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Norm Fragmentation in Indonesia's Offshore Carbon Capture and Storage Regulation: A National and International Legal Analysis

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Abstract

The development of offshore Carbon Capture and Storage (CCS) has become an important component of Indonesia's climate mitigation and energy transition strategy, particularly following the enactment of Presidential Regulation No. 14 of 2024 and Minister of Energy and Mineral Resources Regulation No. 2 of 2023. Despite these regulatory developments, offshore CCS governance remains dispersed across environmental, maritime, energy, climate, and international legal regimes, creating challenges for legal coherence and effective marine environmental governance. This study examines the forms of norm fragmentation within Indonesia's offshore CCS regulatory framework and evaluates their implications for legal certainty and sustainable offshore carbon storage governance. It employs normative legal research using statute and conceptual approaches. The analysis is grounded in Regulatory Fragmentation Theory and supported by institutional mapping and a comparative regulatory matrix to identify overlaps, inconsistencies, and gaps among relevant legal instruments. Primary legal materials consist of Indonesian legislation and international legal instruments, particularly UNCLOS 1982 and the London Protocol framework. The findings reveal five principal forms of norm fragmentation: environmental governance fragmentation, maritime and spatial governance fragmentation, licensing and institutional fragmentation, liability and long-term monitoring fragmentation, and fragmentation between domestic offshore CCS norms and international marine environmental obligations. These forms of fragmentation arise from overlapping authorities, insufficient integration of offshore CCS within marine spatial planning, inconsistent monitoring and liability arrangements, and incomplete alignment with international legal frameworks governing offshore carbon storage and transboundary CO_2 transport.This study contributes to the emerging scholarship on offshore CCS governance by developing a norm-fragmentation framework that integrates environmental, maritime, energy, and international law perspectives. It concludes that legal harmonization, stronger institutional coordination, and greater alignment with international standards are essential to support sustainable offshore CCS development in Indonesia.

Keywords: *Offshore CCS; norm fragmentation; marine governance; UNCLOS 1982; London Protocol; Indonesia.*

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Introduction

Carbon Capture and Storage (CCS) technology has emerged as an important climate mitigation instrument. CCS refers to the process of capturing carbon dioxide (CO_2) emissions from industrial and energy activities, transporting the captured carbon, and storing it within geological formations to prevent atmospheric release. Offshore CCS specifically involves subseabed geological storage located beneath marine areas, including depleted offshore oil and gas reservoirs and deep saline aquifers. Offshore CCS is increasingly recognized as a strategic climate mitigation mechanism because it allows continued industrial operation while significantly reducing carbon emissions.

Globally, offshore CCS development has expanded significantly in recent years. Countries such as Norway, Australia, and the United Kingdom have incorporated offshore CCS into national climate mitigation policies and energy transition strategies. Norway's Sleipner Project in the North Sea is frequently regarded as one of the earliest successful offshore CCS projects, demonstrating the feasibility of long-term subseabed carbon storage. At the international level, the legal governance of offshore CCS has developed through the London Protocol and marine environmental obligations under the United Nations Convention on the Law of the Sea 1982 (UNCLOS 1982). Particular importance has been attached to the 2009 amendment to Article 6 of the London Protocol and the 2019 Resolution on Provisional Application, which provides an interim legal mechanism permitting the cross-border transport of carbon dioxide streams for subseabed storage before the formal entry into force of the amendment. These developments have become increasingly relevant for States seeking to participate in regional carbon storage networks and cross-border CCS cooperation. Hyewon Jang explains that the growing implementation of offshore CCS requires States to harmonize domestic regulations with marine environmental protection obligations under international maritime law.[1]

Indonesia possesses significant potential for offshore CCS development due to the availability of depleted offshore oil and gas reservoirs and sedimentary basins suitable for geological carbon storage. Indonesia's offshore basins are considered capable of supporting long-term carbon sequestration activities while contributing to industrial decarbonization policies.[2]

[1] Hyewon Jang, "Regulation of the London Protocol and CCS Technology: A Legal Framework Analysis of Australia, Indonesia and RoK," *Wonkwang University Legal Research Institute* 40, no. 4 (December 31, 2024): 265–92, https://doi.org/10.22397/WLRI.2024.40.4.265.

[2] D. Ardiyanta et al., "Pertamina's CCS Hub Development in Indonesia: Driving Net Zero and Regional Carbon Storage Leadership," *1st EAGE-AAPG-SEG Carbon Capture Utilisation and Storage Workshop, CCUS 2025* 2025, no. 1 (October 20, 2025): 1–4, https://doi.org/10.3997/2214-4609.2025644048/CITE/REFWORKS.

Consequently, the Indonesian Government has increasingly incorporated CCS into national energy transition and carbon reduction strategies. The enactment of Presidential Regulation No. 98 of 2021 concerning Carbon Economic Value (Nilai Ekonomi Karbon/NEK), Minister of Energy and Mineral Resources Regulation No. 2 of 2023 concerning CCS/CCUS implementation in upstream oil and gas activities, and Presidential Regulation No. 14 of 2024 concerning CCS and CCUS activities demonstrates Indonesia's growing regulatory commitment toward CCS governance. These instruments collectively establish the regulatory foundation for CCS development under Indonesia's broader carbon economic value framework.

Nevertheless, despite the emergence of these regulatory instruments, offshore CCS governance in Indonesia remains legally fragmented. Existing regulations governing offshore CCS are dispersed across environmental law, maritime law, energy law, climate governance regulations, and international marine environmental obligations. This condition creates what legal scholars describe as norm fragmentation, namely multiple overlapping legal norms that lack comprehensive harmonization and integration.[3] Fragmentation is evident not only horizontally across different regulatory sectors but also vertically between different levels of governmental authority. Recent reforms introduced through Law No. 6 of 2023 concerning Job Creation have centralized licensing procedures through nationally integrated licensing mechanisms, while Law No. 23 of 2014 on Regional Government continues to recognize provincial authority over marine areas extending up to twelve nautical miles from the coastline. This interaction potentially creates jurisdictional uncertainty regarding licensing authority, spatial planning approval, and regulatory supervision of offshore CCS projects operating within provincial marine zones.

In practice, fragmented norm may create uncertainty concerning offshore licensing procedures, marine spatial governance, environmental monitoring obligations, and long-term liability standards. For example, the centralization of licensing mechanisms under the Job Creation Law may overlap with provincial marine governance responsibilities established under Law No. 23 of 2014, creating uncertainty regarding the allocation of authority for offshore project approval, supervision, and marine spatial utilization. Similar fragmentation may also arise from the interaction between environmental protection requirements, CCS operational norms, and maritime governance obligations applicable to offshore carbon storage activities.

[3] Christian Kreuder-Sonnen and Michael Zürn, "After Fragmentation: Norm Collisions, Interface Conflicts, and Conflict Management," *Global Constitutionalism* 9, no. 2 (July 1, 2020): 241–67, https://doi.org/10.1017/S2045381719000315.

The issue of fragmentation within marine governance is not unique to offshore CCS. Previous studies on Indonesian maritime governance have identified similar problems relating to overlapping authority, fragmented norm, and weak coordination among sectoral institutions. For example, Achmad Sahri (2021) found that Indonesia's marine mammal governance framework suffers from functional overlap and unclear mandates among regulatory institutions.[4] Likewise, Rizal et al. demonstrate that blue carbon governance in Indonesia remains fragmented because environmental, fisheries, and maritime governance institutions often operate within separate legal frameworks without effective harmonization.[5] Similar to offshore CCS, marine mammal conservation and blue carbon management represent relatively new and evolving uses of the marine environment that must operate within pre-existing maritime, environmental, and sectoral governance frameworks. Consequently, regulatory fragmentation in these sectors reflects a broader systemic challenge associated with integrating emerging marine activities into established governance structures.

Recent academic discussions concerning offshore CCS governance have primarily focused on technological feasibility, carbon storage potential, and climate mitigation policy. Romal Ramadhan et al. (2024) analyze Indonesia's geological storage potential and policy readiness for CCS implementation.[6] Hyewon Jang (2014) and Lina Röschel and Barbara Neumann (2023) discuss governance gaps concerning ocean-based negative emission technologies and emphasize the need for integrated ocean governance frameworks.[7] [8] Meanwhile, Nikolaos Giannopoulos (2021) explains that offshore energy governance under international law frequently experiences regulatory fragmentation due to overlapping environmental and sectoral legal regimes.[9]

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[4] Achmad Sahri, "Put Them on the Map!: Optimising Cetacean Conservation Management in Indonesia through Governance Refinement and Habitat-Use-Based Spatial Planning Using Complementary Methods and Underused Data," April 6, 2021, https://doi.org/10.18174/541076.

[5] M. Zaid, Rikcy Ricky, and Rakotoarisoa M.H. Sedera, "Blue Carbon Regulations and Implementation in Several Countries: Lessons for Indonesia," *Journal of Law, Environmental and Justice* 3, no. 1 (May 6, 2025): 30–78, https://doi.org/10.62264/JLEJ.V3I1.117.

[6] Romal Ramadhan et al., "Carbon Capture, Utilization, and Storage in Indonesia: An Update on Storage Capacity, Current Status, Economic Viability, and Policy," *Energy Geoscience* 5, no. 4 (October 1, 2024): 100335, https://doi.org/10.1016/J.ENGEOS.2024.100335.

[7] Jang, "Regulation of the London Protocol and CCS Technology: A Legal Framework Analysis of Australia, Indonesia and RoK."

[8] Lina Röschel and Barbara Neumann, "Ocean-Based Negative Emissions Technologies: A Governance Framework Review," *Frontiers in Marine Science* 10 (2023), https://doi.org/10.3389/FMARS.2023.995130.

[9] Nikolaos Giannopoulos, "Regionalism and Marine Environmental Protection: The Case of Offshore Energy Production," *SSRN Electronic Journal*, November 15, 2021, https://doi.org/10.2139/SSRN.3770726.

However, despite these developments, studies specifically examining norm fragmentation within Indonesia's offshore CCS regulatory framework remain limited. Existing literature predominantly discusses CCS from technological, environmental, or energy transition perspectives rather than doctrinal legal analysis concerning fragmented offshore CCS norms. Furthermore, few studies comprehensively analyze how Indonesian offshore CCS norms interact with international marine environmental obligations under UNCLOS 1982 and the London Protocol framework, including the implications of the 2019 Resolution on Provisional Application for cross-border carbon dioxide transport and regional carbon storage cooperation. This article therefore fills an important research gap by examining offshore CCS governance in Indonesia through the perspective of norm fragmentation and legal harmonization.

Based on the foregoing discussion, this article raises two principal research questions. First, how is offshore CCS regulated within Indonesia's existing legal framework? Second, how does norm fragmentation manifest within Indonesia's offshore CCS regulatory framework from national and international maritime law perspectives, including the interaction between centralized licensing arrangements, provincial marine authority, and international obligations governing transboundary carbon dioxide transport and subseabed storage? Accordingly, this study aims to analyze the existing legal framework governing offshore CCS in Indonesia and identify forms of norm fragmentation affecting offshore CCS governance and marine environmental protection. Through normative legal analysis, this article further seeks to contribute to the development of harmonized offshore CCS norm supporting sustainable maritime climate governance in Indonesia.

Research Method

This study employs normative legal research (doctrinal legal research) to examine the legal norms governing offshore Carbon Capture and Storage (CCS) activities in Indonesia. This method analyzes legal principles, statutory regulations, legal doctrines, and international legal instruments to assess the coherence and effectiveness of the regulatory framework. It is appropriate because the research addresses norm fragmentation, namely the dispersion of legal norms across multiple regulatory regimes that may create inconsistencies, overlaps, gaps, and legal uncertainty.

The research applies both a statute approach and a conceptual approach. The statute approach examines relevant national and international legal instruments, including the 1945 Constitution, Law No. 32 of 2009 on Environmental Protection and Management, Law No. 32 of 2014 on Maritime Affairs, Law No. 6 of 2023 concerning Job Creation, Presidential Regulations No. 98 of 2021 and No. 14 of 2024, Minister of Energy and Mineral Resources

Regulation No. 2 of 2023, UNCLOS 1982, and the London Protocol governing transboundary carbon dioxide transport and subseabed storage. The analysis also considers the hierarchy of laws under Law No. 12 of 2011, as amended by Law No. 13 of 2022.

The conceptual approach examines legal doctrines on offshore CCS governance, marine environmental protection, regulatory fragmentation, legal harmonization, and sustainable maritime governance. The study adopts Regulatory Fragmentation Theory, focusing on norm fragmentation through four indicators: (1) overlap of regulatory authority; (2) inconsistency between legal norms across hierarchical levels; (3) fragmentation of licensing, monitoring, liability, and marine spatial governance; and (4) disharmony between domestic law and international obligations.

The analysis is supported by institutional mapping and a comparative regulatory matrix. Institutional mapping identifies the distribution of authority among environmental, maritime, energy, and climate institutions, while the comparative matrix evaluates Indonesian offshore CCS regulations against international standards, including Measurement, Monitoring and Verification (MMV), ISO 27914 monitoring principles, long-term liability, and cross-border carbon transport. Primary and secondary legal materials are collected through library research and document analysis and analyzed qualitatively to assess legal coherence, governance effectiveness, and alignment with evolving international CCS standards.

Discussion

Concept and Development of Offshore CCS

Carbon Capture and Storage (CCS) has emerged as one of the most important technological instruments for mitigating climate change and achieving net-zero emission targets.[10] The Intergovernmental Panel on Climate Change (IPCC) identifies CCS as a key mitigation technology capable of supporting deep decarbonization, particularly in hard-to-abate sectors such as cement, steel, petrochemicals, and natural gas processing, where direct emission reductions remain difficult to achieve (IPCC, *Climate Change 2022: Mitigation of Climate Change, Working Group III Contribution to the Sixth Assessment Report*, 2022). As many industrial activities continue to rely on fossil fuels, CCS

[10] Benjamin K. Sovacool et al., "Reconfiguring European Industry for Net-Zero: A Qualitative Review of Hydrogen and Carbon Capture Utilization and Storage Benefits and Implementation Challenges," *Energy and Environmental Science* 17, no. 10 (April 29, 2024): 3523–69, https://doi.org/10.1039/D3EE03270A.

complements renewable energy by reducing emissions while supporting economic development and energy security.[11]

According to the International Energy Agency (IEA), CCS consists of three integrated stages: carbon capture, transportation, and geological storage (International Energy Agency (IEA), *CCUS in Clean Energy Transitions*, 2020). Carbon capture separates CO_2 from industrial emissions through technologies such as post-combustion, pre-combustion, and oxy-fuel combustion. The captured CO_2 is then transported by pipelines, ships, or other infrastructure to suitable storage sites before being injected into deep geological formations for permanent storage. This integrated process prevents CO_2 emissions from entering the atmosphere while enabling continued industrial operations during the energy transition.

Among available storage options, offshore geological storage has gained increasing attention because of its large storage capacity and limited land-use conflicts. Offshore CCS refers to the injection and permanent storage of carbon dioxide beneath subseabed geological formations, including depleted oil and gas reservoirs and deep saline aquifers Obobi Ume Onwuka & Akinsola Adu, 2024). These formations are particularly attractive because many have been extensively explored through offshore petroleum activities, reducing geological uncertainty and enabling the reuse of existing infrastructure.

Compared with onshore CCS, offshore projects involve additional technical and regulatory challenges. They require continuous monitoring of subseabed storage integrity, assessment of impacts on marine ecosystems, management of offshore infrastructure, and verification of long-term storage security under varying hydrostatic pressure conditions. Offshore CCS must also address risks of carbon leakage, well integrity failure, and long-term environmental stewardship. Consequently, offshore CCS intersects environmental protection, maritime governance, offshore energy regulation, marine spatial planning, and international law, requiring an integrated governance framework capable of ensuring environmental safety and regulatory certainty.

Commercial offshore CCS was pioneered in the North Sea. Norway's Sleipner Project, initiated in 1996, is widely recognized as the world's first commercial offshore CCS project, storing approximately one million tonnes of CO_2 annually within a saline aquifer beneath the North Sea and demonstrating the long-term feasibility of subseabed carbon storage.[12]

[11] Sergey Paltsev et al., "Hard-to-Abate Sectors: The Role of Industrial Carbon Capture and Storage (CCS) in Emission Mitigation," *Applied Energy* 300 (October 15, 2021), https://doi.org/10.1016/J.APENERGY.2021.117322.

[12] Temitope Ajayi, Jorge Salgado Gomes, and Achinta Bera, "A Review of CO2 Storage in Geological Formations Emphasizing Modeling, Monitoring and Capacity Estimation

Subsequent developments, including Norway's Northern Lights Project, Australia's Gorgon CCS Project, and several United Kingdom CCS initiatives, have further established offshore CCS as an important component of national climate mitigation strategies (International Energy Agency (IEA), *CCUS in Clean Energy Transitions*, 2020).

The expansion of offshore CCS is closely linked to international commitments under the Paris Agreement and national net-zero emission targets.[13] Martin-Roberts et al. argue that achieving global climate objectives will be difficult without significant CCS deployment because industrial emissions cannot be fully eliminated through renewable energy transition alone.[14] Consequently, many countries have incorporated offshore CCS into long-term decarbonization strategies.

Indonesia possesses considerable potential for offshore CCS development. As one of Southeast Asia's largest oil and gas producers, Indonesia has numerous depleted offshore hydrocarbon reservoirs and sedimentary basins suitable for geological carbon storage. Romal Ramadhan et al., *Carbon Capture, Utilization, and Storage in Indonesia: An Update on Storage Capacity, Current Status, Economic Viability, and Policy* (2024), estimate that Indonesia has substantial storage capacity capable of supporting domestic and regional carbon sequestration. Existing projects, including Tangguh CCUS and several offshore feasibility studies, demonstrate increasing governmental and industrial interest in CCS deployment.

Indonesia's strategic location and offshore geological resources also create opportunities for regional CCS cooperation within the Asia-Pacific.[15] Such cooperation is closely connected with developments under the London Protocol framework, particularly the 2019 Resolution on Provisional Application, which provides an interim legal mechanism permitting transboundary transport of carbon dioxide streams for subseabed storage before the 2009 amendment to Article 6 formally enters into force. This mechanism supports the development of regional carbon storage hubs and aligns with Indonesia's ambition to become a regional carbon storage destination.

Approaches," *Petroleum Science 2019 16:5* 16, no. 5 (July 8, 2019): 1028–63, https://doi.org/10.1007/S12182-019-0340-8.

[13] Yongliang Yan et al., "Harnessing the Power of Machine Learning for Carbon Capture, Utilisation, and Storage (CCUS)-a State-of-the-Art Review," *Energy and Environmental Science* 14, no. 12 (December 1, 2021): 6122–57, https://doi.org/10.1039/D1EE02395K.

[14] Emma Martin-Roberts et al., "Carbon Capture and Storage at the End of a Lost Decade," *One Earth* 4, no. 11 (November 19, 2021): 1569–84, https://doi.org/10.1016/J.ONEEAR.2021.10.002.

[15] Nuki Agya Utama and Beni Suryadi, "8th ASEAN Energy Outlook (AEO8), 2024," 2024.

The growing interest in offshore CCS also supports Indonesia's commitment to achieving net-zero emissions by 2060 or sooner. Accordingly, CCS has become an important element of the national energy transition strategy, particularly for sectors where complete decarbonization remains technologically and economically difficult.[16] Despite its strategic importance, however, offshore CCS is not governed by a single comprehensive statute. Instead, the applicable legal framework is dispersed across environmental, maritime, energy, climate, and international legal regimes. This fragmented regulatory structure constitutes the principal basis for the norm fragmentation examined in this article. The following sections therefore analyze how these legal regimes interact and whether they provide a coherent framework for offshore CCS development, marine environmental protection, and long-term carbon storage governance in Indonesia.

Legal Framework Governing Offshore CCS in Indonesia

The regulation of offshore Carbon Capture and Storage (CCS) in Indonesia is not contained within a single comprehensive statute. Instead, offshore CCS is governed through a combination of environmental, maritime, energy, climate, and international legal frameworks.

From an environmental law perspective, the principal legal basis is Law No. 32 of 2009 concerning Environmental Protection and Management**.** The law establishes obligations relating to environmental protection, pollution prevention, Environmental Impact Assessment (AMDAL), environmental permits, and sustainable development principles, all of which are relevant because offshore CCS may affect marine ecosystems and therefore requires environmental assessment, risk management, and long-term monitoring. The law also introduces the Strategic Environmental Assessment (Kajian Lingkungan Hidup Strategis—KLHS) to integrate environmental considerations into spatial planning and development policies. Its relevance is particularly significant for offshore CCS because storage projects may overlap with marine spatial planning, fisheries, conservation areas, and other maritime uses. However, Presidential Regulation No. 14 of 2024 does not expressly require a CCS-specific KLHS, creating uncertainty regarding the integration of strategic environmental considerations into offshore carbon storage planning. This illustrates fragmentation between general environmental governance and sector-specific CCS regulation.

Maritime governance is primarily regulated through Law No. 32 of 2014 concerning Maritime Affairs, which establishes State responsibilities for marine resource management, marine environmental protection, maritime

[16] Röschel and Neumann, "Ocean-Based Negative Emissions Technologies: A Governance Framework Review."

spatial planning, and sustainable marine utilization.[17] Offshore CCS inevitably falls within this framework because storage sites occupy marine spaces subject to competing environmental and economic interests. However, governance of marine areas is also influenced by Law No. 23 of 2014 concerning Regional Government, which allocates certain marine management functions to provincial governments within marine areas extending up to twelve nautical miles from the coastline. At the same time, Law No. 6 of 2023 concerning Job Creation centralizes licensing through nationally integrated mechanisms.

The energy sector provides another important legal foundation because offshore CCS is closely linked to upstream oil and gas activities, particularly through the use of depleted hydrocarbon reservoirs as storage sites. Minister of Energy and Mineral Resources Regulation No. 2 of 2023 specifically regulates CCS and CCUS implementation in upstream oil and gas operations by establishing requirements for permits, monitoring, verification, reporting, and operational standards.[18] Although this regulation provides operational guidance, it remains sector-specific and therefore must operate alongside environmental, maritime, and climate regulations governing the same offshore activities.

Indonesia further strengthened its regulatory framework through Presidential Regulation No. 14 of 2024 concerning Carbon Capture and Storage and Carbon Capture Utilization and Storage Activities, which extends CCS governance beyond upstream petroleum operations. The regulation introduces mechanisms for carbon storage services and cross-border carbon storage, positioning Indonesia among the first Asian countries to establish a legal framework accommodating imported carbon dioxide for geological storage.[19] [20] Nevertheless, implementation of cross-border storage cannot be separated from the London Protocol framework. In particular, the 2019 Resolution on Provisional Application provides an interim legal mechanism permitting transboundary transport of carbon dioxide streams for subseabed

[17] Ade Maman Suherman et al., "Indonesian Ocean Policy: Paradigm Shift in Strengthening Ocean Governance∗," *Journal of East Asia and International Law* 13, no. 2 (September 1, 2020): 359–78, https://doi.org/10.14330/JEAIL.2020.13.2.06.

[18] Raphael Mayaka et al., "Implementation of Carbon Capture and Storage in Order to Achieve Net Zero Emissions in Indonesia," *Unnes Law Journal* 10, no. 1 (September 30, 2025): 533–56, https://doi.org/10.15294/ULJ.V10I1.4526.

[19] Hening Cipta Putih W Prayudi et al., "Legal Status and Cross-Border Transport in Carbon Capture and Storage (CCS): An International and Indonesian Law Perspective," *Law Development Journal* 7, no. 3 (September 25, 2025): 340, https://doi.org/10.30659/LDJ.7.3.340-354.

[20] Didik Sasono Setyadi, Benedictus Renny See, and Ario Bimo Utomo, "National And Public Interest Perspective on the Governance and Regulation of Carbon Capture and Storage Implementation in Indonesia," *Action Research Literate* 8, no. 8 (August 29, 2024): 2358–64, https://doi.org/10.46799/ARL.V8I8.504.

storage before the formal entry into force of the 2009 amendment to Article 6.

Offshore CCS is also integrated into Indonesia's climate governance through Presidential Regulation No. 98 of 2021 concerning Carbon Economic Value (Nilai Ekonomi Karbon)**,** which recognizes CCS as one of the instruments supporting greenhouse gas mitigation within the national climate policy framework.[21] Accordingly, offshore CCS should be understood not only as an energy-sector activity but also as an essential component of Indonesia's broader carbon reduction strategy.

At the international level, offshore CCS governance is framed by the United Nations Convention on the Law of the Sea (UNCLOS) 1982**.** Although UNCLOS does not specifically regulate CCS, several provisions directly apply. Article 192 obliges States to protect and preserve the marine environment, Article 194 requires measures to prevent, reduce, and control marine pollution, and Article 206 requires environmental impact assessments where planned activities may cause significant marine environmental harm. Collectively, these provisions establish the international legal context for offshore CCS and reinforce the need to balance climate mitigation with marine environmental protection.

Overall, Indonesia's offshore CCS governance consists of multiple legal regimes operating simultaneously across environmental, maritime, energy, climate, and international law. While these regulations collectively provide an initial legal foundation for offshore CCS development, they also reveal both horizontal and vertical norm fragmentation. Horizontal fragmentation results from the dispersion of relevant legal norms across different regulatory sectors, whereas vertical fragmentation arises from the interaction between centralized licensing, provincial maritime authority, and international legal obligations governing offshore carbon storage. These forms of fragmentation raise fundamental issues of regulatory coherence, institutional coordination, and legal certainty that constitute the central focus of this study.

Norm Fragmentation in Offshore CCS Regulation in Indonesia

The development of offshore Carbon Capture and Storage (CCS) regulation in Indonesia demonstrates a significant shift in national climate and energy governance. Through Presidential Regulation No. 14 of 2024 and Minister of Energy and Mineral Resources Regulation No. 2 of 2023, Indonesia has established an initial legal foundation for offshore CCS

[21] Posma Sariguna, Johnson Kennedy, and Anastasia Zefanya, "KAJIAN NORMATIF TERHADAP INVESTASI PERDAGANGAN KARBON DI INDONESIA DALAM REGULASI PENYELENGGARAAN NILAI EKONOMI KARBON (NEK)," *Fundamental Management Journal* 9, no. 2p (October 31, 2024): 1–12, https://doi.org/10.33541/FJM.V9I2P.6311.

deployment. However, despite this regulatory progress, the legal framework governing offshore CCS remains dispersed across multiple regulatory sectors, including environmental law, maritime law, energy law, and climate governance. This condition reflects what Biermann et al. define as fragmentation, namely the existence of multiple governance arrangements addressing a common policy issue without sufficient coordination or integration.[22]

In the context of offshore CCS, norm fragmentation does not necessarily imply the absence of regulation. Rather, it refers to the existence of fragmented legal provisions that may generate inconsistency, overlap, and uncertainty regarding rights, obligations, and regulatory responsibilities. Such fragmentation may occur horizontally across environmental, maritime, energy, and climate governance regimes, as well as vertically between different levels of governmental authority. The following sections examine the principal forms of norm fragmentation affecting offshore CCS governance in Indonesia.

1. Environmental Governance Norm Fragmentation in Offshore CCS Regulation

One of the most significant forms of norm fragmentation in Indonesia's offshore Carbon Capture and Storage (CCS) governance concerns environmental regulation. Offshore CCS inherently involves environmental risks because captured carbon dioxide is transported and permanently stored beneath subseabed geological formations. Accordingly, environmental protection constitutes a core component of offshore CCS governance and requires regulatory mechanisms capable of ensuring ecosystem protection, pollution prevention, and long-term storage integrity.

Indonesia's principal environmental framework is Law No. 32 of 2009 concerning Environmental Protection and Management, which establishes the principles of environmental sustainability, precaution, pollution prevention, and environmental responsibility. Article 22 requires business activities with significant environmental impacts to undergo an Environmental Impact Assessment (AMDAL). The Law also introduces the Strategic Environmental Assessment (Kajian Lingkungan Hidup Strategis—KLHS) as a planning instrument designed to integrate environmental considerations into development policies, programs, and spatial planning. Consequently, offshore CCS projects should ideally be subject not only to project-level environmental assessment through AMDAL but also to broader strategic planning where

[22] Frank Biermann et al., "The Fragmentation of Global Governance Architectures: A Framework for Analysis," *Global Environmental Politics* 9, no. 4 (November 1, 2009): 14–40, https://doi.org/10.1162/GLEP.2009.9.4.14.

carbon storage intersects with marine spatial planning, fisheries, conservation areas, and coastal resource management.

However, Presidential Regulation No. 14 of 2024 does not explicitly incorporate KLHS into the planning or designation of offshore CCS areas. This omission is significant because KLHS functions as an instrument for harmonizing environmental objectives with spatial planning and sectoral development policies. As a result, environmental assessment remains concentrated at the project level through AMDAL, while broader issues such as cumulative environmental impacts, ecosystem compatibility, and long-term integration with marine spatial planning remain insufficiently regulated. This gap illustrates environmental norm fragmentation between Indonesia's general environmental governance framework and CCS-specific regulation.

Environmental fragmentation is further reflected in the distribution of relevant norms across environmental, energy, and CCS-specific legal instruments. Although **Presidential Regulation No. 14 of 2024** establishes monitoring, measurement, reporting, and verification (MRV) obligations throughout the CCS lifecycle, Indonesia has not yet adopted comprehensive technical environmental standards specifically governing offshore geological carbon storage. Existing legislation does not clearly regulate acceptable carbon leakage thresholds, site-specific environmental performance indicators, or detailed criteria for subseabed storage integrity. Consequently, while monitoring obligations exist, uncertainty remains regarding the technical benchmarks used to assess environmental compliance and long-term storage performance. [23] [24]

Similar fragmentation appears in the regulation of marine environmental protection. Offshore CCS involves injecting carbon dioxide beneath the seabed, creating potential risks of carbon leakage, groundwater migration, and impacts on marine ecosystems. Although Indonesian environmental legislation establishes general obligations to prevent pollution, it does not prescribe specific environmental thresholds, ecological indicators, or monitoring standards applicable to offshore carbon storage projects.[25] The absence of such technical standards reduces regulatory certainty concerning environmental risk assessment and long-term stewardship.

Environmental fragmentation is also reinforced by Indonesia's institutional and jurisdictional arrangements. Law No. 6 of 2023 concerning Job Creation centralizes licensing through nationally integrated mechanisms

[23] Wan Mohd Shaharizuan Mat Latif et al., "A Review of Global Carbon Capture and Storage (CCS) and Carbon Capture, Utilization, and Storage (CCUS)," *E3S Web of Conferences* 516 (April 15, 2024): 01009, https://doi.org/10.1051/E3SCONF/202451601009.

[24] Jang, "Regulation of the London Protocol and CCS Technology: A Legal Framework Analysis of Australia, Indonesia and RoK."

[25] Jang.

and the Online Single Submission (OSS) system, whereas Law No. 23 of 2014 concerning Regional Government continues to allocate provincial authority over marine areas extending up to twelve nautical miles from the coastline. For offshore CCS projects located within coastal and nearshore waters, environmental planning, marine spatial governance, and licensing responsibilities may therefore involve different levels of government. The interaction between centralized licensing and decentralized marine governance creates a form of vertical fragmentation, generating uncertainty regarding regulatory authority, institutional coordination, and environmental oversight.

Environmental fragmentation is equally evident in the relationship between domestic regulation and international legal obligations. While Indonesian environmental law emphasizes pollution prevention and environmental assessment, the United Nations Convention on the Law of the Sea (UNCLOS) 1982 establishes broader obligations concerning the protection and preservation of the marine environment. Offshore CCS governance is also increasingly influenced by the London Protocol**,** particularly the 2009 amendment concerning transboundary transport of carbon dioxide streams for subseabed storage. More importantly, the 2019 Resolution on Provisional Application enables participating States to undertake transboundary carbon dioxide transport before the amendment formally enters into force. This mechanism is especially relevant to Indonesia because Presidential Regulation No. 14 of 2024 permits the storage of foreign carbon dioxide within Indonesian geological formations, supporting Indonesia's ambition to become a regional CCS hub.

Despite this legal foundation, uncertainty remains regarding the compatibility of Indonesia's domestic framework with evolving international rules governing transboundary CO_2 transport and marine environmental protection. Indonesia's future participation in the provisional application mechanism remains legally uncertain These overlapping regulatory layers demonstrate that environmental fragmentation in Indonesia's offshore CCS governance is both **horizontal**, across different regulatory sectors, and **vertical**, across multiple levels of governmental authority. [26] [27]

2. Maritime and Spatial Governance Norm Fragmentation in Offshore CCS Regulation

A second form of norm fragmentation emerges from the interaction between offshore CCS norm and Indonesia’s maritime governance

[26] Prayudi et al., “Legal Status and Cross-Border Transport in Carbon Capture and Storage (CCS): An International and Indonesian Law Perspective.”

[27] Jang, “Regulation of the London Protocol and CCS Technology: A Legal Framework Analysis of Australia, Indonesia and RoK.”

framework. Offshore CCS activities occur beneath marine areas and therefore intersect with maritime jurisdiction, marine spatial planning, coastal resource management, and marine environmental governance systems. Because offshore carbon storage requires the allocation and long-term management of marine space, its regulation cannot be separated from Indonesia's broader maritime governance regime.

Indonesia's maritime governance framework is primarily regulated through Law No. 32 of 2014 concerning Maritime Affairs, which establishes State authority over maritime resources and emphasizes sustainable marine environmental management.[28] The law provides the general foundation for marine resource utilization, marine environmental protection, and maritime spatial governance. However, offshore CCS activities are not yet explicitly incorporated into existing marine spatial planning and marine zoning frameworks, creating uncertainty regarding how offshore storage sites should be designated, managed, and integrated with other marine uses.

Marine spatial planning plays a crucial role in balancing competing uses of marine areas, including fisheries, shipping, offshore energy production, marine conservation, tourism, and coastal development. Because offshore CCS infrastructure occupies subseabed geological formations and may require supporting offshore facilities, carbon storage projects inevitably interact with existing marine spatial uses. Nevertheless, Indonesia's marine zoning regulations currently provide limited guidance concerning the designation and management of offshore CCS storage sites.[29]

Norm fragmentation therefore arises because offshore CCS is primarily regulated through energy-sector regulations, whereas marine spatial planning remains governed through separate maritime and environmental regulatory frameworks. The absence of integrated legal provisions linking carbon storage activities with marine zoning systems creates uncertainty regarding site allocation, environmental compatibility assessments, and conflict resolution mechanisms among competing marine uses.

Another dimension of fragmentation concerns maritime jurisdiction and governmental authority. Offshore CCS projects may be located within different maritime zones, including territorial seas, exclusive economic zones (EEZs), and continental shelf areas. Each maritime zone is governed by distinct legal principles under both national law and UNCLOS 1982. International Energy Agency (IEA), *CCUS in Clean Energy Transitions* (International Energy Agency, 2020). Although UNCLOS recognizes coastal

[28] Suherman et al., "Indonesian Ocean Policy: Paradigm Shift in Strengthening Ocean Governance∗."

[29] Romal Ramadhan et al., "Carbon Capture, Utilization, and Storage in Indonesia: An Update on Storage Capacity, Current Status, Economic Viability, and Policy," *Energy Geoscience* 5, no. 4 (October 1, 2024): 100335, https://doi.org/10.1016/J.ENGEOS.2024.100335.

State rights over continental shelf resources and marine environmental protection, Indonesian regulations do not comprehensively clarify how offshore CCS governance should operate across different maritime jurisdictions.[30]

This jurisdictional complexity is further intensified by the interaction between Law No. 6 of 2023 concerning Job Creation and Law No. 23 of 2014 concerning Regional Government. On the one hand, the Job Creation Law has strengthened the centralization of licensing and investment approval mechanisms through the Online Single Submission (OSS) system. On the other hand, Law No. 23 of 2014 continues to recognize provincial authority over marine areas extending up to twelve nautical miles from the coastline. For offshore CCS projects located within coastal and nearshore waters, this creates a form of vertical fragmentation because licensing authority is increasingly centralized while marine spatial governance and resource management responsibilities remain partially decentralized. Consequently, questions may arise concerning which level of government should exercise primary authority over site allocation, environmental supervision, and long-term monitoring obligations. Recent studies on Indonesian maritime governance similarly identify this centralization–decentralization dynamic as a continuing source of jurisdictional friction in coastal resource management.[31]

The absence of clear integration between maritime law, marine spatial planning regulations, environmental planning instruments such as KLHS, and CCS-specific rules demonstrates that Indonesia's offshore CCS framework remains normatively fragmented. While individual regulatory regimes address particular aspects of offshore activities, they do not yet constitute a coherent and integrated legal system governing offshore carbon storage.

3. Licensing and Institutional Authority Norm Fragmentation in Offshore CCS Regulation

Norm fragmentation is also evident within licensing systems and institutional governance arrangements. Offshore CCS norm involves multiple regulatory authorities operating under different legal mandates and sectoral frameworks. As a result, project implementation depends not only on compliance with CCS-specific regulations but also on the ability to navigate a complex network of environmental, maritime, energy, and regional governance requirements.

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[30] Romal Ramadhan et al., "Carbon Capture, Utilization, and Storage in Indonesia: An Update on Storage Capacity, Current Status, Economic Viability, and Policy," *Energy Geoscience* 5, no. 4 (October 1, 2024), https://doi.org/10.1016/J.ENGEOS.2024.100335.

[31] Aif Wahyu Mulya, Arba Arba, and Aris Munandar, "Enforcement of Laws for Utilisation of Natural Resources in the Coastal Areas of Bima Bay, Indonesia," *Path of Science* 10, no. 5 (May 31, 2024): 2001–10, https://doi.org/10.22178/POS.104-1.

At present, CCS governance is primarily coordinated through the Ministry of Energy and Mineral Resources (MEMR), particularly following the enactment of Ministerial Regulation No. 2 of 2023 and Presidential Regulation No. 14 of 2024. These regulations establish operational requirements relating to CCS project approval, monitoring, and implementation.[32] However, offshore CCS projects simultaneously trigger regulatory requirements administered by environmental, maritime, and regional governance authorities.

For example, environmental permits and AMDAL procedures involve environmental regulatory institutions, while marine spatial planning approvals require alignment with marine zoning frameworks and maritime governance authorities. Offshore infrastructure development may additionally intersect with fisheries management regimes, shipping and navigation safety requirements, coastal resource governance mechanisms, and marine conservation policies. Consequently, offshore CCS projects are subject to multiple licensing requirements administered under different legal regimes.

This situation creates what may be described as sectoral licensing fragmentation. Rather than operating under a unified regulatory mechanism, offshore CCS projects must navigate multiple administrative processes governed by separate legal frameworks. A practical example may arise where a proposed offshore CCS storage site has been approved from an energy-sector perspective but overlaps with existing marine spatial allocations for fisheries activities or marine conservation zones. In such circumstances, project proponents may satisfy CCS licensing requirements while simultaneously facing restrictions arising from maritime zoning regulations or fisheries management policies. The coexistence of these overlapping regulatory requirements illustrates how fragmentation may generate uncertainty concerning site approval, regulatory compliance, and conflict-resolution mechanisms.

Institutional fragmentation also arises because existing norms do not clearly establish a comprehensive lead authority responsible for integrating environmental, maritime, and CCS governance functions. While MEMR plays a central role in CCS norm, offshore carbon storage activities involve legal interests extending beyond the energy sector. Marine environmental protection, spatial planning, fisheries management, coastal governance, and ecosystem conservation remain subject to the authority of different governmental institutions.

As Biermann et al. note, fragmented governance often emerges when multiple regulatory institutions operate within overlapping policy domains

[32] Mayaka et al., "Implementation of Carbon Capture and Storage in Order to Achieve Net Zero Emissions in Indonesia."

without effective coordination mechanisms.[33] The Indonesian offshore CCS framework reflects this challenge because different institutions continue to exercise authority based on sector-specific mandates rather than through an integrated offshore CCS governance model.

Consequently, the current legal framework demonstrates that offshore CCS norm in Indonesia is characterized by substantial norm fragmentation across environmental, maritime, spatial planning, licensing, and institutional dimensions. Fragmentation occurs not only horizontally among environmental, maritime, and energy regulatory regimes but also vertically between centralized licensing arrangements and decentralized maritime governance structures. While recent regulatory developments have established an important foundation for CCS deployment, further legal harmonization remains necessary to ensure regulatory coherence, legal certainty, and effective governance of offshore carbon storage activities.

4. Liability Transfer and Long-Term Monitoring Norm Fragmentation in Offshore CCS Regulation

Another significant manifestation of norm fragmentation within Indonesia's offshore Carbon Capture and Storage (CCS) regulatory framework concerns long-term liability transfer and monitoring obligations. Offshore CCS projects involve storing carbon dioxide beneath subseabed geological formations for periods extending decades or even centuries. Because environmental risks may persist long after injection operations cease, post-closure monitoring, liability allocation, carbon leakage, and long-term stewardship are central issues in CCS governance. Presidential Regulation No. 14 of 2024 concerning CCS and CCUS Activities introduces provisions governing monitoring obligations and the transfer of responsibility following the post-injection phase.[34] Nevertheless, fragmentation remains because the relationship between CCS-specific liability rules and broader environmental liability regimes, as well as the adequacy of long-term stewardship mechanisms, remains insufficiently integrated. Comparative studies similarly emphasize that clear post-closure governance is essential for maintaining the long-term integrity of offshore CCS projects.[35]

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[33] Frank Biermann et al., "Governance Fragmentation," *Architectures of Earth System Governance: Institutional Complexity and Structural Transformation*, January 1, 2020, 158–80, https://doi.org/10.1017/9781108784641.008.

[34] Kenji Kimura et al., "Investment Opportunities in Low-Carbon and Cutting-Edge Technology Deployment in Asia," 2024, https://econpapers.repec.org/RePEc:era:eriabk:2024-rpr-37.

[35] Constantinos Yiallourides and Tina Soliman-Hunter, "Maritime Boundaries in the Energy Transition: Carbon Dioxide (CO2) Storage across Maritime Jurisdictions," *Journal of Energy and Natural Resources Law* 43, no. 1 (2025): 1–28, https://doi.org/10.1080/02646811.2024.2312769.

A key issue concerns responsibility after site closure. Indonesian environmental law generally requires business actors to prevent environmental damage and restore affected environments. Offshore CCS, however, presents unique challenges because carbon migration, well integrity failure, or geological leakage may occur decades after injection has ended. To address this, Presidential Regulation No. 14 of 2024 establishes a ten-year post-completion monitoring period followed by the possibility of transferring responsibility to the Government once post-injection obligations have been fulfilled.[36] From a fragmentation perspective, however, questions remain regarding whether a fixed monitoring period is sufficient to manage the long-term risks associated with geological carbon storage, particularly when compared with international approaches that increasingly apply performance-based rather than time-based liability transfer.[37]

Comparative experience demonstrates the importance of performance-based stewardship. In Australia and several European jurisdictions, liability transfer depends not merely on the passage of time but on evidence demonstrating the long-term stability of the storage complex. Operators must prove that injected carbon dioxide remains securely contained, leakage risks are negligible, and monitoring data confirms storage integrity before responsibility may be transferred to the State. These approaches rely on Measurement, Monitoring, and Verification (MMV**)** systems supported by internationally recognized standards, including ISO 27914, using indicators such as reservoir pressure stabilization, plume migration, well integrity, leakage risk assessment, and environmental baseline comparison. Offshore monitoring also increasingly employs technologies such as Distributed Acoustic Sensing (DAS), Vertical Seismic Profiling (VSP), time-lapse seismic surveys, and seabed environmental observation systems to verify storage integrity.[38]

By comparison, Indonesia's framework remains predominantly time-based. Although Presidential Regulation No. 14 of 2024 establishes post-completion monitoring and liability transfer mechanisms, it does not explicitly

[36] Kimura et al., "Investment Opportunities in Low-Carbon and Cutting-Edge Technology Deployment in Asia."

[37] Lukas Schuett, "Permanence and Liability: Legal Considerations on the Integration of Carbon Dioxide Removal into the EU Emissions Trading System," *Transnational Environmental Law* 13, no. 1 (March 12, 2024): 87–110, https://doi.org/10.1017/S2047102524000013.

[38] Temitope Ajayi, Jorge Salgado Gomes, and Achinta Bera, "A Review of CO2 Storage in Geological Formations Emphasizing Modeling, Monitoring and Capacity Estimation Approaches," *Petroleum Science 2019 16:5* 16, no. 5 (July 8, 2019): 1028–63, https://doi.org/10.1007/S12182-019-0340-8.

adopt performance-based criteria or integrate them with broader environmental stewardship obligations.[39]

Norm fragmentation is equally apparent in carbon leakage monitoring. Effective CCS governance depends on continuous monitoring throughout the storage lifecycle. Although Presidential Regulation No. 14 of 2024 establishes monitoring, measurement, reporting, and verification (MRV) obligations, it does not comprehensively incorporate internationally recognized benchmarks such as ISO 27914 or detailed MMV performance criteria. Consequently, uncertainty remains regarding monitoring methodologies, acceptable performance thresholds, and the technical basis for evaluating long-term storage integrity.

These issues are particularly important in offshore environments, where monitoring simultaneously involves marine ecosystems, subseabed geological formations, offshore infrastructure, and multiple governance institutions. Potential carbon leakage may affect marine biodiversity, fisheries, and coastal ecosystems, yet monitoring responsibilities remain dispersed across environmental, maritime, and energy-sector authorities. The absence of an integrated monitoring framework linking CCS operational monitoring with broader marine environmental monitoring contributes to overlapping institutional responsibilities and regulatory uncertainty.[40]

Institutional fragmentation is reinforced by Indonesia's governance structure. Law No. 6 of 2023 concerning Job Creation centralizes licensing through nationally integrated mechanisms, while Law No. 23 of 2014 concerning Regional Government continues to allocate provincial authority over marine areas extending up to twelve nautical miles from the coastline. This creates vertical fragmentation, particularly for offshore CCS projects located in coastal waters, where licensing, marine spatial planning, environmental supervision, and coastal management involve different governmental levels.

Fragmentation also extends to financial responsibility. International CCS practice generally requires operators to provide financial guarantees, trust funds, or other assurance mechanisms capable of supporting long-term monitoring and remediation.[41] Indonesian norms have not yet

[39] Matthew Holding, "Regulation of the Australian Carbon Capture and Storage Industry," *The APPEA Journal* 63, no. 2 (May 11, 2023): S395–98, https://doi.org/10.1071/AJ22137.

[40] Prayudi et al., "Legal Status and Cross-Border Transport in Carbon Capture and Storage (CCS): An International and Indonesian Law Perspective."

[41] Romario de Carvalho Nunes and Hirdan Katarina de Medeiros Costa, "An Overview of International Practices for Authorization and Monitoring CO2 Storage Facilities," *International Journal of Advanced Engineering Research and Science* 7, no. 6 (2020): 133–42, https://doi.org/10.22161/IJAERS.76.16.

comprehensively developed such mechanisms, creating further uncertainty regarding the sustainability of post-closure environmental oversight.[42]

Accordingly, although Indonesia has established liability transfer and long-term monitoring provisions for offshore CCS, the framework remains fragmented regarding responsibility allocation, stewardship mechanisms, technical monitoring standards, institutional coordination, and financial assurance.[43] The principal challenge therefore lies not in the absence of regulation but in ensuring that these mechanisms are adequately integrated and capable of addressing the long-term environmental and governance risks associated with offshore geological carbon storage.

5. Fragmentation between Domestic Offshore CCS Norms and International Marine Environmental Obligations

Beyond domestic regulatory fragmentation, Indonesia's offshore Carbon Capture and Storage (CCS) governance also raises important questions concerning its relationship with international maritime law, particularly the United Nations Convention on the Law of the Sea (UNCLOS) 1982**.** Because offshore CCS involves the injection and long-term storage of carbon dioxide beneath the seabed, it inevitably intersects with international obligations relating to marine environmental protection, pollution prevention, and transboundary environmental governance. Effective offshore CCS governance therefore depends not only on domestic regulation but also on consistency with international marine environmental law.

UNCLOS provides the principal international legal framework governing States' rights and obligations in marine areas. Article 192 establishes the general obligation to protect and preserve the marine environment, while Article 194 requires States to take all necessary measures to prevent, reduce, and control marine pollution from any source.[44] Although UNCLOS predates modern CCS technology, these provisions remain directly relevant because offshore CCS raises issues concerning pollution prevention, ecosystem protection, environmental risk management, and long-term stewardship. Consequently, Indonesia's domestic CCS framework should be interpreted consistently with UNCLOS and broader principles of international marine environmental law.

Nevertheless, norm fragmentation exists between Indonesia's domestic offshore CCS framework and these international obligations. Domestic

[42] Ramadhan et al., "Carbon Capture, Utilization, and Storage in Indonesia: An Update on Storage Capacity, Current Status, Economic Viability, and Policy," October 1, 2024.

[43] Ramadhan et al., "Carbon Capture, Utilization, and Storage in Indonesia: An Update on Storage Capacity, Current Status, Economic Viability, and Policy," October 1, 2024.

[44] "United Nations Convention on the Law of the Sea," *International Legal Materials* 21, no. 6 (November 20, 1982): 1261–1354, https://doi.org/10.1017/S0020782900057363.

regulations primarily emphasize licensing, operational implementation, technical feasibility, and investment facilitation, whereas UNCLOS places greater emphasis on precaution, ecosystem protection, environmental responsibility, and intergenerational stewardship.[45] This divergence illustrates the broader challenge of aligning national economic and climate policies with international environmental obligations.

One important example concerns environmental assessment. Article 206 of UNCLOS requires States to assess activities that may cause substantial pollution or significant harmful changes to the marine environment. Indonesian environmental law similarly requires Environmental Impact Assessments (AMDAL) for environmentally significant projects. However, offshore CCS regulations do not yet provide detailed guidance for marine-specific environmental assessment applicable to subseabed carbon storage. Moreover, Presidential Regulation No. 14 of 2024 does not expressly require a dedicated Strategic Environmental Assessment (Kajian Lingkungan Hidup Strategis/KLHS) for the designation of offshore CCS zones.

A similar challenge concerns pollution prevention and monitoring standards. UNCLOS adopts a precautionary approach requiring States to minimize environmental risks before harm occurs. By comparison, Indonesia's offshore CCS regulations remain largely operational and do not comprehensively establish marine pollution thresholds, leakage response criteria, ecosystem protection indicators, or subseabed integrity standards specifically applicable to offshore carbon storage. Although Presidential Regulation No. 14 of 2024 requires monitoring, measurement, reporting, and verification (MRV), it does not explicitly incorporate internationally recognized standards such as ISO 27914 for geological carbon storage. Consequently, uncertainty remains regarding how domestic monitoring requirements should be evaluated against internationally accepted benchmarks governing storage integrity, leakage prevention, and long-term environmental protection.

Additional complexity arises from transboundary CCS governance. Presidential Regulation No. 14 of 2024 permits cross-border carbon storage and the storage of imported carbon dioxide, supporting Indonesia's ambition to become a regional carbon storage hub.[46] However, implementation of this policy depends upon compliance with international rules governing transboundary carbon transport and subseabed storage.

In this context, the London Protocol constitutes a critical component of the international legal framework. The 2009 amendment permits the export of

[45] Röschel and Neumann, "Ocean-Based Negative Emissions Technologies: A Governance Framework Review."

[46] Prayudi et al., "Legal Status and Cross-Border Transport in Carbon Capture and Storage (CCS): An International and Indonesian Law Perspective."

carbon dioxide streams for subseabed geological storage but has not yet entered into force because the required number of ratifications has not been achieved. To address this limitation, the 2019 Resolution on Provisional Application allows participating States to implement the amendment through bilateral or multilateral agreements before its formal entry into force. This mechanism provides an important legal pathway for cross-border CO_2 transport and storage and is particularly relevant to Indonesia's regional CCS hub strategy.

Despite this development, fragmentation persists because Indonesia's domestic regulations expressly accommodate foreign carbon storage while the international legal basis for transboundary CCS continues to depend on the evolving implementation of the London Protocol and agreements between participating States. As a result, legal certainty regarding cross-border carbon transport, liability allocation, environmental responsibility, and dispute settlement remains incomplete, creating normative fragmentation between Indonesia's domestic policy ambitions and the developing international legal architecture governing offshore CCS. [47] [48]

These issues demonstrate that offshore CCS governance cannot be understood solely through domestic legislation. Effective regulation requires harmonization between Indonesia's environmental, maritime, energy, and climate regulations and international obligations under UNCLOS and the evolving London Protocol framework. As argued by Jang (2024), effective offshore CCS governance increasingly depends on integrating domestic regulation with international obligations concerning marine environmental protection and transboundary environmental governance.

Accordingly, the principal legal challenge for Indonesia is not the absence of regulation but the fragmentation of legal norms across domestic and international legal regimes. Future harmonization should integrate UNCLOS obligations, marine spatial planning, ISO 27914 standards, and the London Protocol framework.

Conclusion

This study conclude that offshore CCS is governed through a combination of environmental, maritime, energy, climate, and international legal frameworks rather than a single comprehensive statute. The principal legal foundations provide the initial legal basis for offshore CCS implementation. It also concludes that Indonesia’s offshore CCS governance remains characterized by significant norm fragmentation across five

[47] Prayudi et al.

[48] Jang, “Regulation of the London Protocol and CCS Technology: A Legal Framework Analysis of Australia, Indonesia and RoK.”

dimensions: environmental governance, maritime and spatial governance, licensing and institutional authority, liability and long-term monitoring, and the relationship between domestic offshore CCS norms and international marine environmental obligations. Fragmentation exists both horizontally across sectoral legal regimes and vertically through jurisdictional tensions between centralized licensing under Law No. 6 of 2023 and provincial maritime authority under Law No. 23 of 2014. These fragmented norms reduce legal certainty and hinder coherent governance of offshore CCS.

The novelty of this study lies in applying Regulatory Fragmentation Theory, institutional mapping, and comparative regulatory analysis to identify both horizontal and vertical norm fragmentation within Indonesia's offshore CCS framework while linking domestic regulation with international marine environmental law. The study contributes to offshore CCS legal scholarship by providing a doctrinal framework for evaluating regulatory coherence beyond technological and policy perspectives.

Accordingly, future legal reform should prioritize harmonizing environmental, maritime, and energy regulations through integrated marine spatial planning, KLHS-based governance, and internationally aligned monitoring and liability frameworks adapted to Indonesia's archipelagic context. Future research should examine the practical implementation of cross-border CCS cooperation, institutional coordination, and the adaptation of international MMV and ISO 27914 standards within Indonesia's offshore CCS governance.

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