



Blue-Green Economy and Its Impact on Plantation Business Strategies: The Indonesian State-Owned Enterprise Perspective

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Abstract. This research explores the integration of blue-green economy principles within PTPN, a key player in Indonesia's agribusiness sector, with a focus on sustainability in the palm oil, rubber, and sugarcane industries. PTPN has made significant strides in adopting renewable energy sources, such as biomass from sugarcane bagasse and palm oil waste, reducing reliance on fossil fuels and lowering operational carbon emissions. The company has also implemented circular economy practices, notably the conversion of palm oil mill effluent (POME) into biogas and the adoption of precision agriculture techniques, improving resource efficiency and waste management. However, the study identifies several challenges, including high upfront costs, regulatory inconsistencies, and the need for enhanced technical expertise. Despite these obstacles, opportunities for further development exist, such as expanding renewable energy projects, improving waste-to-energy technologies, and fostering strategic partnerships. These initiatives could strengthen PTPN's sustainability efforts and enhance its competitiveness in the global market. This research highlights both the achievements and challenges faced by PTPN, offering insights into the practical application of blue-green economy principles in the agribusiness sector.

Keywords: Blue-Green Economy, Renewable Energy, Circular Economy, Biomass Energy, PTPN.

1 Introduction

In recent years, the global shift towards sustainable development has gained momentum, with growing emphasis on the integration of environmental stewardship into business strategies. The blue-green economy framework has emerged as a comprehensive model that intertwines the principles of ocean-based economies (blue economy) and sustainable land-based practices (green economy). This paradigm aims to address the dual challenges of environmental degradation and economic growth by promoting resource efficiency, waste reduction, and renewable energy use. Adopting Blue-Green economic principles is an essential condition for sustainable development and achieving the SDGs in national policies [1]. The adoption of the Blue-Green

Economy concept is crucial for achieving the Sustainable Development Goals (SDGs) through innovative technologies and digital platforms [2]. This is vital in the context of global sustainability efforts. In this context, large-scale agribusinesses, such as Perkebunan Nusantara (PTPN), play a crucial role in leading the transition towards sustainable business practices, particularly within the agricultural and plantation sectors.

PTPN, as one of Indonesia's largest state-owned enterprises in the plantation industry, is uniquely positioned to integrate blue-green economic principles into its business processes. The company's vast landholdings and operations in key agricultural sectors, including palm oil, rubber, and sugarcane, offer significant opportunities for the implementation of sustainable practices. For instance, the adoption of circular economy principles in plantation management, such as utilizing agricultural waste for renewable energy generation, can significantly reduce PTPN's environmental footprint while improving operational efficiency [3]. Furthermore, the alignment of PTPN's business strategies with national and international sustainability goals, such as the United Nations' Sustainable Development Goals (SDGs), can enhance the company's global competitiveness and contribute to Indonesia's broader environmental targets [4]. This paper seeks to explore how PTPN can effectively integrate the blue-green economy into its core business processes, focusing on the potential benefits of sustainability-driven innovations, including renewable energy utilization, waste minimization, and resource efficiency. By examining the current practices and future prospects for PTPN's business model, this study aims to provide insights into the role of state-owned plantation enterprises in fostering sustainable economic growth in Indonesia.

2 Literature Review

The shift toward sustainability in business operations has been a growing focus in both academic literature and industry practice. The concept of the blue-green economy integrates sustainable management of marine resources (blue economy) with land-based ecosystems (green economy), promoting resource efficiency, renewable energy, and environmental stewardship. In this context, biomass sources, including sugarcane and palm oil residues, present significant opportunities for renewable energy generation in Southeast Asia [5]. Furthermore, the renewable energy sector is anticipated to create numerous green jobs, addressing unemployment issues in Indonesia while supporting sustainable economic growth [6]. This highlights the importance of job creation in the transition to renewable energy. In large-scale agribusiness, particularly state-owned enterprises like Perkebunan Nusantara (PTPN), the potential for integrating these principles is vast. The following review explores existing research on the blue-green economy, its application in the plantation industry, and the role of state-owned enterprises in driving sustainable business models.

2.1 The Concept of Blue-Green Economy

The blue-green economy framework is a synthesis of two interconnected strategies: sustainable use of ocean resources and the adoption of eco-friendly practices on land. It seeks to balance economic growth with environmental conservation by encouraging industries to minimize their ecological footprint through renewable energy adoption, waste management, and biodiversity preservation. The blue economy focuses on optimizing the use of marine resources for sustainable growth, while the green economy emphasizes the need for sustainable agricultural and industrial practices that reduce carbon emissions and promote circular economy principles. Together, these concepts form a holistic approach to sustainable development that can be particularly beneficial for industries that rely heavily on natural resources, such as the plantation sector [7].

In the context of agriculture and plantation, the blue-green economy can be applied through several strategies, such as water conservation, the use of renewable energy (like biomass from agricultural waste), and the implementation of sustainable farming practices. This aligns with the United Nations' Sustainable Development Goals (SDGs), particularly goals related to climate action, responsible production, and life below water [8]. For companies like PTPN, which operate on vast tracts of land and engage in intensive agricultural practices, the integration of these principles is essential to ensure long-term sustainability and resilience in an increasingly resource-scarce world.

Renewable Energy in Plantation Operations. The use of renewable energy in plantation operations is a critical aspect of the blue-green economy. Biomass, particularly from agricultural residues like palm oil husks and sugarcane bagasse, presents a significant opportunity for renewable energy generation within plantation systems. Biomass utilization in plantation industries not only reduces reliance on fossil fuels but also helps in waste minimization. In countries like Indonesia, where PTPN operates, the availability of biomass from large-scale plantation crops like palm oil, rubber, and sugarcane can be leveraged to meet the energy needs of the industry while contributing to national renewable energy targets [3].

Studies show that the adoption of biomass energy can lead to substantial reductions in greenhouse gas emissions, contributing to both corporate sustainability and national climate goals. For instance, the Brazilian sugarcane industry has successfully implemented cogeneration systems, where sugarcane waste is converted into electricity and heat, supplying both the industry's energy needs and generating excess electricity for the grid [9]. Such practices can be replicated by PTPN to improve energy efficiency and support Indonesia's efforts to reduce its dependence on fossil fuels.

Circular Economy and Waste Minimization in Agribusiness. A core component of the blue-green economy is the adoption of circular economy principles, which focus on minimizing waste and promoting resource efficiency. In agribusiness, this involves recycling agricultural residues, reducing water consumption, and optimizing the use

of inputs such as fertilizers and pesticides. The importance of circular economy practices in plantation industries, particularly in reducing operational costs and environmental impacts. In Indonesia, where palm oil and rubber are major exports, the potential for circular economy practices to transform waste into valuable resources is significant [4].

For PTPN, the implementation of circular economy practices could involve the development of integrated waste management systems that convert by-products such as palm oil effluent and rubber latex residues into biogas or biofertilizers. This not only helps in reducing the environmental impact of waste disposal but also contributes to resource efficiency by closing the loop in production cycles. Additionally, the application of precision agriculture techniques can further optimize input use, minimizing the need for water and chemicals while maximizing yield [7]. Such innovations align with the company's strategic objectives of improving sustainability while enhancing operational efficiency.

The Role of State-Owned Enterprises in Sustainability. State-owned enterprises (SOEs) like PTPN play a pivotal role in promoting sustainable development, particularly in countries like Indonesia, where SOEs are central to economic and industrial growth. SOEs often have the resources and influence needed to implement large-scale sustainability initiatives, making them key drivers of national efforts to meet environmental goals. In the plantation industry, PTPN's leadership in adopting renewable energy and circular economy practices could serve as a model for other industries looking to integrate blue-green economy principles [9].

However, challenges remain in the implementation of these initiatives. Regulatory frameworks, financial constraints, and the need for technological innovation are often cited as barriers to sustainability in large enterprises. The importance of government support and policy alignment in ensuring the success of renewable energy adoption and circular economy practices in SOEs. For PTPN, collaboration with government agencies, research institutions, and international partners will be essential in overcoming these challenges and scaling up its sustainability efforts.

3 Methodology

This study employs a qualitative approach focused on the application of blue-green economy principles within the agribusiness sector in Indonesia, specifically concerning Perkebunan Nusantara (PTPN). Data was collected through a literature review encompassing a range of academic sources, policy reports, and relevant articles addressing the blue-green economy, sustainability, and renewable energy practices in the context of agribusiness. This process involved identifying pertinent literature from publications over the past decade to ensure the accuracy and currency of the information.

Subsequently, the research analyzes best practices and challenges faced by PTPN in integrating blue-green economy principles into its business model. Secondary data obtained from annual reports, government policy documents, and previous case

studies were utilized to identify opportunities and obstacles in the implementation of sustainability principles. The analysis correlates theory with the practical realities employed by PTPN while assessing the implications for economic growth and job creation within the agribusiness sector.

This methodology also includes a comparative analysis of various policies and initiatives that have been implemented in other agribusiness contexts to understand how PTPN can leverage blue-green economy approaches. By analyzing successful examples from other countries as well as existing literature, this study aims to provide actionable recommendations that can enhance the sustainable implementation of blue-green principles in PTPN's operations. This approach is expected to fortify PTPN's role as a pioneer in sustainability within Indonesia's agribusiness sector.

4 Result and Discussion

4.1 Integration of Renewable Energy in PTPN Operations

Table 1 illustrates PTPN's integration of renewable energy sources from 2021 to 2023. It highlights the capacity and energy generation from Biomass Power Plants (PLTBm), Biogas Power Plants (PLTBg), and Hydroelectric Power Plants (PLTA). Over the three years, PTPN's total renewable energy generation has fluctuated, with a noticeable decrease in 2023 compared to previous years, particularly in biomass energy. Despite this, renewable energy still constituted a significant portion of the company's total energy use, outpacing non-renewable energy. This reflects PTPN's commitment to sustainability and its efforts to reduce reliance on fossil fuels.

Table 1. Renewable Energy Adoption and Impact at PTPN.

Type of Renewable Energy	Capacity (MW)	2021 (GJ)	2022 (GJ)	2023 (GJ)
BiomassPower Plant (PLTBm)	9.2	1.650.100	1.701.214	1.382.455
Biogas Power Plant (PLTBg)	11.35	35.549	28.539	34.060
Hydroelectric Power Plant (PLTA)	17.14	9.557	2.188	5.800
Total Renewable Energy		1.695.206	1.731.941	1.422.315
Total Non-Renewable Energy		494.119	501.214	700.182

Source: [10]

PTPN has significantly increased the use of renewable energy in its operations. This renewable energy includes electricity generated from Biogas Power Plants (PLTBg), Biomass Power Plants (PLTBm), and Hydroelectric Power Plants (PLTA). Additionally, PTPN utilizes process waste, such as vinasse from molasses processing, as fuel for the biogas power plants. In 2023, renewable energy accounted for 67% of

the company's total energy consumption, with the remainder supplied by electricity from PLN (the state-owned electricity provider), diesel generators, gasoline, and diesel fuel. PTPN is committed to further increasing the share of renewable energy through initiatives such as developing biodiesel, biopellet, and bioethanol plants, as well as adding more renewable energy-based power generation units, in line with PTPN's Decarbonization Program.

4.2 Circular Economy Practices and Waste Management

The Circular Economy Practices and Waste Management" section of PTPN provides a comprehensive overview of the company's commitment to environmental sustainability. PTPN implements a robust 3R approach (Reduce, Reuse, Recycle) aimed at minimizing non-hazardous waste and optimizing the reutilization of by-products. For instance, Palm Oil Mill Effluent (POME) and Empty Fruit Bunches (EFB) are repurposed as renewable energy sources, specifically in biogas power plants. Similarly, solid waste from sugar mills, such as blotong, is converted into organic fertilizer, thus creating a closed-loop system where waste is transformed into valuable resources. PTPN has also embraced cleaner production practices, reducing waste generation at its source by implementing closed waste channels and selecting low-risk chemicals to minimize environmental harm. The use of rubber trap ponds and consistent audits of waste management systems illustrate the company's proactive approach to ensuring that waste is managed efficiently, with efforts directed towards converting waste into energy or fertilizers.

Regular waste audits are conducted to assess and identify opportunities for minimizing waste throughout the production process. By integrating these audits into their operations, PTPN supports its circular economy goals by ensuring that waste is either recycled or repurposed to the greatest extent possible. The company also adheres strictly to Indonesia's regulations concerning the management of hazardous and toxic waste (B3 waste), outsourcing the handling of such waste to certified third-party entities to prevent environmental contamination. Furthermore, PTPN places significant emphasis on employee training to ensure optimal waste management processes. Employees are equipped with the knowledge to reduce waste generation and are trained on emerging technologies and techniques in sustainable waste handling.

The company's efforts in waste-to-energy initiatives are also notable. PTPN converts biogas from POME to generate electricity, while empty fruit bunches and other plant residues are processed to produce bioenergy, reducing the company's reliance on fossil fuels. These integrated approaches to waste management exemplify PTPN's strong commitment to promoting a circular economy by closing the resource loop and minimizing environmental impacts, while simultaneously enhancing operational sustainability [10].

4.3 Challenges in Scaling Sustainability Initiatives

The case study revealed several challenges faced by PTPN in scaling its sustainability initiatives. One of the main barriers is the lack of a comprehensive policy framework to support the adoption of renewable energy and circular economy practices in the plantation sector. While the Indonesian government has set ambitious targets for renewable energy adoption, the absence of clear incentives and subsidies for large-scale renewable energy projects hampers the private sector's ability to fully transition to sustainable practices [7].

Additionally, internal challenges such as limited technical expertise and high upfront costs for sustainability projects have slowed down PTPN's efforts. Interviews with operational staff indicated that while the company has made progress in adopting sustainable practices, there is a need for more training and capacity-building to fully integrate renewable energy systems and advanced waste management technologies into everyday operations. This echoes findings from previous studies, which suggest that the success of sustainability initiatives in the agribusiness sector depends not only on technological investments but also on human capital development [3].

Furthermore, fluctuations in commodity prices, particularly for palm oil and rubber, have affected the financial viability of sustainability projects. In years of low commodity prices, PTPN has had to prioritize cost-cutting measures, which often result in the postponement of sustainability investments. As one financial officer noted, "Our ability to invest in long-term sustainability projects is directly tied to the performance of global commodity markets. When prices fall, it becomes difficult to justify large capital expenditures on renewable energy or waste management systems."

4.4 Opportunities for Future Development

Despite these challenges, the integration of blue-green economy principles offers significant opportunities for PTPN to enhance its sustainability and competitiveness. The company's existing biomass and biogas projects provide a foundation for further expansion into renewable energy, with the potential to increase the share of renewable energy in its overall energy mix. Scaling these initiatives could enable PTPN to not only reduce its carbon footprint but also generate additional revenue by selling excess energy to the national grid.

Additionally, the application of circular economy practices can be further expanded by exploring new technologies for waste-to-energy conversion and nutrient recycling. For example, the use of advanced composting technologies and biochar production from agricultural waste can improve soil fertility while reducing the environmental impact of chemical fertilizers. Moreover, PTPN's strategic location and access to vast agricultural landholdings make it well-positioned to become a leader in sustainable agribusiness in Southeast Asia, particularly as global demand for eco-friendly products increases.

Finally, collaboration with government agencies, research institutions, and international organizations can help PTPN overcome regulatory and technical

barriers. By partnering with stakeholders to pilot new technologies and share best practices, PTPN can accelerate the adoption of blue-green economy principles and contribute to Indonesia's broader sustainability goals.

5 Conclusion

In alignment with the global shift towards sustainable development, PTPN's initiatives reflect the integration of blue-green economy principles into its operations, emphasizing resource efficiency and renewable energy use. Despite fluctuations in renewable energy output between 2021 and 2023, particularly in biomass energy, PTPN has maintained a significant reliance on renewable sources, constituting 67% of its total energy mix in 2023. This highlights PTPN's commitment to reducing its environmental footprint while enhancing operational efficiency through innovations such as the use of biogas from Palm Oil Mill Effluent (POME) and the recycling of agricultural by-products.

Furthermore, PTPN's circular economy practices exemplify its strategic alignment with sustainable business models, minimizing waste by converting by-products into renewable energy and organic fertilizers. However, several challenges, such as the absence of a comprehensive policy framework and high upfront costs, impede the full-scale adoption of these practices. Nevertheless, PTPN is well-positioned to expand its sustainability efforts by further developing renewable energy projects and leveraging its vast agricultural landholdings. Through strategic partnerships and adherence to international sustainability goals, PTPN can accelerate its transition to a blue-green economy, contributing both to Indonesia's environmental objectives and its own long-term competitiveness in the global market.

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