNCLOS]. This Convention is analyzed in Chapter 3 of this Report. The United States has neither signed nor ratified UNCLOS, according to the United Nations Treaty Collection website, at https://perma.cc/MV2H-UQXW.

CHAPTER 1: INTRODUCTION

The Intergovernmental Panel on Climate Change defines carbon dioxide capture and storage (CCS) as "a process in which a relatively pure stream of *carbon dioxide (CO_2)* from industrial and energy-related sources is separated (captured), conditioned, compressed, and transported to a storage location for long-term isolation from the *atmosphere*."[55] Therefore, CCS encompasses a series of steps, at minimum: capturing carbon dioxide, its transportation to a storage site and its injection into the subsurface for permanent storage.[56] As such, CCS does not refer to any single activity or technology.[57] The present report focuses on the transportation aspect of CCS and, more precisely, on the cross-border shipping of carbon dioxide for storage abroad.[58] This report presents a comprehensive review of the current international legal framework applicable to the transboundary transportation of carbon dioxide. It also examines the extent to which (if any) current U.S. laws may affect the shipping of carbon dioxide from Europe for permanent storage in the United States.

The issue of cross-border transportation of carbon dioxide for storage is of academic and practical interest, especially when considering the current levels of greenhouse gases (GHGs) in the atmosphere[59] and the need for storing carbon dioxide outside Europe, in particular.[60]

[55] Intergovernmental Panel on Climate Change (IPCC), *Annex I: Glossary in* Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty (J. B. Robin Matthews ed., 2018), at https://perma.cc/Z62G-N29Q. This IPCC Report refers to carbon dioxide capture and storage as a synonym for carbon capture and storage but distinguishes CCS from carbon dioxide capture and utilization (CCU). According to the IPCC, CCU is "a process in which CO_2 is captured and then used to produce a new product. If the CO_2 is stored in a product for a *climate*-relevant time horizon, this is referred to as carbon dioxide capture, utilisation and storage (CCUS). Only then, and only combined with CO_2 recently removed from the *atmosphere*, can CCUS lead to *carbon dioxide removal*. CCU is sometimes referred to as carbon dioxide capture and use." (emphasis in original).

[56] Karl W. Bandilla, *Carbon Capture and Storage in* Future Energy: Improved, Sustainable and Clean Options for our Planet 669, 669–70 (Trevor M. Letcher ed., 2020).

[57] Highlighting that most CCS systems are designed to capture from 85% to 95% of the carbon dioxide source point and higher capture targets significantly increases costs: The Royal Society, *Climate change Science and Solutions: Carbon Dioxide Capture and Storage* 3 (2021), at https://perma.cc/AD4X-B22Z.

[58] The issue of transboundary "migration" once the carbon dioxide is injected or stored is outside the scope of this report.

[59] Richard S. J. Tol, *Quantifying the Consensus on Anthropogenic Global Warming in the Literature: A Re-Analysis,* 73 Energy Pol'y 701, 701–05 (2014) (The scientific community overwhelmingly acknowledges the existence of climate change and that GHG emissions are a primary cause); Ove Hoegh-Guldberg et al., *The Human Imperative of Stabilizing Global Climate Change at 1.5°C*, 365 Sci. 1–11 (2019) (Contending that multiple lines of evidence indicate that the next 0.5ºC increase in temperature would bring more adverse impacts than the previous 0.5ºC uptick).

[60] Because of the curtailing of natural gas from Russia, Europe increased its reliance on coal, despite the increasing costs of carbon dioxide emissions in the EU; to reduce these costs, carbon dioxide transported from Europe to be stored in the United States is of interest because Europe overall lacks vast storage capacity (except for a few countries such as Denmark and Iceland). Stephen Rassenfoss, *Europe Wants to Export Its CO_2 –The Question Is Who Wants It?,* Journal of Petroleum Technology (Jan. 15, 2023).

There is a vast literature discussing technical aspects of CCS[61] and the experience of sectors and specific countries with CCS.[62] There are, however, no books or major reports dedicated to CCS cross-border shipping.[63]

The Sabin Center for Climate Change Law's comprehensive database on CCS law, cdrlaw.org, currently has 484 academic works, legal provisions, and model law entries on CCS and transportation.[64] Each section of the present report relies on this database and additional research to analyze the topic at hand.

Academic interest in CCS (and related carbon dioxide transportation) has been increasing since the early 2000s, with commentators naming the turn of the century as "the birth of a global vision for CCS."[65] The first report by the IPCC exclusively on the topic established CCS as "an option in the portfolio of mitigation actions for stabilization of atmospheric greenhouse gas concentrations."[66] According to this report, which predicted the

[61] Reference books on these aspects include the following: R. E. Hester & R.M Harrison, Carbon Capture: Sequestration and Storage (2009) (Published by the Royal Society of Chemistry, this book focuses on the chemical aspects of CCS); Bash O. Dabboussi et al., Carbon Capture and Storage: Technologies, Policies, Economics, and Implementation Strategies (2011) (Addressing the technological aspects of CCS and related deployment drivers over a decade ago); Jon Gluyas & Simon Mathias Geological Storage of Carbon Dioxide (CO_2): Geoscience, Technologies, Environmental Aspects and Legal Framework (2013); Malti Goel, Carbon Capture, Storage, and Utilization (2014) (Mainly discussing the technological aspects involved in the context of decarbonization needs); Smit Berent et al., Introduction to Carbon Capture and Sequestration (2014)(Addressing engineering and chemistry aspects of the literature while considering some energy policy implications of CCS); Wilhelm Kuckshinrichs & Jürgen-Friedrich Hake, Carbon Capture, Storage (2015) (Discussing technical aspects of CCS in the EU and targeting different sectors, such as energy and transportation); Yongseung Yun, Recent Advances in Carbon Capture and Storage (2017) (This is a technical, engineering-oriented contribution); Howard J. Herzog, Carbon Capture (2018) (Presenting the technological aspects of CCS in the larger context of decarbonization); Jose Carlos Magalhaes Pires & Ana Luisa da Cunha, Bioenergy with Carbon Capture and Storage (2019) (Focusing on bioenergy, engineering and technology).

[62] For specific authoritative book sources on such a topic, *see, e.g.,* Nils Markusson et al., The Social Dynamics of Carbon Capture and Storage (2012) (Analyzing public participation and related perception and representation of CCS projects); Michael Faure & Roy A. Partain, Carbon Capture and Storage (2017) (Centering on CCS's liability regimes and allocation of incentives for these regimes); Clair Gough et al., Biomass Energy with Carbon Capture and Storage (BECCS) (2018) (Focusing on biomass energy, CCS and technical aspects pertinent to legal frameworks). More recently, *see, e.g.,* Ian Havercroft et al. Carbon Capture and Storage: Emerging Legal and Regulatory Issues (2018) (Discussing key regulatory aspects of CCS in the following jurisdictions: Australia, China, the European Union, India, the United States, and the United Kingdom); Jose Carlos Magalhaes Pires, Carbon Capture and Storage (2019) (This is a technology and engineering-oriented work which also considers the environmental feasibility of CCS projects); finally, Hirdan Katarina de M. Costa & Carolina Arlota, Carbon Capture and Storage (CCS) in International Energy Policy and Law: Perspectives on Sustainable Development, Climate Change, and Energy Transition (2021) (Discussing CCS in the context of international energy law and policies).

[63] The authors conducted a Google search on November 4, 2023, and found no books dedicated to the cross-border shipping of carbon dioxide.

[64] Sabin Center for Climate Change Law, Carbon Dioxide Removal Database, at https://cdrlaw.org/.

[65] Juho Lipponen et al., *The Politics of Large-Scale CCS Deployment* 114 Energy Procedia 7581, 7582 (2017).

[66] IPCC, IPCC Special Report on Carbon Dioxide Capture and Storage Prepared by Working Group III of the Intergovernmental Panel on Climate Change 3 (Bert Metz et al. eds., 2005) (From the outset, the report established that widespread application of CCS was contingent on technical maturity, costs, overall potential, diffusion, and transfer of the technology to developing countries and their capacity to apply the technology, regulatory aspects, environmental issues, and public perception).

economic attractiveness of carbon dioxide transported by ships,[67] CCS could potentially reduce the overall mitigation costs while increasing flexibility regarding achieving GHG emission reductions.[68]

Practical interest also increased in the beginning of the millennium. In 2000, major energy companies joined forces and collaborated on several initiatives to advance the deployment of industrial-scale CCS in the oil and gas industry.[69] There have been technical and economic challenges involving CCS projects in the United States[70] and abroad.[71] Yet, new CCS projects were announced each month in 2022 and the number of facilities in construction keeps increasing.[72] As of November 2023, there are forty-one CCS facilities operating worldwide with an estimated capture capacity of 49 million tons per annum (Mtpa).[73] The growth in carbon capture projects is expected to "create a booming global shipping trade."[74] 2023 witnessed key developments in shipping of liquified carbon dioxide.[75]

Domestic regimes are growing increasingly supportive of carbon capture and storage. In the United States, for instance, the Infrastructure and Investment Jobs Act of 2021 allocates 12 billion USD for new investment in carbon capture, use, and storage.[76] The Inflation Reduction Act of 2022 allocated 369 billion USD to climate and energy funding over the next decade and created additional tax incentives through enhancements to Internal Revenue Service Section 45Q for direct air capture and CCS. [77] Meanwhile, federal funding for the transportation

[67] *Id.* at 30 (Underscoring that the cross-border shipping is particularly attractive when the distance between capture and storage locations is large).
[68] *Id.* at 21.
[69] The CO_2 Capture Project (CCP), at https://perma.cc/T63Z-UFYY. (Listing BP, Chevron, and PETROBRAS as among the energy companies spearheading the collaboration).
[70] Clarion Energy Content Directors, *Groundbreaking Petra Nova CCS project back up and running,* Power Engineering (Sep. 14, 2023) (Underscoring that Petra Nova operated for three years after significant delays caused by technical issues; it closed in May 2020, as its operation became unprofitable during the pandemic; and how Petra Nova's operation restarted in late September 2023).
[71] Institute for Energy Economics and Financial Analysis, *The Carbon Capture Crux: Lessons Learned,* IEFA 29–47 (Bruce Robertson & Milad Mousavian eds., 2022) (Discussing CCS projects that have been suspended due to technical and/ or environmental concerns, including *Gorgon* CCS plant, in Australia, which is still operating albeit with revised targets and after a delay of three-and-a-half years due to technical issues and currently underperforming; *In Salah*, a natural gas plant in Algeria that operated from 2004 until 2011 and was suspended because of concerns relating to the integrity of the seal; and the *Boundary Dam*, the only post-combustion CCS plant in the world, which is still operating in Canada despite also underperforming).
[72] Global CCS Institute, *Global Status of CCS 2022: Ambition Action*, Global CCS Institute 1, 7 (Matt Steyn et al., eds. 2022), at https://perma.cc/3T3Y-7QDJ.
[73] Global CCS Institute, *Global Status of CCS 2023: Scaling up Through 2030*, Global CCS Institute 1, 77–78 (Nov. 9, 2023), at https://perma.cc/3NE6-HXNB. *See also* Yuting Zhang et al., *An Estimate of the Amount of Geological CO2 Storage over the Period of 1996–2020,* 9 Environ. Sci. Technol. Lett. 693, 693 (2022) (Underscoring the existence of information gaps that present challenges for the quantification of the current state of CCS. The authors conclude that there is significant difference between the reported storage data and the more frequently reported storage capacity, which increases challenges regarding evaluations of CCS projects. *Id.* at 697).
[74] Shelby Webb, *Carbon Capture to Spur Surge in CO_2 Shipping,* Energywire (Sep. 12, 2023).
[75] Global CCS Institute, *Global Status of CCS 2023, supra* note 73, at 19. (Listing developments in the Northern Lights project, and increasing number of carriers such as NYK Carbon Carriers, the American Bureau of Shipping (ABS), among others).
[76] Infrastructure and Investment Jobs Act (2021), Pub. L. N. 117-58 (Nov. 15, 2021).
[77] Inflation Reduction Act (2022), Pub. L. N. 117-169 (Aug. 16, 2022) (This includes funding for new programs and previously approved demonstrations of programs under the Energy Act of 2020).

stages of the CCS chain, including shipping of carbon dioxide for storage in the United States, made headlines recently.[78] The U.S., which is among the world leaders in CCS projects,[79] is also perfecting its regulatory policies on CCS, aiming at climate justice and equity. The Council on Environmental Quality, among others, has been involved in developing a comprehensive guidance for carbon capture, utilization, storage, and related justice considerations.[80] Controversy remains in parts of the environmental community, however, about the role of CCS; some call it a "false solution," arguing, among other things, that it provides an excuse to continue using fossil fuels.[81] There are also questions about the technical and economic viability of CCS as noted above.[82]

CCS is also experiencing increasing momentum both internationally and supranationally. In 2021 Canada committed to spending 319 million CAD over seven years on CCUS.[83] In the Indo-Pacific region, ministers from Australia, Brunei Darussalam, Fiji, India, Indonesia, Japan, the Republic of Korea, Malaysia, New Zealand, Philippines, Singapore, Thailand, the United States, and Vietnam have specifically agreed to pursue provisions and initiatives supporting demand and supply for carbon capture, utilization, transport, and storage in the region.[84] Early in 2024, Indonesia authorized oil and gas contractors to use depleted reservoirs or aquifers in their blocks for CCS operations, with thirty percent of the carbon dioxide to be stored coming from overseas.[85] The European Union, under the so-called Trans E-Regulation, is significantly investing in carbon dioxide transportation and storage as part of its energy infrastructure.[86] The European Union and UK are jointly advancing CCS with over 3 billion EUR in funding for research,[87] along with many new facilities being

[78] *See, e.g.,* DOE Announces $27 Million for CO_2 Transport Network, CARBON AND CAPTURE JOURNAL (Sep. 20, 2023).
[79] GLOBAL CCS INSTITUTE, *Global Status of CCS 2022*, *supra* note 72, at 15–16.
[80] Notice by the Council on Environmental Quality, *Carbon Capture, Utilization, and Sequestration Guidance* (Feb. 16, 2022), at https://perma.cc/E8GE-GKSB.
[81] CENTER FOR INTERNATIONAL ENVIRONMENTAL LAW (CIEL), *Over 500 Organizations Call on Policymakers to Reject Carbon Capture and Storage as a False Solution* (Jul. 19, 2021), at https://perma.cc/D7HL-M8K3.
[82] *See, e.g.,* Institute for Energy Economics and Financial Analysis, *supra* note 71, at 29–50. (Surveying global CCS projects and listing technical and environmental challenges which have adversely impacted CCS projects, except for Norway, where a different regulatory framework and effective carbon taxes made the country successful in this field. The study concludes that the ninety percent emission reduction target generally claimed by the industry has been unreachable, in practice).
[83] Government of Canada, *A Recovery Plan for Jobs, Growth and Resilience: Budget 2021*, at https://perma.cc/2JJC-T59H.
[84] Ministerial Statement for Pillar III of the Indo-Pacific Economic Framework for Prosperity, *Indo-Pacific Economic Framework for Prosperity (IPEF): Pillar III- Clean Economy* 2 (Sep. 9, 2022), at https://perma.cc/2MRQ-3USV.
[85] Fransiska Nangoy, *Indonesia issues CCS Rules allowing 30% Carbon Storage from Overseas*, REUTERS (Jan. 30, 2024).
[86] European Union, Regulation (EU) 2022/869 of the European Parliament and of the Council of 30 May 2022 on guidelines for trans-European energy infrastructure, amending Regulations (EC) N. 715/2009, (EU) 2019/942, and (EU) 2019/943 and Directives 2009/73/EC and (EU) 2019/944, and repealing Regulation (EU) N. 347/2013 (May 30, 2022), whereas Art. 4 (2) (f) and 3 (c) establish additional investments for projects of mutual interest of the EU on cross-border transportation and storage of carbon dioxide.
[87] The European Commission, *Topics: Carbon Capture, Storage and Utilisation* (Dec. 1, 2022), at https://perma.cc/3CTZ-DTNG.

constructed,[88] with several NGOs actively supporting CCS.[89] Norway is particularly invested in CCS transportation and storage, with the first drilling in its Northern Lights project being completed in November 2022 and predicting five million tons of annual storage capacity for carbon dioxide.[90]

Late in 2022, Mission Innovation, a collaborative initiative of twenty-two countries and the EU, launched the Green Shipping Corridors Hub, which aims to develop zero-emission shipping corridors.[91] Ultimately, this research is of practical interest, particularly after the pioneer cross-border shipping of carbon dioxide for permanent storage that occurred in March 2023.[92]

At the outset, it is important to recognize that the shipping industry itself is a large contributor to global GHG emissions, and expanding cross-border carbon dioxide transportation may increase shipping emissions. Currently, the shipping industry is responsible for three percent of global GHG emissions and, if it were a country, it would be fifth largest emitter.[93] Even if all the captured carbon dioxide transported by ships were to be successfully stored, there would still be residual emissions from the transport ships themselves. However, the extent of those emissions will depend, in part, on the success of ongoing efforts to decarbonize the shipping industry. Relevant developments include the International Maritime Organization (IMO)'s adoption of a Revised IMO Greenhouse Gas Strategy in 2023 to accelerate efforts to decarbonize shipping.[94] Mobilization in the United States is also growing. In April 2023, President Biden asked leaders to join the country in supporting the IMO's

[88] *See, e.g., E.U. Approves €1.1 Billion Danish CCS Scheme*, Carbon and Capture Journal (Jan. 13, 2023) (Informing the approval of CCS financial support under the EU's state aid program); Zsuzsanna Szabo, *Norway's Horisont Selects Storage Site for Major Carbon Capture Scheme,* Upstream Energy (Jan. 6, 2023); *E.U. Innovation Fund to Invest in Seven CCS and CCU Projects*, Global CCS Institute (Jul. 14, 2022) (Informing that an Iceland onshore CCS project will store over 850 million tons of carbon dioxide); *Discussion on the Long-Term Deployment of CCS Technology in the CEE Region is Underway Again*, Global CCS Institute (Nov. 7, 2022) (There is a roadmap for Central and Eastern Europe–CEE that supports CCS deployment in the region). Global CCS Institute, Facilities: CO_2RE Database, at https://co2re.co/FacilityData (CO_2RE is an extensive database containing projected CCS commercial plans expected for 2025, encompassing several countries such as Italy (2026), Belgium (2030), and the UK, which has numerous projects albeit no longer being part of the European Union).

[89] Open Letter: NGOs Calls for E.U. Carbon and Capture and Storage Policy, Carbon and Capture Journal (Dec. 20, 2022) (The letter, which had signatories from Denmark, Germany, Netherlands, Poland, and Romania, underscored the importance of CCS for the Paris Agreement targets).

[90] CCS Norway, *Carbon Storage Well Drilling Complete* (Nov. 11, 2022) (The Northern Lights initiative is part of the Norwegian Longship CCS project).

[91] Zero-Emission Shipping Mission, *Green Shipping Corridors*, at https://perma.cc/4L3J-D5TE.

[92] Carolina Arlota, *Beyond Trouble Waters? Unprecedented cross-border transportation and injection of carbon dioxide (CO_2) shows promise*, Climate Law Blog (Mar. 23, 2023), at https://perma.cc/2NL2-GXLW. (Discussing the unprecedented cross-border transportation of carbon dioxide from Belgium for permanent storage in Denmark).

[93] Mikael Lind et al., *Decarbonizing the maritime sector: Mobilizing coordinated action in the industry using ecosystems approach,* UNCTAD Transport and Trade Facilitation Newsletter N. 94 (Jun. 8, 2022), at https://perma.cc/D95J-B73V.

[94] International Maritime Organization, *International Maritime Organization—IMO adopts revised strategy to reduce greenhouse gas emissions from international shipping*, (Jul. 7, 2023), at https://perma.cc/EK2R-RM6P. (Member States of the IMO, meeting at the Marine Environment Protection Committee (MEPC 80), adopted the 2023 IMO Strategy on Reduction of GHG Emissions from Ships, targeting a to reach net-zero GHG emissions from international shipping by or around, i.e. close to, 2050, including a commitment to secure "an uptake of alternative zero and near-zero GHG fuels by 2030, as well as indicative check-points for 2030 and 2040.").

adoption of 1.5°C-aligned goals for the shipping sector, including a target of zero emissions from international shipping no later than 2050.[95]

This report, which is the first to comprehensively study international transport of carbon dioxide, makes several original contributions. First, it highlights the current legal uncertainties involving the cross-border shipping of carbon dioxide for sequestration. Second, it illustrates how market-based mechanisms under the Paris Climate Agreement do and do not relate to carbon dioxide shipping and sequestration, and the need for clarification. Third, the report provides a detailed analysis of the domestic U.S. laws applicable to the cross-border shipping and sequestration of carbon dioxide, and analyzes the legal consequences of the construction of a pier (or jetty) to enable the receipt of carbon dioxide shipped from overseas. Finally, liability regimes studied go beyond maritime conventions to include contractual liability and U.S. admiralty and maritime jurisdiction.

Ultimately, the report is grounded in a global perspective, including regional agreements involving developing countries, for instance, departing from the Eurocentric approach that has prevailed in the existing literature so far.

This report proceeds as follows.[96] Chapter 2 provides a technical overview of relevant issues involved in the different stages of carbon dioxide shipping. It also contextualizes CCS in the context of climate agreements. Chapter 3 zooms in the international treaties applicable to the cross-border transportation of carbon dioxide for permanent storage overseas. Chapter 4 pivots to how the international shipping of carbon dioxide from the European Union for permanent storage in the United States may fit under Nationally Determined Contributions (NDCs) and the market-based mechanisms of Article 6 of the Paris Agreement. Chapter 5 reviews the domestic legislation of the United States that may be applicable to the international shipping of carbon dioxide for permanent storage in the United States. Chapter 6 presents the scope of environmental reviews that may apply under the National Environmental Policy Act (NEPA). Chapter 7 concludes this report with an analysis of the liability regimes involved in such shipping.

[95] The White House, Fact Sheet: President Biden to Catalyze Global Climate Action through the Major Economies Forum on Energy and Climate (Apr. 20, 2023), at https://perma.cc/2GEC-W3BY.

[96] Footnotes are continuous throughout this report; citations and related cross-references are organized per chapter.

CHAPTER 2: AN OVERVIEW OF THE TECHNICAL ASPECTS OF CCS, CDR METHODS, AND CCS IN INTERNATIONAL CLIMATE AGREEMENTS

This chapter begins with a technical overview of the considerations involved in the CCS chain, which involves three main aspects: carbon capture, transportation, and geological storage.

Part 1 of this chapter provides a technical overview for each of the three stages of the cross-border carbon capture and sequestration chain: (1) capture from point sources, (2) marine transportation from the country of capture to the place of storage, and (3) underground storage and utilization. It also discusses carbon dioxide removal (CDR) process that may create additional demand for cross-border transport and storage of carbon dioxide. Part 2 of this chapter discusses the role of CCS technology in the context of international climate agreements and examines the main reports by international actors on CCS, including studies by the International Energy Agency and the IPCC.

1. Technical Aspects of the CCS Chain (Capture, Transportation, and Storage) and CDR

1.1 Processes to capture carbon dioxide at point sources and from the atmosphere

Carbon dioxide may be captured at a point source, such as a power plant or industrial facility, before it is emitted or removed from the ambient environment using CDR techniques. This section is subdivided into a discussion of the technical aspects of each respective approach. It closes with a final section on the impurities that result from both forms of capture, which are relevant to downstream transportation and storage.

1.1.1 Capture from point sources

There is no single, ideal point source for carbon capture technology. Rather, carbon capture and storage approaches can apply to many large-scale emissions processes, such as coal and gas-fired power generation, natural gas processing and fertilizer production, and the manufacturing of industrial materials like cement, iron and steel, and pulp and paper.[97] In an economy that still makes extensive use of fossil fuels, the mitigation of emissions through CCS can apply to many different sectors. CCS applications of particular relevance include: (i) upstream removal of carbon dioxide produced by oil and gas extraction; (ii) the generation of electricity from oil, coal, or gas; (iii) fuel and process emissions from large industries; (iv) providing heat to domestic and industrial users; (v) the conversion, and particularly combustion, of modern biomass for heat or feedstock; and (vi) the replacement of hydrocarbon fuel in surface transport of electricity or hydrocarbon in electricity.[98] As a result, the value of CCS is optimized if CCS is applied across the economy.[99]

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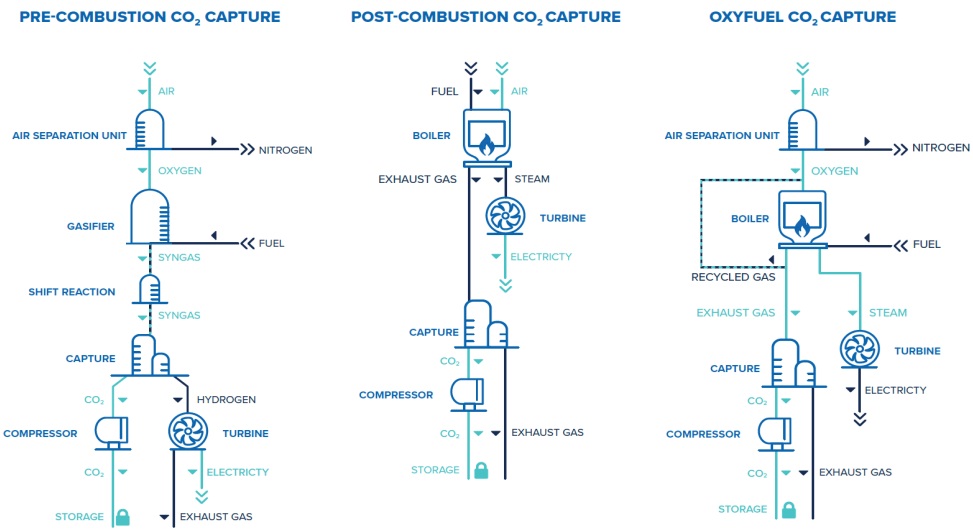
[97] GLOBAL CCS INSTITUTE, *Capturing Carbon Dioxide (CO_2): Fact Sheet,* 1, 1 GLOBAL CCS INSTITUTE (2015), at https://perma.cc/C8NU-CFZ5.

[98] R. Stuart Haszeldine et al., *Negative Emissions Technologies and Carbon Capture and Storage to Achieve the Paris Agreement Commitments,* PHIL. TRANS. R. SOC. A. 376, 281–82 (2018).

[99] *Id.* at 281–82. (Contending that "it has been a historic mistake for developed economies to over-focus on the application of CCS to electricity generation from coal with some attention to gas. This has pitched the final product of decarbonized electricity into a market where subsidized renewable generation can produce electricity at prices comparable to or cheaper than conventional high carbon power. CCS then fails commercially.").

Currently, there are three main processes for capturing the carbon dioxide from point sources: (1) post-combustion capture; (2) pre-combustion capture; and (3) oxy-fuel combustion capture, which is currently still being demonstrated and pending verification.[100] These processes are followed by pressurization of carbon dioxide to reduce its volume, and later drying the carbon dioxide by removing water content to reduce corrosion;[101] and adding the removal of corrosive elements such as nitrogen oxides (NO_x), sulfur oxides (SO_x), hydrogen sulfide (H_2S), and non-dissolved gases such as hydrogen (H_2), oxygen (O_2), argon (Ar), methane (CH_4), nitrogen (N_2), carbon monoxide (CO), where applicable.[102] These capture processes are illustrated by the figure below.

Figure 1: Methods for Capturing Carbon Dioxide[103]



In the pre-combustion capture process, fossil fuels are combined with air or steam to produce both hydrogen, which can be burned for energy, and carbon dioxide, which can be stored. In coal-fired power plants, coal reacts with steam and oxygen at a high temperature and pressure in a process called "partial oxidation" or "gasification."[104] The byproduct is a gaseous fuel consisting mainly of carbon monoxide and hydrogen, which can be burned to generate electricity. Once particulate impurities are removed from the mixture, a two-stage shift

[100] Angela C. Jones & Asley J. Lawson, *Carbon Capture and Sequestration in the United States*, Congressional Research Service R 44902, 4–5 (Oct. 5, 2022), at https://perma.cc/5ENT-TECC.

[101] Karl W. Bandilla, *Carbon Capture and Storage in* Future Energy: Improved, Sustainable and Clean Options for our Planet 669, 669–70 (Trevor M. Letcher ed., 2020) (Underscoring that transportation from the place of capture to the place of storage may be required; and after such capture processes, compressed carbon dioxide may then be injected and stored in appropriate subsurface geological reservoirs).

[102] Personal communication with Panos Deligiannis of Ecolog Ltd. (Jan. 9, 2024) (Noting that compression of captured carbon dioxide is a process required when pipe network connects capturing site to the sequestration one. Where shipping transportation is involved, carbon dioxide needs to be liquified).

[103] Source: Global CCS Institute, *CCS Explained: Capture*, Global CCS Institute (2024), at https://perma.cc/YA8X-8R23.

[104] Karl W. Bandilla, *supra* note 101, at 5.

reactor uses steam to convert the carbon monoxide to carbon dioxide. This results in a mixture of carbon dioxide and hydrogen. A chemical solvent is applied to this new mixture to capture just the carbon dioxide, leaving a stream of nearly pure hydrogen that can be burned in a combined cycle power plant to generate electricity.[105]

Post-combustion capture extracts carbon dioxide from flue gas, which is the mix of gases that enter the exhaust stack after the combustion of fossil fuels or biomass.[106] While several technologies can be used, the most common involves the use of an amine-based chemical solvent that absorbs and captures large quantities of carbon dioxide from flue gases. The flue gas is first "scrubbed" with an amine solution, which typically captures between 85% to 90% of the carbon dioxide. The carbon dioxide-laden solvent is then pumped to a second container, where steam heat is applied to release the carbon dioxide from the solvent. The concentrated is then compressed for pipeline transport to a storage vessel.[107]

The final capture process, called oxy-fuel, resembles the pre-combustion capture process in the sense that the process begins before fossil fuels are burned for use. However, unlike the use of air or steam in the pre-combustion process, oxy-fuel uses pure oxygen for combustion. This results in a flue gas that is predominantly carbon dioxide and water, which easily separate from each other. After separation, the carbon dioxide can be compressed, transported and stored.[108]

Captured carbon dioxide streams from point sources contain different impurities depending on both the specific point source and the carbon capture process used. Carbon dioxide captured from power plants likely contains water, which reacts with carbon dioxide to form the corrosive carbonic acid. In addition, pre-combustion capture yields some combination of nitrogen (N_2), argon (Ar), carbon monoxide (CO), hydrogen sulfide, (H_2S), and methane (CH_4); post-combustion capture yields sulfur dioxide (SO_2) and nitric oxide (NO). Since the oxy-fuel approach uses pure oxygen for combustion, the amount of nitrogen in the flue gas stream is significantly reduced, which decreases the formation of smog-forming pollutants such as nitrogen oxides[109] and improves the purity of the carbon dioxide stream. The impact of all these impurities is further discussed in section 1.1.3.

[105] *Id.*
[106] *Id.* at 4.
[107] *Id.* It is noteworthy that water is resulted mainly by the pre-&post-combustion concentrated carbon dioxide. Also, post-combustion concentrated carbon dioxide may result in CH_4, CO, H_2, H_2S, CoS, NH_3, MeOH, EtOH, Hg and pre-combustion concentrated carbon dioxide may result in O_2, SO_x, NO_x, amines, formaldehyde, acetaldehyde, C_2+, Hg and oxy-fuel may result in N_2, Ar, O_2, SO_x, NO_x. (Personal communication with Panos Deligiannis of Ecolog Ltd. (Jan. 9, 2024)).
[108] Karl W. Bandilla, *supra* note 101, at 6.
[109] *Id.*

1.1.2. Carbon dioxide removal (CDR) processes

In addition to the processes of capturing carbon dioxide from point sources, carbon dioxide streams can also originate from carbon dioxide removal (CDR) processes, which scrub carbon dioxide from the atmosphere.[110] One commonly discussed CDR approaches is direct air capture (DAC).[111] Direct air capture is defined as "chemical processes that capture carbon dioxide from ambient air and concentrate it, so it can be injected into a storage reservoir."[112] Previous literature has highlighted the potential for DAC to increase demand for carbon dioxide storage as, in order to deliver real climate benefits, carbon dioxide removed from the atmosphere through DAC must be stored in secure geologic formations or long-lived products.[113] In this report, we focus on DAC approaches involving geologic carbon dioxide storage.

DAC-related costs are rapidly declining.[114] Therefore, economic and practical interest in DAC and related storage capacity is increasing. The key benefits of DAC include high storage permanence when associated with geological storage, as well as limited land footprint.[115] Additionally, carbon streams produced from DAC typically yield higher purity levels than streams captured from point sources.[116] The purity of the carbon dioxide stream is consequential in several aspects of the carbon capture, transportation, and storage process, as discussed in the section below.

1.1.3. Impact of impurities in captured carbon dioxide streams

While studies have considered the effect of different impurities on carbon dioxide streams, acceptable levels for both pipelines and storage reservoirs remain under developed[117] Due to a shortage of empirical research on the effect of impurities such as oxygen (O_2), sulfur dioxide (SO_2), argon (Ar), carbon monoxide (CO), and hydrogen

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[110] Mahdi Fasihi et al., *Techno-Economic Assessment of CO_2 Direct Air Capture Plants*, 224 Journal of Cleaner Production 957, 957 (2019).

[111] Factors often considered but still debatable include cost-effectiveness, the current state of the technology, and the volume of carbon dioxide removed, according to current techniques. *See, e.g.,* The National Academy of Sciences, Engineering, and Medicine, *Negative Emissions Technologies and Reliable Sequestration: A Research Agenda,* NAS 3–4 (2019), at https://perma.cc/9T7E-KFJ9. (Information regarding estimated costs and current state of technology is summarized at 5–7 and detailed at 354–59).

[112] *Id.* at 5.

[113] *See, e.g.,* Romany M. Webb & Michael B. Gerrard, *The Legal Framework for Offshore Carbon Capture and Storage in Canada*, Sabin Center for Climate Change Law 18–22 (2021).

[114] David Webb, *Achieving Net Zero: Why Costs of Direct Air Capture Need to Drop for Large-Scale Adoption,* World Economic Forum (Aug. 9, 2023), at https://perma.cc/FJP5-U8CZ. (Underscoring the need for DAC costs to decrease). *See also* Tracy Hester, *Negative Emissions Technologies and Direct Air Capture*, *in* Legal Pathways to Deep Carbonization in the United States 754 (Michael B. Gerrard & John C. Dernbach eds., 2019).

[115] International Energy Agency, *Direct Air Capture*, IEA (2022), at https://perma.cc/Y66P-LTX5. (Noting that there are currently eighteen direct air capture plants operating in Canada, Europe, and the United States, but more growth is expected).

[116] Purity levels among DAC technologies may vary considerably. *See* M. Fasihi et al., *supra* note 110, at 966 (Underscoring that, in general, DAC processes produce a high purity stream of carbon dioxide).

[117] Di Zhou et al., *Engineering Requirements for Offshore CO_2 Transportation and Storage: A Summary Based on International Experiences*, UK-China CCUS Centre 12 (Mar. 14, 2014) (Recommending project-specific carbon dioxide stream experiments on the effect of impurities).

(H_2) – all highly relevant to carbon dioxide capture and transport – operators tend to impose conservative limitations on the amount of impurities deemed acceptable for downstream transport. Experts suggest that the tolerance of impurities may vary depending on the expected transport, storage conditions and the destination of the stream.[118]

Despite the lack of established standards, it is clear that in the shipping process, impurities in the carbon dioxide stream affect its solubility in water, density, and pressure-temperature phase equilibria. Each of these shifts could impact the safety and feasibility of transport. While we do not yet know what the impacts of water solubility are on safety, it is too soon to rule out any effect on transportation considerations. We do know that small shifts in density may affect the stability of the sea vessel *en route*.[119] Minimal amounts of hydrogen sulfide (H_2S) or sulfur dioxide (SO_2) also significantly raise transportation risks due to their toxicity,[120] and the presence of oxygen (O_2) also increases corrosion hazards.[121] Finally, the presence of nitrogen (N_2) or hydrogen (H_2) of at least 0.5 mol% may increase vapor pressure significantly.[122] This would likely make transportation unfeasible due to the way N_2 adversely impacts pressure-temperature equilibrium and increases the risk of operational issues, including vessel stability and overall safety.

Despite some stakeholders advocating for a carbon dioxide purity standard of greater than 90% based on technical assessments, many contend that, due to the level of uncertainty on the precise composition of a carbon dioxide stream, it is best to design projects that account for any impurities from the onset.[123] More recently, an international standard that considered the complexities of establishing specific composition requirements for captured carbon dioxide concluded that the operator should set transportation and storage standards on a case-by-case basis.[124] Rather than set a specific standard, the International Organization for Standardization (ISO) focused on ranges of compositions that have been observed in practice so far when issuing its standards.[125]

The ultimate composition of captured carbon dioxide – including any impurities in the stream – may trigger the application of different legal regimes, as detailed in Chapter 3 of this report. While carbon dioxide can be

[118] *Id.*

[119] *Id.* Besides safety, pollution is a major risk in case of loss of containment. Some experts contend that "small changes in density owed to smaller density volatile compounds is not expected to have detrimental effect on ship stability as partial loading is part of the operational envelop, limited only by the effect of sloshing." (Personal communication with Panos Deligiannis of Ecolog Ltd. (Jan. 9, 2024)).

[120] Hisham Al Baroudi et al., *A Review of Large-Scale CO_2 Shipping and Marine Emissions Management for Carbon, Capture, Utilisation and Storage*, 287 Applied Energy 1, 13 (2021).

[121] *Id.* at 13.

[122] *Id.* Experts highlight that these thresholds hold for certain design pressure regimes, *i.e,* lower pressure 8-9barg. Personal communication with Panos Deligiannis of Ecolog Ltd. (Jan. 9, 2024).

[123] World Resources Institute, Guidelines for Carbon Dioxide Capture, Transport, and Storage 32 (Sarah M. Forbes et al., eds. 2008) (The literature often include citizens, regulators, policy makers, industry representatives, among other interested groups as stakeholders).

[124] International Organisation for Standardization, *ISO 27921 on Carbon Dioxide Capture, Transportation, and Geological Storage, Standards for Geological Storage: Cross Cutting Issues — CO_2 Stream Composition* (2020), at https://perma.cc/ABK7-ZQT8.

[125] *Id.* Chapter 3 of this report discusses impurities in the context of international law.

purchased as a commodity for use in several industrial processes, in the climate change space it is most often classified as greenhouse gas (GHG), an emission, or – in some countries – a waste.[126]

There are concerns that the classification of carbon dioxide under various U.S. regulatory programs – whether they concern air, waste, or drinking water protection – may lead to unintended requirements for carbon dioxide transport and storage that would impose additional costs without necessarily improving project performance or safety.[127] Prior to transportation, facility operators will likely be required by both contractual obligations and regulations to dry the carbon dioxide , remove its co-constituents, and compress it before it leaves the facility for storage or use.[128] However, it is currently unclear to what extent impurities may play a role in triggering specific regulations. The European Union Directive on CCS, for instance, does not detail the composition of carbon dioxide streams or establish limits for its impurities. However, the Directive does state that the gas should not adversely affect the integrity of the transportation structure or the storage facility, and shall not pose risks to the environment or human health.[129] The pipelines, the storage tanks on ships and trucks, the geological storage facility, among others, all face limits on the amount of impurities they can tolerate without corroding or degrading over time, for instance.[130]

1.2. Carbon dioxide transportation

The carbon dioxide transport infrastructure moves carbon dioxide from its point of capture to either a point of use or point of storage and occurs by either pipelines or ships.[131] The focus of this report is on the cross-border transportation of carbon dioxide by ships to storage locations for CCS; technical aspects surrounding the design of the carbon dioxide carrier or the onshore loading systems are outside the scope of the current study.[132]

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[126] World Resources Institute, Guidelines for Carbon Dioxide Capture, Transport, and Storage, *supra* note 113, at 42.

[127] *Id.* (Noting that Oklahoma, for instance, has followed this recommendation).

[128] *Id.* at 32.

[129] Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the Geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) N. 1013/2006. Directive 2009/31/EC, Art. 12, 1, reads as follows: "A CO_2 stream shall consist overwhelmingly of carbon dioxide. To this end, no waste or other matter may be added for the purpose of disposing of that waste or other matter. However, a CO_2 stream may contain incidental associated substances from the source, capture or injection process and trace substances added to assist in monitoring and verifying CO_2 migration. Concentrations of all incidental and added substances shall be below levels that would: (a) adversely affect the integrity of the storage site or the relevant transport infrastructure; (b) pose a significant risk to the environment or human health; or (c) breach the requirements of applicable Community legislation."

[130] Romario de Carvalho Nunes et al., *Climate change mitigation and the technological specificities of carbon capture and storage, in* Carbon Capture and Storage in International Energy Policy and Law 43, 47 (Hirdan Katarina de M. Costa & Carolina Arlota eds., 2021) (Also discussing the consequences of impurities for final utilization techniques)

[131] International Energy Agency, *CO_2 Transport and Storage: Tracking Report,* IEA (Rachael Moore & Carl Greenfield eds., Sep. 2022) (Highlighting that pipelines and ships are the most scalable options with the lowest cost per ton of CO_2).

[132] This report considers the 1974 International Convention for the Safety Life at Sea (SOLAS), which sets minimum standards for the construction, equipment and operation of ships transporting dangerous goods in chapter 7.

The viability of pipeline transportation depends on the distance, the volume transported, and whether the carbon dioxide comes from a single source.[133] When the distance between the place of carbon dioxide capture and the storage location is significant – and a body of water exists between the two – transportation by ship is deemed more economically attractive than pipelines.[134] Using marine vessels has recently been considered feasible in the United States for transporting carbon dioxide over large distances or overseas. However, because no large-scale carbon dioxide transport system via vessel is currently in operation, marine tanker costs for carbon dioxide shipping are uncertain.[135]

In some circumstances, transport by ship provides several advantages over pipeline transport. First, shipping allows for the flexibility to combine carbon dioxide from several sources at different flow rates to one or more storage locations.[136] Shipping also allows for potential variations in transportation routes, the ability to reutilize the ships in their return journey, as well as short set-up times.[137] Shipping offers quick deployment and additional resilience with regard to transportation and storage site, which cannot be offered by the pipeline network and often requires less permitting/approval/certification; it also allows modularity allowing phasing-in, and it is less affected by social perception, in general.[138] Marine transport is particularly attractive for countries with limited storage capabilities because it provides a pragmatic solution to exporting carbon dioxide without the high upfront investments required by long-distance pipelines.[139] However, weather conditions may constrain operational windows and adversely impact the amount of carbon dioxide that can be delivered by sea tankers.[140] In practice, however, experts contend that weather is rarely a cause of delays.[141]

Although merchant carbon dioxide shipping has occurred on a small scale (around 2,000 tons or less), large-scale shipping of carbon dioxide has not yet occurred.[142] The current DemoUp Carma research project in Switzerland

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[133] IEAGHG, *The Status and Challenges of CO_2 Shipping Infrastructures*, IEAGHG Technical Report (Jul. 10, 2020), at https://perma.cc/URY6-48Y3.

[134] IPCC, IPCC Special Report on Carbon Dioxide Capture and Storage Prepared by Working Group III of the Intergovernmental Panel on Climate Change 3 (Bert Metz et al. eds., 2005).

[135] Angela C. Jones & Asley J. Lawson, *supra* note 135, at 8. It is noteworthy that some experts contend that the risk of the entire CCS value chain is uncertain, regardless of shipping being involved or not. (Personal communication with Panos Deligiannis of Ecolog Ltd. (Jan. 9, 2024)).

[136] Filip Neele et al., *CO_2 Transport by Ship: The Way Forward in Europe*, 114 Energy Procedia 6824, 6825 (2017). *See also* David Goldberg et al., *Integrated Pre-Feasibility Study for CO_2 Sequestration in the Cascadia Basin Offshore of Washington State and British Columbia* (Phase 1; Final Project Report), DOE (Dec. 2018), at https://perma.cc/4D5E-G3WX. (For a study considering U.S. and Canadian transportation by ship and pipelines).

[137] Hisham Al Baroudi et al., *supra* note 120, at 5. Technically, if the ship is built to have different cargoes for each way of the voyage, this is feasible; nonetheless, it is most likely commercially unrealistic due to the time spent cleaning between cargoes and the restrictive voyage you would need to be on (to return to your load port for carbon dioxide). Personal communication with Jasper Heikens of Ecolog Ltd. (Jan. 9, 2024).

[138] Personal communication with Panos Deligiannis of Ecolog Ltd. (Jan. 9, 2024).

[139] Filip Neele et al., *Ship Transport of CO_2 – Breaking the CO_2 - EOR Deadlock*, 63 Energy Procedia 2638, 2640–42 (2014) (The EOR referred in the title stands for enhanced oil recovery).

[140] IEAGHG, *The Status and Challenges of CO_2 Shipping Infrastructures, supra* note 174.

[141] Personal communication with Jasper Heikens of Ecolog Ltd. (Jan. 9, 2024).

[142] International Energy Agency, *CO_2 Transport and Storage: Tracking Report, supra* note 131.

has delivered small amounts of carbon dioxide from Europe to Iceland for storage, addressing several cross-border shipping issues in its early phases.[143] Two carbon dioxide ships are under construction as part of the Northern Lights project offshore of Norway, and more are being developed by other projects.[144] Finally, cross-border transportation and storage of carbon dioxide from Belgium to Denmark occurred in a trial phase of Project Greensand.[145] Despite its early stages, this project has already contributed to advancements in the field, primarily by providing a technical and economic proof of concept.

Experts have long debated the cost-effectiveness of cross-border shipping of carbon dioxide for storage,[146] often recommending a project-by-project assessment based on case-specific studies and scale.[147] These assessments typically consider distance and weather conditions during the journey, the capture technique, the storage location, the size of the ship, the design of tanks, the optimal volume and pressure-temperature conditioning of the carbon dioxide, and the presence of impurities.[148] More recently, some experts have contended that cross-border transportation costs depends solely on the ratio between distance and volume, as impurities and design pressure/temperature ultimately have minor effect on cost as compared to large volumes of carbon dioxide which need to be stored.[149] Given these ongoing controversies, there is no "one size fits all" approach for the cross-border shipping of carbon dioxide for permanent storage.[150] Experts in the industry expect the market to evolve and see standard concepts emerge in the same way we see that in most other commodities are transported internationally.[151]

To better understand the role of each of these considerations, it is useful to know how carbon dioxide is physically moved from its original point of capture onto a ship for transport. Below, we outline the typical process for the limited occurrences of carbon dioxide shipments that currently dominate the market. While the conditions differ from the large-scale carbon dioxide shipments, it offers an instructive example of what the existing industry process looks like.

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[143] DemoUp Carma & Storage, at http://www.demoupcarma.ethz.ch/en/home/. *See also* Carolina Arlota, *Beyond Troubled Waters? Unprecedented cross-border transportation and injection of carbon dioxide (CO_2) shows promise*, Climate Law Blog (Mar. 23, 2023), at https://perma.cc/2NL2-GXLW. (For a legal analysis of experimental demonstration of carbon dioxide transported from Belgium for permanent storage in Denmark).

[144] International Energy Agency, *CO_2 Transport and Storage: Tracking Report, supra* note 131.

[145] Kira Taylor, *Denmark inaugurates world's first cross-border CO_2 storage site*, Euractiv (Mar. 8, 2023).

[146] Erin Smith et al., *The cost of CO_2 transport and storage in global integrated assessment modeling*, 109 International Journal of Greenhouse Gas Control, 103367 (2021).

[147] Di Zhou et al., *supra* note 117, at 10.

[148] Hisham Al Baroudi et al., *supra* note 120, at 14.

[149] Personal communication with Panos Deligiannis of Ecolog Ltd. (Jan. 9, 2024).

[150] Di Zhou et al., *supra* note 117, at 10. This report considers as the minimum denominator the 1974 International Convention for the Safety Life at Sea (SOLAS), which sets minimum standards for the construction, equipment and operation of ships transporting dangerous goods, in its liability section.

[151] Personal communication with Jasper Heikens of Ecolog Ltd. (Jan. 9, 2024).

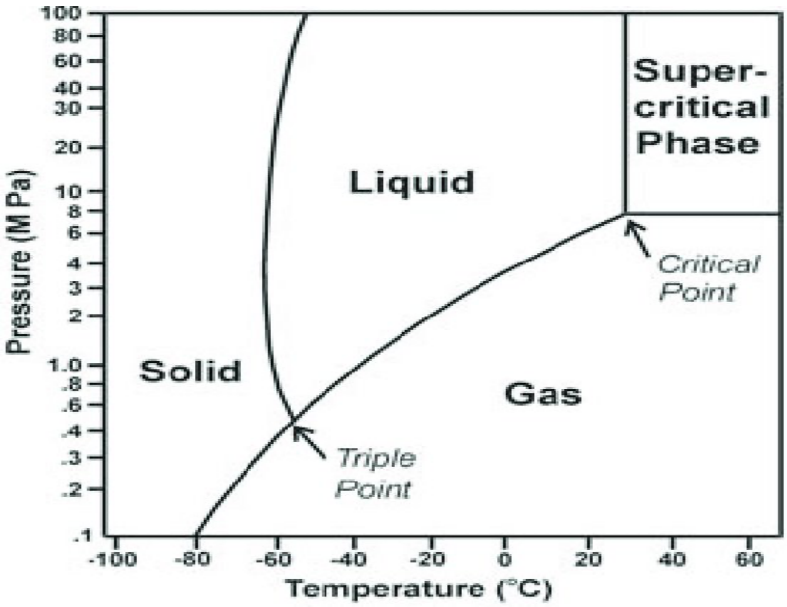
First, the carbon dioxide is usually brought into a liquid state through several cooling and compression steps in a process known as "liquefaction."[152] Liquefied carbon dioxide is then often placed into intermediate storage tanks to bridge the gap between the continuous flow of captured carbon dioxide and discretized transportation by ship.[153] Moving carbon dioxide from those intermediate storage tanks onto ships requires specialized loading and unloading equipment. These often include conventional articulated loading arms (or "flexible cryogenic hoses") and auxiliary equipment, including cryogenic pumps, pipelines to transfer carbon dioxide from storage to the loading arm itself, and a return line for boil-off gas,[154] which may be required to offset any pressure anomalies in the gas as it is moved onto the ship.[155]

While it is preferable to load carbon dioxide onto a ship that was specifically built to transport it, the literature also includes the use of converted LNG ships for carbon dioxide transport; however, these converted ships can pose unique challenges, including those related to safety and optimal conditioning of the cargo, if the ship was not originally designed to transport carbon dioxide.[156] Finally, once the carbon dioxide arrives at its destination for unloading, the carbon dioxide must be brought from its liquid state to a condition for further transportation or injection after shipping. This is commonly achieved by heating and pumping.[157]

The shipment processes outlined above applies primarily to small-scale carbon dioxide transport. However, large-scale transport of carbon dioxide may differ from these small-scale shipments. Perhaps most importantly, carbon dioxide to be transported by ships will be in its liquified state, as supercritical pressure cannot be accommodated;[158] while carbon dioxide destined for storage is typically first conditioned into a supercritical state rather than a liquefied one.[159] This supercritical carbon dioxide has a density that resembles a liquid but expands to fill space like a gas.[160] When transported by pipeline, carbon dioxide is also often in this supercritical state.[161]

[152] Katherine Orchard et al., *The Status and Challenges of CO_2 Shipping Infrastructures*, 15th International Conference on Greenhouse Gas Control Technologies, GHGT-15 (Mar. 15, 2021).
[153] *Id.*
[154] T. Włodek, *Analysis of Boil-off rate problem in Liquified Natural Gas (LNG) receiving terminal*, IOP Conf. Ser.: 214 Earth Environ. Sci. 12105,12105 (2019) (Boil-off gas is a by-product of natural evaporation and must be removed due to potential pressure instabilities).
[155] Katherine Orchard et al., *supra* note 152.
[156] *Id.* Many in the industry argue that, realistically, the cross-border shipping of CO_2 requires dedicated ships; and conversions, if any, are not expected. Personal communication with Jasper Heikens of Ecolog Ltd. (Jan. 9, 2024).
[157] Katherine Orchard et al., *supra* note 152.
[158] Personal communication with Panos Deligiannis of Ecolog Ltd. (Jan. 9, 2024).
[159] World Resources Institute, Guidelines for Carbon Dioxide Capture, Transport, and Storage, *supra* note 113, at 42.
[160] *Id.*
[161] Drax Global, *How and Why is Carbon dioxide transported?* (Apr. 11, 2022), at https://perma.cc/4CWK-C94G.

Figure 2: Carbon Dioxide phase diagram[162]



Large-scale carbon dioxide shipments also face additional conditioning requirements before the carbon dioxide can be injected into a reservoir.[163] There are also different types of ship-import terminal interfacing for which types of discharging the heating and compression remains the same whether it takes place onboard the ship, a platform or onshore before injection.[164] The offloading carbon dioxide from the ship into a temporary storage container closer to the injection platform, where conditioning occurs off the ship.[165] In this process, the temporary storage is defined as "a floating storage and processing vessel suitable for receiving and storing refrigerated liquid carbon dioxide, conditioning it for injection and either injecting it directly from the vessel, or transferring it to a fixed platform for injection."[166] Here, carbon dioxide terminals would be required to load and unload carbon dioxide and to ensure that it is properly conditioned for further transport and injection.[167]

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[162] Figure from Danae Voormeij & George J. Simandl, *Geological and Mineral CO_2 Sequestration Options: A Technical Review*, BRITISH COLUMBIA GEOLOGICAL SURVEY 265, 266 (2003) (Explaining that as temperature and pressure varies, carbon dioxide can be found in three different phases: carbon dioxide is in a supercritical (dense) phase, at temperatures above 31.1°C and pressures above 7.38MPa (critical point); below these temperature and pressure conditions, carbon dioxide will be either a gas or a liquid. *See also* United States Department of Energy (DOE), *Supercritical CO_2 Tech Team*, at https://perma.cc/DBT2-X644. (For additional discussions on supercritical carbon dioxide).

[163] Filip Neele et al., *supra* note 136, at 6826.

[164] Personal communication with Panos Deligiannis of Ecolog Ltd. (Jan. 9, 2024).

[165] Filip Neele et al., *supra* note 136, at 6827. Importantly, large scale transport of carbon dioxide by ship is not restricted to carbon dioxide going directly to a floating unit / directly above a reservoir offshore. Experts also consider the direct injection at sea as just another method with its advantages and disadvantages. Therefore, those experts consider large scale also possible via discharge at an onshore terminal first. (Personal communication with Jasper Heikens of Ecolog Ltd. (Jan. 9, 2024)).

[166] Filip Neele et al., *supra* note 136, at 6826–27.

[167] INTERNATIONAL ENERGY AGENCY, *CO_2 Transport and Storage: Tracking Report, supra* note 131. (Noting that ship-to-platform and ship-to-well delivery are being explored and may be deployed in the future, eventually reducing the need for unloading terminals).

In short, it is clear that across the transportation process, the phase, temperature and pressure conditions of the carbon dioxide play a vital role in moving the gas from one stage to the next. Regardless of the exact temperature and pressure requirements, carbon dioxide transported by ship is likely to be carried at refrigerated and pressurized conditions throughout its journey.

Considering the many complexities involved in the marine transportation pathway, much still has to be done to develop a large-scale carbon dioxide shipping system. As noted in previous sections, the lack of operational data for carbon dioxide shipping effectively imposes conservative limitations on its cross-border transportation and storage.[168] These limitations have not yet incentivized actors to seriously pursue cross-border transportation and storage ventures.[169] As a result, the current carbon dioxide transportation infrastructure is insufficient and not aligned with climate needs, according to a study by the International Energy Agency.[170]

To understand what large-scale carbon dioxide transportation could look like in practice, it is helpful to examine the practices from the main shipper of carbon dioxide: the food and beverage industry. Food and beverage carriers usually transport carbon dioxide at medium pressure and temperature (13 to 18 bar and -30°C to -28°C) because users have no need to move high volumes and do not require large cargos.[171] Food-grade carbon dioxide is also 99.9% pure,[172] reducing the safety and operational risks that many impure captured carbon streams face.[173]

Carbon dioxide shipping is expected to be most cost-effective under either low pressure, low temperature conditions ("Low P"; -55 to -40°C, 5-10 barg) or medium temperature, medium pressure conditions ("Medium P"; -30 to -20°C, 15-20 barg) conditions.[174] The Medium P condition is currently used for small-scale carbon dioxide transportation and has been adopted as the standard transport pressure for early CCS projects. The Low P condition, however, is considered the most cost-effective and the only feasible option for ships carrying more than 10,0t carbon dioxide.[175] While reducing costs by conditioning the carbon dioxide to a lower pressure and temperature may be appealing, prospective carbon dioxide shippers must also consider how both the transportation route and the total volume of carbon dioxide being transported will affect the choice of vessel.

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[168] Hisham Al Baroudi et al., *supra* note 120, at 14.

[169] Carolina Arlota, *Beyond Troubled Waters: Unprecedented cross-border transportation and injection of carbon dioxide (CO_2) for offshore storage shows promise*, Climate Law: A Sabin Center Blog (Mar. 23, 2023), at https://perma.cc/2NL2-GXLW.

[170] International Energy Agency, *CO_2 Transport and Storage: Tracking Report,* IEA (Carl Greenfield et al. eds., 2023), at https://perma.cc/ZFE2-26JB.

[171] *Id.*

[172] Hisham Al Baroudi et al., *Techno-economic analyses of CO_2 Liquefaction: Impact of Product Pressure and Impurities*, 103 Int. J. of Refrigeration 301, 309 (2019).

[173] *Id.* (Underscoring that high purity carbon dioxide is at 99%; and the higher the purity, the higher the costs).

[174] IEAGHG, *The Status and Challenges of CO_2 Shipping Infrastructures*, IEA 5 (James Craig ed., 2020) (Noting that medium-pressure ships can be designed in the 15-20k ton range but become much more expensive than their low-pressure equivalents) (Personal communication with Jasper Heikens of Ecolog Ltd. (Jan. 9, 2024)).

[175] IEAGHG, *The Status and Challenges of CO_2 Shipping Infrastructures*, *supra* note 174.

Another potential venue for accelerated learning comes from looking at other industrial practices that involve liquified compression of gasses in transport. Currently, the transportation of large volumes of carbon dioxide by ship compresses carbon dioxide by liquifying it to 7 bar (-50°C); in order to be cost-effective, carbon dioxide should be in a dense, non-gaseous form for ship transportation.[176] As a result, recent shipping projects use liquified carbon dioxide tank systems.[177] This compression process is quite similar to the one used for transporting liquefied petroleum gas (LPG) or liquefied natural gas (LNG) by ship.[178]

As occurs with both LNG and LPG, the pressure in the tank increases during transport because of the heat transfer from the environment through the wall of the cargo tank. This may require the discharge of some carbon dioxide from the tank while in transit and re-enters the atmosphere.[179] Scholars have highlighted that although "it is not dangerous to discharge carbon dioxide boil-off gas together with the exhaust from the ship's engines, it is of course not in line with the objectives of CCS."[180] Ultimately, LPG tankers are likely closer analogs for carbon dioxide ship transportation than LNG tankers, because both liquefied carbon dioxide and LPG must be transported at higher pressures; LNG is transported at a lower pressure.[181]

Although there is significant potential for spillover learning from the food and beverage industry as well as the LNG and LPG trade, further research and development is still needed to support the development of low-pressure carbon dioxide ships and their deployment.[182] In 2011, the International Organization for Standardization created a technical working group dedicated to the transport of carbon dioxide by ship to better understand the technical requirements for a future carbon dioxide shipping standard.[183] Since 2011, this working group has issued twelve guidance documents on different topics, including enhanced oil recovery (discussed in section 1.1.3), the cement industry, vocabulary development, and cross-cutting issues on purity standards for pipelines and injection. However, standards for ships remain under development.[184]

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[176] *Id.* at 7. (This cost-effectiveness applies to carbon dioxide being non-gaseous for pipelines as well).

[177] *Nedo demonstration test ship for liquified CO_2 Transportation has been launched*, Carbon and Capture Journal (Apr. 2, 2023) (Highlighting the Japanese experience in a demonstration project that collects data on the state of carbon dioxide, *i.e.*, phase changes and overall safety for transportation studies on the topic).

[178] Martha M. Roggenkamp, *Transportation of CO_2 in the EU in* Carbon Capture and Storage: Emerging Legal and Regulatory Issues 257 (Ian Havercroft et al. eds., 2019).

[179] Experts in the industry contest this understanding. They claim that carbon dioxide will not leak from the system, as they would not build such a system. Therefore, only in case of emergency will there be "venting." If the pressure builds in the carbon dioxide tank and it exceeds the limits, the industry will ensure to have onboard some form of liquefaction / subcooling to ensure the boil off gas can go back into the tank as a liquid. (Personal communication with Jasper Heikens of Ecolog Ltd. (Jan. 9, 2024)).

[180] Martha M. Roggenkamp, *supra* note 178, at 257. (Highlighting that zero carbon dioxide emissions can be achieved with the use of refrigeration unit to capture and liquify boil-off and exhaust carbon dioxide. This, however, will raise constructional costs).

[181] Erin Smith et al., *The Cost of CO_2 Transport and Storage in Global Integrated Assessment Modelling,* 109 Int. J. of Greenhouse Gas Control 1, 2 (2021). LNG is effectively transported at ambient pressure. (*See also* personal communication with Jasper Heikens of Ecolog Ltd. (Jan. 9, 2024)).

[182] International Energy Agency, *CO_2 Transport and Storage: Tracking Report*, *supra* note 131.

[183] International Organisation for Standardization, *Technical Committees: ISO/TC 265 Committee on Carbon Dioxide Capture, Transportation, and Geological Storage*, at https://perma.cc/KZ54-MFNY.

[184] *Id.*

1.3. Overall considerations about carbon dioxide utilization and storage

Storage reservoirs typically require porous rock formations like sandstone, sealed with an impermeable cap rock, such as shale. Non-potable saline aquifers and depleted or current oil and gas fields are common reservoir types.[185] Storage in porous basalt formations enables carbon dioxide to mineralize into solid carbonates over time and significantly reduces the risk of leakage, making it a promising option.[186]

Carbon dioxide is less viscous than oil and gas, finding surprising pathways through rock.[187] Once injected in a reservoir, compressed carbon dioxide will move buoyantly toward the surface and can migrate over a hundred kilometers laterally, should geologic conditions allow.[188] To ensure that the gas remains safely stored, injected carbon dioxide plumes are monitored both at the surface and underground using a variety of geophysical and geochemical techniques.[189] Seismic survey data, in-well pressure sensors, and geochemical tracers are helpful tools for identifying plume movements in the subsurface and the interconnectivity between storage reservoirs. Permitting for carbon dioxide storage sites requires pre- and post-injection monitoring to be provided to regulators.[190]

Enhanced oil recovery (EOR) offers an alternative approach for subsurface carbon dioxide utilization and storage (CCUS)[191] and is the only industrial use of carbon dioxide to have achieved significant scale. EOR projects use about seventy three percent of the carbon dioxide captured globally every year.[192] As its acronym conveys, EOR enhances the oil production rate from fields that are no longer producing their maximum output rate.[193] In practice, oil and gas companies inject pressurized carbon dioxide into these fields with the goal of squeezing out more hydrocarbons.[194] Therefore, even though some of the injected carbon dioxide remains stored in the reservoir, EOR uses carbon dioxide to produce additional oil and gas, ultimately increasing GHG emissions instead of reducing them.[195] A detailed analysis of alternative uses of carbon dioxide or of the regulatory framework for CCU is beyond the scope of the present research.

The International Organization for Standardization's technical working group on carbon dioxide transport and storage has already issued two guidance documents establishing requirements and recommendations for the

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[185] Arshad Raza et al., *Carbon Mineralization and Geological Storage of CO_2 in Basalt: Mechanisms and Technical Challenges,* 229 Earth-Science Reviews (2022).
[186] *Id.*
[187] Iain Essau, *Carbon Capture Success Depends on Containing "Runny" Carbon Dioxide*, Energy Transition (Jan. 19, 2023).
[188] *Id.*
[189] Karl W. Bandilla, *supra* note 101, at 669–70.
[190] *Id.*
[191] Institute for Energy Economics and Financial Analysis, *The Carbon Capture Crux: Lessons Learned,* IEFA 7 (Bruce Robertson & Milad Mousavian eds., 2022) (Clarifying that when carbon dioxide is captured and stored underground in saline aquifers or other underground deposits and is not used for EOR, the process is denominated as CCS).
[192] *Id*. at 72.
[193] *Id.*
[194] *Id.*
[195] *Id.* at 7.

geological storage of carbon dioxide (ISO 27914) and its use in enhanced oil recovery (ISO 27916).[196] Designed to complement each other, ISO 27914 aims to promote the commercial, safe, long-term containment of carbon dioxide, whereas ISO 27916 aims to estimate and record the amount of carbon dioxide stored during enhanced oil recovery.[197]

Ultimately, storage is the final and most permanent stage of the CCS chain, and one that has been subject to significant controversies about monitoring and potential leakage.[198] However, a detailed analysis of these issues is beyond the scope of this report.

2. The International Context on CCS Technology

International law clearly establishes the pressing need for the effective mitigation of GHG emissions. The preamble of the Paris Agreement on Climate Change,[199] an umbrella accord to the United Nations Convention on Climate Change (UNFCCC),[200] considers climate change to be a common concern of humankind while emphasizing the importance of carbon sinks and climate justice. The main goal of the Paris Agreement[201] is to keep the rise in global average temperature "well below" 2°C (3.6°F) above preindustrial levels, while advancing efforts to cap the temperature increase to 1.5°C (2.7°F) above preindustrial levels.[202] All parties must reduce their GHG emissions to achieve this established goal. The parties vowed to reach global peaking of GHG emissions as soon as possible and to continue to rapidly reduce emissions thereafter "so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century."[203]

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[196] International Organisation for Standardization, *ISO 27914 on Carbon Dioxide Capture, Transportation, and Geological Storage, Standards for Geological Storage* (2017), at https://perma.cc/9QPT-WELZ; and International Organisation for Standardization, *ISO 27916 on Carbon Dioxide Capture, Transportation, and Geological Storage, Carbon Capture and Storage Using Enhanced Oil Recovery* (2019), at https://perma.cc/Z53U-NZ4Y.

[197] International Energy Agency, Legal and Regulatory Frameworks for CCUS: An IEA CCUS Handbook, 22 IEA (Jul. 2022).

[198] *See, e.g.,* Karl W. Bandilla, *supra* note 101, at 669–80; Johannes M. Miocic et al., *420,000 Year Assessment of Faulty Leakage Rates Shows Geological Carbon Storage is Secure*, 9 Scientific Reports 769, 769 (2019).

[199] The United Nations Paris Agreement, Dec. 12, 2015, 54113 U.N.R.N. 88, [hereinafter Paris Agreement], paragraphs 11–13 of its preamble: "*Acknowledging* that climate change is a common concern of humankind, Parties should, when taking action to address climate change, respect, promote and consider their respective obligations on human rights, the right to health, the rights of indigenous peoples, local communities, migrants, children, persons with disabilities and people in vulnerable situations and the right to development, as well as gender equality, empowerment of women and intergenerational equity, *Recognizing* the importance of the conservation and enhancement, as appropriate, of sinks and reservoirs of the greenhouse gases referred to in the Convention, *Noting* the importance of ensuring the integrity of all ecosystems, including oceans, and the protection of biodiversity, recognized by some cultures as Mother Earth, and noting the importance for some of the concept of 'climate justice,' when taking action to address climate change."

[200] The United Nations Framework Convention on Climate Change art. 23, Sept. 5, 1992, 1771 U.N.T.S. 107 [hereinafter UNFCCC]. This aims at stabilizing GHG emissions "at a level that would prevent dangerous anthropogenic interference with the climate system." UNFCCC, Art. 2.

[201] Paris Agreement, *supra* note 199, Art. 2.

[202] *Id.*

[203] *Id.* at Art. 4.

The Paris Agreement had little to say when it came to CCS, limiting itself to "removals" and the related need for parties to include these in their reporting.[204] Here, making a technical distinction between carbon capture and storage (CCS) and carbon dioxide removal (CDR) is useful. As discussed, CCS refers to the removal of gas from an emissions stream before it reaches the ambient air, and then storing the carbon dioxide in such a way that it cannot reach the atmosphere.[205] By contrast, the IPCC defines CDR to mean "[a]nthropogenic activities removing carbon dioxide from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products. It includes existing and potential anthropogenic enhancement of biological or geochemical sinks and direct air capture and storage but excludes natural carbon dioxide uptake not directly caused by human activities."[206] In summary, CCS removes carbon dioxide from existing emissions streams before they reach the atmosphere; CDR removes carbon dioxide from the atmosphere itself.

CCS, therefore, is not a removal activity as it does not actually remove carbon dioxide from the atmosphere. Rather, CCS prevents the release of additional carbon dioxide into the ambient air. As a result, CCS is not part of the GHG removal (GGR) set of climate interventions.[207] However, as a climate mitigation technology, CCS still aims at reducing anthropogenic carbon dioxide emissions.[208] In order to achieve its intended mitigation effect, the captured carbon dioxide from a CCS stream must be stored for indefinite time periods, but at minimum for several centuries.[209]

A recent IPCC report concluded that the technical geological carbon dioxide storage capacity globally is estimated to be in the order of 1000 $GtCO_2$.[210] This is the equivalent of global anthropogenic carbon dioxide emissions for approximately twenty-seven years.[211] The IPCC report asserted that, if the geological storage site is appropriately selected and managed, the carbon dioxide can be permanently isolated from the atmosphere.[212] Permanent isolation is critical, as leakage to the atmosphere may defeat the climate mitigation goal of CCS.

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[204] *Id.* at Art. 4 and 5, and Art. 13, respectively.

[205] Michael B. Gerrard, *Introduction and Overview, in* Climate Engineering and the Law: Regulation and Liability for Solar Radiation Management and Carbon Dioxide Removal 3 (Michael B. Gerrard & Tracy Hester eds., 2018).

[206] Intergovernmental Panel on Climate Change (IPCC), *Annex I: Glossary in* Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty (J. B. Robin Matthews ed., 2018).

[207] Nils Markusson et al., *Towards a Cultural Political Economy of Mitigation Deterrence by Negative Emissions Technologies (NETs),* Global Sustainability 1, 2 (2017) (Clarifying that bioenergy coupled with carbon capture and storage—BECCS is part of NETs. *Id.* at 2).

[208] Karl W. Bandilla, *supra* note 101, at 669, 681.

[209] *Id.* at 681.

[210] IPCC, *Summary for Policymakers in* Climate Change 2022: Mitigation of Climate Change: Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change 28 (Priyadarshi R. Shukla et al. eds., 2022).

[211] Considering that carbon dioxide global emissions in 2021 were 37,124 $MTCO_2$, which is, approximately, 37,1 GT CO_2 per year. Global Carbon Atlas, *CO_2 Emissions*, Global Carbon Project (2021), at https://perma.cc/CDG6-TAGE.

[212] IPCC, *Summary for Policymakers in* Climate Change 2022: Mitigation of Climate Change: Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, *supra* note 210, at 28.

For CCS to be considered an effective climate change mitigation tool, scientists estimate that the carbon dioxide must be securely retained for 10,000 years with a leakage rate of below 0.01% per year of the total amount injected.[213] The risk of leakage differs significantly between geologic formations. There is, for instance, much lower risk if carbon dioxide is stored in basalt formations, where it rapidly mineralizes.[214] Although leakage rates are generally expected to be low,[215] the migration of carbon dioxide to aquifers that are used as drinking water resources is of particular concern. As carbon dioxide dissolves in water, it reduces the water's overall pH and can release heavy metals that would be otherwise immobile into the drinking water supply.[216] However, a buildup of dangerous levels of carbon dioxide due to leakage is overall considered unlikely.[217]

Although the injection of carbon dioxide into geological storage has been safely achieved since 1972, the current challenge lies in effectively using and expanding storage capacity from the millions of tons available at present to the billions of tons required. Doing so will require significant advancements in monitoring.[218] Moreover, the sheer scale of the required expansion illustrates the amount of technological development needed in the CCS chain, as well as the importance of a scientifically driven regulatory scheme.

The need for technological advancements to scale CCS is now acute. Recent studies estimate that capping the temperature increase to 1.5°C above preindustrial levels – the more ambitious temperature goal of the Paris Agreement – is unlikely at best considering current NDCs.[219] A recent report highlighting record amounts of

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[213] Johannes M. Miocic et al., *420,000 Year Assessment of Faulty Leakage Rates Shows Geological Carbon Storage is Secure*, 9 Scientific Reports 769, 769 (2019).

[214] Claire Nelson et al., *Optimizing Injection Strategies for CO_2 Storage and Mineralization in Basalt through Multiphase Surface Reservoir Simulations,* 16th International Conference on Greenhouse Gas Control Technologies—GHGT-16, 1, 2–6 (2022), at https://perma.cc/S3C2-VFD4. (Underscoring how carbon dioxide storage in basalt formations are fast and effective).

[215] Statistics about average leakage of wells are missing. An expert explains general concerns about carbon dioxide leakage in abandoned wells as follows: "[These concerns are] often attributed to well barrier failures, where CO_2 may escape from the storage reservoir either due to pre-existing failures in the well material or due to subsequent corrosion of the cement and steel casings that are exposed to the subsurface CO_2 plume but were originally not designed to withstand CO_2. Estimates on CO_2 gas flows associated to this kind of leakage are low: 0.1 kg yr^{-1} for leakage along a well with degraded cement (Jordan et al., 2015), less than 0.1 t yr^{-1} for leakage along a well with sustained casin pressure and 0.3–3 t yr^{-1} for poorly cemented wells; higher leakage rates, on the order of 3–52 t yr^{-1} of CO_2 may arise from gas losses along the outside of wells, where drilling has disturbed and fractured the sediment around the wellbore mechanically thereby creating highly efficient pathways for the upward migration of gas." Lisa Vielstädte et al., *Footprint and detectability of a well leaking CO_2 in the Central North Sea: Implications from a field experiment and Numerical Modelling*, 84 International Journal of Greenhous Gas Control 190, 192 (2019).

[216] Karl W. Bandilla, *supra* note 101, at 683.

[217] *Id.* It is noteworthy that carbon dioxide is considered minimally toxic by inhalation. OSHLA has established as a permissible exposure limit of 5,000 parts of carbon dioxide per million (ppm) in air average an eight-hour workday. Occupational Safety and Health Administration, Carbon Dioxide, at https://perma.cc/R2JZ-4FMQ.

[218] The Royal Society, *Climate Change Science and Solutions: Carbon Dioxide Capture and Storage,* The Royal Society Organization 8 (2021), at https://perma.cc/SL68-FW4H. (Also noting that more powerful computer models would play a relevant part in monitoring the movement of carbon dioxide and ensuring its retention underground).

[219] International Energy Agency, *Net Zero by 2050: A Roadmap for the Global Energy Sector,* IEA 41–42 (Oct. 2021), at https://perma.cc/65AF-8SJ8. These estimates were confirmed more recently: United Nations Environment Programme (UNEP), Emissions Gap Report 2022: The Closing Window: Climate Crisis Calls for Rapid Transformation of Societies, UNEP (2022), at https://perma.cc/4DQG-WB9N. (Finding that, without additional action, current policies lead to global warming of 2.8°C over the

global CO_2 emissions estimates that the world's carbon budget will be exhausted within nine years if current levels of emissions are maintained.[220] The report concludes that, "Reaching net zero CO_2 emissions by 2050 entails cutting total anthropogenic CO_2 emissions by about 0.4 GtC (1.4 $GtCO_2$) each year on average, comparable to the decrease observed in 2020 during the COVID-19 pandemic."[221] This, of course, has become even more difficult as countries cope with the ongoing adverse effects of climate change, as well as the Russian invasion of Ukraine and its impact on energy markets. The International Energy Agency (IEA) estimates that global supply for oil will rise by 1.5 mb/d to a new high of 103.5 mb/d based on record-setting output from the United States, Brazil, Guyana, and Canada.[222]

In this context, the drive for CCS research and implementation is growing. This set of technologies initially became crucial when calls first began for an economy-wide energy transition – namely, divesting from fossil fuel energy sources in favor of a more renewable energy mix – specifically as part of the push for the retirement of unabated, non-CCS coal.[223]

The Glasgow Climate Pact and the Sharm el-Sheikh Implementation Plan renewed such calls.[224] The "phase-out" of fossil fuels, specifically, has been a contentious topic in international climate negotiations.[225] One recent decision adopted at the 28th Conference of the Parties to the UNFCCC (COP 28) in 2023 avoided controversies involving the "phase-out" versus "phase-down" language, and instead included an unprecedented call for member states to "transition away" from fossil fuels.[226] The decision also called for countries to accelerate zero

course of this century, and the implementation of unconditional and conditional NDC scenarios reduce this to 2.6°C and 2.4°C, respectively; therefore, there is no "credible path" in place to limit 1.5°C warming. *Id.* at XXI). In a similar vein, *see* Gokul Iyer et al., *Ratcheting of Climate Pledges Needed to Limit Peak Global Warming,* 12 Nat. Clim. Change 1129, 1129 (2022).

[220] Pierre Friedlingstein et al., *Global Carbon Budget*, 14 Earth Syst. Sci. Data 4811, 4814 (2022) (Assuming a 1.5°C threshold).

[221] *Id.*

[222] International Energy Agency, *Oil Market Report: January 2024 Highlights* (Jan. 1, 2024), at https://perma.cc/HA9T-KSX4. (Contextualizing that the growth of oil demand slowed to 1.7 mb/d in the last quarter of 2023, and that this was a significant departure from the 3.2 mb/d rate registered during the second and third quarters of 2023, "[m]irroring the unwinding of China's post-pandemic release of travel demand.").

[223] International Energy Agency, *Net Zero by 2050: A Roadmap for the Global Energy Sector, supra* note 219, at 41–42. (Asserting that: "Beyond projects already committed as of 2021, there are no new oil and gas fields approved for development in our pathway, and no new coal mines or mine extensions are required.").

[224] Conference of the Parties Serving as the Meeting of the Parties to the Paris Agreement, *Report of the Conference of the Parties Serving as the Meeting of the Parties to the Paris Agreement on its Second Session, Held in Glasgow from 31 October to 12 November 2021. Addendum—United Nations Framework Convention on Climate Change* (Mar. 8, 2022), particularly II, at https://perma.cc/23CJ-ZCRY [hereinafter Glasgow Climate Pact]; UNFCCC, Decision-CP 27: Sharm el-Sheikh Implementation Plan (Advanced unedited version: November 20, 2022), IV, Paragraph 13, at https://perma.cc/CH85-CBVW [hereinafter Sharm el-Sheikh Implementation Plan].

[225] With COP26 president Alok Sharma famously fighting back tears as he apologized for a relevant change of wording. China and India had pushed for the Glasgow Pact's original "phase-out" of coal power to be replaced by its "phase-down." The Economist, *COP 28: New Deal and Evasive Tactics,* Economist Impact (Dec. 18, 2023), at https://perma.cc/ULV8-YCBN.

[226] *Id. See also* UNFCCC, Decision-/CMA.5: Outcome of the First Global Stocktake (Advance unedited version: Dec. 13, 2023), Art. 2(A), p. 28 (d), at https://perma.cc/6KES-VHJ2 [hereinafter the UAE Consensus].

and low-emissions technologies, mentioning "abatement and removal technologies such as carbon capture and utilization and storage, particularly in hard-to-abate sectors."[227]

It is unsurprising that carbon capture, usage, and storage feature prominently in the International Energy Agency's recent Net Zero Pathways; they are among the key pillars of decarbonization alongside energy efficiency, renewables, behavioral changes, electrification, bioenergy, and hydrogen and hydrogen-based fuels.[228]

Despite this, CCS has not been spared from criticism. One common critique is that CCS may have a mitigation deterrence effect, broadly defined as "the prospect of reduced or delayed mitigation resulting from the introduction or consideration of another climate intervention."[229] Mitigation deterrence may shift the focus away from actions that are proven to reduce carbon dioxide emissions to interventions that are costly, uncertain, and enable high-emission activities to continue.[230] Concerns about safety risks and ecological damage are often raised in the literature opposing CCS.[231] The Center for International Environmental Law, for instance, steadfastly opposes CCS based primarily on these concerns.[232]

Nonetheless, key international actors understand CCS as a mitigation action aimed at achieving overall GHG emission reductions, rather than as a replacement for the reductions themselves.[233] CCS is not in any way a replacement for emissions reductions, which are the most important mitigation measure; CCS is merely a supplement to these actions. Moreover, there is growing scientific consensus that CDR will also be needed to counterbalance hard-to-abate residual emissions if net zero carbon dioxide or GHG emissions are to be

[227] The UAE Consensus, *supra* note 226, Art. 2(A), at paragraph 28, providing that: "*Further recognizes* the need for deep, rapid and sustained reductions in greenhouse gas emissions in line with 1.5°C pathways and *calls on* Parties to contribute to the following global efforts, in a nationally determined manner, taking into account the Paris Agreement and their different national circumstances, pathways and approaches: . . . (e) Accelerating zero- and low-emission technologies, including, inter alia, renewables, nuclear, abatement and removal technologies such as carbon capture and utilization and storage, particularly in hard-to-abate sectors, and low-carbon hydrogen production."(emphasis in original).

[228] International Energy Agency, *Net Zero by 2050: A Roadmap for the Global Energy Sector, supra* note 219, at 64–80.

[229] Nils Markusson et al., *supra* note 207, at 1. (The authors note that, in this general conceptualization, mitigation deterrence can even be triggered by an intervention that is a form of mitigation. *Id.* at 2). *See also* Duncan McLaren, *Quantifying the Potential Scale of Mitigation Deterrence from Greenhouse Gas Removal Techniques* 162 Climate Change 2411, 2411–412 (2020) ("If mitigation is understood as planned at-source reductions of greenhouse gas emissions, then mitigation deterrence can be defined as the prospect of reduced or delayed at-source emissions reductions resulting from the introduction or consideration of another climate intervention. Understood this way, mitigation deterrence will potentially, although not necessarily, increase climate risk." (Internal citations omitted).

[230] Duncan McLaren, *supra* note 133, at 2412.

[231] *See., e.g.,* Sabine Fuss *et al., Negative Emissions—Part 2: Costs, Potentials and Side Effects*, 13 *Environmental Research Letters* 063002 (2018), at 14. ("CCS poses its own set of risks. Overpressure could lead to the pollution of potable water, to seismic activity or to leaks, which could not only rapidly reverse positive mitigation effects, but cause environmental and health damage at the leakage sites.").

[232] Center for International Environmental Law (CIEL), *Carbon Capture and Storage (CCS): Frequently Asked Questions,* CIEL (2022), at https://perma.cc/M7MK-VVF3. (Also underlying the potential lack of economic feasibility even in cement, for instance).

[233] Key players include all Member States who are Parties of the IPCCC, the IPCCC reports and the IEA, for instance. For their seminal work on CCS, *see, e.g.,* IPCC, IPCC Special Report on Carbon Dioxide Capture and Storage Prepared by Working Group III of the Intergovernmental Panel on Climate Change, *supra* note 133, at 3; and, more recently, International Energy Agency, *Net Zero by 2050: A Roadmap for the Global Energy Sector, supra* note 219, at 64–80.

achieved.[234] Ultimately, CCS and CDR are components of a portfolio of actions toward climate mitigation[235] because achieving global net zero carbon dioxide emissions is a requirement for stabilizing a carbon dioxide - induced global surface temperature increase.[236]

The IPCC Sixth Assessment Report, which is supportive of CCS and used it in the majority of its global scenarios compatible with Paris Agreement targets,[237] highlights that the implementation of CCS currently faces technological, economic, institutional, ecological-environmental, and socio-cultural obstacles.[238] Currently, global rates of CCS deployment are significantly below those in the modeled pathways limiting global warming to 1.5°C or 2°C.[239] In 2021, there were 30 CCS facilities operating worldwide with an estimated capture capacity of 42.5 millions tons of carbon dioxide per year,[240] while the world releases 43 billion tons a year.[241] Policy instruments, greater public support, and technological innovation are all needed to increase levels of deployment.[242]

The International Energy Agency (IEA) recently renewed its vocal support for CCS.[243] In its 2023 report, the agency is adamantly clear about the need of CCS and CDR "to mitigate and compensate hard-to-abate residual

[234] IPCC, *Summary for Policymakers in* Climate Change 2022: Mitigation of Climate Change: Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, *supra* note 210, at 36–38.

[235] IPCC, IPCC Special Report on Carbon Dioxide Capture and Storage Prepared by Working Group III of the Intergovernmental Panel on Climate Change, *supra* note 134, at 19. (Placing CCS among other options in the portfolio of potential climate change mitigation measures).

[236] IPCC, Summary for Policymakers in Climate Change 2021: The Physical Science Basis: Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change 38–40, D.1.8, specifically (Valérie Masson-Delmotte et al. eds., 2021).

[237] IPCC, *Summary for Policymakers in* Climate Change 2022: Mitigation of Climate Change: Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, *supra* note 210, at 24. (Asserting the following: "All global modelled pathways that limit warming to 1.5°C (>50%) with no or limited overshoot, and those that limit warming to 2°C (>67%), involve rapid and deep and in most cases immediate GHG emission reductions in all sectors. Modelled mitigation strategies to achieve these reductions include transitioning from fossil fuels without CCS to very low- or zero-carbon energy sources, such as renewables or fossil fuels with CCS, demand side measures and improving efficiency, reducing non-CO_2 emissions, and deploying carbon dioxide removal (CDR) methods to counterbalance residual GHG emissions.").

[238] IPCC, *Summary for Policymakers in* Climate Change 2022: Mitigation of Climate Change: Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, *supra* note 210, at 28.

[239] *Id.* (Affirming that: "Currently, global rates of CCS deployment are far below those in modelled pathways limiting global warming to 1.5°C or 2°C.").

[240] Global CCS Institute, *Global Status of CCS 2022*, Global CSS Institute 1, 7 (Matt Steyn et al. eds, 2022), at https://perma.cc/DA3G-Q9EE. *See also* Yuting Zhang et al., *An Estimate of the Amount of Geological CO2 Storage over the Period of 1996–2020,* 9 Environ. Sci. Technol. Lett. 693, 693 (2022) (Underscoring the existence of information gaps that present challenges for the quantification of the current state of CCS. The authors conclude that there is significant difference between the reported storage data and the more frequently reported storage capacity, which increases challenges regarding evaluations of CCS projects. *Id.* at 697).

[241] Felicity Bradstock, *Carbon Capture is Coming Under Fire for Underperforming,* Oilprice (Feb. 9, 2023).

[242] IPCC, *Summary for Policymakers in* Climate Change 2022: Mitigation of Climate Change: Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, *supra* note 210, at 3.

[243] International Energy Agency, *Credible Pathways to 1.5°C: Four Pillars for Action in the 2020s,* IEA 1, 3 (Apr. 2023), at https://perma.cc/U4FV-856D.

emissions. Projects capturing around 1.2 Gt CO_2 by 2030 need to be implemented, eclipsing the roughly 0.3 Gt CO_2 currently planned for 2030 ."[244]

Importantly, the IEA estimates that CCS alone is needed to achieve 17% of the emissions reductions required to meet the Paris Agreement's 2°C temperature target by 2050.[245] The IEA calculates that restricting the availability of carbon dioxide storage to its levels of deployment in 2019 – i.e., assuming no additional storage is possible – would increase the costs of the energy transition by 40% while also requiring more renewable sources and removals.[246] Stated differently: if CCS is not scaled up soon, it will increase the need for renewables and CDR in the future. In a different report, the IEA asserts that reaching net zero without carbon dioxide usage and storage is virtually impossible; the role of these technologies in electricity decarbonization increases significantly from today to the 2030 and 2070 scenarios.[247] Taken together, the need for CCS continues to increase – and the need to scale all its associated technologies rises with it.

[244] *Id.* at 3.

[245] INTERNATIONAL ENERGY AGENCY, *Technology Roadmap: Carbon Capture and Storage,* IEA 5 (Jul. 2013), at https://perma.cc/L984-W6XR.

[246] INTERNATIONAL ENERGY AGENCY, *Exploring Clean Energy Pathways: The Role of CO_2 Storage,* IEA 3–4 (Jul. 2019), at https://perma.cc/JK4B-BSQN.

[247] INTERNATIONAL ENERGY AGENCY, *Energy Technology Perspectives: Special Report on Carbon Capture, Utilisation and Storage,* IEA 13–14 (2020), at https://perma.cc/9FLX-P5FB. (The IEA explains that carbon dioxide usage and storage includes CCS, as well as carbon dioxide uses. *Id.* at 20).

CHAPTER 3: THE INTERNATIONAL LEGAL FRAMEWORK GOVERNING OCEANIC CROSS-BORDER TRANSPORT OF CARBON DIOXIDE FOR STORAGE

The contemporary law of the sea is based on the "freedom of the seas," which establishes oceans as a "global commons upon which nations' freedom to travel and extract resources is unimpeded."[248] This freedom to travel, however, can be restricted when threatening the sea commons. Transportation of hazardous and toxic substances presents one such threat.

International agreements on what constitutes a hazardous or toxic substance are not always black and white. Global definitions of "hazardous" and "toxic" substances may be interpreted differently across domestic regulations.[249] Adding to this complexity, international definitions of "hazardous" and "toxic" substances may depend on domestic regulations.[250] Similarly, there are often subtle distinctions between the movement of waste and dumping; while these two activities are not necessarily related, one may follow the other in practice.[251] Finally, the transboundary movement of carbon dioxide raises difficult questions on how to classify carbon dioxide under international treaties that were drafted prior to the development of CCS technologies.[252]

In such a complex setting, this chapter narrows its scope of analysis to solely look at the international agreements that may affect the cross-border transportation of carbon dioxide for storage. It begins by examining the London Convention and Protocol, which is arguably the most important legal framework to understand the regulation of cross-border carbon dioxide transportation and storage. Next, this chapter provides an analysis of the Basel and Bamako Conventions. These conventions, while relevant, will likely not impede the movement of carbon dioxide across borders.

Following the more in-depth analysis of the above international treaties, this chapter then briefly outlines the potential implications of the following treaties and agreements on regulating transboundary carbon dioxide

[248] David Hunter et al., International Environmental Law and Policy 728 (2022) (Noting that the law of the sea predates Roman times, and citing the following famous passage of Hugo Grotius' Mare Liberum, from 1609: "[t]he sea is common to all because it is so limitless that it cannot become a possession of one, and because it is adapted for the use of all, whether we consider it from the point of view of navigation or of fisheries.").

[249] Definitions of "hazardous" and "toxic" can be convoluted domestically, being subject to multiple regulatory frameworks. In the United States, for instance, the definitions of "hazardous" and "waste" depend on the class of pollutant and different regulatory frameworks targeted. *See, e.g.,* the Hazardous Materials Transportation Act, 49 U.S.C.A. §§5101-5127; the Clean Air Act, 42 U.S.C.A. §§7401–7671 (Defining hazardous at §7412 (b) (2)); *but cf.* the Federal Hazardous Substance Act, 15 U.S.C.A. §§ 1261–1276, conceptualizing hazardous at §1261 (f) (1) (a – c)).

[250] *See, e.g.,* the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal Mar. 22, 1989 (entered into force May 5, 1992), 1673 U.N.T.S. 57 [hereinafter Basel Convention]. The Basel Convention, Art. 1 determines: "Scope of the Convention: 1. The following wastes that are subject to transboundary movement shall be 'hazardous wastes' for the purposes of this Convention: (a) Wates that belong to any category contained in Annex I, unless they do not possess any of the characteristics contained in Annex III; and (b) Wastes that are not covered under paragraph (a) but are defined as, or are considered to be hazardous wastes by the domestic legislation of the Party of export, import or transit." *See also* the Bamako Convention on the Ban of Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa, Jan. 30, 1991 (entered into force Apr. 22, 1998) 2101 U.N.T.S. 177 [hereinafter Bamako Convention]. Bamako Convention, Art. 2, (1) (b) in addition to the Convention's list, it considers as hazardous wastes those defined as such in domestic legislation of the State of export, import, or transit.

[251] André Nollkaemper, *Transboundary Movement of Hazardous Waste for the Purpose of Dumping at Sea*, 22 Marine Pollution Bulletin 377, 377 (1991).

[252] Andy Raine, *Transboundary Transportation of CO_2 Associated with CCS Projects,* 2 Carbon and Climate L. Rev. 353, 356 (2008).

movement: UNCLOS (*United Nations Convention on the Law of the Sea*); the High Seas Treaty or BBNJ (*United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction*); MARPOL (*International Convention for the Prevention of Pollution from Ships*); OSPAR (*Convention for the Protection of the Marine Environment of the North-East Atlantic*); the HNS Convention (*International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea*); the OECD Wastes Decision; and specific U.S. bilateral treaties involving the transportation of hazardous waste. While each of these treaties and agreements raises interesting considerations regarding the transport and storage of carbon dioxide, ultimately none pose significant barriers to the industry at this time. The chapter concludes with reflections on how this patchwork international governance system may hinder the expansion of a nascent carbon capture, transportation, and storage industry.

1. London Convention and London Protocol

This section discusses the main provisions relevant to carbon dioxide for storage under the current complex system of the London Convention and the London Protocol. This legal framework only applies to carbon dioxide transport if the carbon dioxide is to be dumped offshore. Should the transported carbon dioxide be stored geologically on land, neither the Convention nor the Protocol would apply.

1.1. London Convention

The London Convention, or the 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, recognizes that "the marine environment and the living organisms which it supports are of vital importance to humanity, and all people have an interest assuring that it is so managed that its quality and resources are not impaired."[253] The Convention requires states to take steps to prevent pollution of the marine environment due to the dumping of waste and other matter.[254]

The following table specifies each of the current 87 parties to the London Convention.[255]

[253] 1972 United Nations Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Dec. 29, 1972, (entered into force Aug. 30, 1975) 1046 U.N.T.S. 120 [hereinafter London Convention], Preamble.
[254] London Convention, *supra* note 253, Art. I.
[255] IMO, *Status of IMO Treaties: Comprehensive Information on the Status of Multilateral Conventions and Instruments in respect of which the International Maritime Organizations or its Secretary-General performs depositary or other functions, The London Convention,* 555 (2023), at https://perma.cc/6WZA-GFRJ.

Table 1: Parties to the London Convention

Parties to the London Convention				
Islamic Republic of *Afghanistan*	Rep. of *Cote d'Ivoire*	Republic of *Iceland*	New Zealand	Republic of *Haiti*
Antigua and Barbuda	Republic of *Croatia*	Islamic Republic of *Iran*	Federal Republic of *Nigeria*	Solomon Islands
Republic of *Argentina*	Republic of *Cuba*	Republic of *Ireland*	Kingdom of *Norway*	Republic of *South Africa*
Commonwealth of *Australia*	Republic of *Cyprus*	Republic of *Italy*	Sultanate of *Omani*	Kingdom of *Spain*
Republic of *Azerbaijan*	Democratic People's Republic of *Korea*	Jamaica	Islamic Republic of *Pakistan*	Republic of *Suriname*
Barbados	Kingdom of *Denmark*	Japan	Republic of *Panama*	Kingdom of *Sweden*
Republic of *Belarus*	Dominican Republic	Hashemite Kingdom of *Jordan*	Independent State of *Papua New Guinea*	Swiss Confederation (*Switzerland*)
Kingdom of *Belgium*	Arabic Rep. of *Egypt*	Republic of *Kenya*	Republic of *Peru*	Syrian Arab Republic
Republic of *Benin*	Rep. of *Equatorial Guinea*	Republic of *Kiribati*	Republic of the *Philippines*	Kingdom of *Tonga*
Plurinational State of *Bolivia*	Republic of *Finland*	Libya	Republic of *Poland*	Republic of *Tunisia*
Fed. Republic of *Brazil*	Republic of *France*	Grand Dutchy of *Luxembourg*	Republic of *Portugal*	Ukraine
Republic of *Bulgaria*	Gabonese Rep. (*Gabon)*	Republic of *Malta*	Russian Federation	United Arab Emirates
Rep. of *Cabo Verde*	Fed. Rep. of *Germany*	United Mexican States (*Mexico)*	Saint Lucia	U. K. of Great Britain and Northern Ireland

Canada	Hellenic Republic (*Greece*)	Principality of *Monaco*	Saint Vincent and the Grenadines	United Republic of *Tanzania*
Republic of *Chile*	Republic of *Guatemala*	Montenegro	Republic of *Serbia*	United States of America
People's Rep. of *China*	Republic of *Haiti*	Kingdom of *Morocco*	Republic of *Seychelles*	Republic of *Vanuatu*
Republic of the *Congo*	Republic of *Honduras*	Republic of *Nauru*	Republic of *Sierra Leone*	
Republic of *Costa Rica*	Hungary	Kingdom of the *Netherlands*	Republic of *Slovenia*	

The Convention defines dumping as "any deliberate disposal at sea of wastes or other matter from vessels, aircraft, platforms or other man-made structures at sea; and any deliberate disposal at sea of vessels, aircraft, platforms or other mandate structure at sea."[256] Under the Convention, the term "wastes or other matter" is defined to mean "material and substance of any kind, form or description."[257]

According to the London Convention, contracting parties "shall prohibit the dumping of any wastes or other matter in whatever form or condition" except as otherwise authorized under the Convention.[258] The London Convention requires parties to "adopt domestic laws to regulate the dumping of waste and other matters within offshore areas under their jurisdiction … and, outside of those areas, by vessels or aircraft that are registered, or were loaded, within their territory."[259]

Parties to the London Convention must prohibit the dumping of any substances listed in Annex I of the Convention.[260] These Annex I substances are often referred to as "blacklisted substances." To regulate the

[256] London Convention, *supra* note 253, Art. III, 1 (a), whereas Art. III, 1 (b) excludes from the scope of the London Convention the application of the MARPOL Convention; the placement of matter for a purpose other than the mere disposal thereof and as long as not this placement is not contrary to the goals of the Convention; and the disposal of wastes or other matter directly arising from, or related to the exploration, exploitation and associated off-shore processing of sea-bed mineral resources. In practice, the London Convention regulates the intentional dumpling and incineration of wastes at sea from ships. *See* HUNTER ET AL., *supra* note 248, at 785.
[257] London Convention, *supra* note 253, Art. III, 4.
[258] London Convention, *supra* note 253, Art. IV.
[259] Romany M. Webb, Korey Silverman-Roati & Michael B. Gerrard, *Removing Carbon Dioxide Through Artificial Upwelling and Downwelling: Legal Challenges and Opportunities*, SABIN CENTER FOR CLIMATE CHANGE LAW 20 (2022). *See also* London Convention, *supra* note 253, Art. VI–VII.
[260] London Convention, *supra* note 253, Art. IV (1) provides as follows: "In accordance with the provisions of this Convention Contracting Parties shall prohibit the dumping of any wastes or other matter in whatever form or condition except as otherwise specified below: (a) the dumping of wastes or other matter listed in Annex I is prohibited; (b) the dumping of wastes or other matter listed in Annex II requires a prior special permit; (c) the dumping of all other wastes or matter requires a prior general permit."

dumping of other non-blacklisted substances,[261] the Convention establishes a dual system for granting permits. Dumping of wastes and other matter listed in a second annex (Annex II) require a prior special permit, whereas the dumping of all other types of waste and matter that are not listed in either annex require a prior general permit.[262]

Carbon dioxide is not currently listed in Annexes I or II.[263] Therefore, its disposal at sea is not expressly prohibited, nor is it subjected to special permits;[264] only general permits would be required.[265] However, the "blacklisted" substances in Annex I include "industrial waste," defined as substances generated by manufacturing or processing operations under Annex I.[266] This definition could encompass carbon dioxide captured at manufacturing or other industrial facilities.[267]

The scientific working group of the London Convention, which plays an advisory role, was charged with examining if carbon dioxide could be considered as "industrial waste" if it originated from a manufacturing or processing operation.[268] However, this question has not yet been answered[269] within the London Convention's framework.[270] If carbon dioxide were considered industrial waste, parties to the London Convention could not issue permits authorizing the dumping thereof.

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[261] London Convention, *supra* note 253, Annex I (11). The list of prohibited substances is as follows: organohalogen compounds; mercury and cadmium and their compounds; persistent plastics and other persistent synthetic materials; crude oil and its wastes, petroleum and refined petroleum products as well as distillate residues and any mixtures containing any of these; radioactive wastes and other radioactive matter; materials in any form produced for biological and chemical warfare. Except for radioactive wastes and related matters, Annex I, 8 determines that the Convention will not apply to these prohibited substances if they are rapidly rendered harmless by physical, chemical or biological process in the sea and provided they do not make edible marine organisms unpalatable or endanger human life of that of domestic animals.

[262] London Convention, *supra* note 253, Art. IV, 1 (b) and (c). In its relevant provisions to dumping, Annex II substances and materials includes the following: wastes containing significant amount of arsenic, beryllium, chromium, copper, lead, nickel, vanadium, zinc, and their compounds; organosilicon compounds, cyanides, fluorides, pesticides and their by-products not covered in Annex I; containers, scrap metal and other bulky wastes liable to sink to the sea bottom which may present a serious obstacle to fishing or navigation. Annex III details the criteria for issuance of dumping permits for general and special permits.

[263] London Convention, *supra* note 253, Art. 4–5.

[264] IEAGHG, *The Status and Challenges of CO_2 Shipping Infrastructures*, IEA 56–57 (James Craig ed., 2020).

[265] London Convention, *supra* note 253, Art. IV (1) (c). *See also* Mark A. de Figueiredo, *The Liability of Carbon Dioxide Storage*, MIT PhD Dissertation (2007), 115, at https://perma.cc/J3GX-YQ2V. (Noting that the Parties of the London Convention have not decided if carbon dioxide could qualified as waste, but it is unlikely such a qualification is applicable).

[266] London Convention, *supra* note 253, Annex I (11).

[267] *Id. See also* Mark A. de Figueiredo, *The International Law of Sub-Seabed Carbon Dioxide Storage: A Special Report to the MIT Carbon Sequestration Initiative*, 17–18 Lab. for Energy and the Environment (Aug. 2005), at https://perma.cc/DNQ5-5MTG. (Highlighting that the Convention does not mention carbon dioxide for storage and that a clarification would be relevant, despite concluding that carbon dioxide for storage would not be precluded by the London Convention).

[268] IMO, Report of the Twenty-Second Meeting of the Scientific Group to the London Convention (1999).

[269] IMO, Reports of the Consultative Meeting of the Parties of the London Convention: LC 21/13, LC 26/15, LC 27/16, LC 28/15, and LC 29/17, at https://docs.imo.org/ (registration required). *See also* Viktor Weber, *Are We Ready for the Ship Transport of CO_2 for CCS? Crude Solutions from International and European Law,* 30 Rev. Eur. Comp. & Int. Law 387, 388 (2021).

[270] Ian Havercroft & Ray Purdy, Carbon Capture and Storage—A Legal Perspective 3 U.N. Sustainable Development (2007), at https://perma.cc/R5PL-AW4P.

There are a few potential arguments against including carbon capture for offshore storage in the list of prohibited substances in Annex I of the Convention. The key point is that the Convention aims only to control dumping "at sea" (in other words, in the water) and thus would not cover carbon dioxide storage, since that would occur in geological formations below the sea column.[271] However, there is a contrary school of thought, which interprets the term "dumping at sea" to include anything that occurs at sea, whether it involves discharges into the water column or injection into the seabed.[272]

While these considerations on whether potential marine carbon dioxide export and storage would be regulated under the London Convention are important, the Convention's true role in these activities cannot be fully evaluated without examining the amendment meant to update and ultimately supersede the London Convention itself: the London Protocol.

1.2. London Protocol

In 1996, the London Protocol[273] was adopted with the aim of modernizing the London Convention.[274] If and when the London Protocol is ratified by all contracting parties, it will replace the Convention. In the meantime, countries that are party to both instruments are bound by the London Protocol, while the London Convention continues to bind those which have only ratified the Convention and not the Protocol.[275]

The table below details the current parties to the London Protocol and is followed by a map comparing the parties to the London Convention and those of the London Protocol.

[271] *Id.*

[272] Romany Webb & Michael Gerrard, *Sequestering Carbon Dioxide Undersea in the Atlantic: Legal Problems and Solutions*, 36 UCLA J. ENVL LAW & POLICY 1, 16–17 (2018) (Highlighting that carbon dioxide injection has been interpreted as to be implicitly included in the London Convention); Yvette Carr, *The International Legal Issues Relating to the Facilitation of Sub-Seabed CO_2 Sequestration Projects in Australia*, AUSTRALIAN INTERNATIONAL LAW JOURNAL 137, 143–45 (2007) (Underscoring that carbon dioxide storage would be considered prohibited under the London Convention); Ray Purdy & Richard Macrory, *Geologic Carbon Sequestration: Critical Legal Issues*, Tydall Centre for Climate Change Research 1, 20 (2003) (Noting the United Kingdom Government's position is that "their express policy of adhering to the more stringent requirements of the Protocol, and that the limitation of the London Convention in this area should not be taken as denying its application to sub-seabed CO_2 storage; rather it should be read in the light of the current standards set by the Protocol.").

[273] 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Nov. 7, 1996 (entered into force Mar. 24, 2006), 36 I.L.M. 7 [hereinafter London Protocol].

[274] INTERNATIONAL ENERGY AGENCY, *Carbon Capture and Storage and the London Protocol: Options for Enabling Transboundary CO_2 Transfer,* IEA 9 (Justine Garret et al. eds., 2011).

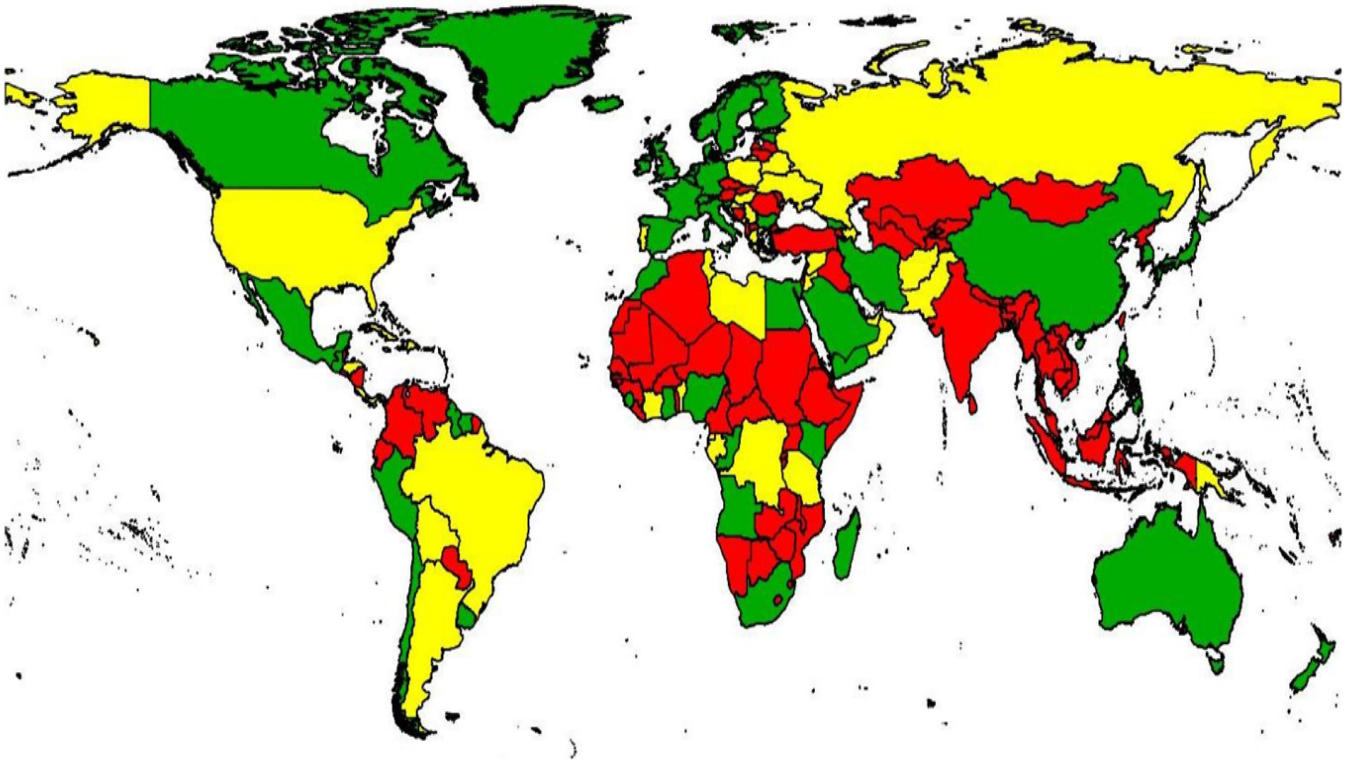
[275] Weber, *supra* note 269, at 388.

Table 2: Parties to the London Protocol[276]

Parties to the London Protocol				
Republic of *Angola*	Kingdom of *Denmark*	Islamic Republic of *Iran*	New Zealand	Republic of *Suriname*
Antigua and Barbuda	Arabic Rep. of *Egypt*	Ireland	Federal Republic of *Nigeria*	Kingdom of *Sweden*
Commonwealth of *Australia*	Republic of *Estonia*	Republic of *Italy*	Kingdom of *Norway*	Swiss Confederation (*Switzerland*)
Barbados	Republic of *Finland*	Japan	Republic of *Peru*	Kingdom of *Tonga*
Kingdom of *Belgium*	Republic of *France*	Republic of *Kenya*	Republic of the *Philippines*	Republic of *Trinidad and Tobago*
Republic of *Bulgaria*	Georgia	Grand Duchy of *Luxembourg*	Saint Kitts and Nevis	U. K. of Great Britain and Northern Ireland
Republic of *Cameroon*	Federal Republic of *Germany*	Republic of *Madagascar*	Kingdom of *Saudi Arabia*	Oriental Republic of *Uruguay*
Republic of *Chile*	Republic of *Ghana*	Republic of the *Marshall Islands*	Republic of *Sierra Leone*	Republic of *Vanuatu*
People's Republic of *China*	Republic of *Guatemala*	United Mexican States (*Mexico*)	Republic of *Slovenia*	Republic of *Yemen*
Republic of the *Congo*	Republic of *Guyana*	Kingdom of *Morocco*	Republic of *South Africa*	
Democratic People's Republic of *Korea*	Republic of *Iceland*	Kingdom of the *Netherlands*	Kingdom of *Spain*	

[276] IMO, *Status of IMO Treaties: Comprehensive Information on the Status of Multilateral Conventions and Instruments in respect of which the International Maritime Organizations or its Secretary-General performs depositary or other functions, The London Convention,* at 567, at https://perma.cc/74FP-XRA7.

Figure 1: Map of Parties to the London Convention and the London Protocol[277]



Under the London Protocol, all dumping is prohibited unless exceptions are provided for specific categories of waste or other matters listed in Annex 1 of the Protocol. The Protocol therefore reverses the assumption of the Convention, prohibiting all dumping unless a substance is specifically listed in the Protocol as an exception.[278] In

[277] IMO, Map of the Parties to the London Convention/London Protocol, IMO (Apr. 2022), at https://perma.cc/ZAP5-YBEF.

[278] London Protocol, *supra* note 273, Art. 1 (4) defines dumping as: (1) any deliberate disposal into the sea of wastes or other matter from vessels, aircraft, platforms, or other man-made structures at sea; (2) any deliberate disposal into the sea of vessels, aircraft, platforms, or other man-made structures at sea; (3) any storage of wastes or other matter in the seabed and the subsoil thereof from vessels, aircraft, platforms, or other man-made structures at sea; and (4) any abandonment or toppling at site of platforms or other

other words, while the Convention organizes its primary annex around a "blacklist" of dangerous substances barred from dumping, the Protocol organizes its primary annex around a "whitelist" of permissible substances for dumping, banning all other substances from dumping entirely. Between this and the "precautionary approach" the Protocol adopts as a general obligation, the Protocol is ultimately more restrictive than the Convention.[279]

The Protocol maintained the Convention's definition of waste, but expanded its definition of "dumping" to include "any storage of wastes or other matter in the seabed and the subsoil thereof from vessels, aircraft, platforms or other man-made structures at sea."[280] The Protocol defines "waste or other matter" as "material and substance of any kind, form or description" which would encompass carbon dioxide.[281] Therefore, the sub-seabed storage of carbon dioxide falls within the original scope of the Protocol.

The London Protocol's importance for the transboundary transportation of carbon dioxide for storage cannot be emphasized enough. In short, the Protocol is the only international legal framework that specifically regulates offshore CCS.[282] Importantly, the London Protocol only regulates offshore, sub-seabed carbon storage and related export of carbon dioxide; it does not regulate the carbon capture process itself, nor does it regulate onshore carbon storage.

While the London Protocol currently regulates the export of carbon dioxide for offshore, sub-seabed storage, the way in which it does so has shifted over time. As such, the remainder of this section is divided into three subsections. The first outlines how the London Protocol came to regulate sub-seabed storage of carbon dioxide, and the second explains how the Protocol has more recently come to regulate the cross-border transportation of carbon dioxide. Since the formal adoption of carbon dioxide transportation regulations has been particularly slow, the third and final subsection details the resolution that aims to operationalize carbon dioxide transport for interested parties.

1.2.1. Sub-seabed carbon dioxide storage under the London Protocol

When the Protocol was first adopted in 1996, carbon dioxide was not included in Annex 1, meaning no exceptions for dumping of carbon dioxide were provided. Under the Protocol's initial language, sub-seabed

man-made structures at sea for the sole purpose of deliberate disposal; Art. 4 establishes the following: (1) Contracting Parties shall prohibit the dumping of any wastes or other matter with the exception of those listed in Annex 1; (2) The dumping of wastes or other matter listed in Annex 1 shall require a permit. Contracting Parties shall adopt administrative or legislative measures to ensure that issuance of permits and permit conditions comply with provisions of Annex 2. Particular attention shall be paid to opportunities to avoid dumping in favor of environmentally preferable alternatives.

[279] London Protocol, *supra* note 273, Art. 3 (1).

[280] London Protocol, *supra* note 273, Art. 1 (4) 3. IEAGHG, *The Status and Challenges of CO_2 Shipping Infrastructures*, *supra* note 264, at 58.

[281] London Protocol, *supra* note 273, Art. 1 (8).

[282] Swati Gola & Kyriaki Noussia, *From CO_2 Sources to Sinks: Regulatory Challenges for Trans-Boundary Trade Shipment and Storage*, 179 Resources, Conservation & Recycling 3 (2022).

storage of carbon dioxide qualified as the dumping of a waste, prohibiting all countries who were party to the Protocol from issuing permits for such an activity.[283]

However, the Protocol provides criteria and guidelines for assessing the addition of new wastes into Annex 1. These guidelines are listed in Annex 2.[284] In 2006, the parties to the London Protocol utilized the Annex 2 guidelines to develop and adopt the Risk Assessment and Management Framework for CO_2 Sequestration in Sub-Seabed Geological Structures (CS-SSGS).[285] This framework was developed to ensure compatibility with Annex 2 of the Protocol, providing generic guidance to the contracting parties of both the London Convention and Protocol.[286] The new framework analyzed the risks to the marine environment from CCS with the goal of making a determination of whether carbon dioxide should be included in Annex 1's list of permitted substances for dumping. The framework concluded that there were knowledge gaps regarding the expected composition of carbon dioxide injection streams, as well as uncertainty regarding the stream's behavior and interactions with other substances that may be present in the injection stream once it is in the geological and marine environment.[287]

Despite these identified knowledge gaps, in 2006 the parties of the London Protocol amended Annex 1 to include carbon dioxide streams from carbon capture processes for storage, placing it among the specific permitted substances for dumping[288] provided that: (1) the carbon dioxide streams for storage are disposed into a sub-seabed geological formation; (2) the streams consist overwhelmingly of carbon dioxide; and (3) no wastes or other matter are added for the purpose of disposing of those wastes or other matter.[289] This amendment entered into force in 2007,[290] since the London Protocol establishes that an amendment to its annexes automatically enters into force one hundred days after the meeting of the parties for those who did not timely object.[291]

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[283] *See, e.g.,* INTERNATIONAL ENERGY AGENCY, *Carbon Capture and Storage and the London Protocol: Options for Enabling Transboundary CO_2 Transfer, supra* note 274, at 10.

[284] IMO, Risk Assessment and Management Framework for CO_2 Sequestration in Sub-Seabed Geological Structures (CS-SSGS): LC/SG-CO2 1/7, Annex 3, IMO (2006), at https://perma.cc/R8N2-2KM9. (This Risk Assessment and Management Framework was adopted at the joint session of the 28th Consultative Meeting of Contracting Parties under the London Convention and the 1st Meeting of Contracting Parties under the London Protocol, 30 October to 3 November 2006, *Id*. at 3).

[285] IMO, Risk Assessment and Management Framework for CO_2 Sequestration in Sub-Seabed Geological Structures (CS-SSGS): LC/SG-CO2 1/7, Annex 3, IMO (2006).

[286] *Id*. at 3.

[287] *Id*. at 13.

[288] London Protocol, *supra* note 273, Annex 1, paragraph 1.8 now reads as follows: "Carbon dioxide streams from carbon dioxide processes for sequestration."

[289] London Protocol, *supra* note 273, Annex 1: "Wastes and Other Matter that may be considered for Dumping: Paragraph 4: Carbon dioxide streams referred to in paragraph 1.8 may only be considered for dumping, if: (1) disposal is into a sub-seabed geological formation; (2) they consist overwhelmingly of carbon dioxide. They may contain incidental associated substances derived from the source material and the capture and sequestration processes used; and (3) no wastes or other matter are added for the purpose of disposing of those wastes or other matter."

[290] INTERNATIONAL ENERGY AGENCY, *Carbon Capture and Storage and the London Protocol: Options for Enabling Transboundary CO_2 Transfer, supra* note 274, at 10.

[291] London Protocol, *supra* note 273, Art. 22, paragraph 4 (detailing the time frame for such an objection).

Once the amendment was approved, licensing arrangements and mandatory impact assessments for carbon dioxide streams needed to be developed, as the treaty requires these for all listed Annex 1 substances.[292] To this end, parties to the London Protocol adopted Specific Guidelines for the Assessment of Carbon Dioxide Streams for Disposal into Sub-Seabed Geological Formations in 2007.[293] These guidelines established assessments and considerations for issuing a permit for carbon dioxide seabed storage, including stream characterization, site selection and characterization, environmental impact and risk assessments, monitoring, mitigation and remediations plans, and risk management.[294] These guidelines also have implications for the transport of carbon dioxide, which are further discussed in the next section.

1.2.2. Export of carbon dioxide under the London Protocol

Ultimately, a dumping regime is not effective if parties are able to circumvent it by exporting the material to be dumped to a nonparty state.[295] As such, the Article 6 export prohibition in the London Protocol is intended to stop parties from exporting their waste to nonparties as a backdoor route for dumping.[296] Article 6 states that contracting parties shall not allow the export of wastes or other matter to other countries for dumping or incineration at sea.[297]

While the Protocol broadly defines "wastes and other matter," it does not define "export."[298] Still, the export of carbon dioxide for onshore storage or its transport for use on EOR is not prohibited, because neither activity is

[292] Tim Dixon & Andrew Birchenough, *Exporting CO_2 for Offshore Storage – The London Protocol's Export Amendment,* GHGT-15, 3 (2021).
[293] IMO, Specific Guidelines for the Assessment of Carbon Dioxide for Disposal into Sub-Seabed Geological Formations (Adopted in the Second Meeting of the Parties to the London Protocol and Convention) (Nov. 2007), at https://perma.cc/VY2A-5VZQ.
[294] IMO, Specific Guidelines for the Assessment of Carbon Dioxide for Disposal into Sub-Seabed Geological Formations, *supra* note 293. These guidelines are quite broad. The complete specifications of the carbon dioxide stream, for instance, are the following: Chapter 4: Chemical and Physical Properties: "4.1. Proper characterization of the carbon dioxide stream is essential. If the carbon dioxide stream is so poorly characterized that proper assessment cannot be made of the risks of potential impacts on human health and the environment, that carbon dioxide stream shall not be dumped. 4.2. Specific characterization of the carbon dioxide stream, including any incidental associated substances, shall take into account the chemical and physical characteristics and the potential for interaction among stream components. Such interactions could potentially affect the reactivity of the stream with the geological formation. This analysis should include as appropriate: 1. origin, amount, form and composition; 2. properties: physical and chemical; and 3. toxicity, persistence, potential for bio-accumulation." *Id.,* Chapter 4.
[295] Weber, *supra* note 269, at 389.
[296] IEAGHG, *Exporting CO_2 for Offshore Storage – The London Protocol's Export Amendment and Associated Guidelines and Guidance,* IEAGHG Technical Review 2 (Apr. 2021).
[297] International Energy Agency, *Carbon Capture and Storage and the London Protocol: Options for Enabling Transboundary CO_2 Transfer, supra* note 274, at 11.
[298] London Protocol, *supra* note 273, Art. 1 (8): "'wastes and other matter' means material and substance of any kind, form or description."

considered dumping under the London Protocol.[299] However, export of carbon dioxide for permanent geological storage below another country's seabed was originally prohibited under Article 6.[300]

Over time, parties identified the need to establish provisions for carbon dioxide export when a party does not have suitable storage but may still benefit from CCS to reduce emissions.[301] As a result, in 2009, Norway made a formal proposal for an amendment of Article 6 that authorized the export of carbon dioxide for geological storage.[302] To date, the amendment has been adopted by all parties.[303] However, the amendment has yet to enter into force because it has not been ratified by two-thirds of the London Protocol's parties.[304] The London Protocol currently has fifty-three parties; thirty six are needed to approve an amendment to its main text.[305] China was the only party who voted against the amendment, contending it could potentially weaken the Protocol's protections by opening the door for exports of other wastes while also highlighting that the technical and legal issues regarding carbon dioxide export were unclear when the amendment was first proposed.[306]

Following the 2009 amendment, parties set out to revise the Carbon Dioxide Specific Guidelines to include transboundary activities, specifically the export (and related migration) of carbon dioxide for storage

[299] London Protocol, *supra* note 273, Art. 1(4) (3). IEAGHG, *The Status and Challenges of CO_2 Shipping Infrastructures*, *supra* note 264, at 58.

[300] London Protocol, *supra* note 273, Art. 6 (before the 2009 Amendment): Export of Wastes or Other Matters: "Contracting Parties shall not allow the export of wastes or other matter to other countries for dumping or incineration at sea."

[301] IEAGHG, *Exporting CO_2 for Offshore Storage – The London Protocol's Export Amendment and Associated Guidelines and Guidance, supra* note 296, at 3.

[302] The 2009 amendment to Art. 6 reads as follows: "Add '1' before: Contracting Parties shall not allow the export of wastes or other matter to other countries for dumping or incineration at sea. 2 Notwithstanding paragraph 1, the export of carbon dioxide streams for disposal in accordance with Annex 1 may occur, provided that an agreement or arrangement has been entered into by the countries concerned. Such an agreement or arrangement shall include: (2.1) confirmation and allocation of permitting responsibilities between the exporting and receiving countries, consistent with the provisions of this Protocol and other applicable international law; and (2.2) in the case of export to non-Contracting Parties, provisions at a minimum equivalent to those contained in this Protocol, including those relating to the issuance of permits and permit conditions for complying with the provisions of Annex 2, to ensure that the agreement or arrangement does not derogate from the obligations of Contracting Parties under this Protocol to protect and preserve the marine environment. A Contracting Party entering into such an agreement or arrangement shall notify it to the Organization." IMO, *CO_2 Export Amendment: Resolution LP.3(4)* (Adopted Oct. 30, 2009).

[303] Raphael J. Heffron et al., *Reducing Legal Risk for CO_2 Transport for Carbon Capture and Storage in the EU*, 6 INT. ENERGY L. REV. 192, 194–95 (2018) (Highlighting Norway's interest in the amendment).

[304] IEAGHG, *Exporting CO_2 for Offshore Storage – The London Protocol's Export Amendment and Associated Guidelines and Guidance, supra* note 296, at 3.

[305] IMO, The London Convention and Protocol, IMO (Jan. 6, 2023), at https://perma.cc/YRE7-4FH3. *See also* the London Protocol, *supra* note 273, Art. 21 (requiring approval of two third of the contracting parties of the Protocol for an amendment to its main text to be valid).

[306] Raphael J. Heffron et al., *Three Layers of Energy Law for Examining CO_2 Transport for Carbon-Capture and Storage,* J. ENERGY LAW & BUSINESS 1, 7 (2017).

purposes.[307] In 2012, the parties agreed on the new Specific Guidelines for the Assessment of Carbon Dioxide for Disposal into Sub-Seabed Geological Formations,[308] which clarified how to approach permitting.[309]

More specific issues regulating permit issuance and the liability of both contracting and non-contracting parties were streamlined in the following year, when the parties agreed on Guidance on the Implementation of Article 6.2 on the Export of Carbon Dioxide Streams for Disposal in Sub-Seabed Geological Formations for the Purpose of Sequestration.[310] Together, these guidelines supplement the previously-established Annex 2 provisions for issuing permits and verification of the carbon dioxide stream, highlighting who may be best situated to verify the purity of the streams.[311]

1.2.3. The 2019 Resolution on Article 6

Progress on the ratification of the 2009 amendment to Article 6 has been slow because not all state parties see CCS as an immediate priority.[312] Although several parties to the London Protocol have stated their interest in

[307] Tim Dixon & Andrew Birchenough, *Exporting CO_2 for Offshore Storage – The London Protocol's Export Amendment,* GHGT-15, 3 (2021) (Noting that the guidelines were split and now disposal has its own exclusive guideline).

[308]IMO, Specific Guidelines for the Assessment of Carbon Dioxide for Disposal into Sub-Seabed Geological Formations, LP 7 and LC 34/15, Annex 8 (Adopted Nov. 2, 2012), at https://perma.cc/4SLN-E797.

[309] *Id*. Like the 2007 guidelines, the 2012 guidelines are also quite general, albeit emphatic in the need for parties to reduce their dumping and disposal. *Id.* (1.5) (for the reduction of dumping and disposal); and exemplifying the generic requirements*, Id.*, Chapter 4: Chemical and Physical Properties: "4.1 Proper characterization of the carbon dioxide stream is essential. If the carbon dioxide stream is so poorly characterized that proper assessment cannot be made of the risks of potential impacts on human health and the environment, that carbon dioxide stream shall not be dumped. 4.2 Specific characterization of the carbon dioxide stream, including any incidental associated substances, shall take into account the chemical and physical characteristics and the potential for interaction among stream components. Such interactions could potentially affect the reactivity of the stream with the geological formation. This analysis should include as appropriate: 1. origin, amount, form and composition; 2. properties: physical and chemical; and 3. toxicity, persistence, potential for bio-accumulation.").

[310] IMO, *Guidance on the Implementation of Article 6.2 on the Export of Carbon Dioxide Streams for Disposal in Sub-Seabed Geological Formations for the Purpose of Sequestration, LC 35/15 Annex 6* (Adopted in the Thirty-Fifth Consultative Meeting of the Contracting Parties to the London Convention & Eight Meeting of the Contracting Parties to the London Protocol: Oct. 14 to 18, 2013), at https://perma.cc/36UB-9SRC.

[311] *Id.* In the relevant part – namely, Chapter 3, paragraph 6.3.3 – the guidelines determine that: "Characterization of the Chemical and Physical Properties of the CO_2 Stream: It is most likely that the exporting country will be best able to characterize the composition, properties and quantity of the CO_2 stream. The exporting country would then share that characterization with the importing country in order that any agreement or arrangement can reflect expected quality, adherence to Action Lists and any special precautions or mitigations needed for the secure import and storage of the CO_2 stream. The agreement or arrangement should reflect the actual results of the application of the Action Lists and should be applied prior to export. The country accepting the carbon dioxide stream should reassure itself of the quality of that characterization, including by undertaking its own characterization if necessary. Because the content of the CO_2 waste stream may change over time, the establishment of an ongoing monitoring information system could be useful to include in the agreement or arrangement."

[312] International Energy Agency, *Carbon Capture and Storage and the London Protocol: Options for Enabling Transboundary CO_2 Transfer, supra* note 274, at 12 (Noting that to reach the two-thirds requirement stipulated under Art. 21 of the London Protocol for an amendment to become effective is not trivial).

CCS,[313] only ten have formally accepted the amendment: Belgium, Denmark, Estonia, Finland, the Islamic Republic of Iran, the Netherlands, Norway, Republic of Korea, Sweden, and the United Kingdom.[314]

In light of the slow pace of ratification of the 2009 amendment to Article 6 – and the need for two-thirds of the parties to ratify the amendment for it to become effective[315] – Norway and the Netherlands proposed a resolution on the provisional application of the 2009 amendment to Article 6 of the London Protocol. The resolution aims to authorize the export of carbon dioxide for geologic storage offshore,[316] creating an interim solution that enables two or more countries to apply the 2009 export amendment before it enters into force. In doing so, the resolution allows countries to consent to cross-border transport of carbon dioxide for geological storage without breaching international commitments.[317] The structure of the resolution was based on the Vienna Convention, which authorizes parties of a treaty to agree to the provisional application of parts of a treaty that have not yet entered into force.[318]

[313] Ian Havercroft & Chritopher Consoli, *Development and Opportunities – A review of National Responses to CCS under the London Protocol*, GLOBAL CCS INSTITUTE 2 (May 2022).

[314] IMO, *Status of IMO Treaties: Comprehensive Information on the Status of Multilateral Conventions and Instruments in respect of which the International Maritime Organizations or its Secretary-General performs depositary or other functions, The London Convention,* at 571, at https://perma.cc/5T6Z-KCPN.

[315] London Protocol, *supra* note 273, Art. 21 establishes the two-thirds requirement for amendments to the Protocol's text entering into force.

[316] IEAGHG, *Exporting CO_2 for Offshore Storage – The London Protocol's Export Amendment and Associated Guidelines and Guidance*, *supra* note 296, at 6. (Explaining that Norway's motivation was the Northern Lights Project).

[317] *Id.*

[318] Vienna Convention on the Law of Treaties, May 23, 1969 (entered into force Jan. 27, 1980), 1115 U.N.T.S. 331 [hereinafter Vienna Convention], Art. 25, (Determining that a treaty, or parts of it, may be applied provisionally while its entry into force is pending if: (a) the treaty itself so provides; or (b) the negotiating states have in some other manner so agreed). Art. 25 (b) was the trigger for the proposed resolution, as the 2009 amendment to Article 6 did not provide for the provisional application of the London Protocol itself. Because there is no guidance in the Vienna Convention regarding the minimum votes for approval of this provisional resolution, it is ultimately up to the Conference of the Parties of the London Protocol to make these determinations. London Protocol, *supra* note 273, Art. 18 (7) and Art. 18 (8). The London Protocol specifically authorizes the consideration of resolutions in the meetings of the Protocol's contracting parties, or in their special meetings, if any. These special meetings determine that parties will establish rules and procedures for the adoption of resolutions. Unfortunately, our analysis of all the resolutions available online in the IMO website for registered users did not show any documentation specifying the quorum for adoption of these resolutions. IMO, Meeting Documents: Assembly Resolutions (Sessions 20 to 23), at https://docs.imo.org/. *See also* INTERNATIONAL ENERGY AGENCY, *Carbon Capture and Storage and the London Protocol: Options for Enabling Transboundary CO_2 Transfer, supra* note 274, at 16 (Also outlining six different solutions for applying the 2009 amendment in the absence of the two-thirds approval by the London Protocol's parties and underscoring that any party that does not vote will not be bound by the resolution, *Id*. at 17).

The resolution was adopted at the 2019 Conference of the Parties.[319] Its final language emphasized the need for parties to reduce their GHG emissions,[320] contextualizing CCS as an option in a portfolio of actions targeting these reductions.[321] The resolution enables the provisional application of the 2009 Amendment to Article 6 for countries that specifically conclude bilateral agreements and consent to be bound by the 2009 amendment. These agreements are defined as legally binding between states, meaning they must take place within instruments such as memorandum of agreement or a treaty; non-binding arrangements between states would include instruments such as a memorandum of understanding (MoU).[322] Parties to the London Protocol must also provide the Secretary-General of the International Maritime Organization (IMO) with a declaration on the provisional application of the 2009 amendment, and commit to notifying the IMO of any agreements and arrangements regarding permitting and liability for the export of carbon dioxide for sub-seabed geologic storage.[323] As long as parties to the London Protocol fully comply with the terms of the 2019 resolution and its related guidance, parties are considered compliant to the London Protocol.[324]

[319] This resolution was adopted on October 11, 2019. IMO, *Resolution LP.5(14) on the Provisional Application of the 2009 Amendment to Article 6 of the London Protocol of 2019* (2020), available as Annex 2 in the report of the meeting LC41. The resolution appears to have been adopted in a consensus, as its text does not refer to objections set forward by any of the Protocol's parties. *See also* the 41st Consultative Meeting of the Parties to the London Convention and the 14th Meeting of the Parties to the London Protocol: Meeting Summaries (October 7–11, 2019), at https://perma.cc/46VB-FTR2.

[320] IMO, *Resolution LP.5(14) on the Provisional Application of the 2009 Amendment to Article 6 of the London Protocol of 2019* (2020), available at Annex 2 in the report of the meeting LC41, Preamble: "*Reiterating* the serious concern regarding the implications for the marine environment of climate change and ocean acidification, as a result of elevated levels of carbon dioxide in the atmosphere; . . . *Reiterating* that resolution LP.1(1) recognizes that carbon dioxide capture and sequestration should not be considered as a substitute to other measures to reduce carbon dioxide emissions, but considered such sequestration as one of a portfolio of options to reduce levels of atmospheric carbon dioxide and as an important interim solution. . . ; *Stressing* that the disposal of carbon dioxide streams into sub-seabed geological formations does not remove the obligation under the London Protocol to reduce the need for such disposal and the commitments under UNFCCC to reduce greenhouse gas emissions, taking into account the recent special reports of IPCC; *Emphasizing* the need to further develop low carbon forms of energy; *Noting* that not all States have suitable sub-seabed geological formations for the sequestration of carbon dioxide streams."

[321] The resolution enables the provisional application of the 2009 export amendment to the London Protocol while urging contracting parties of the London Protocol to accept its 2009 amendments. IMO, *Resolution LP.5(14) on the Provisional Application of the 2009 Amendment to Article 6 of the London Protocol of 2019* (2020), *supra* note 320. This Resolution determines the following: "Decides to allow for the provisional application of the 2009 amendment pending its entry into force by those Contracting Parties which have deposited a declaration on provisional application of the 2009 amendment; (2) Invites Contracting Parties to deposit with the Depositary a declaration on provisional application of the 2009 amendment of the London Protocol pending its entry into force; (3) Further recalls the obligation to notify the Depositary of agreements or arrangements mentioned in article 6, paragraph 2 of the London Protocol (as amended by resolution LP.3(4)); (4) affirms that the export of carbon dioxide under the provisional application of article 6 of the London Protocol (as amended by resolution LP.3(4)), and in compliance with the requirements of paragraph 2 of the article (as amended by resolution LP.3(4)) will not be in breach of article 6 as in force at the time of the export; and (5) Urges Contracting Parties to consider accepting the amendment to article 6 of the London Protocol adopted through resolution LP.3(4)."

[322] IMO, *Guidance on the Implementation of Article 6.2 on the Export of Carbon Dioxide Streams for Disposal in Sub-Seabed Geological Formations for the Purpose of Sequestration, LC 35/15 Annex 6, supra* note 310, at Annex 6, Art. 3 (2).

[323] *Id.*

[324] *See, generally,* IMO, *Guidance on the Implementation of Article 6.2 on the Export of Carbon Dioxide Streams for Disposal in Sub-Seabed Geological Formations for the Purpose of Sequestration, LC 35/15 Annex 6, supra* note 310.

Importantly, the interim resolution also covers export to non-contracting parties. As long as minimum provisions equivalent to those of the London Protocol are met, including issuance of permits and protection and preservation of the marine environment, the amendment enables the export of carbon dioxide for geologic offshore storage.[325] This is particularly relevant when considering any carbon dioxide exports into the United States, which is a member of the London Convention but has not ratified the London Protocol.[326] In this case, the provisional application of the 2009 amendment may authorize the export of carbon dioxide for offshore storage within waters of the United States. By entering a legally binding bilateral agreement with another country that is bound by both the Protocol and its 2009 amendment, the U.S. would effectively be bound by the terms of Protocol for the operations associated with that agreement.

The following table summarizes the application of the London Protocol to the import and export of carbon dioxide, as it relates to both contracting and non-contracting parties.

[325] IMO, *CO_2 export amendment: Resolution LP.3(4), supra* note 302.

[326] United States Environmental Protection Agency, *Ocean Dumping: International Treaties*, at https://perma.cc/7UCG-HAH2. (Underscoring that the United States is a party to the London Convention and has signed, but never ratified, the London Protocol).

Table 3: Cross-border maritime transportation of carbon dioxide for offshore storage under the London Protocol after the 2009 Amendment and the 2019 Resolution for its provisional application[327]

London Protocol Status	*Importer: Contracting Party*	*Importer: Non-contracting Party*
Exporter: Contracting Party	Both exporter and importer must present a declaration of the provisional application of the 2009 amendment with the IMO and establish an agreement consistent with the London Protocol and international law.	The contracting party (exporter) is responsible for compliance with the London Protocol and must establish an agreement with the non-contracting party that, at a minimum, provides the same protection of the Protocol.
Exporter: Non-Contracting Party	The contracting party (importer) would establish an agreement with the non-contracting party and notify IMO. [328]	The London Protocol is not applicable. However, this scenario may be subject to UNCLOS (discussed in section 4 of this chapter).[329]

[327] This CCS table summarizes our previous discussion regarding the application of the London Protocol to its parties and non-parties, according to IMO, *Guidance on the Implementation of Article 6.2 on the Export of Carbon Dioxide Streams for Disposal in Sub-Seabed Geological Formations for the Purpose of Sequestration, LC 35/15 Annex 6, supra* note 310, at Annex 6. Importantly, the guidance focuses on the export from a contracting party to a non-contracting party of the London Protocol. *Id.* at 3.6.3, Annex 6. *See ALSO* INTERNATIONAL ENERGY AGENCY, LEGAL AND REGULATORY FRAMEWORKS FOR CCUS: AN IEA CCUS HANDBOOK, 74–75 IEA (Jul. 2022) (For a different table focusing on storage and utilization of captured carbon dioxide).

[328] In this scenario, only the importer is bound by the London Protocol, which is silent about imports of carbon dioxide; as discussed, the London Protocol only focuses on export. Under a teleological interpretation, *i.e.*, aiming at best fulfilling the goals of the Protocol, the importer-contracting party should notify the IMO that carbon dioxide will be exported by a non-contracting party of the London Protocol.

[329] This report examines UNICLOS in section 4 of this Chapter.

Ultimately, most experts contend that the 2019 resolution has removed the last significant barrier to CCS while still maintaining the marine protections under the London Protocol and related guidance of its parties.[330] Though some view the resolution as imperfect,[331] it is generally regarded as an effective solution.[332]

The following table summarizes the three major modifications to the London Protocol as it relates to carbon dioxide transport and storage.

Table 4: Instrumental modifications of the London Protocol regarding CCS

Instrumental modification to the London Protocol	*Content and status of the modification of the London Protocol*
2006 Amendment to Annex 1	Enables sub-seabed carbon dioxide storage. Status: effective since February 2007.
2009 Amendment to Article 6	Allows cross-border transportation of carbon dioxide for storage. Status: pending approval. The amendment has yet to enter into force, as Article 21 of the London Protocol requires two-thirds approval.
2019 Resolution of the Conference of the Parties	Authorizes the interim application of the 2009 amendment to Article 6 provided interested parties enter into specific bilateral or multilateral agreements, followed by registration and notification to the IMO. Status: effective since October 2019.

A number of countries that are strategically positioned for sub-seabed carbon dioxide storage have yet to enter into specific agreements for provisional application of the export amendment under the 2019 resolution. To date, Belgium, Denmark, Republic of Korea, the Netherlands, Norway, Sweden, and the United Kingdom have

[330] *See, e.g.,* Tim Dixon & Andrew Birchenough, *Exporting CO_2 for Offshore Storage – The London Protocol's Export Amendment,* GHGT-15, 7 (2021). The EU Parliament and EU Council also agree with this interpretation. *See* EU Parliament and EU Council, 2009/31/EC of the European Parliament and of the Council on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No. 1013/2006 (Apr. 23, 2009), stating: "*Whereas* (12-13): At the international level, legal barriers to the geological storage of CO_2 in geological formations under the seabed have been removed through the adoption of related risk management frameworks under the 1996 London Protocol to the 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (1996 London Protocol)." (emphasis in original).

[331] Weber, *supra* note 269, at 392 (Criticizing the solution as not the most fitting but acknowledging its effectiveness).

[332] Hisham Al Baroudi et al., *A Review of Large-Scale CO_2 Shipping and Marine Emissions Management for Carbon, Capture, Utilisation and Storage*, 287 Applied Energy 1, 14 (2021) (Highlighting that the provisional application of the London Protocol under the 2019 resolution enabled the cross-border transportation of carbon dioxide for storage).

deposited declarations on their intent to utilize the provisional application of the 2009 amendment with the IMO.[333]

In late 2022, Denmark signed an agreement with Belgium authorizing cross-border transportation of carbon dioxide for offshore storage.[334] These two countries are the first to pursue cross-border transport of carbon dioxide, effectively injecting it into offshore geologic formations early in 2023.[335] This unprecedented agreement and the subsequent injection are particularly relevant for international law purposes, as it sets the standard for the level of detail that parties to the London Protocol need to provide the IMO in the future. Belgium and Denmark were the first states to have concluded such a bilateral agreement.[336] France followed suit, signing a similar agreement with Denmark; and, more recently, bilateral agreements signed between Norway, France, Belgium, Denmark, the Netherlands and Sweden enable carbon dioxide sequestration in Norway.[337] Germany is facing pressure to sign similar agreements with Norway and Denmark to enable export of carbon dioxide captured in Germany for offshore storage in Norway and Denmark.[338]

Recently, the European Commission concluded that there is significant alignment between the requirements of the London Protocol and the current legal framework in the European Economic Area (EEA)[339] regarding the capture, cross-border transportation, and safe geological storage of carbon dioxide between EU Member States and EEA countries.[340] It contends that Directive 2009/31 and Directive 2003/87, which are binding for all member states, "can act as a relevant 'arrangement' between the parties in the meaning of Article 6 (2) of the London Protocol."[341] Likewise, the EEA treaty and the incorporation of these two directives in the EEA legal regime are also arrangements with EEA partners for the London Protocol's purposes.[342]

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[333] International Maritime Organization (IMO), *Status of IMO Treaties: Comprehensive Information on the Status of Multilateral Conventions and Instruments in respect of which the International Maritime Organizations or its Secretary-General performs depositary or other functions, The London Convention, supra* note 276, at 572.

[334] Naida Hakirevic Prevljack, *Danish-Belgium CCS Agreement Paves Way for Creating 'Actual Market' for Maritime Transport of CO_2*, MARKET OUTLOOKS (Oct. 3, 2022).

[335] Global CCS Institute, *Denmark's Project Greensand Begins Groundbreaking Cross-border CO_2 Injection,* LATEST NEWS (Mar. 8, 2023) (The carbon dioxide came from a chemical facility in Belgium and was injected in Denmark's North Sea, as part of the Greensand Project).

[336] EU: Commission Services Analysis Paper for the Information Exchange Group (IEG) under Directive 2009/31/EC, *London Protocol Analysis,* EU COMMISSION 6 (Sep. 30, 2022), at https://perma.cc/AF28-HGGK.

[337] Paul Messad, *France Strikes CO_2 Storage Deal with Denmark*, EURACTIV FRANCE (Mar. 5, 2024) (Noting the relevance of France and Denmark's bilateral agreement); and Nicolai Mykleby-Skaara, *Four North Sea Countries and Sweden Sign Agreement on CO_2 Transport and Storage*, AKER CARBON CAPTURE (Apr. 15, 2024).

[338] Vera Eckert, *Wintershall Dea Urges Germany to Clear CO_2, Exports for Storage*, REUTERS (Jan. 16, 2023).

[339] The European Parliament, *The European Economic Area, Switzerland and the North*, at https://perma.cc/594T-P5KT. The European Economic Area (EEA) was established in 1994 to extend the EU's provisions on its internal market to the European Free Trade Area (EFTA) countries. Norway, Iceland, and Liechtenstein are parties to the EEA. Switzerland is a member of EFTA but is not part of the EEA. The EU and EEA EFTA partners (Norway and Iceland) are also connected by several northern policies.

[340] EU: Commission Services Analysis Paper for the Information Exchange Group (IEG) under Directive 2009/31/EC, *London Protocol Analysis, supra* note 336, at 26.

[341] *Id.*

[342] *Id.*

The Commission states that member states that are party to the London Protocol may conduct additional bilateral arrangements with other member states and EEA partners exclusively on issues which are not covered by the EU directives. This means that these bilateral agreements would be strictly limited to residual issues not already addressed by EU law.[343]

Ultimately, the Commission's interpretation would authorize EEA member states to circumvent the provisional requirements of having a specific bilateral agreement, because in practice the EU and the EEA would already provide for the general framework for CCS. Of course, this is merely the EU Commission's interpretation and suggests a legal interpretative gymnastic that does not advance international law. Contracting parties under the London Protocol have an obligation to obey the provisions of the treaty and a failure to do so would mean breaching international law.[344] It is noteworthy that in their unprecedented cross-border shipping of carbon dioxide for storage, Belgium and Denmark actually signed an agreement establishing the details for this complex shipping operation as specified under the 2019 provisional application to Article 6 of the London Protocol.[345] Another recent agreement authorizing this provisional application of Article 6 of the London Protocol was signed by France and Denmark.[346]

Finally, the IEA recently highlighted the need for international cooperation to ensure that further agreements are created, emphasizing that the London Protocol is no longer a significant hurdle for the export and storage of carbon dioxide.[347] The ratification of the 2009 amendment would be the optimal solution, as it would negate the need for countries to arrange specific agreements. As the number of parties to the London Protocol may increase, particularly in Africa and Asia, newcomers may be more willing to ratify the amendment upon ascending to the Protocol.[348] For the moment, it remains to be seen how both parties and non-parties will navigate the current system under the interim application of the 2009 amendment.

2. Basel Convention

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal aims to establish a global regime for controlling the international trade of hazardous wastes. The Convention

[343] *Id.* The Commission contends that the EU member states that are parties to the London Protocol should notify the IMO that elements of EU Law (specifically, Directives 2009/31 and 2003/87) are part of the relevant arrangements for exchanges between EU member states jointly with any additional bilateral arrangements concluded among member states on matters not regulated under these directives. Similarly, a notification to IMO must occur regarding the EEA treaty as part of the pertinent arrangement between EU member state parties to the London Protocol and EEA countries.

[344] Lena W. Østgaard & Ingvild Ombudstvetdt, *Regulatory frameworks for cross-border transportation and offshore storage of CO_2 in Europe*, SSRN 1, 16 (Dec. 2023), at https://perma.cc/Q5XY-LBZH.

[345] Carolina Arlota, *Beyond Trouble Waters? Unprecedented cross-border transportation and injection of carbon dioxide (CO_2) shows promise*, Climate Law Blog (Mar. 23, 2023), at https://perma.cc/2NL2-GXLW.

[346] Messad, *supra* note 337.

[347] International Energy Agency, *CO_2 Transport and Storage: Tracking Report,* IEA (Rachael Moore & Carl Greenfield eds., Sep. 2022).

[348] The use of "ascending" here is strictly technical under international law and is not to imply that merely parties to the London Convention would be increasing their protection upon ratification of the London Protocol. In other words, "ascending" is a technical term referring to any party ratifying a treaty.

does not create a general prohibition on the cross-border transportation of hazardous waste.[349] Rather, following the concept of prior informed consent (PIC), the Convention requires that before an export occurs, authorities of the exporting state shall notify the authorities of the prospective importing states as well as any state the hazardous material will pass through in transit. The exporting state is required to share detailed information on the intended movement with all involved states, and the export may only proceed if and when all involved parties provide their written consent.[350]

Parties to the Basel Convention cannot trade Basel-covered waste with nonparties in the absence of a predetermined agreement between countries.[351] In addition, these predetermined agreements cannot be "less environmentally sound" than the Convention itself.[352] There are currently 191 parties to the Basel Convention, with the notable exception of the United States, which signed the Convention in 1990 but never ratified it. [353]

The Basel Convention's PIC procedure establishes strict requirements for the transboundary movement of hazardous and other wastes.[354] The PIC process has four stages: (1) notification; (2) consent and issuance of a movement document; (3) transboundary movement of the waste(s) from an area under the jurisdiction of one state to (or through) an area under the jurisdiction of another state, or through an area under the jurisdiction of no state; and (4) confirmation of disposal.[355] Each of these stages may be expensive and time-consuming.[356] The Convention also requires that only an authorized person or authorized transport and disposal personnel perform these operations, and that wastes subject to a transboundary movement be packaged, labelled and transported in accordance with international practices.[357] As currently designed, these procedures would not pose a significant hurdle for the cross-border transportation of carbon dioxide for storage purposes.

The Basel Convention does not apply to hazardous materials that do not qualify as wastes.[358] The Convention defines wastes as "substances or objects which are disposed of or are intended to be disposed of or are required

[349] Raine, *supra* note 252, at 357.
[350] The Basel Convention, *supra* note 250, Art. 6–7.
[351] United States Environmental Protection Agency, *International Agreements on Transboundary Shipments of Hazardous Waste* (Sep. 13, 2023), at https://perma.cc/2S6T-K3LJ.
[352] The Basel Convention, *supra* note 250, Art. 11.
[353] Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, Status of Ratification (2022), at https://perma.cc/X2EH-MH3F. A table naming each of these 191 parties can be found in the Appendix of this chapter.
[354] "Other wastes," which are also called "wastes subject to special consideration," under Annex II, are not pertinent to our analysis because they refer to household wastes, residues from the incineration of household wastes and several plastic wastes. The Basel Convention, *supra* note 250, Annex II ("other wastes"). See also our discussion *supra* and references thereafter.
[355] The Basel Convention, *supra* note 250, Art. 6 and 7; and Annex V, which details the information to be provided on notification and in the movement document. *See also* Jonathan Krueger, *Prior Informed Consent and the Basel Convention: The Hazards of What Isn't Known*, 7 THE JOURNAL OF ENVIRONMENT & DEVELOPMENT 115–37 (1998).
[356] PREVENT & StEP, Practical Experiences with the Basel Convention, Discussion Paper 1, 4–12 (2021), at https://perma.cc/8YSW-8WXR. (Outlining the lack of cost-effective procedures implementing the Basel Convention, particularly in low- and middle-income countries).
[357] The Basel Convention, *supra* note 250, Art. 4.
[358] The Basel Convention, *supra* note 250, Art. 1 combined with Annexes I, II, III, and VIII as detailed below.

to be disposed of by the provisions of national law."[359] This definition would encompass carbon dioxide that is captured at point sources or removed from the atmosphere and intended to be permanently sequestered in subsurface geologic rock formations (i.e., the carbon dioxide would be "intended to be disposed of" in the rock formations). However, carbon dioxide that is used in EOR or for some other purpose would not qualify as "waste" because it is not "disposed of."[360]

The Basel Convention is organized into multiple annexes. The provisions of the most important annexes for this analysis are listed in the table below:

Table 5: Annexes of the Basel Convention[361]

Basel Convention Annex	***Convention Language***	***Description***
Annex I	Article 1 (a): The following wastes that are subject to transboundary movement shall be '**hazardous wastes**' for the purposes of this Convention: (a) Wastes that belong to any category contained in **Annex I** […]	*Categories of wastes to be controlled*. Divided into a list of "waste streams" and a list of "wastes having as constituents." Relevant **waste streams** include: waste oils/water, hydrocarbons/water mixture (Y9); waste tarry residues arising from refining, distillation (Y11); wastes of explosive nature not subject to other legislation (Y15). Relevant **wastes having as constituents** include: arsenic and compounds (Y24); cadmium and compounds) (Y26); mercury and compounds (Y29).
Annex II	Article 1 (b): Wastes that belong to any category contained in **Annex II** that are subject to transboundary movement shall be '**other wastes**' for the purposes of this Convention.	*Categories of wastes requiring special consideration*. Establishes the scope of "other wastes," specifically household waste and incinerator ash.

[359] The Basel Convention, *supra* note 250, Art. 2.
[360] Raine, *supra* note 252, at 358.
[361] The authors developed Table 5 to summarize the potential application of the Basel Convention (if any) to the transportation of carbon dioxide for storage. Table 5 is based on the text of the Basel Convention as summarized by the authors. The Basel Convention, *supra* note 250, Art. 1 combined with Annexes I–IV.

Basel Convention Annex	***Convention Language***	***Description***
Annex III	Article 1(a): […] unless they do not possess any of the characteristics contained in **Annex III**.	*Hazardous characteristics*. Outlines criteria to determine whether or not a waste is hazardous, including: explosive (H1); flammable liquids (H3); oxidizing (H5.1); poisonous (acute) (H6.1); corrosives (H8); liberation of toxic gases in contact with air or water (H10); toxic (delayed or chronic) (H11); ecotoxic (H12); capable, by any means, after disposal, of yielding another material which possesses any of the characteristics listed in the complete list (H13).
Annex IV	Article 2: For the purposes of this Convention […] 4. '**Disposal**' means any operation specified in **Annex IV** to this Convention.	*Disposal operations*. Presents a specific and exhaustive list of ways to dispose of waste, including deep injections, release of materials into deep water, and permanent storage.

The Basel Convention distinguishes between two types of waste: "hazardous waste" as defined via Annexes I and III, and "other waste" as defined in Annex II.[362] To qualify as a hazardous waste, a substance must either (1) be classified as one of the categories listed in Annex I of the Convention *and* possess at least one of the hazardous characteristics listed in Annex III, or (2) be defined or considered to be hazardous under domestic legislation of the party of export, import or transit.[363]

Establishing whether the Basel Convention applies to potential carbon dioxide transportation and storage first requires determining whether carbon dioxide could qualify as either "hazardous" or "other" waste as defined by the Convention. Since the "other waste" category established by Annex II in Article 1(b) applies primarily to domestic wastes, carbon dioxide does not qualify as "other waste" under the Basel Convention,[364] nor is it

[362] The Basel Convention, *supra* note 250, Art. 1: "Scope of the Convention: (2). Wastes that belong to any category contained in Annex II that are subject to transboundary movement shall be 'other wastes' for the purposes of this Convention."

[363] The Basel Convention, *supra* note 250, Art. 1 states: "Scope of the Convention: (1). The following wastes that are subject to transboundary movement shall be 'hazardous wastes' for the purposes of this Convention: (a) Wastes that belong to any category contained in Annex I, unless they do not possess any of the characteristics contained in Annex III; and (b) Wastes that are not covered under paragraph (a) but are defined as, or are considered to be hazardous wastes by the domestic legislation of the Party of export, import or transit."

[364] "Other wastes," which are also called "wastes subject to special consideration," under Annex II, are not pertinent to our analysis because they refer to household wastes, residues from the incineration of household wastes and several plastic wastes. The Basel Convention, *supra* note 250, Annex II ("other wastes").

eligible for consideration as a "waste presumed hazardous."[365] Additionally, the authors' review of the parties' communication to the Basel Convention's Secretariat do not show any instances of domestic legislation that defines carbon dioxide storage shipments as "hazardous."[366]

The remaining question, therefore, is whether carbon dioxide could qualify as "hazardous" waste within the Convention's existing categorizations in Annexes I and III. With no minimum concentrations or thresholds established in the Basel Convention's classification system for hazardous waste,[367] the precise determinations about what constitutes waste are notoriously convoluted in practice.[368] Annex I does not specify tests for wastes streams or define purity levels, and no percentages of substances are mentioned;[369] likewise, Annex III does not detail percentages nor does it outline tests to determine whether or not a substance possesses a hazardous quality, with the only exception being a test for inflammability.[370] However, Annex III does acknowledge that certain types of wastes are not yet fully documented, welcoming tests of controlled wastes developed by national legislation to decide if the materials of Annex I present any of the hazardous characteristics listed in Annex III.[371]

This lack of clarity has generated legal controversy about whether carbon dioxide for cross-border storage should be considered a "hazardous waste" under the Basel Convention. Some scholars contend that carbon dioxide is not specifically mentioned in the Convention as hazardous waste, and therefore the Convention does not apply.[372] Practically speaking, an official classification of carbon dioxide as hazardous waste could lead to tensions between states that decide to prohibit carbon dioxide transportation and states that allow it, posing a potential obstacle to the uniform development of CCS.[373] Likewise, should carbon dioxide be officially included

[365] The Basel Convention, *supra* note 250, Annex VIII, A does not appear to be relevant for carbon dioxide streams as Annex VIII, A regulates metal and metal bearing wastes; wastes containing principally inorganic constituents, which may contain metals and organic materials; wastes containing principally organic constituents, which may contain metals and inorganic materials (includes waste from the production or processing of petroleum coke and bitumen, waste tarry residues arising from refining, distillation and any pyrolytic treatment of organic materials, among others).

[366] *See* our discussion in this section, a few paragraphs infra; *see also* footnote 394 and references therein.

[367] Ray Evans, *Basel Convention: Why National Sovereignty is Important*, Proceedings of the Fourth Conference of the Samuel Griffith Society, 4 THE SAMUEL GRIFFITH Soc. 1, 10 (1994).

[368] Ishtiaque Ahmed, *The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal: A Legal Misfit in Global Ship Recycling Jurisprudence*, 29 WASH. INT. L. J. 411, 427 (2020).

[369] The Basel Convention, *supra* note 250, Annex I.

[370] The Basel Convention, *supra* note 250, Annex III.

[371] The Basel Convention, *supra* note 250, Annexes I and III.

[372] *See, e.g.,* the University College London (UCL) Carbon Capture Legal Programme, *CO_2 Transport for Storage*, at https://perma.cc/WW3A-XSC8; Swati Gola & Kyriaki Noussia, *From CO_2 Sources to Sinks: Regulatory Challenges for Trans-Boundary Trade Shipment and Storage*, 179 RESOURCES, CONSERVATION & RECYCLING 3 (2022) (Affirming that carbon dioxide is not prohibited nor controlled in the Basel Convention).

[373] The University College London (UCL) Carbon Capture Legal Programme, *CO_2 Transport for Storage*, *supra* note 372.

within the scope of the Convention, there would be discrepancies in how importing parties manage hazardous waste in an "environmentally sound manner" under the Convention.[374]

On the other hand, arguments that favor the inclusion of carbon dioxide for cross-border storage within the Basel Convention interpret the characteristics listed in the annexes of the Convention more literally, contending that some of the hazardous characteristics listed in Annex I (waste tarry residues arising from refinery, explosiveness) and Annex III (explosiveness, corrosiveness, oxidizing, delayed or chronic toxicity, and ecotoxicity) could be applicable to carbon dioxide in a specific set of physical and chemical circumstances.[375] This line of reasoning is further supported under Annex IV of the Convention, which targets disposal activities relating to the "injection and storage" of waste.[376]

However, such a literal interpretation of Annex III would mean that the presence of a single molecule of listed materials would characterize the waste as hazardous.[377] This has been previously discussed in the context of copper and steel, which cannot be entirely pure due to having lead and zinc as compounds.[378] Therefore, applying a literal interpretation of the Basel Convention to the transboundary movement of steel would have made a significant part of world trade virtually impossible.[379] The Basel Convention was amended in 1998, when an additional annex (Annex VIII) was added to authorize, among other inclusions, the cross-border transportation of steel and copper scraps unless they presented "hazardous characteristics."[380] Therefore, this demonstrates that literal interpretation was not favored by the contracting parties of the Convention at that time, because steel and copper scraps were ultimately permitted.

With this in mind, parties should not favor such a literal interpretation regarding the presence of impurities in a carbon dioxide stream. A literal interpretation is ultimately contrary to the intent of the Convention, and, as

[374] The Basel Convention, *supra* note 250, Art. 2 (8): "Environmental sound management of hazardous wastes means taking all practical steps to ensure that hazardous wastes or other wastes are managed in a manner which will protect human health and the environment against the adverse effects which may result from such wastes."
[375] Raine, *supra* note 252, at 358.
[376] The Basel Convention, *supra* note 250, Annex IV (d) (3), for deep injections; Annex IV (d) (4) for release sea/ocean, including sea-bed injections.
[377] Ray Evans, *Basel Convention: Why National Sovereignty is Important*, Proceedings of the Fourth Conference of the Samuel Griffith Society, 4 THE SAMUEL GRIFFITH Soc. 1, 11 (1994) (Highlighting that in superfund collection and enforcement actions in the United States, EPA has interpreted the absence of minimum concentrations to mean that no such limitations were intended; therefore, the presence of a single molecule would characterize the material as within the scope of the legal protection).
[378] Evans, *supra* note 377, 11–12.
[379] *Id.* at 12.
[380] The Basel Convention, *supra* note 250, Annex VIII (B), which lists steel scrap and copper scrap as non-hazardous waste, "unless they contain Annex I material to an extent causing them to exhibit and Annex III characteristic."

such, against international law.[381] It would also be unreasonable, as no stream of carbon dioxide can be completely pure.[382]

The IPCC has long opposed a literal interpretation of the Basel Convention, with its Special Report on Carbon Dioxide Capture and Storage concluding that "there is no indication that carbon dioxide will be defined as a hazardous waste under the [Basel] Convention except in relation to the presence of impurities such as some heavy metals and some organic compounds that may be entrained during the capture of carbon dioxide. Adoption of schemes where emissions of SO_2 and NO_x would be included with the carbon dioxide may require such a review."[383]

Under this IPCC interpretation, the Basel Convention could be differentially applied to carbon dioxide depending on the purity standards of the carbon dioxide stream itself. This interpretation, while rarely cited in the literature,[384] offers one practical way to evaluate whether carbon dioxide would be classified as "hazardous" under the Convention. As mentioned in Chapter 2 of this report, the specific composition of transported carbon dioxide will vary depending on the carbon dioxide capture methodology and the source of the stream.[385] Previous purity guidelines applicable for pipelines are not advisable,[386] as purity levels in ships are likely to be more stringent due to differences in temperature and pressure.[387]

Currently, there are two sets of guidelines for the purity of the carbon dioxide for storage in Europe. The table below summarizes the percentages of each impurity as recommended by both sets of guidelines.

[381] Vienna Convention on the Law of Treaties, May 23, 1969 (entered into force Jan. 27, 1980), 1115 U.N.T.S. 331 [hereinafter Vienna Convention], Art. 31 (1), which requires parties to interpret treaties in good faith and considering its purpose as well as ordinary meaning of its words.

[382] *See, e.g.,* Hisham Al Baroudi et al., *Techno-economic analyses of CO_2 Liquefaction: Impact of Product Pressure and Impurities*, 103 Int. J. of Refrigeration 301, 309 (2019).

[383] IPCC, IPCC Special Report on Carbon Dioxide Capture and Storage Prepared by Working Group III of the Intergovernmental Panel on Climate Change 189 (Bert Metz et al. eds., 2005).

[384] Of all the articles of our literature review, only two addressed the IPCC position. The University College London (UCL) Carbon Capture Legal Programme, *CO_2 Transport for Storage, supra* note 372, acknowledges the position of the IPCC, but highlights that CO_2 is neither a regulated substance nor CCS is a regulated activity under the Basel Convention. In a similar vein, *see* Raine, *supra* note 252, at 357.

[385] Zero Emissions Platform—ZEP, *Network Technology Guidance for CO_2 Transport by Ship: Guidance Note 20 ZEP*, ZEP (Mar. 2022), at https://perma.cc/NG6Z-YSMX.

[386] DYNAMIS, Project N. 019672: DYNAMIS CO_2 Quality Recommendations: Towards Hydrogen and Electricity Production with Carbon Dioxide Capture and Storage, DYNAMIS Consortium 2006-2009 (Einar Jordanger ed., 2009), at https://perma.cc/HX4Y-M54P. (For a renowned guideline for pipelines).

[387] IEAGHG, *The Status and Challenges of CO_2 Shipping Infrastructures*, *supra* note 264, at 10.

Table 6: European Guidance on Shipping Carbon Dioxide Transportation[388]

Component	*Northern Lights Concentration (ppm mol)*	*European Union Recommendations*
Carbon Dioxide (CO_2)	Not defined	>99.7% by volume
Acetaldehyde	≤20	Not defined
Amine	≤10	Not defined
Ammonia (NH_3)	≤10	Not defined
Argon (Ar)	Not defined	<0.3% by volume
Cadmium (Cd) / Titanium (Ti)	≤0.03 (sum)	Not defined
Carbon Monoxide (CO)	≤100	<2000ppm
Hydrogen (H_2)	≤50	<0.3% by volume
Hydrogen sulfide (H_2S)	≤9	<200ppm
Formaldehyde	≤20	Not defined
Mercury (Hg)	≤0.03	Not defined
Methane	Not defined	<0.3% by volume
Nitric oxide/Nitrogen dioxide (NOx)	≤10	Not defined
Oxygen (O_2)	≤10	Not specified
Sulfur oxides (SOx)	≤10	Not defined
Water (H_2O)	≤30	<50ppm

Many of the components listed above are common in carbon dioxide streams captured at point sources. The guidelines above consider certain impurities to be some combination of highly toxic (ammonia, cadmium), toxic (carbon monoxide, mercury, nitric oxide), corrosive (ammonia, hydrogen sulfide, mercury, oxygen in the presence of water), flammable (hydrogen sulfide), and fatal (hydrogen sulfide) as each of these hazardous characteristics are defined by Annex III the Basel Convention.[389]

As such, the above analysis may be relevant for establishing the hazardous characteristics of carbon dioxide stream under Annex III of the Basel Convention. If these guidelines were to be formally incorporated via an

[388] Source: Zero Emissions Platform—ZEP, *supra* note 385.
[389] *Id.* at 36–38.

amendment, the presence of any of these components beyond recommended levels would trigger the need to comply with the requirements for export, transit and import of hazardous wastes established in the Convention.[390]

For the moment, however, this scenario seems farfetched. There are no such proposals for an amendment of this kind. In addition, as the London Protocol's section demonstrates, international law is heading in the opposite direction, creating an enabling legal environment for the permanent storage of carbon dioxide. With the pressing needs posed by climate change, efforts to pave the way for carbon dioxide storage are only expected to gain momentum. Nonetheless, the discussion of purity levels is relevant for the effectiveness of international law, and parties to the Basel Convention should consider clarifying that carbon dioxide is not within its scope.

In short, our literature review found that most authorities do not consider the Basel Convention to be a significant obstacle to cross-border transportation of carbon dioxide for storage. A recent report by the IEA, which was silent on the Basel Convention, concluded that "although there has been a proliferation of public international law which can result in overlap or conflicting frameworks, there do not appear to be any showstoppers that would prevent the international development of CCUS."[391]

Though it seems unlikely to occur, one theoretical possibility for restricting carbon dioxide transportation under the Basel Convention may arise from the passage of domestic laws that establish carbon dioxide as hazardous waste by the parties of the Basel Convention.[392] So long as the party properly communicated this to the Secretariat, the classification of carbon dioxide as a hazardous waste would apply to all of the parties to the Basel Convention.[393] As noted earlier, according to our review of the 79 parties who submitted their information to the Secretariat in 2021, this has not occurred.[394]

However, the authors' analysis did reveal that several parties have mentioned the EU Regulation on Waste Shipment (RWS) in their submission to the Basel Secretariat.[395] The regulation applies to the shipment of waste between EU member states, specifically: (1) waste transported within the EU or transiting through

[390] The Basel Convention, *supra* note 250, Art. 1 (a) combined with Annexes I and III (defining hazardous waste); whereas the procedure of prior informed consent is detailed in Art. 6 and 7.
[391] IEAGHG, *The Status and Challenges of CO_2 Shipping Infrastructures*, *supra* note 264, at 12, 51–54.
[392] The Basel Convention, *supra* note 250, Art. 1 (b), determining that "hazardous waste" can be defined also in accordance with the domestic legislation of the party of export, import, or transit. Art. 3 details the procedures for these inclusions to be effective.
[393] The Basel Convention, *supra* note 250, Art. 3 (1) combined with Art. 13, 2 (b).
[394] Our review of the answers of the parties to question 2 of the questionnaires sent by the Secretariat does not indicate that carbon dioxide has been included as a hazardous substance under their national legislation. Most of the answers do not list additional requirements for handling hazardous materials than those of the Basel Convention, according to answers to question 2 (b) (iv). The exceptions are as follows: Belarus required nontariff measures; Madagascar, Mexico, Thailand, Turkmenistan, and Pakistan required additional documentation under their national law, with Pakistan also requiring pictures and previous environmental assessments of the disposal facilities; Germany, Norway, Sweden, and the UK mentioned EU Waste Shipment Regulation (EC Reg. 1013/2006). The information currently available on the Basel Convention's website is limited to the 2021 legislative year. The Basel Convention, National Reports on Nation Definitions of Waste (2021), at https://perma.cc/G954-948F.
[395] Reference is made to our discussion in the footnote above.

third countries; (2) waste imported into the EU from third countries; (3) waste exported from the EU to third countries; and (4) waste transiting through the EU on the way to or from third countries.[396] In 2009, the EU directive on CCS[397] amended Art. 1(3) of the RWS to exclude the shipment of carbon dioxide for the exclusive purpose of geological storage from these regulations.[398]

While the EU CCS Directive[399] aims at preventing adverse effects regarding the security of the transport network and mandates that member states cooperate to jointly implement EU legislative requirements regarding cross-border transportation of carbon dioxide for CCS,[400] it does not apply to carbon dioxide emissions generated from shipping.[401] Further clarification is needed on how the RWS may apply to the Basel Convention as it relates to transboundary carbon dioxide movement and storage.

It is noteworthy that on December 5, 2019, the "Ban Amendment" to the Basel Convention entered into force. The amendment prohibits hazardous waste exports from member states of the Organization for Economic Co-operation and Development (OECD), the European Union, and Liechtenstein to developing countries.[402] Moreover, hazardous wastes can only be transported if: (1) the state of origin demonstrates that it does not have the technical capacity, storage sites, or adequate facilities to dispose of the waste in its own territory; (2) if the

[396] Regulation (EC) N. 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste (consolidated version: 2021), Art. 1 (2).

[397] Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) N. 1013/2006. (Directive 2009/31, as its name conveys, focuses on storage; Art. 24 contains limited provisions on transportation aspects, ceding much of the regulatory scheme to member states).

[398] European Commission, Study Supporting the Evaluation of Regulation (EC) No. 1013/2006 on Shipments of Waste (Waste Shipment Regulation), EU COMMISSION 107 (Keir McAndrew et al. eds., 2019).

[399] IEAGHG, *Exporting CO_2 for Offshore Storage – The London Protocol's Export Amendment and Associated Guidelines and Guidance, supra* note 296, at 9 (Noting that the EU CCS Directive requirements are aligned with those of the OSPAR Convention and the London Protocol). Interestingly, the London Protocol and OSPAR Convention are aligned, but the Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention, 1992) does not authorize sub-seabed storage and has legal superiority over the EU CCS Directive: Therese Nehler & Mathias Fridahi, *Regulatory Preconditions for the Deployment of Bioenergy with Carbon Capture and Storage in Europe*, 4 FRONTIERS IN CLIMATE: PERSPECTIVES 1, 5 (2022).

[400] Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the Geological Storage of Carbon Dioxide, *supra* note 297, Art. 24.

[401] *See* Carbon Neutral Cities, *Note 7: Barriers to Transport and Storage of CO_2 within the European Union,* CNCA 4 (2020), at https://perma.cc/RUM4-T7NB.

[402] *See* UNEP, *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal: Texts and Annexes*, at https://perma.cc/83HR-M3BA. (The "Ban Amendment" prohibits parties that are included in the new Annex VII (parties and other states that are members of the OECD, EC, Liechtenstein) of all transboundary movements to states not included in Annex VII of hazardous wastes covered by the Convention that are intended for final disposal, and of all transboundary movements to states not included in Annex VII of hazardous wastes covered by paragraph 1 (a) of Article 1 of the Convention that are destined for reuse, recycling or recovery operations. In the so-called Ban Amendment, parties listed in Annex VII (members of OECD, EU, Liechtenstein) immediately prohibit all transboundary movements of hazardous wastes that are destined for final disposal operations from OECD to non-OECD states). The Ban Amendment is binding for parties to the Basel Convention that have expressed their consent to be bound by it.

wastes are required as raw material for recycling or recovery industries by the importing state; or (3) if the transboundary movement is in accordance with other criteria established by the parties of the Convention.[403]

Importantly, the Basel Convention outlines international cooperation and technical standards that shall be obeyed for the purpose of legally transporting hazardous waste.[404] To date, however, there are no uniform international standards regulating the transport of carbon dioxide for storage, which is indicative of a legislative gap that should be closed by the formulation and harmonization of uniform international standards for the transport of carbon dioxide for storage.[405]

There is an expert review working group with a broad mandate to consider potential amendments to Annexes I, III, IV, and VIII of the Convention. Currently, carbon dioxide does not appear to be listed as part of these amendments.[406] As states individually or jointly apply their own interpretation of the Convention,[407] any further interpretation of the Convention related to the elements applicable to carbon dioxide transportation and storage is left to the International Court of Justice or arbitral tribunals under the dispute settlement procedure established in the Convention.[408] Only parties to the Convention have standing to challenge the interpretation of the Convention, and they can only do so after negotiating with the party or parties who have allegedly breached the Convention.[409] In the meantime, international customary law establishes that all states remain obliged to interpret the Basel Convention in good faith, both in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in consideration with the treaty's object and purpose.[410]

3. Bamako Convention

The Bamako Convention is a regional convention applicable to Organization of African Unity (OAU) countries, commonly referred to as the African Union.[411] The Convention reflects the concerns of these countries that the Basel Convention was insufficiently stringent,[412] particularly with regard to authorizing the export of wastes to non-parties under a bilateral or multilateral agreement.[413] The Bamako Convention prohibits the import of waste into Africa from non-contracting parties, deeming such imports illegal and criminal.[414]

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[403] The Basel Convention, *supra* note 250, Art. 4 (9).
[404] The Basel Convention, *supra* note 250, Art. 10.
[405] The University College London (UCL) Carbon Capture Legal Programme, *CO_2 Transport for Storage*, *supra* note 372.
[406] The Basel Convention, Expert Working Group on the Review of the Annexes (2021), at https://perma.cc/J7C8-FXN3.
[407] Raine, *supra* note 252, at 356.
[408] The Basel Convention, *supra* note 250, Art. 20.
[409] *Id.*
[410] Vienna Convention on the Law of Treaties, May 23, 1969 (entered into force Jan. 27, 1980), 1115 U.N.T.S. 331 [hereinafter Vienna Convention], Art. 31 (1).
[411] The Bamako Convention, *supra* note 250, Art. 23.
[412] HUNTER ET AL., *supra* note 248, at 961.
[413] The Basel Convention, *supra* note 250, Art. 11.
[414] The Bamako Convention, *supra* note 250, Art. 4 (1).

The Bamako Convention requires parties to adopt appropriate legal, administrative, and other measures within their jurisdictional area to prohibit the import of hazardous waste into Africa from non-contracting parties. The Convention also prohibits all dumping of waste at sea,[415] which gives it a broader scope than the Basel Convention.[416] The Bamako Convention also has more stringent criteria than the Basel Convention.[417] For example, its definition of hazardous waste also covers substances that are radioactive or have been banned, cancelled, refused registration by government regulatory action, or voluntarily withdrawn from registration in the country of manufacture for human and environmental reasons.[418]

Considering the Bamako Convention's broader definition of "hazardous waste,"[419] scholars have noted that carbon dioxide could be interpreted as a hazardous waste that possesses any of the characteristics contained in Annex II of the Bamako Convention, including explosive, poisonous, corrosive, toxic, or ecotoxic.[420] Mirroring the Basel Convention, the Bamako Convention also does not adopt specific tests to determine if a waste is hazardous.

Considering that the Bamako Convention's prohibition on importing waste into Africa from non-contracting parties – and the fact that only member states of the OAU may become parties[421] – the Convention could effectively prohibit imports of carbon dioxide from outside Africa.[422] It remains to be seen if importing carbon dioxide for storage would actually be interpreted as falling within the scope of the Bamako Convention, which would trigger the prohibition of carbon dioxide imports into OAU countries. Because Africa might be a promising location for carbon sequestration,[423] a clarification (or eventual amendment, if needed) about the current status of carbon dioxide for permanent storage would be helpful to dissipate doubts.

[415] The Bamako Convention, *supra* note 250, Art. 4.
[416] HUNTER ET AL., *supra* note 248, at 962.
[417] *Id.*
[418] The Bamako Convention, *supra* note 250, Art. 2.
[419] The Bamako Convention, *supra* note 250, Art. 2: "The following substances shall be 'hazardous wastes' for the purposes of this convention: 1. (a) Wastes that belong to any category contained in Annex I of this Convention [wastes that are defined as hazardous]; (b) Wastes that are not covered under paragraph (a) above but are defined as, or are considered to be, hazardous wastes by the domestic legislation of the State of export, import or transit; (c) Wastes which possess any of the characteristics contained in Annex II of this Convention [list of hazardous characteristics] . . . 3. Wastes which derive from the normal operations of a ship, the discharge of which is covered by another international instrument, shall not fall within the scope of this convention."
[420] Raine, *supra* note 252, at 359–60.
[421] The Bamako Convention, *supra* note 250, Art. 22–23.
[422] Raine, *supra* note 252, at 360.
[423] Hèléne Pilorgé et al., *Global Mapping of CDR Opportunities*, *in* CDR Primer, J. Wilcox et al. eds., Chapter 3 (2021), at https://perma.cc/G2XM-V9CT. (Noting that: "To maintain a supercritical state, which reduces the risks of leakage, CO_2 needs to be sequestered at pressures greater than 73.8 bars, corresponding to geostatic pressures occurring deeper than 800 meters. In order to ensure safe injection and trapping of CO_2, the threshold of 1,000 meters is preferred. Combining [the two datasets analyzed by the authors] might help . . . This combined information provides a rough guide to areas that can be explored for future CO_2 sequestration projects," and displaying data on East Africa's carbon dioxide overall promising sequestration capacity.).

4. UNCLOS (United Nations Convention on the Law of the Sea)

The United Nations Convention on the Law of the Sea, or UNCLOS,[424] has been referred to as a "constitution for the oceans."[425] Among other provisions, UNCLOS establishes a jurisdictional regime for the world's oceans by dividing marine areas into "zones" based on the distance from each state's coast.

The framework for defining such marine zones works as follows. A state may claim an area up to 12 nautical miles (nm) from its coast as its "territorial sea," all of which is subject to the state's sovereignty.[426] Sovereignty in international law does not have an unequivocal definition,[427] but manifests itself as a state's self-determination.[428] Beyond 12 nm and up to 24 nm from its coast, a state may claim a "contiguous zone," where the coastal state may exercise the limited control necessary to prevent or punish infringement of its customs, fiscal, immigration, sanitary laws and related regulations in its territory or territorial sea.[429] Beyond the territorial sea, a state may claim an area up to 200 nm from its coast as its "exclusive economic zone" (EEZ), where the state has sovereign rights to explore, exploit, conserve and manage living and non-living natural resources. States also retain jurisdiction over marine scientific research and the protection and preservation of the marine environment in its EEZ.[430] Finally, the area beyond 200 nm from any state's coastline is typically referred to as the "high seas" and is open to the use of all states exclusively for peaceful purposes. The high seas are not subject to the exclusive jurisdiction of any state.[431]

UNCLOS establishes rules for measuring the distances from a state's coast to define these zones, and determines the protocol for dealing with overlapping territorial seas, exclusive economic zones, and continental shelves.[432]

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[424] United Nations Convention on the Law of Sea, Dec. 10, 1982 (entered into force Nov. 16, 1994), 1833 U.N.T.S. 3 [hereinafter UNCLOS]. This convention has currently 157 parties. The United States has neither signed nor ratified UNCLOS, according to the United Nations Treaty Collection website, at https://perma.cc/QVN9-XM8G.

[425] Tommy T.B. Koh, President, Third United Nations Convention on the Law of the Sea, *A Constitution for the Oceans*, XXXVII (Dec. 11, 1982), at https://perma.cc/A236-T7YT. ("We worked not only to promote our individual national interests but also in pursuit of our common dream of writing a constitution for the oceans.").

[426] UNCLOS, *supra* note 424, Art. 21–61 (for the different categorizations). Importantly, UNCLOS establishes that states shall notify other affected states in case of imminent danger or damage to the marine environment, and also mandates that states cooperate in developing contingency plans responding to these emergencies. *See* UNCLOS, *supra* note 424, Art. 198–99.

[427] *See* Ronald A. Brand, *External Sovereignty and International Law*, 18 FORDHAM INTERNATIONAL LAW JOURNAL1685, 1686 (1995), explaining that: " [E]arlier concepts of subjects joining to receive the benefits of peace and security provided by the sovereign. [For the author]It diverges from most contemporary commentary by avoiding what has become traditional second- tier social contract analysis. In place of a social contract of states, this redefinition of sovereignty recognizes that international law in the twentieth century has developed direct links between the individual and international law. The trend toward democracy as an international law norm further supports discarding notions of a two-tiered social contract relationship between the individual and international law."

[428] Celia L. Taylor, *A Modest Proposal: Statehood and Sovereignty in a Global Age*, 18 U. PA. INT. ECON. J. 745, 750 (2014).

[429] U.S. SENATE, *Convention of the Law of the Sea*, Senate Executive Report 110-9, 3–4 (Dec. 19, 2007), at https://perma.cc/TK7P-XWUG.

[430] UNCLOS, *supra* note 424, Art. 55, specifically.

[431] UNCLOS, *supra* note 424, Art. 56–57 and Art. 140. *See* also U.S. Senate, Convention of the Law of the Sea, Senate Executive Report 110-9, *supra* note 429, at 3–4.

[432] UNCLOS, *supra* note 424, Art. 76, which defines continental shelf as follows: "(1) The continental shelf of a coastal State comprises the seabed and subsoil of the submarine areas that extend beyond its territorial sea throughout the natural prolongation of its land

In practice, the extension of these zones is measured in nautical miles from the so-called "baseline," which is normally defined under UNCLOS as the low-water line along the coast.[433] Despite the United States not being a party to UNCLOS,[434] the country recognizes many of its provisions (including those defining the maritime zones) as forming part of international customary law.[435]

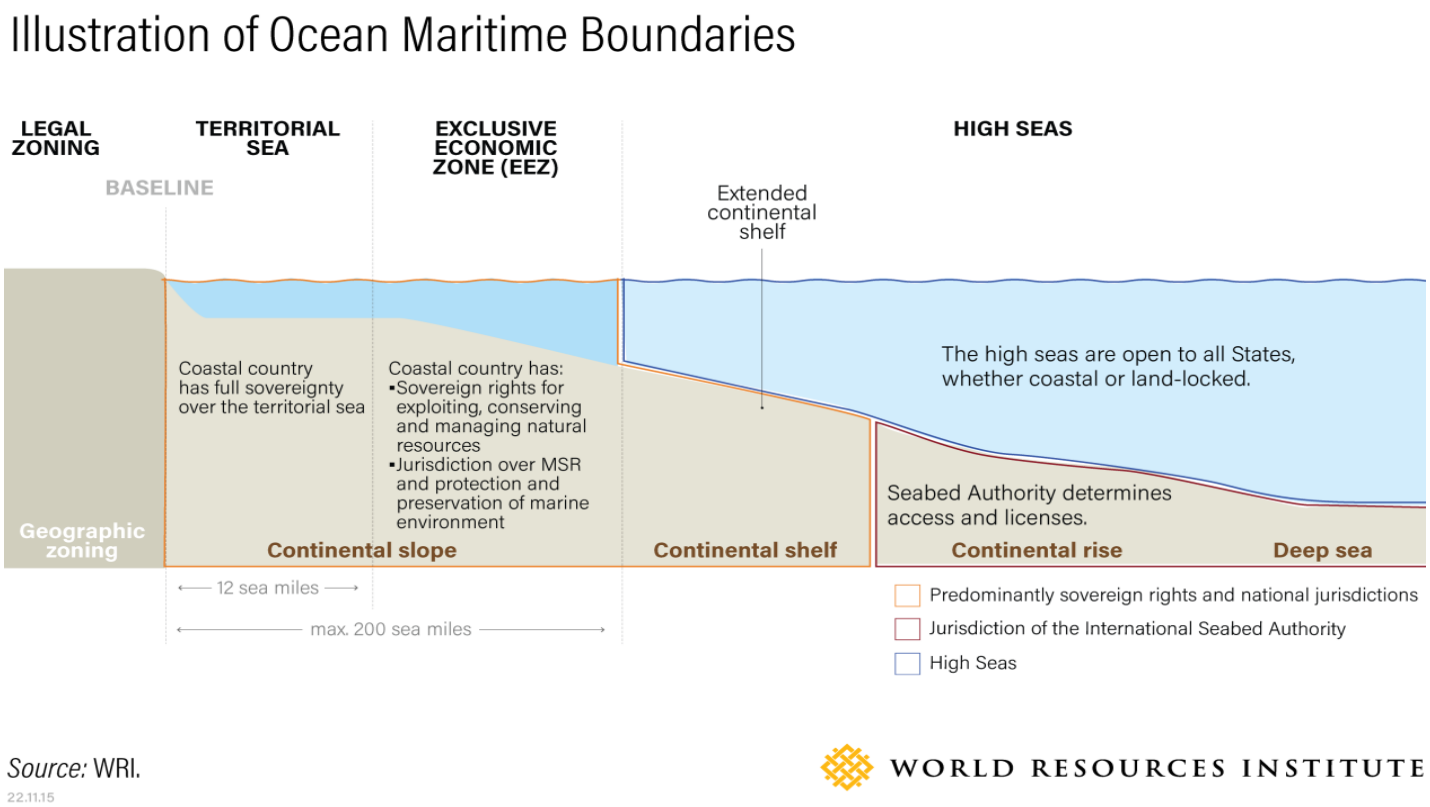
territory to the outer edge of the continental margin, or to a distance of 200 nautical miles from the baselines from which the breadth of the territorial sea is measured where the outer edge of the continental margin does not extend up to that distance. (2) The continental shelf of a coastal State shall not extend beyond the limits provided for in paragraphs 4 to 6. (3) The continental margin comprises the submerged prolongation of the land mass of the coastal State, and consists of the seabed and subsoil of the shelf, the slope and the rise. It does not include the deep ocean floor with its oceanic ridges or the subsoil thereof. (4) (a) For the purposes of this Convention, the coastal State shall establish the outer edge of the continental margin wherever the margin extends beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured, by either: (i) a line delineated in accordance with paragraph 7 by reference to the outermost fixed points at each of which the thickness of sedimentary rocks is at least 1 per cent of the shortest distance from such point to the foot of the continental slope; or (ii) a line delineated in accordance with paragraph 7 by reference to fixed points not more than 60 nautical miles from the foot of the continental slope; (b) In the absence of evidence to the contrary, the foot of the continental slope shall be determined as the point of maximum change in the gradient at its base. (5). The fixed points comprising the line of the outer limits of the continental shelf on the seabed, drawn in accordance with paragraph 4 (a)(i) and (ii), either shall not exceed 350 nautical miles from the baselines from which the breadth of the territorial sea is measured or shall not exceed 100 nautical miles from the 2,500 meters isobath, which is a line connecting the depth of 2,500 meters. (6) Notwithstanding the provisions of paragraph 5, on submarine ridges, the outer limit of the continental shelf shall not exceed 350 nautical miles from the baselines from which the breadth of the territorial sea is measured. This paragraph does not apply to submarine elevations that are natural components of the continental margin, such as its plateaux, rises, caps, banks and spurs. (7) The coastal State shall delineate the outer limits of its continental shelf, where that shelf extends beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured, by straight lines not exceeding 60 nautical miles in length, connecting fixed points, defined by coordinates of latitude and longitude..." Art. 77 provides that the coastal state will have sovereignty over its continental shelf's natural resources.

[433]UNCLOS, *supra* note 424, Art. 5 (The "low-water" is defined according to the State's own chart). *See also* U.S. Senate, Convention of the Law of the Sea, *supra* note 429, at 3–4. UNCLOS provides for the use of alternative baselines in some circumstances (e.g., where a state's coast is heavily indented with bays or fringed with islands). *See* UNCLOS, *supra* note 424, Art. 6–7.

[434] United Nations Treaty Collection (UNTC), *Status of the United Nations Convention on the Law of Sea* (2023), at https://perma.cc/A6XL-CZ62. (UNCLOS currently has 169 parties; the United States never has signed let alone ratified it).

[435] Romany M. Webb, Korey Silverman-Roati & Michael B. Gerrard, *Removing Carbon Dioxide Through Artificial Upwelling and Downwelling: Legal Challenges and Opportunities*, *supra* note 259, at 7.

Figure 2: Illustration of the Ocean Maritime Boundaries[436]



In addition to defining each of these zones, UNCLOS defines the "area" as encompassing "the seabed and ocean floor and subsoil thereof, beyond the limits of national jurisdiction."[437] The area – i.e., the seabed underlying the high seas – is open to all countries.[438] Ultimately, a state's domestic laws apply to activities on the high seas if these activities are performed by either individuals subject to that state's jurisdiction (e.g., because the individual is a national of the country), or using vessels registered or flagged to the state.[439]

Since UNCLOS is a framework convention, it establishes a set of general norms to guide states. As a result, additional specific agreements are often required to make its general provisions concrete.[440] For example,

[436] Katie Lebling et al., *Carbon Removal from the Ocean Explained*, WORLD RESOURCES INSTITUTE (Nov. 15, 2022), at https://perma.cc/554S-9WNP. (source for the figure).
[437] UNCLOS, *supra* note 424, Art. 1, 1 (1).
[438] UNCLOS, *supra* note 424, Art. 140–41.
[439] Romany M. Webb, Korey Silverman-Roati & Michael B. Gerrard, *Removing Carbon Dioxide Through Artificial Upwelling and Downwelling: Legal Challenges and Opportunities*, *supra* note 259, at 8.
[440] HUNTER ET AL., *supra* note 248, at 730.

UNCLOS broadly commands states to "prevent, reduce and control pollution of the marine environment by dumping."[441] Carbon dioxide transportation alone is unlikely to be prohibited under this general provision. However, arguably the transboundary movement of carbon dioxide for storage in ships could trigger the application of UNCLOS, as it could be characterized as a transfer of "hazards" from one area to another.[442]

UNCLOS does not formally define the term "hazard," leaving the term open to interpretation.[443] While it is theoretically possible to interpret that carbon dioxide is a "hazardous substance" under the guiding principles of UNCLOS – that is, to prevent, reduce, and control marine pollution –[444] this interpretation is considered unlikely by experts;[445] as a framework convention, UNCLOS' general scope leaves the elaboration of more precise rules and specifics to other treaties and other agreements.[446]

The general rules set forth by UNCLOS are also typically complemented by more recent and issue-specific treaties.[447] Once ratified, parties are bound to the most stringent applicable law.[448] In practice, treaties like the London Convention and Protocol are therefore more consequential than UNCLOS in regulating transboundary carbon dioxide transport. Because UNCLOS broadly calls for the adoption of more elaborate international rules

[441] UNCLOS, *supra* note 424, Art. 210.

[442] UNCLOS, *supra* note 424, Art. 195: "Duty not to transfer damage or hazards or transform one type of pollution into another: In taking measures to prevent, reduce and control pollution of the marine environment, States shall act so as not to transfer, directly or indirectly, damage or hazards from one area to another or transform one type of pollution into another." *See also* Raine, *supra* note 252, at 361.

[443] Raine, *supra* note 252, at 361.

[444] UNCLOS, *supra* note 424, Art. 194: "Measures to prevent, reduce and control pollution of the marine environment: (1) States shall take, individually or jointly as appropriate, all measures consistent with this Convention that are necessary to prevent, reduce and control pollution of the marine environment from any source, using for this purpose the best practicable means at their disposal and in accordance with their capabilities, and they shall endeavour to harmonize their policies in this connection. (2) States shall take all measures necessary to ensure that activities under their jurisdiction or control are so conducted as not to cause damage by pollution to other States and their environment, and that pollution arising from incidents or activities under their jurisdiction or control does not spread beyond the areas where they exercise sovereign rights in accordance with this Convention. (3) The measures taken pursuant to this Part shall deal with all sources of pollution of the marine environment. These measures shall include, *inter alia*, those designed to minimize to the fullest possible extent: (a) the release of toxic, harmful or noxious substances, especially those which are persistent, from land-based sources, from or through the atmosphere or by dumping; (b) pollution from vessels, in particular measures for preventing accidents and dealing with emergencies, ensuring the safety of operations at sea, preventing intentional and unintentional discharges, and regulating the design, construction, equipment, operation and manning of vessels; (c) pollution from installations and devices used in exploration or exploitation of the natural resources of the seabed and subsoil, in particular measures for preventing accidents and dealing with emergencies, ensuring the safety of operations at sea, and regulating the design, construction, equipment, operation and manning of such installations or devices; (d) pollution from other installations and devices operating in the marine environment, in particular measures for preventing accidents and dealing with emergencies, ensuring the safety of operations at sea, and regulating the design, construction, equipment, operation and manning of such installations or devices."

[445] Raine, *supra* note 252, at 361.

[446] Ian Havercroft & Ray Purdy, *Carbon Capture and Storage: Developments under European Union and International Law*, 4 J. EUR. ENVIR. AND PLANNING LAW 353, 353–54 (2007).

[447] *Id.*

[448] Raine, *supra* note 252, at 361.

on dumping,[449] the London Convention – and, if fully adopted, the Protocol – would ultimately determine what constitutes dumping under UNCLOS.[450]

In the context of carbon dioxide transportation, UNCLOS may also apply to pollution unrelated to dumping. More specifically, under-regulated sources of marine pollution such as ocean noise or heat pollution could, in theory,[451] trigger the application of UNCLOS under its mandate to prevent and reduce pollution.[452] This is the case as the UNCLOS definition of "pollution of the marine environment" is quite broad, meaning "the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities."[453]

Although underwater noise emissions from ships are not currently regulated,[454] there is an understanding that they deserve further environmental analysis[455] since ocean-going traffic is the most significant source of acoustic pollution.[456]

While an analysis of noise pollution is based on a purely theoretical perspective bearing extremely limited practice, this report briefly addresses it for the purpose of completeness. While it remains difficult to estimate the volume of carbon dioxide shipping and the impact it would have on shipping traffic, should ocean noise or heat pollution trigger protection under UNCLOS,[457] states will be encouraged to issue best practices.[458] Still, the UNCLOS system does not specifically implicate the shipping of carbon dioxide for storage; at best, these new provisions may require states to set and improve current standards for all shipping traffic.

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[449] UNCLOS, *supra* note 424, Art. 210 (6).

[450] David Langlet, *Exporting CO_2 for Sub-Seabed Storage: The Non-effective Amendment to the London Dumping Protocol and Its Implications,* 30 Int. J. of Marine and Coastal Law 395, 401 (2015). *See also* University of College London, Offshore *CO_2 Storage: International Marine Legislation, The United Nations Convention on the Law of the Sea (UNCLOS, 1982),* UCL, at https://perma.cc/V8Z2-ET9T.

[451] Karen Scott*, International Regulation of Undersea Noise*, 53 ICQL 287, 293 (2004) (Contending that Art. 194 combined with Art. 1 (4) of UNCLOS includes noise and heat as introducing energy, and thus, pollution).

[452] UNCLOS, *supra* note 424, Art. 211.

[453] UNCLOS, *supra* note 424, Art. 1(4).

[454] Jukka-Pekka Jalkanen et al.*, Underwater Noise Emissions from Ships During 2014–2020*, Env. Pollution 311, 312 (2022).

[455] Scott, *supra* note 451, at 294.

[456] International Maritime Organization–IMO, *Guidelines for the Reduction of Underwater Noise from Commercial Shipping to Address Adverse Impacts on Marine Life,* IMO MEPC1/Circular 833 (Apr. 7, 2014) (Art. 6 notes that "the International Organization for Standardization (ISO) has developed the (ISO/PAS) 17208-1 – Acoustics – Quantities and procedures for description and measurement of underwater sound from ships – Part 1: General requirements for measurements in deep water. This measurement standard is for deep water which implies that the water depth should be larger than 150 m or 1.5 times overall ship length (engineering method), whichever is greater.")

[457] Scott*, supra* note 451, at 293.

[458] UNCLOS, *supra* note 424, Art. 208.

5. The "High Seas" Treaty, or BBNJ Treaty (United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction)

A new agreement under UNCLOS on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction[459] was recently reached by delegates of the Intergovernmental Conference on Marine Biodiversity of Areas Beyond National Jurisdiction. It is commonly referred to either by its acronym, "BBNJ," or simply as the "High Seas Treaty."[460]

As previously discussed in this report, UNCLOS gives countries jurisdiction over the waters that extend within 200 nautical miles from their shores. Beyond this area is the "high seas." Waters of the high seas make up about two-thirds of the global ocean, or almost half of Earth's surface.[461]

UNCLOS regulates certain activities in the high seas, including shipping and seabed mining.[462] The high seas, nonetheless, have long been deemed the "wild west" of the ocean, with few specific provisions on the protection of biodiversity.[463] This new treaty builds on the UNCLOS system,[464] covering access and use of marine genetic resources in both the high seas and exclusive economic zone (EEZ) area as defined by UNCLOS,[465] among other provisions.

A preliminary analysis of the available text of the High Seas Treaty shows that it should not specifically impact cross-border transportation of carbon dioxide for offshore storage overseas. There are, however, two main provisions which are noteworthy for the purposes of this report.

First, the High Seas Treaty provides for cumulative impact and environmental impact assessments that may be potentially relevant for the cross-border transportation and overseas storage of carbon dioxide.[466] As science and technology continue to advance, the scope and extent of currently unrecognized cumulative impacts and

[459] The United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction (The High Seas Treaty, hereinafter) (Mar. 5, 2023: advanced, unedited version, at https://perma.cc/6V2U-94G7.

[460] United Nations, *UN Delegates reach historic agreement on protecting marine biodiversity in international waters,* U.N. NEWS (Mar. 5, 2023).

[461] Nicola Jones, *UN Forges Historic Deal to Protect Ocean Life: What Researchers Think*, NATURE (Mar. 7, 2023).

[462] See our discussion in section 4 of this report and references thereafter.

[463] *Id.*

[464] The High Seas Treaty, *supra* note 459, Art. 1–4 (Defining the supplementary relationship of the new treaty to UNCLOS).

[465] The High Seas Treaty, *supra* note 459, Art. 1 (4); and UNCLOS, *supra* note 424, Art. 1 (1) defines the Area as "the seabed and ocean floor and subsoil thereof, beyond the limits of national jurisdiction," as discussed above.

[466] The High Seas Treaty, *supra* note 459, Art. 1 (9). "'Cumulative impacts' means the combined and incremental impacts resulting from different activities, including known past and present and reasonably foreseeable activities, or from the repetition of similar activities over time, and the consequences of climate change, ocean acidification and related impacts. (10). 'Environmental impact assessment' means a process to identify and evaluate the potential impacts of an activity to inform decision-making." Environmental impact assessments are further detailed in Art. 21–38.

future risks may be clarified. These may be further clarified as countries begin to engage in carbon dioxide shipping and storage activities, since higher volumes of shipped carbon dioxide also increase the chances that damage may occur. Second, the treaty's innovative concept of designating area-based management tools (AMBTs), such as marine protected areas (MPAs), in the high seas may trigger limitations on shipping traffic.[467]

In conclusion, it is still too early to assess the effects of the High Seas Treaty on cross-border carbon dioxide transportation for storage overseas, as this treaty has not yet entered into force. More research is recommended on this topic as countries move towards ratification, as well as once the treaty's newly created scientific body charged with researching the changing conditions of begins its work.

6. MARPOL (International Convention for the Prevention of Pollution from Ships)

The International Convention for the Prevention of Pollution from Ships, or MARPOL,[468] addresses operational pollution from ships, including unintentional releases of pollution.[469] Annex I of MARPOL establishes rules for oil pollution, whereas Annex VI's Regulations for the Prevention of Air Pollution from Ships establishes specific Emission Control Areas for both sulfur oxides (SO_x) and nitrogen oxides (NO_x).[470]

In principle, carbon dioxide transportation for storage should not face additional requirements beyond what any ordinary ship faces under MARPOL's Annex VI. However, further research needs to be done to determine if ships transporting carbon dioxide would use or carry substances that would trigger additional requirements under MARPOL.

MARPOL's Annex VI requirements are implemented in United States' domestic law under the Act to Prevent Pollution from Ships (APPS),[471] which subjects U.S.-flagged vessels to inspection regarding compliance with

[467] The High Seas Treaty, *supra* note 459, Art. 1 (12), provides as follows: "'Marine protected area' means a geographically defined marine area that is designated and managed to achieve specific long-term biodiversity conservation objectives and may allow, where appropriate, sustainable use provided it is consistent with the conservation objectives." This provision should also be combined with Art. 14–18.

[468] The United Nations Convention for the Prevention of Pollution from Ships, Nov. 2, 1973, 12 I.L.M 319 [hereinafter MARPOL].

[469] The definition of discharge in MARPOL's Art. 2 excludes any dumping regulated under the London Convention. MARPOL, *supra* note 468, at Art. 2. *See also* HUNTER ET AL., *supra* note 248, at 786 (Noting that MARPOL's focuses on operational discharges, excepting from its coverage the intentional dumping of waste. The latter is the regulated under the London Convention).

[470] MARPOL, *supra* note 468, at Annex VI. *See also* IMO, MARPOL, at https://perma.cc/4JDT-AJTU. (Sulfur oxide areas have more stringent controls on sulfur emissions; likewise, nitrogen oxide areas have higher stringency requirements and apply to Tier III NOx emission standards).

[471] The Act to Prevent Pollution from Ships (APPS), 33 U.S.C. §§ 1901–1905. Limits on NO_x emissions from marine diesel engines with a power output of more than 130 kW, with standards being applicable to main propulsion and auxiliary engines and determining that the engines to comply with the Annex VI NO_x emission limits. Limits on the sulfur content of marine fuels: ships operating up to 200 nautical miles off of U.S. shores, which is designated as the north American Emission Control Area (ECA), must meet the most advanced standards for NO_x emissions and use fuel with lower sulfur content.

Annex VI's requirements.[472] Non-U.S.-flagged vessels are subject to examination under the Port State Control when operating in U.S. waters.[473]

Under MARPOL's regime,[474] a port state or a coastal state at an offshore terminal may carry out intensive inspections of all ships, but the state's jurisdiction is restricted to the vessel's location at the time of enforcement.[475]

7. OSPAR (Convention for the Protection of the Marine Environment of the North-East Atlantic)

The Convention for the Protection of the Marine Environment of the North-East Atlantic,[476] or OSPAR, is a regional convention that applies to states located in this region, and focuses on regulating offshore dumping.[477]According to the OSPAR Convention, dumping refers to "(i) any deliberate disposal in the maritime area of wastes or other matter (1) from vessels or aircraft; (2) from offshore installations; (ii) any deliberate disposal in the maritime area of (1) vessels or aircraft; (2) offshore installations and offshore pipelines."[478]

In 2007, the OSPAR Convention was amended to expressly authorize carbon dioxide streams from carbon dioxide capture processes for storage to be disposed into a sub-soil geological formations.[479] Despite the amendments focusing on storage, experts[480] have interpreted that transportation is incidentally included as part of the process

[472] *Id.*

[473] The United States Coastal Guard or EPA may bring enforcement action for a violation. *See* APPS, *supra* note 471, at §§ 1903–1907.

[474] MARPOL, *supra* note 468, at Art. 5.

[475] HUNTER ET AL., *supra* note 248, at 796–97 (Noting that when a port state takes an enforcement measure, such as an inspection, to determine where if the vessel has committed a discharge violation on the high seas, the port state will investigate a violation of another state's law (not its own) and it does not have jurisdiction to prescribe).

[476] The Convention for the Protection of the Marine Environment of the North-East Atlantic, Sep. 22, 1992 (entered into force on Mar. 25, 1998), 2454 U.N.T.S. 67 [hereinafter OSPAR].

[477] Contracting States are Belgium, Denmark, the European Union, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom of Great Britain and Northern Ireland. OSPAR CONVENTION, *Contracting Parties*, at https://perma.cc/2NWL-CUW5.

[478] OSPAR Convention, *supra* note 476, Art. 1, (f). This Convention further excludes from this definition MARPOL's application as well as placement of matter for a purpose other than the mere disposal thereof, provided that, if the placement is for a purpose other than that for which the matter was originally designed or constructed, it is in accordance with the relevant provisions of the Convention; and the leaving wholly or partly in place of a disused offshore installation or disused offshore pipeline, provided that any such operation takes place in accordance with any relevant provision of the Convention and international law.

[479] OSPAR Convention, *supra* note 476, Amendment to Annex II on the Prevention and Elimination of Pollution by Dumping or Incineration, Art. 3: The dumping of all waste is prohibited, except for wastes and matters listed in paragraph 2 and 3 of this Article . . . (2) (f): "Carbon dioxide streams from carbon dioxide capture processes for storage, provided: i. disposal is into a sub-soil geological formation; ii. the streams consist overwhelmingly of carbon dioxide. They may contain incidental associated substances derived from the source material and the capture, transport and storage processes used; iii. no wastes or other matter are added for the purpose of disposing of those wastes or other matter; iv. they are intended to be retained in these formations permanently and will not lead to significant adverse consequences for the marine environment, human health and other legitimate uses of the maritime area."

[480] Weber, *supra* note 269, at 388. *See also* IEAGHG, *The Status and Challenges of CO_2 Shipping Infrastructures*, *supra* note 264, at 60.

of storage.[481] Since the amendment came into force, the status of CCS for offshore storage sub-soil geological formation has not been questioned under international law;[482] there are no relevant controversies about the authorization of CCS under the amended legal regime.[483] Exports of carbon dioxide for permanent storage face uncertainties under other European regional conventions.[484] Analysis of these conventions is outside the scope of analysis of this report as they are unlikely to be relevant for the cross-border shipping of carbon dioxide from Europe to the United States.

8. HNS Convention (International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea)

The International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea, or the HNS Convention, will establish an international liability framework in the event of accidents at sea that involve hazardous and noxious substances. Beyond pollution damage from accidental spills, the HNS Convention also covers the risks of fire and explosion, including loss of life or personal injury as well as loss or damage of property.[485]

While the HNS Convention does not regulate the legality of the transport of carbon dioxide per se, it may impose costs on CCS and carbon dioxide shipping as a result of the Convention's mandatory contributing fund from shipowners.[486] Because shipowners of particularly high tonnage have to contribute to the fund, it is likely that the HNS Convention will increase costs for carbon dioxide carriers once it enters into force.[487]

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[481] OSPAR Convention, *supra* note 476, Amendment to Annex II on the Prevention and Elimination of Pollution by Dumping or Incineration (see amendment of the text in the previous footnote).

[482] *See* EU Parliament and EU Council, 2009/31/EC of the European Parliament and of the Council on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No. 1013/2006 (Apr. 23, 2009), stating: "*Whereas* (12 and 14): At the international level, legal barriers to the geological storage of CO_2 in geological formations under the seabed have been removed through the adoption of related risk management frameworks under the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention)." (emphasis in original).

[483] Weber, *supra* note 269, at 388. *See also* Østgaard & Ombudstvetdt *supra* note 344, at 11.

[484] European regional conventions on the topic include the Bucharest Convention (from 1992 and applying to six countries located in the Back Sea); and the Barcelona Convention (from 1976 and applying in the Mediterranean Sea area). As of January of 2024, experts contend that carbon dioxide for storage is not prohibited under both conventions. *See, e.g.,* Østgaard & Ombudstvetdt *supra* note 344, at 11–14.

[485] International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea 1996 and its Protocol of 2010 (Adopted May 3, 1996, and Apr. 29, 2010, respectively, and not yet entered into force), 35 I.L.M. 1415 [hereinafter HNS Convention].

[486] The HNS Convention, *supra* note 485, Art. 9 (Determining the tonnage and the contribution for the HNS fund, which will have separate funds for carriers of oil than carriers of gas, for instance).

[487] Weber, *supra* note 269, at 392.

Even though the HNS Convention has not yet entered into force, the Convention has already been superseded by its Protocol. The Protocol was based on both the Civil Liability and the Fund Conventions,[488] which cover the pollution damage caused by spills of persistent oil from tankers.[489] The HNS Convention, following the original oil pollution compensation regime, will create a two-tiered system for compensation to be paid in the event of accidents at sea involving hazardous and noxious substances.[490] The first tier of compensation will be covered by compulsory insurance taken out by shipowners, who can then use that insurance to limit their liability. In cases where the insurance does not cover an incident or is insufficient to satisfy the claim, a second tier of compensation will be paid from a fund comprising contributions from the receivers of hazardous or noxious substances (HNS).[491]

The main features of the HNS Convention include a system of strict liability for the shipowner. Apart from a few exceptions, a shipowner's liability cannot be excluded.[492] The liability of the shipowner, however, can be limited depending on the size of the ship and whether it carries cargo in bulk or packaged form.[493]

The HNS Convention does not expressly mention carbon dioxide.[494] However, the HNS Convention will apply to ships carrying both liquefied bulk carbon dioxide of a high purity as well as carbon dioxide of reclaimed quality, as per the Convention's reference to the International Code of the Construction and Equipment of Ships Carrying

[488] International Convention on Civil Liability for Oil Pollution Damage and the Fund Conventions, Nov. 27, 1992 (entered into force on May 30, 1996), 1956 U.N.T.S. 255.

[489] INTERNATIONAL MARITIME ORGANIZATION, *International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea*, at https://perma.cc/H7VK-SANY.

[490] *Id.*

[491] *Id.* (Noting that contributions will be calculated according to the amount HNS received by each party in the previous calendar year). This report will further discuss liability in Chapter 7. For additional details, *see* Weber, *supra* note 269, at 393.

[492] The HNS Convention, *supra* note 485, Art. 7 (1), combined with Art. 7(5) and (6). Art. 7 determines the following: "Art.7 (1) Except as provided in paragraphs 2 and 3, the owner at the time of an incident shall be liable for damage caused by any hazardous and noxious substances in connection with their carriage by sea on board the ship, provided that if an incident consists of a series of occurrences having the same origin the liability shall attach to the owner at the time of the first of such occurrences. (2) No liability shall attach to the owner if the owner proves that: (a) the damage resulted from an act of war, hostilities, civil war, insurrection or a natural phenomenon of an exceptional, inevitable and irresistible character; or (b) the damage was wholly caused by an act or omission done with the intent to cause damage by a third party; or (c) the damage was wholly caused by the negligence or other wrongful act of any Government or other authority responsible for the maintenance of lights or other navigational aids in the exercise of that function; or (d) the failure of the shipper or any other person to furnish information concerning the hazardous and noxious nature of the substances shipped either (i) has caused the damage, wholly or partly; or (ii) has led the owner not to obtain insurance in accordance with article 12; provided that neither the owner nor its servants or agents knew or ought reasonably to have known of the hazardous and noxious nature of the substances shipped. (3) If the owner proves that the damage resulted wholly or partly either from an act or omission done with intent to cause damage by the person who suffered the damage or from the negligence of that person, the owner may be exonerated wholly or partially from liability to such person."

[493] The HNS Convention, *supra* note 485, Art. 9 and 14.

[494] HNS Convention, *supra* note 485, Art. 1(5)(a)(v) reads as follows: "Hazardous and noxious substances (HNS) means: (a) any substances, materials and articles carried on board a ship as cargo, referred to in (i) to (vii) below: (v) liquefied gases as listed in chapter 19 of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, as amended, and the products for which preliminary suitable conditions for the carriage have been prescribed by the Administration and port administrations involved in accordance with paragraph 1.1.6 of the Code."

Liquefied Gases in Bulk.[495] Therefore, once the HNS Convention enters into force, its regulations will apply to carbon dioxide carriers.[496] For ships carrying carbon dioxide,[497] the HNS Convention will replace the Convention on Limitation of Liability for Maritime Claims.[498]

It is noteworthy that the HNS Convention only applies when the cargo is onboard.[499] Therefore, while carbon dioxide is waiting in storage tanks or after it has been discharged, liability under the Convention would not be triggered.[500] Further discussion on the HNS Convention appears in Chapter 7 of this report.

9. OECD (Organization for Economic Cooperation and Development) Council Wastes Decision

OECD member states, including the United States, are parties to the OECD Council's decision regulating the transboundary movements of waste for recovery purposes.[501] This decision established a notice and consent system for the transboundary movements of wastes destined for recovery operations among OECD member states.[502]

The OECD Wastes Decision qualifies as a multilateral agreement under the Basel Convention,[503] thus allowing OECD member states who are parties to the Basel Convention to trade wastes covered by the OECD decision with OECD members that have not ratified the Basel Convention – for example, the United States.[504] The decision aims to facilitate the trade of waste for recovery, reducing the likelihood that waste is abandoned or handled illegally.[505] The decision defines disposal and recovery as the activities listed in its annexes,[506] which

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[495] International Maritime Organization, *The International Code of the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC)*, Chapter 19, at https://perma.cc/224N-S9DS. (Carbon dioxide of reclaimed quality is not specifically defined, but it is generally understood as a stream which contains impurities. It may contain water or sulfur dioxide, among other impurities. These impurities may increase acid corrosion-related risks. International Maritime Organization, *The International Code of the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC)*, Chapter 17:22, at https://perma.cc/BUR6-RHSM).

[496] Weber, *supra* note 269, at 392.

[497] HNS Convention, *supra* note 485, Art. 42, combined with LLMC Convention, *infra* note 498, Art. 18 (1) (b).

[498] Convention on Limitation of Liability for Maritime Claims, Nov. 16, 1976 (entered into force on Dec. 1, 1986), Protocol of 1996, May 1996 (entered into force May 13, 2004) 1456 U.N.T.S. 221 [hereinafter LLMC].

[499] The HNS Convention, *supra* note 485, Art. 1(9) combined with Art. 4 (1).

[500] Weber, *supra* note 269, at 392.

[501] OECD Legal Instruments, *Decision of the Council on the Control of Transboundary Movements of Wastes Destined for Recovery Operations*, Mar. 29, 1992 (amended Dec. 31, 2020) [hereinafter OECD Wastes Decision], at https://perma.cc/BXG2-2JCX.

[502] *Id.* at Chapter II. A.– B.

[503] The Basel Convention, *supra* note 250, Art. 11.

[504] Hunter et al., *supra* note 248, at 961.

[505] United States Environmental Protection Agency, *International Agreements on Transboundary Shipments of Hazardous Waste*, *supra* note 351. (Noting that the OECD decision is implemented in U.S. law under Title 40 of the Code of Federal Regulations, section 262.81). This will be further examined in Chapter 5 of this report, which addresses U.S. domestic law.

[506] OECD Wastes Decision, *supra* note 501, Chapter II, A (3) defines disposal as any activity listed in Appendix 5.A; Chapter II, A (4) defines recovery as any of the activities of Appendix 5.B. Appendix 5.A, in the relevant part potentially applicable to CCS, refers to: (D3) Deep injection, meaning the injection of pumpable discards into wells, salt domes or naturally occurring repositories, etc.; (D7) Release into seas/oceans including sea-bed insertion; (D15) Storage pending any of the operations in Appendix 5.A. Appendix 5.B, in the relevant part potentially considered for CCUS, determines (R1) the use as a fuel (other than in direct incineration) or other means to

automatically triggers the application of the Basel Convention and its amendments unless an OECD member objects.[507]

The notice and consent system established by the OECD Wastes Decision is called the Control System. The Control System has two types of control procedures.[508] The Green Control Procedure applies to wastes that present low risk for human health and the environment and are not subject to any other controls than those normally applied in commercial transactions. The Amber Control Procedure applies to wastes that present sufficient risk to justify closer control.[509] As with the Basel Convention, the OECD Wastes Decision does not prohibit the cross-border transportation of hazardous waste, but instead sets specific requirements for its transport.[510] Accordingly, in the unlikely event that carbon dioxide becomes considered hazardous waste under the Basel Convention, it should follow a similar classification under the OECD Wastes Decision. Because the decision could also pose a challenge to the cross-border transportation of carbon dioxide, this would present an additional reason for the parties of the Basel Convention to clarify the scope of its application regarding the cross-border transportation of carbon dioxide for storage.

generate energy; (R7) recovery of components used for pollution abatement; and (R9) used oil re-refining or other reuses of previously used oil.

[507]OECD Wastes Decision, *supra* note 501, Preamble: "Noting that Member countries agreed at the Working Group on Waste Management Policy (WGWMP) meeting in Vienna in October 1998 to further harmonisation of procedures and requirements of OECD Decision C (92)39/FINAL with those of the Basel Convention." *See also* OECD, *The OECD Control System for Waste Recovery*, at https://perma.cc/X2GD-EYKP.

[508] OECD Wastes Decision, *supra* note 501, Chapter II, B.2.

[509] OECD, *Legal Instruments: Appendices 3 and 4 to the OECD Council Decision: The Green and Amber Lists of Wastes* (updated on Dec. 31, 2020), at https://perma.cc/LX3T-C5Z4.

[510]OECD Wastes Decision, *supra* note 501**,** "Chapter I: I. Decides that Member countries shall control transboundary movements of wastes destined for recovery operations within the OECD area in accordance with the provisions set out in Chapter II of this Decision and in the appendices to it; II. Instructs the Environment Policy Committee in co-operation with other relevant OECD bodies, in particular the Trade Committee, to ensure that the provisions of this Control System remain compatible with the needs of Member countries to recover wastes in an environmentally sound and economically efficient manner; III. Recommends Member countries to use for the Notification Document and Movement Document the forms contained in Appendix 8 to this Decision; IV. Instructs the Environment Policy Committee to amend the forms for the Notification Document and Movement Document as necessary; V. Instructs the Environment Policy Committee to review the procedure for amending the waste lists under Chapter II. B, (3) at the latest seven (7) years after the adoption of the present Decision; VI. Requests Member countries to provide the information that is necessary for the implementation of this Decision and is listed in Appendix 7 to this Decision; VII. Requests the Secretary General to transmit this Decision to the United Nations Environment Programme and the Secretariat of the Basel Convention."

10. Bilateral Agreements between the United States and Other Countries

The United States has entered into separate bilateral agreements for importing and/or exporting hazardous wastes with Canada,[511] Mexico,[512] Costa Rica,[513] Malaysia,[514] and the Philippines.[515] These agreements implement the OECD Control System[516] outlined in the previous section. At the time of writing this report, the review of each of these agreements according to documents available online did not indicate that transportation and overseas storage of carbon dioxide is specifically regulated or precluded under these agreements.[517]

11. Concluding remarks

As demonstrated in the previous sections, there is no single international treaty that explicitly addresses the cross-border transportation of carbon dioxide for storage. Currently, the London Convention and Protocol system offers the strongest regulation potential, with the latter being the only treaty expressly allowing for offshore storage of carbon dioxide. The Basel Convention is unlikely to apply to the cross-border transportation of carbon dioxide for storage, so long as purity levels of the carbon dioxide stream are high, and no prohibited co-components are added. This tends to be the case in practice, since low purity streams or the presence of toxic co-components would likely jeopardize shipping and pipeline infrastructure altogether. Finally, as our review has

[511] The Agreement between Canada and the United States Concerning the Transboundary Movement of Hazardous Waste (Oct. 28, 1986; amended on Nov. 4, 1992), at https://perma.cc/XW2T-AABC. (Art. 1 defines hazardous waste for the United States as per the country's legislation; likewise, Canada's definition of hazardous waste are determined according to Canadian laws; Art. 2 authorizes export, import or transit hazardous waste for recycling or disposal).

[512] The Agreement between Mexico and the United States Regarding the Transboundary Shipments of Hazardous Wastes and Hazardous Substances (Nov. 12, 1986), at https://perma.cc/QJ2A-Z45K. (Determines the movement of hazardous waste from Mexico the United States for recycling or disposal; and from the United States to Mexico exclusively for recycling).

[513]The Agreement between the Government of American and the Government of Malaysia Concerning the Transboundary Movement of Hazardous Wastes from Malaysia to the United States (Mar. 10, 1995), at https://perma.cc/GM4F-3E4Q. (The Preamble specifically refers to Art. 4 (5) and Art. 11 of the Basel Convention authorizing parties of the Convention to enter into bilateral agreements with non-parties, provided they are not less stringent than the requirements of the Basel Convention).

[514] The Agreement on the Transboundary Movement of Hazardous Waste from Costa Rica to the United States (Sep. 30, 1997), at https://perma.cc/Y8QB-J3AB. (The Preamble refers to Art. 11 of the Basel Convention).

[515] The Agreement between the Government of the United States and the Government of the Republic of the Philippines Transboundary Concerning the Transboundary Movement of Hazardous Wastes from the Philippines to the United States (Sep. 20, 2001), at https://perma.cc/C2LS-3W3Y. (The Preamble mentions Art. 4 (5) and Art. 11 of the Basel Convention).

[516]OECD, *Decision of the Council on the Control of Transboundary Movements of Wastes Destined for Recovery Operation* (updated on Dec. 31, 2020), at https://perma.cc/5RW8-48Y4.

[517] The review conducted used the documents available at the U.S. Environmental Protection Agency website: United States Environmental Protection Agency, *International Agreements on Transboundary Shipments of Hazardous Waste: Bilateral Agreements between the United States and Other Countries* (Jan. 3, 2023), at https://perma.cc/NGX9-PRYJ. (It is noteworthy that hazardous waste is defined according to domestic legislation. In the United States, the EPA specifically excluded carbon dioxide for storage as hazardous waste, and this exclusion encompasses transportation. *See* EPA, Hazardous Waste Management System: Conditional Exclusion for Carbon Dioxide (CO_2), 79 FR 350 (Published Jan. 3, 2014, and effective since Mar. 4, 2014)).

shown, other international conventions present a general obligation of nonpollution but are not indicative of the legal prohibition of cross-border transportation of carbon dioxide for storage.

The current pending-ratification status of the 2009 Amendment to Article 6 of the London Protocol, as discussed, still requires countries to enter into bilateral agreements to authorize the export of carbon dioxide for permanent offshore storage. Moreover, none of the international legal frameworks discussed contain provisions regulating onshore storage; they only cover offshore storage, but none of them prohibit onshore storage. The provisional application of the 2009 Amendment to Article 6 of the London Protocol coupled with the absence of an international legal framework for cross-border transportation for onshore storage is unlikely to be optimal if the international law community continues to consider CCS as having an important role as a part of a mitigation portfolio of activities needed to reduce GHG emissions, particularly for hard-to-abate sectors.

Overall, there is general agreement regarding the role of international treaties in transboundary offshore carbon dioxide storage. The provisional application of the 2009 export amendment to Article 6 of the London Protocol removed the last significant international legal barrier to the export of carbon dioxide for offshore storage.[518] In a recent report, the IEA encouraged countries to develop and publicly share bilateral agreements for cross-border transport of carbon dioxide under the provisional application of that amendment.[519]

Despite a general understanding that no international treaty poses significant barriers to CCS, actors still face a patchwork of international treaties that each have some level of uncertainty regarding their exact scope of their application. Such a legal patchwork is not ideal to facilitate the transportation of carbon dioxide in order to achieve the climate change mitigation benefits of CCS and promote effective environmental protection. Instead, it is likely to increase transaction costs for all involved parties, which may present a potential deterrence to attracting new actors. The higher the uncertainties of the applicable law, the higher the incentives for actors to litigate.[520] Unsurprisingly, key players in the industry have emphasized the need for a unified legal regime[521] and market.[522]

The cross-border transportation of carbon dioxide for permanent storage may be consequential to enable carbon dioxide storage for countries that would not otherwise have this possibility; without it, more carbon dioxide remains in the atmosphere and continues to pollute. This harmful scenario of high levels of carbon

[518] IEAGHG, *Exporting CO_2 for Offshore Storage — The London Protocol's Export Amendment and Associated Guidelines and Guidance, supra* note 296, at 9.

[519] International Energy Agency, Legal and Regulatory Frameworks for CCUS: An IEA CCUS Handbook, *supra* note 327, at 18.

[520] Robert Cooter & Thomas Ulen, Law and Economics 404–08 (2016) (Contending that legal uncertainty is likely to foster litigation, increasing transaction costs).

[521] International Energy Agency, Legal and Regulatory Frameworks for CCUS: An IEA CCUS Handbook, *supra* note 327, at 72–75 (Underscoring the multiple international legal scenarios involved in the cross-border transportation of carbon dioxide).

[522] Lucy Hine, *EU Policy seeing as blocking Scale Up of Cross-border Liquified CO_2 Exports by Ship*, TradeWinds (Oct. 24, 2022) (Highlighting the following remarks by Jasper Heikens, chief commercial officer for Ecolog Ltd. at the CCUS 2022: Time to Deliver conference in London: "Shipping by its very nature is cross-border. We now have policy in the way preventing free movement of carbon dioxide.").

dioxide in the atmosphere provides an additional reason for parties to ratify the 2009 amendment to Article 6 of the London Protocol as soon as possible.

In the meantime, the interim application of the 2009 amendment to Article 6 of the London Protocol has already enabled the cross-border transportation of carbon dioxide for permanent offshore storage. While the current legal patchwork of international treaties is not exactly the most encouraging for the cross-border transportation of carbon dioxide for storage, it ultimately does not present significant legal hurdles.

13. Appendix

Table 7: Parties to the Basel Convention[523]

Parties to the Basel Convention				
Afghanistan	Cyprus	Kazakhstan	Panama	Türkiye
Albania	Czechia	Kenya	Papua New Guinea	Turkmenistan
Algeria	Republic of Korea (*Democratic People's*)	Kiribati	Paraguay	Tuvalu
Andorra	Democratic Republic of Congo	Kuwait	Peru	Uganda
Angola	Denmark	Kyrgyzstan	Philippines	Ukraine
Antigua and Barbuda	Djibouti	Lao People's Democratic Republic	Poland	United Arab Emirates
Argentina	Dominica	Latvia	Portugal	U. K. of Great Britain and Northern Ireland
Armenia	Dominican Republic	Lebanon	Qatar	Republic of *Vanuatu*

[523] Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, Status of Ratification (2022), at https://perma.cc/9228-VW2E. (As previously mentioned in this chapter, there are currently 191 parties to the Basel Convention and the U.S. never ratified it).

Australia	Ecuador	Lesotho	Republic of Korea	United Republic of Tanzania
Austria	Egypt	Liberia	Republic of Moldova	Uruguay
Azerbaijan	El Salvador	Libya	Romania	Uzbekistan
Bahamas	Equatorial Guinea	Lichtenstein	Russian Federation	Vanuatu
Bahrain	Eritrea	Lithuania	Rwanda	Venezuela (*Bolivarian Republic of*)
Bangladesh	Estonia	Luxembourg	Saint Kitts and Nevis	Viet Nam
Barbados	Eswatini	Madagascar	Saint Lucia	Yemen
Belarus	Ethiopia	Malawi	Saint Vincent and the Grenadines	Zambia
Belgium	European Union	Malaysia	Samoa	Zimbabwe
Belize	Finland	Maldives	San Marino	
Benin	Franca	Mali	Saint Tome and Principe	
Bhutan	Gabon	Malta	Saudi Arabia	
Bolivia (*Plurinational state of*)	Gambia	Marshall Islands	Senegal	
Bosnia and Herzegovina	Georgia	Mauritania	Serbia	
Botswana	Germany	Mauritius	Seychelles	
Brazil	Ghana	Mexico	Sierra Leone	
Brunei Darussalam	Greece	Micronesia (*Federated States of*)	Singapore	
Bulgaria	Grenada	Monaco	Slovakia	
Burkina Faso	Guatemala	Mongolia	Slovenia	

Burundi	Guinea	Montenegro	Solomon Islands
Cabo Verde	Guinea Bissau	Morocco	Somalia
Cambodia	Guyana	Mozambique	South Africa
Cameroon	Haiti	Myanmar	Spain
Canada	Honduras	Namibia	Sri Lanka
Central Africa Republic	Hungary	Nauru	State of Palestine
Chad	Iceland	Nepal	Sudan
Chile	India	Netherlands	Suriname
China	Indonesia	New Zealand	Sweden
Colombia	Iran (*Islamic Republic of*)	Nicaragua	Switzerland
Comoros	Iraq	Niger	Syrian Arab Republic
Congo	Ireland	Nigeria	Tajikistan
Cook Islands	Israel	North Macedonia	Thailand
Costa Rica	Italy	Norway	Togo
Cote D'Ivoire	Jamaica	Oman	Tonga
Croatia	Japan	Pakistan	Trinidad and Tobago
Cuba	Jordan	Palau	Tunisia

CHAPTER 4: CCS AND THE CROSS-BORDER SHIPPING OF CARBON DIOXIDE FOR PERMANENT STORAGE UNDER THE PARIS AGREEMENT

This chapter discusses how the international shipping of carbon dioxide for permanent storage purposes relates to the market-based mechanisms of the Paris Agreement, focusing specifically on compliance carbon markets and related emission reductions (ER).[524] It also investigates how parties to the Paris Agreement must effectively disclose the emissions related to these activities in their reports for emissions inventory purposes.

The Paris Climate Agreement was adopted in 2015[525] at the Twenty-First Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC).[526] Only parties to the UNFCCC can be parties to the Paris Agreement.[527] The Paris Agreement declares that global peaking of greenhouse gases (GHG) emissions should be achieved as soon as possible, and encourages parties to undertake continuing and expedited emissions reductions.[528] Parties are required to submit nationally determined contributions (NDCs),[529] which are voluntarily established by each country and are recorded in a public registry maintained by the UNFCCC's Secretariat.[530] NDCs are, essentially, individual parties' climate action plans.[531] Parties are also called upon to submit more ambitious NDCs [532] every five years.[533]

This chapter proceeds as follows. Section 1 introduces the concept of market-based emissions trading mechanisms under Article 6 of the Paris Agreement, detailing the provisions of both Articles 6.2 and 6.4 and outlining the potential role of CCS on compliance markets. This chapter particularly analyses the implications of trading under Article 6 for CCS projects, and it does not discuss how CDR fits into Article 6, as key issues are still being debated at the international level. More specifically, this chapter excluded any discussion of removals because there is still some uncertainty as to how they will be treated under the Article 6 trading mechanisms. Section 2 provides an overview of relevant international emissions accounting frameworks for CCS, CDR, and shipping activities, outlining the European Union Emissions Trading System (EU ETS) as well as carbon dioxide reporting obligations for parties to the Paris Agreement. Based on the conclusions from these first two sections, Section 3 analyzes the specific case study of the cross-border shipping of carbon dioxide from Europe for permanent storage in the United States considering current reporting obligations and adjustments under the

[524] Technically, this chapter focuses on compliance markets under the Article 6.2 and Article 6.4 of the Paris Agreement. It also addresses the EU ETS and potential linking under Article 6.2 of the Paris Agreement. Analysis of credits generated exclusively under the voluntary carbon market (VCM) is beyond the scope of this report. *See* REGINA BETZ ET AL., THE CARBON MARKET CHALLENGE 5 (2023) (For an overview of voluntary markets).

[525] The United Nations Paris Agreement, Dec. 12, 2015, 54113 U.N.R.N. 88 [hereinafter Paris Agreement].

[526] The United Nations Framework Convention on Climate Change, Sep. 5, 1992, 1771 U.N.T.S. 107 [hereinafter UNFCCC], Art. 2. (Providing that the UNFCCC aims at stabilizing GHG emissions "at a level that would prevent dangerous anthropogenic interference with the climate system.").

[527] Paris Agreement, *supra* note 525, Art. 20 (1).

[528] Paris Agreement, *supra* note 525, Art. 4.1.

[529] Paris Agreement, *supra* note 525, Art. 3–4.

[530] Paris Agreement, *supra* note 525, Art.4.12.

[531] Ralph Bodle & Sebastian Oberthür, *Legal Form of the Paris Agreement and Nature of Its Obligations*, *in* THE PARIS AGREEMENT ON CLIMATE CHANGE, 93 (Daniel Klein et al. eds., 2017).

[532] Paris Agreement, *supra* note 525, Art. 4.3, providing that "Each Party's successive nationally determined contribution will represent a progression beyond the Party's then current nationally determined contribution and reflect its highest possible ambition, reflecting its common but differentiated responsibilities and respective capabilities, in the light of different national circumstances."

[533] Paris Agreement, *supra* note 525, Art. 4.9 (Referring to the five-year cycle).

Paris Agreement. This section determines that it is ultimately unlikely that Article 6 will play a significant role in scaling a cross-border CCS operation under the current provisions. Section 4 concludes. An assessment of carbon markets and the extent to which they are effective is outside the scope of this report.[534]

1. Carbon markets and the Paris Agreement

Carbon markets are controversial. As summarized by the International Energy Agency (IEA), supporters of carbon markets contend that trading allows governments and businesses to reduce emissions wherever it is cheapest to do so, while opponents argue that "trading is a bookkeeping device which substitutes paper transactions for real world reductions."[535]

Despite these controversies, one estimate suggests that the use of market mechanisms to implement countries' NDCs would result in cost reductions of approximately $250 billion per year in 2030 when compared to the cost of independent implementation.[536] For this reason, many view Article 6 of the Paris Agreement as one potential opportunity for creating and scaling a centralized, international carbon market. This article of the Paris Agreement affirms that voluntary cooperation between parties may allow for "higher ambition" in their NDCs, and roughly outlines market mechanisms for allowing for such trading between parties.[537]

The challenges of realizing the full potential cost savings and enhanced ambition of Article 6 cannot be overstated. However, Article 6 market mechanisms are of special interest in a context where "net-zero" emissions are pledged, since parties will have different capacities for achieving net-negative emissions and different amounts of residual, unabatable emissions.[538] Article 6 trading has been promoted as relevant to incentivizing any parties with excess capacity to go net-negative to balance remaining emissions from parties without the ability to achieve net-zero on their own.[539] Of course, there are very serious questions about whether any parties truly do have excess capacity to go net-negative, or if there are any parties that will have

[534] Duncan P. McLaren & Louise Carver, *Disentangling the "net" from the "offset": Learning for net-zero climate policy from an analysis of "no-net-loss" in biodiversity*, 5 FRONT. CLIM.1197608 (2023) (For a detailed analysis of offset trading, comparing carbon offsets with the "[L]onger-standing but largely ineffective efforts to protect biodiversity through offsetting." The article concludes by criticizing the presumption that offsets are crucial to net-zero and outlines the related consequences of this assumption for climate governance).
[535] INTERNATIONAL ENERGY AGENCY, *International Emission Trading — From Concept to Reality*, IEA 1, 13 (Jan. 1, 2021), at https://perma.cc/8QEZ-3YYU.
[536] Jae Edmonds et al., *The Economic Potential of Article 6 of the Paris Agreement and Implementation Challenges*, IETA 1, 1 (Sep. 2019).
[537] Paris Agreement, *supra* note 525, Art. 6 (1), which provides as follows: "Parties recognize that some Parties choose to pursue voluntary cooperation in the implementation of their nationally determined contributions to allow for higher ambition in their mitigation and adaptation actions and to promote sustainable development and environmental integrity."
[538] Edmonds et al., *supra* note 536, at 15. Interestingly, cooperation will tend to shift emissions mitigation to places with a comparative advantage along with capital investment and infrastructure for emissions mitigation; it also shifts mitigation, capital, and infrastructure investments away from regions with the highest ambition.
[539] *Id.*

excess capacity once they advance in their economic development. The only way parties may have this excess capacity is through nature-based offsets, many of which are highly questionable.[540]

Crucial to any trading regime is the concept of avoided emissions (or removals, potentially). Avoided emissions must be accountable, negotiable units that represent tons of carbon dioxide in the atmosphere.[541] An emissions trading regime allows countries or other entities to trade these avoided emissions (or removals) like commodities.[542] The rationale behind this market is that buyers of avoided emissions units will be countries facing high costs of reducing emissions, whereas sellers will be countries where the cost is lower, or where national climate commitments are lower than their actual emissions.[543]

The following subsections provide an overview of the provisions of Article 6 market-based mechanisms within the Paris Agreement. After addressing the provisions of Article 6 as currently understood and highlighting remaining open issues, the section provides a deep dive on the potential role of CCS within both Articles 6.2 and 6.4. This section concludes by highlighting the main concerns relating to CCS within Article 6's market mechanisms.

Finally, is worth noting early on that this chapter's analysis ultimately concludes that Article 6's market mechanisms are unlikely to play a significant role in the development of a cross-border CCS operation given the current provisions of the Paris Climate Agreement. The rationale behind this conclusion is further explained in Section 3. However, the remainder of Section 1 provides a thorough analysis of Article 6 for the purposes of completeness. As political and economic conditions shift over time, it is theoretically possible that Article 6 may become a more appealing mechanism to support cross-border CCS projects.

1.1 Article 6 of the Paris Agreement: general provisions and challenges

This section is divided into two subsections. The first outlines how the market-based mechanisms of Article 6 function, including key operational definitions. The second subsection contextualizes these provisions by analyzing both past developments during the most recent COPs, namely, in 2022 (COP 27) and in 2023 (COP 28), and potential future developments that may occur during future COPs, particularly in the upcoming COP 29.

1.1.1 Overview of Article 6

This subsection provides a general overview of how Article 6 is understood at present. Article 6 is among the most complex provisions of the Paris Agreement. The article was left for the last-minute approval of the

[540] NATURE-BASED SOLUTIONS INITIATIVE, *Report of the Misuse of Nature-Based Offsets*, NBSI 1, 2 (Apr. 2021), at https://perma.cc/RDF4-HSBR. (Concluding that nature-based offsets are being used for greenwashing).
[541] INTERNATIONAL ENERGY AGENCY, *International Emission Trading — From Concept to Reality*, *supra* note 535, at 13.
[542] *Id.*
[543] *Id.*

parties,[544] and its implementation under the so-called Paris Rule Book was only agreed upon during COP 26 in 2021.[545]

The thrust of Article 6 is detailed in paragraphs 2 and 4 of its text, commonly referred to as Article 6.2 and Article 6.4, respectively. The principal goal of both these articles is to enable voluntary cooperation among countries in order to achieve the emission reductions targets established in their NDCs through market-based mechanisms. However, Articles 6.2 and 6.4 approach this goal in two different ways.

Under Article 6.2, emissions reductions are achieved through cooperative approaches in the form of bottom-up bilateral or multilateral agreements that allow for the transfer of emission reduction units, following an accounting framework that prevents double counting. These emission reduction units are called internationally transferred mitigation outcomes, or ITMOs.[546]

ITMOs are required to be the following:

(a) real, verified, and additional;

(b) emission reductions and removals, providing mitigation co-benefits resulting from adaptation actions and/or economic diversification plans or the means to achieve them, when internationally transferred;

(c) generated in respect of or representing mitigation from 2021 onward;

(d) measured in metric tons of carbon dioxide equivalent (t CO_2 eq) as established in the methodologies and metrics by the IPCC and adopted by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA), or in other GHG metrics determined by the participating parties that are consistent with NDCs of the participating parties.

ITMOs may be created by any of the following scenarios:

(a) from a cooperative approach referred to in Article 6.2, involving the international transfer of mitigation outcomes authorized for use towards an NDC pursuant to Article 6.3;

(b) mitigation outcomes authorized by a participating party for use for international mitigation purposes other than achievement of an NDC (referred to as "international mitigation purposes") or authorized for other purposes as determined by the first transferring participating party (referred as "other purposes");

(c) Article 6.4 emission reductions issued under the mechanism established by Article 6.4, when they are authorized for use towards achievement of NDCs and/or authorized for use for other international mitigation purposes.[547]

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[544] Andrew Howard, *Voluntary Cooperation (Article 6)*, *in* THE PARIS AGREEMENT ON CLIMATE CHANGE, 178 (Daniel Klein et al. eds., 2017).

[545] Conference of the Parties Serving as the Meeting of the Parties to the Paris Agreement, *Report of the Conference of the Parties Serving as the Meeting of the Parties to the Paris Agreement on its Second Session, Held in Glasgow from 31 October to 12 November 2021. Addendum—United Nations Framework Convention on Climate Change* (Mar. 8, 2022) [Hereinafter Glasgow Climate Pact].

[546] Eve Tamme & John Scowcroft, *The Role of CCS in the Paris Agreement and its Article 6*, GLOBAL CCS INSTITUTE 1, 1–4 (2020).

[547] Decision 2/CMA.3, *Guidance on Cooperative Approaches referred to in Article 6, paragraph 2, of the Paris Agreement,* Annex, I, Paragraph 1 (Nov. 2021), at https://perma.cc/R8ZL-UJA4. It is noteworthy that paragraph 2 of the same Annex provision defines 'first transfer' as " (a) For a mitigation outcome authorized by a participating Party for use towards the achievement of an NDC, the first international transfer of the mitigation outcome or; (b) For a mitigation outcome authorized by a participating Party for use for other

Under Article 6.4, emission reductions are achieved by determining the basis for measuring the emission reductions associated with authorized activities. To do so, Article 6.4 creates a centralized top-down governance system for both countries and the private sector to trade emission reductions around the world.[548] The article establishes a Sustainable Development Mechanism (SDM) whereby countries can purchase ITMOs to meet their NDCs.[549]

In short, while the Article 6.2 mechanism allows the opportunity for collaborative, voluntary approaches by using ITMOs towards the achievement of NDC targets, Article 6.4 creates a mechanism to contribute towards GHG emissions mitigation while fostering sustainable development.[550] More details on the specific mechanisms within Article 6.2 and Article 6.4, particularly as they relate to CCS activities, are provided in Sections 1.2 and 1.3.

At COP 26, parties finally came to an agreement regarding the concept of Article 6.4 emission reductions (A6.4ER), which are defined as follows: An A6.4ER is issued for mitigation achieved in accordance to Article 6, paragraphs 4 to 6 and all the rules and modalities procedures determined by the parties.[551] Further, an A6.4ER "is measured in carbon dioxide equivalent and is equal to 1 tonne of carbon dioxide equivalent calculated in accordance with the methodologies and metrics assessed by the Intergovernmental Panel on Climate Change and adopted by the CMA or in other metrics adopted by the CMA."[552]

Unlike the generation of ITMOs under Article 6.2, which are regulated by bilateral or multilateral agreements, Article 6.4 ERs are created via a centralized mechanism that is governed directly by the UNFCCC for the authorization and issuance of emission reductions. This creates a system similar to that of the Clean Development Mechanism (CDM) credits under the Kyoto Protocol.[553] The relationship between the CDM of the Kyoto Protocol and the SDM as created by Article 6.4 of the Paris Agreement is further analyzed in Section 1.3.[554] CDM projects established under the Kyoto Protocol do not transition automatically for trade under Article 6.4 of

international mitigation purposes, (1) the authorization, (2) the issuance or (3) the use or cancellation of the mitigation outcome, as specified by the participating Party."

[548] Eve Tamme & John Scowcroft, *supra* note 546, at 1–4.

[549] Romany M. Webb & Jessica A. Wentz, *Human Rights and Article 6 of the Paris Agreement: Ensuring Adequate Protection of Human Rights in the SDM and ITMO Frameworks*, Sabin Center for Climate Change Law, 1, 7 (2018) (Discussing Article 6.4 as a top-down approach).

[550] Gregory Cook et al., *CCS under Article 6 of the Paris Agreement*, GHGGT-16, 1, 3 (Oct. 27, 2022).

[551] Decision 3/CMA.3, *Rules, Modalities and Procedures for the Mechanism established by Article 6, paragraph 4, of the Paris Agreement,* Annex, I, 1(b) (Nov. 2021).

[552] *Id.*

[553] Latham & Watkins, *COP 27: Overview and Key Takeaways,* Commentary 3041 (Dec. 7, 2022), at https://perma.cc/ZTM9-289K.

[554] Under the CDM, Annex I parties could finance projects in developing countries and obtain allowances for certified emission reduction units (CERs), potentially creating aligned incentives for reducing emissions in a cost-effective way. Rosanna Anderson, *Non-market mechanisms under Article 6.8 of the Paris Agreement; A Transnational Perspective,* 13 Transnational Leg. Theory 321, 325 (2022).

the Paris Agreement.[555] When Article 6.4 ERs are authorized for use toward NDC achievement or other international mitigation purposes, they are traded under ITMOs.[556]

The Paris Agreement also establishes a framework for non-market approaches under Article 6.8 and Article 6.9.[557] These approaches are still under development, with recent submissions to the UNFCCC appearing to enjoy momentum.[558] These approaches are currently centered around increasing adaptation financing and are expected to shape potential future non-market approaches.[559]

Presently, Article 6.8 and Article 6.9 of the Paris Agreement provide that integrated, holistic, and balanced non-market approaches shall be available to parties to assist in the implementation of NDCs regarding sustainable development and poverty eradication, which includes mitigation, adaptation, finance, technology transfer and capacity building efforts, among others.[560] These approaches were included as a compromise to detractors of carbon market approaches.[561] Even in the context of the UNFCCC negotiations, it is difficult to precisely define non-market approaches.[562]

The table below summarizes Article 6's market and non-market approaches towards achieving more ambitious NDCs.

[555] Draft Decision CMA.4, *Rules, Modalities and Procedures for the Mechanism established by Article 6, paragraph 2, of the Paris Agreement,* (Nov. 2022), Annex I, I. A. 1–3, at 5, at https://perma.cc/SPE9-86ZL. (Notably, mitigation actions are referred to as "activities" by the Paris Agreement's SDM, but "projects" under the Kyoto Protocol's CDM).
[556] Guidance on Cooperative Approaches referred to in Article 6, paragraph 2, of the Paris Agreement, Paragraph I, Item (g), (UNFCCC, 2022), at https://perma.cc/L7L9-NS2C.
[557] Paris Agreement, *supra* note 525, Art. 6.8.
[558] Anderson, *supra* note 554, at 335.
[559] *Id. See, e.g.,* Submission of Cote D'Ivoire on behalf of Uganda, Eswatini and Kenya, Existing relevant non-market approaches that may be facilitated under the initial focus areas of the framework for non-market approaches referred to in Article 6, paragraph 8, of the Paris Agreement (Submission date: Feb. 2, 2022), at https://perma.cc/DW3Y-26R8.
[560] Paris Agreement, *supra* note 525, Art. 6.8.
[561] Howard, *supra* note 544, at 178.
[562] Anderson, *supra* note 554, at 331–33. (Underscoring that non-market approaches are quite behind market approaches and their coexistence is complex, at best).

Table 1: Article 6 market and non-market approaches

Article 6.2 and 6.3: Cooperative Approaches	*Article 6.4 to 6.7: The Sustainable Development Mechanism (SDM)*	*Article 6.8 to 6.9: Framework for non-market approaches*
Market-based	Market-based	Non-market
Decentralized and country-led approach to climate governance	Centralized, international crediting mechanism under the UNFCCC	Integrated, holistic, and balanced approaches
Rules are set	Rules being elaborated (Art.6.4's Supervisory Body is discussing several topics, including removals)	Under development or in operation
Trade unit: ITMOs	Trade unit: Art.6.4 ERs	N/A

As the table above conveys, there are still open questions regarding the Article 6.4 mechanism, and it remains unclear when the SDM will be implemented.[563]

There is some uncertainty regarding how Article 6.2 and 6.4 markets will interact both with each other and with existing voluntary carbon markets, especially as Article 6 market mechanisms continue to develop.[564] As noted in the introduction, this report does not analyze voluntary carbon markets, as the demand for these markets is generated by companies seeking to achieve their own net-zero pledges. However, a cursory overview of how these voluntary markets differ from compliance markets – and why they are unlikely to be relevant to CCS activities – is provided below for the purpose of completeness.

[563] Implementation of the SDM will certainly not occur before June 2025, as this is when the first version of the accounting mechanism is currently scheduled to be finalized. *See* Draft Decision CMA.4, *Guidance on Cooperative Approaches referred to in Article 6, paragraph 2, of the Paris Agreement and in decision 2/CMA.3* (Nov. 2022), Paragraph 25, at 5, at https://perma.cc/HU7Q-XDXD. (Specifically requesting the Secretariat to prioritize the development of a centralized accounting and reporting platform and the Article 6 database as well as to make a test version available by June 2024, with the goal of the first version being finalized by June 2025).

[564] INTERNATIONAL ENERGY AGENCY, *Integrating CCS in International Cooperation and Carbon Markets under Article 6 of the Paris Agreement*, in Paul Zakkour et al. eds, IEAGHG Report N. 2023-01, at 1, 4, and 6–7 (Jan. 2023), at https://perma.cc/X3QC-XT2D.

Unlike the centralized compliance markets of the Paris Agreement, voluntary markets operate with their own varying standards and their own tradable units.[565] Examples include the Gold Standard, which uses verified emission reductions (VERs), and VERRA, which uses verified carbon units (VCUs).[566] Some large voluntary carbon market standards have become stricter over time,[567] while small niche standards have offered low-quality credits.[568] Voluntary carbon markets have therefore been defined as a site of climate governance beyond the state, in which several predominant private actors "compete in developing validation and verification standards and providing offsets of varying qualities."[569]

To date, the voluntary carbon market is largely unregulated and has been operating without government intervention.[570] Carbon projects in these markets are typically developed by project proponents, often private and local actors, who apply local laws to these projects.[571] Projects currently operating in the voluntary carbon market include removals and storage in afforestation and reforestation, coastal wetland creation, and tidal wetland and seagrass restoration. CCS projects are not of targeted interest.[572]

The fact that CCS projects have not played a large role in voluntary carbon markets indicates that while transboundary carbon dioxide shipping for permanent storage can theoretically fit into these markets, interest is not expected to be significant. The cross-border shipping component under analysis in this report creates additional complexity for a CCS project. Ultimately, voluntary markets are an unlikely alternative for this type of cross-border CCS project under contemporary conditions. However, as the technology involved in the CCS chain becomes more accessible and carbon prices increase, this scenario may change and begin providing additional incentives for CCS-involved actors.

1.1.2 Current outlook and future developments of Article 6

The Paris Agreement had little to say regarding CCS in its original text, limiting itself to "removals" and the need for parties to include these in their reporting.[573] Article 1 of the Paris Agreement[574] adopts the UNFCCC's definition of sink, stating that a "sink means any process, activity or mechanism which removes a greenhouse

[565] *See* BETZ ET AL., *supra* note 524, at 5. *See also* Thomas Day et al., *Corporate Climate Responsibility Monitor*, New Climate Institute (Feb. 2023) (Identifying and highlighting good practice approaches while scrutinizing the credibility of companies' offsetting plans).
[566] BETZ ET AL., *supra* note 524, at 5.
[567] *Id.* (Noting that this is true of Gold Standard and is also true of Verra to some extent).
[568] BETZ ET AL., *supra* note 524, at 8.
[569] *Id.*
[570] This unregulated trend is changing. California has just adopted a law that will require a great deal of disclosure from and about voluntary carbon markets. *See* Grant Thornton, *California Voluntary Carbon Market Disclosure Act* (Nov. 9, 2023), at https://perma.cc/A7TP-Y6JV.
[571] UK Voluntary Carbon Markets Forum, *Enabling the Voluntary Carbon Market in the Context of the Paris Agreement* 1, 13 (2023).
[572] *Id.* at 13.
[573] Paris Agreement, *supra* note 525, Art. 4–5 and Art. 13, respectively.
[574] Paris Agreement, *supra* note 525, Art. 1.

gas, an aerosol or a precursor of a greenhouse gas from the atmosphere."[575] Notably, this definition is not limited to naturally-occurring processes.[576] Likewise, the definition of "reservoir" encompasses both geological and biological storage of GHGs, which would include the forms of storage contemplated by CDR technologies.[577] Carbon dioxide removal techniques that draw carbon dioxide down from the atmosphere and store it fit within the definition of "sink;" carbon capture techniques that prevent carbon dioxide from escaping into the atmosphere from industrial sources would not.[578]

Despite not specifically using the term, the Paris Agreement embodies the concept of "net zero" when referring to the need for parties to achieve a balance between anthropogenic emissions of GHGs and removals by sinks.[579] Because CCS is a climate mitigation technology, it aims at reducing anthropogenic carbon dioxide emissions[580] and is therefore covered in both Articles 6.2 and 6.4 of the Paris Agreement.[581] Captured carbon dioxide needs to be stored for indefinite time periods to achieve a meaningful mitigation effect, at a minimum for centuries.[582]

From its inception, the Conference of the Parties to the Paris Agreement required that Article 6.4's mitigation benefits should be real, measurable, long-term, and certified, and that the associated emission reductions shall be additional to any that would otherwise occur.[583] Additionality is defined as the requirement that a credited benefit consists exclusively of gains that would not otherwise have occurred and that are fully additional to the expected scenario without the existence of such credited benefit.[584]

However, the continued challenges associated with storage, actual removal, and verification illustrate the need for constant monitoring, accounting, and overall reporting. Legal issues relating to monitoring, reporting, the possibility of eventual revocation of non-authorized emission reductions, leakage, and reversal risks were a

[575] UNFCCC, *supra* note 526, Art. 1(8).
[576] Neil Craik & William C. G. Burns, *Climate Engineering under the Paris Agreement*, 49 ELR 11113,111122 (2019).
[577] *Id.*
[578] *See* Eve Tamme & John Scowcroft, *supra* note 546, at 5.
[579] Cook et al., *supra* note 550, at 3. (*See also* Paris Agreement, *supra* note 525, Art. 4 (1): "In order to achieve the long-term temperature goal set out in Article 2, Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions thereafter in accordance with best available science, *so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases* in the second half of this century, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty." (emphasis added).
[580] Karl W. Bandilla, *Carbon Capture and Storage in* FUTURE ENERGY: IMPROVED, SUSTAINABLE AND CLEAN OPTIONS FOR OUR PLANET 669, 669, 681 (Trevor M. Letcher ed., 2020).
[581] Art. 4.4 of the Paris Agreement refers to "emission reduction" targets.
[582] Bandilla, *supra* note 580, at 681.
[583] The Conference of the Parties serves as the meeting of the Parties to the Paris Agreement, Decision 1/CP.21 paragraph 38, at https://perma.cc/HC2E-2PUQ. These discussions date back to the UNFCCC talks. *See, e.g.,* Jørgen Wettestad, *Monitoring and Verification in* THE OXFORD HANDBOOK OF INTERNATIONAL ENVIRONMENTAL LAW 974, 975 (Daniel Bodansky et al. eds., 2010).
[584] Martine Maron et al., *Taming a wicked problem: Resolving controversies in biodiversity offsetting*, 66 BIOSCIENCE, 489, 490 (2016).

priority in COP 28,[585] but ended up being postponed to COP 29, as parties of the Paris Agreement did not agree on issues relating to market mechanisms under Articles 6.2 and 6.4.[586] As such, further details were automatically postponed to COP 29, due to the automatic application of the UNFCCC Draft Rules of Procedure.[587]

As the market mechanisms of the Paris Agreement are still being developed, uncertainty remains regarding the role of CCS, removals, and overall accounting and accreditation.

A key issue at COP 26 and COP 27 was the application of "corresponding adjustments" to avoid double counting of ITMOs and other transferred units by both host and recipient country.[588] COP 27 clarified that the vintage of an ITMO is the calendar year in which the underlying mitigation occurred.[589] COP 27 also established that upcoming COPs will consider how parties should act when there are inconsistencies highlighted by expert review of their reporting and the implications of non-responsiveness, if any.[590] COP 27 postponed the following clarifications to COP 29 (2024): the elaboration of further guidance for corresponding adjustments in NDCs to ensure no double counting on cumulative emissions by sources and removals by sinks; methods for averaging corresponding adjustments; and considerations on whether ITMOs could include emissions avoidance.[591] These postponements signal the complexity involved in addressing each of these concerns.

In addition, COP 27 deferred the process for ITMO authorization to future COPs. Article 6.3 of the Paris Agreement first introduced the concept of ITMO authorization, stating that the use of ITMOs to meet NDCs must first be authorized by participating parties. Authorization is therefore an important component of voluntary cooperation under Article 6, as it determines both when a mitigation outcome would qualify as an ITMO as well as the applicable corresponding adjustments and reporting requirements for participating parties.[592] COP 27 specifically requested clarification on what else an ITMO may be authorized towards beyond meeting NDCs, the process for managing these authorizations, as well as what entity has the ability to authorize ITMOs in a way that ensures transparency and consistency.

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[585] Eve Tamme & Paul Zakkour, *COP 27: Paving the Way for the "Removals COP*," EVETAMME BLOG (Nov. 24, 2022). *See also* Craik & Burns, *supra* note 576, at 11121–22. (For an in-depth discussion about the inclusion of removals and associated carbon storage processes in the Paris Agreement, ultimately concluding that their inclusion is likely).

[586] Noora Al Amer, *Six Key COP 28 Outcomes for CCS*, GLOBAL CCS INSTITUTE 1, 13 (Dec. 20, 2023), at https://perma.cc/MY7W-3RHH.

[587] The UNFCCC Draft Rules of Procedure of the Conference of the Parties and Subsidiary Bodies, as adopted by the Conference of the Parties of the UNFCCC in Geneva (Jul. 1996), which reads as follows: "Rule 16: Any item of the agenda of an ordinary session, consideration of which has not been completed at the session, shall be included automatically in the agenda of the next ordinary session, unless otherwise decided by the Conference of the Parties." *See also* Al Amer, *supra* note 586, at 13. (Specifically informing that further implementation of market-based mechanisms provided in Article 6 were postponed to COP 29).

[588] Cook et al., *supra* note 550, at 3.

[589] Draft Decision CMA.4, *Guidance on Cooperative Approaches referred to in Article 6, paragraph 2, of the Paris Agreement and in decision 2/CMA.3* (Nov. 2022), Paragraph 5, at 2, at https://perma.cc/JB6J-FKNH.

[590] *Id.,* Paragraph 16 (a), at 3.

[591] *Id.,* Paragraph 16 (b), at 3.

[592] Luca Lo Re et al., *The Birth of an ITMO: Authorisation under Article 6 of the Paris Agreement*, OECD & IEA Climate Change Expert Group 1, 11 (Oct. 2022), at https://perma.cc/2PFB-QV2G.

Despite these delays in clarification, COP 27 did create a new mitigation contribution ER under Article 6.4.[593] The parties provided for the differentiation between "authorized ERs" used within the scope of NDCs or other international mitigation purposes, and "mitigation contribution ERs" used to reduce emissions in the host country.[594] However, it is uncertain how these mitigation contribution ERs and corresponding adjustments will operate in practice.

Finally, issues regarding the need for functionalities and procedures to allow for the transfer of A6.4 ERs to the international registry[595] as well as challenges related to the common nomenclature for cooperative approaches reported by participating parties were deferred to future COPs.[596]

In summary, specific provisions key to mitigation, emissions avoidance, and related trading have yet to be defined and may be streamlined in future COPs. Despite these limitations, the following two sections provide a closer analysis of how CCS projects specifically may function under the current understanding of both Article 6.2 and Article 6.4.

1.2 Article 6.2 and CCS

While the implementation of Article 6.2's decentralized mechanism was quite complex, its general rules are set, and countries have started to engage under its provisions.[597] This mechanism aims to enable cooperative approaches between parties to the Paris Agreement through signing bilateral or multilateral agreements for the transfer of ITMOs. To engage in this approach, the country must be a party to the Paris Agreement; have submitted its national inventory; and have prepared, communicated, and maintained its NDC.[598] In addition, the party must also have arrangements in place for authorizing the use of ITMOs towards its NDCs, and comply with Article 6.3 and all applicable decisions of the CMA.[599]

[593] Decision CMA.4 (Advance unedited version), *Guidance on the mechanism established by Article 6, paragraph 4, of the Paris Agreement* (Nov. 2022), at https://perma.cc/2YUD-NWUR.
[594] *Id.*
[595] *Id*, at. Paragraph 17 (g), at 4, providing as follows: "The need for additional functionalities and procedures for the international registry to allow for transfer of Article 6, paragraph 4, emission reductions to the international registry and to provide services for cooperative approaches if voluntarily requested by Parties participating in a cooperative approach, including, inter alia, additional technical functionalities and administrative arrangements, for authorizing account access, and further guidance on procedures for reporting and review for the cooperative approaches of the participating Parties requesting such services, which may be required in addition to the relevant guidance in decision 2/CMA.3 and annex I to this decision."
[596] *Id.*, at Paragraph 17 (j), at 4.
[597] For updated trackers on these bilateral agreements and overall implementation of Article 6, *see* IETA, *Visualizing Article 6 Implementation* (Feb. 1, 2023), at https://perma.cc/Y63F-CHWX.
[598] Decision 2/CMA.3, *Guidance on Cooperative Approaches referred to in Article 6, paragraph 2, of the Paris Agreement,* Annex, I, Paragraph 4 (Nov. 2021).
[599] *Id.*

Parties can also agree for companies to trade ITMOs under the terms established in those cooperative approaches, enabling the private sector to participate in ITMO transactions.[600] Once parties provide for companies to trade ITMOs under Article 6.2, ITMO transactions would present a dual-tier system. First, a bilateral governmental agreement (often named a "Cooperation Agreement") is signed between the host country and the country that will receive the ITMO and provides for the overall requirements for issuance of ITMO. Next, under the framework established in the bilateral governmental agreement, third parties may sign commercial agreements for the transfer of ITMOs for specific activities.[601]

According to the scheme established in Article 6.2, the country procuring the ITMO is the "host country" (seller) where the activity that will originate the GHG emission reduction or removal is based. In practice, host countries are often located in the Global South.[602] In theory, ITMOs enable the receiving country (buyer) to "take on greater ambition in setting its NDC by allowing it to finance projects or activities in geographic locations where GHG emissions reductions or removals can be achieved in a more cost-effective manner."[603] It is worth highlighting that the cooperation agreements do not mandate that the host country must trade a specific number of ITMOs; instead, they create a framework for the two countries to authorize individual transactions under which ITMOs will be transferred.[604]

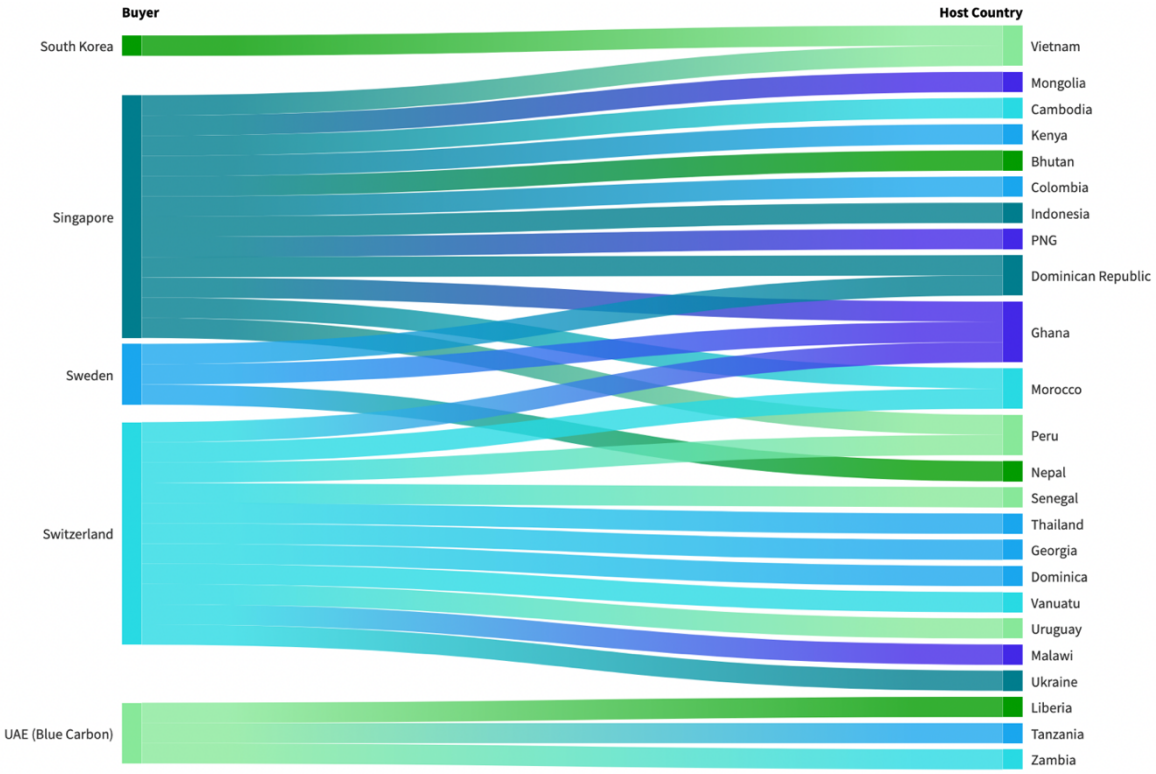
Because Article 6.2 is based on bilateral or multilateral agreements, it provides flexibility for countries to develop their own rules, particularly those regarding controls and safeguards. However, this requires more political capital and time than a standard Article 6.4 setting.[605] It is noteworthy that developing a bilateral agreement under Article 6.2 is merely the first stage in the journey for trading, as countries must issue letters of authorization,[606] fulfill reporting requirements and, once the activity is concluded, initiate monitoring and verification processes.[607]

Figure 1 shows which countries have established bilateral agreements under Article 6.2 of the Paris Agreement as of July 2023. Additional relevant agreements include those of the Indo-Pacific Carbon Offset Regimes (IPCO) and its implementation advancing Article 6.2 of the Paris Agreement[608] as well as the memorandum of

[600] Sam Kerschener et al, *Emerging Fundamentals in Climate Mitigation Through ITMO Transactions Under Paris Agreement Article 6.2,* WHITE & CASE, 1, 4 (Mar. 8, 2023), at https://perma.cc/S8H7-K2L7.
[601] *Id.*
[602] *Id.* at 2.
[603] *Id.* (Noting that the Switzerland is entering into cooperative agreements with Ghana and Vanuatu but chose not to use the ITMOs towards its NDC; rather, it decided to complement it).
[604] *Id.* at 12.
[605] Beatriz Granziera et al*., Article 6 Explainer*, THE NATURE CONSERVANCY 1, 6 (2023).
[606] Decision 2/CMA.3, *Guidance on Cooperative Approaches referred to in Article 6, paragraph 2, of the Paris Agreement,* Annex, I, Paragraph 1 (Nov. 2021) (Detailing the requirements for authorization).
[607] Granziera et al*., supra* note 605, at 13.
[608] Katie Sullivan, *Visualizing Article 6 Implementation: IPCO*, IETA (Jul. 6, 2023), at https://perma.cc/YP5J-5TF2

understanding (MOU) signed by Japan with several countries in Asia, Central and South America, Africa, and Europe.[609]

Figure 1: Bilateral Agreements under Article 6.2 of the Paris Agreement[610]



Currently, a contentious issue under Article 6.2 is the accounting of emissions avoidances, which may be solved in upcoming COPs Importantly, the UNFCCC and the IPCC have not defined the term "emission avoidance."[611] Should this issue be resolved – and depending on whether CCS projects would qualify as emission avoidances – it may create an incentive for CCS projects and related cross-border shipping of carbon dioxide for permanent storage.

[609] Carbon Market Express, *JCM Partnership* (Nov. 2022), at https://perma.cc/F7M4-NRHJ. *See also* Katie Sullivan, *Visualizing Article 6 Implementation: JCM*, IETA (Jul. 6, 2023), at https://perma.cc/88JA-MYSL.

[610] Katie Sullivan, *Visualizing Article 6 Implementation*, IETA (Jul. 6, 2023). This interactive map is available at https://perma.cc/88JA-MYSL.

[611] Granziera et al*., supra* note 605, at 11. (Explaining that the concept of "emissions avoidance" has been used to include policies that explicitly forgo the development of fossil fuel resources. The concept has also been used to include a mitigation intervention that would reduce the rate of existing emissions. As such, the term emission avoidance would also constitute an emission reduction).

Beyond the ability for CCS to qualify as an emissions avoidance, there are several additional possibilities to enable CCS development under Article 6.2 which have yet to occur in practice. Three of these possibilities are outlined below.

The first possibility involves the voluntary linkage between the emission trading systems of different jurisdictions.[612] This is a very complex and likely time-consuming operation that requires parties to have very similar regulations for their emission trading systems and for both cap-and-trade markets to effectively work.[613] California and Quebec, for instance, adopted an agreement that mostly functions as a merger.[614] In addition, the cap itself is an essential parameter for defining the level of ambition in any emissions trading system (ETS), and as such would be significant for any linkage to be effective.[615] In the EU experience, the emissions cap is the central lever for both enforcing an EU ETS budget and for defining emissions reductions pathways that may be viewed as compatible with the Paris Agreement, while simultaneously ensuring scarcity on the allowance market.[616]

Despite this possibility, the literature points out that ETS linking would be unlikely in the near-term future, highlighting two previous examples of unsuccessful linkages in the global market. The first is the EU-Switzerland ETS linking, which faced challenges due to different levels of ambition between countries and regions; this linkage is further discussed in Section 2.1.2. The second is the California-Ontario linkage, which ultimately ended due to the shifting politics of Ontario.[617]

The second possibility for Article 6.2's cooperative approach to influence CCS would build on the baseline-and-credit system utilized by the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), which was created in 2016 by the International Civil Aviation Organization (ICAO).[618] CORSIA aims to boost carbon-

[612] Paris Agreement, *supra* note 525, Art. 6.2. (This provision states: "Parties shall, where engaging on voluntary basis in cooperative approaches that involve the use of internationally transferred mitigation outcomes towards nationally determined contributions, promote sustainable development and ensure environmental integrity and transparency, including in governance, and shall apply robust accounting to ensure, inter alia, the avoidance of double counting, consistent with guidance adopted by the Conference of the Parties serving as the meeting of the Parties to this Agreement." The references to "cooperative approaches" and "internationally transferred mitigation outcomes" are interpreted to authorize the linking of ETS systems). *See also* Femke de Jong, *The Impact of the Paris Agreement on the EU's Climate Policies*, CARBON MARKET WATCH 1, 5 (2016), at https://perma.cc/6WJM-XZPS. (This was among the first views that underscored the possibility of linking the EU ETS to other ETS systems under the Paris Agreement).

[613] BETZ ET AL., *supra* note 524, at 41 (Noting that the link between the European Union and Switzerland ETS systems took almost a decade).

[614] Aleksandar Zaklan et al., *The EU ETS to 2030 and beyond: Adjusting the cap in light of the 1.5°C target and current energy policies*, 21 CLIM. POLICY, 778, 779 (2021).

[615] *Id.*

[616] *Id.*

[617] INTERNATIONAL ENERGY AGENCY, *Integrating CCS in International Cooperation and Carbon Markets under Article 6 of the Paris Agreement*, *supra* note 564, at 19. (Contending that the United States and Canadian states and provinces linkage was largely set aside); *but cf* Program Linkage: California Air Resources Board, at https://perma.cc/STY7-6D9J. (Noting that the linkage between California and Ontario ended in 2018, and detailing how California and Quebec worked together to continue their ETS linkage after Ontario's departure).

[618] BETZ ET AL., *supra* note 524, at 4.

neutral growth of the civil aviation sector.[619] The scheme accepts credits originated from CCS activities from specific CORSIA-approved registries, including under previous credits under Kyoto Protocol's CDM.[620] Critics of CORSIA contend that the scheme allows the aviation industry to avoid reducing emissions as much as possible by buying these offset credits.[621] Thus CORSIA should probably not be looked to as a model.

These criticisms aside, in theory a similar scheme could be developed for the cross-border shipping of carbon dioxide for storage under the auspices of the International Maritime Organization (IMO), with shipping companies offered the ability to offset their own emissions under an IMO-regulated offset and trade regime. The IMO could benefit from using some elements of ICAO's framework. Accounting for full lifecycle emissions, including both upstream and induced emissions to ensure that alternative marine fuels issue true environmental benefits, would be an interesting recommendation.[622] Likewise, third-party verification and certification to ensure transparency of emissions reduction claims and environmental integrity while also avoiding double counting concerns would be essential.[623] In addition, all GHG emissions should be considered, not merely carbon dioxide. The ICAO's emission reduction threshold of 10% of GHG emissions – meaning the GHG lifecycle emissions of jet fuel must be reduced by at least 10% compared to current average petroleum jet fuel – seems extremely low as a starting point fora threshold for alternative marine fuels.[624]

However, this type of credits scheme should not be perceived as an alternative to decarbonization of the shipping sector, but merely as an additional emissions reduction pathway for this notoriously hard-to-abate sector.[625] Moreover, the requirements for offsetting and trading would need to consider current criticisms of CORSIA, particularly those regarding the avoidance of double counting and overall environmental integrity.[626] Details would have to be streamlined so as to ensure environmental integrity.[627]

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[619] International Civil Aviation (ICAO), *Environmental Protection: CORSIA States for Chapter 3 State Pair*, athttps://perma.cc/K6TJ-4LKL. (CORSIA will be implemented in three phases: a pilot phase (2021-2023), a first phase (2024-2026), and a second phase (2027-2035), with participation being voluntary for the first two phases and, from 2027 onwards, participation being determined based on 2018 Revenue Tonne Kilometers (RTK) data).

[620] International Energy Agency, *Integrating CCS in International Cooperation and Carbon Markets under Article 6 of the Paris Agreement*, *supra* note 564, at 19. (Highlighting that CORSIA accepts the CDM, despite no CCS methodology being approved).

[621] Lambert Schneider et al., *CORSIA: Fit for Purpose? Key issues for the review of CORSIA,* Oeko-Institut (Apr. 2022), at https://perma.cc/8YPX-LRM7.

[622] Nishatabbas Rehmatulla et al., *Exploring the relevance of ICAO's Sustainable Aviation Fuels framework for the IMO,* Environmental Defense Fund & UMA 1, 26 (Jun. 30, 2020), at https://perma.cc/TY2S-SJZ3.

[623] *Id.* at 26–27.

[624] *Id*. (Also discussing that the 10% minimum threshold should be higher in CORSIA in order to be compatible with the IMO's mission strategy recommendations to halve emissions in the sector by 2050). *Id*. at 8.

[625] *See* Global Maritime Forum, *The Shipping Industry's Fuel Choices on the Path to Net Zero* (2023), at https://perma.cc/V5B3-JUCB. (Underscoring that more than 95 percent of ships today are powered by internal combustion engines that use fossil fuels, such as heavy fuel oil (HFO), marine gas oil (MGO), and marine diesel oil (MDO)).

[626] Schneider et al., *supra* note 621, at 15. (Finding that many certified programmes under CORSIA do not ensure carbon credit quality).

[627] Rehmatulla et al., *supra* note 622, at 26. (Highlighting that any adaptation from CORSIA should proceed with caution).

A final set of theoretical possibilities for folding CCS projects under Article 6.2 would involve countries providing for the inclusion of CCS to fulfill their NDC targets based on a bilateral or multilateral agreement.[628] In that agreement, one party with carbon storage capacity would agree to accept imports of carbon dioxide for storage from the other(s) involved in the extraction or capture of carbon dioxide and co-components. Rather than trade ITMOs, parties would trade carbon storage units (CSUs). While the mechanism for these CSUs has yet to be clarified, the rationale is that the party storing the carbon dioxide would determine an equivalency between CSUs and tons of carbon dioxide and would establish a maximum storage capacity for storage across a certain amount of time.[629] Participating parties looking to export carbon dioxide for storage would then trade CSUs with the host country up to that storage quota. In this scenario, the parties exporting the carbon dioxide could count their exported carbon as a non-emission (or potentially a removal) in their NDCs, depending on the origins of the carbon stream.[630] However, this kind of elaborate trading scheme would not be necessary. Rather, emitting country A would ship its carbon dioxide to storing country B. A would simply pay B. In its emissions accounting, A could reduce its reported emissions by the amount of carbon dioxide that it has captured and prevent from going into the atmosphere.

As described above, Article 6.2 provides several creative avenues that could potentially advance CCS deployment, particularly in the context of cross-border shipping. However, pragmatic considerations – including time-consuming negotiations and questions about whether offsets are a viable mechanism – pose significant challenges to both implementation and efficacy.

1.3 Article 6.4 and CCS

The Article 6.4 market mechanism, which is centralized under the UNFCCC and is often called the Sustainable Development Mechanism (SDM),[631] was developed to succeed the Clean Development Mechanism (CDM) of the Kyoto Protocol.[632] Both are baseline-and-credit systems, as they are based on emissions reductions and removals compared to a tradable target (or baseline) and their units are credits generated after verification and certification.[633] However, a major distinction between the Kyoto Protocol's CDM and the Paris Agreement's SDM

[628] INTERNATIONAL ENERGY AGENCY, *Integrating CCS in International Cooperation and Carbon Markets under Article 6 of the Paris Agreement*, *supra* note 564, at 23–25.

[629] *Id.*

[630] In practice, such an elaborate trading scheme appears unlikely. Emitting country A would ship its carbon dioxide to storing country B. A would simply pay B. In its emissions accounting, A could reduce its reported emissions by the amount of carbon dioxide that it has captured and prevented from going into the atmosphere.

[631] Decision 3/CMA.3, *Rules, Modalities and Procedures for the Mechanism established by Article 6, paragraph 4, of the Paris Agreement,* (Nov. 2021) (Designating the Article 6.4 mechanism as such).

[632] Kyoto Protocol to the United Nations Framework Convention on Climate Change, 2303 U.N.T.S. 162 (signed Dec. 11, 1997, and entered into force Feb. 16, 2005) [hereinafter Kyoto Protocol]. Kyoto Protocol, Art. 3 (1) (Establishing the first commitment period from 2008 to 2012). Doha Amendment to the Kyoto Protocol, Decision 1/ CMP.8, Art. 1, C, amending Art. 3, paragraph 1 of the Kyoto Protocol (Dec. 8, 2012), at https://perma.cc/C72Q-JR2G. (Determining the second commitment period under Kyoto from 2013 to 2020).

[633] BETZ ET AL., *supra* note 524, at 3. (Distinguishing baseline-and-credit from cap-and-trade systems. The latter is based on allocated allowances, which enable holders to emit a specific quantity of emissions; its units are tradable allowances that are allocated/auctioned *ex ante* to regulated entities).

is that all parties may participate in the SDM and related trading, whereas under the Kyoto Protocol only non-Annex I countries could receive CDM financing.[634]

To understand how the SDM was intentionally designed to improve upon the CDM, it is useful to briefly analyze the structure and pitfalls of CDM. For context, the Kyoto Protocol divided its parties into two main categories: Annex I parties and non-Annex I parties. The CDM financed emission reduction projects in non-Annex I countries, meaning countries without emission reductions targets under the Kyoto Protocol.[635] Under the UNFCCC, Annex I parties include developed countries that were members of the Organisation for Economic Co-operation and Development (OECD) in 1992 as well as countries in economic transition at that time – i.e., the states of the former Soviet Union. Each of these Annex I parties had unique and (theoretically) binding emission reduction targets. By contrast, non-Annex I parties were developing parties with no emission reduction targets.[636] The CDM financed emission reduction projects in these non-Annex I countries.[637] The certified emission reductions (CERs) generated by CDM projects could be used by Annex I countries towards the fulfillment of their emission reduction targets.[638]

The CDM featured a controversial design. Several open credits came to be called "hot air,"[639] where estimates for the projected future emissions of a country under a business as usual (BAU) scenario were overinflated based on the country's historical and projected development patterns, resulting in CDM credits being awarded for activities that technically avoided emissions on paper, but did not actually result in net emission reductions.[640] In practice, credits were awarded to activities that would have occurred anyway, resulting in equivalent adjustments that were inconsequential for the host country; since the adjustment was made based on an overinflated emissions estimate, they were considered to have been deducted from "hot air."[641] Since for this and other reasons the Kyoto Protocol's design was suboptimal[642] at best, especially regarding the determination of a BAU baseline and qualifications for additionality, there is significant scrutiny over the SDM's rules.[643]

CDM projects can only have authorized tradable credits if the project is registered with the UNFCCC's Secretariat and designated national authority, or listed as provisional project with the host party while register with the

[634] Paris Agreement, *supra* note 525, Art. 6.4. *See also* Craik & Burns, *supra* note 576, at 11117. (Emphasizing that the Paris Agreement departed from the Kyoto Protocol's experience, as this Protocol stipulated quantified emission reductions commitment within specific time frames).
[635] Kyoto Protocol, supra note 632, Art. 1 (7) (Incorporates the definitions of the UNFCCC for Annex I parties).
[636] UNFCCC, *supra* note 526, Annex I (Annex I parties are named in this Annex, but the UNFCCC does not name non-Annex I parties).
[637] BETZ ET AL., *supra* note 524, 9–23.
[638] Kyoto Protocol, *supra* note 632, at Art. 12.
[639] Ian H. Rowland, *The Kyoto Protocol's 'Clean Development Mechanism': A Sustainability Assessment*, 22 THIRD WORLD QUARTERLY 795, 800–06 (2001) (This was a seminal work underscoring the main challenges surrounding the CDM, albeit not using the term "hot air.").
[640] INTERNATIONAL ENERGY AGENCY, *Integrating CCS in International Cooperation and Carbon Markets under Article 6 of the Paris Agreement*, *supra* note 564, at 4.
[641] *Id.*
[642] Lisa Benjamin & David Wirth, *From Marrakesh to Glasgow: Looking Backward to Move Forward on Emissions Trading*, 11 *Climate Law*, 245, 254–55 (2021) (Discussing the Kyoto Protocol's design weakness).
[643] *See, generally,* BETZ ET AL., *supra* note 524, 9–23 (2023).

Secretariat is still pending.[644] A CDM project's activities may transition to the Article 6.4 mechanism if all the following criteria are met: (1) the request for transition is made to the Secretariat and the CDM host party by December 31, 2023; (2) the approval for such transition is provided by the CDM host party by December 31, 2025; and (3) there is full compliance with Article 6.4's rules, modalities, and procedures, including corresponding adjustments.[645] New rules provide that the activity may continue to apply its current approved CDM methodology until whichever of the two dates comes first – the end of its current crediting period, or December 31, 2025. In addition, the Supervisory Body of Article 6.4 shall ensure that small-scale activities are granted an expedited transition process.[646]

In 2011, parties to the UNFCCC included CCS as a type of project that could benefit from the CDM under the Kyoto Protocol.[647] However, the literature lists two previous contrasting experiences that occurred before this inclusion. Norway used the emission reductions achieved in the Sleipner CCS project towards its Kyoto Protocol targets; by contrast, Canada was not able to use the carbon dioxide injected in its Weyburn-Midale installation towards its Protocol's targets because the carbon dioxide came from the United States.[648] Importantly, after the specific inclusion of CCS projects in the CDM, no CCS projects were submitted for CDM credit authorization, and geological storage technologies have been poorly represented in existing crediting systems.[649]

Six years after the SDM was created by Article 6.4 of the Paris Agreement, parties created the Supervisory Body of Article 6.4 mechanism at COP 26. The Supervisory Body has several functions, including approval and supervision of the host party's arrangements for accreditation of operational entities.[650] Under Article 6.4, activity participants[651] must register their activity with the Supervisory Body, and their activity "shall be designed to achieve mitigation of GHG emissions that is additional, including reducing emissions, increasing removals and mitigation co-benefits of adaptation actions and/ or economic diversification" without leading to an increase in global emissions.[652] The activity must be first approved by the host country, which has to confirm that the

[644] Decision 3/CMA.3, *Rules, Modalities and Procedures for the Mechanism established by Article 6, paragraph 4, of the Paris Agreement,* Annex I, I, C, Paragraphs 6–13 (Nov. 2021).
[645] Draft Decision CMA.4, *Rules, Modalities and Procedures for the Mechanism established by Article 6, paragraph 2, of the Paris Agreement,* (Nov. 2022), Annex I, I. A. 1–3, at 5, at https://perma.cc/ZGU8-RQPC.
[646] *Id. See also* Article 6.4 Mechanism: A6.4–SB006–A02, *Procedure: Procedure for the Transition of CDM Activities to the Article 6.4 Mechanism*, 1, 3–10 (Jul. 2023), at https://perma.cc/NQ45-SRN3. (Specifically establishing the procedures for the CDM transition).
[647] UNFCCC, *Modalities and Procedures for Carbon Dioxide Capture and Storage in Geological Formations as Clean Development Mechanism Project Activities*, Dec. 10/ CMP.7, at 13–30, U.N. Doc. FCCC/KP/CMP/2011/10/Add.2 (2012).
[648] International Energy Agency, *Integrating CCS in International Cooperation and Carbon Markets under Article 6 of the Paris Agreement*, *supra* note 564, at 15.
[649] *Id.* at 19.
[650] Decision 3/CMA.3, *Rules, Modalities and Procedures for the Mechanism established by Article 6, paragraph 4, of the Paris Agreement,* Annex, III, B, Paragraph 24 (viii) (Nov. 2021).
[651] "Activity participants" is the designation similar to "project developers" in the Kyoto Protocol.
[652] Decision 3/CMA.3, *Rules, Modalities and Procedures for the Mechanism established by Article 6, paragraph 4, of the Paris Agreement,* Annex, V, Paragraph 42 (Nov. 2021).

activity fosters sustainable development, before it is registered under the Supervisory Body.[653] Therefore, approval by both the host country and the Supervisory Body are required before any issuance of A6.4ERs.[654]

The Supervisory Body of Article 6.4's mechanism relies on the technical expertise provided by the Subsidiary Body for Scientific and Technological Advice (SBSTA) of the UNFCCC to resolve technical issues, including the definition of activities under Article 6.4 and whether the emissions avoidance would be included.[655] The SBSTA has held different consultations since COP 27 on these issues, and is expected to continue the discussion on the definition of removals, reversals, and applicable methodologies ahead of COP 28,[656] and future COPs considering that no agreement was reached.[657] The Supervisory Body of Article 6.4's mechanism is examining the definition of removals, whether CDR (and carbon storage more broadly) would qualify as such, as well as what the applicable accounting methodology would be.[658]

Ultimately, there is still much uncertainty concerning Article 6.4's practical implications for both CDR and CCS.

1.4 Concluding remarks

Despite the implementation of the Paris Agreement's Rulebook in COP 26, there are still significant operational issues that need to be streamlined. Items pending clarification include, but are not limited to: the process for ITMO authorization, specifically regarding what uses an ITMO can be authorized towards, the process for managing authorizations, as well as determining what entity may authorize ITMOs in a way that ensures

[653] Decision 3/CMA.3, *Rules, Modalities and Procedures for the Mechanism established by Article 6, paragraph 4, of the Paris Agreement,* Annex, V, Paragraphs 40–49 (Nov. 2021).

[654] *Id*. (Specifically, paragraph 40 (a), for the requirement of sustainable development). *See also* Jonathan Crook, *COP 27 FAQ: Article 6 of the Paris Agreement Explained*, CARBON MARKET WATCH (Nov. 2, 2022), at https://perma.cc/6MDL-JBUT. (Underscoring that ERs can be bought by countries, companies or individuals).

[655] Decision 7/ CMA.4, Guidance on the Mechanism Established by Article 6, Paragraph 4, of the Paris Agreement, paragraph 9 (Nov. 2022), at https://perma.cc/X64K-UZNM. (Stating that the Supervisory Body of the Article 6.4 Mechanism: "Also requests the Subsidiary Body for Scientific and Technological Advice to continue its consideration of, and to develop, on the basis of the rules, modalities and procedures for the mechanism and elaboration thereon, recommendations for consideration and adoption by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement at its fifth session (November–December 2023) on: (a) Consideration of whether Article 6, paragraph 4, activities could include emission avoidance and conservation enhancement activities; . . . (c) Provision of a statement by the host Party to the Supervisory Body specifying whether it authorizes Article 6, paragraph 4, emission reductions issued for an Article 6, paragraph 4, activity for use towards achievement of nationally determined contributions and/or for other international mitigation purposes, as defined in decision 2/CMA.3, in accordance with paragraph 42 of the rules, modalities and procedures, including its timing relevant information on the authorization and any revisions."

[656] Subsidiary Body for Scientific and Technological Advice (SBSTA), Draft Conclusion: Rules, modalities and procedures for the mechanism established by Article 6, paragraph 4, of the Paris Agreement and referred to in decision 3/CMA.3, paragraphs 8–9 (14 Jun. 2023), at https://perma.cc/5EH8-KHHY.

[657] *See also* Al Amer, *supra* note 586, at 13. (Specifically informing that market mechanisms of Article 6 were automatically postponed to COP 29).

[658] Article 6.4 Mechanism: A6.4–SB005–A02, *Information note: Guidance and questions for further work on removals*, 1, 2–4 (Jun. 2023), at https://perma.cc/Y8KP-N6N7. (Emphasizing the ongoing work on the definition of removals and related crediting and accounting under Article 6.4's mechanism).

transparency and consistency; to what extent the parties' previous decision expanding the use of ITMOs towards achieving NDCs may apply to other potential uses for ITMOs; issues relating to the need for functionalities and procedures for the international registry to allow for transfer of A6.4ERs to the international registry; and the common nomenclature for cooperative approaches as reported by participating parties. Overall, it remains uncertain how the new mitigation contribution ERs of Article 6.4 and corresponding adjustments will operate in practice. It is also unclear how the market-based mechanisms of both Article 6.2 and Article 6.4 will interact with each other in a scenario that is also influenced by voluntary carbon markets.

COP 26 provided for two interesting features in response to environmental and related climate justice considerations embedded in Article 6.4.[659] First, with the goal of delivering an overall mitigation in global emissions (OMGE),[660] the parties agreed to a mandatory cancellation of a minimum two percent of A6.4 ERs. These automatically-cancelled ERs cannot be further transferred or used for any purpose.[661] The second feature refers to a five percent mandatory levy of the share of proceeds for adaptation and administrative expenses.[662] These factors may be relevant to parties deciding whether they would rather engage with Article 6.4, which has a generally applicable and predetermined setting of rules including a mandatory levy and retirement from ITMOs, or Article 6.2, which involves signing bilateral or multilateral agreements with other parties and following rules of their own design.

In addition to these uncertainties, the previous discussions in this section illustrate two potentially detrimental implications regarding Article 6's effectiveness and overall capacity to boost NDC commitments. The first is the possibility that trading mitigation outcomes – which include emission reductions under both Article 6.4 and ITMOs – that exceed the ambition of a host country's NDC may deter host countries from setting more ambitious emission reduction targets in subsequent NDCs.[663] The second is that the availability of tradeable mitigation outcomes may lead buyer countries to purchase these credits instead of actually implementing longer-term (and potentially higher cost) domestic mitigation measures, leading to "higher-emission technologies being locked-in while urgent-required mitigation being delayed."[664]

All in all, our review shows that few parties are currently engaging in Article 6 trading mechanisms. Considering the additional complexity of the activities involved in the CCS chain, the numerous current uncertainties are likely to discourage parties from engaging in such market-mechanisms at present. It remains to be seen to what extent, if any, CCS will play a role in the operation of Article 6.

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[659] Paris Agreement, *supra* note 525, Art. 6.4 (d) and Art. 6.5 (Referring to the overall mitigation of global emissions and administrative expenses, respectively).
[660] Paris Agreement, *supra* note 525, Art. 6.4 (d).
[661] Decision 3/CMA.3, *Rules, Modalities and Procedures for the Mechanism established by Article 6, paragraph 4, of the Paris Agreement,* VII, Paragraph 69 (Nov. 2021).
[662] Decision 3/CMA.3, *Rules, Modalities and Procedures for the Mechanism established by Article 6, paragraph 4, of the Paris Agreement,* Annex, VII, Paragraph 66–67 (Nov. 2021).
[663] INTERNATIONAL ENERGY AGENCY, *Integrating CCS in International Cooperation and Carbon Markets under Article 6 of the Paris Agreement*, *supra* note 564, at 4.
[664] *Id.*

2. International emissions accounting and CCS

Building on the previous analyses developed in this chapter, this section discusses three main topics regarding international emissions accounting that are directly connected with the cross-border shipping of carbon dioxide from Europe for permanent storage in the United States. The first subsection analyzes the CCS and shipping emissions provisions under the European Union ETS system. The second subsection outlines carbon dioxide reporting obligations for the parties to the Paris Agreement, with a specific focus on implications for CCS activities. The third and final subsection addresses emissions reporting obligations from shipping activities under the Paris Agreement.

2.1 CCS and shipping emissions under the EU ETS

This subsection summarizes the main provisions regarding CCS and shipping emissions under the EU Emissions Trading System (EU ETS). Since our analysis assumes that carbon dioxide will be exported from Europe, the potential application of EU ETS must be analyzed. Furthermore, as discussed throughout Section 1 of this chapter, the Article 6.2 mechanism welcomes linking with other trading markets – including, in theory, the EU ETS.

Below, we first outline the main applicable provisions of the EU ETS related to CCS. Following this overview, this report analyzes how the EU ETS may handle shipping emissions associated with the cross-border transportation of captured carbon dioxide.

2.1.1 EU ETS overview and CCS applicability

The EU ETS, which was created by the ETS Directive,[665] is a market-based instrument that helps form the foundation of the EU's climate change policy.[666] Related to the EU ETS is the Carbon Border Adjustment Mechanism of the European Union, more commonly known as the CBAM.[667] Despite the CBAM entering into force on October 1, 2023, details for this mechanism were still being streamlined at the time of writing.[668]

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[665] Directive 2003/87/EC of the European Parliament and of the Council of 25 October 2003 establishing a Scheme for Greenhouse Gas Emission Allowance Trading within the Community and amending Council Directive 96/81/EC. Directive 2003/87/EC has been amended. Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC to improve and extend the GHG emission allowance trading scheme of the Union.

[666] Lorenzo Squintani et al., *Regulating Greenhouse Gas Emissions From EU ETS Installations: What Room is left for Member States?, in* CLIMATE LAW IN EU MEMBER STATES: TOWARDS NATIONAL LEGISLATION FOR CLIMATE PROTECTION, 67 (Marjan Peeters et al. eds., 2012).

[667] EU Regulation 2023/956 of the European Parliament and of the Council establishing a carbon border adjustment mechanism, Consideration N. 20 (May 10, 2023), at https://perma.cc/Z993-UPND. Importantly, the CBAM regulation officially entered into force the day following its publication in the Official Journal of the EU on May 16, 2023. The CBAM itself will enter into application in its transitional phase on October 1, 2023, with the first reporting period for importers ending January 31, 2024. *See* European Union: Customs and Taxation, *Carbon Border Adjustment Mechanism*, at https://perma.cc/MRE5-EEWH.

[668] European Commission: Taxation and Customs Union, *Carbon Border Adjustment Mechanism*, *supra* note 667.

The EU ETS and the CBAM share a common objective of pricing GHG emissions from the same sectors and goods by using specific allowances or certificates. Both systems are regulatory in nature and are based on the need to curb GHG emissions, as is required by the binding environmental target under EU law.[669] However, there are a few notable differences between the two systems. While the EU ETS establishes the total number of allowances issued on GHG emissions related to activities within its scope and permits the trading of allowances – essentially, establishing a "cap" and creating an associated "cap and trade system" – the CBAM would not set quantitative limits on imports to avoid restricting trade. In addition, while the EU ETS applies to activities conducted within the EU, the CBAM would apply to certain goods imported into the customs territory of the EU.[670]

Regulations on the CBAM, the EU ETS, and related matters are currently in flux.[671] While many of the details of the CBAM remain uncertain, the CBAM currently taxes imports from non-EU jurisdictions that do not have comparable climate change mitigation regulations and that face the highest risk of carbon leakage, including imports from the cement, iron and steel, aluminum, fertilizers, electricity, and hydrogen sectors.[672] As the CBAM expands its scope, it is expected to eventually apply to over 50 percent of the emissions in ETS-covered sectors.[673] However, since the CBAM is currently in a transition period, importers of goods within the scope of these new rules will only have to report direct and indirect GHG emissions of their imports without making any financial payments or adjustments. After this transition period concludes, indirect emissions for certain additional sectors like cement and fertilizers will fall within the scope of the CBAM; the specific methodologies for calculating this tax has yet to be determined.[674] While tax provisions are outside the scope of this report, it is noteworthy that as the CBAM evolves, it may apply to EU CCS related activities.

Discussions on both the EU ETS and EU CCS policy have become more intertwined[675] since negotiations around the EU directive on CCS began.[676] To date, the strict division between EU and national regulatory systems as well as emission performance standards (EPS) for large combustion plants were among the most contentious issues

[669] EU Regulation 2023/956 of the European Parliament and of the Council establishing a carbon border adjustment mechanism, Consideration N. 20 (May 10, 2023).
[670] *Id.* at Consideration N. 21.
[671] In addition to the regulations cited above, the European Commission has recently issued EU Sustainability Reporting Standards. *See* European Commission, Commission Delegated Regulation (EU, yet to be numbered) supplementing Directive 2013/34/EU of the European Parliament and of the Council as regards sustainability reporting standards (Jul. 31, 2023). (Their memorandum explaining these standards provides as follows: "The Accounting Directive (2013/34/EU) as amended by the Corporate Sustainability Reporting Directive (CSRD - 2022/2464) requires large companies and listed small and medium-sized companies (SMEs), as well as parent companies of large groups, to include in a dedicated section of their management report the information necessary to understand the company's impacts on sustainability matters, and the information necessary to understand how sustainability matters affect the company's development, performance and position.").
[672] EU Regulation 2023/956, *supra* note 669, Art. 1–3.
[673] *Id.*
[674] European Commission: Taxation and Customs Union, *Carbon Border Adjustment Mechanism, supra* note 667.
[675] Squintani et al., *supra* note 666, at 68.
[676] Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the Geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC, and Regulation (EC) N. 1013/2006. (Directive 2009/31 centers on storage).

that have been reconciled.[677] Carbon prices have also been a contentious matter domestically as well as in the EU supranational sphere. Current EU ETS carbon prices are fluctuating but are not considered particularly effective.[678] The EU committed to reducing its economy-wide net GHG emissions by at least fifty-five percent compared to 1990 levels by 2030 in their updated NDC submitted to the UNFCCC Secretariat.[679]

The EU's NDC does not provide for CCS.[680] In practice, the EU is pursuing carbon pricing policies that increase the cost of carbon dioxide pollution. As the EU ETS system raises the cost for carbon dioxide emissions, interest in CCS in general and, more specifically, in the cross-border transportation of carbon dioxide for permanent storage, is expected to increase. Ultimately, the higher the carbon prices, the higher the interest in CCS, in general, and in all its chain aspects, including transboundary shipping for permanent storage.

The EU directive on CCS regulates the storage element of the CCS chain. However, the directive has a few provisions for the transportation component of the CCS chain; these provisions mainly cover pipelines.[681] The directive requires third-party access to be granted to carbon dioxide transport and storage networks.[682] Within countries of the EU and the European Economic Area (EEA), it is likely that the most natural contractual arrangement for exports would be for the emitter to contract directly with the storage operator and for the storage operator to contract directly with the transporter, rather than the emitter contracting with both the transporter and storage operator.[683] The definition of "contracting party" is expected to affect both the type of contract entered into and the main terms of the agreement; this includes the use of offtakes, meaning the advance selling of production in order to finance the main contract.[684]

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[677] Squintani et al., *supra* note 666, at 68.

[678] *See* EMBER, *Carbon Price Tracker* (2023), at https://perma.cc/6CM9-MBM3. (Data for 2023 shows that EU ETS carbon prices are yet to consistently surpass the $100 Euro threshold that would signal an effective carbon price). Actors involved in the EU market acknowledge that the EU ETS is the main tool of the EU to incentivize decarbonization. As such, while not many sectors have reached this cross over point of $100 Euro, it is clear to many that this will happen soon. Therefore, these actors are expediting decarbonization measures in their industries before this price increase and decrease of free allowances kicks in. (Thanks to Kostis Andreou for bringing this EU perspective to our attention).

[679] United Nations: Climate Change, Nationally Determined Contributions Registry: European Union (2023), at https://perma.cc/7VNM-DAEQ. Implementing this commitment, the EU issued a regulation providing a binding Union domestic reduction target for net GHG emissions, i.e., emissions after deduction of removals, of at least fifty-five percent compared to 1990 levels by 2030. See Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) No 2018/1999 ('European Climate Law').

[680] United Nations: Climate Change, Nationally Determined Contributions Registry: European Union (2023), at https://perma.cc/7VNM-DAEQ.

[681] Directive 2009/31/EC, *supra* note 676.

[682] Directive 2009/31/EC, *supra* note 676, at Art. 21 (Art. 21 provides that member states shall take the necessary measures to ensure that potential users obtain access to transport networks and to storage sites for the purposes of geological storage of the produced and captured carbon dioxide).

[683] Katherine Orchard et al., *The Status and Challenges of CO_2 Shipping Infrastructures*, 15th International Conference on Greenhouse Gas Control Technologies, GHGT-15, 9 (Mar. 15, 2021).

[684] *Id.*

From a practical standpoint, the EU ETS Directive[685] is deemed as limiting emitters to decarbonize at scale and at speed, because it does not incentivize carbon dioxide sequestration outside the EU.[686] This is the case, as the exception to surrender allowances originating from CCS only applies when the emissions are stored in a facility with a permit in force in accordance with the CCS Directive.[687] The EU ETS Directive refers to the capture, transport or storage "in a storage site permitted under Directive 2009/31/EC."[688] Under the CCS Directive, only storage facilities within the EU, which in practice includes countries in the European Economic Area (EEA),[689] can obtain a permit whereas storage outside the EEA is not contemplated under the EU ETS.[690] Accordingly, if carbon dioxide is stored in the EEA in compliance with the EU CCS directive, the emitted carbon dioxide will be considered as "not having been emitted" under the EU ETS, and industrial point-source emitters are authorized to subtract captured emissions from their compliance obligations.[691] Storing carbon dioxide emissions outside the EEA is not forbidden, but "these emissions will not benefit from the possibility of not surrendering allowances under the EU ETS, providing little incentive to store carbon dioxide abroad."[692]

2.1.2 EU ETS and shipping emissions

Shipping emissions will be included within the scope of the EU ETS in steps, with shipping companies surrendering the following allowances: 40 percent for verified emissions from 2024; 70 percent for 2025; and 100 percent for 2026.[693] This provision applies to commercial ships transporting passengers or cargo that weigh at least 5,000 gross tons; further details have yet to be determined regarding offshore ships,[694] but it is expected

[685] Directive 2003/87/EC of the European Parliament and of the Council of 25 October 2003 establishing a Scheme for Greenhouse Gas Emission Allowance Trading within the Community and amending Council Directive 96/81/EC, *supra* note 665, Art. 12.

[686] Thanks to Kostis Andreou for sharing some of the industry's views. *See also* S. La Hoz Theuer & A. Olarte, *Emissions Trading Systems and Carbon Capture and Storage: Mapping possible interactions, technical considerations, and existing provisions*, 1, 36 INTERNATIONAL CARBON ACTION PARTNERSHIP (2023), at https://perma.cc/B4EU-GXLE. (For an in-depth discussion about the EU ETS and CCS).

[687] Directive 2003/87/EC of the European Parliament and of the Council of 25 October 2003 establishing a Scheme for Greenhouse Gas Emission Allowance Trading within the Community and amending Council Directive 96/81/EC, *supra* note 665, Article 12(3a). According to Directive 2003/87/EC (the ETS Directive), emissions that are captured and safely stored in accordance with the legal framework on CCS are considered as not emitted. Art. 12(3a) provides as follows: "An obligation to surrender allowances shall not arise in respect of emissions verified as captured and transported for permanent storage to a facility for which a permit is in force in accordance with Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide."

[688] *Id.*, Annex I (Listing CCS activities).

[689] As noted in Chapter 3 of this report, the European Economic Area (EEA) was established in 1994, and all 27 EU countries are also members of the EEA. Iceland, Liechtenstein, and Norway are the only countries that are parties to the EEA but are not members of the EU. *See* Netherlands Worldwide, *What Countries are in the EU, EEA, EFTA, and the Schengen Area?*, Government of the Netherlands, at https://perma.cc/4JL2-9MY5. The EU CCS directive applies to all EEA member states. *See* S. La Hoz Theuer & A. Olarte, *supra* note 686, at 36. (Underscoring that the EU CCS directive applies to all EEA member states).

[690] Directive 2009/31/EC, *supra* note 676, Art. 2–9. (Detailing the requirements for such permits).

[691] S. La Hoz Theuer & A. Olarte, *supra* note 686, at 36.

[692] *Id.* at 36. (Emphasizing that this would include carbon dioxide transported from the EEA to be storage in the United Kingdom).

[693] DNV, *EU ETS: Preliminary Agreement to Include Shipping in the EU's Emission Trading System from 2024* (Jan. 23, 2023), at https://perma.cc/L57R-N3AF.

[694] The number refers to the weight of the ships. Directive (EU) 2023/959 of the European Parliament and of the Council of 10 May 2023 amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union and Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas

that some regulation for these ships will enter into effect in 2027.[695] Emissions from intra-EU/EEA voyages will be fully accounted in the EU ETS, while half of the emissions during trips to and from non-EU countries will be covered.[696]

The inclusion of shipping emissions within the EU ETS has long been supported by experts,[697] and was a consequential step towards decarbonization of the shipping sector. The shipping industry has long been accustomed to using fossil fuels, and the industry is unlikely to discontinue the use of fossil fuels unless it is compelled by government regulation[698] or if the economics of non-fossil propulsion become much more favorable. As the EU ETS regulatory scheme is outside the International Maritime Organization (IMO) framework, the scheme may eventually provide additional incentives for the IMO to accelerate decarbonization.[699] In the meantime, the EU is using its own leverage, as it holds approximately a third of the world fleet in 2023.[700] The inclusion of shipping emissions within the EU ETS may also provide a template for other countries to adopt greener shipping policies.[701]

The EU and the IMO currently have different regimes for monitoring, reporting, and verification (MRV) of carbon dioxide in the maritime sector.[702] The EU and the IMO have each established their own data-gathering initiatives that provide for mandatory verification and reporting aimed at collecting data to inform further policy actions to reduce emissions from the shipping industry. The pertinent EU regulation was issued in 2021,[703] while IMO

emission trading system, Art. 1 (7), amending Art. 3ga of the Directive 2003/87/EC. For the EU ETS current directive, offshore ships include ships performing voyages departing from a port of call under the jurisdiction of a member state and arriving at a port of call outside the jurisdiction of a member state, and ships performing voyages departing from a port of call outside the jurisdiction of a member state and arriving at a port of call under the jurisdiction of a member state.

[695] *Id.,* at Art. 1 (7), amending Art. 3ga and Art. 3gb of the Directive 2003/87/EC.

[696] *Id.* at Art. 1 (7), amending Art. 3ga of the Directive 2003/87/EC. *See also* DNV, *EU ETS: Preliminary Agreement to Include Shipping in the EU's Emission Trading System from 2024*, *supra* note 693. (Underscoring that ship companies will not receive free allowances, and that emission allowances can be acquired in the primary market through auctions arranged by the European Energy Exchange (EEX), which is currently contracted by the EU. In addition, there is a secondary market in which allowances can be traded bilaterally or through several derivatives offered by financial institutions).

[697] *See, e.g.,* Viktor Weber, *Are We Ready for the Ship Transport of CO_2 for CCS? Crude Solutions from International and European Law,* 30 Rev. Eur. Comp. & Int. Law 387, 393 (2021); Hisham Al Baroudi et al., *A Review of Large-Scale CO_2 Shipping and Marine Emissions Management for Carbon, Capture, Utilisation and Storage*, 287 Applied Energy 1, 11 (2021) (Highlighting that the EU ETS did not encompass carbon dioxide emissions from shipping among the regulatory limitations at the time).

[698] *See, generally,* Michael Petroni & Andrzej Ancygier, *Global maritime carbon footprint: EU policy diffusion*, Climate Analytics 1, 7 (Apr. 30, 2023).

[699] United Nations Conference on Trade and Development (UNCTAD), Shared of the World Merchant Fleet Value by Country of Beneficial Ownership, Annual, UNCTADStat (2023), at https://perma.cc/QXF7-UH9M. (Highlighting that Chinese, including Hong Kong, and Taiwanese companies account for 20 percent, Japan for 11 percent, and the United States 7 percent, respectively, as of Jan. 2023).

[700] Petroni & Ancygier, *supra* note 698, at 23.

[701] *Id.*

[702] Katherine Orchard et al., *The Status and Challenges of CO_2 Shipping Infrastructures*, 15th International Conference on Greenhouse Gas Control Technologies, GHGT-15, 9 (Mar. 15, 2021).

[703] Regulation 2023/957 of the European Parliament and of the Council of 10 May 2023 amending Regulation (EU) 2015/757 to provide for the inclusion of maritime transport activities in the EU Emissions Trading System and for the monitoring, reporting and verification

regulatory efforts to maximize energy efficiency in shipping date back to 2011.[704] More recently, parties of the IMO adopted the 2023 IMO Strategy on Reduction of GHG Emissions from Ships, which established heightened targets to tackle GHG emissions from shipping.[705] The EU and IMO regimes operate in parallel and differ in their application. While the EU scheme only applies within the EU and the EEA, the IMO scheme covers global shipping emissions.[706]

Incentives for harmonization between the EU ETS and the IMO regimes may increase if the EU ETS is linked to other ETS systems. As discussed in Section 1.2, this would be a very complex operation under Article 6.2 of the Paris Agreement. However, the EU ETS does already allow for linkage with other compatible national and regional trading emission markets.[707] As previously outlined, this linkage can be authorized as long as three minimum requirements are fulfilled: (1) both systems are compatible and aligned in both overall environmental integrity and carbon dioxide accounting equivalency; (2) both systems are mandatory; and (3) both provide for an absolute cap on emissions.[708] Finally, the EU ETS legislation recommends the inclusion of aviation in both systems whenever possible.[709] Overall, these requirements are consistent with the literature, which emphasizes that lower MRV standards or lax enforcement in one system may reduce the effectiveness of trading across both systems, ultimately leading to increased emissions and lower prices than what existed before the linkage.[710]

The EU ETS was finally linked to the Switzerland emissions trading system in 2020.[711] Despite being considered relatively straightforward,[712] the linkage took almost a decade to be implemented.[713] So far, this is the only

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of emissions of additional greenhouse gases and emissions from additional ship types (For updated EU monitoring, reporting and verification rules).

[704] IMO, Resolution MEPC.203(62), Amendments to the Annex of the Protocol of 1997 to amend the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the related Protocol of 1978 (Jul. 15, 2011), at https://perma.cc/M953-JL9U. (In summary, this resolution of the parties amended Annex VI of the MARPOL Convention).

[705] IMO, Resolution MEPC. 377 (80), adopted in the Member States Meeting at the Marine Environment Protection *Committee* (MEPC 80) (Jul. 7, 2023), at https://perma.cc/XUH8-E4DU.

[706] For the specific references of each appropriate regulatory scheme, *see* Petroni & Ancygier, *supra* note 698, at 18–19 and references therein. *See also* Orchard et al., *supra* note 702, at 9. (For a similar interpretation).

[707] Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC, *supra* note 665. Art. 25 of this Directive provides for the possibility to link the EU ETS with other compatible emissions trading systems in the world at national or at regional level and sets out several conditions for linking. This Directive has recently been amended. *See* Directive (EU) 2023/958 of the European Parliament and of the Council of 10 May 2023 amending the Directive 2003/87/EC regarding aviation's contribution to the Union's economy-wide emission reduction target and the appropriate implementation of a global market-based measure.

[708] *Id.*

[709] European Union: Climate Action, *International Carbon Market* (2023), at https://perma.cc/B59G-DBHQ.

[710] BETZ ET AL., *supra* note 524, at 40.

[711] Agreement between the European Union and the Swiss Confederation on linking their greenhouse gas emissions trading systems (Nov. 5, 2020), at https://perma.cc/NF24-DY5Q.

[712] INTERNATIONAL ENERGY AGENCY, *Integrating CCS in International Cooperation and Carbon Markets under Article 6 of the Paris Agreement*, *supra* note 564, at 6.

[713] Council of the European Union*, Linking of Switzerland to the EU emissions trading systems entry into force on Jan. 2, 2020*, (Dec. 19, 2019), at https://perma.cc/52B4-Y5PZ.

example of integration between supranational and national ETS systems, and was made possible in large part because both regulations were almost identical.[714] Ultimately, this experience demonstrates that linking the EU ETS to other systems is significantly complex and requires compatible provisions between the integrated systems. However, if effectively enacted, this kind of linkage is likely to foster harmonization between different regional shipping emissions, adding incentives for a single system of reporting emissions with the IMO. By doing so, it may reduce the overall transaction costs for the export of carbon dioxide for storage.

2.1.3 Concluding remarks

The EU presents different frameworks that may be relevant for this project. The EU ETS and the CBAM share a common objective of pricing GHG emissions associated with the same sectors and goods, but in practice the EU CCS directive has yet to apply to international shipping. Importantly, shipping emissions will be gradually included within the scope of the EU ETS, which may optimize emissions reductions relating to the shipping stage of the CCS chain. Finally, incentives for harmonization between the EU ETS and the IMO regime may increase if the EU ETS is linked to other ETS systems. However, this process is likely to be complicated and lengthy. Ultimately, if an effective price on carbon becomes operable, the EU ETS system is likely to increase interest in the cross-border transportation of carbon dioxide for permanent storage.

2.2 Carbon dioxide reporting obligations under the Paris Agreement

This subsection presents the current obligations and applicable methodologies for parties to the Paris Agreement to report their GHG emissions and removals, with a focus on reporting that is relevant to CCS.

As discussed in the introduction of this chapter, parties to the Paris Agreement are required to provide a national inventory report of anthropogenic emissions by sources and removals by sinks of GHGs[715] every two years,[716] as established by the agreement's transparency framework. These reports are to be prepared using both "good practice methodologies accepted by the Intergovernmental Panel on Climate Change (IPCC) and agreed upon by the Conference of the Parties serving as the meeting of the Parties to this Agreement," as well as all the information necessary to track progress made on implementing and achieving its NDCs.[717] This information is subject to technical expert review.[718]

[714] BETZ ET AL., *supra* note 524, at 5 and 41.
[715] *See, e.g.,* Paris Agreement, *supra* note 525, Art.13.8 (Requiring parties to communicate information of climate change's impacts and adaptation); and Art. 13.9–10 (Providing for information sharing about the transfer of technology). A detailed analysis of all the important information that must be disclosed is beyond the scope of this report.
[716] Paris Agreement, *supra* note 525, Art.13.4.
[717] Paris Agreement, *supra* note 525, Art.13.7.
[718] Paris Agreement, *supra* note 525 Art. 13.11–12.

In addition to these transparency measures, parties also submit NDCs to the official registry administrated by the UNFCCC's Secretariat every five years.[719] In their NDCs, parties must account for their anthropogenic emissions and removals, promoting "environmental integrity, transparency, accuracy, completeness, comparability and consistency, and ensure the avoidance of double counting, in accordance with guidance adopted by the Conference of the Parties serving as the meeting of the Parties to this Agreement."[720]

The Paris Agreement provides that emissions reporting for NDCs, emissions reporting for transparency framework purposes, and all reporting communications are based on the modalities, procedures, and guidelines stated in Article 13,[721] and further states that these guidelines are to be defined by the IPCC.[722] Currently, these guidelines are provided by the 2006 IPCC Guidelines,[723] which offer methodologies for the estimation of national inventories of anthropogenic emissions by sources and removals by sinks of GHGs.[724]

Developed at the invitation of UNFCCC Parties, the 2006 IPCC Guidelines aim to assist parties in fulfilling their commitments to report their inventories of anthropogenic emissions by sources and removals by sinks of GHGs not controlled by the Montreal Protocol.[725] In 2019, the IPCC issued refined guidelines. These refined guidelines "do not revise the 2006 IPCC Guidelines, but update, supplement and/or elaborate the 2006 IPCC Guidelines

[719] Paris Agreement, *supra* note 525, Art. 4 (12) (Providing for NDCs to be reported to the Secretariat. A technical clarification is required. This methodology does not refer to emissions reporting used in companies' net-zero pledges, which use different standards, the most common being the Greenhouse Gas (GHG) Protocol, which was developed by the World Resources Institute (WRI) and the World Business Council on Sustainable Development (WBCSD)). *See* The Greenhouse Gas (GHG) Protocol, *The GHG Protocol Standards and Guidance Update Process* (2023), at https://perma.cc/BD7T-34P5. (The Greenhouse Gas (GHG) Protocol sets the global standard for how to measure, manage, and report GHG emissions, targeting specific sectors. New standards are being developed in 2023 "to align with best practice approaches to ensure GHG Protocol standards for scope 1, scope 2 and scope 3 are effective in providing a rigorous and credible accounting foundation for businesses to measure, plan and track progress toward science-based and net-zero targets in line with the global 1.5°C goal. Any future updates will seek harmonization and alignment with accounting rules under development through major disclosure initiatives.").

[720] Paris Agreement, *supra* note 525, Art. 4.13. In the following paragraph, the Paris Agreement asserts: "In the context of their nationally determined contributions, when recognizing and implementing mitigation actions with respect to anthropogenic emissions and removals, Parties should take into account, as appropriate, existing methods and guidance under the Convention, in the light of the provisions of paragraph 13." (*Id.* at Art. 4. 14).

[721] Paris Agreement, *supra* note 525, Art.13.4 (Reporting for NDCs are also detailed in Art. 4.4 of the Paris Agreement, which provides for absolute emission reduction targets for developed parties while accepting limitation targets or emission reduction targets for developing parties according to their capabilities).

[722] Paris Agreement, *supra* note 525, Art.13.7 (a).

[723] International Panel on Climate Change (IPCC), *The 2006 IPCC Guidelines for National Greenhouse Gas Inventories*, IPCC (2006), at https://perma.cc/EEU7-SFFU [hereinafter 2006 IPCC Guidelines].

[724] 2006 IPCC Guidelines, *supra* note 723, Introduction to the Guidelines, Vol. 1: General Guidance and Reporting, 1, 4, at https://perma.cc/6Q67-UXXM. (Reporting is further detailed in Chapter 8, Vol. 1).

[725] 2006 IPCC Guidelines, *supra* note 723, Vol.1, at 4.

where gaps or out-of-date science have been identified."[726] Hence, this refinement does not replace the 2006 IPCC Guidelines and should be used in conjunction with the 2006 IPCC Guidelines.[727]

The 2006 IPCC Guidelines underscore that emissions inventories are standardized to ensure that countries can be compared to each other; that inventories do not contain double counting or omissions; and that the time series reflect actual changes in emissions.[728] The guidelines also clarify that emissions and removals included in national inventories must be a result of human activities.[729]

National inventories include GHG emissions and removals taking place within both the national territory and offshore areas over which the country has jurisdiction.[730] These inventories provide the estimates for the calendar year during which the emissions and removals occur; if data for a specific year is missing, different methods for estimations including averaging, interpolation, and extrapolation, can be used depending on the circumstances.[731]

Current IPCC Guidelines state the need for reporting of emissions and removals in a country's territory and offshore areas, and countries may report reducing emissions from technologies like CCS.[732] These guidelines specifically provide for the scenario described in this report, where carbon dioxide is captured in a country and then exported to another country. In their relevant part, the 2006 Guidelines read as follows:

> "CO_2 may be captured in one country, Country A, and exported for storage in a different country, Country B. Under this scenario, Country A should report the amount of CO_2 captured, any emissions from transported and/or temporary storage that takes place in country A, and the amount of CO_2 exported to Country B. Country B should report the amount of CO_2 imported, any emissions from transport and/or temporary storage (that takes place in Country B), and any emissions from injection and geological sites."[733]

Therefore, carbon dioxide captured in an EU/EEA jurisdiction and later stored in the United States should be reported under these guidelines.

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[726] International Panel on Climate Change (IPCC), *The 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*, IPCC (2019), at https://perma.cc/TZV5-8TA4.

[727] International Panel on Climate Change (IPCC), *The 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Overview*, at https://perma.cc/FDE5-X67T.

[728] 2006 IPCC Guidelines, *supra* note 723, Introduction to the Guidelines, at 1.4.

[729] The distinction between natural and anthropogenic emissions and removals follows straightforward from the data used to quantify human activity, without additional specifications being required. See 2006 IPCC Guidelines, *supra* note 723, Introduction to the Guidelines, at 1.4.

[730] 2006 IPCC Guidelines, *supra* note 723, Vol. 1, Chapter 8.2.1 (Specifically details the jurisdictional issues).

[731] 2006 IPCC Guidelines, *supra* note 723, Introduction to the Guidelines, at 1.4.

[732] 2006 IPCC Guidelines, *supra* note 723, Reporting Guidance, Paragraph 8.2, at https://perma.cc/YD6K-TNYG. (Paragraph 8.2.1 specifically refers to Chapter 5, Volume 2 of for CCS operations).

[733] 2006 IPCC Guidelines, *supra* note 723, Vol. 2, Chapter 5, Paragraph 5.10 (at page 5.20), at https://perma.cc/7P62-9RZU.

However, for the purpose of the scenario discussed in this report, removals of atmospheric carbon dioxide via direct air capture (DAC) are not presently covered in the 2006 IPCC Guidelines. The Supervisory Body has signaled optimism about the eligibility of biological removal methods including reforestation and ocean-based methods, while expressing reluctance about engineering-based removals like DAC.[734] Importantly, this clarification would only be relevant for the operation described in this report if significant amounts of the transported carbon dioxide came from DAC. However, this will not be the case in practice, as most if not all the carbon dioxide to be transported in the near-term future is expected to come from CCS. Nonetheless, since carbon dioxide from DAC sources was included in our research, this report also discusses the current Supervisory Body's take on engineering-based removals below.

The Supervisory Body has highlighted the following cons of engineering-based approaches, including DAC:

> "Engineering-based removal activities are technologically and economically unproven, especially at scale, and pose unknown environmental and social risks . . . Currently these activities account for removals equivalent to 0.01 $MtCO_2$ per year . . . compared to 2,000 $MtCO_2$ per year removed by land-based activities. These [engineering-based removal] activities do not contribute to sustainable development, are not suitable for implementation in the developing countries and do not contribute to reducing the global mitigation costs, and therefore do not serve any of the objectives of the Article 6.4 mechanism."[735]

Participants in the carbon removal industry have been actively advocating for a broader definition of removals that includes both natural and engineered-based removals, and argued that the Supervisory Body of Article 6.4 failed to use the best scientific data regarding engineering-based removals, and also did not have a comprehensive list of cons for nature-based removals.[736] In an open letter addressed to the Supervisory Body, more than a hundred signatories – including several companies specializing in engineered-based removals – pointed to what they saw as the potential shortcomings of the Supervisory Body's approach, including the use of the term "engineering-based removals" itself.[737] Interestingly, parties to the Paris Agreement have not actively participated in the public comments of the Supervisory Body.[738] Taken together, there are uncertainties regarding whether removals and related CCS could qualify for trading under Article 6.4 mechanism.

Importantly, several distinctions need to be considered. For instance, CCS captured from a point source, like a power plant, may be more easily attributable and credited than a removal from the atmosphere (i.e., from the

[734] *Id.,* Paragraphs 35–41, at 14.
[735] *Id.,* Paragraph 39, at 18–20.
[736] Eve Tamme, *Challenges for Carbon Removal under the UN Standard*, EVETAMME BLOG (May 21, 2023), at https://perma.cc/SS8B-C46Y. (Highlighting that the approach proposed by the Supervisory Body was not aligned with the current science under the IPCC and is not balanced, arguably being biased in favor of biological-based removals).
[737] Carbon Business Council, *Meeting the Goals of the Paris Agreement: Letter from 100 + Carbon Removal Experts,* (May 24, 2023), at https://perma.cc/WD9Z-Y2LY.
[738] UNFCCC, *Paris Agreement: Article 6.4 Mechanism Calls for Input*, at https://perma.cc/PQB3-UGN2. (Until November 2023, only Papua New Guinea has submitted an input for the Article 6.4 mechanism, albeit on behalf of the Coalition for the Rainforest Nations).

commons). However, removals from the commons could be attributed to the party where the removal is occurring, allowing that party to engage in emissions trading for the purposes of meeting NDC targets within its jurisdiction. Ultimately, the removal would be attributed to the place where it is occurring. Leakage, or the unintended release of carbon dioxide throughout the Article 6.4 exchange for the operation described in this report (more technically, at any point in the CCS chain), is likely to be treated as a reversal.[739] Carbon dioxide emissions involved in the capture or removal process should also be considered, which implies that crediting should include net storage or net removals. This appears to be the most consistent approach aligned with the effective mitigation goals established under the Paris Agreement.[740]

Ultimately, carbon accounting is intimately connected to these methodological considerations, and is intertwined with several consequential issues. Chief among these issues is the underlying assumption that, for carbon trading purposes, "a ton is a ton."[741] While this framing is useful for carbon budget purposes in the abstract – after all, it provides consistency and facilitates evaluations about progress toward defined targets – the assumption is not a neutral one.[742] It does not weigh in factors such as time and space, socioeconomic effects, and risk profiles, all of which trigger climate justice considerations between both developed and less developed countries as well as between current and future generations.

Climate justice and the effectiveness of the market-based approach under Article 6.4 appear to be at the center of the ongoing work of the Supervisory Body. This body is currently working on the validation of relevant activities and projects, recommending accounting for the possibility of double counting, double issuance, and double claiming in the context of the various international cooperation instruments, mechanisms and registries.[743]

Finally, the transportation and storage of carbon dioxide associated with such emissions are covered in the applicable parts of the 2006 IPCC Guidelines.[744] The guidelines do not currently provide for removals, but do specifically provide for carbon dioxide capture and storage,[745] including fugitive emissions during the capture

[739] Article 6.4 Mechanism: A6.4–SB005–AA–09, *Information note: Removal Activities under Article 6.4 Mechanism*, Paragraph 181. (Differentiating unintentional reversal from intentional reversal: the first refers to natural events whereas the second is a product of the intentional decision of participants). It is worth clarifying that for the CMA, leakage refers to "the net change of GHG emissions that occurs outside the accounting boundary of the removal activity and which is measurable and attributable to the removal activity." Article 6.4 Mechanism: A6.4–SB005–AA–09, *Information note: Removal Activities under Article 6.4 Mechanism*, Paragraph 185.

[740] *Id.,* at Paragraph 17. (For arguments in favor of the adoption of net removals; paragraph 132 defines net removals as achieved "by a removal activity are equal to the total removals minus the baseline removals, minus the activity emissions, minus the leakage emissions.").

[741] Wim Craton et al., *Undoing Equivalence: Rethinking Carbon Accounting for Just Carbon Removal*, 3 FRONTIERS IN CLIMATE: 664130, 1, 2 (Apr. 16, 2021).

[742] *Id.* at 2–4.

[743] Article 6.4 Mechanism: A6.4–SB005–AA–09, *Information note: Removal Activities under Article 6.4 Mechanism*, Paragraphs 252–255 (2023).

[744] 2006 IPCC Guidelines, *supra* note 723; and International Panel on Climate Change (IPCC), *The 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Overview*, *supra* note 727.

[745] 2006 IPCC Guidelines, *supra* note 723, Vol. 2, Chapter 5, Paragraph 5.10 (p. 5.20), at https://perma.cc/R2DC-ZFEH.

and transport stages.[746] Further analysis of CCS for the purposes of a cross-border project is detailed in Section 3,with specific attention to the role of the market-based mechanisms of the Paris Agreement.

2.3 Shipping emissions reporting obligations under the Paris Agreement

Following the previous sections' analysis of the obligations for Paris Agreement parties to report carbon dioxide emissions, this subsection focuses on these parties' obligations – or lack thereof – to report international shipping emissions. It addresses a recent academic controversy about the need for such reporting, while highlighting that the Paris Agreement ultimately does not impose an obligation to report shipping emissions in practice.

The 2006 IPCC Guidelines provide that emissions for water-borne transportation include "all water-borne transport from recreational craft to large ocean-going cargo ships that are driven primarily by large, slow and medium speed diesel engines and occasionally by steam or gas turbines. It includes hovercraft and hydrofoils."[747] The guidelines include all water-borne navigation emissions except fugitive emissions, which are reported separately.[748]

Under the 2006 IPCC Guidelines, emissions from domestic and international water-borne navigation are to be reported separately.[749] The difference between international and domestic transportation should be determined on the basis of the port of departure and port of arrival, rather than by the flag or nationality of the ship.[750] The guidelines further detail that emissions from fuels used by vessels of all flags that are engaged in international water-borne navigation include those from navigation that takes place at sea, on inland lakes and waterways, in coastal waters, and from journeys that depart from one country and arrive in a different country.[751] International water-borne navigation emissions exclude consumption by fishing vessels. Emissions from international military water-borne navigation can be included as a separate sub-category of international water-borne navigation, so long as the same definitional distinction is applied, and data is available to support the definition.[752]

As analyzed in Sections 2.2 and 1.3, the 2006 IPCC Guidelines were developed as a request from the UNFCCC, and the Kyoto Protocol was developed to implement the goals defined in the UNFCCC, making both instruments

[746] 2006 IPCC Guidelines, *supra* note 723, Vol. 2, Chapter 4. (Chapter 4 provides for fugitive emissions from mining, procession, storage and transportation of coal, and fugitive emissions from oil and natural gas systems, at https://perma.cc/DR5K-UEJ9). Table 4.24 provides the equivalent factor for fugitive emissions for storage in developed countries (*Id.* at 4.49).

[747] 2006 IPCC Guidelines, *supra* note 723, Chapter 3: Mobile Combustion, at 3.47, at https://perma.cc/S77C-K2KB. Water-borne navigation causes emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), as well as carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs), sulfur dioxide (SO_2), particulate matter (PM) and oxides of nitrogen (No_x).

[748] *Id.*

[749] 2006 IPCC Guidelines, *supra* note 723, Chapter 3: Mobile Combustion, at 3.48.

[750] *Id.* (Fugitive emissions shall be reported in Chapter 4, which provides specifically for this topic).

[751] *Id.* (*See also* Table 3.5.1: Source category structure).

[752] *Id.*

intrinsically connected to the UNFCCC.[753] The Kyoto Protocol stated that Annex I parties "shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization, respectively."[754] Therefore, consistent with the 2006 IPCC Guidelines as well as with the Kyoto Protocol, domestic and international shipping emissions are separately reported and international shipping is not required to be reported in NDC targets.

The main justification for this exclusion is that international shipping and aviation emissions occur beyond national borders and, as such, reporting challenges would be likely to occur. An obligation to report could be disproportionally burdensome for developing countries that may have more difficulty with data collection and reporting.[755] This argument bears some scrutiny, as some developing country flag states' ship registries are run by commercial outfits that would have plenty of resources to conduct robust reporting. Moreover, while the Kyoto Protocol specifically mentioned ICAO and IMO, the Paris Agreement does not specifically address emissions from shipping or aviation.[756] This mismatch resulted in some uncertainty regarding the exact requirements for reporting GHG emissions generated by international shipping and aviation.

Aiming to clarify this uncertainty, Decision 18/CMA provides that "international aviation and marine bunker fuel emissions should be reported as two separate entries and should not include such emissions in national totals but report them distinctly."[757] IMO has consistently reiterated that the Paris Agreement does not cover international shipping emissions, including upon the release of its 2023 strategies for the reduction of GHG emissions from international shipping.[758] While acknowledging that IMO has the majority view on this topic, a few legal scholars contend that change is needed. They argue that, given the differing text and overarching goals of the Paris Agreement and the Kyoto Protocol, international shipping and aviation emissions should also be

[753] Kyoto Protocol, *supra* note 632, Preamble and Art.1.
[754] Kyoto Protocol, *supra* note 632, Art. 2 (2).
[755] Transport & Environment, *Briefing: Don't Sink Paris: Legal basis for inclusion of aviation and shipping emissions in Paris targets* 1, 2 (Sep. 2021), at https://perma.cc/7VYY-G3CJ.
[756] *Id*. at 3.
[757] Decision 18/CMA.1, *Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement* (2018), at https://perma.cc/996A-F9A6. (Annex: Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement, Paragraph 53: "Each Party should report international aviation and marine bunker fuel emissions as two separate entries and should not include such emissions in national totals but report them distinctly, if disaggregated data are available, making every effort to both apply and report according to the method contained in the IPCC guidelines referred to in paragraph 20 above for separating domestic and international emissions.").
[758] INTERNATIONAL MARITIME ORGANIZATION (IMO) *In Focus: Initial IMO GHG Strategies* (2023), at https://perma.cc/ZJY6-9F6Z.

required in NDCs.[759] Specialized literature analyzing international shipping emissions under previous IMO regulations[760] also points out that these regulations are far from aligned with the Paris Agreement's goals.[761]

3. Analysis: cross-border CCS in NDCs

The remainder of this chapter analyzes the combined findings of the previous two sections on Article 6 and international emissions accounting frameworks. As a brief summary, Section 1 detailed the complex provisions of Article 6, highlighting the numerous uncertainties and challenges associated with its use for CCS. Section 2 provided an overview of several relevant international emissions accounting mechanisms, including both the EU ETS and the carbon reporting obligations of parties to the Paris Agreement, and their role in incentivizing CCS activities.

As a general premise, regardless if the cross-border CCS activity is reported within NDCs, carbon dioxide captured in the European Union and transported for permanent storage in the United States would not count as an emission from the country where it is generated, as such carbon dioxide has never entered the atmosphere.

This section now proceeds to analyze two key questions given the cross-border CCS scenario analyzed in this report. First, can the cross-border shipping of carbon dioxide from Europe for permanent storage in the United States be credibly used in the NDCs of the parties involved? If so, how?

The answers to both of these questions have practical implications. If the carbon dioxide to be stored in the United States could be included to advance NDC commitments, the inclusion of the cross-border shipping described in this report would be highly interesting for the parties involved, whether these parties are private companies or entire countries. European parties with a particular interest in this determination include those without carbon dioxide storage capacity, those with high hard-to-abate emissions in specific sectors, and those where public acceptance for CCS projects faces resistance or a combination of these factors.[762] Parties in the United States could also conceivably be interested in this determination, since the different CCS activities of this

[759] Transport & Environment, *supra* note 755o, at 2–3.

[760] International Maritime Organization (IMO), *cusocus: Initial IMO GHG Strategies*, *supra* note 758. (Noting that the IMO first regulated carbon dioxide from international shipping in 2018). *See also* Fiona Harvey*, Carbon Dioxide from Ships at Sea to Be Regulated for First Time*, The Guardian (Apr. 13, 2018).

[761] *See, e.g.,* Beatriz Garcia et al.*, Net Zero for the International Shipping Sector? An Analysis of the Implementation and Regulatory Challenges of the IMO Strategy on Reduction of GHG Emissions*, Journal of Environmental Law, 1, 12 et seq (2020) (Finding that market-based mechanisms proposed at that time by IMO were insufficient and advising for a carbon tax instead; ultimately the authors conclude that international shipping's decarbonization can only be truly achieved with zero-carbon fuels). *See also* Sebastian Franz et al., *Requirements for a Maritime Transition in Line with the Paris Agreement*, 25 iScience, 1, 12 (2022) (Advocating for carbon pricing and green fuels).

[762] *See generally* International Energy Agency, *Integrating CCS in International Cooperation and Carbon Markets under Article 6 of the Paris Agreement*, *supra* note 564, at 19.

project could not only be a source of foreign exchange income, but also would help develop technologies and facilities that could be useful to domestic emitters.

The cross-border shipping of carbon dioxide from Europe for permanent storage in the United States can be used to advance the NDC targets of the party who is shipping its emissions. The Paris Agreement provides that emissions reporting for NDCs (and all emissions reporting and related communications) are based on the modalities, procedures, and guidelines established by the IPCC.[763] As previously discussed, current IPCC guidelines state the need to report emissions and removals in a country's territory and offshore areas, and countries may report negative emissions from technologies like CCS.[764]

For the CCS operation described in this report, the EU country where the carbon is captured should report the amount of carbon dioxide captured as well as any emissions from transport and/or temporary storage that took place, and the amount of carbon dioxide exported to the United States. The United States should report the amount of carbon dioxide imported, any emissions from transport and/or temporary storage (that takes place in the United States), and any emissions from injection and geological sites.[765]

Therefore, the emissions involved in the transportation of carbon dioxide from Europe to the United States should be accounted in the EU country where capture occurred as well as in the United States' GHG reports. The 2006 IPCC Guidelines specifically provide for carbon dioxide capture and storage,[766] including the need for accounting for leakage during the capture and transport stages.[767] In the scenario described in this report, should any leakage occur in the transportation from Europe to the United States, it should be accounted for in the sending states,' i.e., the European country's emission inventory as well as its NDC.

As discussed in section 2, international shipping emissions fall outside the national GHG emission accounting obligations.[768] Current guidelines, however, recommend reporting international shipping emissions separate from national inventories. Because the Decision 18/CMA provides that "international aviation and marine bunker fuel emissions should be reported as two separate entries and should not include such emissions in national totals but report them distinctly,"[769] each country should also report the emissions involved in the

[763] Paris Agreement, *supra* note 525, Art.13.4.
[764] 2006 IPCC Guidelines, *supra* note 723, Reporting Guidance, Paragraph 8.2, at https://perma.cc/58CS-XZLY. (Paragraph 8.2.1 specifically refers to Chapter 5, Volume 2 of for CCS operations).
[765] 2006 IPCC Guidelines, *supra* note 723, Vol. 2, Chapter 5, Paragraph 5.10 (at page 5.20), at https://perma.cc/WQ7K-D5TN.
[766] *Id.*
[767] 2006 IPCC Guidelines, *supra* note 723, Vol. 2, Chapter 4 (Chapter 4 provides for fugitive emissions, which should be reported separately).
[768] International Maritime Organization (IMO), *In Focus: Initial IMO GHG Strategies*, *supra* note 758. *See also* International Renewable Energy Agency, *A Pathway to Decarbonizing the Shipping Sector by 2050*, IRENA 20 (2021), at https://perma.cc/8L7Y-BPCC.
[769] Decision 18/CMA.1, *Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement*, 27 (2018), at https://perma.cc/NP4P-NUAB. (Annex: Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement, Paragraph 53: "Each Party should report international aviation and marine bunker fuel emissions as two separate entries and should not include such emissions in national totals but report them distinctly, if disaggregated data are available, making every effort to both apply and report according

international shipping route as part of the CCS chain operation, i.e., from the EU country where the carbon dioxide was captured to its final place of storage in the United States. While each country should report such data, IMO has its global inventory per country and issues reports to the UNFCCC Secretariat.[770]

A related issue refers to the return journey of the ship from the United States to Europe. Let's suppose the ship returns carrying LNG or any other cargo. This return trip is not material for the CCS operation described in this report, i.e., it is not part of the obligation to report for purposes of the CCS chain analysis as applicable to NDCs. In other words, only the emissions in the Europe-to-United-States trip would have to be accounted for.

Accordingly, carbon dioxide emissions captured and stored as part of the CCS chain would have to be separately reported in accordance with the 2006 IPCC Guidelines, but these captured emissions could be deducted from the total reported emissions of the source country to yield a lower level of net emissions. This lower level of net emissions would assist the country in meeting its NDC. The emissions from the ships and any leakage of carbon dioxide in the shipment process should be reflected in the accounting to yield the overall net emissions reductions. The country where the storage occurs (the U.S.) would not be able to take credit for this storage in meeting its own NDC due to the prohibition of double counting.[771]

In its current NDC submission, the United States affirms that the country will not use the cooperative approaches of Article 6.2 or the mechanism of Article 6.4 toward achieving its NDCs climate targets.[772] The European Union's current NDC submission begins by highlighting that the EU reviewed and amended its legislation regarding the EU ETS to fulfill its NDCs,[773] and specifically states that its GHG reduction target "is to be achieved through domestic measures only, without contribution from international credits."[774]

Taken together, the current NDC commitments from the European Union and United States signal that it is highly unlikely that the market-based mechanisms of Article 6 of the Paris Agreement will provide additional incentives for parties to engage in the cross-border transportation of carbon dioxide from Europe to permanent storage in the United States, at least in the immediate future.

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to the method contained in the IPCC guidelines referred to in paragraph 20 above for separating domestic and international emissions.").

[770] International Maritime Organization (IMO), *IMO Action to Reduce GHG Emissions from International Shipping* (2023), at https://perma.cc/43VX-LWAK. (Noting that, since Jan. 1st, 2019, ships of or above 5,000 gross tonnage, which are responsible for 85% of the emissions in international shipping, are required to collect fuel oil consumption data for their annual report to IMO under its Data Collection System).

[771] 2006 IPCC Guidelines, *supra* note 723, Vol. 2, Chapter 5, Paragraph 5.10 (at page 5.20).

[772] The United States of America, *Submission of National Determined Contribution under the Paris Agreement to the United Nations Framework Convention on Climate Change Registry* 1, 21 (Apr. 2021).

[773] UNFCCC, *NDCs Registry: Update of the NDC of the European Union and its Member States*, 1, 3 (Dec. 17, 2020), at https://perma.cc/MJ5T-SQYD. (These amendments are estimated to accelerate the annual decreases in the cap of the EU ETS from 1.74% to 2.2% from 2021 onwards and will also apply in respect of aviation. Moreover, an updated market stability reserve within the ETS is addressing any build-up of surpluses that would undermine the orderly functioning of the EU ETS market, and allowances held in the reserve above a certain level shall no longer be valid from 2023 onwards).

[774] *Id.* at 17.

On top of these significant practical limitations, there are additional technical challenges to consider when incorporating of a potential cross-border CCS operation into a party's NDC. One of the most significant involves the open issue of how to account for emissions for international storage – and for removals more broadly – within the current applicable framework under the Paris Agreement.

Early on, the parties of the Paris Agreement agreed to the use of IPCC Guidelines for the submission of NDCs.[775] As noted in subsection 2.2, while these guidelines do not currently provide for removals, they do specifically provide for carbon dioxide capture and storage, including fugitive emissions during the capture and transport stages.[776] These estimations use conventional inventory approaches; any losses from carbon dioxide stored underground are estimated by a combination of modelling and measurement techniques based on the amount injected.[777] These inventory methods reflect the estimated actual emissions in the year in which they occur.[778]

As a note, a few methodological updates were made in the 2019 refinement guidelines.[779] A detailed analysis of these highly technical and methodological issues is beyond the scope of this report, but the specialized CCS literature states that these new methodological updates are not material for CCS projects.[780]

The above challenges aside, both countries must report on the cross-border CCS operation and include the fugitive emissions involved in both the transportation and temporary storage within their jurisdiction under the IPCC guidelines.[781] In the cross-border operation described in this report, the current framework will be used once the carbon dioxide is stored, with eventual unintended fugitive emissions factored in and related requirements fulfilled.

Finally, regardless of whether a cross-border CCS activity is reported within NDCs, carbon dioxide captured in European Union and transported for permanent storage in the United States would not count as an emission from the country where it is generated, because that carbon dioxide never gets to the atmosphere. Nonetheless,

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[775] Decision 4/CMA.1, *Further Guidance in Relation to the Mitigation Section of Decision 1/CP* (Dec. 15, 2018), Annex II: Accounting for Parties Nationally Determined Contributions referred to in Decision 1/CP.21, paragraph 31, at 12, and available at https://perma.cc/U96K-ZBRV. (Specifically providing for the use of the IPCC Guidelines).

[776] 2006 IPCC Guidelines, *supra* note 723, Vol. 2, Chapter 4, at https://perma.cc/MXX8-AUC6. (Chapter 4 provides for fugitive emissions from mining, procession, storage and transportation of coal, and fugitive emissions from oil and natural gas systems). Table 4.24 provides the equivalent factor for fugitive emissions for storage in developed countries (*Id.* at 4.49).

[777] 2006 IPCC Guidelines, *supra* note 723, Vol.1, at 4. (The guidelines underscore that the amount of carbon dioxide injected is also considered for monitoring purposes).

[778] *Id.* (It is noteworthy that amount of carbon dioxide captured from combustion of biofuel and subsequently injected into underground storage are included in the inventory as a negative emission; there is no distinction between any subsequent leakage of carbon dioxide captured from combustion of biofuel that is subsequently injected into underground storage and that of carbon dioxide from fossil sources.).

[779] International Panel on Climate Change (IPCC), *The 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Overview*, *supra* note 727, at 12. (Noting that all methodological updates were in the fugitive emissions categories, without methodological updates for stationary combustion, mobile combustion, or other sources other than fugitive ones).

[780] International Energy Agency, *Integrating CCS in International Cooperation and Carbon Markets under Article 6 of the Paris Agreement*, *supra* note 564, at 16. (Asserting that: "No revisions to the 2006 guidance on CCUS was included in the 2019 refinement.").

[781] 2006 IPCC Guidelines, *supra* note 723, Vol. 2, Chapter 5, Paragraph 5.10 (at p. 5.20).

parties should report carbon dioxide captured in their jurisdiction as per the 2006 IPCC Guidelines, which apply to both NDCs and the Paris Agreement's general emissions reporting obligations discussed in Section 2.2.

4. Conclusion

This chapter concludes that the 2006 IPCC Guidelines specifically provide for the reporting of carbon dioxide capture in one country and export to another one. These guidelines require the country exporting carbon dioxide and the country receiving it to report the exact amount of carbon dioxide exported and/or imported under their jurisdiction, including emissions generated by temporary storage and all fugitive emissions involved the process. For purposes of this report, therefore, cross-border CCS operations have specific and detailed rules under the emissions inventories and NDCs required for parties to the Paris Agreement. The transfer and storage of carbon dioxide from DAC sources, however, have yet to be contemplated in the guidelines.

This chapter highlights the complexities involved in the integration of the cross-border shipping of carbon dioxide from Europe for permanent storage in the United States into the market-based mechanisms of the Paris Agreement. It concludes that incorporating the permanent storage of carbon dioxide into an NDC via the market mechanisms of Article 6 of the Paris Agreement could theoretically occur in two forms: (1) under Article 6.2's cooperative bilateral or multilateral approach, particularly through the use of ITMOs towards NDCs and to promote sustainable development and ensuring environmental integrity; or (2) under Article 6.4's SDM, so long as emissions reductions resulting from this SDM are not used to demonstrate achievement by multiple parties' NDCs.

However, the market-based mechanisms of the Paris Agreement currently present significant challenges. While some of these challenges may be streamlined in the upcoming COPs, many uncertainties around these mechanisms remain, which ultimately does not incentivize member states of the European Union to engage in the cross-border shipping of carbon dioxide for permanent storage in the United States for the purposes of counting this activity towards their NDCs.

As a result, far and away the largest barrier facing the practical application of Article 6 in this scenario is the fact that neither the EU nor the US is interested in using these mechanisms to advance their NDCs at present. Whether future COPs can sufficiently clarify Article 6's operational uncertainties to the point that either party is interested in revising this stance remains to be seen.

There are a handful of potential adjustments that may serve as a starting point to incentivize the use of Article 6 for CCS activities between these two parties. Using Article 6.2 to develop a cooperative approach integrating the EU ETS and the CBAM – and then creating an agreement that provides sufficient incentives for both the United States government and interested private companies to permanently store the EU's carbon dioxide – may attract U.S.-based storage and transportation companies to engage in cross-border CCS activities, leading to a potential shift in the government's approach to its NDC. The use of Article 6.4's SDM is contingent upon resolving the methodological issues and operational uncertainties, which currently disincentivize its use.

All of these opportunities are merely theoretical at this point. Ultimately, both the European Union and the United States remain explicitly uninterested in the market-based mechanisms of Article 6 for purposes of fulfilling their NDC's targets, with current NDCs signaling that it is very unlikely that market-based mechanisms of Article 6 of the Paris Agreement will provide additional incentives for parties to engage in the cross-border transportation of carbon dioxide from Europe to permanent storage in the United States, at least in the near-term future.

Incentives that could be provided by market-based mechanisms may be unnecessary, however, because the EU can use subtract captured emissions from its emissions reporting and thus more readily meet its NDCs, and the United States can benefit from the compensation it would receive from the EU for storing EU emissions.

CHAPTER 5: UNITED STATES FEDERAL AND STATE LAWS

This chapter reviews the main U.S. federal and state laws applicable to the transportation and geologic storage of carbon dioxide, including laws enacted to implement relevant international treaties to which the United States is a party and relevant principles of customary international law.[782] As established in earlier chapters, this analysis focuses on activities related to geological carbon sequestration, specifically the storage of carbon dioxide in underground geologic formations.[783] It does not address the subsurface injection of carbon dioxide for enhanced oil recovery.

This chapter builds on our previous findings on the current existing requirements imposed under international law, which are discussed in Chapter 3. As this report focuses exclusively on international laws and any U.S. subnational laws that may be relevant to international transport of carbon dioxide, a detailed analysis of U.S. law concerning reservoirs, pipelines, and the like is outside the scope of this research. That said, this report analyzes eventual requirements that current pipeline regulations may impose regarding purity standards and specifications for carbon dioxide streams.

This chapter is divided into three sections. Section 1 focuses on federal legislation that may potentially apply to the cross-border shipping of carbon dioxide. This section is further divided into two subsections that address carbon dioxide transportation and carbon dioxide storage, respectively. NEPA is not discussed in this chapter's analysis of federal laws; it is the subject of Chapter 6.

After the discussion on federal laws, Section 2 of this chapter outlines current state experiences in handling the transportation for permanent storage of carbon dioxide. The section primarily focuses on how states have handled provisions under the Safe Drinking Water Act, one of the federal statutes outlined in the first section. For the purposes of this report, just four states are relevant to this analysis: North Dakota, Wyoming, Louisiana, and Texas. Finally, Part 3 concludes with our main findings.

1. Current federal laws

There is no comprehensive domestic legal framework regulating the cross-border transportation of carbon dioxide from a foreign country for permanent storage in the United States. Even exclusively domestic

[782] Charter of the United Nations and Statute of the International Court of Justice (1945), Art. 38 (1) and (2), as codified in the United States in the USTS 993, which reads as follows: "Art. 38 (1): The Court, whose function is to decide in accordance with international law such disputes as are submitted to it, shall apply: a. international conventions, whether general or particular, establishing rules expressly recognized by the contesting states; b. international custom, as evidence of a general practice accepted as law." Customary international law is as a set of legal rules that restrict the activities of states and are not written down or codified in a specific source; it arises when a significant number of states consistently engage in a pattern of behavior and the conviction has developed among states that this behavior is required by international law. The University of South Carolina, *International, foreign and comparative legal research: customary international law* (2018), at https://perma.cc/G4L2-RYTK. (Noting that the conviction has developed among states that this behavior is required by international law is often called *133pinion juris* and is understood as the general belief that the observed state practice is legally obligatory).

[783] U.S. Geological Survey, *Frequently asked questions: What's the difference between geologic an biologic carbon sequestration* (2020), at https://perma.cc/3ZU2-K4DM. (Differentiating geologic storage from biological storage. The latter is the removal from atmospheric CO_2 for storage in vegetation, soil, woody products, and aquatic environments).

transportation faces challenges. In 2010, an interagency report assessed the then-existing elements of a multi-regulatory framework with the goal of determining whether these disparate regulations could be integrated into a single framework for governing CCS.[784] Ultimately, the task force found that a range of barriers including differences in scope, implementation approaches, administrative procedures, compliance assurance, and enforcement mechanisms present challenges for creating a unified framework.[785]

In the United States, authority over carbon dioxide imports for permanent storage, to the extent it exists, is generally at the federal level. Despite recent developments in United States federal policy, importing carbon dioxide for permanent storage remains subject to different provisions that were not designed with this kind of activity in mind. However, the 2021 Infrastructure Investment and Jobs Act, or the IIJA,[786] provided a boost for carbon dioxide use and permanent storage.

The specific domestic regulatory requirements for carbon capture, transportation, usage and storage and related implementing agencies differ depending on several factors, including the location of the project, the type of project (experimental or commercial), the source of funding (government or private), land ownership (public or private), the location of injection wells (onshore or offshore), the purity of the carbon dioxide stream, and the source of the stream (power generation, industrial processes, or other sources).[787]

The remainder of this section analyzes the extent to which current federal laws may impact the import of carbon dioxide into the United States for permanent storage.[788] This analysis is divided in two subsections. Section 1.1 discusses the potentially applicable federal statues regarding the cross-border transportation of carbon dioxide, and Section 1.2 focuses on carbon dioxide for storage purposes. This section concludes with a summary of the main findings.

1.1 Carbon dioxide transportation

This subsection discusses the main federal statutes regulating the cross-border transportation of carbon dioxide for storage, focusing specifically on the Marine Protection, Research, and Sanctuaries Act (MPRSA), the Hazardous Materials Transportation Act (HMTA), and the Act to Prevent Pollution from Ships (APPS).

[784] The Interagency Task Force on Carbon Capture and Storage, *Report of the Interagency Task Force on Carbon Capture and Storage*, 66 (Aug. 2010), at https://perma.cc/FSF7-X9N6.
[785] *Id.*
[786] The Infrastructure Investment and Jobs Act, Pub. L. No. 117-58, §§40306, 40307 (2021) (Amending, *e.g.*, the Safe Drinking Water Act and the Geological Carbon Sequestration on the Outer Continental Shelf, respectively).
[787] The Interagency Task Force on Carbon Capture and Storage, *supra* note 784, at 66.
[788] EPA's Greenhouse Gas Reporting Program (GHGRP), which gathers information of GHG emissions in injection and storage sites, is excluded from our analysis. *See* 40 CFR Part 98 Subparts RR (for geologic sequestration) and UU (for injection).

1.1.1 The Marine Protection, Research, and Sanctuaries Act (MPRSA)

Titles I and II of the Marine Protection, Research, and Sanctuaries Act (MPRSA),[789] also referred to as the Ocean Dumping Act,[790] essentially transposes the London Convention into the domestic law of the United States.[791] Having previously analyzed the London Convention in Chapter 3 of this report, this section focuses exclusively on domestic issues that may impact the cross-border transportation of carbon dioxide for permanent storage in the United States.

MPRSA prohibits (1) the transportation of "material" from the United States for the purpose of ocean "dumping"; (2) the "transportation" of material from anywhere for the purpose of ocean dumping by U.S. agencies or U.S.-flagged vessels; and (3) the dumping of material transported from outside the United States into ocean waters.[792] However, a permit may authorize any of those activities.[793] Implementation of MPRSA is overseen by the Environmental Protection Agency, or EPA.

MPRSA broadly defines "material" as "matter of any kind or description, including, but not limited to, dredged material, solid waste, incinerator residue, garbage, sewage, sewage sludge, munitions, radiological, chemical, and biological warfare agents, radioactive materials, chemicals, biological and laboratory waste, wreck or discarded equipment, rock, sand, excavation debris, and industrial, municipal, agricultural, and other waste."[794] Likewise, "dumping" is also broadly defined as "the disposition of any material."[795] Finally, "transportation" is defined as the "carriage and related handling of any material by a vessel, or by any other vehicle, including aircraft."[796]

Incidentally, EPA can only issue permits authorizing such dumping if the agency concludes that it "will not unreasonably degrade or endanger human health, welfare, or amenities or the marine environment, ecological systems, or economic potentialities."[797] EPA will also need to analyze these environmental requirements under the Class VI Rule permits as delegated by the Safe Drinking Water Act (SDWA).[798] While the same activity can be

[789] 33 USC §1401.
[790] U.S. Environmental Protection Agency, Summary of the Marine Protection, Research, and Sanctuary Act (Jan. 3, 2023), at https://perma.cc/4BHH-MKNH.
[791] 33 USC §1402 (m).
[792] 33 USC §1410–11, providing that "Ocean waters," under 33 USC §1402 (b), means "those waters of the open seas lying seaward of the baseline from which the territorial sea is measured."
[793] 33 USC §1411–12.
[794] 33 USC §1402 (c).
[795] 33 USC §1402 (f). There are several exceptions for dumping, but none are likely to apply for permanent storage of carbon dioxide. *But cf* 33 USC §1402 (f) (1) (It is worth clarifying that one of the exclusions of "dumping" refers to activities regulated within the Federal Water Pollution Control Act, which nowadays —and after numerous amendments — is commonly known as the Clean Water Act).
[796] 33 USC §1402 (l).
[797] 33 USC §1412(a) (Listing several factors that EPA may consider in its assessment, including the need for such dumping activities and their impact on recreation, ocean life and ecosystems, among others). *See also* 40 CFR §227.
[798] Section 2 details the discussion of Class VI Rules.

regulated by two statutes, the SDWA ultimately applies more directly to storage than transportation considerations. The SDWA and its Class VI Rule are discussed in further detail in Section 1.2.1 of this chapter.

Given the broad definition of "dumping" under MPRSA,[799] sub-seabed carbon dioxide injection for geologic storage may be considered "dumping" and fall within the scope of MPRSA regulation, subject to the IIJA amendment discussed below.[800]

In the past, federal authority supported an interpretation that MPRSA would apply to sub-seabed carbon dioxide injection and storage. As recently as 2017, federal agencies underscored that MPRSA, much like the London Convention, aims to prevent the dumping of waste streams into the sea and, as such, "the injection of carbon dioxide into deep ocean waters (below 3000m) or near-surface seabed sediments may be considered ocean dumping."[801] Likewise, EPA has previously considered that MPRSA may be applicable to offshore permanent storage of carbon dioxide streams, stating that "sub-seabed CO_2 injection for [geological storage] may, in certain circumstances, be defined as ocean dumping and subject to regulation under MPRSA."[802] More recently, legal scholars have pointed out that the definition of dumping under MPRSA[803] "excludes the placement of a device 'in the [seabed] *for a purpose other than disposal*, when such . . . placement is otherwise regulated by federal or state law.'"[804] Therefore, the permanent storage of sub-seabed carbon dioxide could qualify as "dumping" under MPRSA, as this storage is arguably a type of disposal.

[799] 33 USC §1402(f).

[800] The MPRSA, as amended by the IIJA, specifically says that MPRSA permits are not required for offshore carbon storage. However, were this not be the case, permanent storage occurring within 12 nautical miles from the United States' coast would require a permit. If permanent storage occurred outside these 12 nautical miles and the discharge originated from a U.S. registered vessel (or a foreign vessel loaded in the United States), a permit would also be required. *See* 33 USC §1411. That said, there is reciprocity for international vessels carrying substances (including carbon dioxide), so permits issued by other member states of the Convention are recognized outside the 12 nautical miles from the United States. *See* 33 USC §1412(e).

[801] US Department of the Interior: Bureau of Ocean Energy Management, *Best Management Practices for Offshore Transportation and Sub-Seabed Geologic Storage of Carbon Dioxide*, 19 (Rebecca C. Smyth & Susan D. Hovorka eds., Dec. 2017), at https://perma.cc/7TEH-UMAS. *See also* our discussion in Chapter 3, where this report highlights that some experts and some parties to the London Convention have concluded that the Convention does apply to subseabed injection.

[802] U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells Final Rule, 75 Fed Reg 77230, 77236 (Dec. 10, 2010), at https://perma.cc/G56E-3RGM. (This is in the context of Class VI Rule, which will be analyzed later in this chapter).

[803] 33 USC §1402 (f). According to MPRSA, the definition of "dumping" includes the disposition of "any material" except, among others, "the construction of any fixed structure or artificial island . . . or the intentional placement of any device in ocean waters or on or in the submerged lands beneath such waters, for a purpose other than disposal, when such construction or such placement is otherwise regulated by Federal or State law or occurs pursuant to an authorized Federal or State program."

[804] Romany M. Webb & Michael B. Gerrard, *Overcoming Impediments to Offshore Carbon Dioxide Storage: Legal Issues in the U.S. and Canada*, Sabin Center for Climate Change Law 17 (2019) (emphasis in original).

Importantly, the IIJA recently clarified that a carbon dioxide stream injected for permanent sequestration into the Outer Continental Shelf (OCS) is not considered to be "material" under MPRSA.[805] Therefore, no permits under MPRSA are required for storage in the OCS.[806]

While the IIJA clarified the lack of any MPRSA-triggered permits for storage in the OCS, the act does not clarify how MPRSA might regulate sub-seabed carbon dioxide injection and storage outside of the OCS.

Here, it helps to shift attention away from the definition of "dumping" into the definition of "transportation" under MPRSA. Given MPRSA's broad definition of "transportation."[807] The analysis is complex. MPRSA requires a permit for the transportation of material from outside the United States if the transportation occurs on a vessel or aircraft registered in the United States or flying the United States flag and the material is to be dumped into US ocean waters.[808] The IIJA, however, says that carbon dioxide to be stored in the sub-seabed of the OCS does not qualify as "material."[809]

Considering such statutes, an MPRSA permit will only be required for transportation from overseas if the transportation is done using a U.S. vessel and the dumping will occur in an area other than OCS. Assuming that no carbon dioxide will be dumped in the water column, that leaves the seabed underlying state waters. In practice, it can be inferred that MPRSA does not apply to the carbon dioxide injection into the seabed underlying state waters. This injection is deemed controlled by the Safe Drinking Water Act (SWDA),[810] because EPA requires SDWA permits for sub-seabed injected in state waters.[811] Because MPRSA has a quite broad preemption clause,[812] if MPRSA were to apply, SDWA permits would not be required.[813]

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[805] The Infrastructure Investment and Jobs Act, Pub. L. No. 117-58, § 40307 (c) (2021). "A carbon dioxide stream injected for the purpose of carbon sequestration under subparagraph (E) of section 8(p)(1) of the Outer Continental Shelf Lands Act (43 U.S.C. 1337(p)(1)) shall not be considered to be material (as defined in section 3 of the Marine Protection, Research, and Sanctuaries Act of 1972 (33 U.S.C. 1402)) for purposes of that Act (33 U.S.C. 1401 et seq.)."

[806] The OCS includes the Gulf of Mexico. *See, e.g.,* US Department of the Interior: Bureau of Ocean Energy Management, *Gulf of Mexico OCS Region* (2023), at https://perma.cc/N5VR-WYD9.

[807] 33 USC §1402(l), which provides as follows: "'Transport' or 'transportation' refers to the carriage and related handling of any material by a vessel, or by any other vehicle, including aircraft."

[808] 33 USC §1412 (a): "[T]he Administrator may issue permits, after notice and opportunity for public hearings, for the transportation from the United States or, in the case of an agency or instrumentality of the United States, or in the case of a vessel or aircraft registered in the United States or flying the United States flag, for the transportation from a location outside the United States, of material for the purpose of dumping it into ocean waters, or for the dumping of material into the waters described in section 1411(b) of this title, where the Administrator determines that such dumping will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities." Ocean waters are defined under 33 USC §1402(b): "those waters of the open seas lying seaward of the base line from which the territorial sea is measured." In practice, within twelve nautical miles of the United States coast, as further explained.

[809] The Infrastructure Investment and Jobs Act, Pub. L. No. 117-58, § 40307 (c) (2021).

[810] Safe Drinking Water Act of 1974, 42 USC §§ 300h et seq. Section 2 details the discussion of SDWA and Class VI Rules for injection and storage of carbon dioxide.

[811] *See* 40 CFR §144.l (e). *See also* U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells Final Rule, *supra* note 802, at 77235.

[812] 33 USC §1416.

[813] Special thanks to Romany Webb for highlighting this possibility.

Both the SDWA and MPRSA contain substantive environmental protection requirements that would need to be satisfied prior to the start of geologic storage.[814] EPA has already considered the need for coordination between these two regulations.[815] Importantly, these laws do not appear to impose additional restrictions on the source and overall purity of the carbon dioxide streams for permanent storage in the United States.

Finally, it is worth clarifying MPRSA's scope regarding industrial waste. MPRSA does not authorize the issuance of permits for "industrial waste,"[816] which is defined as "any solid, semisolid, or liquid waste generated by a manufacturing or processing plant."[817]

Nonetheless, federal agencies have highlighted that if assuming that carbon dioxide qualifies as "industrial waste," MPRSA can be interpreted to ban permanent offshore storage of carbon dioxide outside the OCS.[818] (As noted above, the IIJA exempts offshore storage from the MPRSA within the OCS). Scholars have contended that carbon dioxide streams captured from power plants or other industrial processes are more likely to qualify as "industrial waste," whereas carbon dioxide streams captured from CDR processes may be less likely to qualify as "industrial waste."[819] The classification of carbon dioxide for permanent storage as "industrial waste" could mean that MPRSA would conflict with the offshore storage of carbon dioxide. In practice, this issue is not consequential, as MPRSA would only apply to state waters, which are deemed under the SDWA's purview (instead of MPRSA), under EPA's interpretation, as discussed above.

1.1.2 The Hazardous Materials Transportation Act (HMTA)

The HMTA aims to protect against the risks to life, property, and the environment inherent in the transportation of hazardous material in intrastate, interstate, and foreign commerce.[820] The HMTA's regulations also set detailed requirements for carriers of "hazardous materials," as defined by the Secretary of Transportation.[821]

Our analysis of the HMTA is divided in two subsections. The first focuses on the HMTA requirements for transportation of carbon dioxide by ship; the second focuses on the HMTA requirements of this transportation by pipelines.

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[814] U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells Final Rule, *supra* note 802, at 77236; and 33 USC §1402 (For MPRSA).

[815] *Id.* at 77236–37.

[816] 33 USC §1412a (Regulating emergency dumping of industrial waste).

[817] 33 USC §1412a(b) (Defining industrial waste).

[818] US Department of the Interior: Bureau of Ocean Energy Management, *Best Management Practices for Offshore Transportation and Sub-Seabed Geologic Storage of Carbon Dioxide*, BOEM 212 (Rebecca C. Smyth & Susan D. Hovorka eds., Dec. 2017), at https://perma.cc/N8NV-V7EZ.

[819] Webb & Gerrard, *supra* note 804, at 17–18.

[820] The Hazardous Materials Transportation Act of 1975, 49 USC §§5101, codified at CFR part 171.

[821] 49 CFR§5102 (2), defining "hazardous materials" as "any substance or material under 49 CFR§5103(a)," *i.e.*, as defined by the Secretary.

1.1.2.1 Ship-based transport

The U.S. Coast Guard, which lies within the Department of Homeland Security,[822] is responsible for enforcing the HMTA requirements with respect to the transportation of hazardous materials via ship.[823] The HMTA establishes shipping documentation and disclosure requirements applicable to the transport of hazardous waste,[824] as well as general requirements for bulk and non-bulk packaging of hazardous materials.[825]

Regulations adopted under the HMTA establish general requirements for the shipment of compressed gases and other hazardous materials in cylinders, UN pressure receptacles[826] and spherical pressure vessels.[827] More specifically, compressed gases must be in UN pressure receptacles built in accordance with the UN standards or in metal cylinders and containers built in accordance with DOT regulations.[828] A pressure relief is not required for carbon dioxide cylinders that meet these dimensions.[829]

Carbon dioxide is listed as a Class 2.2 (non-flammable gas) hazardous material under DOT regulations.[830] According to the table in Part 172.101 of the HMTA as well as the related vessel stowage requirements in part 172.101(k)(2), carbon dioxide refrigerated liquid falls into stowage category "B." This means that carbon dioxide "must be stowed "on deck" or "under deck" on either a cargo vessel or a passenger vessel. If stowed on a passenger vessel, the HMTA provides additional limitations on the number and density of passengers on the ship. The act provides that the number of passengers either cannot (a) exceed 25 people, or (b) exceed one

[822] The United States Coast Guard, which was established in 1915 (14 U.S.C. 1), became a part of the Department of Transportation in 1967, pursuant to the Department of Transportation Act of October 15, 1966. Upon the enactment of the Homeland Security Act of 2022, the Coast Guard was transferred from the Department of Transportation to the Department of Homeland Security on March 1, 2023 (116 Stat. 2135). *See* the U.S. Coast Guard: The Journal of the United States Government (2023), at https://perma.cc/2SFL-L8N7.
[823] 49 CFR§5121(c) (Authorizing the Secretary of Transportation to delegate such enforcement authority).
[824] 49 CFR§5110.
[825] 49 CFR§§171, 173, 178–80. (Highlighting that the regulations are applicable to bulk and non-bulk packaging; the effectiveness of packaging is not reduced during transportation; and that effectiveness of packaging cannot be reduced from the mixture of gases or vapors).
[826] UN is a specific technical measure used in different types of cylinders. More information on UN pressure receptables can be found at: Department of Transportation (DOT), Hazardous Materials Transportation: Compliance Basics Series (2006), at https://perma.cc/TT7C-T7TP.
[827] 49 CFR§173.301(a), providing as follows: "a) *General qualifications for use of cylinders.* Unless otherwise stated, as used in this section, the term "cylinder" includes a UN pressure receptacle. As used in this subpart, filled or charged means an introduction or presence of a hazardous material in a cylinder. A cylinder filled with a Class 2 hazardous material (gas) and offered for transportation must meet the requirements in this section and §§ 173.301a through 173.305, as applicable."
[828] 49 CFR § 173.301(a) (1) (And as specified: " and ICC specifications and part 178 of this subchapter in effect at the time of manufacture or CRC, BTC, CTC or TC specification, and requalified and marked as prescribed in subpart C in part 180 of this subchapter, if applicable.").
[829] 49 CFR § 173.301(f) (7)(i).
[830] 49 CFR part 172.101. According to the table in Part 172.101, and related vessel stowage requirements in part 172.101(k)2), carbon dioxide refrigerated liquid has a stowage category "B," meaning it "(i) The material may be stowed 'on deck' or 'under deck' on a cargo vessel and on a passenger vessel carrying a number of passengers limited to not more than the larger of 25 passengers, or one passenger per each 3 m of over- all vessel length; and (ii) 'On deck only' on passenger vessels in which the number of passengers specified in paragraph (k)(2)(i) of this section is exceeded."

passenger per three meters of vessel length; whichever number of passengers is larger is considered the limit. If a passenger vessel exceeds both of these numbers, the transport of carbon dioxide is prohibited.[831]

1.1.2.2 Pipeline-based transport

The HMTA delegates regulatory authority over pipeline safety to the Pipelines and Hazardous Materials Safety Administration (PHMSA), an agency within DOT.[832]

PHMSA issues and enforces regulations on the construction, operation, maintenance, and spill response planning for certain carbon dioxide pipelines.[833] Although several agencies are involved in the regulation of interstate pipelines in the United States, only PHMSA has federal safety regulatory authority over pipelines carrying carbon dioxide.[834] PHMSA regulations specify the scope of application of the HMTA regarding carbon dioxide in federal and state waters and related exclusions.[835] States regulate intrastate pipeline safety[836] and are subject to minimum federal law requirements.[837]

The scope of PHMSA regulation covers "pipeline facilities and the transportation of hazardous liquids or carbon dioxide associated with those facilities in or affecting interstate or foreign commerce, including pipeline facilities on the Outer Continental Shelf (OCS)."[838] Under PHMSA's regulations, the OCS is defined as "submerged lands lying seaward and outside the area of lands beneath navigable waters as defined in Section 2 of the Submerged Lands Act (43 U.S.C. 1301) and of which the subsoil and seabed appertain to the United States and are subject to its jurisdiction and control."[839] In practice, the OCS generally extends between 3 to 200 nautical miles from the United States coast.[840] This includes the relevant portions of the Gulf of Mexico.

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[831] 49 CFR part 172.101 (Table in Part 172.101, and related vessel stowage requirements in part 172.101(k)(2).
[832] The Hazardous Materials Transportation Act of 1975, 49 USC §§5101–27, codified at 40 CFR parts171–180; and 49 USC § 60102 (a).
[833] 49 CFR part 190, 195–99. (Importantly, PHMSA regulations apply to carbon dioxide pipelines carrying carbon dioxide as a supercritical liquid. See 49 CFR part 195. 2: "*Carbon dioxide* means a fluid consisting of more than 90 percent carbon dioxide molecules compressed to a supercritical state.").
[834] Michael B. Gerrard & Justin Gundlach, *CCS in US Climate Change Policy in* CARBON CAPTURE AND STORAGE: EMERGING LEGAL AND REGULATORY ISSUES 108–9 (Ian Havercroft et al. eds., 2019) (Explaining that the Federal Energy Regulatory Commission, the Surface Transportation Board, and the Office of Pipeline Safety in the Department of Transportation's PHMSA regulate the siting, economics, and safety of several interstate pipelines in the country).
[835] 49 CFR Part 195.1(b)(5), (6), (7). These regulations apply to the "transportation of hazardous liquids or carbon dioxide."
[836] Gerrard & Gundlach, *supra* note 834, 109. For a website with links to state performance, including incidents and accidents across the country: Pipeline and Hazardous Materials Safety Administration, State Pages, at https://perma.cc/2PA3-RMDM.
[837] *See, e.g.,* U.S. Department of Transportation: Pipeline and Hazardous Materials Safety Administration, Federal Effort (Mar. 18, 2023), at https://perma.cc/9H9U-DAW7.
[838] 49 CFR part 195.1(a).
[839] 49 CFR part 195.2.
[840] 43 USC § 1301 and 43 USC § 1301(b). The definition of OCS is detailed in Chapter 3 and is also discussed further in the OCSLA analysis (Section 1.2.3 of this Chapter).

PHMSA regulations define carbon dioxide as "a fluid consisting of more than 90 percent carbon dioxide molecules compressed to a supercritical state."[841] While PHMSA regulations apply to pipelines transporting carbon dioxide in a supercritical liquid state,[842] they do not regulate pipelines transporting carbon dioxide in a subcritical fluid or gaseous state.[843] PHMSA could, under its existing authority, also adopt regulations applying to the transport of gaseous carbon dioxide,[844] but arguably lacks authority to regulate interstate and intrastate pipelines transporting liquid carbon dioxide.[845]

PHMSA regulations also specifically exclude transportation of carbon dioxide "through onshore production (including flow lines), refining, or manufacturing facilities or storage or in-plant piping systems associated with such facilities."[846] Likewise, it excludes from its scope of application the transportation of carbon dioxide by ships and other non-pipeline modes of transportation.[847]

Carbon dioxide is classified as a "highly volatile and non-flammable/non-toxic" fluid under PHMSA regulations.[848] Despite carbon dioxide being listed as a Class 2.2 ("non-flammable gas") hazardous material under DOT regulations,[849] PHMSA currently applies similar safety requirements to carbon dioxide pipelines as it does to pipelines carrying hazardous liquids, such as crude oil and anhydrous ammonia.[850] However, the PHSMA regulations do not specifically include carbon dioxide within its definition of "hazardous liquids."[851] In other words, while PHMSA regulations do not identify carbon dioxide as a "hazardous liquid," they impose requirements for carbon dioxide pipelines similar to those imposed on other pipelines carrying hazardous

[841] 49 CFR part 195.2.
[842] 49 CFR part 195.1(a).
[843] Seth Kerschner & Taylor Pullins, *How US Environmental Laws and Regulations Affect Carbon Capture and Storage*, White & Case (Jan. 29, 2021), at https://perma.cc/D7BP-X3A8.
[844] 49 CFR part 60102 (i).
[845] California Natural Resources Agency, California Public Utilities Commission & California State Lands Commission, Proposal to the Legislature for Establishing a State Framework and Standards for Intrastate Pipelines Transporting Carbon Dioxide 4 (Mar. 2023). *See also* Martin Lockman, *Permitting CO2 Pipelines,* Sabin Center for Climate Change Law (Sep. 2023), at https://perma.cc/RWD7-5MM3.
[846] 49 CFR part 195.1(b)(8).
[847] 49 CFR part 195.1(b)(9): "Transportation of hazardous liquid or carbon dioxide: (i) By vessel, aircraft, tank truck, tank car, or other non-pipeline mode of transportation; or (ii) Through facilities located on the grounds of a materials transportation terminal if the facilities are used exclusively to transfer hazardous liquid or carbon dioxide between non-pipeline modes of transportation or between a non-pipeline mode and a pipeline. These facilities do not include any device and associated piping that are necessary to control pressure in the pipeline under §195.406 (b) or (10) Transportation of carbon dioxide downstream from the applicable following point: (i) The inlet of a compressor used in the injection of carbon dioxide for oil recovery operations, or the point where recycled carbon dioxide enters the injection system, whichever is farther upstream; or (ii) The connection of the first branch pipeline in the production field where the pipeline transports carbon dioxide to an injection well or to a header or manifold from which a pipeline branches to an injection well."
[848] 49 CFR part 195, Appendix B to Part 195 – Risk-Based Alternative to Pressure Testing Older Hazardous Liquid and Carbon Dioxide Pipelines, Table 4: Product Indicators.
[849] 49 CFR part 172.101.
[850] Paul W. Parfomak, *Carbon Dioxide Pipelines: Safety Issues*, Congressional Research Service (Jun. 3, 2022), at https://perma.cc/F34E-B37Z.
[851] 49 CFR part 195.2.

liquids. This approach has been justified based on the fact that the pipelines carry highly pressurized carbon dioxide in a supercritical phase much like pipelines carrying other hazardous material transportation.[852]

Under PHMSA regulations, pipeline owners and operators are required to ensure that carbon dioxide streams are chemically compatible with the pipeline and related commodities within the pipeline, and will not corrode the pipeline and pipeline systems.[853] Therefore, owners and operators are incentivized to comply with the purity levels and overall regulatory requirements for the composition of the stream due to the risks posed by deviating from these requirements, including pipeline corrosion and eventual liability. Operators of pipelines transporting carbon dioxide have additional obligations to investigate the corrosive effect of the carbon dioxide on the pipeline and take adequate steps to mitigate internal corrosion.[854] Moreover, operators of pipelines in the OCS must fulfill specific notification requirements[855] and comply with construction and design requirements for pipelines transporting carbon dioxide.[856]

Considering the analysis above, current PHMSA regulations do not require specific levels of purity of the carbon stream (except for requiring a substance to be at least 90% pure to qualify as carbon dioxide), and do not impose extra requirements depending on the source of the carbon dioxide.[857] That said, these regulations are in flux. In 2019, PHMSA amended its regulations for pipelines carrying hazardous liquids, requiring additional reporting requirements, inspections, and periodic assessments, among others.[858] In the aftermath of a 2020 accident in Satartia, Mississippi in which a carbon dioxide pipeline ruptured, prompting the evacuation of several hundred

[852] U.S. Department of Energy: Office of Fossil Energy, *A Review of the CO_2 Pipeline Infrastructure in the U.S.* (Matthew Wallance et al. eds., Apr. 21, 2015), at 32. (Underscoring that, overall, smaller carbon dioxide distribution lines, which transport the carbon dioxide from the trunkline to individual wells, are not subject to these PHMSA safety standards).

[853] 49 CFR part 195.4, determines that: "No person may transport any hazardous liquid or carbon dioxide unless the hazardous liquid or carbon dioxide is chemically compatible with both the pipeline, including all components, and any other commodity that it may come into contact with while in the pipeline."

[854] 49 CFR part 195.579 (a).

[855] 49 CFR part 195. 4, establishing that: "Operators of transportation pipelines on the Outer Continental Shelf must identify on all their respective pipelines the specific points at which operating responsibility transfers to a producing operator. For those instances in which the transfer points are not identifiable by a durable marking, each operator will have until September 15, 1998, to identify the transfer points. If it is not practicable to durably mark a transfer point and the transfer point is located above water, the operator must depict the transfer point on a schematic maintained near the transfer point. If a transfer point is located subsea, the operator must identify the transfer point on a schematic which must be maintained at the nearest upstream facility and provided to PHMSA upon request. For those cases in which adjoining operators have not agreed on a transfer point by September 15, 1998, the Regional Director and the MMS Regional Supervisor will make a joint determination of the transfer point."

[856] 49 CFR part 195. Specific requirements include, for instance, that a carbon dioxide pipeline system must be designed to mitigate the effects of fracture propagation. *See* 49 CFR part 195 §111.

[857] 49 CFR part 195. 2: "*Carbon dioxide* means a fluid consisting of more than 90 percent carbon dioxide molecules compressed to a supercritical state.").

[858] 49 CFR part 195, as amended by Pipeline and Hazardous Materials Safety Administration, Pipeline Safety: Safety of Hazardous Liquid Pipelines, Final Rule, 84 Fed. Reg. N. 190, 52260 (Oct. 1, 2019), at https://perma.cc/PXV6-57LH. (These changes were incorporated throughout our analysis).

people, in 2022, PHMSA announced its intention to issue a new rulemaking to update the safety regulations for carbon dioxide pipelines.[859] Future developments from the agency need to be followed closely.

1.1.3 The Act to Prevent Pollution from Ships (APPS)

The Act to Prevent Pollution from Ships, or the APPS, transposes the MARPOL Convention into to United States domestic law,[860] particularly the Convention's Annex VI requirements.[861] As discussed in Chapter 3 of this report, MARPOL's focus is on operational discharges, whereas intentional dumping of waste[862] is regulated under the London Convention and Protocol.[863] Under the APPS, "discharge" has the same meaning as it has in the MARPOL Convention,[864] which specifies that "discharge," in relation to harmful substances or effluents containing such substances, means any release howsoever caused from a ship and includes any escape, disposal, spilling, leaking, pumping, emitting or emptying."[865]

The APPS[866] subjects U.S.-flagged vessels to inspection regarding compliance with MARPOL's Annex VI's requirements. Non-U.S.-flagged vessels are subject to examination under the Port State Control when operating in U.S. waters.[867] Port State Control is "the inspection of foreign ships in national ports to verify that the condition of the ship and its equipment comply with the requirements of international regulations and that the ship is manned and operated in compliance with these rules."[868]

Consistent with our findings in Chapter 3, the APPS does not regulate the transportation of carbon dioxide for permanent storage in the United States (though of course if a ship carrying carbon dioxide experienced a spill of its fuel, the APPS would apply to that spill). A recent comprehensive report on carbon capture, utilization and sequestration by CEQ did not even include the APPS in its analysis.[869] Accordingly, this report merely mentions

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[859] Pipeline and Hazardous Materials Safety Administration, *PHMSA Announces New Safety Measures to Protect Americans from Carbon Dioxide Pipeline Failures After Satartia*, MS LEAK (May 26, 2022), at https://perma.cc/S9EV-QPFE. ("The carbon dioxide pipeline failure in Satartia, Mississippi in 2020 resulted in local evacuations and caused almost 50 people to seek medical attention.").

[860] 33 U.S.C. § 1901 (5) (Determining that "Convention" in the APPS refers to the MARPOL Convention).

[861] 33 U.S.C. §§ 1901–1905.

[862] The United Nations Convention for the Prevention of Pollution from Ships, Nov. 2, 1973, 12 I.L.M 319 [hereinafter MARPOL], at Art. 2.

[863] DAVID HUNTER ET AL., INTERNATIONAL ENVIRONMENTAL LAW AND POLICY 786 (2022).

[864] 33 U.S.C. § 1901 (6) (Establishing that "discharge," "emission," "garbage," "harmful substance," and "incident" shall have the meanings provided in the MARPOL Convention).

[865] MARPOL, *supra* note 862, at Art. 2, 3 (a). The definition of discharge in MARPOL's Art. 2, 3 (b) excludes, among others, any dumping regulated under the London Convention and release of harmful substances directly arising from the exploration, exploitation and associated offshore processing of seabed mineral resources.

[866] 33 U.S.C. §1902.

[867] The United States Coastal Guard or EPA may bring enforcement action for a violation. *See* APPS, §§ 1903–1907.

[868] INTERNATIONAL MARITIME ORGANIZATION, *Port State Control* (2023), at https://perma.cc/68WQ-UWQY.

[869] COUNCIL ON ENVIRONMENTAL QUALITY (CEQ), COUNCIL ON ENVIRONMENTAL QUALITY REPORT TO CONGRESS ON CARBON CAPTURE, UTILIZATION, AND SEQUESTRATION DELIVERED TO THE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS OF THE SENATE AND THE COMMITTEE ON ENERGY AND COMMERCE, THE COMMITTEE ON NATURAL RESOURCES, AND THE COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE OF THE HOUSE OF REPRESENTATIVES, AS DIRECTED IN SECTION 102 OF DIVISION S OF THE CONSOLIDATED APPROPRIATIONS ACT 58–64 (2021), at https://perma.cc/VMW4-YEUP.

the APPS here for the purpose of completeness, as the subject matter the act regulates does not cover the international shipping of carbon dioxide streams for storage.

1.2 Carbon dioxide storage

This section analyzes main federal statutes regulating the permanent storage of carbon dioxide, focusing specifically on the Safe Drinking Water Act, the Resource Conservation and Recovery Act, and the Outer Continental Shelf Lands Act.

1.2.1 The Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) is the main federal statute regulating underground injection activities in the United States, including activities related to the geologic sequestration of carbon dioxide.[870] This subsection starts with a survey of the key definitions in the SDWA and EPA's authority to issue regulations under the act. It proceeds to introduce the Class VI Rule, which governs the underground injection of carbon dioxide for geologic sequestration. Finally, the section provides an analysis of the standards for carbon dioxide injection and sequestration under the Class VI Rule.

1.2.1.1 SDWA overview

The SDWA imposes federal requirements, administered by EPA, with the possibility of delegation to states of the regulation of injection control (UIC) programs to protect underground sources of drinking water. The state regulations must, among other requirements, prohibit any underground injection activity unless authorized by a permit or rule.[871] Injections by federal agencies or on property owned or leased by the federal government are subject to the state's UIC requirements.[872] State UIC regulations shall "contain minimum requirements for effective programs to prevent underground injection which endangers drinking water sources."[873]

EPA regulations issued under the SWDA define an underground source of drinking water as an "aquifer or its portion which supplies any public water system or which contains a sufficient quantity of ground water to supply a public water system; and currently supplies drinking water for human consumption; or contains fewer than 10,000mg/l total dissolved solids; and which is not an exempted aquifer."[874] Underground injection is defined as "the subsurface emplacement of fluids by well injection,"[875] excluding "(i) the underground injection of natural gas for purposes of storage; and (ii) the underground injection of fluids or propping agents (other than diesel

[870] Angela C. Jones, *Injection and Geologic Sequestration of Carbon Dioxide: Federal Role and Issues for Congress: Report 46192*, CONGRESSIONAL RESEARCH SERVICE 9 (Sep. 22, 2022), at https://perma.cc/BT8G-R8SZ.
[871] Safe Drinking Water Act of 1974, 42 USC §§ 300h.
[872] Safe Drinking Water Act of 1974, 42 USC §§ 300h(b)1(D).
[873] *Id.* at 300h(b)1.
[874] 40 C.F.R. §146.3.
[875] Safe Drinking Water Act of 1974, 42 USC §§300h(d)1(A).

fuels) pursuant to hydraulic fracturing operations related to oil, gas, or geothermal production activities."[876] Underground injection is considered to endanger drinking water sources if the injection "may result in the presence in underground water which supplies or can reasonably be expected to supply any public water system of any contaminant, and if the presence of such contaminant may result in such system's not complying with any national primary drinking water regulation or may otherwise adversely affect the health of persons."[877]

EPA acknowledged that risks to underground sources of drinking water could be posed by the large injection volumes typically present in geologic carbon storage projects, the buoyant and mobile nature of carbon dioxide, the potential existence of impurities in the carbon dioxide stream, and carbon dioxide's corrosivity in the presence of water.[878] EPA listed both hydrogen sulfide and mercury as potential drinking water contaminants associated with impurities in the carbon dioxide stream.[879] The agency also highlighted that pressures induced by injection may force native brines, or naturally occurring salty water, into underground sources of drinking water. This could lead to the degradation of water quality and adversely impact drinking water.[880]

Pursuant to the SDWA,[881] EPA designated six classes of underground injection wells. These classes consider the type and depth of the injection activity and the potential of this injection to result endangerment of an underground source of drinking water.[882] Construction, injection depth, design requirements and operating techniques vary among these well classes.[883] The well class that currently applies most directly to permanent geological carbon dioxide storage is Class VI, which is further detailed in the next section.

1.2.1.2 The Class VI Rule

Under the SDWA,[884] EPA issued specific safety standards for carbon dioxide injection and sequestration in 2010.[885] The rule created UIC Class VI,[886] a new class of wells for injection of carbon dioxide into geologic

[876] *Id.* at 300h(d)1(B).
[877] *Id.* at 300h(d)2.
[878] U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells Final Rule, *supra* note 802, at 77234.
[879] *Id.* at 77235.
[880] *Id.*
[881] Safe Drinking Water Act of 1974, 42 USC §§ 300h.
[882] 40 CFR §146.5. (This report discusses the main classes of wells pertinent to carbon dioxide for permanent storage in the next section); and 40 CFR §144 et seq. (Regulating endangerment of underground sources of drinking waters).
[883] Jones, *Injection and Geologic Sequestration of Carbon Dioxide: Federal Role and Issues for Congress: Report 46192*, *supra* note 870, at 10.
[884] Safe Drinking Water Act of 1974, 42 USC §§ 300f-300j-26, 300h(b)(2).
[885] Gerrard & Gundlach, *supra* note 834, at 109.
[886] 40 CFR. §144(6)f.

formations for long-term storage or geologic sequestration.[887] As such, these standards are often simply referred to as the Class VI Rule.[888]

The Class VI Rule was the first federal rule to specifically regulate underground carbon dioxide injection for sequestration.[889] Before this rule entered into effect in January 2011, the injection of carbon dioxide was permitted according to either the Class II Rule if the injection would occur for EOR purposes, or the Class V Rule if the injection was conducted for experimental storage and research purposes.[890]

The Class VI Rule establishes the minimum requirements for state UIC programs regulating the "subsurface injection of fluids onshore and offshore under submerged lands within the territorial jurisdiction of states," tribal lands and any territories.[891] These jurisdictions are defined in the Submerged Land Act for land beneath navigable waters within state boundaries,[892] and Territorial Submerged Land Act for land beneath tribal lands and territories.[893] State jurisdiction typically extends three nautical miles from shore,[894] but can extend further in some circumstances.[895] States seeking primary enforcement authority for UIC Class VI wells, also known as primacy, must show EPA that the state has jurisdiction over underground injection, that the state meets EPA's minimum requirements for UIC program, and that the state has the necessary administrative, civil and criminal enforcement penalty remedies.[896]

EPA delegated primacy to two states: North Dakota (in 2018) and Wyoming (in 2020). Late in December 2023, EPA approved Louisiana primacy's authority.[897] In the remaining states and all territories, EPA retains direct implementation authority.[898] EPA is considering applications for primacy from Texas, West Virginia, and

[887] U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells Final Rule, *supra* note 802, at 77234–35.
[888] *Id.*
[889] Jones, *Injection and Geologic Sequestration of Carbon Dioxide: Federal Role and Issues for Congress: Report 46192*, *supra* note 870, at 10.
[890] *Id.*
[891] U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells Final Rule, *supra* note 802, at 77235. (*See* 40 CFR 144.3 for references to tribal government and territories).
[892] 43 USC § 1311.
[893] 48 USC § 1705.
[894] 43 USC § 1312–13.
[895] Texas and Florida extend their jurisdiction over the Gulf of Mexico out to 9 nautical miles, and Louisiana extends its jurisdiction out 3 U.S. nautical miles seaward of the baseline from which the breadth of the territorial sea is measured. U.S. Department of the Interior: Bureau of Ocean Energy Management (BOEM), Outer Continental Shelf, at https://perma.cc/EDX5-MGT6. *See also* US Department of the Interior: Bureau of Ocean Energy Management, *Gulf of Mexico OCS Region* (2023), at https://perma.cc/Q9M7-D2BG. (Highlighting that the OCS includes the Gulf of Mexico). *See also* our discussion on Section 1.2.3.
[896] *Id. See also* the Safe Drinking Water Act of 1974, 42 USC §§ 300h-1.
[897] U.S. Environmental Protection Agency, *State of Louisiana Underground Injection Control Program; Class VI Primacy* (Dec. 28, 2023), at https://perma.cc/Q7VE-2Z4W.
[898] U.S. Environmental Protection Agency, *Primary Enforcement Authority for the Underground Injection Control Program* (Aug. 18, 2022), at https://perma.cc/49A8-EJSS.

Arizona.[899] States that have secured primacy may receive grants from the administrator of EPA to assist with the costs associated with UIC Class VI wells.[900] Challenges and considerations regarding primacy and the implementation of Class VI wells in different states is discussed in Section 2 of this chapter.

1.2.1.3 Carbon dioxide injection under the Class VI Rule

The Class VI Rule provides minimum federal requirements for the injection of carbon dioxide to protect underground sources of drinking water from endangerment, while providing consistency for the requirements of these injections across the United States.[901]

According to the Class VI Rule, geologic sequestration is "the long-term containment of a gaseous, liquid, or supercritical carbon dioxide stream in subsurface geologic formations."[902] Carbon dioxide capture and transportation are not regulated by the rule—only sequestration itself is regulated.[903] Subsurface geologic formations, however, are not defined in the rule. Considering all the definitions proposed in the Class VI Rule, it is reasonable to interpret that subsurface geologic formations include onshore federal as well as onshore and offshore state waters;[904] offshore wells in U.S. federal waters are not covered.[905]

The Class VI Rule defines a carbon dioxide stream as "carbon dioxide that has been captured from an emission source (e.g., a power plant), plus incidental associated substances derived from the source materials and the capture process, and any substances added to the stream to enable or improve the injection process."[906]

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[899] U.S. Environmental Protection Agency, *Table: UIUC Primacy and Program Revision Applications: Class VI Wells Permitted by EPA* (Jan. 29, 2024), at https://perma.cc/T7R7-ZR93.

[900] Safe Drinking Water Act of 1974, 42 USC §§ 300h-9(c)(2).

[901] U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells Final Rule, *supra* note 802, at 77234.

[902] 40 CFR§144.3.

[903] *Id.*

[904] U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells Final Rule, *supra* note 802, at 77235. *See also Id.,* at 77258 (Mentioning offshore state wells only).

[905] *See* 40 CFR§144.3 and 40 CFR§144.1(2), which lists specific exclusions: "The following are not covered by these regulations: (i) Injection wells located on a drilling platform or other site that is beyond the State's territorial waters." *See also* U.S. Environmental Protection Agency, *Geologic Sequestration of Carbon Dioxide: Underground Injection Control (UIC) Program Class VI Implementation Manual for UIC Program Directors* (2018), 1, 3-9 and 3-10, at https://perma.cc/8DNN-TLPK.

[906] U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells Final Rule, *supra* note 802, at 77231. (Also codified at 40 CFR§146.81(d)). This definition specifically excludes any carbon dioxide stream that meets the definition of a hazardous waste under 40 CFR §261. These wastes are subject to the notification requirements under Section 3010 of the Resource Conservation and Recovery Act (RCRA). The next section discusses RCRA.

The technical requirements of the Class VI Rule include (a) permitting, which encompasses geologic site characterization, delineating the area of review where drinking waters may be endangered[907] and identifying corrective action,[908] and financial responsibility; (b) well construction; (c) operation, specifically mechanical integrity testing and monitoring; (d) well plugging; (e) post-injection site care; and (f) site closure.[909] New Class VI wells can only be authorized by permits,[910] and a permit can only be authorized if information about the sources of carbon dioxide stream and an analysis of the chemical and physical characteristics of this stream are provided to EPA.[911]

Under the Class VI Rule, information about the analysis of the carbon dioxide stream shall be provided to EPA before commencing the injection and throughout the injection process, including both the carbon dioxide source as well as the likelihood of variability in the injected composition.[912] The rule also requires that the carbon dioxide stream be analyzed with sufficient frequency to provide data on its chemical and physical characteristics, including fluid composition (such as the percentage of carbon dioxide and other constituents), temperature, and pressure, as well as additional parameters that may be used for understanding potential interactions between the stream and the storage site.[913]

In 2013, EPA issued specific guidance regarding the testing of carbon dioxide streams.[914] The guidance is not mandatory, and EPA reserved its discretion to depart from the guidance if needed.[915] Owners or operators are encouraged to consult with the UIC Program Director to establish a carbon dioxide stream characterization protocol that is designed to the specificities of their geologic storage project.[916]

In short, the guidance indicates that since carbon dioxide for geologic sequestration is likely to be transported and injected in the supercritical phase, samples may need to be extracted from the pipeline or wellhead with a valve and then allowed to decompress into a gaseous phase within a sample holder or other device for analysis. However, if these samples decompress to the gas phase for chemical analysis, the sample's temperature and

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[907] U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells Final Rule, *supra* note 802, at 77231.
[908] *Id.*
[909] *Id.*
[910] 40 CFR§146.81 and 146.82. Other classes of wells can also be authorized by rule. *See, e.g.,* 40 CFR§144.21(for well classes I, II, and III).
[911] U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells Final Rule, *supra* note 802, at 77293. Information about the carbon dioxide source is codified at 40 CFR §146.82(a)(7)(iii). The analysis of the carbon dioxide stream prior to commencing injection is codified at 40 CFR§146.82(a)(7)(iv); likewise, further monitoring is codified at 40 CFR§146.90(a), (b), (c), and (f).
[912] U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells Final Rule, *supra* note 802, at 77259–60.
[913] 40 CFR§146.90(a)-(d), specifically.
[914] U.S. Environmental Protection Agency, Geologic Sequestration of Carbon Dioxide: Underground Injection Program (UIP) Class VI Well Testing and Monitoring Guidance (Mar. 2013), at https://perma.cc/Y33G-EZ2N .
[915] *Id.* at 2.
[916] *Id.* at 30. (Noting that this protocol should be in the Testing and Monitoring Plan, which is detailed in 40 CFR§146.90)

pressure will also decrease, no longer representing conditions in the pipeline or as injected.[917] EPA therefore recommends that, whenever possible, the temperature and pressure measurements represent the *in situ* conditions at the injection point. Where not possible, samples may be allowed to decompress prior to analysis and standard methods may be used to calculate the chemical and physical properties at *in situ* pressure and temperature from the results of analysis of the decompressed samples.[918]

At the time of writing, EPA had not provided any additional details on requirements for testing carbon dioxide streams.[919] Underscoring that EPA's Class VI Rule was officially published without these details,[920] the U.S. Department of Energy (DOE) has summarized general tests used in previous injection projects.[921]

Having analyzed the current requirements of the carbon dioxide stream for capture and storage under the Class VI Rule, this subsection concludes that the SDWA and its Class VI Rule are unlikely to pose legal barriers for the import of carbon dioxide for injection and storage in the United States.

1.2.2 The Resource Conservation and Recovery Act (RCRA)

The Resource Conservation and Recovery Act, or RCRA, regulates the management of hazardous and non-hazardous solid waste. The act is notoriously complex. This subsection first outlines the principal definitions and regulatory scheme potentially applicable to carbon dioxide streams under RCRA. It proceeds to discuss RCRA and EPA's conditional exemption of carbon dioxide streams for permanent storage under RCRA's definition of "hazardous waste." This discussion is followed by an analysis of the main consequences of this conditional exemption for the cross-border transportation and storage of carbon dioxide.

1.2.2.1 RCRA definitions and regulations

Non-hazardous waste is regulated under subtitle D of RCRA. Hazardous waste, which has more onerous regulatory requirements, is covered in subtitle C.[922] Under subtitle C, hazardous waste generators must (among other things) keep records that accurately identify the hazardous wastes generated; properly label containers of waste for transportation, storage, treatment or disposal; use appropriate containers for storage; provide information regarding the composition of the hazardous waste; start the manifest system and use any other means necessary for tracking the hazardous waste from generation to a treatment, storage or disposal facility; and file reports with the EPA.[923]

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[917] U.S. Environmental Protection Agency, Geologic Sequestration of Carbon Dioxide: Underground Injection Program (UIP) Class VI Well Testing and Monitoring Guidance (Mar. 2013), *supra* note 914, at 30.
[918] *Id.*
[919] U.S. Environmental Protection Agency, Underground Injection Control Regulations, at https://perma.cc/737P-CZMR.
[920] U.S. Department of Energy, *Class VI injection permit: Salient features and regulatory challenges*, DOE 2 (2018), at https://perma.cc/GQF2-MEXS.
[921] *Id.* at 20 (For carbon dioxide purity, the DOE recommended the ISBT 2.0 Method, which is the same used in the food industry).
[922] Robin Kundis Craig, Environmental Law in Context 154–55 (2022).
[923] 42 USC § 6922 (a).

Further downstream in the supply chain, RCRA requires hazardous waste transporters to keep records of all hazardous waste transported from the source and their delivery points; transport hazardous waste only if properly labeled as "hazardous waste"; continue the manifest system initiated by the generators; and transport the hazardous waste exclusively to a treatment, storage or disposal facility determined in the manifest system.[924]

RCRA does not define "transporters."[925] However, the act does define "disposal" as "the discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground waters."[926] Under the act, storage "when used in connection with hazardous waste, means the containment of hazardous waste, either on a temporary basis or for a period of years, in such a manner as not to constitute disposal of such hazardous waste."[927]

In short, subtitle C of RCRA establishes a comprehensive "cradle to grave" regulatory scheme[928] for certain "solid wastes" that are also "hazardous wastes."[929] Importantly, RCRA defines "solid waste" as discarded material, including solid, liquid, semisolid, or contained gaseous material, among others.[930] The broad definition triggers relevant points for our analysis. First, some gaseous materials may qualify as solid waste under RCRA. Second, "solid waste" must be waste – in other words, discarded material.[931]

Under EPA regulations, generators of solid waste shall determine whether their wastes are "hazardous wastes."[932] A "solid waste" is considered a "hazardous waste" if it exhibits any of four characteristics of a

[924] 42 USC § 6923(a).
[925] *Id.*
[926] 42 USC § 6903(3).
[927] 42 USC § 6903(33).
[928] CRAIG, *supra* note 922, at 189–90.
[929] 42 USC § 6903(5) codified at 40 CFR 261.1. 42 USC § 6903(5) defines 'hazardous waste' as "a solid waste, or combination of solid wastes which because of its quantity, concentration, or physical, chemical, or infectious characteristics may—(A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed." In addition, 40 CFR 260.10 determines that the definition of "hazardous waste" can be found at 40 CFR 261.3. Importantly, to be considered "hazardous waste," a material must first be classified as a "solid waste" according to the regulations. 40 CFR 261.2. *See also* U.S. ENVIRONMENTAL PROTECTION AGENCY, CRITERIA FOR THE DEFINITION OF SOLID WASTE AND SOLID HAZARDOUS WASTE EXCLUSIONS (Jan. 26, 2023), at https://perma.cc/AG9H-DW7X.
[930] 42 USC § 6903 (27), conceptualizing "solid waste" as "any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under section 1342 of title 33, or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended (68 Stat. 923) [42 U.S.C 2001 et seq.]."
[931] CRAIG, *supra* note 922, at 122. EPA, when regulating under RCRA, provides for "solid waste" as needed to be "discarded material." 40 CFR 261.2.
[932] 40 CFR 262.11.

"hazardous waste" – ignitability, corrosivity, reactivity, or toxicity[933] – or is a listed waste under 40 CFR 261.30–.33, which lists several used chemical products, byproducts from specific industries, and unused commercial products.[934] Importantly, carbon dioxide streams are not themselves listed as "hazardous waste" under RCRA.[935]

1.2.2.2 RCRA conditional exemption for carbon dioxide streams into Class VI wells

Carbon dioxide may not be considered a hazardous waste under RCRA, unless it is contaminated by other substances that are RCRA hazardous wastes.[936] In 2014, EPA conditionally exempted carbon dioxide streams injected into UIC Class VI wells from the hazardous waste requirements in subtitle C of RCRA, so long as the agency finds that the waste "might pose a hazard only under limited management scenarios, and other regulatory programs already address such scenarios."[937]

Similar to EPA's definition in the Class VI Rule under the SDWA, the agency's current regulations under RCRA define a carbon dioxide stream as "carbon dioxide that has been captured from an emission source (e.g., power plant), plus incidental associated substances derived from the source materials and the capture process, and any substances added to the stream to enable or improve the injection process."[938]

In its 2014 exemption, EPA concluded that supercritical carbon dioxide injected into Class VI wells for geologic sequestration is a "solid waste" under RCRA.[939] EPA found that such streams are "discarded material" under the purview of RCRA, as the streams are injected underground for the purpose of isolating them from re-entry into the atmosphere.[940]

However, EPA decided to conditionally exclude carbon dioxide streams from the definition of hazardous waste, so long the streams are: (1) captured from emission sources; (2) transported in compliance with DOT requirements; (3) injected into UIC Class VI wells for purposes of geologic sequestration; and (4) not mixed with, or otherwise co-injected with, any other hazardous waste.[941]

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[933] 40 CFR 261.20–.24.

[934] U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells Final Rule, *supra* note 802, at 77260. (When issuing the Class VI Rule, EPA highlighted the definition of "hazardous waste" under RCRA).

[935] *Id.*

[936] *See, generally,* Craig, *supra* note 922, at 174. (Noting that underground storage of carbon dioxide seems to fall within the scope of RCRA, at first glance)

[937] *Id.* at 353.

[938] 40 CFR 260.10.

[939] U.S. Environmental Protection Agency, Hazardous Waste Management System: Conditional Exclusion for Carbon Dioxide (CO_2) Streams in Geologic Sequestration Activities, 79 Fed Reg 350, 352 (Jan. 3, 2014). This is the case, because carbon dioxide streams are within the scope of RCRA's definition of "solid waste." *Id.* at 355.

[940] *Id.* at 355.

[941] 40 CFR 261.4(h)(1)-(3).

Finally, the owner or operator of any UIC Class VI well that claims the exclusion must have an authorized representative[942] sign a certification attesting that the carbon dioxide has not been mixed with other hazardous wastes and complies with the requirements for UIC Class VI wells.[943]

1.2.2.3 Implications of the RCRA conditional exemption

The conditional exemption of carbon dioxide streams from hazardous waste regulations under RCRA requires a more detailed analysis of its scope and consequences. This analysis is organized into five main points.

First, it is a legal premise that regulatory exemptions are interpreted restrictively. As such, the conditional exemption will not apply to carbon dioxide streams that are disposed of by means other than injection into a Class VI well.[944] EPA highlighted that the requirements of UIC Class VI injection wells are specifically tailored to ensure that carbon dioxide streams (as well as "any incidental substances derived from the source materials and capture process") will be isolated within the injection zone.[945] The agency found that the permit requirements under the UIC Class VI wells will ensure protection, and that ultimately additional regulation under RCRA would be duplicative and therefore unnecessary.[946] Notably, because the exception only applies to carbon dioxide streams injected in UIC Class VI wells, it could not cover carbon dioxide injected on the OCS.

Second, it is worth noting that this conditional exemption was contentious,[947] with some stakeholders arguing that it should not even exist. In their view, carbon dioxide does not qualify as a hazardous waste to begin with, which means RCRA regulations do not apply; following this logic, an exemption for carbon dioxide streams is superfluous and inappropriate.[948] By contrast, other stakeholders were vocal about the risks of injecting hazardous waste underground, contending that UIC Class VI wells would not offer enough protection.

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[942] 40 CFR 260.10 defines authorized representative as "the person responsible for the overall operation of a facility or an operational unit (i.e., part of a facility), *e.g.*, the plant manager, superintendent or person of equivalent responsibility."

[943] 40 CFR 261.4(h)(4)(ii): "Any Class VI Underground Injection Control well owner or operator, who claims that a carbon dioxide stream is excluded under paragraph (h) of this section, must have an authorized representative (as defined in 40 CFR 260.10 sign a certification statement worded as follows: 'I certify under penalty of law that the carbon dioxide stream that I am claiming to be excluded under 40 CFR 261.4(h) has not been mixed with, or otherwise co-injected with, hazardous waste at the Underground Injection Control (UIC) Class VI permitted facility, and that injection of the carbon dioxide stream is in compliance with the applicable requirements for UIC Class VI wells, including the applicable requirements in 40 CFR Parts 144 and 146.'"

[944] Council on Environmental Quality (CEQ), *supra* note 869, at 60.

[945] U.S. Environmental Protection Agency, Hazardous Waste Management System: Conditional Exclusion for Carbon Dioxide (CO_2) Streams in Geologic Sequestration Activities, *supra* note 939, at 353 and 357.

[946] *Id.*

[947] Carbon Sequestration Council v. EPA 787 F. 3d 1129, 1132–33 (D.C. Cir. 2015) (Challenging the conditional exemption; the case was eventually dismissed on standing grounds).

[948] U.S. Environmental Protection Agency, Hazardous Waste Management System: Conditional Exclusion for Carbon Dioxide (CO_2) Streams in Geologic Sequestration Activities, *supra* note 939, at 355.

Ultimately, EPA determined that these wells did offer enough protection.[949] The agency also justified the application of RCRA to carbon dioxide streams based on the fact that, at that time, the agency could not unequivocally conclude that supercritical carbon dioxide streams could never exhibit any hazardous waste characteristic under RCRA.[950] EPA's rationale was as follows: because there are no "[h]azardous waste listings that apply to the supercritical CO_2 streams being considered here, a CO_2 stream could only be defined as a hazardous waste if it exhibits one or more of the hazardous waste characteristics as defined in 40 CFR part 261, subpart C."[951] The agency contended that the exemption was necessary due to "the early state of data development" in the field,[952] and committed to an adaptative approach for the analysis of both the exemption itself and to carbon capture and storage more generally.[953]

Third, the conditional exclusion of carbon dioxide streams from RCRA's hazardous waste definition triggers the need to consider the potential that additional hazardous wastes may eventually be mixed or co-injected in such streams. With that in mind, it is worth clarifying that EPA limited the exclusion to "hazardous waste,"[954] not "waste components" or other classifications. Furthermore, throughout RCRA's regulations, detailed substances and percentages are specified.[955] If regulators had wanted to depart from this standard practice, they would have done so.

Fourth, EPA underscored that the conditional exemption would provide additional regulatory certainty by significantly reducing uncertainty associated with identifying the carbon dioxide streams for permanent storage under RCRA subtitle C. EPA argued that the exemption could facilitate the deployment of geologic sequestration activities.[956] According to the agency, generators of non-hazardous waste carbon dioxide streams are not subject to RCRA subtitle C regulations, and are therefore not required to use the conditional exemption.[957] However, the agency also noted that generators may want to use the conditional exemption if uncertain about the hazardous waste status of their carbon dioxide stream. Ultimately, if EPA was aiming to bring certainty, the agency would have specified threshold, percentages and/or sources of carbon dioxide streams.

In its attempt to enhance certainty, EPA clarified that "incidental associated substances" are "other substances captured together with the carbon dioxide from a gas stream,"[958] and the numerical values addressed in the proposed rule's preamble are merely examples.[959] Importantly, EPA emphasized that the definitions under RCRA

[949] *Id.* at 356.
[950] *Id.*
[951] *Id.* at 355.
[952] *Id.* at 355–56.
[953] *Id.* at 359–60.
[954] 40 CFR 261.4(h)(3).
[955] *See, e.g.,* 40 CFR 261.4(a)21(i)(A) (Specifically detailing in a table the contaminant limits for zinc fertilizers).
[956] U.S. Environmental Protection Agency, Hazardous Waste Management System: Conditional Exclusion for Carbon Dioxide (CO_2) Streams in Geologic Sequestration Activities, *supra* note 939, at 352. (Some stakeholders disagreed, arguing that the conditional exemption would lead to uncertainty. *Id.* at 360).
[957] *Id.* at 356.
[958] *Id.* at 359.
[959] *Id.* at 359. For the preamble of the proposed rule: 76 Fed Reg 152, 48079 (Aug. 8, 2011), at https://perma.cc/2WD3-MM5J.

and UIC Class VI wells needed to be consistent; any addition of substances to the carbon dioxide stream to enable or improve the injection process will be part of the permitting process of UIC Class VI wells, and will already be regulated under the Class VI rule.[960]

Lastly, should hazardous waste be mixed with the carbon dioxide stream, this stream not only is ineligible for the conditional exclusion, but also will need to be managed as an RCRA hazardous waste. If well injection were the means for disposal, it would need to be injected into a UIC Class I hazardous well.[961]

In conclusion, it is unlikely that substances routinely used in the injection process will trigger additional protection required under the "hazardous waste" classification under RCRA and the currently applicable regulatory scheme.

1.2.3 The Outer Continental Shelf Lands Act (OCSLA)

The Outer Continental Shelf Lands Act (OCSLA)[962] was enacted in 1953, placing the administration of mineral exploration under the outer continental shelf (OCS) within the purview of the Secretary of Interior.[963] The Bureau of Ocean Energy Management (BOEM)—formerly the Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE) and, before that, the Minerals Management Service (MMS)—is the agency within the Department of the Interior that administers OCSLA.[964]

OCSLA defines the OCS as "all submerged lands lying seaward and outside of the area of lands beneath navigable waters . . . and of which the subsoil and seabed appertain to the United States."[965] According to OCSLA, the subsoil and seabed of the OCS belong to the United States and are subject to its jurisdiction, control, and power of disposition.[966]

As previously stated in Chapter 3, the United States OCS includes the area beyond state jurisdiction out to 200 nautical miles (nm) from shore, with state jurisdiction over the seafloor extending out to 3 nm seaward of the baseline from which the breadth of the territorial sea is measured.[967] For context, one nautical mile spans approximately 6076 feet. There are three exceptions to how states establish jurisdiction over their territorial seas. Texas and the Florida Gulf Coast extend their jurisdiction out to 9 nautical miles, and Louisiana extends its

[960] U.S. Environmental Protection Agency, Hazardous Waste Management System: Conditional Exclusion for Carbon Dioxide (CO_2) Streams in Geologic Sequestration Activities, *supra* note 939, at 359.
[961] *Id.* at 353.
[962] 43 USC §1301.
[963] Bureau of Ocean Energy Management (BOEM), *OCS Lands Act History*, at https://perma.cc/CKG3-FKDS.
[964] In 2011, the Obama administration created BOEM, as an agency to streamline offshore energy sources. Department of Interior (DOI), *Interior Department Completes the Reorganization of the Former MMS* (Sep. 30, 2011), at https://perma.cc/FR2G-JAUL.
[965] 43 USC §1331(a), providing that "the term 'outer Continental Shelf' means all submerged lands lying seaward and outside of the area of lands beneath navigable waters as defined in section 2 of the Submerged Lands Act (Public Law 31, Eighty-third Congress, first session), and of which the subsoil and seabed appertain to the United States and are subject to its jurisdiction and control."
[966] 43 USC §1332(1).
[967] 43 USC §1301(a). *See also* BOEM, Outer Continental Shelf, *infra*.

jurisdiction out 3 U.S. nautical miles seaward of the baseline from which the breadth of the territorial sea is measured.[968] The U.S. nautical mile is slightly longer, spanning approximately 6080 feet.

OCSLA initially focused on enabling mineral development regarding the exploration, development, and production of minerals from the OCS.[969] These concepts are defined in OCSLA, and they did not address permanent storage of carbon dioxide.[970]

Prior to enactment of the IIJA,[971] BOEM could only issue leases for projects involving the storage of carbon dioxide captured at coal fired power plants. After the IIJA, BOEM can now issue leases for the storage of any carbon dioxide that has been "captured" regardless of where it was sourced, provided certain purity requirements are met.[972] Considerations for meeting these purity requirements are examined below.

In the IIJA, Congress amended OCSLA to add a definition of "carbon dioxide stream."[973] The term is defined as follows: "carbon dioxide that—(A) has been captured; and (B) consists overwhelmingly of—(i) carbon dioxide plus incidental associated substances derived from the source material or capture process; and (ii) any substances added to the stream for the purpose of enabling or improving the injection process."[974] The act specifically excludes additional waste or other matter added to the carbon dioxide stream for the purpose of disposal from this definition.[975]

[968] U.S. Department of the Interior: Bureau of Ocean Energy Management (BOEM), Outer Continental Shelf, at https://perma.cc/HT69-E5S8. *See also* US Department of the Interior: Bureau of Ocean Energy Management, *Gulf of Mexico OCS Region* (2023), at https://perma.cc/XRM8-FQH9. (Highlighting that the OCS includes the Gulf of Mexico).

[969] 43 USC §1332(4).

[970] 43 USC §1301 (k), providing that: "The term 'exploration' means the process of searching for minerals, including (1) geophysical surveys where magnetic, gravity, seismic, or other systems are used to detect or imply the presence of such minerals, and (2) any drilling, whether on or off known geological structures, including the drilling of a well in which a discovery of oil or natural gas in paying quantities is made and the drilling of any additional delineation well after such discovery which is needed to delineate any reservoir and to enable the lessee to determine whether to proceed with development and production; (l) The term 'development' means those activities which take place following discovery of minerals in paying quantities, including geophysical activity, drilling, platform construction, and operation of all onshore support facilities, and which are for the purpose of ultimately producing the minerals discovered; (m) The term 'production' means those activities which take place after the successful completion of any means for the removal of minerals, including such removal, field operations, transfer of minerals to shore, operation monitoring, maintenance, and work-over drilling."

[971] The Infrastructure Investment and Jobs Act, Pub. L. No. 117-58, §§40306, 40307 (2021).

[972] *See* Romany Webb, *Carbon Storage in the New Bipartisan Infrastructure Bill*, CLIMATE LAW BLOG (Aug. 10, 2021), at https://perma.cc/JJK5-7P7Y.

[973] 135 Stat. 1003, 1033 (Nov. 15, 2021); Pub. L. 117—169, 40307(a)1(2021) (The IIJA).

[974] 43 USC §1331 r (1).

[975] 43 USC §1331 r (2).

Under OCSLA (as amended by the IIJA), carbon sequestration is defined as "the act of storing carbon dioxide that has been removed from the atmosphere or captured through physical, chemical, or biological processes that can prevent the carbon dioxide from reaching the atmosphere."[976]

OCSLA currently provides that the Secretary of Interior may issue leases, easements, or right-of-way for activities that "provide for, support, or are directly related to the injection of a carbon dioxide stream into sub-seabed geologic formations for the purpose of long-term carbon sequestration."[977] No further details or specifications are mentioned. Technically, this requirement to obtain a lease is a result of the fact that the U.S. federal government controls the OCS;[978] if a private party wants to use the OCS, it needs the approval of the federal government. Case law highlights this necessity.[979]

OCSLA has not yet been used to authorize permanent carbon dioxide storage.[980] After all, the explicit authority to issue leases for offshore carbon storage is still brand new. In any event, given the trend of current specific regulatory changes to enable and boost carbon dioxide storage, it is very unlikely that this statute will pose constraints on the import of carbon dioxide streams for permanent storage, especially when it comes to regulating purity levels of the stream and its sources.

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[976] 43 USC §1331 s.

[977] 43 USC §1337 p (1), which determines that: "In general: The Secretary, in consultation with the Secretary of the Department in which the Coast Guard is operating and other relevant departments and agencies of the Federal Government, may grant a lease, easement, or right-of-way on the Outer Continental Shelf for activities not otherwise authorized in this subchapter, the Deepwater Port Act of 1974 (33 U.S.C. 1501 et seq.), the Ocean Thermal Energy Conversion Act of 1980 (42 U.S.C. 9101 et seq.), or other applicable law, if those activities . . . (E) provide for, support, or are directly related to the injection of a carbon dioxide stream into sub-seabed geologic formations for the purpose of long-term carbon sequestration."

[978] 43 USC §1337.

[979] *See, e.g., Ensco Offshore Co. v. Salazar,* No. 10-1941, 2011 U.S. Dist. LEXIS 96652 (E.D. La. Aug. 29, 2011) (The Court agreed with the previous decision holding that "[t]he requirements the Outer Continental Shelf Lands Act (OCSLA), 43 U.S.C. §§ 1331 et seq., together with the Administrative Procedure Act, establishes a nondiscretionary duty on the Department of the Interior to act on OCSLA drilling permit applications within a reasonable." *Id.* at 4). In a similar vein, *Mobil Oil Exploration & Producing Southeast v. United States,* 530 U.S. 604, 609 (2020) (Noting that "the companies received exploration and development permission in accordance with procedures set out in, *inter alia,* the Outer Continental Shelf Lands Act (OCSLA), the Coastal Zone Management Act of 1972 (CZMA), and regulations promulgated pursuant to those Acts. OCSLA, among other things, requires the Department of the Interior to approve a company's Plan of Exploration (Plan) within 30 days of its submission if the Plan meets certain criteria."); and *Ctr. for Biological Diversity v. Haaland*, No. 2:22-cv-06996-CAS-KSx, 2023 U.S. Dist. LEXIS 68791 (C.D. Cal. Apr. 17, 2023) (Holding that: "OCSLA establishes a framework under which the Secretary of the Interior may lease areas of the outer continental shelf ("OCS") for purposes of exploring and developing the oil and gas deposits of submerged land. 43 U.S.C. §§ 1131-1356b. There is a four-stage process for the development of offshore oil and gas resources: (1) formulation of a five-year leasing plan by the Department of the Interior; (2) lease sales; (3) exploration by the lessees; and (4) development and production." *But cf. Friends of the Earth v. Haaland,* 583 F. Supp. 3d 113, 126 (2022), holding that: "And although OCSLA's primary purpose is development of the Outer Continental Shelf, 'OCSLA does not mandate the approval of every proposed lease sale.' *Gulf Restoration Network v. Bernhardt*, 456 F. Supp. 3d 81, 97 (D.D.C. 2020)." *See also State of Cal. ex rel. Brown*, 712 F.2d at 588. (Stating that: "While an area excluded from the [Five-Year] leasing program cannot be leased, explored, or developed, an area included in the program may be excluded at a later stage.").

[980] Council on Environmental Quality (CEQ), *supra* note 869, at 32. (Until 2021, OSCLA has never been used for permanent storage of carbon dioxide streams).

Finally, additional guidance from BOEM on how it will exercise its new leasing authority for storage would be welcomed. According to the IIJA, BOEM was supposed to have issued regulations clarifying this authority "not later than 1 year after the date of enactment of this act;"[981] though the date of enactment was November 15, 2021, as of this writing, this has yet to occur.[982]

1.3. Summary of main findings

While there is no comprehensive domestic legal framework regulating the cross-border transportation of carbon dioxide for permanent storage in the United States, the 2021 amendments under IIJA were consequential for closing previous gaps regarding permanent storage of carbon dioxide. All the federal statutes and related regulations researched here – MPRSA, HMTA, APPS, SDWA, RCRA, and OCSLA – are unlikely to impose legal barriers for the import of carbon dioxide for permanent injection and storage in the United States. This is primarily the case because most of these acts do not impose additional requirements beyond those currently in place under international law which are mainly concerned with the purity levels of the carbon dioxide stream for storage and its sources. While the SDWA and RCRA include additional requirements, EPA emphasized that the definitions under RCRA and UIC Class VI wells needed to be consistent and any addition of substances to the carbon dioxide stream to enable or improve the injection process will be part of the permitting process of SDWA's UIC Class VI wells and will already be regulated under the Class VI rule.[983] Ultimately, it is unlikely that substances routinely used in the injection process will trigger additional protection required under the "hazardous waste" classification under RCRA and the currently applicable regulatory scheme.

2. Current state regulations

Section 2 of this chapter outlines state laws that may pose a challenge for the import of carbon dioxide streams, to the extent that state laws may impose additional requirements for transport and permanent storage of carbon dioxide streams. Details about storage, property rights, liability rules, monitoring, carbon dioxide migration under the subsurface, leakage, and related topics are beyond of the scope of this review.[984] It is worth highlighting that no state has developed a comprehensive legal framework to regulate carbon dioxide sequestration, which leaves the country with a patchwork system of different and incomplete rules of ownership and liability.[985]

The design of our research targets U.S. states that are a probable destination of carbon dioxide for permanent storage – Texas and Louisiana. That said, there is no best area for carbon sequestration in general. In the United

[981] The Infrastructure Investment and Jobs Act, Pub. L. No. 117-58, §40307 (d) (2021).
[982] U.S. Department of Interior: Bureau of Ocean Energy Management (BOEM), Carbon Sequestration, at https://perma.cc/X5LR-JBY2.
[983] U.S. Environmental Protection Agency, Hazardous Waste Management System: Conditional Exclusion for Carbon Dioxide (CO_2) Streams in Geologic Sequestration Activities, *supra* note 939, at 359.
[984] A thorough analysis regarding the connections among these issues is provided in Owen Anderson, *Geologic Sequestration in the United States of America, in* Carbon Capture and Storage in International Energy Policy and Law 43, 47 (Hirdan Katarina de M. Costa & Carolina Arlota eds., 2021).
[985] Gerrard & Gundlach, *supra* note 834, at 110.

States, the area with the most carbon dioxide storage potential is the Coastal Plains region, specifically in the coastal basins from Texas to Georgia.[986] This area accounts for 2,000 metric gigatons (65 percent) of the storage potential.[987]

This section is divided into three subsections. Subsection 2.1 begins with an analysis of state authority regarding permanent storage of carbon dioxide. Subsection 2.2 is devoted to the analysis of pertinent intrastate pipeline regulations. Both subsections study the state legislations of North Dakota and Wyoming, which have primacy authority, as well as the efforts to establish primacy by Louisiana and Texas, which are especially likely to import carbon dioxide for storage. Finally, Subsection 2.3 concludes.

2.1 Carbon dioxide storage

With the exception of North Dakota and Wyoming, the legal regime applicable to permanent carbon dioxide injection and storage is currently centralized in the federal level, as the EPA regulates and administers all UIC Class VI Rule wells in all other states. However, Texas is in the process of attempting to obtain primacy over Class VI wells, while Louisiana obtained its approval late in December 2023.[988]

This subsection starts with an overview about the Class VI Rule and primacy conceptualization, examining current developments in Texas and Louisiana. It then compares existing North Dakota and Wyoming Class VI rules. This subsection concludes with an assessment of future regimes regarding primacy rules.

2.1.1 Primacy under the Class VI Rule

As discussed in subsections 1.2.1.2 and 1.2.1.3 of this chapter, EPA's UIC Class VI Rule establishes the minimum federal requirements for the injection and storage of carbon dioxide to protect underground sources of drinking water from endangerment.[989] States may apply for primary enforcement authority, or primacy, with respect to Class VI wells. As previously examined, states seeking primacy for Class VI wells must show EPA that the state has jurisdiction over underground injection; that the state meets EPA's minimum requirements for UIC program; and the applicant state has the necessary administrative, civil and criminal enforcement penalty remedies.[990] In the absence of state primacy, EPA is mandated to implement the federal UIC program.[991]

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[986] U.S. Geological Survey, *Frequently asked questions: Which area is the best for geologic carbon sequestration?* (2020), at https://perma.cc/RP3C-SLUG.
[987] *Id.* (Underscoring that other promising areas are in Alaska and the Rocky Mountains-Northern Great Plains).
[988] U.S. Environmental Protection Agency, State of Louisiana Underground Injection Control Program; Class VI Primacy, 89 Fed Reg 703, 703 et seq (Jan. 5, 2024), at https://perma.cc/VNF7-VDCJ.
[989] U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells Final Rule, *supra* note 802, 77234.
[990] *Id. See also* the Safe Drinking Water Act of 1974, 42 USC §§ 300h-1.
[991] 42 U.S.C. § 300h(b)(4).

The delays involved in EPA's approval for Class VI wells have been repeatedly pointed out as jeopardizing the development of CCS in the country.[992] To date, EPA has only issued permits for two projects, both in Illinois.[993] State developers in Texas and Louisiana currently have project applications for permits of Class VI wells with EPA.[994] In 2022, North Dakota, which has primacy under UIC Class VI well program, issued three carbon dioxide injection permits for geologic sequestration.[995] Therefore, only four carbon dioxide storage projects – two under EPA and two in North Dakota – have been licensed so far. By contrast, there are over 119,500 enhanced oil recovery wells in the United States, predominantly in California, Texas, Kansas, Illinois, and Oklahoma.[996]

Unsurprisingly, state primacy is experiencing increasing momentum despite delays in the review process. EPA's process for delegating state primacy is comprehensive and includes five stages: pre-application activities, completeness determination, application evaluation, rulemaking and codification, and, finally, application approved.[997]

2.1.2 Primacy efforts: Louisiana and Texas

Currently, Louisiana and Texas have primacy for all UIC wells, except UIC Class VI.[998] Both have recently applied for primacy for UIC Class VI wells.[999]

In June 2021, House Bill n.1284 was introduced in the Texas state legislature. The bill would grant the Texas Railroad Commission exclusive jurisdiction over carbon sequestration wells, including offshore carbon storage in state waters.[1000] Since this jurisdiction had previously been shared with the Commission on Environmental Quality, the centralization of authority would likely expedite Texas' primacy application.[1001] As of this writing, this bill has not been enacted. On May 3, 2022, the Railroad Commission approved submission to EPA of a pre-application for Class VI wells, formally requesting that the governor ask EPA for a Class VI UIC well program

[992] *See, e.g.,* Gabriel Pacyniak*, Can We Just Bury It?: Towards Climate and Equity Principles for Carbon Sequestration After the Inflation Reduction Act,* 14 San Diego J. Climate & Energy L. 95, 138–40 (2023).
[993] U.S. Environmental Protection Agency, Table VI: Class VI Wells Permitted by EPA (Nov. 27, 2023), at https://perma.cc/3P3A-2ZN9.
[994] U.S. Environmental Protection Agency, Class VI Wells Permitted by EPA (Feb. 20, 2024), at https://perma.cc/UZ3C-4EQW.
[995] North Dakota, Class VI Geologic Sequestration Wells in North Dakota, at https://perma.cc/HMF3-XM3E.
[996] Angela C. Jones & Ashley J. Lawson, *Carbon Capture and Sequestration (CCS) in the United States: Report 44902*, Congressional Research Service, 1, 23 (Oct. 5, 2022), at https://perma.cc/25XV-QAAM.
[997] U.S. Environmental Protection Agency, Primacy Enforcement Activity for the Underground Injection Program (Aug. 18, 2022), at https://perma.cc/7S39-HC8A.
[998] *Id.*
[999] *Id.*
[1000] Texas House Bill 1284, at https://perma.cc/3H3H-68VM. On March 3, 2023, the bill was referred to Pensions, Investment & Financial Services committee. *See* HB 1284, Texas House Bill, at https://perma.cc/C2ZA-FVUA.
[1001] Lauren A. Batchel et al., *Carbon Capture, Utilization, and Storage: Class VI Wells and US State Primacy*, Mayer Brown, at https://perma.cc/JDY6-9BH5.

approval.[1002] According to primacy under the Class VI Rule, the state governor has to formally submit an application letter requesting approval for the UIC program.[1003]

EPA's website currently lists Texas as within the "pre-application activities," or the first stage of the application process.[1004] Texas primacy application has been engulfed in controversies. Two Democratic members of the U.S. House of Representatives from Texas stated in a recent letter to the EPA's administrator that the Texas Railroad Commission has a reputation of not championing environmental justice considerations.[1005] Meanwhile, EPA has issued an advisory guidance specifically addressing these considerations in the Rule VI's context.[1006] In any case, the application review process is expected to last at least two years.[1007]

Louisiana, meanwhile, has recently been granted Class VI well primacy.[1008] Under the state's legal framework, the source of the carbon stream as well as the analysis of the chemical and physical characteristics must be provided, but no specific requirements of this analysis are determined.[1009] EPA's rule on primacy for Louisiana has just been approved.[1010]

2.1.3 Primacy examples: North Dakota and Wyoming

Both North Dakota and Wyoming – the only two states that currently have primacy for Class VI wells – opted to not impose additional purity requirements or limitations on the sources of carbon dioxide streams. While a detailed analysis of North Dakota and Wyoming's experiences regulating injection and storage of carbon dioxide is outside the scope of this project, a few comparisons may be illustrative for future developments of state legislation elsewhere.

[1002] *Id.*

[1003] U.S. Environmental Protection Agency, Primary Enforcement Authority for the Underground Injection Control Program, at https://perma.cc/T5ZU-9YH2. (As of this writing, the governor of Texas does not appear to have submitted this request).

[1004] U.S. Environmental Protection Agency, Table: UIUC Primacy and Program Revision Applications: Class VI Wells Permitted by EPA (Jan. 29, 2024), at https://perma.cc/QG59-FTBQ.

[1005] Lloyd Doggett & Joaquin Castro, Castro-Doggett EPA Letter (Jul. 14, 2023) at https://perma.cc/972G-N6VD. (Contending that: "The Commission has a history of waiving its own rules and regulations to favor oil and gas companies over health and environmental protection standards."). *See also* Practical Law Oil and Gas, *Texas Railroad Commission Proposes Additional Amendments to Carbon Storage Rules*, Thomson Reuters Practical Law (Jun. 15, 2023).

[1006] U.S. Environmental Protection Agency, Memorandum: Environmental Justice Guidance for UIC Class VI Permitting and Primacy (Aug. 17, 2023), at https://perma.cc/F7GK-C96T.

[1007] Simon Willis et al, *Texas Crawls Towards Primacy for CCS Permits,* Vinson & Elkins LLP (Sep. 21, 2023), at https://perma.cc/7UUM-PDP4.

[1008] U.S. Environmental Protection Agency, Table: UIUC Primacy and Program Revision Applications: Class VI Wells Permitted by EPA, *supra* note 1004.

[1009] Louisiana Statewide Order N. 29-N-6 §3607f (iii) and (iv), respectively. *See* Title 43, Natural Resources, Part XVII, Injection and Mining, at https://perma.cc/8KRB-LG5N.

[1010] U.S. Environmental Protection Agency, State of Louisiana Underground Injection Control Program; Class VI Primacy (Dec. 28, 2023), at https://perma.cc/9CBQ-L45L.

Under North Dakota's state Class VI wells program' law, the applicable definition for carbon dioxide is as follows: "carbon dioxide produced by anthropogenic sources which is of such purity and quality that it will not compromise the safety of geologic storage and will not compromise those properties of a storage reservoir which allow the reservoir to effectively enclose and contain a stored gas."[1011] It is telling, perhaps, that the state's statute highlighted in the policy justifications for the law that carbon dioxide is a valuable commodity.[1012] In this statute, environmental protection is listed alongside reservoir integrity.[1013] There are no specifications regarding sources or purity levels of the carbon dioxide stream.[1014]

By contrast, Wyoming's underground storage program presents a more nuanced definition: "'Carbon dioxide stream' means carbon dioxide, plus associated substances derived from the source materials and any processing, and any substances added to the stream to enable or improve the injection process. Within this Chapter, the term 'carbon dioxide stream' does not include any carbon dioxide stream that meets the definition of a hazardous waste under 40 C.F.R. §261.3,"[1015] referring to the federal regulation that defines "hazardous waste" under the RCRA. Several provisions in the state's law mention that the source and properties of the injected carbon dioxide shall be informed in the permit process.[1016] The permit application specifically requires analysis of the carbon dioxide stream.[1017] To fulfill construction requirements, information about corrosiveness as well as the chemical composition shall be provided so the administrator can determine the construction requirements for the well.

2.1.4 Summary of state storage regulations

Given the current experiences in North Dakota and Wyoming regarding the regulation of Class VI wells, it seems unlikely that future state Class VI Rules will depart from practice and impose additional requirements regarding

[1011] North Dakota Century Code, 38-22-02, at https://perma.cc/9RU8-6XAH. (Stating that: "Environmental protection - Reservoir integrity. (1) The commission shall take action to ensure that a storage facility does not cause pollution or create a nuisance. For the purposes of this provision and in applying other laws, carbon dioxide stored, and which remains in storage under a commission permit, is not a pollutant nor does it constitute a nuisance. . . (3) The commission shall take action to ensure that substances that compromise the objectives of this chapter or the integrity of a storage reservoir do not enter a storage reservoir.").

[1012] *Id.* at 38-22-01, providing as follows: "It is in the public interest to promote the geologic storage of carbon dioxide. Doing so will benefit the state and the global environment by reducing greenhouse gas emissions. Doing so will help ensure the viability of the state's coal and power industries, to the economic benefit of North Dakota and its citizens. Further, geologic storage of carbon dioxide, a potentially valuable *commodity*, may allow for its ready availability if needed for commercial, industrial, or other uses, including enhanced recovery of oil, gas, and other minerals." (emphasis added).

[1013] *Id.*, at 38-22-02.

[1014] *Id.*, at 38-22-08, providing that: "Before issuing a permit, the commission shall find: "(3)That the carbon dioxide to be stored is of a quality that allows it to be safely and efficiently stored in the storage reservoir; . . . (9)That substances that compromise the objectives of this chapter or the integrity of a storage reservoir will not enter a storage reservoir. . . . (10) That the storage facility will not endanger human health nor unduly endanger the environment."

[1015] Wyo. Code R. § 29-2 (Adopted and effective Aug. 19, 2022), at https://perma.cc/PZ8V-7AWW.

[1016] *Id*. at §3.

[1017] *Id*. at §10.

the source and purity levels of the carbon dioxide. While our sample is admittedly limited to the only two states that currently have primacy for Class VI wells, the Louisiana and Texas proposals do not yet indicate any additional requirements. It would be surprising if Louisiana and Texas change course and decide to include these specifications, departing from current legislative trends in North Dakota and Wyoming.

After all, there may be some competition to store carbon dioxide in the future. Considering the policy approach to treat carbon dioxide as a "valuable commodity" – as explicitly signaled in the North Dakota Class VI law – this kind of interstate market competition is not farfetched. Carbon dioxide may be treated as a commodity based on several interests, including enhanced oil recovery (which runs counter the GHG goals, as discussed in Chapter 2), the revenue that the disposal and/ or storage facilities may receive, benefits from green marketing, among others. Therefore, states may be using CCS as to accommodate their oil and gas industry; they may also be competing to become "storage magnets" for carbon dioxide storage. In any event, both scenarios appear to encourage CCS, which might lead to less rather than more stringent requirements. Ultimately, current incentives for states are unlikely to add requirements, but rather reduce barriers to entry.

2.2 Carbon dioxide transportation by pipeline

As addressed in section 1.1.2.2, only the PHMSA has federal regulatory authority over pipelines carrying carbon dioxide.[1018] Assuming compliance with minimum federal requirements,[1019] intra-state pipeline safety is further regulated at the state level.[1020] Based on the potential interest in storage, this section surveys both the Louisiana and Texas[1021] state legislation to examine if either of them include specifications referring to purity levels or sources of the carbon dioxide stream.

2.2.1 Louisiana

[1018] Gerrard & Gundlach, *supra* note 834, 108–9 (Explaining that the Federal Energy Regulatory Commission, the Surface Transportation Board, and the Office of Pipeline Safety in the Department of Transportation's PHMSA regulate the siting, economics, and safety of several interstate pipelines in the country).

[1019] State regulations must be at least as strong as the federal regulations. The research in this report indicates that the following provisions of PHSMA are often incorporated in state legislation: 49 CFR 190–95 (Pipeline Safety Programs and Rulemaking Procedures; Transportation of Natural Gas and Other Gas by Pipeline; Annual Reports, Incident Reports, and Safety-Related Condition; Reports; Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards; Liquefied Natural Gas Facilities: Federal Safety Standards Response Plans for Onshore Oil Pipelines Transportation of Hazardous Liquids by Pipeline) and 49 CFR 199 (Drug and Alcohol Testing).

[1020] Gerrard & Gundlach, *supra* note 834, 109.

[1021] Additional information about specific state rules on carbon dioxide utilization and storage (CCUS) is available at the CCUS Legislative Tracker, launched on March 15, 2023, by the Sabin Center for Climate Change Law and Arnold &Porter, at https://perma.cc/L827-P2AR.

The Louisiana Rule defines carbon dioxide as "a fluid consisting of more than 90 percent carbon dioxide molecules compressed to a supercritical state."[1022] The rule also incorporates the federal PHMSA standards.[1023] Extra requirements for safety include records, corrosion analysis, training, and notification; however, they all refer back to the federal regulation.[1024] A careful reading of the rule yielded no results regarding specifications of the carbon dioxide stream or its sources. Likewise, research of additional state statutes led to no different results.[1025]

2.2.2 Texas

The Texas Administrative Code regulates the "intrastate pipeline transportation of hazardous liquids or carbon dioxide and all intrastate pipeline facilities as provided in 49 U.S.C. §§60101, et seq.; and Texas Natural Resources Code, §117.011 and §117.012."[1026] By explicit reference, this code incorporates all federal standards for the transportation of hazardous liquid or carbon dioxide.[1027] Additional requirements exist for records and reporting, corrosion control requirements, education and liaison, and locations located within 1,000 feet from public school buildings or facilities.[1028] After researching additional state legislation,[1029] no further requirements for carbon dioxide streams or its sources were found.

2.2.3 Summary of state transportation considerations

The research into state legislative and regulatory requirements for pipeline transport of carbon dioxide for storage indicate that no additional requirements have been imposed with respect to purity levels of the carbon stream and its sources.

3. Conclusion

This chapter concludes that, in the absence of a single federal framework on carbon dioxide transportation and storage, the IIJA was consequential for filling previous regulatory gaps, implementing several federal statutory amendments and regulatory changes to enable carbon capture and permanent storage. These findings are consistent with previous studies that underscore the existing federal regulatory trend aiming to facilitate carbon

[1022] Louisiana Hazardous Liquid Rule, §30105, at https://perma.cc/M2MT-2HD9.
[1023] *Id.* at § 30109 (citing 49 CFR 195.4, *i.e.*, the PHSMA); § 30114 (citing 49 CFR 195.8).
[1024] *Id.* at § 30109 et seq (every subsection of the rule cites to the specific provision under the PHSMA).
[1025] *See* 6 Environmental Law Practice Guide § 60.12 (2023); for injection wells, *see* 6 Environmental Law Practice Guide § 60.14 (2023) (For a discussion on hazardous waste).
[1026] Tex. Adm. Code, Rule 8.1(a)1(C), at https://perma.cc/F7Y6-W4S2.
[1027] Tex. Adm. Code, Rule 8.1(a)2.
[1028] Tex. Adm. Code, Rules 8.301; 8.305; 8.310; 8.315, respectively.
[1029] Tex. Nat. Res. Code § 86.002; 16 Texas Adm. Code Rule 3.70 (pipeline permits); Rule 3.9 (disposal wells); Environmental Law Practice Guide § 86.16 (2023).

dioxide use and storage.[1030] This trend is particularly visible in both the transportation and storage stages of the CCS chain. Overall, the United States is trending towards excluding carbon dioxide for capture, transport, and permanent storage from regulatory frameworks applicable to waste and pollutants.[1031]

Section 1 analyzed the federal statues potentially applicable to cross-border transportation of carbon dioxide for permanent storage in the United States, including: MPRSA, HMTA, APPS, SDWA, the RCRA, and OCSLA.

Our analysis determined that MPRSA, the APPS, and OCLSA do not pose barriers for transportation and storage projects. Current PHMSA regulations, adopted pursuant to HMTA, do not impose additional constraints on the import of carbon dioxide; they do not require specific purity levels of the carbon stream beyond the ordinary 90 percent purity level for transportation of carbon dioxide, nor do they impose extra requirements for the source of the carbon dioxide. As for RCRA, EPA's 2014 conditional exclusion of carbon dioxide streams for injection from the act's definition of hazardous waste provides, in practice, for the permanent storage of carbon dioxide stream so long as Class VI requirements are met, as carbon dioxide that is stored in Class VI wells is not considered hazardous waste and so is not subject to the requirements of subtitle C of RCRA.

Unless additional hazardous wastes were injected into these streams beyond the chemicals that are ordinarily present, it is improbable that these streams would be classified as "hazardous waste" under RCRA. Finally, under the SDWA, EPA's 2010 Class VI Rule created a new class of wells for the express purpose of injecting carbon dioxide into geologic formations for long-term storage. Our research on the SDWA and its Class VI Rule concludes that the current legislative framework does not appear to impose legal barriers for the import of carbon dioxide for permanent injection and storage in the United States.

At the state level, the research in Section 2 indicates that the current examples of state regulations of Class VI wells do not impose additional requirements for the source and purity levels of the carbon dioxide. Current Louisiana and Texas proposals for Class VI primacy do not indicate an interest in any of those additional requirements.

In conclusion, the current U.S. legal framework does not appear to impose additional restrictions on sources or purity level standards of the carbon dioxide streams to be transported and stored. Accordingly, the country's regulatory framework is unlikely to pose obstacles to the import of carbon dioxide streams for permanent storage, provided the stream is not mixed with hazardous substance.

[1030] Council on Environmental Quality, Council on Environmental Quality Carbon Capture, Utilization, and Sequestration Guidance, 87 Fed. Reg. 8808, 8809 (Feb. 16, 2022), at https://perma.cc/LX6S-7484. (Recommending expedited procedures).
[1031] International Energy Agency, Legal and Regulatory Frameworks for CCUS: An IEA CCUS Handbook, 34 IEA (Jul. 2022).

CHAPTER 6: NEPA REVIEW AND PRACTICAL INQUIRIES

This chapter builds upon the analysis from the previous chapter (Chapter 5) that reviewed relevant U.S. federal and state laws applicable to the transportation and geologic storage of carbon dioxide. While Chapter 5 focused on federal and state legislation, it notably excluded a full analysis of the National Environmental Policy Act (NEPA), since the application of NEPA extends to all federal agencies mentioned in the chapter. This chapter proceeds to conduct such an analysis, detailing how NEPA review may apply to the cross-border shipping and storage of carbon dioxide.

This chapter is divided into three sections. Section 1 discusses how NEPA review may be applied by federal agencies, establishing the scope of the NEPA review that may be triggered under a scenario in which carbon dioxide is imported into the United States for permanent storage, as well as how the recent amendment to NEPA will affect this review processes.

Following an overview of how NEPA may generally apply to these projects, Section 2 of this chapter proceeds to analyze the legal repercussions of a specific practical scenario involving in the construction of a new pier or jetty to assist in the final stages of transportation of the carbon dioxide for permanent storage chain. Finally, Section 3 concludes.

1. NEPA review: general and practical implications

This section on NEPA is divided into five subsections. The first subsection provides an overview of NEPA,[1032] and the second proceeds to determine the actions in the CCS chain that may trigger a NEPA review for various the federal agencies mentioned in the first part of Chapter 5. The third subsection analyzes the inclusion of greenhouse gas (GHG) emissions in NEPA reviews. Following this analysis, the fourth subsection further details the NEPA analysis of direct, cumulative, and indirect effects. The fifth and final subsection concludes with a summary of the main findings.

1.1 Overview

NEPA[1033] requires all federal agencies to include a detailed statement about the environmental impact of their proposed action in every recommendation or report on proposals for legislation and other major federal actions that may significantly affect the quality of the human environment.[1034] NEPA was recently amended by the Fiscal Responsibility Act. [1035]

[1032] National Environmental Policy Act of 1969, 42 U.S.C.§§ 4321–4370e (As amended by the Builder Act, i.e., Title III, C, of the 2023 Fiscal Responsibility Act of May 28, 2023).
[1033] *Id.*
[1034] 42 U.S.C. § 4332(2)(C).
[1035] Title III, C, of the 2023 Fiscal Responsibility Act (May 28, 2023).

NEPA requires an environmental impact statement (EIS) for any action with a substantial federal nexus that also significantly affects the quality of the human environment.[1036] This includes any "major federal action," which previous regulations have defined as "an activity or decision subject to Federal control and responsibility."[1037] The recently-modified NEPA now defines "major federal action" as "an action that the agency carrying out such action determines is subject to substantial federal control and responsibility."[1038] Eligible actions often include applying for permits or receiving federal funding, among others.[1039]

EISs for proposed actions must include a discussion of: (i) reasonably foreseeable environmental effects of the proposed agency action; (ii) any reasonably foreseeable adverse environmental effects that cannot be avoided if the proposal be implemented; (iii) a reasonable range of alternatives to the proposed agency action that are technically and economically feasible and that meet the purpose of the proposal, including a no-action alternative; (iv) the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity; and (v) any irreversible and irretrievable commitments of federal resources that would be involved in the proposed agency action if implemented.[1040]

NEPA review is detailed in regulations issued by the White House Council on Environmental Quality (CEQ),[1041] which considers NEPA a procedural statute[1042] as determined by the United States Supreme Court.[1043] NEPA requires agencies to take a "hard look" at the environmental impacts of their actions before deciding to proceed with them, but it does not require a particular result. So long as the NEPA process is obeyed, courts are not to substitute their own substantive judgments for those of the agencies.[1044]

[1036] 42 U.S.C. § 4332(2)(C).

[1037] 40 CFR § 1508 (q) (Jun. 2, 2023).

[1038] Title III, C, of the 2023 Fiscal Responsibility Act (May 28, 2023), § 111. (The current definition drops the "major" and "effects," adding uncertainty to the definition. Legal scholars have pointed out the consequences. *See, e.g.,* Daniel Farber, *On the Perils of Hasting Drafting*, LEGAL PLANET (May 31, 2023)).

[1039] *See* 40 CFR § 1508 (q) (3) (Jun. 2, 2023) (Providing that: "Federal actions tend to fall within one of the following categories: (i) Adoption of official policy, such as rules, regulations, and interpretations adopted pursuant to the Administrative Procedure Act, 5 U.S.C. 551 et seq.; implementation of treaties and international conventions or agreements, including those implemented pursuant to statute or regulation; formal documents establishing an agency's policies which will result in or substantially alter agency programs. (ii) Adoption of formal plans, such as official documents prepared or approved by federal agencies which guide or prescribe alternative uses of Federal resources, upon which future agency actions will be based. (iii) Adoption of programs, such as a group of concerted actions to implement a specific policy or plan; systematic and connected agency decisions allocating agency resources to implement a specific statutory program or executive directive. (iv) Approval of specific projects, such as construction or management activities located in a defined geographic area. Projects include actions approved by permit or other regulatory decision as well as federal and federally assisted activities.").

[1040] 42 U.S.C. § 4332(2)(C) (1)- (v) (As amended by the Builder Act, i.e., Title III, C, of the 2023 Fiscal Responsibility Act of May 28, 2023).

[1041] 40 C.F.R.§1500. 1 et seq (Jun. 2, 2023).

[1042] 40 C.F.R.§1500. 1 (a) (Jun. 2, 2023).

[1043] Strycker's Bay Neighborhood Council, Inc. v. Karlen, 444 U.S. 223, 227 (Jan. 7, 1980) (Where the United States Supreme Court held that: "NEPA, while establishing 'significant substantive goals for the Nation,' imposes upon agencies duties that are 'essentially procedural.'. . . NEPA was designed 'to insure a fully informed and well-considered decision,' but not necessarily 'a decision the judges of the Court of Appeals or of this Court would have reached had they been members of the decisionmaking (sic) unit of the agency.'").

[1044] Jamilson E. Colburn, *The Risk in Discretion: Substantive NEPA's Significance*, 41, 1 COLUMBIA J. ENVL. L., 1, 2–4 (2016).

While courts will not review an agency's environmental analysis to "second-guess substantive decisions committed to the discretion of the agency,"[1045] courts have clarified that "simple, conclusory statements of no impact are not enough to fulfill an agency's duty under NEPA."[1046] For example, the Tenth Circuit recently held that the Bureau of Land and Management's dismissal of a project involving 199 new oil and gas wells was "arbitrary and capricious" for disregarding the climate impacts of those wells and failing the "hard look" requirement under NEPA.[1047] The court emphasized that "NEPA does not command agencies to reach any particular outcome, and it does not direct agencies to give special weight to environmental concerns. It requires only that the agency take a 'hard look' at the environmental consequences before taking a major action."[1048]

In assessing whether NEPA applies, federal agencies must determine: (i) if the proposed activity or decision is expressly exempt from NEPA under another statute; (ii) if compliance with NEPA would clearly and fundamentally conflict with the requirements of another statute; (iii) if compliance with NEPA would be inconsistent with Congressional intent as expressed in another statute; (iv) if the proposed activity or decision is a major federal action and has, or could have, significant environmental effects; (v) if the proposed activity or decision, in whole or in part, is a non-discretionary action for which the agency lacks authority to consider environmental effects as part of its decision-making process; and (vi) if the proposed action is one for which another statute's requirements serve the function of agency compliance with NEPA.[1049]

Technically, agencies can comply with NEPA in three different ways: (1) prepare a comprehensive environmental impact statement (EIS), (2) prepare a simplified environmental assessment (EA) and make a finding of no significant impact (FONSI); or (3) apply a categorical exclusion (CE) if the project is a type that does not normally have significant environmental impacts.[1050]

In assessing the appropriate level of NEPA review (EIS, EA and FONSI, or CE), federal agencies will assess if the proposed action: (i) would normally not have significant effects and is categorically excluded; (ii) is not likely to have significant effects (FONSI), or the significance of the effects is unknown and is therefore appropriate for an EA; or (iii) is likely to have significant effects and is therefore appropriate for an EIS.[1051]

With this context in mind, this report addresses the main scenarios in which NEPA may apply to carbon dioxide transportation and storage. For carbon capture, usage and storage projects that occur on federal lands or require a federal permit, the lead federal agency will ultimately determine if the project significantly affects the

[1045] Delaware Riverkeeper Network v. FERC, 753 F.3d 1304, 1313, 410 U.S. App. D.C. 137 (D.C. Cir. 2014).
[1046] *Id.* at 1313 (Emphasizing that an arbitrary and capricious agency action in the NEPA context is one that "is not the product of reasoned decisionmaking (sic)." (Internal quotation marks and citations omitted).
[1047] Diné Citizens Against Ruining Our Env't v. Haaland, 59 F.4th 1016, 1025 (10th Cir. 2023).
[1048] *Id.* (Highlighting that "NEPA directs agencies to prepare an Environmental Impact Statement ('EIS') for 'proposals for . . . major Federal actions significantly affecting the quality of the human environment.'").
[1049] 40 C.F.R.§1501. 1 (a) (Jun. 2, 2023).
[1050] 40 CFR § 1508.1(h), (j), and (l) (Jun.2, 2023) (Defining EA, EIS, and FONSI, respectively).
[1051] 40 C.F.R.§1501.3 (a) (Jun. 6, 2023) (Current NEPA provisions added that such environmental assessment shall be a concise document prepared by a federal agency setting forth the agency's finding of no significant or determination that an environmental impact statement is necessary. It also has page limits. The Fiscal Responsibility Act of 2023, § 107 (May 28, 2023)).

environment and involves substantial control and responsibility. These determinations will either trigger the preparation of an EIS or an EA or will fit within a categorical exclusion. The agency will also need to conduct an environmental review with the appropriate public involvement prior to making a final decision about the project.[1052] The next subsection details where in the CCS chain a NEPA review may be triggered.

1.2 NEPA review: triggers in the CCS chain

As detailed in Chapter 5, several statutes regulate different aspects of the cross-border CCS chain, and each involves several different agencies. These statutes and agencies are summarized in the table below.

Table 1: Statutes and agencies involved in the CCS chain

Part of CCS Chain	***Statute***	***Agency***
Storage	The SDWA (*Safe Drinking Water Act*)	EPA
	RCRA (*Resource Conservation and Recovery Act*)	EPA
	OCSLA (*Outer Continental Shelf Lands Act*)	BOEM
Transportation	MPRSA (*Marine Protection, Research, and Sanctuaries Act*)	EPA
	The HMTA (*Hazardous Materials Transportation Act*)	DOT (ships); PHMSA (pipelines)
	The APPS (*Act to Prevent Pollution from Ships*)	EPA

[1052] Council on Environmental Quality (CEQ), Council on Environmental Quality Report to Congress on Carbon Capture, Utilization, and Sequestration Delivered to the Committee on Environment and Public Works of the Senate and the Committee on Energy and Commerce, the Committee on Natural Resources, and the Committee on Transportation and Infrastructure of the House of Representatives, as directed in Section 102 of Division S of the Consolidated Appropriations Act 52 (2021).

This subsection first analyzes which of the above agencies are required to implement an environmental review under NEPA, and then briefly examines a practical scenario in which NEPA may be triggered for an agency that would not typically directly govern CCS – the Army Corps of Engineers.

First, this analysis examines the considerations for triggering NEPA review during the storage stage of the CCS process. Previous discussion in Chapter 5 showed that while the SDWA and RCRA offer potential regulatory tools over CCS, only the OCSLA, which expressly provides for the issuance of leases for carbon storage,[1053] and SDWA currently have an active role in regulating geological carbon dioxide storage. However, EPA's current regulation exempts the SDWA UIC program from NEPA review based on the functional equivalence analysis – in other words, the idea that the review EPA conducts is the functional equivalent of a NEPA review. The pertinent EPA regulation provides as follows: "The SDWA UIC program is exempt from performing an Environmental Impact Statement (EIS) under section 101(2)(C) and an alternatives analysis under section 101(2)(E) of NEPA under a functional equivalence analysis. See *Western Nebraska Resources Council* v. *US EPA,* 943 F.2d 867, 871–72 (8th Cir. 1991) and EPA Associate General Counsel Opinion (August 20, 1979)."[1054]

NEPA review would be required if BOEM leases offshore land for the sequestration of carbon dioxide in the OCS. Under the IIJA,[1055] BOEM can now issue leases for the storage of any carbon dioxide that has been "captured" regardless of where it was sourced, provided certain purity requirements are met.[1056] As discussed in chapter 5, no further details or specifications are mentioned.[1057] The requirement to obtain a lease is a result of the fact that the U.S. federal government controls the OCS.[1058] Therefore, this lease, which will be within the purview of BOEM as it is the agency within the Department of the Interior that administers OCSLA,[1059] would invoke NEPA.[1060]

Considerations for triggering NEPA review during the transportation stage of the CCS progress are notably more complex than those of carbon dioxide storage. Previous analysis in Chapter 5 showed that MPRSA, the HMTA,

[1053] 43 USC §1337 p (1) (Providing that the Secretary of Interior "[m]ay grant a lease, easement, or right-of-way on the Outer Continental Shelf, . . . if those activities . . . (E) provide for, support, or are directly related to the injection of a carbon dioxide stream into sub-seabed geologic formations for the purpose of long-term carbon sequestration.").

[1054] U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells Final Rule, 75 Fed Reg 77230, 77236 (Dec. 10, 2010), at https://perma.cc/G56E-3RGM.

[1055] The Infrastructure Investment and Jobs Act, Pub. L. No. 117-58, §§40306, 40307 (2021).

[1056] *See* Romany Webb, *Carbon Storage in the New Bipartisan Infrastructure Bill*, Climate Law Blog (Aug. 10, 2021), at https://perma.cc/JJK5-7P7Y.

[1057] Under the IIJA, BOEM was supposed to have issued regulations clarifying this authority "not later than 1 year after the date of enactment of this act." The Infrastructure Investment and Jobs Act, Pub. L. No. 117-58, §40307 (d) (2021). These regulations are yet to be issued. U.S. Department of Interior: Bureau of Ocean Energy Management (BOEM), Carbon Sequestration, at https://perma.cc/7U8U-AB4S.

[1058] 43 USC §1337.

[1059] Department of Interior (DOI), *Interior Department Completes the Reorganization of the Former MMS* (Sep. 30, 2011), at https://perma.cc/7FPT-5MUV.

[1060] 42 U.S.C. § 4336e (10) (A).

and the APPS serve as potential regulators of CCS activities, with more significant regulatory implications from the first two acts than the third.

MPRSA is unlikely to trigger NEPA review. The IIJA provides that sub-seabed carbon storage projects authorized by BOEM do not require an EPA permit under MPRSA.[1061] Therefore, no NEPA review would be required under these specific circumstances, as EPA would not be taking any "major federal action." The IIJA provides that a carbon dioxide stream injected for permanent sequestration into the OCS is not considered to be material under MPRSA.[1062] Moreover, NEPA has been held not to apply to decisions taken under the MPRSA.[1063]

As for the HMTA, the act provides that DOT regulates shipping transportation and PHMSA regulates pipelines transportation, with each agency imposing standards for relevant activities.[1064] The application of either of these sets of standards is also not subject to NEPA as a federal action, as these agencies are not engaged in actions that amount to a " major federal action."[1065] DOT issues the regulations but ships subject to these regulations do not require permits from DOT. Therefore, no NEPA review is to be triggered.

In summary, all but one (OCSLA) of the federal statutes previously discussed in Chapter 5 are unlikely to trigger NEPA review. Under OCSLA, BOEM would be the federal agency to conduct such a review. There is one final but logistically important practical consideration regarding the import of carbon dioxide for storage. This scenario is discussed and analyzed in detail below.

At the final transportation stage of moving carbon dioxide off a ship and onto shore, the transfer process may require either the use of an existing pier or the construction of a new pier, jetty, or similar structure within the navigable waters of the United States, the latter of which might also require dredging.[1066] While this new structure may be a pier, a jetty, or another similar structure, for the purposes of simplification this section's analysis condenses all these potential structures under the term "pier," as each of these structures have similar legal implications at the federal level. Whether or not a new or existing structure is used, both scenarios are

[1061] The Infrastructure Investment and Jobs Act, Pub. L. No. 117-58, § 40307 (c) (2021).
[1062] *Id.*
[1063] Romany M. Webb & Michael B. Gerrard, *Overcoming Impediments to Offshore Carbon Dioxide Storage: Legal Issues in the U.S. and Canada*, Sabin Center for Climate Change Law 17 (2019) (Citing the following authorities: Maryland v. Train, 415 F. Supp. 116 (D. Md. 1976), ruling that EPA is not obliged to prepare an EIS for actions taken under the MPRSA as "[w]here federal regulatory action is circumscribed by extensive procedures, including public participation, for evaluating environmental issues and is taken by an agency with recognized environmental expertise, formal adherence to the NEPA requirements is not required unless Congress has specifically so directed"), and the Policy and Procedures for Voluntary Preparation of National Environmental Policy Act (NEPA) Documents, 63 Fed. Reg. 58045, 58046 (Oct. 29, 1998) (Highlighting that EPA will voluntarily comply with NEPA for the designation of dump sites under the MPRSA)).
[1064] 49 CFR part 172.101 and 49 CFR part195.1(b)(9), respectively, both provisions referring to carbon dioxide.
[1065] 42 U.S.C. § 4336e (10) (A) (Stating that: "The term 'major Federal action' means an action that the agency carrying out such action determines is subject to substantial Federal control and responsibility." (Defining major federal action as amended by the Title III, C, of the 2023 Fiscal Responsibility Act, § 111(May 28, 2023)).
[1066] Because it is likely to be operationally and technically infeasible for the same ship to carry carbon dioxide in one direction and LNG in the return route, this section will not analyze the legal implications of this scenario.

administered by the Army Corps of Engineers and are regulated under Section 10 of the RHA)[1067] as well as the Clean Water Act (CWA).[1068] The RHA is further discussed in Section 2.1.

For the first scenario, the use of a preexisting pier would not require Army Corps' authorization and eventual permits, so long as it does not need modifications of the existing pier or if eventual modifications qualify as "reasonable improvements as means to transport foreign commerce."[1069] The use of an existing pier would enable cross-border transportation of carbon dioxide for permanent storage in the United States, and a strong argument could be made that adaptations or enlargement of current infrastructure would not require Corps approval under the RHA. If this is the case, no discretionary action is likely to be involved. Therefore, NEPA review by the Army Corps should not be required.

That said, should the Army Corps determine that the use of such a pier would not qualify as "reasonable improvements as means to transport foreign commerce," NEPA review may be triggered. In other words, the Army Corps might determine that it is acceptable to use an existing pier, but that the modifications are so large that NEPA review is needed, despite these modifications not requiring the construction of a new pier.

As for the second scenario in which a new pier must be constructed and/or new materials be dredged, Army Corps' permits are likely to be required.[1070] Since these permits are very likely to qualify as a discretionary federal action, NEPA review will also be required.[1071] This specific scenario is further analyzed in Section 2.3.

Given the fact that NEPA review could be triggered in both scenarios, the rest of this analysis proceeds under the assumption that NEPA could play a role in moderating the cross-border transportation of carbon dioxide for geological storage. As such, the next subsection analyzes general topics that may come up in a NEPA review, whether the review is conducted by the Army Corps or another federal agency.

[1067] 33 U.S.C. §401 et seq.

[1068] 33 U.S.C. § 1251 et seq. (Permits for dredging materials are regulated under § 404).

[1069] 33 U.S.C. §401 (In the relevant part, it states: "When plans for any bridge or other structure have been approved by the Secretary of the department in which the Coast Guard is operating or by the Chief of Engineers and Secretary of the Army, it shall not be lawful to deviate from such plans either before *or after completion of the structure* unless modification of said plans has previously been submitted to and received the approval of the Secretary of the department in which the Coast Guard is operating or the Chief of Engineers and the Secretary of the Army. The approval required by this section of the location and plans or any modification of plans of any bridge or causeway *does not apply* to any bridge or causeway over waters that are not subject to the ebb and flow of the tide and that are not used and are not susceptible to use in their natural condition o*r by reasonable improvement as a means to transport interstate or foreign commerce*."). (emphasis added).

[1070] 33 U.S.C. §401 (Providing as follows: "It shall not be lawful to construct or commence the construction of any bridge, causeway, dam, or dike over or in any port, roadstead, haven, harbor, canal, navigable river, or other navigable water of the United States until the consent of Congress to the building of such structures shall have been obtained and until the plans for (1) the bridge or causeway shall have been submitted to and approved by the Secretary of the department in which the Coast Guard is operating, or (2) the dam or dike shall have been submitted to and approved by the Chief of Engineers and Secretary of the Army).

[1071] The case law is clear regarding the need of such a NEPA review. *See, e.g.,* Red Lake Band of Chippewa Indians v. United States Army Corps of Eng'rs, Civil Action No. 20-3817 (CKK), 2022 U.S. Dist. LEXIS 183743, at 5-6 (D.D.C. Oct. 7, 2022) (Discussing the need for an EIS to fulfill the required NEPA review).

It is important to note that while our analysis does not anticipate a current need for NEPA review by any federal agency other than BOEM and the Army Corps, the following discussion on NEPA's application is not necessarily restricted to the Army Corps alone. After all, multiple federal agencies may be involved in a single project. Should more than one agency be involved, the NEPA review conducted by the lead agency may either be limited to the activity for which their permit is required or may include NEPA review for the complete project. Although it remains to be seen how the recent amendments to NEPA will play out in practice, it appears that these amendments have narrowed the scope of required NEPA review. Accordingly, the legal analysis provided below is likely to remain accurate.

1.3 Inclusion of GHG emissions

NEPA has been recently amended[1072] and regulations are in flux.[1073] The Biden administration has recently reviewed the Trump administration decision to withdraw CEQ's 2016 climate guidance, which directed that agencies consider of the effects of climate change on a proposed action as part of the scope of environmental impacts.[1074] The updated guidance recommends agencies consider incorporating environmental justice principles into their policies, actions, and activities,[1075] as well as recommends that agencies discuss whether and to what extent their proposed actions' reasonably foreseeable GHG emissions are aligned with GHG reduction goals, including those reflected in the U.S. Nationally Determined Contribution (NDC) under the Paris Agreement.[1076]

Notably, CEQ's regulations or related guidance do not require the decision maker to select the alternative with the lowest net GHG emissions or climate costs or the greatest climate benefits.[1077] Rather, the agency's guidance recommends agencies to use the information provided through the NEPA process to assist informing decisions that align with climate change commitments and goals.[1078]

Despite NEPA review not requiring a cost-benefit analysis, the use of this type of assessment as well as considering the social cost of greenhouse gases (SC-GHG) are useful pieces of information to disclose to

[1072] The Fiscal Responsibility Act of 2023 (May 28, 2023), §106 et seq.
[1073] *Id.* at §111.
[1074] Council on Environmental Quality, Withdrawal of Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews 82 Fed. Reg. 16576 (Apr. 5, 2017). For a detailed discussion about the regulatory changes under the Biden administration and suggestions for future reform: Michael Burger et al., *Incorporating Climate Change in NEPA Reviews: Recommendations for Reform,* Sabin Center for Climate Change Law 3–4 (May, 2022).
[1075] Council on Environmental Quality, National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change 88 Fed Reg, 1196, 1211 (Jan. 9, 2023).
[1076] *Id.* at 1203. (Underscoring that agencies are better decision makers when comparing relevant GHG emissions, emissions reductions, and carbon sequestration potential across reasonable alternatives, assessing trade-offs with other environmental values as well as assessing the risks from or resilience to climate change that are inherent in a proposed action and its design).
[1077] *Id.* at 1204.
[1078] *Id.*

policymakers and stakeholders.[1079] In addition, agencies may consider co-benefits of the proposed action, alternatives, and potential mitigation measures regarding human health, economic and social stability, ecosystem services or other benefits that increase climate change preparedness or resilience.[1080] Recent case law trends towards this direction.[1081]

Importantly, the kind of carbon dioxide storage project analyzed in this review would facilitate the sequestration of a greenhouse gas that might otherwise be released into the atmosphere. Sequestration would be a benefit that would be an important factor in the analysis of the project. Therefore, even if the Army Corps were to consider a cost-benefit or SC-GHG modelling analyses, the net impact is likely to be in favor of the project.

Current CEQ regulations on NEPA define the "effects or impacts" of a proposed action as "changes to the human environment from the proposed action or alternatives that are reasonably foreseeable,"[1082] and include: (i) direct effects, which are caused by the action and occur at the same time and place;[1083] and (ii) indirect effects, which are caused by the action and are later in time or removed in distance, despite being reasonably foreseeable.[1084] Listed examples of potential indirect effects include "growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems."[1085]

CEQ regulation also defines "cumulative effects," which are effects on the environment resulting from the incremental effects of the action when added to the effects of other past, present, and reasonably foreseeable actions regardless of what agency or person undertakes such other actions.[1086] Finally, the CEQ regulation underscores specific effects such as ecological, aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative.[1087]

The consideration of direct, indirect, and cumulative effects has just been reincorporated in the scope of NEPA review by the Biden-Harris administration.[1088] These considerations have traditionally been a part of CEQ

[1079] *Id.* at 1211.
[1080] *Id*. at 1209.
[1081] Vecinos para el Bienestar de la Comunidad Costera v. FERC, 6 F.4th 1321, 1329, 453 U.S. App. D.C. 439 (Mar. 23, 2021) (The court decided that the Commission's analyses of the projects' impact on climate change and environmental justice communities were deficient under NEPA, and FERC did not respond to plaintiffs' specific claims regarding the social cost of carbon (or some other generally accepted methodology to assess of the impact of the projects' GHG emissions)).
[1082] 40 C.F.R.§1508.1 (g) (Jun.2, 2023).
[1083] 40 C.F.R.§1508.1 (g) (1) (Jun. 2, 2023).
[1084] 40 C.F.R.§1508.1 (g) (2) (Jun. 2, 2023).
[1085] *Id.*
[1086] 40 C.F.R.§1508.1 (g) (3) (Jun. 2, 2023) (Clarifying that cumulative effects may result from individually minor but collectively significant actions taking place over a period of time).
[1087] 40 C.F.R.§1508.1 (g) (4) (Jun. 2, 2023) (Highlighting that ecological effects include the effects on natural resources and on the components, structures, and functioning of affected ecosystems; and effects may include those resulting from actions which may have both beneficial and detrimental effects, even if on balance the agency believes that the effects will be beneficial.
[1088] Council on Environmental Quality, Withdrawal of Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews, 82 Fed. Reg.16,576 (Apr. 5,

regulations but were removed under President Trump.[1089] These have also been incorporated in the most recent CEQ guidance for agencies on NEPA, which directs agencies to consider the potential effects of a proposed action on climate change including the assessment of GHG emissions and reductions, as well as the effects of climate change on a proposed action and its environmental impacts.[1090]

Case law has interpreted that NEPA review requires a qualitative consideration of GHG emissions,[1091] with some decisions highlighting that "the impact of greenhouse gas emissions on climate change is precisely the kind of cumulative impacts analysis that NEPA requires agencies to conduct."[1092] Legal scholars have argued for the need for inclusion of downstream and upstream GHG emissions in NEPA review,[1093] emphasizing the importance of the federal government conducting a comprehensive analysis of GHG emissions at some point in the supply chain for natural gas, for instance, that is transported via federally approved pipelines and export terminals.[1094]

Given the anticipated need to consider direct, cumulative, and indirect effects of federal projects in NEPA reviews, it is useful to analyze the ways in which each of these three components may inform potential NEPA review for a future carbon dioxide transportation and storage project. Using a likely Army Corps permit as the most practical example for NEPA review, the rest of this subsection analyzes: (i) the direct emissions regarding the construction and operation of a terminal built specifically to receive carbon dioxide; (ii) potential cumulative effects; and (iii) the indirect downstream and upstream emissions involved.

1.3.1 Direct effects

NEPA requires agencies to consider "reasonably foreseeable" direct effects of their proposed actions, the direct effects of reasonable alternatives[1095] and of a no action alternative.[1096] Agencies have been encouraged to use

2017), at https://perma.cc/VMW4-YEUP. For a detailed discussion about the regulatory changes under the Biden administration and suggestions for future reform: Michael Burger et al., *Incorporating Climate Change in NEPA Reviews: Recommendations for Reform, supra* note 1074, at 3–4.

[1089] Council on Environmental Quality, Update to the Regulations Implementing the Procedural Provisions of the National Environmental Policy Act; Final Rule, 85 Fed. Reg. 43304 (July 16, 2020) (For the Trump administration's regulations). *See also* Carolina Arlota, *How President Trump's War on Science Undermines Cost-Benefit Analysis of Climate Policies*, 50 ELR 10999, 11011–12 (2020) (Finding that the Trump-Pence administration's flexibilization of NEPA was detrimental to climate policies).

[1090] Council on Environmental Quality, National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change, *supra* note 1075, at 1197.

[1091] Anthony R. Raduazo, *The CO_2 Monetization Gap: Integrating the Social Cost of Carbon into NEPA*, 118 Columbia L. Rev. 605, 607 (2018).

[1092] *See, e.g.,* Center for Biological Diversity v. National Highway Traffic Safety Administration. 528 F. 3d 1172, 1217 (9th Cir. 2008).

[1093] Michael Burger & Jessica A. Wentz, *Downstream and Upstream Greenhouse Gas Emissions: The Proper Scope of NEPA Review*, 41 Harv. Envtl. L. Rev. 109, 142–43 (2017) (Noting that "The case law is less clear on the agency's obligation to evaluate upstream and downstream emissions in the context of transportation proposals such as pipelines and export terminals. Here, courts have, without much explanation, treated oil and gas pipelines differently than coal rail lines.").

[1094] *Id.* at 168.

[1095] 42 U.S.C. § 4332(2)(C) (i) (for direct effects); and 42 U.S.C. § 4332(2)(E) (for alternatives). These provisions have been renumbered and the language has been streamlined in the current NEPA: The Fiscal Responsibility Act of 2023, §10 (May 28, 2023).

[1096] 40 C.F.R.§1502. 14 (c) (Jun. 6, 2023) (For non-action alternatives).

the NEPA process to identify and assess reasonable alternatives that may avoid or minimize adverse effects on the human environment.[1097]

When assessing if the effects of the proposed action are significant, agencies shall analyze the potentially affected environment and degree of the action's effects.[1098] Identifying the affected environment involves the identification and description of reasonably foreseeable trends, including climate change effects.[1099] Agencies are encouraged to consider the following: (i) both short-and long-term effects; (ii) both beneficial and adverse effects; (iii) effects on public health and safety; and (iv) effects that would violate federal, state, tribal, or local law protecting the environment.[1100]

As a result, specific NEPA reviews are very detailed. For example, in an EIS approving the construction of an LNG terminal in which FERC was the lead agency and the Army Corps of Engineers was the cooperating agency, the NEPA review concluded that the LNG vessel traffic would not significantly impact the six hazardous waste sites located in the town.[1101] To reach this conclusion, the review analyzed the direct effects on geological resources, soils and sediments, water resources, wetlands, special status species, fisheries and aquatic resources. Tax revenue increases and environmental justice considerations were also assessed.[1102] The construction was ultimately approved based on mitigation actions.[1103] Similarly, a 2022 draft EIS involving port modification projects in which the Army Corps was the lead agency was quite comprehensive, analyzing the direct effects and related impacts on wetlands protection, navigable waters, marine transportation, mitigation measures, cultural, and socio-economic resources; environmental justice considerations have yet to be addressed.[1104]

In the context of a cross-border carbon dioxide transportation and storage project that requires significant pier modification and/or new construction, the direct effects likely to be analyzed by the Army Corps include the emissions associated with pier construction, operation, and any necessary dredging or land clearing; ecological effects, including eventual species impacts and potential pollution from spills or unexpected releases; and potential adverse environmental impacts on vulnerable communities.

[1097] Council on Environmental Quality, National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change, *supra* note 1075, at 1203.
[1098] 40 C.F.R.§1501. 3 (b) (Jun. 6, 2023).
[1099] Council on Environmental Quality, National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change, *supra* note 1075, at 1206.
[1100] 40 C.F.R.§1501. 3 (b) (2) (Jun. 6, 2023).
[1101] Federal Energy Regulatory Commission, *DownEast LNG Project: Final Environmental Impact Statement: 4-207*, FERC (May 2014).
[1102] *Id.* at 4-225 and 4-230, respectively.
[1103] *Id.* at 4-1 to 4-169. (Mitigation actions were based on the fact that natural gas is less polluting than oil).
[1104] *See, e.g.,* U.S. Army Corps of Engineers: Galveston District Southwestern Division, *Draft Environmental Impact Statement for the Proposed Corpus Christi Ship Channel Deepening Project* (Jun. 2022); U.S. Army Corps of Engineers: Jacksonville District, *Revised Draft Supplemental Environmental Impact Statement Port Everglades Harbor Broward County, Florida* (Feb. 2022).

1.3.2 Cumulative effects

The consideration of cumulative impacts is related to that of direct effects. Recent case law held that in addition to naming the relevant geographic area, a cumulative impact analysis must identify (1) expected impacts to the area, (2) "past, present, proposed, and reasonably foreseeable" other actions that impact the area, (3) the effects of those other actions on the area, and (4) the "overall impact that can be expected if the individual impacts are allowed to accumulate."[1105] This language is also part of CEQ's guidance on NEPA.[1106]

There are precedents in which Army Corps permits were invalidated due to the lack of consideration of the cumulative effects of a project,[1107] but courts have sometimes signaled that merely mentioning these effects would suffice to meet NEPA.[1108] Therefore, the cumulative effects of any work, such as pier construction or material dredging, may be mentioned by the Army Corps in their NEPA review. It is unclear if the Army Corps will actually need to analyze these effects based on their internal agency "small handle" regulatory approach, which is detailed in the next section on indirect effects.

1.3.3 Indirect effects

NEPA review of a coastal terminal that will handle carbon dioxide destined for storage may include the analysis of indirect downstream effects associated with the sequestration stage in the CCS chain.[1109] However, indirect

[1105] Sierra Club v. FERC, 38 F.4th 220, 234 (2022) (Citing *Sierra Club v. FERC*, 827 F.3d 36, 49, 423 U.S. App. D.C. 394 (D.C. Cir. 2016)).

[1106] Council on Environmental Quality, National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change, *supra* note 1075, at 1206.

[1107] *See, e.g.,* Ark. Nature Alliance, Inc. v. United States Army Corps of Eng'rs, 266 F. Supp. 2d 876, 879. (Invalidating the Corps' decision to issue a permit for the extension of low-water bridge across a river, the court ruled: "The potential for cumulative impact on the environment existed at the time the permit was issued. The possibility of cumulative impact was admitted in the administrative record and ignored by the Corps. The Corps either knew, or should have known, that the proposed development would encounter appreciable opposition. And, finally, the Corps violated its own regulations.").

[1108] Sierra Club, Inc. v. Bostick, 2013 U.S. Dist. LEXIS 181087, at 29. (The court underscored the following: "The Corps estimates that this NWP will be used approximately 7,900 times per year on a national basis, resulting in impacts to approximately 400 acres of waters of the United States, including jurisdictional wetlands. The Corps estimates that approximately 480 acres of compensatory mitigation will be required to offset these impacts. . . Using the current trend, approximately 39,500 activities could be authorized over a five-year period until this NWP expires resulting in impacts to approximately 2,000 acres of waters of the United States, including jurisdictional wetlands.")

[1109] This may be the case, according to CEQ's updated guidance and some case law. *See, e.g.,* Sierra Club v. FERC, 867 F.3d 1357, 1371 (Apr. 18, 2017) (Holding that: "It's not just the journey, though, it's also the destination. All the natural gas that will travel through these pipelines will be going somewhere: specifically, to power plants in Florida, some of which already exist, others of which are in the planning stages. Those power plants will burn the gas, generating both electricity and carbon dioxide. And once in the atmosphere, that carbon dioxide will add to the greenhouse effect, which the EIS describes as "the primary contributing factor" in global climate change. J.A. 915. The next question before us is whether, and to what extent, the EIS for this pipeline project needed to discuss these "downstream" effects of the pipelines and their cargo. We conclude that at a minimum, FERC should have estimated the amount of power-plant carbon emissions that the pipelines will make possible." *But conf.* Sierra Club v. FERC, 423 U.S. App. D.C. 394, 405, 827 F.3d 36, 47 (2016) (This was a case about a conversion of an import natural gas facility to an export and import LNG facility, and the court held that the NEPA review of indirect effects was not required because the FERC did not have authority to authorize such export of LNG (only the DOE). The court asserted: "Here, an agency 'has no ability to prevent a certain effect due to that agency's 'limited

GHG downstream effects are not pertinent to this specific project as the carbon dioxide will be sequestrated instead of emitted.

Upstream emissions, on the other hand, may produce indirect effects. Both the overseas capture of carbon dioxide and the associated international transportation activities are likely to generate emissions, and therefore may be included in an extraterritorial application on NEPA. Importantly, the recent NEPA amendments provide that no environmental review is required for actions with impacts entirely outside the U.S.[1110]

Historically, the extraterritorial application of NEPA has been a contentious issue.[1111] The main barrier facing the extraterritorial application of NEPA arises from the extraterritoriality principle, which states that "rules of the United States statutory law, whether prescribed by federal or state authority, apply only to conduct occurring within, or having effect within, the territory of the United States."[1112]

Despite initial controversies in applying NEPA to effects outside of the United States,[1113] some scholars and some courts have concluded that the presumption against extraterritoriality was not strong, and that NEPA did not conflict with international law principles.[1114] More recent case law shows courts upholding NEPA analysis based on the transboundary application of the law, especially within the United States' exclusive economic zone (EEZ).[1115] This is relevant because, as discussed in Chapter 3, the EEZ is not technically part of the country's territory. This interpretation therefore indicates that some courts were willing to expand NEPA's application.

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statutory authority over the relevant action,' then that action 'cannot be considered a legally relevant *cause* of the effect' for NEPA purposes.'"). (emphasis added).

[1110] The Fiscal Responsibility Act of 2023, § 111 (b), (i), (VI) (May 28, 2023) (Defining a "non-federal action" as the following: "extraterritorial activities or decisions, which means agency activities or effects located entirely outside of the jurisdiction of the United States.").

[1111] Lois J. Schiffer, *The National Environmental Policy Act Today, With an Emphasis on its Application Across U.S. Borders*, 14 Duke Env. L. & Pol. Rev. 325, 224 (2004).

[1112] Envtl. Def. Fund v. Massey, 300 U.S. App. D.C. 65, 986 F.2d 528, 530 (1993).

[1113] Karen A. Klick, *The Extraterritorial Reach of NEPA'S EIS Requirement After Environmental Defense Fund v. Massey*, 44 Am. Univ. L. Rev. 291, 296 (1994).

[1114] Viviane Meunier-Rubel, Interstitial Law-Making in Public International Law: A Study on Environmental Impact Assessments, 32–33 (2022).

[1115] *See, e.g.,* Ctr. for Biological Diversity v. NSF, No. C 02-5065 JL, 2002 U.S. Dist. LEXIS 22315, at 9 (N.D. Cal. Oct. 30, 2002) (Holding as follows: "However, to require an agency like the National Science Foundation to consider the environmental consequences of its decisions made in the United States affecting projects outside the United States but not within the territory of other countries will not affect the enforcement of other statutes and regulations. Defendant has failed to identify any foreign policy implications of the Research Project. It implies that any activities within the Exclusive Economic Zone ("EEZ") of Mexico is beyond the reach of NEPA. This court disagrees. The waters of the Gulf of California are considered as the high seas, rather than the territorial waters of Mexico, for the purposes of U.S. law."); and NRDC v. United States Dep't of the Navy, No. CV-01-07781 CAS (RZx), 2002 U.S. Dist. LEXIS 26360, at 30-31 (C.D. Cal. Sep. 17, 2002) (Holding that NEPA applies, as most of the sonar sea tests have been conducted in the United States Exclusive Economic Zone ("EEZ"), where the United States exercises the requisite degree of legislative control to trigger the application of NEPA).

In the late 1970s, CEQ issued guidance encouraging agencies to apply NEPA extraterritorially.[1116] In 1997, CEQ determined that agencies must include analysis of reasonably foreseeable transboundary effects of proposed actions in their analysis of proposed actions in the United States.[1117]

However, NEPA's recent amendments provide that no environmental review is required for actions with impacts entirely outside the U.S.[1118] This language is quite similar to the language used under CEQ's 2020 regulation (issued under President Trump) and appears to set a stricter standard for extraterritorial considerations than courts have previously applied.[1119]

For the purposes of this analysis, any upstream emissions from the capture of carbon dioxide, and emissions from ships carrying the carbon dioxide to the United States, would create impacts exclusively outside the United States. However, shipping emissions within the United States, including those in the U.S. EEZ, would ultimately need to be included in the lifecycle analysis of the project under NEPA. A complete lifecycle analysis would also include shipping emissions outside the EEZ, even if NEPA does not require such analysis.[1120]

1.4 Summary of main findings

While several federal statutes and associated agencies including EPA, BOEM, DOT and PHMSA might be involved in the cross-border transportation of carbon dioxide for permanent storage, only one (namely, OCSLA) of the statutes evaluated in this report is currently likely to trigger NEPA review. However, the final logistical step of transferring carbon dioxide from ship to shore would likely require some type of pier, jetty, or other similar structure. If construction of a new pier or sufficiently major modifications to an existing pier trigger the need for Army Corps permits, NEPA review would also be triggered.

Current CEQ regulations on NEPA direct agencies to include direct, cumulative, and indirect effects. When assessing whether direct effects of the proposed action are significant, agencies shall analyze the potentially affected environment and degree of the action's effects. Agencies are encouraged to consider the following: (i) both short-and long-term effects; (ii) both beneficial and adverse effects; (iii) effects on public health and safety; and (iv) effects that would violate federal, state, tribal, or local law protecting the environment. For the activities

[1116] Council on Environmental Quality, Memorandum on the Application of the EIS Requirement to Environmental Impacts Abroad of Major Federal Actions (1976), 42 Fed. Reg. 61066 (Dec. 1, 1977).
[1117] Council on Environmental Quality, Memorandum to Heads of Agencies on the Application of NEPA to proposed Federal Actions in the U.S. with Transboundary Effects (Jul. 1, 1997).
[1118] The Fiscal Responsibility Act of 2023, § 111 (b), (i), (VI) (May 28, 2023) (Defining a "nonfederal action" as the "extraterritorial activities or decisions, which means agency activities or effects located entirely outside of the jurisdiction of the United States.").
[1119] Farber, *supra* note 1038.
[1120] Life Cycle Assessment (LCA) refers to the quantitative analysis of the environmental aspects of a product over its entire life cycle. Under the standards provided in the ISO 14040, the environmental impacts outside the United States would also be included in the LCA, despite not being required by NEPA. *See* International Standard Organization (ISO), ISO14040 (2006), at https://perma.cc/6TZU-LRBX. (Further details focus on goals and definitions, life cycle inventory methods, and life cycle interpretation methods, life cycle impact assessment, among others).

involved in this report, Army Corps review will include the emissions associated with pier construction, operation, and any necessary dredging or land cleaning; ecological effects, including species impacts and potential pollution from spills or unexpected releases; and potential adverse environmental impacts on vulnerable communities.

NEPA review of a coastal terminal that will handle carbon dioxide destined for storage may include the analysis of indirect downstream effects associated with the sequestration stage in the CCS chain. Importantly, indirect downstream effects are not pertinent to this specific project, as the carbon dioxide will be sequestrated instead of emitted. Upstream emissions, on the other hand, may produce indirect effects. Nonetheless, recent NEPA amendments provide that no environmental review is required for actions with impacts entirely outside the United States.

2. A practical inquiry: offloading carbon dioxide in the United States

While the previous section provided a review of how NEPA may broadly apply to a project involving the international shipment and storage of carbon dioxide, this section advances the analysis one step further by examining a practical scenario in which a new jetty, dock, pier, or other fixed facility is constructed for the express purpose of unloading carbon dioxide ships. The legal implications of creating this structure are worthy of more in-depth consideration given that, realistically, this is the most likely environmental modification that could trigger NEPA for this project.

This analysis assumes that this new structure will be built in Louisiana or Texas – the two states with the highest likelihood of receiving overseas shipments of carbon dioxide for storage under this project. Further analysis on the intricacies of state law is discussed in Chapter 5. Notably, there may be different legal implications between the construction of a pier, jetty, or dock at the state level; while all these terms were collapsed under the umbrella term of "pier" in Section 1, this is not necessarily the case throughout Section 2.

The permitting responsibility of the construction of this new pier, dock or jetty falls to the Army Corps of Engineers. This section begins with an overview of the RHA, which serves as the key statute for Army Corps permitting.[1121] Next, it analyzes the Army Corps' public interest review. This is followed by a discussion of the Army Corps' permits under NEPA, including how the Army Corps' NEPA review may also trigger the inclusion of the complete project, including the upstream international transportation component of the project. Following the assumption that this construction is most likely to occur in Louisiana or Texas, the section provides an overview of relevant state laws that may require additional permits. The section also addresses the so-called FAST-41 covered projects and potential pathways for this type of infrastructure project. The section concludes by highlighting that Army Corps NEPA review of the entire project is unlikely to be triggered, but some additional state permits may be needed in Louisiana and Texas under their respective coastal laws.

[1121] 33 U.S.C. §401 et seq.

2.1 The Rivers and Harbors Act (RHA)

The RHA[1122] establishes the authority for the U.S. Army Corps of Engineers' regulatory permit program to protect navigable waters in the development of harbors and other construction and excavation.[1123]

Section 10 of the RHA prohibits the unauthorized obstruction or alteration of any navigable waters of the United States.[1124] This provision states that that the construction of any structure in or over any navigable waters of the United States – or the accomplishment of any other work affecting the course, location, condition, or physical capacity of such waters – is not lawful unless the work has been recommended by the Chief of Engineers and authorized by the Secretary of the Army.[1125] The Secretary's approval authority has been delegated to the Chief of Engineers.[1126]

Section 10 permits are required for activities including structures such as piers, jetties, and other construction in the navigable waters of the United States.[1127] The Army Corps' regulations also provide that "permits are required under section 10 for structures and/or work in or affecting navigable waters of the United States."[1128] The precise definition of "navigable waters of the United States" is still in flux after the Sackett decision.[1129] Regardless of the exact scope of this definition, there should be no questions that the pier will be constructed in waters that are "navigable." States may have similar requirements to those established under Army Corps regulations.[1130]

[1122] 33 U.S.C. §401 et seq.
[1123] *Id. See also* Office for Coastal Management, 2023: Rivers and Harbors Act, at https://perma.cc/X453-NNH3.
[1124] 33 U.S.C. § 403.
[1125] *Id.*
[1126] Office for Coastal Management, 2023: Rivers and Harbors Act, *supra* note 1123.
[1127] 33 U.S.C. § 403, which reads as follows: "The creation of any obstruction not affirmatively authorized by Congress, to the navigable capacity of any of the waters of the United States is prohibited; and it shall not be lawful to build or commence the building of any wharf, pier, dolphin, boom, weir, breakwater, bulkhead, jetty, or other structures in any port, roadstead, haven, harbor, canal, navigable river, or other water of the United States, outside established harbor lines, or where no harbor lines have been established, except on plans recommended by the Chief of Engineers and authorized by the Secretary of the Army; and it shall not be lawful to excavate or fill, or in any manner to alter or modify the course, location, condition, or capacity of, any port, roadstead, haven, harbor, canal, lake, harbor or refuge, or inclosure (sic) within the limits of any breakwater, or of the channel of any navigable water of the United States, unless the work has been recommended by the Chief of Engineers and authorized by the Secretary of the Army prior to beginning the same."
[1128] 33 CFR § 322.3(a).
[1129] *Sackett v. Environmental Protection Agency,* 598 U.S. (May 25, 2023). After the *Sackett* decision, agencies are updating their definition. *See* U.S. Environmental Protection Agency, Waters of the United States, at https://perma.cc/VC83-NEWK.
[1130] Louisiana, for instance, requires similar information for permits within the coastal zone. *See* U.S. Corps of Engineering, New Orleans District, at https://perma.cc/LN6K-BN4A.

The Army Corps' regulations are also in flux,[1131] but construction of a new pier, jetty, or dock built to assist carbon storage is unlikely to be subject to any nationwide permits (NWP)[1132] or regional permits by the Army Corps.[1133]

2.2 Army Corps' public interest review

The RHA does not explicitly require the Army Corps to consider the "public interest" when issuing permits under Section 10 of the RHA or Section 404 of the Clean Water Act.[1134] The Army Corps, however, has issued regulations requiring the consideration of public interest when issuing permits. This is referred to as the Army Corps' public interest review.[1135] Current regulations require a finding that the proposed structure or work is in the public interest prior to the issuance of any Corps permits, which involves the evaluation of the probable impacts, including cumulative ones, of the proposed activity and its intended use on the public interest. Determining what constitutes public interest under the RHA or CWA requires a careful weighing of all those factors which become relevant in each particular case.[1136]

Consequentially, the decision of whether to authorize a proposed activity is based on a balancing test in which the Army Corps must weigh the benefits that may be reasonably expected to accrue from the proposal against the detriments that are reasonably foreseeable from the project.[1137] Specifically, the regulations provide that the Army Corps must consider "[a]ll factors which may be relevant to the proposal," such as "general

[1131] The White House, *Fact Sheet: Biden-Harris Administration Outlines Priorities for Building America's Energy Infrastructure Faster, Safer, and Cleaner* (May 10, 2023) (Highlighting, among the objectives of the Administration's permitting reforms, the improvement of efficiency and predictability).

[1132] US Army Corps of Engineers Permit, *USACE Jurisdiction determinations and permit decisions*, at https://perma.cc/U8VL-NATM. (The Corps has issued several programmatic general permits and regional general permits for its Galveston District, which covers the Gulf coast from Louisiana. Carbon dioxide ships appear unlikely to qualify under nationwide permits (NWP) by the Corps. *See* DEPARTMENT OF DEFENSE: DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, REISSUANCE AND MODIFICATION OF NATIONWIDE PERMITS: FINAL RULE, 86 Fed. Reg. N. 245, 73522, 73572 (Dec. 27, 2021). The list includes, among others, aids to navigation; structure in artificial canals; maintenance; fish and wildlife harvesting, enhancement, and attraction devices and activities; scientific measurement devices; survey activities; outfall structures and associated intake structures).

[1133] Regional general permits, which are agency specific for the location, would apply to dredging should this work eventually be determined as required for the pier's construction. Additional information was gathered as follows. US Army Corps of Engineers New Orleans District Website: General Permits, at https://perma.cc/HUD3-F699 (For New Orleans); and US Army Corps of Engineers Galveston District Website, at https://perma.cc/7J7L-EGF4 (For Texas).

[1134] Burger & Wentz, *supra note 1093*, at 121.

[1135] 33 C.F.R.§320.1(a) 1 (May 23, 2023) (Highlighting that the review reflects national concerns over both the protection and utilization of natural resources).

[1136] 33 C.F.R.§320.4 (a) (May 23, 2023) (*In practice, Section 10 and 404 (wetlands) permits are referred together. See, e.g.,* U.S. Corps of Engineers*, Notice of Intent to Prepare an Environmental Impact Statement for the Proposed Mid-Breton Sediment Diversion, in Plaquemines Parish, Louisiana*, 85 Fed. Reg., N.128, 39892 (Jul. 2, 2022), at https://perma.cc/BAG7-WXUH (Asserting that "under section10/ 404, the engineer issue permits." *Id.* at 39893).

[1137] 33 C.F.R.§320.4 (a) (May 23, 2023).

environmental concerns," "energy needs," "navigation," "mitigation," and "in general, the needs and welfare of the people."[1138]

Under the Army Corps' regulations, a permit is granted for construction or work unless the engineer determines it to be against the public interest.[1139] Several general criteria regarding public interest must be considered in the evaluation of every application, including (i) the extent of the public and private need for the proposed structure or work; (ii) whether there are unresolved conflicts regarding resource use, the practicality of using reasonable alternative locations, and methods to accomplish the objective of the proposed structure or work; and (iii) the extent and permanence of the beneficial and/or detrimental effects that the proposed structure or work is likely to accrue for the public or private uses of the area.[1140] Each of these factors are weighted in a concrete proposal.[1141] In addition, environmental benefits, economic benefits for the local community and for National Economic Development (NED) purposes, and pertinent mitigation actions are also factored in the decision of issuing a permit.[1142]

Under the Army Corps' regulation, permits shall not be issued to a nonfederal applicant until a certification has been provided by the state agency ensuring that the proposed activity complies with the coastal zone management program, and the appropriate state agency has either concurred with that certification or has waived its right to do so.[1143] Importantly, a permit may be issued to a nonfederal applicant if the Secretary of Commerce, acting on their own initiative or upon appeal by the applicant, finds that the proposed activity is consistent with the objectives of the Coastal Zone Management Act (CZMA) or is necessary in the interest of national security.[1144] Consistency with plans under CZMA is required if the applicant is not a federal agency and

[1138] *Id.* (Stating that: "All factors which may be relevant to the proposal must be considered including the cumulative effects thereof: among those are conservation, economics, aesthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shore erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership and, in general, the needs and welfare of the people.").

[1139] 33 C.F.R.§320.4 (a) 1 (May 23, 2023) (Providing that: "Subject to . . . any other applicable guidelines and criteria (*see* §§ 320.2 and 320.3), a permit will be granted unless the district engineer determines that it would be contrary to the public interest.").

[1140] 33 C.F.R.§320.4 (a) 2 (May 23, 2023).

[1141] 33 C.F.R.§320.4 (a) 3 (May 23, 2023) (Explaining the following: "A specific factor may be given great weight on one proposal, while it may not be present or as important on another. However, full consideration and appropriate weight will be given to all comments, including those of federal, state, and local agencies, and other experts on matters of their expertise.").

[1142] 33 C.F.R.§320.4 (p), (q), and (r), respectively (May 23, 2023).

[1143] 33 C.F.R.§320.4 (h) (May 23, 2023).

[1144] *Id.* (Further providing that "Federal agency and Indian tribe applicants for DA permits are responsible for complying with the Coastal Zone Management Act's directives for assuring that their activities directly affecting the coastal zone are consistent, to the maximum extent practicable, with approved state coastal zone management programs.").

if constructing the pier or jetty affects the coastal zone.[1145] The Secretary of Commerce is authorized to overrule eventual state objections in limited circumstances, including in the interest of national security.[1146]

Following the analysis above, this section concludes that permits for the construction of a new pier or jetty are subject to the Army Corps public interest review. Since criteria for public interest reviews are significantly less specific than those required for NEPA review, litigation often strategically targets the scope of NEPA review.[1147] Moreover, courts give broad deference to the Army Corps' public interest consideration.[1148]

2.3 Army Corps permits and NEPA

In addition to the agency's internal public interest review requirements, the Army Corps of Engineers' permit requirements also invoke NEPA, since agencies must consider the environmental impacts of their actions[1149] when undertaking a "major federal action," including issuing permits.[1150] In line with NEPA, Army Corps regulation provides that the agency's EIS should consider both significant environmental impacts as well as alternatives to the proposed action.[1151] As an initial consideration, an agency may prepare an Environmental Assessment (EA) to decide if a proposed action may "significantly affect" the environment and thus trigger the

[1145] 33 C.F.R. § 325.2(b)(2)(ii) (May 31, 2023) (Stating that: "If the applicant is not a federal agency and the application involves an activity affecting the coastal zone, the district engineer shall obtain from the applicant a certification that his proposed activity complies with and will be conducted in a manner that is consistent with the approved state CZM Program. Upon receipt of the certification, the district engineer will forward a copy of the public notice (which will include the applicant's certification statement) to the state coastal zone agency and request its concurrence or objection. If the state agency objects to the certification or issues a decision indicating that the proposed activity requires further review, the district engineer shall not issue the permit until the state concurs with the certification statement or the Secretary of Commerce determines that the proposed activity is consistent with the purposes of the CZM Act or is necessary in the interest of national security." Likewise, no permit shall be issue in Marine Sanctuaries, under "Title III of the Marine Protection, Research and Sanctuaries Act of 1972, as amended, and can be carried out within the regulations promulgated by the Secretary of Commerce to control activities within the marine sanctuary." *See also* 33 C.F.R.§320.4 (i).

[1146] 33 C.F.R.§320.4 (h) (Stating: "[p]ermit may be issued to a non-federal applicant if the Secretary of Commerce, on his own initiative or upon appeal by the applicant, finds that the proposed activity is consistent with the objectives of the Coastal Zone Management Act of 1972 or is otherwise necessary in the interest of national security.").

[1147] *See, generally,* Timothy J. Hagerty, *Beyond Section 404: Corps Permitting and the National Environmental Policy Act,* 32 ELR 10853, 10859 (2002).

[1148] *See, e.g.,* Residents for Sane Trash Solutions, Inc. v. United States Army Corps of Eng'rs, 31 F. Supp. 3d 571, 590–91(internal citations omitted) (The court held that Corps' own public interest analysis was thorough, justifying it as follows: "Nearly half of the Corps' MFR analyzes the CWA's public interest factors. (USACE 138-99.) The Corps considered thousands of public comments. (USACE 4985-10224.) Plaintiffs cannot credibly claim the Corps did not consider issues such as the economic effects of the 91st St project, aesthetic issues resulting from the construction of a larger MTS, environmental concerns pertaining to the East River and its marine habitat or flood hazards.").

[1149] 42 U.S.C. § 4332(2)(C).

[1150] 40 CFR § 1508.1 (q) (3) (May 26, 2023) (Detailing that: "Federal actions tend to fall within one of the following categories: . . . (iv)Approval of specific projects, such as construction or management activities located in a defined geographic area. Projects include actions approved by permit or other regulatory decision as well as federal and federally assisted activities.").

[1151] 40 C.F.R. §§1502.1, 1502.2,1502.14, 1508.1(j) (May 26, 2023) (Discussing the purpose of an EIS, its implementation, consideration of alternatives and the definition of an EIS, respectively).

need to prepare an EIS.[1152] Importantly, if there is a substantive question if an action "may have a significant effect" on the environment, the agency must prepare an EIS.[1153]

None of the categorical exclusions under the Army Corps' regulation are likely to be applicable for the construction of a pier or jetty.[1154] Categorial exclusions under NEPA are also unlikely to apply, as the RHA is not listed.[1155] Therefore, this report proceeds with its comprehensive analysis assuming that NEPA review would be necessary for such a structure.

Major actions potentially requiring Army Corps' approval are now subject to a pre-consultation procedure.[1156] The Army Corps' current regulations include both pier and jetty within its definition of "structure," as well as aid to navigation and any other obstacle or obstruction.[1157] Army Corps regulation defines *"individual permit"* as an authorization issued following the case-by-case evaluation of a specific structure or work in accordance with the procedures of the Army Corps' regulation, and a determination that the proposed structure or work is in the public interest.[1158] Permit applications for any construction that is likely to be pertinent to piers or jetties also require a detailed description of the whole project.[1159] The Corps regulations provide for cooperation between state, tribal and local authorities to avoid duplication of NEPA procedures.[1160]

Under Army Corps regulations, should the construction of a pier be required, the district engineer determines if an EA or an EIS would be required in cases where the pier would be a part of a larger project.[1161] In the context of this report, the construction of a new, purpose-built jetty appears to be similar to this pier scenario for legal purposes.

[1152] 40 C.F.R. § 1508.1 (h) (May 26, 2023).

[1153] *See, e.g.,* Blue Mountains Biodiversity Project v. Blackwood, 161 F.3d 1208, 1212 (9th Cir. 1998).

[1154] 33 C.F.R. §230.9 (May 23, 2023) (Listing as limited categorical exclusions: real state grants for rights-of-way with minor disturbances to earth, air or water; and real estate grants for Government-owned housing; among others).

[1155] Executive Office of the President of the United States, NEPA Categorical Exclusions (May, 2021), at https://ceq.doe.gov/nepa-practice/categorical-exclusions.html.

[1156] 33 C.F.R. § 325. 1 (b) (May 26, 2023) (Providing as follows: "Whenever a potential applicant indicates the intent to submit an application for work which may require the preparation of an environmental document, a single point of contact shall be designated within the district's regulatory staff to effectively coordinate the regulatory process, including the National Environmental Policy Act (NEPA) procedures and all attendant reviews, meetings, hearings, and other actions, including the scoping process if appropriate, leading to a decision by the district engineer.").

[1157] 33 C.F.R. § 322.2 (b) (May 23, 2023).

[1158] 33 C.F.R. § 322.2 (e) (May 23, 2023) (Public interest is defined in 33 C.F.R. § 320, as presented in the previous subsection).

[1159] 33 C.F.R. § 325.1 (d) 5 (May 23, 2023) (Stating: "the activity would include the construction of a filled area or pile or float-supported platform the project description must include the use of, and specific structures to be erected on, the fill or platform.").

[1160] 33 C.F.R. §325, Appendix B, § 4 (May 23, 2023).

[1161] 33 C.F.R. § 325, Appendix B, § 7(b)(1) (May 23, 2023), NEPA Implementation Procedures for the Regulatory Program, at https://perma.cc/M2ND-68XH. (Discussing the following: "In some situations, a permit applicant may propose to conduct a specific activity requiring a Department of the Army (DA) permit (e.g., construction of a pier in a navigable water of the United States) which is merely one component of a larger project (e.g., construction of an oil refinery on an upland area). The district engineer should establish the scope of the NEPA document (e.g., the EA or EIS) to address the impacts of the specific activity requiring a DA permit and those portions of the entire project over which the district engineer has sufficient control and responsibility to warrant Federal review." The same provision underscores that additional guidance will be issued as cases develop).

Appendix B of the Army Corps regulation provides some additional guidance on how NEPA may apply to this type of project. For regulated activities that "comprise merely a link in a transportation or utility transmission project," the scope of analysis should address the federal action – *in other words,* the specific activity requiring the Army Corps permit and any other portion of the project that is within the control or responsibility of the Army Corps or other federal agencies.[1162]

The implication of "other federal agencies" could be relevant for this report, particularly if the construction of both the pier and the sequestration facility are integrally related. This kind of construction integration is one possible, albeit unlikely, interpretation of how this project would be executed in practice. However, should this be the case, it may lead to the inclusion of the subsequent carbon dioxide sequestration in the Army Corps' NEPA review for the pier or jetty if the sequestration occurs under the control of another federal agency bound by NEPA. (Note that most EPA actions are exempt from NEPA by statute or under the "functional equivalence" doctrine).

Appendix B of the Army Corps' regulation also states that, for any activities that require a permit for a major portion of a shoreside facility, the scope of NEPA analysis should also extend to upland portions of the facility.[1163] The regulation uses a shipping terminal as an example, which normally requires dredging, wharves, bulkheads, berthing areas, and disposal of dredged material in order to function. In this case, "permits for such activities are normally considered sufficient federal control and responsibility to warrant extending the scope of analysis to include the upland portions of the facility."[1164]

Taken together, it seems as though an EIS may be required for the construction of a pier or jetty.[1165] The precise scope of the NEPA review would depend on the factual circumstances of the project and how the Army Corps interprets these circumstances.

The debate over the scope of the Army Corps' NEPA analysis is among the most common and controversial examples of the so-called "small federal handle problem" – in short, at what point does federal involvement in

[1162] 33 C.F.R. § 325, Appendix B, § 7(b)(1) (May 23, 2023) (Detailing the following: "For example, a 50-mile electrical transmission cable crossing a 1¼-mile-wide river that is a navigable water of the United States requires a DA permit. Neither the origin and destination of the cable nor its route to and from the navigable water, except as the route applies to the location and configuration of the crossing, are within the control or responsibility of the Corps of Engineers. Those matters would not be included in the scope of analysis which, in this case, would address the impacts of the specific cable crossing.").
[1163] 33 C.F.R. § 325, Appendix B, § 7(b).
[1164] 33 C.F.R. § 325, Appendix B, § 7(b).
[1165] *See, e.g.,* Ocean Advocates v. United States Army Corps of Eng'rs, 402 F.3d 846, 865 (U.S. Court of Appeals for the Ninth Circuit, Mar. 4, 2005) (In this 2005 decision, the Ninth Circuit reversed the trial court and ultimately held that the Corps has failed to provide the requisite convincing statement of reasons explaining why the dock extension to BP "[w]ould have only a negligible impact on the environment and therefore has left us unpersuaded that it took a 'hard look' at the environmental impact of the dock extension. Moreover, the permit necessitated an EIS because OA raised a substantial question as to whether the dock extension *may* cause *significant* degradation of the environment."). (emphasis in original).

a project proposed by a nonfederal actor (whether a private party, state, or local government, among others) "federalize" the entire action and subjects the whole activity to NEPA requirements.[1166]

Within Army Corps permitting decisions, such a "handle" issue surfaces when determining whether the issuance of an Army Corps permit for a project with both federal and nonfederal elements requires the nonfederal portion to be included in the scope of the NEPA review – and, if this is the case, the degree of this NEPA review.[1167] This is consequential, as this determination will impact "whether the reasonable range of alternatives evaluated in the NEPA document must include alternatives to the specific elements within Corps jurisdiction, or alternatives to the overall project."[1168]

As mentioned previously, Appendix B of the Army Corps regulation specifically addresses the scenario in which a permit applicant proposing to conduct an activity requiring an Army Corps permit is actually conducting a larger-scale project in which the permit activity is merely one component.[1169] The scope of the Army Corps NEPA review defines the degree of federal control and responsibility over a nonfederal project. Over the years, federal courts have identified two main forms in which this definition occurs: legal control and factual control.[1170]

A project may become federalized if an agency exercises legal control over the project; in other words, when federal action is a condition antecedent to accomplish the entire nonfederal project. Courts often refer to "legal control" as "enablement."[1171] Appendix B specifically mentions that federal control and responsibility will be extended to the portions of the project beyond the limits of Army Corps jurisdiction where environmental consequences are essentially products of federal financing, assistance, direction, regulation, or approval.[1172]

Our review of current case law did not yield controlling cases specifically on the construction of piers or jetties under Section 10 of the RHA.[1173] The scope of the Army Corps' NEPA review has been litigated more recently,

[1166] Hagerty, *supra* note 1147, at 10854.
[1167] *Id*.
[1168] *Id*.
[1169] 33 C.F.R. § 325, Appendix B, § 7(b)(1) (May 23, 2023).
[1170] Hagerty, *supra* note 1147, at 10856.
[1171] *See, e.g.,* Winnebago Tribe of Neb. v. Ray, 621 F.2d 269, 272 (8th Cir. 1980) (A case litigating the construction of power line that required a section 10 permit. The court held that the proposed construction has not been federalized as the Corps' permits were limited to the power line located in jurisdictional waters; not the construction of the entire power line). Appendix B of the Corps regulation, as previously quoted, details this requirement: sufficient "control and responsibility" will be assessed in light of several factors, including if the regulated activity comprises "merely a link" in a corridor type project (*e.g.,* a transportation or utility transmission project), "the extent to which the entire project will be within Corps jurisdiction," and "the extent of cumulative Federal control and responsibility."). *See also* 33 C.F.R. § 325, Appendix B, § 7(b)(2) (May 23, 2023).
[1172] 33 C.F.R. § 325, Appendix B, § 7(b)(2)(iv) (a) (May 23, 2023) (Excluding funding assistance solely in the form of general revenue sharing funds, with no Federal agency control over the subsequent use of such funds, and not including judicial or administrative civil or criminal enforcement actions).
[1173] *See* 33 C.F.R.§320.4 (a) (May 23, 2023) (As previously noted, this would also include permits under Sections 401 and 404).

and both the agency and the courts appear prone to limit its review to the specific activity being permitted by the Army Corps.[1174]

Our research also yields three cases in which NEPA review was required for projects involving the construction of jetty, docks or LNG terminals where the Army Corps was the lead agency, from 2018 to 2023.[1175] Most of the projects with the Army Corps as a lead agency in the EPA's database across this time period shows that the Army Corps' NEPA review focused on projects involving the Section 408 program of the Army Corps. This section regulates the Army Corps' Civil Work Program and involves partnerships between the Army Corps and project stakeholders to manage the country's water resources, specifically focusing on the construction of dams, lake improvements, coastal flooding risk, coastal storm risk, flood damage reduction, and other similar construction projects.[1176]

[1174] *See, e.g.,* Residents for Sane Trash Solutions, Inc. v. United States Army Corps of Eng'rs, 31 F. 3d 571, 588-89 (9th Cir. 2014) (The court upheld the Corps' determination that the activity requiring the permit was limited to dredging and filling in a small area of U.S. waters and the construction (not the operation) of an enlarged Marine Transfer Station (MTS) platform; it also ruled as valid the Corps' conclusion that it did not have sufficient control and responsibility over post-construction operations to warrant an expanded review beyond the specific activity requiring the permit. The Court underscored that the mere requirement that the project could not have been built without a Corps' permit was insufficient to require that the whole project would fall within the Corps' jurisdiction and explaining that NEPA's scope of review is assessed on a "case by case analysis." *See also* Wetlands Action Network v. U.S. Army Corps of Eng'rs, 222 F.3d 1105, 1116–17 (9th Cir. 2000) (The court referred to the 33 C.F.R. pt. 325, app. B § 7(b)(3)), and concluded that the need for Corps permit does not necessarily put the complete project within the Corps' purview); and, more recently, *see* Sierra Club v. United States Army Corps of Eng'rs, 997 F.3d 395, 402 (1st, 2021) (Upholding the Corps' limited review in a case involving the private construction of an electric transmission corridor in Maine that required Corps' permits for the permanent and temporarily filling of wetlands as well as for the construction of an under-river tunnel. In particular, the Court highlighted that the Corps "[r]epeatedly emphasized that activities requiring a Corps permit 'comprise approximately 1.9% of the total project corridor.' The Corps also found that the total cumulative federal oversight was insufficient to 'federalize' the entire project. It stated, 'the scope of review . . . does not overlap with other federal agencies' review.").

[1175] NEPAccess, for instance, yielded no results for projects involving the construction of LNG terminals that has the Corps as a lead agency. NEPAccess, at https://perma.cc/HV9G-P5JD.The EISs discussed below are available at the EPA's EIS database. *See* Environmental Protection Agency, Environmental Impact Statement (EIS) database, at https://perma.cc/27X5-GJJE.

[1176] U.S. Corps of Engineers, *Port of Long Beach Deep Draft Navigation Feasibility Study* (Aug. 10, 2021), at https://perma.cc/7LK4-D3T5.

Our research found two recent EISs that were conducted following court orders, where the courts held that an EIS was required.[1177] One of these EISs, issued for the *B.P.Cherry Point Dock,*[1178] appears to support our point: the Corps only considered the portions of the project over which it had jurisdiction. Our research also found three NEPA reviews where the Army Corps was the lead agency that ended up triggering the Army Corps' review of the entire project.[1179] However, these three decisions are not "small handle" cases, as the entire proposed project did fall within the Army Corps' review due to the large proportion of the Army Corps' involvement in the entire project.

In summary, our analysis of these recent NEPA reviews in which the Army Corps was the lead agency shows that the Army Corps is mindful of the necessary scope of NEPA review. Overall, the Army Corps appears reluctant to expand the scope of its NEPA review beyond the permits or specific action that the agency is required to analyze. Several factors are relevant in both the Army Corps' determination of the scope of its NEPA review and whether courts are likely to defer to the agency's decision, including whether the Army Corps will have federal control and responsibility over a nonfederal project.

It is clear that the scope of NEPA review is established on a case-by-case basis, as previously held by courts. Our analysis of judicial decisions and recent EISs shows that both the Army Corps and the courts have generally been reluctant to expand the agency's environmental review beyond the scope of the Army Corps' jurisdiction. Ultimately, additional details regarding the type of pier or jetty will be helpful to the determine of the precise scope of the NEPA review required under the Corps regulations and its related Appendix.

[1177] U.S. Corps of Engineers, *B.P. Cherry Point Dock: Final EIS*, ES-3 (Aug. 2022): "Because the scope of this EIS is limited to the incremental environmental risk of operating the North Wing dock at the terminal, operation of the BP Cherry Point Refinery (BP refinery or the refinery) itself, including the tank farm and interconnecting piping, is not considered in this EIS."; and U.S. Corps of Engineers, *Surry to Skiffes Creek to Whealton Project,* at iii and ES- 42 (Feb. 10, 2021), which was litigated in Nat'l Parks Conservation Ass'n v. Semonite, 916 F.3d 1075, 1082-1083 (D.C. Cir.2021) (Holding that: "Whether a project has significant environmental impacts, thus triggering the need to produce an EIS, depends on its 'context' (region, locality) and 'intensity' ('severity of impact'). Here, because all parties agree that the historically-saturated 'context'—i.e., this 50-mile stretch of the James River—qualifies as significant, our inquiry focuses on the 'intensity' element, which enumerates ten factors that 'should be considered.' Implicating any one of the factors may be sufficient to require development of an EIS." The Court ultimately decided that the project would implicate three such factors: the degree to which the effects on the quality of the human environment are likely to be highly controversial; the unique characteristics of the geographic area such as proximity to historic or cultural resources; and the degree to which the action may adversely affect districts or sites listed (or eligible for) in the National Register of Historic Places. It concluded that the project not only would impact historical sites but also would benefit from an EIS).

[1178] U.S. Corps of Engineers, *B.P. Cherry Point Dock: Final EIS*, ES-3, *supra* note 1177.

[1179] EPA, Environmental Impact Statement Database, at https://perma.cc/R949-ML27. (In a federal project for navigation improvements for the Port of Long Beach, Los Angeles County, California, the construction of piers was considered within the scope of the larger project of enhancement: *see* U.S. Corps of Engineers, *Port of Long Beach Deep Draft Navigation Feasibility Study* (Aug. 10, 2021); In an expansion project of a highway from West Point to Scriber, Nebraska, the Corps' NEPA review included the entire project as the expansion required Corps permits due to the extended federal location of the project: *see* U.S. Corps of Engineers, *U.S. Highway 275 West Point to Scribner Expressway: EIS* (Apr. 4, 2021); and, finally, *see* U.S. Corps of Engineers, *Alaska Stand Alone Pipeline Project: SEIS*, 1-7 (Jul. 18. 2018) (In this 2018 supplemental environmental impact assessment (SEIS), the Corps extended their NEPA review to the complete project given the proposed Alaskan pipeline crossed waters of the United States and required dredging of significant materials throughout its construction)).

2.4 State regulations and permits for coastal use

Assuming a new pier or jetty needs to be built, state legislation could potentially require additional permits beyond those issued by the Army Corps. Given that Louisiana and Texas are the most likely recipients of carbon dioxide shipments from overseas, this analysis proceeds to detail the relevant state laws regulating construction on coastal waters is detailed below.

Louisiana law presents different permit classes for the construction or work involved in the state's coastal zone. It provides that "Any person desiring to construct, create, alter, improve, extend, or maintain any wharf, pier, dock. . . structure, or other encroachment"[1180] needs to obtain a permit from the State Land Office.[1181] While noncommercial piers and wharves are not subject to permit requirements,[1182] since this probable pier will be for commercial uses, it is likely to require a Class C permit under this state statute.[1183] Louisiana administrative code also highlights that a Class C permit is needed for the construction of commercial piers and wharves.[1184] The permit application procedure requires that the applicant notify the commissioner of the Division of Administration in writing of their intent to apply for a permit for the work contemplated.[1185]

Legal analysis regarding the construction of a new pier or jetty to offload carbon dioxide in Louisiana is relatively straightforward. Since the project falls under the jurisdiction of the Army Corps of Engineers and federal permits will be sought from that agency, Louisiana allows that these permit applications submitted to the Army Corps may be also submitted to the Division of Administration in lieu of the specific procedure detailed in the Louisiana law.[1186] Once these permit requirements are met, a lease agreement is needed.[1187] This agreement will be entered between the applicant and the Commissioner of the Division of Administration to operate or maintain

[1180] LA Rev Stat § 41:1706 (A)(2017).
[1181] La. R.S. § 41:1701.1.
[1182] La. R.S. § 41:1706 (B).
[1183] LA Rev Stat § 41:1706 (A)(3)(2017) (Stating that: "(3) Class C Permits: Permits to construct commercial wharves and piers.").
[1184] La. Admin. Code tit. 43 § XXVII-230 (A), at https://perma.cc/B7KB-VUMT. This Louisiana law provides: "Exempted from permit and lease requirements are commercial and noncommercial wharves and piers less than 50 linear feet whose surface area does not exceed 150 square feet, unless part of another encroachment or unduly interferes with public interests, navigation or fishery." As previously discussed, it is unlikely that the pier, which will assist large ships, would qualify under this exception.
[1185] La. Admin. Code tit. 43 § XXVII-230 (B) to (D) (Section (D) further details: "Applications must be submitted in triplicate to the commissioner of the Division of Administration, and each application must include the following: 1. application form as provided by the Division of Administration; 2. approval of the parish governing authority for the project; 3. a certified deed of ownership (of the lands contiguous to public lands); 4. if the applicant is not the owner, a certified copy of the deed or other instrument under which the owner holds title plus written permission for the applicant to carry out the project.").
[1186] La. Admin. Code tit. 43 § XXVII-230 (E) (This is the case provided that all copies are clear and legible, and the Corps permit application contains all the information required by the La. Admin. Code).
[1187] La. Admin. Code tit. 43 § XXVII-230 (F) (Detailing that all Class C permits require a lease).

the encroachment; consideration for the agreement will be calculated based on the size and nature of the encroachment.[1188]

In Texas, however, this legal analysis is less straightforward. Under Texas law, any person interested in the acquisition of rights in the surface estate of any coastal public land needs to submit a written application[1189] to the School Land Board.[1190] The Board may grant an interest in coastal public land to any person if the Board determines that the grant is in the best interest of the state.[1191]

There are two approaches that may be applicable to the construction of a commercial pier to assist in the transportation of carbon dioxide for storage.[1192] In the first approach, the Board may grant an easement for purposes related to either the ownership of littoral property – which could be too cumbersome for the project developer building the pier or jetty – or "connected with the operation of a facility operated by an existing channel and dock corporation" under Texas law. Should this be the case, the Board may grant easement rights to construct projects such as channels, wharves, or docks to this existing corporation under Tex. Nat. Res. Code § 33.111(b).[1193] Despite not specifically mentioning "pier," this provision may be of interest for the construction of a commercial pier. Wharves are often synonymous with piers, as both serve similar purposes in assisting with loading and unloading vessels.

That being said, Section 33.111(b) of the Texas Natural Resources Code specifically requires the project developer to be an existing channel and dock corporation that has been issued articles of incorporation under Texas law.[1194] From a pragmatic standpoint, this incorporation requirement may pose some bureaucratic challenges. However, the only way a corporation may use or acquire property from the State of Texas is if it conforms with this provision.[1195] To add more complexity, these piers need to be registered with the Board,[1196] and the construction of all structures in the water based on leases also require an applicant to fill out a detailed form that includes information on dredging materials.[1197] This form needs to be certified by a Texas registered

[1188] *Id.* (Providing that: "Leases: 1. All Class C and D permits are accompanied by a lease agreement described as follows: a. after fulfilling the requirements for a structure permit, the applicant and the commissioner of the Division of Administration shall enter into a lease agreement to operate or maintain the encroachment.").
[1189] Tex. Nat. Res. Code § 33.101
[1190] Tex. Nat. Res. Code § 31.001(2).
[1191] Tex. Nat. Res. Code § 33.105.
[1192] Tex. Nat. Res. Code § 33.115 (Non-commercial piers of small dimensions may be exempt).
[1193] Tex. Nat. Res. Code § 33.111(b) (Stating that: "The board may grant easement rights to construct channels, wharves, docks, and marinas to an existing corporation that was issued articles of incorporation under Chapters 13 and 14, Title 32, Revised Statutes.").
[1194] Tex. Nat. Res. Code § 33.103 (a) 2 (B), *supra* note 227.
[1195] Tex. Nat. Res. Code § 33.111(c).
[1196] Tex. Nat. Res. Code § 33.115(c), stating: "The location and dimensions of the pier and description of any associated appurtenances must be registered with the board in the manner provided in this chapter."
[1197] State of Texas: Texas General Land Office: Application for State Land Use Lease (Commercial/Multi-Family), at https://perma.cc/7ULT-GXUX.

public land surveyor.[1198] On the bright side, Texas authorizes single permits for state agencies or departments if more than one permit is required for the activity involving the easement.[1199]

In the second approach, the Board has a catch-all provision that allows it to grant any other interest in coastal public land for any purpose, so long as the Board determines this would be in the best interest of Texas.[1200] Here, the challenge arises in determining the precise interest that the Board could grant, given that this provision applies to "any other interest."[1201] Given the limitations for both options, it is difficult to determine which of the two options would be preferable.

In conclusion, Louisiana and Texas may require additional state permits for the construction of the pier and related work. In Louisiana, a Class C permit is likely needed, but it can be replaced by the Army Corps national permits. If these Army Corps national permits are used and approved by the state, the project developer and Louisiana's commissioner of the Division of Administration must enter into a lease agreement. In Texas, the construction of a pier and related work may occur if authorized under a lease, an easement, or an unnamed interest in coastal public land for any purposes the Board assesses will be in the best interest of the state.

Any party wishing to build a pier would, of course, need to engage environmental counsel in Louisiana or Texas, as the case may be, to advise in more detail on the applicable permit requirements and procedures.

2.5 Fixing America's Surface Transportation (FAST-41)

Carbon capture, usage and storage projects are considered "covered projects" under the Fixing America's Surface Transportation Act, or FAST-41.[1202] FAST-41 seeks to streamline the timeframe, predictability, and transparency of federal environmental review and authorization procedures for significant infrastructure projects, and specifically contemplates carbon dioxide and storage projects.[1203]

In general, with many CCS projects expected to take advantage of the 45Q tax credit available for carbon dioxide storage,[1204] some new carbon capture facilities and storage sites are likely to be created. Importantly, no carbon sequestration facility is being built specifically for the current project discussed in this report. Rather, carbon dioxide from ships will be transported to sequestration facilities already being planned and built by other companies to serve a number of customers.

[1198] *Id.*

[1199] Tex. Nat. Res. Code § 33.118.

[1200] Tex. Nat. Res. Code § 33.103 (Stating that: "(a) The board may grant the following interests in coastal public land for the indicated purposes: (5) subject to Section 33.001(g), any other interest in coastal public land for any purpose if the board determines that the grant is in the best interest of the state." Importantly, Section 33.001(g) states that "the surface estate in coastal public land shall not be alienated except by the granting of leaseholds and lesser interests and by exchanges of coastal public land for littoral property as provided in this chapter.").

[1201] Tex. Nat. Res. Code § 33.103 (a) (1) and (2) (For leases and easements).

[1202] 42USC § 4370m et seq.

[1203] 42USC § 4370m (6) (A) and (C).

[1204] 26 USC§45 Q(a).

With that in mind, this section of our analysis considers whether the construction of a new pier or jetty could qualify for the streamlined procedure for review and permitting under FAST-41 covered projects. Firstly, FAST-41 centralized review would only be available if storage were not to occur in Class VI wells. Class VI wells are generally exempt from NEPA review due to the requirements of the Class VI Rule being considered as the functional equivalence analysis of NEPA.[1205]

The requirements for carbon capture and storage projects under FAST-41 include either (1) being subject to NEPA, not qualifying for abbreviated environmental review, and being likely to require an investment greater than two hundred million dollars, or (2) being subject to NEPA, with the FAST-41 Council determining that the project would benefit from joint oversight.[1206] While the transportation and storage components of the carbon dioxide operation for offshore storage in federal waters may qualify under these specific provisions,[1207] there is some uncertainty as to whether the construction of the pier or jetty could be included in the same project that ultimately benefits from FAST-41's centralized review and permitting process.

Considering the stated goals of the FAST-41 initiative as well as the fact that that surface transportation, ports, and waterways alone may qualify as covered projects under FAST-41,[1208] an argument could be made that the inclusion of a pier or jetty could qualify under FAST-41 on its own, depending on the cost, size, and structure of the facility. The cost of the construction of the pier itself may not surpass the $200 million-threshold, but proponents of the project could ask the FAST-41 Council for the benefit from joint oversight in a NEPA-subject project. Whether this pier or jetty could qualify for FAST-41 status is unclear, since no permits have been granted to FAST-41 projects for carbon dioxide storage to date.[1209]

Finally, it is worth reiterating that any associated tax implications are not within the scope of this report; this report merely flagged the issue of FAST-41 in connection with the scenario of the construction of the new pier.

[1205] U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells Final Rule, *supra* note 1054, at 77236.

[1206] 42 USC § 4370m (6) (Stating that: "Covered project (A) In general The term 'covered project' means any activity in the United States that requires authorization or environmental review by a Federal agency involving construction of infrastructure for renewable or conventional energy production, electricity transmission, surface transportation, aviation, ports and waterways, water resource projects, broadband, pipelines . . . , carbon capture, or any other sector as determined by a majority vote of the Council that— (i) (I) is subject to NEPA; (II) is likely to require a total investment of more than $200,000,000; and (III) does not qualify for abbreviated authorization or environmental review processes under any applicable law; . . . or (iv) is subject to NEPA and the size and complexity of which, in the opinion of the Council, make the project likely to benefit from enhanced oversight and coordination, including a project likely to require— (I) authorization from or environmental review involving more than 2 Federal agencies; or (II) the preparation of an environmental impact statement under NEPA. . . (C) Inclusion For purposes of subparagraph (A), construction of infrastructure for carbon capture includes construction of— (i) any facility, technology, or system that captures, utilizes, or sequesters carbon dioxide emissions, including projects for direct air capture . . . and (ii) carbon dioxide pipelines.").

[1207] 42 USC § 4370m (6). (*See also* our discussion in Chapter 5 for Class VI wells).

[1208] 42 USC § 4370m (6).

[1209] U. S. Government: Fast-41 Covered Projects, *Federal Infrastructure Projects: Permitting Dashboard*, at https://perma.cc/7CBD-SL25.

2.6 Summary of main findings

As discussed, Section 10 of the RHA (and Section 404 of the CWA) requires permits for certain activities in the navigable waters of the United States, including the construction of piers and jetties. This permit requirement may, in turn, invoke NEPA review. Importantly, this analysis is only relevant if a new pier must be constructed. If no new or substantially reconstructed pier is required, it does not seem that any Army Corps or NEPA review is required.

Furthermore, Army Corps regulations require a finding that the proposed structure or work is in the public interest prior to the issuance of any permits. The public interest analysis requires the careful weighing of several factors, including environmental impact, economics, energy needs, and the overall public interest in the proposal. These factors are considered and weighted in a holistic approach depending on the specificities of each project.

The Army Corps' NEPA review is handled on a case-by-case basis. Examples considered by Army Corps regulations and our review of recent EISs listing the Army Corps as the lead agency suggest that, even if an EIS is required, the review by the Army Corps is likely to be limited to the portions of the project that the agency would have control over. It is unlikely that the Army Corps would assess the environmental impact of the upstream cross-border transportation of carbon dioxide in their NEPA review. Considering the recent NEPA amendments preventing the consideration of exclusively extraterritorial effects, an EIS would also not need to consider the impacts of carbon dioxide storage in Europe, for instance. Accordingly, our findings indicate that any NEPA review by the Army Corps is likely to have limited scope.

Finally, additional permits, leases, or other authorizations from the states of Louisiana or Texas would be required should a new pier specifically constructed to receive carbon dioxide from ships be built in either of these states' coastal waters.

3. Conclusion

The NEPA analysis in Section 1 concluded that if an existing dock will be used to transfer carbon dioxide from ships to U.S. land, so long as the dock is not significantly modified below the water's surface, there does not seem to be any federal action subject to NEPA review. However, if a new dock must be built or the existing dock needs to be significantly modified under the water surface, Army Corps permits will be required. These permits would be subject to NEPA. However, the NEPA analysis would be limited to the impacts of the construction or modification of the dock. Ultimately, it is not certain that a full EIS will be required; the Army Corps may opt to issue a FONSI if the project will not have significant environmental impacts.

Finally, permits, leases or other authorizations from the states of Louisiana or Texas would be required if a new pier were to be built specifically to receive carbon dioxide from ships in those states.

CHAPTER 7: LIABILITY FOR CARRIERS OF CARBON DIOXIDE FOR PERMANENT STORAGE

Liability for carriers of carbon dioxide for storage is still a nascent topic in the literature.[1210] The practical implications of the topic are increasing, since on March 8, 2023, this international transportation occurred for the first time.[1211] As such, this chapter focuses on the main international legal aspects concerning the liability of carriers during the cross-border transportation of carbon dioxide for permanent storage purposes.[1212]

Liability is important to consider when analyzing the cross-border transportation of carbon dioxide because, put simply, shipping carbon dioxide may pose risks that lead to damages for which carriers may be liable. These shipments may pose risks to human life based on the quantities involved, the onboard conditions of storage, and the potential for eventual accidents.[1213] In the case of a spill, these shipments may pose hazards to both human life and marine life.

Environmental protection is an integral part of the regimes set forth by international law, as well as in the domestic legislation, case law and executive actions that implement these provisions.[1214] Protection of the marine environment has long revolved around several key actions, including ensuring that vessels are properly constructed, crewed and navigated according to national and international laws and best practices.[1215] Since it is inevitable that some accidents will occur, actions related to the prevention, clean-up conduct, and compensation for the parties and environment affected are also required.[1216]

However, transportation by sea is considered a unique activity from an international environmental standpoint. It not only bears specific regulation under international treaties developed within the auspices of the International Maritime Organization (IMO), but it also may be excluded from more general international environmental treaties.[1217] As such, this chapter analyzes key IMO conventions that apply to both the regulation and liability of shipping carbon dioxide.

[1210] *See* IPCC, IPCC Special Report on Carbon Dioxide Capture and Storage Prepared by Working Group III of the Intergovernmental Panel on Climate Change 188 (Bert Metz et al. eds., 2005) (Noting that an accident with a carbon dioxide tanker remains a knowledge gap that requires further study); Viktor Weber & Michael Tsimplis, *The UK liability framework for the transport of CO_2 for offshore carbon and capture operations*, 32 IJMCL 147 (2017).

[1211] Carolina Arlota, *Beyond Trouble Waters? Unprecedented cross-border transportation and injection of carbon dioxide (CO_2) shows promise*, Climate Law Blog (Mar. 23, 2023), at https://perma.cc/2NL2-GXLW. (Discussing the experimental demonstration of the first cross-border transportation of carbon dioxide for storage in the world, shipping it from Belgium for permanent storage in Denmark).

[1212] Research about pollution caused by vessels carrying oil and issues relating to wreck removal as well as detailed analyses of construction and inspection of vessels are, therefore, excluded from this analysis. These topics are treated in specific IMO Conventions. *See, e.g.,* the International Convention on Civil Liability for Oil Pollution Damage and the Fund Conventions, Nov. 27, 1992, (entered into force on May 30, 1996), 1956 U.N.T.S. 255 (Regulating the liability for oil carriers); and the Nairobi International Convention on the Removal of Wrecks, May 18, 2007 (entered into force on Apr. 14, 2015), 3283 U.N.T.S. 55565.

[1213] Andy Brown et al., *IMPACTS: Framework for Risk Assessment of CO_2 Transport and Storage Infrastructure*, Energy Procedia 6501, 6504 (2017).

[1214] Douglas Brubaker, Marine Pollution and International Law: Principles and Practice 1 (1993).

[1215] Douglas J. Cusine & John P. Grant, *Introduction in* The Impact of Marine Pollution 24 (Douglas J. Cusine & John P. Grant eds., 1980).

[1216] *Id.*

[1217] *See, e.g.,* The Convention on Civil Liability for Damage Resulting from Activities Dangerous to the Environment (This is a European Union Convention signed in Lugano: European Treaty Series (ETS) n. 150, Jun. 21, 1993) (Art. 4 states: "This Convention shall not apply to damage arising from carriage; carriage includes the period from the beginning of the process of loading until the end of the process

This chapter proceeds as follows. Following an introduction section that provides an overview of how liability may be triggered in the cross-border shipment of carbon dioxide, Section 2 discusses the international conventions established under the IMO that are specifically applicable to the potential shipping carbon dioxide. Section 3 provides an outline of contractual liability as it applies to carbon dioxide carriers, and Section 4 presents an analysis of the different liability regimes applicable under both the relevant IMO conventions as well as parties' autonomy based on contract law. Section 5 presents the main issues regarding admiralty and maritime jurisdiction, and Section 6 concludes.

1. Introduction

Before analyzing these conventions and their implications for carriers' liability, it is useful to first survey the nature of the potential environmental risks involved in transporting carbon dioxide by sea. Long-distance transportation of carbon dioxide would probably have similar accident rates as similar oil and gas vessel operations.[1218] While vessels transporting carbon dioxide face a lower risk of fire than that of LNG and LPG tankers, they have a higher risk of asphyxiation should a collision rupture a tank.[1219] The literature highlights that these risks can be minimized if standards used in LPG marine transportation are also made applicable to carbon dioxide operations.[1220]

In addition to fire and asphyxiation risks, an accident involving a carbon dioxide tanker may result in liquefied carbon dioxide being released onto the surface of the sea. Carbon dioxide would behave differently from LNG if spilled, since liquid carbon dioxide in a tanker is both warmer and much denser than LNG. While this release is not considered to have the long-term environmental impact of crude oil spills,[1221] carbon dioxide that is accidentally released would present complex interactions with the sea. Hydrates and ice may form, and temperature differences could induce strong currents; some of the gas would dissolve in the sea, while some would be released into the atmosphere.[1222] These risks can be minimized by several actions, including careful planning of routes as well as high standards for training and management.[1223]

Finally, the environmental risks from carbon dioxide shipments are not limited to accidents and spills. Other impacts include navigation hazards, including physical obstacles like unidentified submarine objects, variable

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of unloading. However, the Convention shall apply to carriage by pipeline, as well as to carriage performed entirely in an installation or on a site unaccessible to the public where it is accessory to other activities and is an integral part thereof.").

[1218] IPCC, IPCC Special Report on Carbon Dioxide Capture and Storage Prepared by Working Group III of the Intergovernmental Panel on Climate Change, *supra* note 1210, at 187.

[1219] *Id.* at 188–89.

[1220] *Id.* at 189.

[1221] *Id.*

[1222] IPCC, IPCC Special Report on Carbon Dioxide Capture and Storage Prepared by Working Group III of the Intergovernmental Panel on Climate Change, *supra* note 1210, at 187. (Highlighting that some specific conditions, such as little wind combined with a temperature inversion, may lead to the formation of carbon dioxide clouds and related risk of asphyxiation and potential stop to the ship's engines).

[1223] IPCC, IPCC Special Report on Carbon Dioxide Capture and Storage Prepared by Working Group III of the Intergovernmental Panel on Climate Change, *supra* note 1210, at 189.

river channels, or icebergs, as well as the pollution risks associated with bunkers, lubrication oils and other potentially hazardous materials onboard of the ship.[1224] These risks, however, are not different from those involved in the shipment other cargoes.

To protect against the risks involved in the cross-border transportation of carbon dioxide for permanent storage, carriers are likely to be covered under insurance policies with similar terms to current P&I (protection and indemnity for third parties) and hull & machinery insurance. The latter often covers the reasonable cost of repairing damages accidently caused by a peril insured against, including perils of the sea (weather, collision, stranding and the like), force majeure, and negligence of masters and officers.[1225] Overall, the insurance prices for carbon dioxide carriers are not likely to surpass the costs of LNG carriers, which is an indicator that the market is expected to use LNG as a paradigm for insurance.[1226]

Taken together, such unique risks and potential safety hazards of cross-border transportation of carbon dioxide warrant further consideration from a liability standpoint, especially in light of the global deployment of CCS. Legal experts recently highlighted the need for a new legal and regulatory regime for transboundary movement of large-scale carbon dioxide, specifying the liability of carbon dioxide carriers.[1227] Indeed, this new regulatory regime would be desirable, as carriers are currently exposed to different sets of liabilities when transporting carbon dioxide while having multiple avenues to limit their liability exposure. Despite the absence of a specific formal regulatory regime, the cross-border shipment of carbon dioxide for permanent storage has already occurred in an experimental setting and is expected to move beyond that stage.[1228]

The next sections analyze the currently applicable legal framework. For the purposes of our analysis, public international law-based liability (i.e., liability for states' wrongful conduct) is outside the scope of this research.[1229] Likewise, liability for carbon dioxide storage after ships reach their destination is also not within the scope of this research,[1230] though there is a growing body of literature targeting this aspect of the CCS chain

[1224] Michael Tsimplis & Kyriaki Noussia, *The Use of Ships within a CCUS System: Regulation and Liability*, 181 Resources, Conservation & recycling 1, 5 (2022).
[1225] *See, generally*, Sabine Knapp & Christiaan Heij, *Evaluation of total risk exposure and insurance premiums in the maritime industry*, 54 Transportation Research Part D: Transport and Environment 321, 321–22 (2017) (Explaining that the International Union of Marine Insurance (IUMI) publicly reports three main categories of insurance policy each year: hull and machinery, transport cargo, and marine liability. The latter includes loss of life, pollution, and other third-party liabilities.).
[1226] *See, generally,* Tsimplis & Noussia, *supra* note 1224, at 7.
[1227] Swati Gola & Kyriaki Noussia, *From CO_2 Sources to Sinks: Regulatory Challenges for Trans-boundary trade, shipment and storage*, 179 Resources, Conservation & recycling 1, 5 (2022).
[1228] Carolina Arlota, *Beyond Trouble Waters? Unprecedented cross-border transportation and injection of carbon dioxide (CO_2) shows promise*, *supra* note 1211.
[1229] Malgosia Fitzmaurice, *International Responsibility and Liability in* The Oxford Handbook of International Environmental Law 1010, 1011 (Daniel Bodansky et al. eds., 2010) (Explaining that state responsibility for environmental damage has traditionally played a limited role in environmental law due to not encompassing liability for private actors and those are largely responsible for pollution.).
[1230] It is worth recalling that Chapter 4 discusses storage and fugitive emissions in the context of emissions inventories and national determined contributions (NDCs) in the Paris Agreement and the United Nations Framework Convention on Climate Change (UNFCCC), whereas the current chapter focuses on carriers' liability.

based on specific domestic experiences[1231] and comparative perspectives.[1232] Finally, third party and insurance claims are also excluded from this review. In short, the goal of this chapter is to highlight the main legal treaties applicable to the liability of carriers who internationally transport carbon dioxide. The aim is not to exhaust this novel topic, but rather to discuss potential contractual issues arising out of carriers' liability, as well as analyze maritime and admiralty jurisdiction under United States law.

2. International Shipping Conventions

This section provides an overview of the main international conventions under the IMO that are applicable to carriers engaged in the cross-border transportation of carbon dioxide for storage. These conventions either establish regulatory requirements or liability regimes for shipping activities.

The section first analyzes both the SOLAS Convention (*Convention for the Safety of Life at Sea*) and MARPOL (*International Convention for the Prevention of Pollution from Ships*), as both conventions provide for states' conduct to secure the safe transportation of goods. Technically, both SOLAS and MARPOL are considered regulatory conventions.

In addition to these regulatory conventions, the IMO has also established several liability conventions that are relevant to the potential shipment of carbon dioxide. Therefore, after the discussion on SOLAS and MARPOL, the following international treaties focusing on carriers' liability are examined: the LLMC Convention (*Convention on Limitation of Liability for Maritime Claims*), the HNS Convention (*International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea*), and the Bunkers Convention (*International Convention on Liability for Bunker Oil Pollution Damage).*

[1231] *See, e.g.,* Michael Fauvre, *Liability and Compensation for Damage resulting from CO_2 storage sites*, 40 WILLIAN & MARY ENVIRONMENTAL LAW AND POLICY REVIEW 387 (2016) (For a seminal work presenting the legislative gaps of the United States' laws for storage liability); Michael B. Gerrard & Justin Gundlach, *CCS in US Climate Change Policy in* CARBON CAPTURE AND STORAGE: EMERGING LEGAL AND REGULATORY ISSUES 110 (Ian Havercroft et al. eds., 2019) (Underscoring the legislative gaps on sequestration and the "patchwork of diverse and incomplete rules of ownership and liability."); Owen. L. Anderson, *Geologic CO2 sequestration: Who owns the pore space?* 9 WYO L. REV. 97**,** 125 (2009) (Discussing negligence related issues); Mark the Figueiredo et al., *The liability of Carbon Dioxide Storage,* MIT PHD DISSERTATION (2007), at https://perma.cc/J3GX-YQ2V. (Analyzing technical issues). As detailed in Chapter 5, the Safe Drinking Water Act, Part C (42 U.S.C. § 300h) created a program regulating carbon dioxide storage (the so-called Class VI Rule). *See* U.S. ENVIRONMENTAL PROTECTION AGENCY, FEDERAL REQUIREMENTS UNDER THE UNDERGROUND INJECTION CONTROL (UIC) PROGRAM FOR CARBON DIOXIDE (CO_2) GEOLOGIC SEQUESTRATION (GS) WELLS FINAL RULE, 75 Fed Reg 77230, 77236 (Dec. 10, 2010), at https://perma.cc/G56E-3RGM.

[1232] *See, e.g.,* Weber & Tsimplis, *supra* note 1210. (Focusing on the United Kingdom's experience); Silvia Andrea Cupertino et al., *Relevant Aspects of carbon storage activities' liability in paradigmatic countries: Australia, Brazil, Canada, European Union, Japan, Norway, United Kingdom and United States in* CARBON CAPTURE AND STORAGE IN INTERNATIONAL ENERGY POLICY AND LAW 315 (Hirdan Katarina de M. Costa & Carolina Arlota eds., 2021) (Analyzing liability in the storage context and providing an overview of legal regimes on the topic). *But cf* INTERNATIONAL ENERGY AGENCY, *Ship Transport of CO_2, PH-4-30,* IEAGHG (2004). (This IEA report discusses the international transportation of carbon dioxide for storage, but it does not address shipping liability). In the same vein: INTERNATIONAL ENERGY AGENCY, *CO_2 Transport and Storage: Tracking Report,* IEAGHG (Rachael Moore & Carl Greenfield eds., Sep. 2022) (This IEA study does not address shipping liability).

2.1. SOLAS Convention (Convention for the Safety of Life at Sea)

The Convention for the Safety of Life at Sea, or SOLAS Convention,[1233] has 168 contracting states corresponding to over 98 percent of the world's fleet.[1234] SOLAS is considered the most important treaty governing the safety aspects of ships,[1235] setting standards for the construction, installation, and carriage of goods.[1236] While SOLAS does not specifically address liability,[1237] it provides for important safety requirements that are connected with liability regimes that may be applied to carbon dioxide carriers. Therefore, it is still discussed in this section.

Under the SOLAS Convention, contracting states "undertake to promulgate all laws, decrees, orders and regulations and to take all other steps which may be necessary" to give the Convention full and complete effect, ensuring that from the standpoint of safety of life, a ship is fit for the service for which it is intended.[1238] Annex I, Article 1 provides that the Convention applies only to ships engaged on "international voyages."[1239] An international voyage is defined as a "voyage from a country to which the present Convention applies to a port outside such country, or conversely."[1240] Contracting states must ensure that ships sailing under their jurisdiction – in other words, flag-state jurisdiction – obey the minimum safety standards regarding their construction, equipment, and operation,[1241] including the transportation of dangerous goods.[1242]

The SOLAS Convention is particularly relevant for carbon dioxide carriers. The International Maritime Dangerous Goods Code (IMDG Code),[1243] while initially developed by IMO separately from the Convention, [1244] is considered an extension of Chapter VII of SOLAS and is mandatory under the Convention.[1245] Importantly, the code lists

[1233] International Convention for the Safety of Life at Sea, Nov. 1, 1974 (entered into force on May 25, 1980), 1184 U.N.T.S. 279 [hereinafter SOLAS].
[1234] International Maritime Organization, *Status of IMO Treaties,* 16-19 (Feb. 2023), at https://perma.cc/2X34-E2PK. (The United States is a Contracting Party as it ratified the Convention on May 25, 1980).
[1235] Martha M. Roggenkamp, *Transportation of CO_2 in the EU in* Carbon Capture and Storage: Emerging Legal and Regulatory Issues 257 (Ian Havercroft et al. eds., 2019).
[1236] SOLAS Convention, *supra* note 1233, Article I.
[1237] SOLAS Convention, *supra* note 1233, Art. 1 et seq.
[1238] SOLAS Convention, *supra* note 1233, Art. 1 (b).
[1239] SOLAS Convention, *supra* note 1233, Annex: Chapter 1, Regulation 1 (a).
[1240] SOLAS Convention, *supra* note 1233, Annex: Chapter 1, Regulation 2 (d).
[1241] SOLAS Convention, *supra* note 1233, Art. 2. (Novel ship designs must comply with SOLAS. *See also* Tsimplis & Noussia, *supra* note 1224, at 5).
[1242] Roggenkamp, *supra* note 1235, at 258.
[1243] International Maritime Organization, *International Maritime Dangerous Goods Code* (IMDG Code), at https://perma.cc/UM3C-LEWY. It is noteworthy that, in April 2022, the IMO's safety committee amended this code adding amendments 41, which will be mandatory on January 1, 2024. In the United States, this international instrument is codified under 49 CFR 172.519 (f) (Jun. 22, 2023).
[1244] Roggenkamp, *supra* note 1235, at 258.
[1245] International Maritime Organization ((IMO), *International Convention for the Safety of Life at Sea*, at https://perma.cc/77Y9-LUQ3. (Highlighting that the IMDG was initially adopted in 1965 as a recommendatory instrument. In 2002, the General Assembly, in its 17th session, adopted by resolution A.716(17) the Code and decided to give it a mandatory status under the umbrella of the SOLAS Convention, from 1 January 2004, despite limited provisions remaining recommendatory).

carbon dioxide as a dangerous cargo.[1246] More specifically, liquified and refrigerated liquified carbon dioxide are classified as a non-flammable, non-toxic gas substance under the IMDG Code.[1247] As part of the IMDG Code, requirements applicable to each individual substance, material or article are specified. This includes addressing packaging, container traffic and stowage, and emphasizing the segregation of incompatible substances.[1248]

In addition, the SOLAS Convention provides for the carriage of dangerous goods by sea[1249] by adopting the International Bulk Chemical Code (IBC Code).[1250] Under the IBC Code, minimum standards are set for the safety carriage in bulk by sea of dangerous chemicals and noxious liquid substances.[1251] Further discussion of the IBC Code is detailed in the next section about MARPOL.[1252]

Finally, SOLAS provides that the construction and operation of carbon dioxide ships shall comply with the detailed provisions of the International Code of the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, also known as the IGC Code.[1253] Compliance with IGC Code is mandatory for contracting parties of SOLAS.[1254] The IGC Code is attested under the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk, which is awarded after extensive periodic inspections of elements including the construction, equipment, installations, and materials of these ships.[1255] Ultimately, the IGC Code aims to provide an international standard for the safe sea carriage of liquified gases in bulk by providing design and construction standards for ships involved in this transport, as well as provisions for the equipment they are required to carry in order to reduce the risks for the ship, its crew and the environment.[1256]

Accordingly, ships engaging in the international transportation of carbon dioxide are subject to the provisions of the SOLAS Convention. These ships must also comply with the specific requirements of the IMDG, IBC, and IGC Codes. Contracting states of the SOLAS Convention are responsible for the certificates, inspections, and authorization of their ships.

[1246] These are non-recommendatory provisions, as they are found in Chapter 4 of the IMDG Code.

[1247] International Maritime Organization ((IMO), *International Maritime Dangerous Goods Code* (IMDG Code, Amend. 33-06), U.N. 1058 (Table for Packing and Tank, under Proper Shipping Name: Liquified gases, non-flammable), Chapter 4, at 148 (for gas) and 149 (for liquified form), at https://perma.cc/W9J4-7UXY. Likewise, these are part of the United Nations Recommendations on the Transport of Dangerous Goods: Model Regulations: Vol. 2, 209 (Princeton, Oct. 2021).

[1248] International Maritime Organization ((IMO), *International Convention for the Safety of Life at Sea*, at https://perma.cc/J8TE-925A.

[1249] SOLAS Convention, *supra* note 1233, Chapter VII.

[1250] INTERNATIONAL MARITIME ORGANIZATION, IBC Code (2023), at https://perma.cc/BUG7-8W2V.

[1251] *Id.*

[1252] For the moment, note that the IBC Code lists such substances in Chapter 17.

[1253] International Maritime Organization (IMO), *The International Code of the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC)* (2016), at https://perma.cc/HC5Y-3EBP.

[1254] Maritime Safety Committee of the International Maritime Organization ((IMO) Resolution MSC.6(48), adopted on Jun. 17, 1983, at https://perma.cc/3QRP-RSW6.

[1255] IGC Code, Article 1.5.1 et seq. (The Code also provides for semi-annual inspections and detailed inspection every five years).

[1256] Roggenkamp, *supra* note 1235, at 258.

2.2. MARPOL (International Convention for the Prevention of Pollution from Ships)

The International Convention for the Prevention of Pollution from Ships, or MARPOL, addresses operational pollution from ships, including unintentional releases of pollution.[1257] This Convention has also been increasingly used by the IMO to tackle protection of natural environment more broadly.[1258] As discussed in Chapter 3, MARPOL's focus is on operational discharges.[1259]

MARPOL is of particular relevance for carbon dioxide carries due the Convention's large number of state parties, covering approximately 99% of the world's fleet.[1260] Annexes I and II of MARPOL are deemed as international customary law, meaning that these provisions are generally accepted international rules and standards.[1261] This makes both annexes binding even to non-contracting states.[1262]

Annex I of MARPOL provides the main definitions applicable to the Convention. Annex II regulates the carriage by sea of chemicals and liquid substances in bulk.[1263] Like the SOLAS Convention, this annex also adopts the IBC Code, which provides construction guidelines for the safety of ships carrying bulk liquid chemicals.[1264] The code regulates the design and construction standards for ships built after July 1, 1986 that carry noxious and liquid substances in bulk.[1265] It also provides a list of chemicals and their hazards, identifying both the type of ship required to carry that product as well as the environmental hazard rating for those substances.[1266]

Chapter 17 of the IBC Code,[1267] which specifically regulates the transportation of noxious liquid substances, does not currently provide for carbon dioxide.[1268] Nonetheless, carriers of carbon dioxide are expected to comply with the design and construction requirements set under Annex II of MARPOL and the IBC Code.[1269] Since this code establishes general safety requirements for the transportation of liquid substances under the categorization of

[1257] The United Nations Convention for the Prevention of Pollution from Ships, Nov. 2, 1973, 12 I.L.M 319 [hereinafter MARPOL].
[1258] Ludovica De Benedetti, *Regional Pollution in* 32 Yearbook of International Environmental Law 63, 64 (Bharat H Desai *et al* eds., 2021) (Highlighting that MARPOL's Annex VI, which addresses air pollution from vessels has been used to specifically advances environmental protection).
[1259] David Hunter et al., International Environmental Law and Policy 786 (2022).
[1260] International Maritime Organization (IMO), *Status of IMO Treaties,* 124 (Feb., 2023), at https://perma.cc/KAT8-GFHN. (The United States is a contracting party and a signatory of Annexes I, II, III, V, and VI of MARPOL).
[1261] International Energy Agency, *The Status and Challenges of CO_2 Shipping Infrastructures,* IEAGHG: Technical report, 60 (Jul. 2020).
[1262] *Id.*
[1263] International Maritime Organization, *Carriage of Chemicals by Ship,* at https://perma.cc/KZ74-BBYP.
[1264] International Maritime Organization, IBC Code, at https://perma.cc/UH6S-68MX.
[1265] International Maritime Organization, *Carriage of Chemicals by Ship,* at https://perma.cc/S8DX-R8QM.
[1266] *Id.*
[1267] International Maritime Organization, IBC Code, at https://perma.cc/E39Q-P6R7.
[1268] IBC Code: International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (as amended by the Resolution MEPC 225.64), at https://perma.cc/RPF6-WXV7.
[1269] *See* Tsimplis & Noussia, *supra* note 1224, at 3.

"other substances that were not currently considered as noxious,"[1270] compliance with the code requires meeting less stringent requirements than those required for noxious liquid substances under the code.[1271]

In addition, MARPOL's Annex III regulates the prevention of pollution by harmful substances in packaged form. The annex includes overall requirements for the issuance of specific standards on packing, marking, labelling, documentation, and quantity limitations, among other procedural standards.[1272] Under Annex III, "harmful substances" are limited to those classified as "marine pollutants" in the IMDG Code. Importantly, the IMDG Code does not list carbon dioxide among its "marine pollutants," which are regulated under the code's third chapter. Therefore, while carbon dioxide is regulated elsewhere in the IMDG Code,[1273] carbon dioxide is not considered a "marine pollutant" under Annex III of MARPOL.[1274]

In summary, Annex II of MARPOL applies to the carriage of noxious liquid substances in bulk and is mandatory for ships carrying carbon dioxide; Annex III, which specifically regulates marine pollutants, is not applicable.

This concludes our analysis of regulatory conventions under the IMO. The following three IMO conventions pertain to liability of carbon dioxide carriers.

2.3 LLMC (Convention on Limitation of Liability for Maritime Claims)

The Convention on Limitation of Liability for Maritime Claims, or LLMC, was established in 1976 and limits the liability of shipowners and salvors.[1275] Under the LLMC, "shipowners" include the owner, charterer, manager, and operator of a seagoing ship; "salvor" means any person rendering services in direct connection with salvage operations.[1276] Salvage operations include the recovery of losses related to sunken, wrecked, stranded, or abandoned ships or the removal or destruction of the cargo, among other related operations.[1277]

[1270] INTERNATIONAL MARITIME ORGANIZATION, *Carriage of Chemicals by Ship*, at https://perma.cc/CEW5-JUAL.
[1271] *Id.*
[1272] INTERNATIONAL MARITIME ORGANIZATION, *Carriage of Chemicals by Ship, Carriage of Chemicals by Ship,* at https://perma.cc/5HT3-2BHV.
[1273] *Id.* Carbon dioxide is listed in Chapter 4 of the IMDG Code. See also our discussion about the SOLAS Convention in the previous subsection.
[1274] International Maritime Organization ((IMO), *International Maritime Dangerous Goods Code* (IMDG Code, Amend. 33-06), Chapter 3. *See also* Chemsafetypro, *How to Define and Labe Environmentally Hazardous Substances* (Jun. 11, 2015), at https://perma.cc/DC7K-AMF3. (Detailing the Code's definitions on 'marine pollutant' from a chemistry-based standpoint).
[1275] Convention on Limitation of Liability for Maritime Claims, Nov. 16, 1976 (entered into force on Dec. 1, 1986), 1456 U.N.T.S. 221 [hereinafter LLMC].
[1276] LLMC, *supra* note 1275, Art.1 (2) and (3).
[1277] LLMC, *supra* note 1275, Art. 2 (d) to (f).

The LLMC defines its scope of application to whenever shipowners and salvors[1278] seek to limit their liability before the court of a state party; or seek to procure the release of a ship or other property; or seek to procure the discharge of any security given within the jurisdiction of any such state.[1279]

According to the IMO, the LLMC provides for a "virtually unbreakable system of limiting liability."[1280] Under the Convention, shipowners have their liability capped except if "it is proved that the loss resulted from his personal act or omission, committed with the intent to cause such a loss, or recklessly and with knowledge that such loss would probably result."[1281]

Overall, the LLMC provides for limitations based on two types of claims: (1) claims for loss of life or personal injury, and (2) property claims,[1282] which includes damage to other ships, property or harbor works.[1283] The convention covers pollution damage from spilled bunkers, damage caused by hazardous cargo to third parties, and damage incurred from navigation risks, such as collisions.[1284] According to the LLMC, the liability is capped at 333,000 SDR[1285] for personal claims arising out of ships not exceeding 500 tons, with additional amounts based on excess tonnage.[1286] For other claims, the liability was initially fixed at 167,000 SDR, with additional amounts based on tonnage for ships exceeding 500 tons.[1287]

[1278] Salvors' liability is outside the scope of this report.

[1279] LLMC, *supra* note 1275, Art. 15, which provides as follows: "This Convention shall apply whenever any person referred to in Article 1 seeks to limit his liability before the Court of a State Party or seeks to procure the release of a ship or other property or the discharge of any security given within the jurisdiction of any such State. Nevertheless, each State Party may exclude wholly or partially from the application of this Convention any person referred to in Article 1 who at the time when the rules of this Convention are invoked before the Courts of that State does not have his habitual residence in a State Party or does not have his principal place of business in a State Party or any ship in relation to which the right of limitation is invoked or whose release is sought and which does not at the time specified above fly the flag of a State Party."

[1280] International Maritime Organization (IMO), *Convention on Limitation of Liability for Maritime Claims (LLMC),* at https://perma.cc/S7SP-LWRA.

[1281] LLMC, *supra* note 1275, Art. 4.

[1282] LLMC, *supra* note 1275, Art. 2.

[1283] *Id.*

[1284] *Id.* The LLMC further provides for liability limitation due to delay and loss of the cargo, among others.

[1285] LLMC, *supra* note 1275, at Art. 8 (1) (Explains the use of SDR, defining that it stands for Special Drawing Rights. SDRs are updated daily by the IMF and published at https://perma.cc/8NMU-3B9F.

[1286] LLMC, *supra* note 1275, at Art. 6 (1) (a) (i).

[1287] LLMC, *supra* note 1275, at Art. 6 (1) (b) (i).

The later LLMC Protocol[1288] and its amendment increased these liability exposures, establishing a system of tacit acceptance for updating these amounts.[1289] With 63 parties and covering over 69 percent of the global fleet,[1290] the Protocol is the most widely applicable treaty on limiting liability.[1291]

The most updated limits concerning liability are as follows, also summarized in the table below. For claims regarding loss of life or personal injury on ships not exceeding 2,000 gross tonnage, the liability is limited to 3.02 million SDR. For larger ships, additional amounts are increased based on tonnage. For each ton from 2,001 to 30,000 tons, the liability is limited to 208 SDR per additional ton; for each ton from 30,001 to 70,000 tons, the liability is limited to 906 SDR per additional ton; and for each ton in excess of 70,000, the liability is limited to 604 SDR per additional ton.[1292] Shifting to property claims applicable to ships not exceeding 2,000 gross tonnage, liability is capped at 1.51 million SDR. For larger ships, the following additional amounts are applied: for each ton from 2,001 to 30,000 tons, liability is capped at 604 SDR per additional ton; for each ton from 30,001 to 70,000 tons, liability is capped at 453 SDR per additional ton; for each ton in excess of 70,000 tons, liability is capped at 302 SDR per additional ton.[1293]

Table 1: Liability limitations in LLMC Protocol

Claim type	*Gross tonnage of ship*	*Liability limitation*
Loss of life or personal injury	**<2,000 tons**	**3,020,000 SDR *(baseline)***
	2,001 to 30,000 tons	1,208 SDR per additional ton
	30,001 to 70,000	906 SDR per additional ton
	>70,001	604 SDR per additional ton
Loss or damage of property	**<2,000 tons**	**1,510,000 SDR *(baseline)***
	2,001 to 30,000 tons	604 SDR per additional ton
	30,001 to 70,000	453 SDR per additional ton
	>70,001	302 SDR per additional ton

[1288] Protocol of 1996 to amend the Convention on Limitation of Liability for Maritime Claims, 1976, adopted 2 May 1996, entered into force 13 May 2004.
[1289] *Id.* at Art. 8.
[1290] International Maritime Organization (IMO), *Status of IMO Treaties,* 407–8 (Feb., 2023), at https://perma.cc/WX5H-YSUW. (The United States is not a Contracting Party).
[1291] Maja Radunovic*, Law on limitation of liability for maritime claims: A Legislation Drafting Project submitted in partial fulfillment of the requirements for the award of the Degree of Master of Laws (LL.M.) in International Maritime Law at the IMO International Maritime Law Institute,* 3 (2019), at https://perma.cc/TCC6-GC6M.
[1292] Resolution LEG.5(99): 2012 Amendments to the Protocol of 1996 to Amend the Convention on Limitation of Liability for Maritime Claims, 1976, Annex (2012), at https://perma.cc/2NDN-C8XZ.
[1293] *Id.*

The United States is not party to the LLMC Convention nor Protocol, but rather has its own Limitation of Liability Act.[1294] This act limits the liability of the owner of a vessel for any claim, debt, or liability arising from any embezzlement, loss, or destruction of any property, goods, or merchandise shipped or put on board the vessel; any loss, damage, or injury by collision; or any either (1) act, matter, or thing, or (2) loss, damage, or forfeiture, that is done, occasioned, or incurred without the privity or knowledge of the owner.[1295] Wages are excluded from this limitation. The liability shall not exceed the value of the vessel and pending freight.[1296] The act provides for a minimum liability if the amount of the vessel owner's liability "is insufficient to pay all losses in full, and the portion available to pay claims for personal injury or death is less than $420 times the tonnage of the vessel, that portion shall be increased to $420 times the tonnage of the vessel. That portion may be used only to pay claims for personal injury or death."[1297]

In summary, the LLMC is likely to provide for the limitation of the liability of a carbon dioxide carrier should an event covered within the scope of the Convention occur. The liability cap set under the LLMC is subject to claims brought in a court of a member state of the Convention.

2.4. HNS Convention (International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea)

As discussed in Chapter 3 of this report, the International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea, or HNS Convention, [1298] will establish an international liability framework in the event of accidents at sea involving hazardous and noxious substances, such as chemicals. Therefore, it regulates the non-contractual liability for incidents arising out of the maritime carriage of hazardous and noxious substances (HNS). The Convention was adopted in 2010 but has not yet entered into force.[1299]

At the time of this writing, the HNS Convention has a limited number of contracting parties. With 14 state parties, it covers less than 14 percent of the world combined merchant fleet.[1300] The following table lists the Convention's current members.

[1294] 46 U.S.C. §§ 30501 et seq. (2006). (The limitations do not apply for small vessels on domestic routes).
[1295] 46 U.S.C. §§ 30523 (b).
[1296] 46 U.S.C. §§ 30523 (a).
[1297] 46 U.S.C. §§ 30524.
[1298] International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea 1996 and its Protocol of 2010 (adopted May 3, 1996, and Apr. 29, 2010, respectively, and not yet entered into force), 35 I.L.M. 1415 [hereinafter HNS Convention].
[1299] International Maritime Organization (IMO), *Status of IMO Treaties,* 517 (Feb. 2023), at https://perma.cc/3XS6-CJKZ.
[1300] *Id.*

Table 2: Parties to the HNS Convention[1301]

State Parties		
Angola	Lithuania	Sierra Leone
Cyprus	Morocco	Slovenia
Ethiopia	Russia Federation	Syrian Arab Republic
Hungary	Saint Kitts and Nevis	Tonga
Liberia	Samoa	

The main feature of the HNS Convention is a system of strict liability of the shipowner. A shipowner's liability is not excluded, save for a few exceptions that the shipowner has to prove.[1302] These exceptions include: acts of war; insurrection; natural phenomenon of exceptional, inevitable and irresistible character; damage intentionally and completely caused by a third party with intent to do so; failure of the shipper to provide information concerning the hazardous nature of the substances shipped; or damage wholly caused by the negligence or other wrongful act of any government or other authority responsible for the maintenance of lights or other navigational aids in the exercise of that function.[1303] Importantly, the strict liability of the shipowner can be limited depending on the size of the ship and whether it carries cargo in bulk or packaged form.[1304]

The HNS Convention will apply exclusively to an enumerated set of legal circumstances. First, it will be applicable to any damage caused in the territory of a state party, including the territorial sea.[1305] In addition, the HNS Convention provides for the liability for damage by contamination of the environment caused in the exclusive economic zone of a state party, established in accordance with international law, or, "if a state party has not

[1301] *Id.*

[1302] The HNS Convention, *supra* note 1298, Art. 7, which states: "Art.7 (1) Except as provided in paragraphs 2 and 3, the owner at the time of an incident shall be liable for damage caused by any hazardous and noxious substances in connection with their carriage by sea on board the ship, provided that if an incident consists of a series of occurrences having the same origin the liability shall attach to the owner at the time of the first of such occurrences. . . (3) If the owner proves that the damage resulted wholly or partly either from an act or omission done with intent to cause damage by the person who suffered the damage or from the negligence of that person, the owner may be exonerated wholly or partially from liability to such person."

[1303] The HNS Convention, *supra* note 1298, Art. 7 (2): "No liability shall attach to the owner if the owner proves that: (a) the damage resulted from an act of war, hostilities, civil war, insurrection or a natural phenomenon of an exceptional, inevitable and irresistible character; or (b) the damage was wholly caused by an act or omission done with the intent to cause damage by a third party; or (c) the damage was wholly caused by the negligence or other wrongful act of any Government or other authority responsible for the maintenance of lights or other navigational aids in the exercise of that function; or (d) the failure of the shipper or any other person to furnish information concerning the hazardous and noxious nature of the substances shipped either (i) has caused the damage, wholly or partly; or (ii) has led the owner not to obtain insurance in accordance with article 12; provided that neither the owner nor its servants or agents knew or ought reasonably to have known of the hazardous and noxious nature of the substances shipped."

[1304] The HNS Convention, *supra* note 1298, Art. 9 and 14.

[1305] The HNS Convention, *supra* note 1298, Art. 3(a).

established such a zone, in an area beyond and adjacent to the territorial sea of that state determined by that state in accordance with international law and extending not more than 200 nautical miles from the baselines from which the breadth of its territorial sea is measured."[1306]

The Convention also provides for the liability for damages unrelated to the contamination of the environment and caused outside the territory of any state, including the territorial sea. However, this only applies if this damage was caused by a substance carried onboard a ship registered in a state party or, in the case of an unregistered ship, on board a ship entitled to fly the flag of a state party.[1307] Finally, the Convention includes liability for preventive measures, wherever taken, to prevent or minimize the damages covered in its regime.[1308] In short, the strict liability system of the HNS Convention covers damages arising out of loss of life, personal injury, property damage outside the ship, damage by contamination, cost and related damages from preventive measures, and reasonable measures of reinstatement of the environment. Liability for damages caused to the cargo, however, is based on contractual liability and is outside the scope of the Convention.[1309]

Once the HNS Convention enters into force, it is expected to apply to carbon dioxide carriers[1310] and replace the LLMC Convention[1311] for parties who have ratified both.[1312] The text of the HNS Convention technically does not address carbon dioxide,[1313] but the Convention is still expected to apply to both liquefied bulk carbon dioxide of a high purity as well as to carbon dioxide of reclaimed quality under the Convention's reference to the International Code of the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code).[1314]

Importantly, this Convention only applies when the cargo is onboard.[1315] Occasions when the carbon dioxide is waiting in storage tanks or after it has been discharged would not trigger liability under the HNS Convention.[1316] Therefore, accidents that may happen before the cargo is loaded, during the storage of carbon dioxide in tanks

[1306] The HNS Convention, *supra* note 1298, Art. 3(b).
[1307] The HNS Convention, *supra* note 1298, Art. 3(c).
[1308] The HNS Convention, *supra* note 1298, Art. 3(d).
[1309] *See, generally*, Tsimplis & Noussia, *supra* note 1224, at 6.
[1310] Viktor Weber, *Are We Ready for the Ship Transport of CO_2 for CCS? Crude Solutions from International and European Law,* 30 Rev. Eur. Comp. & Int. Law 387, 392 (2021). *See also* Weber & Tsimplis, *supra* note 1210, at 153.
[1311] LLMC, *supra* note 1275.
[1312] HNS Convention, *supra* note 1298, Art. 42, combined with LLMC Convention, *supra* note 1275, Art. 18 (1) (b).
[1313] HNS Convention, *supra* note 1298, Art. 1(5)(a)(v) reads as follows: "Hazardous and noxious substances (HNS) means: (a) any substances, materials and articles carried on board a ship as cargo, referred to in (i) to (vii) below: … (v) liquefied gases as listed in chapter 19 of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, as amended, and the products for which preliminary suitable conditions for the carriage have been prescribed by the Administration and port administrations involved in accordance with paragraph 1.1.6 of the Code."
[1314] International Maritime Organization, *The International Code of the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC)*, Chapter 19, at https://perma.cc/A8TL-M8D8. Carbon dioxide of reclaimed quality is not specifically defined, but it is generally understood as a stream which contains impurities. It may contain water and sulfur dioxide, among other impurities. These impurities may increase acid corrosion-related risks. International Maritime Organization, *The International Code of the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC)*, Chapter 17:22, at https://perma.cc/B6H3-92S7.
[1315] The HNS Convention, *supra* note 1298, Art. 1(9) combined with Art. 4 (1).
[1316] Viktor Weber, *supra* note 1310, at 392.

not onboard ships, or following its discharge are not within the Convention's purview, even though the cargo may be in possession of the shipowner. In short, the HNS' applicability is contingent upon the damage occurring before or after the cargo has crossed the ships' rail or loading line.[1317] It is unclear if the HNS Convention would be applicable in temporary discharges or transshipment cases.[1318]

According to the HNS Convention's two-tiered system of liability, tier one will be covered by compulsory insurance taken out by shipowners, who can thereby limit their liability. In cases where the insurance does not cover an incident or is insufficient to satisfy the claim, a second tier of compensation will be paid from a fund comprising contributions from the "receivers of HNS contributing cargo."[1319]

Under the Convention, a "receiver" is a person that physically receives or on whose behalf the transported cargo was physically received.[1320] The Convention defines "contributing cargo" as "any bulk HNS which is carried by sea as cargo to a port or terminal in the territory of a state party and is discharged in the state."[1321] Currently, the HNS database does not list carbon dioxide in bulk as a "contributing cargo."[1322]

As noted in Table 2, the United States is not a party to the HNS Convention.[1323] Given that the United States is where the "receiver" terminal in our current analysis will be located, the receiver will not be required to contribute to the HNS fund. Therefore, no economic burden is added for a U.S. corporation involved in the storage of carbon dioxide.

Until the 2010 HNS Convention comes into force, loss of life, personal injury claims, and any environmental damage caused by a carbon dioxide carrier will be covered under the domestic laws in place.[1324] In common law jurisdictions, such as the United States, this means that it will fall under negligence and tort-related claims.[1325]

In conclusion, carriers of liquified carbon dioxide are regulated under the IGC Code and will therefore be strictly liable once the HNS Convention comes into force. However, their liability will be based on both the size of the

[1317] Cea Mittler, *Navigating Uncertainties* – Exploring the Challenges of CO_2 Emissions Liability in Transporting CO_2 *by Sea for CCS,* 3 OGEL 1, 9 (2023).
[1318] *Id. See also* Admiralty and International Law Guide: International Conventions, Convention on the Facilitation of International Maritime Traffic, (London, Apr. 9, 1965), Annex, Section 1, at https://perma.cc/4V4L-5U4H. (Under international maritime law, temporary discharge refers to cargo that is not discharged at the final port of the intended destination.)
[1319] INTERNATIONAL MARITIME ORGANIZATION, International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea, at https://perma.cc/G5AR-FQS7. (Noting that contributions will be calculated according to the amount HNS received from each party in the previous calendar year).
[1320] The HNS Convention, *supra* note 1298, Art. 1 (4).
[1321] The HNS Convention, *supra* note 1298, Art. 1 (10).
[1322] The HNS Finder (2023), at https://perma.cc/CKX8-6K3D.
[1323] International Maritime Organization (IMO), *Status of IMO Treaties,* 517 (Feb. 2023), at https://perma.cc/R3GT-Y275.
[1324] Tsimplis & Noussia, *supra* note 1224, at 6.
[1325] *Id.* (Subsection 3 of this chapter discuss the U.S. liability for maritime claims, clarifying that claims may be brought under negligence or tort law).

ship and the availability of funds available to claimants under the HNS fund. Until the HNS Convention enters into force, the LLMC Convention and Protocol remain applicable for contracting parties.

2.5. Bunkers Convention (International Convention on Civil Liability for Bunker Oil Pollution Damage)

Damage related to bunker oil is regulated under the International Convention on Liability for Bunker Oil Pollution Damage, also called the Bunkers Convention.[1326] According to this treaty, "bunker oil" is "any hydrocarbon mineral oil, including lubricating oil, used or intended to be used for the operation or propulsion of the ship, and any residues of such oil."[1327]

The Convention defines "pollution damage" as any loss or damage caused outside the ship by contamination resulting from the escape or discharge of bunker oil from the ship, regardless of where this escape may occur, "provided that compensation for impairment of the environment other than loss of profit from such impairment shall be limited to costs of reasonable measures of reinstatement actually undertaken or to be undertaken."[1328] In addition, damages include the costs of preventive measures and further loss or damage caused these measures.[1329]

The Bunkers Convention applies to the "state of the ship's registry," which is the state of registration of the ship; for an unregistered ship, this applies to the state whose flag the ship is entitled to fly.[1330] In addition, the Convention applies exclusively to damages caused in the territory of a state party, including its territorial sea and exclusive economic zone, and to preventive measures, wherever taken, to prevent or minimize such damage.[1331]

Under the Convention, the shipowner is strictly liable for such damages.[1332] Nonetheless, the Bunkers Convention explicitly accepts the limitation of the shipowners' liability in accordance with the LLMC Convention and its amendments.[1333] Accordingly, shipowners of carbon dioxide carriers may incur liability for damage caused by oil spills from bunker oil up to the limited thresholds established under the LLMC Conventions and further amendments.

[1326] The International Convention on Civil Liability for Bunker Oil Pollution Damage, Mar. 23, 2001 (entered into force on Nov. 11, 2008), 1456 U.N.T.S. 221 [hereinafter Bunkers].
[1327] Bunkers, *supra* note 1326, Art. 1(5).
[1328] Bunkers, *supra* note 1326, Art. 1(9).
[1329] *Id.*
[1330] Bunkers, *supra* note 1326, Art. 1(10).
[1331] Bunkers, *supra* note 1326, Art. 2.
[1332] Bunkers, *supra* note 1326, Art. 3. Articles 4 and 5 provide classic exclusions, including act of war, exclusive act of third party or government action.
[1333] Bunkers, *supra* note 1326, Art. 6.

3. Contractual liability

In addition to a being regulatory matter in international conventions, the carriage of goods by sea is also a contractual subject matter.[1334] As a general rule, parties are free to negotiate the exact contractual clauses.[1335]

Contracts for the international carriage of sale of goods are subject to liability limitation under a system of different international treaties. The Hague Rules are the most agreed upon treaty and are codified in the United States under the Carriage of Goods by Sea Act (COGSA).[1336] Under the COGSA, carriers' liability is limited to US$500 per package, or per customary freight unit for goods not shipped in packages.[1337] The Hague Rules were later amended, but the United States did not adopt these amendments; countries that did are considered part of the Hague/Visby Rules.[1338] The United States has ratified another related convention – the Rotterdam Rules – but this convention has yet to enter into force.[1339]

The contract for the carriage of goods may be an incidental contract to the main contract of international sale of goods. Should this be the case, parties are likely to use Incoterms to address payment, transfer of title, risk of loss, among other contractual provisions.[1340] Incoterms, however, are not a choice of law clause. From an international law perspective, it is recommended that parties consider the law governing their transaction.

Importantly, carbon dioxide tankers may qualify as goods under the United Nations Convention on Contracts for the International Sale of Goods (CISG).[1341] The CISG is a self-executing treaty.[1342] Therefore, in the United States, both state and federal courts must apply the CISG directly to applicable disputes rather than the common law of contracts or the Uniform Commercial Code (UCC).[1343] Despite this, the CISG is not widely applicable in practice and overall, parties are unfamiliar with the specific requirements for its exclusion.[1344]

[1334] Tsimplis & Noussia, *supra* note 1224, at 4.

[1335] *Id.*

[1336] The COSGA was originally included in the 46 USC Appx. 1300—1315. Congress moved the COSG to a statutory note. This alteration has no effect in the validity of the COGSA. Pub. L. 109-304§6 (c), Oct. 6, 2006, 120 Stat. 1516.

[1337] COSGA §1304(5).

[1338] The International Convention for the Unification of Certain Rules of Law Relating to Bills of Lading as amended by Protocol 1968-02-03, in force 1977-06-23, and by Visby SDR Protocol 1979-12-21, in force 1984-02-14. These rules became known as the Hague-Visby Rules, after the Visby Amendments in 1968.

[1339] The United Nations Convention on Contracts for the International Carriage of Goods Wholly or Partly by Sea (2008).

[1340] International Commercial Terms (Incoterms) are a set of standard clauses governing different modalities of international sale of goods. They are published by the International Chamber of Commerce (ICC) and are accepted around the world.

[1341] The United Nations Convention on Contracts for the International Sale of Goods, Apr. 11, 1980, S. Treaty Doc. No. 98-9, 1489 U.N.T.S. 3 [hereinafter CISG], Art. 1 (1) (Defining that the CISG applies, *inter alia*, to contract of sale of goods when both parties have their place of business located in different contracting states. The United States and most EU countries are members of the CISG. The United Kingdom, for instance, is notably a non-contracting parties).

[1342] Eric Bergsten, *Methodological Problems in the Drafting of the CISG, in* CISG METHODOLOGY 5, 15 (André Janssen & Olaf Meyer eds., 2009).

[1343] RALPH H. FOLSOM ET AL., PRINCIPLES OF INTERNATIONAL BUSINESS TRANSACTIONS 48 (2017).

[1344] Carolina Arlota & Brian McCall, *When Federal Law goes Unnoticed: Assessing the CISG's Applicability Across U.S. Courts Based on an Empirical Research of Decisions from 1988 to 2020*, 60, 3 AM. BUSINESS LAW JOURNAL 1, 37–42 (2023).

Article 6 of the CISG respects party autonomy by permitting parties whose contract would otherwise be governed by the CISG to opt-out of the Convention.[1345] Importantly, this election to exclude the application of the CISG to a contract to which it applies must be made explicit: a clause merely stating "the contract shall be governed by the law of New York state" is insufficient to opt-out of the CISG since, due to its self-executing nature, the Convention is part of the law of the state of New York.[1346] Accordingly, should parties not be willing to have the provisions of the CISG directly applicable – particularly the risk of loss, delivery and so forth – they should explicitly mention the CISG and state which law they explicitly chose to apply to their contract.

4. Analysis of liability regimes

As stated previously, SOLAS and MARPOL are technically regulatory conventions under the auspices of the IMO, whereas LLMC, HNS, and Bunkers are liability conventions. Importantly, the IMO regulatory and liability regimes are decoupled, since "a violation of a regulatory requirement under the regulatory conventions does not affect the degree of liability under the liability conventions, because liability is strict, nor the total amount payable to the victims of a shipping incident."[1347] Therefore, even if the ship is non-compliant with SOLAS, for instance, the shipowner will still be entitled to limit its liability.

The table below summarizes our previous findings on the liability regimes discussed in Sections 2 and 3. Since SOLAS and MARPOL are not technically liability conventions, they are not included in the table below.

[1345] CISG, *supra* note 1341, Art. 6.

[1346] RONALD A. BRAND, INTERNATIONAL BUSINESS TRANSACTIONS FUNDAMENTALS 55 (2019) (Highlighting that the clause should exclude the CISG by name and then determine that the contract shall be governed by the rules of Pennsylvania, for instance).

[1347] Tsimplis & Noussia, *supra* note 1224, at 4.

Table 3: Liability of Shipowners of Carbon Dioxide Carriers, Based on Damage Type

Type of Damage	*Liability of Shipowners of Carbon Dioxide Carriers*	*Potential Limitations on Liability*
Damages related to bunker oil	Strict liability (Bunkers Convention)	LLMC Convention
Damages to third parties from the carriage of hazardous cargo	Domestic law in place (torts in common law jurisdictions); strict liability when HNS enters into force.	LLMC Convention; HNS Convention once it enters into force.
Damages to cargo	Contractual liability (CISG or party's autonomy to elect applicable law).	Hague (COGSA, if in the United States); Hague-Visby; Rotterdam; Contractual limitations, if any.

The IMO Conventions on liability listed in the table above – namely, the LLMS, HNS, and Bunkers Conventions – incorporate different principles of international environmental law, most prominently among them the "polluter pays" principle. The principle, which appeared for the first time in 1972,[1348] states that the polluter should bear the costs of carrying out polluting activities and prevention, as "the costs these measures should be reflected in the cost of goods and services which cause pollution in production and/or consumption."[1349] More recently, the

[1348] Weber & Tsimplis, *supra* note 1210, at 149.

[1349] The Organisation for Economic Co-operation and Development (OECD), Recommendation of the Council on Guiding Principles Concerning International Economic Aspects of Environmental Policy of the Organisation for Economic Co-operation and Development (OECD), Adopted on May 25, 1972, at https://perma.cc/8K4U-HB52. (Providing that: "(1). (A) Guiding principles (a) Cost Allocation: The Polluter-Pays Principle, (4), which also underscores that such measures should not be accompanied by subsidies that would create significant distortions in international trade and investment; and 1 (A), (a)(5), stating that the principle should be an objective for Member Countries)." The principle is also part of the Trail Smelter principles, which establish the prohibition of transboundary harm as well as the obligation of compensation ("polluter-pays" principle) from a state liability standpoint. The Trail Smelter Arbitration (1941) involved a Canadian smelter which produced fumes that caused damages in the U.S. territory, namely, in Washington State. The tribunal ruled that the activity of the Smelter has to be reduced and regulated in accordance with the regime determined in the award. Reference is made the Reports of International Arbitration Awards by the United Nations, available at https://perma.cc/59YQ-43VC). In addition to the duty to prevent transboundary harm, *Trail Smelter* determined that, under the "polluter pays" principle, the polluting state should pay compensation for the transboundary harm it has caused. REBECCA M. BRATSPIES & RUSSEL A. MILLER, *in* TRANSBOUNDARY HARM IN INTERNATIONAL LAW: LESSONS FROM THE TRAIL SMELTER ARBITRATION 1, 3 (Rebecca M. Bradspies & Russelll A. Miller Eds., 2006)).

principle was included in the Rio Declaration on Sustainable Development, providing that states should adopt policies making the polluter bear the cost of pollution.[1350]

For purposes of carriers' liability, the LLMC and HNS Conventions incorporate the "polluter pays" principle.[1351] The determination of who the polluter(s) are, as well as the actual liability to be compensated, involves legal principles as well as enforcement actions.[1352] Moreover, considerations based on the precautionary principle are expected to be included in potential liability assessments,[1353] to the extent that damage caused by the cross-border shipping of carbon dioxide has yet to occur in practice.

As Table 3 illustrates, the operation of carbon dioxide carriers is covered by several international instruments. However, when such instruments are not applicable, national liability laws will apply.[1354] Subject to the international and national framework on liability and their applicable limitations, it is expected that an agreement between the parties will establish when the liability passes over at the delivery point to the ship owner or operator, and when the liability passes over at re-delivery.[1355] From a regulatory standpoint, the metering point at carbon dioxide transfer – meaning, the measurement point of carbon dioxide – would be the natural liability transfer point to establish who is to be held responsible of any leakage and environmental damage under the aforementioned "polluter pays" principle, as parties would know the conditions of the cargo at that precise point. This, nonetheless, has been considered as a potential cost driver within the European Union context, so alternative contractual arrangements are expected to determine such allocation.[1356]

While the focus of this report is not the EU ETS, which is currently under implementation,[1357] it should be noted that segments of the international shipping industry increasingly interpret that the transfer of title and risk

[1350] The Rio Declaration is officially known as the United Nations Conference on Environment and Development (UNCED), G.A. Res. 228, U.N. GAOR, 44th Sess., Supp. No. 49, U.N. Doc. A/44/49 (1992). Principle 16 states: "National authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment."

[1351] *See, generally,* Gola & Noussia, *supra* note 1227, at 5. (Highlighting that the HNS Convention incorporated the polluter pays principle).

[1352] *See, generally,* Weber & Tsimplis, *supra* note 1210, at 149.

[1353] JONATHAN B. WIENER, *Precaution in* THE OXFORD HANDBOOK OF INTERNATIONAL ENVIRONMENTAL LAW 597, 598–603 (Daniel Bodansky et al. eds., 2010), (Asserting that even in light of uncertainty, one of the interpretations of the precautionary principle would require would command anticipation, prevention and attack of environmental risks).

[1354] Tsimplis & Noussia, *supra* note 1224, at 4.

[1355] Katherine Orchard et al., The Status and Challenges of CO_2 Shipping Infrastructures, 15th International Conference on Greenhouse Gas Control Technologies, GHGT-15, 9 (Mar. 15, 2021).

[1356] *Id.*

[1357] The European Parliament and European Council, Directive (EU) 2023/959 of the European Parliament and of the Council, amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union and Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading system (May 10, 2023), Paragraphs 16–22 (Providing for the inclusion of international maritime transport for the first time in the EU ETS system). See also our discussion in Chapter 4.

regarding carbon dioxide occurs simultaneously with the risk of loss, pollution, or emissions.[1358] This approach ensures that there is no residual risk to the emitter if the transportation and shipping company faces issues, like insolvency, for instance. Should this be the case, the transportation and shipping company assumes full responsibility and risk for the carbon dioxide once it reaches the transportation system.[1359]

This distinction is crucial and separate from the regulatory liability imposed by the EU ETS,[1360] which is governed by relevant EU legislation and cannot be reassigned by the involved parties.[1361] The industry's current understanding is based on the EU ETS not enforcing the transfer of carbon dioxide title to individual "installation" owners within the carbon dioxide value chain; if carbon dioxide escapes within this value chain, however, the EU ETS mandates that the operator of the installation from which the carbon dioxide escapes surrenders allowances.[1362] For instance, if carbon dioxide leaks from a pipeline during transport, the operator of that pipeline incurs liability under the EU ETS.[1363] The allocation of this risk on a back-to-back basis will therefore require bilateral negotiation between contracting parties;[1364] it may also operate in a different direction as placing the economic liability with the actor that causes leaks or emissions may remove the need for contractual redistribution of liability.[1365]

[1358] Personal communication with Kostis Andreou of Ecolog Ltd. (Jan. 9, 2024).

[1359] *Id.*

[1360] European Parliament and of the Council, Directive (EU) 2023/959 of the European Parliament and of the Council, amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union and Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading system (May 10, 2023), Paragraph 31 (Stating that the person or organization responsible for compliance with the EU ETS is the shipping company).

[1361] *Id.* at Paragraph 34. (Placing in member states the enforcement authority of compliance with the new regulations of EU ETS as to shipping companies registered in their territory).

[1362] European Parliament and of the Council, Directive (EU) 2023/959 of the European Parliament and of the Council, amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union and Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading system (May 10, 2023), Paragraph 69 affirms: "As CO_2 is also expected to be transported by means other than pipelines, such as by ship and by truck, the current coverage in Annex I to Directive 2003/87/EC for transport of greenhouse gases for the purpose of storage should be extended to all means of transport for reasons of equal treatment and irrespective of whether the means of transport are covered by the EU ETS. Where the emissions from the transport are also covered by another activity under Directive 2003/87/EC, the emissions should be accounted for under that other activity to prevent double counting." (Under this provision, operators of ships and trucks involved in carbon dioxide transport for geological storage need a greenhouse gas emissions permit under the EU ETS and will be liable for carbon dioxide emissions associated with this activity, including any leakage. *Id.* at Paragraphs 38–39.

[1363] The method for monitoring and reporting emissions is outlined in the Monitoring and Reporting Regulation (See European Commission, EU Commission Implementing Regulation (EU) on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 601/2012 (Dec. 19, 2018)). (Importantly, the technical requirements for monitoring and reporting mentioned in this regulation are tailored specifically to carbon dioxide transport via pipelines and may not seamlessly align with the technical reporting methods for ships and trucks).

[1364] Personal communication with Kostis Andreou of Ecolog Ltd. (Jan. 9, 2024).

[1365] S. La Hoz Theuer & A. Olarte, *Emissions Trading Systems and Carbon Capture and Storage: Mapping possible interactions, technical considerations, and existing provisions*, 1, 34 INTERNATIONAL CARBON ACTION PARTNERSHIP (2023) (Noting that the EU ETS places the economic liability with the actor that causes the leakage/emissions).

It is worth recalling that, although the United States is not a party to the United Nations Convention on the Law of the Sea (UNCLOS),[1366] the country recognizes much of the Convention as part of international customary law.[1367] Under UNCLOS, which has been referred to as a constitution for the oceans,[1368] jurisdiction over a vessel is linked to its nationality, and the flag a vessel flies is the symbol of its nationality.[1369] The right of states to confer flags to vessels is considered unconditional, as UNCLOS merely requires "a genuine link between the State and the ship."[1370]

Because there is no unequivocal definition of a "genuine link," it is unclear what the consequences would be should this requirement not be met.[1371] State authorities have avoided challenging this link, with global efforts focusing on the specific performance requirements for flag states.[1372] Since ships themselves are not subjects of international law, they are unable to incur responsibilities under international law.[1373] Consequently, the flag state is the one that bears the duty to comply with international law; ships derive their rights and obligations from the states whose nationality they have.[1374]

As a result, this system may incentivize shipowners to register (or re-register, if moving to another state's flag) their ships in jurisdictions with more flexible standards or lower costs. These are often the basis for the so-called "flag of convenience." The term has multiple definitions, but a classic definition in the literature is as follows: "a 'flag of convenience' can be defined as the flag of any country allowing registration of foreign-owned and foreign-controlled vessels under conditions which, for whatever reasons, are convenient and opportune for the persons who are registering the vessels."[1375]

Under UNCLOS, the nationality of a ship is consequential due to the "concept of exclusive flag state jurisdiction," which provides that, as a general rule, flag states have exclusive jurisdiction over their vessels on the high

[1366] United Nations Convention on the Law of Sea, Dec. 10, 1982 (entered into force Nov. 16, 1994), 1833 U.N.T.S. 3 [hereinafter UNCLOS]. This Convention is analyzed in Chapter 3 of this Report. The United States has neither signed nor ratified UNCLOS, according to the United Nations Treaty Collection website, at https://perma.cc/K6GW-H4SF.

[1367] Romany M. Webb, Korey Silverman-Roati & Michael B. Gerrard, *Removing Carbon Dioxide Through Artificial Upwelling and Downwelling: Legal Challenges and Opportunities*, Sabin Center for Climate Change Law 7 (2022).

[1368] Tommy T.B. Koh, President, Third United Nations Convention on the Law of the Sea, *A Constitution for the Oceans*, XXXVII (Dec. 11, 1982), at https://perma.cc/A236-T7YT. ("We worked not only to promote our individual national interests but also in pursuit of our common dream of writing a constitution for the oceans.").

[1369] UNCLOS, *supra* note 1366, Art 91(1), providing that: "Every State shall fix the conditions for the grant of its nationality to ships, for the registration of ships in its territory, and for the right to fly its flag. Ships have the nationality of the State whose flag they are entitled to fly."

[1370] UNCLOS, *supra* note 1366, Art 91(1).

[1371] Tamo Zwinge, *Duties of Flag States to Implement and Enforce International Standards and Regulations - And Measures to Counter Their Failure to Do So,* 10, 2 Journal of International Business and Law 297, 298 (2011).

[1372] *Id.*

[1373] Zwinge, *supra* note 1371, at 298.

[1374] *Id.*

[1375] David W. Abecassis, The Law and Practice Relating to Oil Pollution from Ships 77 (1978) (Highlighting that this definition has endured because it is so general; and how countries that have been named as flags of convenience changed over time).

seas.[1376] The Convention also provides that "every state shall effectively exercise its jurisdiction and control in administrative, technical and social matters over ships flying its flag,"[1377] and exemplifies several obligations to the state flag, including to effectively exercise jurisdiction and control over their ships, to maintain a register of ships, and to take measures to ensure safety at sea with regard to the construction, equipment and seaworthiness of ships, the manning of ships, among other requirements.[1378]

UNCLOS provides that in taking such measures, each state is required to conform to generally accepted international regulations, procedures, and practices and to take any steps which may be necessary to secure their observance, as established by Article 94 of the Convention.[1379] Therefore, the Convention obligates states to implement standards that, even when generally accepted, a state may not have necessarily agreed to apply to its own ships, thus creating a minimum standard.[1380]

Some commentators have argued that this application of Article 94 would extend these generally accepted standards to all states, even those not formally bound by them.[1381] Other legal scholars contend that such an interpretation would not be admissible, because "States are the supreme actors in international law and the suggestion that they are subject to a responsibility to conform to standards other states have adopted goes against the equal status of all states in international law."[1382] Both interpretations are legally admissible. Should the first interpretation prevail, it is unclear what level of consensus must exist about a given practice to legally bind a non-contracting party. It remains to be seen how courts will actually decide the scope of Article 94.[1383]

Ultimately, it is clear that not only may carriers be exposed to different sets of liabilities when transporting carbon dioxide, but they also have multiple avenues to limit their liability exposure. The type of damage that may trigger liability considerations includes damage from spilled bunkers, damage to third parties from the carriage of hazardous cargo, and damages to the cargo itself. The liability of shipowners will be strict for damage from spilled bunkers, but that liability may be limited under the LLMC. Liability arising out of damages from the carriage of hazardous cargo to third parties is currently provided for under domestic law but will become strict liability if and when the HNS enters into force. However, that liability may be limited under the LLMC as well as

[1376] UNCLOS, *supra* note 1366, Art 92 (1), stating that: "Ships shall sail under the flag of one State only and, save in exceptional cases expressly provided for in international treaties or in this Convention, shall be subject to its exclusive jurisdiction on the high seas. A ship may not change its flag during a voyage or while in a port of call, save in the case of a real transfer of ownership or change of registry."
[1377] UNCLOS, *supra* note 1366, Art 94 (1).
[1378] UNCLOS, *supra* note 1366, Art 94 (3).
[1379] UNCLOS, *supra* note 1366, Art 94 (5), stating that: "In taking the measures called for in paragraphs 3 and 4 each State is required to conform to generally accepted international regulations, procedures and practices and to take any steps which may be necessary to secure their observance."
[1380] James Harrison*, International Labour Organization*, 23 THE INTERNATIONAL JOURNAL OF MARINE AND COASTAL LAW 125, 134 (2008).
[1381] *Id.* at 135.
[1382] Tsimplis & Noussia, *supra* note 1224, at 3.
[1383] *See, e.g.,* Tsimplis & Noussia, *supra* note 1224, at 3. (Underscoring that the precise scope of Art. 94 (5) of the UNCLOS has not been subject to judicial interpretation).

the HNS. Finally, damages to the cargo are subject to contractual liability, which may be limited under the Hague Convention (COGSA, if in the United States), or Hague-Visby, or Rotterdam and/or contractual limitations, if any.

5. Jurisdiction over liability claims

As previously established in the introduction of this report, while the transportation of carbon dioxide originates in Europe, the precise jurisdiction of the exporter has yet to be determined. Likewise, the flag of the vessel is not defined. Therefore, the focus of this section on jurisdiction for liability claims is based on the United States' law.

There are a few preliminary points to be made on this matter before proceeding. First, the fact that the transportation contract will likely have a European party – whether this is the vessel owner, crew, or even eventual victims – is likely to provide enough of a basis for European courts to find their own jurisdiction. Second, the flag state of the vessel is a key component for liability inquiries. As a result, international courts may find that they are authorized to hear cases based on both the vessel's flag as well as where the damage may occur. However, as storage is to occur in the United States, this section proceeds to analyze the main jurisdictional scenarios that may allow claims to be brought in the United States' courts.

The United States Constitution grants original jurisdiction over admiralty and maritime cases to U.S. federal courts.[1384] Federal district courts have original subject matter jurisdiction over any civil case of admiralty or maritime jurisdiction, and federal courts are called "admiralty courts" when exercising admiralty or maritime jurisdiction.[1385]

The terms "admiralty law" and "maritime law" are frequently used as synonyms in the United States, but technically they are distinct. Admiralty law is comprised of rules that define the scope of the court's admiralty jurisdiction; maritime law is the substantive law applied by a court exercising admiralty jurisdiction.[1386] Maritime law consists of substantive rules created by federal courts, which are referred to as "general maritime law" and do not arise from the Constitution or legislation of the United States. Rather, the federal courts' power to create these rules arises from the Constitution's grant of admiralty jurisdiction, as does Congress' limited power to supplement admiralty law. General maritime law may apply rules that are customarily applied in other countries

[1384] U.S. Constitution, Art. 3, § 2, Cl. 1, which provides as follows: "The judicial Power shall extend to all Cases, in Law and Equity, arising under this Constitution, the Laws of the United States, and Treaties made, or which shall be made, under their Authority. . . to all Cases of admiralty and maritime Jurisdiction."

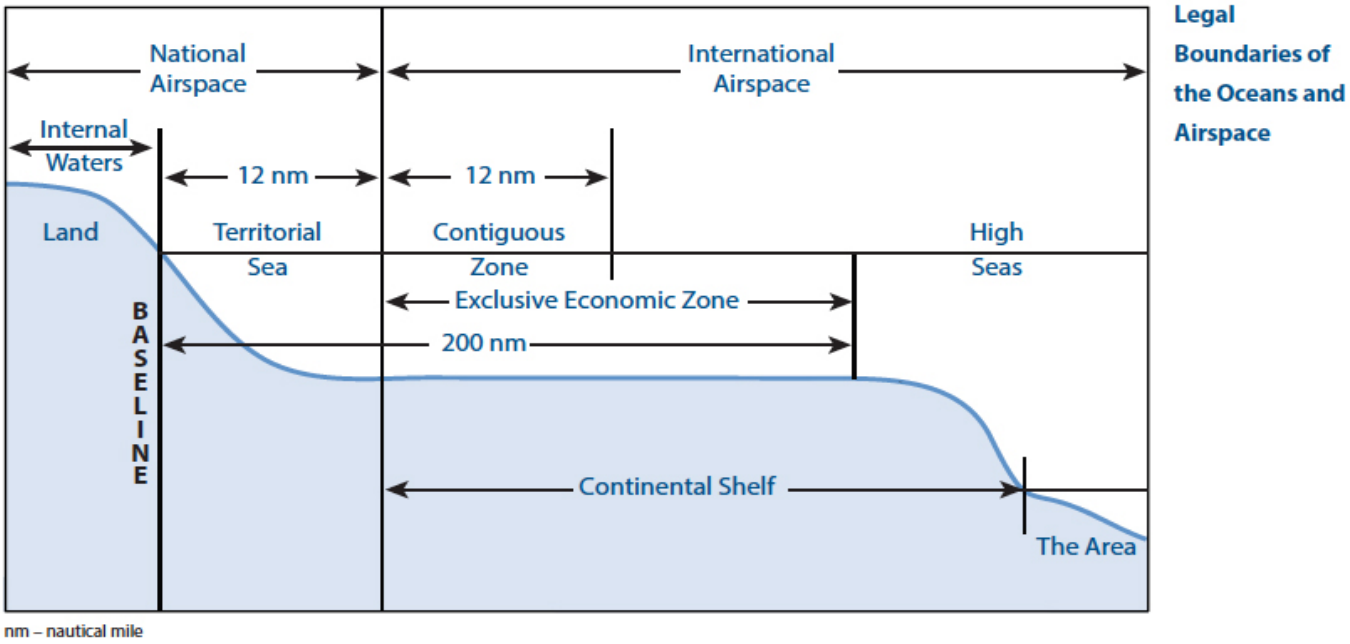
[1385] 28 U.S.C. § 1333. *See also* MATTHEW J. VALCOURT & ANTHONY J. CUVA, FLORIDA MARITIME LAW AND PRACTICE § 1.1 (2022), (There is an exception to the exclusive jurisdiction of federal courts, under the savings clause: "saving to suitors in all cases all other remedies to which they are otherwise entitled." This exception allows concurrent jurisdiction in state courts as well as federal question jurisdiction for admiralty-type claims under 28 U.S.C.§1331; it also allows for supplemental jurisdiction for other common-law claims in diversity to be brought within an admiralty claim.).

[1386] Martin J. Davies, *Teaching Admiralty Law Requires Dismissing Important Subjects*, 55 ST. LOUIS U. L. J. 483 (2011).

or those which are purely domestic.[1387] Common law action in federal court arising out of admiralty law is governed by general maritime law.[1388]

Under U.S. law, admiralty courts exercise jurisdiction over all admiralty and maritime actions, which includes two types of cases: (1) those involving acts committed on the high seas or other navigable waters, including prize cases and torts, injuries, and crimes committed on the high seas, and (2) those involving contracts and transactions connected with shipping on the seas or navigable waters.[1389] Figure 1 illustrates where the high seas is located in relation to other legal boundaries of oceans.

Figure 1: Legal Boundaries of the Oceans and Airspace[1390]



Maritime jurisdiction includes injuries or damage on land that were caused by a vessel on navigable waters.[1391] These actions can be brought *in rem*, meaning they arise out of the thing (i.e., the ship), or *in personam*, meaning

[1387] *Id.* (Noting that state laws on the topic may occasionally be used).
[1388] Jansson v. Swedish American Line, 185 F.2d 212, 1950 U.S. App. LEXIS 3817 (1st Cir. 1950).
[1389] Admiralty Court, Legal Information Institute at Cornell Law School, available at https://perma.cc/56EX-HHZN. (The figure includes airspace because sometimes air vehicles have also triggered maritime jurisdiction, as cases below involving helicopters demonstrate).
[1390] National Oceanic and Atmospheric Administration (NOAA), Ocean exploration (Jul. 20, 2022), *(Figure courtesy of Tufts University, Law of the Sea: A Policy Primer, Chapter 2: Maritime Zone), at* https://perma.cc/CE7Q-53B8.
[1391] *46 U.S.C. § 30101(a).*

they involve a quality of the person or agent (i.e., being a captain of the ship).[1392] Claims for maritime injury or death must be brought within three years of when the claim arose.[1393]

A maritime cause of action arises from an injury to persons or damage to property connected to a vessel in navigation on navigable waters during the course of traditional maritime activity with the potential to affect maritime commerce.[1394] The following analysis details each of these tort requirements.

The definition of "vessel" for admiralty purposes has long been broadly interpreted by Congress and the courts, but it is an issue of jurisdictional fact. As such, the United States Supreme Court incorporated statutory rules of construction.[1395] Under these rules, "vessel" is a "watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on water."[1396]

Connected to this definition is the "in navigation" requirement. A watercraft does not have to be "in motion to qualify as a vessel."[1397] Moreover, a vessel does not "pass in and out of [maritime jurisdiction] depending on whether it was moving at the time of the accident."[1398] Therefore, "in navigation" does not require a vessel to be in motion.[1399]

As for the third requirement regarding navigability, the "navigable-in-fact test" is the general maritime law for a waterway to be considered navigable.[1400] According to this test, waterways are navigable in fact "when they are used, or are susceptible of being used . . . as highways for commerce, over which trade and travel are or may be conducted."[1401]

The precise definition of "navigable waters of the United States" changed after the recent Sackett decision.[1402] Regardless of the exact scope of this definition, the United States' territorial sea is included as within the

[1392] 46 U.S.C. § 30101(b).
[1393] 46 U.S.C. § 30106.
[1394] MATTHEW J. VALCOURT & ANTHONY J. CUVA, FLORIDA MARITIME LAW AND PRACTICE § 1.2 (2022) (Surveying the case law on key topics and underscoring the following: *Stewart v. Dutra Constr. Co.*, 543 U.S. 481, 495 (2005) (Defining "vessel"); *Jerome B. Grubart, Inc. v. Great Lakes Dredge & Dock Co.,* 513 U.S. 527, 534 (1995) (Discussing "location" and the requirement of "in connection with maritime activity" tests); *Sisson v. Ruby*, 497 U.S. 358, 365–66 (1990) (Defining "traditional maritime activity."). These requirements are discussed below.
[1395] MATTHEW J. VALCOURT & ANTHONY J. CUVA, FLORIDA MARITIME LAW AND PRACTICE § 1.2 (2022) (Noting that the broad interpretation was to include new types of watercraft and vessels).
[1396] Rules of Construction Act, 1 U.S.C. § 3.
[1397] *Stewart v. Dutra Constr. Co.*, 543 U.S. 481, 495 (2005).
[1398] *Id.* (Highlighting that if a vessel is outside water for a long time, it may no longer qualify as "in motion.").
[1399] MATTHEW J. VALCOURT &ANTHONY J. CUVA, FLORIDA MARITIME LAW AND PRACTICE § 1.2 (2022).
[1400] *The Daniel Ball*, 77 U.S. 557, 563 (1871).
[1401] *The Daniel Ball*, 77 U.S. 557, 563 (1871); and, more recently, Lykes Bros., Inc. v. United States Army Corps of Engineers, 64 F.3d 630 (11th Cir. 1995) ("'Navigable waters' are waters upon which there may be maritime commerce with other states or foreign countries in customary modes. "Once a waterway is found to be navigable, it remains so." *Id*. at 634); *Alderman v. Pacific Northern Victor, Inc.*, 95 F.3d 1061, 1064 (11th Cir. 1996) (Detailing the location prong of the tort claim).
[1402] *Sackett v. Environmental Protection Agency*, 598 U.S. (May 25, 2023). 33 U.S.C. § 1251 et seq. The 1972 amendments to the Clean Water Act determined federal jurisdiction over "navigable waters," defined in the Act as the "waters of the United States." Under the

navigable waters of the United States, extending up to 12 nautical miles from shore. By contrast, the exclusive economic zone (EEZ), which extends out to 200 nautical miles from shore, is not technically included as navigable waters of the United States, since countries do not have exclusive jurisdiction over these waters.[1403] However, the high seas and EEZ may trigger U.S. admiralty jurisdiction despite those waters not being "navigable waters of the United States." Figure 1 also illustrates these ocean boundaries.

The fourth requirement is "during the course of traditional maritime activity," which refers to activities such as navigating, storing and maintaining a vessel at a marina on a navigable waterway, and other activities traditionally associated with vessels.[1404] Traditional maritime activities may be recreational or commercial.[1405] Courts will consider several factors to determine if a "traditional maritime activity" is present to trigger the courts' admiralty jurisdiction, including: "the function and role of the parties; the types of vehicles and instrumentalities involved; the causation and type of injury; and other traditional concepts of the role of admiralty law."[1406] These factors often point to an overall concern of uniformity in maritime decisions.

The final requirement refers to "potential to affect maritime commerce," which courts have interpreted broadly.[1407] Courts have ruled that the following incidents met this requirement: collision between pleasure boats in waterway that rarely has commercial activity;[1408] a passenger falling backwards of the operator in a leisurely boat;[1409] and fire in a noncommercial vessel in a marina located in navigable waters.[1410] This requirement does not refer to the actual effects of an incident on maritime commerce, but rather on whether the general features of the type of incident involved have the potential to disrupt commercial activity.[1411] The

CWA, the EPA and the Corps of Engineers have the delegated authority to issue regulations defining the term. After the *Sackett* decision, the agencies are updating their definition. *See* U.S. Environmental Protection Agency, Waters of the United States, at https://perma.cc/7YJP-QMLX.

[1403] We defined these concepts in Chapter 3 of this report. For immediate reference on the topic: Coast Guard: DHS, *Territorial Seas, Navigable Waters, and Jurisdiction* (Jul. 18, 2003), at https://perma.cc/V3C3-PFAU. ("Under customary international law as reflected in the 1982 United Nations Convention on the Law of the Sea and without prejudice to high seas freedoms that may be exercised within exclusive economic zones pursuant to article 58 of the United Nations Convention on the Law of the Sea, and unless the context clearly requires otherwise (*e.g.*, The International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties, 1969, including annexes thereto), *high seas* means all waters that are not the exclusive economic zone . . . territorial sea . . . or internal waters of the United States or any other nation.").

[1404] *Sisson v. Ruby*, 497 U.S. 358, 366 (1990). *See also Jerome B. Grubart, Inc. v. Great Lakes Dredge & Dock Co.,* 513 U.S. 527, 534 (1995).

[1405] *Foremost Ins. Co. v. Richardson,* 457 U.S. 668, 674 (1982).

[1406] *Cochran v. E.I. duPont de Nemours*, 933 F.2d 1533, 1538 (11th Cir. 1991).

[1407] MATTHEW J. VALCOURT & ANTHONY J. CUVA, FLORIDA MARITIME LAW AND PRACTICE § 1.2 (2022)

[1408] Foremost Insurance Co. v. Richardson, 457 U.S. 668, 102 S.Ct. 2654, 73 L.Ed.2d 300 (1982).

[1409] *Mink v. Genmar Industries, Inc.*, 29 F.3d 1543 (11th Cir. 1994) (The court underlined that the passenger could easily fall in front of the operator thus potentially causing an accident).

[1410] *Sisson v. Ruby*, 497 U.S. 358, 366 (1990).

[1411] MATTHEW J. VALCOURT & ANTHONY J. CUVA, FLORIDA MARITIME LAW AND PRACTICE § 1.2 (2022).

court will ultimately assess "the general features of the type of incident involved . . . to determine whether the incident has 'a potentially disruptive impact on maritime commerce.'"[1412]

Following the analysis above, a vessel carrying carbon dioxide from Europe for permanent storage in the United States is likely to meet all the requirements of admiralty jurisdiction. There may be some uncertainty if the event occurs in the high seas or in the EEZ, but even though these are not territorial waters of the United States, admiralty and maritime jurisdiction is still applicable. For torts occurring in the EEZ, courts have highlighted that "[T]he law is entirely well settled . . . that torts originating within the waters of a foreign power may be the subject of a suit in a domestic court."[1413] For accidents in the high seas, for instance, there is vast case law as long as it is in pursuit of an activity bearing a significant relationship to a traditional maritime activity.[1414] For death in the high seas in particular, there is specific legislation authorizing admiralty jurisdiction.[1415]

It is noteworthy that traditionally, admiralty jurisdiction has not been construed to extend to accidents on piers, jetties, and bridges, nor was a court entitled to exercise supplemental jurisdiction over claims made against an impleaded party brought by employer who suffered an accident in a pier.[1416] The Admiralty Extension Act,[1417] which Congress passed in 1948, aimed at remedying these historic inequities.[1418] This act specifically extends the admiralty and maritime jurisdiction to include "cases of injury or damage, to person or property, caused by a vessel on navigable waters, even though the injury or damage is done or consummated on land."[1419] Therefore, the act ended controversies over the blurred line between land and water by investing admiralty with jurisdiction over "all cases" when the injury was caused by a ship or other vessel on navigable water, even if such an injury occurred on land.[1420]

Federal courts also exercise admiralty and maritime jurisdiction arising out of contractual claims. "Maritime contracts" have been traditionally defined as all contracts that "relate to the navigation, business, or commerce

[1412] Jerome B. Grubart v. Great Lakes Dredge & Dock Co., 513 U.S. 527, 534 (1995).
[1413] *Malay. Int'l Shipping Corp. v. Sinochem Int'l Co.,* 436 F.3d 349, 355-56 (3d Cir. 2006). *See also* Perforaciones Exploracion y Produccion v. Maritimas Mexicanas, S.A., 356 Fed. Appx. 675, 678 (U.S. App. 5th Cir., 2009).
[1414] *See, e.g.,* Green v. Industrial Helicopters, Inc., 593 So. 2d 634, 636 (S. Ct. La., 1992) ("When an accident involving a helicopter transporting passengers was considered to trigger maritime jurisdictions because the accident happened in high seas and in furtherance of activity bearing significant relationship with a traditional maritime activity."); Tucker v. Petroleum Helicopters, Inc., 9 So. 3d 966 (La.App. 4 Cir., 2009).
[1415] 46 U.S.C.S. § 761. (The Death on the High Seas Act) (Providing that "whenever the death of a person shall be caused by wrongful act, neglect or default occurring on the high seas beyond a marine league from the shore of any state, or the District of Columbia, or the Territories or dependencies of the United States, the personal representative of the decedent may entertain a suit for damages in the district courts of the United States, in admiralty for the exclusive benefit of the decedents' wife, husband, parent, child or dependent relative against the vessel, person, or corporation which would have been liable if death had not ensued.").
[1416] Da Cruz v. Towmasters of N.J., Inc., 217 F.R.D. 126, 2003 U.S. Dist. LEXIS 14166 (E.D.N.Y. 2003).
[1417] 46 U.S.C. § 30101 et seq.
[1418] MATTHEW J. VALCOURT &ANTHONY J. CUVA, FLORIDA MARITIME LAW AND PRACTICE § 1.2 (2022).
[1419] 46 U.S.C. § 30101 (a). *See also Victory Carriers, Inc. v. Law*, 404 U.S. 202, 209, 92 S.Ct. 418, 30 L.Ed.2d 383 (1971) (Discussing the original language of the Act, which is similar to the current provision).
[1420] MATTHEW J. VALCOURT AND ANTHONY J. CUVA, FLORIDA MARITIME LAW AND PRACTICE § 1.2 (2022).

of the sea."[1421] To trigger this specialized jurisdiction, the contract "must be wholly maritime in nature, or its non-maritime elements must be either insignificant or separable without prejudice to either party."[1422] Furthermore, the contractual obligations must " pertain directly to and be necessary for commerce or navigation upon navigable waters."[1423] When deciding if the subject matter of a contract is necessary to the operation, navigation, or management of a ship, courts apply "a test of reasonableness, not absolute necessity."[1424] It is noteworthy that the nature of the disputed contract, not the status of parties, is the key factor in determining whether a contract is in admiralty.[1425] The literature clarifies a few examples. Contracts for the sale and purchase of vessels are not maritime contracts, but intuitively, a general agency contract in connection with the operation of a ship is a maritime contract; likewise, marine insurance policies are maritime contracts.[1426]

Accordingly, a contract for the cross-border carriage of carbon dioxide for storage in the United States is expected to pass muster and fulfill the requirements demonstrating its relation to the navigation business. In addition, it is directly related to commerce of the sea, being of maritime nature. Therefore, federal jurisdiction should be granted without controversies.

6. Concluding remarks

The previous sections discussed the main international conventions specifically addressing shipping, the expected issues arising out of contractual liability, and an analysis of the consequences of the different liability regimes potentially applicable to the cross-border shipment of carbon dioxide for permanent storage in the United States. Our findings conclude that, subject to the international and national frameworks on liability and their applicable limitations, it is expected that the agreement between the parties will establish when liability passes over at the delivery point to the ship owner or operator, as well as when liability passes over at re-delivery. Our findings also conclude that federal courts have extensive admiralty and maritime jurisdiction, including cases arising out of an injury to persons or damage to property connected to a vessel in navigation on navigable waters during the course of traditional maritime activity with the potential to affect maritime commerce. Moreover, torts that occur in the EEZ as well as contractual claims are likely to be included within federal courts' admiralty and maritime jurisdiction in the United States.

[1421] *DeLovio v. Boit*, 7 F.Cas. 418, 444 (C.C. D. Mass. 1815).
[1422] *Inbesa America, Inc. v. M/V Anglia*, 134 F.3d 1035, 1036 (11th Cir. 1998).
[1423] MATTHEW J. VALCOURT &ANTHONY J. CUVA, FLORIDA MARITIME LAW AND PRACTICE § 1.2 (2022).
[1424] *Id.*
[1425] *Exxon Corp. v. Central Gulf Lines, Inc.*, 500 U.S. 603, 111 S.Ct. 2071, 114 L.Ed.2d 649 (1991).
[1426] MATTHEW J. VALCOURT & ANTHONY J. CUVA, FLORIDA MARITIME LAW AND PRACTICE § 1.2 (2022).