FIRM Journal of Management Studies, Vol. 10(1), March, 2025
ISSN: 2527-5852 (Print) | ISSN 2541-3473 (Online)

Decarbonization Commitment to Net Zero Emissions by 2060: A Sustainable Business Opportunity for Seaweed in Indonesia and Australia

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Abstract

Seaweed is among the most valuable products derived from the marine and fisheries sectors, offering numerous health benefits to consumers. In 2014, Indonesia emerged as the world's second-largest seaweed producer—following China, with a combined production of over 23 million tons between the two countries (Buschmann, 2017). Given the substantial economic potential of seaweed commodities, it is imperative to conduct comprehensive trade analyses and formulate appropriate policies to support sustainable industry development. Furthermore, Indonesia–Australia collaboration in the seaweed sector presents significant opportunities to generate broad economic, environmental, and social benefits for both nations. Although the seaweed industry remains relatively nascent in both countries, the environmentally sustainable use of seaweed, sea moss, and other algae can play a pivotal role in advancing sustainability efforts, particularly in the context of both countries' commitments to achieving net-zero emissions. To fully realize these benefits and ensure alignment with decarbonization policies in the industrial sector, a well-defined policy framework is essential. This framework should prioritize the establishment of a cost-effective industry while embedding robust decarbonization standards and governance mechanisms. Bilateral cooperation between Indonesia and Australia could serve as a catalyst in meeting decarbonization targets and progressing toward net-zero emissions by 2060. By leveraging shared resources, expertise, and technological innovations, both nations can accelerate the development of sustainable seaweed cultivation and utilization practices. Such collaboration could encompass joint research projects, knowledge exchange programs, and policy harmonization to foster the widespread adoption of environmentally responsible innovations within the seaweed sector.

Keywords: *Carbon Trading; Seaweed; Indonesia; Australia; Bilateral.*

Introduction

Seaweeds are a diverse group of marine organisms that flourish in a wide range of coastal ecosystems globally, from tropical to polar regions. They are taxonomically classified into three major groups: red, brown, and green algae, collectively comprising an estimated 8,000 to 10,500 species (Radulovich et al., 2017). These three phyla serve multiple purposes, particularly as food and industrial raw materials. While green and brown algae are commonly consumed directly, red and brown algae are primarily processed for the extraction of water-soluble polysaccharides - known as hydrocolloids - including carrageenan, agar, and alginate.

Article History: *Submitted 14-04-2024, Revised 15-01-2025, Accepted 29-03-2025*

These compounds are widely used in the food processing industry, cosmetics, and pharmaceuticals.

Figure 1. Seaweed
Source: Guiry (2022)

A significant milestone in sustainable seaweed development occurred in August 2020, when the Commonwealth Scientific and Industrial Research Organisation (CSIRO) launched Future Feed, a company dedicated to commercializing seaweed cultivation. This initiative underscores seaweed's potential contribution to climate change mitigation and adaptation. Seaweed's capacity to sequester carbon dioxide, reduce methane emissions from livestock, and offer an environmentally friendly alternative to conventional agricultural practices has drawn increasing interest from Australian investors and ecopreneurs—entrepreneurs focused on addressing climate change.

Similarly, in Indonesia, the growing abundance, rapid growth rates, and sustainable nature of seaweed have driven the emergence of seaweed-based enterprises. These ventures are integral to the country's efforts to diversify its economy and reduce environmental degradation. Seaweed stands out as one of the most prominent products of the marine and fisheries sector, offering not only nutritional benefits but also considerable commercial potential. In 2014, Indonesia was the world's second-largest seaweed producer, following China, with a combined output exceeding 23 million tons between the two countries (Buschmann, 2017).

Given seaweed's strategic value, there is a critical need to undertake robust trade analyses and establish policy frameworks that can foster sustainable industry growth. While the seaweed sectors in both Indonesia and Australia are still at a nascent stage, the increasing ecological awareness surrounding algae—including sea moss and other marine species—positions the industry to play a key role in advancing national sustainability agendas, particularly in relation to commitments toward achieving net-zero emissions.

Study Objective

This study aims to examine the potential of seaweed as a sustainable business opportunity in both Indonesia and Australia, with a focus on the shared commitment to achieving net-zero emissions by 2060. Specifically, it seeks to:

- Highlight the strategic importance of seaweed in both countries;
- Promote bilateral collaboration in the seaweed sector;
- Discuss the role of carbon trading and climate policy;
- Explore the implications of diplomatic and economic relations under the Indonesia–Australia Comprehensive Economic Partnership Agreement (IA-CEPA).

Additionally, the study underscores the multifunctional benefits of seaweed, including its health-promoting properties and its industrial uses—particularly in hydrocolloid production. It further emphasizes the need for coherent policy development, targeted investment, and collaborative frameworks to maximize the economic, environmental, and social returns of the seaweed industry. Ultimately, the study aspires to provide a roadmap for leveraging IA-CEPA as a platform for mutual growth, enhanced decarbonization efforts, and the promotion of sustainable practices across the region.

Research Methodology

The methodology of this study involves a qualitative analysis of the potential of seaweed as a sustainable business opportunity in Indonesia and Australia, with a particular emphasis on both countries' commitments to achieving net-zero emissions by 2060. The analysis encompasses several key dimensions, including the current state and future prospects of the seaweed industry in both nations, trade dynamics, and the role of carbon trading mechanisms in supporting decarbonization goals. Additionally, the study examines the diplomatic and economic relations between Indonesia and Australia, with a focus on the strategic framework provided by the Indonesia–Australia Comprehensive Economic Partnership Agreement (IA-CEPA). This partnership is explored as a foundation for fostering bilateral cooperation, advancing sustainable practices, and driving mutual growth within the seaweed sector.

Findings and Discussions

Carbon Trading

Carbon trading is a market-based mechanism designed to reduce carbon dioxide (CO_2) emissions by placing a cap on permissible emission levels and allowing the trading of emission allowances. The concept emerged in response to the environmental consequences of fossil fuel use and was institutionalized under international frameworks such as the Kyoto Protocol. Signatory countries are classified into Annex I (including Annex B) and non-Annex I groups. Annex I countries are obligated to meet specific emission reduction targets through binding caps, whereas non-Annex I countries, such as Indonesia, are not bound by quantitative targets but commit to voluntary efforts to lower greenhouse gas emissions.

International regulations governing carbon trading were further strengthened under the 2015 Paris Agreement, which introduced mechanisms for the transfer of Internationally Transferred Mitigation Outcomes (ITMOs). This provision facilitates global cooperation by enabling countries to trade verified emission reductions under internationally agreed standards. In Indonesia, carbon trading is governed by several regulatory instruments, including Presidential Regulation No. 98 of 2021, the Ministry of Environment and Forestry Regulation No. 21 of 2022, and the Financial Services Authority (OJK) Regulation No. 14 of 2023. These regulations collectively establish the legal foundation for the implementation and oversight of carbon trading within Indonesia.

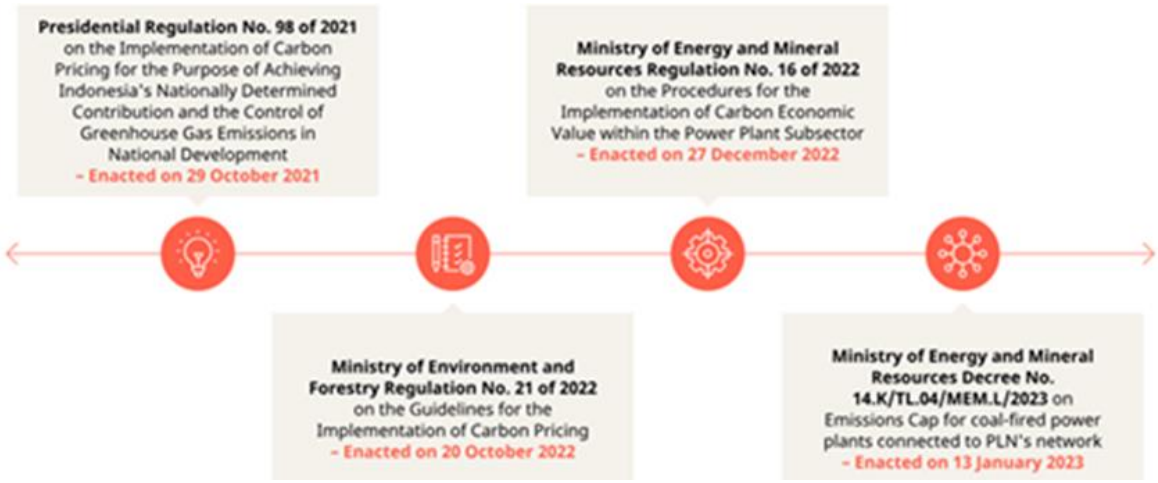

Figure 2. Regulations Governing Carbon Trading in Indonesia
Source: Ashurst (2023)

Seaweed Industry in Indonesia

Coastal and marine ecosystems such as seagrass beds, mangroves, and tidal swamps serve as significant blue carbon sinks by absorbing and storing atmospheric carbon. Indonesia, which holds approximately 3.4 gigatonnes or 17% of the world's blue carbon reserves (KKP, 2022), has substantial potential to leverage carbon pricing mechanisms to incentivize conservation and climate mitigation through these ecosystems.

Seaweed cultivation, long practiced in coastal regions, has diversified beyond traditional uses such as food and animal feed. It now serves as a key raw material for industries producing cosmetics, pharmaceuticals, fertilizers, and biofuels. Notably, seaweed plays a vital role in climate mitigation strategies. To meet global climate targets aligned with limiting warming to 1.5–2°C, annual carbon removal exceeding 1 gigaton of carbon (equivalent to 3.67 $GtCO_2$) will be required post–net zero. This underscores the need to significantly scale up seaweed farming, despite uncertainties concerning species-specific productivity, ecological impact, net emissions reduction, and cost-effectiveness.

Seaweed is also a primary source of hydrocolloids such as agar and carrageenan, which are widely used as gelling, thickening, and stabilizing agents in food, pharmaceutical, and cosmetic products (Bjerregaard et al., 2016). According to the World Bank (2016), if current growth trends continue, global seaweed production could reach 500 million dry tons annually by 2050. This growth could enhance global food security by 10%, generate 50 million jobs, and displace 1.5% of fossil fuel use in the transport sector.

Indonesia plays a pivotal role in the global seaweed economy, being the world's second-largest producer after China. Advances in bio-refining have further increased the versatility of seaweed, expanding its applications across various industries including animal feed, food additives, bioenergy, cosmetics, and chemicals. Consequently, the sector has become an important contributor to Indonesia's economic diversification and environmental sustainability goals.

Indonesia–Australia Diplomacy and the Seaweed Industry

Indonesia and Australia share a strategic partnership, particularly in the Indo-Pacific region, where economic cooperation and environmental sustainability are growing priorities. The Indonesia–Australia Comprehensive Economic Partnership Agreement (IA-CEPA) provides a robust framework for bilateral investment and collaboration, including in the seaweed sector. As the world's largest producer of carrageenan-producing seaweed, Indonesia offers a significant comparative advantage, while Australia contributes technological expertise and market access.

In 2014, Indonesia's seaweed exports reached AUD 300 million, with annual output growth averaging 30% (Sedayu, 2018). Recognizing its economic and environmental significance, the Indonesian government has designated seaweed as a strategic commodity. The dominant industrial application involves the extraction of hydrocolloids—tasteless, transparent, water-soluble carbohydrates that provide structural support and are widely used to stabilize food products, create dissolvable films, form gels of varying consistencies, and thicken liquids (McHugh, 2003). The global carrageenan industry is expanding rapidly, and Indonesia's leadership in this sector reflects its international competitiveness (Yulisti et al., 2021).

Beyond its industrial relevance, seaweed cultivation provides substantial socio-economic benefits to coastal and island communities. As seaweed farming expands into remote areas, it enhances local livelihoods and supports inclusive, sustainable development. To facilitate this, the Indonesian government has introduced supportive regulations that encourage investment in seaweed farming and infrastructure.

Through IA-CEPA, both nations can synergize their strengths—Indonesia's production capacity and Australia's R&D and market systems—to drive innovation, sustainability, and economic growth in the seaweed sector. The agreement promotes cross-border investments, research collaboration, and value-chain integration, creating a pathway for green industrial development aligned with the broader decarbonization agenda.

In addition to economic gains, seaweed farming can support sustainable livelihoods and community resilience. Favourable national policies further reinforce the sector's role in achieving Indonesia's environmental and socio-economic objectives. When viewed through the lens of IA-CEPA, the seaweed industry presents a compelling case for regional cooperation, environmental stewardship, and economic transformation.

By aligning policy frameworks and trade mechanisms with sustainability goals, both Indonesia and Australia have the opportunity to establish a leading role in the global seaweed economy. Strategic investments, clear regulatory guidance, and inclusive development models will be essential to maximize the sector's contribution to industrial decarbonization, biodiversity conservation, and regional prosperity.

Conclusion and Recommendations

Collaboration between Indonesia and Australia in the seaweed sector holds significant promise for delivering integrated economic, environmental, and social benefits. To fully realize this potential and align with industrial decarbonization goals, a clear and coherent policy framework is needed—one that emphasizes low-cost industry development, robust governance, and decarbonization measures. Bilateral cooperation can accelerate sustainable seaweed cultivation and utilization by leveraging shared resources, technological expertise, and joint innovation.

Key initiatives could include collaborative research, knowledge exchange programs, and policy harmonization to support the adoption of environmentally sustainable practices.

While this paper underscores the promising prospects of such collaboration, it does not fully address potential challenges that may hinder progress. Future research should explore risks such as cultural and institutional differences, political tensions, and economic asymmetries that may impact joint efforts. Furthermore, detailed implementation strategies—especially for policy alignment and knowledge-sharing—are crucial for operational success. Rigorous assessment of the ecological impacts of large-scale seaweed farming, alongside mitigation plans, is essential to ensure sustainability. Finally, a deeper analysis of the sector's socioeconomic contributions will strengthen its positioning as a key driver in the broader decarbonization and sustainable development agenda.

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