Jurnal Kajian Pembaruan Hukum (2024) 4:2 207-238
DOI: https://doi.org/10.19184/jkph.v4i2.51726
Published by the University of Jember, Indonesia
Available online 13 November 2024

Dilemma of Legal Transplantation in CCS Regulations: Between Harmonization and Adaptation to Local Context

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ABSTRACT: Climate change necessitates innovative solutions like Carbon Capture and Storage (CCS) to reduce CO2 emissions. CCS involves capturing and storing CO2 in underground geological formations. Implementing CCS in Indonesia requires a comprehensive regulatory framework addressing technical standards, permits, monitoring, and financing, while also considering environmental and social risks. This research analyzes the dilemma of "legal transplantation" in Indonesian CCS regulations, balancing harmonization with international standards and adaptation to local contexts. Legal transplantation involves adopting legal rules from one jurisdiction to another. In this context, it might involve incorporating international best practices into Indonesian law. This raises questions about reconciling foreign legal elements with existing Indonesian legal frameworks and the country's unique context. This research employs normative legal methods with a qualitative approach. Data was gathered through literature reviews, comparative analysis, case studies, and comprehensive interviews. This study examines the impact of legal transplantation on developing CCS regulations in Indonesia, analyzing the challenges and opportunities in adapting regulations from other countries. It explores achieving a balance between global harmonization and local adaptation. Utilizing normative legal research methods with a qualitative approach, this research aims to contribute to developing effective and sustainable CCS regulations in Indonesia. With a suitable regulatory framework, CCS can be a crucial tool in mitigating climate change

KEYWORDS: Carbon Capture and Storage (CCS); CCS Regulations; Legal Transplantation.

HOW TO CITE:
Rizaldy, Wahyu Fahmi & Elbouche Chems Sadjda Lilleh, " *Dilemma of Legal Transplantation in CCS Regulations: Between Harmonization and Adaptation to Local Context*" (2024) 4:2 Jurnal Kajian Pembaruan Hukum 207-238. DOI: <https://doi.org/10.19184/jkph.v4i2.51726>.

Submitted: 31/07/2024 Reviewed: 23/09/2024 Revised: 29/10/2024 Accepted: 10/11/2024

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I. INTRODUCTION

Climate change has become an urgent global threat, prompting the search for innovative solutions to reduce carbon dioxide (CO2) emissions. One promising technology is Carbon Capture and Storage (CCS), which involves capturing CO2 from large emission sources, such as power plants and industrial plants, and then storing it permanently in underground geological formations. The International Energy Agency (IEA) estimates that CCS could make a significant contribution, up to 15%, in the emissions reductions needed to reach global climate targets by 2050.[1]

For CCS to be implemented safely and sustainably, an effective and comprehensive regulatory framework is needed. These regulations must cover various aspects, from technical standards for CO2 capture and storage, licensing and monitoring of CCS projects, to financing and incentive mechanisms In addition, regulations also need to address potential environmental and social risks related to CCS, such as CO2 leaks and impacts on local communities.

With the right regulatory framework, CCS can become an important tool in global efforts to reduce CO2 emissions and address climate change. This technology can help reduce dependence on fossil fuels, encourage the transition to clean energy, and create new economic opportunities in the low-carbon energy sector.[2] However, the successful implementation of CCS will depend heavily on the ability of the government and other stakeholders to develop and implement effective and responsible regulations.

In formulating CCS regulations, many countries are faced with a dilemma between harmonization with international standards and adaptation to local contexts. Legal transplantation, namely adopting CCS regulations from other countries, is often seen as an efficient solution and allows learning from other countries' experiences. However, it is important to remember that each country has unique geological, social, economic, and

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1 Bouckaert, Stéphanie et al, *Net Zero by 2050: A Roadmap for the Global Energy Sector* (France: International Energy Agency, 2021).

2 *Mai Bui et al,* "Carbon Capture and Storage (CCS): The Way Forward" (2018) 11:5 Energy Enviromental Science Journal 1062-1176.

political conditions. Therefore, adapting CCS regulations is crucial in order to respond to the specific needs and challenges of each country.[3]

For example, countries with geological formations suitable for CO2 storage may require stricter regulations regarding storage monitoring and verification. On the other hand, countries with high dependence on fossil fuel-based industries may require regulations that provide economic incentives to encourage the adoption of CCS technologies. Social and political factors, such as public acceptance of CCS technology and policy stability, also need to be considered in the formulation of effective regulations.

Therefore, the development of optimal CCS regulations requires a balanced approach between harmonization and adaptation. Harmonization with international standards can ensure interoperability and facilitate technology transfer, while adaptation to local contexts ensures the relevance and effectiveness of regulations in addressing each country's specific challenges. Collaboration between policymakers, scientists, industry and civil society is key in formulating comprehensive and sustainable CCS regulations.

This research aims to analyze the dilemma of legal transplantation in CCS regulations in Indonesia, focusing on how to achieve a balance between harmonization and adaptation to the local context. This study will examine how legal transplantation influences the development of CCS regulations in Indonesia and the challenges and opportunities in adapting CCS regulations from other countries to the local context. Apart from that, this research will also explore how to balance the harmonization of CCS regulations globally and adaptation to specific conditions in Indonesia.

II. METHODS

[3] Arananda Dwi Putri, Nugroho Adi Sasongko & Donny Yoesgiantoro, "Carbon Capture Storage dan Carbon Capture Utilization Storage (CCS/CCUS) sebagai Solusi Transisi Energi Fosil di Indonesia" (2024) 8:2 Pendipa Journal of Science Education 191-203.

This research employs a normative legal research method with a qualitative approach, combining multiple data collection techniques, including literature studies, comparative analysis, case studies, and in-depth interviews. [4] The initial phase of the research involves an extensive review of literature relevant to legal transplantation, CCS (Carbon Capture and Storage) regulations, and Indonesia's unique context. This literature review draws from a variety of sources, such as statutory regulations, policy documents, scientific journals, and books, aiming to develop a comprehensive understanding of key concepts, the development of CCS regulations in various countries, and the challenges and opportunities for legal transplantation in Indonesia.

Building on this foundational knowledge, the research conducts a comparative analysis of CCS regulations in Indonesia and other countries with established CCS frameworks, including Norway, the United States, and European nations. This analysis aims to identify similarities and differences in regulatory approaches, evaluating the effectiveness of these regulations in meeting CCS policy goals. By drawing on the experiences of other nations, this research seeks to derive insights that may inform and improve the CCS regulatory framework in Indonesia.[5] The case studies will examine specific instances of CCS implementation, both in Indonesia and in countries with more established CCS practices, allowing for a closer examination of how these regulations operate in practice, the challenges encountered, and factors influencing successful implementation. These real-world examples are expected to provide valuable lessons for Indonesia.

To complement the case studies, in-depth interviews with policymakers, legal experts, and relevant stakeholders in Indonesia will be conducted. These interviews aim to gather rich perspectives on the legal transplantation process, decision-making considerations, and views on the challenges and opportunities associated with implementing CCS in Indonesia. By integrating insights from both the case studies and interviews, this research will deliver a comprehensive analysis of the

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[4] Kornelius Benuf & Muhamad Azhar, "Metodologi Penelitian Hukum sebagai Instrumen Mengurai Permasalahan Hukum Kontemporer" (2020) 7:1 Gema Keadilan 20-33.

[5] Fernando Almeida, "Strategies To Perform A Mixed Methods Study" (2018) 4:1 European Journal of Education Studies 137-151.

nuances of legal transplantation in the context of CCS regulations in Indonesia.

III. THE INFLUENCE OF LEGAL TRANSPLANTATION ON THE DEVELOPMENT OF CCS REGULATIONS IN INDONESIA

A. Legal Transplantation in CCS Regulations in Indonesia

Indonesia has adopted several legal norms from other countries in CCS regulations. This practice, known as legal transplantation, is increasingly common globally as nations grapple with the complexities of CCS regulation and seek to harmonize standards while adapting them to their unique contexts.[6] A brief overview of the legal relevance of transplantation in CCS regulation worldwide will provide valuable context for understanding the Indonesian case.

Some examples of legal transplantation in CCS regulations in Indonesia include adopting CCS principles from Norway, adopting CCS technical standards from the United States, and adopting the European Union's CCS funding mechanism.[7] These instances of borrowing legal frameworks from other jurisdictions highlight the complex interplay between international standards and local adaptation in developing a comprehensive regulatory framework for CCS in Indonesia. Indonesia's adoption of CCS standards demonstrates its commitment to climate change mitigation efforts. One of the important steps taken was to adopt CCS principles from Norway, a country that already has established experience and expertise in this technology.[8]

One key element adopted from Norway is the principle of Monitoring, Reporting, and Verification (MRV), which ensures transparency and accountability in CCS processes. MRV ensures that the CCS process runs

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[6] Bima Niko Pamungkas & Vissia Dewi Haptari, "Analisis Skema Pengenaan Pajak Karbon Di Indonesia Berdasarkan United Nations Handbook Mengenai Penerapan Pajak Karbon Oleh Negara Berkembang" (2022) 6:2 Jurnal Pajak Indonesia 357-367.

[7] Sugihardjo, "Penyaringan dan Peringkat Cekungan Kalimantan Timur serta Potensinya untuk Implementasi CCUS" (2021) 55:3 Lembaran Publikasi Minyak Dan Gas Bumi 171-185.

[8] International Energy Agency, *Energy Technology Perspectives: Special Report on Carbon Capture Utilisation and Storage CCUS in clean energy transitions 2020* (France: International Energy Agency, 2020).

transparently and accountably.[9] In this case, Indonesia has formulated regulations that require monitoring of captured and stored CO2 emissions, as well as regular reporting to the relevant authorities. Apart from that, independent verification is also carried out to ensure the accuracy of the data and the effectiveness of CCS implementation.

Norway's adoption of MRV principles not only provides a strong legal basis for the development of CCS in Indonesia but also increases investor and public confidence in this technology. With guaranteed transparency and accountability, it is hoped that CCS can become an effective solution in reducing greenhouse gas emissions and achieving the emissions reduction targets that have been set.

Apart from MRV principles, Indonesia also adopted technical and safety standards from Norway in developing CCS infrastructure. This is important to ensure that CCS facilities operate safely and efficiently, as well as minimizing the risk of leaks or negative impacts on the environment. Collaboration between Indonesia and Norway in technology and knowledge transfer is also an important factor in accelerating CCS development in Indonesia.[10]

The United States, as one of the pioneers in developing CCS technology, has had a significant influence on CCS regulations in Indonesia through the adoption of technical standards. These standards cover various important aspects of CCS implementation, from the CO2 capture stage to long-term monitoring.

One example of the adoption of technical standards from the United States is in terms of CO2 injection into geological formations. These standards regulate various technical parameters, such as injection rate, injection pressure and quality of injected CO2. The aim is to ensure that CO2 injection is carried out safely and does not cause negative impacts on the environment.[11]

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[9] Matt Steyn, *Global Status of CCS 2022* (Australia: The Global CCS Institute, 2022).

[10] Kementerian Energi dan Sumber Daya Mineral, *Grand Strategi Energi Nasional* (ESDM) (Jakarta, 2021).

[11] Lechtenböhmer & Schlömer, "Transnational Legal Perspectives on CCS: A Comparative Analysis of The US, EU, and China." (2017) 109:1 Journal of Energy Policy 641-652.

Apart from that, Indonesia has also adopted standards related to monitoring and verification of CO2 storage. These standards include methods for monitoring CO2 leaks, as well as verification procedures to ensure that stored CO2 remains in geological formations over the long term.[12]

The adoption of technical standards from the United States provides several benefits for Indonesia. First, these standards help ensure that CCS projects in Indonesia are implemented to high safety and environmental standards. Second, the adoption of these standards helps accelerate the development of CCS projects in Indonesia, because these standards have been tested and proven effective in other countries. Third, the adoption of these standards helps increase investor confidence in CCS projects in Indonesia, because these standards demonstrate Indonesia's commitment to responsible CCS development.[13]

Indonesia, in its efforts to reduce carbon emissions and achieve climate targets, is actively studying and adopting various best practices from other countries in Carbon Capture and Storage (CCS) regulations. One of the most prominent examples is the potential adoption of the European Union's CCS funding mechanism.

The European Union has long been a pioneer in implementing emissions trading systems (ETS) as a tool to reduce greenhouse gas emissions. This system creates a carbon market where companies can buy and sell emissions permits. Companies that succeed in reducing emissions below the specified limit can sell their excess permits, while those that exceed the limit must purchase additional permits. This mechanism provides economic incentives for companies to invest in low-carbon technologies, including CCS.[14]

Indonesia sees great potential in adopting a similar mechanism. By implementing ETS, Indonesia can create a strong domestic carbon market, which will encourage investment in CCS projects. Additionally, ETS can

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[12] Ahmad Wisnu Prasetyo & Jaka Windarta, "Pemanfaatan Teknologi Carbon Capture Storage (CCS) dalam Upaya Mendukung Produksi Energi yang Berkelanjutan" (2022) 3:3 Jurnal Energi Baru Dan Terbarukan 231-238.

[13] Badan Penelitian dan Pengembangan ESDM, *Kajian Potensi Pemanfaatan Teknologi Carbon Capture and Storage (CCS) di Indonesia* (Jakarta: Badan Penelitian dan Pengembangan Energi dan Sumber Daya Mineral, 2019).

[14] Sabine Fuss,"Negative emissions-Part 2: Costs, Potentials and Side Effects" (2018) 13:6 Environmental Research Letters 1-47.

also provide a new source of revenue for governments, which can be used to finance other climate initiatives.[15]

However, the European Union's adoption of CCS funding mechanisms is not without challenges. Indonesia needs to consider the local context, including industrial structure, institutional capacity and technological readiness. Additionally, it is important to ensure that the system adopted is fair and effective, and does not overburden certain industry sectors.

Nonetheless, with careful planning and careful implementation, adopting the European Union's CCS funding mechanism could be an important step for Indonesia in achieving its climate goals. This will demonstrate Indonesia's commitment to the clean energy transition and can attract foreign investment in the renewable energy and low-carbon technology sectors.

B. The Impact of Legal Transplantation on CCS Regulations in Indonesia

Legal transplantation has both positive and negative impacts on the development of CCS regulations in Indonesia. On the positive side, it can accelerate the development of CCS regulations by providing a readily available framework, and it can also improve the quality of those regulations by drawing on best practices and lessons learned in other countries.[16]

Legal transplantation in the context of Carbon Capture and Storage (CCS) regulations in Indonesia has had a significant positive impact, especially in terms of accelerating regulatory development. By adopting legal practices from countries that already have experience in CCS, Indonesia can avoid the long and winding process of formulating regulations from scratch.

Countries such as Norway, the United States and Canada already have mature and proven effective CCS legal frameworks. Through legal transplantation, Indonesia can draw lessons from the experiences of these

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[15] A Purwanto & S Suhartono, "Potensi dan Tantangan Penerapan Teknologi Carbon Capture and Storage (CCS) di Indonesia" (2020) 21:1 Jurnal Teknologi Lingkungan 1-10.

[16] Usman, "Prospect For Co2 Eor To Offset The Cost Of CCS At Coal Power Plants" (2018) 39:3 Sci Contribution Oil Gas 107-118.

countries, identify best practices, and adapt them to suit the local context. This will save significant time and resources, allowing Indonesia to more quickly design comprehensive and effective CCS regulations.

Apart from that, by observing other countries' experiences, Indonesia can avoid regulatory pitfalls and design stronger, more resilient CCS regulations. By studying the experiences of other countries, Indonesia can identify potential problems and challenges that may arise, as well as ways to overcome them. This will help Indonesia to design CCS regulations that are stronger and more resilient, and avoid mistakes that could hinder the development of CCS in Indonesia.

Furthermore, legal transplantation can increase the credibility of CCS regulations in Indonesia. By adopting legal practices from countries that have been recognized as leaders in CCS, Indonesia can demonstrate its commitment to responsible and sustainable CCS development. This will increase the confidence of investors and other stakeholders in CCS regulations in Indonesia, as well as encourage investment and development of CCS in Indonesia.

Legal transplantation, namely the process of adopting and adapting legal norms from one legal system to another, has significant potential in improving the quality of Carbon Capture and Storage (CCS) regulations in Indonesia. Through legal transplantation, Indonesia can take advantage of the experience and best practices from countries that are more advanced in developing CCS regulations.

Oneway legal transplantation can improve the quality of CCS regulations is by enriching the existing legal framework. CCS regulations are a relatively new and complex field, so Indonesia can adopt legal concepts, definitions and technical standards from other countries that already have well-established CCS regulations. [17]This will help speed up the process of drafting CCS regulations in Indonesia and ensure that these regulations take into account various important aspects, such as safety, the environment and the economy.

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[17] I Gusti Ngurah Agung, "Implementasi Carbon Capture and Storage (CCS) Sebagai Upaya Mitigasi Perubahan Iklim Di Indonesia: Studi Perbandingan Dengan Norwegia" (2019) 10:2 Jurnal Ilmu Hukum 141- 152.

Apart from that, legal transplantation can also help Indonesia to identify and overcome potential problems or weaknesses in CCS regulations. By studying the experiences of other countries, Indonesia can avoid the same mistakes and develop more effective and efficient CCS regulations. For example, Indonesia could adopt monitoring and enforcement mechanisms that have proven successful in other countries to ensure compliance with CCS regulations.

Furthermore, legal transplantation can encourage the transfer of CCS-related knowledge and technology. In the process of adopting and adapting legal norms, Indonesia can also collaborate with other countries in the field of research, development and implementation of CCS technology. This will accelerate the transfer of knowledge and technology from developed countries to Indonesia, thereby strengthening Indonesia's capacity to develop and apply CCS technology independently.

In order to improve the quality of CCS regulations in Indonesia, legal transplantation can be a very useful instrument. By utilizing experience and best practices from other countries, Indonesia can develop comprehensive, effective and sustainable CCS regulations. This will provide legal certainty for business actors and investors in the CCS sector, as well as encourage the development of more advanced and environmentally friendly CCS technology in Indonesia.[18]

However, legal transplantation also has potential drawbacks. It can lead to CCS regulations that are not appropriate to the Indonesian context, given differences in legal systems, socioeconomic conditions, and geographical characteristics. This lack of fit can result in ineffective CCS regulations that fail to achieve their intended objectives or create unintended consequences.

Legal transplantation in the context of Carbon Capture and Storage (CCS) regulations in Indonesia has the potential to cause detrimental

[18] Didi Adisaputro & Bastian Saputra, "Carbon Capture and Storage and Carbon Capture and Utilization: What Do They Offer to Indonesia?" (2017) Frontiers in Energy Research 1-4.

incompatibilities.[19] CCS regulations transplanted from other countries are often developed based on different geographic, economic, and social conditions. Indonesia's unique geological conditions, with large carbon storage potential but also the risk of earthquakes and volcanoes, require specific regulations and cannot be simply compared to other countries.

Apart from that, the level of development of CCS technology in Indonesia, which is still at an early stage, also needs to be considered. Overly strict and complex regulations, which may be appropriate for countries with mature CCS technology, could hinder investment and innovation in Indonesia. On the other hand, regulations that are too loose can create undesirable environmental and social risks.

Differences in economic conditions also play a crucial role. Regulations designed for developed countries with abundant financial and technological resources may not suit Indonesia, where balancing economic growth with environmental goals is still challenging. Regulations that do not take resource constraints into account can burden industry and hinder decarbonization efforts.[20]

Therefore, in developing CCS regulations in Indonesia, it is important not only to transplant regulations from other countries but also to make careful adaptations and adjustments. A deep understanding of the Indonesian context, including geological conditions, level of technological development, and economic conditions, is key to formulating effective and appropriate CCS regulations. Collaboration between government, academia, industry and civil society is also needed to ensure CCS

[19] Arananda Dwi Putri, Nugroho Adi Sasongko & Donny Yoesgiantoro,"Carbon Capture Storage dan Carbon Capture Utilization Storage (CCS/CCUS) sebagai Solusi Transisi Energi Fosil di Indonesia"(2024) 8:2 Pendipa Journal of Science Education 191-203.

[20] Shaharizuan, Wan & Sabdullah, Norassyikin & Aenun, Siti & Binti Bosamah, Nur "A Review of Global Carbon Capture and Storage (CCS) and Carbon Capture, Utilization, and Storage (CCUS)" (2024) 516: 1 EDP Science Journal 1-10.

regulations can accommodate the interests of all parties and support the transition to a sustainable low-carbon economy.[21]

Legal transplantation in the context of Carbon Capture and Storage (CCS) in Indonesia has the potential to result in ineffective regulations for several crucial reasons. First, transplanted CCS regulations may not align with Indonesia's unique geological and infrastructure context. Each region has different geological characteristics, and regulations that do not take this into account can hinder the safe and efficient implementation of CCS.

Second, ineffective CCS regulations can ignore relevant social and economic aspects in Indonesia. For example, regulations that focus too much on the technical aspects of CCS without considering the impact on local communities and related industries can lead to conflict and resistance. In addition, regulations that do not provide adequate economic incentives for CCS investment could hinder the development of this technology in Indonesia.

Third, ineffective CCS regulations can ignore the rapid development of CCS technology. CCS technology continues to develop, and rigid and unadaptive regulations can hinder innovation and implementation of more advanced CCS technology in Indonesia. Ineffective regulations could also ignore the potential of CCS to contribute to reducing greenhouse gas emissions and transitioning to sustainable energy in Indonesia.

Therefore, it is important for Indonesia to develop CCS regulations that are effective and relevant to the local context. These regulations must take into account the unique geological, social, economic and technological characteristics of Indonesia. In addition, CCS regulations must be adaptive to technological developments and able to provide adequate incentives for CCS investment. In this way, Indonesia can exploit the potential of CCS to reduce greenhouse gas emissions and achieve sustainable development goals.

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[21] Ting Zhang, Mei Jie & Wang Hao, "The Regulatory Model of Carbon Capture and Storage Technologies (CCS) in China: Under the Perspective of Central-Local Government Relations" (2023) SSRN Journal 1-10.

IV. CHALLENGES AND OPPORTUNITIES OF ADAPTATION OF CCS REGULATIONS FROM OTHER COUNTRIES TO THE LOCAL INDONESIAN CONTEXT

A. CCS Regulatory Adaptation Challenge

Adapting CCS regulations from other countries to the local Indonesian context presents several key challenges. These include differences in geological conditions, which may require modifications to technical standards and safety protocols. Additionally, variations in legal frameworks and institutional capacity between Indonesia and other countries necessitate careful consideration of how to integrate foreign legal concepts and ensure effective implementation. These challenges highlight the need for a nuanced approach to legal transplantation that considers the unique characteristics of the Indonesian context.

The main challenge in adapting CCS regulations from other countries to the local Indonesian context lies in the significant differences in geological conditions. Indonesia, as an archipelagic country with active tectonic activity, has unique and diverse geological characteristics. These conditions include the presence of active volcanoes, active faults, and the high potential for earthquakes. These various factors need to be considered carefully in determining a safe and stable CO2 storage location.[22]

Choosing the right CO2 storage location is crucial because you must consider the potential risk of leaks. In areas with high tectonic activity, the risk of CO2 leakage may increase due to ground movement or earthquakes. Therefore, CCS regulations in Indonesia must include strict criteria in selecting storage locations, ensuring that the selected geological formation has adequate storage capacity, low levels of permeability, and high tectonic stability.

In addition, differences in geological conditions also influence the monitoring methods required. In the Indonesian context, comprehensive monitoring of CO2 storage locations is very important. This includes

[22] Hendra Amijaya, "Geological Consideration For CO2 Storage In Indonesia: A Basinal Scale outlook" (2015) 1:1 Journal of Applied Geology 19-24.

monitoring pressure, temperature and potential CO2 leaks.[23] CCS regulations should set strict monitoring standards as well as the use of advanced technology to detect potential leaks early and take necessary preventive measures.

Thus, differences in geological conditions between Indonesia and other countries require specific adjustments to CCS regulations. Such regulations must take into account Indonesia's unique geological characteristics, including the risk of earthquakes and tectonic activity. Thus, CCS implementation in Indonesia can be carried out safely, effectively and sustainably, contributing to global climate change mitigation efforts.

The striking differences in the legal framework between Indonesia and other countries are the main stumbling block in adapting CCS (Carbon Capture and Storage) regulations. One of the most crucial differences lies in the concept of ownership of natural resources. In Indonesia, natural resources, including potential geological storage space for CCS, are essentially state property.[24] This is different from several other countries where private ownership of natural resources is more recognized. The implication is that CCS regulations in Indonesia must consider clear mechanisms regarding the rights and obligations of the state and private parties involved in CCS projects.

Apart from that, the licensing system in Indonesia also has unique characteristics that need to be accommodated in CCS regulations. The licensing process in Indonesia often involves many government agencies and complex stages. The adopted CCS regulations must be able to simplify and clarify the licensing process so as not to hinder the implementation of CCS projects. Good coordination between relevant government agencies is required to ensure the licensing process runs smoothly and efficiently.

Differences in legal frameworks are also reflected in other aspects such as contractual arrangements, dispute resolution mechanisms and

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[23] Kahide Adefila & Yong Yan, "A Compendium of CO2 Leakage Detection and Monitoring Techniques in Carbon Capture and Storage (CCS) Pipelines" (2013) Journal Abbreviation: Eurocon 1377-1381.

[24] Suyanto Edi Wibowo, “Memahami Makna Pasal 33 Undang-Undang Dasar Negara Republik Indonesia Tahun 1945 Perihal Penguasaan Oleh Negara Terhadap Sumber Daya Alam"(2016) 18 :1 Jurnal Konstitusi 1-57.

environmental responsibilities. The adopted CCS regulations need to comprehensively address these aspects by taking into account the legal principles applicable in Indonesia. For example, in terms of environmental responsibility, CCS regulations must clearly regulate mechanisms for monitoring, reporting and handling potential environmental impacts from CCS activities.

Efforts to harmonize the adopted CCS regulations with the legal framework applicable in Indonesia are the key to the success of CCS implementation in the country. This can be achieved through dialogue and collaboration between relevant stakeholders, including government, industry players, academics and civil society. By comprehensively understanding and addressing differences in legal frameworks, Indonesia can utilize CCS technology as part of an effective climate change mitigation strategy.Differences in institutional capacity are a big challenge in adapting CCS regulations from other countries to Indonesia. Institutional capacity, both at the central and regional levels, is often insufficient to implement complex CCS regulations. CCS regulations demand a deep understanding of carbon capture, transport and storage technologies, as well as the ability to monitor and enforce stringent standards. Institutions in Indonesia may not yet have human resources that are sufficiently trained and experienced in this field.[25]

In addition, CCS regulations also require effective coordination between various government agencies, industry and other stakeholders. In Indonesia, cross-sector coordination is often a challenge due to differences in interests and lack of effective communication. This can hinder the implementation of CCS regulations which require close cooperation between all relevant parties.

Another challenge is the lack of supporting infrastructure for implementing CCS regulations. CCS regulations may require adequate carbon storage facilities, carbon transport pipelines, and advanced monitoring technology.

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[25] Leslie Mabon & Wan-Yu Shih, "Urban Greenspace as A Climate Change Adaptation Strategy For Subtropical Asian Cities: A Comparative Study Across Cities in Three Countries" (2021) 68:2 Journal Global Environmental Change 1-15.

This infrastructure may not yet be available in Indonesia, or may not meet the standards required by CCS regulations.

To overcome these differences in institutional capacity, systematic and sustainable capacity building efforts need to be made. Training and capacity development for human resources in government institutions and industries related to CCS needs to be improved. In addition, it is necessary to build an effective coordination mechanism between various institutions and stakeholders related to CCS. Supporting infrastructure for implementing CCS regulations also needs to be developed gradually.

B. CCS Regulation Adaptation Opportunities

Apart from challenges, adapting CCS regulations from other countries also provides several opportunities for Indonesia. These include accelerating CCS development by leveraging existing knowledge and best practices, improving the quality of CCS regulations by incorporating international standards, and increasing investment in CCS projects by signaling a commitment to international best practices and creating a more stable and predictable regulatory environment. These opportunities highlight the potential benefits of thoughtfully adapting foreign legal frameworks to the Indonesian context.[26]

Adapting CCS regulations from other countries opens up opportunities for Indonesia to accelerate the development of this technology domestically. By studying regulatory frameworks that have been successfully implemented in developed countries, Indonesia can identify best practices, avoid common mistakes, and design more effective regulations.

One example is how Norway, as a pioneer in CCS, has built a comprehensive regulatory system, including fiscal incentives, technical standards and strict monitoring mechanisms.[27] By adapting these elements, Indonesia can create an attractive investment climate for CCS companies,

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[26] Zhang Hao, "Regulations For Carbon Capture, Utilization, and Storage: Comparative Analysis of Development in Europe, China, and The Middle East" (2021) 173 Resources, Conservation and Recycling Journal 100-112.

[27] Bui et al, *supra* note 2.

encourage technological innovation, and accelerate the implementation of CCS projects.

Apart from that, international collaboration in developing CCS also becomes easier with regulatory alignment. Uniform technical standards, for example, can facilitate the transfer of technology and knowledge from developed countries to Indonesia. International companies will also be more interested in investing in Indonesia if CCS regulations in this country are in line with global standards.

Thus, adapting CCS regulations from other countries is not just an administrative step,[28] but is also a strategic strategy to accelerate CCS development in Indonesia. Through learning from the experiences of other countries, international collaboration, and harmonization of regulations, Indonesia can take advantage of this opportunity to become a major player in mitigating global climate change.

Improving the quality of CCS regulations through adapting regulations from other countries provides significant opportunities to accelerate CCS development in Indonesia. By adopting best practices and valuable lessons from countries that have previously implemented CCS, Indonesia can avoid common mistakes and design more effective and comprehensive regulations. This opportunity allows Indonesia to refine CCS regulations by considering local context, including unique geological characteristics, industrial conditions and energy needs. In this way, the resulting CCS regulations will be more relevant and able to encourage optimal CCS implementation in Indonesia.

Improving the quality of CCS regulations will also provide legal certainty and attractive incentives for investors and industry players. Clear and supportive regulations will encourage investment in CCS technology, accelerate the development of CCS projects, and ultimately contribute to reducing greenhouse gas emissions in Indonesia.

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[28] Floris Swennenhuis et al, "What Role for CCS in Delivering Just Transitions? An Evaluation in The North Sea Region" (2020) 94 International Journal Greenh Gas Control 57-70.

Apart from that, adapting CCS regulations from other countries can also speed up the process of drafting regulations in Indonesia. By leveraging existing experience and knowledge, Indonesia can save time and resources in designing comprehensive and effective CCS regulations. This will pave the way for a faster and more efficient implementation of CCS, and support the achievement of Indonesia's emissions reduction targets in the long term.

Increased investment in the CCS (Carbon Capture and Storage) sector in Indonesia can be encouraged significantly through clear and comprehensive regulations. Legal certainty and attractive incentives for investors are the main keys in attracting capital flows into CCS projects. With good regulations, Indonesia can assure investors that their investments will be protected and generate sustainable profits.

Comprehensive regulations will cover various aspects, from efficient licensing processes, clear technical standards, to transparent monitoring and reporting mechanisms. This will create a conducive investment climate and reduce risks for investors. In addition, regulations that provide fiscal incentives, such as tax reductions or investment credits, will further increase the investment attractiveness of the CCS sector.

Increasing investment in the CCS sector not only provides economic benefits but also contributes to climate change mitigation efforts. Investments in CCS technology can help significantly reduce greenhouse gas emissions, especially from industrial sectors that are difficult to decarbonize. Thus, appropriate CCS regulations can be a catalyst for green economic growth in Indonesia.

To attract investment and foster CCS development, Indonesia can learn from successful projects in other countries. For example, the Sleipner project in Norway has successfully captured and stored over one million tons of CO2 annually since 1996. This project demonstrates the viability of offshore storage and highlights the importance of government support and a stable regulatory framework in attracting investment.[29] Similarly, the Quest project in Canada showcases the successful application of CCS

[29] Semere Solomon, "Carbon Dioxide Storage: Geological Security and Environmental Issues-Case Study on the Sleipner Gas field in Norway" (2007) Bellona Report 1-126.

technology in a challenging environment, capturing CO2 from an oil sands operation. By studying and adapting elements from these successful projects, Indonesia can create a conducive environment for CCS investment and contribute to global climate change mitigation efforts.[30]

Apart from attracting foreign investment, the growth of the CCS sector in Indonesia can also create new jobs and encourage domestic technology development. With the transfer of technology and knowledge from foreign investors, Indonesia can increase local capacity and expertise in the CCS field. This will provide long-term benefits for the Indonesian economy and environment.

Overall, clear and comprehensive CCS regulations have great potential to attract significant investment to Indonesia. By taking advantage of this opportunity, Indonesia can accelerate the transition to clean energy, reduce greenhouse gas emissions, and achieve sustainable economic growth.

V. ACHIEVE A BALANCE BETWEEN HARMONIZATION OF GLOBAL CCS REGULATIONS AND ADAPTATION TO LOCAL CONTEXT

A. Opportunities for Harmonization of Global CCS Regulations

The increasing global momentum behind CCS technology presents a unique opportunity for harmonizing CCS regulations internationally. This harmonization can foster collaboration, facilitate investment, and accelerate the deployment of CCS technology worldwide. Key areas where international cooperation can play a crucial role include: developing consistent technical standards, establishing clear legal frameworks for cross-border CO2 transport and storage, and creating robust monitoring and verification mechanisms. Furthermore, international collaboration can support the development of innovative funding mechanisms to incentivize

[30] Ian Silk, "Quest Carbon Capture & Storage Project" (2011) 1:4 November Strategy 1–12.

CCS projects and ensure equitable access to technology and knowledge transfer, particularly for developing countries.[31]

International cooperation is the main pillar in efforts to harmonize Carbon Capture and Storage (CCS) regulations at the global level. Organizations such as the International Energy Agency (IEA) and the United Nations Framework Convention on Climate Change (UNFCCC) play a crucial role in facilitating dialogue and collaboration between countries. Through this platform, countries can share knowledge, experience and best practices regarding CCS.

This exchange of information is invaluable in addressing knowledge gaps and accelerating CCS technology development. Developing countries can learn from developed countries that have already implemented CCS, avoid the same mistakes, and adopt proven technologies.[32] In addition, international cooperation also encourages the development of uniform CCS technical standards. This standard will ensure that CCS projects around the world meet the same safety, environmental and effectiveness criteria, thereby increasing investor and public confidence in this technology.

Furthermore, international cooperation can stimulate innovation in CCS technology. By sharing knowledge and resources, countries can develop CCS solutions that are more efficient, affordable and sustainable. Collaboration in research and development can also accelerate the discovery of technological breakthroughs that could revolutionize the CCS industry.

Overall, international cooperation is a key element in creating a harmonious global CCS regulatory framework. Through information exchange, standards development, and collaboration on innovation, countries can jointly address the challenges of climate change and achieve sustainable development goals.

The development of a global funding mechanism is crucial in accelerating the adoption of Carbon Capture and Storage (CCS) technology

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[31] Ahmed Hamdy El-Kady et al, "Analysis of CO2 Pipeline Regulations from A Safety Perspective For Offshore Carbon Capture, Utilization, and Storage (CCUS)" (2024) 439 Journal of Cleaner Production 1-25.

[32] *CCUS in Clean Energy Transitions. IEA Publications.*, by IEA (Paris, 2020).

throughout the world, especially in developing countries. Mechanisms such as the Clean Development Mechanism (CDM) have proven effective in providing financial incentives for emission reduction projects. In the context of CCS, CDM can be modified or further developed to provide carbon credits for every tonne of CO2 captured and stored. This will attract investment from developed countries that have emission reduction obligations, while encouraging the transfer of CCS technology to developing countries.

Apart from CDM, other innovative funding schemes also need to be explored. For example, implementing a global carbon tax could create a significant source of revenue to fund CCS projects. These funds can be channeled through multilateral institutions such as the Green Climate Fund (GCF) to support CCS initiatives in developing countries. In addition, the development of a more integrated and transparent carbon market will provide clear price signals for CCS investments, thereby increasing investor confidence and encouraging private sector participation.[33]

International cooperation also plays an important role in mobilizing funding for CCS. Developed countries can provide technical and financial assistance to developing countries to build CCS infrastructure, including CO2 capture, transport and storage facilities. Collaboration between governments, the private sector and international financial institutions will accelerate the development of economically viable and sustainable CCS projects.

It is important to remember that the development of funding mechanisms must be in line with harmonized global CCS regulations. Clear and consistent technical standards will ensure that CCS projects meet stringent environmental criteria and provide real benefits in reducing greenhouse gas emissions. Thus, the development of effective funding mechanisms and harmonized regulations will create a conducive environment for CCS

[33] Niklas Döbbeling-Hildebrandt et al, "Systematic Review and Meta-analysis of Ex-post Evaluations on The Effectiveness of Carbon Pricing" (2024) 15:1 Nature Communication Journal 1-12.

investment, encourage technological innovation, and accelerate the transition to a low-carbon economy globally.

The development of effective funding mechanisms is key to achieving global harmonization of CCS regulations. Given the large investments required in CCS technology, international collaboration in providing financial resources is essential. One mechanism that could be considered is the creation of a global climate fund dedicated to CCS projects. These funds can come from contributions from developed countries, energy companies and international financial institutions. In addition, innovative financing schemes such as green bonds or carbon credits can also be used to attract private investment.[34]

The transfer of technology and knowledge from developed to developing countries also plays an important role in the development of CCS funding mechanisms. By increasing the capacity and ability of developing countries to manage CCS projects, investment risks can be reduced, thereby attracting more investors. Training, expert exchange programs, and technical assistance can be effective means of transferring this technology and knowledge.

Additionally, the development of clear standards and methodologies for measuring and verifying emissions reductions from CCS projects will also increase investor confidence. With high transparency and accountability, investors will be more confident in investing their capital in CCS projects, thereby accelerating the implementation of this technology globally.

B. Adaptation of CCS Regulations to Local Contexts

While harmonization of global CCS regulations offers valuable benefits, it is equally crucial to recognize the importance of adapting these regulations to local contexts. This adaptation ensures that CCS implementation aligns with the unique geographical, social, economic, and political realities of each country. Geographical considerations encompass factors such as

[34] Maria B Mills et al, "Tropical Forests Post-Logging are A Persistent Net Carbon Source to The Atmosphere" (2023) 120:3 The Proceedings of the National Academy of Sciences Journal 1-7.

geological suitability for CO2 storage, seismic activity, and proximity to population centers. Social considerations involve addressing potential community concerns, ensuring public acceptance, and respecting the rights of indigenous peoples. Economic considerations include assessing the costs and benefits of CCS deployment, evaluating its impact on local industries, and creating opportunities for economic development.[35] Lastly, political considerations involve aligning CCS regulations with national climate targets, securing government support, and ensuring policy consistency. Geographical considerations are a crucial pillar in adapting Carbon Capture and Storage (CCS) regulations to the local context in Indonesia. Diverse geological characteristics demand special attention in selecting CO2 storage locations. Ideal geological formations, such as deep saline aquifers or depleted oil and gas reservoirs, need to be identified and carefully evaluated. Additionally, potential geological risks, such as earthquakes and active faults, must be mapped to ensure the long-term safety of CO2 storage.[36]

Comprehensive geological risk mapping is an important foundation in the development of adaptive CCS regulations. Identification of earthquake-prone zones and active faults allows appropriate decisions to be made in determining safe storage locations. In addition, studies regarding rock characteristics and potential CO2 leaks need to be carried out to ensure storage integrity and prevent negative impacts on the environment.[37]

Adaptive regulations also need to consider variations in geographic conditions between regions in Indonesia. Different geological characteristics between islands or regions require a specific approach in selecting locations and storage technology. For example, regions with high volcanic activity may require special attention to the risk of CO2 leaks triggered by geothermal activity.

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[35] Swati Gola & Kyriaki Noussia, "From CO2 Sources to Sinks: Regulatory Challenges for Trans-boundary Trade, Shipment and Storage" (2022) 179 Resour Conserv Recycling Journal 1-15.

[36] Tanikawa & Michael, "Geological Storage of Carbon Dioxide in Indonesia: A Review of The Potential and Challenges" (2022) 10:1 International Journal of Green Gas Control 101 - 120.

[37] *Ibid.*

In this context, collaboration between government, scientists, and industry is key in developing CCS regulations that are adaptive to geographic considerations. Accurate geological risk mapping, research into local geological characteristics, and development of storage technology appropriate to geographical conditions are important steps in ensuring the success of CCS implementation in Indonesia.

Social considerations are a crucial pillar in adapting CCS (Carbon Capture and Storage) regulations to be in line with the local context. Community acceptance of CCS projects is often influenced by their understanding of the technology, its potential benefits, and the risks that may arise. Therefore, transparency and public involvement from the early stages of project planning are key to building trust and reducing the potential for social conflict.[38]

Open dialogue between stakeholders, including government, industry, academia, and local communities, can facilitate a comprehensive exchange of information and views. In this dialogue, it is important to honestly discuss the potential social impacts of the CCS project, both positive and negative, as well as the mitigation steps that will be taken. For example, public concerns about possible CO2 leaks and their impact on health and the environment need to be taken seriously and explained scientifically.

In addition, CCS regulations also need to consider the impact of projects on the livelihoods of local communities. If a CCS project has the potential to disrupt traditional economic activities, such as agriculture or fishing, then efforts need to be made to provide fair compensation and find sustainable alternative solutions. For example, the development of new skills training programs or economic diversification can help local communities adapt to changes.

Furthermore, aspects of social justice also need to be considered in CCS regulations. The distribution of benefits and burdens from CCS projects must be carried out fairly and evenly among all community groups. This includes ensuring that communities living around the project site do not

[38] Katherine A Nelson, "The Role of Payment for Ecosystem Services in Incentivizing Carbon Sequestration in Agricultur" (2014) 38:2 Enviromental Science and Policy Journal 118-128.

bear a disproportionate environmental burden, and receive balanced economic benefits.[39]

By comprehensively integrating social considerations into CCS regulations, we can ensure that this technology is not only effective in reducing carbon emissions but also has a positive impact on society and the environment as a whole. Effective CCS regulations must comprehensively consider the economic viability of CCS projects. It includes an in-depth analysis of the entire CCS life cycle, from CO2 capture at emission sources, and transportation via pipelines or ships, to permanent storage in underground geological formations. These costs can vary greatly depending on the technology used, transportation distance, and characteristics of the storage location.[40]

In addition to costs, regulators also need to assess the potential economic benefits of CCS projects. This includes job creation in various sectors, such as construction, operations, and maintenance of CCS facilities. In addition, the development of the CCS industry can encourage technological innovation, increase industrial competitiveness, and open opportunities for CCS technology exports.

To encourage private investment in high-risk and capital-intensive CCS projects, regulators need to design attractive incentives. This could take the form of tax credits, subsidies, or a carbon price that places economic value on reducing CO2 emissions. Additionally, regulation can facilitate access to innovative financing mechanisms, such as green bonds or climate funds, to reduce financial barriers for project developers.

Regulations should require a comprehensive cost-benefit analysis for every proposed CCS project. This analysis should consider the project's economic, social, and environmental impacts, including potential risks and uncertainties. Transparency in decision-making processes and public access

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[39] Fiqya Fairuz Zaemi & Rian Cahya Rohmana, "Carbon Capture, Utilization, and Storage (CCUS) untuk Pembangunan Berkelanjutan: Potensi dan Tantangan di Industri Migas Indonesia" (2021) 3:1 Prosiding Seminar Nasional Teknik Lingkungan Kebumian (Satu Bumi) Ke-III 11- 24.

[40] Klenert et al, "Making Carbon Pricing Work for Citizens" (2018) 8:8 National Climate Change Journal 669-677.

to project information are critical to building public trust and ensuring accountability.

Regulations can encourage public-private partnerships (PPPs) in the development of CCS projects. PPPs can combine resources and expertise from the public and private sectors to address financial, technical, and operational challenges. Regulations can provide a clear framework for PPPs, including fair sharing of risks and benefits, as well as effective dispute resolution mechanisms. Carbon Capture and Storage (CCS) regulations in Indonesia must take into account complex political dynamics and diverse interests. Political stability is key in attracting the long-term investment required for the development of CCS projects. Consistent policies and cross-party support for CCS will provide certainty for investors and encourage growth in this sector.[41]

Government support, both at the central and regional levels, is a determining factor in the success of CCS implementation. Governments can provide fiscal incentives, such as tax breaks or subsidies, to reduce high initial investment costs. Apart from that, the government can also speed up the licensing process and provide technical support to CCS project developers.

Public participation and transparency in decision making also need to be considered. Effective outreach regarding the benefits and risks of CCS to the public can reduce the potential for social conflict and increase acceptance of this technology. Involving stakeholders, including NGOs and local communities, in the CCS planning and implementation process can ensure that the regulations produced are in line with community needs and aspirations.

Political considerations also include geopolitical aspects. International cooperation in CCS development can provide access to better technology and funding. Indonesia can learn from the experiences of other countries that have successfully implemented CCS and established strategic partnerships to accelerate the development of this sector. By considering

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[41] Ghanshyam Patle, Bandyopadhyay & Singh, "Impact of Conservation Agriculture and Resource Conservation Technologies on Carbon" Sequestration–a Review" Indian Journal of Agriculture Science 3-13.

these various complex political aspects, CCS regulations in Indonesia can be an effective instrument in achieving emissions reduction targets and the transition to clean energy.

VI. CONCLUSION

This research has revealed the dilemma of legal transplantation in CCS regulations in Indonesia, highlighting the complexity of achieving a balance between global harmonization and local adaptation. Legal transplantation, while offering a tested framework, does not always suit Indonesia's unique local context. Challenges such as differences in geological conditions, existing legal frameworks, and socio-political dynamics require careful adaptation. This study confirms the importance of a holistic approach in designing CCS regulations. Global harmonization must be balanced with adaptation that takes into account local characteristics, including geological conditions, institutional capacity, and community aspirations. Collaboration between policy makers, technical experts, and local stakeholders is key in formulating effective and sustainable CCS regulations.

Further research is needed to explore optimal adaptation mechanisms for CCS regulations in Indonesia. This research should delve deeper into specific aspects crucial for successful local adaptation. For example, further investigation is needed into the geological characteristics of potential CO2 storage sites in Indonesia to ensure safe and effective storage. Additionally, research should focus on developing financing models that incentivize CCS investment while considering the economic conditions in Indonesia. Other areas requiring further exploration include social and cultural factors influencing public acceptance of CCS, as well as legal and institutional frameworks necessary for effective implementation. By focusing on these specific aspects, future research can provide clearer guidance on the next steps in CCS development in Indonesia and contribute to the creation of a robust and locally adapted regulatory framework., including the use of flexible and participatory legal instruments. Comparative studies with other countries can also provide valuable insight into best practices in CCS legal transplantation. By overcoming the dilemma of legal transplantation,

Indonesia can develop CCS regulations that are effective, fair, and in line with sustainable development goals.

ACKNOWLEDGMENTS

The author would like to express his deepest gratitude to all the law lecturers at Surabaya University of Technology, especially at the Faculty of Social Sciences and Humanities, for all the guidance, support and knowledge they have provided during the process of writing this scientific work. Thank you for the dedication of the lecturers in guiding and directing the author, so that the author can complete this research well. The author is also grateful for the opportunity given to learn and develop himself in a conducive academic environment. Hopefully, this scientific work can make a positive contribution to the development of legal science. The author hopes that this scientific work can be useful for the wider community

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