Legal Implications of CO_2 Ocean Storage

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Introduction

Ocean sequestration of CO_2, a potentially significant technique to be used in combination with renewable power sources, energy efficiency improvements and proposed lifestyle changes to mitigate climate change, must overcome various environmental, legal, economic and political challenges before it can be fully deployed as an important greenhouse gas abatement strategy. Because of its vital role in naturally removing carbon dioxide from the atmosphere, the ocean is considered an essential partner in slowing the accumulation of anthropogenic greenhouse gas emissions. In addition, the ocean is thought to have an enormous capacity available (on the order of 1,000-10,000Gt) to absorb and store carbon dioxide in addition to the vast quantities already stored naturally. A few recent research and experimental projects, which have been developed to further study the efficacy and safety of this hypothesis, have been met with some legal and political resistance.

Two major international conventions, the Framework Convention on Climate Change, 1992 (FCCC) and the London Dumping Convention, 1972, seem to contradict each other regarding the use of the ocean as a "sink" or disposal area for carbon dioxide. On one hand, the FCCC specifically encourages the development of the ocean as a sink for CO_2; on the other, the London Convention prevents dumping of "industrial waste" into and under the seas without permit. To further complicate the issue, most parties to these conventions also have national laws that govern their territorial seas. For example, the United States Congress passed the Clean Water Act in 1972 and the Ocean Dumping Act in 1988. Both laws, which regulate disposal of substances into ocean waters, may impede the deployment of CO_2 storage technologies used in the marine environment. This paper will address some of the legal issues involved in ocean storage of carbon dioxide from a US perspective. The following paragraphs will review the Framework Convention on Climate Change, the London Convention, the Clean Water Act and the Ocean Dumping Act while focusing specifically on their implications for ocean storage of CO_2. International and US case studies will be analyzed within the context of these legal frameworks followed by an analysis of the legal implications for ocean storage and suggestions for moving forward.

Ocean Storage of CO_2

Ocean storage of CO_2 is in the nascent stages of development; thus many questions still need to be answered before this technology can be employed as a viable solution to reduce anthropogenic greenhouse gas emissions. In order for ocean storage of carbon dioxide to become a workable strategy for mitigating climate change, certain criteria must be met: 1) sequestration technologies must be cost effective, 2) environmental impacts must be acceptable, 3) techniques must be politically and legally feasible, and 4) scientific certainty must be increased as to the effectiveness of the oceans to safely sequester CO_2. Essentially, there are four general techniques to sequester carbon dioxide in the marine environment. CO_2 can be injected directly into the water where it then dissolves and is diluted in large volumes of seawater or it may sink to the ocean floor. Direct injection of this kind can be done by a sea-based or a land-based source. For example, ships towing a pipe can release CO_2 into the water to achieve a greater degree of dilution and therefore ameliorate some of the environmental impacts, such as lowering the pH of the seawater in concentrated areas. An alternative method could possibly involve piping unadulterated CO_2 into the water from an on-shore facility, such as a power plant

or an industrial facility. In this case, ocean currents may prevent stagnation or accumulation in certain locations. CO_2 can also be injected via pipeline from sea-based or land-based sources under the water into the sub-seabed. "A 1996 European study estimated the potential capacity for underground storage of CO_2 under the Northwest of Europe as 800 billion tonnes. This storage potential is equivalent to the total emissions from EU power stations for 800 years."[1] From a legal perspective, it is important to distinguish between the methods, destinations and sources of injection as well as the purpose for which injection (enhanced oil and gas recovery, oil and gas processing, disposal, etc.) is done.

International Law

Technologies and innovations often emerge into a regulatory environment not designed for certain new developments. Ocean storage of CO_2 is one example of a new technical process that has emerged within the grey areas of an existing regulatory regime designed well before concerns of climate change came to international attention. In general, the Framework Convention on Climate Change, which has been ratified by more states than any other convention, promotes the development of the ocean as a reservoir for carbon dioxide; however, the London Convention, the UN Convention on the Law of the Sea (UNCLOS), the Paris Convention and customary law are ambiguous in their application to this new technological process[2]. Variations in membership and jurisdiction prevent broad application of these laws; hence, the scope of this section will be limited to reviewing the FCCC and the London Convention, both of which the US is a party to, and two US regulations relevant to ocean storage, the Clean Water Act and the Ocean Dumping Act.

Framework Convention on Climate Change, 1992

The Climate Convention is the overarching and most widely agreed upon framework for addressing the problem of climate change and anthropogenic emissions of greenhouse gases. The Convention explicitly recognizes the role and importance in terrestrial and marine ecosystems of sinks and reservoirs of greenhouse gases.[3] The Convention specifically mentions the need for using sinks and reservoirs as one component of a more comprehensive portfolio of strategies for reducing greenhouse gas emissions. Article 4.1.d of the Convention notes:

> *4(1)(d)...Promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems;*

Ocean storage of carbon dioxide is singled out as an important mechanism in helping to reduce the level of atmospheric carbon dioxide. Although development of the oceans is encouraged by the agreement, it does not suggest that the ocean environment should suffer at the expense of the atmosphere. According to Article 3, Principle 3 of the Convention,

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[1] JOULE II (1996) "Underground Storage of CO2," managed by British Geological Survey, www.ieagreen.org.uk
[2] McCullagh, J., (1996) "International Legal Control Over Accelerating Ocean Storage of Carbon Dioxide," in IEA Greenhouse Gas R&D Programme, *Ocean Storage of CO2, Workshop 3, International Links and Concerns*
[3] United Nations Framework Convention on Climate Change (1992), Article 4.1.d, http://unfccc.int/

3....The Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost. To achieve this, such policies and measures should take into account different socio-economic contexts, be comprehensive, cover all relevant sources, sinks and reservoirs of greenhouse gases and adaptation, and comprise all economic sectors. Efforts to address climate change may be carried out cooperatively by interested Parties[4].

Under this principle, it seems that carbon sequestration in ocean reservoirs is consistent with the precautionary measures advocated for in the convention. Principle 3 states that policies and measures should be cost-effective, which at the present time may appear to exclude carbon storage in the ocean, but as the Statoil experiment later shows, sequestration, although relatively expensive to other technologies, can be at least equally cost effective for operators in countries such as Norway, where a carbon tax has been implemented. This point may prove significant if carbon storage in the oceans can be shown to be a cost effective way to ensure global benefits.

London Convention, 1972

With more than 70 member states including all major OECD countries, the London Convention essentially prohibits all dumping activity in the oceans without authorization by a national authority. A resolution in 1991 formally adopted the Precautionary Principle and outlawed the dumping of all radioactive and industrial waste. The resolution defined industrial waste as "generated by manufacturing or processing operations" and identified a list of material not considered industrial waste[5]. Since then, ongoing discussions have not produced a consensus on whether CO_2 should be classified as an industrial waste.

Particularly, the London Convention applies only to ships, aircraft and offshore platforms. Land-based disposal, from a pipeline for example, would not fall under the purview of the London Convention, but would be governed by national laws. Because carbon dioxide is not on the list of banned (Annex I) or controlled (Annex II) substances, any activity which attempts to sequester carbon dioxide in the ocean or under the seabed must be authorized by the national authority that has jurisdiction over the waters. If permission is granted, then the disposal activity will be subject to the assessment requirements in Annex III of the Convention and any applicable national regulation.

The 1996 Protocol to the London Convention, though not yet in force, made some significant changes to the original agreement. Fundamentally, the Protocol will replace the London Convention's list of banned substances with a list of allowable materials, which does not include CO_2. The Protocol further clarified the meaning of "dumping" and disallowed "any storage of wastes or other matter in the seabed and subsoil[6]." Notably, with respect to ocean storage of CO_2, the Protocol exempted

[4] United Nations Framework Convention on Climate Change (1992), Article 3, Principle 3 http://unfccc.int/
[5] Campbell, J. (1996) "Legal, Jurisdictional and Policy Issues – 1972 London Convention" in IEA Greenhouse Gas R&D Programme, *Ocean Storage of CO2, Workshop 3, International Links and Concerns*
[6] 1996 Protocol to the London Convention, Article 1, Definitions 4.1.3 http://www.londonconvention.org/

the disposal or storage of wastes or other matter directly arising from, or related to the exploration, exploitation and associated off-shore processing of seabed mineral resources[7].

Despite the exemption of activities involved in natural resource recovery, the Convention generally prohibits carbon dioxide storage resulting from sea-based sources in and under the ocean, unless a permit authorizing the activity has been issued. In 1997, the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) reported that unless a two-thirds majority of Contracting Parties amended the Convention, CO_2 dumping from ships (specifically dry ice and liquid CO_2) violates the London Convention[8].

National (US) Law

In addition to meeting these international obligations to which the United States is a party, sequestration technologies employed in US waters[9] must also comply with the requirements of national law. Two important national laws have special relevance to ocean storage of carbon dioxide, namely, the Clean Water Act and the Ocean Dumping Act.

Clean Water Act, 1972

The Federal Water Pollution Control Act, commonly known as the Clean Water Act, prohibits point source discharges (discharges from municipal or industrial facilities) into "navigable" waters including the territorial seas without a National Pollutant Discharge Elimination System (NPDES) permit, which certifies that technology and water-quality requirements have been met. Further, Section 403 of the Clean Water Act ensures that marine environments will not suffer "unreasonable degradation" or "irreparable harm" through mandatory ecological risk assessments. Section 403 can require ambient monitoring programs, alternative assessments that consider and evaluate alternative disposal options and pollution prevention techniques designed to reduce the pollutant at the source[10]. To carry out its Congressional mandate, the EPA has established Ocean Discharge Guidelines to be used by the agency in evaluating the potential for unreasonable degradation of any proposed dumping activity. If the available information is insufficient to support a finding of "no unreasonable degradation", then the applicant must prove that "no irreparable harm" will result from the disposal into the marine environment[11].

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[7] ibid

[8] Johnston, P. et al., (1999) "Ocean Disposal/Sequestration of Carbon Dioxide from Fossil Fuel Production and Use: An Overview of Rationale, Techniques and Implications," Greenpeace Research Laboratories, Amsterdam

[9] Individual states have jurisdiction within three miles of the shore. The costal country has sovereignty within the territorial sea extending twelve miles from the coast. The Exclusive Economic Zone, extending up to 200 miles, is a zone in which the coastal country has jurisdiction and exclusive rights to explore natural resources. See Churchill, J. (1996) "International Legal Issues Relating to Ocean Storage of CO2: A focus on the UN Convention of the Law of the Sea," in IEA Greenhouse Gas R&D Programme, *Ocean Storage of CO2, Workshop 3, International Links and Concerns.* Note: Although UNCLOS has not been ratified by the United States, these delineations have been agreed upon.

[10] Clean Water Act, Section 403, (1972) "A Framework for Ecological Risk Assessment," EPA Office of Water, www.epa.gov/owow/oceans/discharges/403.html

[11] ibid

With respect to CO_2 disposal from municipal or industrial facilities, Section 403 of the Clean Water Act suggests that this activity will not be allowed until further research is done on the impact of CO_2 in marine environments. For example, CO_2 can cause changes in the pH of water that may adversely affect marine ecology. Under the Act, scientific certainty that degradation will be prevented is not required, but enough evidence must be available to prove that CO_2 storage will not be irreparably deleterious. Thus, further research on the ecological impacts of carbon dioxide is necessary before disposal of carbon dioxide from point sources could be allowed in US waters under existing regulations.

Ocean Dumping Act, 1988

The Marine Protection, Research, and Sanctuaries Act (MPRSA), also known as the Ocean Dumping Act, regulates the ocean dumping of waste, provides for a research program on ocean dumping, and provides for the designation and regulation of marine sanctuaries[12]. The act regulates the ocean dumping of all material beyond the territorial limit (three miles from shore) and prevents or strictly limits dumping material that "would adversely affect human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities."[13] Passed by Congress in 1988 to increase protection of marine environments, the Ocean Dumping Act further regulates the transport and discharge of substances into and beneath the ocean.[14]

The EPA's criteria for granting a permit under the Ocean Dumping Act are as stringent as those employed under the Clean Water Act. For example, the standard for a permit is based upon assurance that no unreasonable degradation or endangerment to humans or the marine environment will occur. As far as CO_2 storage is concerned, the mandate categorically excludes "industrial waste" from obtaining an EPA permit, unless a permit is authorized in the case of an emergency[15].

> *"after December 31, 1991, it shall be unlawful for any person to dump into ocean waters, or to transport for the purposes of dumping into ocean waters, sewage sludge or industrial waste"*

The Act directs EPA to enforce the binding requirements of the London Convention, and consider among other things, the need for dumping, its impact on humans and ecosystems, and the effects of particular volumes and concentrations of the substance. Again, the current regulatory environment suggests that ocean storage of carbon dioxide is unlikely to be permitted unless 1) a greater level of scientific certainty can be achieved that demonstrates low potential for harm and 2) the law can be amended either by specifically allowing CO_2 dumping or by

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[12] Department of Energy, (May 2002), EH-41 Environmental Law Summary: Marine Protection, Research, and Sanctuaries Act http://tis.eh.doe.gov/oepa/

[13] ibid

[14] *Unless authorized by permit, the Marine Protection, Research and Sanctuaries Act (Ocean Dumping Act) generally prohibits (1) transportation of material from the US for the purpose of ocean dumping; (2) transportation of material from anywhere for the purpose of ocean dumping by US agencies or US-flagged vessels; (3) dumping of material transported from outside the US in the US territorial se;* EPA (May 2002) Summary of Marine Protection, Research, and Sanctuaries Act Title I (MPRSA) http://www.epa.gov/owow/ocpd/marine.html

[15] Ocean Dumping of Sewage Sludge and Industrial Waste, Title 33, Chapter 27, Sec. 1414b (a)(1)(B), http://www4.law.cornell.edu/uscode/33/1414b.html

excluding it from the "industrial waste" classification. Further, even if CO_2 could be exempted from the "industrial waste" classification, it may be difficult to demonstrate a "need for CO_2 dumping" to regulators who may point to more 'acceptable' and less political alternatives such as terrestrial and/or geologic sequestration techniques. The law implies that ocean dumping is only possible if no other reasonable alternatives are available. The need for dumping will be determined by evaluation of the following factors including but not limited to:[16]

(c) The relative environmental risks, impact and cost for ocean dumping as opposed to other feasible alternatives including but not limited to:

(1) Land fill;
(2) Well injection;
(4) Spread of material over open ground;
(5) Recycling of material for reuse;
(6) Additional biological, chemical, or physical treatment of intermediate or final waste streams;
(7) Storage.

(d) Irreversible or irretrievable consequences of the use of alternatives to ocean dumping.

The basis for determination of need for ocean dumping includes:[17]

(a) A need for ocean dumping will be considered to have been demonstrated when a thorough evaluation of the factors listed in Sec. 227.15 (above) *has been made, and the Administrator, Regional Administrator or District Engineer, as the case may be, has determined that the following conditions exist where applicable:*

(1) There are no practicable improvements which can be made in process technology or in overall waste treatment to reduce the adverse impacts of the waste on the total environment;

(2) There are no practicable alternative locations and methods of disposal or recycling available, including without limitation, storage until treatment facilities are completed, which have less adverse environmental impact or potential risk to other parts of the environment than ocean dumping.

Legal Analysis of CO_2 Ocean Storage

Locations, methods, processes and technologies used for CO_2 ocean storage are important to consider in analyzing the legal framework governing its application. Earlier it was mentioned that ocean injection can occur from both land and sea-based sources. CO_2 can be stored directly in seawater or beneath the ocean floor. This is not as distinguishing under international law since the 1996 Protocol to the London Convention, which included the regulation of sub-seabed dumping. But, as the examples below will point out, the *purpose* for which CO_2 injection occurs in a given scenario is significant from a legal perspective.

[16] US Code of Federal Regulations (May 2002) Criteria for the Evaluation of Permit Applications for Ocean Dumping of Materials Title 40, Volume 21 (40 CFR 227)
[17] ibid

Statoil Sequestration Experiment – Sea Based Injection

Since 1996, Statoil, a Norwegian state-owned oil company, has been injecting carbon dioxide, a byproduct of natural gas recovery, into a 32,000 km^2 aquifer 800m below the floor of the North Sea[18]. This innovative approach to greenhouse gas reduction was spurred in 1991 by a government imposed carbon tax on all carbon emissions from extraction activities on Norway's continental shelf. The continental shelf, a legal zone that establishes rights to the coastal State for exploration and recovery of natural resources, extends generally to the point at which the depth of water no longer permits seabed exploration[19]. In order to avoid a NOK 1 million/day penalty due, Statoil developed a carbon injection mechanism that sequesters the carbon dioxide in the underground aquifer once it has been removed from the natural gas[20]. (Figure 1 below)

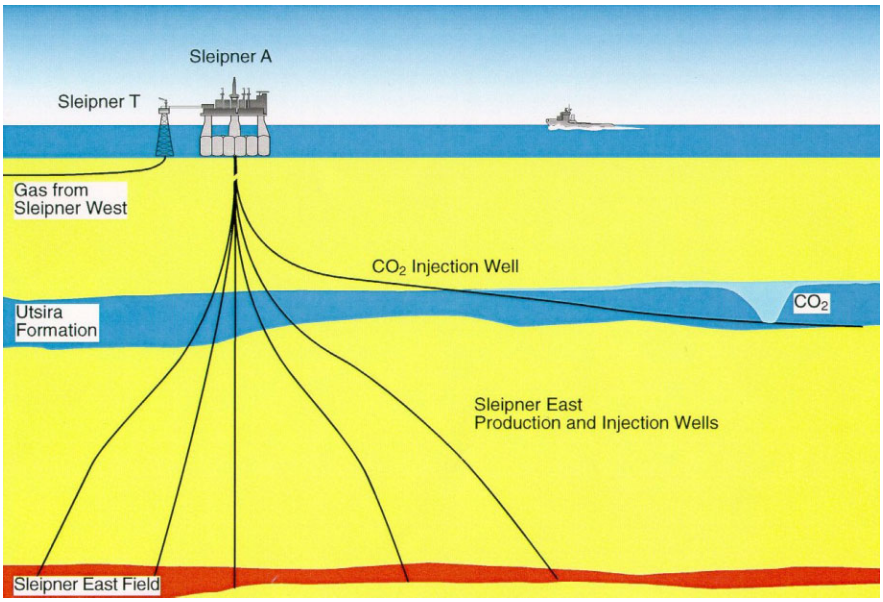

Figure 1: Statoil CO_2 Injection[21]

From a technical perspective, carbon sequestration has been successfully implemented as an alternative way to reduce the level of CO_2 reaching the atmosphere. Nevertheless, objections have been raised as to the legality of this procedure. Some environmental groups, notably Greenpeace International have claimed Statoil is in violation of the 1972 London Convention, to which Norway is a party, which prohibits dumping from sea-based objects. Specifically, Greenpeace insists that CO_2 is an "industrial waste" defined by the Convention as "waste

[18] Hanisch, C. (1998) "The pros and cons of carbon dioxide dumping." *Environmental Science and Technology* 32 (1): 20A-24A.

[19] Churchill, J. (1996) "International Legal Issues Relating to Ocean Storage of CO2: A focus on the UN Convention of the Law of the Sea," in IEA Greenhouse Gas R&D Programme, *Ocean Storage of CO2, Workshop 3, International Links and Concerns.* Note: UNCLOS has not been ratified by the United States, Norway ratified in 1996.

[20] Statoil (May 2000) "Carbon Dioxide Storage Prized," http://www.statoil.com/

[21] International Energy Agency (May 2002) "Saline Aquifer CO_2 Storage," http://www.ieagreen.org.uk/sacshome.htm

materials generated by manufacturing or processing operations."[22] They assert the 1993 Amendment that added industrial waste to the forbidden list of substances should include Statoil's disposal of carbon dioxide because it is generated from the manufacturing and processing of natural gas. There is support for this argument in American case law. In *Arco Oil and Gas Company v EPA* (1993), the United States Court of Appeals for the Tenth Circuit upheld an EPA decision to force Arco to apply for a Class I EPA permit for its natural gas extraction operation in which CO_2 was extracted and used for enhanced oil recovery. In doing so, EPA characterized the waste fluids disposed of as "hazardous," "industrial" or "municipal" waste. In this case, "the EPA's narrow interpretation of the term "natural gas" has the effect of subjecting carbon dioxide injection wells to stricter regulatory scrutiny…"[23]

Before piping the natural gas to shore, Statoil strips the CO_2 from the fuel and subsequently disposes of the CO_2 via pipeline under the seabed. Under the London Convention then, it would seem that Statoil is in violation of international law; however, the 1996 Protocol to the Convention, as mentioned above, specifically excludes disposal and storage of wastes resulting from the processing of off-shore minerals. Greenpeace and other critics of Statoil's project have attempted to dismiss this exemption by pointing out that the platform used to produce natural gas is not the same platform that injects the CO_2 into the ocean floor (Figure 2). Therefore,

> *it must be noted that while the gas is produced by Sleipner B platform, the stripping treatment and injection of CO_2 occurs at Sleipner T, some 12 km from the production platform and into a different formation. Sleipner T therefore clearly "operates for the purpose of disposal of such matter" and, as the CO_2-rich gas is transported to the platform for this purpose, the operation by definition constitutes dumping under the terms of the Convention.*[24]

[22] Campbell, J. (1996) "Legal, Jurisdictional and Policy Issues – 1972 London Convention" in IEA Greenhouse Gas R&D Programme, *Ocean Storage of CO2, Workshop 3, International Links and Concerns*
[23] *Arco Oil and Gas Company v EPA,* No. 90-9545, (1993) United States Court of Appeals for the Tenth Circuit
[24] Email from David Santillo (April 2001) Greenpeace Research Laboratories, Department of Biological Sciences, University of Exeter

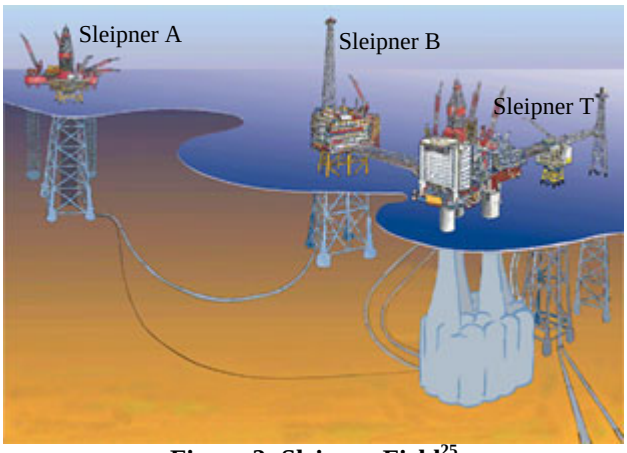

Figure 2: Sleipner Field[25]

This argument, which attempts to separate the production of natural gas from the injection of carbon dioxide, is not robust. Sleipner T, where the carbon dioxide is stripped from the gas stream and then injected into the ground, is where a critical piece of natural gas production occurs. Natural gas from the Sleipner West field has a high content of carbon dioxide (about 9%). This must be reduced to 2.5% before the gas can commercially viable.[26] Thus, Sleipner T represents a key component of natural gas production for commercial use. Without this process, the natural gas produced from these platforms would not be suitable for the marketplace. Consequently, the 1996 Protocol, which excludes operations engaged in natural mineral recovery from the restrictions of the Convention, applies to Statoil's CO_2 storage activity on Sleipner T.

In short, contrary to Greenpeace's assertions, Statoil is not in violation of the London Convention. Further, the Protocol also allows for the "placement of matter for a purpose other than the mere disposal of…"[27] It might be possible to argue that through the process of natural gas extraction, the CO_2 is merely relocated or "placed" in a new location. However, this argument could probably dismissed on the grounds that it is "contrary to the aims of the Protocol."[28]

If a similar project were to be attempted in US waters, the same international restrictions and exemptions would apply. However, the Ocean Dumping Act, which includes the London Convention to the extent that it does not weaken the Ocean Dumping Act, makes the dumping of industrial waste unlawful. Given that CO_2 "generated by manufacturing or processing operations" is considered industrial waste, it appears that CO_2 storage in or under (via the LC) the ocean "from anywhere" is prohibited[29]. As mentioned above, before granting a permit, EPA

[25] www.statoil.com (May 2002)
[26] International Energy Agency (May 2002) "Saline Aquifer CO2 Storage Project" http://www.ieagreen.org.uk/sacshome.htm
[27] 1996 Protocol to the London Convention, Article 1, Definitions 4.2.3 (May 2002) http://www.londonconvention.org/
[28] 1996 Protocol to the London Convention, Article 1, Definitions 4.2.2 (May 2002) http://www.londonconvention.org/
[29] EPA (May 2002) Summary of Marine Protection, Research, and Sanctuaries Act Title I (MPRSA) http://www.epa.gov/owow/ocpd/marine.html

must evaluate among others the need for dumping, as well as the effect on humans, marine life and environment.

Norway Natural Gas Power – Land Based Injection

The Norwegian permit authority authorizing the development of the HydroKraft project, said CO_2 emissions must be reduced 90% over the original application in order to comply with their Kyoto targets.[30] To meet such demands, project leaders propose to inject CO_2 from power production into sub-seabed oil reservoirs to both dispose of the greenhouse gas and to create value through enhanced oil recovery.[31]

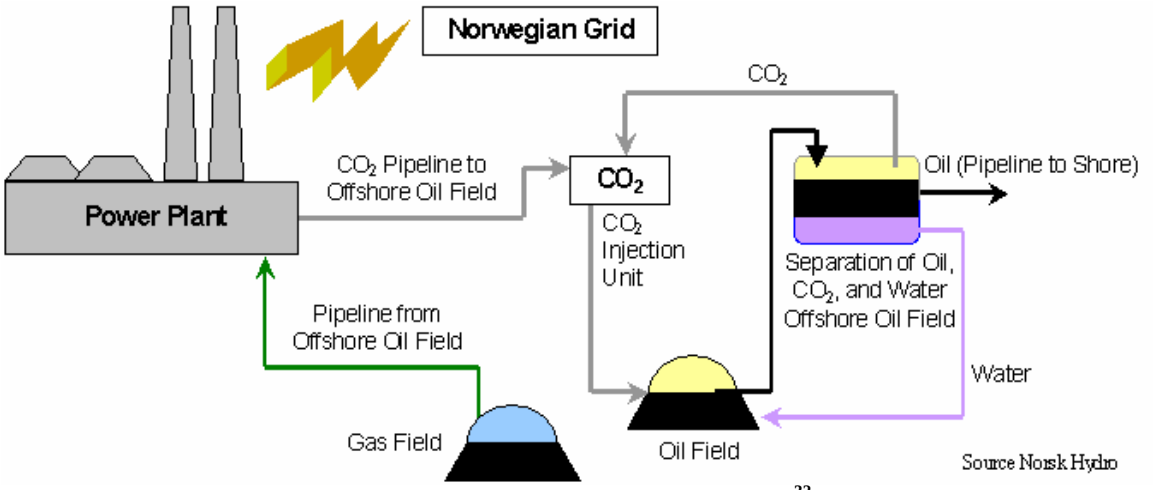

Figure 3: Proposed HydroKraft Project[32]

From a legal perspective, the HydroKraft project is substantially different than the Statoil case. The Statoil CO_2 injection mechanism was an offshore rig involved in the production of natural gas. The fact that it was a man-made facility offshore meant that the London Convention had jurisdiction. In contrast, the HydroKraft project involves a gas-fired power plant located onshore with disposal of CO_2 via a pipe under the sea-bed for enhanced oil recovery. Because the power plant is located onshore, the London Convention does not apply. Other international agreements do exist that may regulate this type of disposal, such as the Paris Convention[33], which regulates on-shore disposal in many European countries including Norway. The UN Convention on the Law of the Sea is another example, but these conventions are somewhat limited geographically or have not been ratified by the US in particular. In situations where disposal occurs from onshore activity, national laws have jurisdiction.

In the United States, this scenario might seem to be regulated by the Clean Water Act, which prevents discharges from "municipal and industrial facilities," and the Ocean Dumping Act,

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[30] Quiviger, G., "Building New Power Plants in a CO2 Constrained World: A Case Study from Norway on Gas-Fired Power Plants, Carbon Sequestration, and Politics, " M.I.T. Masters Thesis, (2001)

[31] Profile: Electronic News from Hydro (September 1998) "Hydrokraft Concept Looking Good," http://www2.hydro.com/konsern/news/eng/1998/980929a.html (accessed May 2002)

[32] Quiviger, G. (2001) "Building New Power Plants in a CO2 Constrained World: A Case Study from Norway on Gas-Fired Power Plants, Carbon Sequestration, and Politics, " M.I.T. Masters Thesis

[33] Summary of Paris Convention at http://europa.eu.int/scadplus/leg/en/lvb/l28061.htm

which "prohibits transportation of material from the US for the purposes of ocean dumping." Unauthorized injections are also prohibited.

> *Any underground injection, except into a well authorized by rule or except as authorized by permit issued under the UIC program, is prohibited.*[34]

The construction of any well which may require a permit is prohibited until the permit has been issued; however it is unclear whether the Underground Injection Control (UIC) program (under the Safe Drinking Water Act), which is a state-run program regulating and protecting sources of drinking water, has jurisdiction over sub-seabed injection. Hypothetically, if an injection well was drilled through a sub-seabed aquifer that was also a source of drinking water then the UIC requirements could apply. Almost certainly, activity beyond three miles from shore would not fall under the state-run UIC program since federal regulations apply beyond this threshold. In fact, it is likely that neither the Clean Water Act nor the Ocean Dumping Act have legal jurisdiction over sub-seabed injection via pipeline. For example, the NPDES regulations under the Clean Water Act is restricted to discharges in "navigable waters," which according to EPA attorney Toni Brandowicz, does not include the sub-seabed, as long as CO_2 remained below the ocean floor.[35] In the HydroKraft situation described above, the Ocean Dumping Act would not apply, because CO_2 injection for enhanced oil recovery is not "…for the purposes of dumping" as defined under the Act. Nevertheless, Jonathon Amson, EPA Oceans and Costal Division, had this to say about the scenario:

> *…even though it's EOR, it sounds like dumping to me. I would say there is 1 in 1000 chance that you would get a permit for that*[36].

Norwegian and Japanese Sea-Based Injection

Other scenarios concerning the capture and sequestration of carbon dioxide into ocean waters involve the use of ships to release liquefied CO_2 into open ocean waters and/or injection of CO_2 into oil and gas reserves for enhanced recovery. Researchers in Japan have been studying the dilution and dispersion of CO_2 released by moving ships, while engineers at Statoil have designed a vessel for transporting and injecting liquid CO_2 into the sub-seabed to increase the pressure of oil and gas wells. To this end,

> *the CO_2 would be extracted from power stations or industrial plants and transported under pressure at a temperature of -50 degrees centigrade to an oilfield.*[37]

As written, both the London Convention and the Ocean Dumping Act clearly disallow dumping industrial wastes from vessels into ocean waters. In fact, recall in 1997 GESAMP specifically reaffirmed the dumping of liquid CO_2 into the ocean violated the London Convention. In order for this type of sequestration to proceed, it appears that the Convention and the Ocean Dumping Act would have to be amended. In the case of Statoil's proposal for ship-based injection of

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[34] 40 CFR 144.11
[35] Phone interview with Toni Brandowicz, EPA Region 1 Attorney, May 13, 2002
[36] Phone interview with Jonathon Amson, EPA Ocean and Coastal Protection Division, May 13. 2002
[37] Ambrogi, Stephano (April 24, 2002) "Shipping CO2 could help Norway reach Kyoto Targets", Reuters, http://www.planetark.org/dailynewsstory.cfm/newsid/15643/story.htm

liquid carbon dioxide for enhanced oil and gas recovery, the application of the London Convention is not as clear. The Convention does prohibit the dumping of industrial wastes from ships both in and under the ocean, but similar to the Sleipner case, the 1996 Protocol excludes the "disposal or storage of wastes or other matter related to the exploitation and off-shore processing of seabed minerals."[38] Since the London Convention is concerned with sea-based sources of waste, it would follow that enhanced oil recovery from ships using CO_2 would be excluded from the requirements of the Convention. From an international legal perspective, this application of CO_2 storage and disposal may have the most potential in the near term.

As mentioned in the HydroKraft discussion, the Ocean Dumping Act does not seem to apply to applications involving enhanced oil recovery because the Act is ambiguous as to whether the use of CO_2 for this process is considered "ocean dumping." Enhanced oil and gas recovery is undoubtedly distinct from dumping. In sum, this is a grey area of the law that will likely become an issue if or when ocean sequestration technologies become more commercially viable.

Direct Injection of CO_2 into Seawater – Land Based Injection

A fourth procedure of injecting CO_2 into the ocean involves direct injection from an onshore source. This technique requires a fairly concentrated stream of CO_2 and a method of delivery from a stationary source (Figure 4) into the ocean at depths greater than 1000m[39]. The CO_2 would likely be in the form of a liquid and could dissolve in the water column[40]. Although this procedure may be technically feasible, legally it is currently prohibited without a permit. Because this method of direct injection into the seawater is from a stationary land-based source, the London Convention does not apply. However, both the Clean Water Act and the Ocean Dumping Act would have relevance to this application.

First, the Clean Water Act would require an ecological impact study and subsequent NPDES permit in order to allow this activity. Disposal by means of a pipe, regardless of how far at sea the discharge occurs, is regulated by the Clean Water Act, through the NPDES permit process. The guidelines of Section 403 of the Act call for evaluating the importance of the receiving water area to spawning sites, migratory pathways, recreational and commercial fishing and many other factors. Although scientific certainty is not a requirement, the applicant must provide sufficient information demonstrating "no irreparable harm." The current state of scientific certainty regarding carbon sequestration may not be sufficient to meet this burden of proof, hence there is a need for continued research and experiments.

[38] 1996 Protocol to the London Convention, Article 1, Definitions 4.3 http://www.londonconvention.org/
[39] Herzog, H. (1998) "Ocean Sequestration of CO2: An Overview," presented at the Fourth International Conference on Greenhouse Gas Control Technologies, Interlaken, Switzerland
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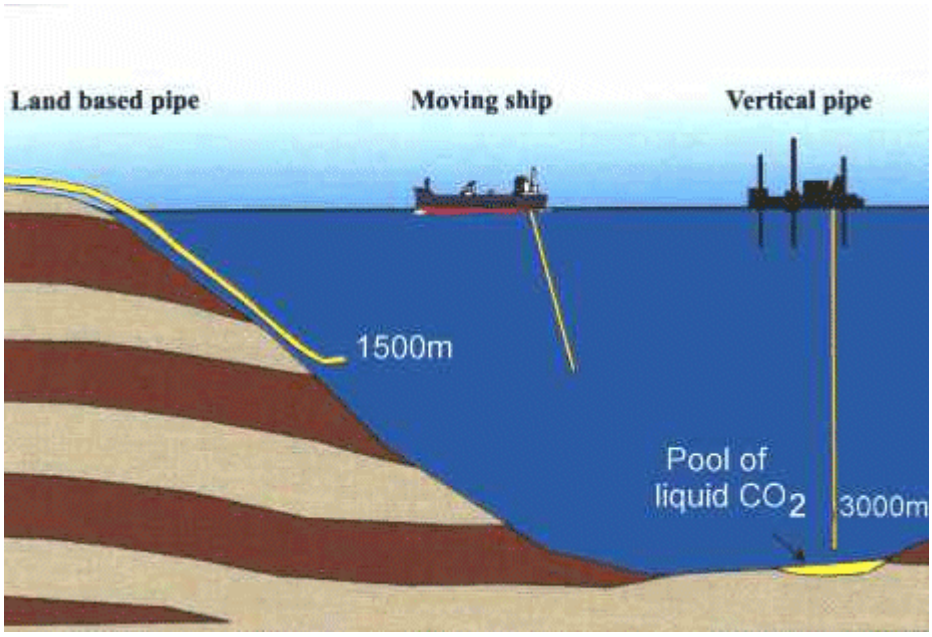

Figure 4: Direct Injection Methods[41]

Although the Clean Water Act takes precedent in this scenario, the Ocean Dumping Act disallows direct injection of carbon dioxide into ocean waters. Unlike the techniques used for enhanced oil recovery, direct injection is specifically for the "…purpose of ocean dumping" as it is defined under the Ocean Dumping Act. Therefore, the Ocean Dumping Act, if applicable would categorically prohibit the dumping of "industrial waste" into ocean waters. But, because this technique involves discharge from a pipe, the requirements of the Clean Water Act should apply in place of the ocean dumping laws.

Conclusions and Implications for CO_2 Ocean Storage

Different elements of the existing legal framework relevant to ocean storage of CO_2 both encourage and prohibit the development of this new technology. The Framework Convention on Climate Change supports the study and future use of the oceans as a partner in reducing the level of anthropogenic greenhouse gas emissions. On the contrary, conventions and laws such as the London Convention, the Clean Water Act and the Ocean Dumping Act, written before our understanding of the linkages between atmospheric carbon dioxide and climate change and their policy complications, currently prohibit most uses of the ocean in this manner. Certainly, before ocean storage from sea-based sources can be deployed on a large scale, the London Convention and the Ocean Dumping Act will have to be amended. If the political will exists and CO_2 ocean storage is scientifically shown to be environmentally acceptable, this could eventually be done by including carbon dioxide on the list of exceptions listed in Annex I of the convention or specifically excluding CO_2 as an "industrial waste." A two-thirds majority of the Contracting Parties would be needed to approve the amendment to the Convention while an amendment to the Ocean Dumping Act would require an act of Congress. Alternatively, sea-based injection of CO_2 could be limited to enhanced oil and gas recovery operations. Offshore platforms and ships

[41] http://www.ieagreen.org.uk/

designed to aid mineral recovery could play a limited but important role in developing ocean storage knowledge and technology and reducing anthropogenic emission of greenhouse gases while still complying with the Protocol to the London Convention. Using CO_2 injection techniques in this way would likely not require an amendment to the Convention.

Under current American law, direct CO_2 injection via pipe from land-based sources into ocean water is prohibited without a permit under the Clean Water Act. Possibly, with robust scientific research and ecological impact assessments showing that ocean storage does not result in "unreasonable harm" or "irreversible damage," developers could be awarded a NPDES permit authorizing the activity. Because ocean storage would not be politically viable if it caused environmental harm, it appears that the real barriers to the development of direct injection from land-based sources are not the existing regulations under the Clean Water Act, but rather the lack of scientific evidence. Therefore, despite the existing regulatory environment that now seems to limit the possibility of ocean storage, there is room under the current law that could allow for land-based direct injection technologies provided that CO_2 storage in ocean water can be shown to be environmentally innocuous. Therefore, what is needed most for this application is more research on the ecological effects and impacts on human health and welfare from storing CO_2 in the ocean.

However, scientific evidence may not be enough to legalize ocean sequestration. The Ocean Dumping Act, which is typically concerned with non-pipe (i.e. ship) applications, may still be used to constrain direct ocean injection. Besides categorically prohibiting the injection of industrial waste for the purpose of dumping, the Act further sets out criteria for evaluating the need for ocean dumping as well. Considering other techniques and technologies currently used to reduce greenhouse gas emissions coupled with the fact that no regulations currently exist requiring the reduction of carbon dioxide in the US, it may be difficult to show a need for ocean dumping. In either case, it would appear that the current law would need to be changed, which would require an amendment by Congress in the face of tough resistance from environmental groups. Unless greenhouse gas reduction requirements are codified into law, which would create needed economic incentives to develop mitigating technologies, it is unlikely that enough public support would be garnered to overcome fierce resistance from environmental groups. At this point the problem appears to be a classic Olsonian case of concentrated costs and diffuse benefits[42]. In other words, the opponents of CO_2 ocean storage would be out in force, while its supporters, though hopeful a new mitigating strategy could be deployed, would not have enough incentive to organize and build the political support needed to 'loosen' existing environmental laws.

Regulation governing land-based injection into the sub-seabed, whether for CO_2 storage or enhanced oil recovery, is the most ambiguous. Within the three-mile zone, the state-enforced, EPA-controlled UIC program may have jurisdiction, but even that is questionable as these requirements pertain to sources of drinking water, not ocean waters. Further analysis of the Safe Drinking Water Act and the UIC program needs to be done to make this determination. However, it does seem to be clear that the Clean Water Act is not relevant to offshore sub-seabed injections. Likewise, the Ocean Dumping Act appears not to be applicable in this situation as it

[42] Olson, Mancur (1971) "The Logic of Collective Action: Public Goods and the Theory of Groups," Harvard University Press, Cambridge, Mass.

also concerns the transporting and dumping of wastes *into* ocean waters. Although the London Convention, brought into force in the US by the Ocean Dumping Act, regulates sub-seabed injection from offshore sources, it does not pertain to land-based injection techniques. Land-based disposal under the ocean floor seems to be the least inhibited under the regulatory frameworks analyzed here. The Convention for the Prevention of Marine Pollution from Land-Based Sources (Paris Convention) would regulate this activity in many European jurisdictions, but not in the United States. A broader analysis that closely reviews the UIC program, the broader Safe Drinking Water Act and other agencies with similar jurisdiction, such as the Mineral Management Service within the Department of Interior should be conducted. In addition, if ocean sequestration were to occur from a land-based source, specific state laws would need to be reviewed. For example, Massachusetts has its own version of the Marine Sanctuaries Regulations[43].

Source	Destination	Legal Implications	Interpretation for US
Land (via pipe)	Direct Water Injection	Strictly regulated by Sections 402 & 403 of the Clean Water Act; Although Ocean Dumping Act applies to sea-based sources, opponents could challenge permit on the ground that the Ocean Dumping Act, which categorically prohibits "industrial waste," regulates "transportation from anywhere;" Nevertheless, Clean Water Act should trump in this situation	Allowed, but strict NPDES permit requirements
Land (via pipe)	Sub-seabed Injection related to mineral recovery	Possibly regulated by the state operated Underground Injection Control program under the Safe Drinking Water Act within three miles of shore; seems to be unregulated beyond; Paris Convention could apply in some EU jurisdictions	Allowed beyond 3 miles
Land (via pipe)	Sub-seabed Storage	Possibly regulated by the state operated Underground Injection Control program under the Safe Drinking Water Act within three miles of shore; seems to be unregulated beyond; Paris Convention could apply in some European jurisdictions	Allowed beyond 3 miles
Sea	Direct Water Injection	Injecting "industrial waste" into ocean water is categorically forbidden by the London Convention and the Ocean Dumping Act	Forbidden
Sea	Sub-seabed Injection related to mineral recovery	London Convention applies, but 1996 Protocol exempts activity related to mineral recovery; Ocean Dumping Act is only concerned with dumping "into" ocean water and "for the purposes of dumping"	Allowed
Sea	Sub-seabed Storage	London Convention, enforced through Ocean Dumping Act, prohibits the dumping of industiral waste into the subseabed unless for purposes pertaining to mineral recovery;	Forbidden

Figure 5: Summary of Regulations

As Figure 5 illustrates, the regulatory environment regarding ocean storage of carbon dioxide is complex and ambiguous. In short, the summary above represents the author's interpretation of existing law. By increasing scientific certainty, utilizing oil and gas operations as pilot projects, and building assurance with and support within the public in the near term, ocean sequestration may be able to overcome some of the legal barriers that prevent its broader deployment and application as a viable climate change mitigation strategy.

[43] Phone interview with David Delaney, EPA Attorney, Region 1, May 14, 2002

Acronyms	Full Name
CWA	Clean Water Act
EPA	Environmental Protection Agency
FCCC	Framework Convention on Climate Change
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
LC	London Convention
MPRSA	Marine Protection, Research and Sanctuaries Act
NPDES	National Pollutant Discharge Elimination System
SDWA	Safe Drinking Water Act
UIC	Underground Injection Control
UNCLOS	United Nations Convention on the Law of the Sea

Figure 6: List of Acronyms

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