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The Impact of the EU Carbon Border Adjustment Mechanism on Indonesia: Trade Competitiveness, Economic Stability, and Policy Adaptation

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Abstract

The European Union's Carbon Border Adjustment Mechanism (CBAM) introduces carbon prices on imported goods to reduce carbon leakage and accelerate decarbonization. While designed to encourage sustainable industrial practices, CBAM presents significant risks for Indonesia, a country highly dependent on carbon-intensive exports such as steel, cement, and aluminum. This study aims to analyze the impact of CBAM on Indonesia's trade competitiveness, economic stability, and policy adaptation strategies. A mixed-method qualitative approach was employed, combining a systematic literature review, comparative case studies of countries facing similar challenges (i.e., China, Vietnam, South Korea, and India), and a policy cycle framework to assess both EU implementation and Indonesia's potential responses. The findings show that CBAM will substantially increase production costs, reduce export competitiveness in EU markets, and pose risks to gross domestic product, employment, and inflation. Steel and cement industries are identified as the most vulnerable sectors, with projected penalties of €99/ton and €36/ton, respectively, translating into a potential 8–12% decline in export demand. Beyond trade, CBAM may exacerbate social challenges, including an estimated 120,000 jobs at risk in labor-intensive industries. However, the mechanism also offers opportunities to accelerate Indonesia's green transition by stimulating investment in renewable energy, low-carbon technologies, and international cooperation on climate policy. In conclusion, CBAM represents both a challenge and an impetus for Indonesia to strengthen domestic carbon pricing, diversify export markets, and invest in industrial upgrading. This research highlights the urgency of adaptive policy strategies that balance economic competitiveness with climate commitments. The study contributes to the global discourse on equitable climate governance by emphasizing the need for fair transition pathways for emerging economies.

Keywords:
Carbon Border Adjustment Mechanism, economic impact, green transition, policy adaptation, trade competitiveness

1. Introduction

Climate change has become an urgent global challenge, with global average temperatures increasing by 1.1 °C compared to pre-industrial times and its impacts becoming increasingly evident in extreme natural disasters and rising sea levels (IPCC, 2023). Various countries have implemented stricter policies to reduce greenhouse gas emissions, including through cross-border carbon adjustment mechanisms to respond to this challenge. As a global environmental policy leader, the European Union (EU) initiated the Carbon Border Adjustment Mechanism (CBAM). This instrument sets a carbon price

on imported goods based on their emissions intensity. This policy aims to overcome carbon leakage, namely the phenomenon when industries move production to countries with looser environmental regulations to avoid higher carbon taxes in their home countries (European Commission, 2023; WTO, 2022). CBAM will be implemented in stages from 2023 and covers sectors that have a high carbon footprint, such as steel, cement, aluminum, electricity, and fertilizer (European Parliament, 2023). Although aimed at encouraging global industry to adopt low-carbon practices, this policy presents major challenges for exporting countries that still depend on high-emitting industries. The impact is not only limited to increasing production costs but can potentially disrupt economic stability in developing countries.

The CBAM could affect Indonesia's trade competitiveness by increasing the financial burden on exporters and having wider social and economic consequences. As a developing country with an economy highly dependent on high-carbon-based industrial exports such as manufacturing, steel, cement, and coal, Indonesia faces significant risks due to implementing CBAM. According to a report by the Organization for Economic Co-operation and Development (OECD, 2023), around 60% of Indonesia's exports come from high-carbon-based sectors, which this policy could directly affect. In addition, analysis from the International Energy Agency (IEA, 2023) shows that implementing CBAM can increase the burden of export costs by up to 30% for developing countries with high carbon intensity industries, including Indonesia. Data from BPS (2023) notes that the EU is one of Indonesia's main trading partners, with a total trade value reaching USD 6 billion in 2022. Around 20% of Indonesia's exports to the EU come from industrial sectors included in the scope of CBAM. Thus, CBAM can increase production costs because companies must purchase carbon emission certificates to keep their products competitive in the EU market (OECD, 2024). This impact can lead to reduced export competitiveness, especially in sectors that do not yet have adequate low-carbon infrastructure. In addition, this policy can have broader social and economic consequences, such as the potential for increased inflation due to a spike in production costs, reduced employment opportunities due to decreased export demand, and uncertainty in national economic stability (IMF, 2023). Therefore, an in-depth analysis of the impact of CBAM on Indonesia's trade structure and domestic policies is becoming increasingly important in formulating effective mitigation strategies.

Research on CBAM has been carried out in various countries, especially countries with close trade relations with the EU. Jia et al. (2025) used the method event study to analyze stock market reactions in China to EU CBAM policy announcements. As a result, Chinese companies in high-carbon-emission industries experience a significantly negative cumulative abnormal return around the CBAM announcement date. More specifically, companies that export their products to the EU experience a larger decrease in abnormal stock returns than companies that are not oriented towards EU exports. This indicates market concerns regarding increased costs for carbon-intensive exporters due to CBAM implementation. However, Jia et al. (2025) also revealed that companies with strong international supply chain management and involvement in carbon trading tend to experience fewer negative impacts.

Dobranschi et al. (2024) evaluated the potential impact of CBAM on the economies of the Visegrád countries (i.e., Poland, Hungary, the Czech Republic, and Slovakia), which are members of the EU but have industries that still depend on carbon-based energy. They analyzed trade data to calculate price and income elasticities of high-emission intensity goods, Emission-Intensive Trade-Exposed (EITE) goods, that Visegrád imports from non-EU countries. By simulating various carbon tariff scenarios, they found that CBAM would reduce import demand for EITE products outside the EU. These findings suggest that a product's high price elasticity and high carbon intensity correlate with significantly reduced import demand under CBAM. From a macroeconomic perspective, the negative impact of CBAM on the economic growth of Visegrád countries is expected to be relatively small. At the same time, the effect of reducing global emissions is also limited.

Chu et al. (2024) focused on the steel sector as one of the main export commodities from Vietnam to the EU. Using a multi-technology partial equilibrium model, they simulated the impact of CBAM on Vietnam's steel industry. The analysis results showed that Vietnam's steel exports to the EU will experience a decline when the CBAM comes into force, along with the increase in the effective price

of Vietnamese steel products on the European market. One estimate suggests that Vietnam's steel production output could fall by around 3.6% in 2030 due to reduced demand from the EU. However, the decline in exports was not strong enough to directly encourage a shift in production technology from a high-emission pathway to a low-emission pathway. Manufacturers are more likely to look for alternative markets outside the EU rather than immediately investing in more expensive green technologies. Therefore, CBAM does not appear to be the main driver of technological transformation in Vietnam's steel sector without a more proactive domestic policy supporting the clean energy transition.

In South Korea, Cho et al. (2024) highlighted the potential carbon leakage due to CBAM. Using the method of event study, they examined how the announcement of the CBAM policy impacts the value of companies in South Korea and the strategic responses taken by related companies. Their research results showed that CBAM can encourage companies to relocate their operations to countries with looser carbon regulations, thereby increasing the risk of carbon leakage globally. This phenomenon indicates that instead of reducing overall emissions, CBAM may cause production to shift to jurisdictions with more flexible carbon policies.

Banerjee (2021) evaluated how CBAM and Domestic Carbon Adjustment (DCA) in India can contribute to reducing emissions. The study considered the domestic policy responses of developing countries as a complement to the CBAM mechanisms implemented by developed countries. This computable general equilibrium (CGE) study simulated the impact of implementing a carbon price at the border (Border Carbon Adjustment, BCA) on India's exports, while also considering the implications of domestic carbon adjustment policies. This analysis was carried out by comparing two emissions accounting frameworks: production-based accounting (PBA) versus consumption-based accounting (CBA). As a result, harmonizing the BCA and DCA prices can increase the effectiveness of overall emission reduction. In addition, compensation schemes for affected sectors were also found to be an effective mechanism in reducing economic distortions resulting from CBAM policies.

Although various studies have examined the impact of CBAM in various countries, there is still a gap in the literature regarding the specific impact of CBAM on Indonesia's trade competitiveness. Most existing research focuses on developed countries or economies with more mature energy transition infrastructure. At the same time, few studies have explored how CBAM affects developing countries that are highly dependent on carbon-based industries. Against this backdrop, our study holds strong relevance. It directly addresses an urgent policy gap by analyzing how CBAM affects Indonesia’s trade competitiveness, economic stability, and policy adaptation in comparison with EU experiences. Beyond academic inquiry, this relevance extends to multiple stakeholders, especially policymakers seeking evidence-based mitigation strategies, industries facing rising costs and supply chain restructuring, and international negotiations on equitable climate governance.

Based on this problem formulation, we aim to evaluate the impact of CBAM on Indonesia's export competitiveness, analyze the economic and social impacts arising from this policy, and identify strategies Indonesia can implement to face CBAM challenges. With an approach comparable to the EU, our study will provide a deeper understanding of the mechanisms for implementing CBAM and adjustment policies that can be adopted to maintain trade competitiveness. In addition, we aim to develop evidence-based policy recommendations that can help Indonesia navigate the transition to a low-carbon economy more strategically and fairly. To achieve this goal, an in-depth analysis of Indonesia's challenges and opportunities in the CBAM context is necessary, especially in understanding how other countries have responded to similar policies.

The originality of our study lies in four aspects. First, it focuses on Indonesia, a carbon-intensive developing economy underexplored in CBAM literature. Second, it employs a comparative lens with the EU, deriving practical lessons from mature regulatory contexts. Third, the research integrates a systematic literature review (PRISMA), comparative case studies with China, Vietnam, South Korea, and India, as well as a policy cycle approach offering a qualitative, multi-layered analysis that complements prior model-based works. Fourth, it frames CBAM through the lens of global regulatory

justice, emphasizing how climate–trade instruments risk disproportionately burdening developing economies.

The contribution of this study is threefold. Academically, it expands the literature by providing one of the first comprehensive analyses of CBAM's impact on Indonesia. Policy-wise, it formulates adaptive strategies that balance economic resilience with decarbonization commitments. Practically, it guides industries in identifying sectoral risks and adaptation pathways while informing global debates on making CBAM fairer for developing countries. In sum, our study not only fills a significant knowledge gap but also generates actionable insights. It enriches academic debates on climate–trade interactions, informs national and industrial strategies in Indonesia, and contributes to shaping more adaptive, strategic, and inclusive responses to global environmental regulation.

2. Methods and Materials

Our study employs a mixed-method qualitative design, combining a systematic literature review (SLR) guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) framework with a comparative case study and policy cycle approach. This integration ensures both transparency in evidence collection and depth in contextual analysis.

2.1 Systematic Literature Review (PRISMA)

The systematic review was conducted to capture global academic and policy perspectives on the CBAM and its implications for developing economies. Literature searches were carried out across Scopus, Web of Science, ScienceDirect, JSTOR, and Google Scholar, as well as institutional repositories such as the OECD, WTO, IMF, World Bank, IEA, European Commission, UNFCCC, and Indonesia's Central Statistics Agency. The keywords used included "Carbon Border Adjustment Mechanism" OR "CBAM", "trade competitiveness", "developing economies" OR "Indonesia", and "carbon tax" OR "green transition," with the review focusing on the 2019–2025 period to align with the EU Green Deal and CBAM timeline.

Studies were eligible if they were peer-reviewed or policy-based, analyzed CBAM or related carbon border policies, and examined trade, competitiveness, or policy adaptation, while non-English/non-Indonesian publications, non-scientific commentaries, and unrelated studies were excluded. As shown in Figure 1, the selection process followed the PRISMA 2020 framework, ensuring transparency, replicability, and robustness of the evidence base in analyzing CBAM's impact on trade competitiveness, economic stability, and adaptation strategies in Indonesia. A total of 500 records were initially retrieved (420 from academic databases and 80 from institutional reports). After removing duplicates, 450 records were screened. Of these, 300 were excluded at the title/abstract stage, and 150 articles underwent full-text review. Following the eligibility assessment, 100 articles were excluded for not meeting the inclusion criteria, leaving 50 studies in the qualitative synthesis. Of these, 35 studies were further incorporated into the comparative and policy-oriented synthesis that informs the discussion on Indonesia's CBAM adaptation strategies.

2.2 Comparative Case Study

To contextualize Indonesia's experience, a comparative case study approach was adopted. The analysis focused on China, Vietnam, South Korea, and India, which share structural similarities with Indonesia, particularly in their dependence on carbon-intensive exports to the EU. The case study method identifies these countries' challenges in adapting to CBAM, evaluates their economic impacts, and analyzes mitigation strategies as lessons for Indonesia. Case selection was based on trade dependency, industrial structure, and policy response comparability.

Data sources included policy documents (European Commission, WTO, OECD; Indonesia's Ministry of Trade, Ministry of Energy and Mineral Resources, and Bappenas), international institutional reports

(IMF, World Bank, IEA, UNFCCC), and statistical data (BPS, Eurostat). Academic publications from reputable journals further enriched the analysis.

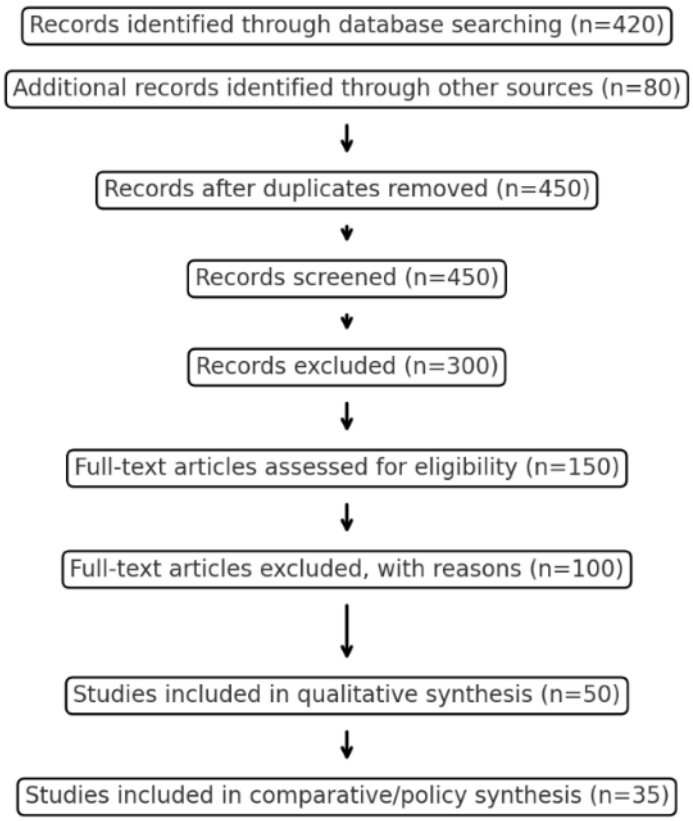

Figure 1. PRISMA flow diagram of study selection.

2.3 Policy Cycle Approach

The policy cycle framework (Lasswell, 1956; Jann & Wegrich, 2007) was applied to evaluate CBAM's design, implementation, and implications across five stages. First, economic, environmental, and geopolitical drivers of CBAM adoption in the EU are identified. Second, regulations and options available, such as trade negotiations or domestic carbon pricing, are reviewed. Third, economic and political considerations influencing both EU adoption and Indonesia's responses are assessed. Fourth, compliance mechanisms, industry readiness, and regulatory adaptation challenges in Indonesia are examined. Last, CBAM's effectiveness in reducing emissions and its implications for Indonesia's competitiveness are assessed.

2.4 Data Collection and Analysis

Data collection combined systematic review outputs (organized through PRISMA) with comparative case evidence. Coding and thematic analysis were conducted using NVivo/ATLAS.ti, enabling synthesis of common patterns, divergences, and country-specific strategies. The triangulation of PRISMA-based evidence, case comparisons, and policy cycle analysis ensures that findings are both evidence-driven and context-sensitive. Through this integrated methodology, our study not only evaluates the impacts of CBAM on Indonesia's trade competitiveness and economic stability but also formulates adaptive policy recommendations grounded in international best practices and systematic evidence.

To strengthen the analysis, our study also reviews and synthesizes previous literature that examines the impact of CBAM across different countries. The reviewed studies were systematically categorized based on country/region, methodological approach, research focus, and key findings as shown in Table 1. This comparative synthesis provides a clearer understanding of common patterns and variations in CBAM's effects, which serve as lessons for Indonesia.

Table 1. Summary of review literature and previous research.

Author(s) & Year	Country/ Region	Method	Focus	Key Findings
Jia et al., 2025	China	Event study (stock market reactions)	Impact of CBAM announcements on stock returns of high-carbon firms	Negative abnormal returns for exporters to the EU; firms with strong supply chain management & carbon trading are less impacted
Dobranschi et al., 2024	Visegrád (Poland, Hungary, Czech Republic, Slovakia)	Trade data simulation (price & income elasticities)	Effect of CBAM on imports of emission-intensive goods	Reduced demand for EITE imports; small macroeconomic effect; limited emission reduction
Chu et al., 2024	Vietnam	Partial equilibrium model	Impact on Vietnam's steel exports	Steel exports decline by ~3.6% in 2030; firms prefer seeking alternative markets over green tech upgrades
Cho et al., 2024	South Korea	Event study	Risk of carbon leakage	CBAM may trigger relocation of firms to low-regulation countries, increasing leakage risk
Banerjee, 2021	India	CGE model (Border Carbon Adjustment & Domestic Carbon Adjustment)	Interaction of CBAM & domestic carbon pricing	Harmonizing BCA & DCA enhances emission reduction effectiveness; compensation schemes reduce economic distortions

3. Results and Discussions

3.1 The Impact of CBAM on Indonesia's Export Competitiveness

The introduction of the CBAM by the EU has significantly impacted the competitiveness of Indonesian exports, especially for products with a high carbon footprint. CBAM is designed to reduce carbon leakage, namely the shift of production of goods with a high carbon footprint to countries with looser environmental policies, which can undermine global efforts to reduce carbon emissions. CBAM is imposed on imported products based on the carbon intensity produced in the production process. This is a big challenge for Indonesia, which has an export structure highly dependent on carbon-based commodities. Therefore, Indonesian products produced using carbon-based processes, such as steel, cement, aluminum, fertilizer, and energy, will be subject to an additional cost, directly increasing their selling prices on the EU market. The increase can cause a decrease in the competitiveness of Indonesian products, affecting the volume of exports to the EU market.

Table 2 provides an overview of Indonesia's exports to the EU in CBAM-affected sectors for the year 2022. The data highlight the dominance of steel, which alone accounted for USD 3.7 billion in export value or approximately 12% of Indonesia's total exports to the EU. Cement (USD 1.0 billion, 3.2%)

and aluminum (USD 0.8 billion, 2.6%) follow as significant contributors, while fertilizer and electricity make up smaller shares. This concentration suggests that Indonesia's vulnerability to CBAM is not evenly distributed across industries, but rather heavily tied to steel and cement as the backbone of its EU-oriented trade structure.

Table 2. Indonesia's Exports to the EU in CBAM-Affected Sectors (2022).

Sector	Export Value (USD Billion)	Share of EU Exports (%)	CO_2 Intensity (tCO_2/ton)	EU Average CO_2 (tCO_2/ton)	Penalty at €90/ton CO_2 (€/ton)
Steel	3.7	12.0	1.8	0.7	99
Cement	1.0	3.2	0.9	0.5	36
Aluminum	0.8	2.6	12.0	8.0	360
Fertilizer	0.4	1.3	6.0	3.0	270
Electricity	0.2	0.7	0.6	0.3	27

Table 2 also shows the proportional shares of each sector in Indonesia's EU exports. Steel and cement dominate Indonesia's exposure to CBAM, together accounting for more than 15% of total EU-bound exports. This structural reliance indicates that even a moderate contraction in EU demand for these commodities could create substantial ripple effects for Indonesia's export earnings and industrial employment. By contrast, sectors such as fertilizer, aluminum, and electricity, while facing high carbon penalties, represent smaller shares of total trade and thus pose more contained risks at the macroeconomic level.

The steel, cement, and aluminum sectors have significant contributions to export earnings. However, steel production, which generally uses energy from fossil fuels such as coal, produces significant carbon emissions. The WSA (2020) reported that the steel production process can produce more than 1.8 tons of CO_2 per ton of steel produced. Likewise, the cement industry produces around 0.9 tons of CO_2 per ton of cement due to burning limestone in the production process (CSI, 2019). These products will be directly affected by the implementation of the CBAM price due to their high carbon footprint. This tariff will worsen Indonesian products' price competitiveness in the European market because the price of Indonesian products will be higher compared to products produced using low-carbon technology. This increase in production costs will directly impact the competitiveness of Indonesian products, especially in the highly competitive EU market. The CBAM price can increase production costs by up to 10-15% for products with a high carbon footprint, such as steel and cement (Dechezleprêtre et al., 2025).

In terms of carbon intensity, the comparison underscores Indonesia's disadvantage. For instance, Indonesia's blast-furnace-based steel production emits around 1.8 tCO_2 per ton, substantially higher than the 0.7 tCO_2 per ton benchmark typical in EU countries using Electric Arc Furnace (EAF) technology. A similar gap is evident in cement (0.9 vs. 0.5 tCO_2/ton) and aluminum (12 vs. 8 tCO_2/ton).

The average carbon emissions per ton of steel produced in countries with advanced and low-carbon technology, such as Japan and Germany, are much lower compared to countries that rely on fossil energy, such as Indonesia (WSA, 2020). Steel produced in Japan and Germany uses technology such as EAF, which utilizes electrical energy from renewable sources, producing much lower carbon emissions than blast furnaces still used in Indonesia (WSA, 2020). In comparison, carbon emissions from steel production using a blast furnace can reach around 1.8 tons of CO_2 per ton of steel, while using EAF can reduce carbon emissions by more than 50% (IEA, 2023). With the CBAM price imposed based on carbon footprint, steel produced in Indonesia, which has a high carbon footprint, will be subject to higher surcharges when entering the EU market. Meanwhile, steel produced in countries such as Japan or Germany, with a lower carbon footprint, will avoid these additional costs, making it more competitive in the EU market.

When CBAM is applied at the EU emissions trading system (ETS) average of €90/ton CO_2 in 2023, Indonesian exports incur substantial additional costs due to their relatively high carbon intensity. As

shown in Table 2, the estimated surcharges differ across commodities: aluminum production faces a penalty of approximately €360/ton, while fertilizer incurs about €270/ton. For steel and cement, the respective penalties are €99/ton and €36/ton, which, although lower in absolute terms, are significant given their large export volumes to the EU. These tariff-induced cost increases correspond to an estimated 10–15 percent rise in export prices for Indonesian steel and cement, while aluminum and fertilizer are expected to experience proportionally higher effective price hikes. Using elasticity estimates for EITE goods (Dobranschi et al., 2024), such price adjustments are projected to reduce EU demand for Indonesian exports by 8–12 percent in the affected sectors. This quantification indicates that CBAM implementation introduces a measurable decline in trade competitiveness for Indonesia, particularly in industries structurally dependent on carbon-intensive production processes.

At the same time, a closer look at Indonesia's export composition underscores that, although the EU is a major market, its share of Indonesia's overall exports remains relatively modest. As shown in Figure 2, the EU accounted for only about 9 percent of Indonesia's total exports in 2022, far behind ASEAN (20 percent) and China (22 percent), while the United States and Japan absorbed roughly 9 percent and 8 percent, respectively. This distribution suggests that Indonesia is not structurally overexposed to the EU market, and therefore possesses considerable policy space to diversify trade away from Europe if CBAM-induced costs erode competitiveness. In practical terms, the relatively small EU share means that redirecting export flows toward ASEAN, South Asia, or African markets, many of which have yet to adopt stringent carbon adjustment policies, would be more achievable without triggering systemic trade shocks. Consequently, while CBAM poses significant sectoral risks, Indonesia's broader trade architecture provides resilience and flexibility for diversification strategies.

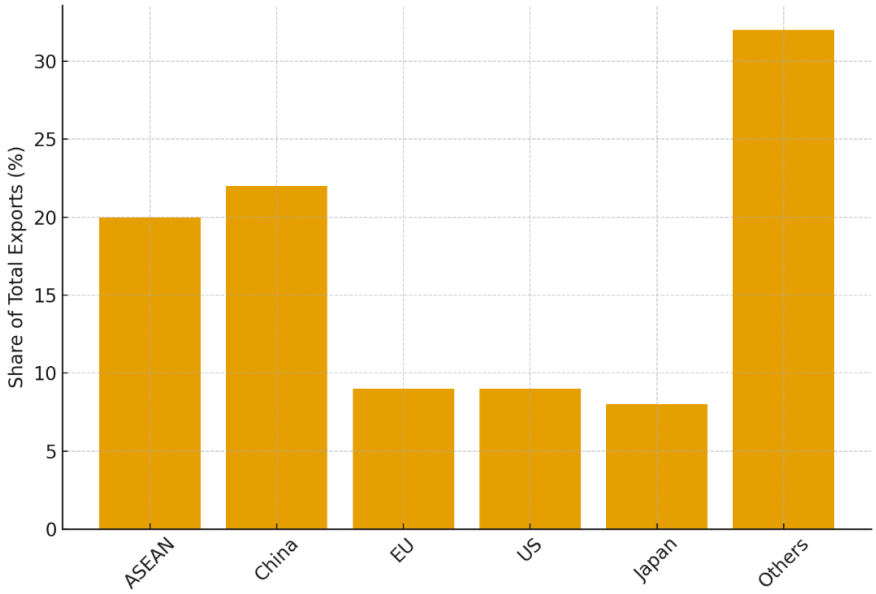

Figure 2. Indonesia's export shares by major trading partner, 2022 (%).

Besides that, CBAM price will also affect the overall price structure of Indonesian products on the international market. Although domestic carbon prices in Indonesia are still relatively low, which provides incentives for industry to remain dependent on carbon-based processes, the CBAM price will add to higher production costs (Parjiono, 2023). This worsens Indonesia's position in competition with other countries that have adopted more environmentally friendly technology and have higher carbon prices, such as EU countries. Dependence on cheap carbon-based production processes can worsen Indonesian products' competitiveness in international markets, especially when other large countries have adopted more environmentally friendly technologies and can produce goods with a lower carbon footprint (OECD, 2020). In this light, they are not subject to additional price when entering the EU market.

Overall, implementing CBAM has the potential to increase production costs, which will greatly impact the competitiveness of Indonesian exports. Carbon-dependent industrial sectors, such as steel, cement, and aluminum, will face major challenges in maintaining their price competitiveness in the EU market. A significant increase in production costs due to the CBAM price could make Indonesian products more expensive, risking demand from EU importers and reducing the volume of Indonesian exports to that market. Therefore, it is important for Indonesia to immediately respond by investing in low-carbon technology and switching to more environmentally friendly production processes to maintain product competitiveness in international markets.

3.2 Economic and Social Impact of CBAM in Indonesia

The EU CBAM, set to be fully implemented in 2026, is poised to significantly impact Indonesia's economy due to the imposed carbon price on imports based on their embedded emissions, compelling exporting countries to internalize the environmental costs of production (Teusch & al., 2024). This translates into higher production costs as domestic firms must calculate and offset the carbon content of their goods to remain competitive in international markets. The resulting increase in production expenses could undermine the competitiveness of Indonesian exports and ultimately impact national GDP growth. With approximately 20 percent of Indonesian exports to the EU comprising products affected by CBAM, the policy has the potential to produce macroeconomic ripple effects beyond its immediate trade boundaries (Fauri et al., 2025). To illustrate the scale of these potential effects more concretely, the GDP loss ($\Delta GDP\%$) resulting from a contraction in steel exports to the EU can be calculated by using Equation 1. The $\Delta GDP\%$ is affected by export share on GDP ($\alpha = 18\%$), share of steel export to the EU in the total exports ($\kappa = 5.5\%$), and contraction in EU steel export ($\Delta X = -20\%$).

$$\Delta GDP\% \approx \alpha \times \kappa \times \Delta X \approx 18\% \times 5.5\% \times -20\% \approx -0.20\% \quad (1)$$

Approximately, a 20 percent decline in Indonesia's steel exports to the EU could reduce national GDP by about 0.2 percent. While 0.2 percent may appear modest in percentage terms, in an economy the size of Indonesia's, this equates to billions of dollars in lost value-added. The effect is also systemic, as the steel industry is deeply embedded in domestic supply chains, from coal mining to downstream manufacturing. In other words, a trade shock concentrated in just one commodity is sufficient to generate macroeconomic pressure, particularly if similar contractions occur in other CBAM-exposed sectors such as cement and aluminum. This underlines that CBAM is not merely a trade issue but a broader challenge to Indonesia's economic stability.

Despite these challenges, CBAM may also present strategic opportunities for Indonesia to accelerate its transition toward a green economy. Industries that adopt low-carbon technologies could gain a competitive edge in the global marketplace. The Indonesian Iron and Steel Association reports that the country's steel industry is preparing to produce green steel using scrap-based EAF technology with a capacity of 6 million tons annually. However, the transition faces challenges, including clean electricity and regulatory support for scrap metal imports. Moreover, the growing international demand for environmentally friendly products may incentivize domestic industries to redirect investments toward clean technologies. Nevertheless, such transitions require industrial readiness, robust policy support, and financial facilitation from the government. Without targeted incentives and technical assistance, many energy-intensive industries will likely face considerable barriers in achieving rapid decarbonization.

Investment patterns are also expected to shift in response to rising uncertainty over carbon pricing and tightening global environmental regulations (Parry et al., 2021). Fossil fuel-based sectors may see declining investor interest due to their increasing risk exposure, while renewable energy and green technology sectors are positioned to attract greater capital inflows (Takacs, 2023). These investment realignments align with Indonesia's broader energy transition agenda and its commitment to net zero emissions. However, significant obstacles persist, particularly regarding the availability of green infrastructure and adequate funding mechanisms to support a just and timely transition. Without

resolving these structural constraints, the potential for CBAM to catalyze green transformation may remain underutilized.

Another critical dimension of CBAM's implementation involves its impact on labor market structures. Carbon-intensive, labor-intensive sectors often employ low-skilled workers, making them particularly vulnerable to structural shifts induced by decarbonization mandates (Shah, 2023). Job losses or a mismatch between existing and emerging skill demands are likely outcomes. Without sufficient retraining and reskilling programs, a substantial portion of the workforce risks marginalization during the green transition. This reality underscores the urgent need for adaptive workforce policies to mitigate social inequality and ensure a just transition. The socioeconomic stability of communities tied to traditional industrial employment hinges on proactive labor market interventions.

To illustrate the magnitude of this risk in measurable terms, the potential job losses can be estimated using Equation 2. A 10% contraction in the activity of steel and cement industries, sectors directly exposed to CBAM, would put approximately 120,000 jobs at risk. Most of these workers are low- to medium-skilled, concentrated in industrial belts such as Java and Sumatra, where steel and cement plants dominate local economies. In practice, the displacement effect would not only reduce household incomes but also create knock-on effects in upstream (mining, transport) and downstream (construction, real estate) sectors. The figure of 120,000 should therefore be viewed as a conservative baseline, since indirect employment impacts are likely to push the true number even higher. This reinforces the urgency of integrating labor reskilling and social safety nets into Indonesia's CBAM adaptation strategy, ensuring that economic decarbonization does not translate into widespread social dislocation.

$$Jobs\ at\ risk \approx Total\ workers\ in\ steel\ and\ cemen\ industries \times |Output\ contraction| \approx 1{,}200{,}000 \times |-10\%| \approx 120{,}000 \quad (2)$$

Micro, Small, and Medium Enterprises (MSMEs) represent another vulnerable segment facing CBAM. Many MSMEs in sectors such as textiles, handicrafts, and food processing still rely on energy-inefficient production processes and cannot meet international emissions standards (UNTC, 2024a). Consequently, their production costs will likely surge, further eroding global competitiveness. Over time, this could exacerbate existing economic disparities, as small enterprises typically face limited access to clean technologies and green financing. State intervention is crucial to address these gaps through targeted technological support, training programs, and facilitated access to sustainable funding channels, enhancing MSMEs' resilience amid tightening carbon regulations.

Furthermore, the rise in production costs associated with CBAM could contribute to inflationary pressures in the domestic market. Sectors directly affected by the policy are expected to pass the cost burden onto consumers through higher retail prices (IRENA, 2020). This could reduce purchasing power and trigger inflation, particularly for basic commodities closely linked to household consumption. The inflationary impact may generate social stress and widen intergroup inequality, especially if appropriate compensatory mechanisms are not in place. Therefore, while CBAM has the potential to drive Indonesia toward a greener economy, it simultaneously demands comprehensive preparedness in regulatory frameworks, social protection systems, and inclusive transition strategies to ensure that no segment of society is left behind.

3.3 Indonesia's Adaptation Strategy in Facing CBAM

The implementation of the CBAM by the EU marks a significant step in efforts to mitigate climate change by integrating carbon adjustment policies in international trade (European Commission, 2021). This policy aims to balance the costs borne by domestic EU producers complying with carbon emissions regulations, with imported products originating from non-EU countries that may not have similar regulations. Consequently, products with a high carbon footprint will be subject to an additional price, which could threaten the competitiveness of products from trading partner countries, including Indonesia. In facing this challenge, Indonesia needs to develop a comprehensive and sustainable

adaptation strategy to reduce the negative impact of CBAM on its export sector, especially those related to high-carbon-based products.

First, it is important to identify the implications of implementing CBAM for developing countries with high export dependence on the EU. Indonesia's export products, many of which are produced through production processes with a high carbon footprint, have the potential to be subject to a carbon price, which can increase production costs and reduce competitiveness. In this context, Indonesia needs to learn from the EU's experience in designing carbon adjustment policies that focus on reducing emissions and aspects of sustainability and economic prosperity. The EU has successfully implemented a carbon adjustment mechanism that integrates the industrial sector with stricter environmental policies, allowing the transition to a green economy without marginalizing the industrial sector.

Beyond mitigating the risks of CBAM, the policy also offers a strategic opportunity for Indonesia and ASEAN countries to establish robust domestic and regional carbon markets. These mechanisms are not only essential to cushion exporters against EU carbon tariffs but also align with the region’s long-term carbon neutrality commitments. By coordinating carbon pricing and emissions trading across ASEAN, member states could create a larger, more liquid carbon market that enhances efficiency, attracts green investment, and strengthens the region’s bargaining position in global climate negotiations. In this sense, CBAM should not be viewed merely as a threat but as a catalyst for accelerating institutional readiness toward a carbon market architecture that ASEAN economies urgently need to meet their net-zero targets.

The lesson that can be taken from the EU is the importance of collaboration between government, the private sector, and society in formulating policies that can reduce carbon emissions. This approach can be used as a reference for Indonesia in formulating more proactive domestic policies in overcoming the challenges posed by CBAM. One of the first steps that Indonesia needs to take is to introduce policies that facilitate the transition to low-carbon technology in industrial sectors that are a mainstay of exports. For example, the utilization of renewable energy and energy efficiency can be strengthened by incentivizing companies that invest in environmentally friendly technologies.

China, as one of the countries with high export dependence on the EU, has responded to CBAM with various policies aimed at reducing carbon emissions and introducing more environmentally friendly production processes. One of the important policies implemented is shifting focus from coal-based steel production to more efficient and environmentally friendly technology, such as the EAF, which produces lower carbon emissions (Li et al., 2021). China also introduced a national ETS in 2021 that covers power generation and is starting to expand to other industrial sectors. However, carbon prices in the Chinese market are still much lower than carbon prices in the EU, which makes it even more challenging for Chinese manufacturers to compete in the EU market (Tian et al., 2024). This difference in carbon prices creates a gap that must be addressed, considering that the price imposed by CBAM is highly dependent on the emissions costs borne by exporting countries.

India, which also has a high export dependence on the EU, faces similar challenges in responding to CBAM. Although India considers this policy unfair and contrary to the principle of "common but differentiated responsibilities" in the Paris Agreement, which provides more leeway for developing countries, India is also seeking to introduce policies that support their industrial transition towards more environmentally friendly production. India has set a target of achieving net zero by 2070 and is formulating a domestic carbon trading system that will be applied to energy-intensive sectors. Additionally, India is working to increase renewable energy capacity and reduce carbon intensity through energy efficiency policies and the adoption of clean technologies. While India's response to CBAM has been more critical, strategic steps to strengthen its renewable energy sector and reduce dependence on fossil fuels are part of its efforts to reduce the impact of carbon policies implemented by the EU.

As a country that also depends on exports to the EU, Indonesia can take advantage of the policies implemented by China and India to design effective adaptation strategies. One crucial first step is to

harmonize domestic carbon prices with international standards. Considering the increasingly stringent regulations related to carbon emissions in the global market, Indonesia must ensure that domestic carbon prices are not far behind those of developed countries that have already implemented similar regulations. By matching domestic carbon prices with prices prevailing in international markets, Indonesia can more easily access global markets that increasingly prioritize sustainability. This policy will also allow Indonesia to participate in global carbon trading mechanisms, providing the country with the opportunity to earn additional income from international carbon transactions.

One effective instrument to realize carbon price harmonization is to implement a domestic carbon trading scheme. In this scheme, Indonesian companies will be given incentives to reduce their carbon emissions by buying and selling carbon credits according to set emission limits. This will encourage companies to invest in greener technologies and adapt to increasingly stringent international standards regarding carbon emissions. In this way, Indonesia can overcome the direct impact of CBAM and ensure that Indonesian products can remain competitive in the global market.

In addition, to reduce the greater impact of CBAM, Indonesia needs to encourage the industrial transition to more efficient and environmentally friendly production processes. As a country with many industrial sectors that have a high carbon footprint, such as steel, textiles, and manufacturing, Indonesia must focus on using energy efficiency technology that can reduce carbon emissions in production. The application of this energy-efficient technology will not only reduce the carbon footprint but also increase the productivity and competitiveness of Indonesian products in the international market. Apart from that, low-carbon-based sectors, such as renewable energy and electric vehicles, must also be a priority in developing the Indonesian industry. These sectors not only support the reduction of carbon emissions but also open new opportunities in a global market that increasingly demands sustainability.

In addition, to ensure the transition of the Indonesian industry towards a more sustainable green economy, the development of policies that support this change is essential. Strengthening carbon trading regulations at the domestic level and implementing a more progressive carbon tax could be critical steps. A carbon tax, imposed on sectors with high carbon emissions, would motivate companies to reduce their carbon footprint and switch to more efficient technologies. If implemented wisely, this tax can also be a source of funding to support investment in green sectors and environmentally friendly technologies. Therefore, a fair and progressive carbon tax policy will greatly support Indonesia's transition towards a more sustainable low-carbon economy.

Apart from strengthening more resilient domestic policies, export market diversification is an important aspect to reduce Indonesia's dependence on the EU market. Expanding Indonesia's export market to countries that do not implement strict carbon adjustment policies can reduce the negative impact of the carbon price imposed by the EU. Countries in Southeast Asia and Africa, most of which have not implemented carbon policies as stringent as the European Union, could be attractive alternative destinations for Indonesian products affected by CBAM.

However, to take advantage of this opportunity optimally, Indonesia needs to identify and map markets that have the potential for expansion, considering economic aspects and long-term sustainability. Strengthening trade relations with these countries can provide space for Indonesian products affected by the EU's carbon policies, while reducing dependence on markets that are influenced by these policies. However, export market diversification is not a simple short-term solution, but requires commitment. Still, it requires a trade strategy, including economic diplomacy efforts, improving logistics infrastructure, and adjusting products to suit the preferences of the new markets to be reached. Indonesia also needs to pay attention to potential technical and trade barriers in these new markets, such as tariff constraints, uncertain regulations, and differences in quality standards.

3.4 Policy Recommendations for Indonesia

3.4.1 Short-Term Strategy

In the short term, the most urgent strategy for Indonesia in facing global carbon trading policies, especially the CBAM implemented by the EU, is to carry out intensive negotiations with European parties to obtain flexibility in implementing this mechanism. Behind this urgency, Indonesia faces the fact that many industrial sectors, such as steel, textiles, and chemical products, depend highly on exports to European markets. Therefore, imposing high carbon fees on these products poses a big risk to the competitiveness of the Indonesian industry in the global market. If implemented without adjustments, CBAM regulations could significantly reduce export volumes, affect state revenues, and put pressure on industries that still depend on production processes with high carbon emissions.

Developing countries, including Indonesia, should take advantage of the space for negotiations in dealing with CBAM policies. They point out that in the context of carbon trading policies, developing countries can seek exceptions or adjustments in the carbon price imposed by developed countries, such as the EU. For example, countries such as China and India have managed to gain leeway in the implementation of international carbon policies by arguing that their industries are still in the development stage and need more time to adapt to strict emissions standards. In the Indonesian context, a similar approach could be adopted, emphasizing that Indonesia's domestic industry is still in the transition stage and strengthening its capacity to reduce carbon emissions, which requires international support in the form of exceptions or extended implementation times.

Apart from that, multilateral diplomacy could also be one of the paths taken by Indonesia. Given that CBAM regulations affect many countries in the world, Indonesia can strengthen its position by collaborating with other developing countries to encourage the EU to agree on more inclusive and fair policies. For example, in these negotiations, Indonesia could introduce a national commitment regarding reducing carbon emissions in the form of realistic and measurable targets, but by providing concessions regarding the application of the CBAM price on Indonesian export products. This, apart from preventing the industry from excessive impacts, also provides space for Indonesia to make long-term improvements without having to be burdened by burdensome regulations.

Apart from diplomatic channels, providing incentives for industries directly affected by CBAM regulations is also crucial in the short-term strategy. Considering that sectors with high carbon emissions will be most affected by this policy, Indonesia must design a fiscal policy that supports their transition to more environmentally friendly technologies. Providing fiscal incentives, such as subsidies or financing for the adoption of low-carbon technologies, can accelerate this transition. For example, the government can provide incentives in the form of low-interest financing for investment in technology that can reduce carbon emissions (e.g., renewable energy technology and more efficient production processes). This, apart from accelerating the adoption of green technology, will also increase the competitiveness of Indonesian products in the global market, which increasingly prioritizes environmental sustainability.

However, these incentives are not enough just on the technological side. Training and capacity-building programs for workers in affected sectors need to be an integral part of this policy. This training aims to prepare Indonesian workers to face technological transformation and production processes that are more efficient and environmentally friendly. With training, workers can more easily adapt to new technology and production processes based on renewable energy and low-carbon technology. Apart from that, this policy also plays a role in protecting jobs that could be threatened, considering that sectors that rely on high emissions have the potential to experience reduced activity or even layoffs if they fail to adapt to international policies.

This international incentive and negotiation policy is not only to support industrial transition, but also to protect the Indonesian economy from the wider impacts that may occur due to international carbon regulations. The success of this policy, based on case studies in other developing countries, shows that

through a combination of wise negotiations and appropriate fiscal policies, Indonesia can protect its domestic industry while still meeting international commitments regarding reducing carbon emissions. For example, countries such as Brazil and Mexico have succeeded in implementing more flexible emission reduction policies through international agreements that provide room for them to adapt better.

Through these steps, Indonesia will not only be able to survive in the international market but can also prepare the industry in the long term to transform to become more sustainable one. In the end, this short-term strategy based on case study observations provides a practical solution that not only reduces the negative impact on Indonesia's competitiveness in the global market but also prepares the Indonesian industry to enter a more competitive and environmentally friendly low-carbon economy era.

3.4.2 Medium Term Strategy

To achieve a sustainable energy transition in Indonesia, strengthening the domestic carbon tax scheme is a strategic step that needs to be implemented in the medium term. However, the implementation of this policy cannot be carried out haphazardly, considering the ongoing domestic economic challenges, especially dependence on sectors with high carbon emissions, such as energy and transportation. Therefore, the carbon tax policy must consider Indonesia's specific conditions and refer to successful case studies in other countries.

For example, countries such as Sweden and Canada have successfully implemented progressive carbon taxes with a positive impact on reducing carbon emissions without compromising the stability of their economies. Sweden, for example, has implemented a carbon tax since 1990 with significant results. Over more than two decades, Sweden has managed to reduce carbon emissions by 80%, while the country's GDP continues to grow (Brändlin, 2024). This success is supported by a progressive carbon tax structure, which imposes higher rates on sectors with greater emissions and provides exemptions or lower rates for sectors more vulnerable to economic impacts, such as agriculture and transport. In the Indonesian context, a similar policy could be adapted by implementing a carbon tax based on the scale of emissions produced by each industrial sector. Thus, sectors that contribute more to global emissions will be required to innovate and switch to low-carbon technologies, while more vulnerable sectors, such as agriculture, can be given incentives or concessions to make the transition run more fairly.

However, to ensure that the carbon tax policy is effective, the Indonesian government needs to build a fair and transparent system by identifying the sectors most at risk and preparing a detailed transition strategy. For example, the agricultural sector in Indonesia, which contributes around 13% of the country's total greenhouse gas emissions, is a sector that is vulnerable to the additional burden of a carbon tax (Wiloso et al., 2024). Therefore, the government could adopt a carbon tax subsidy model for agricultural sectors that adopt environmentally friendly practices, such as organic farming and sustainable forest management. By providing incentives to farmers who reduce emissions or switch to sustainable farming, carbon taxes can encourage positive change without overburdening the sector.

Apart from that, to support the success of the carbon tax policy, Indonesia also needs to increase investment in low-carbon technology and renewable energy. Countries that have invested in renewable energy sectors, such as solar and wind power, have not only succeeded in reducing dependence on fossil fuels but also created new economic opportunities (Hassan et al., 2024). For example, Germany and China, which have aggressively invested in renewable energy, have not only experienced significant reductions in emissions but also recorded the creation of new jobs in the green energy sector. In the Indonesian context, this investment policy is very important to create a more inclusive economic sustainability.

The Indonesian government could design policies that support private investment in the green energy sector by providing fiscal incentives such as tax breaks for companies that invest in solar, wind, or biomass power plants. For example, countries such as Spain have incentivized renewable energy investment by providing guaranteed energy purchases from the private sector, and the result has been a significant increase in renewable energy capacity in the last decade (Hassan et al., 2024). In addition,

Indonesia needs to build infrastructure that allows efficient distribution of renewable energy. This includes strengthening the electricity network, which can distribute energy from renewable sources to consumers more evenly, and reducing dependence on fossil energy, which currently still dominates Indonesia's energy supply.

Apart from that, Indonesia must also accelerate investment in research and development for technology that is more efficient in reducing carbon emissions. For example, research into the development of more efficient energy storage technologies, such as batteries that can store energy from renewable sources, will be essential to ensure that energy produced from the sun and wind can be used optimally (Kamarlouei et al., 2022). The Indonesian government needs to provide special funding for research institutions and universities that develop green technology, as well as facilitate collaboration between the public and private sectors in developing renewable energy technology solutions.

However, to realize this policy effectively, Indonesia must strengthen existing regulations. This includes improving carbon tax collection mechanisms and ensuring that the funds raised are used optimally to finance the energy transition (UNTC, 2024b). Experience from countries that have successfully implemented carbon taxes, such as Canada, shows that it is important to ensure that carbon tax revenues are reallocated to affected sectors through subsidies or investment in green technologies.

By implementing a progressive carbon tax policy, increasing investment in low-carbon technologies, and strengthening regulations, Indonesia can capitalize on global momentum to make a more sustainable energy transition. This policy will not only help Indonesia achieve long-term emission reduction targets but also open new economic opportunities, create green jobs, and accelerate the adoption of more efficient renewable energy technologies. However, to achieve this goal, it is important for the government to ensure that the policies implemented can maintain a balance between economic sustainability and environmental sustainability, without adding unnecessary burdens to sectors that are still vulnerable.

3.4.3 Long-Term Strategy

In the long term, Indonesia is faced with big challenges in realizing structural transformation towards a low-carbon economy and green industry. Given the country's dependence on high-carbon-based sectors such as coal and oil, this change requires policies that are holistic, innovative, and based on empirical evidence from relevant observations and case studies. The transition process towards a green economy involves concrete steps to diversify economic sectors, with a focus on developing sectors that are more environmentally friendly and sustainable.

One study that is very relevant in understanding how countries successfully transition to a low-carbon economy is that conducted by Sacco et al. (2024) regarding Germany's experience in switching from high-carbon-based industries to green sectors. Germany, as a country with a high dependence on fossil energy in the past, has succeeded in carrying out a transformation by developing new sectors that focus on green technology and energy efficiency. The policies implemented in this transformation include several important steps, one of which is the development of an energy transition, an ambitious energy transition model that aims to reduce carbon emissions, increase energy efficiency, and accelerate the use of renewable energy such as solar, wind, and biomass power.

The development of renewable energy infrastructure is the main pillar in policy of energy transition. Germany is not only building renewable power generation capacity, but also strengthening energy distribution and storage systems to ensure the energy produced can be utilized optimally. In addition, tax policies that support the reduction of carbon emissions through a higher price for fossil energy, as well as incentives for renewable energy, provide incentives for the private sector to invest in green technologies. In addition, the establishment of a domestic carbon market that is integrated with overall European policy, such as the EU ETS, has created a system that encourages companies to reduce their carbon emissions. As a result of this policy, Germany succeeded in reducing dependence on fossil energy and increasing the contribution of the renewable energy sector to total national energy.

Indonesia must design policies that encourage a transition like the policies implemented in Germany. One policy that can be implemented is fiscal incentives for companies that invest in green technology, such as tax exemptions or subsidies for renewable energy development. In this case, the solar and wind energy sectors are very relevant options for development in Indonesia, considering the abundant natural resource potential. This incentive program should be extended to the manufacturing sector, which is one of the sectors with high carbon emissions, by supporting them to switch to more efficient and environmentally friendly technologies.

In addition, policies that include the development and diversification of economic sectors are very important in ensuring the sustainability of the energy transition. Indonesia can learn from the experience of countries like Germany, which have succeeded in developing new, greener sectors, such as the electric vehicle sector, energy storage technology, and environmentally friendly products. Therefore, Indonesia needs to pay more attention to developing new industries that focus on low-carbon technology. By utilizing its natural resources, such as the potential for renewable energy from geothermal, wind, and solar, Indonesia can develop green industrial sectors that can create new jobs, increase economic growth, and reduce dependence on fossil energy.

The transition to a green economy is not only about developing new sectors but also involves structural changes in the labor sector. This is where the government's role is crucial in creating policies that support retraining and skills development for workers affected by this transition. For example, the renewable energy sector requires workers with specific technical skills, so there is a need for adequate training programs to increase the capacity of Indonesia's human resources. Training programs involving the education and vocational training sectors can be integrated to prepare a workforce ready to face the challenges of this transition.

Apart from developing the domestic green sector, international cooperation also plays an important role in Indonesia's long-term strategy. Given the complexity of the climate change problem and dependence on global policies related to carbon trading, Indonesia needs to strengthen international cooperation with developed countries and other developing countries. This cooperation is important to create a more harmonious carbon trading policy and reduce trade barriers caused by differences in carbon policies between countries. Countries that successfully collaborate on global carbon trading policies can accelerate the adoption of green technologies and reduce dependence on fossil energy (Clausing et al., 2025). In the Indonesian context, cooperation with the EU, for example, will provide greater access to the low-carbon technologies and renewable energy needed in this transition.

Not only that, but international cooperation also includes funding for energy transition projects. Many developing countries, including Indonesia, face financial constraints in implementing sustainable energy transition policies. Therefore, Indonesia needs to utilize funds from various international sources, such as the Green Climate Fund and the UN Development Program, which can provide funding for projects that support the low-carbon energy transition. Developed countries that have greater capacity in terms of funding also need to play a role in supporting developing countries through technology transfer and greater allocation of funds for energy transition programs.

Infrastructure that supports energy transition is also an aspect that cannot be ignored. Indonesia needs to make large investments in developing renewable energy infrastructure, such as solar and wind power plants, as well as distribution networks that can support the spread of renewable energy throughout Indonesia. Good infrastructure will ensure that renewable energy can be utilized efficiently and can reduce dependence on increasingly limited fossil energy sources. The government needs to work together with the private sector to build adequate infrastructure and ensure that the policies implemented support the financing and development of environmentally friendly energy infrastructure.

3.4.4 Roadmap

Building on these strategies in the three terms outlined above, Indonesia's successful adaptation to CBAM depends not only on policy direction but also on clear institutional responsibilities to carry them out. Each strategy must be translated into specific roles and mandates across government agencies to ensure effective coordination and transparent accountability. The following table maps out the key policy areas, lead agencies, supporting institutions, and core functions required to operationalize the strategy in a structured and coherent manner aligned with EU CBAM requirements.

Table 3 highlights the institutional architecture required for Indonesia to respond effectively to the EU's CBAM. Each policy area is assigned to a lead agency with clearly identified supporting institutions. This structure ensures that technical, fiscal, industrial, and diplomatic dimensions of CBAM adaptation are not treated in isolation but coordinated across ministries. By clarifying who is responsible for what, the table provides the foundation for accountability, minimizes duplication, and enables Indonesia to align domestic actions with international requirements.

Table 3. Roadmap agencies are responsible for the proposed recommendations.

Area	Lead Agency	Supporting Agencies	Key Functions
Carbon accounting & MRV (Measurement, Reporting, Verification)	Ministry of Environment and Forestry	BPS, Ministry of Industry	Develop national MRV protocol, align with EU ETS reporting, certify carbon content of exports.
Trade & customs integration	Ministry of Trade	Directorate General of Customs & Excise, Ministry of Finance	Embed CBAM carbon declarations in customs clearance; coordinate with EU authorities.
Carbon pricing & financing	Ministry of Finance	Financial Service Authority, Bank Indonesia	Develop domestic carbon pricing; design subsidies/green credit lines for MSMEs.
Industrial decarbonization	Ministry of Industry	ESDM, State-owned Enterprises	Sectoral roadmaps (steel, cement, aluminum), technology adoption, and investment facilitation.
Just transition & equity	Bappenas	Ministry of Manpower, Cooperatives & MSMEs	Reskilling programs, MSME green fund, and regional transition packages.
Diplomacy & negotiations	Ministry of Foreign Affairs	Coordinating Ministry of Economic Affairs	Trade diplomacy, advocating for fair CBAM terms, seeking technology transfer.

While Table 3 outlines the "who" and "what" of Indonesia's CBAM response, the next step is to sequence "when" these actions will take place. A phased timeline is essential to balance urgent short-term adjustments with the medium- and long-term structural changes required for a low-carbon economy. Table 4 organizes the implementation roadmap into three horizons, detailing concrete steps that translate institutional responsibilities into measurable outcomes. Taken together, the institutional framework and phased implementation roadmap provide a structured foundation for Indonesia's CBAM response. However, to ensure these measures are not only enacted but also effective, they must be accompanied by a clear system of monitoring and evaluation.

Table 5 sets out the Monitoring and Evaluation framework designed to track Indonesia's progress in adapting to the EU CBAM. The framework identifies six priority objectives, each with measurable indicators, baselines, and time-bound targets. Reducing carbon intensity in steel and cement is

prioritized because these sectors dominate Indonesia's CBAM exposure. The Measurement, Reporting, Verification (MRV) coverage ensures compliance with EU reporting requirements, while green finance mobilization reflects the scale of domestic and international investment needed to support the transition. Equity and just transition indicators address the social dimension to ensure that workers and MSMEs are not left behind. Finally, trade resilience measures diversification into non-EU markets, protecting Indonesia from overreliance on a single trading bloc. Together, these indicators establish a robust accountability system that links institutional responsibilities and phased actions to tangible outcomes.

Table 4. The Implementation Roadmap.

Period	Strategies
0–2 years (2025–2027)	• Establish National CBAM Task Force (multi-ministerial). • Adopt EU-compatible MRV guidelines. • Launch pilot carbon accounting in steel & cement sectors. • Create Green Transition Fund for MSMEs. • Begin EU–Indonesia dialogue on technical assistance.
2–7 years (2027–2032)	• Scale MRV to all CBAM-exposed industries. • Introduce phased domestic carbon pricing & subsidy reallocation. • Implement industrial technology pilots (e.g., Electric Arc Furnace steel). • Roll out nationwide worker reskilling programs. • Develop regional transition packages (Java, Sumatra industrial belts).
7–15 years (2032–2040)	• Achieve full integration of MRV into customs. • Reach >50% renewable electricity supply for industry. • Operationalize green industrial zones linked to export markets. • Reduce carbon intensity of steel/cement/aluminum by at least 40%. • Position Indonesia as a regional hub for green exports.

Table 5. Monitoring and evaluation of CBAM adaptation.

Objective	Indicator	Baseline (2022)	2027 Target	2032 Target	2040 Target
Reduce the carbon intensity of exports	CO_2/ton steel	1.8	1.5	1.2	1.0
	CO_2/ton cement	0.9	0.8	0.6	0.5
MRV coverage	% of CBAM-exposed exports with verified carbon data	<5%	50%	90%	100%
Green finance mobilization	$ billion/year mobilized	<0.5	2	5	10
Equity & just transition	# workers retrained	0	50,000	250,000	500,000+
	MSMEs receiving green financing	<100	1,000	5,000	10,000
Trade resilience	Share of exports to non-EU low-CBAM markets (%)	9%	15%	20%	25%

By integrating institutional roles, a phased implementation timeline, and measurable monitoring and evaluation indicators, Indonesia's CBAM response framework moves beyond broad recommendations toward a prescriptive and actionable plan. This comprehensive approach not only aligns with EU compliance requirements but also safeguards national competitiveness, promotes equity, and strengthens resilience in the global low-carbon transition.

4. Conclusions

Our study has examined the implications of the EU's CBAM for Indonesia and identified a set of adaptive strategies that balance economic competitiveness with climate commitments. The findings highlight Indonesia's structural vulnerability as an exporter of carbon-intensive products, such as steel

and cement, and the potential risks to national revenue, employment, and industrial resilience. Comparative case studies of China, Vietnam, South Korea, India, and Germany demonstrate that successful adaptation requires a combination of negotiation, fiscal reform, industrial upgrading, and just transition policies.

From the analysis results, three major insights emerge. First, in the short term, Indonesia must leverage international negotiations and coalition-building with other developing countries to secure flexibilities while providing immediate fiscal incentives and capacity-building for exposed industries and workers. Second, in the medium term, strengthening domestic carbon pricing, scaling up MRV systems, and expanding investment in renewable energy are essential to align with global standards without undermining growth. Third, in the long term, Indonesia's structural transformation toward a low-carbon economy requires coordinated investment in green industries, retraining of the workforce, and stronger integration into international low-carbon value chains.

To operationalize these strategies, we underscore the importance of institutional clarity, phased implementation, and measurable monitoring frameworks. Clear agency mandates, sequencing of policy instruments, and evidence-based evaluation are critical to ensure that CBAM adaptation is not only a defensive response but also an opportunity to accelerate Indonesia's green transition. By embedding these measures into national planning, Indonesia can mitigate trade risks, safeguard vulnerable groups, and position itself as a competitive player in the global low-carbon economy.

This research has several limitations, especially in terms of the scope of the sectors analyzed. The focus of this research is limited to high carbon-based products that are affected by the European Union's CBAM policy, such as steel, cement, and aluminum, without considering other sectors that are also potentially affected, such as the agricultural and textile sectors. In addition, this research does not include an in-depth analysis of Indonesia's capacity to adapt to green technology in the long term, including investment, infrastructure, and human resource readiness challenges. This research also has not explored the impact of CBAM on the SME sector, which may be more vulnerable to additional costs resulting from this policy. Moreover, although our study highlights employment and equity concerns, it does not provide a quantitative estimate of the distributional impacts across vulnerable households and regions.

Future research should expand the analysis to include other sectors that could also be affected by CBAM policies, such as the agricultural and textile sectors, to get a more comprehensive picture of the impact on the Indonesian economy. In addition, there is a need to carry out more in-depth research into the impact of CBAM on SMEs and more vulnerable sectors, as well as exploring how policy can support their transition to greener technologies. Further research should also consider external factors such as global policies on climate change and fluctuations in energy prices, which can affect the competitiveness of Indonesian exports in international markets. Future research can also focus on undertaking a CGE study to capture both macroeconomic and microeconomic impacts of CBAM on Indonesia, which will be very useful for policymaking.

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