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CARBON MONETIZATION AS A FISCAL STRATEGY: RETROSPECTIVE AND PROSPECTIVE ANALYSIS OF INDONESIA

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ABSTRACT
Research Originality — This research introduces a combined retrospective and prospective analytical approach to examine the fiscal potential of carbon monetization in Indonesia. By linking past fiscal experiences with forward-looking revenue projections, it provides a comprehensive perspective on how carbon pricing instruments can address climate financing needs.
Research Objectives — The study aims to evaluate the potential of carbon monetization as a fiscal strategy to support Indonesia in achieving its Enhanced Nationally Determined Contributions (NDCs). Specifically, it investigates whether carbon taxes and carbon credits can close the financing gap for climate commitments.
Research Methods — This study applies retrospective analysis using historical fiscal data on climate budget tagging (CBT) and international climate funding, complemented by prospective analysis to project revenues from carbon taxes and carbon credit markets. Input-output analysis is also employed to link sectoral multipliers with carbon emissions, offering a distinctive methodological approach in the Indonesian context.
Empirical Results — The findings reveal a substantial financing gap between available funds and Indonesia's NDC requirements, with current fiscal resources covering less than 20 percent of the estimated needs. Retrospective analysis shows that Climate Budget Tagging and international funding remain inadequate. Prospective simulations indicate that carbon taxes could generate IDR 12–22 trillion annually, while carbon credits could yield up to USD 61.9 billion, making them significant alternative financing instruments.
Implications — The results imply that carbon monetization is not only an environmental necessity but also a strategic fiscal tool. For policymakers, it provides evidence-based insights to align climate action with sustainable economic growth.

Keywords: Carbon monetization, carbon tax, carbon credit, carbon fund, climate budget tagging
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INTRODUCTION

It is estimated that more than 95% of human activities over the last 50 to 100 years have caused an increase in the Earth's temperature (IPCC, 2015). Climate change has detrimental impacts on various sectors, such as social and economic crises, including natural disasters. Developing countries are particularly susceptible to these risks due to their limited fiscal capacity for emergency policies, making them vulnerable to the impacts of climate change.

The risks of climate change have encouraged various countries to initiate conventions and agreements. Global consensus on climate change has evolved significantly since the early 20th century, initially reinforced through the establishment of the United Nations Environment Program in 1972, marked by the subsequent formation of the Intergovernmental Panel on Climate Change (IPCC) in 1988, the inception of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, the subsequent establishment of the Kyoto Protocol in 1997, and culminating in the implementation of the Paris Agreement in 2015. The 2015 Paris Agreement places a strong emphasis on the responsibility of developed countries to reduce emissions, whereas the ambitions and contributions of developing countries are voluntary and depend on their national capacities. According to Article 4, Paragraph 4 of the Agreement, developed countries are required to lead by adopting absolute emission reduction targets across their economies.

Notably, all 195 countries participating in the UNFCCC have accepted the norms of the 2015 Paris Agreement by ratifying it (UNFCCC, 2024).

Indonesia as a developing country has also adopted the norms of the 2015 Paris Agreement. Indonesia has ratified the 2015 Paris Agreement through Law Number 16 of 2016 concerning Ratification of the Paris Agreement to the UNFCCC. Indonesia's stance on climate change is particularly significant due to its possession of the world's third-largest tropical rainforest, which plays a crucial role in addressing climate change (Apriwan and Sinulingga, 2015). However, Indonesia was in fact among the top ten largest contributors to carbon emissions worldwide in 2023 (Friedlingstein et al., 2023). Indonesia saw the largest rise in carbon emissions, with an 18.3% annual increase, largely driven by its growing reliance on fossil fuels, notably coal, as well as widespread deforestation and land conversion.

APPLICATIONS FOR PRACTICE

- The findings of this study indicate that a significant gap remains between the available funds in Indonesia and the amount required to meet the NDCs target.
- Monetizing carbon through approaches such as carbon taxes and carbon credits provides a strategic way to alleviate the financial challenges Indonesia is experiencing.
- The expected revenue from carbon monetization acts as an essential resource for policymakers, helping them develop strategies that align environmental objectives with economic growth.

Indonesia's commitment to responding to climate change and following up on the results of the ratification of the Paris Agreement is demonstrated, including through climate budget tagging (CBT) and carbon monetization. CBT is a scheme to increase public funding for sustainable projects through mitigation and adaptation actions (Fiscal Policy Agency, 2020), while carbon monetization can take the form of carbon taxes or carbon trading systems, where emissions are either directly taxed (a cap-and-tax scheme) or limited by a cap-and-trade system that allows for the trading of emission allowances (Goulder & Schein, 2013). Strategies employed in this context possess the dual benefit of mitigating the detrimental effects of carbon emissions in addition to generating novel economic prospects. For instance, the revenue generated from carbon taxes can be reinvested in renewable energy projects, enhancing energy efficiency and supporting technological innovation in the green sector (Metcalf, 2009). For this reason, this study addresses a critical question: Can carbon monetization serve as a viable fiscal strategy to close the financing gap for Indonesia's climate commitments? The objective is to assess the fiscal potential of carbon monetization in supporting Indonesia's NDC targets and to provide evidence-based insights that can inform policy direction.

LITERATURE REVIEW

Carbon emission

Carbon emissions, primarily from the combustion of fossil fuels, are the largest contributor to anthropogenic greenhouse gas (GHG) emissions, which blanket the Earth and trap the sun's heat, leading to global warming and climate change (IPCC, 2007). Furthermore, IPCC (2018) has indicated that to limit global warming to 1.5°C above pre-industrial levels, a threshold beyond which the consequences of climate change become increasingly severe, a substantial decrease of approximately 45% in carbon dioxide emissions from 2010 benchmarks is required by 2030, accompanied by the goal of achieving complete carbon neutrality by the mid-21st century. The environmental repercussions of unchecked carbon emissions are manifold. They contribute to extreme weather events, such as tropical storms, wildfires, severe droughts, and heat waves, which in turn have devastating effects on crop production, biodiversity, and freshwater availability (Pachauri and Reisinger, 2007). Moreover, the health implications are significant; improved air quality resulting from reduced emissions could prevent numerous health issues and economic losses (Stern, 2007; Smith et al., 2014). Indonesia as an archipelagic country prone to the impacts of climate change, such as rising sea levels. The country is experiencing a sea level rise of 0.8 – 1.2 cm annually, whereas a substantial 65% of the population lives in coastal areas (Ministry of National Development Planning, 2021). Furthermore, Indonesia witnessed a trend in temperature increase, with an average annual increase of 0.03°C, over the periods 1981-2018 (Ministry of Environment and Forestry, 2022). The country also saw an increase in national GHG emissions of around 3.9% per year between 2000 and 2019 (Ministry of Environment and Forestry, 2021).

Climate Budget Tagging

Climate budget tagging is an essential tool for tracking public expenditures and aligning them with climate-related objectives. It allows governments to visibly manifest their dedication to addressing climate change. By systematically identifying and designating allocated fiscal resources, governments may indicate their commitment to climate change mitigation and adaptation initiatives (World Bank, 2021). This process helps with the assessment of climate change-related expenditures within the national budget, facilitating

better monitoring and reporting of climate finance. By tagging climate-related expenditures, policymakers can assess the alignment of national budgets with climate objectives, enhance transparency, and improve accountability in climate finance (OECD, 2022).

In Indonesia, climate budget tagging (CBT) has been a pivotal step towards integrating climate change mitigation and adaptation into the national budgeting process. Initiated in 2016, the Ministry of Finance has been instrumental in implementing CBT within the national planning and budgeting cycle, ensuring that line ministries tag climate-related outputs during work plan formulation (Fiscal Agency Policy, 2020). This systematic approach allows for the monitoring and annual reporting of climate expenditures, providing a clear picture of the country's financial commitment to climate objectives. The Indonesian government's efforts are further supported by the United Nations Development Programme (UNDP), which has helped develop a detailed assessment of the climate benefits of projects undertaken by line ministries.

Moreover, Indonesia's climate budget tagging is not only a tool for accountability but also a strategic framework for aligning financial resources with the country's climate action plans. It serves as a critical mechanism to track and identify climate change-related outputs and budgets within the central government, thereby supporting the nation's commitments under international agreements like the Paris Agreement (UNDP, 2019). The process involves a comprehensive analysis of budget allocations and realizations, focusing on both mitigation and adaptation measures. The Fiscal Policy Agency of the Ministry of Finance has published detailed reports on climate change mitigation and adaptation budgets, which provide insights into the distribution of climate change budgets across various sectors and activities, highlighting the government's targeted approach to addressing climate change challenges. Additionally, the implementation of climate change has helped attract international climate finance by providing clear evidence of the country's financial commitments to combating climate change (Asian Development Bank, 2023).

Carbon Monetization

Monetizing carbon through both carbon credits and carbon taxes represents a comprehensive approach to internalizing the environmental costs of GHG emissions and incentivizing reductions. Carbon credits are tradable certificates that represent the right to emit one ton of CO_2 or its equivalent. They are typically generated through projects that reduce, avoid, or sequester carbon emissions, such as reforestation, renewable energy installations, or energy efficiency improvements (Gillenwater, 2012). These credits can be bought and sold in carbon markets, providing financial rewards to entities that successfully reduce their emissions.

Indonesia has been actively developing its carbon credit market as part of its broader strategy to combat climate change and promote sustainable development. Carbon credits in Indonesia are primarily generated through projects that reduce, avoid, or sequester GHG emissions. These projects include reforestation, afforestation, renewable energy installations, and energy efficiency improvements (Dwisatrio et al., 2021). One of the key mechanisms facilitating carbon credits in Indonesia is the Reducing Emissions from Deforestation and Forest Degradation (REDD+) program, which aims to incentivize the conservation of forests by providing financial rewards for verified emissions reductions (Angelsen et al., 2018). The carbon credit market in Indonesia is supported by both voluntary and compliance markets. The voluntary market allows businesses and individuals to offset their carbon footprint by buying carbon credits as part of their sustainability efforts and corporate social responsibility commitments. The compliance market, on the other hand, is driven by regulations that require certain industries to cap their emissions and purchase credits to comply with those limits (Hamrick & Gallant, 2017). Indonesia's government has also introduced policies and frameworks to support the development of the carbon credit market through the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number 21 of 2022, including the establishment of a national registry system for carbon credits to ensure transparency and accountability (Ministry of Environment and Forestry, 2022).

On the other hand, monetizing carbon through a tax involves imposing a direct fee on the carbon content of fossil fuels, thereby internalizing the external costs of carbon emissions and incentivizing reductions in GHG output. This approach assigns a specific price per ton of CO_2 emitted, providing a clear economic signal to businesses and consumers to reduce their carbon footprint by adopting energy-efficient practices and investing in renewable energy technologies (Goulder & Schein, 2013). Indonesia has implemented a carbon tax as part of its broader strategy to reduce GHG emissions and transition towards a low-carbon economy. Indonesia's 2021 carbon tax law marks a major milestone in its efforts to tackle climate change and drive sustainable economic development. The law stipulates a carbon tax rate initially set at IDR 30 (approximately USD 0.002) per kilogram of CO_2 equivalent emissions, targeting sectors with significant GHG outputs, particularly the energy and industrial sectors (Katadata, 2022).

The introduction of the carbon tax is aimed at internalizing the environmental costs of carbon emissions. The tax is levied on carbon-intensive sectors, particularly energy and industrial processes, which

are significant sources of the country's emissions. This policy aligns with Indonesia's Nationally Determined Contributions (NDCs) under the Paris Agreement, which commit to a substantial reduction in emissions by 2030 (IMF, 2022). This approach not only curbs emissions but also fosters sustainable economic growth by promoting green investments and technological innovation (Wang et al., 2024). However, the implementation of the carbon tax also faces challenges, including potential impacts on economic competitiveness and the need for robust monitoring and enforcement mechanisms to ensure compliance (Gandhi and Cuervo, 1998).

METHODS

This research uses a combination of retrospective and prospective analysis. Retrospective analysis is used to measure and evaluate fiscal policies that have been implemented by the government based on historical data and its gap in achieving the target of the new Enhanced NDC. Meanwhile, prospective analysis is applied to forecast the income that Indonesia may obtain as a result of efforts in achieving carbon emission reduction targets.

Retrospective analysis involves looking backward at historical data to identify patterns, trends, and outcomes that have occurred. This approach is particularly useful for understanding the evolution of events, assessing the impact of past interventions, and deriving insights from historical data (Lacey & Luff, 2009). In contrast to the retrospective analysis which relies on historical data, the prospective analysis relies on information that will be obtained as the research progresses and is oriented towards efforts to predict the subject's behavior in the future. This approach is essential for forecasting, planning, and decision-making, as it allows researchers to anticipate future scenarios and prepare accordingly (Hulley et al., 2013). According to Hatem et al (1993), prospective analysis is a look into the future to enlighten current actions.

Integrating retrospective and prospective analyses in research methodologies allows for a more robust understanding of the subject matter. Retrospective analysis provides a solid foundation of knowledge and insights from the past, while prospective analysis builds on this foundation to anticipate and plan for the future. This combined approach can enhance the validity and applicability of research findings, offering a holistic view that is both informed by historical context and oriented towards future implications (Creswell & Creswell, 2018). In studying carbon monetization in Indonesia, retrospective analysis could review the outcomes of existing carbon projects and policies, such as those under climate budget tagging and the REDD+ program. Prospective analysis could then model the potential impacts of expanding these initiatives or introducing new carbon pricing mechanisms, providing valuable insights for policymakers and stakeholders.

This study applies input-output (I-O) analysis to explore the relationship between sectoral economic multipliers and carbon emissions. Using the most recent Indonesian I-O table, updated with the modified Ratio Allocation System (RAS) developed by Miller and Blair (1985), the analysis calculates output, income, and employment multipliers across sectors. These multipliers are then compared with sectoral of CO_2 emissions to assess whether sectors with higher economic impact also contribute more significantly to carbon emissions. In a retrospective analysis, government spending and international funding received by the Indonesian government are compared with the cost requirements to achieve the NDC target. Government spending for handling climate change refers to climate budget tagging data released by the Ministry of Finance, while international green funding received by the government uses data released by the Indonesian Environment Fund (BPDLH). For prospective analysis purposes, the potential financial benefits obtained by monetizing carbon through carbon tax and carbon credit schemes are simulated. The carbon tax rate used in the calculation refers to the Law on Harmonization of Tax Regulations, while the carbon price refers to the carbon price scenario according to a study from International Monetery Fund (IMF) (Parry et al., 2021).

RESULTS AND DISCUSSION

According to the Ministry of Environment and Forestry (2020), Indonesia's carbon emissions totalled 1,866,552 gigagrams of carbon dioxide equivalent (CO_2e) in 2019, with the energy sector playing a substantial role (34.22%). Reducing carbon emissions can have an impact on Gross Domestic Product (GDP), especially in energy-intensive sectors such as industry, transportation and electricity.

Upon updating the latest input-output table for Indonesia using the modified RAS model, we obtained an estimate of the business sector multiplier on GDP on output creation or total production value from all economic sectors needed to meet demand. As shown in Table 1, the results indicate that the sector with the largest output multiplier value is the electricity and gas, followed by manufacturing, with values of 2.76 and 1.93, respectively. This value suggests that an increase in final demand in the electricity and gas supply sector by IDR 1 million, while other sectors are assumed to remain constant, will increase the output of all sectors in the economy by IDR 2,763 million. When compared with the CO_2 emissions produced, there is a linear relationship. This indicates that sectors with the largest contribution to GDP are those with the

Table 1 Multiplier on GDP and CO_2 emissions per sector

Sector	MULTIPLIER			CO_2 emissions based on Energy use (Gg CO_2e)
	Output	Income	Employment	
Agriculture, Forestry and Fishing	1.33	0.44	0.00097	86,503
Mining and Quarrying	1.51	0.26	0.00002	29,280
Manufacturing	1.93	0.31	0.00001	340,711
Electricity and Gas	2.76	0.13	0.00001	297,221
Transportation and Warehousing	1.91	0.31	0.00009	81,082
Water supply, Sewerage, Waste Management and Remediation Activities	1.48	0.18	0.00004	30,840
Construction	1.98	0.41	0.00003	21,595
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	1.47	0.47	0.00008	
Transportation and Storage	1.87	0.43	0.00008	
Information and Communication	1.63	0.30	0.00001	
Financial and Insurance Activities	1.41	0.48	0.00001	
Real Estate Activities	1.39	0.09	0.00001	
Business Activities	1.66	0.49	0.00004	
Public Administration and Defense; Compulsory Social Security	1.78	0.70	0.00026	
Education	1.55	0.80	0.00013	
Human Health and Social Work Activities	1.83	0.53	0.00016	
Other Service Activities	1.70	0.67	0.00007	

Source: Processed by the author

highest level of output multiplier and carbon emissions. For example, with the manufacturing sector contributing around 20% to total GDP, there will be a dilemma in balancing carbon reduction efforts with the rapid economic growth in Indonesia.

Therefore, carbon pricing can be a solution to recover GDP losses caused by carbon reduction needs. Carbon pricing is the price or monetization value of one ton of CO_2e which is used as a reference in emissions management activities and climate change mitigation efforts. According to a study by Wu and Zhu (2021), a carbon reduction target of 10% set by China is projected to correspond with an optimal carbon trading price within the range of CNY 256.2 per ton to CNY 394.8 per ton. Meanwhile, when supplemented by more stringent targets, China may recuperate a substantial sum of CNY 598.62 billion in monetary losses via the carbon trading market, underscoring the significant association between the optimal carbon trading price and the specified carbon emission reduction target. Singh (2024) found that GDP growth has outpaced CO_2 emissions growth in emerging economies. Aguilar, Gonzales and Hutardo (2022) also found that carbon pricing has a positive effect on sectoral employment, since the revenue collected from carbon pricing is used to reduce labor taxes. Furthermore, the World Bank (2024) indicates that carbon pricing revenues reached a record USD 104 billion in 2023, with over half of this revenue funding climate and nature-related programs. This demonstrates the financial viability and environmental benefits of carbon pricing mechanisms as tools to reduce emissions and support economic development.

Retrospective analysis

The analysis used in this research consists of backward-looking and forward-looking analysis. For the retrospective analysis, we look historically at the government's commitment, both in terms of costs that have been incurred and income that has been obtained through efforts to reduce carbon emissions.

Climate Budget Tagging

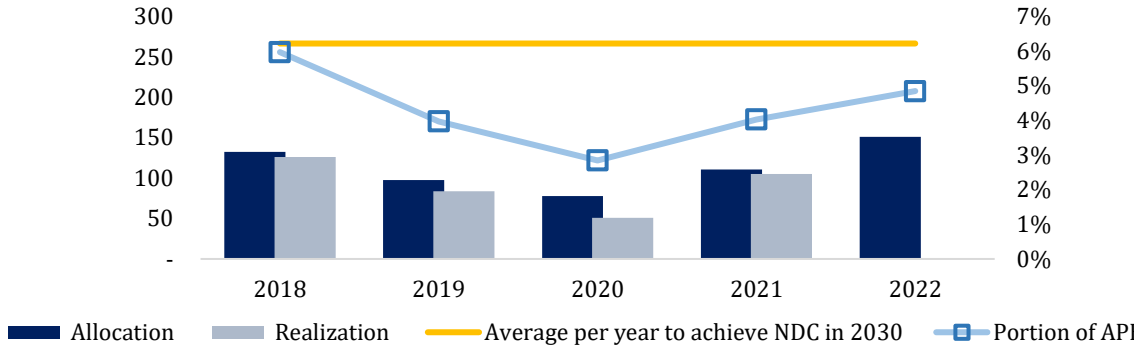
Climate change budget marking has been carried out since 2016, and since 2018 it has been completely carried out by ministries or institutions through the Collaborative Planning and Performance Information application (Fiscal Agency Policy, 2023). The annual climate change budget allocation from 2018 to 2022 was quite volatile due to a deep contraction in 2020, which decreased by 20.3% (YoY). The decrease was caused by the policy of refocusing activities and budget reallocation due to the COVID-19 pandemic.

According to data from the Ministry of Finance, the composition of the climate change budget for the 2016-2020 periods was allocated 74% for mitigation and 26% for adaptation. This reflects a greater priority on mitigation, which is understandable given its impact on reducing severe climate change effects in the future. The five priorities in the mitigation program include forestry and land, energy and

transportation, agriculture, industrial processes and product use (IPPU), and waste. Meanwhile, adaptation covers the fields of health, housing and infrastructure, food security, biodiversity of forest, coastal and small island ecosystems, as well as research and development. A larger budget for mitigation reflects proactive efforts to address the root causes of the problem, while adaptation is more reactive to impacts that have already occurred. The less mitigation is undertaken today, the greater the need for adaptation in the future. However, it is also important to note that adaptation is an urgent need for communities that are already experiencing the impacts of climate change directly. Therefore, adequate budget allocation for adaptation remains crucial.

Handling climate change requires enormous funds. According to the Ministry of Environment and Forestry (2018), Indonesia needs a budget of IDR 266.3 trillion a year to achieve the NDC target in 2030. As illustrated in Figure 1, when compared with the climate change budget allocation in the APBN, there is still a budget gap of more than IDR100 trillion each year. The funding requirement to achieve Indonesia's initial target of reducing emissions by 2030 is around USD 281.23 billion or IDR 4,002 trillion. This figure is difficult to cover solely through the APBN. In fact, currently Indonesia's fiscal capacity has only reached less than 20% of the total funding needed to achieve this target. Relying solely on state climate budgets can be a precarious strategy for addressing the multifaceted challenges of climate change. Stokes (2020) found that state budgets are often constrained by competing priorities and limited resources, which can lead to underfunding of critical climate initiatives. Nevertheless, the struggle remains to balance immediate economic pressures with the long-term imperative of climate resilience, making the dependence on state climate budgets alone a challenging and potentially unsustainable approach. However, the implementation of climate budget tagging has facilitated the integration of climate policies into sectoral planning and has helped attract international climate finance by providing clear evidence of the country's financial commitments to combating climate change (Asian Development Bank, 2023).

Figure 1 Climate Budget Tagging in Indonesia



Source: Processed by the author

Carbon Fund

Reliance on public finance alone is insufficient to meet the global needs for emissions reductions. Achieving Nationally Determined Contributions (NDCs) should not rely solely on state budgets but must also seek substantial international funding to meet climate targets effectively. The scale of investment required for meaningful climate action often surpasses the fiscal capacities of many countries, particularly developing nations. Therefore, international financial support is crucial in bridging this funding gap. Multilateral climate funds, such as the Green Climate Fund (GCF), play a pivotal role in providing financial resources to support mitigation and adaptation projects in developing countries, helping them to achieve their NDCs (Robinson & Dornan, 2017). By tapping into these international funds, countries can mobilize additional resources necessary for implementing large-scale renewable energy projects, enhancing energy efficiency, and building climate-resilient infrastructure (Buchner et al., 2019).

The Indonesian government has successfully managed and will continue to manage Results-Based Payment (RBP) funds for the 2021-2027 periods as compensation for its performance in reducing GHG emissions through the REDD+ program amounting to USD 319.8 million. RBP is one of the schemes in the Implementation of Carbon Economic Value in Indonesia as stated in Presidential Regulation Number 98 of 2021 and Minister of Environment and Forestry Regulation Number 21 of 2022. The program is carried out through several schemes such as the Green Climate Fund (GCF), Forest Carbon Partnership Facility, Bio Carbon Fund, and REDD+ Norway. According to IETA (2021), the effectiveness of RBP indicates that they

can significantly enable carbon markets, acting as a bridge between public finance and the funding required for substantial emissions reductions.

In the RBP scheme, Indonesia has received positive incentives from the Green Climate Fund (GCF) amounting to USD 103.8 million for reducing GHG emissions in the Forestry and Other Land Use (FOLU) sector for the 2014-2016 periods of 20.25 million tons of CO_2 equivalent, or also known as Performance-Based Payment (PBP). GCF Output 1 was distributed from 2020 to 2022 and amounted to USD 5.1 million to strengthen governance through the development of systems, regulations and human resource capacity. For GCF Output 2, USD 51.4 million was allocated in 2024. These funds were distributed to 34 provinces in Indonesia through the Indonesian Environment Fund (BPDLH).

Apart from that, through the Indonesia-Norway Partnership, Indonesia also received Result-Based Contribution (RBC), identical to RBP, amounting to USD 56 million for emission reductions from 2016 to 2017, then USD 100 million for emission reductions for the periods from 2017 to 2018 and from 2018 to 2019. Likewise, through the East Kalimantan FCPF-Carbon Fund, a multilateral funding program managed by the World Bank, provides financial support to East Kalimantan Province for reducing GHG emissions from the Forestry and Other Land Use (FOLU) sector. This achievement is assessed in three reporting periods: from June 2019 to December 2020, from January 2021 to December 2022, and from January 2023 to December 2024, with a nominal commitment of USD 110 million for a reduction target of 22 million tons of CO_2e. Even though international funding is substantial, the amount is not yet able to close the financial gap needed to achieve the NDCs target.

Prospective Analysis

Carbon pricing is seen as an effective strategy to hold major polluters accountable for the climate-related costs they generate, while also directing private investments towards lower-emission projects (Allen & Mulyana, 2024). The application of carbon pricing not only aids in achieving decarbonization targets, but also has financial implications. The country needs to take advantage of this momentum to generate income which can later be used to offset the impact of costs incurred in efforts to reduce carbon emissions. For this reason, income projections are simulated due to the impact of implementing carbon pricing, which is expected to be an input in formulating policies.

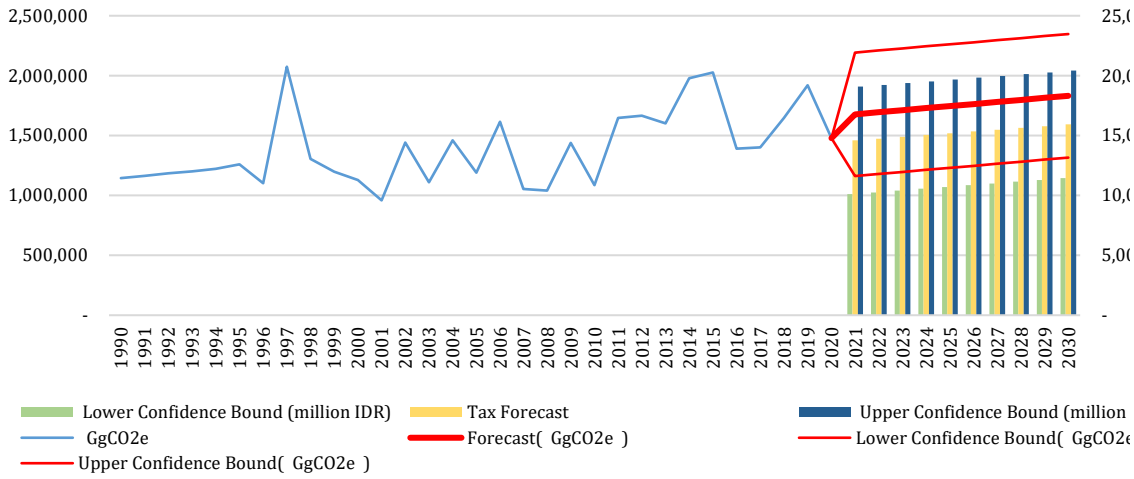
Carbon tax

Imposing a carbon tax not only helps reduce carbon emissions but can also boost state revenue. According to Andersson (2019), carbon tax succeeded in reducing carbon emissions by 40% in 2005 and had no negative implications for the economy. Furthermore, Gugler et al. (2022) found that the UK electricity sector was subject to a carbon tax in 2013, 2014, and 2015, which resulted in a notable decrease of 26% in carbon emissions. In the first NDCs in 2016, Indonesia committed to reducing carbon emissions by 29% by 2030 with its own efforts, or 41% with international assistance. Then in the new enhanced NDCs, the carbon emission reduction target was increased to 31.89% with its own efforts, or 43.2% with international assistance.

The implementation of the carbon tax in Indonesia has been regulated in the Law Number 7 of 2021 concerning the Harmonization of Tax Regulations. Paragraph (5) of Article 13 of the law specifies that a carbon tax is leviable upon the acquisition of goods containing carbon or activities generating a certain level of carbon emissions over a predetermined period. The carbon tax rate in Indonesia is delineated in paragraphs (8) and paragraphs (9) of Article 13 of the law, with the rate established at a minimum of the prevailing market price for carbon per kilogram of CO_2e in the carbon market, or IDR 30 per kilogram of CO_2e, whichever is greater. Indonesia plans to implement a full carbon tax in 2025. Initially, this carbon tax was planned to be implemented from April 2022 with a cap-and-tax scheme aimed at coal-fired power plants, but it was later postponed several times due to regulatory issues and economic conditions.

Using GHG emissions data from 1990 to 2020, a projection of carbon emissions to 2030 is simulated through exponential smoothing with a 95% confidence level, assuming no interventions are implemented to reduce carbon emissions. Exponential smoothing is computationally efficient and easy to implement, making it accessible for various applications, including environmental studies (Hyndman & Athanasopoulos, 2018). Furthermore, the use of a confidence interval, such as the 95% confidence level, enhances the robustness of the forecasts by providing a range within which the actual future values are expected to fall. This allows policymakers and researchers to account for uncertainty and variability in their projections (Hyndman et al., 2008). According to the carbon emission forecast shown in Figure 2, applying a rate of IDR 30 per kilogram of CO_2e is estimated to generate carbon revenues ranging from IDR 12 trillion to IDR 22 trillion for a carbon emissions reduction target of 31.89%. A carbon tax will increase production costs for companies whose emissions exceed set limits. These additional costs may be passed on to consumers in the form of higher product prices. This is especially true for industries that rely heavily on

Figure 2 Potential Income from Carbon Tax



Source: Processed by the author

fossil fuels, such as coal-fired power plants and other heavy industries (Metcalf, 2009; Goulder & Schein, 2013).

Tax collection on negative externalities generated by economic activity is called a Pigouvian Tax. The implementation of Pigouvian Tax results in an increase in prices which in turn can result in a reduction in production and demand. Therefore, in the short term there will be an increase in energy prices, which will ultimately affect household consumption. The implementation of such taxes can be politically challenging, and the distributional impacts on different income groups must be carefully considered to ensure fairness and public acceptability (Pearce, 1991). According to the IMF (2019), if Indonesia implements a carbon tax of USD 35 per ton of CO_2, the average energy price will increase quite significantly by 2030, such as coal by 108%, natural gas by 17%, electricity by 35% and gasoline by 15%. However, the carbon tax policy can narrow the budget deficit. A domestic carbon tax of USD 35 per ton of CO_2 may increase revenue by 1.1% of GDP (IMF, 2019). The effectiveness of the carbon tax depends on accurately estimating the external costs and setting the tax rate accordingly.

Carbon credit

The sale of carbon credits is an important mechanism in carbon markets that allows entities that reduce or capture carbon emissions to gain financial benefits. There are two main ways to earn carbon credits, through carbon emission reduction and carbon capture or sequestration. In terms of reducing carbon emissions, countries often use conditional mitigation scenarios and unconditional mitigation scenarios to set emissions targets and measure their progress in reducing GHG emissions, including Indonesia as stated in the new Enhanced NDCs. These emission reductions then become the basis for calculating the number of carbon credits that can be sold or purchased on the carbon market. A carbon market turns CO_2 emissions into a commodity by giving a price to it. The aim of using carbon prices is to see how wide the scope of the global carbon market might be in Indonesia. This is important considering that currently Indonesia is one of the main destinations for investors or countries that are determined to reduce their carbon emission levels.

Parry et al. (2021) proposed a basic carbon price scenario of USD 75 per ton for advanced economies, USD 50 per ton for developing economies and high-income countries, and USD 25 per ton for developing economies and low-income countries. Indonesia's GDP per capita is estimated to be USD 13,045 in 2036, and it is projected to continue to increase to USD 23,199 in 2045 (Ministry of National Development Planning, 2019). Considering this projection, a revenue scenario from carbon sales is used based on carbon prices of USD 25 and USD 50 per ton. Based on the simulation results presented in Table 2, GHG emissions in 2030 under a business-as-usual (BAU) scenario indicate that Indonesia could generate significant state revenue through carbon pricing mechanism. Under an unconditional mitigation scenario (UMS), where carbon emissions reduction efforts are solely funded by the Indonesian government, potential state revenue ranges from USD 22,875 million to USD 45,750 million. Meanwhile, if carbon emissions reduction in Indonesia uses a conditional mitigation scenario (CMS), where the carbon emissions reduction program uses Indonesian government funds and foreign funds, the potential annual state revenue is USD 30,988 million to USD 61,975 million. Simulation results indicate that the largest contributor to revenue comes

Table 2 Potential Income from GHG Emission Reduction

Sector	GHG Emission Level 2030	GHG Emission Reduction Mton CO 2-eq		Potential income (million USD) USD25 USD50 USD Millon			
	BAU	UMS	CMS	UMS	CMS	UMS	CMS
Energy	1,669	358	446	8,950	11,150	17,900	22,300
Waste	296	40	44	1,000	10,880	2,000	2,175
IPPU	70	7	9	175	225	350	450
Agriculture	120	10	12	250	300	500	600
Forestry	714	500	729	12,500	25,000	25,000	36,450
Total	2,869	915	1,240	22,875	47,555	45,750	61,975

Source: Processed by the author

from the forestry sector, followed by the energy sector. Implementing carbon emission reduction programs in Indonesia may present substantial potential revenue from carbon trading.

The carbon credit mechanism can also be as a compensation for developing countries, which are required to maintain forest conditions to absorb carbon. Forests serve as critical components of the carbon cycle, offsetting the impact of climate change through their substantial capacity as natural carbon storage reservoirs. The extent of forest coverage is positively correlated with the effectiveness of carbon sequestration from the atmosphere, which in turn generates tradable carbon credits. The resulting carbon credits must be verified and certified by an authorized entities to ensure that the carbon sequestration is legal and can be traded in international carbon markets. This trade will greatly give benefit for the 222 countries with extensive forests, including Indonesia.

For simulation purposes, the Norwegian carbon price is used because the Norwegian carbon trading scheme is a reference for carbon trading through the REDD+ scheme. Norway's carbon price is USD 5 per ton of CO_2 and is fixed. Based on the simulation results in Table 3, there is a large potential for carbon sales revenue at the national level with an average of more than USD 43,000 million. The large potential income from maintaining forest area in its role as a natural carbon sink should encourage the government to suppress land conversion. IETA (2021) stated the voluntary carbon market, for instance, saw a 280% increase in payments for REDD+ carbon credits in 2021, reflecting a strong demand for results-based climate finance solutions. As the demand for mechanisms to offset carbon emissions grows, the role of forests as natural carbon reservoirs becomes increasingly significant, offering a path towards achieving net-zero emissions and a long-term sustainable trajectory.

Table 3 Potential Income from Carbon Sequestration

Forest type	Area (thousand ha)	carbon sequestration per ha	Price (USD/ha)	potential income (USD million)
Primary dryland	38,709,60	126,64	5	24,510,92
Secondary dryland	31,713,00	62,33	5	9,883,36
Primary swamp	4,701,70	91,83	5	2,158,79
Secondary swamp	5,588,00	62,33	5	1,741,50
Primary mangrove	1,597,60	199,01	5	1,589,69
Secondary mangrove	1,043,80	86,99	5	454,00
Plantation	4,939,20	107,86	5	2,663,71
Total				**43,001,96**

Source: Processed by the author

Apart from maintaining forests as natural carbon sinks, technological innovation and investment in carbon capture also plays an important role in reducing carbon emissions from the industrial sector. The development of carbon markets can provide dynamic incentives to encourage technological shifts that lead to low-carbon technological innovation. The United Nations Conference on Trade and Development (2022) stresses the imperative of decoupling prosperity from rising CO_2 emissions globally, a goal that requires not only developed but also developing countries to transition towards more sustainable paths with significant technology and financial support.

Empirical evidence has shown that policies around environmental issues usually lead to technological innovation. One of the innovations in carbon technology is carbon capture, utilization, and storage (CCUS), which can provide benefits. Based on the Paris Agreement, the projected demand for CCS/CCUS in Southeast Asia is 35 million tons of CO_2 by 2030 and over 200 million tons of CO_2 by 2050. In Indonesia, the implementation of CCS/CCUS is anticipated to enhance oil and gas production, lower GHG emissions, and facilitate carbon monetization. Indonesia has geological formations that allow permanent storage of carbon emissions. Indonesia is geologically rich in salty aquifers, making it suitable for CO_2 storage with a capacity

of 80 – 100 giga tons. The country's geological formations, particularly deep saline aquifers, offer significant potential for long-term CO_2 sequestration, contributing to efforts in reducing GHG emissions and mitigating climate change (ERIA, 2024).

In Indonesia, CCUS activities remain in the preliminary stages of research and development, albeit progressing towards commercial implementation by 2030 (IEA, 2023). The most significant development is at Tangguh LNG which has received Plant of Development (POD) approval. According to the International Energy Agency (2020), investment costs for carbon capture technology range from USD 60 to USD 90 per ton of CO_2 captured.

The high investment costs, as illustrated in Table 4, need to be offset with fiscal and non-fiscal incentives from the government. Providing tax credits is a recognized government incentive to encourage the implementation of CCUS. A well-known tax credit for carbon capture is the 45Q tax credit which is implemented in the US. The provision of a tax credit aids in reducing the financial burdens associated with CCUS initiatives, thereby increasing their economic viability and attractiveness to potential investors (Dindi et al., 2022).

Table 4 Investment Cost for Carbon Capture Technology

Sector	Carbon Capture Potential (million tCO_2)	Investment Cost (USD million)	
		US$60	US$90
Coal to DME+	26 – 131 (20 years)	1,560,00	2,340,00
Gundih	3 (10 years)	180,00	270,00
Sukowati	7 – 14 (15 years)	420,00	630,00
East Kalimantan	10 (10 years)	600,00	900,00
Blue Ammonia	19 (20 years)	1,140,00	1,710,00
Abadi	70	4,200,00	6,300,00
Tangguh	25 – 33 (10 -15 years)	1,500,00	2,250,00

Source: Processed by the author

Inflationary pressures, behavioral responses, and broader macroeconomic adjustments are important considerations when evaluating carbon monetization policies, as they can affect energy prices, production structures, and income distribution. These dynamic interactions, however, are not fully captured in the current analysis. Future research should apply dynamic modeling approaches to more accurately assess the long-term economic implications and support more robust policy design. Nevertheless, the study offers an important preliminary assessment of its fiscal potential and sectoral implications, serving as a foundation for more advanced analyses.

CONCLUSION

The results of this research show that there is a significant gap between the funding currently available in Indonesia and the funding needed to achieve the NDCs target. Climate Budget Tagging in the APBN and international carbon funding are in fact insufficient. Therefore, monetizing carbon through mechanisms such as carbon taxes and carbon credits offers a strategic solution to mitigate the financial burdens faced by Indonesia. Properly calibrated carbon tax can force various industrial sectors to reduce carbon production. It can also increase state income and reduce the budget deficit in the APBN. Meanwhile, carbon credits can increase income through the sale of carbon credits resulting from reduced carbon emissions, such as by protecting forests as natural carbon sinks. By assigning a monetary value to the reduction of carbon emissions, these credits can be traded on various markets, incentivizing the reduction of GHG. Carbon pricing mechanisms can provide the government significant potential to generate income. By providing a financial incentive for reducing emissions, carbon credits encourage the development and adoption of innovative carbon technologies. These technologies range from carbon capture and storage to advanced renewable energy systems, which are essential for transitioning to a low-carbon economy.

The financial implications of carbon monetization are complex and far-reaching. Revenue generated from carbon monetization can provide a steady stream of funds that can be allocated towards climate change mitigation and adaptation strategies. It can also be used to lower other taxes, such as income or payroll taxes, in a process known as revenue recycling, which can offset the economic impact of carbon monetization on businesses and consumers. Moreover, it can fund social programs to alleviate any regressive effects of carbon monetization on low-income households, ensuring a just transition for all segments of society. The application of carbon monetization is not only an environmental imperative but also an economic opportunity. By carefully planning and implementing carbon monetization policies, Indonesia can harness this momentum to foster sustainable development, drive innovation, and build resilient economies. The anticipated income projections from carbon monetization serve as a vital tool for policymakers, enabling them to craft strategies that balance environmental goals with economic prosperity.

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