Competing Tenure

The Intersection of Forests, Food, and Fuel at Indonesia's National Strategic Project in Merauke, South Papua

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Center for Global Sustainability

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List of Acronyms and Abbreviations

AMAN	*Aliansi Masyarakat Adat Nusantara* (Indigenous Peoples Alliance of the Archipelago)
ASEAN	Association of Southeast Asian Nations
B50	Biodiesel Blending Rate of 50%
BAU	Business-As-Usual
BRWA	*Badan Registrasi Wilayah Adat* (Ancestral Domain Registration Agency)
CO	Carbon Monoxide
E10	Bioethanol Blending Rate of 10%
EV	Electric Vehicle
GCAM	Global Change Analysis Model
GKP	*Gula Kristal Putih* (White Crystal Sugar)
GOI	Government of Indonesia
Ha	Hectares
HC	Hydrocarbons
L	Liters
LDV	Light-Duty Vehicle
LUC	Land Use Change
MIFEE	Merauke Integrated Food And Energy Estate
$MtCO_2e$	Million Metric Tons of Carbon Dioxide Equivalent
NOx	Nitrogen Oxides
OECD	Organization for Economic Co-operation and Development
Presidential Decree No. 15/2024	Presidential Decree Number 15 of 2024 on the Formation of Task Force for Accelerating Sugar and Bioethanol Self-Sufficiency in Merauke Regency, South Papua Province
PM	Particulate Matter
Presidential Regulation No. 40/2023	Presidential Regulation Number 40 of 2023 regarding Acceleration of National Sugar Self-Sufficiency and Provision of Bioethanol as Biofuel
Presidential Regulation No. 55 of 2019	Presidential Regulation Number 55 of 2019 on electric vehicles
PSN	*Proyek Strategis Nasional* (National Strategic Project)
PT	*Perseroan Terbatas* (Limited Liability Company)
SAR	Synthetic Aperture Radar
tc	Metric Tons Of Sugarcane
TNI	*Tentara Nasional Indonesia* (Indonesian National Armed Forces)
TSP	Total Suspended Particulate
UN-FAO	United Nations - Food And Agriculture Organization

Executive Summary

Key Findings

- In 2023, driven by a long-term trade deficit for both oil and sugar, former President of Indonesia Joko Widodo promulgated legislation establishing the target of achieving 1.2 million kiloliters of bioethanol production and sugar-self sufficiency by 2028, later establishing that these plantations should be located in Merauke, South Papua Province.
- Sugarcane concessions in South Papua span across an area of up to 1.14 Mha, the majority of which is covered by dryland forests.
- Forest clearing within sugarcane concessions between June of 2024 and June of 2025 resulted in the loss of 5,315 ha of forest and generated an estimated 4.8 ± 0.5 $MtCO_2e$ emissions.
- Sugarcane expansion consistent with national bioethanol production targets would require 1.1-1.5 Mha land conversion and result in clearing emissions of 630.6 ± 59.3 to 834.5 ± 87.6 $MtCO_2e$, a scale on par with emissions from the 2015 fires.
- Due to widespread overlap with peatlands, the emissions benefits associated with fuel switching from oil to bioethanol would fail to offset the impacts of peat drainage.
- The emissions intensity of clearing is highest, exceeding 1,000 tCO_2e/ha, in the concessions of PT Sejahtera Gula Nusantara, PT Global Papua Makmur, and PT Agrindo Gula Nusantara, each of which falls under the ownership of the investment consortium Merauke Sugar Group.
- A suite of policy alternatives—intensification of existing sugarcane crops, enactment of fuel efficiency standards, and continued incentivization of electric vehicles—could help offset oil demand at a scale consistent with or higher than the widescale clearing planned, which would yield only a 2.8% bioethanol blending rate, far below the country's 10% target.
- Though sugarcane intensification can vastly improve Indonesia's sugar yield, existing plantations cannot satisfy rising domestic demand through land productivity and mill efficiency improvements alone.

1. Introduction

In 2023, President Joko Widodo promulgated Presidential Regulation Number 40 of 2023 regarding Acceleration of National Sugar Self-Sufficiency and Provision of Bioethanol as Biofuel (Presidential Regulation No. 40/2023),[1] outlining the Indonesian government's commitment to achieving sugar self-sufficiency and expanding bioethanol production through the development of sugarcane food estates. Indonesia has long targeted increased bioethanol uptake and reduced imports of staple crops, and Presidential Regulation No. 40/2023 set the target of achieving sugar self-sufficiency by 2028 and producing 1.2 million kiloliters (kL) of bioethanol by 2030. To achieve these targets, the regulation specifies that 700,000 hectares of land will be converted into sugarcane plantations, later estimating that as many as two million hectares (Mha) will be required.[2] Land conversion at this scale could dramatically shift local landscapes and livelihoods, and related forest loss could threaten Indonesia's commitment to becoming a net carbon sink by 2030.[3]

Presidential Regulation No. 40/2023 further dictates that land for sugarcane expansion be sourced from forest areas and existing plantations dedicated to other crops, and aims to increase sugarcane yield from 67[4] to 93 tons per hectare while improving the sugar extraction yield in factories from 7.5[5] to 11.2%. This roadmap, developed in coordination with the Minister for Economic Affairs, outlines the nation's plans to improve factory production, create supporting infrastructure such as roads, offer financial incentives through government-funded support and capital, and ease business licensing. To facilitate implementation, President Jokowi signed Presidential Decree Number 15 of 2024 on the Formation of Task Force for Accelerating Sugar and Bioethanol Self-Sufficiency in Merauke Regency, South Papua Province (Presidential Decree No. 15/2024), forming a task force to accelerate these efforts, and designating Merauke as a priority location for plantation development.[6] Later in 2024, Indonesia elected and inaugurated President Prabowo Subianto, who identified food and energy self-sufficiency as top policy priorities during his candidacy.[7] Under Prabowo's presidency, the government of Indonesia (GOI) continues to work towards implementing Presidential Regulation No. 40/2023 and Presidential Decree No. 15/2024, aiming to achieve biodiesel and bioethanol blending rates of 50% (B50) and 10% (E10) by 2029, respectively, through the expansion of food estates.[7]

Indonesia has long aimed to achieve food self-sufficiency, and its Constitution dictates that "the land and the water as well as the natural resources therein are controlled by the state and utilized for the optimal welfare of the people."[8] As early as the mid-1960s, policymakers began targeting national self-sufficiency in rice production, a culturally important staple crop, temporarily reaching this goal in 1984.[9] As part of this ongoing effort, in 1995 President Suharto initiated the nationalized food estate program, allocating peat forests in Central Kalimantan for crop cultivation.[10] Following presidents continued to establish food estates, including the Merauke Integrated Food and Energy Estate (MIFEE) and the Delta Kayan Food Estate under President Susilo Bambang Yudhoyono.[11,12] In response to a United Nations Food and Agriculture Organization (UN-FAO) report on food insecurity during COVID-19,[13] the Jokowi administration revived the food estate program under the umbrella of National Strategic Projects (*Proyek Strategis Nasional*, or PSN). However, both past iterations and newly established projects have raised concerns. Food estates often began operating without the

free, prior, and informed consent of local communities,[14] have been associated with deforestation, ecosystem fragmentation,[15] peat fires,[16] and reduce local food security, diet diversity, and nutritional outcomes[17,18] while failing to achieve their broader production targets.[19]

A major aim of the food estate program is achieving self-sufficiency in staple food products, including rice, corn, cooking oil, and sugar. Indonesia remains heavily dependent on sugar imports. Over the past 10 years, Indonesia imported approximately 70% of all sugar used. In 2024 alone, sugar imports exceeded 6.4 million tons, and are expected to rise to reach nearly seven million tons by 2030 as demand continues to grow.[20] Under President Prabowo, the program expanded to emphasize energy security, to be attained through the accelerated production of woody bioenergy products, oil palm-based biodiesel, and sugarcane for molasses-based bioethanol. While Indonesia's biodiesel program has consistently attained increased blending targets, rising to the highest blending rate globally,[21] bioethanol development has lagged. Despite earlier mandates to reach blending rates of 5% (E5) by 2015 and 20% (E20) by 2025,[22] the actual blending rate remains negligible.[23]

Previous efforts to establish nationalized food and energy plantations in South Papua faced considerable backlash for their resulting deforestation, local food insecurity from converting forests to exporting plantations, land seizure, and human rights abuses.[24] The MIFEE, established in 2010, aimed to create an export-focused agricultural industry in South Papua to alleviate national food insecurity.[25] The project aimed to produce two million tons of both rice and corn, 2.5 million tons of sugar, 937,000 tons of palm oil, and 167,000 tons of soybeans, but failed to reach these targets.[11] Given the new food estate's classification as a National Strategic Project, the Ministry of Defense is responsible for development and is actively deploying military personnel from the Indonesian Armed Forces (TNI) for land clearing in Merauke.[26] Over the course of 2024, the Ministry sent nearly 3,200 troops to South Papua,[27] with the National Military Commander sending five battalions to enforce project implementation.[28]

The latest food estate in Merauke, highlighted in Presidential Regulation No. 40/2023 and designated as a PSN dedicated to sugar and bioethanol production, risks duplicating these past impacts while aiming to achieve national targets. The scale of planned land conversion and the emphasis on rapid implementation warrants careful evaluation of potential impacts associated with the project's expansion.

In this report, we assess the implications of full-scale implementation of Presidential Regulation No. 40/2023. We map deforestation during the first year of project development and evaluate the impacts of ongoing and intensified development while considering alternative means of strengthening Indonesia's sugar and fuel self-sufficiency. Our findings indicate that meeting the regulation's bioethanol target would require substantially more land conversion than the 700,000 ha initially allocated, potentially requiring 0.95 to 1.5 Mha of land for plantations and generating 578-835 $MtCO_2e$ in land-clearing emissions, depending on sugarcane productivity assumptions. While the associated increase in sugar production can offset imports and make Indonesia self-sufficient, attaining this regulation's bioethanol target of 1.2 million kL by 2030 through mass

clearing would result in a bioethanol blending ratio of merely 2.8% of total fuel consumption. These findings suggest that ongoing and projected land conversion under PSN Merauke may have notable climate implications while contributing negligibly to national bioethanol blending goals.

2. Methods and Data Collection

2.1. Finding and demarcating concessions

To meet increased sugarcane demand, the GOI is expanding plantation areas by providing concessions to companies operating in the region and reclassifying forest areas. Under Government Regulation Number 23 of 2021 on Forestry Management, government officials have the authority to propose forest areas for reclassification in order to allocate land for PSNs. This regulation allowed the Ministry of Energy and Mineral Resources to propose two Mha[29] of land for sugarcane plantation development, expanding upon the 700,000 ha initially referenced in Presidential Regulation No. 40/2023. The regulation also allows businesses to obtain forest utilization permits of up to 50,000 ha in general, or up to 100,000 ha in Papua.[30] Additionally, subsidiaries of parent companies are able to function independently, receiving multiple business utilization permits, allowing companies like PT Global Papua Abadi and PT Murni Nusantara Mandiri to receive Plantation Business Permits totaling 637,420 ha.[30]

For our analysis, we gathered and compared reporting on size and extent of sugarcane concessions in South Papua, referencing government sources alongside non-governmental sources including Nusantara Atlas, EcoNUSA, and PUSAKA. We cross-checked reporting on concessions across these sources, finding Nusantara Atlas to have the most expansive set of concessions, georeferencing these 28 mapped concessions for our analysis of all potential sugarcane concessions. Concession ownership is opaque for sugarcane in South Papua, with smaller subsidiaries named, some with differing reports of company parentage. Further, though all concessions are reported by at least one source as being allocated for sugarcane production, for some concessions, multiple crops are reported across sources (see Table 1). For example, 18 concessions are reported as being rice producing concessions, primarily concentrated on the western half of South Papua. Those on the easternmost side are more likely to only be reported as sugarcane. Ownership and commodity production is most certain under concessions belonging to the PT Merauke Sugar Group, a consortium of companies operating in the eastern portion of Merauke Regency.

We separately analyzed this group of concessions, identified by the Ministry of Investment as the Merauke Cluster III Planning Area, which has an area of 563,661 ha. This planning area includes many concessions listed in the more comprehensive list of concessions, listed under Group 1, Group 2, Group 3, Group 4, and PT Borneo Citra Persada, sometimes called BCP Merauke, which includes parts of the concessions Karyabumi Papua, Bhakti Agro Lestari, and Rizki Kemilau Berjaya (see Figure 1). The Strategic Environmental Study regarding this planning site indicates that further investment and planning into this site will require changing the statuses of Production Forests and Convertible Production Forests— 82% of the land within these concessions falls under one of these classifications—to Agricultural Forest Area before applying for permits and land use approvals. The study also states that this site will produce an estimated 0.24 billion liters of bioethanol annually, given cultivation of only half of the concession area.

Table 1: Potential sugarcane concessions in Merauke by reported ownership and potential range of crops.

Concession Name	Reported Ownership	Planned Crop(s)
Agri Surya Agung	Jhonlin Group[1], Modern Internasional[234]	Sugarcane[23], Rice[15]
Belantara Abadi Utama	Jhonlin Group[1]	Sugarcane[23], Rice[15]
Bhakti Agro Lestari	Jhonlin Group[1], Jardine Matheson[234], Merauke Sugar Group[7]	Sugarcane[2356], Rice[1]
Bumi Agung Lestari	Jhonlin Group[1]	Sugarcane[23], Rice[15]
Cendrawasih Jaya Mandiri	Jhonlin Group[1], Rajawali Corporation[234]	Sugarcane[23], Rice[15]
Energi Mitra Merauke	Jhonlin Group[1], Medco Group[234]	Sugarcane[23], Rice[15]
Karyabumi Papua	Jhonlin Group[1], Rajawali Corporation[234], Merauke Sugar Group[7]	Sugarcane[2356], Rice[15]
Kharisma Agri Pratama	Jhonlin Group[1], Modern Internasional[234]	Sugarcane[2], Rice[15]
Nusantara Agri Resources	Jhonlin Group[1], Modern Internasional[234]	Sugarcane[23], Rice[15]
Pelangi Prima Indonesia	Jhonlin Group[1], Gama Group[34]	Sugarcane[23], Rice[1]
Perwita Citra Nusantara	Jhonlin Group[1], Sinarmas[34]	Sugarcane[23], Rice[15]
PT Agrindo Gula Nusantara	Merauke Sugar Group[17]	Sugarcane[1256], Rice[15]
PT Andalan Manis Nusantara	Merauke Sugar Group[17]	Sugarcane[1256]
PT Berkat Tebu Sejahtera	Merauke Sugar Group[17]	Sugarcane[1256]
PT Global Bagus Makmur*	Merauke Sugar Group[17]	Sugarcane[1256]
PT Global Papua Abadi	Merauke Sugar Group[17]	Sugarcane[12356]
PT Dutamas Resourses International	Merauke Sugar Group[17]	Sugarcane[12356]
PT Murni Nusantara Mandiri	Merauke Sugar Group[17]	Sugarcane[1256]
PT Sejahtera Gula Nusantara	Merauke Sugar Group[17]	Sugarcane[1256]
PT Semesta Gula Nusantara	Merauke Sugar Group[17]	Sugarcane[1256]
Rizki Kemilau Berjaya	Jhonlin Group[1], Rajawali Corporation[234], Merauke Sugar Group[17]	Sugarcane[2356], Rice[1]
Purna Karsa Wibawa	Jhonlin Group[1]	Sugarcane[23], Rice[15]
Sinergi Tani Nusantara	Jhonlin Group[1]	Sugarcane[23], Rice[15]
Subur Alam Pratama Indonesia	Jhonlin Group[1], Wilmar Group[34]	Sugarcane[23], Rice[15], Ranching[5]
Sukses Pratama Andalan	Jhonlin Group[1], Gama Group[34]	Sugarcane[23], Rice[15], Ranching[5]
Tiara Mas Investama	Jhonlin Group[1]	Sugarcane[23], Rice[15]
Valensia Indo Makmur	Jhonlin Group[1], Phoenix Resources International[34]	Sugarcane[23], Rice[15]
PT Global Papua Makmur	Merauke Sugar Group[17]	Sugarcane[1256]

1. Mighty Earth [32]
2. Nusantara Atlas [33]
3. EcoNUSA [34]
4. LexisNexus
5. Greenpeace [35]
6. PUSAKA [36]
7. Ministry of Investment [37]

*In many sources, PT Global Bagus Makmur is referred to as PT Global Papua Makmur, falling under its ownership structure.

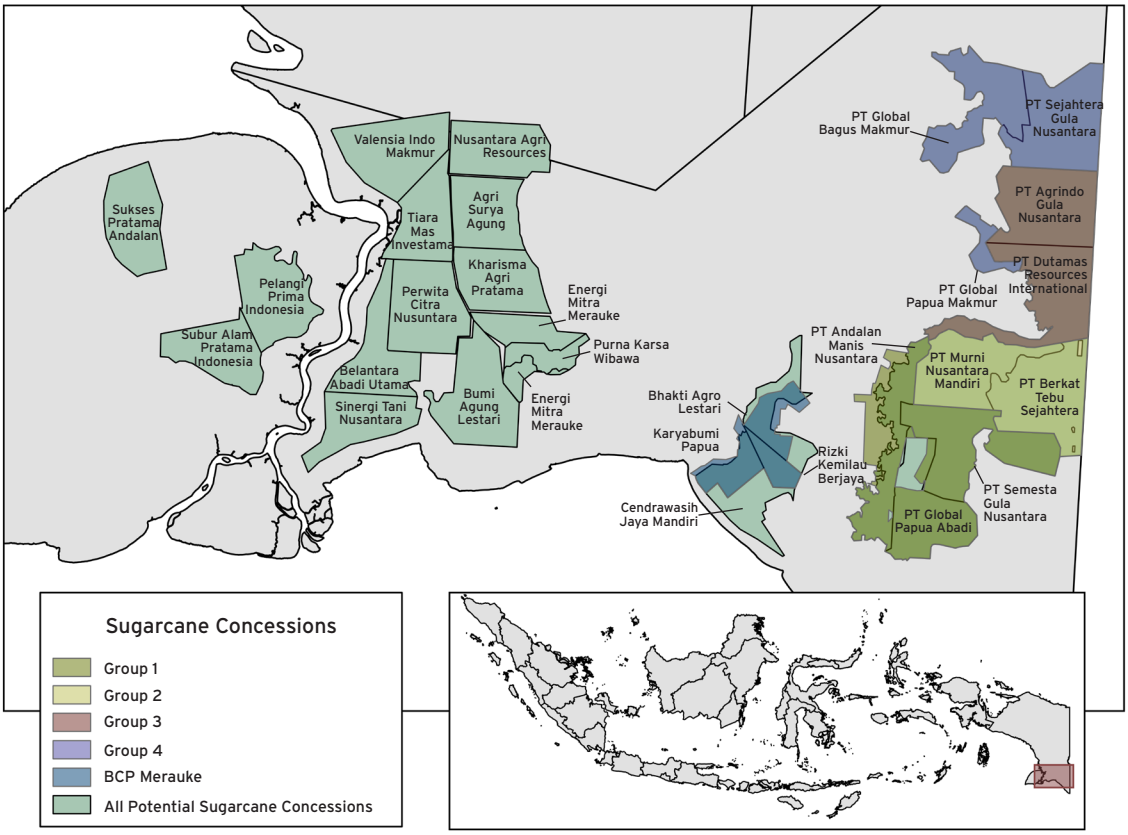


Figure 1: Sugarcane concessions by subsidiary name and documentation. Transparent concessions are part of Group 1, Group 2, Group 3, Group 4, Group 5, or BCP Merauke planning zones, owned by the investment consortium Merauke Sugar Group.

2.2. Calculating existing clearing

On July 23, 2024, President Jokowi planted the first seeds within PT Global Papua Abadi's sugarcane concession, ceremonially launching the sugarcane food estate program.[2] However, land clearing had begun approximately one month prior to the ceremony, with organizations that track land cover change noting ongoing clearing in concessions throughout South Papua Province.[38] We therefore define the first year of project development as spanning June 2024 to June 2025. To assess land cover change during this period, we analyzed optical imagery from Landsat 8 and 9, integrated with Synthetic Aperture Radar (SAR) imagery from Sentinel-1, and compared land cover in South Papua before June 2024 with land cover in June of 2025. Data processing and classification was conducted using Google Earth Engine and ArcGIS. We defined 10 land cover classes based on visual interpretations of satellite imagery, later training and digitizing polygons to determine changes in land cover during the first year of project implementation to identify forest loss. Additional methodological details are provided in the Technical Appendix.

2.3. Protest and project perception analysis

To understand local perceptions of PSN Merauke, this paper analyzed protest data to determine the presence and scope of protests against the project. Using regional data for the Asia-Pacific region from the Armed Conflict Location and Event Data (ACLED) database, we conducted a

qualitative analysis, coding data entries categorized as "Demonstrations" or "Political Violence; Demonstrations" occurring between January 1, 2020 and July 11, 2025.[39] We further filtered the data to assess all Papuan provinces—Central Papua, Highland Papua, Papua, South Papua, Southwest Papua, West Papua—for coverage of the whole region. Reading through each data entry, coders identified key actors, issues, and protest activities. After assigning themes, coders standardized naming conventions and recoded, repeating this process until four categories with 26 groups emerged, available in the Technical Appendix.

2.4. Calculating one-time and annual emissions

We calculated projected land clearing emissions considering changes in both aboveground and belowground biomass following conversion from initial land cover to sugarcane, using carbon values and uncertainty percentages from Indonesia's National Forest Reference Level for all available land cover classes.[40] Due to its omission from the this dataset, we use other literature to estimate biomass lost under oil palm clearing, and associated uncertainty.[41,42] We assume no sequestration from sugarcane grown for harvest, and given the use of excavators for clearing, we assume no emissions from clearing fires.[43,44] We calculated annual emissions resulting from operations within the field, transportation to the mill, sugarcane processing, ethanol production, and peat drainage, subtracting emissions reductions from fuel switching. We do not include emissions from transporting fuel from mill to end user.

2.5. Modeling Indonesia's future oil demand

We used a version of the open-source Global Change Analysis Model (GCAM) to estimate projected oil demand. GCAM is an integrated assessment model that represents five systems: agriculture and land, the climate, the economy, the energy system, and water systems, with global coverage and country-specific breakout capability. For this assessment, we used GCAM v7.0, adjusting transportation assumptions to understand fuel demand and the impact of interventions on projected demand. To match historical transportation data in Indonesia, we calibrated the model, adjusting the shareweight for trucks and buses running on refined liquids, assumptions about biodiesel production rates, and removing natural gas from the transportation sector using shareweight adjustment. Using these calibrations, we ran a reference scenario to determine base national refined liquids demand for transportation in 2030 and 2035. Through post-processing, we determined the oil and diesel shares by transportation type, aggregating to determine total oil demand for transportation (see the Technical Appendix).

2.6. Calculating alternative scenarios

Indonesia has long faced low sugar production efficiency, in terms of both productivity per hectare on the field and sugar recovery efficiency at factories. Intensification through improvements in site selection, crop productivity, and factory efficiency could boost sugar production.[45] Mill efficiency determines sugar yield at factories, which require substantial revitalization and modernization in Indonesia, as the majority of factories, infrastructural legacies of Dutch colonialism, are over 100 years old.[46] Beyond equipment age, inefficient performance, low-quality raw material, low

grinding capacity, a high proportion of non-operational hours, and high production costs limit sugar output.[45,47] In Presidential Regulation No. 40/2023, Indonesia set the target of achieving a sugar recovery rate of 11.2% within factories dedicated to servicing PSN Merauke. This goal will be difficult to reach, given an average efficiency of 7.4% at existing factories,[48] and a technical potential for recovery of 7.2-10.2%.[45] On the ground, this policy targets land productivity of 90 tc/ha, a yield far greater than the historical average from 2020-2023 of 66.7 tc/ha and greater than estimates of technical potential of 58-80 tc/ha.[49] To determine the potential for increased sugar production through field productivity and factory efficiency improvements, we estimate sugar yield under achievement of Presidential Regulation No. 40/2023 goals.

A number of strategies beyond sugarcane extensification could reduce oil demand while limiting land conversion for energy plantations. First, intensification of existing sugarcane plantations could improve bioethanol yield. Increasing cane production and sugar yield upstream also increases molasses generation, and intensification of existing plantations could aid in reducing the bioethanol gap without further land conversion. As with improvements in sugar production, we test the technical potential for increased molasses yield, and thus bioethanol production, under achievement of Presidential Regulation No. 40/2023 targets.

Mandated fuel efficiency improvements for light-duty vehicles (LDVs) could also aid in reducing oil demand. Indonesia's average fuel economy is poor, despite its low LDV fleet weight, with an average national fuel consumption approximately 13% above the global average,[50] and lags behind other Association of Southeast Asian Nations (ASEAN) member countries.[51] To address this, in 2018 the Minister of Transportation co-created and adopted the ASEAN Fuel Economy Roadmap target of reducing "the average fuel consumption of new light-duty vehicles sold in ASEAN by 26%" over ten years,"[51] to be achieved through implementation of a fuel efficiency standard. Though the GOI took other actions in that last decade, including the expansion of 2013 tax incentives for low-emissions vehicles to include hybrids and electric vehicles (EVs), a fuel efficiency standard has not yet materialized in energy planning.[52] To estimate efficiency, we applied the ASEAN target of reducing fuel consumption of new LDVs sold by 26% over ten years,[51] but began policy implementation in 2025, extending until 2035.

Further, under Presidential Regulation Number 55 of 2019 on electric vehicles (Presidential Regulation No. 55/2019), Indonesia outlined its EV ambition, including the target of reaching 13 million electric motorcycles and two million EVs on the road by 2030. Though initial uptake has been slow due to the lack of supporting infrastructure such as charging stations,[53] the rate of sales is rising, with mid-year EV sales in 2025 already double those in 2024.[54] Observers attribute the success in LDV deployment to the 2024 policy shift waiving import taxes on foreign EV companies that invest in local manufacturing, allowing for sizeable price drops in models from companies like BYD Auto, which reached near-price-parity with ICEs under this regulation. A subsidy for electric motorcycles that lasted between 2023 and 2024 helped raise sales during this period, though sales subsequently dropped following termination of this policy in December of 2023.[55] We tested two EV scenarios to understand the role that continued ratcheting of deployment could play in offsetting oil demand. In our moderately ambitious scenario, which includes continued implementation of

four-wheel incentives and recovered two-wheel sales, Indonesia achieves deployment of .6 million LDVs and four million electric motorcycles by 2030. Under our more ambitious scenario, Indonesia increases electric vehicle stock in alignment with targets outlined under Presidential Regulation No. 55/2019.

3. First Year Development Outcomes at PSN Merauke

3.1. Clearing within concessions during the first year (June 2024 to June 2025) of project development responsible for 5,315 ha of forest loss

Our analysis indicates that during the first year of project implementation, South Papua experienced 8,579 ha of forest loss, of which 3,006 ha occurred on peatlands. Overall, clearing patterns closely align with mapped sugarcane concessions. Of the total forest loss, 5,315 ha has occurred within sugarcane concessions, primarily within land allocated to PT Global Papua Abadi (2,559 ha) at the intersection of Jagebob, Tanah Miring, and Animha Districts, and Valensia Indo Makmur (1,821 ha) in Ilwayab District (see Table 2). Further, forest clearing within concessions impacted 1,710 ha of peatlands, with nearly all peatland conversion occurring within the Valensia Indo Makmur concession.

Degraded dryland forests and degraded peatland forests comprise the majority of forest loss during the study period. Our estimates indicate that total forest clearing generated approximately 7.3 ± 0.9 $MtCO_2e$ emissions, of which 4.8 ± 0.5 $MtCO_2e$ were within sugarcane concessions. Given that 32% of forest loss occurred on peatlands, we further estimate that peat drainage associated with plantation establishment contributed an additional 98.6 ± 39.1 $MtCO_2e$ during the first year of clearing on sugarcane concessions.

Table 2. Forest loss, peatland conversion, and clearing emissions by concession.

Concession Name	Forest Loss (ha)	Peat Loss (ha)	Clearing Emissions ($MtCO_2e$)
Agri Surya Agung	45	2	46 ± 4
Belantara Abadi Utama	0.5	0.5	0.5 ± 0.5
Bumi Agung Lestari	66	25	48 ± 7
Cendrawasih Jaya Mandiri	7	2	7 ± 0.7
Energi Mitra Merauke	1	1	1 ± 0.1
Pelangi Prima Indonesia	7	3	5 ± 0.7
Perwita Citra Nusantara	3	0.1	3 ± 0.4
PT Andalan Manis Nusantara	0.1	0.1	0.1 ± 0.1
PT Berkat Tebu Sejahtera	5	0	5 ± 0.4
PT Global Papua Abadi	2,559	10	2,729 ± 218
PT Murni Nusantara Mandiri	329	0	347 ± 27
PT Semesta Gula Nusantara	22	6	24 ± 2
Rizki Kemilau Berjaya	2	2	1 ± 0.2
Subur Alam Pratama Indonesia	68	35	43 ± 7

Tiara Mas Investama	383	186	347 ± 42
Valensia Indo Makmur	1,821	1,438	1,146 ± 188

Forest clearing in the first year of project development follows established trends and on-the-ground reporting. The link between road expansion and deforestation, well-documented in existing literature,[56,57] is evident at PSN Merauke. Ongoing road construction and existing infrastructure, some of which came from MIFEE development, enabled and drove project development and forest loss. Deforestation also extends from port construction along the Multi Straight, where early excavator shipments landed, towards Wanam Village. This clearing follows road construction from Ilyawab District to Muting District, where approximately 40 km of a planned 135 km road has been constructed.[33] Additionally, consistent with local reporting, forest loss is concentrated within PT Global Papua Adabi, particularly the central portion of the concession (see Figure 2).

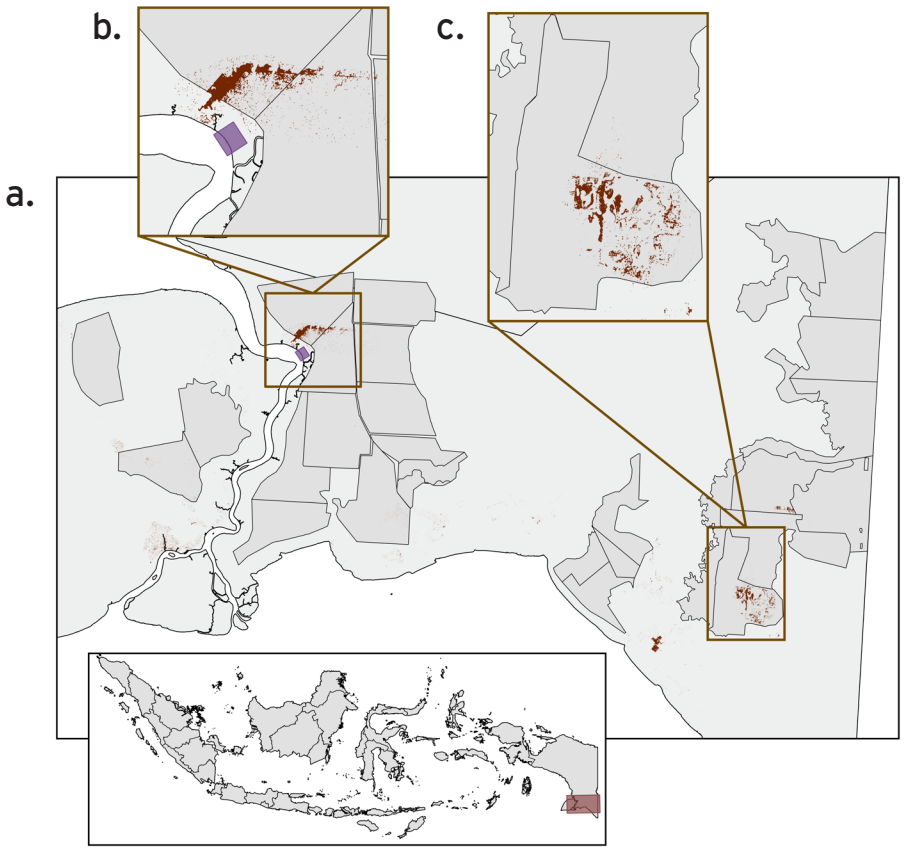


Figure 2. Deforestation between June 2024-June 2025. a. Deforestation in southern South Papua Province. **b.** Forest clearing from port construction along the Muli Straight and road construction from Ilyawab to Muting. Red shading represents areas identified as deforested during the analysis period. Purple shading represents port construction. **c.** Forest clearing at the concession belonging to Global Papua Abadi.

3.2. Across project development stages, PSN Merauke met with protests

Across Indonesia, PSN Merauke has faced opposition based on concerns regarding environmental impacts, climate change implications, and the rights of indigenous communities. In South Papua, individuals from the Awyu, Marind, Moi, Yei, Khimaima, and Maklew groups organized to represent indigenous community sovereignty and advocate for the protection of ancestral forests through the "Merauke Solidarity" group.[41] The group criticizes the project's role in continuing patterns of human rights abuses, environmental damage,[58] and degradation of Papuan culture.[60] In the recent past, industrial plantation projects such as MIFEE faced community resistance[11] and criticism for its destruction of customary forests,[61] contribution to local malnutrition,[62] pollution of water for fishing and drinking, and loss of cultural identity for groups such as the Marind.[62] PSN Merauke continues to exacerbate these tensions, resulting in public protests.

Qualitative review of these protests reveals that between 2020 and 2025, a total of 38 recorded protests explicitly contested "National Strategic Projects" or "sugarcane". As clearing and planting began from June 2024 to July 2025, protests with specific grievances against PSNs and sugarcane plantations increased in five of the six Papuan provinces. Common protest grievances include exploitation of natural resources on customary lands, human rights abuses, and the issuance of permits on indigenous land, including those granted to PT Bintuni Agro Prima Perkasa and PT Global Papua Abadi. In this five year period, PSNs drove the most protests of any cause, at 142 documented protests, surpassing protests on general environmental concerns (137), violence and conflict (121), and land disputes (121).[39]

PSN Merauke has also been subject to widespread pushback from international advocacy groups for the continuation of human rights abuses against indigenous communities in Papua,[26] drawing attention from international media[63] and the United Nations.[31] In March of 2025, nine Special Rapporteurs to the United Nations Human Rights Council signed a letter to the Government of Indonesia on the human rights violations against indigenous communities linked to PSN Merauke.[31] This followed a similar letter from nine Special Rapporteurs in October of 2024 concerning human rights abuses from international palm oil companies operating without permits and Free and Prior Informed Consent on indigenous land in Sulawesi.[64] The letter emphasized the potential of PSN Merauke to have catastrophic impacts on local communities and called for the Government of Indonesia to address the environmental and human impacts of the project before continuing.[31]

4. Planned Expansion and Projected Impacts

4.1. Full project implementation would achieve sugar self-sufficiency but offset only 2.8% of projected oil demand in 2030

Indonesia's bioethanol policies set the targets of achieving self-sufficiency in sugar for food consumption by 2028 and production of 1.2 million kL of sugarcane ethanol by 2030. Our analysis indicates that sugarcane production at the scale outlined in Presidential Decree No. 15/2024 and Presidential Regulation No. 40/2023 is adequate to achieve sugar self-sufficiency. According

to UN-FAO projections, domestic sugar demand for food consumption is expected to increase from 8.14 in 2024 to 8.96 Mt by 2029. In the absence of policies encouraging intensification or extensification, imports are projected to rise to approximately 6.77 Mt by 2029 (see Table 3).[20] Meanwhile, producing 1.2 million kL of sugarcane ethanol requires 88.2 Mt of sugarcane, yielding about 7.1 Mt of sugar. This level of production would be sufficient to offset sugar imports of 6.77 Mt even amidst growing demand.

However, given present and projected vehicle fuel oil projections, rapid attainment of the bioethanol target does little to offset oil demand and transportation-related emissions. Using GCAM, we find that by 2030, fuel oil use rises to 43.6 million kL, in alignment with other estimates of 2030 fuel demand, which range from 41.3 - 44.2 million kL.[23,66,67] Attaining ethanol production in alignment with Presidential Regulation No. 40/2023 thus only enables a 2.8% bioethanol blending ratio, resulting in negligible reductions in oil demand and failing to meet Prabowo's campaign target of 10% national bioethanol blend (E10) by 2029.[7]

Table 3. Historical and projected sugarcane, molasses, and bioethanol production compared with targets in Presidential Regulation No. 40/2023.

	Historic and BAU Projections											Targets
Year	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2030**
Sugarcane Feedstocks (Thousand Tons)												
Sugar Production[1]	2,294	2,303	2,271	2,200	2,148	2,161	2,128	2,124	2,131	2,163	2,205	6,571*
Sugar Imports[1]	5,249	5,747	5,860	5,100	6,427	6,217	6,417	6,499	6,602	6,774	6,918	~0
Sugar Consumption[1]	6,884	7,182	7,352	7,567	7,788	7,931	8,079	8,234	8,399	8,565	8,719	-
Molasses Production[1]	1,078	1,082	1,067	1,034	1,007	1,024	1,021	1,022	1,025	1,041	1,061	4,412*
National Land Use (Ha)												
Sugarcane Extent[2]	418,997	449,008	490,008	489,339	-	-	-	-	-	-	-	1,189,339*
Efficiency (tc/ha)[2]	68.48	70.68	66.26	61.70	-	-	-	-	-	-	-	93
Bioethanol Uptake (Million Liters)												
Gasoline Use[3]	37,850	37,966	38,082	38,198	38,315	38,431	39,469	40,506	41,544	42,582	43,619	-
Fuel Ethanol Use[4]	0	0	0	0	5	5	5	5	5	5	5	1,200
Blend Rate (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	10%**

1. OECD-FAO Agricultural Outlook 2024-2033.[20]
2. BPS-Statistics Indonesia, Indonesian Sugar Cane Statistics 2023.[4]
3. Own model results from the Global Change Analysis Model (GCAM).
4. USDA-FAS Biofuels Annual 2024.[23]

*Targets from Presidential Regulation No. 40/2023, combined with own calculations on attainment.
**Presidential campaign biofuel blending target.

[1] Assuming a molasses yield of 0.05 tons per ton of cane (t/tc),[48] a molasses conversion rate of .0037 tons of molasses per liter of ethanol,[48-49,65] and a sugar retrieval rate of .0805 t/tc, as called for in Presidential Regulation No. 40/2023.

Total sugarcane concessions in South Papua cover an area of 1.14 Mha, between the range of the initial area proposed under Presidential Regulation No. 40/2023 and the expanded extent of two Mha (Figure 3). We evaluate two concession groupings: (1) the Merauke Sugar Group concessions (Figure 3a), corresponding to the Cluster III Planning Area, and (2) the full set of potential sugarcane concessions in South Papua (Figure 3b). Figure 3a shows that the Cluster III Planning Area, which has a total area of 559.5 Kha, is primarily comprised of forests, at 420.4 Kha (75.1%), followed by grasslands, wetlands, and shrublands, at 111.8 Kha (20.0%), then agriculture, at 23.2 Kha (4.1%) and other land classes, including infrastructure, at a negligible 4.1 Kha (0.7%). Similarly, across all potential sugarcane concessions (Figure 3b), forested land accounts for 560.4 Kha (49.0%) of total area, with smaller shares of land covered by grasslands, wetlands, and shrublands, at 540.2 Kha (47.2%), agriculture, at 38.2 Kha (3.3%) and other land classes, at 5.6 Kha (0.5%). In both concession groups, the forests at risk of being converted are mostly dryland forests, including 181.0 Kha of primary dryland forest and 211.1 Kha of degraded dryland forest within all potential concessions. Overlap with existing agricultural lands is limited, most of it occurring on oil palm plantations alongside a smaller amount on rice paddies, illustrating the conflict between food and energy security targets being pursued in the region. Additionally, a sizable portion of these concessions overlap with peatlands, a total of 55 Kha within the planning area and 277.5 Kha in all concessions, which has implications for the carbon intensity of conversion and drainage for sugarcane production. Additionally, despite their prevalence within food estate planning areas, peatland ecosystems are not suitable for growing crops such as rice or sugarcane.[61]

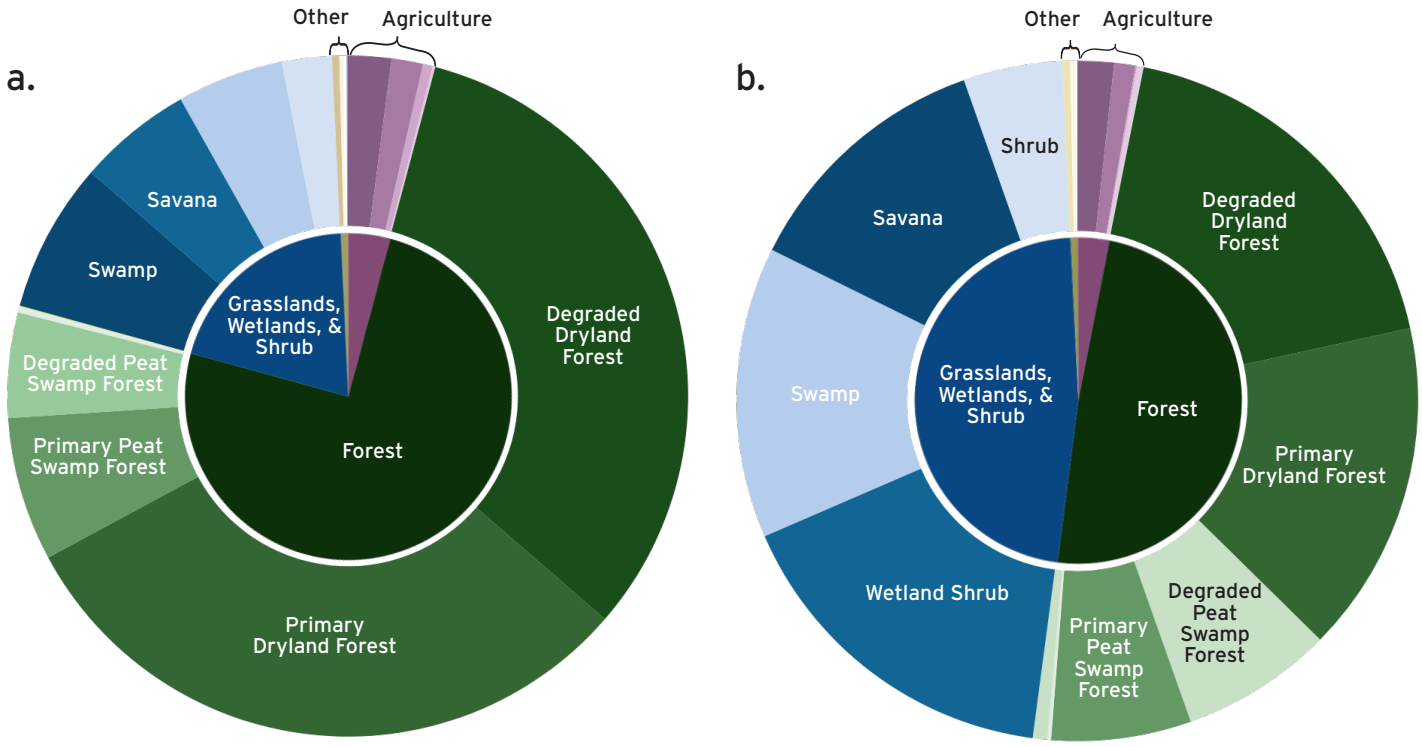


Figure 3: Land cover within sugarcane concessions. a. Merauke Sugar Group concessions. **b.** All potential sugarcane concessions in South Papua. Inner rings display the overall land cover category converted, while outer rings depict the share of each land cover class converted.

Concessions granted impact a range of communities in South Papua, including those living on indigenous land. Mapping of indigenous land in Indonesia is an ongoing and incomplete process, one recently championed by the Indigenous Peoples Alliance of the Archipelago (*Aliansi Masyarakat Adat Nusantara*, or AMAN) through the Ancestral Domain Registration Agency (*Badan Registrasi Wilayah Adat*, or BRWA), which compiles and registers locally created maps of indigenous land. As of 2025, BRWA mapped 31.6 Mha of customary land, primarily through participatory mapping,[68] resulting in the Jokowi Administration granting official customary land titles on eight Mha of these lands.[69] In South Papua, BRWA mapped five tracts of customary land: Marind Rahuk (registered), Onggari (registered), Kaiburse (registered), Animha (registered), and Yei I'Man' (verified). While BRWA's mapping allows indigenous land to be tracked with greater ease, it does not directly translate into granted concessions, titles, or central government recognition; representation by BRWA does not prevent community land from being granted to companies for sugarcane, palm oil, and rice estates. Of the 1.14 Mha proposed by the central government for sugarcane plantations, 465,295 ha (40.6%) overlap with land registered by the Marind Rahuk, Onggari, Kaiburse, Animha, and Yei I'Man' (see Figure 4).[68]

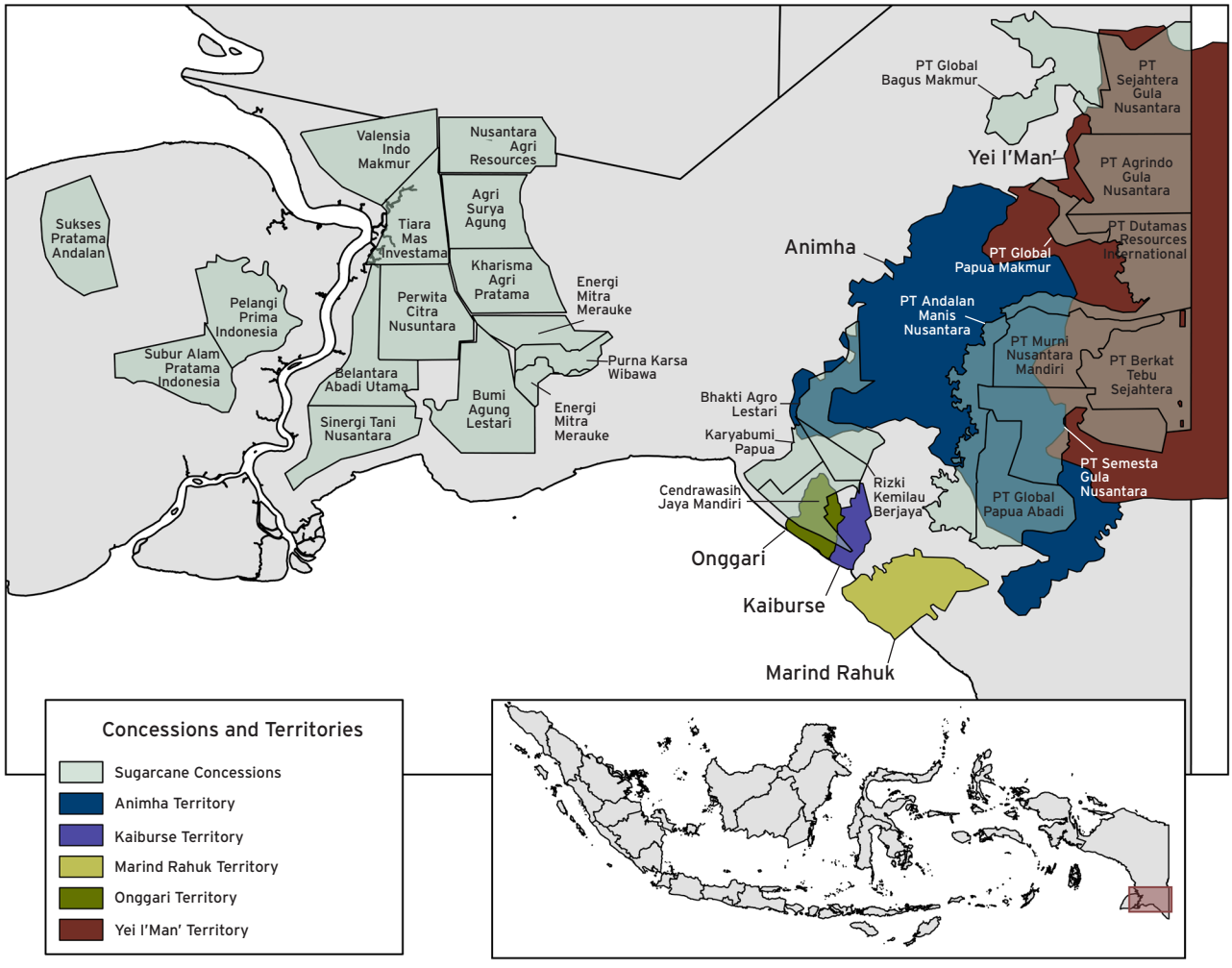


Figure 4: Sugarcane concessions and indigenous land registered or verified with BRWA. Blue, translucent shapes represent sugarcane concessions and other colors represent indigenous territories.

4.2. Potential emissions from clearing on par with those from historic 2015 fires

Emissions associated with sugarcane development for bioethanol arise across the full lifecycle: from initial land clearing and site preparation to cultivation, processing, and transportation. Determining total emissions across these stages can help determine whether these emissions exceed the reductions achieved through subsequent fuel switching. To determine potential emissions from land clearing and site preparation, we tested a range of scenarios based upon sugarcane productivity and the associated land area required. The scenarios include lower bound sugarcane productivity (58 tc/ha),[49] average national productivity reported by BPS between 2020-2023 (67 tc/ha),[4,70] upper bound sugarcane productivity (80 tc/ha),[49] and the aspirational productivity targeted in Presidential Regulation No. 40/2023 (93 tc/ha).

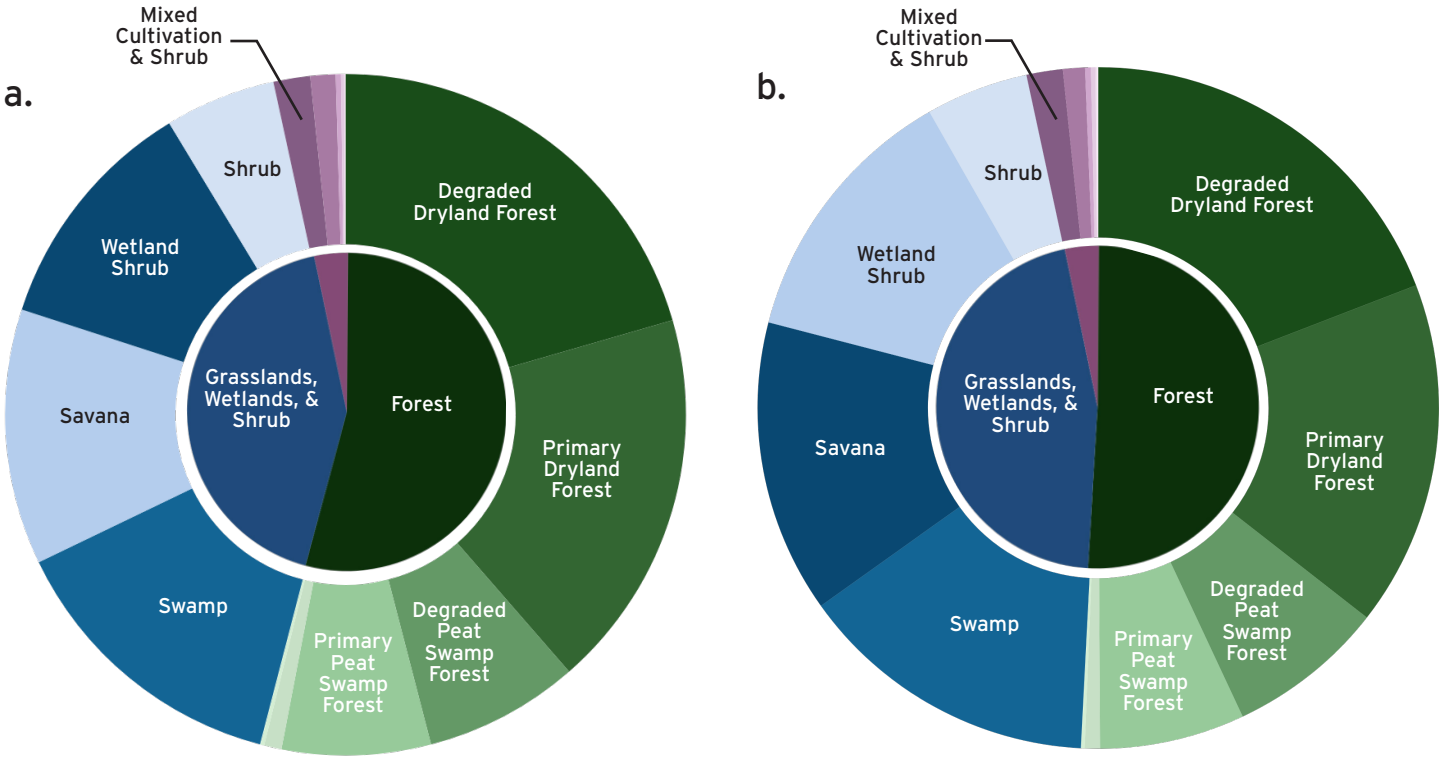
Using a 23-class land cover map that combines and refines government and NGO land cover mapping,[71] we determined the land conversion and emissions associated with clearing of aboveground and belowground biomass for sugarcane production across scenarios.[72] Land conversion increases as sugarcane productivity drops, rising from Presidential Regulation No. 40/2023's aspirational land productivity (0.95 Mha) to exceed one million hectares under the high productivity (1.10 Mha), average historical national productivity (1.32 Mha), and low productivity scenarios (1.52 Mha). Though the share of land conversion occurring on forests decreases as land conversion increases, seen in Figure 5a-d, total forest loss within concessions rises from .51 Mha to 0.72 Mha as land productivity decreases.

Emissions are lowest under Presidential Regulation No. 40/2023's optimistic land productivity scenario (577.7 ± 52.9 $MtCO_2e$) and rise as land clearing expands under the high productivity (630.6 ± 59.3 $MtCO_2e$), average national productivity (748.6 ± 76.4 $MtCO_2e$), and low productivity scenarios (834.5 ± 87.6 $MtCO_2e$) (Figure 5e). Land clearing alone under the latter two scenarios would thus be responsible for emissions within the range of historic events such as the 2015 fires, which released an estimated 748±209 $MtCO_2e$ into the atmosphere.[73] The emissions intensity of this policy is driven both by its scale and the location of sugarcane concessions, nearly half of which would convert land classified as forests, 47% of which is primary forest. Across all scenarios, we find a high share of forest conversion. See the Technical Appendix for more details on calculations.

Annual emissions from production and processing range from 10.2-20.0 $MtCO_2e/yr$, increasing with land use inefficiency and driven by emissions from peat drainage (Figure 5f). Though the emissions associated with sugar cultivation, sugar processing, ethanol processing, and transportation are more than offset by the benefits of fuel switching (-4 $MtCO_2e/yr$), ongoing peat drainage results in positive annual emissions. The total extent of sugarcane plantation overlap with peatlands rises along with total land use, from 223.6 - 395.2 Kha, with the percentage of total land covered by peat also rising, calculated using peat distribution mapping from Global Forest Watch.[74] Excluding peat, the majority of emissions from production and processing come from fertilizer use; over 87% of this share of emissions comes from sugar cultivation, with smaller shares from ethanol processing, sugar processing, and transportation.

Though concessions within the Cluster III Planning area cover less total area than any of the scenarios built around all possible concessions, emissions associated with this area have a high average emissions intensity of 858.2 tCO_2e/ha. Driven by the densely forested land cover within this group of concessions—forests make up 75% of land cover—it is estimated that clearing in this area could drive emissions of up to 478 ± 37 $MtCO_2e$. Annual emissions from peat drainage, production, and processing in this concessions group are estimated at 3.7 ±1.3 $MtCO_2e$, which are not offset by the benefits brought about by fuel switching (-1.5 $MtCO_2e$).

Additionally, we include summaries of our calculations on total area, forested area, indigenous territory overlap, and emissions intensity of clearing by concession (Table 4). We find that PT Dutamas Resourses International, PT Sejahtera Gula Nusantara, and PT Agrindo Gula Nusantara hold substantial forest cover within their borders, each exceeding 50,000 ha, and that relatedly, each of these concessions also has among the highest projected emissions intensities from land clearing. The concessions allocated for Nusantara Agri Resources, Valensia Indo Makmur, Perwita Citra Nusantara, which are located on the western side of Merauke Regency, within Tubang, Ilyawab, and Ngguti Districts, contain the most peatlands. As a result, any ongoing drainage for agriculture in that region would drive ongoing emissions. In contrast, concessions on the eastern side of Merauke Regency—mostly Cluster III Planning Area concessions—have the most overlap with indigenous territories. Concessions granted to PT Agroindo Gula Nusantara, PT Global Papua Makmur, PT Berkat Tebu Sejahtera, and PT Sejahtera Gula Nusantara are almost entirely within Yei I' Man', while concessions granted to PT Semesta Gula Nusantara, Murni Nusantara Mandiri, and PT Dutamas Resourses International are split between Animha and Yei I' Man'.



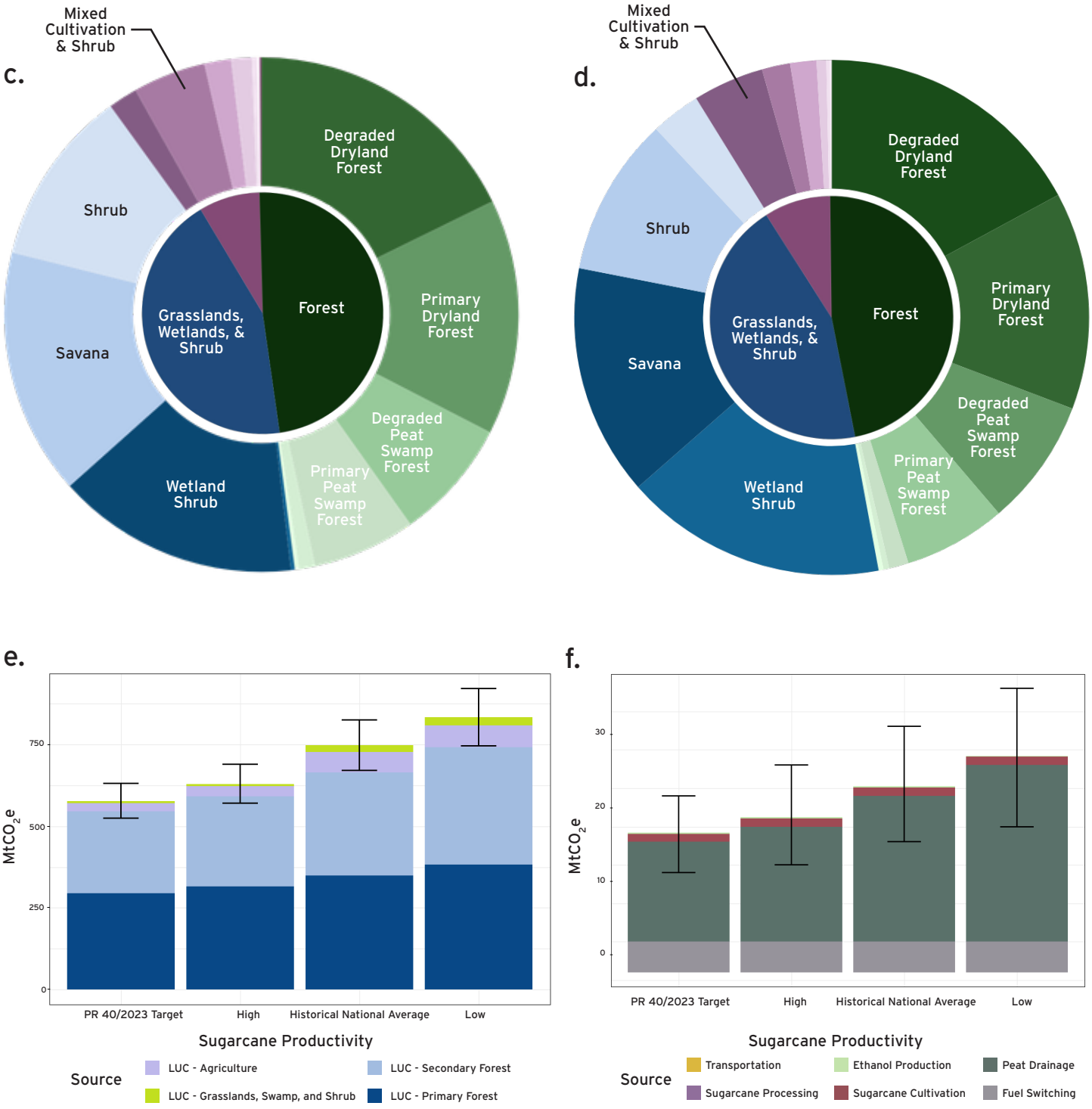


Figure 5: Land conversion and emissions impacts of implementing Presidential Regulation No. 40/2023. **a.** Land cover within Presidential Regulation No. 40/2023 efficiency scenario **b.** Land cover within high efficiency scenario **c.** Land cover within average historic efficiency scenario **d.** Land cover within low efficiency scenario **e.** Clearing emissions by scenario **f.** Annual emissions by scenario.

Table 4. Sugarcane concessions by land cover, land tenure, and emissions intensity of clearing. Using our concessions and land cover mapping, we calculated total area, forest cover (including primary and secondary forests), peat area, overlap with registered indigenous territory, and emissions intensity (tCO_2e released per hectare cleared) for each concession.

Concession Name	Total Area (ha)	Forest Cover (ha)	Peat Area (ha)	Indigenous Land (ha)	Emissions Intensity of Clearing (tCO_2e/ha)
Agri Surya Agung	38,563	16,877	5,957		490
Belantara Abadi Utama	41,019	6,304	14,075		183
Bhakti Agro Lestari	27,879	15,521	15,956	19,343	513
Bumi Agung Lestari	54,823	14,115	15,626		325
Cendrawasih Jaya Mandiri	21,809	9,703	843	11,639	413
Energi Mitra Merauke	26,951	6,525	6,245		299
Karyabumi Papua	15,133	8,839	3,096	719	476
Kharisma Agri Pratama	40,827	13,397	3,628		438
Nusantara Agri Resources	40,864	4,004	24,547		140
Pelangi Prima Indonesia	46,801	687	19,533		43
Perwita Citra Nusantara	52,072	7,743	24,066		219
PT Agrindo Gula Nusantara	59,162	50,252	2,697	59,162	1,065
PT Andalan Manis Nusantara	40,063	16,979	7,790	25,733	521
PT Berkat Tebu Sejahtera	59,759	43,164	7,687	59,759	795
PT Dutamas Resourses International	62,344	55,014	2,362	62,344	958
PT Global Bagus Makmur	49,935	45,627	745	1,776	1,122
PT Global Papua Abadi	50,078	21,285	8,417	44,964	503
PT Global Papua Makmur	10,619	9,960	294	10,567	1,024
PT Murni Nusantara Mandiri	50,926	43,350	427	50,928	938
PT Sejahtera Gula Nusantara	61,902	55,147	2,078	56,517	1,131
PT Semesta Gula Nusantara	60,843	48,110	9,559	60,839	847
Purna Karsa Wibawa	13,035	379	6,137		123
Rizki Kemilau Berjaya	10,053	6,253	3,493	1,005	612
Sinergi Tani Nusantara	37,829	15,091	13,036		341
Subur Alam Pratama Indonesia	38,519	5,452	14,179		152
Sukses Pratama Andalan	42,830	139	14,407		92
Tiara Mas Investama	37,951	13,379	13,880		410
Valensia Indo Makmur	52,557	26,923	36,761		357

5. Policy Alternatives

5.1. Intensification can improve but not overcome need for sugar imports

Beyond sugarcane extensification, alternative intensification practices could reduce reliance on sugar imports, namely, improvements in field productivity and factory efficiency. To determine the potential for increased sugar production through these measures, we test sugar yield growth under the field productivity and factory efficiency called for under Presidential Regulation No. 40/2023. Our results shows that while under a business-as-usual (BAU) baseline, sugar production remains static at 2.3 million tons of white crystal sugar (*gula kristal putih*, or GKP) across all time steps, under intensified scenarios, production rises to 3.3 Mt by 2030, hitting 4.4 Mt by 2035, seen in the light green line on Figure 6. However, the OECD-FAO estimates that Indonesian sugar demand will rise to 8.7 Mt of GKP by 2030, reaching 9.2 Mt in 2033, the last projected year in their dataset. Though intensification can vastly improve Indonesia's sugar yield, existing plantations cannot satisfy rising domestic demand through land productivity and mill efficiency improvements alone.

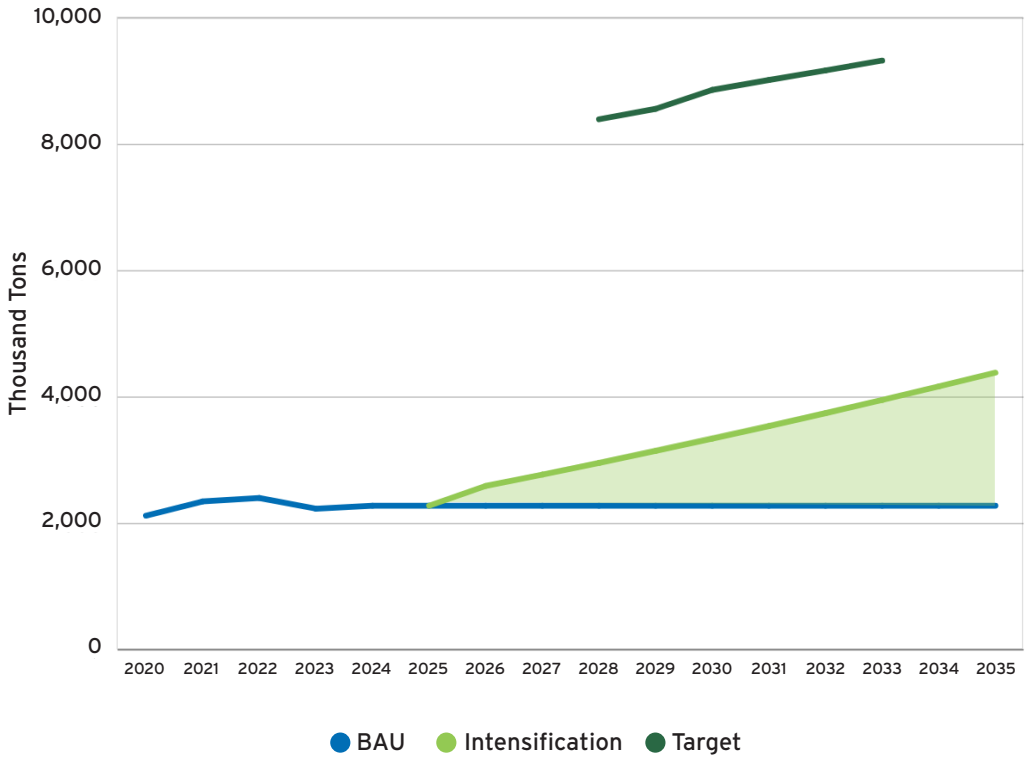


Figure 6: Sugar production under a business-as-usual (BAU) scenario and intensification scenario compared with the self-sufficiency target. Under the intensification scenario, factory efficiency linearly grows from BAU levels in 2025 to reach 11.2% in 2035, and field efficiency similarly grows from BAU to reach 80 tc/ha in 2035.

5.2 A suite of alternate policies could reduce oil demand

Beyond sugarcane extensification for increased bioethanol uptake, a suite of strategies could reduce oil demand, including sugarcane intensification, fuel efficiency mandates, and EV deployment. First, as with the sugar production improvements, we test the technical potential for increased molasses yield. Under a business-as-usual baseline, bioethanol production rises to reach 0.023 million kL by 2030, shrinking to 0.021 million kL in 2035. However, under intensified scenarios, production rises to 0.087 million kL by 2030, hitting 0.125 million kL by 2035, and under intensification and cessation of molasses exports, production reaches 0.265 million kL by 2030 and 0.490 million kL by 2035 (see the Technical Appendix for more detail). Although intensification can vastly improve Indonesia's sugar yield, existing plantations cannot meet the target of 1.2 million kL by 2030, let alone the bioethanol needed to reach the targeted blending rate of E10.

Adjustments to Indonesia's vehicle fleet to add more fuel-efficient vehicles and EVs could also aid in reducing oil demand. Using GCAM to apply a lagged version of the ASEAN target of reducing fuel demand in new LDVs by 26% over 10 years,[51] we find that a new policy mandating fuel efficiency among LDVs could reduce BAU fuel consumption by 0.58% by 2030 and 1.17% by 2035. Additionally, we consider the ability for enhanced EV deployment to drive fuel demand reductions. Under the moderately ambitious scenario, Indonesia deploys .6 million EVs and four million electric motorcycles by 2030, while under the ambitious scenario, Indonesia increases EV deployment in alignment with targets outlined under Presidential Regulation No. 55/2019. These policies result in fuel reductions of 1.6 billion L and 5.7 billion L, respectively, and across scenarios, approximately two-thirds of these fuel demand reductions are attributable to LDVs with the rest from electric motorcycle growth.

Considering each of these policies—sugar intensification, fuel efficiency standards, and EV deployment—we assess the ability of these strategies to cumulatively offset oil demand in the coming decade (see Figure 7). Across strategies, gains from implementation require lag time to begin rising in efficacy, and EV deployment and fuel efficiency standards could provide more substantial gains than those from sugar intensification. Meeting the 1.2 billion L worth of fuel offset by 2030 requires moderate EV uptake, while meeting 10% requires the highly ambitious EV deployment targeted by the GOI in 2019. Though short-term fuel demand reductions from these strategies remain small relative to overall fuel demand for road transportation, this suite of policies could provide lower carbon means of reducing oil demand relative to the extensification required under the current bioethanol strategy.

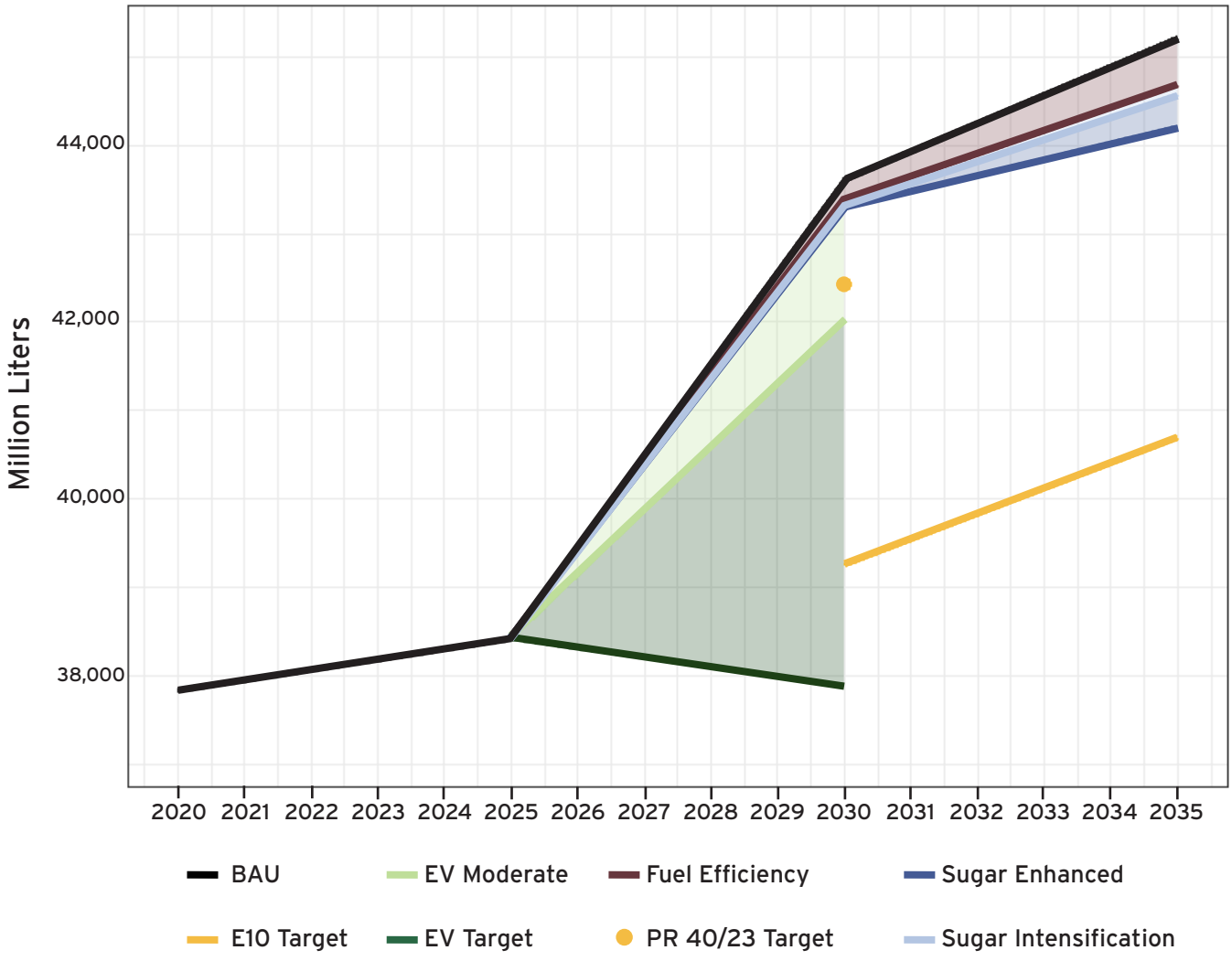


Figure 7: Projected oil demand for road transportation, reduced oil demand under various mitigation strategies, and oil displaced under Indonesian policy targets. Strategies are displayed cumulatively, with shading showing fuel demand reductions by policy.

As an alternate strategy, expanded use of other first-generation biofuels, such as palm oil, sugar palm, sago, and cassava, could aid in reducing oil demand, though their use diverts food products from consumption, challenging Indonesia's food sufficiency target. Second generation biofuels, sourced from food waste and agricultural residue, or third generation algae-based biofuels, could alleviate this pressure on arable land and competition with food products.[75] However, these fuels have been slower to develop due to high costs associated with processing and labor input.[76] Using a suite of policies, including sugarcane intensification, fuel efficiency mandates, broader EV adoption, and use of second generation biofuels could collectively contribute to offsetting oil demand and rival sugarcane extensification as a strategy, especially given its negligible impact on reducing oil demand.

6. Discussion

Qualitative analysis of protests in Papua over a five-year period indicate opposition to PSN Merauke in some areas. However, communities selected for sugarcane concession expansion have limited recourse to attempt to stop undesired projects. Under Government Regulation Number 19 of 2021 on Implementation of Land Acquisition for Development for Public Interest, passed to implement the Omnibus Law, impacted communities who take legal action against companies or attempt to stop land acquisition for PSNs lose the ability to claim compensation and tax incentives from completed projects.[77] Given that tax incentives and company payments serve as one of a few means of receiving land compensation, this provision disincentivizes legal action. Further, in 2023 the Awyu tribe's Woro clan filed a lawsuit against PT Indo Asiana Lestari, presenting evidence that company maps did not initially include Woro land, failed to conduct community review, and used intimidation tactics.[78] Despite these licensing issues, the court ruled in favor of PT Indo Asiana Lestari, and in 2024, the Supreme Court of Indonesia rejected to hear an appeal from the Awyu,[78] creating a precedent for future land dispute cases.[79] More immediately, the use of the military in clearing provides additional barriers to project opposition. In October of 2024, residents reported being threatened with violence for attempting to obstruct mass clearings.[80]

Persistently high import dependency and regional food insecurity motivates ongoing efforts to implement policies aimed at strengthening national food security, including through food estates. However, paradoxically, previous food estates, such as the Mega Rice Project in Central Kalimantan, the Ria-Ria Food Estate in North Sumatra, and MIFEE in South Papua had adverse impacts on the resiliency of local food systems.[81–83] Decadal shifts in Papuan diets, characterized by a reduction in fresh food consumption alongside increased reliance on processed and ultra-processed foods, is attributable to land use changes in the region.[84] Among hunter-gatherer societies, deforestation and fragmentation associated with the PSN could make food increasingly distant and inaccessible. Previous developments in Jambi, where oil palm-driven disruptions to gathering patterns and food supply resulted in 11 cases of starvation among Orang Rimba hunter-gatherers,[85] and in South Papua, where pollution and fragmentation from timber plantations disrupted hunting and lowered fish catch, resulting in malnutrition and increased infant mortality, illustrate the threats projects could pose to regional health and food access.[86]

Production of sugarcane and the combustion of resulting bioethanol may have mixed impacts on air quality and associated health. Pre-harvest burning of sugarcane leaves, aimed at increasing processing efficiency, emits large volumes of particulate matter (PM) and total suspended particulates (TSP),[87] inhalation of which is linked to lowered lung functioning and increased rates of asthma, lung cancers, and hospitalizations.[88] To address these threats, other major sugarcane producers introduced policies to phase out pre-harvest burning. In 2002, under São Paulo State Law 11.241,[89] the Brazilian state began requiring farmers and ethanol producers to gradually reduce pre-harvest burning and adopt mechanized farming practices, leading to significant reductions in PM and smoke emissions.[90] Within Indonesia, the Province of Lampung passed Governor Regulation Number 33 of 2020[91] to limit pre-harvest sugarcane burning, but later revoked it in 2024, citing the need to increase sugarcane productivity.[92]

On the tailpipe end, introduction of bioethanol blending may result in slight improvements in air quality compared with oil. Bioethanol combustion emits pollutants including hydrocarbons (HC), carbon monoxide (CO), CO_2, acetaldehyde, and nitrogen oxides (NO_x), which have a detrimental impact on air quality.[93,94] However, whether tailpipe emissions of these pollutants rise or fall with the introduction of bioethanol blending depends upon factors including engine type, blending ratio, and the crop used to produce bioethanol.[95] In Indonesia, the most commonly purchased LDV is a Toyota Avanza,[96] which has a four-cylinder, four-stroke engine. Implementation of a molasses-based bioethanol blend of ten percent in this type of engine would likely result in a reduction of tailpipe emissions of CO_2, NO_x, and CO, alongside a slight increase in HC.[97]

7. Conclusion

Ongoing activities at PSN Merauke have the capacity to reshape Papua's landscape, and early activities between June of 2024 and June of 2025 resulted in the loss of 5,315 ha of forest and an estimated 4.8 ± 0.5 $MtCO_2e$ emissions. Sugarcane concessions planned in South Papua extend across an area of up to 1.14Mha, the majority of which is covered by dryland forests. Among other impacts, plantation expansion in this region threatens biodiversity and local ecosystems.[98] Though the region is a signatory to the Manokwari Declaration, which aims to place more than 70% of forests in Papua under conservation, land conversion for sugarcane concessions threaten both this target and the biodiversity it aims to protect.[99]

Sugarcane expansion consistent with national bioethanol production targets would require substantial land conversion, at 1.1-1.5 Mha, and would result in clearing emissions of approximately 630.6 ± 59.3 - 834.5 ± 87.6 $MtCO_2e$. The emissions intensity of clearing is highest, exceeding 1,000 tCO_2e/ha, in the concessions of PT Sejahtera Gula Nusantara, PT Global Papua Makmur, and PT Agrindo Gula Nusantara, each of which falls under the ownership of the investment consortium Merauke Sugar Group. Concessions procurement and planning is most advanced among members of this consortium, indicating that land clearing, and thus forest loss, is likely to occur in this region. Beyond clearing emissions, most of which are attributable to dryland forest loss, annual emissions from production and processing sugarcane exceed the emissions benefits of fuel switching, as reductions in oil use cannot offset the impact of ongoing peat drainage.

Additionally, the scale of the agricultural expansion proposed under PSN Merauke would require investment in relevant infrastructure to prevent crop failures and allow for production and processing. Project environmental impact analysis regarding the Merauke Planning Area found that 10% of the area is flood-prone and 67% is drought prone, making irrigation system construction and the inclusion of water storage technology vital.[37] Achieving production of 1.2 million kiloliters annually will require additional investments in sugarcane processing; current blending capacity is approximately .35 million kL annually, concentrated on East Java.[23] Planned bioethanol production plants, to be located at PT Agrindo Gula Nusantara and PT Global Papua Abadi, will have a combined capacity of .27 million kL, nearly doubling national capacity but failing to enable the broader blending target. Additionally, Groups 1-4 in the Merauke Planning Area will each construct sugar mills, adding a capacity of 2.6 million tons of sugar per year.[37]

Proceeding with this project poses numerous challenges, highlighted above. The climate impacts of clearing and production could be mitigated through extension of the moratorium on peatlands and primary forest—National Strategic Projects are currently exempted—and by enacting and enforcing bans on preharvest sugarcane burning. However, minimizing the emissions impact of this project fails to reckon with its societal ramifications, including land seizure without the consent of local residents, expanded use of the military in a conflict zone, and the possibility of negative impacts of food security and air quality. Alternative means of reducing reliance on sugar and oil exports, including sugarcane intensification, fuel efficiency standards, and EV expansion, could improve the existing trade deficit, but for sugar production, cannot offset growing demand. In the case of transportation, reducing oil reliance in alignment with policy targets laid out in Presidential Regulation No. 40/2023 would require continued growth in LDV uptake alongside improvements in electric two-wheeler growth, which may require reinstating relevant subsidies. Reducing reliance upon sugar and oil imports in service of Indonesia's self-sufficiency and sovereignty will require investment into a range of strategies, designed to improve energy and food security while minimizing negative impacts.

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