The Pathway Towards Supporting the Implementation of the New Indonesian Law on Carbon Capture and Storage in Indonesian Universities

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Abstract. Carbon Capture and Storage (CCS) technology emerges as a promising solution to combat CO2 emissions from industrial processes and power generation, playing a vital role in the global efforts to mitigate climate change. However, despite its potential benefits, the widespread adoption of CCS faces challenges across technical, economic, and regulatory domains. In Indonesia, a nation heavily dependent on fossil fuels, CCS presents a significant opportunity to reduce emissions while sustaining economic growth. Therefore, this paper explores Indonesia’s strategic approach to CCS initiatives, examining the regulatory framework and the current landscape of CCS projects within the country. The study discusses the contributions of Indonesian universities towards advancing CCS technology through collaborative research, partnerships, and innovative initiatives. By assessing the role of universities in addressing environmental challenges and fostering a greener future, this paper highlights the pivotal importance of universities in driving sustainable solutions for mitigating greenhouse gas emissions and achieving climate objectives. The finding concludes that Indonesian universities significantly contribute to the development and implementation of CCS through collaborative efforts and partnerships, facilitating a path towards sustainability.

1 Introduction

Carbon Capture and Storage (CCS) technology stands as a pivotal tool in the global endeavour to combat climate change, offering a promising pathway to mitigate CO2 emissions originating from industrial processes and power generation [1]. This innovative technology involves capturing carbon dioxide emissions at their source, whether from coal-fired power plants or industrial facilities and securely storing them underground, thereby preventing their release into the atmosphere [2, 3]. CCS not only allows for the continued utilization of fossil fuels but also significantly reduces their environmental impact, aligning with international climate agreements such as the Paris Agreement and facilitating the transition towards a low-carbon economy [4].

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However, the widespread adoption of CCS faces multifaceted challenges across technical, economic, and regulatory fronts [5]. Technical hurdles encompass the development of efficient and cost-effective capture technologies, identifying suitable storage sites, and ensuring the integrity and safety of stored CO2 over the long term [6, 7]. Moreover, significant upfront costs, uncertain policy frameworks, and a lack of financial incentives pose barriers to investment and commercialization. Public perception and stakeholder engagement also play critical roles in the acceptance and deployment of CCS projects, emphasizing the need for effective communication and community involvement throughout the development and implementation phases [8]. Addressing these challenges necessitates a holistic and collaborative approach involving governments, industry stakeholders, research institutions, and civil society to fully harness the potential of CCS technology in combatting climate change.

In the context of Indonesia, CCS holds particular significance as the nation grapples with the dual challenge of economic development and environmental sustainability [9]. With its reliance on coal for electricity generation and industrial processes, Indonesia faces substantial emissions contributing to climate change. CCS offers a viable option for Indonesia to address these emissions while still utilizing its abundant fossil fuel resources. As a country vulnerable to the impacts of climate change, Indonesia has a vested interest in exploring CCS technology as part of its climate mitigation strategy [10]. Despite unique challenges such as tailored solutions to suit the country's geology, infrastructure requirements, and regulatory framework, initiatives are underway to explore the feasibility of CCS deployment in Indonesia [11]. Collaborations between government agencies, research institutions, and industry stakeholders aim to advance CCS technology and integrate it into Indonesia's energy and climate policies.

Universities, as research institutions, are at the forefront of tackling the technical challenges associated with CCS technology. They conduct fundamental research to enhance the efficiency and cost-effectiveness of CO2 capture processes, develop novel materials and methodologies for storage, and assess the environmental impacts of CCS deployment [12]. Through interdisciplinary collaboration and access to state-of-the-art facilities, universities drive innovation in CCS technology, pushing the boundaries of what is possible in mitigating greenhouse gas emissions.

This paper investigates the contribution of Indonesian universities to Carbon Capture and Storage (CCS). Universities are depicted to have a vital role in knowledge dissemination and technology transfer within the CCS domain. They bridge the gap between scientific advancements and practical application by fostering partnerships with industry stakeholders, facilitating the scaling up of CCS solutions, and providing expertise in policy development and regulatory frameworks. By nurturing a collaborative ecosystem that brings together academia, industry, and government, universities accelerate the adoption and implementation of CCS technology, contributing to global efforts to combat climate change and achieve sustainable development goals.

The rest of this paper is organized as follows. Section 2 describes the method for reviewing the CCS initiative by Universities in Indonesia. Section 3 shows the regulations and university initiatives related to CCS. Section 4 concludes the findings.

2 Data Collection Methods

In this study, data were collected through a comprehensive review of existing literature and regulations pertaining to Carbon Capture and Storage (CCS) in Indonesia. Through a systematic search and analysis of government documents, relevant information regarding the implementation of CCS technology and its regulatory framework in Indonesia was gathered. Additionally, data regarding CCS projects, regulations, and initiatives were collected and
synthesized to provide insights into the current state of CCS in Indonesia and the regulatory mechanisms governing its deployment.

Furthermore, information regarding the contributions of universities in CCS gathered from various news sources, was incorporated to enrich the understanding of the academic community's involvement in advancing CCS technology and addressing environmental challenges. The analysis aimed to evaluate the current state of Carbon Capture and Storage (CCS) technology implementation in Indonesia, focusing on understanding the regulatory framework, existing projects, and the contributions of universities in advancing CCS initiatives.

3 Result and Discussion

This section discusses the CCS and its regulatory framework in Indonesia. The current state of CCS technology adoption and the regulatory environment governing its implementation within the country is examined. Furthermore, the contributions made by Indonesian universities towards the implementation of CCS solutions is also discussed.

3.1 Carbon Capture and Storage (CCS) and Regulation in Indonesia

In recent years, CCS has risen as a vital tool in addressing climate change. This technology captures carbon dioxide emissions released by industries and power plants, subsequently storing them underground. In Indonesia, where carbon emissions are significant due to its reliance on fossil fuels, the implementation of CCS holds significant promise for reducing greenhouse gas emissions. The implementation plan for CCS or Carbon Capture, Utilization, and Storage (CCUS) in Indonesia proposed by various stakeholders can be seen in Figure 1. The figure illustrates that 16 CCS/CCUS projects in Indonesia are still in the study/preparation stage, with the majority aiming to be operational by 2030 [13].

![Fig. 1. Implementation Plan for CCS/CCUS in Indonesia [13]](image-url)

Indonesia took a major step forward in its climate change mitigation efforts on November 24, 2023, with the launch of its first-ever CCUS project in West Papua province. Led by President Joko Widodo and operated by British multinational oil and gas company BP Plc...
(BP.L), this project signals Indonesia's commitment to innovative carbon storage solutions. The project has the capacity to store 1.8 gigatonnes of carbon dioxide, and the first injection is expected in 2026. Indonesia's abundant potential for carbon storage makes CCUS/CCS technologies particularly attractive, and the nation has 15 such projects in development, with estimated investments totalling $8 billion [14].

The adoption of CCS technology in Indonesia is governed by specific regulations aimed at ensuring its safe and effective deployment while addressing environmental concerns and legal considerations. Carbon emission control is not detached from the active role of the government in managing it. Several regulations regarding carbon mitigation and monetization in Indonesia are described in Figure 2.

Presidential Regulation Number 14 of 2024, enacted on Tuesday, January 30, 2024, establishes the framework for Carbon Capture and Storage (CCS) activities in Indonesia, outlining terms and technical procedures across 14 chapters and 77 articles. This regulation aims to reduce carbon emissions from industrial and energy sectors by safely capturing and storing CO2. It sets clear responsibilities for contractors and storage operation permit holders, emphasizing safety monitoring and encouraging investment in CCS business processes to create economic value. Additionally, the regulation aligns with Indonesia's goal of achieving net-zero emissions by 2060 or earlier, providing a legal basis and certainty for CCS implementation while ensuring the continuity of related regulations under its provisions [15].

Fig. 2. CCS Regulation in Indonesia [13]

3.2 Indonesian University's contribution to carbon capture and storage development

Universities serve as crucial hubs for driving research and innovation in the field of CCS, playing a vital role in developing sustainable solutions to effectively mitigate greenhouse gas emissions. Through academic initiatives, collaborative studies, and cutting-edge technologies, universities contribute substantially to the ongoing efforts aimed at addressing environmental challenges and fostering a greener future.
Several universities in Indonesia have actively contributed to the advancement of CCS technology through various initiatives, focusing on training and education, collaboration with external parties, and engagement with experts. For example, the Faculty of Engineering at the Universitas Indonesia (FTUI) has established a strategic partnership with the Tokyo University of Agriculture and Technology (TUAT) in Japan to address global CCS challenges [16]. Similarly, the Bandung Institute of Technology (ITB) has organized sharing sessions and discussions, highlighting the importance of innovation and sustainable solutions in CCS development, particularly in creating decarbonized industrial hubs [17]. CCS implementation activities at UI and ITB can be seen in Figure 3.

Moreover, Universitas Pertamina (UP) has been instrumental in developing CCS technology, with its students actively supporting initiatives for net-zero emissions. They emphasize the significance of geological assessments to ensure the safe implementation of CCS and prevent potential CO2 leakage [18]. Additionally, UPN Veteran Yogyakarta has collaborated with PT. Pertamina, emphasizing the importance of transitioning to carbon-reduced energy and the development of CCS/CCUS technology in response to environmental impacts. The university is ready to support the advancement of oil and gas technology, particularly in CCS and CCUS, through interdisciplinary expertise and operational cooperation [19]. CCS implementation activities at UP and UPN Veteran Yogyakarta can be seen in Figure 4.

Furthermore, Universitas Trisakti has organized seminars in collaboration with PT Geoservices, focusing on CCS/CCUS monitoring and Amplified Geochemical Imaging (AGI) technology for exploration. These initiatives aim to provide insights into the role of technology in oil and gas exploration and the implementation of Carbon Capture Storage practices [20]. CCS implementation activities at universities can be seen in Figure 3. Through these collaborative efforts, Indonesian universities are actively contributing to the development and implementation of CCS technology, paving the way for a sustainable and environmentally friendly future.

![Fig. 3. CCS implementation activities at (a) Bandung Institute of Technology (ITB) [16] and (b) Universitas Trisakti [19]](image)

Moreover, UI GreenMetric encourages the adoption of sustainable practices such as CCS initiatives by providing universities with a platform to evaluate their environmental impact. UI GreenMetric is a tool to measure the sustainability performance of universities worldwide. It focuses on six categories: setting and infrastructure, energy and climate change, waste, water, transportation, and education and research. Efforts made by universities in implementing CCS can be incorporated into the evidence for UI GreenMetric, particularly within the Education and Research criteria. These efforts may include offering sustainability courses as a proportion of total courses, organizing sustainability-related events, and engaging in community service projects focused on sustainability, thereby demonstrating a
commitment to environmental responsibility and promoting sustainable initiatives within the academic community [21].

4 Conclusion

Carbon Capture and Storage (CCS) technology holds immense promise for Indonesia in mitigating climate change by capturing and storing carbon dioxide emissions, particularly in light of its significant reliance on fossil fuels. The country's strategic engagement in CCS initiatives, underscored by ongoing projects and a supportive regulatory framework, reflects its proactive stance towards reducing greenhouse gas emissions and transitioning to a more sustainable energy landscape. Furthermore, Indonesian universities have shown a pivotal role in advancing CCS technology through research, collaboration, and education initiatives. Universities in Indonesia contribute to the development and implementation of CCS technology by leveraging interdisciplinary expertise and fostering partnerships, paving the way for a sustainable and environmentally friendly future. The collaborative efforts of regulatory bodies, industry stakeholders, and academic institutions underscore Indonesia's strategic positioning in the global CCS landscape and its dedication to addressing climate challenges while promoting economic growth and environmental stewardship.

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