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# IMPLEMENTATION POTENTIAL AND CHALLENGES OF CARBON CAPTURE AND STORAGE IN INDONESIA

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**Abstract**

*Carbon capture and storage (CCS) is a technology designed to absorb carbon emissions generated by a system, enabling various energy sectors to reduce $CO_2$ emissions and contribute to climate change mitigation. This article investigates the potential and challenges associated with implementing CCS in Indonesia. Indonesia boasts significant carbon storage potential, estimated at 400 to 600 gigatons in depleted reservoirs and saline aquifers. Capitalizing on this potential, Indonesia has proactively developed CCS technology and established a CCS hub center, fostering a global market for low-carbon emission products. However, the challenges of engineering, funding, and regulation must be addressed for CCS's widespread and sustainable implementation. Effective oversight by Commission IV DPR RI ensures the CCS project achieves emission reduction targets without causing environmental harm. Simultaneously, Commission VII DPR RI should actively promote the adoption of CCS technology by large industries to facilitate the decarbonization of the industrial sector.*

## Introduction

During the inaugural debate for Vice Presidential (VP) Candidates held at the Jakarta Convention Center on December 22, 2023, the term "carbon capture and storage" (CCS) or CCS technology surfaced as a significant theme. The broader community exhibits a considerable and widespread curiosity about comprehending the essence of CCS.

In the context of addressing climate change, the adoption of CCS technology offers an alternative to mitigate the adverse impacts. This technology facilitates carbon dioxide ($CO_2$) capture, allowing various high-emission sectors like manufacturing, power generation, refining, petrochemical, steel, and cement industries to curb emissions. In central Indonesia, endeavors are underway

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to achieve the Enhanced Nationally Determined Contribution (ENDC) target, aiming for a 31.89 percent reduction in emissions by 2030 through domestic initiatives and 43.20 percent with international support. This commitment was articulated during the international climate change conferences, COP 27 in Sharm El Sheikh, Egypt, and COP 28 in Dubai at the end of 2023. The proposals discussed included exploring $CO_2$ emission reduction technologies focusing on CCS (Syarif, 2023).

In pursuit of the Net Zero Emission (NZE) target by 2060, Indonesia has embarked on advancing CCS technology and establishing a CCS hub center. This proactive step is poised to generate significant breakthroughs for the Indonesian economy, open up new prospects in the industrial sector, and cultivate a global market for low-carbon emission products. This paper delves into examining and analyzing the potential and challenges of implementing CCS within a low-carbon development framework in Indonesia.

## CCS Potential in Indonesia

CCS, commonly referred to as carbon capture utilization and storage (CCUS), stands out as a recognized technology for mitigating global warming by curbing the release of $CO_2$ into the atmosphere. In simple terms, CCS/CCUS technology enables the recapture of $CO_2$ from fossil fuels or waste combustion, with the captured $CO_2$ subsequently stored underground or beneath the sea (Pertamina, 2023).

The Ministry of Energy and Mineral Resources (ESDM) has revealed that Indonesia currently boasts 15 projects aimed at developing $CO_2$ carbon storage technology, particularly within the oil and gas sector, amounting to a total capacity of 4.31 gigatons of $CO_2$ (Setiawan, 2023). The implementation of CCS/CCUS in Indonesia is expected to enhance oil and gas production while mitigating greenhouse gas (GHG) emissions. Aligned with the International Energy Agency's Roadmap for Net Zero Emission (NZE) in the energy sector, CCS technology is projected to contribute to over 10 percent of the total global emissions reduction by 2050 (Aditriandi, 2023).

Indonesia possesses geological formations ideal for permanently storing carbon emissions through CCS technology. Jodi Mahardi, the Deputy for Maritime Sovereignty and Energy Coordination at the Coordinating Ministry for Maritime Affairs and Investment, has emphasized that Indonesia is at the forefront of the green industrial era. The country showcases a substantial $CO_2$ storage potential ranging from 400 to 600 gigatons in depleted reservoirs and saline aquifers. With this capacity, Indonesia can store its national $CO_2$ emissions for an estimated 322 to 482 years, factoring in the projected peak emissions of 1.2 gigatons of $CO_2$ equivalent in 2030 (Pertamina, 2023).

Recognizing this potential, Indonesia, in its pursuit of achieving Net Zero Emission (NZE) by 2060, aims to develop CCS technology and establish a CCS hub. This initiative is designed to effectively manage domestic $CO_2$ and encourage international cooperation, particularly in carbon trade. As a result, CCS is acknowledged as a 'license to invest,' particularly in industries characterized by low carbon emissions, such as blue ammonia, blue hydrogen, and advanced petrochemicals (Pertamina, 2023). Besides advancing the decarbonization of the industrial sector, the application of CCS technology represents a ground-breaking development for the Indonesian economy, generating new industrial opportunities and creating a global market for low-carbon products.

## Challenges and Solutions in Implementing Carbon Capture and Storage

Despite its substantial economic potential and positive impacts on emissions reduction, the development of CCS in Indonesia encounters several challenges, primarily in technical, funding, and regulatory aspects. Addressing technical challenges involves critical stages such as reception, transportation, injection, storage, measurement monitoring, reporting, and verification. Each stage requires adherence to location-specific characteristics using robust engineering protocols (Aditriandi, 2024). The technological process spans from capture to transport and storage. However, as reported by New Scientist, many CCUS projects have faced failures or achieved lower carbon capture than anticipated, with concerning incidents in the $CO_2$ piping process (Syarif, 2024). Therefore, regulations are crucial to ensuring high operational safety and security standards. The choice of technology and strategy must be tailored to meet the specific needs and objectives that Indonesia aims to accomplish.

The subsequent challenge revolves around the need for substantial investments. For instance, the agreement on CCS development between the Indonesian Government and ExxonMobil required an investment of USD15 billion. Similarly, the CCS Quest project in Canada calls for USD1.35 billion for a capacity of 1.2 million tons of $CO_2$ per year (Pertamina, 2023). Therefore, it is crucial to explore funding opportunities from external sources. Presidential Regulation No. 98 of 2021 on the Implementation of Carbon Economic Value has enabled the monetization of carbon credits, recognizing the economic potential stemming from the implementation of CCS/CCUS. Leveraging international partnership funds also presents an opportunity. For instance, the Carbon Capture and Storage Fund from Australia, acting as a partner trust fund under the Clean Energy Financing Partnership Facility, provides funds for CCS development in all developing countries that are members of the Asian Development Bank, including Indonesia (ADB, 2024).

Furthermore, a strong legal foundation is imperative, especially given Indonesia's leadership role in ASEAN in implementing CCS regulations. However, there is a need to address CCS technology in Law No. 32 of 2009 on Environmental Protection and Management, Law No. 22 of 2001 on Oil and Natural Gas, and Law No. 30 of 2007 on Energy. Additionally, it is crucial to include CCS in the Republic of Indonesia's 2022 Nationally Determined Contribution (NDC) document.

Several regulations related to CCS include Minister of Energy and Mineral Resources Regulation (Permen ESDM) No. 2 of 2023 on the Maintenance of Carbon Capture and Storage, and Capture, Utilization, and Carbon Storage in Upstream Oil Business Activities and Natural Gas. Another relevant regulation is Presidential Regulation No. 98 of 2021 on Implementing Carbon Economic Value for the Achievement of Determined Contribution Targets Nationally and Controlling Greenhouse Gas Emissions in National Development. Financial Services Authority Regulation No. 14 of 2023 also addresses carbon trading via the carbon exchange.

It is noteworthy that ESDM Ministerial Regulation No. 2 of 2023 does not reference the Environmental Law and NDC; instead, it focuses solely on carbon storage within oil and gas businesses and excludes other carbon emissions. Furthermore, the ESDM Ministerial Regulation does not require an environmental impact analysis for CCUS projects. It is important to note that CCUS projects have the potential to cause environmental damage, pose risks to human safety, and result in damage to resources, equipment, and installations (Syarif, 2024).

Several CCS and CCUS projects in Indonesia are still in the study or preparation phase, indicating the need for comprehensive regulations. The establishment of a regulatory framework, particularly concerning financial incentives, international partnerships, spatial planning and zoning, continuous monitoring and evaluation, and other non-technical aspects like target markets for CCS, education and training, research and innovation stimulation, public awareness campaigns, and government support, must be arranged before the broader operation of CCS (Fitriyah, 2024).

Incorporating CCS into the legal framework is crucial, especially within laws related to life protection, energy, and industry, despite existing risks, such as accidents in CCS piping. Therefore, creating a comprehensive regulatory framework overseeing CCS operations and addressing non-technical aspects is essential. This approach helps instill investor confidence in development projects in Indonesia and assures the community regarding operational safety and security.

## Conclusion

CCS technology is crucial in global decarbonization and mitigation efforts, particularly within the energy sector and fossil fuel power plants. With its substantial $CO_2$ storage potential, Indonesia has a significant opportunity to become a key player in developing this technology. However, it is essential to address engineering, financial, and regulatory challenges to ensure that CCS can be implemented widely and sustainably in Indonesia. Overcoming these challenges will be instrumental in realizing the full potential of CCS in contributing to Indonesia's and the world's efforts to combat climate change.

The Commission IV of the DPR RI must exercise oversight to ensure that the CCS project under preparation meets expectations as an alternative technology in mitigating the negative impacts of climate change without causing environmental damage. Additionally, comprehensive regulations should be prepared to address climate change. Simultaneously, Commission VII of the DPR RI, which is responsible for industry, should continue to encourage large industries to adopt CCS technology to realize green energy. This collaborative effort between the commissions can contribute significantly to the effective implementation of CCS technology in Indonesia.

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