The Dynamics of the Discourse on Biofuels in Indonesia in Its Ecological, Economic, and Social Contexts

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"The Extensive Historical Trajectory of Biofuel in Indonesia: Preface"

Discussing biofuels (BBN) in Indonesia inevitably involves a journey through time. Prior to achieving the distinction of having the highest biofuel blending rate in the world, Indonesia's biofuel industry has a storied history. The inception of biofuel development in Indonesia can be traced back to various institutions, including the Center for Research and Development of Oil and Gas Technology (LEMIGAS), Agency for the Assessment and Application of Technology Indonesia (BPPT), the Palm Oil Research Center (PPKS), the Indonesian Plantation Research Institute (LRPI), and the Bandung Institute of Technology (ITB), dating back to the 1990s. These organizations undertook extensive research, exploring biodiesel production from diverse raw materials like palm oil, used cooking oil, jatropha, and various vegetable oils. Despite the research reaching the trial stages for production, this period lacked any substantial policy support for biofuel development in Indonesia. Furthermore, the rationale for selecting biodiesel over other biofuel types, such as bioethanol, remains unclear.

The issuance of Presidential Regulation Number 5 of 2006, which pertains to the National Energy Policy, and Presidential Instruction Number 1 of 2006, focused on the Provision and Utilization of Biofuels, marked a pivotal moment in the dynamics of biofuels in Indonesia. Since then, the landscape of national biofuel development has seen significant evolution, encompassing improvements in quality, production volume, biofuel varieties, and a notable increase in the participation of companies. This transformation initially aimed to advance poverty reduction and bolster the nation's energy self-sufficiency.

Throughout its development, Biofuels (BBN) have grown to be intricately tied to the energy transition and the imperative of reducing carbon emissions. Globally, the continued use of fossil fuels to meet future energy requirements is acknowledged as unsustainable, primarily due to the depletion of finite resources and the environmental harm it inflicts. Ideally, there should be efforts to curtail energy consumption. However, it's crucial to recognize that worldwide energy demand is projected to surge by an estimated 47% by 2050. Consequently, biofuels have emerged as a prominent component of the energy transition strategies being explored, not least in Indonesia.

Indonesia's interest in diminishing its reliance on petroleum and mitigating emissions within the transportation sector has spurred the swift growth of the biofuel industry. Nevertheless, the advancement of biofuels is not devoid of its dilemmas. A growing unease revolves around the use of vegetable oils, which also serve as essential food resources, in biofuel production and its potential implications on food security and the environment.

This concern is well-founded, as the ever-increasing demand for vegetable oils, coupled with the tendency of productivity to plateau, inevitably forces the government into a challenging conundrum. It must decide between enhancing productivity, potentially impacting another sector, or allocating

additional land to meet these escalating demands. Despite the various potential challenges that may arise from the development of biofuels, these challenges do not justify reverting to fossil fuels and abandoning the pursuit of biofuels.

The solution to the challenges posed by the energy transition may still find answers, at least in part, through biofuels. The critical focus lies in determining how the governance of BBN in Indonesia can effectively strike a balance between the interest of energy security and environmental sustainability. This document serves as a synthesis of various discussions on BBN in Indonesia drawn from multiple publications.

The initial section of the report will serve as an introduction, providing readers with a comprehensive understanding of the historical context and factors that have shaped the development of biofuels in Indonesia. This background information will offer readers insights into the author's intentions for the entire article and clarify why this report is not only significant but also compelling to read.

The second section will provide a detailed account of the journey of BBN policies in Indonesia, spanning from 2006 to 2021. This journey of biofuel policy in Indonesia has witnessed a series of transformations intricately linked to both national and international dynamics.

The third section will delve into the dynamics of ecological, economic, and social sustainability discourse concerning the implementation of biofuels in Indonesia. The portrayal in this chapter is significant, as it presents a comprehensive and impartial depiction of the BBN issue in Indonesia as a whole.

The fourth section will guide readers towards understanding the potential directions for biofuel policies in Indonesia. It will explore three critical issues: the economic significance of BBN and its strategic value for actors in the supply chain, as well as the integration of low-carbon development scenarios in Indonesia.

The concluding section of the article will offer a summary of key findings and present recommendations concerning the challenges encountered in the development of biofuels in Indonesia.

EXECUTIVE SUMMARY

The Biofuel (BBN) policy was introduced in Indonesia in 2006. At that time, the primary driving force behind the development of BBN was to attain energy sovereignty, stimulate economic growth, and, most notably, liberate the country from its reliance on conventional fuel oil (BBM). In pursuit of this objective, the development of biofuels was outlined in the 2006-2025 Blueprint, aimed at accelerating the reduction of poverty and unemployment. Within the Blueprint, the government identified a range of potential raw materials for BBN, including palm oil, jatropha, kemiri sunan (candlenuts), cassava, sugar cane, and various other plantation products found in Indonesia.

In its development, BBN extends beyond being solely an energy independence policy. In 2009, President Susilo Bambang Yudhoyono announced his first climate commitment, highlighting biofuels as a key component of his strategies. Subsequently, biofuels were incorporated into the Nationally Determined Contribution (NDC) aimed at reducing emissions by 11%-15.5% compared to the Business as Usual scenario by 2030 in the energy sector, with the overarching goal of achieving net-zero emissions by 2060 or sooner.

As a strategy for poverty reduction and reducing emissions, biofuels are expected to become sustainable energy both from an ecological, economic and social perspective. Unfortunately, over the last 15 years, the literature shows not only opportunities but also various challenges faced by the biofuel industry in this sector.

From an ecological perspective, the success of the biofuel policy can be measured by its ability to reduce emissions in alignment with Indonesia's climate commitments. In this context, while BBN results in reduced emissions during engine combustion, it is crucial to consider emissions generated throughout the entire BBN production process. Notably, the production of palm-based biodiesel, a primary product in Indonesia's biofuel industry, contributes to significantly higher emissions – up to 83-95% more – due to factors like land clearing and the production of liquid waste by factories. Furthermore, the cultivation of 40% of palm oil in deep peatlands within Central Kalimantan carries the potential to trigger the release of CO2 emissions ranging from 133.31 to 310.02 MtCO2e due to peat oxidation resulting from the drainage of oil palm plantations during the initial 25 years of the plantation cycle.

When examined through an economic lens, the original aim of the biofuel industry, which was designed as a poverty alleviation program, appears to have shifted towards becoming a market for addressing the over supply of palm oil in Indonesia. This perspective stems from the concentration of BBN development on palm-based biodiesel, which has seen a substantial surge in its blend ratio, soaring from 10% to 30% since 2013. This increase in the blend ratio is perceived as a mechanism to absorb excess palm oil production, which has swelled from 27.78 million tonnes in 2013 to 51.58 million tonnes by 2020.

The BBN industry also faces significant social challenges. The failure to implement the traceability principle creates opportunities for the biofuel industry to source raw materials from plantations that may not adhere to human rights principles, such as labor rights violations, improper land acquisition procedures that disregard Free Prior Informed Consent (FPIC) rules, child labor practices, and more.

To address some of these issues, the government must reevaluate and update the roadmap for implementing the BBN policy, which has remained largely unchanged since its initial launch in 2006. This step is essential for providing clear guidance on Indonesia's BBN policy, especially in response to the governance challenges associated with managing Indonesian biofuels from ecological, economic, and social perspectives.

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LIST OF ABBREVIATIONS

APBN: State Budget for Revenue and Expenditure

APL: Other Usage Area

BAKOREN: National Energy Coordination Agency

BaU: Business as Usual

BBM: Petroleum Fuel (fossil fuel)

BBN: Biofuel

BKPM: Investment Coordinating Agency

Blueprint 2006–2025: Blueprint for the Development of biofuel for Accelerating Poverty and Unemployment Reduction

BPDPKS: Palm Oil Plantation Fund Management Agency

BUBBM: Fossil Fuel Business Entities

BUBBN: Biofuel Business Entities

BUMN: State-Owned Enterprise

BUMD: Regional-Owned Enterprise

CMI1: Counter Measure Scenario 1

CM2: Counter Measure Scenario 2

COVID-19: Coronavirus Disease

CPO: Crude Palm Oil

DBH: Revenue Sharing

DEN: National Energy Council

Direktorat Jenderal EBTKE: Directorate General of New and Renewable Energy and Energy Conservation

DPR: People's Consultative Assembly/Representative Council

EBT: New and Renewable Energy

FAME: Fatty Acid Methyl Ester

FOLU: Forest and Other Land Use

FPIC: Free Prior Informed Consent

GAP: Good Agricultural Practices

GAPKI: Association of Indonesian Palm Oil Entrepreneurs

GFSI: Global Food Security Index

GRK: Greenhouse Gasses

GWP: Global Warming Potential

HAM: Human Rights

HIP: Market Price Index

Inpres: Presidential Instruction

Inpres Moratorium Sawit: Presidential Instruction No. 8 of 2018 on the Postponement and Evaluation of Oil Palm Plantation Licensing and the Improvement of Oil Palm Plantation Productivity

ISPO: Indonesian Sustainable Palm Oil

IUPHHK HT: Business Permit for Forest Product and Plantation Forest Management

Kementerian ESDM: Ministry of Energy and Mineral Resources

Keppres: Presidential Decree

Kl: Kiloliter

KPA: Agrarian Renewal Consortium

KUBE: General Energy Policy

LCA: Life Cycle Analysis

LTS-LCCR 2050: Long-Term Strategy on Low Carbon and Climate Resilience 2050

MRP: Mega Rice Project

Migas: Oil and Gas

Minerba: Mineral and Coal

NDC: Nationally Determined Contributions

NDPE: Commitments to No Deforestation, No Peat and No Exploitation

NGO: Non-Governmental Organization (NGO)

NTP: Farmer Exchange Rate

NZE: Net Zero Emission

PDB: Gross Domestic Product

PDRB: Gross Regional Domestic Product

PEN: National Economic Recovery

Permen ESDM: Minister of Energy and Mineral Resources Regulation

Perpres: Presidential Regulation

PIAPS: Indicative Map of Social Forestry Areas

PIPPIB: Indicative Map for the Cessation of New Permits

PKS: Palm Oil Plant

POME: Palm Oil Mill Effluent

PP: Government Regulation

PSO: Public Service Obligation

PTPN: State Plantation Company

RPJMN: National Medium-Term Development Plan

RUEN: National General Energy Plan

SDM: Human Resources

SHM: Certificate of Ownership

SPKS: Palm Oil Farmers Union

TBS: Fresh Fruit Bunches

UCO: Used Cooking Oil

UU Energi: Law No. 30 of 2007 on Energy

Chapter 1. Introduction

1.1 Background

Indonesia is amongst the countries with the most serious efforts to develop their biofuel (*Bahan Bakar Nabati* or BBN) policy. Such efforts can be seen from the introduction of the Energy Mix Policy (*Kebijakan Bauran Energi*) in 2006. The main drive is to achieve energy sovereignty and develop the economy, especially to end the state's reliance on fuel imports, which have created a significant financial burden. After Indonesia became one of the first developing countries to commit to reducing emissions, as announced by President Susilo Bambang Yudhoyono in 2009, biofuel development was gradually included as a part of the national emission reduction strategies. As of the time of writing of this document, the biofuel policy has been manifested in Indonesia's Nationally Determined Contribution (NDC) to reduce the energy sector's emissions by 11%–15.5% from the business-as-usual (BaU) scenario by 2030, as well as the Long-Term Strategy to achieve net zero emissions (NZE) by 2060 or sooner.

Since the beginning, Indonesia has prepared the development of biofuels through the Blueprint on Biofuel Development for the Acceleration of Poverty and Unemployment Reduction (*Cetak Biru Pengembangan BBN untuk Percepatan Pengurangan Kemiskinan dan Pengangguran*) (2006-2025 Blueprint).[1] In this document, biofuels are viewed as a huge potential for Indonesia to help achieve energy sovereignty and alleviate poverty. As a country with enormous resources in the plantation and agricultural sectors, Indonesia has the potential to develop crop-based industrial biofuels. The blueprint also properly addresses the diversification of biofuel feedstocks—in addition to palm oil, the blueprint also includes other types of feedstocks, such as jatropha, *kemiri sunan* (*Reutealis trisperma*), cassava, and sugarcane.

In its development, the discourse on biofuels has caused quite a stir. Concerns were raised over the use of food crops as biofuel feedstocks, as it might threaten food security (food vs. fuel). Furthermore, many have also highlighted that the increasing needs for lands to grow the feedstocks can jeopardise the existence of forests and peatlands. The controversy over biofuel implementation in Indonesia became even more heated when the discourse narrows down to palm oil-based biodiesel (fatty acid methyl ether/FAME).[2]

[1] Tim Nasional Pengembangan Bahan Bakar Nabati Untuk Percepatan Pengurangan Kemiskinan dan Pengangguran (2016). *Blueprint 2006–2025 Pengembangan Bahan Bakar Nabati Untuk Percepatan Pengurangan Kemiskinan dan Pengangguran*. Jakarta: Tim Nasional Pengembangan Bahan Bakar Nabati Untuk Percepatan Pengurangan Kemiskinan dan Pengangguran.

[2] Biodiesel is one of the forms of biofuels that is produced from vegetable oils and animal fats. Biodiesel consists of monoalkyl esters formed by a catalysed reaction of the triglycerides in the oil or fat with a simple monohydric alcohol (Gerpen, J.V. (2005). Biodiesel processing and production. *Fuel Processing Technology,* 86(10), 1097–110. Accessed from https://doi.org/10.1016/j.fuproc.2004.11.005).

Figure 1. General overview of biofuels

Source: Awongbemi, et al. (2021)[3].

Biofuels				
Generation	**First**	**Second**	**Third**	**Form**
Biodiesel	Oil from crops, such as palm, soybean, sunflower, maize, and cassava	Oil from crops' residues, such as rice hulls, corn cobs, and waste cooking oil	Oil from microalgae	**Liquid**
Bioethanol	Oil from fermentation, such as sugar, maize, and wheat	Oil from plantation residues, such as bagasse and palm fronds	Oil from microalgae and seaweed	
Biomethane	Biogas from agricultural and livestock residues	Synthesis gas (syngas)	Synthesis gas (syngas)	**Gas**
Biohydrogen	-	-	Hydrogen from microalgae and microbes	

Biofuels are categorized into three generations (Figure 1). Every generation indicates its technological advancement as well as its feedstocks. First generation biofuels are the easiest to produce and are derived from crops/agricultural products, whereas second generation biofuels are derived from crops/agricultural products' residues, and third generation biofuels are derived from microalgae.

The narrowing of the Indonesian biofuel industry can be seen from the prioritization of first-generation biofuels since 2013. Initially, as stipulated under the Minister of Energy and Mineral Resources (MEMR) Regulation No. 32/2008, the biodiesel mix was set at 10% until 2020. Through the revised MEMR Regulation in 2013, the mix percentage was increased, indicating a more ambitious biodiesel development. Lastly, in 2021, the plan to increase the mix to 40% was announced. In his annual State Address before the House of Representatives (*Dewan Perwakilan Rakyat* or DPR) on 16th of August 2019, President Joko Widodo expressed his readiness to implement B100.[4]

There are multiple factors that caused this industry narrowing, one of which is the challenge that is currently faced by Indonesia related to the absorption of the crude palm oil (CPO) oversupply.[5] Indonesia is the biggest palm oil producer in the world. In 2020, Indonesia's palm oil production

[3] Awongbemi, O., Kallon, D., Onuh, E.I., & Aigbodion, V.S. (2021). An Overview of the Classification, Production and Utilization of Biofuels for Internal Combustion Engine Applications. *Energies*, 14(18), 5687. Accessed from https://doi.org/10.3390/en14185687.

[4] Prasetia, Andhika (2019). Ini Pidato Kenegaraan Lengkap Jokowi di Sidang Bersama DPD-DPR. *Detiknews*. Accessed from https://news.detik.com/berita/d-4668058/ini-pidato-kenegaraan-lengkap-jokowi-di-sidang-bersama-dpd-dpr on 11th of February 2022.

[5] Koaksi Indonesia (2019, 2 Agustus). *Over Supply CPO, Biodiesel Berkelanjutan dan Kesejahteraan Petani Sawit*. Accessed from https://coaction.id/en/over-supply-cpo-biodiesel-berkelanjutan-dan-kesejahteraan-petani-sawit/ on 12th of April 2022.

reached 51.58 million tonnes[6] with a total export volume of 34 million tonnes.[7] The oversupply of CPO was discussed in the Indonesian Palm Oil Association's (*Gabungan Pengusaha Kelapa Sawit Indonesia* or GAPKI) report (2019), which revealed a palm oil surplus[8] at least in the 2015–2019 period.[9] Hence, the discourse on biofuels in Indonesia slowly shifted to palm oil-based biodiesel or FAME only. The government responds to the national palm oil surplus by promoting biodiesel utilization to create a "market" that can absorb the abundant supply of palm oil. However, does this mean that the biofuel development in Indonesia will be dominated by only palm oil-based biodiesel and is it just a market engineering mechanism to absorb the CPO surpluses?

In this context, the direction of the national energy policy pertaining to transport fuels becomes very relevant. This question has been asked in small informal discussions with some climate change activists, but answering this issue is not that simple. Various issues in Indonesia, including making biofuels as sources of energy for transportation, are often faced with multifaceted challenges, from the automotive industry players themselves to the politics in the agrarian and plantation affairs. The direction to which the energy policy for transportation is heading is therefore pivotal, as the biofuel development was initially aimed to providing an alternative energy to transport fuels[10], although the discourse on biofuel utilization for power generation emerged in its development.[11]

Although it might seem very basic, the most important question to answer is about how to lay out a robust foundation in planning and implementing the national biofuel policy. With palm oil dominating the biofuel feedstocks, the government may not put enough focus on the other types of feedstocks. Moreover, policies on biofuels will focus only on matters related to palm oil. Consequently, the discourse on innovative biofuel development becomes minimal and only prioritizes increasing the mix.[12] Such a condition can hinder the efforts to make biofuels a renewable source of energy that serves as a bridge to energy transition. Meanwhile, other issues related to feedstock diversification, land needs for growing feedstocks, national biofuel grand design, and the dynamics of the feedstock market also may not receive enough portion in the discourse.

According to Madani Berkelanjutan's investigation, there are 122 national and international-scale studies in the last 15 years that focus on the ecological, economic, and social issues of the biofuel utilization in Indonesia. There are studies that support the existing biofuel policies, but many others also criticize them. These differences in opinion present opportunities as well as challenges for the public who seek to fully understand the contexts of biofuels in Indonesia.

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[6] Ramli, Rully R. (2021, 10 Februari). Sepanjang 2020, Produksi Kelapa Sawit Capai 51,58 Juta Ton. *Kompas.com*. Accessed from https://money.kompas.com/read/2021/02/10/170000226/sepanjang-2020-produksi-kelapa-sawit-capai-51-58-juta-ton on 26th of November 2021.

[7] GAPKI (2021). *Ekspor Minyak Sawit Indonesia Turun 9% pada 2020.* Accessed from https://databoks.katadata.co.id/datapublish/2021/02/05/ekspor-minyak-sawit-indonesia-turun-9-pada-2020 on 26th of November 2021.

[8] The surplus value is the number of oil palm production minus total exports and domestic consumption in the same year.

[9] GAPKI (2022). *Kinerja Industri Sawit Indonesia 2021 dan Outlook 2022*. Accessed from https://gapki.id/kinerja-industri-sawit-indonesia on 14th of April 2022.

[10] Guo, M., Song, W., & Buhain, J. (2015). Bioenergy and Biofuels: History, Status, and Perspective. *Renewable and Sustainable Energy Reviews*, 42, 712-725. Accessed from https://doi.org/10.1016/j.rser.2014.10.013.

[11] Presidential Regulation (PR) No. 22/2017 on the National Energy General Plan (RUEN).

[12] From the result of a systematic review conducted by Madani.

Therefore, a study that provides an illustration of the dynamics of the national discourse on biofuels from the ecological, economic, and social sustainability aspects from the existing literature is needed. As such, the views of various parties towards the biofuel issues in Indonesia can be clearly mapped. This study is hoped to contribute towards the improvement of sustainable biofuel policies in Indonesia as a part of the strategies to achieve energy sovereignty, improve the economy, and reduce emissions.

1.2 Research Objectives

This report is an effort to map the dynamics of the discourse on biofuels from the ecological, economic, and social sustainability aspects from the literature published in the last 15 years.[13] It aims to obtain a more complete picture of different positions and analyses on biofuels from various parties. The study results of this report are hoped to contribute towards the development of a sustainable biofuel master plan from its ecological, economic, and social aspects.

Although this study aims to observe the biofuel policy that is currently in place in general, it is hard to deny that the developing discourse on mass media, literature, and previous studies focus more on palm oil-based biodiesel. Consequently, the current study also highlights more previous studies on biodiesel. Nevertheless, this study attempts to provide an objective illustration regarding the discourse on biofuels in Indonesia that has been discussed in various literature and studies.

1.3 Research Questions

This study started from an underlying preliminary hypothesis that the focus of biofuel development in Indonesia tends to narrow from biofuels in general to only the palm oil-based ones. In the end, the discourse on biofuels in Indonesia cannot be separated from the issues that have plagued the palm oil industry thus far, such as land conflicts, deforestation, human rights violations, and the increasing greenhouse gas (GHG) emissions. Hence, biofuels are not yet viewed as the eco-friendly alternative energy that serves as a bridge to energy transition.

This study attempts to answer these three basic questions to identify the direction of Indonesia's biofuel policy.

a. How is the development of Indonesia's biofuel policy thus far?
b. How is the dynamics of the discourse on biofuels in Indonesia from its ecological, economic, and social sustainability aspects in the existing literature in the last 15 years?
c. What efforts should be done to improve the biofuel governance in Indonesia?

[13] The biofuel issue first arose in Indonesia's policy in 2006, and therefore this year became the initial parameter to examine the literature included in this study.

1.4 Methodology

The data in this study were collected by analysing regulations and policies, as well as conducting a literature review of the regulations, policies, and literature related to biofuels that were published and accessible in the last 15 years. This parameter was determined based on the fact that the biofuel issue in Indonesia first arose when the Energy Mix Policy was introduced for the first time in 2006.

In determining the literature to be included in the scope of this study, the main keyword used was *biofuels in Indonesia*. To answer the preliminary hypothesis that the discourse on biofuels in Indonesia is dominated by only one type of feedstock, other additional keywords were also implemented, such as *oil palm*, *sugarcane, maize, soybean, cassava, jatropha*, *kemiri sunan (Reutealis trisperma)*, *tamanu*, *waste cooking oil*, and *pongamia/malapari*. The searches were carried out using search engines, open-access journals, and various libraries/public sites (of non-governmental organisations/NGO and the government) that are available online. Other keywords used include issues in the dynamics of biofuel controversy debates at the national level, such as poverty, land conflicts, gender, renewable energy, and human rights (Table 1).

Table 1. List of Keywords Used in the Literature Search

Main Keyword	Additional Keywords (Feedstocks)	Complementary Keywords
Biofuels in Indonesia	Oil palm Maize Rice Soybean Cassava Jatropha *Kemiri sunan* (*Reutealis trisperma*) Tamanu Waste cooking oil Pongamia/malapari	Deforestation
		Land degradation
		Biodiversity
		Forest and land fire
		Water and air quality
		Emissions
		Tax
		Foreign exchange
		Gross Domestic Product (GDP)/Gross Regional Domestic Product (GRDP)
		Locally generated income (*Pendapatan asli daerah* or PAD)
		Food security
		Farmer's welfare
		Agrarian conflicts
		Human rights
		Gender

The search yielded a result of 122 articles that contain the main and additional keywords, and 66 articles with complementary keywords. Upon filtering, this study decided to use and refer to 66 articles about biofuels in Indonesia.

The primary sources for analysing the national biofuel policy were laws and regulations that regulate its implementation. The legal analysis in this study was conducted using a descriptive analytical approach. The provisions in the laws and regulations are explained, and then compared to the reality of their implementation. This study also provides a spatial analysis to enrich the existing literature related to the discourse on biofuels.

1.5 Research Limitations

Because this study is based on the existing literature, it has several limitations, such as the possibility that some articles might have been overlooked and not analyzed properly. Therefore, inputs from various parties are needed so that the authors can continue to improve the analysis in this study.

1.6 Report Structure

This study is divided into five main chapters. The first chapter expounds on the backgrounds and contexts pertaining to issues related to biofuels in Indonesia, as well as describing the methods, scope, and preliminary hypothesis of this study.

The second chapter reviews the regulations and policies on energy mix and biofuels in Indonesia. The general overview highlights the new and renewable energy policies that had been implemented in Indonesia from 1980 to 2021. This includes the energy mix and biofuel policy as an effort to achieve Indonesia's climate commitment as manifested in the NDC. This chapter also discusses the position and portion of biofuel policy in Indonesia.

The third chapter elucidates the dynamics of the discourse on the ecological, economic, and social sustainability of Indonesia's biofuel policy. The main point of this chapter is to show that the existence of clean renewable energy is an absolute necessity, yet there are several important aspects that need to be considered in the discourse, which are ecological, economic, and socio-cultural sustainability. This chapter also presents a spatial analysis on the implementation of biofuel policy in Indonesia.

The fourth chapter discusses the direction (*quo vadis*) of the biofuel policy at the national level, economic value of biofuels in the national context, social and market challenges, and the biofuel sustainable development scenario in Indonesia in the future.

The fifth chapter combines and draws a conclusion from the findings of the referred literature in this study and proposes several recommendations and necessary measures to improve the biofuel governance in Indonesia.

Chapter 2. Timeline of Biofuel Policies in Indonesia

The National Energy Policy framework is inseparable from the provisions as stipulated under the Article 33 Paragraph 3 of the 1945 Constitution (*Undang-Undang Dasar* or UUD) because almost all energy provisions are based on natural resources, be it renewable or not. This also renders the energy issues inextricably linked to natural resources management issues. This chapter will expound on the national policy frameworks related to energy mix and biofuels.

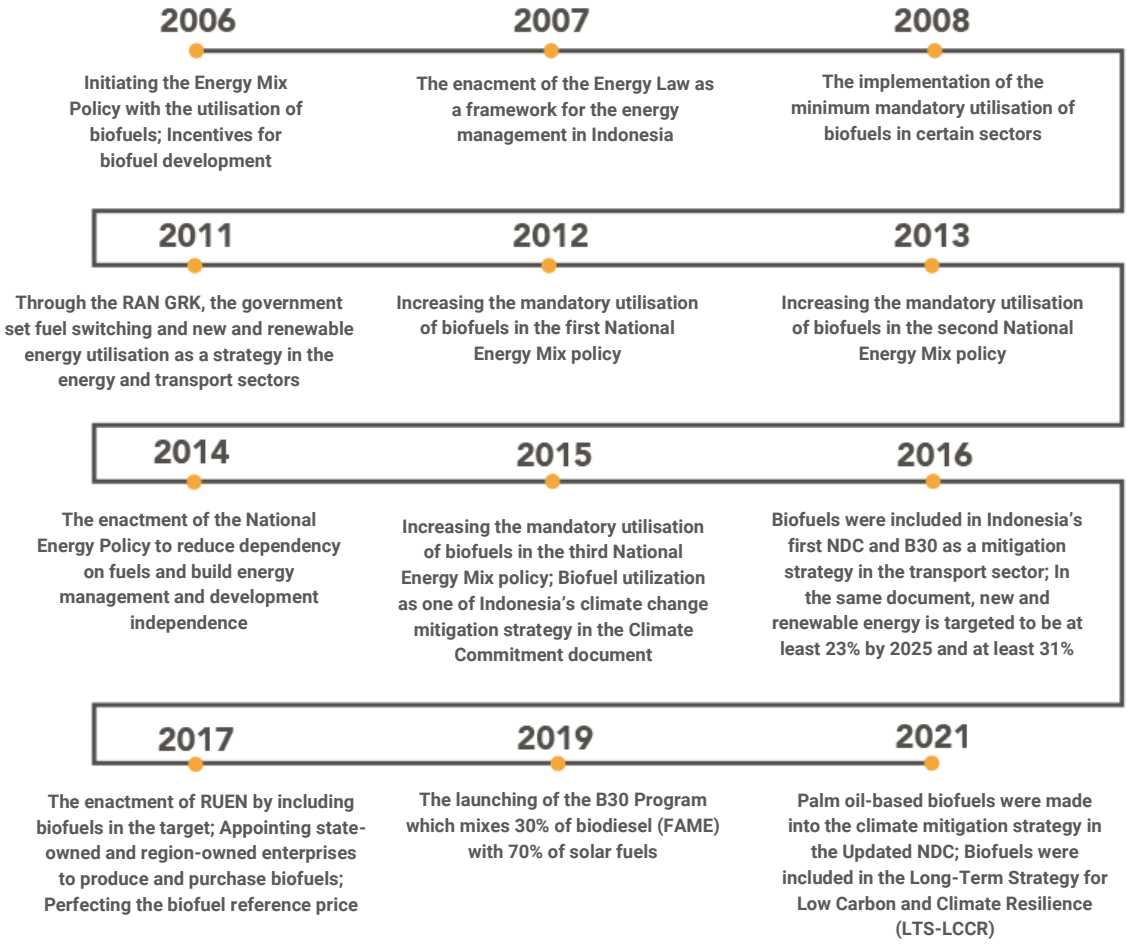

Figure 2. Timeline of biofuel policies in Indonesia

Source: Processed by Madani Berkelanjutan's researcher team.

2.1 1980–2008

Energy in Indonesia has been discussed integratively (multi-sector) since the 1980's with the establishment of the National Energy Coordination Agency (*Badan Koordinasi Energi Nasional* or BAKOREN), which was the forerunner of the National Energy Council (Dewan Energi Nasional or DEN). The main tasks of BAKOREN were to formulate policies, implement the national energy development programmes, and coordinate the implementation of the programmes and policies.[14] At that time, energy policies were still focused on fossil fuels. There was almost no direction to even consider

[14] Article 2 of Presidential Decree No. 46/1980 on National Energy Coordination Agency.

renewable energy. BAKOREN later drew up the General Policy in the Energy Sector (*Kebijakan Umum Bidang Energi* or KUBE) document that focused on energy intensification, diversification, and conservation. Although the document addressed energy diversification, it was aimed at reducing reliance on crude oils and shifting to other sources of energy. Power and cement plants were encouraged to use coals, but there was no specific explanation on the other sources of energy.[15]

The Indonesian government started shifting their attention to renewable energy when crude oils production experienced a continuing downward trend since 1995.[16] The skyrocketing price of crude oils throughout 2004–2006 was also one of the government's reasons to consider renewable energy.[17] To solve this problem, the government undertook an initiative to find alternative energy sources that can replace a share of fuels to fulfill the energy consumption needs in Indonesia.

In 2006, with the enactment of Presidential Regulation (PR) No. 5/2006 on National Energy Policy, the government overhauled the composition of energy consumption in Indonesia by targeting an energy mix and allocating 5% from the total energy consumption for renewable energy by 2025. The renewable components of the energy mix were those produced by biomass, nuclear, water, solar, and wind power.[18] The goal of the energy mix policy was to ensure an affordable access to sources of energy and maintain the domestic energy supply in the long term.[19] Additionally, the policy was also a form of the government's effort to reduce crude oil imports.[20] The enactment of PR No. 5/2006 was followed by Presidential Instruction (PI) No. 1/2006 on the Provision and Utilisation of Biofuels as an Alternative Energy Source, which instructed the ministries/government agencies and regional governments to issue policies that aim to accelerate the utilization of biofuels. The government even established the National Team for Biofuel Development for the Acceleration of Poverty and Unemployment Reduction through Presidential Decree No. 10/2006, who was tasked with preparing the biofuel roadmap for Indonesia.

The Indonesian government's commitment to be independent in managing and ensuring the fulfillment of domestic energy needs optimally was more evident with the promulgation of Law No. 30/2007 on Energy (Energy Law). The Energy Law lays out the energy management framework that is underlied by the basis of (i) utility, (ii) rationality, (iii) fair efficiency, (iii) value added improvement, (iv) sustainability, (iv) people welfare, (v) living environment preservation, (vi) national resilience, and (vii) integrity principles by prioritizing the national capability.[21]

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[15] *Komitmen Indonesia untuk Pembatasan Subsidi Bahan Bakar Fosil dan Peningkatan Efisiensi Energi di G20*, Kajian Pusat Kebijakan Pembiayaan Perubahan Iklim dan Multilateral (BKF). Accessed from https://www.kemenkeu.go.id/sites/default/files/pembatasan%20subsidi%20bahan%20bakar%20fosil%20dan%20efisiensi%20energi.pdf on 18 August 2021.

[16] Direktorat Sumber Daya Energi, Mineral, dan Pertambangan Bappenas RI (2015). *Kajian Penggembangan Bahan Bakar Nabati*. Jakarta: Kementerian PPN / Bappenas RI.

[17] Koaksi Indonesia (2018). *Dinamika Hulu Hilir Industri Biodiesel di Indonesia*. Jakarta: Koaksi Indonesia.

[18] Article 2 paragraph (2) of Presidential Regulation No. 5/2006 on National Energy Policy.

[19] Article 2 paragraph (2) of Presidential Regulation No. 5/2006 on National Energy Policy.

[20] Koaksi Indonesia (2018). *Dinamika Hulu Hilir Industri Biodiesel di Indonesia*. Jakarta: Koaksi Indonesia

[21] According to the Energy Law, the principles of benefit are the basis for energy management, which must meet the needs of the community; the principle of efficiency with equity is the basis for energy management, which must achieve equal access to energy at an economical and affordable price; the principle of increasing added value is the basis for energy management, which must achieve optimal economic value; the principle of sustainability is the basis for energy management, which must guarantee the provision and utilization of energy for both the present and future generations; the principle of community welfare is the basis for energy management, which must maximize the welfare of the community; the principle of preserving the function of the environment is the basis for energy management, which must ensure a better quality of environmental function; the

In the Energy Law, BAKOREN's role was replaced by DEN, which was tasked with formulating the national energy policy with the president and developing the National Energy General Plan (*Rencana Umum Energi Nasional* or RUEN) and Regional Energy General Plan (*Rencana Umum Energi Daerah* or RUED).[22] The government sought to explore the utilization of renewable energy as a source of alternative energy by facilitating ease of utilization and/or providing incentives to the new and renewable energy source providers. The facilitation and/or incentives were given by the central and/or regional government in a certain period until its economic value is achieved.[23]

To implement the energy mix policy, in 2008, the Minister of Energy and Mineral Resources issued the MEMR Regulation No. 32/2008 on the Provision, Utilisation, and Commercialisation of Biofuels as an Alternative Energy Source. Through the regulation, the production and consumption of biofuels started to be regulated. From the production side, in addition to giving a space for biofuel business entities (*badan usaha BBN* or BUBBN) to produce biofuels, this regulation also regulates individual business entities and those in the energy independent village programme to produce and trade energy to fulfill both the internal and external energy needs of the villages.[24] From the consumption side, the MEMR Regulation No. 32/2008 requires fuel oil business entities (*badan usaha BBM* or BUBBM) and direct consumers (both individuals and business entities) to gradually use biofuels.[25] Furthermore, the utilized biofuels must be produced domestically.[26] Incentives were given as an economic stimulus to increase the domestic biofuel production and consumption.[27] This shows a regulation pattern that guarantees the production and consumption of biofuels to actualise national energy security.

The sector coverage of the energy mix policy in the MEMR Regulation No. 32/2008 includes public service obligation (PSO) transport, non-PSO transport, industrial and commercial sectors, power generation, and industries and transportations that use low- and medium-speed engines. It should be noted that the MEMR Regulation No. 32/2008 was the first policy that shows the government's commitment to implementing the biofuel mix policy. This policy was also an effort to test the concept of biofuel utilization in Indonesia. In the next period, the development (revision) of this regulation signified a bigger ambition to implement the biofuel mix policy. The mix for each type of biofuel in the MEMR Regulation No. 32/2008 for biodiesel (B100), bioethanol (E100), and pure plant oil (O100) are shown in Table 2.

principle of national resilience is the basis for energy management, which must achieve national capability in energy management; the principle of integration is the basis for energy management, which must achieve integrated energy management across sectors.

[22] Article 12 paragraph (2) of Energy Law.

[23] Article 20 paragraph (5) of Energy Law.

[24] Article 1 Jo. Article 3 of the MEMR Regulation No. 32/2008.

[25] Article 3 Paragraph 1 of the MEMR Regulation No. 32/2008.

[26] Article 4 of the MEMR Regulation No. 32/2008.

[27] Article 6 of the MEMR Regulation No. 32/2008.

Table 2. Phases of the Minimal Requirements of Biofuel Utilisation According to the MEMR Regulation No. 32/2008

SECTOR		October–December 2008	January 2009	January 2010	January 2015	January 2020	January 2025
Biodiesel (B100)							
Household		-	-	-	-	-	-
PSO transport		1%	1%	2.5%	5%	10%	10%
Non-PSO transport		-	1%	3%	7%	10%	20%
Industrial and commercial sector		2.5%	2.5%	5%	10%	15%	20%
Power generation		0.1%	0.25%	1%	10%	15%	20%
Bioethanol (E100)							
Household		-	-	-	-	-	-
PSO transport		3%	1%	3%	5%	10%	15%
Non-PSO transport		5%	5%	7%	10%	12%	15%
Industrial and commercial sector		-	5%	7%	10%	12%	15%
Power generation		-	-	-	-	-	-
Pure Plant Oil							
Household		-	-	-	-	-	-
Industrial and transport (low- and medium-speed engines)	Industrial	-	-	1%	3%	5%	10%
	Water transport	-	-	1%	3%	5%	10%
Power generation		1%	0.25%	1%	5%	7%	10%

The MEMR Regulation No. 32/2008 also imposes sanctions on the fuel oil direct consumers that failed to adhere to the minimal requirements of biofuel utilisation as an alternative energy source.[28]

In the initial period of biofuel development, the projected mix for every type of biofuel and its development were even until 2025—the differences were not significant, and the development was carried out gradually. The biofuel development policy applied to all types of biofuels and incentives were given to the actors along the feedstocks to the biofuel industry's supply chains. To develop biofuels, the government provided various incentives, such as fiscal incentives or financing through financial agencies, with the enactment of implementing regulations in the forms of government regulations and ministerial regulations[29].

2.2 2011–2015

In 2011, the government published the National Action Plan to Reduce Greenhouse Gases (*Rencana Aksi Nasional Pengurangan Gas Rumah Kaca* or RAN-GRK) to achieve the Indonesian government's commitment as announced at the G20 meeting in Pittsburgh, that is to reduce greenhouse gas (GHG) emissions by 26% with its own efforts to 41% with international support by 2020 from the business-as-usual (BAU) level. The energy and transport sectors were the main activities, along with the agricultural, forestry and peatlands, industrial, and waste management sectors.

In the energy and transport sectors, two of the five government's policies aimed to use cleaner fuels (fuel switching) and increase the use of new and renewable energy. Although biofuels were not explicitly mentioned in this document, strategies such as reducing the non-renewable energy consumption and small to medium biofuel utilization implies the aim to shift from fossil fuels to the others that are more sustainable.

Next, throughout 2013–2015, the government increased the biofuel mix target to a more ambitious percentage. This is reflected in the fact that the energy mix policy (MEMR Regulation No. 32/2008) underwent revisions three times within just two years.[30] Substantively, since 2013, the biofuel mix has been focused more on biodiesel (B100) as its main component, rather than on bioethanol (E100) or pure plant oil (O100) in the main sectors. The phased implementation of the minimum obligation for biodiesel utilization (B100) with a 20% portion, originally targeted for January 2025 for most sectors, was accelerated to January 2016. Conversely, the phased implementation of the minimum obligation for bioethanol utilization (E100) and pure biofuels (O100) tends to experience stagnation.

[28] Article 28 of the MEMR Regulation No. 32/2008.

[29] See GR No. 1/2007 on the Income Tax Facility for Investments in Certain Business Sectors and/or in Certain Regions and Minister of Finance Regulation No. 79/PMK.05/2007 on Food and Energy Security Credits.

[30] Between 2013–2015, the government enacted (i) MEMR Regulation No. 25/ 2013, (ii) MEMR Regulation No. 20/2014, and (iii) MEMR Regulation No. 12/2015; all were revisions of the MEMR Regulation No. 32/2008.

Table 2. Stages of Mandatory Minimum Biofuel Utilization in the MEMR Regulation No. 32/2008 and Its Revisions from 2013–2015

Sector		MEMR Regulation No. 25/2013						MEMR Regulation No. 20/2014					MEMR Regulation No. 12/2015			
		Sep '13	Jan '14	Jan '15	Jan '16	Jan '20	Jan '25	Jul '14	Jan '15	Jan '16	Jan '20	Jan '25	Apr '15	Jan '16	Jan '20	Jan '25
Biodiesel																
Household		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PSO transport		10%	10%	10%	20%	20%	25%	10%	10%	20%	30%	30%	15%	20%	30%	30%
Non-PSO transport		3%	10%	10%	20%	20%	25%	10%	10%	20%	30%	30%	15%	20%	30%	30%
Industrial and commercial sector		5%	10%	10%	20%	20%	25%	10%	10%	20%	30%	30%	15%	20%	30%	30%
Power generation		7.5%	20%	25%	30%	20%	25%	20%	25%	30%	30%	30%	25%	30%	30%	30%
Bioethanol																
Household		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PSO transport		-	0.5 %	1%	2%	5%	20%	0.5 %	1%	2%	5%	20%	1%	2%	5%	20%
Non-PSO transport		1%	1%	2%	5%	10%	20%	1%	2%	5%	10%	20%	2%	5%	10%	20%
Industrial and commercial sector		-	1%	2%	5%	10%	20%	1%	2%	5%	10%	20%	2%	5%	10%	20%
Power generation		-	-	-	-	-	-	-	-	-	-	-				
Pure Plant Oil																
Household		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Industrial and transport (low- and medium-speed engines)	Industrial	1%	5%	10%	20%	20%	20%	5%	10%	20%	20%	20%	10%	20%	20%	20%
	Water transport		5%	10%	20%	20%	20%	5%	10%	20%	20%	20%	10%	20%	20%	20%
Air transport					2%	3%	5%	-	-	2%	3%	5%	-	2%	3%	5%
Power generation		1%	5%	15%	20%	20%	20%	6%	15%	20%	20%	20%	15%	20%	20%	20%

During this period, the government also implemented various policies in the energy sector, including those related to energy mix. The development of new and renewable energy was strengthened with the promulgation of Government Regulation (GR) No. 79/2014 on National Energy Policy. Through this regulation, the government prioritized reducing reliance on fuel oil and achieving independence in managing and developing domestic energy.[31] According to Article 2 of GR No. 79/2014, energy management in Indonesia shall be based on the principles of fairness, sustainability, and environmental sound aimed to create energy independence and national energy security.[32] This regulation also states that, for the fulfillment of energy provisions and utilization, the national energy policy targets shall be achieved by actualising an optimal primary energy mix, which is at least 23% of new and renewable energy by 2025 and at least 31% by 2050.[33] Biofuels were aimed to replace fuel oil, especially in the transport and industrial sectors.[34]

It was in 2015 when the diversification of biofuel products started to narrow down and focus more on palm oil-based biofuels, especially biodiesel. In addition to the bigger percentage of biodiesel in the energy mix, the government also promoted the development of palm oil-based biofuels with policies that are relatively more structured, ranging from the incentive schemes to establishments of supporting agencies. Through the GR and its implementing regulations, the government established the (Badan Pengelola Dana Perkebunan Kelapa Sawit (BPDPKS)) whose functions are, amongst others, to allocate funds, manage financing partnerships, develop fund distribution plans, conduct research, and processing data related to biodiesel development.[35]

The government's focus on biodiesel development has pushed forward the development of other biofuel types and hampered its diversification. This can indirectly cause the government to depend on certain fuels, which certainly hinders Indonesia's efforts to achieve energy security as mandated in the Energy Law, as well as creating unjust energy management.

2.3 2015–Now

The government's focus on developing biofuels as an alternative energy in Indonesia is realized by passing and adjusting a series of policies related to the use of renewable energy sources, which are done to accelerate the development and utilization of renewable energy in all sectors from 2015 until now. Through the Presidential Decree No. 22 of 2017 on RUEN[36], the supply of renewable energy in the primary energy mix is targeted at 23% (92.3 MTOE) in 2025 and 31.2% (315.7 MTOE) in 2050.[37]

[31] Description of GR No. 79/2014.

[32] Energy management is the implementation of activities related to the provision, operation, and utilization of energy, as well as the provision of strategic reserves and conservation of energy resources (Article 1 Number 8 of GR No. 79/2014); energy self-sufficiency is the assurance of energy availability by utilizing the maximum potential from domestic sources (Article 1 Number 9 of GR No. 79/2014); energy security is a condition where the availability of energy is assured, and public access to energy is at an affordable price in the long term, while still considering environmental protection (Article 1 Number 9 of GR No. 79/2014).

[33] Article 9 GR No. 79/2014.

[34] Article 12 GR No. 79/2014.

[35] Article 12 of Minister of Finance Regulation No. 113/PMK.01/2015 on the Organisation and Work Procedures of the Estate Crop Fund for Palm Oil.

[36] RUEN is a central government policy that regulates energy management plans at the national level, which are the elaboration and implementation plans of the National Energy Policy that are cross-sectoral in nature to achieve the targets of the National Energy Policy.

[37] RUEN p. 61.

Biofuels is also implemented in the energy mix target, among others, through bioenergy power plants with the following activities:[38]

a. Guaranteeing the availability of CPO to meet the demand for CPO as domestic biofuels
b. Assigning state-owned enterprises (*Badan Usaha Milik Negara,* henceforth BUMN) and/or regional-owned enterprises (*Badan Usaha Milik Daerah,* henceforth BUMD) to produce and purchase biofuels
c. Developing biogas power plants from palm oil mill effluent (POME) in each palm oil mill with the obligation of purchasing electrical power from the electricity supply business entities (PLN and its subsidiaries)
d. Improving the benchmark price of biofuels.

The implementation of RUEN by the government is followed by the adoption of a series of policies related to the development, as well as the procurement and/or installation of electricity for new energy and/or renewable energy. Through the MEMR Regulation No. 39/2017 on the Implementation of Physical Activities for Utilization of New and Renewable Energy and Energy Conservation[39], the government seeks to accelerate the development of renewable energy for electricity purposes, as well as the distribution and utilization of new and renewable energy sources for electricity and non-electric power generation in order to increase the ability to supply national energy. The government has also set the purchase price of electric power by PT Perusahaan Listrik Negara (PLN) from new and renewable energy-sourced power plants. Furthermore, MEMR Regulation No. 50/2017 on Utilization of Renewable Energy for the Supply of Electric Power[40] requires PLN to purchase electricity generated by power plants which utilize renewable energy sources, including biofuels.

In the transportation sector, biodiesel becomes the main mix in the supply plan with a mix target of 20% in 201 and 30% in 2050.

Table 3. Plans for Supply of Biofuels for Transportation in the 2017 RUEN

Type		2016	2025	2050
Biodiesel	Mix	20%	30%	30%
	Volume (million kl)	2,5	6,9	17,1
Bioethanol	Mix	5%	20%	20%
	Volume (million kl)	0,1	2,6	11,4
Bioavtur	Mix	2%	5%	10%
	Volume (million kl)	0,0	0,1	2,7

[38] RUEN p. 76.

[39] MEMR Regulation No. 39/2019 has been amended through MEMR Regulation No. 12/2018 on the Amendment to MEMR Regulation No. 39/2019.

[40] MEMR Regulation No. 50 of 2017 has been amended through (i) MEMR Regulation No. 53/2018 on the Amendment to MEMR Regulation No. 50/2017 and (ii) MEMR Regulation No. 4/2020 on the Second Amendment to MEMR Regulation No. 50/2017.

At the end of 2019, the government launched the 30% Biodiesel Programme.[41] This policy instructs mixing 30% biodiesel (FAME) with 70% diesel fuel. The B30 programme is a manifestation of the Mandatory Biodiesel Programme following the MEMR Regulation No. 32/2008 and its amendments. The government continues to work on the implementation of the Mandatory Biodiesel Programme on a wider scale, one of which is by accelerating the implementation of the advanced programme, i.e., the 50% Biodiesel Programme, in early 2021.[42]

2.4 Regulations related to biofuels in Indonesia

From 2006 until now, the government has issued a series of policies to build and develop the biofuel industry in Indonesia (Table 4). Through these policies, the government provides tax facilities and other incentives in laws and regulations.

Table 4. Policies on the Development of Biofuel Industry in Indonesia

No.	Policy/Regulation	Description
1.	Government Regulation No. 1 of 2007 on the Income Tax Facilities for Investment in Certain Business Fields and/or in Certain Regions	Government Regulation No. 1 of 2007 classifies biofuel producers as businesses in sectors of economic activity that receive high priority on a national scale and provides incentives in the form of (i) tax breaks, (ii) amortization rates, and (iii) business losses that can be borne longer as a tax deduction in the following year compared to other business fields.
2.	Government Regulation No. 24 of 2015 on Collection of Plantation Funds	Government Regulation No. 24 of 2015 is the basis used by the government to raise funds aimed at encouraging the development of sustainable plantations for strategic plantation commodities, i.e., (i) oil palm, (ii) coconut, (iii) rubber, (iv) coffee, (v) cocoa, (vi) sugar cane, and (vii) tobacco. The purpose of raising funds is, among others, to develop plantations and use their products to meet food and biofuel needs, as well as to encourage the downstream plantation industry.
3.	Presidential Decree No. 61 of 2015 on Collection and Use of Palm Oil Plantation Funds, as last amended by Presidential Decree No. 66 of 2018	The government specifically applies levies on exports and fees for oil palm plantation commodities and/or their derivatives paid by (i) palm oil plantation business entities which export oil palm plantation products and/or their derivatives, (ii) business entities which predominantly use products of oil palm plantations, and (iii) exporters of oil palm plantation products and/or their derivatives. The funds raised are used for,

[41] Kominfo (2019, 23 December). *Pertama di Dunia, Indonesia Terapkan Biodiesel 30 Persen (B30)*. Accessed from https://kominfo.go.id/index.php/content/detail/23437/pertama-di-dunia-indonesia-terapkan-biodiesel-30-persen-b30/0/artikel_gpr on 25 September 2021.

[42] *Kelompok Kajian Ekonomi Lingkungan Lembaga Penyelidikan Ekonomi dan Masyarakat FEB Universitas Indonesia* (2020). Analisis Risiko Kebijakan Biodiesel B30. *Policy Review, 2*(1).

		among other things, food interests, down streaming the palm oil industry, as well as the supply and utilization of biodiesel-type biofuels.
4.	Minister of Finance Regulation No. 117/PMK 06/2006 on Bio-energy Development Credit and Plantation Revitalization	This regulation is the foundation for banks and other financial institutions to provide credit to the biofuel industry, such as palm oil and rubber. *Jatropha* (castor tree) is not included in the list of commodities to receive credit from banks and financial institutions.
5.	Minister of Finance Regulation No. 79/PMK.05/2007 on Food and Energy Security Credit	Application of lower interest rates to farmers with small-scale businesses (smallholders).
6.	Minister of Finance Regulation No. 113/PMK.01/2015 on the Organizational Policies and Procedures of the Palm Oil Plantation Fund Management Agency (BPDPKS)	This regulation is the basis for the formation and management of BPDPKS. This institution is tasked with collecting, cultivating, and channeling export levy funds for oil palm plantation products.
7.	MEMR Regulation No. 24/2021 on the Supply of Utilization of Biodiesel-type Biofuels in the Financing Framework of the Palm Oil Plantation Fund Management Agency (BPDPKS)	● Biodiesel-type BUBBN is entitled to receive biodiesel financing funds/incentives to cover the difference between the market index price of diesel fuel and of biodiesel-type biofuels from the BPDPKS. ● BUBBM is required to mix biodiesel-type biofuels with diesel fuel following the percentage determined by the MEMR and distribute it. ● Supply and utilization of biodiesel-type biofuels within the financing framework by BPDPKS aim to achieve the minimum mandatory phasing of biodiesel-type biofuels in a sustainable manner, which includes environmental, economic, and social aspects.
8.	MEMR Decree No. 89.K/HK.02/MEM.L/2019 on Ratification of the Electricity Supply Business Plan of PT Perusahaan Listrik Negara (PERSERO) for 2021 to 2031	The government is encouraging the use of biodiesel as fuel for the existing diesel-fired power plants (PLTD) in stages by converting diesel fuel into biofuels.
9.	MEMR Decree No. 182 K/10/MEM/2020 on Market Index Prices of Biodiesel-type Biofuels Mixed into Fuel Oil	This decree is a government policy instrument in determining the market index price of biodiesel-type biofuels. It is a reference for the government and

		BPDPKS in providing subsidies for the utilization and distribution of biodiesel-type biofuels.

2.5 NRE Mix Policy in Indonesia's Climate Commitment

The development and use of biofuels is no longer a trivial energy policy, but also a climate policy. When they were first enacted, both the Law of Energy and Government Regulation No. 79 of 2014 as the main instruments for energy security policies did not explicitly pay attention to the government's commitment to reducing greenhouse gas (GHG) emissions.

Indonesia's commitment to mitigating the climate crisis by signing the Paris Agreement [43] has also influenced the development of the energy mix policy framework in Indonesia. In the recently updated NDC document submitted in 2021, the government targets to reduce GHG emissions by 29% on its own, and with international support up to 41% compared to the BaU scenario in 2030. The energy sector is targeted to contribute 11%-15.5% of this target or the second highest after the forest and other land uses (FOLU) sector (Table 5).

Table 5. BaU Projection and Emission Reduction Target for Each Sector in the Updated NDC Document

Sector	2020 GHG Emission Rate (MtonCO2e)	2030 GHG Emission Rate (MtonCO2e)			GHG Emission Reduction (Mton CO2e)		% Total BaU		Average Annual Growth in BaU 2010-2030)	Average Growth 2000-2012
		BaU	CM1	CM2	CM1	CM2	CM1 (%)	CM2 (%)		
Energy*	453.2	1.669	1.355	1.223	314	446	11	15,5	6,7%	4,50%
Waste	88	296	285	256	11	40	0,38	1,4	6,3%	4,00%
Industrial processes and production use (IPPU)	36	70	67	66	3	3.25	0,10	0,11	3,4%	0,10%
Agriculture**	111	120	110	116	9	4	0,32	0,13	0,4%	1,30%
Forestry (FOLU)***	647	714	217	22	497	692	17,2	24,1	0,5%	2,70%
TOTAL	**1.334**	**2.869**	**2.034**	**1.683**	**834**	**1.185**	**29**	**41**	3,9%	3,20%

Description:

*) Including fugitive emissions

**) Only includes rice and livestock cultivation

***) Including emissions from estate crop plantations

Since the first NDC was issued, the government views the energy mix policy as one of the key components to achieve the target of reducing GHG emissions in Indonesia. The composition of the primary energy mix in the first and the newest NDC is detailed as follows:

a. NRE at least 23% in 2025 and 31% in 2050
b. Petroleum must be less than 25% in 2025 and less than 20% in 2050

[43] Adopted from the 21st Conference of Parties (COP) United Nations Framework Convention on Climate Change (UNFCCC) in Paris.

c. Coal is at least 30% in 2025 and 25% in 2050
d. Gas is at least 22% in 2025 and 24% in 2050

The use of biofuels as one of the emission reduction strategies in the energy sector is also stated in the NDC focusing on B30. In the first NDC, the use of B30 in the transportation sub-sector in the energy sector is a component of *countermeasure 1 scenario* (CM1)[44] and *countermeasure 2 scenario* (CM2)[45]. B30 in the transportation sub-sector is projected to reach 90%-100% compared to the BaU condition of 0% (Table 6).

Table 6. BaU Projection Assumptions and Emission Reduction in the Energy Sector in the First NDC Document

Energy Sector			
	BaU	**CM 1**	**CM 2**
Final energy consumption efficiency	Final energy consumption is not efficient	75%	100%
Application of clean coal technology (CCT) in power plants	0%	75%	100%
Renewable energy in electricity supply	Coal-fired power plants	19,6% (7.4 GW Commitment based on the Electricity Supply Business Plan [RUPTL])	Electricity Production 137,74 TWh
Use of biofuels (B30) in the transportation sector	0%	90%	100%
Addition of gas network	0%	100%	100%
Addition of gas refueling stations	0%	100%	100%

[44] An emission scenario with mitigation actions with considerations to sectoral development targets.
[45] A more ambitious emission scenario with considerations to sectoral development targets should international support suffice.

Additionally, the use of biofuels also becomes one of the emission reduction strategies in the Updated NDC with the same numerical target. In the document, it is detailed that the main feedstock for biofuels in the transportation sub-sector will come from palm oil.[46]

Not only is it a key strategy in achieving emission reductions by 2030, the use of biofuels is also part of the *Long-Term Strategy on Low Carbon and Climate Resilience* 2050 (LTS-LCCR 2050) to achieve *Net Zero Emissions* (NZE) in 2060 or faster. The strategy of using new energy, coal with *carbon capture and storage/carbon capture, utilization, and storage* (CCS/CCUS), and biofuels in the transportation sub-sector in the energy sector is projected to reduce emissions significantly from 1,030 Mton CO2e in 2030 and 572 Mton CO2e in 2050 based on LTS-LCCR 2050.[47] Mitigation targets are expected to be achieved by implementing (i) electrification of transportation (ii) biofuel supply (FAME and *green diesel*[48]) as diesel substitution, and (iii) diesel fuel replacement (bioethanol and gasoline from CPO).[49]

It is even said that biofuels will dominate the energy mix in the transportation sub-sector by 46% in 2050, greater than electric vehicles which only reach 30%, fuel oil by 20%, and natural gas by 4%. Palm oil-based biofuel is considered a success, and therefore, efforts to develop biodiesel will continue until 2050 with an increased mix up to B50, but with a specific note that biodiesel production is carried out using sustainable resources. Aside from being a fuel in the transportation sub-sector, biodiesel is also used as a government strategy to meet the demand and ensure the availability of electricity in the future. According to LTS-LCCR 2050, the government aims to develop power plants using biofuels processed from plantations' raw materials.[50]

The Indonesian LTS-LCCR document recognizes that a strategy for reducing emissions using biofuels can bring about negative impacts on, among other things, food security, biodiversity, and other environmental goals.[51] This is interconnected with the focus of the development of biofuels in Indonesia on one single commodity, i.e., palm oil, which is still coloured by various issues related to sustainability, looking from a social, economic, and ecological perspective.

Initially, the policy for the development and use of biofuels in Indonesia was based on the enthusiasm to find alternative energy to replace diesel fuel that Indonesia could self-produce. The aim of this policy is, among others, to achieve energy security and independence, as well as reduce poverty and unemployment.[52] With such enthusiasm, various types and feedstocks for biofuels were planned to

[46] *Updated* NDC Indonesia, 2021, p. 21.

[47] Long-Term Strategy for Low Carbon and Climate Resilience 2050, p. 56.

[48] *Green-diesel*/vegetable diesel/D100 is a hydrocarbon oil without oxygenate content for high-speed diesel engine fuel derived from vegetable materials processed through various specific stages using advanced technologies. Source: Humas EBTKE (2020, 20 Juli). *Tingkatkan Penggunaan Energi Bersih, Pemerintah Dorong Pengembangan Green Diesel*. Accessed from https://ebtke.esdm.go.id/post/2020/07/21/2589/tingkatkan.penggunaan.energi.bersih.pemerintah.dorong.pengembangan.green.diesel?lang=en on 21 April 2022.

[49] Long-Term Strategy for Low Carbon and Climate Resilience 2050 p. 59.

[50] Long-Term Strategy for Low Carbon and Climate Resilience 2050 p. 66.

[51] Long-Term Strategy for Low Carbon and Climate Resilience 2050 p. 29.

[52] Tim Nasional Pengembangan Bahan Bakar Nabati Untuk Percepatan Pengurangan Kemiskinan dan Pengangguran (2006). *Blueprint 2006-2025 Pengembangan Bahan Bakar Nabati Untuk Percepatan Pengurangan Kemiskinan dan Pengangguran*. Jakarta: Tim Nasional Pengembangan Bahan Bakar Nabati Untuk Percepatan Pengurangan Kemiskinan dan Pengangguran.

be developed; however, over time, the government tends to focus on developing biofuels from palm oil, especially CPO, which is supported by various policies and incentives.

The government's strategy in developing biofuels in Indonesia based on the First NDC in 2016 was followed by the establishment of the RUEN in 2017. After the First NDC document was stipulated, biofuel was recognized as part of the GHG emission reduction strategy or climate change mitigation. Regardless, the policy is still focused on biofuels made from palm oil. To further comprehend the ecological, economic, and social risks of developing biofuels from palm oil, we need to discuss sustainability issues from the results of collecting and reviewing existing literature as well as the spatial analysis presented in the following Chapter 3.

Chapter 3. The Dynamics of Ecological, Economic, and Social Sustainability in the Implementation of Biofuel in Indonesia

3.1 Clean and Renewable Energy: An Inevitability

The national energy need is directly proportional to the growth of the human population. Data from the Ministry of Energy and Mineral Resources (ESDM) show that in the BaU scenario, national energy demand will increase by 23% from 446.2 MTOE in 2018 to 548.8 MTOE in 2050. Of this energy demand, the industry and transportation (public and non-public) sub-sectors require the most energy.[53] The energy requirement may not be solely dependent on fossil fuels, especially given that GHG emissions from transportation in Indonesia have reached 157,771 g CO_2e, or 16.75% of total emissions,[54] with land transportation dominating. This trend continues to increase, and transportation will become one of the main contributors to CO_2 emissions in Indonesia.

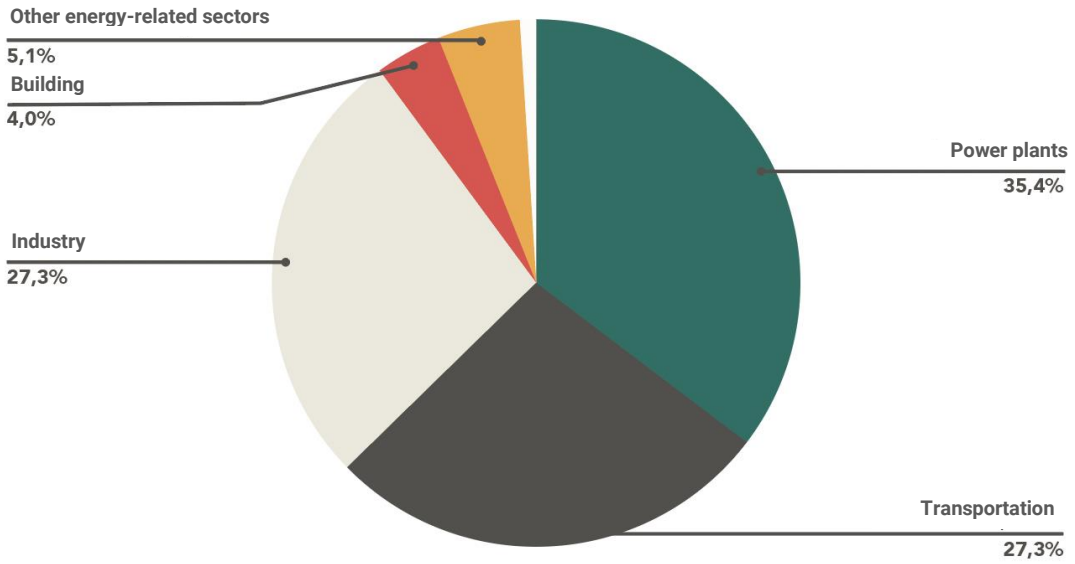

Figure 3. Other energy-related sectors as CO_2 emission contributors
Source: Enerdata (2021).[55]

Indonesia needs an alternative to fossil fuels for combustion engines in motorized vehicles in order to reach its goal of reducing emissions. There are two main options in the discussion so far: electric vehicles and biofuels. As stated in the LTS-LCCR 2050, the largest proportion of the energy mix in the

[53] Secretariat General of the National Energy Council (2019). *Outlook Energi Indonesia 2019*. Accessed from https://www.esdm.go.id/assets/media/content/content-outlook-energi-indonesia-2019-bahasa-indonesia.pdf on June 24, 2022.

[54] Directorate General of Climate Change Control, Ministry of Environment and Forestry (2021). *Laporan Inventarisasi Gas Rumah Kaca (GRK) dan Monitoring, Pelaporan, dan Verifikasi (MPV) 2020*. Accessed from http://ditjenppi.menlhk.go.id/reddplus/images/adminppi/dokumen/igrk/LAP_igrk2020.pdf.

[55] Enerdata (2021). *Global Energy and CO2 Data*. Accessed from https://www.enerdata.net/research/energy-market-data-co2-emissions-database.html on June 24, 2022.

transportation sub sector in 2050 will be biofuel, which is 46%, with a projected increase in the biodiesel mixture up to B50.[56]

This study focuses on the use of biofuels in the national energy mix. Despite being renewable, biofuels are considered an unclean energy source. Since its introduction in 2006, the concept of biofuels as a new and renewable energy source has raised various pros and cons.

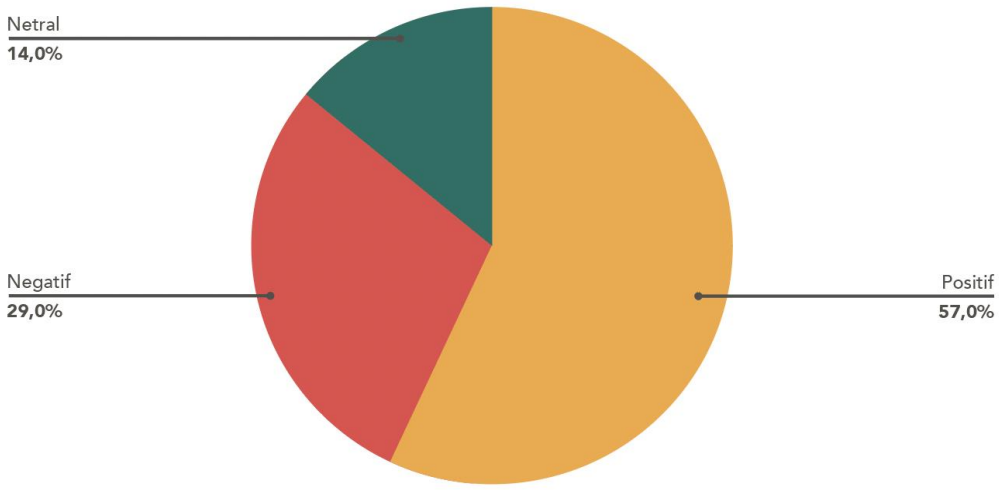

Figure 4. Public sentiment towards biofuel news in 2018–2019

Source: Koaksi Indonesia and Lokadata (2021).[57]
Note: These results are sourced from 1,743 articles adapted with a predetermined methodology.

Several studies show that, in general, the majority of the public has a positive perception of biofuels. Koaksi and Lokadata (2021) monitored the media on the issue of biofuels during 2018–2019 and found that positive sentiment dominates (57%), followed by negative sentiment (29%), and the rest is neutral (14%).[58]

Similar to the Koaksi and Lokadata studies, the Traction Energy Asia and Eye to Eye (2021) studies also show that, in general, people have a positive perception of biofuel—in this context, biodiesel—

[56] Ministry of Environment and Forestry. 2021. *Indonesia Long-Term Strategy for Low Carbon and Climate Resilience 2050*. Jakarta: Ministry of Environment and Forestry.

[57] Koaksi Indonesia dan Lokadata (2021). *Pemetaan Hulu-Hilir, Sosial Ekonomi, dan Dampak Lingkungan Industri Sawit dan Biodiesel di Indonesia*. Jakarta: Koaksi Indonesia dan Lokadata.

[58] This study divides it into several focus issues: biodiesel, economics and finance, energy and fuel, palm oil, institutions and regulations, trade administration, world oil, and other issues, such as electric vehicles. The number of articles covering these issues reached 1,743 articles, both from 1st priority and 2nd priority media, with the majority of the news related to economic/financial issues and biodiesel.

because it has the word "bio" in it.[59] In fact, not a single respondent in this study was aware of the deforestation risks that might arise from the demand for biodiesel.[60]

Regardless of these results, various views require careful consideration regarding the use of biofuels. Each view has a basic argument and an urgency that is equally worthy of consideration. However, it's not uncommon for each side to counter the other's points, leaving the debate on biofuels with no clear solution. On the one hand, the critics argue that biofuel is a 'false solution' to climate change. On the other hand, the pro-party tends to dismiss the opposition's arguments as completely illogical. Meanwhile, those who choose to be neutral see biofuels as a potential solution. Nonetheless, there is a lot of unfinished business that requires serious consideration for biofuels to become truly clean fuels. Sorting out the unfinished work in the implementation of biofuels in Indonesia is not an easy matter since it is surrounded by various social, political, and economic issues.

Table 7. Several Views Underlying Pro, Contra, and Moderate Attitudes on the Biofuel Development Efforts

Pro	Contra	Moderate
The plantation sector as a source of biofuel feedstocks in Indonesia has a large potential to solve many challenges, ranging from economic problems to poverty and energy independence.	The plantation sector as a source of biofuel feedstocks is surrounded by many social and ecological issues. Biofuel is unlikely to be a solution to climate change since it causes environmental damage.	There are various ways that biofuels can be a solution to climate change. Basically, biofuels can be considered an alternative energy source, especially as transitional energy.

Amidst various arguments on biofuels, the challenge of providing alternative energy for transportation in Indonesia remains a necessity. Therefore, even the slightest opportunity that allows Indonesia to realize clean and renewable energy solutions is worth thinking about.

3.2 The Future Direction of Biofuel Development in Indonesia

In the 2006–2025 Blueprint on Biofuel Development to Accelerate Poverty and Unemployment Reduction, the first goal for biofuel development in Indonesia is energy independence, which is made possible by the strong plantation sector. Various choices of commodities are discussed as the biofuel feedstocks, including oil palm (minimum 1.5 million hectares)[61], *Jatropha curcas* (minimum 1.5 million hectares), cassava (minimum 1.5 million hectares), and sugar cane (minimum 750 thousand

[59] Traction Energy Asia dan Eye to Eye (2021). *Laporan Riset Kualitatif: Eksplorasi Narasi Alternatif untuk Meningkatkan Pengetahuan Mengenai Biofuel*.

[60] Koaksi Indonesia dan Lokadata (2021). *Pemetaan Hulu-Hilir, Sosial Ekonomi, dan Dampak Lingkungan Industri Sawit dan Biodiesel di Indonesia*. Jakarta: Koaksi Indonesia dan Lokadata.

[61] Based on Madani's spatial analysis, there were 16.7 million oil palm covers in 2019. Source: Forest area, land cover, forestry utilization and planning, peat ecosystem function, social forestry, burnt footprint (MOEF Geoportal 2019, 2020, and 2021); mineral and coal, oil and gas (ESDM 2020); oil palm cover and oil palm business (CSO Network Node); administrative limit (RBI 2019); indigenous territories (BRWA 2018).

hectares).[62] The document dedicates a minimum of 5.25 million hectares for biofuel.[63] Despite the shortcomings, this document provides a starting point in the development of biofuels in Indonesia.

During the process, the blueprint was no longer employed, especially in the preparation of policies on biofuel use in Indonesia. This is reflected in the various policies that emerged after 2008, which barely discussed biofuel feedstocks other than palm oil, either in land provision, research, or development. Based on the literature, most research on biofuels discusses palm oil as the feedstocks.[64]

According to the Regulation of the MEMR Regulation No. 32/2008, the biodiesel mixture made from palm oil in 2015 was determined at 5%, especially for PSO transportation. Bioethanol was also initially determined at 5% for PSO transportation. In the MEMR Regulation No. 32/2008, which was amended in the MEMR Regulation No. 25/2013, the biodiesel mix for PSO transportation was significantly increased to 10%, but the bioethanol mixture was reduced to 1%. This indicates a shift in the direction of biofuel policies in Indonesia to focus solely on palm oil. Aside from the policy aspect, public discourse also points in the same direction, that the mainstay of biofuels in Indonesia is palm oil-based biodiesel.

The growing biofuel discourse in society is directly proportional to the policies that consistently increase the biodiesel mix. It means that the biofuel discourse narrows down to biodiesel only. This narrowing of the discourse brings up many responses from various parties. Certain party view that the direction of biofuel development in Indonesia, which currently prioritizes palm oil-based biodiesel, is both a blessing and a fortune. The reason is that Indonesia is the world's biggest producer of palm oil, and using biodiesel can help the country sell its large stocks of palm oil that aren't being used by its export or domestic markets. In 2020, total CPO stocks in Indonesia are 51.58 million tons[65], while total exports are 21.1 million tons[66], and total domestic consumption is 17.35 million tons[67]. This condition results in a surplus of CPO stocks in Indonesia.

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[62] National Team for the Development of Biofuels to Accelerate Poverty and Unemployment Reduction (2006). *Blueprint 2006-2025 Pengembangan Bahan Bakar Nabati Untuk Percepatan Pengurangan Kemiskinan dan Pengangguran*. Jakarta: National Team for the Development of Biofuels to Accelerate Poverty and Unemployment Reduction

[63] National Team for the Development of Biofuels to Accelerate Poverty and Unemployment Reduction (2006). *Blueprint 2006-2025 Pengembangan Bahan Bakar Nabati Untuk Percepatan Pengurangan Kemiskinan dan Pengangguran*. Jakarta: National Team for the Development of Biofuels to Accelerate Poverty and Unemployment Reduction.

[64] There are 65 studies discussing palm oil, consisting of 30 journals (scientific articles) and 33 CSO reports. Meanwhile, the number of studies discussing other feedstocks was only nine studies: one on *jatropha*, one on *reutealis trisperma*, two on *calophyllum inophyllum*, one on *pongamia*, one on maize, and one on sugar cane.

[65] Ramli, Rully R. (2021). Sepanjang 2020, Produksi Kelapa Sawit Capai 51,58 Juta Ton. *Kompas.com*. Accessed from https://money.kompas.com/read/2021/02/10/170000226/sepanjang-2020-produksi-kelapa-sawit-capai-51-58-juta-ton pada 26 November 2021.

[66] GAPKI (2021). *Ekspor Minyak Sawit Indonesia Turun 9% pada 2020.* Accessed from https://databoks.katadata.co.id/datapublish/2021/02/05/ekspor-minyak-sawit-indonesia-turun-9-pada-2020 pada 26 November 2021.

[67] Uly, Y.A. (2021). Meski Ada Pandemi, Konsumsi CPO Dalam Negeri Naik Jadi 17,35 Juta Ton di 2020. *Kompas.com*. Accessed from https://money.kompas.com/read/2021/02/04/170500526/meski-ada-pandemi-konsumsi-cpo-dalam-negeri-naik-jadi-1735-juta-ton-di-2020 pada 26 November 2021.

Since 2006, palm oil has been one of Indonesia's most important exports, and it is still growing to become the main export crop from plantations. This makes Indonesia the biggest producer of palm oil in the world. The area of oil palm plantation permits in Indonesia has reached 19 million hectares[68] in 2021 and the plantation covers 16.2 million hectares[69] with an average national productivity level of 3.6–4 tons/hectare/year.[70] In the midst of the fast growth of the oil palm plantation industry, there are a number of big problems to solve in terms of environmental, economic, and social sustainability.

Technically, biodiesel-type biofuels also receive various criticisms from business actors and users or manufacturers of automotive products. One of the criticisms is that biofuel might damage diesel car engine components because the vehicles on the current market are not specifically designed for biodiesel.[71] Moreover, the performance of the car would decrease, and the filter's lifespan would be shorter.[72]

Under these circumstances, it is time for all interested parties to start thinking about the direction of the energy transition for transportation in Indonesia. Various advances in the palm oil sector, which is currently the mainstay commodity for biofuels in Indonesia, require clear steps to address the various challenges. The main problem lies not in the type of commodity as the feedstocks, but rather in the quality of management, starting from production to distribution. The next section discusses various dynamics related to the use of biofuels from an ecological, economic, and social perspective.

3.3 The Dynamics of Biofuels Discourse on Ecological Aspects

Biofuel is indeed sourced from renewable vegetable-based ingredients. However, the production requires vast land and often intersects with key ecosystems, such as natural forests and peatlands. The development of biofuels in Indonesia prioritizes oil palm, which exacerbates land issues. The palm oil commodity has long been the target of criticism at home and abroad, especially plantation practices that disregard ecological sustainability. Thus, palm oil-based biodiesel will make the existing ecological problems worse.

Based on the literature, there are at least four main aspects related to ecological sustainability that require in-depth analysis in the development of biofuels: plantation practices, exhaust emissions, land availability, and ecosystem sustainability.

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[68] Palm oil permit (CSO Network Node); land cover (MoEF, 2019). Data processed by Madani (2021).

[69] Palm oil permit (CSO Network Node); land cover (GWF dan Adrià *et al.* [2020] accessed from https://zenodo.org/record/3884602#.YraRZXbMLIX). Data diolah Madani (2021).

[70] Directorate General of Plantations, Ministry of Agriculture (2019). *Statistik Perkebunan Indonesia (Sawit) 2018-2020.* Jakarta: Directorate General of Plantations, Ministry of Agriculture.

[71] Purnama, R. (2018). *Balada Biodiesel B20, Dibutuhkan tapi Dikeluhkan*. Accessed from https://docs.google.com/document/d/1fCD3TGWvEdojw1GK4i681kSTTwajsdo0Aw9EurHjSIY/edit pada 26 November 2021.

[72] Ihsan, M.A.F. (2021). Ini Efek Buruk jika Mobil Diesel Modern Sering Pakai Biodiesel. *Kompas.com*. Accessed from https://otomotif.kompas.com/read/2021/08/03/122200115/ini-efek-buruk-jika-mobil-diesel-modern-sering-pakai-biodiesel pada 26 November 2021.

3.3.1 Availability of Land

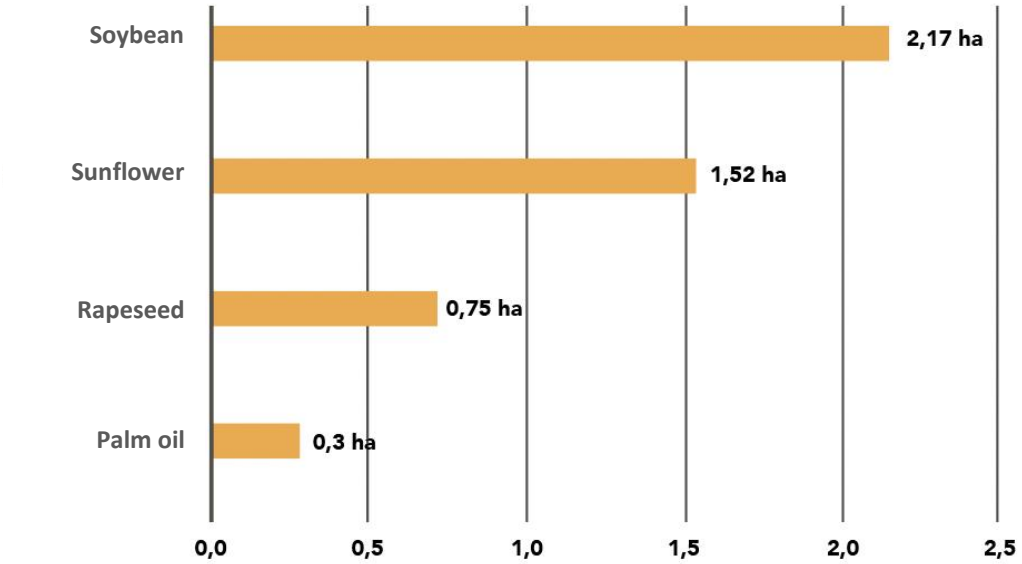

Figure 5. Land area required for 1 ton of oil
Source: Hai (2004).[73]

The availability of land for the production of biofuel feedstocks is a complicated issue. Palm oil does have land efficiency advantages compared to several other vegetable oil commodities, such as soybean, sunflower, and rapeseed. To produce 1 ton of vegetable oil, palm oil only requires 0.3 hectares of land. Meanwhile, soybeans, sunflowers, and rapeseed require more.[74] Despite oil palm having advantages in land efficiency, one thing to keep in mind is that the plantation industry exists in a very complex socio-cultural space.

Madani Berkelanjutan's analysis shows that only about 3.6 million hectares of the 19 million hectares of oil palm business permits are outside of natural forest, peat ecosystem functions, indigenous territories, which are home to more than 15 species, and areas that have been changed to oil palm cover (Figure 6).

[73] Hai, T. (2004). *Selling the Green Palm is Advantage?* Oil Palm Industry Economic Journal, 4, 22-31.
[74] Hai, T. (2004). *Selling the Green Palm is Advantage?* Oil Palm Industry Economic Journal, 4, 22-31.

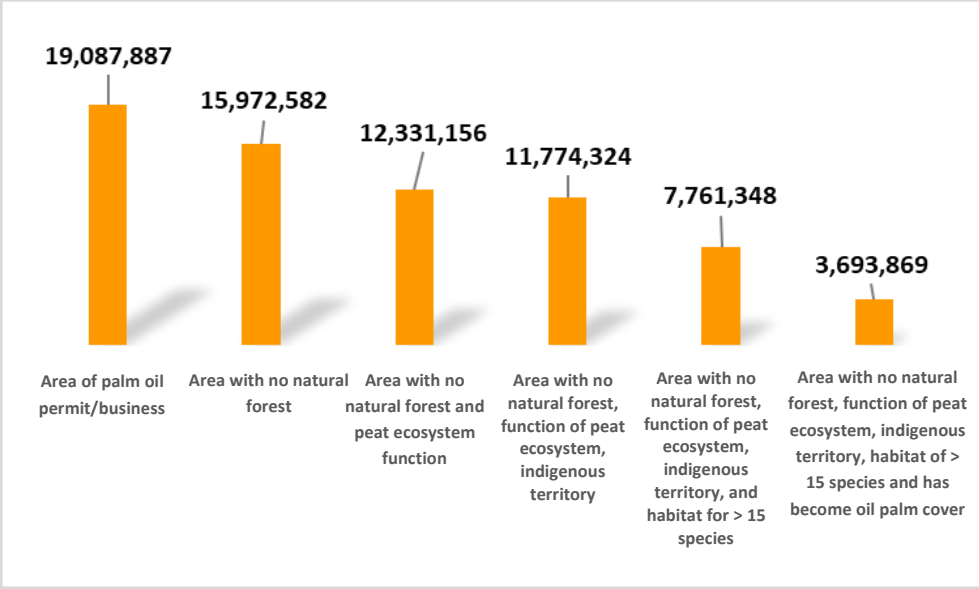

Figure 6. Stipulation of land availability in palm oil permits

Data sources: Forest area, land cover, forest use and planning, and peat ecosystem function (MOEF Geoportal 2019 and 2020); mineral and coal, oil and gas (ESDM 2020); oil palm cover and oil palm business (CSO Network Node); administrative limit (RBI 2019); indigenous territories (BRWA 2018).

Of this area, there are still one million hectares of oil palm permit area aside from land unused for other purposes (ponds, rice fields, settlements, plantations, mines, etc.). However, this area still overlaps with other permits/concessions, areas of interest, the Indicative Map of Social Forestry Areas (PIAPS), and the Indicative Map for the Termination of New Permits (PIPPIB). The majority of these palm oil permits overlap with mineral and coal concessions (237 thousand hectares), oil and gas concessions (193 thousand hectares), and Business Licenses of Timber Forest Product Management (IUPHHK HT) (74 thousand hectares). Thus, the land for oil palm permits has potential, is ecologically feasible, and does not overlap with other permits/concessions (**only 600 thousand hectares**).

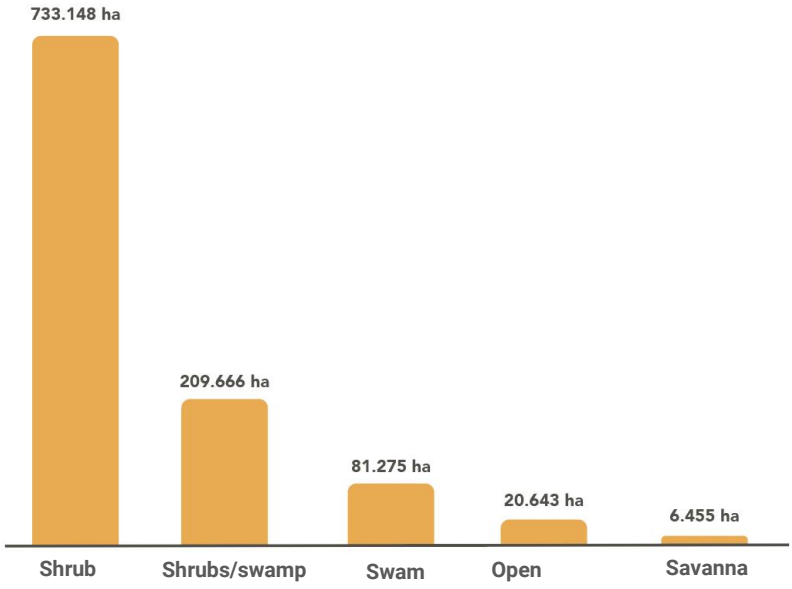

Figure 7. Details of land cover in 2019 on available land

Data sources: Forest area, land cover, forest use and plans, and peat ecosystem functions (MOEF Geoportals 2019 and 2020); mineral and coal, oil and gas (ESDM 2020); oil palm cover and oil palm business (CSO Network Node); administrative limit (RBI 2019); indigenous territories (BRWA 2018).

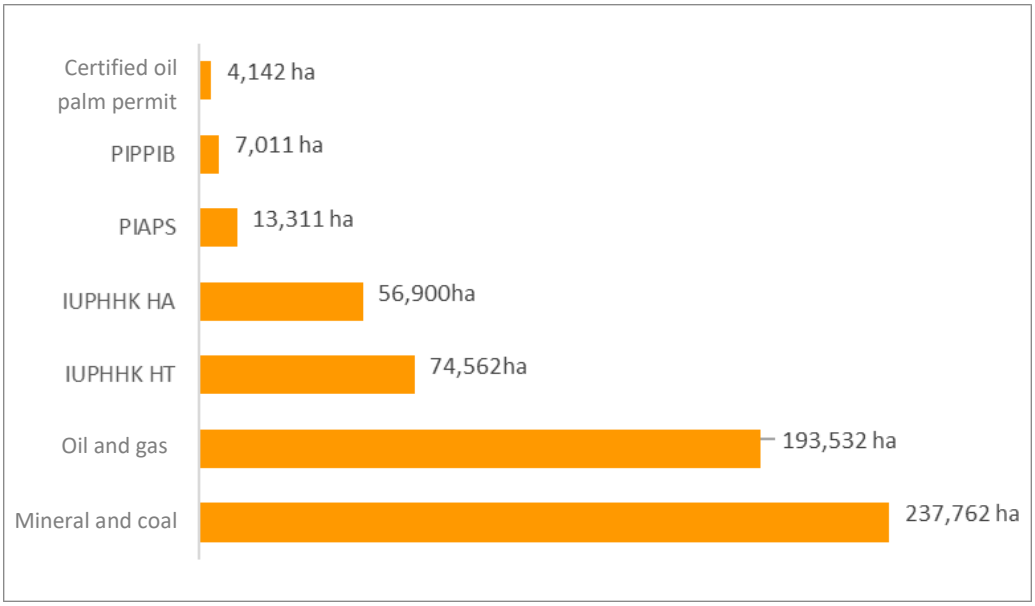

Figure 8. Available land and the overlapping permits and concessions

Data sources: Forest area, land cover, forest use and plans, and peat ecosystem functions (MOEF Geoportal, 2019 and 2020); oil and gas, mineral and coal (ESDM, 2020); oil palm cover and oil palm business (CSO Network Node); administrative limits (RBI, 2019); indigenous territories (BRWA, 2018).

Meanwhile, there are approximately 11.3 million hectares of land for alternative commodities in permanent production forest areas, conversion production forest areas, and areas for other use (APL). [75]

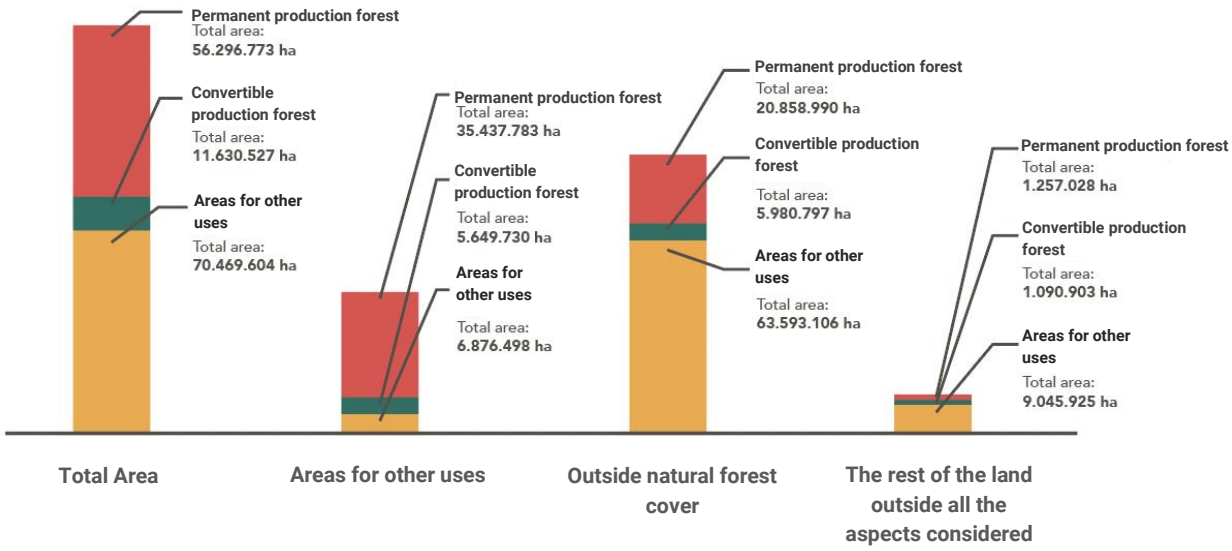

Figure 9. Flowchart for stipulating land availability for biofuel feedstocks

Data sources: Forest area, land cover, forest use and plans, and peat ecosystem functions (MOEF Geoportals 2019 and 2020); mineral and coal, oil and gas (ESDM 2020); oil palm cover and oil palm business (CSO Network Node); administrative limit (RBI 2019); indigenous territories (BRWA 2018).

In more detail, regarding land cover for both non-plantation and plantation,[76] the remaining land is only 2.27 million hectares suitable for producing biofuel feedstocks.[77]

[75] These aspects include peat ecosystem function areas (FEG), PIPPIB, PIAPS, oil and gas concessions, mineral and coal concessions, oil palm permits, IUPHHK HT, IUPHHK HA, IUPHHK BE, PKH, IPPKH, certified palm oil permit, indigenous areas, areas with high biodiversity (the habitat for more than 15 species of flora and fauna).

[76] Non-plantation and plantation land cover sreferred to include airports, ports, industrial forest plantations, plantations, settlements, mining areas, agriculture, ponds, transmigration areas, and bodies of water. Data sources: Forest area, land cover, utilization and forestry plan, and peat ecosystem function (KLHK Geoportal 2019 and 2020); mining and oil and gas (MEMR 2020); palm oil cover and palm oil businesses (CSO Network Node); administrative boundaries (RBI 2019); customary territories (BRWA 2018); commodities (BKPM Regional Government).

[77] Land covers referred to include shrubland, marshes, savannahs, swamps, open land, and undefined/unclassified land cover classes. Data sources: Forest area, land cover, utilization and forestry plan, and peat ecosystem function (KLHK Geoportal 2019 and 2020); mining and oil and gas (MEMR 2020); palm oil cover and palm oil businesses (CSO Network Node); administrative boundaries (RBI 2019); customary territories (BRWA 2018); commodities (BKPM Regional Government).

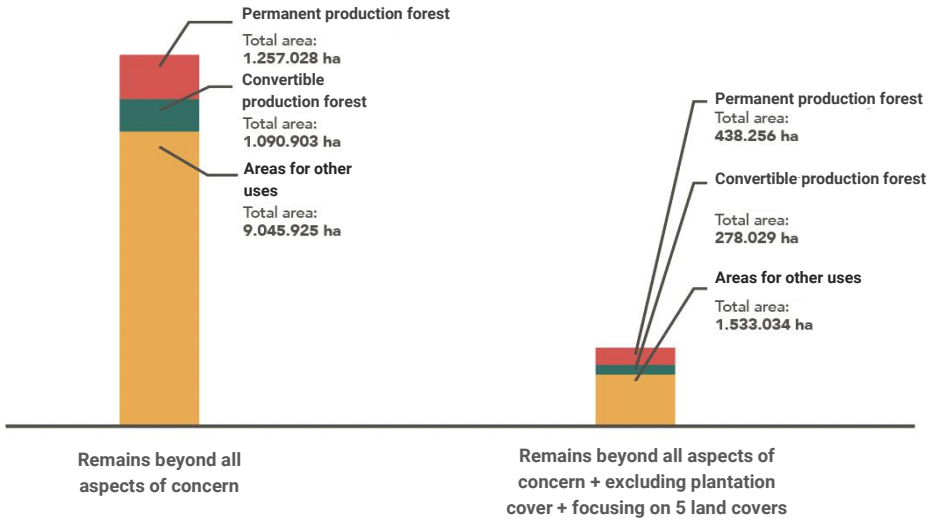

Figure 10. The flow of determining the focus of the second part of the policy area

Data sources: Forest area, land cover, forest use and plans, and peat ecosystem functions (MOEF Geoportal of 2019 and 2020); mineral, coal oil and gas (2020 EMR); oil palm cover and business (CSO Resource Network); administrative limit (2019 Geospatial Portal); indigenous territory (2018 Indigenous Territory Registration Agency); commodity (Investment Coordinating Board in Local Government).

If combined with the potential commodity distribution map from the Investment Coordinating Board or *Badan Koordinasi Penanaman Modal* (henceforth BKPM) there are several potential feedstocks that can be developed based on areas with a distance of less than 30 km from the existing commodity point. The potential commodities with the largest area of land are coconut with an area of 969,000 hectares, cassava of 913,000 hectares, and sweet potatoes of 912,000 hectares (Figure 11).

Figure 11. Land potential for biofuel raw commodities (different commodities may occupy the same area)

Data sources: Forest area, land cover, forest use and plans, and peat ecosystem functions (MOEF Geoportal of 2019 and 2020); mineral, coal oil and gas (2020 EMR); oil palm cover and business (CSO Resource Network); administrative limit (2019 Geospatial Portal); indigenous territory (2018 Indigenous Territory Registration Agency); commodity (Investment Coordinating Board in Local Government).

Several studies have shown the potential for increased land demand for oil palm plantations as a result of biofuel development, despite the widely varying figures as the consequence of different parameters and assumptions used. Research by Arie Rahmadi, Lu Aye, and Graham Moore (2013) demonstrates that in order to meet the target of 5%[78] contribution of biofuels to the national energy mix in 2025, additional land is required to reach 5.15 million hectares. [79] Meanwhile, the Institute for Economic and Social Research from Universitas Indonesia or *Lembaga Penyelidikan Ekonomi dan Masyarakat* (LPEM UI) projects the need for additional oil palm land for biodiesel around 338,000 hectares for the B20 scenario in 2025. As for the B30 and B50 scenarios, the need is projected to increase to 5.2 million hectares and 9.2 million hectares in the same year.[80]

Calculations of the need for additional land to achieve the biodiesel target were also carried out by several other institutions. Koaksi (2018) concludes that 3.78 million hectares of new oil palm land is needed for the B100 scenario in 2025.[81] Whereas IESR (2012) estimates that 4-6 million hectares are necessary for new oil palm land for the B30 and B50 scenarios.[82] The Carbon Disclosure Project (2021) also gathers that the biodiesel programme would require an additional 9-15 million hectares of oil palm plantations.[83]

Khatiwada *et al*. (2021) states that to meet the domestic needs without meeting global demand—both for food and energy needs in 2025—it is still possible not to rely on land expansion. However, if one wants to meet the domestic demand as well as the global one simultaneously of approximately 51 million tonnes in 2025, 6 million hectares of land expansion will be necessary, if the productivity figures are not increased.[84]

Table 8. Potential Additional Demand for Oil Palm Land as a Result of the Biodiesel Programme

Institution (Year)	Mix (B30/B50/etc)	Projection Results	Method	Parameter/Assumptions
Koaksi (2018)	B100	The demand for CPO is 10.58 million tonnes. Additional land requirement is		Assuming the need for B100 in 2025 with the following data: - Projection data from the MEMR

[78] Referring to the primary energy mix target in the National Energy Policy or *Kebijakan Energi Nasional* (KEN).

[79] Rahmadi, A., Aye, L., & Moore, G. (2013). The feasibility and implications for conventional liquid fossil fuel of the Indonesian biofuel target in 2025. *Energy Policy*, 61, 12-21.

[80] LPEM UI. (2020). *Risiko Kebijakan Biodiesel dari Sudut Pandang Indikator Makroekonomi dan Lingkungan*. Jakarta: LPEM UI

[81] Koaksi Indonesia (2018). *Dinamika Hulu Hilir Industri Biodiesel di Indonesia*. Jakarta: Koaksi Indonesia

[82] IESR (2021). *Critical Review on the Biofuel Development Policy in Indonesia*. Jakarta: IESR

[83] Carbon Disclosure Project (2021). *Seberapa Hijaukah Bahan Bakar Nabati (Biofuel)? Memahami Risiko dan Lanskap Kebijakan di Indonesia*. Accessed from https://cdn.cdp.net/cdp-production/cms/policy_briefings/documents/000/005/723/original/Final_Biofuel_Policy_Brief_Bahasa.pdf?1628247765 on 24 June 2022.

[84] Khatiwada, D., Palmen, C., & Silveira, S. (2021). Evaluating the palm oil demand in Indonesia: production trends, yields, and emerging issues. *Biofuels*, 12(2), 135-147. Accessed from https://doi.org/10.1080/17597269.2018.1461520.

		3.78 million hectares		- Projection data for oil demand is an average of 4% of the DEN - Conversion data of CPO to biodiesel; 1L of biodiesel is equivalent to 0.9 kg of CPO (Wilmar's assumed average) - Projection data on land requirement to produce CPO of 2.7 tonnes/hectares (average national productivity from the Ministry of Agriculture for the past decade)
LPEM UI (2020)	B20, B30, B50	Additional land requirement until 2025: - B20 scenario: 13,695,091 hectares - B30 scenario: 18,602,552 hectares - B50 scenario: 22,647,760 hectares Note: Additional land requirement is the result of subtracting the total land demand minus the current plantation area.	Using the annual deficit on the CPO balance (not accumulation) which will be divided by annual productivity	The assumption of an increase in CPO production is in accordance with the estimated land requirement for BaU is calculated based on the annual CPO deficit divided by the annual increase in land productivity. The reference for productive land is 13.35 million hectares.
IESR (2021)	B30-B50	20.5–22.8 million hectares in 2024 compared to the area of oil palm plantations in 2019 which only reached 16.4		Assumptions: - All biofuel feedstocks come from oil palm - 1 kg of CPO can produce 1.1 litres of biodiesel or 1 litre of HVO - In 2024, the need for

		million hectares. Additional land requirement is around 4-6 million hectares.		CPO for domestic consumption of biofuels will reach 10.1-16.3 million tonnes (National Medium-Term Development Plan/RPJMN scenario) - Consumpion of palm oil for the food industry reached 9.86 million tonnes and for the chemical industry 1.06 million tonnes in 2019. Thus, the estimated need for both industries in 2025 is 12 million tonnes. - Land productivity reaches 2.8 tonnes/hectares.
CDP (2021)		Additional 9-15 million hectares for new oil palm plantations		
Khatiwada *et al*. (2021)	B30	Additional land requirement is up to 6 million hectares in 2025.	The method used is to change the volume of biodiesel needed to meet the blending target to an amount equivalent to CPO feedstocks. Feedstocks for biodiesel later aggregated with requests for other uses (food, industry, and export). Furthermore,	Projections - CPO for food needs: 6.9 million tonnes (2025) - CPO for biodiesel needs (11.2 million tonnes) and others (2 million tonnes) (2025) - CPO for export (31 million tonnes) (2025) Assumptions: - The productivity of oil palm land reaches 3.8 tonnes/hectares.

			the total plantation area is the result of a calculation of CPO needs and land productivity, which is assumed to reach 3.8 tonnes/hectares.	
Rahmadi, Aye, dan Moore (2013)	B5–B50	Additional land requirement of 1.52-5.15 million hectares to achieve the 2025 biofuel consumption target.		Assumptions: - Energy elasticity is less than 1, which means that energy growth is less than or equal to GDP growth. - Energy growth rate is 6%.

Meanwhile, research by Sharma et al. employing three scenario projections, i.e., the BaU scenario, conservation, and sustainable intensification, shows that the BaU scenario is projected to cause significant environmental impacts due to high expansion, especially in old-growth forest and regrowth forest areas. In this scenario, 2 million hectares of expansion is expected to occur in agricultural areas, and 0.6 million hectares in forest and shrubland areas.[85] The risk of land expansion projected by various studies can be even greater with the enactment of the Job Creation Law, which makes it easier to permit[86] oil palm plantations as energy plantations, especially if they are included in the National Strategic Project or *Proyek Strategis Nasional* (PSN).[87]

If we look at other feedstocks, there are commodities that can grow well on degraded land, and therefore have a low carbon footprint. Research by Maimunah et al. demonstrates that tamanu is the most adaptable species, followed by *reutealis* (Philippine tung) in second place. Both species grow robustly in the agroforestry system, compared to the monoculture system. [88] Research

[85] Sharma, Sunil K., Baral, H., Laumonier, Y., Okarda, B., Komarudin, H., Purnomo, H., & Pacheco, P. (2019). Ecosystem services under future oil palm expansion scenarios in West Kalimantan, Indonesia. *Ecosystem Services*, 39. Accessed from https://doi.org/10.1016/j.ecoser.2019.100978.

[86] Maskun, Achmad, Naswar, Assidiq, H., & Mubarak, M.R. (2021). Environmental Standard of Indonesian Palm Oil Post Omnibus Law Ratification. *IOP Conf. Series: Earth and Environmental Science* 824. DOI:10.1088/1755-1315/824/1/012098.

[87] Jonathan, R., Dawanis, M.F., Komaria, L., & Prihatiningtyas, W. (2021). Prospek Pencapaian Indonesia atas Tujuan Pembangunan Berkelanjutan Angka 15 "Ekosistem Daratan" dalam Industri Sawit setelah Adanya Undang-Undang No. 11 Tahun 2020 tentang Cipta Kerja. *Jurnal Hukum Lingkungan Indonesia*, 7(2), 323–346. Accessed from https://doi.org/10.38011/jhli.v7i2.326.

[88] Maimunah, S., Rahman, S.A., Samsudin, Y.B., Artati, Y., Simamora, T.I., Andini, S., Lee, S.M., & Baral, H. (2018). Assessment of Suitability of Tree Species for Bioenergy Production on Burned and Degraded Peatlands in Central Kalimantan, Indonesia. *Land*, 7(4), 115. DOI: 10.3390/land7040115.

conducted by Leksono et al. supports this finding and even proves that tamanu's resistance level is above 90% in ultisol, which is known for its low fertility rate and acid.[89]

Concurrently, the use of castor trees can bind nitrogen to turn it into a good instrument for releasing oxygen back into ozone, and most significantly, it doesn't compete with comestible plants. In terms of the Global Warming Potential (GWP), the total GWP value of castor tree is lower than oil palm. The total GWP of palm oil is 2568,82 kg-CO2eq./t-BDF, while castor tree is only 1733,67 kg-CO2eq./t-BDF.[90]

The development of various alternative feedstocks can also be carried out on degraded lands thereby reducing the risk of emissions due to land conversion from natural forest cover and peatlands. Research by Jaung *et al.* shows that 3.5 million hectares of degraded land in Indonesia are suitable for 5 species, i.e., tamanu, *reutealis* (Philippine tung), pongame oiltree[91], *calliandra*, and *gliricidia* (quick stick). Of the 3.5 million hectares, 2.85 million hectares are suitable for *calliandra*, 1.64 million hectares for *gliricidia* (quick stick), 0.21 million hectares for *reutealis,* 0.14 million hectares for pongame oiltree, 0.05 million hectares for tamanu.[92] Concurrently, Leksono et al. state that 5.7 million hectares of degraded land are available and suitable for the development of tamanu commodity.[93]

3.3.2 Good Agricultural Practices (GAP)

Biofuel starts its life cycle from plantation crops. The biggest challenge in this context is ensuring the application of good agricultural practices (GAP), especially when an industry is on a national scale. With oil palm currently dominating the plantation commodity, the Ministry of Agriculture states that the oil palm sector is divided into the following plantation types: [94]

a. Large-scale private plantation, cultivated or managed commercially by individual legal entities.
b. Large-scale state plantation, cultivated or managed commercially by legal entities belonging to BUMN. In Indonesia, these plantations are managed by PT Perkebunan Nusantara (PTPN).

[89] Leksono, B., Windyarini, E., Adinugraha, H.A., Artati, Y., Kwon, J., & Baral, H. (2021). Growth Performance of Calophyllum Inophyllum at A Bioenergy Trial Plot in Bukit Soeharto Research and Education Forest, East Kalimantan. *IOP Conference Series: Earth and Environmental Science*, 749(1), 012059. Accessed from https://doi.org/10.1088/1755-1315/749/1/012059.

[90] Siregar, K., Tambunan, A.H., Irwanto, A.K., Wirawan, S.S., & Araki, T. (2015). A Comparison of Life Cycle Assessment on Oil Palm (Elaeis guineensis Jacq.) and Physic Nut (Jatropha curcas Linn.) as Feedstock for Biodiesel Production in Indonesia. *Energy Procedia*, 65, 170-179. Accessed from https://doi.org/10.1016/j.egypro.2015.01.054.

[91] Malapari atau pongamia banyak ditemukan di sebelah garis Wallace, seperti Banten, Jawa Timur, Sumatera Selatan, dan Jawa Barat. Sumber: Hasnah, T., Leksono, B., Sumedi, N., Windyarini, E., Adinugraha, H.A., Baral, H., & Artati, Y. (2020) Pongamia as a Potential Biofuel Crop: Oil Content of Pongamia pinnata from the Best Provenance in Java, Indonesia. *2020 International Conference and Utility Exhibition on Energy, Environment and Climate Change (ICUE)*, 1-6. DOI: 10.1109/ICUE49301.2020.9307094.

[92] Jaung, W., Wiraguna, E., Okarda, B., Artati, Y., Goh, C.S., Syahru, R., Leksono, B., Prasetyo, Budi, L., Lee, S.M., & Baral, H. (2018). *Spatial Assessment of Degraded Lands for Biofuel Production in Indonesia*. Sustainability, 10, 4595. DOI: 10.3390/su10124595.

[93] Leksono, B., Windyarini, E., Hasnah, T., Rahman, S., & Baral, H. (2018). Calophyllum inophyllum for Green Energy and Landscape Restoration: Plant Growth, Biofuel Content, Associate Waste Utilization and Agroforestry Prospect. *International Conference and Utility Exhibition on Green Energy for Sustainable Development (ICUE)*, 1-7. DOI: 10.23919/ICUE-GESD.2018.8635740.

[94] Direktorat Jenderal Perkebunan, Kementerian Pertanian (2019). *Buku Statistik Perkebunan: Kelapa Sawit 2018-2020*. Jakarta: Direktorat Jenderal Perkebunan, Kementerian Pertanian.

c. Smallholder plantations (not incorporated as a legal entity), organized or managed by the local community/smallholders grouped into smallholder plantation crop entity and smallholder plantation household entity.

Practicing GAP in oil palm plantations aims to prevent contamination and degradation of fresh fruit bunches (FFB) during plant maintenance, harvesting, and mobilization of FFB to palm oil mills.[95] Additionally, several studies state that GAP results in positive impacts on farmers' income as well as the growth and productivity of oil palm plants.[96] Effective maintenance as a component of the GAP also largely influences the growth and productivity of oil palm plants.[97] Nonetheless, challenges are unavoidable in the implementation of GAP, including the following:

a. Smallholder plantations managed by independent farmers generally lack access to high quality seeds, financial institutions, agricultural capacity building, and knowledge about GAP. The limited implementation of GAP among farmers has resulted in their low productivity and income.[98]
b. Commonly, large-scale plantations managed by private companies or the state can fulfill all elements of GAP. However, what often escapes monitoring in the implementation of GAP in business entities is, among other things, slash-and-burn as land clearing method.

Independent smallholders face many other challenges in terms of land legality and land administration. In order to obtain legality for the land they cultivate, independent smallholders need to complete several requirements, i.e., a Cultivation Registration Certificate (STD-B)[99], a Freehold Title (SHM), a statement of environmental management and monitoring undertaking (SPPL)[100]obligation to own/affiliate with independent smallholder organizations/unions, as well as use of legal seeds in accordance with the criteria stipulated by the Centre for Oil Palm Research of the Ministry of Agriculture. This aspect of land legality is significant to ensure that independent smallholder business entities can stably run. Nevertheless, the problem remains that there are still illegally operating oil palm plantations managed by independent smallholders in forest areas. Approximately 713,895 hectares or 36% of independent smallholders' plantations are operating illegally, while the remaining 1,247,750 hectares or 64% cannot be rightfully stated to be fully legal as the suitability of the land with the applicable spatial land, not to mention the land overlap with

[95] Siahaan D. & Erningpraja, L. (2005). Penerapan Good Agricultural Practice and Manufacture Practice dalam Meningkatkan Mutu dan Keamanan Pangan Minyak Kelapa Sawit. *Jurnal Penelitian Kelapa Sawit*, 13(3), 119-118. Accessed from https://publikasi.iopri.org/produk/jurnal-pks-volume-13-nomor-3-desember-2005/ on 24 June 2022.

[96] Syarfi, I. W. (2006). Realitas Perkebunan Rakyat di Sumatera Barat. *Agria*, 3(1), 35-40. Lihat Budi Fachrudin et. all. (2020). Analisis Penerapan GAP (Good Agricultural Practices) dalam Pengelolaan Kebun Kelapa Sawit pada PT Duta Reka Mandiri Company Desa Sungai Dua, Kecamatan Rambutan, Kabupaten Banyuasin. *Agripita,* 4(2), 43-50. Accessed from https://agribisnis.uss.ac.id/wp-content/uploads/2021/03/Jurnal-Budi.pdf

[97] Risza, S. (2010). *Masa Depan Perkebunan Kelapa Sawit Indonesia*. Yogyakarta: Penerbit Kanisius (Anggota IKAPI).

[98] Purwanto, E. & Jelsma, I. (2020). *Peluang dan tantangan pemberdayaan petani sawit mandiri yang inklusif dan berkelanjutan di Kabupaten Ketapang, Provinsi Kalimantan Barat*. Info brief. Bogor: Tropenbos Indonesia.

[99] Based on the Minister of Agriculture Regulation No. 98 of 2013 on Guidelines for Plantation Business Licensing.

[100] Based on the Government Regulation No. 27 of 2012 on Environmental Permits.

other uses, have not been guaranteed.[101] Apart from that, another challenge found is the absence of adequate land ownership documents, i.e., Freehold Title.[102]

Cassava, corn, and sugarcane commodities are still facing similar problems related to GAP, for instances the lack of innovation and cultivation technology, less quality seeds, and farmers' inadequate capacity to implement GAP. The difference between the former commodities and oil palm is the land area. Oil palm plantations tend to expand, while land for the aforementioned commodities tends to shrink over time due to land conversion from agricultural to non-agricultural land.[103]

The implementation of GAP in the oil palm commodity also faces challenges due to the large area of natural forest cover in the current permits. By 2022, there will be around 19 million hectares of oil palm plantation permits, in which around 3.1 million hectares[104] of them are still natural forest cover, which develops into an obstacle for implementing GAP, particularly with regard to protection of key ecosystems.

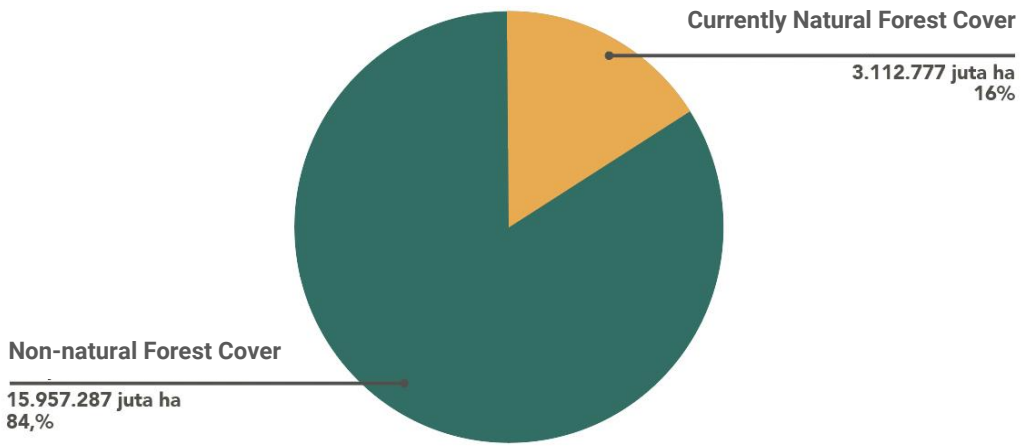

Figure 12. The distribution of oil palm plantation permits in the form of natural forest cover
Source: Oil Palm Plantation Permits (CSO Resource Network); land cover (MOEF 2019).

[101] SPOS Indonesia (2020). *Kertas Kebijakan: ISPO dan Momentum Penataan Legalitas Perkebunan Sawit Swadaya.* Jakarta: Yayasan Kehati.

[102] Jelsma, I., Schoneveld, G.C., Zoomer, A., & van Westen, A.C.M. (2017). Unpacking Indonesia's Independent Oil Palm Smallholders: An Actor-Disaggregated Approach to Identifying Environmental and Social Performance Challenges. *Land Use Policy* 69, 281-297.

[103] Ariningsih, E. (2016). Peningkatan Produksi Ubi Kayu Berbasis Kawasan di Provinsi Jawa Barat dan Sulawesi Selatan. *Analisis Kebijakan Pertanian*, 14(2).

[104] Data Source: CSO Resource Network; MOEF Geoportal Data; RSPO and ISPO data; oil palm cover data from Adrià *et al*. (2020) (https://zenodo.org/record/3884602#.YHRurD8xWUn); oil palm cover data from GFW (https://data.globalforestwatch.org/datasets/5bee22b4a22a4423b140af505960cce6_0/data?geometry=-12.896%2C4.837%2C-6.024%2C6.750); other permit data processed from various sources

Some of these permits are even located in forest areas, which incidentally are not for plantations. Despite the majority being in other land use areas, around 3 million hectares of oil palm permits are within the forest areas. In fact, around 216 thousand hectares of oil palm permits are located in protection and conservation forests.[105]

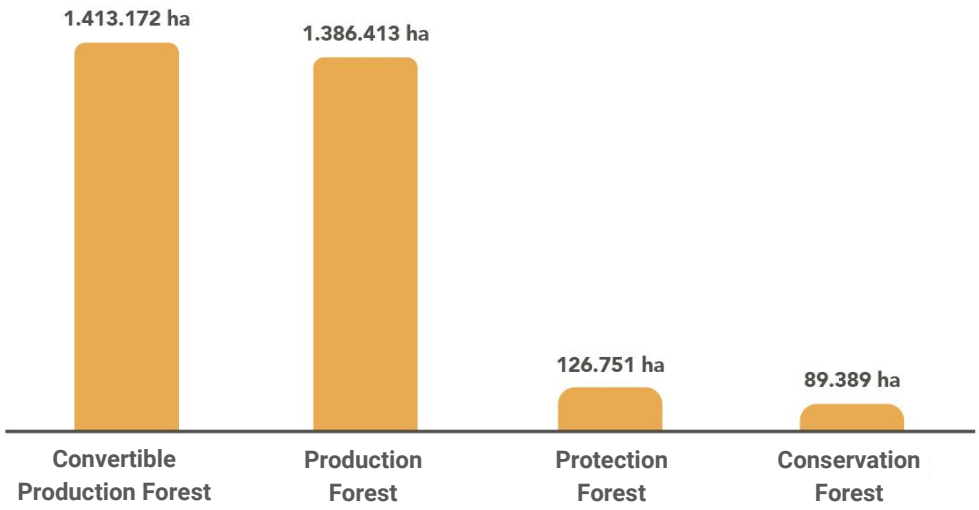

Figure 13. The distribution of oil palm permits in forest area

Source: Oil Palm Plantation Permits (CSO Resource Network); land cover (MOEF 2019).

Another fact that needs to be considered in the context of implementing GAP in oil palm plantations is its overlap with other permits/concessions, PIPPIB, and indigenous territory. The majority of oil palm permits overlap with oil and gas concessions (4 million hectares), mineral and coal concessions (1.86 million hectares), areas within the PIPPIB (840 thousand hectares), and indigenous territories (963 thousand hectares). This increases the risk of conflict at a later date, which needs to be greatly taken into account.

[105] Source: Oil Palm Plantation Permits (CSO Resource Network); forest area (MOEF 2019).

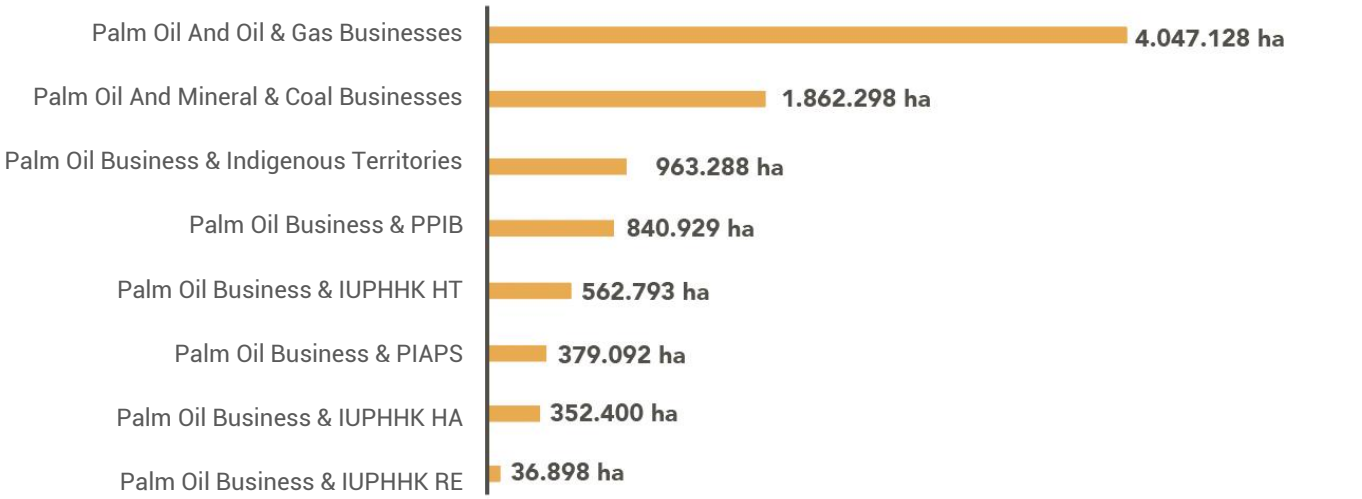

Figure 14. The overlapping of oil palm businesses and land concessions
Source: Oil palm covers and businesses (CSO Network Node).

3.3.3 Gas Emissions

Gas emissions are one of the ecological dimensions related to biofuels discussed in various literature sources. Compared to fossil fuels, biofuels have lower gas emissions.

Table 9. Savings on biofuels and fossil fuels and their gas emissions[106]

Biofuel			Fossil Fuels	
Feedstocks	Energy Savings /(GJ/hectare)	Gas Emission /(g CO^2/MJ)	Fossil Fuels	Gas Emission /(g CO^2/MJ)
Bioethanol-sugarcane	150–200	33.6	Gasoline	96.9
Bioethanol-beets	30–150	32.4		
Bioethanol-wheat	10–50	49.0		
Bioethanol-corn	25–50	84.9		
Biodiesel-sunflower	25–70	82.5	Diesel	82.3
Biodiesel-palm oil	17.5–22.5	1044.6		

[106] Kularatna, Indrani (2019). *The Effect of Use of Biofuels on Environmental Pollution -A Review*. Accessed from https://www.researchgate.net/publication/348297676_The_Effect_of_Use_of_Biofuels_on_Environmental_Pollution_-A_Review on June 24, 2022.

Biodiesel-soy	10–22.5	102.3		

Table 9 shows that biofuel gas emissions vary greatly, depending on the feedstock. The ICCT study (2021) shows that, for the B100 scenario, palm biodiesel improves emissions of unburned hydrocarbons (HC) by 20%, carbon monoxide (CO) by 25%, and particulate matter (PM) by 43% compared to diesel fuel. However, there is a special note regarding nitrogen oxides (NOx):[107] it is 0.8% higher for every 10% of the mix compared to diesel, both in old and new vehicle engines and it is more effective in new vehicles and in fuels with low sulfur.[108]

Besides gas emissions, some literature also raises the life cycle analysis (LCA) of biofuels, especially biodiesel. The analysis emphasizes that the calculation of gas emissions includes the plant life cycle, biofuel production, and engine combustion. The LCA also examines emissions at each stage of production, starting from the plantation to fuel production. The calculation of emissions through LCA is important considering the resulting emissions involve two reduction target sectors: the energy sector and the land use sector.

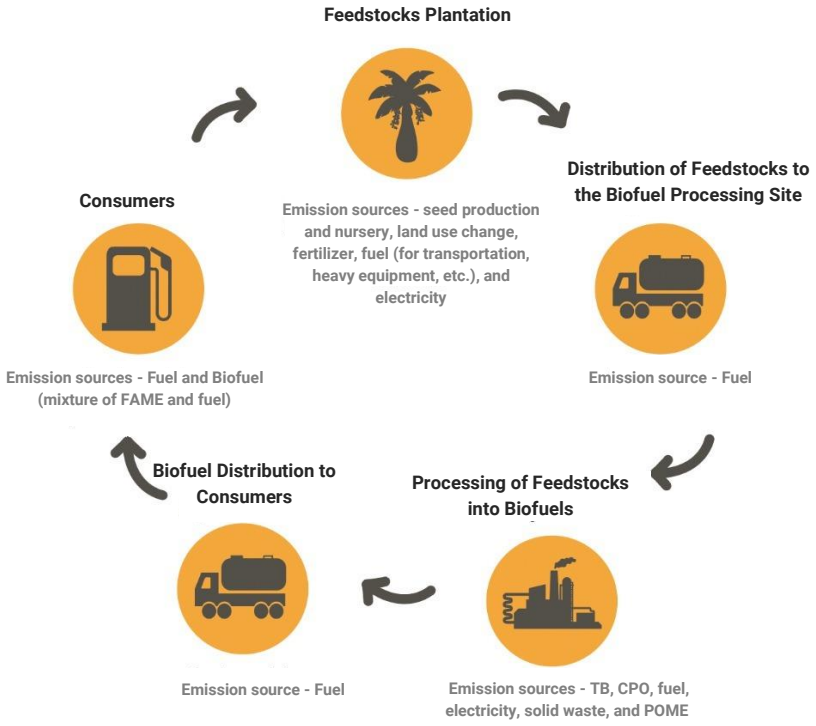

Figure 15. Life cycle analysis of biofuel

Source: Processed from Traction Energy Asia (2019).[109]

[107] NOx and Sulfur Oxide (SOx) in the atmosphere are captured by water vapor to form acid rain. Acid rain can damage the environment as well as many other objects, such as buildings, statues, monuments, and vehicles. Source: Clean Air Technology Center. (1999). *Technical Bulletin: Nitrogen Oxides (NOx) Why and How They Are Controlled*. North Carolina: US Environmental Protection Agency.

[108] O'Malley, J., Searle, S., & Kristina, T. (2021). *Air Quality Impacts of Palm Biodiesel in Indonesia*. ICCT White Paper. Washington DC: International Council on Clean Transportation.

[109] Traction Energy Asia (2019). *Greenhouse Gas Emissions from Biodiesel Production in Indonesia Based on Life Cycle Analysis*. Jakarta: Traction Energy Asia.

The Traction study concluded that, although biofuels produce fewer emissions in engine combustion, the carbon footprint generated during the production process needs more attention. In the biodiesel production process, 83–95% of emissions are generated from land-clearing activities, and the factory emitted liquid waste.[110] Meanwhile, more than 40% of oil palm plantations in Central Kalimantan are located in the ex-Mega Rice Project (MRP) area, which is a deep peatland. This increases the chance of releasing 133.31 up to 310.02 MtCO2e of CO2 due to the oxidation of peat caused by draining oil palm fields during the first 25 years of the plantation cycle.[111]

Lam et al. (2019) specifically note that the GHG emissions resulting from land degradations in Papua and Sulawesi are the largest compared to other regions due to a large number of intact forest landscapes with high carbon stocks.[112] These emissions will increase by 25% in 2030 if forest areas and peatlands expansion continue.[113] Land use change from forest cover and peatland produces far greater emissions than shrubs, fields, and grass.[114] According to Obidzinski et al. (2012), during 1989–2009, the natural forest cover under three palm oil permits in West Papua, West Kalimantan, and Papua decreased due to the growth of oil palm farms associated with the development of biofuels.[115]

Table 10. The Decrease in Natural Forest Cover Area under the Three Oil Palm Permits in West Papua, West Kalimantan, and Papua

Province/Regency	Concession Owner/Group/ Affiliate	Area (Hectares)	% Decrease in Natural Forest Cover Area
West Papua (Manokwari)	PTPN II	12,409	69%
West Kalimantan (Kubu Raya)	PT BPK/Wilmar	13,605	70%
Papua (Boven Digoel)	PT TSE/Korindo	34,000	53%

Source: Obidzinski *et al*. (2012).[116]

[110] Traction Energy Asia (2019). *Greenhouse Gas Emissions from Biodiesel Production in Indonesia Based on Life Cycle Analysis*. Jakarta: Traction Energy Asia.

[111] Dohong, A., Aziz, A.A., & Dargusch, P. (2018). Carbon Emissions from Oil Palm Development on Deep Peat Soil in Central Kalimantan Indonesia. *Anthropocene*, 22, 31-39. Accessed from https://doi.org/10.1016/j.ancene.2018.04.004.

[112] Lam, W.Y., Kulak, M., Sim, S., King, H., Huijbregts, Mark A.J., Chaplin-Kramer, R. (2019). Greenhouse Gas Footprints of Palm Oil Production in Indonesia over Space and Time. *Science of the Total Environment*, 688, 827-837.

[113] Lam, W.Y., Kulak, M., Sim, S., King, H., Huijbregts, Mark A.J., Chaplin-Kramer, R. (2019). Greenhouse Gas Footprints of Palm Oil Production in Indonesia over Space and Time. *Science of the Total Environment*, 688, 827-837.

[114] Traction Energy Asia (2019). *Greenhouse Gas Emissions from Biodiesel Production in Indonesia Based on Life Cycle Analysis*. Jakarta: Traction.

[115] Obidzinski, K., Andriani, R., Komarudin, H., & Andrianto, A. (2012) Environmental and Social Impacts of Oil Palm Plantations and Their Implications for Biofuel Production in Indonesia. *Ecology and Society*, 17(1). Accessed from http://www.jstor.org/stable/26269006.

[116] Obidzinski, K., Andriani, R., Komarudin, H., & Andrianto, A. (2012) Environmental and Social Impacts of Oil Palm Plantations and Their Implications for Biofuel Production in Indonesia. *Ecology and Society*, 17(1). Accessed from http://www.jstor.org/stable/26269006.

Meanwhile, research by Cerulogy projected the possible loss of natural forests and peatlands with an estimated 0.94–5.1 million hectares for natural forests and 0.5–2.88 million hectares for peatlands in 2025 and 2030 to meet biofuel mandates in various countries[117]

Table 11. Reduction Scenarios of Natural Forest and Peatland Cover to Fulfill the Biofuel Mandate

Scenarios	Reduction in the Cover Area by 2025 (in Million Hectares)		Reduction in the Cover Area by 2030 (in Million Hectares)	
	Natural Forest	Peatlands	Natural Forest	Peatlands
High (above B30–B50)	3.09	1.65	5.41	1.65
Moderate (B30)	1.8	0.96	1.87	1
Low (moderate growth after 2020)	0.94	0.5	1.07	0.57

Source: Malins (2020).[118]

From the perspective of the life cycle analysis as a biofuel feedstocks, used cooking oil has a total emission that is 40% lower than the first generation of biofuels, such as biofuel made from palm oil (FAME), which is ~0,.55t CO2eq (or equivalent to ~14g CO2eq/MJ).[119] Also, utilizing used cooking oil as biofuel is beneficial for the environment because it prevents water pollution since it is often disposed of into the sewage system.[120] The ICCT study (2018) also shows that used cooking oil in Indonesia could replace 2.4 billion liters of CPO if all were gathered and utilized for biodiesel. This would cut CO2 emissions by almost 12 million tons per year.[121]

Other than used cooking oil, no other literature in this study found any studies describing the LCA for other potential commodities as biofuel feedstocks.

[117] Malins, C. (2020). *Biofuel to the fire–The impact of continued expansion of palm and soy oil demand through biofuel policy*. Report commissioned by Rainforest Foundation Norway.

[118] Malins, C. (2020). *Biofuel to the fire–The impact of continued expansion of palm and soy oil demand through biofuel policy*. Report commissioned by Rainforest Foundation Norway.

[119] Foteinis, S., Chatzisymeon, E., Litinas, A., & Tsoutsos, T. (2020). Used-cooking-oil biodiesel: Life cycle assessment and comparison with first- and third-generation biofuel. *Renewable Energy*. DOI: https://doi.org/10.1016/j.renene.2020.02.022.

[120] Foteinis, S., Chatzisymeon, E., Litinas, A., & Tsoutsos, T. (2020). Used-cooking-oil biodiesel: Life cycle assessment and comparison with first- and third-generation biofuel. *Renewable Energy*. DOI: https://doi.org/10.1016/j.renene.2020.02.022.

[121] The International Council on Clean Transportation (2018). *White Paper: The Potential Economic, Health, and Greenhouse Gas Benefits of Incorporating Used Cooking Oil into Indonesia's Biodiesel*. Accessed from https://theicct.org/sites/default/files/publications/UCO_Biodiesel_Indonesia_20180919.pdf on June 24, 2022

3.3.4 Ecosystem Sustainability

Ecosystem sustainability and plantation industry, which is currently dominated by oil palms, are often in opposite positions. This is due to the large scale of the palm oil industry and ever-increasing demand, as well as the upstream and downstream management of the said industry which is still disorganized. Eventually, ecosystem interests are often sacrificed for the proper running of the plantation industry in Indonesia.

In terms of biodiversity, increasing the area of oil palm land by converting forest cover into oil palm plantation has a significant negative impact. Research conducted by Sharma et al. which uses three scenario projections, i.e., BaU, conservation, and sustainable intensification, shows that the BaU scenario results in reduced habitat quality so as to reduce biodiversity.[122] However, if the land used is not from forest cover, and instead bush, oil palm plantations surprisingly have a positive impact on biodiversity, especially plant species. On the other hand, Hilwan and Santosa prove that changing the land cover from bush to oil palm plantations increased the gain of 44 types of plants (244.44%), and only eliminated 7 types of plants (38.89%).[123]

The production of palm oil as a feedstock for biofuels also needs to be considered in the context of decreasing water quality. According to Rulli et al., there are substantial environmental impacts from the production of palm oil; one of them being water pollution up to 18.3 km^3 grey waters.[124] Additionally, as stated by Koaksi Indonesia, 35% of 4.783 villages in Indonesia relying on palm oil as their main commodity experience environmental pollution, with water pollution ranked the highest (24%).[125]

[122] Sharma, Sunil K., Baral, H., Laumonier, Y., Okarda, B., Komarudin, H., Purnomo, H., & Pacheco, P. (2019). Ecosystem services under future oil palm expansion scenarios in West Kalimantan, Indonesia. *Ecosystem Services*, 39. Accessed from https://doi.org/10.1016/j.ecoser.2019.100978.

[123] Hilwan, I. & Santosa, Y. (2019). Impact of oil palm plantation on species diversity of tropical Vegetation. *IOP Conf. Series: Earth and Environmental Science*, 336. DOI:10.1088/1755-1315/336/1/012033

[124] Rulli, M.C., Casirati, S., Dell'Angelo, J., Davis, K.F., Passera, C., & D'Odorico, P. (2019). Interdependencies and telecoupling of oil palm expansion at the expense of Indonesian rainforest. *Renewable and Sustainable Energy Reviews*, 105.

[125] Koaksi Indonesia & Lokadata (2021). *Pemetaan Hulu-Hilir, Sosial Ekonomi dan Dampak Lingkungan Industri Sawit dan Biodiesel di Indonesia*. Jakarta: Koaksi Indonesia.

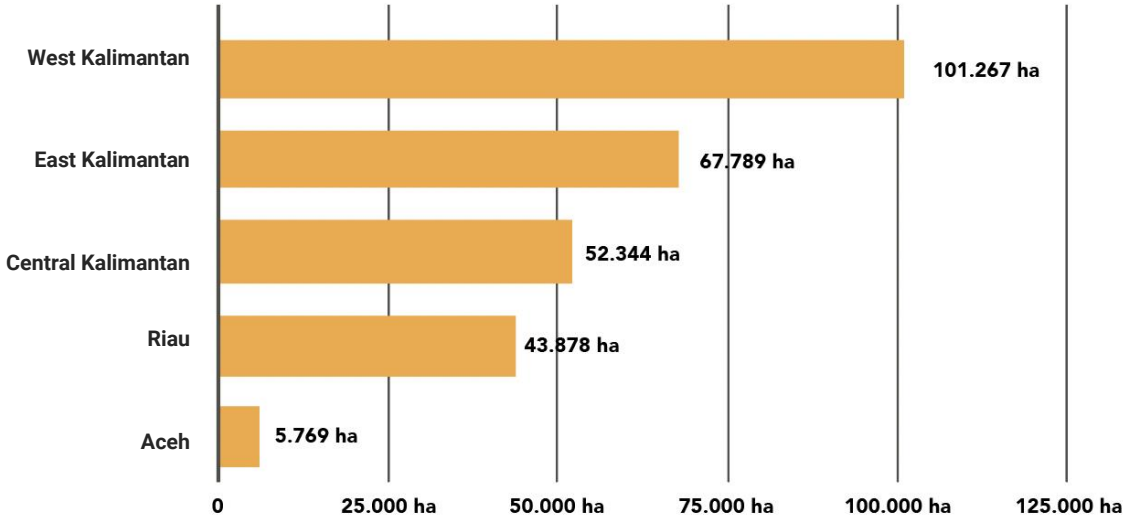

Figure 16. Five provinces with the largest deforestation in palm oil concession permits in Indonesia (2010–2018)

Source: Madani Berkelanjutan (2019).[126]

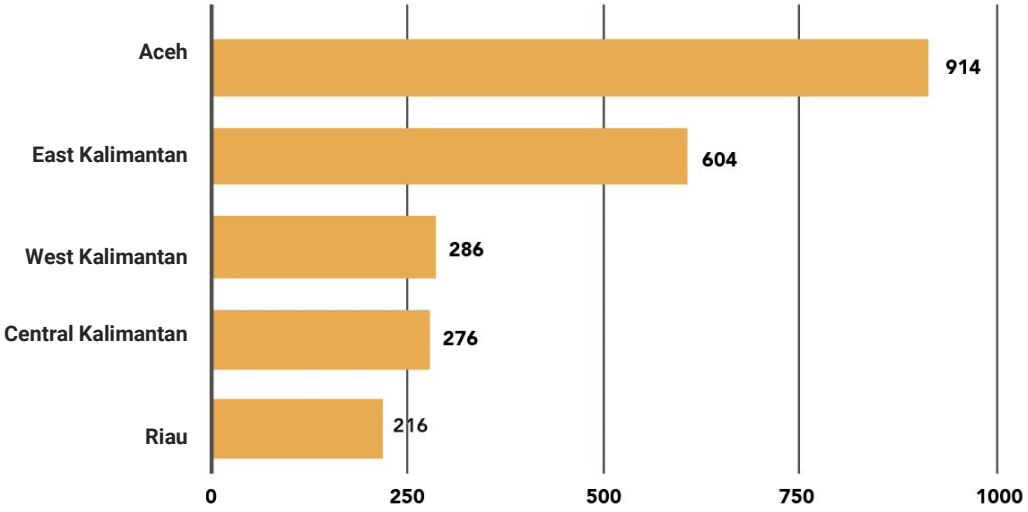

Figure 17. Number of floods and landslides in the course of 2010-2018

Source: Madani Berkelanjutan (2019).[127]

Meanwhile, research conducted by Madani Berkelanjutan shows a correlation between deforestation in oil palm concessions and the number of disaster events, such as floods and landslides

[126] Madani Berkelanjutan (2019). Madani Insight Vol I: Gambaran Industri Sawit Indonesia, Menjawab Asumsi dengan Fakta dan Angka. Jakarta: Madani Berkelanjutan.

[127] Madani Berkelanjutan (2019). *Madani Insight Vol I: Gambaran Industri Sawit Indonesia, Menjawab Asumsi dengan Fakta dan Angka*. Jakarta: Madani Berkelanjutan.

in five provinces, i.e., Aceh, Riau, Central Kalimantan, East Kalimantan, and West Kalimantan throughout 2010-2018 (Figure 17).[128]

3.4 Dynamics of Biofuel Utilization and Its Economic Impact

Seen at a glance, the use of biofuels will boost the national economic sector. However, there are many things that deserve a closer look. The initial spirit that underlies the formulation of biofuels policy in Indonesia is to achieve energy sovereignty and overcome poverty through the use of various feedstocks. Yet, the implementation of the policies is getting further away from the aforementioned spirit. The increase in the biodiesel blend to 10% in 2013[129] coincided with Indonesia's high production of palm oil, which was around 27.78 million tonnes in 2013[130] , and increased drastically to 51.58 million tonnes in 2020.[131] In spite of that, the market was unable to absorb the abundance of CPO stocks, resulting in a surplus.[132] With these facts in mind, one of the conclusions that can be drawn is that the biofuel policy in Indonesia is implemented as an option to create demand to help absorb the high CPO stocks.

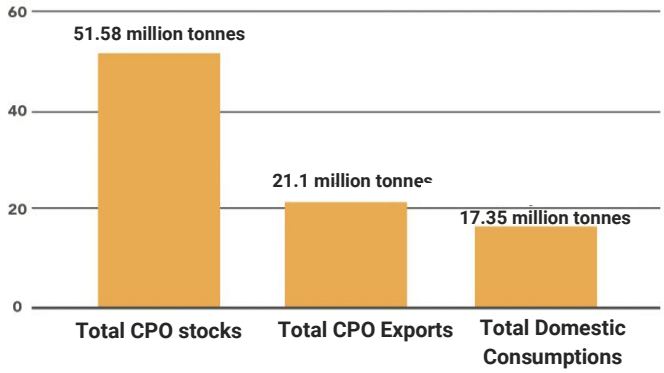

Figure 18. Total stocks and allocations of CPO in Indonesia in 2020

Source**:** Total CPO stocks: Ramli (2021); total CPO exports: GAPKI (2021); total CPO consumptions: Uly, Y.A. (2021). [133]

[128] Madani Berkelanjutan (2019). *Madani Insight Vol I: Gambaran Industri Sawit Indonesia, Menjawab Asumsi dengan Fakta dan Angka*. Jakarta: Madani Berkelanjutan.

[129] MEMR Regulation No. 25/2013 on Amendments to the MEMR Regulation No. 32/2008 on the Provision, Utilization, and Trading Administration of Biofuels as Other Fuels. The regulation increases the minimum limit of biodiesel from 2,5% to 10%.

[130] Badan Pusat Statistik (2014). *Statistik Kelapa Sawit Indonesia* 2014*.* Jakarta: Badan Pusat Statistik

[131] Ramli, R.R. (2021) Sepanjang 2020, Produksi Kelapa Sawit Capai 51,58 Juta Ton. *Kompas.com*. Accessed from https://money.kompas.com/read/2021/02/10/170000226/sepanjang-2020-produksi-kelapa-sawit-capai-51-58-juta-ton on 26 November 2021.

[132] In 2020, the total stocks of *crude palm oil* (CPO) in Indonesia amounts to 51.58 million tonnes, while the total exports 21.1 million tonnes and total domestic consumption 17.35 million tonnes. Source on CPO exports: GAPKI (2021). *Ekspor Minyak Sawit Indonesia Turun 9% pada 2020.* Accessed from https://databoks.katadata.co.id/datapublish/2021/02/05/ekspor-minyak-sawit-indonesia-turun-9-pada-2020 on 26 November 2021; source on CPO consumption: Uly, Y.A. (2021) Meski Ada Pandemi, Konsumsi CPO Dalam Negeri Naik Jadi 17,35 Juta Ton di 2020. *Kompas.com*. Accessed from https://money.kompas.com/read/2021/02/04/170500526/meski-ada-pandemi-konsumsi-cpo-dalam-negeri-naik-jadi-1735-juta-ton-di-2020 on 26 November 2021.

[133] Total CPO stocks: Ramli, R.R. (2021). Sepanjang 2020, Produksi Kelapa Sawit Capai 51,58 Juta Ton. *Kompas.com*. Accessed from https://money.kompas.com/read/2021/02/10/170000226/sepanjang-2020-produksi-kelapa-sawit-capai-51-58-juta-ton on 26 November 2021; total CPO exports: GAPKI (2021). *Ekspor Minyak Sawit Indonesia Turun 9% pada 2020*. Accessed from https://databoks.katadata.co.id/datapublish/2021/02/05/ekspor-minyak-sawit-indonesia-turun-9-pada-2020) on 26 Novermber 2021; total CPO consumption: Uly, Y.A. (2021). Meski Ada Pandemi, Konsumsi CPO Dalam Negeri Naik Jadi 17,35 Juta Ton di 2020. *Kompas.com*. Accessed from

This conclusion may not be correct; yet, the currently available evidence points to that very conclusion. Furthermore, there are several aspects that color the dynamics of biofuels and the economy in Indonesia, i.e., economic incentives and subsidies, the balance of trade, and the economic impact on society (users and farmers). Almost all of these aspects revolve around the national palm oil industry sector. The development of biofuels is quite vulnerable as the industry itself, based on vegetable oil, ultimately only depends on one type of commodity, which means that obstacles or challenges faced by the palm oil sector can eventually disrupt the entire biofuel industry.

The following section discusses the economic aspects of the implementation of biofuels policy in Indonesia. The discussion is not in the perspective of advantages and disadvantages, but more emphasis on the dynamics of economic issues coloring the implementation of biofuels, especially biodiesel as the main biofuel currently circulating in Indonesia.

3.4.1 Economic Incentives (Biofuel Subsidies)

The market index price of biodiesel is one of the determinants of the final selling price of biofuel to the public. In the past year, the market index price of biofuel (B100) has been higher than the market index price of biofuel mixed with fossil fuels. Data from the Ministry of Energy and Mineral Resources shows the large difference between the market index price for biofuel and fossil fuels.[134] This eventually led to a scenario of economic incentives (subsidies) for biofuels. The main goal is to balance the market price of biofuel for competing with fossil fuels. Yet, this often raises criticism from various parties.

The subsidy policy was criticized because it was seen as "spoiling" the inefficient biodiesel industry. Ultimately, it will rely heavily on subsidies to survive in the market.[135] This dependency raises the potential for further increases in the need for subsidies due to the governments' higher biodiesel-blending target.[136] This criticism also came from farmers considering that the majority of palm oil funds managed (by the BPDPKS) were actually used for biodiesel subsidies.[137]

Prior to 2015, biofuel subsidies came from the State Budget allocation.[138] However, since the government issued the Presidential Decree No. 61 of 2015 on the Collection and Use of Oil Palm Plantation Funds and established BPDPKS, biofuel subsidies (especially biodiesel) have no longer

https://money.kompas.com/read/2021/02/04/170500526/meski-ada-pandemi-konsumsi-cpo-dalam-negeri-naik-jadi-1735-juta-ton-di-2020) on 26 November 2021.

134 Data for the January 2019-January 2020 period processed by the research team. Source: LPEM FEB UI (2020). *Risiko Kebijakan Biodiesel dari Sudut Pandang Indikator Makroekonomi dan Lingkungan*. Jakarta: LPEM FEB UI.

135 Basri, F. & Putra, Gatot. A. (2020). *Kajian Makroekonomi Biodiese*l. Jakarta: Indonesia.

136 Halimatussadiah, A. Nainggolan, D., Yui, S., Moeis F.R., & Siregar, A.A. (2021). Progressive biodiesel policy in Indonesia: Does the Government's economic proposition hold? *Renewable and Sustainable Energy Reviews,* 150, ISSN 1364-0321.

137 Serikat Petani Kelapa Sawit (2020). *Tata Kelola BPDP-KS yang Buruk Merugikan Petani Sawit, Kajian Good Governance BPDP-KS*. Serikat Petani Kelapa Sawit.

138 Dharmawan, A.H., Nuva, Sudaryanti, D.A., Prameswari, A.A., Amalia, R., dan Dermawan, A. (2018). *Pengembangan bioenergi di Indonesia: Peluang dan tantangan kebijakan industri biodiesel*. Working Paper 242. Bogor, Indonesia: CIFOR.

come from the State Budget, but from palm oil export levies. The palm oil export levies, or palm oil levies, are intended to fund several programmes, i.e., human resources (HR) development, oil palm research and development, oil palm plantations promotions, oil palm plantations rejuvenation, facilities and infrastructure construction, and biodiesel supply provision.[139] Regardless, in practice, palm oil levies are mostly used to subsidize the latter. Of the total palm oil levies throughout 2015-2019 of IDR 33.6 trillion, the funds channeled to subsidize the supply of biodiesel reached IDR 30.2 trillion or 89.86%.[140] The remainder was channeled to the development of facilities and infrastructure amounting to 0.22% or IDR 1.73 billion, human resource development amounting to 0.42% or IDR 140.674 billion, and the rejuvenation programme amounting to 8.03% or IDR 2.7 trillion (Figure 19).

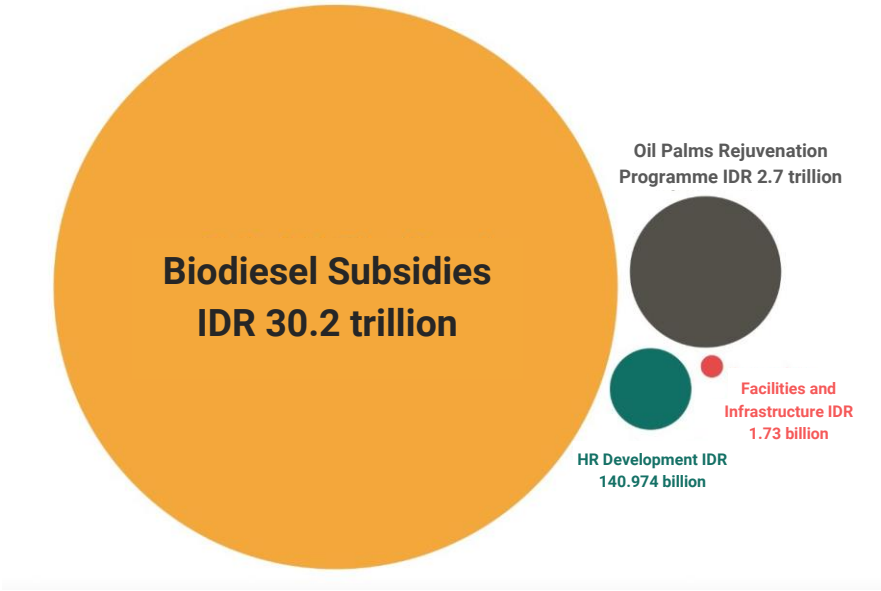

Figure 19. Distribution of palm oil levies allocations throughout 2015-2019
Source: Pandelaki (2021).[141]

Apart from biodiesel subsidies, palm oil levies which have been in effect since 2015 should be used to support sustainable palm oil management by maximizing oil palm rejuvenation, HR development, facilities and infrastructure construction, scientific research, and promotion of sustainable palm oil.[142] Research conducted by Nurfatriani *et al*. (2018) show several options for optimizing the use of palm oil levies to support the sustainable palm oil development; one of which is by providing financial assistance to farmers to meet the requirements of the Indonesian Sustainable Palm Oil (ISPO) policy.

[139] Article 11 Paragrah 1 and Paragraph 2 of Presidential Decree No. 61/2015 on Collection and Use of Oil Palm Plantation Funds

[140] Pandelaki, T. (2021, 20 Februari). *Menakar Keseriusan Pemerintah Bantu Petani Swadaya*. Accessed from https://www.mongabay.co.id/2021/02/20/menakar-keseriusan-pemerintah-bantu-petani-sawit-swadaya/ on 21 August 2021.

[141] Pandelaki, T. (2021, 20 Februari). *Menakar Keseriusan Pemerintah Bantu Petani Swadaya*. Accessed from https://www.mongabay.co.id/2021/02/20/menakar-keseriusan-pemerintah-bantu-petani-sawit-swadaya/ on 21 August 2021.

[142] Nurfatriani, F., Ramawati, Sari, G.K., dan Komarudin, H. (2018). *Optimalisasi Dana Sawit dan Pengaturan Instrumen Fiskal Penggunaan Lahan Hutan untuk Perkebunan dalam Upaya Mengurangi Deforestasi*. Working Paper 238. Bogor, Indonesia: CIFOR.

The ISPO requirements in question include the legality of farmers' land (Freehold Land Title/Land Certificate/sporadic/*girik* letter [letter D]/deed of sale) and Good Agricultural Practices (GAP), i.e., the use of quality seeds.[143] Palm oil levies can also be allocated for loan interest payments during the grace period after the oil palms rejuvenation programme. With costs reaching IDR 50 million-IDR 60 million, farmers need to access credit facilities to replant their palms. The interest expense during the grace period (the initial period when oil palms are not yet productive) which still has to be paid will certainly burden the farmers.[144]

Too much dependence on the development of biodiesel on subsidies has a significant impact which needs to be greatly considered. The amount of subsidy that depends on the price of palm oil in the global market and the fluctuation in income from palm oil levies collected by the BPDPKS poses a risk of increasing the burden on the state budget for biodiesel subsidies.[145] For example, in 2020, the government paid IDR 2.78 trillion for biodiesel subsidies from the State Budget through the National Economic Recovery programme.[146] In addition, a progressive biodiesel blends policy scheme will be more sensitive to fluctuations in CPO and diesel prices on the global market, thereby posing risks, especially to the country's fiscal stability in future policy developments.[147]

In this regard, one of the topics that often appears in biofuel discourse so far is the trade balance. In the implementation of the policy, biodiesel's selling price in Indonesia is highly dependent on fluctuations in CPO and diesel oil prices, while CPO prices are affected by world vegetable oil prices. All of these are interrelated in influencing the selling price of biofuels to consumers. This condition raises the risk of losing the value of CPO exports, which is higher than the value of savings from diesel imports. In the end, to obtain the acceptable price of biofuel for consumers, a subsidy is needed to lower its selling price. Thus, the biofuels policy which has so far focused on biodiesel can cause the trade balance to become negative.[148]

3.4.2 Economic Impact on Oil Palm Smallholders

One of the initial objectives of developing biofuels in Indonesia is to alleviate poverty; meaning that the development of biofuels is based on the spirit to improve the people's economy, including the empowerment of farmers and planters. Regarding the implementation of the current biofuels policy, especially for biodiesel from palm oil, the area of smallholders' oil palm plantations in 2019 was

[143] Nurfatriani, F., Ramawati, Sari, G.K., dan Komarudin, H. (2018). *Optimalisasi Dana Sawit dan Pengaturan Instrumen Fiskal Penggunaan Lahan Hutan untuk Perkebunan dalam Upaya Mengurangi Deforestasi*. Working Paper 238. Bogor, Indonesia: CIFOR.

[144] Nurfatriani, F., Ramawati, Sari, G.K., dan Komarudin, H. (2018). *Optimalisasi Dana Sawit dan Pengaturan Instrumen Fiskal Penggunaan Lahan Hutan untuk Perkebunan dalam Upaya Mengurangi Deforestasi*. Working Paper 238. Bogor, Indonesia: CIFOR.

[145] Halimatussadiah, A. Nainggolan, D., Yui, S., Moeis F.R., & Siregar, A.A. (2021). Progressive biodiesel policy in Indonesia: Does the Government's economic proposition hold? *Renewable and Sustainable Energy Reviews,* 150, ISSN 1364-0321.

[146] Indrawan, Rio (2020). Pastikan B30 Tetap Jalan, Pemerintah Talangi Rp 2,78 Triliun Kekurangan Dana Insentif Biodiesel. *Dunia Energi.* Accessed from https://www.dunia-energi.com/pastikan-b30-tetap-jalan-pemerintah-talangi-rp278-triliun-kekurangan-dana-insentif-biodiesel/ on 1 September 2021.

[147] Halimatussadiah, A. Nainggolan, D., Yui, S., Moeis F.R., & Siregar, A.A. (2021). Progressive biodiesel policy in Indonesia: Does the Government's economic proposition hold? *Renewable and Sustainable Energy Reviews,* 150, ISSN 1364-0321.

[148] LPEM FEB UI (2020). *Risiko Kebijakan Biodiesel dari Sudut Pandang Indikator Makroekonomi dan Lingkungan*. Jakarta: Indonesia.

40.97% or 5.896.775 hectares of the total land area of 14.456.611 hectare, cultivates by 2,509,214 heads of smallholders.[149]

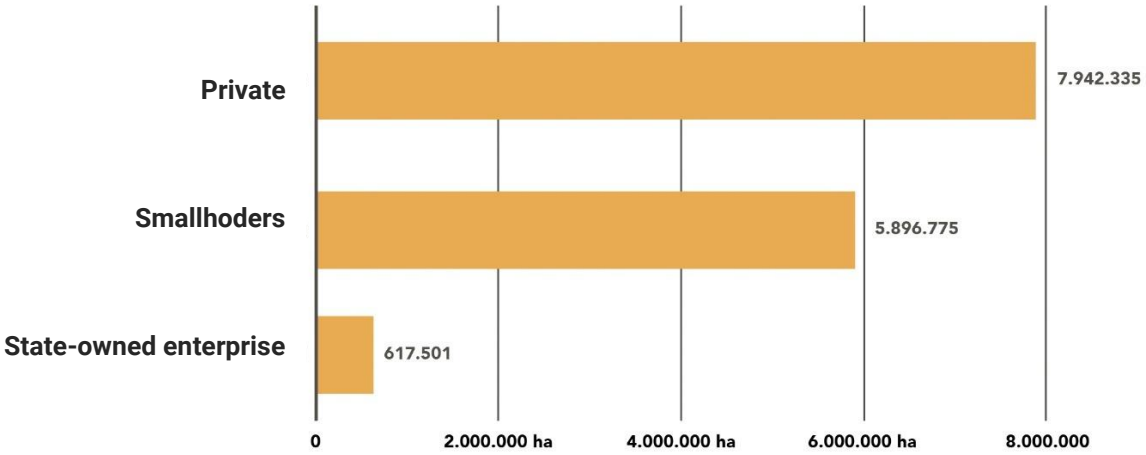

Figure 20. Oil palm plantation area in 2019

Source: Directorate General of Plantations, Ministry of Agriculture (2020).[150]

Although productivity is still relatively low compared to private and state plantations, smallholder plantations contribute 31.76% of national CPO production or 14,925,877 tonnes of 47,120,247 tonnes.[151]

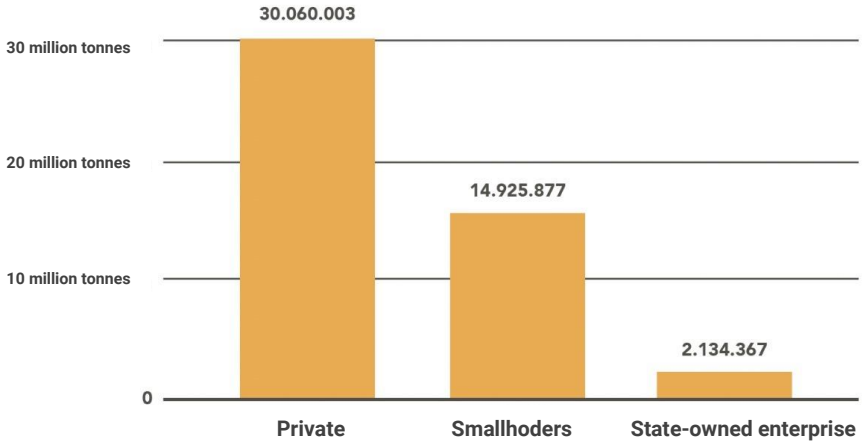

Figure 21. Total production of oil palm plantations

Source: Directorate General of Plantations, Ministry of Agriculture (2020).[152]

[149] Direktorat Jenderal Perkebunan, Kementerian Pertanian. 2020. *Statistik Perkebunan Unggulan Nasional 2019-2021*. Jakarta: Direktorat Jenderal Perkebunan, Kementerian Pertanian.

[150] Direktorat Jenderal Perkebunan, Kementerian Pertanian. 2020. Statistik Perkebunan Unggulan Nasional 2019-2021. Jakarta: Direktorat Jenderal Perkebunan, Kementerian Pertanian.

[151] Direktorat Jenderal Perkebunan, Kementerian Pertanian. 2020. *Statistik Perkebunan Unggulan Nasional 2019-2021*. Jakarta: Direktorat Jenderal Perkebunan, Kementerian Pertanian.

[152] Direktorat Jenderal Perkebunan Kementerian Pertanian. 2020. *Statistik Perkebunan Unggulan Nasional 2019-2021*. Jakarta: Direktorat Jenderal Perkebunan Kementerian Pertanian.

Judging only from this area, the role of smallholders in the entire CPO supply chain in the biofuel industry can be considered significant. However, several parties, i.e., the Oil Palm Farmers Union [153], are pushing for the government to provide a stronger position for independent smallholders as part of the actors in the CPO supply chain. As they do not have direct access to BUBBN, farmers have to sell their produce to middlemen.[154] The price set by the middlemen is, of course, lower than the price set by the government. In the end, the low selling price has implications for the welfare [155] and farmer exchange rate.

For example, throughout 2016-2019, the exchange rate for smallholders in oil palm central provinces, such as Riau and West Kalimantan, tended to lag behind other sectors, i.e., freshwater fisheries, agronomic crops, and horticultural crops (Figure 22; Figure 23).[156]

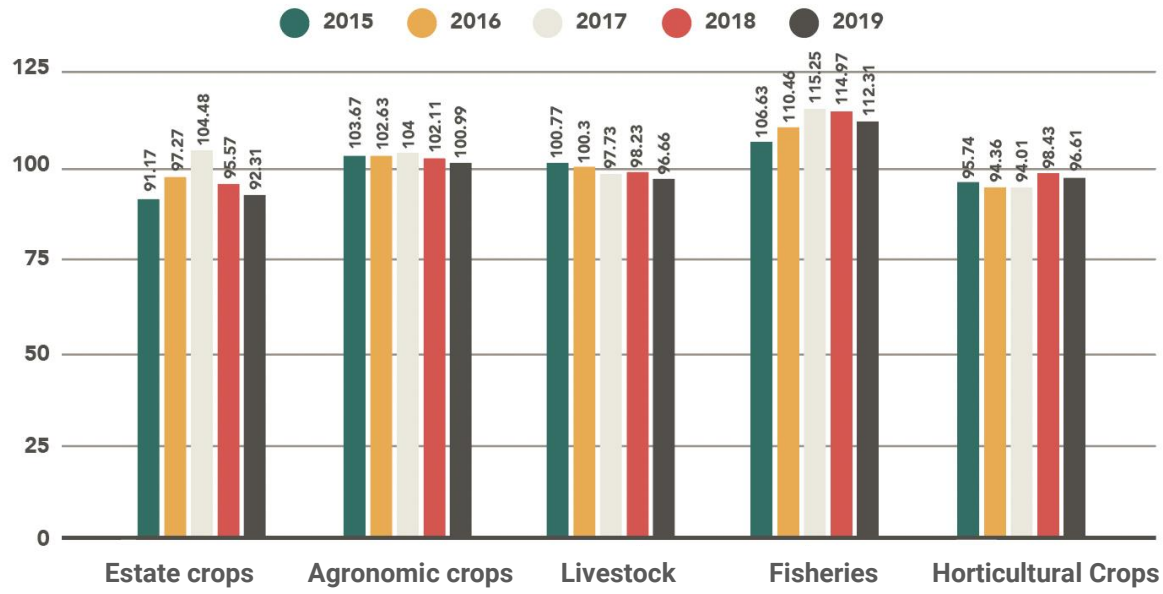

Figure 22. Exchange rate for oil palm smallholders and other commodities in Riau (2015–2019)
Source: Central Bureau of Statistics (2020).[157]

[153] Gatra.com (2021). Serikat Petani Kelapa Sawit Ingin Kemitraan dengan Industri B30. *Gatra.com*. Accessed from https://www.gatra.com/detail/news/524438/info-sawit/serikat-petani-kelapa-sawit-ingin-kemitraan-dengan-industri-b30 on 16 December 2021.

[154] Syahni, Della (2021). *Menimbang Kebijakan Bahan Bakar Nabati dari Sawit*. Accessed from https://www.mongabay.co.id/2021/09/13/menimbang-kebijakan-bahan-bakar-nabati-dari-sawit/ on 28 January 2022.

[155] Wright, A. (2014). Socio-Economic Impacts of Palm Oil and Biodiesel: The Case of Indonesia. Dalam Rutz D. & Janssen R. (eds.) *Socio-Economic Impacts of Bioenergy Production*. Springer. Accessed from https://doi.org/10.1007/978-3-319-03829-2_9.

[156] Badan Pusat Statistik (2020). Nilai Tukar Petani. Jakarta: Badan Pusat Statistik.

[157] The majority of smallholder plantations in Riau are oil palm plantations.

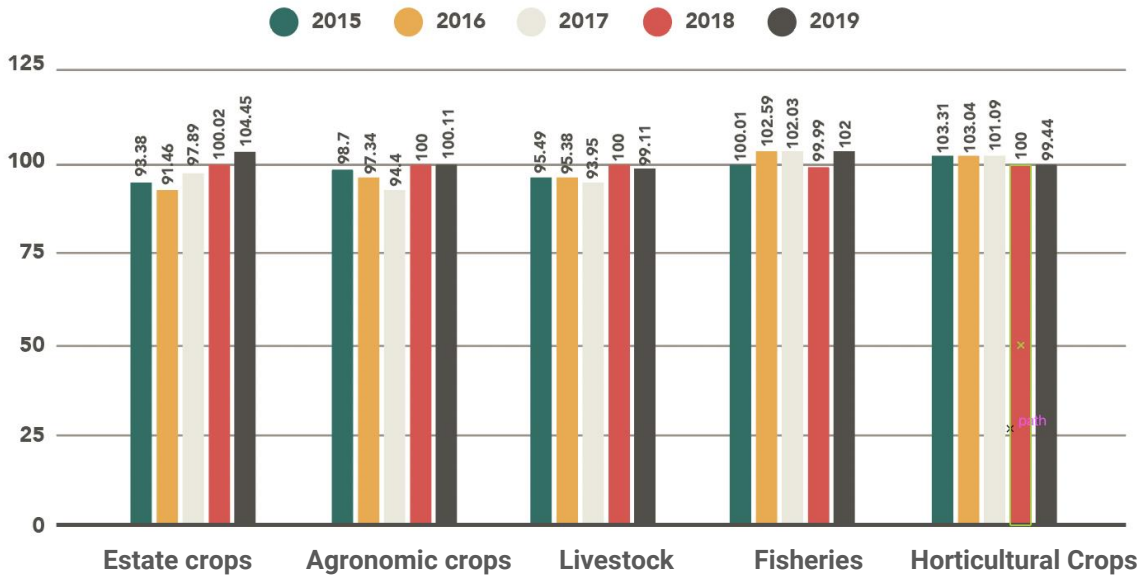

Figure 23. Exchange rate for oil palm smallholders and other commodities in West Kalimantan
Source: Central Bureau of Statistics (2020).[158]

Meanwhile, one of the crucial issues in the discourse regarding the welfare of independent smallholders is the inequality of biodiesel subsidies. The percentage of BPDPKS funding for the benefit of stabilising biofuel prices is greater than that of the benefit of farmers. BPDPKS as the manager of palm oil levies is ensnared by the interests of the biodiesel industry. This is due to the presence of biodiesel industry owners, who are also owners of large-scale plantation concessions in the BPDPKS Steering Committee and Supervisory Board.[159] Palm oil funds are also considered to have no impact on the price of fresh fruit bunches at the farmer level as well as purchase prices by companies and mills.[160]

In addition, other issues arise concerning the legality of smallholders, the implementation of good plantation practices, and the approach which still tends to be sectoral in addressing the needs of independent smallholders. The high uncertainty of the market and production chain, as well as difficulties for farmers in fulfilling sustainability aspects at certain standards, cause smallholders to have a high risk of investing in the palm oil business. In fact, it is possible that smallholders are not

[158] The majority of smallholder plantations in West Kalimantan are oil palm plantations.

[159] Serikat Petani Kelapa Sawit (2020). *Pelibatan Petani Swadaya dalam Rantai Pasok Biodiesel untuk Energi Berkelanjutan dan Kesejahteraan Petani*. Bogor: Serikat Petani Kelapa Sawit.

[160] Nurfatriani, F., Ramawati, Sari, G.K., dan Komarudin, H. (2018). *Optimalisasi Dana Sawit dan pengaturan instrumen fiskal penggunaan lahan hutan untuk perkebunan dalam upaya mengurangi deforestasi*. Working Paper 238. Bogor, Indonesia: CIFOR.

considered in the palm oil supply chain in general.[161] The direction of government policy regarding biofuels to involve independent smallholders is also unclear. A road map for involving independent smallholders in the production chain of biofuels needs to be considered so that biofuels policy can truly have a positive impact on independent smallholders.[162]

3.4.3 Biofuels and Regional Economic Development

The government's desire to make biofuels one of the regional economic development agendas is shown in Presidential Decree No. 10/2006 on the National Team for Biofuel Development for the Acceleration of Poverty and Unemployment Reduction. Since then, various studies have shown the positive and negative impacts of developing palm oil-based biodiesel for regional and rural communities' development. Research by Nuva et al. (2015), for instance, shows that the development of biodiesel does not directly impact communities and regions as feedstocks for cultivated palm oil is not solely for biodiesel production.[163] Other studies conducted by Madani Berkelanjutan (2020)[164] and Koaksi Indonesia (2021)[165] further prove that many villages around oil palm plantations and concessions are still in the category of underdeveloped and very underdeveloped.

In addition, in several areas, workers in oil palm plantations are dominated by immigrants—not local residents—and therefore the economic benefits in the context of employment are not too significant. Oil palm plantation workers also often receive different treatment. Local residents who become workers often do not have permanent employee status and are not paid according to the provincial minimum wage.[166] Observed from the perspective of regional income, the palm oil industry often receives negative attention as it is considered unable to make a realistic contribution to the respective region. One of the things highlighted is the profit-sharing fund from palm oil export levies.

Profit-sharing fund is a source of regional income originating from the State Budget, which is allocated to the regions based on the percentage of funds needed by the regions in the framework of decentralization. Profit-sharing fund is divided into two schemes: (i) funds originating from taxes

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[161] Moreno-Penaranda, R., Gasparatos, A., Stromberg, P., Suwa, A., & de Oliveira, Jose A. Puppim (2019). Stakeholder perceptions of the ecosystem services and human well-being impacts of palm oil biofuels in Indonesia and Malaysia. Dalam Takeuchi, K., Shiroyama, H., Saito, O., & Matsuura, M. (eds.). *Biofuels and Sustainability, Science for Sustainable Societies*. Accessed from https://doi.org/10.1007/978-4-431-54895-9_10.

[162] Serikat Petani Kelapa Sawit (2020). *Pelibatan Petani Swadaya dalam Rantai Pasok Biodiesel untuk Energi Berkelanjutan dan Kesejahteraan Petani*. Bogor: Serikat Petani Kelapa Sawit.

[163] Nuva, Fauzi, A., Dharmawan, A.H., & Putri, E.I.K. (2019). Political Economy of Renewable Energy and Regional Development: Understanding Social and Economic Problems of Biodiesel Development in Indonesia. Sodality: Jurnal Sosiologi Pedesaan, 7(2).

[164] Madani Berkelanjutan (2020). *Madani Insight Vol 5: Gambaran Industri Sawit Indonesia, Menjawab Asumsi dengan Fakta dan Angka*. Jakarta: Madani Berkelanjutan.

[165] Koaksi Indonesia (2021). *Pemetaan Hulu-Hilir, Sosial Ekonomi dan Dampak Lingkungan Industri Sawit dan Biodiesel di Indonesia*. Jakarta: Koaksi Indonesia.

[166] Moreno-Penaranda, R., Gasparatos, A., Stromberg, P., Suwa, A., & de Oliveira, Jose A. Puppim (2019). Stakeholder perceptions of the ecosystem services and human well-being impacts of palm oil biofuels in Indonesia and Malaysia. Dalam Takeuchi, K., Shiroyama, H., Saito, O., & Matsuura, M. (eds.). *Biofuels and Sustainability, Science for Sustainable Societies*. Accessed from https://doi.org/10.1007/978-4-431-54895-9_10.

(land and building tax[167], land and building rights acquisition fee, and income tax [168]), and (ii) funds originating from natural resources (Figure 24).

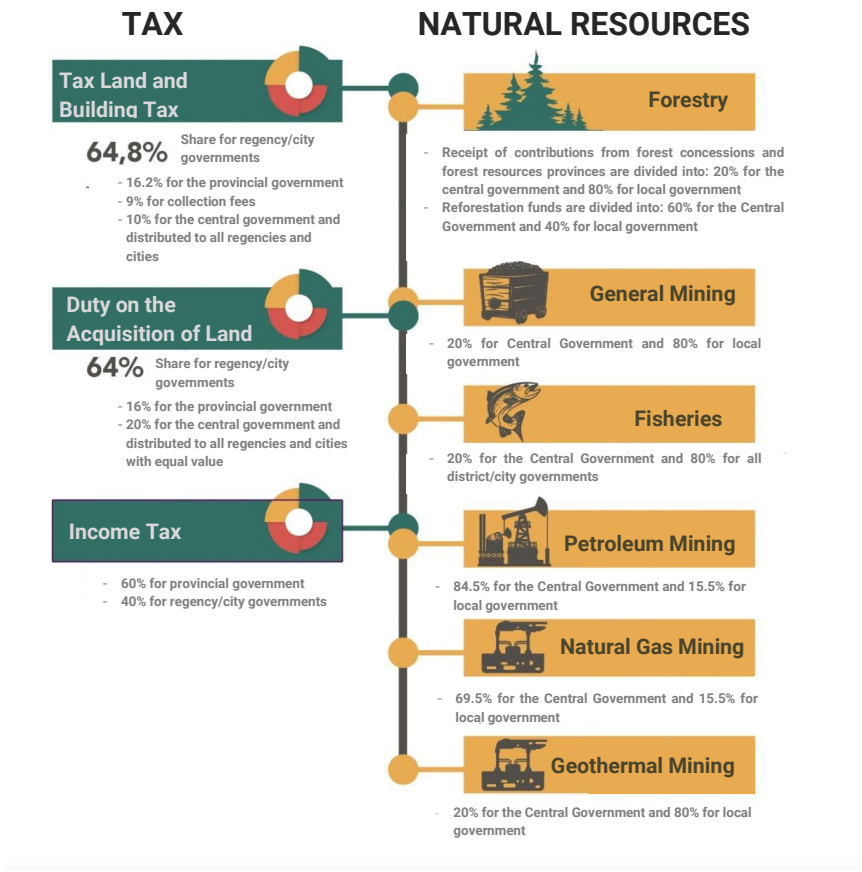

Figure 24. The economic value of the oil palm plantation sector
Source: Madani Berkelanjutan (2020)[169]; Article 11 Paragraph 2 of Law No. 33 of 2004 on Financial Balance between the Central Government and Local Government.

Regarding profit-sharing funds in the context of oil palm, regional revenues from taxes only come from land and building tax and income tax. Specifically for profit-sharing funds from natural resources, oil palm is not included in the scheme as export levies for this commodity are not included in the profit-sharing scheme.[170] The absence of a profit-sharing funds scheme originating from natural resources has resulted in a small percentage of revenue from palm oil received by the

[167] Tax subjects are people or entities which actually possess rights and/or obtain as well as control the benefits of land and/or building on land and property tax objects on plantations. The object of tax is land and/or buildings within the area used for plantation business activities, including oil palm-cattle integration. (Sourcer: Madani Berkelanjutan (2020). *Madani Insight: Nilai Ketimpangan Ekonomi Sawit*. Jakarta: Madani Berkelanjutan).

[168] Tax subjects: business entities and individuals who carry out palm oil export, import, and re-import. The object is the income of a business entity from the calculation of gross income minus costs for obtaining, collecting, and maintenance income from oil palm plantations (Source: Madani Berkelanjutan (2020). *Madani Insight: Nilai Ketimpangan Ekonomi Sawit*. Jakarta: Madani Berkelanjutan).

[169] Madani Berkelanjutan (2020). *Madani Insight: Nilai Ketimpangan Ekonomi Sawit*. Jakarta: Madani Berkelanjutan.

[170] Minister of Finance Regulation No. 2/PMK.05/2007 on Peraturan Menteri Keuangan No.2/PMK.05/2007 Amendments to Minister of Finance Regulation No. 99/PMK.06/2006 on State Revenue Module.

regions.[171] Auriga Nusantara (2021) conducts a simulation on palm oil export levies with a percentage of 16% for provinces and 64% for regencies and cities. The result shows that, from the export levy income in 2019 of IDR 11.69 trillion, it is estimated that around IDR 1.8 trillion can be obtained for the provincial government, and IDR 7.5 trillion for palm oil producing regencies/city governments.[172] Such a profit-sharing system is not equivalent to the impact of oil palm plantations, such as infrastructural damage due to the transportation of CPO to environmental damage which results in water, soil, and air pollution, as well as forest and land fires.

With this imbalance, the goal of making biofuels part of strengthening the local economy (including poverty alleviation) becomes difficult to achieve. It is not surprising that the implementation of the biofuels policy is ultimately seen as only benefiting a handful of groups. Such a situation is of course not only a matter of direct application of biofuels, but is also closely related to the dominance of CPO (palm oil)-based biodiesel in biofuels policy in Indonesia.

3.4.4 Biofuels and Food

Another crucial issue in the development of biofuels in Indonesia relates to its impact on food security. Food security, based on the Global Good Security Index (GFSI) , is achieved when a country is able to ensure food affordability, availability, safety, and resilience. Given the fact that currently the feedstocks for biofuels in Indonesia is dominated by palm oil, there are two main challenging scenarios concerning food security, i.e., the competition between palm oil as food and fuel commodity and the possibility of conversion of agricultural land into oil palm plantations.

In the first scenario, most of the oil palms used for biofuel production in Indonesia are initially grown for consumption needs. In Indonesia, palm oil is used as a feedstock for many processed foods due to its abundant availability and low price. It becomes a great concern that the development of biofuels in Indonesia could lead to the competition between the need for food and the need for fuel, which could result in a reduced supply of palm oil for food needs and ultimately an increase in food prices. This situation is often referred to as the 'food vs. fuel'.[173]

On the other hand, the development of biofuels also allows the conversion of land functions, including agricultural land. Some farmers have shifted from managing paddy fields or vegetable plantations to opening oil palm plantations, as currently happened in Kalimantan.[174] Therefore, a decrease in food supply can occur due to the de-escalation of usable land area or the shift of food commodity farmers to oil palm planters. Research by Madani Berkelanjutan (2020) proves that four

[171] Madani Berkelanjutan (2020). *Madani Insight: Nilai Ketimpangan Ekonomi Sawit*. Jakarta: Madani Berkelanjutan

[172] Auriga Nusantara (2021). *Bahan Presentasi dalam acara Tiga Bulan Bicara Sawit: Fakta dan Data Sawit Indonesia 16 Desember 2021 dengan judul Rekomendasi Bagi Sawit Indonesia.*

[173] Jupesta, Joni (2010). Impact of the Introduction of Biofuel in the Transportation Sector in Indonesia. *Journal of Sustainability*, 2, 1831-1848. DOI: 10.3390/su2061831.

[174] Kinley, D. (2015) *Foreword - The Palm Oil Industry and Human Rights: A Case Study of Palm Oil Corporations in Central Kalimantan*. Sydney Law School Research Paper No. 15/27. Accessed from https://ssrn.com/abstract=2596422.

out of seven regencies in Riau with a substantially domineering area of oil palm compared to other plantations are in the critical level of food insecurity.[175]

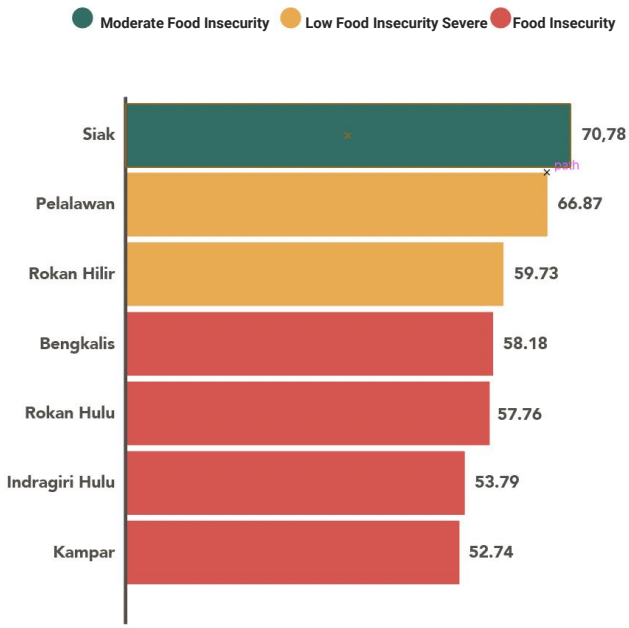

Figure 25. Food security index values in 7 regencies in Riau

Source: Madani Berkelanjutan (2020)[176]; Article 11 Paragraph 2 of Law No. 33 of 2004 on Financial Balance between the Central Government and Local Government.

Oil palm plantation operations also affect food supply, especially fish.[177] It occurs because the river was polluted by plantation waste, which disrupted the distribution and supply of fish as a food source.

3.5 Dynamics of Biofuel Use and Social Issues

In the midst of domination of palm-based feedstocks, human rights violations, land conflicts, and gender discriminations have also coloured the discourse on the development of biofuels as a derivative issue from the social dimension of oil palm plantations. Moreover, social issues in the development of biofuels as a fuel offered to consumers frequently invite various responses. This issue has received less attention in the context of the entire biofuel supply chain. The following section looks at various social issues found in the literature related to the development of biofuels so far.

[175] Madani Berkelanjutan (2020). *Madani Insight Volume VI: Gambaran Industri Sawit Indonesia, Menjawab Asumsi dengan Fakta dan Angka.* Jakarta: Madani Berkelanjutan.

[176] Madani Berkelanjutan (2020). *Madani Insight: Nilai Ketimpangan Ekonomi Sawit*. Jakarta: Madani Berkelanjutan.

[177] Santika, T., Wilson, K.A., Meijaard, E., & Budiharta, S. (2019). Changing Landscapes, Livelihoods and Village Welfare in the Context of Oil Palm Development. *Land Use Policy*, 87, ISSN 0264-8377.

3.5.1 Responsibilities of Social Actors

One of the key actors in the development of biofuels in Indonesia is PT Pertamina, as a government-appointed state enterprise to conduct the mandatory biodiesel programme.[178] As part of the state apparatus, as set forth in the UN Guiding Principles, PT Pertamina is obliged to respect human rights.[179] However, a study by Ahsinin *et al*. found that PT Pertamina has not properly implemented traceability aspects in its biodiesel supply chain. [180] This is unfortunate considering how the feedstocks used may be obtained from plantations with ambiguous human rights principles, i.e., violations of workers' rights, land acquisition processes without proper principles of free prior informed consent (FPIC), and the presence of underage workers.

Additionally, PT Pertamina's Code of Business Conduct and Ethics as a reference for its partners has not yet implemented the principles of human rights due diligence to determine what actions have been planned and carried out to mitigate the human rights impacts of its operations. Regarding FPIC, PT Pertamina also does not yet have a mechanism regulating victims affected by operations by PT Pertamina's partner company to submit complaints to PT Pertamina, and therefore the mechanism is only limited to those directly affected by PT Pertamina's operations.

With palm oil as the dominant commodity, the challenges in developing biofuels in Indonesia are even greater as, apart from being controlled by many large corporations, it faces many challenges, especially concerning human rights.

3.5.2 Human Rights Issues

Apart from palm oil as a feedstock for biodiesel, the palm commodity basically still has various fundamental problems related to human rights violations, including unfair work systems, occupational health and safety issues, low wages, poor living conditions, gender discrimination, and labor issues hidden from audits.[181]

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[178] MEMR Decree No. 252/2020 on Stipulation of Fuel Business Entities and Biodiesel Business Entities and Allocation of Volume Ratio for Blending Fuel Oil-type Diesel Oil for the period of January-December 2021.

[179] Barnes, Mihaela-Maria (2019) State-Owned Entities as Key Actors in the Promotion and Implementation of the 2030 Agenda for Sustainable Development: Examples of Good Practices. *Laws, MDPI*, 8(2), 1-22. Accessed from https://www.mdpi.com/2075-471X/8/2/10/htm#fn063-laws-08-00010.

[180] Ahsinin, A., Karunian, A.Y., & Fuad, M.B. 2020. *Menempatkan PT. Pertamina (Persero) sebagai Aktor Kunci dan Teladan dalam Penghormatan HAM dan Perlindungan Lingkungan: Pengembangan Kebijakan Biofuel sebagai Modalitas dalam Mewujudkan Produk Biofuel yang Berkelanjutan*. Policy Brief. Jakarta: Elsam

[181] Assalam, R. & Sitorus, H.P. (2018). *Keuntungan di Atas Manusia: Kondisi di Bawah Rantai Pasokan Perkebunan Sawit Milik Sinar Mas*. Jakarta: Sawit Watch.

The palm oil production system also possesses issues concerning the position of women in the commodity production chain. Gender discrimination makes women vulnerable to violence and sexual harassment. This occurs, among others, in the process of recruiting casual workers or workers outside of oil palm plantations, in which foremen often manipulate and ask for compensation from women they are attracted to if they want to be recruited.[182]

As a derivative of issues concerning human rights, the gender aspect has also become one of the highlights in the context of oil palm plantations and the implementation of biofuels in general. Women are important actors in the management of oil palm plantations.[183] Nonetheless, a study by Dewi *et al*. prove that the policies and regulations for managing palm oil as the major feedstock for biofuels and the management of biofuels itself have evaded the issue of gender empowerment in order to achieve gender equality as a priority.[184] As a matter of fact, women face various evident challenges, i.e., women's rights in managing land and workers' rights for women, all in dire need of attention.[185]

Furthermore, the work environment in oil palm plantations exhibits gender inequality, making women's rights as workers unfulfilled.[186] For instance, in the formulation of a decision concerning a farmer cooperative, members, which are dominated by men, often exclude women from the decision-making processes.[187] This inequality is also found in other matters, i.e., the recruitment process, work status, and wages for women workers.[188] Women workers who work on plantations are usually the wives of permanent workers, and they are often employed in maintenance duties and casual labour jobs whose wages are based on a unit of output. Women workers are also frequently recruited from "pockets of cheap labour".[189]

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[182] Elsam (2010). *Pelanggaran Hak Asasi Manusia di Kawasan Perkebunan Kelapa Sawit PT PP Lonsum Tbk-Sumatera Utara.* Position Paper. Jakarta: Sawit Watch

[183] Uwin, S. (2020) Perempuan dan Perkebunan Kelapa Sawit: Studi Kasus di Kabupaten Sekadau, Provinsi Kalimantan Barat. *SPKS Nasional*. Accessed from https://www.spksnasional.or.id/research/perempuan-danperkebunan-kelapa-sawit/.

[184] Dewi, S.N., Heroepoetri, A., & Leonard, S. (2018). *Effectively Integrating Human Rights and Gender Equality into EU Climate Actions, a Case of Palm Oil for Biofuels in Indonesia*. Heinrich Boll Stiftung.

[185] Dewi, S.N., Heroepoetri, A., & Leonard, S. (2018). *Effectively Integrating Human Rights and Gender Equality into EU Climate Actions, a Case of Palm Oil for Biofuels in Indonesia*. Heinrich Boll Stiftung.

[186] Moreno-Penaranda, R., Gasparatos, A., Stromberg, P., Suwa, A., & de Oliveira, Jose A. Puppim (2019). Stakeholder perceptions of the ecosystem services and human well-being impacts of palm oil biofuels in Indonesia and Malaysia. Dalam Takeuchi, K., Shiroyama, H., Saito, O., & Matsuura, M. (eds.). *Biofuels and Sustainability, Science for Sustainable Societies*. Accessed from https://doi.org/10.1007/978-4-431-54895-9_10.

[187] Li, T.M. (2015). *Social impacts of oil palm in Indonesia: a gendered perspective from West Kalimantan*. Bogor: Center for International Forestry Research (CIFOR).

[188] Wright, A. (2014). Socio-Economic Impacts of Palm Oil and Biodiesel: The Case of Indonesia. Dalam Rutz D. & Janssen R. (eds). *Socio-Economic Impacts of Bioenergy Production*. Springer, Cham. Accessed from https://doi.org/10.1007/978-3-319-03829-2_9.

[189] Yason, N., Yulyanus, M.M., Juwanda, Y., Baru, M., Pengkik, D. (2020). *Baseline Study Memetakan Kondisi Perburuhan di Perkebunan Sawit Tanah Papua*. Elsam: Jakarta

3.5.3 Land Conflict

Another challenge in implementing biofuels from the oil palm plantation sector is land conflict. Generally, there are four types of land conflicts which often occur in Indonesia,[190] i.e., conflicts between (i) local communities and companies/corporations, (ii) farmers and companies, (iii) local communities and the State-owned Forestry Company (Perum Perhutani), as well as indigenous people and companies.

Land conflicts generally occur due to differences in the basis of land claims between the parties involved. The company uses a formal claim basis, while local communities or indigenous people use a non-formal historical claim basis.[191] In the context of oil palm plantations, land conflicts are caused by several elements, such as land disputes, overlapping concessions, unclear partnership programmes, environmental degradation involving plantation companies, as well as conflicts already existing between local communities and security forces and company-assisted paramilitary forces.[192]

Apart from that, the frequent cause of conflict is the failure of the implementation of FPIC on local residents. The process of land acquisition often ignores customary rights [193] and local communities. Locals are often oblivious and given incomplete information of any development plan for a plantation.[194] This kind of information is significant considering the ecological impact of oil palm plantation operations on communities which are highly dependent on the environmental services provided by forests. Corruption in the issuance of licenses is another factor which triggers conflicts. The practice of corruption has affected the large expansion of oil palm plantations, which has sparked social conflicts and violence with local communities.[195] Over time, the company becomes a greater authority guaranteed by the government[196], thereby increasing the possibility of corruption. Additionally, due to the company's great influence, even though migrant residents and transmigrant communities possess legal land ownership from the government, they still lose theirs due to the expansion of oil palm plantations. Those who are reluctant to agree with plantation expansion often experience intimidation and even threats of being prosecuted in court.[197]

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[190] Perkumpulan HuMa (2012). *Outlook Konflik Sumberdaya Alam dan Agraria 2012.* Perkumpulan HuMa: Jakarta.

[191] Perkumpulan HuMa (2012). *Outlook Konflik Sumberdaya Alam dan Agraria 2012.* Perkumpulan HuMa: Jakarta.

[192] Sawit Watch (2014). Kaleidoskop Perkebunan Sawit 2014: Tugas Menyelesaikan Warisan Konflik di Sektor Perkebunan Sawit. *Tandan Sawit Edisi No. 8/Desember 2014*. Accessed from http://sawitwatch.or.id/wp-content/uploads/2015/01/Tandan-Sawit-No-8.pdf; Andreanto, G. (2014). Bias Arah Reforma Agraria Jokowi-Jusuf Kalla. *Jurnal Land Reform, Konsorsium Pembaruan Agraria*.

[193] Colbran, N. (2011) Indigenous Peoples in Indonesia: At Risk of Disappearing as Distinct Peoples in the Rush for Biofuel? *International Journal on Minority and Group Rights*, 18(1), 63–92. Accessed from http://www.jstor.org/stable/24675811.

[194] Koaksi Indonesia (2018). *Dinamika Hulu Hilir Industri Biodiesel di Indonesia*. Jakarta: Koaksi Indonesia

[195] Simon, Gumilang, A., Harizajudin, Andriyanu, B., Asurambo, Parsaoram, H., Siahaan, R., & Peranginangin, J. (2015). *Menakar Sawit: Riset Kawasan, Korupsi, dan Pendapatan Daerah*. Bogor: Sawit Watch.

[196] Rietberg, P.I. & Hospes, O. (2018). Unpacking land acquisition at the oil palm frontier: Obscuring customary rights and local authority in West Kalimantan, Indonesia. *Asia Pacific Viewpoint*, 59(3).

[197] Human Rights Watch Indonesia (2021). *Mengapa Tanah Kami? Ekspansi Perkebunan Kelapa Sawit di Indonesia Membahayakan Lahan Gambut dan Penghidupan Masyarakat*. Jakarta: Human Rights Watch Indonesia.

As a result, agrarian conflicts have been rife, even during the coronavirus disease 2019 (COVID-19) pandemic and the implementation of Presidential Instruction No. 8 of 2018 on Postponement and Evaluation of Licensing for Oil Palm Plantations and Increasing the Productivity of Oil Palm Plantations (Presidential Instruction on Palm Oil Moratorium). According to the records of the Consortium for Agrarian Reform, in 2020 the total agrarian conflicts that occurred amounted to 101 conflicts caused by palm oil plantations.[198] Even before the pandemic, land conflicts often took place (69 conflicts in 2019 and 83 conflicts in 2018).

The Palm Oil Moratorium Coalition also found 108 cases of conflicts in forest areas as of March 2019.[199] On top of that, within a year of the implementation of Instruction on Palm Oil Moratorium or in 2019, there were 11 agrarian conflicts spread across several provinces, such as Central Sulawesi, Riau, North Sumatra, Aceh, Papua, Central Kalimantan, and North Kalimantan.[200] Meanwhile, at the regional level, agrarian conflicts were found due to oil palm plantation operations. For example, in 2014, East Kotawaringin Regency found 70 cases of land conflicts; 60 of these were conflicts between oil palm plantation companies and communities.[201]

3.6 Summary of Challenges in Biofuel Governance in Indonesia

Public perceptions which are quite positive towards biofuels policy in Indonesia need to be supported by improved governance. In the context of commodity management in biofuel production chain, palm oil—as the main commodity for biofuel feedstocks in Indonesia—still faces a number of challenges, i.e., overlap between palm oil permits and other permits as well as customary territories, palm oil permits located in forest areas, land legality, and land productivity. Apart from these challenges, another issue found in palm oil—as well as other commodities, such as cassava, corn, and sugarcane, is the issue of seed quality and farmer capacity in implementing GAP.

The biofuel development policy as a strategy to strengthen the national and regional economy needs adequate support. Unfortunately, in the economic context, biofuels policy in Indonesia faces various challenges, i.e., the involvement of farmers in the biofuel production chain, the value of biofuel contributions to regional development, the enormous palm oil levies channeled into biodiesel incentives/subsidies, and the food vs fuel discourse. Additionally, the issues of land conflicts, human

198 Konsorsium Pembaruan Agraria (2021). *Catatan Akhir Tahun 2020 Konsorsium Pembaruan Agraria, Edisi Peluncuran I: Laporan Konflik Agraria di Masa Pandemi dan Krisis Ekonomi*. Accessed from http://kpa.or.id/publikasi/baca/laporan/92/Catahu_2020_KPA_Edisi_I:_Laporan_Konflik_Agraria_di_Masa_Pandemi_dan_Krisis_Ekonomi/ on 24 June 2022

199 Koalisi Moratorium Sawit (2019). *Shadow Report – Kemana Arah Implementasi Inpres No. 8 Tahun 2018?* Accessed from https://sawitwatch.or.id/2019/05/27/shadow-report-kemana-arah-implementasi-inpres-no-8-tahun-2018-moratorium-sawit-berjalan/

200 Koalisi Moratorium Sawit (2019). *Implementasi Inpres Moratorium Sawit: Jauh Panggang dari Api?* Accessed from http://sawitwatch.or.id/2020/09/01/laporan-satu-tahun-implementasi-inpres-moratorium-sawit/ on 24 June 2022.

201 Syafii, I. (2016). Konflik Agraria di Indonesia: Catatan Reflektif Konflik Perkebunan Sawit di Kotawaringin Timur. *Jurnal Masyarakat dan Budaya*, 18(3). DOI: https://doi.org/10.14203/jmb.v18i3.572.

rights violations, and gender inequality in commodity management, especially palm oil, also need to be resolved to increase the welfare of the actors involved in the biofuel production chain.

In point of fact, Indonesia possesses the potential to develop other commodities other than palm oil as a feedstock for biofuels, especially when viewed from the potential availability of existing land. Based on the results of spatial analysis by Madani Berkelanjutan, there are at least 2.27 million hectares of land which can be developed for several feedstocks, such as castor tree, sugar cane, sugar palm, areca nut, corn, sweet potato, cassava, and coconut. Apart from food crops, Indonesia has great potential to also develop non-food crops, such as tamanu, *reutealis* (Philippine tung), pongame oiltree, *calliandra*, and *gliricidia* (quick stick). These plants can even be developed on a degraded land area of 3.5 million hectares. Unfortunately, the economic value and market stability of these feedstocks are challenges to be carefully overcome to encourage the participation of the community and business actors in developing other feedstock commodities for biofuels; and that way, their diversification can be realized.[202]

The management and future use of biofuels in Indonesia should not only be observed at the national scale, but also at the local one. This means that the fulfillment of energy at the village scale by using biofuels also needs to be considered in the policies. This is a necessary step to ensure that the spirit of developing and using biofuels cannot be separated from the spirit of realizing energy independence.

[202] Artati, Y., Wanggi Jaung, Juniwaty, K.S., Andini, S., Lee, S.M., Segah, H., & Baral, H. (2019). Bioenergy Production on Degraded Land: Landowner Perceptions in Central Kalimantan, Indonesia. *Forests*, 10, 99. DOI: 10.3390/f10020099.

Chapter 4. Biofuel Policy in Indonesia: Quo Vadis?

Looking back at the dynamics of the discourse on biofuels in Indonesia, there are various points of view. There is a lot of unfinished business in distribution and the environmental aspects. Nevertheless, the government has been quite enthusiastic about putting biofuel development ideas into practice through a requirement for biodiesel-type biofuel since 2008. The government's optimistic attitude is mostly driven by reasons for incrementing domestic CPO stocks, in this case, the biggest source is palm oil-based biodiesel biofuel. As a choice of policy, it is not completely wrong, but it will be wrong when they do not consider the impact of this policy.

The goal of Indonesia's biofuel policy is currently a big question. As of today, biofuel development policies in Indonesia are mostly focused on one type of fuel (biodiesel) made from one commodity (palm oil). Planning for the long run is still fraught with uncertainty. In implementing the currently running B30 blending mandate, several technical[203] and distribution problems occur. The big difference in index prices between regular diesel and biodiesel is another reason why biodiesel distribution is over-reliant on economic incentives.[204] If the financial incentives (subsidies) are discontinued, it is still unknown if biodiesel may be used. As an alternative and renewable fuel, it is common to rely on economic incentives, especially to stimulate market and innovation growth in renewable energy.[205] Nonetheless, a fair, measurable, transparent, and accountable system is also necessary for these incentives. In Indonesia, especially in the development of biofuels, the measurability of the implementation of economic incentives has not been conducted. As a result, economic incentives failed to grow innovation and market stimulation, instead, it created dependence.

Until today, the government has not built any scenarios or implementation plans for biofuels. Despite having a biofuel roadmap since 2006, this roadmap is used in the current implementation of biofuel policies. Therefore, there is a significant urgency to clarify the direction of the development and implementation of biofuel policies in Indonesia.

4.1 The Economic Value of Biofuels in the National Context

The biofuel policy is designed to answer several problems, especially in the economic context. It is evidenced by the issuance of Presidential Decree No. 10/2006 on the National Team for Biofuels Development for the Acceleration of Poverty and Unemployment Reduction. The Decree states that the objectives of the biofuel development policy are to reduce poverty and unemployment, promote long-term economic growth by providing biofuels, and reduce the consumption of fossil fuels.

[203] Ravel, S. (2020). Ragam Masalah Biosolar B30, retrieved from Usia Filter Sampai jadi Gel. *Kompas.com*. Accessed from https://otomotif.kompas.com/read/2020/02/13/071200315/ragam-masalah-biosolar-b30-dari-usia-filter-sampai-jadi-gel?page=all on January 18, 2021.

[204] The index price of biodiesel in January 2022 is Rp13.177 (https://ebtke.esdm.go.id/post/2022/01/12/3051/harga.indeks.pasar.hip.bahan.bakar.nabati.bbn.jenis.biodiesel.bulan.januari.2022). The index price of diesel in January 2022 is Rp7.506 (https://migas.esdm.go.id/uploads/harga-indek-pasar-/2022-hip/januari-2022---hip-solar-dalam-rangka-perhitungan-selisih.pdf).

[205] Sadie Cox. (2016). *Financial Incentives to Enable Clean Energy Development.* Clean Energy Solutions Center. Accessed from https://www.nrel.gov/docs/fy16osti/65541.pdf on June 24, 2022.

Currently, Indonesia is a net importer of fossil fuels, therefore, implementation of the biofuel policy is expected to reduce dependence on fossil fuels. In addition, fossil fuels require subsidies, which are charged to the state budget. According to the coordinating minister in the economic sector during the 2015–2019 period, Darmin Nasution, the foreign exchange savings from the B20 biodiesel program might reach US$5.5 billion, equals IDR 79.2 trillion a year.[206] The result is attainable if Indonesia fully uses B20, especially for the distribution of PSO fuel, both subsidized and unsubsidized.[207] However, in practice, the foreign exchange savings from the B20 and B30 biodiesel programs are still below the expected savings rate of IDR 79.2 trillion a year (Figure 26).

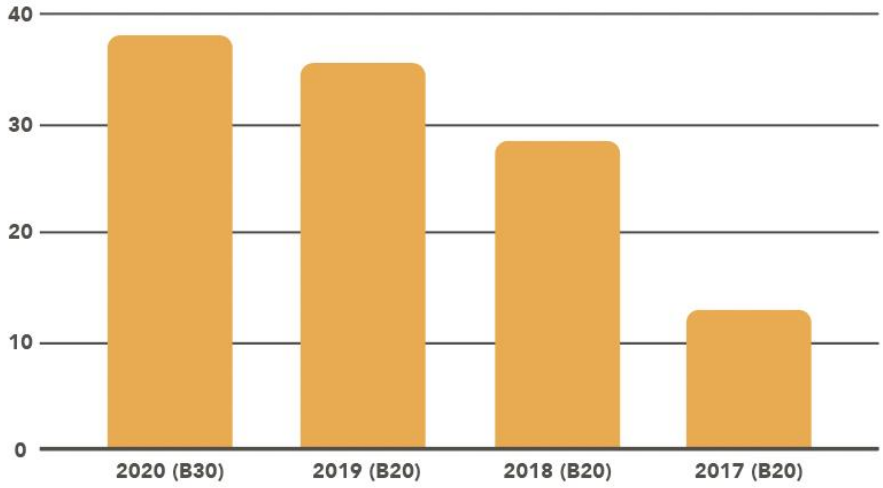

Figure 26. Foreign exchange savings from the Biodiesel Program (in trillion rupiahs)
Source: Processed from various sources.[208]

Biofuel development policies take economic aspects into account and currently focus on palm oil as a feedstock. Palm oil was chosen as the main feedstock for two reasons: (i) it is well known and has been widely cultivated, and (ii) the biofuel policy is expected to open up markets for palm oil, or CPO, which were previously used as feedstocks for non-energy industries.[209] Meanwhile, the development

[206] Alika, Rizky (2018). *Penerapan Biodiesel B20 Dapat Hemat Devisa Rp 79,2 Triliun Setahun*. Accessed from https://katadata.co.id/muchamadnafi/finansial/5e9a55e3a9fd0/penerapan-biodiesel-b20-dapat-hemat-devisa-rp-792-triliun-setahun on November 12, 2021.
[207] Alika, Rizky (2018). *Penerapan Biodiesel B20 Dapat Hemat Devisa Rp 79,2 Triliun Setahun*. Accessed from https://katadata.co.id/muchamadnafi/finansial/5e9a55e3a9fd0/penerapan-biodiesel-b20-dapat-hemat-devisa-rp-792-triliun-setahun on November 12, 2021.
[208] CNN Indonesia (2021). Serapan Biodiesel 8,4 Juta Kl Hemat Devisa Rp38,31 T di 2020. *CNN Indonesia*. Accessed from https://www.cnnindonesia.com/ekonomi/20210114161413-85-593806/serapan-biodiesel-84-juta-kl-hemat-devisa-rp3831-t-di-2020; Utami, S.S. (2020). Serapan B20 di 2019 Hemat Devisa hingga Rp35,6 Triliun. *Medcom.id*. Accessed from https://www.medcom.id/ekonomi/mikro/yKXGn4ak-serapan-b20-di-2019-hemat-devisa-hingga-rp35-6-triliun; Arvirianty, A. (2019). 4 Juta KL Biodiesel Terserap di 2018, RI Hemat Rp 28,4 T. *CNBC Indonesia*. Accessed from https://www.cnbcindonesia.com/news/20190104162742-4-49171/4-juta-kl-biodiesel-terserap-di-2018-ri-hemat-rp-284-t; Tampubolon, A.P. (n.d.*). Indonesia Clean Energy Outlook*. Accessed from http://iesr.or.id/wp-content/uploads/2019/11/IESR-ICEO-Presentation.pdf.
[209] Maulana, M., & Azis, M. (2012). Kinerja dan Prospek Pengembangan Bahan Bakar Nabati di Indonesia. *Forum Penelitian Agro Ekonomi*, 30(2). DOI: http://dx.doi.org/10.21082/fae.v30n2.2012.147-158.

of other feedstock commodities, such as *Jatropha*, faces difficulties related to unstable market conditions[210], therefore, the development of biofuels still relies on palm oil as the main feedstock.

The exorbitant price of biodiesel compared to fossil fuels is one of the drawbacks of the biofuel policy.[211] Therefore, to reach competitive prices, the government issued a biodiesel subsidy charged to the state budget and was implemented until 2015. Initially, This policy was disapproved by the House of Representatives. However, after considering indirect benefits to the farmers through the increment of farmer's FFB in the biodiesel sector and the state's efforts to build a national downstream palm oil industry, the House of Representative approved the biodiesel subsidy policy charged to the state budget.[212] However, due to the Balance of Payment (BoP) deficit, the subsidy was stopped.[213] Instead, an "incentive" policy was issued.[214] It was charged to the palm oil export levies, known as the palm oil fund. The regulatory basis for this policy is the issuance of Government Regulation No. 24 /2015 on the Collection of Plantation Funds, and Presidential Decree no. 61/2015 on the Collection and Appropriation of Oil Palm Plantation Funds.

Most palm oil funds, managed by the Indonesian Palm Oil Plantation Fund Management Agency (BPDPKS), are allocated for biodiesel incentives. During 2015–2019, the allocated palm oil funds reached IDR 33.6 trillion and the subsidized funds for biodiesel supply reached IDR 30.2 trillion, or 89.86%.[215] It shows that the government provides support for the development of biofuels, especially biodiesel. In this case, it is necessary to take a closer look at the incentives for biofuel (biodiesel), to avoid overburden on the state budget. For example, through the PEN program, the government covered this incentive for IDR 2.78 trillion in 2020.[216]

A study from the Institute for Economic and Social Research of the University of Indonesia (LPEM UI) on the incentives for biodiesel policies shows that the impact of these incentives is largely determined by subsidies on the two commodities that make up biodiesel: diesel and FAME. The FAME incentive is calculated based on the difference between the biodiesel index price and diesel index price, plus transportation and freight costs.[217]

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[210] Syakir, M. (2010). Prospek dan Kendala Pengembangan Jarak Pagar (Jatropha curcas L.) sebagai Bahan Bakar Nabati di Indonesia. *Jurnal Perspektif*, 9(2); Artati, Y., Wanggi Jaung, Juniwaty, K.S., Andini, S., Lee, S.M., Segah, H., & Baral, H. (2019). Bioenergy Production on Degraded Land: Landowner Perceptions in Central Kalimantan, Indonesia. *Forests*, 10, 99. DOI:10.3390/f10020099.

[211] Directorate of Energy, Minerals Resources and Mining of The Ministry of National Development Planning Republic of Indonesia (2015). *Kajian Pengembangan Bahan Bakar Nabati (BBN)*. Jakarta: The Ministry of National Development Planning Republic of Indonesia.

[212] Koaksi Indonesia (2018). *Dinamika Hulu Hilir Industri Biodiesel di Indonesia*. Jakarta: Koaksi Indonesia.

[213] Ministry of Energy and Mineral Resources Research and Development Agency (2021). *Biodiesel, Jejak Panjang Sebuah Perjuangan*. Jakarta: Ministry of Energy and Mineral Resources Research and Development Agency.

[214] The term incentive is used because, according to some biodiesel business actors, the funds collected are not from the state budget, thus it is not appropriate to be considered subsidies (Sumber: Koaksi Indonesia (2018). *Dinamika Hulu Hilir Industri Biodiesel di Indonesia*. Jakarta: Koaksi Indonesia.

[215] Pandelaki, T. (2021). *Menakar Keseriusan Pemerintah Bantu Petani Swadaya*. Accessed from https://www.mongabay.co.id/2021/02/20/menakar-keseriusan-pemerintah-bantu-petani-sawit-swadaya/ on August 21, 2021.

[216] Indrawan, Rio (2020). *Pastikan B30 Tetap Jalan, Pemerintah Talangi Rp 2,78 Triliun Kekurangan Dana Insentif Biodiesel*. Accessed from https://www.dunia-energi.com/pastikan-b30-tetap-jalan-pemerintah-talangi-rp278-triliun-kekurangan-dana-insentif-biodiesel/ on September 1, 2021.

[217] LPEM FEB UI (2020). Risiko Kebijakan Biodiesel dari Sudut Pandang Indikator Makroekonomi dan Lingkungan. Jakarta: Indonesia.

Table 12. The differences between diesel subsidies and biodiesel subsidies

Aspects	Diesel Subsidies	FAME Subsidies
Subsidy cost calculation	Maximum subsidy per liter is determined by the government for one fiscal year	Formula: Index price of biodiesel - Index price of diesel + transportation costs/freight (varies per region). In the case index price of biodiesel ≤ the index price of diesel, the subsidy is on hold.
Funding	Charged to state budget	Source: BPDPKS (charged to CPO export levies and state budget through PEN)
Example of subsidy value	Maximum IDR 2,000 per liter (in 2018) Maximum IDR 2,000 per liter (in 2019)	IDR 3,043 per liter (in 2018) IDR 1,194 per liter (in 2019)

Source: Institute for Economic and Social Research of the University of Indonesia (LPEM FEB UI, 2020).[218]

Furthermore, the study made two scenarios to compare the impact of FAME and diesel subsidies on biodiesel subsidies. In the scenario where the FAME subsidy is greater than the diesel subsidy, a greater biodiesel mixture results in the greater biodiesel subsidy (directly proportional). In the scenario where the diesel subsidy is greater than the FAME subsidy, a greater biodiesel mixture results in a smaller biodiesel subsidy (inversely proportional).[219] Therefore, since it is over-reliant on the two biodiesel-forming commodities, it is urgent to consider the impact of biodiesel incentives on the state budget.

Another LPEM UI study shows that the accumulation of the difference between the savings on diesel imports and the potential loss on CPO exports from 2020 to 2025 is positive. This means that for each scenario created, the value of saving on diesel imports is higher than the CPO exports losing value. Therefore, the more aggressive the biodiesel policy, the higher the budget savings will be.[220]

Table 13. Calculation Summary of the Biodiesel Policy Impact on the Current Account (in Trillion Rupiahs)

Scenarios	(Basic) Imported Biodiesel = 100% Diesel	Imported Diesel	Savings on Imported Diesel	Potential Loss of CPO Exports	Savings on Imported Diesel – Potential Loss of CPO Exports
Scenario 1 (B20)	3.999	3.199	799	782	17

[218] LPEM FEB UI (2020). *Risiko Kebijakan Biodiesel dari Sudut Pandang Indikator Makroekonomi dan Lingkungan*. Jakarta: Indonesia.
[219] LPEM FEB UI (2020). *Risiko Kebijakan Biodiesel dari Sudut Pandang Indikator Makroekonomi dan Lingkungan*. Jakarta: Indonesia.
[220] LPEM FEB UI (2020). *Risiko Kebijakan Biodiesel dari Sudut Pandang Indikator Makroekonomi dan Lingkungan*. Jakarta: Indonesia.

Scenario 2 (B30)	3.999	2.799	1.199	1.154	44
Scenario 3 (B50)	3.999	2.096	1.903	1.825	77

Source: Institute for Economic and Social Research of the University of Indonesia (LPEM FEB UI, 2020).[221]

Based on the calculations in Table 13, the potential net savings from Scenario 1 to 3 is IDR 17 trillion–IDR 77 trillion. It is to be noted that these savings depend on the price of diesel and CPO. If the price of CPO per ton is almost the same or even exceeds the price of diesel per kilo, the net savings will be lower or even negative.[222]

4.2 Strategic Economic Value of Biofuel for Actors in the Supply Chain

Initially, the development of biofuels in Indonesia was driven by energy independence interest and the abundance of CPO production as biodiesel fuel. The government's biodiesel program has resulted in increasing biodiesel production for domestic needs every year (Figure 27).

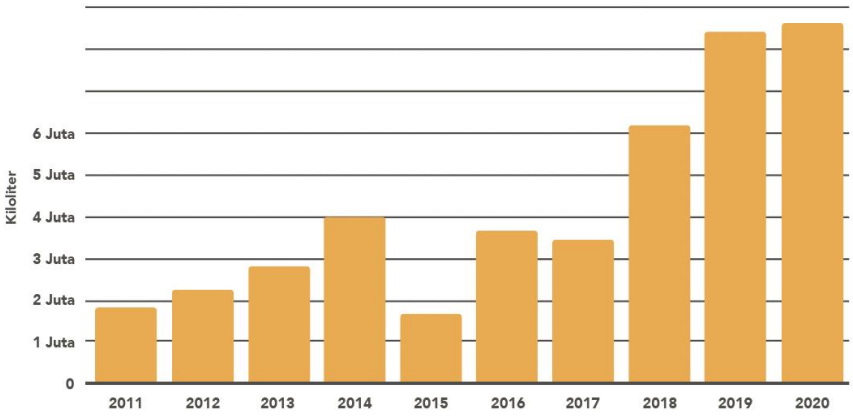

Figure 27. Biodiesel production data (2011–2020)

Source: Katadata (2021).[223]

Biodiesel production in Indonesia continued to grow throughout 2011–2020, except in 2015 (Figure 27). There are two possible causes for this anomaly. First, there was a transition of the biodiesel subsidy from the state budget to an "economic incentive" mechanism through BPDPKS. The allocation of state budget subsidies for biodiesel was not as smooth as expected, and affected CPO production.[224]. The second possibility is the natural disaster in Indonesia. El Nino in 2015 reduced the productivity of oil palm plantations.[225]

[221] LPEM FEB UI (2020). *Risiko Kebijakan Biodiesel dari Sudut Pandang Indikator Makroekonomi dan Lingkungan*. Jakarta: Indonesia.

[222] LPEM FEB UI (2020). *Risiko Kebijakan Biodiesel dari Sudut Pandang Indikator Makroekonomi dan Lingkungan*. Jakarta: Indonesia.

[223] Katadata (2021). *Produksi Biodiesel Terus Meningkat dalam Empat Tahun Terakhir*. Accessed from https://databoks.katadata.co.id/datapublish/2021/02/04/produksi-biodiesel-terus-meningkat-dalam-empat-tahun-terakhir.

[224] Koaksi Indonesia (2018). *Dinamika Hulu-Hilir Industri Biodiesel di Indonesia.* Koaksi Indonesia. Accessed from https://coaction.id/katalog/laporan-lengkap-dinamika-hulu-hilir-industri-biodiesel-indonesia/.

[225] Darlan, N.H., Pradiko, I., & Siregar, H.H. (2016). Dampak E l Nino 2015 terhadap Performa Tanaman Kelapa Sawit di Bagian Selatan Sumatera. *Jurnal Tanah dan Iklim*, 40(2), 113-120.

The increase in biodiesel production every year is expected to be in line with the initial goal of the national biofuel development policy. Aside from energy independence, another objective is poverty alleviation. This section reviews the economic impact of biodiesel production on the actors directly involved in the supply chain. Thus, it is important to examine these actors, from upstream to downstream. In the upstream sector, there are three actors: oil palm plantation entrepreneurs and farmers, palm oil mills, and BUBBN. In the middle, a fuel terminal, also known as a blending station. Downstream, there are parties for the distribution of biofuels to consumers.

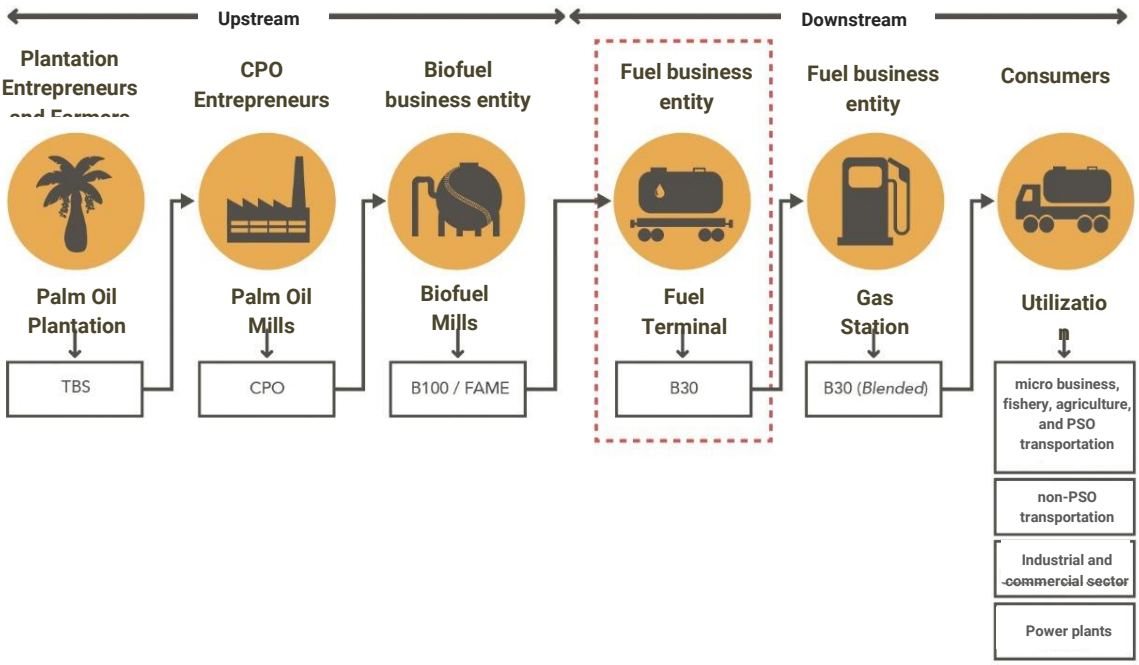

Figure 28. Overall supply chain for the B30 industry in Indonesia

Source: Koaksi Indonesia (2018).[226]

In Indonesia, most palm oil is grown and made on large private plantations. There are 54.9% large private plantations, 40% smallholder plantations, and 5.1% large state plantations. Large private plantations account for 60.6% of all palm oil production, followed by smallholder plantations for 33.6% and large state plantations for 5.8%. Farmers working on smallholder plantations are one of the main upstream actors in the biofuel supply chain, accounting for nearly half of the total area. However, despite having a strategic role, smallholder farmers are the only business actors upstream who still struggle with life.

Being a palm oil producer does not necessarily improve the welfare of the socio-economic life of independent smallholders. Sudaryadi's (2020) study of oil palm-growing areas in Siak, Riau and Sanggau in West Kalimantan shows that their social and economic indicators are low. Their low socio-economic condition comes from several aspects, such as their debt burden, side businesses to make ends meet, and low level of education (elementary school and junior high school or equivalent).

[226] Koaksi Indonesia (2018). *Dinamika Hulu-Hilir Industri Biodiesel di Indonesia*. Jakarta: Koaksi Indonesia.

A similar study concluded that a single factor that contributes to the deterioration of the social-economic conditions of rural people is the inability to transfer FFB to palm oil mills that produce biodiesel. This is supported by the fact that, based on the number of biodiesel producers in Indonesia in 2016, industrial agglomeration has yet to reach every major city in Indonesia. For example, Sumatra has more than 60% of the country's manufacturing capacity. In 2016, Sumatra had several biodiesel/BUBBN producers, whereas Kalimantan had only one biodiesel producer. Viewed from the perspective of the plantation's potential, Borneo is no less potent. The uneven distribution of biodiesel producers will lead to inefficient transportation costs to distribute FAME/B100 to various parts of Indonesia[227].

As a private sector, BUBBN as the main supplier of biodiesel (B100) gains benefit from the implementation of the Mandatory Biodiesel Program in Indonesia. The emergence and growth of BUBBN in Indonesia were driven by the implementation of the biodiesel policy. Biodiesel market guarantees are relatively well-maintained and growing, especially with government support in implementing the B30 policy. Moreover, BUBBN is free from various political upheavals at the international level related to antidumping, CPO exports, or biodiesel.

In contrast to BUBBN, BUBBM play a role in the downstream biodiesel supply chain. Its role is to mix diesel with B100 biodiesel from BUBBN to produce a biodiesel product ready for distribution to end users. Pertamina Ltd was initially a major player in downstream biodiesel. Pertamina's main business is fossil fuels, and biodiesel is potentially an additional product variant. As a BUBBM, Pertamina's main motivation is not the economy, but obligations stipulated by the government. Pertamina's responsibility is to set up blending stations and supervise distribution facilities. Currently, more and more companies are engaged in downstream biodiesel.

[227] Koaksi Indonesia (2018). *Dinamika Hulu-Hilir Industri Biodiesel di Indonesia*. Koaksi Indonesia.

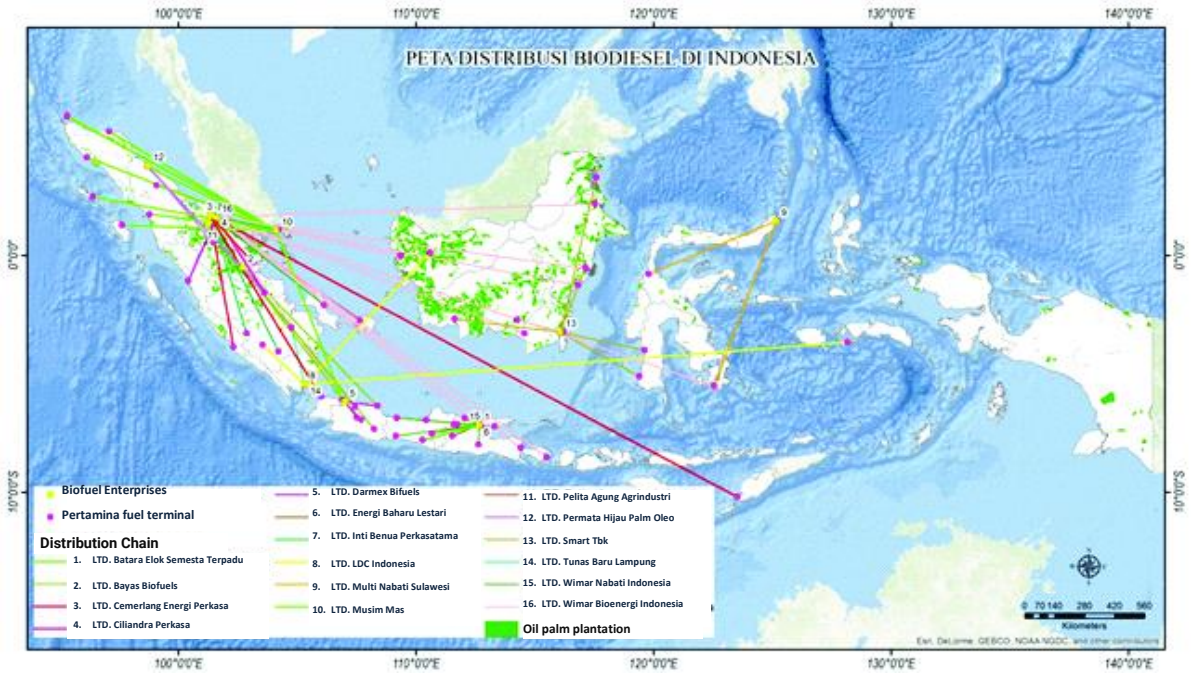

Figure 29. Distribution map of Pertamina's biodiesel plants and fuel terminals in 2016

Source: Koaksi Indonesia (2018).[228]

From an economic point of view, a review of the strategic biofuel industry for biodiesel shows that B10 marketing started in 2014. Gradually, in 2016, the B20 Mandatory Program ran well under the incentives provision by BPDPKS for the PSO sector. There are 16 BUBBNs supplying CPO to Pertamina.

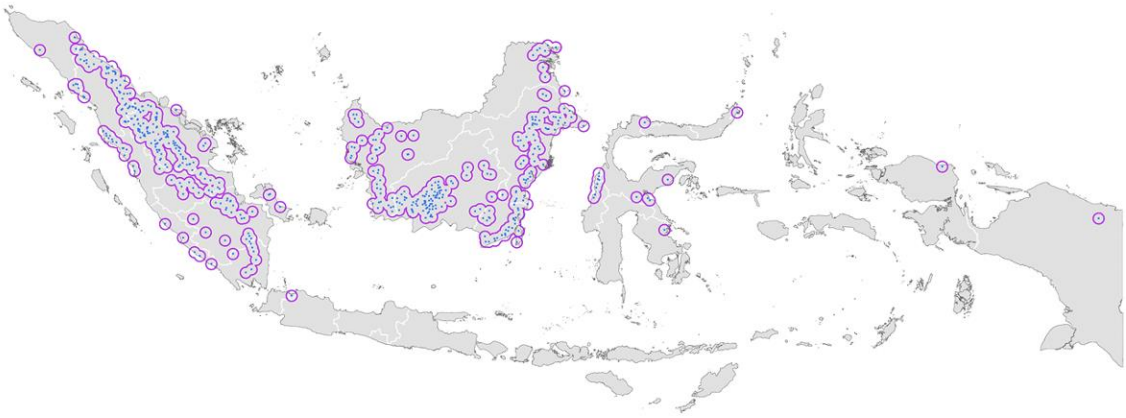

Figure 30. Distribution map of palm oil mills supplying B20 and a 25km radius of the mills' locations

Source: Forest area, land cover, forest use and planning, burnt tracks, deforestation, peat ecosystem function, Indicative Map of New Permits Termination (PIPPIB), Indicative Map of Social Forestry Areas (PIAPS), and AOI Food Estate (Geoportal of the Ministry of Environment and Forestry, 2019); oil and gas mineral and coal (DEN, 2019); oil palm

[228] Koaksi Indonesia (2018). *Dinamika Hulu-Hilir Industri Biodiesel di Indonesia*. Jakarta: Koaksi Indonesia.

permits (various sources); administrative limit (RBI 2019); customary territories (BRWA 2018); APT Madani Berkelanjutan, 2021); oil palm cover (GFW and Adrià et al., 2020 [229]).

In the location of B20 supplying mills, the potential land conflicts should be anticipated since it affects the biofuel industry as a strategic industry. In 2020, Madani Berkelanjutan noted there were at least 644 mills that supplied B20. The mills are spread across several provinces and are concentrated on two major islands, Sumatra and Kalimantan. This is in line with the vastness of oil palm plantation area on both islands. In detail, the provinces with the highest numbers are Central Kalimantan with 143 mills, East Kalimantan with 116 mills, and Riau with 106 mills.

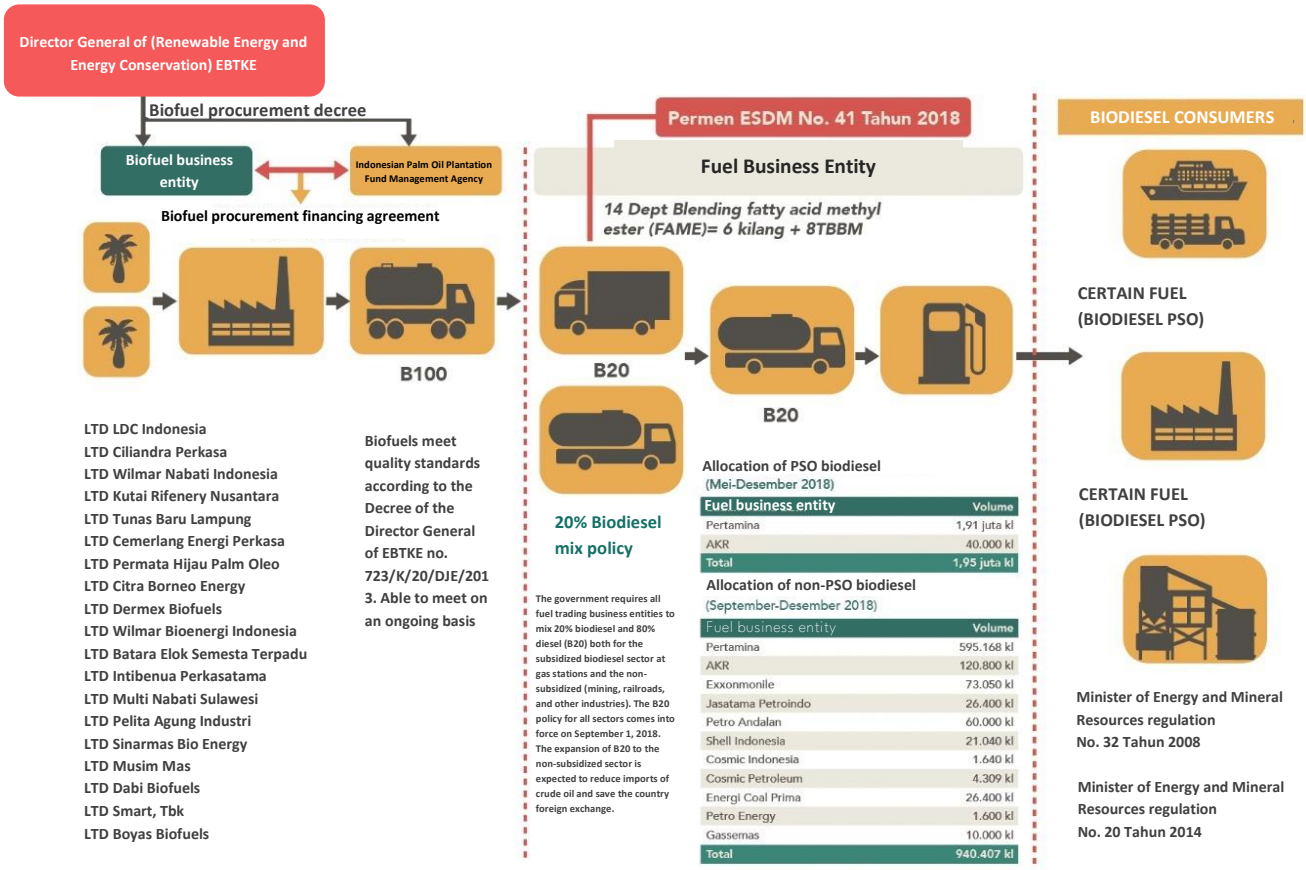

Figure 31. The supply chain of biofuels, particularly biodiesel

Source: Traction Energy Asia (2020).[230]

Starting September 1, 2018, the incentives were extended to the non-PSO sectors. There are 20 BUBBNs supplying CPO to BUBBMs under the PSO (Pertamina) and non-PSO schemes (Pertamina, AKR, Exxonmobil, Jasatama Petroindo, Petro Andalan, Shell Indonesia, Cosmic Indonesia, Cosmic Petroleum, Energi Coal Prima, Petro Energi, and Gasemas). The mandatory target sectors for biodiesel users include subsidy recipients, such as households, small and medium enterprises (SMEs)

[229] Adrià, D., Serge, W., Erik, M., David, G., Stephen, P., & Zoltan, S. (2020). *High resolution global industrial and smallholder oil palm map for 2019.* Accessed from https://zenodo.org/record/3884602#.YHRurD8xWUn.

[230] Traction Energy Asia (2020). *Rantai Pasok CPO Pekebun Mandiri dalam Skema Tata Niaga Biodiesel*. Jakarta: Traction Energi Asia.

in the agricultural sector, and transportation, as well as non-subsidized transportation, commercial industry, and power plants.

In 2020, the government designated 20 BUBBNs for biodiesel production, and the regulation was in the Decree of the Minister of Energy and Mineral Resources No. 252.K/10/MEM/2020, declared on December 18, 2020.[231] The number of companies registered as BUBBNs will grow by 2021. Forty-one BUBBNs were granted licenses to operate biofuel with a total capacity of 14,75 million kiloliters (kl), comprising 27 active BUBBNs and 14 inactive BUBBNs. In addition, one enterprise was constructing a biodiesel plant with a capacity of 478.000 kl and three enterprises were constructing a new biodiesel plant with a capacity of 1,57 million kl and were granted permits in 2021.[232] With increased capacity, 20 BUBBMs were involved in biodiesel downstreaming (Table 14).

Table 14. List of BUBBMs in 2021

No.	Daftar BUBBM	No.	Daftar BUBBM
1	PT Pertamina Persero	11	PT Jagad Energy
2	PT AKR Corporindo	12	PT Petro Energi Samudra
3	PT Exxonmobil Lubricants Indonesia	13	PT Baria Bulk Terminal
4	PT Jasatama Petroindo	14	PT Mitra Andalan Batam
5	PT Petro Andalan Nusantara	15	PT Sinaralam Dutaperdana II
6	PT Shell Indonesia	16	PT Inti Lingga Sejahtera
7	PT Cosmic Indonesia	17	PT Pec Tech Service Indonesia
8	PT Cosmic Petroleum Nusantara	18	PT Multi Trading Pratama
9	PT Energi Coal Prima	19	PT Mitra Utama Energi
10	PT Gasemas	20	PT Bahari Berkah Madani

Source: Decree of MEMR on Determining Biodiesel-type BUBBM and BUBBN and the Allocated Volume for Mixing Diesel Fuel Oil for the January-December 2021 Period.

Table 15. Summary of Mandatory Biodiesel Program Implementation

Parameter	2014	2015	2016	2017	2018	2019	2020	2021
% Mixture	10%	15%	20%	20%	20%	20%	30%	30%
Volume Biodiesel (Juta kl)	1,84	0,92	3	2,57	3,7	6,3	8,4	9,2
The number of BUBBN	Skema B to B	11	16×	19	19	19	19	20
The number of BUBBM	2	2	2	2	11	18	19	20
Delivery point	Skema B to B	Skema B to B	75	66	66	48	56	72
Freight cost	Included in the index price			609 M	557 M	1.399 M	2.503 M	1.742 M*
The average of OA/litre	-			267	239	332	317	382*
Information	Skema B to B	BPDPKS	BPDPKS	BPDPKS	BPDPKS	BPDPKS	BPDPKS	BPDPKS

*current year

Source: Processed by Madani Berkelanjutan from various sources.

[231] Direktorat Jenderal EBTKE (2020). *20 Badan Usaha BBN Akan Salurkan Biodiesel 9,2 Juta KL di 2021*. Accessed from https://ebtke.esdm.go.id/post/2020/12/22/2745/20.badan.usaha.bbn.akan.salurkan.biodiesel.92.juta.kl.di.2021.

[232] Direktorat Jenderal EBTKE (2020). *20 Badan Usaha BBN Akan Salurkan Biodiesel 9,2 Juta KL di 2021*. Accessed from https://ebtke.esdm.go.id/post/2020/12/22/2745/20.badan.usaha.bbn.akan.salurkan.biodiesel.92.juta.kl.di.2021.

At the moment, Indonesia is the first country in the world to have achieved a 30% increase in solar energy through the Biodiesel B30 program. Other countries, such as Argentina, Brazil, and the United States, are now introducing B10, B12, and B20.[233] The EBTKE Directorate of the MEMR has set a target of $9.2 billion in biodiesel volume by 2021. This amount will be used for blending 30% biodiesel into diesel fuel (B30). This consideration arises from the realization of biodiesel distribution in 2020. By the end of December 2020, the projected realization was 8.5 million kl, or 88% of the target of 9.6 million kl. The causes for the 12% decline were, among others, the COVID-19 pandemic and the failure to supply several BUBBNs in the distribution of biodiesel.[234]

Currently, the biodiesel (B100) industry from palm oil is dominating, however, it is possible that the Indonesian government might enhance for the development of liquid biofuels from non-palm oil commodities and/or in the form of bioethanol (E100) and pure vegetable oil (O100). The bioethanol mandatory program is outlined in the Minister of Energy and Mineral Resources Regulation No. 16/2020 (Figure 3). Similar to biodiesel, the index price for biofuel-type bioethanol is regulated and issued periodically by the Directorate General of Mineral and Coal Budgeting. In August 2021, the regulation was addressed to several producers, such as Pertamina Ltd, the Association of Companies Holding General Trading Permits for Oil Fuel, the Association of Indonesian Biofuels Producers (Aprobi), and the Indonesian Spiritus and Ethanol Association (Asendo).

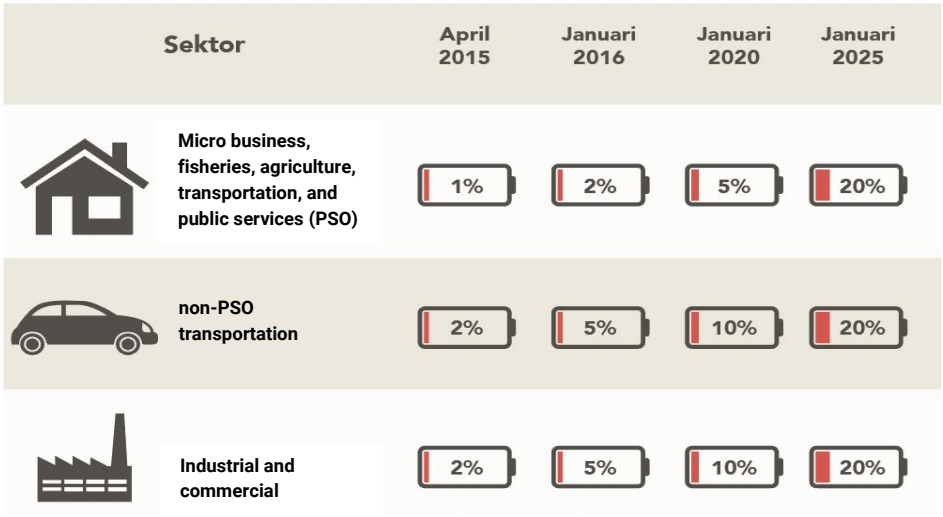

Figure 32. The stages of the mandatory bioethanol program

Source: ESDM Regulation No. 16/2020 on the Strategic Plan of the Ministry of Energy and Mineral Resources for 2020–2024.

[233] Situmorang, H. (2021). Ciptakan Energi Terbarukan, Indonesia Jadi Produsen Nomor Satu Biodiesel. *Investor.id*. Accessed from https://investor.id/business/265720/ciptakan-energi-terbarukannbsp-indonesia-jadi-produsennbsp-nomor-satu-biodiesel.

[234] Directorate General of EBTKE (2020). *20 Badan Usaha BBN Akan Salurkan Biodiesel 9,2 Juta KL di 2021*. Accessed from https://ebtke.esdm.go.id/post/2020/12/22/2745/20.badan.usaha.bbn.akan.salurkan.biodiesel.92.juta.kl.di.2021.

4.3 Sustainable Low Carbon Development Scenario in Indonesia

Economic development with high quality is critical to reduce externalities caused by a deterioration in the environment, which results in less-than-optimal economic growth. As a result, it has become clear that national economic development is concerned with more than just the pursuit of economic growth, but also the quality of economic growth that can contribute to the well-being of the people and provide a positive impact on the economy. Therefore, it is unlikely that a trade-off between environmental sustainability and economic growth will occur.[235]

Scenarios of sustainable economic development are listed in several development planning documents. In these documents, the biofuel policy is always stated as one of the strategies to realize the energy transition in Indonesia. Before Indonesia's NDC was ratified in 2016, Indonesia had a scheme for the National Action Plan for Reducing Greenhouse Gas Emissions as stipulated in Presidential Decree no. 61/2011. The action plan includes a voluntary emission reduction plan of 26%–41%. Biofuel, in this scheme, is planned to replace motor vehicle fuel.[236] The development of biofuels not only focuses on energy supply but also energy utilization.

In the Roadmap for Green Economic Growth in Indonesia, biofuels are stated as developing opportunities to stimulate green economic growth in Indonesia. The mandate of using biofuels for transportation and industries is expected to support the policy of abolishing fossil fuel subsidies.[237]

In the 2020–2024 RPJMN, the biofuel policy is included in the National Priority "Strengthening Economic Resilience for Quality and Equitable Growth." This National Priority has two targets: (i) increasing the carrying capacity and quality of economic resources as the capital for sustainable economic development; and (ii) increasing added value, employment, investment, exports, and economic competitiveness. The biofuel policy is specifically used as an indicator of sustainable economic development, with a cumulative target of up to 17.4 million kl in 2024.

[235] Bappenas RI dan Global Green Growth Institute Program (2015). *Mewujudkan Pertumbuhan Ekonomi Hijau di Indonesia*. Jakarta: Bappenas RI.

[236] Appendix II Presidential Decree No. 61/2011 on the National Action Plan for Reducing Greenhouse Gas Emissions.

[237] Bappenas RI dan Global Green Growth Institute Program (2015). *Mewujudkan Pertumbuhan Ekonomi Hijau di Indonesia*. Jakarta: Bappenas RI.

Table 16. The Benefit Value of Policy in Implementing B20 and B30 as biofuels

BENEFIT	PROGRAM VALUE				
	B20 TAHUN 2017	B20 TAHUN 2018	B20 TAHUN 2019	B30 TAHUN 2020	B30 TAHUN 2021
Volume used	2,57 million kl =16,17 million barrel/years =44,31 thousand barrel/days	3,75 million kl =25,59 million barrel/years =64,62 thousand barrel/days	6,39 million kl =41,68 million barrel/years =114,21 thousand barrel/days	8,4 million kl =52,83 million barrel/years =114,74 thousand barrel/days	9,2 million kl =57,86 million barrel/years =158,83 thousand barrel/days
Foreign exchange savings	USD 0,9 billion = Rp 12,12 trillion	USD 1,89 billion = Rp 26,67 trillion	USD 0,9 billion = Rp 12,12 trillion	USD 2,64 billion = Rp 38,04 trillion	USD 3,91 billion = Rp 56,24 trillion
Increased added value (CPO to biodiesel)	Rp 3,45 trillion	Rp 5,78 trillion	Rp 9,54 trillion	Rp 10,28 trillion	Rp 11,26 trillion
Employment	On farm 321.446 people Off farm 2.426 people	On farm 478.325 people Off farm 3.609 people	On farm 828.488 people Off farm 6.252 people	On farm 1.071.491 people Off farm 8.085 people	On farm 1.150.000 people Off farm 8.678 people
Reducing GHG emissions and improving	6,83 million ton CO2	9,96 million ton CO2	16,98 million ton CO2	22,3 million ton CO2	24,4 million ton CO2

Source: Directorate General of EBTKE (2021).[238]

According to the records of the Directorate General of EBTKE (2021), the economic and social benefits of implementing biofuels in the B20 and B30 programs are quite promising. The economic benefit of the implementation of B20 and B30 programs is IDR 3.45 trillion and continues to increase every year up to IDR 11.26 trillion towards increasing added value; meaning, there is a shift from only producing CPO as a feedstock to a ready-to-use biodiesel product.[239] Other economic benefits are saving foreign exchange and increasing employment opportunities for upstream and downstream industries, with palm oil as the main feedstock. Equally important, the use of biodiesel can reduce emissions and improve environmental quality to mitigate the risk of the climate crisis since it reduces 6.83 million tons to 24.4 million tons of CO2. [240] The B20 and B30 programs will be able to answer the challenge of low-carbon development if the entire process and feedstock procurement chain considers quality economic development and avoids externality values due to environmental damage.

To realize the biofuel policy as one of the strategies for sustainable development, there are several aspects to consider. The first aspect relates to technical matters. For instance, incompatible engines with biodiesel cause vehicle engines to break more quickly. As an example, filter clogging results in shortened filter life, compaction at low temperatures, and increased nitrogen oxide emissions.[241] It is also an obstacle to the development of B40. A pure FAME mixture in B40 does not meet the minimum recommended fuel quality limits. In addition, the levels of acid and residual precipitation increased significantly after 30 days of storage, which poses a risk to the machine. [242] These

[238] Directorate General of EBTKE (2021). *Pahami Istilah B20, B30, B100, BBN dalam Bioenergi*. Direktorat Bioenergi. Accessed from https://ebtke.esdm.go.id/post/2019/12/18/2433/pahami.istilah.b20.b30.b100.bbn.dalam.bioenergi.

[239] Lukas, R.W., Nurul, S.L., & Yanto, R. (2020). *Kebijakan Pengembangan Biodiesel Berbasis Sawit: Mungkinkah Tanpa Peningkatan Konversi Kawasan Hutan?* Policy paper. Research and Development Center for Socio-Economic Policy and Climate Change. Accessed from http://simlit.puspijak.org/files/other/Policy_Paper_Biodiesel_2020_(3)_edited_final_ok.pdf.

[240] Directorate General of EBTKE (2021). *Kebijakan dan Implementasi Bahan Bakar Nabati (Biodiesel)*. Jakarta: Directorate of Bioenergy

[241] U.S Department of Energy (2018). *Biodiesel Blends*. Accessed from https://afdc.energy.gov/fuels/biodiesel_blends.html on January 21, 2022

[242] Moffitt, Lauren (2021). *Indonesia to Push Back B40 Rollout to 2025: MEMR*. Accessed from https://www.argusmedia.com/en/news/2278871-indonesia-to-push-back-b40-rollout-to-2025-memr on January 11, 2022.

drawbacks certainly have an impact on consumer acceptance of biofuels. Another aspect to consider is related to the distribution pattern of biofuels. The distribution is hampered by the scarcity of oil barges, tankers, and delivery points. [243]

Another aspect to take into consideration is how the implementation of the biofuel policy can bring economic benefit to all stakeholders involved in the development of this policy. The cost of fossil fuels and feedstocks determine the price of biofuels, and therefore, it is important to pay close attention to keeping subsidies for palm oil funds separate from the state budget. In order to allocate more funds from the consumption of palm oil to the support of the development of sustainable palm oil governance, it is also required to pay attention to the duration of the subsidy program that supports biofuel policies.

For regional development, the biofuel policy can be a solution to increase regional energy independence. The various development potentials of biofuel feedstocks in each region are opportunities for both energy independence and regional development, such as increasing household income, providing employment opportunities, and improving the quality of public facilities and infrastructure. This potential is supported by the authority of the provincial government in matters of issuing permits, fostering, and supervising the trading of biofuels as alternative fuels.[244] However, many local governments believe that biofuel policies are the domain of the central government, and thus, many of them failed to utilize this authority fully.[245] To avoid any negative impact, the potential for increased conflict and environmental damage in the regions due to the development of biofuel feedstocks also requires assessment.

Aside from contributing to state foreign exchange savings and regional development, biofuel policies are expected to improve the well-being of independent smallholders. The Palm Oil Farmers Union (SPKS) noted that many independent smallholders within a 5-kilometer radius of the biodiesel supply chain factory are not fully involved in the biofuel production chain; due to that exclusivity, they sell their plantation products to middlemen. [246] The selling price to middlemen is lower than the price set by the government, and it certainly affects the welfare of independent smallholders. In addition, the long biofuel production chain from independent smallholders to downstream industries also needs attention, with the hope that they will be involved in the biofuel production chain in the future. That way, they have potential to increase their welfare and no longer sell plantation products to middlemen.

[243] Oktarina, S.D., Nurkhoiry, R., Nasution, M.A., & Rahutomo, S. (2019). Riset Pasar Biodiesel B20 di Indonesia: Evaluasi Terhadap Produk dan Kesadaran Konsumen. *Analisis Kebijakan Pertanian*, 17(2), 79-93. DOI: http://dx.doi.org/10.21082/akp.v17n2.2019.79-93.

[244] Attachment to Law No. 23/2014 on Regional Government.

[245] Dharmawan, A.H., Nuva, Sudaryanti, D.A., Prameswari, A.A., Amalia, R., dan Dermawan, A. (2018). *Pengembangan bioenergi di Indonesia: Peluang dan tantangan kebijakan industri biodiesel*. Working Paper 242. Bogor, Indonesia: CIFOR.

[246] Syahni, Della (2021). *Menimbang Kebijakan Bahan Bakar Nabati dari Sawit*. Accessed from https://www.mongabay.co.id/2021/09/13/menimbang-kebijakan-bahan-bakar-nabati-dari-sawit/ on January 28, 2022

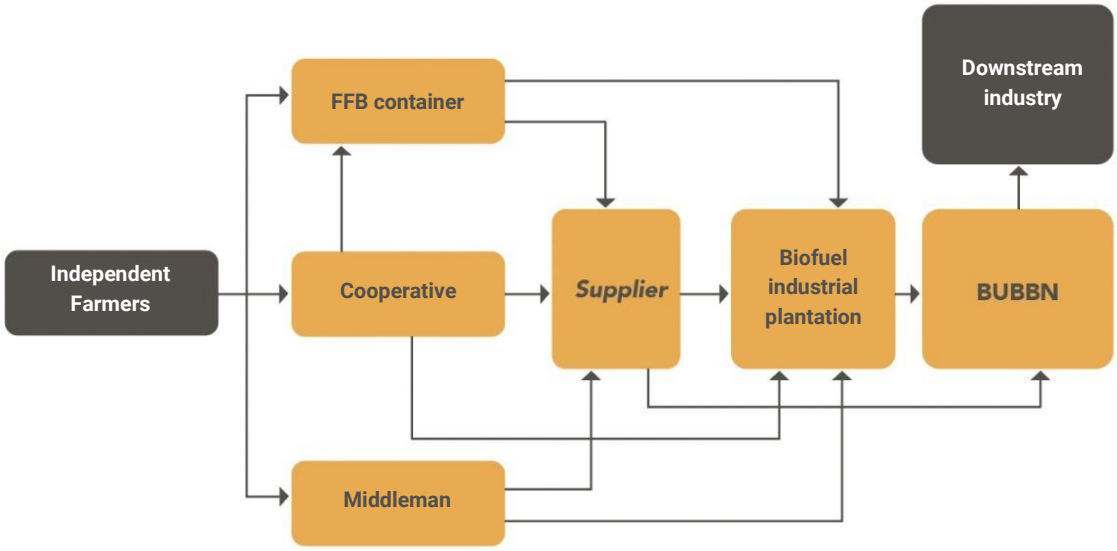

Figure 33. The biofuel supply chain

Source: IESR (2021); SPKS (2020).[247]

Another aspect to consider is planning for the development of energy, both biofuels and electrification, in the transportation sector. Careful planning is crucial to make sure that the national biofuel policy mandate will not leave any stranded assets in the future,[248] especially the supporting infrastructure during biofuel policy development. This could happen if the focus of the policy changes or if new technology comes out. Furthermore, the increasing trend of electric vehicles at the global level[249] will lower the price of batteries and spare parts, surely the price of electric vehicles will be more competitive with conventional vehicles that use biofuels. Similar to the global trend, Indonesian people, especially those who already have private cars, have a great interest in replacing their conventional vehicles with electric ones.[250]

The final aspect to consider is the role of the biofuel policy roadmap as a guideline for integrating upstream and downstream aspects into biofuel policies. In 2006, the National Team for the Development of Biofuels to Accelerate Poverty and Unemployment Reduction created a Blueprint for the Development of Biofuels 2006–2025. The document contains several strategies and programs for developing biofuels from upstream to downstream aspects (Table 17).

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[247] IESR (2021). *Critical Review on the Biofuel Development Policy in Indonesia*. Jakarta: IESR; Serikat Petani Kelapa Sawit (2020). *Tata Kelola BPDP-KS yang Buruk Merugikan Petani Sawit: Kajian Good Governance Badan Pengelola Dana Perkebunan Kelapa Sawit.* Accessed from https://spks.or.id/file/publikasi/Kajian-Good-Governance-BPDP-SAWIT.pdf.

[248] For information, currently in the 2020-2024 National Medium-Term Development Plan and Presidential Decree No.109/2020 on the Acceleration of Implementation of National Strategic Projects, the strategic project mentioned is Green Refinery Standalone with a capacity of 20 thousand barrels per day at RU III Plaju, Green Diesel Bio Refinery Revamping RU IV Cilacap, PT Pusri Palembang CPO Hydrogenation, and the Katalis Merah Putih Pupuk Kujang Cikampek.

[249] Bloomberg NEF (2020). Electric vehicle outlook 2020. *Bloomberg*. Accessed from https://about.bnef. com/electric-vehicle-outlook/

[250] Kusuma, F., & Sopha, B.M. (2019). *Analisis penerimaan dan persepsi masyarakat terhadap mobil listrik*. Yogyakarta: Universitas Gadjah Mada. Accessed from http://etd.repository.ugm.ac.id/ penelitian/detail/173716.

Table 17. National Biofuels Development Strategy

Strategies	Strategic Measures
Developing investment and funding schemes for biofuels provision	- Prioritizing investment in biofuel factories with feedstocks in-stock - Encouraging private sector investment both from domestic and international - Fully utilizing domestic funds, while carefully selecting among international funds - Providing special funds for the development of biofuel feedstock plants - Mobilizing funding through the establishment of a "Biofuel endowment fund"
Developing a price scheme starting from the feedstocks to biofuel products that effectively support the development of biofuel	
Implementing the domestic component level (TKDN)	- Increasing mastery of biofuel technology nationwide - Encouraging the use of TKDN in the biofuel business
Increasing the supply of feedstocks and production facilities	- Determining *Jatropha curcas*, sugar cane, cassava, oil palm, and coconut as the main biofuel-producing plants and, at the same time, developing other potential crops - Providing production and supporting facilities, such as high-yielding seedlings, fertilizers, and methanol
Establishing the biofuel trade system	- Establishing standards and quality requirements for biofuels as alternative fuels - Establishing a simple system and procedure for testing the quality of biofuels - Establishing a simple trading system for biofuels as an alternative fuel in the fuel trading system - Stipulating standby buyers of biofuel feedstocks and products
Hastening the provision of land	- Making use of abandoned land, critical land, and converted production forest - Making use of neglected cultivation rights (HGU) and inactive plantation business permits
Promoting special biofuel areas and energy-independent villages	- Creating an excellent, swift, and punctual one-stop service system - Accelerating the development of infrastructure and production facilities to support the biofuel business
Increasing the inclusivity of local governments and communities in the biofuel business	- Accommodating the development of the plasma-nucleus pattern for biofuel plantations - Creating business patterns to provide maximum added value to society - Allocating funds from regional budget

Fulfilling the supply of biofuels	Declaring obligations to fulfill the domestic market or export taxes to meet domestic supply while considering national interests and the business community

Source: National Team for the Development of Biofuels to Accelerate Poverty and Unemployment Reduction (2006).[251]

In the Strategic Plan from the Directorate General of Renewable Energy and Energy Conservation of the MEMR for 2020–2024, there are several policy goals targeted at the bioenergy sector. One of the guidelines for these goals is the 2020–2024 RPJMN, especially Development Agenda 1, namely Strengthening Economic Resilience for Quality Growth. On the agenda, the mandated policy goals to meet the 2024 biofuel consumption target of 17.4 million kl are: (i) increasing palm oil productivity, (ii) developing energy forests, and (iii) fulfilling biofuel production capacity through community oil palm empowerment.[252]

The policy objectives in these planning documents have emphasized the importance of upstream biofuel development in the overall success of the national policy. However, the integration of upstream and downstream policies is an unsolved challenge. For example, policies related to the intensification of oil palm land and smallholders' inclusion in the biofuel supply chain have not been integrated at the technical level. The 4-million-hectare National Energy General Plan does not technically integrate the upstream and downstream land development strategies for the provision of feedstocks for biofuel production.

Aside from the integration of upstream and downstream aspects in biofuel development, the roadmap for biofuel development should examine closely the 2nd and 3rd generations of biofuels, which are currently under discussion. Advanced generation of biofuels with various feedstocks is important to develop to reduce the need for additional land, which could lead to deforestation and an increase in food prices. The development of next-generation biofuels also minimizes the risk of feedstock price volatility due to their dependence on just one feedstock. [253] It also prevents disruptions to the supply continuity of certain feedstocks caused by pests or pathogens. [254] As an illustration, Indonesia has great potential to produce next-generation biofuel feedstocks (Table 18, Table 19).

[251] National Team for the Development of Biofuels to Accelerate Poverty and Unemployment Reduction (2006). *Blueprint 2006-2025 Pengembangan Bahan Bakar Nabati Untuk Percepatan Pengurangan Kemiskinan dan Pengangguran*. Jakarta: National Team for the Development of Biofuels to Accelerate Poverty and Unemployment Reduction.

[252] Directorate General of EBTKE, MEMR (2020). *Rencana Strategis Direktorat Jenderal Energi Baru, Terbarukan, dan Konservasi Energi 2020-2024*. Jakarta: Directorate General of EBTKE, MEMR.

[253] Gülşen, E., Olivetti, E., Freire, F., Dias, L., & Kirchain, R. (2014). Impact of feedstock diversification on the cost-effectiveness of biodiesel. *Applied Energy*, 126, 281–296. Accessed from https://doi.org/10.1016/j.apenergy.2014.03.063.

[254] Smith, V. H., McBride, R. C., Shurin, J. B., Bever, J. D., Crews, T. E., & Tilman, G. D. (2015). Crop diversification can contribute to disease risk control in sustainable biofuels production. *Frontiers in Ecology and the Environment*, 13(10), 561–567. Accessed from https://doi.org/10.1890/150094.

Table 18. Potential Agricultural Residues for Biofuels

Commodity	Yield Production in 2018 (Million Tons)	Agricultural Residues	Total Residue (Million Tons)	*Cellulosic Ethanol (Billion Liters)*
Paddy	83	Sugarcane	151	40
Corn	30	Corn stover	31	10
Sugarcane	21,2	Bagasse	8	2

Source: Zhou *et al*. (2020).[255]

Table 19. Availability of Five Waste Materials and the Production of Biodiesel or Renewable Diesel Fuel in Maximum Amounts

	Inedible Animal Fats	Fish Oil Waste	Sludge Palm Oil	Tall Oil	Used cooking oil	Total
Availability of feedstocks (thousand tons)	205	240	500	270	2.700	3.915
Biodiesel Production (million liters)	240	280	570	310	3.200	4.600
Renewable diesel fuel production (million liters)	230	265	550	300	3.000	4.345

Source: Zhou *et al*. (2021).[256]

[255] Zhou, Y., Searle, S., Pavlenko, N., Kristiana, T., Sudaryadi, & Amukti, R.H. (2020). *Analisis Tekno-Ekonomi Pemanfaatan Cellulosic Ethanol di Indonesia yang berasal dari Limbah Kelapa Sawit*. ICCT White Paper. Accessed from https://theicct.org/sites/default/files/publications/Indonesia-cellulosic-ethanol-BH-dec2020.pdf.

[256] Zhou, Y., Searle, S., Pavlenko, N., Kristiana, T., Sudaryadi, & Amukti, R.H. (2020). *Analisis Tekno-Ekonomi Pemanfaatan Cellulosic Ethanol di Indonesia yang berasal dari Limbah Kelapa Sawit*. ICCT White Paper. Accessed from https://theicct.org/sites/default/files/publications/Indonesia-cellulosic-ethanol-BH-dec2020.pdf

On the other hand, there is great potential for alternative feedstocks, such as used cooking oil (UCO), which is also made from palm oil. Until today, despite UCO becoming an export commodity to countries in Europe and America as a feedstock for biodiesel, the economic value of UCO has not been fully included in the economic value of biofuels. Records from the Central Statistics Agency show that Indonesia's UCO export volume in the 2014–2019 period reached 618,502 tons. [257] It indicates that the UCO should be included in the economic value of biofuels.

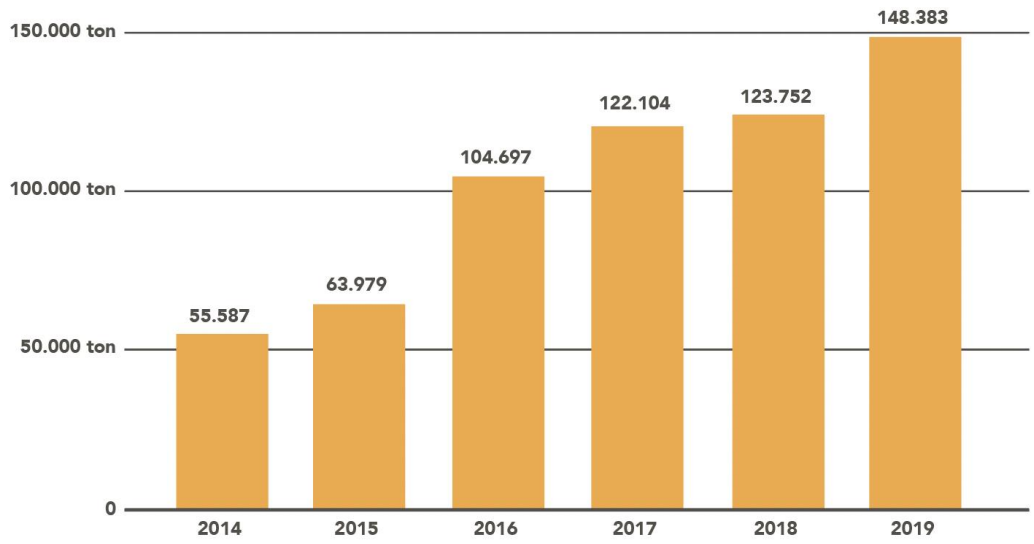

Figure 34. Development of Indonesia's used cooking oil exports

Source: Data from the Central Bureau of Statistics (2019).[258]

4.4 Biofuel in the Energy Transition Scenario

The scenario for the national energy transition should include the use of biofuels. The goal of the energy transition is inextricably linked to the advancement of renewable energy technology, which has been successful in displacing traditional power sources. This process will also affect the transportation sector and may have a significant impact on projections for fuel consumption, mobility in the digital age, and the fuel sources. However, before we switch to clean and renewable energy sources as a whole, the biofuel option holds enormous urgency and potential as an alternative. The government should be able to ensure that this biofuel program can bring more benefits to society through recommendations and more thorough policy changes to help achieve a quick and sustainable energy transition. Therefore, it is essential to develop a long-term strategy for the role of

[257] Data from the Central Bureau of Statistics (2019) quoted from the presentation of the National Team for the Acceleration of Poverty Reduction (TNP2K) Secretariat of the Vice President of Indonesia and Traction Energy Asia, October 2020.

[258] Data of Central Bureau of Statistics (2019) quoted from the presentation of TNP2 of the Secretariat of the Vice President of Indonesia and Traction Energy Asia, October 2020.

biofuels in the energy transition that considers the development of alternative technologies through the development of a resilient biofuel production system that can withstand future disruptions. One way to do this is by using processing technology that can flexibly accommodate other product portfolios, such as fuel, hydrogen, chemical, and electricity, as well as non-fuel products. Since the current biofuel policy does not place a high priority on achievement criteria related to biofuel objectives and specific schemes to measure it, it is advised to set clear and transparent criteria for measuring the economic, social, and environmental benefits of the biofuel program. Some steps to take are certification schemes, such as ISPO and PROPER, to ensure that the feedstocks meet certain standards and are also supported by the Cradle to Cradle certification scheme. It would encourage participants to set their orientation on achieving higher certification, with each step leading to sustainable practices.[259] It is also important to take into account the diversification of feedstocks used to make biofuels since this will help to mitigate some environmental effects like land expansion and disruption. In the economic aspect, diversification also reduces the uncertainty of feedstock prices. According to Bappenas' research, a number of raw resources, including *Jatropha*, *Calophyllum inophyllum*, and *Pongame oiltree*, have been identified to have no competition as food ingredients.

The establishment of supportive policies in promoting the production of second-generation biofuels, among other things, is because their use can reduce the need for land conversion and their associated emissions are lower than those of the first generation. Currently, the development of the second generation is very slow, thus it needs more policy support, financial incentives, and research and development. A variety of incentive programs can be modified in accordance with the readiness and potential of their feedstocks; those that are commercially ready would receive support through initiatives in public procurement, soft loans, certain mandates, and fiscal incentives to create a favorable market, while those that are not commercially ready might receive support through projects of publicly funded research and demonstrations and public-private partnerships to reduce the risk of technology development. Additionally, it is crucial to make sure that the incentive program fosters a culture of sustainability and innovation. This can be done by offering incentives through the low carbon fuel standard program. This plan examines not just the price difference between fossil fuels and biodiesel, but also the life cycle carbon intensity, where sustainability performance serves as a benchmark for offering incentives for various prospective feedstock sources.

[259] Critical Review on the Biofuel Development Policy in Indonesia - IESR https://iesr.or.id/en/pustaka/critical-review-on-the-biofuel-development-policy-in-indonesia

Chapter 5. Conclusions and Recommendations

5.1 Conclusion

Initially, the biofuel policy in Indonesia was developed in response to Indonesia's dependence on fossil fuels. However, eventually, not only does this policy function as an effort to stop relying on fossil fuels but also as a strategy to mitigate climate change. In addition to the policy objective, the biofuel policy has changed the development plan for biofuel feedstock commodities; initially, it was multi-commodity but is now dominated by palm oil. This decision was driven by the abundance of palm oil commodities in Indonesia, the world's largest palm oil-producing country. Furthermore, the government's compelling reason for completely supporting the palm-based biofuel industry downstream is to improve the well-being of stakeholders, particularly farmers. Along the way, however, there have been various challenges in realizing biofuel as a truly "clean" renewable energy, especially in its governance, which includes ecological, economic, and social aspects as the pillars of the principle of sustainability.

From an ecological perspective, biofuels have lower emissions compared to fossil fuels. However, from the perspective of life cycle analysis, from upstream activities (especially the management of feedstocks) to downstream activities, the emissions are relatively high; this is especially due to the function of forests and peatlands that are converted into monoculture plantations, such as oil palm plantations. Due to Indonesia's low productivity in oil palm plantations and the rising demand for palm oil for food, energy, and exports, there is a growing potential for converting forests and peatlands. Besides increasing emissions, the conversion of forests and peatlands would result in declining biodiversity and an increase in natural disasters, especially floods and landslides.

From an economic perspective, it should be noted that the reliance on subsidies from palm oil funds could potentially strain the state budget when the palm oil funds experience cash shortages. However, if we look at the contribution of the biofuels program to the national economy, especially in terms of budget savings, the biofuels program has proven to save the budget for diesel imports. Additionally, an important point to consider is the price of biofuel, which is heavily influenced by the prices of its two composing materials: FAME and diesel. As a result, there is a chance that the profit from saving the diesel import budget would be lower than the profit made from exporting local CPO to global markets. Unlike its contribution to the national economy, biofuel development policies have not shown a significant impact on local government or farmers' income. In terms of palm oil as the main feedstock for biofuel, the lack of a DBH plan for palm oil export levies reduces local governments' revenue from palm oil commodities. Farmers, particularly oil palm farmers, have no other choice but to sell their plantation products to middlemen for low prices because they lack access to the CPO supply chain, which is directly linked to BUBBN. This certainly affects their welfare, which is heavily affected by the selling price of the commodities they produce.

From the social perspective, there is no biofuel governance policy in Indonesia that ensures the application of human rights principles in the management of feedstocks. As a result, biofuel policies have a crucial gap in the traceability of their supply chains, which is very important to ensure the true implementation of the principles of sustainability. Moreover, the operation of oil palm plantations, as the source of the main feedstock for biofuels, faces human rights problems, such as bad working conditions, an unfair work system, and gender discrimination. Another common problem is agrarian conflicts, especially between local residents and companies. The procedure of acquiring property is even more difficult because of the overlap between oil palm permits and local people's and indigenous people's territories. Even worse, the land purchase procedure frequently violates the FPIC principle, leaving locals in the dark about plans to develop a plantation.

5.2 Recommendations

To overcome the various problems listed above, the government needs to re-formulate the road map for implementing the biofuel policy, which has not been updated since the first road map was launched in 2006. It is important to clarify the direction of biofuel policy in Indonesia, including as a strategic step in facing the challenges of biofuel governance.

There were several good agendas in the previous roadmap, but they lacked realization, among others, the plan to diversify biofuel feedstocks. Therefore, these agendas should be included in the latest road map.

Currently, palm oil, or CPO, as the main feedstock for biofuels in Indonesia, is also consumed as food. This raises the potential for competition in the use of palm oil for food and energy. Therefore, it is crucial to avoid the dominance of just one feedstock to minimize this potential. Besides the plan to diversify feedstocks, the new roadmap should include a plan for developing non-food feedstocks. Wastes like used cooking oil, rice straw, corn stover, and bagasse have a lot of development potential in Indonesia, given the country's abundant supply of these feedstocks and their assured continuity. Other than waste, other biofuel feedstock crops, such as *Calophyllum inophyllum, Pongame oiltree*, Candlenut, *Aleurites trisperma blanco, Calliandra calothyrsus*, and *Gliricidia sepium*, also have great potential since these plants grow on degraded land.

Another agenda item to include in the latest roadmap is the provision of special areas for biofuel feedstock plants. Indonesia has the potential for clean and clear land (2.27 million hectares)[260] for biofuel feedstock plantations. Several different kinds of feedstock plants, including jatropha, sugar cane, *Arenga pinnata*, areca nut, coconut, corn, sweet potato, and cassava, can be grown on the land. The direct participation of farmers in the management of biofuel feedstock plantations can help

[260] Land cover in this area includes shrubs, swamps, savanna, open land, and cover that has not been defined or outside the land cover class. Data sources: forest area, land cover, forest use and planning, and peat ecosystem function (MOEF Geoportal, 2019 dan 2020); oil, gas, mineral, and coal (ESDM, 2020); oil palm cover and oil palm business (CSO Network Node); administrative territory (RBI, 2019); indigenous territory (BRWA, 2018); Commodity (Local Government Investment Coordinating Board).

maximize the potential of this land. That way, the biofuel policy is expected to have a positive impact on the welfare of farmers.

The most recent roadmap must also maintain the incentive program for biofuel research. At the moment, Indonesia's incentive plan to support the biofuel industry only applies to palm-based biofuels, leaving non-palm-based biofuel development far behind. Therefore, an incentive plan is necessary to support the growth of the non-palm biofuel industry, particularly the later generations of biofuels that do not use food crops as feedstocks. This support is important given that there has not been a strong stimulus to create an established market for the development of other biofuel feedstock plants, such as *Calophyllum inophyllum* or *Jatropha*.

To complete the roadmap, there are several agendas to include as well, such as a plan to improve land productivity for biofuel feedstock crops to reduce the potential for land clearing that could contribute to deforestation and land degradation. Increasing land productivity certainly needs capacity building and support for farmers, who have a big role in the production of biofuel feedstocks, especially palm oil. Capacity building and support for farmers are achieved through strengthening farmer institutions, rejuvenating gardens, providing quality seeds, and increasing farmer knowledge regarding good agricultural practices. These supports are expected to assist farmers in obtaining commodity sustainability certifications, such as the Indonesian Sustainable Palm Oil (ISPO) and the Roundtable on Sustainable Palm Oil (RSPO).

The obligation to fulfill sustainability certification should be included in the latest roadmap since it is important to ensure that the biofuel production chain, from upstream to downstream, implements the principles of sustainability. Currently, there are only about 26.53% of oil palm plantations in Indonesia with sustainability certification, both RSPO and ISPO, or No Deforestation, No Peat, No Exploitation (NDPE) commitments.[261] This new agenda is anticipated to expand the scope of sustainability certification, making biofuel traceability safer in ecological, economic, and social aspects. Sustainability certifications, such as ISPO or RSPO, are expected to be applied to non-palm oil biofuel feedstocks, ensuring that all biofuel feedstock commodities in Indonesia have protections for secure traceability.

Downstream aspects of biofuel growth in Indonesia should also be certified for sustainability. Currently, the Ministry of Energy and Mineral Resources is formulating Indonesian Bioenergy Sustainability Indicators (IBSI), which will be implemented as sustainability certification downstream. IBSI is expected to be included in the new roadmap. Correspondingly, the new roadmap can reinforce safeguards for Indonesia's overall management of biofuels.

The development of a new roadmap requires solid implementation. Reflecting on the 2006 road map, the realization of the biofuel policy is quite different from what was planned. The government needs

[261] Madani Spatial Analysis, 2021.

to make an action plan and technical instructions for implementing the new roadmap for all ministries and agencies, along with enlisting local governments. In addition to boosting implementation support, the policy's completeness can serve as a guideline for measuring and evaluating the government's success in developing biofuel policies.

List of Reviewed Studies

Focus of the Study/Perspectives on the Ecological Context

No	Researcher(s) (Year)	Research Title	Research Type	Subtopic	Research Location	Research Methods	Results	Link
1	Jonathan, *et al.* (2021)	Prospek Pencapaian Indonesia atas Tujuan Pembangunan Berkelanjutan Angka 15 "Ekosistem Daratan" dalam Industri Sawit setelah Adanya Undang-Undang No. 11 Tahun 2020 tentang Cipta Kerja	Scientific article (ICEL)	Deforestation	Indonesia	Literature review	In its implementation, the palm oil industry tends to result in damage to the area and land cover. This has the potential to increase with several provisions of the Job Creation Law, namely allowing the release of forests for the palm oil industry, which is a National Strategic Project and part of the national economic recovery, releasing forest areas to accommodate established and licensed palm oil plantation activities prior to the enactment of the	https://jhli.icel.or.id/index.php/jhli/article/view/326/129

							Job Creation Law, and providing amnesty for illegal palm oil plantation violations in forest areas.	
2	Dilip Khatiwada, Carl Palm en and Semida Silveira (2018)	Evaluating the palm oil demand in Indonesia: production trends, yields, and emerging issues	Scientific article (Taylor and Francis)	Deforestation	Indonesia	Projection and extrapolation	Domestic demand to meet (i) biodiesel target and (ii) industrial & food sectors will reach 20 million tons by 2025 (a 61% increase compared to 2014). It is still possible to be self-sufficient and achieve the biodiesel target without expansion. However, if both domestic and global demands are to be met (51 million tons by 2025), an expansion of 6 million hectares would be required if productivity is not increased. However, expansion would lead to deforestation, posing a threat to biodiversity, and increasing GHG emissions. A combination of ambitious mandatory biodiesel initiatives with productivity	https://www.tandfonline.com/doi/epub/10.1080/17597269.2018.1461520?needAccess=true

							enhancement programs, utilizing degraded lands, and utilizing palm biomass residues for energy (2G/second-generation biofuel) can reduce competition with food. Projections indicate an annual increase in palm oil usage for energy demand from diesel and a 5.4% blending rate (USDA and BPPT), 1.1% for food, and 5.1% for the oleochemical industry.	
3	Sharma, *et al.* (2019)	Ecosystem services under future oil palm expansion scenarios in West Kalimantan, Indonesia	Scientific article (Science Direct)	Deforestation	Indonesia	Spatial analysis using ArcGIS and InVEST Tool	This research maps out the land use impacts of oil palm plantation expansion until 2035 across three scenarios: BAU, conservation, and sustainable intensification. The BAU scenario is projected to result in significant environmental impacts due to high expansion intensity, particularly in old-growth forest and regrowth forest regions.	https://www.sciencedirect.com/science/article/pii/S2212041619301652

							In this scenario, 2 million hectares of expansion will occur in agricultural areas and 0.6 million hectares in forest and shrubland cover areas. Additionally, this expansion will lead to a 20% loss in carbon storage, a reduction in habitat quality of up to 14%, and a 1.7% decrease in water discharge. The economic value of ecosystem services in this scenario is the lowest among the three scenarios outlined in this study. The research concludes that the sustainable intensification scenario represents a middle path that can be taken for future oil palm plantation expansion.	
4	Rulli, *et al.* (2019)	Interdependencies and telecoupling of oil palm expansion at the expense of	Scientific article (Science Direct)	Deforestation, water and air quality	Indonesia	Dataset analysis and various calculation models	This research found that there are substantial environmental impacts from palm oil production, including an increased level of deforestation	https://www.sciencedirect.com/science/article/abs/pii/S1364032118308529

		Indonesian rainforest					(28% within concession areas since 2000), forest fragmentation (44% within concession areas since 2000), CO2 emissions (up to 4.37 GtCO2), and water pollution (up to 18.3 km3 of grey water).	
5	Sawit Watch, *et al.* (2019)	Laporan Satu Tahun Implementasi Inpres Moratorium Sawit: Jauh Panggang dari Api?	CSO report (Koalisi CSO)	Deforestation	Indonesia, especially Papua, West Kalimantan, East Kalimantan, South Sumatra, and Central Kalimantan	Monitoring results and documentation of the efforts and achievements in the implementation of Presidential Instruction No. 8/2018	From an environmental perspective, this research identifies various palm oil plantations that overlap with forested areas in the regions of Papua, West Kalimantan, East Kalimantan, South Sumatra, and Central Kalimantan, contributing to deforestation and environmental degradation. This article also found that the conversion of forests into palm oil plantations is the primary cause of logging and peatland conversion in Central Kalimantan.	sawitwatch.or.id/wp-content/uploads/2020/09/FINAL-Laporan-Satu-Tahun-Inpres-Moratorium-sawit-05-Okt-2019.pdf
6	Susanti and	Development	Scientific	Deforestati	Indonesia	Content	There are three stages of	https://www.science

	Maryudi (2016)	narratives, notions of forest crisis, and boom of oil palm plantations in Indonesia	article (Science Direct)	on and biodiversity		analysis, literature review, dan in-depth interview	palm oil industry expansion in Indonesia. The first stage is driven by increasing global demand for palm oil as a food ingredient. The second stage is propelled by the urgency to find alternative sources of income to replace the forestry sector. The third stage is motivated by concerns about greenhouse gas emissions and the search for alternatives to replace fossil fuels. However, this expansion has led to massive changes in land use and cover, resulting in reduced biodiversity and deforestation.	direct.com/science/article/abs/pii/S1389934116302908
7	Simon, *et al.* (2015)	Menakar Sawit: Riset Kawasan, Korupsi, dan Pendapatan Daerah di Sulawesi dan Kalimantan	CSO report (Sawit Watch)	Deforestation	Buol, Banggai, Donggala, Bulungan Regencies	Literature review and interviews in Central Sulawesi (Buol, Banggai, and	This research has found that there are 84 hectares of forest potentially at risk of being lost due to palm oil plantation permits in Buol Regency. The study also uncovered various corrupt practices,	sawitwatch.or.id/wp-content/uploads/2015/12/Menakar-Sawit.pdf

						Donggala Regencies) and North Kalimantan (Bulungan Regency) between August and September 2014	primarily related to licensing issues, between government officials and palm oil business actors in the two provinces being researched.	
8	Iwan Hilwan and Yanto Santosa (2019)	Impact of oil palm plantation on species diversity of tropical vegetation	Scientific article (IOP Publishing)	Biodiversity	Indonesia (Riau)	Direct observation at the oil palm plantations in Indragiri Hilir Regency, Riau Province	The research findings indicate that the change in land cover from shrubland and coconut plantations to oil palm plantations has a positive impact, leading to an increase in plant biodiversity. The number of plant species in oil palm plantations is 2.5 to 4 times higher compared to shrubland and coconut plantations. The transition from shrubland to oil palm plantations resulted in a gain of 44 plant species (244.44%) and a loss of 7 species (38.89%). Similarly, the	https://iopscience.iop.org/article/10.1088/1755-1315/336/1/012033/pdf

							shift from coconut plantations to oil palm plantations resulted in a gain of 52 plant species (520%) and a loss of 6 species (60%).	
9	Maskun, *et al* (2021)	Environmental standard of Indonesian palm oil post omnibus law ratification	Scientific article (IOP Publishing)	Emmission	Indonesia	Literature review	This research finds that the facilitation of investments after the enactment of the Job Creation Law will lead to an increase in land use change and greenhouse gas emissions in Indonesia. Additionally, the Job Creation Law represents a step backwards in environmental protection in Indonesia. The removal of the minimum 30 percent forest requirement, spatial planning flexibility, changes in environmental permits, and the elimination of Environmental Impact Assessments (AMDAL) for plantation businesses are	https://iopscience.iop.org/article/10.1088/1755-1315/824/1/012098/pdf

							systematic environmental degradation efforts.	
10	Lam, *et al.* (2019)	Greenhouse gas footprints of palm oil production in Indonesia over space and time	Scientific article (Science Direct)	Emmission	Indonesia	Quantitative data analysis with scenarios: without the expansion of forests and peatlands; without the expansion of forests, peatlands, and other lands; expansion of concession lands; and expansion based on the proximity with the current plantations	This research has found that the average carbon footprint of palm oil production in Indonesia in 2015 was approximately 5.5 tons of CO2 equivalent per ton of CPO. Specifically, emissions resulting from land degradation in Papua and Sulawesi are due to the presence of intact forests, highlighting the importance of conserving forests with high carbon stocks. Furthermore, this carbon footprint is projected to increase by 25% in 2030 if expansion into concession areas, particularly current forested areas, continues. However, the study also found that future carbon footprint could be reduced by 42% without compromising output levels by limiting	https://www.sciencedirect.com/science/article/abs/pii/S004896971932950X

							expansion into non-forest and non-peatland areas.	
11	Dohong, Aziz, and Dargusch (2018)	Carbon emissions from oil palm development on deep peat soil in central kalimantan indonesia	Scientific article (Science Direct)	Emmission	Central Kalimantan	Spatial analysis, literature data, and modelling that focuses on ex-Mega Rice Project (MRP) lands in Central Kalimantan	This research found that over 40% of the oil palm plantations in the ex-MRP areas are situated on deep peatlands. The study also estimates that if this practice continues, there is a potential release of CO2 emissions ranging from 133.31 to 310.02 MtCO2e due to the peat oxidation process caused by the drainage systems of the oil palm plantations over the first 25 years of the plantation cycle.	https://www.sciencedirect.com/science/article/abs/pii/S2213305418300274
12	Jaung, Wanggi et al. (2018)	Spatial Assessment of Degraded Lands for Biofuel Production in Indonesia	Scientific article (CIFOR)	Land degradation	Indonesia	Spatial analysis	This study identifies that there are 3.5 million hectares of degraded land in Indonesia (which do not serve a function for food production, carbon storage, and biodiversity conservation) that can support the production	https://www.cifor.org/publications/pdf_files/articles/AJaung1801.pdf

							of bioenergy in the form of biodiesel (*nyamplung*, *malapari*, and *kemiri sunan*) as well as biomass sources (Kaliandra and Gamal).	
13	Obidzinski et al. (2012).	Environmental and Social Impacts of Oil Palm Plantations and their Implications for Biofuel Production in Indonesia	Scientific article (CIFOR)	Deforestation	Indonesia (West Papua (Manokwari), West Kalimantan (Kubu Raya), and Papua (Boven Digoel)	Spatial analysis & in-depth interview	The research findings suggest that the development of oil palm, including its association with biofuels, in three locations: West Papua (Manokwari), West Kalimantan (Kubu Raya), and Papua (Boven Digoel), has led to a decrease in natural forest cover by 69% in Manokwari; 70% in Kubu Raya; and 53% in Boven Digoel. The research focus was on several concessions, namely in Manokwari, specifically the concessions owned by PTPN II covering an area of 12,049 hectares; in Kubu Raya, owned by	https://www.ecologyandsociety.org/vol17/iss1/art25/

							PT. BPK, a subsidiary of the Wilmar Group, covering an area of 13,605 hectares; and in Boven Digoel, owned by PT. TSE, a subsidiary of the Korindo Group, covering an area of 34,000 hectares. This research was conducted by observing natural forest cover between 1989 and 2009.	
14	Leksono, Budi et al. (2018)	Calophyllum inophyllum for Green Energy and Landscape Restoration: Plant Growth, Biofuel Content, Associate Waste Utilization and Agroforestry Prospect	Scientific article (CIFOR)	Land degradation, feedstock diversification	Indonesia	Spatial & modeling	The research findings identify that Indonesia has approximately 16.8 million hectares of degraded land. These lands have the potential to serve as feedstock sources for biofuel production, meeting energy security needs, increasing income, and aiding in land restoration. The nyamplung commodity is well-suited to thrive on 5.7 million hectares	https://doi.org/10.23919/ICUE-GESD.2018.8635740

							of degraded land in Indonesia and can contribute to green energy production and the restoration of these degraded lands. During its growth phase, this species can grow up to 1 meter in height per year and tolerate harsh environmental conditions. Its seeds provide non-edible oil, making it an ideal source for biodiesel production. Additionally, during the biodiesel production process, its waste and by-products can be utilized as raw materials for the pharmaceutical and cosmetic industries, as well as compost for soil enrichment.	
15	Hasnah et al. (2020)	Pongamia as a potential biofuel crop: Oil content of Pongamia	Scientific article (CIFOR)	Feedstock diversification	Indonesia (Banten)	Solvent extraction method	This research concludes that *Pongamia*/*malapari* can serve as a potential biofuel feedstock. In Indonesia, Pongamia is	https://www.cifor.org/knowledge/publication/7903

		pinnata from the best provenance in Java, Indonesia					found widely across all islands but is primarily concentrated to the west of the Wallace Line, in provinces such as Banten, East Java, South Sumatra, and West Java. The economic viability of *Pongamia* depends on the number of seeds per tree and the oil content of the seeds. Studies on Pongamia oil in Indonesia reveal that trees grown in Ujung Kulon National Park, Banten Province, yield seeds with a higher oil content (i.e., 15.59%).	
16	Rahmadi, Aye, and Moore (2016)	The feasibility and implications for conventional liquid fossil fuel of the Indonesian	Scientific article (Science Direct)	Land use	Indonesia	Modelling analysis	This research concludes that in achieving the target of 5% contribution of biofuel to the national energy mix by 2025, meeting this goal has the potential to have environmental impacts	https://www.sciencedirect.com/science/article/abs/pii/S0301421513006101

		biofuel target in 2025					as it requires an additional 5.15 million hectares of land for plantations and changes in land use.	
17	Mukherjee and Sovacool (2014)	Palm oil-based biofuels and sustainability in southeast Asia: A review of Indonesia, Malaysia, and Thailand	Scientific article (Science Direct)	Deforestation, biodiversity, emmission	Indonesia	Systematic review	This research finds that biofuel production in Indonesia, particularly in relation to the palm oil industry, has negative environmental impacts, such as reduced carbon sink, deforestation, decreased biodiversity, and the release of greenhouse gas emissions. On the other hand, the high level of government subsidies for palm oil-based biofuel production becomes an issue.	https://www.sciencedirect.com/science/article/abs/pii/S1364032114003177
18	Jane O'Malley, Stephanie Searle, and Tenny Kristiana	Dampak Penggunaan Biodiesel Kelapa Sawit terhadap Kualitas	CSO report (ICCT)	Air quality	Indonesia	Meta-analysis	Palm oil biodiesel is estimated to increase NOx emissions compared to regular diesel, both in older and newer vehicle engines.	https://theicct.org/publications/AQ-impacts-biodiesel-indonesia-BH-jan2021

		Udara di Indonesia					This effect is more pronounced in newer vehicles and fuels with low sulfur content. Additionally, while palm oil biodiesel can improve HC, CO, and PM emissions compared to regular diesel, these benefits diminish when used in more modern vehicles. This trend is statistically significant and indicates an increase in NOx emissions of 12%, 17%, and 41% for B30, B40, and B100 blend levels in the coming years in Indonesia.	
19	Rulli, et al. (2019)	Interdependencies and telecoupling of oil palm expansion at the expense of Indonesian rainforest	Scientific article (Science Direct)	Deforestation, emmission, air quality	Indonesia	Dataset analysis and various calculation models	This research found substantial environmental impacts from palm oil production, including an increased level of deforestation (28% within concession areas since 2000), forest	https://www.sciencedirect.com/science/article/abs/pii/S1364032118308529

							fragmentation (44% within concession areas since 2000), CO2 emissions (up to 4.37 GtCO2), and water pollution (up to 18.3 km3 of grey water).	
20	Tim Penulis Coaction Indonesia and Lokadata (2021)	Pemetaan Hulu-Hilir, Sosial Ekonomi dan Dampak Lingkungan Industri Sawit dan Biodiesel di Indonesia	CSO report (Koaksi)	Water and air quality	Indonesia	Baseline data analysis and media monitoring analysis	From an environmental perspective, this article reveals that 35% of the 4,783 villages with palm oil as their main commodity in Indonesia experience pollution, particularly in the form of water and air pollution. It is assumed that the primary source of this pollution comes from palm oil processing facilities.	https://coaction.id/katalog/pemetaan-hulu-hilir-sosial-ekonomi-dan-dampak-lingkungan-industri-sawit-dan-biodiesel-di-indonesia
21	Harsono, et al. (2012)	Energy balances and greenhouse gas emissions of palm oil biodiesel in	Scientific article (Wiley)	Life cycle analysis	Indonesia	Quantitative (ECPT)	This study aims to understand the energy balance and greenhouse gas emissions of palm oil biodiesel in Indonesia, considering the entire	https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1757-1707.2011.01118.x

		Indonesia					process from the initial stages to the final product, also known as Life Cycle Assessment (LCA). The assessment indicates variations in the energy balance across different regions, specifically comparing Kalimantan with Sumatra. Sumatra requires higher energy input compared to Kalimantan, influenced by the planting systems and the actors involved (companies/small-scale farmers). The highest energy input is needed during the industrialization process, while the highest greenhouse gas emissions are generated from land clearing, followed by the industrialization process, fertilizer product usage, agricultural activities,	

							milling, and finally transportation. The calculation of land clearing compared to the energy produced is assessed through ECPT (Ecosystem Carbon Payback Time), which measures the years needed to offset the carbon loss from land clearing for biofuel. Effective management assessment indicates that biodiesel from palm oil meeting European standards is highly dependent on small-scale farmer cultivation in Sumatra for carbon emission mitigation from land use change.	
22	Kurniawan, et al. (2018)	Dinamika Hulu Hilir Industri Biodiesel di Indonesia	CSO report (Koaksi)	Carbon footprint	Indonesia	Empirical-normative method wth qualitative - quantitativ	From an environmental standpoint, this article states that the palm oil plantation industry is one of the main contributors to forest loss in Indonesia,	https://coaction.id/en/katalog/ikhtisar-dinamika-hulu-hilir-industri-biodiesel-indonesia/

						e analysis (literature review, interviews, and observation)	including through forest and land fires, due to the widespread conversion of natural vegetation into palm oil plantations. Additionally, while biodiesel energy is expected to serve as an alternative to fossil fuels, when considering the upstream sector, the carbon footprint of biodiesel can be larger than that of fossil fuels. This creates a paradox.	
23	Petir (2018)	Sustainability index assessment of palm oil-based bioenergy in Indonesia	Scientific article (Science Direct)	Sustainability index	Indonesia	Assessment	The sustainability assessment results have obtained an average index score of 35.02%, indicating that Indonesia's sustainability status in palm oil-based bioenergy is still low (less sustainable). This sustainability index utilizes the Multidimensional Scaling method, which is	https://www.sciencedirect.com/science/article/pii/S0959652618317220

							a statistical data analysis technique used to visually map the perceptions and preferences of respondents in a geometric map. In conclusion, it is expected that this sustainability index can serve as a foundation for determining the best strategies for the future development of bioenergy in Indonesia.	
24	Lembaga Penyelidikan Ekonomi dan Masyarakat (LPEM) FEB UI (2020)	Risiko Kebijakan Biodiesel dari Sudut Pandang Indikator Makroekonomi dan Lingkungan	CSO report (Greenpeace dan LPEM FEB UI)	Land use	Indonesia	Projections with several scenarios	With various scenarios (B20, B30, up to B50) in 2025, there is a predicted need for new oil palm plantation expansion. The B20 scenario indicates that around 338 thousand hectares of new land will be required by 2025. Subsequently, the B30 scenario requires approximately 5.2 million hectares of new	https://www.greenpeace.org/static/planet4-indonesia-stateless/2020/11/cc19cf62-laporan-biodiesel-lpem_bahasa-indonesia_final.pdf

							land, and finally, the B50 scenario necessitates the largest amount of new land, around 9.2 million hectares.	
25	Traction (2019)	Greenhouse Gas Emissions from Biodiesel Production in Indonesia Based on Life Cycle Analysis.	CSO report (Traction)	Land use, emmission	Indonesia	Projections with several scenarios	1. Independent smallholders have lower productivity compared to companies, with an average yield of 13.5 tons of FFB/hectare/year. Therefore, independent smallholders need up to twice the amount of land to produce the same output as a company. 2. Emissions from land conversion in forests and peatlands are greater compared to conversion in	https://tractionenergy.asia/wp-content/uploads/2019/10/LCA_Biodiesel_English.pdf

							shrublands, fields, and grasslands.	
26	Julius Christian Adiatma; Hadi Prasojo	Critical Review on The Biofuel Development Policy in Indonesia	CSO report (IESR)	Land use	Indonesia	Projections with several scenarios	If the plantation's productivity remains at its current level of approximately 2.8 tons per hectare for the total area (including non-producing areas), the land required for palm oil production will reach 20.5-22.8 million hectares by 2024. The existing oil palm plantations in 2019 covered an area of 16.4 million hectares. This implies that an additional 4-6 million hectares need to be converted into oil palm plantations to meet domestic and export demands.	https://iesr.or.id/pustaka/critical-review-on-the-biofuel-development-policy-in-indonesia
27	Hugo Rosa da Conceição	Seberapa Hijaukah	CSO report (Carbon	Land use	Indonesia	Projections with	1. There is a possibility that	https://6fefcbb86e61af1b2fc4-

	et al. (2021)	Bahan Bakar Nabati (Biofuel)? Memahami Risiko dan Lanskap Kebijakan di Indonesia	Disclosure Project)			several scenarios	the biodiesel program will require an additional 9-15 million hectares of land. 2. Without a significant increase in palm oil productivity, the current biodiesel blending targets have the potential to add to a loss of forest cover by 4.5 million hectares.	c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/cms/policy_briefings/documents/000/005/723/original/Final_Biofuel_Policy_Brief_Bahasa.pdf?1628247765
28	Adzkar Ahsinin; Alia Yofira Karunian; Muhammad Busyrol Fuad (2020)	Menempatkan PT. Pertamina (Persero) sebagai Aktor Kunci dan Teladan dalam Penghormatan HAM dan Perlindungan	CSO report (Elsam)	Traceability	Indonesia	Qualitative	1. P.T. Pertamina does not yet have internal policies that obligate its supplier companies to meet specific sustainability commitments and standards	https://elsam.or.id/menempatkan-pt-pertamina-persero-sebagai-aktor-kunci-dan-teladan-dalam-penghormatan-ham-dan-perlindungan-lingkungan-pengembangan-

		Lingkungan: Pengembangan Kebijakan Biofuel sebagai Modalitas dalam Mewujudkan Produk Biofuel yang Berkelanjutan					such as NDPE, RSPO, ISPO, and others. 2. P.T. Pertamina does not yet have internal policies related to traceability in the supply chain of the mandatory B20 program. This raises concerns that the feedstocks for this program may not adhere to sustainable principles.	kebijakan-biofuel-sebagai-modalitas-dalam-mewujudkan-produk-biofuel/
29	M. Syakir (2010)	Prospek dan Kendala Pengembangan Jarak Pagar (*Jatropha Curcas L.)* Sebagai Bahan Bakar Nabati di Indonesia	Scientific article (Garuda)	Land availability	Indonesia	Life cycle analysis study	Based on the exploration-scale map, the land suitable within fence distance covers an area of 49.53 million hectares, consisting of highly suitable land (14.28 million hectares), moderately suitable land (5.53 million hectares), and marginally suitable	http://ejurnal.litbang.pertanian.go.id/index.php/psp/article/view/2712/2349

							land (29.72 million hectares). The highly suitable land class is found in Kalimantan with 4.72 million hectares, followed by Papua, Maluku, and Sulawesi with 2.56 million hectares. For moderately suitable land, it is present in Kalimantan with 1.71 million hectares and in Nusa Tenggara with 1.26 million hectares. Marginally suitable land is most extensive in Sumatra with 11.09 million hectares, followed closely by Kalimantan with 11.03 million hectares. Despite the extensive area of suitable land at 49.53 million hectares, it is important to note that the assessment has a limitation as it only considers the	

							biophysical conditions of the land, climate, and environment.	
30	Siregar, *et al*. (2015)	A Comparison of Life Cycle Assessment on Oil Palm (Elaeis guineensis Jacq.) and Physic Nut (Jatropha curcas Linn.) as Feedstock for Biodiesel Production in Indonesia	Scientific article (Science Direct)	Emmission	Java Island	Life cycle impact assessment	This study found that palm oil production for biodiesel has a higher environmental impact compared to Jatropha curcas production, especially in terms of Global Warming Potential (GWP), where emissions largely stem from fertilization processes and biodiesel production. Prior to reaching stable production, the total GWP value for palm oil is 2568.82 kg-CO2eq./t-BDF, while for Jatropha curcas, it is 1733.67 kg-CO2eq./t-BDF.	https://www.sciencedirect.com/science/article/pii/S1876610215000557
31	Kharina, Anastasia, *et al.*	The Potential Economic, Health, and Greenhouse Gas Benefits	White paper (ICCT)	Emmission	Indonesia	Quantitative	Used cooking oil can replace 45% of CPO for biodiesel consumption, saving about 6 million tons of carbon	https://theicct.org/publication/potential-economic-health-and-greenhouse-gas-benefits-of-

		of Incorporating Used Cooking Oil into Indonesia's Biodiesel					equivalent (CO_2e) annually. While collecting used cooking oil remains a challenge, this study estimates the potential of used cooking oil that can be obtained to be more than 3 billion liters per year.	incorporating-used-cooking-oil-into-indonesias-biodiesel/
32	Foteinis, Spyros *et al.*	Used-cooking-oil biodiesel: Life Cycle Assessment and Comparison wit first-and third-generation Biofuel	Scientific article (Science Direct)	Emmission			The total carbon produced by Biodiesel made from used cooking oil is approximately 0.55 tons of CO_2 equivalent (i.e., about 14g CO_2eq/MJ) and 58.37 Pt, 40% lower than first-generation biodiesel. Using used cooking oil as a raw material can also reduce water pollution caused by direct disposal of used cooking oil into the irrigation system.	https://www.sciencedirect.com/science/article/abs/pii/S0960148120302081
33	Hery Santoso and Wiko Saputra	Kertas Kebijakan: ISPO dan	CSO report (SPOS Indonesia/	Land governance	Indonesia	Qualitative	Independent smallholders face difficulties in obtaining	https://sposindonesia.org/wp-content/uploads/20

		Momentum Penataan Legalitas Perkebunan Sawit Swadaya	Yaysan Kehati)				ISPO certification due to the lack of legal status for their cultivated land. About 713,895 hectares or 36% of farmers' land is located in forest areas. Meanwhile, approximately 1,247,750 hectares or 64% are in APL (Forest Area Release) and are not yet fully considered legal. Therefore, the mandatory ISPO certification to be fulfilled by 2025 is an opportunity to improve land use governance by the smallholders. The government itself needs to promptly resolve the issue of land legality for smallholders within the time frame until 2025 so that all independent smallholders have equal access to the ISPO certification system.	20/06/Information-Brief -ISPO-DAN-LEGALITAS-KEBUN-SAWIT-SWADAYA-fin.pdf

Focus of the Study/Perspectives on the Economic Context

No	Researcher(s) (Year)	Research Title	Research Type	Subtopic	Research Location	Research Methods	Results	Link
1	Simon, *et al.* (2015)	Menakar Sawit: Riset Kawasan, Korupsi, dan Pendapatan Daerah di Sulawesi dan Kalimantan	Report	Regionally generated revenues	Buol, Banggai, Donggala, and Bulungan Regencies	Literature review and interviews in Central Sulawesi (Buol, Banggai, and Donggala Regencies) and North Kalimantan (Bulungan Regency) between August andSeptember 2014	This study concludes that the small amount of revenue generated for the Donggala and Bulungan Regencies from the vigorous issuance of licenses and concessions to palm oil plantation companies does not match the provision of land to accommodate palm oil plantations, which has led to a further reduction in forest cover and agricultural areas.	sawitwatch.or.id/wp-content/uploads/2015/12/Menakar-Sawit.pdf
2	Halimatussadia et al. (2021)	Progressive biodiesel policy in	Scientific article (Science	State revenues	Indonesia	Ex-ante analysis	This research finds that Indonesia's biodiesel policy strategy may lead	https://www.sciencedirect.com/science/article/abs

		Indonesia: Does the Government's economic proposition hold?	Direct)				to even greater export losses compared to diesel import savings until 2030. Additionally, the increasingly progressive biodiesel blending targets may also escalate government expenditures in the form of subsidies to support this policy.	/pii/S1364032121007140
3	Nuva et al. (2019)	Political Economy of Renewable Energy and Regional Development: Understanding Social and Economic Problems of Biodiesel Development in Indonesia	Scientific article	Economy-politics	Indonesia	In-depth interview	For the case of palm oil-based biodiesel in Indonesia, the development of biodiesel does not directly impact the community and regions because its main feedstock, palm oil, is cultivated not solely for biodiesel production. However, in some regions of Indonesia, such as Pelalawan District (Riau Province) and Asahan District (North Sumatra Province), palm oil plays a significant role in enhancing the economic and social capacity of the	https://journal.ipb.ac.id/index.php/sodality/article/view/19727/17690

							community. It is not denied that there are still social and environmental issues felt by the community due to the expansion of palm oil plantations, with one of its downstream products being biodiesel.	
4	Joni Jupesta (2012)	Impact of the Introduction of Biofuel in the Transportation Sector in Indonesia	Scientific article (Springer)	Food security	Indonesia	Modeling	One thing to consider in the context of biofuel development in Indonesia is the competition between palm oil as a food ingredient and palm oil as an energy feedstock. This could potentially lead to an increase in food prices due to the dual use of palm oil as an energy source.	https://link.springer.com/chapter/10.1007/978-2-8178-0268-8_19
5	SPKS (2020)	Kajian Good Governance BPDP SAWIT	CSO report (SPKS)	Biodiesel subsidies	Indonesia	Qualitative	BPDPKS is merely serving the role of "fund management" and administration, rather than strengthening palm oil smallholders. It even tends towards	https://spks.or.id/file/publikasi/Kajian-Good-Governance-BPDP-SAWIT.pdf

							corporatization in favor of the biodiesel industry's interests. Consequently, this entity only subsidizes biodiesel. The appointment of surveyors in the implementation of programs by BPDPKS does not align with transparent principles and is fraught with the interests of specific groups in the biodiesel industry. This leads to the unproductive, sporadic, and non-impactful use of BPDPKS budget for the benefit of smallholders.	
6	SPKS (2020)	Pelibatan Petani Swadaya dalam Rantai Pasok Biodiesel untuk Energi Berkelanjutan dan	CSO report (SPKS)	Biodiesel subsidies	Indonesia	Qualitative	In the management body of the plantation fund, there are conflicts of interest in decision-making for the allocation of the BPDPKS. These conflicts of interest are triggered by the presence of owners of biodiesel industries who also have large-scale plantation	https://spks.or.id/detail-publikasi-pelibatan-petani-swadaya-dalam-rantai-pasok-biodiesel-untuk-energi-berkelanjutan-dan-kesejahteraan-petani-kecil

		Kesejahteraan Petani					concessions in the board of directors and board of supervisors of the BPDPKS. This has an impact on fund distribution. Despite the B30 program being a government priority, the presence of these conglomerates further convinces the public that they are contributing a significant amount of palm oil funds back to their industry. The direct consequence is that oil palm smallholders do not receive empowerment, such as oil palm rejuvenation for independent smallholders, and capacity-building for oil palm smallholders.	
7	Christian, Julius; Prasojo, Hadi (2021)	Critical review on the biofuel development policy in	CSO report (IESR)	Farmers	Indonesia	Social life cycle assessment	Creating 800,000 job opportunities. However, another social issue that arises is regarding smallholders who still	https://iesr.or.id/pustaka/critical-review-on-the-biofuel-development-

		Indonesia					cannot compete with large companies, especially in determining prices.	policy-in-indonesia
8	Alison Wright (2013)	Socio-Economic Impacts of Palm Oil and Biodiesel: The Case of Indonesia	Scientific article	Farmers	Indonesia	Desk research and three small-scale field studies	The study employs several case studies, such as in Labuhan Batu Regency (North Sumatra) and Tanjung Jabung Timur (Jambi), and examines the socio-economic impacts of oil palm development as a biodiesel feedstock in these two areas. The results show that the income of independent smallholders depends on the price of FFBs. Independent smallholders in Harapan Makmur (Tanjung Jabung Timur), which is far from the mills, have lower FFB prices, making them dependent on FFB prices from middlemen. On the other hand, the FFB price for independent smallholders in Asam Jawa (Labuhan	https://link.springer.com/chapter/10.1007/978-3-319-03829-2_9

							Batu) is higher due to the proximity of their plantations to the oil palm plantations.	
9	Obidzinski (2012)	Environmental and Social Impacts of Oil Palm Plantations and their Implications for Biofuel Production in Indonesia	Scientific article	Community welfare	Indonesia	Stakeholder mapping	The three main trading activities related to oil palm plantation development, including those related to biofuel, result in uneven economic benefits at the expense of significant environmental losses; there are some beneficiaries, but also many who are adversely affected; and economic gains are obtained at the cost of weak legal regulations.	https://www.jstor.org/stable/26269006?seq=1&cid=pdf-reference#references_tab_contents
10	Faisal Basri and Gatot A. Putra – Greenpeace Indonesia (2020)	Kajian Makroekonomi Biodiesel	CSO report (Greenpeace)	Trade balance, biodiesel subsidies	Indonesia	Scenarios	1. The biodiesel program leads to a trade deficit as it results in missed opportunities for CPO exports, combined with increased imports of capital goods for	https://www.greenpeace.org/static/planet4-indonesia-stateless/2020/11/a4239ee6-kajian-makroekonomi-biodiesel_baca-

							the construction of new biodiesel plants, as capacity after 2020 is expected to be expanded. 2. The biodiesel program is unlikely to enhance the trade balance surplus even if the biodiesel is exported, considering that in the future, the European and US markets are actually reducing the use of biodiesel significantly. 3. The biodiesel program overlooks the most efficient economies of scale (natural monopoly) as it is co-opted by the interests of large	digital_final_lores.pdf

							CPO producers seeking to increase biodiesel producer surplus through biodiesel subsidies. The 18 biodiesel crops for the B30 program result in highly inefficient economies of scale. 4. Small-scale oil palm smallholders and/or owners stand to benefit significantly if export taxes are eliminated and biodiesel subsidies to CPO producers are also removed.	
11	Lembaga Penyelidikan Ekonomi dan Masyarakat (LPEM) FEB UI (2020)	Risiko Kebijakan Biodiesel dari Sudut Pandang Indikator Makroeko	CSO report (Greenpeace)	Trade balance, biodiesel subsidies	Indonesia	Scenarios	1. The macroeconomic aspects, which include the trade balance and biodiesel incentives/subsidie	https://www.greenpeace.org/static/planet4-indonesia-stateless/2020/11/a4239ee6-kajian-

		nomi dan Lingkungan					s, show that biodiesel policy has an ambiguous impact depending on the conditions of the CPO and diesel markets. There is a possibility that the potential loss of exports could be higher than the savings from diesel imports, resulting in a negative trade balance due to biodiesel policy. 2. The supply of CPO for biodiesel is vulnerable to changes in CPO prices in the market. Biodiesel stocks will decrease when CPO prices are high in the market. When CPO prices increase in the	makroekonomi-biodiesel_baca-digital_final_lores.pdf

							world market, producers are more likely to sell CPO to foreign markets, reducing the available CPO for biodiesel production. 3. The impact on subsidies is highly determined by the subsidy value of both biodiesel-forming commodities. 4. The higher the proportion of biodiesel blend, the higher the total subsidy expenditure if the FAME subsidy value is high. The FAME subsidy value is determined by the Biodiesel Market Price Index (HIP).	
12	Raquel Moreno-	"Stakehold	Scientific	Communit	Indonesia	Qualitative	1. In some regions,	https://link.sprin

	Penarand et al. (2019)	er Perception s of the Ecosystem Services and Human Well-Being Impacts of Palm Oil Biofuels in Indonesia and Malaysia"	article (Springer)	y welfare			palm oil plantation workers are predominantly migrants, not local residents. Moreover, the majority of local palm oil plantation workers do not have permanent employee status and receive wages below the Provincial Minimum Wage. Therefore, the economic impact of palm oil plantations on some areas is limited. 2. The high market uncertainty and production chain, as well as the difficulty for farmers to meet sustainability aspects according	ger.com/chapter/10.1007/978-4-431-54895-9_10

							to specific standards, result in farmers facing risks in their investments in palm oil ventures, with a possibility of being excluded from the palm oil supply chain altogether.	
13	Madani Berkelanjutan (2020)	Infobrief Vol. V	CSO report	Food security	West Kalimantan and Riau	Qualitative	1. In the case study of five regencies in West Kalimantan, three regencies—namely Ketapang, Landak, and Sekadau—showed a significant disparity in the Village Development Index (VDI), primarily characterized by the number of villages that have not yet benefited optimally from	

							plantation business permit holders. 2. The low Village Development Index is associated with the location of Oil Palm Plantation Permits, mainly due to the low composite index values for the economy and environment.	
14	Yustina Artati et al. 2019	Bioenergy Production on Degraded Land: Landowner Perceptions in Central Kalimantan, Indonesia	Scientific report (CIFOR)	Availability of biofuel feedstock development	Buntoi Village, Central Kalimantan	Survey	This study surveyed the preferences of 150 landowners in the village of Buntoi, Central Kalimantan, regarding the cultivation of bioenergy commodities. Only 8% of the community showed interest in developing *nyamplung*. The low interest in cultivating *nyamplung* fruit is attributed to the still unstable market for *nyamplung* bioenergy.	https://www.cifor.org/publications/pdf_files/articles/AArtati1901.pdf

							Therefore, several steps need to be taken to increase community participation, such as stabilizing the market for *nyamplung*, raising awareness about alternative feedstocks for bioenergy development, and providing support to the community for the cultivation of a particular commodity.	
15	Nurfatriani F, Ramawati, Sari GK, and Komarudin H. 2018.	*Optimalisasi Dana Sawit dan pengaturan instrumen fiskal penggunaan lahan hutan untuk perkebunan dalam upaya menguran gi*	Working paper (CIFOR)	Oil palm fund optimalisation	Indonesia	In-depth interview, FGD, and literature review	Farmers or smallholders still have a low bargaining position in the context of oil palm fund management. However, farmers themselves play a crucial role and have significant interests in oil palm funds. Therefore, there is a need for strong political commitment in decision-making regarding the use of oil palm funds, with greater attention given to the needs of rejuvenating smallholder	https://www.cifor.org/knowledge/publication/6882/

		deforestasi.					plantations and ISPO certification.	
16	Jelsma, et al.	Unpacking Indonesia's independent oil palm smallholders: An actor-disaggregated approach to identifying environmental and social performance challenges	Scientific article (Science Direct)	Independent smallholder challenges	Indonesia (Rokan Hulu, Riau)	Sample was drawn through a spatial analysis. Data collection was conducted through a field study and in-depth interviews.	The research shows that smallholders face several challenges related to sustainable plantation practices, especially regarding land legality. Currently, many stakeholders have committed to implementing sustainability principles in their supply chains. Since smallholders themselves struggle to meet these sustainability requirements, there is a potential for them to be excluded from the palm oil market chain.	https://www.sciencedirect.com/science/article/pii/S0264837717304751

Focus of the Study/Perspectives on the Social Context

No	Researcher(s) (Year)	Research Title	Research Type	Subtopic	Research Locatio	Research Methods	Results	Link

					n			
1	Konsorsium Pembaruan Agraria (2020)	Catatan Akhir Tahun 2020 Konsorsium Pembaruan Agraria Edisi Peluncuran I: Laporan Konflik Agraria di Masa Pandemi dan Krisis Ekonomi	Report	Agrarian conflict	Indonesia	Qualitative based on direct reports from the community members and victims to the KPA at the national and regional levels; report from the KPA networks at the national and regional levels; monitoring results and data collection on agrarian conflicts in regions; and monitoring results of news on	In 2020, amidst the pandemic situation in Indonesia, there was an eruption of agrarian conflicts, predominantly driven by the plantation sector, especially oil palm plantations. There were 101 conflicts triggered by oil palm plantations. Many instances of eviction from farmers' agricultural lands by oil palm plantations occurred. Companies demolished farmers' huts, disposed of harvests, and often received assistance from the police while the legal process regarding the land was still ongoing in the courts. One of the actors involved is a state-owned enterprise called PTPN. PTPN frequently engaged in violence and coercion. As an example, with the assistance of the military and the police, PTPN evicted agricultural lands and traditional settlements of the Indigenous People's Struggle Body of Indonesia in North Sumatra. The oil palm plantation	http://kpa.or.id/assets/uploads/files/publikasi/4db26-catatan-akhir-tahun-kpa_peluncuran-1_laporan-konflik-agraria-2020.pdf

						mass media (printed, electronic, and online)	companies that engaged in land grabbing during the pandemic are affiliated with several palm oil conglomerates in Indonesia, both on a national and global scale, serving as suppliers, partners, or subsidiaries. The primary findings of the research indicate that oil palm plantations are a leading cause of agrarian conflicts.	
5	Sawit Watch, *et al*. (2019)	*Shadow Report* – Kemana Arah Implementasi Inpres No. 8 Tahun 2018?	Report	Agrarian conflict	Indonesia	Monitoring results and documentation of the efforts and achievements in the implementation of Presidential Instruction No. 8/2018	This research identified a total of 108 cases of conflicts related to oil palm plantations in forested areas until March 2019.	http://sawitwatch.or.id/wp-content/uploads/2020/09/Shadow-Report-Moratorium-Sawit-IDN-09-AGUSTUS-2019-COVER.pdf
6	Abram, *et al.* (2017)	Oil palm-community conflict mapping in Indonesia: A case for	Scientific article (Science Direct)	Agrarian conflict	Kalimantan Island	Spatial analysis and modelling on 265 conflict reports in Kalimantan	This research found that conflicts within communities related to the palm oil industry occur more frequently in areas where residents perceive that the negative environmental	https://www.sciencedirect.com/science/article/abs/pii/S0143622816306087

		better community liaison in planning for development initiatives				Island, including 199 cases related to the palm oil industry	impacts will outweigh the benefits. The study also discovered that 48% of villages strongly oppose palm oil companies, as these communities heavily rely on the environmental services provided by the surrounding forests.	
8	Simon, *et al.* (2015)	Menakar Sawit: Riset Kawasan, Korupsi, dan Pendapatan Daerah di Sulawesi dan Kalimantan	Report	Agrarian conflict	Buol, Banggai, Donggala, and Bulungan Regencies	Literature review and interviews in Central Sulawesi (Buol, Banggai, and Donggala Regencies) and North Kalimantan (Bulungan Regency) between August and September 2014	This study found that there is a potential loss of 84 hectares of forest due to palm oil plantation permits in Buol Regency. The research also uncovered various corrupt practices, mainly revolving around licensing issues between government officials and palm oil entrepreneurs in the two provinces examined. These corrupt licensing practices have led to the expansion of large-scale palm oil plantations, further exacerbating social conflicts and violence with local communities. On the other hand, the study also concluded that the small amount of revenue generated for Donggala and Bulungan Regencies from the vigorous issuance of licenses and concessions for palm oil	sawitwatch.or.id/wp-content/uploads/2015/12/Menakar-Sawit.pdf

							plantation companies does not justify the provision of land to accommodate palm oil plantations, which has resulted in a decreasing forest cover and agricultural areas.	
10	Sawit Watch, *et al.* (2019)	Laporan Satu Tahun Implementasi Inpres Moratorium Sawit: Jauh Panggang dari Api?	CSO report	Agrarian conflict	Indonesia, especially Papua, West Kalimantan, East Kalimantan, South Sumatra, and Central Kalimantan	Monitoring results and documentation of the efforts and achievements in the implementation of Presidential Instruction No. 8/2018	In social terms, this research identifies 11 agrarian conflicts within palm oil plantations located in forest areas, which are expected to draw the government's attention.	sawitwatch.or.id/wp-content/uploads/2020/09/FINAL-Laporan-Satu-Tahun-Inpres-Moratorium-sawit-05-Okt-2019.pdf
11	Petra Irene Rietberg and Otto Hospes (2018)	Unpacking land acquisition at the oil palm frontier: Obscuring customary rights and	Scientific article (Wiley)	Social change	West Kalimantan	Semi-structured interview	This research explains the stages and process of land acquisition for palm oil plantations. The increasing demand for land is driven by the high demand for food and biofuel. The study was conducted in the Dop Village in West Kalimantan. The method used was semi-structured	https://onlinelibrary.wiley.com/doi/full/10.1111/apv.12206

		local authority in West Kalimantan, Indonesia					interviews. The research results show that land acquisition is a transformation process that blurs customary rights and local authority. In the initial stage, the company acknowledges customary rights and local authority. However, over time, the company gains greater authority guaranteed by the government. The community does not reject the presence of palm oil, but they demand the fulfillment of the rights promised by the company at the beginning. Therefore, state intervention is needed to oversee the process and stages of acquisition. Additionally, there is a need for alternative options for the poor communities aside from conversion into palm oil plantations.	
13	Assalam and Parsaoran (2018)	Keuntungan di Atas Manusia: Kondisi Kerja di Bawah	CSO report (Sawit Watch)	Human rights	Central Kalimantan	Literature review, and field research from September	This research found serious violations of human rights and labor rights in two plantations owned by Golden Agri-Resources, the palm oil business wing of Sinar Mas (managed by	sawitwatch.or.id/wp-content/uploads/2018/08/Keuntungan-Di-Atas-Manusia2-

		Rantai Pasokan Perkebunan Sawit Milik Sinar Mas				to December 2017 (including interviews with 49 plantation workers, 3 ex-plantation workers, and 2 informants from an NGO that focuses on oil palm plantation issues)	PT Tapian Nadenggan and PT Mitra Karya Agroindo in Seruyan Regency, Central Kalimantan). These violations include unfair labor practices, occupational health and safety issues, low wages, poor living conditions, gender discrimination, and concealing workers from audits.	compressed.pdf
14	Imam Syafii (2016)	Konflik Agraria di Indonesia: Catatan Reflektif Konflik Perkebunan Sawit di Kotawaringin Timur	Scientific article	Agrarian conflict	Kotawaringin Timur	Qualitative	1. The palm oil plantation conflict in East Kotawaringin is in its first to third phases. The first phase is the normative phase, where location permits and plantation principle permits issued by the regent, governor, and even the central government overlap.	https://jmb.lipi.go.id/jmb/article/view/572

							The second phase involves the imbalance in the relationship between the community and the company in establishing plasma farms, often leading to disadvantages for the community. The third phase, or conflict phase, is similar to the second phase, where the quality of the land/assets collaborated in the plasma farm is poor, thus causing harm to the local community in that area. 2. In 2014, the land conflicts recorded by the East Kotawaringin Regional Government consisted of 70 cases, comprising 60 cases between palm oil plantation companies and the community, 8	

							cases between different groups within the community, and 2 cases of conflicts involving the community with both the government and companies.	
15	Sawit Watch (2014)	Kaleidoskop Perkebunan Sawit 2014: Tugas Menyelesaikan Warisan Konflik di Sektor Perkebunan Sawit	CSO report (Sawit Watch)	Agrarian conflict	National	Qualitative	Conflict in palm oil plantations arises due to land disputes, unclear partnership programs, environmental degradation involving plantation companies, and conflicts between the local community and security forces as well as paramilitary forces affiliated with the company.	http://sawitwatch.or.id/wp-content/uploads/2015/01/Tandan-Sawit-No-8.pdf
16	Tania Murray Li (2015)	Social Impacts of Palm Oil in Indonesia, A Gendered Perspective from West	Scientific article (CIFOR)	Gender	West Kalimantan	Qualitative	Women are not represented in any decision-making of the farmers' cooperative. This is because only men are registered as members of the farmers' cooperative, so rights such as the right to vote in cooperative meetings or the	https://www.cifor.org/knowledge/publication/5579/#:~:text=press%2Drelease-,Social%20impacts%20of%20oil%20palm%20in%2

		Kalimantan					election of cooperative leaders cannot be exercised by women.	0Indonesia,gendered%20perspective%20from%20West%20Kalimantan&text=Oil%20palm%20plantations%20and%20smallholdings%20are%20expanding%20massively%20in%20Indonesia.&text=Conversely%2C%20support%20for%20independent%20oil,men%2C%20and%20enhancing%20their%20prosperity.
17	Human Rights Watch (2021)	Mengapa Tanah Kami? Ekspansi Perkebunan Kelapa Sawit di Indonesia Membahay	CSO report (Human Rights Watch)	Agrarian conflict	West Kalimantan	Interviews with more than 90 members of 3 transmigrant and immigrant communiti	Even though immigrants and transmigrant communities have legal rights to the land provided by the government, they still lose their land due to palm oil plantation expansion. Communities that are unwilling to agree with the plantation expansion face intimidation	https://www.hrw.org/id/report/2021/06/03/378784

		akan Lahan Gambut dan Penghidupan Masyarakat				es, which are Seruat Dua, Mengkalang Jambu, and Olak Olak in Kubu Raya Regency, West Kalimantan Province, and interviews with lawyers and representative of an NGO that focuses on land and agrarian reformation in Indonesia	threats and are sometimes taken to court.	
18	Yason Ngelia, Musa	Baseline Study Memetaka	CSO report (Elsam)	Gender	National	Interview, field observation	From a social perspective, there is gender-based work segregation in palm oil	https://elsam.or.id/baseline-study-

	Yulyanus, and Mambrasar Maria Baru (2020)	n Kondisi Perburuhan di Perkebunan Sawit Tanah Papua				, and literature review	plantations. This segregation is evident in recruitment, employment status, and wages of female laborers. Often, female laborers working in the plantations are the spouses of permanent laborers. Women are also employed in maintenance, care, and menial tasks as casual laborers paid on a piece-rate basis. Female workers are recruited from pockets of cheap labor.	memetakan-kondisi-perburuhan-di-perkebunan-sawit-tanah-papua/
19	Colbran (2011)	Indigenous Peoples in Indonesia: At Risk of Disappearing as Distinct Peoples in the Rush for Biofuel?	Scientific article (JSTOR)	Agrarian conflict	Indonesia	Literature review	The method of planting feedstocks for biofuels in Indonesia is currently unsustainable and places indigenous communities "on the brink of losing their traditional territories entirely, and thus disappearing as distinct communities".	https://www.jstor.org/stable/i24675807
20	Kurniawan, et al. (2018)	Dinamika Hulu Hilir Industri Biodiesel di Indonesia	CSO report (Koaksi)	Agrarian conflict	Indonesia	Normative-empirical method with qualitative-	This report reveals that there are many land conflicts between indigenous communities and oil palm plantations. According to a	https://coaction.id/katalog/policy-brief-mendorong-penguatan-

						quantitative analysis (literature review, interview, and observation)	study by TuK Indonesia et al. (2013), conflicts between companies and local communities generally arise due to the failure to implement FPIC with the surrounding residents. Most residents do not have complete information about the plantation development plans.	standar-berkelanjutan-dalam-pengembangan-biodiesel-di-indonesia/
21	Alison Wright (2013)	Socio-Economic Impacts of Palm Oil and Biodiesel: The Case of Indonesia	Scientific article (Springer)	Gender	Indonesia	Desk research and three small-scale field studies	The research uses several case studies, such as in Labuhan Batu Regency (North Sumatra) and East Tanjung Jabung (Jambi), and examines the socio-economic impacts of palm oil development as a biodiesel feedstock in these two areas. The research findings indicate that women working in palm oil plantations have lower incomes compared to men. Additionally, women tend to be employed in administrative roles, while men typically hold more critical positions	https://link.springer.com/chapter/10.1007/978-3-319-03829-2_9
22	Sisila	Effectively	CSO report	Gender	Indones	Qualitative	5. There is currently no	https://eu.boell.

	Nurmala Dewi et al (2018)	Integrating Human Rights and Gender Equality Into EU Climate Actions, A Case of Palm Oil for Biofuels in Indonesia	(FNF)		ia		gender-related policy within certification standards (ISPO RSPO) and sustainability policies (such as GAR and PTPN IV policies). 6. Indonesia lacks clear policies that link the connection between climate change and human rights (Indonesia's NDC)	org/en/2018/02/13/human-rights-and-gender-equality-eu-climate-actions-case-study-palm-oil-biofuels
23	Adzkar Ahsinin; Alia Yofira Karunian; Muhammad Busyrol Fuad	Menempatkan PT. Pertamina (Persero) sebagai Aktor Kunci dan Teladan dalam Penghormatan HAM dan Perlindungan Lingkungan:	CSO report (Elsam)	Traceability	Indonesia	Qualitative	1. P.T. Pertamina also does not yet have an internal policy regarding traceability in the supply chain of the mandatory B20 program. This raises concerns that feedstocks for the program may not adhere to human rights principles. 2. The scope of victims, who are entitled to file complaints and seek restitution, is still	https://elsam.or.id/menempatkan-pt-pertamina-persero-sebagai-aktor-kunci-dan-teladan-dalam-penghormatan-ham-dan-perlindungan-lingkungan-pengembangan-kebijakan-biofuel-sebagai-modalitas-dalam-mewujudkan-

		Pengembangan Kebijakan Biofuel sebagai Modalitas dalam Mewujudkan Produk Biofuel yang Berkelanjutan					limited. It only covers victims affected by P.T. Pertamina's business operations and does not yet include victims impacted by the business relations between P.T. Pertamina and its partners.	produk-biofuel/
25	Galih Andreanto (2014)	Bias Arah Reforma Agraria Jokowi-Jusuf Kalla, Jurnal Landreform "Membangun Kekuatan Politik Agraria" Volume II/Desember 2014	CSO report (KPA)	Land conflict	Indonesia	Literature review	The research results indicate that there is ease in obtaining permits for plantations, even though their status often overlaps. As a result, the total area of oil palm plantations is increasing, primarily controlled by a small group of corporations. The extensive control of oil palm land by corporations displaces the rights of the local population to the land, leading to numerous agrarian conflicts in the plantation sector, totaling 536 conflicts in the last 10 years.	http://kpa.or.id/assets/uploads/files/publikasi/ea6cb-jurnal-landreform-vol-2-desember2014_kpa.pdf

26	Perkumpulan HuMa (2012)	*Outlook* Konflik Sumberdaya Alam dan Agraria 2012	CSO report (Perkumpulan HuMa)	Land conflict	Indonesia	Qualitative	Some of the causes of plantation conflicts include the perception that the government prioritizes large capital owners; non-participatory spatial planning; unbalanced cooperation patterns between companies and smallholders, and so on. Additionally, land acquisition processes often do not adhere to the principle of FPIC, which should be mandatory in land acquisition processes.	https://storage.huma.or.id/publikasi//files/5449c2d2c3b9e.pdf
27	Elsam (2010)	Pelanggaran Hak Asasi Manusia di Kawasan Perkebunan Kelapa Sawit PT PP Lonsum Tbk-Sumatera Utara	CSO report (Elsam)	Human rights	Indonesia (North Sumatra)	Qualitative	PT PP Lonsum Tbk-North Sumatra has been involved in various human rights violations against the residents living in the company's oil palm plantation area. These violations occur due to the extensive authority granted by the government through the HGU, which can serve as justification for the company to commit human rights abuses.	file:///Users/arifvirgy/Downloads/1372924048_Pelanggaran_HAM_di_Kawasan_Perkebunan_Kelapa_Sawit_PT_PP_Lonsum_Sumatera_Utara%20(1).pdf