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Challenges and Formulation of the Legal Framework for Carbon Capture Storage (CCS/CCUS) in Indonesia in Building a Regulatory Basis for Decarbonization Projects in the Oil and Gas Sector

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Abstract: Global climate change demands that every country accelerate decarbonization measures, including Indonesia, which is committed to achieving Net Zero Emissions by 2060. One potential mitigation strategy is the implementation of Carbon Capture Storage (CCS) and Carbon Capture Utilization and Storage (CCUS) technology in the oil and gas sector. However, the implementation of CCS/CCUS in Indonesia still faces significant legal and institutional challenges. This study aims to analyze the normative, institutional, and policy barriers to CCS/CCUS implementation and to formulate an ideal legal framework to support decarbonization projects in the oil and gas sector. The method used is normative legal research with legislative, conceptual, and comparative approaches. The results show that the absence of *lex specialis* related to CCS/CCUS causes legal uncertainty, especially in the aspects of licensing, post-carbon storage environmental responsibilities, and legal protection for investors. In addition, overlapping authorities between the Ministry of Energy and Mineral Resources, the Ministry of Environment and Forestry, and the Upstream Oil and Gas Regulatory Special Task Force (SKK Migas) weaken the effectiveness of supervision. Therefore, the establishment of specific regulations and integrated institutions is needed to govern the implementation of CCS/CCUS, including establishing a liability regime and economic incentive mechanisms. Therefore, the formulation of a comprehensive CCS/CCUS legal framework is a key prerequisite for the success of decarbonization projects in the oil and gas sector in Indonesia.

Keywords: Carbon Capture Storage, Environmental Law, Decarbonization, Oil and Gas Sector

INTRODUCTION

Global climate change has become the most crucial issue of the 21st century due to its widespread impacts on the sustainability of ecosystems and human life (Antarissubhi et al., 2023). Advancing average global temperatures, melting polar ice caps, and rising sea levels are clear indicators of an increasingly urgent climate crisis that must be addressed (Irma & Gusmira, 2024). Indonesia, as an archipelagic nation with a high level of vulnerability to climate disasters, has a significant responsibility to contribute to reducing greenhouse gas emissions (Puspita, 2024). The government has stated its commitment to achieving Net Zero Emissions by 2060 as part of the Paris Agreement adopted at COP21 (Abisono, 2024). This effort requires not only changes to national energy policy but also strengthening the legal and institutional framework to accommodate innovations in emission control technology.

The oil and gas sector contributes significantly to national carbon emissions, stemming from the exploration, production, and distribution of fossil fuels (Prasetyo & Windarta, 2022). Reliance on carbon-based energy remains very high because it is the backbone of national energy needs and a source of foreign exchange (Wibowo, 2024). Emissions from the oil and gas industry include the release of carbon dioxide, methane, and other gases with high global warming potential (Zaky & Sari, 2024). The challenge of transitioning to cleaner energy sources is increasingly complex because this sector is closely linked to economic interests, investment, and the stability of the national energy supply. Therefore, controlling emissions in the oil and gas sector requires technology-based strategies that can reduce environmental impacts without sacrificing economic growth (Adiwardhana, 2023).

Carbon Capture Storage (CCS) and Carbon Capture Utilization and Storage (CCUS) technologies have emerged as potential solutions to address carbon emissions from the heavy industry and oil and gas sectors (Budiman, 2024). CCS works by capturing carbon dioxide from industrial processes and storing it underground to prevent its release into the atmosphere. CCS/CCUS goes further by utilizing captured carbon for other industrial purposes, such as enhanced oil recovery or as a chemical feedstock (Osman et al., 2021). This technology has been successfully implemented in countries such as Norway, Australia, and the United States, which have supporting legal and policy frameworks (Puspitasari et al., 2024). The implementation of CCS/CCUS allows Indonesia to continue managing its oil and gas resources while significantly reducing emissions, thus playing a crucial role in achieving its Net Zero Emissions target (Fransiskus & Rifawan, 2025).

CCS/CCUS development requires clear regulatory support due to its high-risk activities for the environment and public safety. Technical aspects such as storage locations, capture capacity, and long-term security guarantees require strict legal standards. The absence of specific regulations regarding CCS/CCUS creates uncertainty in project implementation, including licensing, legal liability, and compensation mechanisms in the event of carbon leakage. A strong legal framework serves as an umbrella for all parties involved, including the government, business actors, and affected communities. Clear regulations can also strengthen investor confidence in the development of high-tech decarbonization projects.

Environmental legal principles provide an ethical and normative framework for guiding CCS/CCUS regulations. The polluter pays principle asserts that those causing pollution are obligated to bear the costs of environmental restoration as a form of legal responsibility (Amalia et al., 2025). The precautionary principle demands preventive action even when scientific evidence is not yet fully conclusive, especially for new technologies like CCS/CCUS, which pose potential environmental risks (Poorhashemi, 2023). Sustainable development emphasizes that economic activities must maintain a balance between economic progress, environmental protection, and social justice (Wardhana, 2024). Intergenerational equity emphasizes that natural resource management must consider the interests of future

generations (Anshori et al., 2024). These principles serve as the moral and legal foundation for developing CCS/CCUS regulations to align with the values of ecological justice.

The relevance of environmental legal theory to CCS/CCUS regulations is significant because these technologies lie at the intersection of industrial innovation and environmental conservation. Underground carbon storage activities have direct implications for ecosystems and geological balance, thus requiring strict legal oversight (Agustina et al., 2025). Environmental principles-based regulations ensure that CCS/CCUS implementation does not pose a new threat to environmental sustainability. Protecting the community's right to a clean and healthy environment, as guaranteed in Article 28H paragraph (1) of the 1945 Constitution, must remain a top priority (Chandra et al., 2024). CCS/CCUS implementation must be carried out with prudence and public transparency to avoid conflicts of interest between industrial development and environmental sustainability.

Legal certainty is a key prerequisite for the successful implementation of decarbonization technologies such as CCS/CCUS. Vague or overlapping regulations have the potential to hinder investment, increase compliance costs, and increase legal risks for industry players. Legal certainty ensures clarity of rights, obligations, and responsibilities between the government and business actors at every stage of the project (Aufat et al., 2025). When legal rules are predictable and consistently enforced, investor confidence increases, and technological innovation can develop safely. A stable legal system that supports CCS/CCUS will ultimately accelerate the transformation to a highly competitive low-carbon economy.

Regulatory effectiveness is a benchmark for the success of environmental law enforcement in facing new challenges, such as decarbonization. Good regulations not only provide normative guidance but also are implemented through effective oversight and enforcement mechanisms. The relationship between legal effectiveness and environmental policy stability is evident in the extent to which regulations can provide both certainty and flexibility in response to technological change (Mahardhika et al., 2024). Legal instruments that fail to adapt to developments in CCS/CCUS technology will lose their relevance amidst global change. Strengthening institutional capacity and human resources in environmental law is an integral part of efforts to increase the effectiveness of these regulations.

Decarbonization is a strategic effort to reduce the intensity of greenhouse gas emissions to maintain global climate balance. The goal is not simply emission reduction but also a comprehensive transformation of the energy system, the economy, and national development policies. CCS/CCUS is a crucial instrument in supporting the national decarbonization strategy because it can address difficult-to-eliminate emissions from the heavy industry sector (Rahma et al., 2025). The integration of CCS/CCUS with clean energy policies demonstrates a new direction for more sustainable development without sacrificing economic growth. The development of this technology requires progressive legal support to balance environmental interests and investment certainty.

CCS/CCUS technology operates through several key stages: carbon capture from emission sources, transportation to storage locations, and storage or reuse of the carbon. These stages require strict technical and legal oversight due to the potential hazards to the environment and human health. Storage site security is crucial to ensure carbon does not leak into the atmosphere in the long term (Budi & Falson, 2024). Furthermore, monitoring, reporting, and verification (MRV) mechanisms must be implemented transparently to ensure project accountability (Kennedy, 2025). This complexity emphasizes the need for specific and comprehensive regulations for the safe and sustainable implementation of CCS/CCUS.

CCS/CCUS plays a strategic role within the national energy transition policy as a bridge to clean energy. Indonesia's energy policy remains oriented toward the utilization of fossil fuels, while renewable energy development has not yet reached optimal capacity. CCS/CCUS can be a transitional solution by reducing emissions from the oil and gas sector

while accelerating investment in low-carbon energy. The implementation of this technology supports the emission reduction targets set out in the Enhanced Nationally Determined Contribution (E-NDC) of 31.89% independently and 43.2% with international support (Soraya, 2023). A clear and progressive legal framework will be key to the success of this transformation, enabling Indonesia to balance national energy needs with global commitments to environmental sustainability.

METHOD

This study uses a normative legal research method with two main approaches: a statutory approach and a conceptual approach. The statutory regulatory approach is used to review and analyze various legal provisions relating to the regulation of Carbon Capture Storage (CCS) and Carbon Capture Utilization and Storage (CCUS), both those that are in effect and those that are still in the design stage. This analysis includes a review of Law Number 32 of 2009 concerning Environmental Protection and Management, Law Number 22 of 2001 concerning Oil and Gas, and the draft New and Renewable Energy Law, which are relevant to the development of decarbonization projects in the oil and gas sector. This approach is intended to identify disharmony, gaps, and overlapping legal norms that hinder the implementation of CCS/CCUS in Indonesia. Meanwhile, a conceptual approach is used to explore the legal ideas and theories underlying the formation of regulations on carbon storage, including environmental legal principles such as the polluter pays principle, the precautionary principle, and sustainable development. Through this approach, the research seeks to formulate an ideal concept for a CCS/CCUS legal framework oriented toward legal certainty, environmental sustainability, and support for national energy transition policies. The combination of these two approaches is expected to produce a comprehensive analysis of the existing positive norms and new normative needs to address the legal challenges of carbon management in the future.

RESULT AND DISCUSSION

Legal Challenges in CCS/CCUS Implementation in Indonesia

The development of Carbon Capture Storage (CCS) and Carbon Capture Utilization and Storage (CCUS) technologies in Indonesia faces major regulatory hurdles due to the lack of specific laws and regulations governing their implementation. Currently, regulations related to carbon emission control are scattered across various regulations, such as Law Number 32 of 2009 concerning Environmental Protection and Management, Law Number 22 of 2001 concerning Oil and Gas, and Presidential Regulation Number 98 of 2021 concerning the Implementation of the Economic Value of Carbon for Achieving the Nationally Determined Contribution (NDC) Target. However, none of these regulations explicitly address underground carbon storage, post-storage legal responsibilities, or CCS/CCUS technical standards. This legal vacuum creates uncertainty for industry players and investors planning to implement CCS/CCUS technology in their operations.

This lack of synchronization between regulations poses a serious obstacle to creating a strong legal basis for CCS/CCUS development. Law Number 32 of 2009 emphasizes the principle of environmental protection through environmental permits and environmental impact analyses (Articles 36 and 22), while Law Number 22 of 2001 focuses on increasing oil and gas production and management without explicitly regulating carbon capture or storage. The currently drafted New and Renewable Energy Law (RUU EBT) also lacks clarity regarding CCS/CCUS mechanisms, despite incorporating the principle of energy decarbonization. This disparity in regulatory direction has the potential to lead to overlapping authority and legal interpretation between government institutions. This situation

demonstrates the weak harmonization of policies between the environmental, energy, and industrial sectors, which should operate synergistically.

The licensing aspect remains a legal issue that is unclear. In the Indonesian legal system, every activity with the potential to cause environmental impacts is required to obtain an environmental permit, as stipulated in Article 36 paragraph (1) of Law Number 32 of 2009. However, there is no specific licensing mechanism for underground carbon storage or the utilization of captured carbon. When CCS/CCUS projects are implemented in oil and gas working areas, the permits used are often equated with oil and gas exploitation permits, even though their technical characteristics and risks differ. The lack of standard operating procedures (SOPs) also creates difficulties in ensuring the security of carbon storage and protection against potential leaks. This situation highlights the urgency of establishing a legal instrument that can regulate CCS/CCUS in a comprehensive and integrated manner.

The institutional structures involved in CCS/CCUS management also lack clarity regarding legal relationships. The Ministry of Energy and Mineral Resources (ESDM) has technical authority over oil and gas activities as stipulated in Article 4 paragraph (2) of Law Number 22 of 2001, while the Ministry of Environment and Forestry (KLHK) is authorized to oversee environmental aspects as stipulated in Article 63 of Law Number 32 of 2009. Furthermore, the Special Task Force for Upstream Oil and Gas Business Activities (SKK Migas) is tasked with managing cooperation contracts with oil and gas companies. These three institutions have overlapping functions when CCS/CCUS technology is applied to oil and gas projects, but there is no formal coordination mechanism governing the division of responsibilities between agencies. The unclear institutional structure potentially hampers CCS/CCUS implementation due to conflicts over administrative authority.

Overlapping authority between government agencies impairs the effectiveness of CCS/CCUS project oversight. The Ministry of Energy and Mineral Resources (ESDM) is responsible for exploration and technical aspects of carbon storage, while the Ministry of Environment and Forestry (KLHK) is responsible for environmental impact evaluation and AMDAL approval. SKK Migas, as the implementing agency, often lacks full authority to regulate carbon storage because it is not regulated in the oil and gas implementing regulations. This situation creates uncertainty regarding who is responsible for carbon leakage or post-storage environmental damage. When legal responsibility is not clearly defined, a liability gap risks arising, harming both the state and affected communities.

Monitoring and reporting mechanisms for CCS/CCUS activities remain very limited. Law Number 32 of 2009 mandates environmental oversight in Article 71, but this provision does not cover long-term carbon storage activities. There are no national standards governing the monitoring, reporting, and verification (MRV) system for carbon capture and storage activities. As a result, the government lacks legal instruments to assess the effectiveness of carbon storage and the potential for future gas leaks. When oversight is inadequate, environmental and social risks increase due to the lack of legal mechanisms to ensure project security and transparency.

Another emerging issue relates to post-carbon storage legal liability. CCS/CCUS activities can have long-term consequences for the geological and subsurface environment. Law Number 32 of 2009, through Article 69 paragraph (1) letter e, prohibits anyone from disposing of waste into the environment without a permit, but does not clarify whether carbon stored underground falls into this category. Should future carbon leaks occur, there are no legal provisions defining who should be responsible for environmental restoration and compensation. The absence of a liability regime creates legal uncertainty for industry players and communities impacted by carbon storage activities.

Legal risks in CCS/CCUS investments also pose a significant challenge for businesses. Investing in CCS/CCUS technology requires high costs and long payback periods, so legal

certainty is a key factor for investors. When regulations are lacking, investors face uncertainty regarding asset protection, ownership of captured carbon, and compensation mechanisms in the event of policy changes. Furthermore, Article 33, paragraph (3) of the 1945 Constitution stipulates that natural resources are controlled by the state for the greatest prosperity of the people, so management of captured carbon also has the potential to spark debate over ownership status. This condition shows that the legal aspects of CCS/CCUS investments require clarity to attract private interest without violating the principle of state control over resources.

Uncertainty in the implementation of carbon pricing and trading systems in Indonesia also worsens the economic prospects of CCS/CCUS. Presidential Regulation Number 98 of 2021 has introduced a carbon economic value mechanism, but its implementation remains limited to the energy and forestry sectors. There are no regulations yet that integrate CCS/CCUS carbon capture into the national carbon trading system, so the potential financial benefits from these projects cannot be exploited. Investors ultimately lack assurance that emission reductions through CCS/CCUS will be recognized or economically rewarded. This situation hinders the influx of foreign capital and slows the development of decarbonization technologies based on the oil and gas industry.

Legal protection for the private sector and foreign investors remains weak due to the lack of a legal instrument specifically regulating CCS/CCUS as an investment. Law Number 25 of 2007 concerning Investment does provide a guarantee of equal treatment for foreign and domestic investors in Article 6, but does not cover the technical and environmental risks of carbon storage projects. Without legal certainty regarding responsibilities, permits, and incentive mechanisms, investors will view the CCS/CCUS sector as a high-risk investment. When the state fails to guarantee adequate legal protection, the development of decarbonization projects in the oil and gas sector has the potential to stagnate and lag behind other countries with mature CCS/CCUS legal systems, such as Australia and Norway.

Formulation of the CCS/CCUS Legal Framework in Indonesia

The direction of CCS/CCUS regulatory development in Indonesia must begin with the awareness that carbon storage activities have different technical and legal characteristics than oil and gas exploration and production activities. Law No. 32 of 2009 concerning Environmental Protection and Management does not explicitly regulate underground carbon storage mechanisms, while Law No. 22 of 2001 concerning Oil and Gas focuses solely on the management of fossil fuel resources. This regulatory gap creates legal uncertainty for industry players seeking to implement CCS/CCUS technology. The development of special regulations, or *lex specialis*, is a crucial step in providing a strong legal basis for all technical, administrative, and legal responsibilities related to carbon capture and storage activities. This step will also strengthen Indonesia's position as a country serious about preparing a legal framework for a low-carbon energy transition.

The need for *lex specialis* on CCS/CCUS is increasingly pressing, given the interplay between these activities and numerous sectors, including energy, the environment, and mineral resources. New regulations should address not only licensing aspects but also safety standards, post-project liability mechanisms, and ownership rights over stored carbon. Article 63 paragraph (1), letter f of Law No. 32 of 2009 authorizes the government to establish policies to control pollution and environmental damage, which can serve as the legal basis for developing technical regulations for CCS/CCUS. Integration of environmental and energy regulations is also crucial to avoid overlapping policies that could hinder implementation. Such regulations will provide legal certainty that encourages technological innovation and green investment.

The integration of CCS/CCUS regulations in the New and Renewable Energy (NRE) Bill needs to be directed towards becoming part of the national decarbonization strategy. The NRE Bill currently being discussed by the House of Representatives (DPR) includes regulations on the use of clean energy and low-emission technology innovation, which can provide a legal framework for CCS/CCUS as a carbon mitigation instrument. Articles in the bill should include norms that authorize the Ministry of Energy and Mineral Resources to oversee CCS/CCUS projects, while ensuring integration with the Ministry of Environment and Forestry's environmental policies. This substantial alignment will strengthen the position of CCS/CCUS as an integral part of sustainable energy policy. Synergy between the energy and environmental sectors is the basis for efficient oversight, transparent licensing, and accountability for legal responsibility.

Lessons from Australia demonstrate that CCS/CCUS regulations can be effective if supported by a coordinated and specific legal system. The Offshore Petroleum and Greenhouse Gas Storage Act 2006 (Australia) serves as an example of how governments can regulate offshore carbon storage with clear licensing requirements and a clear division of post-project responsibilities. This regulation establishes separate exploration and storage permits and stipulates the obligations of permit holders to ensure the long-term security of carbon storage sites. This system provides clarity for industry players while protecting the public interest. The Australian model can serve as a reference in designing a CCS/CCUS legal framework in Indonesia, particularly regarding environmental monitoring and post-storage site restoration.

Norway is another country that has successfully developed a progressive CCS/CCUS legal framework through Storage Regulations under the CO₂ Storage Directive. These regulations provide a strong foundation for the Sleipner and Northern Lights projects, renowned as the most successful CCS projects in Europe. Norwegian law establishes long-term government responsibility for storage sites after the operator has completed safety verification. This approach demonstrates the importance of a clear liability regime to avoid disputes between industry players and the state after storage activities are completed. Such a mechanism can be adapted in Indonesia, taking into account geological conditions and national institutional structures.

Japan demonstrates best practices in governance and policy innovation by integrating CCS/CCUS into the Act on the Rational Use of Energy and its Green Transformation (GX) policy. The Japanese government has established a system of fiscal incentives and research support to accelerate the development of CCS projects, including public-private partnerships. The Japanese legal system emphasizes transparency in emissions reporting and the security of long-term carbon storage. This approach, which emphasizes synergy between science, policy, and industry, can serve as an important reference for Indonesia in designing policies that adapt to the challenges of new technologies. Implementing a similar institutional model will strengthen the legal legitimacy of CCS/CCUS at the national level.

The ideal legal framework for CCS/CCUS in Indonesia should be based on an integrated institutional design between the government, oil and gas industry players, and environmental authorities. This integrated institutional structure could take the form of a dedicated agency or cross-ministerial coordinating unit responsible for regulating, supervising, and evaluating CCS/CCUS projects. The legal basis for establishing such an institution could refer to Article 12 of Law No. 39 of 2008 concerning State Ministries, which allows for the formation of cross-sectoral units to carry out specific government duties. Such institutional synergy will strengthen oversight effectiveness and prevent conflicts of authority between agencies.

Licensing and oversight of CCS/CCUS activities need to be clearly regulated to avoid legal and environmental risks. Licensing procedures should encompass exploration,

construction, operation, and post-storage phases, with the obligation to conduct an Environmental Impact Assessment (AMDAL) as stipulated in Article 22 of Law No. 32 of 2009. Oversight is carried out through a periodic reporting system and independent audits of carbon storage sites to ensure long-term safety. Post-project legal responsibility must also be clearly defined to ensure there is no gap in responsibility after operators cease storage activities. Clarity in licensing and oversight will strengthen investor confidence in CCS/CCUS projects in Indonesia.

Legal instruments in the form of fiscal incentives and carbon credit mechanisms are crucial elements in formulating a CCS/CCUS legal framework. Article 43, paragraph (2) of Law No. 4 of 2009 concerning Mineral and Coal Mining provides the government with the opportunity to establish incentive policies for activities that contribute to environmental conservation. Similar principles can be adopted to provide tax breaks, technology subsidies, or facilitate licensing for CCS/CCUS projects. Carbon credit trading mechanisms also need to be explicitly legalized so that emissions reductions can be traded legally and transparently. Strong economic support will accelerate private sector participation in the national decarbonization program.

Harmonization of regulations across ministries and agencies is the final element of an ideal CCS/CCUS legal framework. Synergy between the Ministry of Energy and Mineral Resources, the Ministry of Environment and Forestry, and the Ministry of Finance must be formally regulated through government regulations or presidential regulations to prevent sectoral coordination. Establishing a collaborative mechanism, division of authority, and reporting system between institutions will ensure efficient policy implementation. A coordinated legal framework will create long-term regulatory stability and provide clarity for industry players and investors. The success of this formulation will mark Indonesia's progress toward a robust decarbonization legal system that is adaptive to global change.

CONCLUSION

An analysis of the legal challenges and direction of Carbon Capture Storage (CCS/CCUS) regulatory reform in Indonesia shows that the development of carbon storage and utilization technologies still faces a significant legal gap. The absence of a *lex specialis* that comprehensively regulates CCS/CCUS activities creates legal uncertainty, particularly in the areas of licensing, post-storage responsibilities, and investment certainty. The inconsistency between Law No. 32 of 2009 concerning Environmental Protection and Management, Law No. 22 of 2001 concerning Oil and Gas, and the draft New and Renewable Energy Bill demonstrates the weak harmonization of cross-sectoral regulations. The oil and gas sector, as one of the largest contributors to emissions, requires a strong legal basis to support national decarbonization efforts, in line with Indonesia's commitment to the 2060 Net Zero Emissions target. Legal reform is urgently needed to ensure that CCS/CCUS is recognized as a legitimate instrument for climate change mitigation that focuses on sustainability, environmental protection, and legal certainty for industry players.

Future steps should be directed at establishing specific laws or government regulations governing the entire CCS/CCUS activity cycle, from planning and licensing to storage and post-project monitoring. The establishment of a national institution, such as the National CCS/CCUS Regulatory Authority, is urgently needed to coordinate policies across ministries and ensure technical oversight and compliance with environmental safety standards. International cooperation must also be strengthened to accelerate technology transfer, investment, and access to green funding, particularly through carbon credit and climate finance schemes. The government needs to develop technical guidelines for CCS/CCUS implementation based on environmental safeguard principles to ensure that every carbon storage activity meets sustainability standards and does not pose long-term ecological risks.

This integration of laws, institutions, and policies will be the main foundation for Indonesia's success in building a resilient, progressive, and globally competitive decarbonization legal ecosystem.

REFERENCES

- Abisono, F. G. (2024). Di Bawah Bayang-Bayang Perubahan Iklim: Transformasi Negara Pembangunan dan Agenda Transisi Energi di Indonesia. *Politika: Jurnal Ilmu Politik*, 15(1), 95-118.
- Adiwardhana, A. (2023). Penggunaan Teknologi Ccs/Ccus Untuk Mendukung Penurunan Emisi Grk Sektor Energi. *Buletin Pertamina*, 9(2), 125.
- Agustina, R., Aditiameri, Ahmad, A., Tebai, N., Fidhatami, I. I., La Habi, M., . . . Azizah, A. (2025). *Konservasi Sumber Daya Alam dan Lingkungan*. Padang: Azzia Karya Bersama.
- Amalia, I., Isma, N., & Noviarani, D. (2025). Penerapan Prinsip Polluter Pays Dalam Corporate State Responsibility: Perspektif Hukum Perusahaan. *Jurnal Ilmiah Wahana Pendidikan*, 11(6C), 66-77.
- Anshori, I., Setyawan, A., & Firdaus, A. (2024). IMPLIKASI KEBIJAKAN PENGELOLAAN SUMBER DAYA ALAM TERHADAP ASPEK KEBERLANJUTAN SOSIAL DAN LINGKUNGAN. *JOURNAL OF LAW AND NATION*, 3(1), 123-131.
- Antarissubhi, H., Serang, R., Leda, J., Salamena, G. E., Pagoray, G. L., Gusty, S., & Safar, A. (2023). *Krisis Iklim Global di Indonesia (Dampak dan Tantangan)*. Makassar: Tohar Media.
- Aufat, M. F., Arjunita, S., Efika, N., & Hasni, H. (2025). ANALISIS PENTINGNYA ASPEK HUKUM DALAM STUDI KELAYAKAN BISNIS SEBAGAI JAMINAN KEABSAHAN USAHA. *Journal of Information Systems Management and Digital Business*, 2(4), 314-325.
- Budi, A. S., & Falson, J. (2024). Carbon Capture Storage dalam Pengelolaan Barang Milik Negara. *JURNAL MANAJEMEN KEUANGAN PUBLIK*, 8(2), 104-120.
- Budiman, A. (2024). *CCUS (Carbon Capture, Utilization, and Storage): Teknologi Penangkapan, Utilisasi, dan Penyimpanan CO2*. Yogyakarta: UGM PRESS.
- Chandra, F., Diar, A., & Hartati, H. (2024). Konstitusi Hijau (Green Constitution) dalam Upaya Pelestarian Lingkungan Hidup yang Berkeadilan. *Jurnal Penelitian Inovatif*, 4(3), 889-896.
- Fransiskus, F., & Rifawan, A. (2025). Peran Indonesia Sebagai Norm Entrepreneur Dalam Konsepsi Sentralitas ASEAN Melalui Inisiatif Karbon Lintas Batas Berbasis Teknologi Carbon, Capture and Storage (CCS). *Padjadjaran Journal of International Relations*, 7(1), 83-100.
- Irma, M. F., & Gusmira, E. (2024). Tingginya Kenaikan Suhu Akibat Peningkatan Emisi Gas Rumah Kaca Di Indonesia. *JSSIT: Jurnal Sains dan Sains Terapan*, 2(1).
- Kennedy, P. S. (2025). Kajian Normatif atas Pengukuran, Pelaporan, dan Verifikasi dalam Perdagangan Karbon. *IKRA-ITH HUMANIORA: Jurnal Sosial dan Humaniora*, 9(1), 154-166.
- Mahardhika, Z. M., Hapsari, I. M., & Rajib, R. K. (2024). Urgensi Reformasi Hukum Lingkungan terhadap Perubahan Iklim di Indonesia. *Jurnal Kebijakan Pembangunan*, 19(2), 235-244.
- Osman, A. I., Hefny, M., Abdel Maksoud, M. I., Elgarahy, A. M., & Rooney, D. W. (2021). Recent advances in carbon capture storage and utilisation technologies: a review. *Environmental Chemistry Letters*, 19(2), 797-849.

- Poorhashemi, A. (2023). Principles of international environmental law. *CIFILE Journal of International Law*, 4(7), 80-106.
- Prasetyo, A. W., & Windarta, J. (2022). Pemanfaatan teknologi carbon capture storage (CCS) dalam upaya mendukung produksi energi yang berkelanjutan. *Jurnal Energi Baru Dan Terbarukan*, 3(3), 231-238.
- Puspita, N. Y. (2024). KESIAPSIAGAAN INDONESIA DALAM MITIGASI DAMPAK PERUBAHAN IKLIM DI INDONESIA. *Jurnal Komunikasi Hukum (JKH)*, 10(2), 92-109.
- Puspitasari, A., Maylani, S., Cindy, C. N., & Putri, R. K. (2024). Peran Carbon Capture and Storage dalam Kebijakan Cap and Tax: Analisis Strategi untuk Pengurangan Emisi dan Transisi Energi. *Prosiding Seminar Nasional Ekonomi dan Perpajakan*, 4(1), 115-126.
- Rahma, R., Sugiarto, M., & Isya, M. (2025). *Strategi Dekarbonisasi Transportasi: Inventarisasi dan Proyeksi Emisi Udara*. Banda Aceh: USK Press.
- Soraya, A. D. (2023). Kebijakan investasi hijau dalam perundang-undangan Indonesia sebagai upaya penurunan emisi GRK nasional menuju E-NDC 2030. *UNES Law Review*, 6(2), 5321-5333.
- Wardhana, C. S. (7 2024). DUA SISI MATA UANG YANG HARUS DIPERHATIKAN DALAM PERJALANAN MENUJU PEMBANGUNAN BERKELANJUTAN. *Journal of Syntax Literate*, 9(7), 3406-3416.
- Wibowo, K. (2024). Kontribusi Pembangkit Listrik Energi Terbarukan dalam Mengurangi Emisi Karbon. *Innovative: Journal Of Social Science Research*, 4(6), 5140-5153.
- Zaky, R. F., & Sari, D. A. (2024). Upaya pereduksian emisi karbon dioksida (CO₂) di Indonesia melalui analisis integrasi power-to-gas dengan PLTU batubara. *Sprocket Journal of Mechanical Engineering*, 5(2), 66-75.