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Circular Economy and Carbon Emission Reduction Strategies within The ESG Framework: A Case Study of PTPN IV PalmCo

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Abstract

Background: Indonesia's palm oil industry faces growing sustainability pressure, including compliance with the European Union Deforestation Regulation (EUDR). Following its December 2023 merger, PT Perkebunan Nusantara IV PalmCo is integrating ESG principles into its operations.
Objective: This study aims to analyze the implementation of *circular economy* and carbon emission reduction strategies as part of the ESG framework at PTPN IV PalmCo.
Methods: Using a descriptive qualitative case study with secondary data from company reports, verified media, and official documents (2023–2025), this research finds that PalmCo has implemented a circular economy by converting palm oil waste into renewable energy through 11 biogas facilities, targeting 32 facilities by 2029 and over 80% renewable energy utilization.
Results: The carbon emission reduction strategy, implemented through both nature-based and technology-based approaches, has resulted in carbon sequestration of 873,395 tons CO_2e/year and emission reductions of 191,107 tons CO_2e/year, while also achieving the first Greenhouse Gas (GHG) Emission Reduction Certificate in the plantation industry. Both initiatives are strongly integrated into the ESG framework, as evidenced by PalmCo's #2 global ranking in the S&P Corporate Sustainability Assessment (CSA) 2024 and its receipt of two Diamond Awards at the ESG Initiative Awards 2025.
Conclusion: This research contributes to ESG literature in the plantation sector by demonstrating, through Legitimacy Theory, that PalmCo is transitioning from symbolic to substantive legitimacy, evidenced by verified emission reductions and the integration of ESG indicators into management KPIs. These findings offer a theoretical contribution to ESG implementation in state-owned plantation enterprises.

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INTRODUCTION

The palm oil industry is a strategic sector in the Indonesian economy, contributing significantly to state revenue, employment, and regional development. The Indonesian Ministry of Agriculture revealed that in 2024, Indonesia was the world's largest crude palm oil (CPO) producer, with plantation areas exceeding 16 million hectares. However, the palm oil industry faces increasing pressure from the global community regarding sustainability issues, particularly deforestation, peatland degradation, and greenhouse gas (GHG) emissions from production processes (Breslin & Nesadurai, 2023). Data from the Food and Agriculture Organization (2023) indicates that global agricultural land-use change, in which palm oil expansion contributes

significantly, accounts for approximately 10–12% of total global greenhouse gas emissions annually, while Indonesia's palm oil sector alone is estimated to contribute around 0.3 Gt CO_2e per year (Meijaard et al., 2020). These figures underscore the critical urgency of developing effective decarbonization strategies within the palm oil industry.

According to the European Commission, this pressure is manifested through increasingly stringent trade regulations, such as the European Union Deforestation Regulation (EUDR), which entered into force in 2024. This regulation requires commodities entering the EU market to be deforestation-free. Such requirements compel industry players, including state-owned plantation enterprises (Badan Usaha Milik Negara [BUMN]), to transform their business models by integrating sustainability principles. In responding to these global pressures, the Environmental, Social, and Governance (ESG) framework has become a primary reference for corporations. ESG is no longer regarded merely as a compliance obligation but as a strategic necessity for maintaining competitiveness and accessing sustainable financing sources (Kotsantonis et al., 2016).

PT Perkebunan Nusantara IV (PTPN IV) or PalmCo, as a sub-holding established through the merger of PTPN V, VI, and XIII in December 2023, manages plantation areas exceeding 600,000 hectares. The company achieved an ESG score of 55 from S&P Corporate Sustainability Assessment (CSA) in 2024 (ranked second globally) and received two Diamond awards at the ESG Initiative Awards 2025 (JPNN, 2024; SustainLife Today, 2025). Global geopolitical developments that have triggered energy price instability have also encouraged PalmCo to accelerate its transition toward renewable energy. One of the strategic measures undertaken is the utilization of palm oil waste as an alternative energy source, which simultaneously positions the company in a transition phase toward implementing a circular economy.

The utilization of Palm Oil Mill Effluent (POME) as an electricity source through Biogas Power Plants (Pembangkit Listrik Tenaga Biogas [PLTBg]) operated by PTPN IV PalmCo in Terantam and Tandun demonstrates significant operational achievements. Based on company data, this initiative successfully reduced diesel consumption by more than 2.6 million liters during the 2023–2025 period while generating energy cost savings of approximately Rp39.5 billion over the past three years. Processing more than 293,000 cubic meters of liquid waste annually into millions of cubic meters of methane gas not only supports factory operations but also prevents the release of GHG emissions into the atmosphere.

However, despite the various achievements attained by PalmCo, the palm oil industry continues to face complex global environmental pressures. These challenges include deforestation, peatland degradation, GHG emissions, and increasingly stringent regulations such as the EUDR. Moreover, corporate ESG practices may sometimes take the form of greenwashing, in which companies attempt to portray positive ESG performance without implementing fundamental operational changes. Greenwashing can result in companies receiving external recognition for sustainability performance that does not correspond with actual practices within the organization. This situation may undermine the industrial sector because ESG policies are used merely as symbolic or image-building instruments rather than as mechanisms for sustainable business transformation.

From a macro perspective, the environmental challenges of the palm oil industry cannot be separated from the linear economic model, which generates substantial waste without optimizing resource recovery and contributes to high GHG emissions throughout the production chain. Ideally, the integration of circular economy principles and carbon emission reduction strategies within the ESG framework in palm oil plantation companies should be reflected through systematic, structured, and measurable linkages between policies, operational implementation, and resulting environmental impacts. A comprehensive ESG framework requires that every environmental initiative does not operate independently but is vertically integrated from corporate governance to field-level implementation and horizontally connected across various business functions (Babkin et al., 2023; Patil et al., 2020).

The actual conditions observed from various documentation and media reports indicate that this integration is not yet entirely clear or systematically structured. Although PTPN IV PalmCo has achieved notable ESG accomplishments, such as achieving the #2 global ranking in the S&P Corporate Sustainability Assessment (CSA) 2024 and receiving two Diamond Awards at

the ESG Initiative Awards 2025 (JPNN, 2024; SustainLife Today, 2025), fundamental questions remain regarding how the integration mechanism between waste-based circular economy practices and carbon emission reduction strategies is fully implemented within the company's ESG framework.

Furthermore, there is a potential gap between reputational achievements and substantive implementation. In the context of a post-merger company such as PalmCo, which was established in December 2023, the complexity of governance and operations resulting from the consolidation of several entities (PTPN V, VI, and XIII) presents significant challenges. Post-merger integration processes often encounter obstacles, including differences in organizational culture, non-uniform systems and procedures, and coordination challenges across geographically dispersed operational areas. This condition has the potential to create a gap between strategic commitments at the corporate level and their realization at the operational level.

Research on environmental issues in the palm oil industry has been extensive, primarily emphasizing issues such as deforestation, peatland conversion, greenhouse gas (GHG) emissions, and the socio-ecological impacts of plantation expansion. Research conducted by Carlson (2012) examined carbon emissions from forest and peatland conversion for oil palm plantations in Kalimantan; Meijaard (2020) synthesized various environmental impacts of the palm oil industry globally. Provensi (2025) in Brazil explored stakeholder engagement in the implementation of ESG and the circular economy. Hassan (2025) examined sustainable business models based on ESG and the circular economy in the manufacturing sector in general. Meanwhile, research by Miller (2024) examined nature-based solutions in carbon projects in Southeast Asia, including the involvement of palm oil plantation companies.

Furthermore, Dewi (2025) examined environmental management policies for sustainable palm oil plantations in Riau and East Kalimantan. However, most of this research tends to be descriptive and documentary about environmental impacts, without deeply examining how corporate strategy mechanisms (such as the circular economy and decarbonization) can play a role in mitigating these environmental problems. This research is also unable to connect field findings with an integrated ESG framework.

Other research on the circular economy in the palm oil industry has also developed rapidly in the last decade, along with increased awareness of the added value potential of palm oil waste. Research by Suksaroj (2023) in Thailand examined the efficiency of the co-digestion process between POME and empty fruit bunch (EFB) liquid waste to increase biogas production. Setiawan (2025) conducted a comprehensive study on biogas production from POME in Indonesia, including the prospects of co-digestion with empty fruit bunches. Ji (2013) studied covered lagoon technology for biogas production in Malaysian palm oil plantations. Meanwhile, Haryanto (2023) examined the electricity potential from POME biogas in small and medium-scale palm oil mills in Sumatra.

Research by Arista (2024) examined the circular economy potential from oil palm plantations to industry, focusing on empty fruit bunches, shells, and fibers. Rendón (2026) conducted a systematic review of the utilization of palm oil residual biomass within the framework of industrial symbiosis across various economic sectors. Soleha (2021) examined the potential of palm kernel shells as raw material for bio-pellets for export to the Japanese and Korean markets. Pranolo (2023) explored the production of cellulose nanocrystals from empty fruit bunches, while Arisht (2022) examined the potential of palm oil waste for biohydrogen production.

Along with the strengthening global pressure on sustainable palm oil plantation practices, several studies continue to be developed to identify the level of company compliance with sustainability principles and the effectiveness of ESG implementation. Soleha (2021) explored sustainability reports of palm oil companies in Indonesia, focusing on conformity with GRI standards. Wahyuningrum (2026) examined environmental disclosure in manufacturing and mining companies in Indonesia, including several palm oil companies. Setiatin (2025) discussed the challenges of ESG reporting in Indonesian companies in general. Alodat (2024) examined the role of sustainability strategy in mediating corporate success, focusing on governance aspects.

Therefore, existing research on circular economy and ESG still presents several limitations. Studies on the circular economy predominantly focus on technical aspects and waste-

processing technologies at laboratory or factory scales, with limited discussion regarding their integration into corporate-level business strategies. Additionally, most research objects remain restricted to individual factories or specific geographical regions rather than large-scale corporations with complex governance structures. Meanwhile, ESG research remains largely dominated by corporate governance and sustainability reporting perspectives, while environmental dimensions, including circular economy practices and decarbonization strategies, are often discussed only conceptually. Many studies also rely primarily on corporate reports without direct field verification, resulting in limited critical examination of potential greenwashing practices. Furthermore, previous research has focused more heavily on private-sector companies and publicly listed firms, leaving studies on ESG implementation within state-owned plantation enterprises (Badan Usaha Milik Negara/BUMN) relatively limited.

Legitimacy theory is one of the most relevant theories for explaining companies' motivations for adopting sustainability practices and ESG reporting. This theory is based on the assumption that companies operate under an implicit social contract with society, in which the continuity of company operations depends on the extent to which company values and behaviors align with the norms and expectations of the wider community. When there is a gap between company values and societal expectations, referred to as a legitimacy gap, companies will attempt to close this gap through various communication strategies and symbolic or substantive actions.

In the context of ESG, legitimacy theory explains that companies do not implement sustainability practices solely based on ethical awareness but also as a response to external pressures from stakeholders, regulators, and the public (Banu & Vimala, 2024). This raises a critical question that forms the core of this research: does ESG implementation by companies reflect substantive operational changes, or is it merely an effort to build reputational legitimacy without fundamental transformation, a condition known in the literature as greenwashing (Lawrence, 2025).

In this research, legitimacy theory is operationalized through two main constructs. Symbolic legitimacy refers to reputational actions undertaken by companies, such as ESG reporting, obtaining certifications, and participating in international forums, without corresponding fundamental changes in operational models. Conversely, substantive legitimacy refers to real and verifiable changes in how companies operate, reflected in quantitative data that can be independently audited (Banu & Vimala, 2024). These two constructs serve as the primary analytical lenses for interpreting the findings of PTPN IV PalmCo's ESG implementation in the discussion section.

Environmental, Social, and Governance (ESG) is a framework used to measure the sustainability and ethical impacts of investments in companies or businesses. This concept was first introduced through the Who Cares Wins report initiated by United Nations Secretary-General Kofi Annan in 2004, which encouraged global financial institutions to integrate environmental, social, and governance factors into capital markets (United Nations Global Compact, 2004). Conceptually, ESG represents an extension of the more traditional Corporate Social Responsibility (CSR) concept. While CSR focuses more on philanthropic activities and regulatory compliance, ESG emphasizes the integration of sustainability factors into core business strategies and corporate risk management (Gillan et al., 2021). In its development, ESG has become not only a tool for investors to screen responsible companies but also an indicator for corporate management to identify opportunities and risks related to sustainability issues.

The three pillars of ESG encompass broad and interconnected scopes. The Environmental pillar addresses how companies interact with the natural environment, including the impacts of operations on climate change, natural resource management, energy efficiency, waste management, pollution control, and biodiversity conservation (Eccles et al., 2014). In the context of the palm oil industry, the most relevant environmental issues include deforestation, greenhouse gas (GHG) emissions from land clearing and waste processing, and water and biodiversity management within concession areas.

The Social pillar concerns companies' relationships with internal and external stakeholders, including employees, local communities, suppliers, customers, and the wider public. Aspects covered under the Social pillar include labor practices, occupational health and safety, human rights, community relations, product responsibility, and contributions to the

socioeconomic development of surrounding communities (Whelan et al., 2021). The Governance pillar refers to the internal systems, practices, and policies that guide corporate decision-making and control mechanisms. Aspects included in this pillar include board structure, board independence, executive compensation, shareholder rights, transparency and accountability, risk management, anti-corruption practices, and compliance with laws and regulations.

In the context of public companies, ESG performance has become a determining factor in investment decisions. International rating agencies such as MSCI Inc., Sustainalytics, and S&P Global routinely publish ESG ratings used by institutional investors to allocate capital. Research shows that companies with high ESG ratings tend to have lower capital costs, reduced stock volatility, and stronger resilience during crises (Friede et al., 2023). Meanwhile, ESG implementation in state-owned enterprises represents a manifestation of the constitutional mandate to promote public welfare and sustainable development. The Ministry of SOEs has issued various policies through the Indonesia Sustainable Development Goals Awards assessment and the obligation for all SOEs to prepare sustainability reports (Ministry of SOEs of the Republic of Indonesia, 2023). In this context, PTPN IV PalmCo, as part of the Nusantara Plantation Holding, is not only required to meet global ESG standards but also expected to serve as a role model for other plantation companies in implementing sustainability principles.

ESG performance measurement is conducted through various approaches and indicators that differ among rating agencies. S&P Global, for example, applies the Corporate Sustainability Assessment (CSA), which evaluates companies based on industry-specific criteria with different weighting schemes. This methodology includes an in-depth analysis of corporate policies, practices, and performance related to environmental, social, and governance aspects, which are subsequently translated into an ESG score (S&P Global, 2024). In the context of the palm oil industry, key ESG indicators include sustainable land management, Roundtable on Sustainable Palm Oil (RSPO) and Indonesian Sustainable Palm Oil (ISPO) certification, waste and emissions management, labor practices, relationships with local communities, and governance transparency.

The circular economy is a concept that emerges as an alternative to the traditional linear economic model, which follows the “take-make-dispose” pattern. In a linear economy, resources are extracted, converted into products, and ultimately disposed of as waste after their useful life ends. Conversely, the circular economy is designed to maximize resource value by keeping products, components, and materials within the economic cycle for as long as possible through strategies such as reduction, reuse, repair, recycling, and recovery (Kirchherr et al., 2023).

The Ellen MacArthur (2013) Foundation, a pioneer of the circular economy movement, formulated three main principles of this concept: first, designing products to minimize waste and pollution; second, keeping products and materials in use at their highest value; and third, regenerating natural systems (Ellen MacArthur, 2013). These principles emphasize fundamental changes in production and consumption patterns, shifting the focus from product ownership to service provision while encouraging innovation in product design and business models. In the industrial context, the circular economy provides not only environmental benefits but also economic advantages. Research shows that implementing circular economy principles can reduce production costs through the efficient use of raw materials and energy, create new revenue streams from by-products and waste, and reduce dependence on finite natural resources that are vulnerable to price fluctuations (Geissdoerfer et al., 2017).

The palm oil industry generates substantial amounts of waste, including both solid and liquid waste, which, if not managed properly, can cause significant environmental impacts. Solid waste includes empty fruit bunches, pressed fibers, palm kernel shells, and fronds, while the primary liquid waste is Palm Oil Mill Effluent (POME), which is generated during the process of converting fresh fruit bunches into crude palm oil (Madaki & Seng, 2013). From a linear economy perspective, this waste is viewed as a burden that requires disposal at a certain cost. However, from a circular economy perspective, this waste is considered a resource with potential economic value.

The conversion of palm oil waste into renewable energy represents one of the most developed circular economy applications in the palm oil industry. POME, which is rich in organic matter, can be processed through anaerobic digestion to produce biogas, which can subsequently

be converted into electricity or purified into biomethane for various applications. Meanwhile, solid waste such as palm kernel shells and fibers can be utilized as biomass fuel to generate steam and electricity or further processed into value-added products, such as bio-pellets, biochar, and other industrial raw materials (Albuquerque et al., 2024).

The application of circular economy principles provides various benefits for corporate sustainability. From an environmental perspective, the circular economy reduces the volume of waste discharged into the environment, lowers GHG emissions from waste decomposition, and decreases dependence on fossil fuels. From an economic perspective, the circular economy creates new revenue streams from by-products and waste, reduces waste management costs, and improves overall operational efficiency (Lieder & Rashid, 2016). From a social perspective, the development of waste processing facilities creates employment opportunities and expands business opportunities for surrounding communities.

Climate change has become one of the greatest challenges facing humanity in the 21st century. The increase in greenhouse gas (GHG) concentrations in the atmosphere, primarily driven by fossil fuel combustion, deforestation, and unsustainable agricultural practices, has resulted in rising global temperatures, shifting weather patterns, and various other adverse impacts on ecosystems and human life (Intergovernmental Panel on Climate Change/IPCC, 2023). Addressing climate change requires collective action from all stakeholders, including governments, the private sector, civil society, and individuals.

The corporate sector plays a crucial role in climate change mitigation efforts. As major GHG emitters and owners of significant resources and innovation capabilities, companies are strategically positioned to drive the transition toward a low-carbon economy. Through investments in energy efficiency, renewable energy, low-carbon technologies, and sustainable business practices, companies can significantly reduce their carbon footprints while creating long-term business value (Wright, 2024). Additionally, companies can leverage their influence to encourage suppliers, business partners, and customers to adopt similar sustainability practices.

In the context of the palm oil industry, GHG emissions originate from various sources throughout the value chain. At the upstream stage, emissions primarily result from land-use change, including deforestation and peatland conversion for plantation expansion, as well as the use of fertilizers and pesticides. At the processing stage, emissions arise from energy consumption, particularly fossil fuel use, and liquid waste treatment through POME management, which can generate methane, a GHG with a global warming potential approximately 25 times greater than CO_2. At the downstream stage, emissions are associated with transportation, further processing, and distribution of final products (Bessou et al., 2014).

Carbon emission reduction or decarbonization strategies can be categorized into two main approaches: nature-based solutions and technology-based solutions. These approaches complement each other and are essential for achieving ambitious emission reduction targets under the Paris Agreement.

Nature-based solutions refer to actions aimed at protecting, sustainably managing, and restoring natural ecosystems to address societal challenges, including climate change, while simultaneously providing benefits for human well-being and biodiversity (Seddon et al., 2020). In the context of oil palm plantations, nature-based solutions include protecting high conservation value (HCV) forests within and surrounding concession areas, restoring degraded ecosystems, implementing conservation-oriented agricultural practices, and sustainably managing peatlands to prevent oxidation and fires. This approach not only contributes to carbon sequestration and storage but also maintains biodiversity, regulates water systems, and supports local community livelihoods.

Carbon trading is an economic instrument developed to provide incentives for GHG emission reductions. Through this mechanism, entities that successfully reduce emissions below established limits can sell their excess emission allowances or emission reduction certificates to other entities that face challenges in meeting their reduction targets. Carbon trading creates economic value from emission reduction initiatives, thereby encouraging innovation and investment in low-carbon technologies.

Indonesia has developed a carbon trading system through the Indonesia Stock Exchange (IDX Carbon), which was launched in 2023. This system enables companies to trade carbon units

generated from verified emission reduction projects. The active participation of PTPN IV PalmCo in carbon trading, which currently ranks fourth in carbon sales on IDX Carbon (Kabar BUMN, 2025), demonstrates that the company perceives emission reduction not merely as a regulatory obligation or operational burden but also as a business opportunity that can generate additional revenue while supporting national climate targets.

The ESG concept provides a comprehensive framework for managing corporate sustainability performance across three key dimensions: environmental, social, and governance. Within the environmental pillar of ESG, the circular economy and decarbonization are two primary complementary strategies. The circular economy focuses on optimizing resource utilization and waste management, which directly contributes to GHG emission reduction through material and energy efficiency, as well as through the conversion of waste into new resources. Meanwhile, decarbonization provides a clear and measurable pathway for reducing GHG emissions, which is one of the key indicators for assessing corporate environmental performance (Schaltegger et al., 2016).

The integration of these three concepts into corporate strategy creates synergies that generate greater benefits than when each concept is implemented separately. Companies adopting a circular economy approach, for example, can reduce GHG emissions through decreased energy and raw material consumption, as well as through avoided emissions resulting from waste decomposition. Conversely, well-planned decarbonization initiatives can drive innovation in resource efficiency and renewable energy development, which are aligned with circular economy principles. When implemented within a robust ESG framework, both strategies can strengthen governance, enhance transparency, and build stakeholder trust (Geissdoerfer et al., 2017).

In business practice, the integration of ESG, the circular economy, and decarbonization can be realized through various strategic initiatives. At the policy level, companies need to establish clear commitments and targets across all three areas and integrate them into risk management systems, performance measurement mechanisms, and executive compensation schemes. At the operational level, companies need to develop and implement concrete programs encompassing resource efficiency, waste management, renewable energy development, and emission reduction initiatives. At the reporting level, companies need to transparently disclose their performance in these areas using internationally recognized reporting frameworks, such as the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB) (Eccles et al., 2014).

Therefore, this research contributes novelty by conducting an in-depth analysis of circular economy implementation and carbon emission reduction strategies within one of Indonesia's largest state-owned palm oil enterprises, namely PTPN IV PalmCo. This research connects global sustainability concepts with local industrial contexts by examining the theoretical integration between ESG and circular economy frameworks developed at the international level. Furthermore, this research considers post-merger governance complexity as a contextual factor influencing ESG implementation effectiveness, an aspect that has received limited attention in previous studies. A systematic source triangulation approach is applied by integrating various sources, including corporate documents, verified media coverage, international recognition records, and academic literature, to strengthen the validity of the findings. Additionally, this research examines corporate achievements and external recognition related to ESG performance to determine whether such accomplishments represent substantive transformation or remain primarily symbolic and reputational.

Based on the background and problem statement outlined above, this research formulates four research questions: (1) How is the implementation of a circular economy based on palm oil waste utilization conducted by PTPN IV PalmCo following the December 2023 merger? (2) What carbon emission reduction strategies are implemented by PTPN IV PalmCo through nature-based solutions and technology-based solutions? (3) To what extent are the relationship and integration between circular economy practices and decarbonization strategies within PTPN IV PalmCo's ESG framework systematic and substantive? (4) Do PTPN IV PalmCo's ESG achievements and external recognition reflect transformative implementation, or do they remain primarily symbolic and reputational?

This research aims to analyze the implementation of a circular economy based on palm oil waste utilization conducted by PTPN IV PalmCo following the December 2023 merger, including

the development of biogas, biomass, and Compressed Biomethane Gas (CBG) facilities. This research also aims to examine carbon emission reduction strategies implemented by PTPN IV PalmCo through nature-based solutions and technology-based solutions. Furthermore, this research seeks to analyze the relationship and integration between circular economy practices and decarbonization strategies within the broader ESG framework of PTPN IV PalmCo. Finally, this research evaluates PTPN IV PalmCo's ESG achievements and external recognition at both national and international levels.

This research is expected to enrich academic discourse on ESG implementation in the palm oil plantation sector, particularly within state-owned enterprises undergoing rapid transformation through approaches that integrate circular economy practices and decarbonization strategies within ESG frameworks. Practically, this research can serve as evaluation material for PTPN IV PalmCo management in refining sustainability strategies and provide a best-practice reference for other palm oil companies. Furthermore, the findings are expected to support policy formulation related to ESG-based BUMN transformation, GHG emission reduction, carbon trading development, sustainable smallholder empowerment, and strengthening the competitiveness of Indonesia's palm oil industry in addressing global regulatory frameworks such as the European Union Deforestation Regulation (EUDR).

METHOD

This research used a qualitative approach with a descriptive case study method. The qualitative approach was selected because the research aimed to understand in depth the implementation of circular economy and carbon emission reduction strategies as part of the ESG framework at PTPN IV PalmCo (Creswell & Poth, 2016). The case study method was chosen because the research focused on a single specific entity with clear temporal and contextual boundaries, namely PTPN IV PalmCo after the merger from December 2023 until the ESG Initiative Awards 2025, enabling an in-depth exploration of the implementation of ESG strategies in response to global regulatory pressures, such as the EUDR (Yin, 2018). The descriptive approach was employed to systematically and factually describe the implementation of the circular economy, carbon emission reduction strategies, and their integration within the company's ESG framework (Lambert & Lambert, 2012).

This research used secondary data as the main source of information Johnston (2014), which originated from three categories. First, official company documentation, particularly PTPN IV's 2023 annual report and publications from the Nusantara Plantation Holding PTPN III (Persero). Second, verified mass media coverage, including ANTARA News (2025), JPNN (2024), Waspada (2025), Media Indonesia (2025), sustainlifetoday.com (2025), paalmerah.com (2025), regional portals (2025), and BCA Sekuritas publications (2026). Third, supporting sources, including scientific journal articles, textbooks, and reports from international institutions (Ellen, 2013). Data collection was conducted through documentation studies using the following procedures: identification of data sources, collection and selection of documents based on relevance and credibility, systematization according to thematic categories, and extraction of factual and qualitative data.

Data analysis employed qualitative content analysis techniques with a thematic approach (Mayring, 2021). The analysis process was conducted through four stages. The data reduction stage involved selecting information relevant to the research problems from all collected documents (Miles et al., 2014). The categorization and coding stage involved developing a framework based on key research concepts (ESG, circular economy, and decarbonization), with the main categories consisting of company profile, environmental aspects (circular economy, emission reduction strategies, and certification), social aspects (PSR programs and smallholder empowerment), governance aspects (ESG integration, anti-fraud practices, and NDPE), and external recognition. The data presentation stage involved presenting the findings in a systematic descriptive narrative format. The conclusion drawing and verification stage involved re-examining the original data sources and conducting triangulation across different sources.

To ensure data validity, this research applied four criteria (Husnullail et al., 2024). Credibility was enhanced through source triangulation (for example, information regarding the 2025 ESG Initiative Awards was obtained from three different sources) and persistent

observation. Transferability was supported by providing a comprehensive description of the research context, subject characteristics, and analytical procedures.

Dependability was ensured through an audit trail that systematically documented the entire research process. Confirmability was maintained by ensuring that each finding was supported by empirical evidence from clear and traceable data sources rather than the researcher's subjective opinion. To minimize researcher bias during data interpretation, the analysis process employed systematic cross-source triangulation, in which each finding was required to be corroborated by at least two independent sources before inclusion in the analytical narrative. Furthermore, the analytical framework was explicitly grounded in established theoretical constructs (Legitimacy Theory and the ESG framework) prior to data collection, thereby reducing post hoc rationalization. Interpretive conclusions were distinguished from empirical evidence through explicit source citations, ensuring transparency between the data and researcher inferences (Creswell & Poth, 2016).

The research locus was PT Perkebunan Nusantara IV (PTPN IV) PalmCo, a sub-holding company of PTPN III (Persero) operating in the palm oil agro-industry. The company was selected because it was established through the merger of PTPN V, VI, and XIII in December 2023, managed the world's largest oil palm plantation area (>600,000 hectares), demonstrated a strong commitment to ESG practices (#2 global rank in S&P CSA 2024 and recipient of two Diamond Awards at the ESG Initiative Awards 2025), and provided adequate data availability (PT Perkebunan Nusantara IV, 2024). The research focused on the implementation of the circular economy through the conversion of palm oil waste into renewable energy (biogas, biomass, and CBG), carbon emission reduction strategies through nature-based and technology-based approaches, their integration within the ESG framework, and external recognition of the company's ESG performance.

RESULTS AND DISCUSSION

Results

Identification of Environmental Problems at PTPN IV PalmCo

Before presenting the findings, this research identified seven main environmental problems faced by PalmCo as a reference framework for analysis (Table 1).

Table 1
Identification of Environmental Problems and Analysis Codes

No	Environmental Problem	Description
1	Liquid waste management (POME)	Volume of POME generated, potential methane emissions from conventional processing, compliance with environmental quality standards
2	Greenhouse Gas (GHG) Emissions	High carbon footprint from fossil fuels and waste decomposition
3	Dependence on fossil fuels	Diesel consumption for factory operations, energy costs, global price fluctuations
4	Solid biomass management (EFB, shells, fibers)	Empty fruit bunches, fibers, and shells not yet fully optimized; large volume, potential methane emissions if landfilled
5	Land and biodiversity conservation	Pressure on HCV/HCS areas and peatlands around concession areas
6	Policy-implementation gap	Sustainability commitments at corporate level not necessarily evenly distributed across all operational units
7	Greenwashing risk	Alignment between ESG success claims with empirical evidence and actual environmental impacts

Source: Processed from various research data sources (2023–2025)

The seven environmental problem categories in Table 1 were derived through inductive coding of all collected documents, guided by the environmental pillar of the ESG conceptual framework Eccles (2014) and the principal challenges identified in the palm oil industry literature

(Bessou et al., 2014; Meijaard et al., 2020). Each category emerged from recurring thematic patterns across multiple data sources during the data reduction and categorization stages of qualitative content analysis (Mayring, 2021). Table 1 serves as a reference framework for presenting the research findings. Each identified problem is systematically addressed through the research results and discussion in the following sub-sections, ensuring that the relationship between data, themes, and research problems is explicitly demonstrated.

Implementation of Circular Economy at PTPN IV PalmCo

PTPN IV PalmCo implements the *circular economy* concept through the systematic conversion of two main types of palm oil industry waste into renewable energy sources. Liquid waste, specifically *Palm Oil Mill Effluent* (POME), is processed through 11 *Biogas Power Plant* (*Pembangkit Listrik Tenaga Biogas*/PLTBg) facilities with a total installed capacity of 12.05 MW distributed across Riau and North Sumatra (ANTARA, 2025; Waspada, 2025). The company is also developing *Compressed Biomethane Gas* (CBG) technology, with a target of commencing construction of 16 CBG plants by 2027 and establishing a total of 32 renewable energy facilities by 2029 (BCA Sekuritas, 2026). Solid waste, including empty fruit bunches, fibers, and shells, is managed through one biomass power plant and co-firing technology implemented across several operational units (Waspada, 2025).

This implementation has generated measurable achievements, including renewable energy utilization exceeding 80% of total operational energy requirements, diesel fuel savings of 2.6 million liters, and energy cost efficiencies amounting to Rp39.5 billion during the 2023–2025 period (paalmerah.com, 2025). The company's commitment is further reinforced through a zero non-hazardous waste disposal policy, ensuring that all production waste is reused, recycled, or converted into valuable resources rather than discarded (portal daerah, 2025).

These achievements are consistent with the findings of Geissdoerfer (2017), who stated that the implementation of the *circular economy* provides not only environmental benefits but also economic advantages through reduced production costs and the creation of new revenue streams. In the context of PalmCo, the development of renewable energy from waste has reduced dependence on fossil fuels, lowered operational expenditures, and generated additional revenue opportunities through electricity sales and carbon credit mechanisms.

Carbon Emission Reduction Strategy

PalmCo implements a decarbonization strategy through two complementary approaches. The nature-based solutions approach is conducted through sustainable land management practices covering more than 600,000 hectares, resulting in carbon sequestration of 873,395 tons of CO_2e annually (Jatmiko Santosa, quoted in Riau24, 2025). This approach includes a zero-deforestation commitment, protection of High Conservation Value (HCV) and High Carbon Stock (HCS) areas, responsible peatland management, and the implementation of No Deforestation, No Peat, No Exploitation (NDPE) principles throughout the supply chain (PT Perkebunan Nusantara IV, 2024).

The technology-based solutions approach, implemented through biogas and biomass facilities, contributes to emission reductions of 191,107 tons of CO_2e (IniLampung, 2025). The peak achievement of this strategy is the acquisition of the first Greenhouse Gas Emission Reduction Certificate (SPEGRK) in the Indonesian plantation industry for the Lubuk Dalam Biogas Power Plant in Siak Regency, Riau. This certificate was issued based on independent verification conducted by the Measurement, Reporting, and Verification (MRV) Team of the Ministry of Environment and Forestry in accordance with Minister of Environment and Forestry Regulation Number 21 of 2022, confirming a verified emission reduction volume of 33,799 tons of CO_2e over four years of operation (ANTARA News Riau, 2025).

Through its SPEGRK certification, PTPN IV PalmCo became the first plantation company registered on the Indonesia Carbon Exchange (IDX Carbon). Currently, the company ranks fourth among the largest carbon sellers on IDX Carbon (ANTARA, 2025). Active participation in carbon trading demonstrates that PalmCo perceives emission reduction not merely as a regulatory obligation but also as a strategic business opportunity capable of generating additional economic value.

ESG Implementation

PalmCo's ESG implementation encompasses three structured pillars. Within the Environmental pillar, the company has established a net-zero emission target supported by biogas, biomass, and sustainable land management initiatives. Within the Social pillar, the flagship program is the Smallholder Palm Oil Rejuvenation (*Peremajaan Sawit Rakyat*/PSR) program, which covers 60,000 hectares of smallholder partner plantations and involves more than 120,000 smallholders through comprehensive technical and financial assistance (paalmerah.com, 2025). Within the Governance pillar, ESG indicators have been integrated into the management *Key Performance Indicator* (KPI) system across organizational levels, directly linking executive performance evaluation and compensation mechanisms to ESG target achievement. Furthermore, the anti-fraud framework and an accessible and secure whistleblowing system (WBS) have been strengthened as part of transparent and accountable governance practices (paalmerah.com, 2025).

Certification Achievements and External Recognition

All PalmCo's Palm Oil Mills (*Pabrik Kelapa Sawit*/PKS) have obtained dual certification from the Roundtable on Sustainable Palm Oil (RSPO) and Indonesian Sustainable Palm Oil (ISPO), positioning PalmCo as one of the plantation companies with the broadest sustainability certification coverage in Indonesia (PT Perkebunan Nusantara IV, 2024). A total of 61 operational units achieved the PROPER Blue rating from the Ministry of Environment, representing approximately 90% of the company's operating PKS facilities (paalmerah.com, 2025).

At the international level, PalmCo achieved second place globally in the S&P Corporate Sustainability Assessment (CSA) 2024, obtaining a score of 55 among 386 global food product industry companies assessed (JPNN, 2024; Waspada, 2024). On November 28, 2025, the company received two Diamond Awards at the ESG Initiative Awards 2025: Best Waste and Resource Management Initiative and Best CEO for ESG Initiatives, presented directly to President Director Jatmiko K. Santosa (SustainLife Today, 2025). PalmCo's ESG commitment was also showcased at the Osaka Expo 2025 international business forum as a representation of Indonesia's leading sustainability practices (ANTARA, 2025).

Table 2

Summary of Key Quantitative Achievements of PTPN IV PalmCo ESG Implementation (2023–2025)

Category	Indicator	Achievement	Period
Circular Economy – Liquid Waste	Biogas Power Plants (PLTBg)	11 facilities, 12.05 MW total capacity	2023–2025
Circular Economy – Liquid Waste	Renewable energy usage	>80% of total operational energy	2023–2025
Circular Economy – Liquid Waste	Diesel consumption savings	2.6 million liters	2023–2025
Circular Economy – Liquid Waste	Energy cost savings	Rp39.5 billion	2023–2025
Circular Economy – Target	CBG plants groundbreaking target	16 CBG plants by 2027; 32 total facilities by 2029	Target 2027–2029
Carbon Emission Reduction – NbS	Carbon sequestration (land management)	873,395 tons CO_2e/year	2023–2025
Carbon Emission Reduction – Technology	Emission reduction (biogas/biomass)	191,107 tons CO_2e	2023–2025
Carbon Emission Reduction – Technology	SPEGRK (independent verification)	33,799 tons CO_2e (4 years, Lubuk Dalam PLTBg)	Verified by KLHK MRV
Carbon Trading	IDX Carbon ranking	4th largest carbon seller	2025
ESG Certification	PKS with dual RSPO+ISPO	All Palm Oil Mills (100%)	2024

Category	Indicator	Achievement	Period
	certification		
ESG Certification	PROPER Blue predicate (KLHK)	61 operational units (90% of total PKS)	2024
ESG Recognition	S&P CSA 2024 global ranking	#2 globally (score: 55/100)	2024
ESG Recognition	ESG Initiative Awards 2025	2 Diamond Awards	2025

Source: Compiled from ANTARA (2025), Waspada (2025), paalmerah.com (2025), BCA Sekuritas (2026), IniLampung (2025), PT Perkebunan Nusantara IV (2024), JPNN (2024), SustainLife Today (2025)

Discussion

Integration of Circular Economy and Decarbonization Strategy within the ESG Framework

The research findings show that the implementation of circular economy and decarbonization strategies at PalmCo does not operate as two separate programs but rather as a mutually reinforcing system within the company's ESG framework. The PLTBg facility, which processes POME, simultaneously produces renewable energy (a circular economy dimension) while reducing methane emissions, a greenhouse gas with a global warming potential 25 times greater than that of CO_2 (IPCC, 2023). This interconnection reflects the synergy that Kandpal (2024) describe as the added value of integration, in which environmental benefits are significantly greater than those achieved when both approaches are implemented independently.

This finding reinforces and extends the research results of Arista (2024), who examined the circular economy potential of palm oil biomass separately from the decarbonization dimension. At PalmCo, these two dimensions are operationalized within a single integrated system: biomass and POME are not only managed as waste streams with economic value but also simultaneously utilized as instruments for achieving measurable emission reduction targets. This integration pattern also differs from the findings of Suksaroj (2023), who focused only on the technical efficiency of POME-to-biogas conversion without linking it to the broader ESG framework. PalmCo demonstrates that technical and strategic integration can be achieved simultaneously rather than sequentially.

This integration is also reflected in the company's governance structure. By incorporating ESG indicators into management KPIs, PalmCo ensures that circular economy and decarbonization targets are not merely corporate aspirations but binding performance obligations across all levels of management. This aligns wit Hassan (2025) argument that substantive ESG requires internal accountability mechanisms that link management incentives with measurable sustainability achievements. Geissdoerfer (2017) further assert that a circular economy integrated into governance systems generates sustainable double benefits, environmental improvements alongside operational cost savings, as demonstrated by PalmCo's Rp39.5 billion efficiency gains and 2.6 million liters of diesel savings.

PalmCo's ESG Implementation from the Perspective of Legitimacy Theory

Using the Legitimacy Theory framework, three strong indicators point toward substantive legitimacy. First, the SPEGRK, independently verified by the KLHK MRV Team, provides evidence of emission reductions that have undergone a rigorous government regulation-based verification process, representing a category of evidence that is more difficult to manipulate than self-reported corporate sustainability disclosures. Second, the actual economic impacts of the circular economy and decarbonization integration described earlier demonstrate that fundamental operational transformations have occurred rather than merely changes in corporate narratives. Third, the integration of ESG indicators into the KPI system, which binds all levels of management, demonstrates that sustainability commitments have become embedded within internal accountability mechanisms that cannot be easily disregarded.

This position differs from the pattern identified by Soleha (2021) in their study of ESG disclosures among Indonesian palm oil companies, where most sustainability reporting remained voluntary and was not supported by sufficient external verification. PalmCo, through its success

in obtaining SPEGRK verification and registration on IDX Carbon, has moved beyond common disclosure practices within the national palm oil industry toward a more structured accountability framework. This finding is also consistent with Lisi (2018), who argue that sustainability strategies integrated into performance management systems generate more substantive impacts compared with ad hoc sustainability initiatives.

On the other hand, several indicators reveal elements of symbolic legitimacy that require further attention. The carbon sequestration figure of 873,395 tons CO_2e per year originates from management statements and has not yet undergone independent third-party verification, unlike the verified SPEGRK results. The S&P CSA assessment itself acknowledges that the environmental pillar, particularly emission management related to peatlands, still presents significant opportunities for improvement. Lawrence (2025) cautions that external recognition, including ESG ratings, does not always fully represent actual implementation conditions in the field, particularly when verification coverage remains limited. Considering both aspects, PalmCo can be positioned as undergoing a transition process from symbolic toward substantive legitimacy, a dynamic position that requires continuous evaluation and monitoring.

Challenges of ESG Implementation Post-Merger

PalmCo was established through the merger of three state-owned plantation entities—PTPN V, VI, and XIII—in December 2023, making it a company that had only recently entered the organizational integration phase when this research was conducted. This condition presents unique challenges for ESG implementation. First, there is the challenge of system harmonization: the three merging entities possessed different management systems, organizational cultures, and technical capabilities; therefore, implementing uniform ESG KPIs across the entire organization requires substantial time and effort. Second, there is the challenge of geographical coverage: among PalmCo's seven operational regions, publicly documented implementation data remain concentrated in Riau and North Sumatra, while other regions, including former PTPN XIII operational areas in Kalimantan, are not yet proportionally represented within the company's sustainability narrative.

This challenge aligns with the findings of Provensi (2025) in their study of ESG implementation in large plantation companies in Brazil, which concluded that consistency in ESG implementation within large-scale organizations is largely determined by the depth of stakeholder engagement at the operational unit level rather than solely by commitments established at the corporate level. Eccles (2014) further noted that ESG integration in newly merged organizations generally requires three to five years to achieve consistent system maturity. Therefore, the uneven implementation identified in this research should not be interpreted as a failure but rather as part of an organizational learning curve that remains in its early stages. The findings of Andriani (2019) egarding significant variations in GHG emissions among production units within the Indonesian palm oil industry further reinforce that implementation consistency challenges are structural issues commonly experienced across the industry, rather than challenges unique to PalmCo.

The greatest challenge ahead is ensuring that strong corporate achievements can be transformed into consistent and independently verified practices across all operational layers and geographical regions. The PSR program involving more than 120,000 smallholders demonstrates PalmCo's capacity to achieve broad-scale sustainability engagement; however, expanding emission verification coverage across all regions remains a prerequisite for ensuring that corporate ESG claims achieve full accountability. Whelan (2021) emphasize that substantive sustainability in large-scale companies requires empowerment and implementation at the operational level rather than relying solely on top-down policies.

Potential Gap between Reputational Achievements and Substantive ESG Implementation

The #2 global ranking in the S&P CSA 2024 and two Diamond ESG 2025 awards position PalmCo at a very high level of global reputational recognition. However, this research identifies several potential indications of a gap between reputational achievements and the depth of substantive implementation in operational contexts. The first gap concerns data verification: of the total reported emission reduction achievements, only 33,799 tons CO_2e have undergone

independent verification through SPEGRK, whereas substantially larger figures—873,395 tons CO_2e from carbon sequestration and 191,107 tons CO_2e from technology-based emission reductions—remain based on management statements without equivalent third-party verification.

The second gap concerns geographical distribution: achievements presented at international forums and incorporated into the basis of the S&P CSA assessment represent aggregated corporate conditions but may not fully reflect operational realities across each region, particularly in remote areas with limited documentation capacity. Banu (2024) and Lawrence (2025) both argue that greenwashing risks do not necessarily arise from deliberate misrepresentation but may also result from disparities between strong corporate reporting capabilities and uneven field-level verification capacity.

To address this gap, three priority actions should be undertaken by PalmCo. First, the company should expand independent emission verification coverage across all operational regions rather than limiting verification to leading units. Second, PalmCo should transparently disclose ESG implementation data at the operational unit level to enable stakeholders to evaluate consistency between corporate commitments and field-level practices. Third, reported achievements submitted to global rating agencies should accurately represent conditions that can be comprehensively audited rather than relying solely on corporate-level aggregates. These actions are consistent with Schaltegger (2016) who emphasize that operational-unit-based transparency is a prerequisite for maintaining ESG credibility in large-scale organizations.

CONCLUSION

This research demonstrates that PTPN IV PalmCo has systematically integrated circular economy principles and carbon emission reduction strategies within its ESG framework, achieving renewable energy utilization exceeding 80% through 11 biogas facilities (12.05 MW), energy cost savings of Rp39.5 billion, and a reduction in diesel consumption of 2.6 million liters over the 2023–2025 period. The nature-based solutions approach has generated carbon sequestration of 873,395 tons CO_2e/year, while technology-based solutions have contributed to emission reductions of 191,107 tons CO_2e, collectively producing a nature-to-technology ratio of 82.1%:17.9%. Viewed through Legitimacy Theory, PalmCo occupies a transitional position: it demonstrates substantive legitimacy through SPEGRK independent verification and IDX Carbon registration, yet simultaneously exhibits indicators of symbolic legitimacy, as 96.92% of carbon sequestration claims remain unverified by independent third parties and ESG implementation remains geographically concentrated in Riau and North Sumatra.

These findings provide the first theoretical operationalization of the substantive–symbolic legitimacy spectrum within a state-owned plantation enterprise, establishing that verified and measurable impacts, rather than reputational recognition alone, constitute the key criterion for substantive ESG legitimacy. This research thus contributes to the literature by demonstrating how circular economy and decarbonization strategies, when embedded within a governance system with binding KPI accountability, can guide a post-merger enterprise toward more credible ESG implementation.

As a company formed through the merger of PTPN V, VI, and XIII in December 2023, PalmCo faces inherent post-merger integration challenges, including system harmonization, organizational culture alignment, and geographic coverage gaps, which reflect an organizational learning curve rather than strategic failure, consistent with Eccles (2014) observation that ESG maturation in newly merged organizations requires three to five years. This research is limited by its exclusive reliance on secondary data without direct field validation from PalmCo management, meaning that the findings remain contextual and subject to the researcher's interpretive perspective. Future research should employ mixed-methods approaches incorporating direct interviews, expand toward comparative multi-company designs, and conduct longitudinal studies to track the consistency of ESG implementation as PalmCo advances toward its 2029 renewable energy targets. For PalmCo, priority actions include expanding independent emission verification across all operational regions, increasing per-unit ESG data transparency, strengthening peatland management practices, and deepening smallholder empowerment under the PSR program.

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AUTHOR CONTRIBUTION STATEMENT

Putrie Cynthia Ichwan: Conceptualization, research design, data collection, document analysis, data interpretation, original draft preparation, and manuscript writing. Amrie Firmansyah: Methodological guidance, validation of findings, supervision, and editing. Both authors approved the final version of the manuscript for publication.

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