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Regulatory Frameworks for South Korea's Offshore Caron Capture and Storage (CCS) Activities

한국 이산화탄소 포집 및 보관 활동을 위한 규제의 기초

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〈국문초록〉

본 논고에서는 한국의 해역 내에서의 CCS 프로젝트를 위한 기존의 정부의 규제와 바람직한 모델이 될 수 있는 규제 프레임을 비교 연구 하고자 한다. 그러함으로써 한국의 기존 환경법과 국제관습 사이에 놓여 있는 해안 CCS 활동과 CCS 저장 프로젝트가 어떻게 견고하고 독자적인 법적 기틀을 마련하는데 유효할 수 있는지 분석하고자 한다. 이산화탄소 포집 및 저장 기술(CCS)은 산업 활동에서 배출되는 온실가스가 대기에 도달하기 전에 지중에 저장하는 것을 가능하게 하는데 이 CCS 기술은 이산화탄소를 지질층에 주입함으로써 기존 석유유전에서 원유의 생산량을 향상시킬 수 있기도 하다; 그러한 공정에서 대부분의 이산화탄소는 지표면으로 다시 돌아오지 않음이 밝혀졌으며 따라서 이런 방식 속에서 잠재적으로 이산화탄소를 저장하는 것이 가능하다는 것을 보여준다.

일부의 친환경 학자나 활동가들이 CCS 의 수행을 반대하는 가운데 그 외의 다수는 보다 더 친환경적이 대체 기술이 보급되기를 기다리는 동안에 CCS 기술이 온실가스의 실제적인 감소와 산업생산지수를 효과적으로 유지함에 있어서 가교가 될 수 있을 것으로 보고 있다. 이러한 이산화탄소 보관 활동은 육상과 해상 둘 모두의 산업경제에 적용될 수 있다.

한국에는 탄소를 저장할 수 있는 육상의 장소가 마땅하지 않기에 해안에서의 CCS 작업을 기획할 필요가 있을 것이다. 법적인 의미에서 이는 호재일 수 있는데 왜냐하면 국가적 그리고 지역적인 행정상의 문제들이 겹치는 혼란을 피할 수 있고 또한 더 나아가 기존의 국제관습이 적용되는 해안 CCS 활동에서 많은 것을 참조 할 수 있기 때문이다. 1996 런던 프로토콜, 유럽연합의 "the CCS Directive", OSPAR Decision 2007/2와 유엔 산하의 교토 프로토콜등이 그러한 예시가 될 수 있다. 본 논고는 그러한 컨벤션들과 대한민국의 환경법령을 비교 분석하여 한국이

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해안 CCS 저장 프로젝트를 수행하는 데에 있어서 기존의 한국법규와 국제 컨벤션에서 얻을 수 있는 주요 원리들을 반영하여 해당 영역에서 지도적인 모델이 될 수 있음을 시사 하려 한다.

주제어 : 이산화탄소 포집및 보관, CCS, 이산화탄소, 하이드레이트, 해안, 대한민국, 주입, 온실 가스, 기후 변화

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To assist in its efforts to prevent climate change, the South Korea government has made strong commitments to reduce its carbon emissions.[1] In order to achieve those emission reductions while preserving the industrial capacity of its domestic industries, Korea has decided to integrate carbon capture and storage (CCS) technologies into its overall strategy.[2] Because Korea has few suitable onshore storage locations for carbon storage, it will need to plan for offshore CCS operations[3]. This article explores how South Korea might best adopt its current environmental regulatory framework to govern the risks of those offshore CCS activities.

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1) The Republic of Korea is commonly known as South Korea; this research will use both terms interchangeably. At the time of writing, the two states of the Republic of Korea and of the Democratic Republic of Korea were undertaking discussions that might foreseeably include a potential end-of-war agreement, which might entail a singular government for the Korean peninsula. Nevertheless, this research has been conducted with an assumption of continuity of the present condition, except where otherwise note herein.

2) United Nations Environmental Program, "Overview of the Republic of Korea's National Strategy for Green Growth," (UNEP, April 2010), 20 and 37.

3) The Carbon Sequestration Leadership Forum (CSLF) has reported out that the Korean Ministry of Fish, responsible for certain marine environmental issues, had spent approximately 40M USD on identification of offshore storage sites in the years 2011-2015. Further, the Korea Research Institute of Ships & Ocean Engineering (KRISO), the Korea National Oil Corporation (KNOC), and the Korea Institute of Ocean Science & Technology (KIOST) have identified a suitable geological CO2 storage site in the southwestern seabed of the Ulleung Basin (60 km east of Ulsan, on the east coast of South Korea); see Carbon Sequestration Leadership Forum , "Korea;" available at https://www.cslforum.org/cslf/Members/Korea . Accordingly, KRISO has opened the Offshore CCS Research Center to develop necessary technologies for offshore CCS activities; available at: http://www.kriso.re.kr/intro-research/offshore-ccs-research-unit/.

The South Korean government announced its goal to achieve commercially viable carbon capture and storage technology by 2020. As of Fall 2016, the South Korean government has yet to enact specific regulation to address the risks and hazards, amongst other legal questions presented, of offshore CCS activities.

Given the advanced state of several offshore CCS projects in other waters overseas, and given the decade plus progress in legal scholarship, there are existing laws for offshore CCS in a few countries, operational international maritime conventions that have binding guidance for private operators, and scholastic research has, for the most part, stabilized onto certain policy points.[4] Thus a menu of regulatory models can be presumed to exist for Korean policy makers.

Given that South Korea has yet to enact specific legislation regarding offshore CCS activities, research needs be undertaken to determine if a sufficient regulatory regime is already in place, or if incomplete, a determination would need to be made to identify where regulatory drafting could be helpful. Or, should there be a finding that existing legal frameworks are wholly inadequate, research would need to be presented in determining which legal model would be robust for the facts and circumstances of South Korea's offshore CCS activities.

In short, this article will present an argument that current Korean environmental regulatory efforts are insufficient for the facts and circumstances of offshore CCS storage projects and that they will need revising, especially if there is a goal to come in alignment with international standards, such as under the CDM's Decision 10/CMP.7 on

4) While the present article is focused on the legal issues particular to the potential regulation of offshore CCS activities in the waters of the Republic of Korea (South Korea), much of the analysis builds on previous related research. *See* Michael G. Faure & Roy A. Partain, Carbon Capture and Storage: Efficient Policies for Risk Governance and Compensation (MIT Press, 2017). For a scholastic perspective on ideal CCS regulatory policies, see Faure & Partain, 207-217. *See also* Roy A. Partain & Michael G. Faure, *Development of a Regulatory Framework for CDM-Enabled Offshore Carbon Capture and Storage (OCCS) in China*. In: The Rise of the Regulatory State: The U.S., E.U. and China's Theory and Practice (Stefan Weishaar & Niels Philipsen, eds., Edward Elgar; 2017).

CCS storage projects or the EU CCS Directive.

A comparative review of existing Korean regulations against model regulatory frameworks will be presented.[5] The final finding will be that South Korea's existing environmental laws and existing international conventions to regulate offshore CCS activities can be used to draft a stand-alone CCS legal framework appropriate for offshore CCS storage projects in South Korean waters.

Ⅰ. Facts and Circumstances of Offshore Carbon Capture and Storage

Carbon capture and storage (CCS) is a collection of technologies and practices that could enable the permanent removal of the greenhouse gas carbon dioxide from the atmosphere by placing it into permanent geological storage. This article focuses on the storage aspect, on those activities that occur after capture of the CO2 from emission sources and after the transport of the CO2 to an offshore injection and storage facility.

1. *Technology of Deep Earth Carbon Storage*

CCS is known by several related names. A variant common in the U.S. is carbon capture and sequestration. A related concept that adds a policy to use the carbon dioxide in green industrial practices if possible prior to storage is called carbon capture, utilization, and storage (CCUS).

There is a related practice that involves the injection of carbon dioxide with a goal of enhancing hydrocarbon recovery is called Enhanced Oil Recovery with Carbon Dioxide Flooding (EOR-CO2); while storage of carbon dioxide is not a primary goal of EOR-CO2, a high percentage of the

5) Korean legislative materials are available online at the Korea Legislation Research Institute's (KLRI) Statutes of the Republic of Korea website; available at: http://elaw.klri.re.kr/eng_service/main.do; example, the Framework Act on Environmental Policy is *available at*: http://elaw.klri.re.kr/eng_service/lawView.do?hseq=44666&lang=ENG.

CO2 does indeed become permanently 'lost' in geological storage.[6]

Another related technology is the practice of re-injecting co-produced acidic gases from natural gas wells back into the original gas reservoir, this is called acid gas injection (AGI).[7]

All of these approaches involve the injection of supercritical carbon dioxide into deep geological reservoirs wherein a majority of the injected carbon dioxides remains permanently, but only CCS, CCUS, and AGI inject with a primary goal of permanent geological storage of the carbon dioxide.

Carbon capture is a group of technologies that enable recover of the carbon dioxide emitted from combustion activities at power plants and other industrial activities. A common approach is to cascade a liquid solution, such as a glycol, down on an upwardly moving chimney of emissions, trapping and dissolving the carbon dioxide into the glycol. The glycol can then be further treated to release the carbon dioxide, which can then be temperature treated and filter treated to remove impurities. Once that has occurred, the carbon dioxide can be temperature-and-pressure adjusted to meet pipeline conditions for transport away from the combustion and capture facility. Carbon dioxide can also be transported in containers and on oceanic vessels, but most CCS plans call for pipelines.

Carbon dioxide has long been a commonly used industrial chemical so regulations for its shipping, transportation, and handling are well developed. There are known risks, but as everyone who drinks carbonated beverages will appreciate, it is not generally seen as a hazardous chemical. There are thousands of miles of existing carbon dioxide pipelines that have operated

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6) See Faure & Partain, at 17. While shale oil and gas have benefitted from technologies that evolved from EOR practices, such as hydraulic fracturing, carbon dioxide flooding has not been widely used in their production. However, research is underway to replace hydraulic fracturing with carbon dioxide flooding for shale oil and gas deposits. See Kevin Bullis, "Skipping the Water in Fracking," MIT Technology Review, March 22, 2013; available at https://www.technologyreview.com/s/512656/skipping-the-water-in-fracking/.

7) Carbon dioxide is an acidic gas; e.g., when it blends with water it creates carbonic acid (H2CO3), albeit in practice carbonic acid primarily results in the salts of carbonate and bicarbonate, which can then affect the durability of metals or dissolve underground materials such as limestone. See.

for decades; thus there is a broad base of experience to draw upon for the development of carbon dioxide pipelines that would be required for CCS transportation needs.

Once the carbon dioxide is delivered to the injection facility, it will need to undergo a final stage treating process to purify it prior to its becoming a super-critical fluid.[8] As a supercritical fluid, carbon dioxide exhibits behaviors common to both gases and liquids. Supercritical carbon dioxide is a commonly used industrial solvent; it is perhaps best known as the chemical used to wash out caffeine from green coffee beans to provide caffeine for soda drinks and to produce decaffeinated coffee beans. After its preparation, the supercritical carbon dioxide flows into a well and is then injected deep into the Earth. Upon reaching the bottom of the well, and exiting from the wellbore holes into the reservoir, the supercritical carbon dioxide expands and forces itself into the pore space between the granular elements of the reservoir rock formations.

For 'conventional' onshore CCS projects, once injected into the earth, there are several means to ensure the permanence of the storage. One issue is the existence of a cap rock formation, that serves as a shield over the injected volumes preventing their vertical escape from the storage system. A second issue is the potential for the carbon dioxide to force itself through capillary action into tiny crevices, from which the fluid would not escape. A third issue is the potential for the carbon dioxide to work as a solvent on the underground materials, such as limestone, to create carbonates that could then re-solidify in place and permanently trap and secure the carbon dioxide. A fourth issue is that the injected volumes of carbon dioxide could become dissolved into deep underground aquifers, particularly saline aquifers, that are already secure in their geological depth. Estimates suggest, that if an injection project were to operate for several decades, that approximately 2/3rds of the carbon dioxide would be mineralized by the end of the injection project; full mineralization might

8) Becoming supercritical requires the carbon dioxide to reach a minimum of 87.98 °F (304.25 K, 31.10 °C) and at least 72.9 atm (7.39 MPa, 1,071 psi) of pressure. In lay parlance, this is a room-temperature condition at very high pressures.

take several centuries to a couple millennia depending on the reservoir conditions.[9)]

2. *Consideration of Offshore CCS*

While the onshore techniques are available offshore,[10)] deep sea conditions do enable alternative storage methods not available onshore.[11)] Thus, the offshore environment presents several unique opportunities to improve on the onshore sequestration technologies.[12)]

First, at the right depths and pressures, carbon dioxide will no longer be buoyant, as it is in onshore storage, but instead it will become 'negatively buoyant' and seek to sink into the earth. This unique behavior would dramatically reduce the chance of venting and seeping, as the carbon dioxide would no longer be expected to move towards the surface.

Second, it is important to understand that carbon dioxide can react to water to create a frozen material called a hydrate. A hydrate is a

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9) Faure & Partain, at 14, citing to FN 32. Compare this loss rate with the almost instant loss of 50% of the CO2 in EOR projects, see footnote 6.

10) See Yi Kyun Kwon, *Demonstration-scale Offshore CO2 Storage Project in the Pohang Basin, Korea*, 28(2) Journal of Engineering Geology 133-160 (2018) [권이균, '포항분지 해상 중소규모 CO2 저장 실증연구', 28(2) 지질공학 133-160 (2018).] See also Hung-Man Moon et al, *Design and Construction Study of an Injection Facility for CO2 Offshore Storage,* 28(2) Journal of Engineering Geology 207-215 (2018). [문홍만, 김효준, 신세진, 이용일, 권시현, & 권이균, 'CO2 해상 지중저장을 위한 주입설비 설계 및 구축 연구', 28(2) 지질공학 207-215 (2018).].

11) For an introductory survey to the literature on CO2 hydrate formation in the offshore CCS context, *see* H. Koide, Y Shindo, Y. Tazaki, M. Iijima, K. Ito, N. Kimura, & K. Omata, *Deep Sub-Seabed Disposal of CO2 – The Most Protective Storage,* 38(Suppl.) Energy Conversion and Management S253-S258 (1997); Kurt Zenz House, Daniel P. Schrag, Charles F. Harvey, & Klaus S. Lackner, *Permanent carbon dioxide storage in deep-sea sediments,* 103(33) Proceedings of the National Academy of Sciences 12291-12295 (2006); Qi Li, Zhishen Wu, & Xioachun Li, *Prediction of CO2 Leakage During Sequestration into Marine Sedimentary Strata,* 50 Energy Conversion and Management 503-509 (2009); and *see also* Daniel P. Schrag, *Storage of Carbon Dioxide in Offshore Sediments,* 325 Science 1658-1659 (2009).

12) For an account of the development of offshore CCS technology in South Korea, *see* S.G. Kang & C. Huh, R&D Status on Offshore CCS Technology and its Deployment Plan in Korea, Proceedings of the Conference for the Korean Society for Marine Environment & Energy, 177 (November 2011).

cage-structure of water molecules that trap a singular carbon dioxide molecule inside. Hydrates naturally occur in a variety of oceanic settings, most notable perhaps are the vast deposits of methane hydrates offshore most coastal nations.[13] Hydrates are endothermic materials,[14] so generally speaking they are stable when trapped within geological settings. If carbon dioxide is injection into the correct depths and pressures offshore, the carbon dioxide would solidify and form hydrates, preventing their escape from geologic containment, even if there were cracks or fissures in the cap rock formation or mud barriers.

Third, in offshore saline reservoirs, the saline solutions are very similar to the waters immediately above them in the open oceans, from which they were derived. This enables the relocation of reservoir waters to the benthic depths, facilitating enhanced storage capacity while also reducing the risks of over-pressurization which might otherwise increase the risk of leaks and venting. In the U.S., such relocation of geological salines to oceanic depths is permitted and regulated and is a routine event in offshore operations.

Fourth, even if carbon dioxide were to escape from its geological storage, it would likely be remediable. Because the benthic depths of the oceans, the carbon dioxide would likely remain pooled and concentrated near the source of the leak, enabling the recovery and removal of the carbon dioxide before substantial harm to the water column or surrounding environments could occur.

Thus, in offshore CCS storage operations, there are several technological

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13) For discussions on the environmental impacts and potential governance thereof related to offshore methane hydrates, *see* Roy A. Partain, *Public and Private Regulations for the Governance of the Risks of Offshore Methane Hydrates,* 17 Vt. J. Envt'l L. 87 (2015); Roy A. Partain, *A Comparative Legal Approach for the Risks of Offshore Methane Hydrates: Existing Laws and Conventions,* 32 Pace Envt'l L. Rev. 101 (2015); Roy A. Partain, *The Application of Civil Liability for the Risks of Offshore Methane Hydrates,* 26 Fordham Envt'l L. R. 225 (2015); and Roy A. Partain, *Avoiding Epimetheus: Planning Ahead for the Commercial Development of Offshore Methane Hydrates,* 14 Sustainable Dev. L. & Pol'y 16- 25, 56- 58 (2014).

14) Endothermic means that a chemical substance needs to absorb energy in order to react, and in this case, hydrates need to absorb energy to enable the dissolution of the carbon dioxide from the water. If that external energy supply is not present, then the icy structure of a hydrate is secure and stable.

differences that should enhance the overall security of geological storage over the safety levels of onshore CCS storage. The carbon dioxide would not be buoyant but sinking in nature, preventing the fundamental motive of most leaks. If monitored, over-pressured storage reservoirs could have saline volumes safely relocated to reduce pressure and reduce the risks of cracks or fissures that could enable the escape of carbon dioxide. Even if the carbon dioxide were to begin to migrate towards those cracks or fissures, the pressure and temperature of the reservoir would likely induce hydrate formation would block and clog any additional cracks or fissure and prevent leakage. And if that were to fail, the carbon dioxide would be expected to pool in benthic depths and be removable prior to the onset of any substantial injury to the surrounding ecology.

3. *Conclusion to Introduction to Offshore CCS*

In summary, carbon dioxide emissions can be prevented by capturing them at their emissions point, by processing and treating them to enable their ready transportation, and by injecting them into deep geological storage wherein they will eventually become mineralized and permanently prevented from atmospheric interactions. While there are substantial reasons to expect that onshore CCS could be undertaken in a safe and reliable manner, there are reasons to expect offshore CCS to be even safer and more secure in its prevention of accidental release of carbon dioxide.

While these arguments might have been paramount in the early planning of the world's earliest and longest running CCS projects, it remains insightful to observe that the CCS projects of Snøhvit and Sleipner in Norway are offshore CCS storage facilities that remain safe and secure as of the date of this writing in 2018; in fact, the Norwegian Ministry of Petroleum and Energy has recently called for planning to consider three new offshore CCS storage locations on the Norwegian continental shelf at the Utsira, Heimdal and Smeaheia field locations.[15] Thus both scientific

15) Norwegian Ministry of Petroleum and Energy "Initiates Feasibility Study on Subsea

expectations and historical experiences suggest the safety and reliability of offshore CCS storage.

Ⅱ. Existing International Regulatory Frameworks for Offshore Carbon Storage

As stated earlier, the idea of CCS is not new and offshore CCS activities have been undertaken in Norway for decades, thus international conventions exist that correspond with the regulatory needs of offshore CCS storage projects.

This section will review four such models, namely that of the EU's CCS Directive, the accommodations for CCS storage projects under the London Protocol, the accommodations for CCS storage projects under OSPAR, and finally the detailed results of the CDM's Decision 10/CMP.7 (2011). It will follow the analyses that a common vision of offshore guidance can be found across the four conventions.[16]

1. *EU's CCS Directive*

The European Union has produced binding legal guidance for carbon capture storage projects, in its Directive on the Geological Storage of Carbon Dioxide, also known as the CCS Directive.[17] The Directive itself does

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CO2 Storage," 01 January 2016; *available at* https://www.regjeringen.no/en/aktuelt/statoil-skal-utgreie-co2-lager-pa-norsk-kontinentalsokkel/id2469150/.

16) This section does not review the US EPA guidance on CCS injection wells, as advocated by Jang et al., because the EPA's guidance is designed for onshore CCS activities and not offshore as examined herein; *see* Eunseon Jang, Seong-Taek Yun, Byoung-Young Choi, & David Chung Hun Kang, *Status and Implications of Regulatory Frameworks for Environmental Management of Geologic CO2 Storage in USA and EU*, 17(6) 지하수토환경 9 - 22 (2012).

17) 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) No 1013/2006 (Text with

include both onshore and offshore CCS,[18] and it appears to provide governance for the offshore CCS projects in Norway,[19] thus its framework can be guiding for offshore CCS storage projects in similar Korean waters.[20]

The Directive requires that CCS storage be rock-based and not water-column-based; the sequestered CO2 volumes must be contained. Art. 1, Sec. 2 sets out the goals of CCS storage, "The purpose of environmentally safe geological storage of CO2 is permanent containment of CO2 in such a way as to prevent and, where this is not possible, eliminate as far as possible negative effects and any risk to the environment and human health." As such, the key terms for Korea's own regulatory frameworks are 'environmentally safe geological storage' and 'permanent containment of CO2' to ensure that the offshore storage technology is securely deep geological, and not water-column, based in character. Further, that geological storage needs to be found in 'lithostratigraphical subdivision' within 'underground geological formations,' further clarifying the necessity of rock-based storage.[21] The Directive also explicitly bans water-column based CCS storage technologies.[22]

The Directive is very focused on ensuring that scientific and engineering standards are kept very high for CCS storage operations. The examination of potential storage sites is to be rigorous, as "[a] geological formation shall only be selected as a storage site, if under the proposed conditions of use

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EEA relevance) (Hereinafter 'CCS Directive.'); *available at*: https://ec.europa.eu/clima/policies/lowcarbon/ccs/directive_en.

18) The Preamble does at sections 12, 13, and 14, with reference to the CCS provisions made under the London Protocol and OSPAR. CCS Directive Art. 2, Sec. 1 provides specific inclusion of all CCS projects within the UNCLOS-delimited exclusive economic zones and on their continental shelves of the EU Member States.

19) The offshore projects are Statoil's CCS projects at Sleipner and Snøhvit, and the potentially upcoming project at injection wells east of the Troll field on the Norwegian continental shelf. See Statoil, "Statoil evaluating new CO2 storage project on the Norwegian continental shelf," 30 June 2017, *available at*: https://www.statoil.com/en/news/co2-ncs.html.

20) A similar observation was made by Yi, see JongYeong Yi, 유럽연합의 이산화탄소 포집,저장 지침에 관한 연구(*'Zur Richtlinie der Europaischen Kommission zur geologischen Speicherung von Kohlendioxid'*), 14(2) Jungang Law Review 7-33 (2012).

21) CCS Directive, art. 3, secs 1 and 4.

22) CCS Directive, art. 1, sec. 4, and at art. 3, sec. 2.

there is no significant risk of leakage, and if no significant environmental or health risks exist."[23] The Directive contains an Annex I which supplements Art 4's requirement with detailed lists of the types of data, and of the types of evidences expected, to be gathered and included in a permit application.[24] Annex I requires a dozen different types of scientific data,[25] construction of a three-dimensional static geological earth model utilizing seven different types of data,[26] a model of the characterization of the storage dynamic behavior using a score of data sets,[27] and both a sensitivity characterization and a risk assessment,[28] all followed by a five factor hazard characterization.[29] This reflects the EU's guidance that much of the risk of CCS storage sites is determined by the place and condition of the storage site itself and that the information regarding site selection be both rigorous and publicly available.[30] Very similar levels of caution and prevention-based efforts can be found for the operation period as well, both in the Directive and at Annex II.[31]

The polluter pays principle (PPP) guides the function of the liability regime of the Directive.[32] The operator's liability is only cut-off if and only if certain terms of financing and gas-stability are made evident.[33] Once those tests are met, then the liability and responsibility for the

23) CCS Directive, art. 4, sec. 4. See also.
24) CCS Directive, Annex I: Criteria for the Characterization and Assessment of the Potential Storage Complex and Surrounding Area Referred to in Article 4(3).
25) CCS Directive, Annex I, Step 1: Data collection.
26) CCS Directive, Annex I, Step 2: Building the three-dimensional static geological earth model.
27) CCS Directive, Annex I, Step 3.1: Characterization of the storage dynamic behavior.
28) CCS Directive, Annex I, Step 3.2: Sensitivity characterization and Step 3.3: Risk assessment.
29) CCS Directive, Annex I, 3.3.1. (The enumeration in the original follows an unorthodox change in format.)
30) Art. 4, sec. 2, with reference to arts. 26 and 27.
31) See arts. 7 through 11 for operation periods, 12 through 15 for post-closure planning, and Annex Ii: Criteria for Establishing and Updating the Monitoring Plan Referred to in Article 13(2) and for Post-Closure Monitoring in support of both.
32) CCS Directive, art 16, sec. 5, with regards to "necessary corrective measures, as well as measures related to the protection of human health". Additional PPP duties for the operator are found at CCS Directive, art 17, sec. 2.
33) CCS Directive, art. 18, sec. 1.

storage sites and its sequestered CO2 volumes is to be transferred to the competent authority of the Member State.[34]

To prevent problems of financial insolvency, the operator is required to present proof of financial means to provide funding for a variety of potential needs, including for compensation.[35] The financial means must be in-place from the time of first permitting until the final transposition of the liabilities and responsibilities, as discussed in the previous paragraph.[36] There is also a requirement for funds to be transferred to the competent authority in advance of that final transposition and that the funds should be adequate to support at least thirty (30) years of post-closure expenses.[37]

There are additional rules in place to prevent injuries. Transboundary cooperation to prevent transboundary injuries is required of the Member States.[38] In alignment with the Århus Convention, the Directive requires Member States to make available "public environmental information relating to the geological storage of CO2."[39] The Member States are also called upon to ensure that "effective, proportionate and dissuasive" penalties are brought to bear on the operators.[40]

Thus, the Directive reflects concerns on scientific and engineering standards, the clear provision of liability (both before and after closure), and of financial arrangements to prevent problems with rules of civil liability and to ensure the function of the PPP.

2. *London Convention and its Protocol*

The London Protocol builds on the London Convention, preparing for a more updated implementation of the same concerns to prevent dumping of wastes into the ocean.[41] As such, a key question becomes whether injected

34) *Id.* See also CCS Directive, art. 18, sec. 5.
35) CCS Directive, arts. 19 and 20.
36) CCS Directive, art. 19, secs. 1 and 3(a).
37) CCS Directive, art. 20, sec. 1.
38) CCS Directive, art. 24.
39) CCS Directive, art. 26.
40) CCS Directive, art. 28.

CO2 volumes qualify as a waste or as something else.

The Convention bars offshore dumping of Annex I wastes altogether,[42] requires a prior special permit for items on Annex II,[43] and requires a prior general permit for all other items.[44] Under Annex I, CO2 might qualify under "Crude oil and its wastes,"[45] under Annex II, it might qualify as "Materials which, though of a non-toxic nature, may become harmful due to the quantities in which they are dumped;"[46] and could also raise concerns under the Annex III provisions for all other items, namely at (1) Amounts, (3) Properties, (5) Persistence, and (7) "Susceptibility to physical, chemical and biochemical changes and interaction in the aquatic environment with other dissolved organic and inorganic materials."[47]

The Convention requires all Parties to provide "appropriate measures to prevent and punish conduct in contravention of the provisions of this Convention."[48] Further, rules of civil liability are required of the Parties, that they "develop procedures for the assessment of liability and the settlement of disputes regarding dumping."[49] Potentially, but not explicitly, the concept of settlement of disputes could include financial measures that ensure payment of established damages.

The Protocol, being from 1996 and as amended in 2006, reflects evolution in the principles of international environmental law. The polluter pays principle (PPP),[50] the precautionary principle,[51] and a novel duty to "not to

41) Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter ('London Convention 1972'); 26 UST 2403, 1046 UNTS 120, 11 ILM 1294 (1972); and the latter 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter ('London Protocol'); 36 ILM 1 (1997).
42) London Convention, art. 4, sec. 1(a).
43) London Convention, art. 4, sec. 1(b).
44) London Convention, art. 4, sec. 1(c).
45) London Convention, Annex I, sec. 5.
46) London Convention, Annex II, sec. D.
47) London Convention, Annex III, sec. A(1, 3, 5, and 7).
48) London Convention, art. 7, sec. 2.
49) London Convention, art. 10.
50) London Protocol Art. 3, sec. 2.
51) London Protocol Art. 3, sec. 1.

transfer, directly or indirectly, damage or likelihood of damage from one part of the environment to another or transform one type of pollution into another."[52] The Protocol follows the norms established on the Convention with regards to enforcement of the rules and for the provision of "procedures regarding liability."[53] Thus the notions of liability, fault, and provisions of punishments, enforcement, and liability systems are similar for both the Convention and the Protocol, albeit the Protocol represents a more modern form.

Where a key difference lays between the two conventions, is the explicit mention, or lack thereof, of the seabed. While the Convention limited waste dumping 'at sea,' the Protocol adds "any storage of wastes or other matter in the seabed and the subsoil thereof," to the definition of waste dumping.[54] (Emphasis added.) The Convention defined the sea as "'Sea' means all marine waters other than the internal waters of States,"[55] whereas the Protocol expanded it to "all marine waters other than the internal waters of States, as well as the seabed and the subsoil thereof; it does not include sub-seabed repositories accessed only from land."[56] (Emphasis added.) Thus, notionally, the Protocol includes a more overt focus to protect the seabed from waste dumping, and thus could frustrate offshore CCS storage plans.

While the London Convention did not explicitly provide for storage of CO2 volumes in the ocean's seabed,[57] the Protocol has been updated to include certain methods of offshore CCS storage.[58] The CCS Guidelines provide no new rules or guidance on liability, financial measures, or the

52) London Protocol Art. 3, sec. 3.
53) London Protocol Art. 10, sec. 2; and Art 15.
54) London Convention, art. 3, sec. 1(a)(i); and London Protocol Art. 1, sec. 4.1.3.
55) London Convention, art. 3, sec. 3.
56) London Protocol Art. 1, sec. 7.
57) But see London Convention, art. 4, sec. 3, that does limit the strongest prohibition on dumping to Annex I items, and barring arguments for including CO2 on Annex, it might be possible to place CO2 under Annex III guidance, and thus be potentially permissible.
58) 2012 Specific Guidelines for the Assessment of Carbon Dioxide for Disposal into Sub-Seabed Geological Formations adopted 2 November 2012 (LC 34/15, annex 8). (Hereinafter 'CCS Guidelines').

like, but they do provide extensive details on scientific and engineering norms and expectations. The details of the carbon stream itself are to be accurately characterized.[59] Similarly to the EU CCS Directive, the CCS Guidelines provides a strong focus on the scientific investigation of the subsea seabed storage site.[60] There is a requirement for study into the potential effects of the CO2 subsea sequestration, with need to return both a risk assessment and an Impact hypothesis.[61] Thus, the CCS Guidelines add content to the London Protocol so that *en toto* its overall approach is similar to the EU's CCS Directive.

3. *OSPAR*

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the 'OSPAR Convention')[62] includes many EU Member States as well as the EU itself,[63] thus the Convention run complementary to the EU CCS Directive and to the London Protocol for those countries.

The OSPAR Convention does not directly address matters of enforcement

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59) CCS Guidelines, arts. 4 and 5.

60) CCS Guidelines, art. 6.

61) CCS Guidelines, art. 7; *see* 7.7 through 7.10 and *see also* 7.11 through 7.15.

62) Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention); 2354 UNTS 67; 32 ILM 1069 (1993); available at https://www.ospar.org/convention/text . The moniker of OSPAR is based in history; "OSPAR stands for Oslo and Paris, and the acronym refers to the documentary history of the Convention in that it conjoined the Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft, "Oslo Convention" (1972), against at-sea dumping of wastes with the Convention for the Prevention of Marine Pollution from Land-Based Sources, "Paris Convention" (1974), against land-based sea pollution and oil pollution. OSPAR was founded under Article 197 of UNCLOS for global and regional cooperation." Roy Andrew Partain, *A Comparative Legal Approach for the Risks of Offshore Methane Hydrates: Existing Laws and Conventions,* 32 Pace Envtl. L. Rev. 791 (2015), 829.

63) Namely, they 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, plus the EU. See "Contracting Parties," *available* at: https://www.ospar.org/organisation/contracting-parties.

or of provision for liability, rather it requires Parties to:

> "take all possible steps to prevent and eliminate pollution and shall take the necessary measures to protect the maritime area against the adverse effects of human activities … To this end Contracting Parties shall, individually and jointly, adopt programmes and measures and shall harmonise their policies and strategies."[64]

OSPAR is a convention between states, and while it requires that each Party

> "OSPAR requires the Contacting Parties to take all possible steps to prevent and eliminate pollution to protect the maritime area. OSPAR requires the Contracting States to adopt programs and measures and to cross-harmonize their policies."[65]

Nevertheless, the obligations cease without further clarification as to specifics of enforcement, so there are no particular requirements with regards to regulatory frameworks, liability rules, or provisions for financial needs.

Annex II provides for the exclusion of CO2 streams when used for geological storage.[66] The Annex II requires four basic conditions for CCS storage projects to qualify under this rule: (i) disposal is into a sub-soil geological formation, (ii) that the streams consist overwhelmingly of carbon dioxide, (iii) no co-mingling of other wastes in the stream, and (iv) intention of permanent storage with no expectation of significant adverse consequences.[67]

OSPAR Decision 2007/2 provides clarity for subsea storage of CO2

64) OSPAR art. 2., sec. 1.
65) Partain (2015), supra at 53, 829.
66) OSPAR, Annex II, art. 3, secs. 1 and 2(f).
67) OSPAR, Annex II, art. 3, sec. 2(f)(i) through (iv). *See also* Annex III, art. 3, sec. 3(a) though (d).

within the OSPAR Convention.[68] 'Sub-soil geological formation' is defined as "geological formations in the sub-soil of the OSPAR maritime area, including sub-seabed geological formations;"[69] enabling the use of storage site further offshore than territorial seas. The Decisions requires an eight-part "full risk assessment and management process" to be satisfactorily completed, as judged by the Party's competent authority that the CCS storage project "will not lead to significant adverse consequences for the marine environment, human health and other legitimate uses of the maritime area."[70] Data created by the operator with regards to initial applications and annual updates are to be provided to both the Public-at-Large and to the OSPAR Commission, and for "[s]ufficient stakeholder involvement" during the permitting process,[71] all in alignment with Århus.

Throughout OSPAR, there is a repeated requirement for the Parties to "ensure the application of best available techniques and best environmental practice as so defined, including, where appropriate, clean technology;"[72] and such would be required of CCS storage projects, as allowed. The first requirement is detailed as "'best available techniques' means the latest stage of development (state of the art) of processes, of facilities or of methods of operation which indicate the practical suitability of a particular measure for limiting discharges, emissions and waste."[73] Important for avoiding regulatory centralization and ossification, the Appendix further guides that "'best available techniques' for a particular process will change with time in the light of technological advances, economic and social factors, as well as changes in scientific knowledge and understanding."[74] Further, a working

68) OSPAR Decision 2007/2 on the Storage of Carbon Dioxide Streams in Geological Formations.
69) OSPAR Decision 2007/2; art 1.1.
70) OSPAR Decision 2007/2; art 3.1; the eight part analysis is found at 3.2.1 through 3.2.6(iii).
71) OSPAR Decision 2007/2; art 3.4, 3.5, and 3.6.
72) OSPAR art. 1., sec. 3(b)(i) and (ii). See also Annex III, art. 2, sec. 1(a) and (b).
73) OSPAR, Appendix 1 Criteria for the Definition of Practices and Techniques Mentioned in Paragraph 3(B)(I) of Article 2 of the Convention, sec. 2.
74) OSPAR, Appendix 1, sec. 3.

definition for 'best environmental practice' is provided with nine factors of analysis, which provide "application of the most appropriate combination of environmental control measures and strategies."[75]

Broadly summarizing, the OSPAR requirements for offshore CCS storage projects is very similar in approach to the EU CCS Directive and the approach of the London Protocol, except for its lack of specific clarity of means of enforcement, liability rules, and financial provisions. But that OSPAR operates within the umbra of the EU and its directives, this lack is not a major deficit.

4. *Clean Development Mechanism on CCS Regulatory Frameworks*

The Clean Development Mechanism (CDM) of the Kyoto Protocol enables financial opportunities for countries listed on Annex I of the United Nations Framework Convention on Climate Change (UNFCCC) to invest in emissions reduction projects in non-Annex I countries whilst availing those Annex I countries of baseline emission offsets.[76]

While many might expect South Korea to be considered as a developed economy, under the UNFCCC, it is listed as a non-Annex I country (as is North Korea)[77] and thus could avail itself of the CDM financial benefits,[78] thus Korea's attention to the CDM's treatment of CCS frameworks may be

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75) OSPAR, Appendix 1, sec. 6(a) through (i).

76) Kyoto Protocol to the United Nations Framework Convention on Climate Change, opened for signature Mar. 16, 1998, 2303 U.N.T.S. 148 [hereinafter Kyoto Protocol] (entered into force Feb. 16, 2005), at art. 12. United Nations Framework Convention on Climate Change, May 9, 1992, 1771 U.N.T.S. 107 [hereinafter UNFCCC], at Annex I. *See also* "Clean Development Mechanism (CDM)," United Nations Framework Convention on Climate Change; *available* at http://unfccc.int/kyoto_protocol/mechanisms/clean_development_mechanism/items/2718.php.

77) Both the Republic of Korea and the Democratic Republic of Korea are currently listed as "Non-Annex I Parties to the Convention;" see UNFCCC, "List of Non-Annex I Parties to the Convention," *available* at: http://unfccc.int/parties_and_observers/parties/non_annex_i/items/2833.php.

78) See an anticipatory article on the CDM's adoption of CCS activities at JaeHyup Lee, *Legal Measures to Fulfill Eco-Friendly Implementation of the Proposed Basic Law on Green Growth -Market Mechanisms for Responding to Climate Change*, 31(1) Environmental Legal Research 39-62 (2009).

rewarding.[79]

However, if there should one day be a political result of one country in the area of the formerly two Koreas, there is some uncertainty as to the future standing of these UNFCCC issues. Should either one of the Koreas agree to merge into the other Korea, and thus should that one Korea become the singular survivor state for both previous states, then Article 15 'Succession in respect of part of territory' would apply to the new state and the UNFCCC and the rules of the CDM would continue to apply as they had before.[80] On the other hand, were the two Koreas to agree that the new successor country was to be in fact a 'newly independent State,' then they would not necessarily be bound by the UNFCCC, amongst other conventions, and additional analysis would be required including its options under Art 17;[81] thus is beyond the scope of the present research.

While the CDM did not originally include CCS storage activities within its parameters, the CDM has been updated via Decision 10/CMP.7 ('Decision')[82] to enable certain CCS projects to be included.[83] Furthermore, the Decision requires the provision and enforcement of particular regulatory frameworks for a Host to receive the CDM's financial benefits for its CCS projects. Notably, the Decision provides extensive requirements for scientific and engineering protocols and standards, above and beyond those requirements provided in the previously discussed EU CCS Directive (which

79) A then-contemporary appraisal of the Decision and its potential impacts on Korean CCS policy planning can be found at Hyon-Jeong Noh, Cheol Huh & Seong-Gil Kang, *Analysis of Modality and Procedures for CCS as CDM Project and Its Countmeasures,* 15(3) Journal of the Korean Society for Marine Environmental Engineering 263-272 (2012).

80) Vienna Convention on Succession of States in Respect of Treaties, 1946 UNTS 3; 17 ILM 1488 (1978); 72 AJIL 971 (1978) (Hereinafter 'Convention on Succession'); see art. 15. *Available* at: http://legal.un.org/ilc/texts/instruments/english/conventions/3_2_1978.pdf.

81) Convention on Succession, arts. 16 and 17, see also art. 19. A choice to remain committed to multi-lateral conventions, in the case of a newly independent State, would need an Art. 22 declaration to that effect.

82) Decision 10/CMP.7: Modalities and procedures for carbon dioxide capture and storage in geological formations as clean development mechanism project activities. *Available* at http://unfccc.int/resource/docs/2011/cmp7/eng/10a02.pdf#page=13 [hereinafter 'Decision 10/CMP.7'].

83) Decision 10/CMP.7, art. 1.

were already more robust than those called for in the London Protocol and the OSPAR guidance.)[84] The Decision also calls for establishment of regulations at the Hosting State level and for contractual arrangements at the operator level to provide for the complete addressing of property rights and liability rules to ensure the proper mechanisms to deal with injuries and potential damages.[85] There are also requirements for financial provisions and other financial mechanisms to ensure that the PPP remains functional and that there will be sufficient capital available for all of the issues that might arise over the life of the storage facility.[86]

This repeated cascade of requirements for a holistic approach to science, engineering, establishment of legal rights and liabilities, and of financial provisions and mechanisms result in the Decision being as functional a model as the EU CCS Directive if not an even more detailed framework.

5. *Summary and Observations*

The four international and transboundary conventions analyzed in this section have provided a clear framework for offshore CCS storage policies. They all require the placement of CO2 into subterranean structures and not in the water column; most requiring placement into rock structures. It is clear that they all provide rigorous attention to the matters of site selection, of risk/hazard analyses of the proposed storage system, and of other issues related to the successful containment of CO2 and the prevention of environmental and human-related injuries. The more fully developed EU CCS Directive and the CDM's Decision 10/CMP.7 both provide extensive requirements for management of liabilities and damages, including provision of financial measure in advance of permitting. These frameworks, while

84) For example, see the extensive lists of such requirements at Decision 10/CMP.7, Appendix art. C, sec. 4; art. F, sec. 8; art. G, sec. 10; art. I, secs. 15 to 17; and the whole of Appendix B.

85) For example, see Decision 10/CMP.7, Appendix art. C, sec. 4(f); art. F, sec. 8(c) and (e); art. G, sec. 10(f); and Appendix B, art. 5, secs. 22 through 25.

86) For example, see Decision 10/CMP.7, Appendix art. C, sec. 4(f); art. G, sec. 10(g); and Appendix B, art. 4, secs. 18 through 21.

perhaps remaining in on-going improvement processes, do represent very good models of how South Korea might seek to provide regulatory guidance for offshore CCS storage operations.

Ⅲ. Review of In-Place Korean Legislation

This section will attempt to provide review and comparative analysis of nine of the most relevant rule sets to offshore CCS storage activities in Korean law.[87] It will broadly demonstrate that while a broad framework is in place, it is mostly patchwork without explicit consideration or provision for offshore CCS storage projects and as such lacks the coordination and completeness of regulatory measures as would be required under the CDM's Decision 10/CMP.7, for example. As such, it will be suggested that

87) In many ways, this research is the counterpart of the report produced by the Korean National Institute of Environmental Research, which analyzed CCS regulatory frameworks from around the world. *See* Heon Kang, Seong-Taek Yun, & Ki-Hak Park, 환경분야 CCS(이산화탄소 포집 및 저장)에 대한 법적근거 마련 연구 ('Research on a Legal Framework for CCS'), Korean Ministry of Environment, National Institute of Environmental Research, December 2012. Similarly, this article seeks to complement and extend on previous Korean scholarship for onshore CCS, including but not limited to: Koh Moon-Hyun, Necessity of Legislation of CCS and its Major Contents to Cut Down Greenhouse Gas, 74(1) Public Land Law Review 317 - 341 (2016) [고문현, 온실가스 감축을 위한 CCS 법 제정의 필요성과 주요내용, 토지공법연구, 74권 1호, 한국토지공법학회, 2016, 317p-341p], Koh Mon-Hyun, Legal Issues of CCS, 35 Soongil Law Review 31 - 74 (2016), [고문현/안태용, CCS 관련 법적 쟁점, 법학논총, 35권, 숭실대학교 법학연구소, 2016, 31p-74p], Koh Moon-Hyun, Underground Injection Control (UIC) Program Class VI Rule of EPA and Its Implications, 24(4) Legal Research 19-40 (2016) [고문현, '미국 환경보호청 (EPA)의 이산화탄소 지중저장 규칙과 그 시사점', 24(4) 법학연구 19-40 (2016)]; Jun-Seo Lee, Legal Tasks for Risk Management to Carbon Capture and Storage (CCS), 40(1) Research in Environmental Law 79-110 (2018) [이준서, '이산화탄소 포집 및 저장(CCS)으로 인한 리스크 관리를 위한 법적 과제', 40(1) 환경법연구 41-77 (2018)]; Soonja Lee, Research on the Legal Task for the CCS Acceptance in our Society, 40(1) Research in Environmental Law 41-77 (2018) [이순자, 'CCS의 사회적 수용성 제고를 위한 법적 과제', 40(1) 환경법연구 41-77 (2018)]; Moonsook Park, South Korea's Legal and Regulatory System for Carbon Capture and Sequestration: Backgrounds, Current Circumstances, and Recommendations, 18(1) Journal of Korean Law 235-268 (2018)]; and Moon-Ji Rhee, Legal & Regulatory Issues of CCS Projects. 36 Anam Law Review 681-739 (2011) [이문지, '온실가스 감축을 위한 이산화탄소 회수,저장사업의 법적 규제', 36 안암법학 681-739 (2011)].

a specific enactment be created for offshore CCS activities in South Korean waters, in the same spirit of the EU's CCS Directive, to coordinate better with the pre-existing array of environmental and safety regulatory enactments already in place.[88]

1. *Framework Act on Environmental Policy*

The Framework Act on Environmental Policy (FAEP) has the regulatory aims to prevent environmental pollution and environmental damage and to manage and preserve the environment in a sustainable manner.[89] It provides rule to enable a cross-generation model of sustainable development.[90]

It defines the environment to be composed of the 'natural environment' and the 'living environment.'[91] The natural environment is defined to include both ecosystems and natural scenery, further including all life forms underground, at the surface, in the seas, and above the ground, including all the inanimate matter surrounding them.[92] Living environment is defined as that space of humans and their daily lives, inclusive of "air, water, soil, waste, noise, vibration, malodor, and sunshine."[93] To the extent that

88) This aligns with the findings presented by Global CCS Institute, which found that Korea's legal frameworks for CCS activities gained 37.7 out of 87 possible points (43%), resulting in South Korea placing into the 'BAND B CCS-specific laws or existing laws that are applicable across parts of the CCS project cycle;' *see* Ian Havercroft, "Global CCS Institute CCS Legal and Regulatory: A Global Assessment of National Legal and Regulatory Regimes for Carbon Capture and Storage" (Global Carbon Capture and Storage Institute, 2015), 9. In fact, the report found that South Korea was weakest in the category of "The Comprehensiveness of the legal framework in providing for all aspects of a CCS project, including siting, design, capture, transport, storage, closure and monitoring for potential releases of stored CO2," receiving only 13 of 36 possible points (36%); *id.*, 23. Korea also scored poorly for stakeholder and public involvement issues and for liability rules and post-closure risk management; *id.*

89) FAEP art. 1.

90) FAEP art. 2.

91) FAEP art. 3(1).

92) FAEP art. 3(2).

93) FAEP art. 3(3).

offshore CCS activities were to occur within Korean jurisdictional waters and the attached lands below, FAEP's definition of environment would be engaged and applicable.

FAEP defines environmental pollution as derived from industrial and other human activities that inflict damage on human health or the environment by means of "air pollution, water pollution, soil pollution, sea pollution, radioactive contamination, noise, vibration, malodor, sunshine interceptions, etc."[94] As so defined, environmental pollution displays a human-centric perspective in contrast to the nature-centered definition of environmental damage. FAEP defines environmental damage as serious inflictions of damage on the intrinsic function of the natural environment.[95] If an offshore CCS activity were to damage human health or the environment, or if those activities were to cause serious inflictions of damage to the natural environment surrounding a CCS site, then the offshore CCS activity could be a source of environmental pollution or damage, correspondingly.

Environmental preservation is then defined as "any activity undertaken to protect the environment from pollution and damage, … as well as to maintain and create more delightful environmental conditions."[96] To that end, the Framework Act requires the State, not the private actor, to undertake environmental impact assessments to analyze the impact of potential development plans if a development would foreseeably impact the environment.[97] Furthermore, the national government is required to provide economic incentives to promote the efficient utilization of resources and to reduce environmental pollution.[98]

It is foreseeable that the underlying motive for an offshore CCS project is to protect and preserve the environment generally from the consequences of carbon emissions and of subsequent impacts from anthropogenic climate

94) FAEP art. 3(4). It is noted that these subsidiary ideas of pollution are not defined within the Act itself.
95) FAEP art. 3(5).
96) FAEP art. 3(6).
97) FEAP art. 41(1).
98) FEAP art. 32.

change. Given the intrusion into the offshore environment and the potential impact from offshore drilling, injecting, and storage activities, it is likely that an environmental impact assessment would be required of each offshore CCS project.

Given the preservation argument for CCS activities, the State would be required to provide economic incentives to encourage this means of environmental preservation and of efforts required to capture and relocate the CO2 from emission sources. Yet, the State would similarly be obligated to provide economic incentives to ensure that offshore CCS operations would be undertaken both efficiently with regards to its environmental settings and with a focus on the prevention of environmental pollution.

Under the Framework Act, all and any business entities are obligated to prevent environmental pollution and damage and must participate in environmental preservation policies both local and national government actors.[99] Korea's Framework Act embodies the Polluter Pays principle, requiring parties to be liable to prevent environmental pollution, to prevent environmental damage, to recover or restore the environment, and to also bear the expenses of others engaged in the restoration of the environment caused by the first party's own acts.[100] Strict liability, called 'absolute liability' in the official translation, is the rule of liability applied under the Framework Act;[101] in cases of multiple parties, the liability is to be handled joint and severally.[102] The Act does provide for rapid and fair settlement of damages from environmental pollution and environmental damages via mediation.[103] And where remedies are not available, the State is required to provide policies "to smoothly relieve any sufferings caused by environmental pollution and environmental damage."[104]

Should an operator of an offshore CCS facility cause environmental pollution or environmental damage, the operator as 'polluter' would be held

99) FEAP art. 5.
100) FEAP art. 7.
101) FEAP art. 44(1).
102) FEAP art. 44(2).
103) FEAP art. 42.
104) FEAP art. 43.

to a rule of strict liability for the injuries incurred and be liable for the respondent damages. It would be expected that mediation would be brought by the State to ensure a swift response and to enable quicker compensation and restoration efforts. Where funds would be lacking, the State and local governments would be required to assist in relieving suffering from the CCS accident.

However, it is notable that the Framework Act provides no punishments, neither incarceration nor fees in punishment are provided as incentives to prevent environmental pollution and environmental damage.

2. *Act on Liability for Environmental Damage and Relief*

The Act on Liability for Environmental Damage and Relief (LEDR Act) provides the victims of environmental damage with means of redress.[105] Environmental damages are those arising from air pollution, water pollution, soil pollution, marine pollution, noise, vibration, and certain other causes arising from the installation and operation of a facility.[106] The LEDR Act does not limit the application of the Civil Act in providing a basis for recovery for environmental or other similar damages.[107]

However, it limits the concept of 'environmental damage' for the application of the LEDR Act to the "damage inflicted on the life, body (including mental harm) or property of any third person."[108] This is clearly a different frame of reference from the EU's Environmental Liability Directive, where the paradigm is on nature itself and on those elements lacking such direct personal attribution.[109] As an interesting buttress to the notion that the LEDR Act focuses on private injuries, it excludes those environmental damages that cycle back to the business owner or its employees if caused by the installation or operation of their own facility.[110]

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105) LEDR Act art. 1.
106) LEDR Act art. 2(1).
107) LEDR Act art. 5.
108) LEDR Act art. 2(1).
109) Need a footnote.
110) LEDR Act art. 2(1).

'Facility' is a defined term, inclusive of eleven categories of regulated facilities under separate environmental enactments.[111] While offshore CCS might be included within waste disposal facilities,[112] soil contamination facilities,[113] or hazardous chemical substances facilities,[114] it is most reasonable to expect that offshore CCS facilities would qualify under 'maritime facilities' as defined within the Marine Environmental Management Act.[115] A 'business owner' is likewise defined as an "owner, installer, or operator who has actual control" over the facility.[116]

When the installation or operation of a facility gives rise to environmental damages, as defined above, then the business owner is deemed to be liable for the damages.[117] Further, when the facts are not in evidence but it is highly probable that the facility gave rise to the injuries, then the LEDR Act requires a presumption of the causal relationship between the activities of the facility and the resultant injuries.[118] This determination is to be made based on a totality of the circumstances analysis.[119] The business owner can raise a defense, that they met their good faith obligations to prevent environmental damage[120] and that they have met all the regulatory requirements under the LEDR Act, then they shall be exempted from the application of the presumption.[121]

However, even if the business owner is found to be liable, there are financial limits to that liability.[122] Liability is capped at KRW 200 billion, roughly equivalent to $180 million.[123] That cap does not apply in certain

111) LEDR Act art. 3(1) to (11).
112) LEDR Act art. 3(3).
113) LEDR Act art. 3(6).
114) LEDR Act art. 3(7).
115) LEDR Act art. 3(10). For a discussion on the definitions and legal ramifications of the Marine Environmental Management Act for offshore CCS activities, *see* sec ##, *infra.*
116) LEDR Act art. 2(3).
117) LEDR Act art. 6(1).
118) LEDR Act art. 9(1).
119) LEDR Act art. 9(2).
120) As detailed at LEDR Act art. 4(3).
121) LEDR Act art. 9(3).
122) LEDR Act art. 7.

cases; (i) when the environmental damage is a result of the business owner's intentional negligence or gross negligence,[124] (ii) when the environmental damage is a result of the business owner's per se negligence,[125] and (iii) when the business owner did not respond adequately to the emergent incident to prevent the environmental damage.[126]

Liability for environmental damages is joint and several when it is impracticable to identify which business owner might be liable for injuries arising from a joint undertaking.[127] Business owners are allowed to allocate the liabilities for their facilities to subcontractors, given that certain forms of documentation and disclosure are undertaken.[128]

Business owners are required to carry environmental liability insurance,[129] if insurance is not available to the business owner then they must provide an indemnity contract.[130] The Ministry of Environment is enabled to set minimum deductibles to ensure some retention of risk for the business owners and the prevention of moral hazard.[131] However, there is no clarification as to what amount of insurance needs to be carried by the business owner, thus, there are also no penalties for inadequate insurance, see below. The lack of a minimal threshold of coverage leaves the requirement overall of little incentive.

The LEDR Act does provide penalties for non-compliance, but they are surprisingly low in consequences. A business owner that fails to provide sufficient financial guarantees could face a year in prison or a fine of KRW 10,000,000, roughly $9,000.[132] A business owner who refuse to provide information related to the incident that resulted in environmental damage can face a fee of KRW 10,000,000 but faces no risk of imprisonment.[133]

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123) LEDR Act art. 7.
124) LEDR Act art. 7(1).
125) LEDR Act art. 7(2).
126) LEDR Act art. 7(3).
127) LEDR Act art. 10.
128) LEDR Act art. 12(1).
129) LEDR Act art. 17(1).
130) LEDR Act art. 17(2).
131) LEDR Act art. 19(1).
132) LEDR Act art. 47(2)(1).

Insurance agencies can risk a fine of KRW 10,000,000 for not providing an environmental liability insurance policy,[134] a fine of KRW 10,000,000 for not making an advance payment in relief,[135] or a fine of KRW 5,000,000, approximately $4,500, for a range of data-related failures.[136] Given the potential high costs of addressing environmental damages, these fines are not proportionate incentives. (These are also in contrast to the fees and punishments available for those seeking relief under fraud, which allows for two years in prison and up to KRW 20,000,000, roughly $18,000.[137])

Given the foreseeable situation wherein a victim is unable to receive proper compensation due to a lack of identifiable fund from the business owner, the LEDR Act empowers the Ministry of Environment to directly provide relief to that victim.[138] The LEDR Act permits this direct relief when the identity of the business owner is unknown, when the business owner is insolvent, when the business owner is thought to have been extinguished,[139] and when the actual damages are in excess of the KRW 200 billion cap.

3. *Act on the Control and Aggravated Punishment of Environmental Offenses*

The Act on the Control and Aggravated Punishment of Environmental Offenses (CAPEO Act) was enacted to provide enhanced tools for the prevention of and punishment for environmental damages.[140]

In the CAPEO Act, the term 'pollution' is defined by inclusive reference to eight different statutes and the term 'illegal discharge' by reference to fourteen statutes,[141] reflecting the design of the Act to support a wide

133) LEDR Act art. 49(2)(1).
134) LEDR Act art. 49(1)(1).
135) LEDR Act art. 49(1)(2).
136) LEDR Act art. 49(2)(2) through (5).
137) LEDR Act art. 47(1).
138) LEDR Act art. 23(1).
139) LEDR Act art. 23(1)(1) and (2).
140) CAPEO Act art. 1.

array of pre-existing environmental enactments. Given analysis of the relevant statutes, both *supra* and *infra*, the CO2 injected and stored for offshore CCS storage operations is not likely to be considered waste or illegal pollutants under those statutes.

The Act provides rigorous punishment options to supplement penal options in pre-existing environmental regulations.

- For those actors who inflict danger or injury on humans by illegally discharging pollutants, or those who place drinking waters at risk, shall face imprisonments of no less than three years.[142]
- For those actors who's act from the previous statement also include death of a human victim or injury to a human victim, the imprisonment should be no shorter than five years.[143]
- For actors who have rendered farm lands unsuitable for farming, who have contaminated an ocean, river, lake, marsh, or ground water, or who have caused death to fish or shellfish "en masse" shall face imprisonment of at least one year but in excess of seven years.[144]

While the CO2 might not qualify as a waste or as an illegal pollutant, leaked volumes of CO2 might possibly place drinking waters at risk, render injury to farms lands, contaminate various waters, and could place fish or shellfish at risk. By placing the injection site and geological storage reservoir offshore, the risks to farm lands and drinking waters could be essentially eliminated. While leakage could impact adjacent waters, such leakage at depth would be remediable and unlikely to contaminate the waters in the sense foreseen by the Act. Again, leakage from injection activities can be halted and thus risk to fish and shellfish can be mitigated long before death "en masse" occurs. Thus, while the Act could be brought

141) CAPEO Act art. 2(1)(a) through (g) and 2(2)(a) through (k).
142) CAPEO Act art. 3(1).
143) CAPEO Act art. 3(2).
144) CAPEO Act art. 3(3). There are enumerated specific minimum thresholds of damage, e.g., 300 square meters of farmland, but these are not 'difficult' levels of damage to achieve.

to bear on offshore CCS activities, such application is not likely.

There are additional rules to address environmental damage brought by acts of criminal negligence.[145]

- For actors who have rendered farm lands unsuitable for farming via criminal negligence, the imprisonment is set at a maximum of seven years with a fine not exceeding KRW 100 million (approx. USD 100,000).[146]
- For actors who have contaminated an ocean, river, lake, marsh, or ground water via criminal negligence, the imprisonment is set at a maximum of ten years with a fine not exceeding KRW 150 million (approx. USD 150,000). [147]
- For actors who have caused death to fish or shellfish "en masse" via criminal negligence, the imprisonment is set at a maximum of three years with a fine not exceeding KRW 30 million (approx. USD 30,000). [148]

Were offshore CCS operations to be undertaken with criminal negligence, then certainly the likelihood of harms to waters, fish, and shellfish would be exacerbated. As such, given management with a character of criminal negligence, these sections of the Act would be certain to apply to offshore CCS operations.

Corporate liability for environmental damages are addressed within the Act. When a representative, an agent, an employee, or another servant of the corporation acts criminally negligent in a manner leading to environmental damages, then both the actor and the corporation can be fined.[149] Furthermore, when it is difficult to establish the causal connection between a business operator's illegal discharge of pollutants and subsequent injuries to third parties, the Act requires a presumption of the causation to

145) CAPEO Act art. 5.
146) CAPEO Act art. 5(1).
147) CAPEO Act art. 5(2).
148) CAPEO Act art. 5(3).
149) CAPEO Act art. 10. The attendant fines are the same fines specified in the CAPEO Act where a private actor would have incurred the fine.

be assumed by courts and administrative authorities.[150] If a business operator is found guilty of an illegal discharge,[151] then the Ministry of Environment is to levy a fine from 200% to 1,000% of the profits collected from the business operations associated with the illegal discharge of pollution.[152] As seen above, to the extent that offshore CCS operations are undertaken with criminal negligence, these sections of the Act would be likely applied to the business owners and corporate actors responsible for those acts of criminal negligence.

Following on the requirement to provide economic incentives, the Ministry of Environment is directed to provide 'prizes' and to 'pay rewards' to private parties who identify and bring to the awareness of governmental agencies the existence of environmental law violations prior to the discovery of such violations by government agencies.[153] This is a useful tool to provide rigor to private regulatory mechanisms.[154]

4. *Environment Improvement Expenses Liability Act*

The Environment Improvement Expenses Liability Act (EIEL Act) provides the tools to effect the polluter pays principle in Korean environmental law.[155] Of note, it is a very short enactment. It enables the Ministry of the Environment to impose and collect environmental improvement charges from the owners of buildings, facilities, or vehicles that directly cause environmental pollution.[156] These fees shall be governed, mutatis mutandis, by Korea's Framework Act on National Taxes, following the pattern seen in other Korean environmental codes.[157]

The fees so collected are to be used to subsidize environmental

150) CAPEO Act art. 11.
151) As defined at CAPEO Act art. 2.
152) CAPEO Act art. 12(1).
153) CAPEO Act art. 15.
154) *See* sec. 4.2., *infra*.
155) EIEL Act art. 1.
156) EIEL Act art. 1(1) and (2).
157) EIEL Act art. 1(7).

improvement projects under the FAEP Art. 17, and to subsidize air and water improvement projects carried out be entrepreneurs in pursuit of low-pollution technology.[158] A potential application of such funds could be to subsidize CCS technology projects as low-pollution technologies.

5. *Conservation and Management of Marine Ecosystems Act*

The Conservation and Management of Marine Ecosystems Act (CMME Act) protects certain marine ecosystems by enabling the Ministry of Land, Transport, and Maritime Affairs to establish and steward 'protected marine areas.'[159]

The Act charges the Ministry with a "duty to protect the habitat, spawning areas, and migratory routes of migratory marine animals and marine mammals."[160] The Ministry may place certain marine animals under protection,[161] preventing their capture or collection.[162] Similarly, the Ministry may designate certain zones as 'protected marine zones;'[163] preventing acts that damage marine animals or alter the quality or quantity of public waters,[164] amongst other issues, unless overridden by development activities in consultation with the Ministry.[165] Thus, while the Ministry could set aside a marine area for protection and could list marine animals known to exist nearby, if the Ministry was also consulted on the development of an offshore CCS facility, then those protections would not be applicable.

The penal sections provide that if an actor were to injure marine organisms under protection, then they could face up to three years in

158) EIEL Act art. 11(1) and (2).
159) CMME Act art. 1 and 2(14).
160) CMME Act art. 16(1).
161) CMME Act art. 19(1).
162) CMME Act art. 20(1).
163) CMME Act art. 25(1). *See also* art. 43; providing for the establishment of facilities to conserve and manage marine ecosystems and sound use of the sea.
164) CMME Act art. 27(1)(1), (3), and (4).
165) CMME Act art. 27(2)(5).

imprisonment and a fine of KRW 20 million (approx. USD 20,000). Actors who damage marine ecosystems or marine organisms in area for protecting marine organisms could face up to two years' imprisonment or a fine up to KRW 10 million (approx. USD 10,000). But again, to the extent that offshore CCS operations were development in consultation with the Ministry, these punishments would not avail.

6. *Marine Environment Management Act*

The Marine Environment Management Act (MEM Act) was drafted to "prevent any danger due to either damage of marine environment or pollution."[166] As such, it has seen a call from Korean academics as a model for a future Korean CCS legal framework.[167]

The term 'marine environment' is defined broadly as 'oceanic nature and life status,' including organisms living in the sea and "abiotic environments such as sea water, oceanic land, marine atmosphere, etc. and human behavior in the ocean."[168] The scope of its application is intended to dove-tail with other acts protecting the ocean's environment.[169]

The phrasing for marine pollution bear the hallmark of EU legislation, in its reference to the introduction of dangerous materials or energy into the ocean.[170] But most importantly, marine pollution is a "status of dangerous results," [171] whereas 'waste' is defined to be unusable materials that are discharged into the ocean which cause (or could cause) dangerous results to the marine environment. So pollution is an injurious state resulting from

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166) MEM Act art. 1.

167) Sun-Young Chae & Suk-Jae Kwon, *A Study on Domestic Policy Framework for Application of Carbon Dioxide Capture and Storage (CCS),* 18:6 Journal of the Korean Society of Marine Environment & Safety 617-625 (2012).

168) MEM Act art. 2(1). The word choice 'abiotic' is intriguing and leaves the reader uncertain if it meant the 'non-living elements of' the marine environment instead of the 'lifeless' suggestion it might bring in a plain reading of the text. An abiotic environment is an unnatural state for most of the ocean.

169) MEM Act art. 3(1). *See also* art. 3(1)(4).

170) MEM Act art. 2(2).

171) MEM Act art. 2(2).

exogenous materials or energies and waste are the embodiment of unusable materials that can cause injurious states.

The injection of CO2 into a subterranean geologic reservoir ought not to provide a substantial source of either marine pollution or waste. In terms of pollution, only in the case of a leak might CO2 pose a risk as a source of pollution. Assuming the accident occurred during injection, the leaked volumes could be controlled and limited by cessation of the activity. If the leaked volumes were benthic, and the CO2 is at sufficient depth as foreseen in current offshore CCS storage technologies, there would be little risk to oceanic water columns and the CO2 could be re-collected and the area of leakage could be remediated. If the leakage was closer to the surface, it is likely that the CO2 would cause minimal damage as both cessation and venting to the surface could minimize the formation of carbonic acid and other concerns. And as the injected CO2 is expected to be clean of contaminants, such as H2S, there would be little opportunity for ancillary pollution from the accident.

Is the CO2 a waste in and of itself? Is it a material which cannot be utilized itself in the case of discharging into the ocean which will also cause dangerous results? A repeat of the above analysis suggests that even in leakage events, barring the most extreme scenarios, that the CO2 would not likely discharge into the ocean in a manner to cause dangerous results. Thus, the CO2 should not be considered a waste for the purposes of the Act.

There is another term, 'pollution material,' which includes "wastes, oils, dangerous liquid material, and packaged dangerous material, of which inflow or discharge into ocean" could be dangerous to the marine environment.[172] Even if the flow of liquid CO2 were to cause dangerous impacts to the marine environment, and the previous paragraphs have addressed why small volumes would not so present, the CO2 would need to qualify under 'dangerous liquid material."[173] A dangerous liquid material is any liquid that would have dangerous impacts on the marine environment, or a liquid mixed with such a dangerous liquid, and as designated by the Ministry of

172) MEM Act art. 2(10).
173) MEM Act art. 2(7).

Land, Transport, and Maritime Affairs.[174] Thus the key issue is whether at the time of injection would the Ministry designate the injected CO2 volumes as dangerous liquids? One suspects not, given the announced government policy to sponsor the development of the technology and the expected use to reach South Korea's carbon emission reduction commitments. Thus, the CO2 is not likely to qualify as a dangerous liquid nor as a pollution material for offshore CCS projects.

With regards to liability, the MEM Act mandates both the polluter pays principle and imposes the rule of strict liability.[175] Further, it adopts a position that international agreements on marine environment and pollution will prevail over domestic enactments; unless the domestic enactment is more restrictive.[176] (Example, although the MEM Act forbids the discharge of polluting substances from a vessel into the ocean, the rules of the London Convention and Protocol are more detailed and restrictive and thus operative.[177]) Thus the role of international agreements on offshore CCS, like the London Protocol to the London Convention, would become applicable within this Act. The State has an affirmative duty to enforce those rules, both the domestic enactments and the international conventions.[178]

The Ministry of Land, Transport, and Maritime Affairs is charged with collecting what is referred to as a 'marine environment improvement surcharge' fee.[179] The surcharge is to be imposed on each act of discharge or pollution.[180] The fee is compulsory to the polluter, and when not paid timely, it is to be collected under the rules governing national taxes in arrears.[181] To that extent, the fee might be reasonably viewed as a

174) MEM Act art. 2(7).
175) MEM Act art. 7 and art. 5(2), respectively.
176) MEM Act art. 4.
177) *See* MEM Act art. 22 and 23. The Republic of Korea entered the London Convention on January 20, 1994, and the London Protocol on February 21, 2009; IMO, "Status of Multilateral Conventions and Instruments in Respect of Which the International Maritime Organization or its Secretary-General Performs Depositary or Other Functions," September 20, 2016; available at http://www.imo.org/en/About/Conventions/StatusOfConventions/Documents/Status%20-%202016.pdf
178) MEM Act art. 5(1).
179) MEM Act art. 19(1).
180) MEM Act art. 19(1)(1) and (2).

pollution tax.

The penal provisions of the MEM Act are separated into intentional acts and negligent acts sections. Anyone found intentionally discharging wastes, dangerous liquid materials in violation of the Act could face up to three years' incarceration or a fine of up to KRW30 million. (Approx. 30,000 USD.)[182] Identical punishments and fee rules faces parties who intentionally failed to undertake certain prevention measures.[183] The punishments and fines for acts of negligence are lesser; for the same discharges of pollutants as previously described, the punishment is a maximum two years' incarceration and a maximum fine of KRW20 million. (Approx. 20,000 USD.) There are numerous other activities with respondent punishments and fines.[184] In alignment with other environmental laws in South Korea, the collection of fines in arrears will be collected under the national tax rules.

7. *Development and Management of Deep Sea Water Act*

The Development and Management of Deep Sea Water Act (DMDSW Act) provides a regulatory framework to "ensure that the State preserves and manages deep sea water … in an environmentally friendly manner."[185]

The application of the Act is limited to "deep sea water," which is "sea water in the sea," above a certain prescribed depth,[186] so it would not apply to subsea volumes located within geological formations. It could potentially apply to leaks from CCS storage systems that do communicate into the benthic waters, but only if those sea waters are above the depth limits so prescribed, which given the circumstances of offshore CCS and the behavior of CO2 at benthic depths, is not likely.

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181) MEM Act art. 20(2).
182) MEM Act art. 127(1).
183) MEM Act art. 127(4) and (5).
184) MEM Act art. 127 through 133.
185) DMDSW Act art 1.
186) DMDSW Act art 2(1).

The Act does have a contextual focus on drinking water extracted from oceanic volumes.[187] The Act provides the Ministry of Land, Transport, and Maritime Affairs with the powers to regulate both "deep sea water development business" and "business related to deep sea water,"[188] which include the activities of "storing, processing, supplying, or selling" of deep sea water,[189] of "manufacturing deep sea drinking water,"[190] and of "importing deep sea drinking water."[191] Offshore CCS operations are not engaged in the business of deep sea drinking water, nor would it foreseeably involve storing, processing, supplying, or selling of deep sea water. Similarly, offshore CCS is not foreseeably engaged in the manufacturing, marketing, or importing of deep sea drinking water. Thus, there would not appear to be a direct application of the Act to the activities of offshore CCS.

However, the Act does provide the Ministry of Land, Transport, and Maritime Affairs with the powers to manage the marine resources in the areas from which that deep sea water development businesses would draw sea water from and the powers to preserve the marine environment,[192] presumably in the same area given the subsequent subsection which refers to powers to survey the "sea water intake area (including the seafloor) and adjacent areas."[193] To the extent that a deep sea water development business is licensed to operate in a given sea water intake area, then an offshore CCS project in the same vicinity might foreseeably become regulated under these subsections, primarily with regards to its potential impact on the seafloor and leakage into water columns in or adjacent to the sea water intake area. Ideally, the Ministry would coordinate offshore CCS project planning and sea water intake area planning to avoid overlapping of operational sites, but it foreseeable that in certain

187) See DMDSW Act art 2(2), on the definition of "deep sea drinking water."
188) DMDSW Act art 4(1).
189) DMDSW Act art 2(4).
190) DMDSW Act art 2(5).
191) DMDSW Act art 2(5).
192) DMDSW Act art 4(6).
193) DMDSW Act art 4(7).

circumstances, both planned and accidental, that the offshore CCS operations could be within the scope of this Act.

While an operator of an offshore CCS operation would not likely need to receive a license to undertake a deep sea water development business, the guidelines for standards are illuminating.[194] Licensing requires a deep sea water development business to demonstrate the reasonableness of its business plans,[195] its financial means to handle its operations and regulatory requirements,[196] its technical capacity,[197] and its environmental planning for the sea water operations. [198] Persons having records of incompetence or criminality are barred from obtaining licenses, but there is no guidance provided for insolvent persons.[199] Should a business violate the environmental protection standards,[200] the Ministry is granted authority to revoke the business's license.[201] These types of requirements, of proofs of financial securities, technological capacity and precaution, and of forward-looking environmental planning, are in alignment with model international regulations for offshore CCS operations.

Once a license is received, the operator would become liable to pay fees for the privilege and occupation of using deep sea water to local regional governments.[202] When these fees are not timely paid by the operator, their collection will be sought under the local tax code.[203] Thus, these fees are a kind of franchise taxes.

Similarly, the Ministry itself shall charge a fee for the transfer of property from the State to the private operator.[204] The fees collected are to

194) DMDSW Act art 12.
195) DMDSW Act art 12(1).
196) DMDSW Act art 12(2).
197) DMDSW Act art 12(2).
198) DMDSW Act art 12(3) and (4). The Mining Damage Prevention and Restoration Act does forbid bankrupt or insolvent parties who have not yet been reinstated. MDPR Act art. 14(2).
199) DMDSW Act art 13. For corporations, officers are to be examined in lieu of the personhood of the corporation. DMDSW Act art 13(4).
200) See Measures to Preserve the Marine Environment, DMDSW Act, art. 37.
201) DMDSW Act art 23(1)(8). See similarly at art 32(1)(9).
202) DMDSW Act art 39(1).
203) DMDSW Act art 39(4).

be used for a projects and efforts protecting and preserving marine ecosystem.[205] When these fees are not timely paid, they are to be collected under the provisions of national taxation for defaults.[206] As such, these fees appear to function as a form of severance or production taxes.

Chapter VII, "Supplementary Provisions," provides legal guidance on the protection of the environment. Business operators are required to take measures necessary to prevent pollution of the marine environment.[207] The Ministry itself is granted authority to examine business operators and to order them to "take measures to preserve the marine environment or take corrective measures."[208] A person, including officers of corporations, who fail to comply with the requirements under Art. 37 can be punished with imprisonment for no more than three years or be fined not more than KRW15 million. (Approx. 14,000 USD.) The financial penalty of KRW15 million is not a substantial cost vis-à-vis the expected costs of operating an offshore CCS project and might not prove a meaningful incentive. The potential risk of imprisonment is a stronger incentive, one that reaches beyond insolvency of the operator, but one worries that in a complex setting with many actors that courts might be faced with complexity and high transaction costs in seeking such a punishment.

8. *Submarine Mineral Resources Development Act*

As the purpose of the Submarine Mineral Resources Development Act (SMRD Act) is to support the rational exploitation of "the sea areas adjacent to the coasts of the Korean Peninsula,"[209] one might be hopeful that offshore carbon storage would be addressed within the SMRD Act,

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204) DMDSW Act art 40(1).
205) DMDSW Act art 40(6).
206) DMDSW Act art 41(3).
207) DMDSW Act art 37(1).
208) DMDSW Act art 37(2).
209) SMRD Act art. 1. Also, the SMRD Act is the offshore alternative to the onshore Mining Damage Prevention and Restoration Act, which appears to be focused primarily on coal mining and related concerns.

such is not the case. Yet, it remains enlightening as to how offshore CCS might be addressed in a novel act from the legislature.

The Act is primarily focused on the licensing of rights to extract submarine minerals from the continental shelf areas of South Korea by the Ministry of Knowledge Economy;[210] and notably not by the Ministry of Land, Transport, and Maritime Affairs. Example, "submarine minerals" are defined as petroleum, natural gas, and "etc. from among the natural resources which are rich in the continental shelves of the republic of Korea."[211] This is an interesting definition because its plain reading refers only to those minerals which could be described as being abundant in nature within the offshore subsea lands, except for petroleum and natural gas. Carbon dioxide is not considered to be "rich in the continental shelves of the republic of Korea," and as such would not appear to meet this definition, much less the vacuous pore space into which it would be injected, unless again, pore space could be considered a submarine mineral, which is not a reasonable reading of the word 'mineral.'

The definition of 'submarine mining' includes the exploitation and gathering of submarine minerals;[212] were pore space or the injected carbon dioxide to be considered submarine minerals, then their utilization in CCS storage could be considered a sense of 'exploitation.'[213] However, the definition of 'submarine mining right' is delimited to the exploration, gathering, and acquisition of submarine minerals, making the previous suggested interpretation of 'exploitation' infeasible. Thus, it would seem most likely that the Act wouldn't apply to the storage systems of offshore CCS.

The SMRD Act does contain a variety of legal issues that might eventually be influential in drafting CCS regulatory policy. Even when leases for submarine mining are to be granted, the Act provides that the ultimate right remains with the State and not a private operator.[214] This

210) SMRD Act art. 2-2(1).
211) SMRD Act art. 2(1).
212) SMRD Act art. 2(2).
213) See the Mining Damage Prevention and Restoration Act (MDPR Act), wherein the concept of an 'active mine' is defined as "a mine in which the ground is drilled to extract minerals or from which minerals are extracted." MDPR Act art. 2(2).

potentially holds great impact for the post-injection cessation of CCS storage activities and for the addressing of long-term liabilities, as the State would (potentially) be the owner of the both the injection rights and the CO2 attached (via permanent storage) to the land-in-place. Exploration and extraction rights are limited to 10 years and 30 years,[215] respectively; again providing a template for a limited time license to inject CO2 in an offshore CCS storage project.

The SMRD Act also provides the Ministry of Knowledge Economy with the powers to require the restoration of the submarine mining site to its original state within one year of cessation of mining activities.[216] Should the operator fail to do so, the Ministry may take measures to restore the location under the Administrative Vicarious Execution Act.[217] Given that petroleum and natural gas extraction alter geological reservoirs and that it is unlikely to be the State's policy to return those geological reservoirs to original condition, it is foreseeable and reasonable that the State would also not seek CO2 storage systems to be returned to their 'original condition,' but rather, that the facilities installed near the seabed surface and whatever platforms or vessels used in injection activities be removed and the oceanic ecology returned as closely as possible to its original condition.

Of potential importance is the lack of punishment and fee structures that one might expect to see in an offshore mining act. Most of the few punishments listed are for operating at various stages without proper licenses.[218] There is a financial penalty for failing to restore the mining site to an original condition of no more than KRW 10 million, approximately 10,000 USD. This fee is proportionately tiny in contrast with the costs of subsea restoration and may in fact operate as an incentive to

214) *See* SMRD Act art. 4, 9, and 10; note the differences in the terms "submarine mining right," held by the State, and "submarine mining concession," held by the operator. Art. 19 enables an operator to extinguish its claim to an extraction license, leaving the State with the assets.
215) SMRD Act art. 9 and 10.
216) SMRD Act art. 19-2(1) and (2).
217) SMRD Act art. 19-2(3).
218) SMRD Act art. 35, 36, and 38(1) and (2).

not restore in a timely manner, as the time value of deferred restoration efforts might well dwarf that sum.

9. *Compensation for Oil Pollution Damage Guarantee Act*

The Compensation for Oil Pollution Damage Guarantee Act (COPDG Act) is not foreseeably applicable to offshore CCS operations,[219] as the COPDG Act strictly applies to spilt petroleum and has no breadth to accommodate CO2 leakages, but its approach to fluid leaks and resultant environmental damages and liabilities does provide some insight into how offshore CCS operations might be regulated.

The Act provides specific definitions of the pollutant, 'oil,'[220] and of the damage it creates, 'oil pollution damage.' The definition of oil pollution damage includes three constituents; loss or damage caused by the spilt volumes,[221] costs of preventative measures in response to the spill, [222] and additional losses or damages caused by the preventative measures. [223]

Liability for the incident is addressed by the Act. If the leak is from a tanker, then the owner of the vessel is liable for the oil pollution damage;[224] the Act has no text related to oil pollution damage related to offshore oil wells and thus appears to assign no liability in those cases. (South Korea currently produces very little petroleum from an offshore operation and not from onshore; what volumes it produces are natural gas and light distillates, not conventional crude oil.[225])

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219) COPDG Act art. 1.
220) COPDG Act art. 2(5) and (7).
221) COPDG Act art. 2(7)(a).
222) COPDG Act art. 2(7)(b); with 'preventative measure' defined at 2(9).
223) COPDG Act art. 2(7)(c).
224) COPDG Act art. 5(1).
225) "Since exploration began in the 1970s, South Korea has discovered one commercially producing field among its Ulleung Basin, Yellow Basin, and Jeju Basin so far. Discovered in 1998, Donghae-1, Block 6-1 in the Ulleung Basin, has total proved reserves of 3.2 million barrels of ultra-light crude (condensates). Although natural gas production from Donghae-1 began in November 2004, oil production did not begin until 2010 after further exploration and discovery. On average, KNOC has produced 1,000 b/d of ultra-light crude (condensates) from the Donghae-1 natural

Liability for oil pollution damage can be limited,[226] if the vessel owner applies for limited liability;[227] limited liability is not available for vessel owners that acted with intent to cause damages.[228] The liability limits are predicated on the units of tonnage of the vessel, the larger the tonnage the higher the limit of the liability.[229] The liability limit for the smallest vessels is set at 4.51 million units of account and for the largest of vessels at 89.77 million units of account;[230] that range is approximately 6.31 million USD to 125.64 million USD.[231] Each owner of a vessel is required to carry an insurance contract for each vessel to satisfy a requirement to bear indemnity contracts to cover their third-party liability claims.[232] When the oil pollution damage is found to be non-intentional in origin, the third party can directly sue the insurance company for damages, but not if the accident was intentional.[233]

While penal provisions for illegal discharges and for damages to water might be applicable under the CAPEO Act, penal provisions under the COPDG Act are limited to matters of insurance and issues related to notifications.[234] Failure to have insurance in place shall face imprisonment of not more than three years or a fine not exceeding KRW 50 million (approx. USD 50,000.) The application of these fines to corporate actors and business owners follows the guidelines established in the CAPEO Act.[235]

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gas field, representing a negligible portion of its 2.4 million b/d total petroleum consumption, nearly all of which was imported." EIA, "South Korea: International Energy Data and Analysis," U.S. Energy Information Agency, (2016), 4-5; available athttps://www.eia.gov/beta/international/analysis_includes/countries_long/Korea_South/south_korea.pdf.

226) COPDG Act art. 7(1). See also COPDG Act art. 32, 33, and 34.

227) COPDG Act art. 7(2).

228) COPDG Act art. 7(1).

229) COPDG Act art. 8.

230) COPDG Act art. 8(1) and (2); the unit of account is defined to be the Special Drawing Rights of the IMF. *Id.*, at 8(2).

231) The IMF provides a daily exchange rate from Special Drawing Rights to U.S. dollars at its website: http://www.imf.org/external/np/fin/data/rms_sdrv.aspx.

232) COPDG Act art. 14(1) and 15(1) and (3).

233) COPDG Act art. 16.

234) See COPDG Act art. 60, 61, and 62.

235) COPDG Act art. 63.

10. *Summary and Analysis of Regulatory Preparedness for Offshore CCS Storage Projects in South Korea*

What we find in the Korean enactments that might be applicable to any potential offshore CCS storage plans are a wide mix of methodologies and approaches, which while each rule or sub-rule might have its own purpose and policy justification, will ensure complexity and multiplicity of policy interpretations, frustrating long-term planning of such offshore CCS opportunities.

The Framework Act, while laudable on many fronts, likely requires the State, not the operator, to draft and file the EIA for the offshore project. Further, the Framework Act might require the State to provide subsidies for the CCS project, potentially frustrating an arms' length review of its environmental fitness. And while it calls for application of a strict liability rule, it provides little bite for regulatory compliance.

The Act on Liability for Environmental Damage and Relief (LEDR Act) provides what appears to be a robust liability regime, with liability for operators capped at close to 200M USD. Even the strict liability rule's test for causal proximity is relaxed by the Act, enabling more ready application of the liability rule. This liability rule is backed by a requirement for operators to carry sufficient insurance, which is also financially supported (in part) by the State. Again, quite effective policy. However, the fines for not following the regulatory requirements of the Act are met with comparatively minimal fines, in the range of 10K to 20K USD, creating no effective incentive for capital projects that might cost many magnitudes more to develop and operate.

The primary problem identified with the Act on the Control and Aggravated Punishment of Environmental Offenses (CAPEO Act) is its very unlikelihood of applicability to offshore CCS storage projects. That said, the Act does provide a very good tool set that if brought to apply could be very useful in its governance of offshore CCS projects, not the least of which are its allowance for private regulatory mechanisms in

environmental monitoring.

The Environment Improvement Expenses Liability Act (EIEL Act), due to its narrow approach, was found highly unlikely to be applicable to the offshore CCS context.

The Conservation and Management of Marine Ecosystems Act (CMME Act) could enable protection of special marine zones, but again, the negative financial incentives provided as punishment range in the 10K to 20K USD range, which provide little transactional cost hesitation for major construction projects as the offshore CCS storage sites likely would be.

The application of the Marine Environment Management Act (MEM Act) to offshore CCS storage sites is not expected to be applicable, as the injection of CO2 into a subterranean geologic reservoir would not be expected to provide a substantial source of either marine pollution or waste. A potential additional limit on the applicability of the MEM Act, is that the Act defers to international conventions, and South Korea is a Party to the London Convention and to its Protocol, and thus their offshore CCS rules would override any local interpretation from the MEM Act. And again, the negative financial incentives provided as punishment range in the 20K to 30K USD range, which provide minimal transactional costs.

The Development and Management of Deep Sea Water Act (DMDSW Act) is focused on the extraction of potable water supplies from the marine environment, and as offshore CCS would not be foreseeably engaged in the manufacturing, marketing, or importing of deep sea drinking water, the legal nexus between the DMDSW Act and offshore CCS would appear to be minimal in the basic case, and readily avoidable with careful site selection.

The Submarine Mineral Resources Development Act (SMRD Act) is focused on the extraction of resources that are abundant in the submarine environment. As such, it is the opposite of the injection of what one hopes is presently a rare gas for subsea and submarine settings. That said, the leasing paradigms and the call for a return to natural conditions once the lease is exhausted, may well be fodder for thought in developing a Korean CCS framework.

The Compensation for Oil Pollution Damage Guarantee Act (COPDG Act) is primarily limited in that it is addresses oil spill pollution and was not definitionally drafted with carbon dioxide leaks in mind. That said, many of its elements might well be foundations for consideration in the development of a CCS liability framework.

Thus, overall, South Korea has many excellent enactments for protecting the marine and oceanic environments, but none provide a full response to the legal and policy needs of offshore CCS storage projects, nor is it readily apparent that the current tapestry of those enactments provides a synoptic narrative of how to construct that legal framework. Thus, South Korea would benefit from the development of a specific legal framework to facilitate policy compliance matters and environmental safeguards for both ministry officials and operators alike.

Ⅳ. Conclusions

This research has demonstrated that a singular comprehensive legal framework for offshore CCS storage projects remains elusive, despite strong efforts made in international conventions and in South Korean domestic enactments to protect marine and oceanic environments. That said, the tools to build that legal framework can be seen scattered across these efforts. If pulled together, South Korea could create and enact a leading model for offshore CCS storage projects.[236]

One would likely begin with the CDM's guidance for CCS projects, as provided within the Decision 10/CMP.7. By building off of this template, South Korea would gain both the benefits of one of the more complete templates to address the legal complexities of offshore CCS and the potential financial benefits that might follow under the CDM. Next, South Korean legislators might look to the EU's CCS Directive for additional

236) And as such, might help to set a trend towards a global standard in CCS legal frameworks, as called for by Rhee; *see* Moon-Ji Rhee, *Legal & Regulatory Issues of CCS Projects,* 36 Anam Law Review 681-739 (2013).

guidance on how to transpose the ideas of Decision 10/CMP.7 into effective and operational language. Additionally, South Korea can draw on its existing engagements with the London Protocol to ensure that its new framework remains in compliance with those rules. Finally, South Korea might avail itself of the resources available from cooperating with OSPAR on environmental protection in the ocean and marine settings.

While modelling its CCS legal framework on these international conventions could expedite the timeframe of development while ensuring coordination on certain key issues, such as the CDM's financial mechanisms, the reviewed Korean environmental enactments all offer positive elements to retain and coordinate within the Korean CCS Framework. As seen in the EU context, its own CCS Directive draws on a variety of other EU environmental rules and enactments, which strengthen and reinforce the whole of the system.

Thus, while this research found that South Korea presently lacks a coordinated legal framework for offshore CCS projects; this research equally finds that South Korea could rapidly and readily design and prepare such a South Korean Legal Framework for Offshore CCS based on its own environmental laws and on existing international conventions.

Given the urgency to reduce carbon emissions, and given South Korea's pre-existing leadership on green energy transitions, it is readily foreseeable that Korea could again take leadership and draft such a unified enactment for its future offshore CCS projects.

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[Abstract]

Regulatory Frameworks for South Korea's Offshore Carbon Capture and Storage (CCS) Activities

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This article provides a comparative review of existing Korean regulations against model regulatory frameworks for carbon capture and storage (CCS) projects within South Korean waters. Its analysis will demonstrate that South Korea's existing environmental laws and existing international conventions to regulate offshore CCS activities can be used to draft a robust stand-alone legal framework appropriate for offshore CCS storage projects in South Korean waters.

Carbon capture and storage (CCS) is a technology that could enable nations that emit greenhouse gases from their industrial activities to capture the emission before they reach the atmosphere and to place those greenhouse gases into deep geological storage. CCS re-purposes a pre-existing technology which injected carbon dioxide (CO2) into geological formations to enhance the production of crude oil from older fields; in those operations, it was discovered that most of the injected CO2 never returned to the surface, suggesting the potential to store CO2 in that manner. While some green scholars and activists oppose its implementation, many have seen CCS as a potential bridging technology to enable earlier reductions in net greenhouse gas emissions while maintaining industrial output levels, until greener technological alternatives are mainstays of industrial economies. These carbon storage activities could be undertaken both onshore and offshore of the industrial economies.

Because Korea has few suitable onshore storage locations for carbon storage, it will need to plan for offshore CCS operations. Legally, this could be fortuitous, as it would reduce the complexity of overlapping national and local

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administration issues and further could take inspiration from pre-existing international conventions on offshore CCS activities, such as under the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter ("London Protocol"), the EU's Directive on the Geological Storage of Carbon Dioxide ("the CCS Directive"), OSPAR Decision 2007/2 for the Convention for the Protection of the Marine Environment of the North-East Atlantic ("OSPAR Convention"), and the Decision 10/CMP.7 of the Clean Development Mechanism (CDM) of the Kyoto Protocol, under the UN Framework Convention on Climate Change. This article evaluates these conventions comparatively with a variety of South Korean environmental enactments to find that if South Korea brought together its laws with key elements from those conventions, then South Korea could create and enact a leading model for offshore CCS storage projects.

Keywords : Carbon capture and storage, CCS, carbon dioxide, hydrate, offshore, South Korea, injection, greenhouse gas, climate change