

UNHEEDED WARNINGS:

FOREST BIOMASS THREATS TO TROPICAL FORESTS IN INDONESIA AND SOUTHEAST ASIA

OCTOBER 2024



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Cover Image:

(Top) Industrial plantation forest (HTI, acronym in Bahasa) within the concession area managed by the company PT Adindo Hutani Lestari in North Kalimantan. Image credit: Courtesy of Yudi Nofiandi/Auriga Nusantara. **(Bottom left)** East Kalimantan Deforestation, PT WKL. An aerial view of the deforestation expansion of PT Wana Kaltim Lestari (WKL), East Kalimantan, Indonesia. Image courtesy of Ekselsa/Auriga Nusantara. **(Bottom right)** Borneo Orang Utan. Orang Utan at Camp Lakey rehabilitation center, Tanjung Puting National Park, West Kalimantan. Image courtesy of Auriga Nusantara.

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EXECUTIVE SUMMARY AND KEY FINDINGS

Indonesia is home to some of the Earth's most biodiverse and carbon-rich forests, and 50 to 70 million Indigenous people who rely on these intact ecosystems for their survival.¹ Yet burning wood in biomass power or “co-fired” in coal power plants could bring Indonesia's forests to an “irreversible point” by 2040.² Carbon reduction policies that divert public dollars from solar and wind into biomass energy threaten forests and biodiversity across Southeast Asia.

A letter signed by more than 500 scientists and economists in 2021 warned that the European Commission's mandate to increase renewable energy by 20% and treat biomass as a carbon neutral power source would “create a model that encourages tropical countries to cut more of their forests.”³

Three years later, their prediction is unfolding across Southeast Asia.

Last year, South Korea and Japan were the primary actors driving growth in global demand for wood pellets. In 2023, Asia experienced 20% year-on-year growth in wood pellet demand, led by Japan and South Korea.⁴ In 2022, Japan and South Korea imported the most wood pellets outside of Europe with 4.4 million tonnes and 3.9 million tonnes, respectively.⁵

Their dire warning is illustrated in this preliminary assessment of threats to Indonesia's forests from co-firing coal plants, energy plantation forest concessions, and wood chip and pellet mill haul zones. Under Indonesia's energy transition plans, biomass will generate 19.7TWh by 2025, the majority of which (64.5%) will come from co-firing in coal plants.⁶ Forests designated as “energy plantations” are expected to supply half of what is needed.⁷ The country's forests face unprecedented threats from the industrial scale projected for biomass demand.⁸



Mangrove forest and coral reefs in split shot, Gam Island Raja Ampat Indonesia. Image credit: Anemone via Adobe Stock

Burning wood for energy in Indonesia, Japan and South Korea is a threat to bio-diverse tropical forests across Southeast Asia.

Subsidy programs in South Korea and Japan have radically expanded demand and production of wood pellets and chips from forests across Southeast Asia.

An analysis of wood pellet imports found a direct causal relationship between South-east Asian wood pellet production and South Korea's renewable energy policy.⁹ From 2012 to 2021, Vietnam's total wood pellet production grew from 50 thousand tonnes to 3.5 million tonnes; Malaysia's production jumped from 40 thousand tonnes to 710.0 thousand tonnes, while Indonesia's production increased from 20 thousand tonnes to 330 thousand tonnes.^{10,11} Additional power plant capacity is expected to make Japan the largest wood pellet consumer in the world.¹²

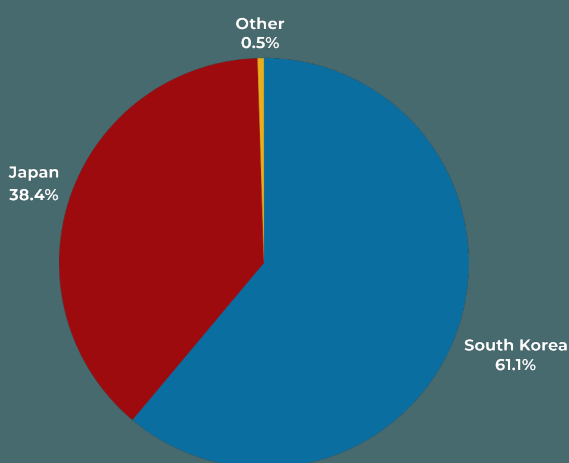


Kawasaki Biomass Power Corp.'s Biomass Power Plant in Kawasaki City, Japan. Image credit: Tomohiro Ohsumi/Bloomberg via Getty Images

Deforestation Threats from Wood Energy in Indonesia

Wood pellet demand in South Korea and Japan is spurring a fast-growing, nascent forest energy industry in Indonesia. As seen in the graph below, **the two countries combined bought more than 99% of Indonesia's wood pellet exports from 2021 to 2023.** In this time frame, Indonesia's wood pellet exports to South Korea jumped from 49.8 tonnes to 68,025.1 tonnes; exports to Japan rose from 54 tonnes to 52,734.7 tonnes.¹³

Figure 1. Indonesia Wood Pellet Export 2021-2023



Source Auriga Nusantara 2024

Our haul zone threat assessment shows that both chip mills and co-firing plants represent a significant threat to Indonesian forests and biodiversity as seen in the figures below:

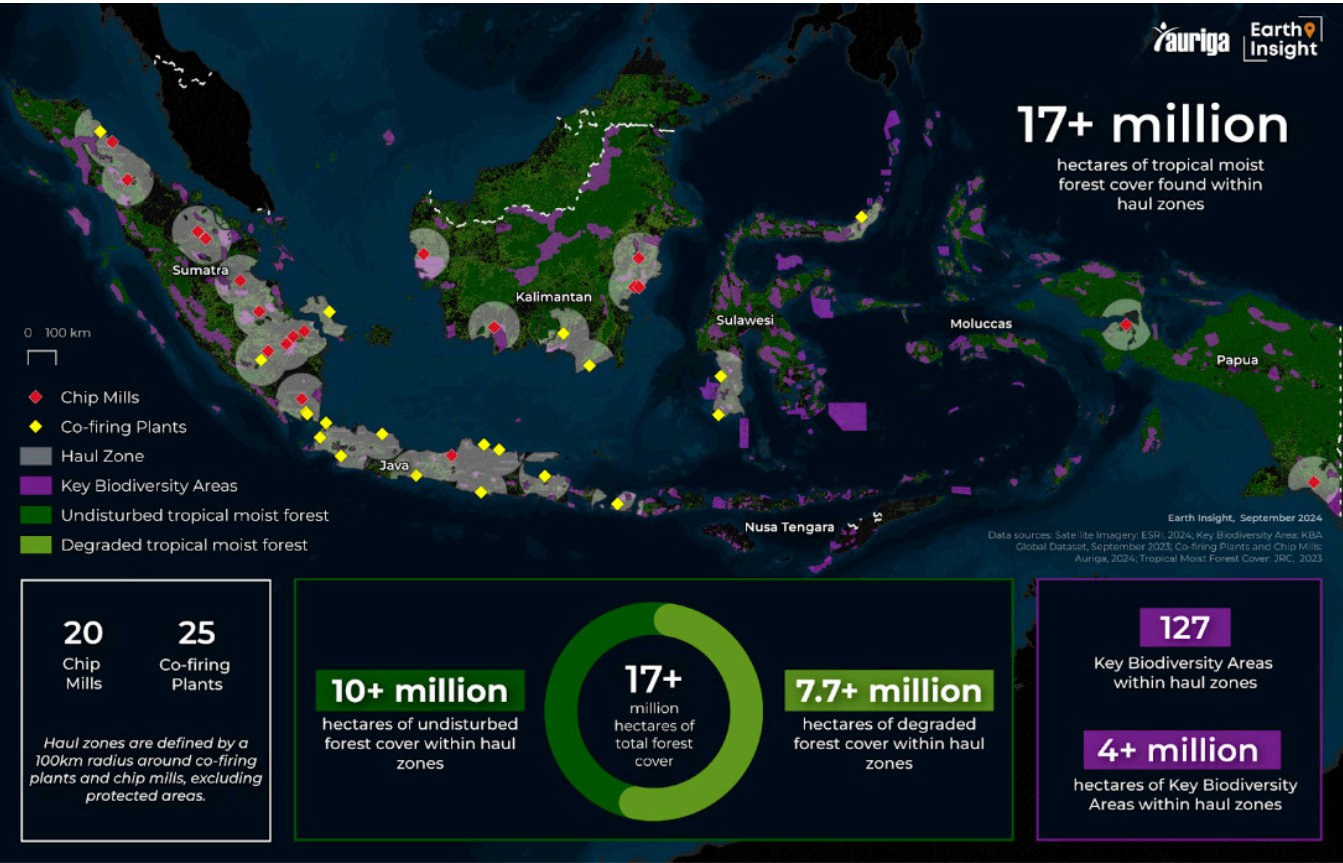
Figure 2. Tropical Moist Forest Cover in Haul Zones

	Co-firing Plants	Chip Mills	Energy Plantation Forest (Hutan Tanaman Energi)
	within 100 km buffer and Protected Areas, excluded, values rounded to nearest ten thousand		
Undisturbed Tropical Moist Forest in ha	3,900,000+	7,690,000+	400,000+
# Key Biodiversity Areas	104	43	14
Key Biodiversity Area within haul zone in ha	1,590,000+	2,810,000+	48,000+
Orangutan Extent (IUCN Red List) in ha	4,190,000+		190,000+

Indonesia’s 10% co-firing mandate poses a threat to 10 million hectares of undisturbed cover in wood chip and pellet haul zones. It is estimated that using wood for a 10% reduction in coal at Indonesia’s largest power plants could **trigger the deforestation of an area roughly 35 times the size of Jakarta – resulting in CO2 emissions almost five hundred times higher**

than current levels.¹⁴ This year, six power plants (Paiton 1 & 2, Indramayu, Rembang, Ropa, and Adipala) used wood pellets; another four (Anggrek, Bolok, Tembilahan, and Tarahan) burned wood chips.¹⁵ **The country’s 2021-2030 electricity strategy projects demand for 8.05 million tonnes of biomass for co-firing by 2030.** New power plants are being designed to burn up to 30% biomass.¹⁶

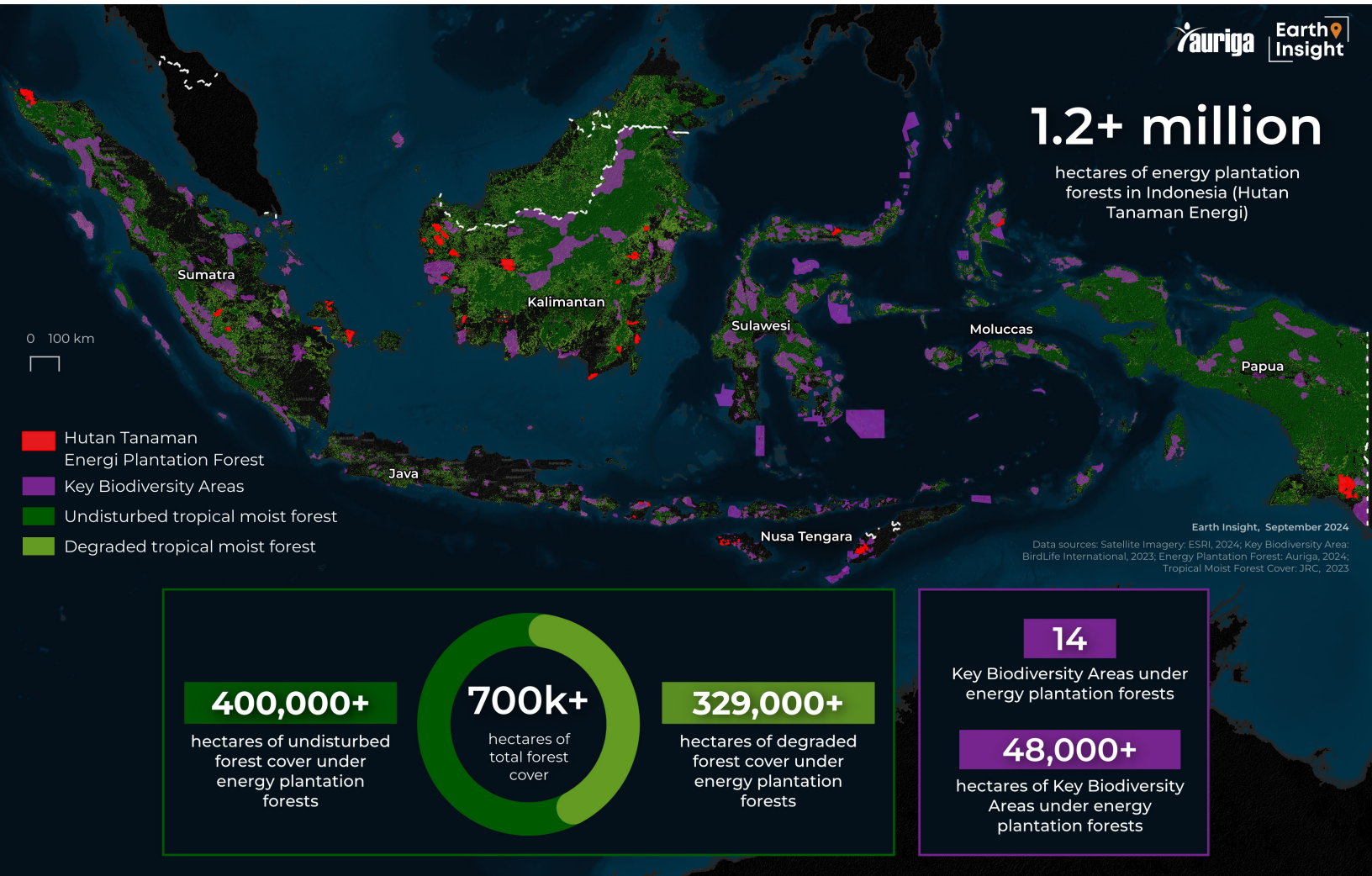
Map 1. Indonesia Bioenergy: Co-Firing Plants and Chip Mills



Energy Plantation Forests:

In order to meet projected domestic and foreign demand for woody biomass, forest energy “estates” have emerged as another industrial pressure on forests that need restoration and protection. Our estimates show that there are currently more than 400,000 hectares of undisturbed tropical forest in more than 1.2 million hectares of energy plantation forests in Indonesia. These threats could expand drastically, unless different energy transition pathways are chosen. **Meeting the country’s co-firing mandate could require 10.23 million tonnes of wood pellets a year – an area equivalent to 3.27 million football fields¹⁷ – potentially driving deforestation rates as high as 2.1 million hectares a year.¹⁸**

Map 2. Indonesia bioenergy: Energy Plantation Forests



Gorontalo: A Troubling Example of Forest Loss, Not Climate Solutions



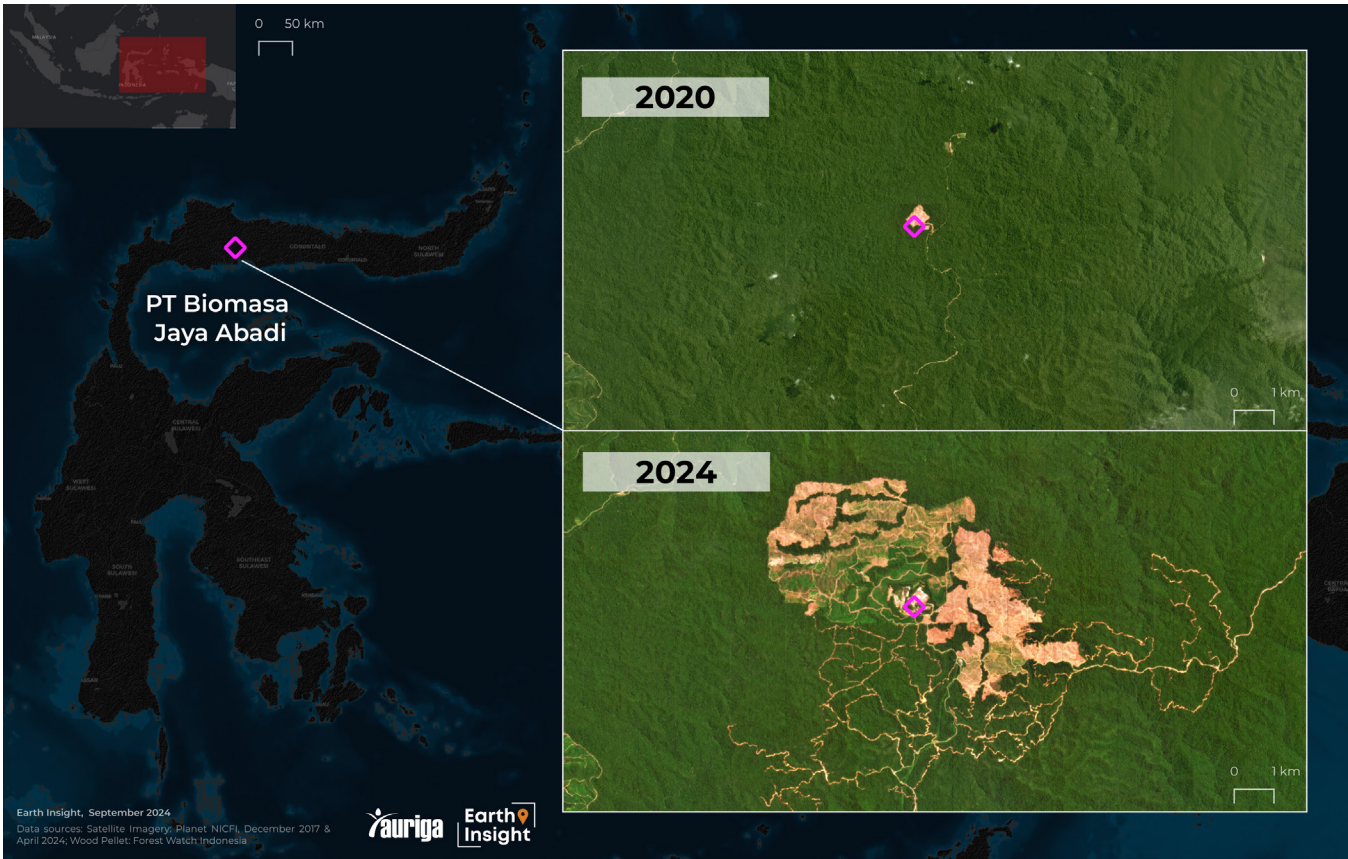
Whole logs harvested for wood pellet production in Gorontalo.
Image courtesy of Forest Watch Indonesia

Gorontalo province on the island of Sulawesi is a stopover site for at least 49 migratory bird species¹⁹ where forests are being cleared for export to Japan²⁰ and South Korea. According to data from the Indonesian NGO Auriga Nusantara, a wood pellet processor, PT Biomasa Abadi, exported 126,441 tonnes from Gorontalo forests last year. There is clear evidence of whole logs being processed into wood pellets for export, which indicates clearance of biodiverse forests.

In a site visit, Auriga documented that in 2023 close to 1,000 hectares of primary forests were cleared for wood pellet exports. This is just the beginning of biodiversity and forest destruction as the wood energy industry takes hold in Indonesia.

This map below shows the extent of deforestation in the area prior to the current spike in forest clearing for pellet processing.

Map 3. Case Study: PT Biomasa Jaya Abadi



Wood Bioenergy is a False Climate Solution



Drax power station in England. Image credit: Paul Glazzard via Wikipedia. [CC BY-SA 2.0](https://creativecommons.org/licenses/by-sa/2.0/)

Biomass power plants emit 50% – 60% more CO₂ per megawatt-hour than modern coal plants.²¹ The premise that forest biomass is a renewable energy source is based on carbon accounting rules that hide full emissions. In 2022, for example, biomass carbon accounting rules enabled South Korea to shift 5.8mt CO₂ of its mitigation burden to other countries, including Vietnam, Indonesia, and Malaysia.²²

The findings of this preliminary threat assessment reflect not only the risks of the wood pellet

and chip trade to Indonesia's forests but also to other biodiverse forests across the region, particularly in Vietnam and Malaysia, and Cambodia, and possibly Taiwan in the future.²³

While other Southeast Asian countries, particularly Vietnam, are already exporting massive amounts of wood pellets, Indonesia's industry is just coalescing. **There is still time to consider policies that promote and provide subsidies for true low emission climate solutions, such as wind and solar.**

A GLOBAL CALL TO ACTION:

As 500 scientists and economists wrote in 2021, forest preservation and restoration should be key tools to reach 2050 carbon neutrality goals and address the global biodiversity crisis. Wood bioenergy violates the principle of a just energy transition as co-firing coal with biomass entrenches the use of this fossil fuel and threatens forests vital to the communities that depend on them.²⁴

The following is a compilation of expert recommendations:

Global

- Report and account for bioenergy CO₂ emissions in a manner similar to fossil fuels.
- Exclude biomass from subsidies; fund low-emission alternatives.
- Include the threat from the international trade in wood pellets in the International Union for the Conservation of Nature (IUCN) species assessments and Convention on International Trade in Endangered Species (CITES) regulations.
- Designate Indigenous peoples' and local communities' lands and areas of endemic or threatened species, including Key Biodiversity Areas, as "no-go" areas for industrial expansion, including bioenergy extraction and cultivation.
- Complete High Carbon Stock/High Conservation Value assessments before expanding cultivation. Adopt the No Deforestation, No Peat, No Exploitation (NDPE) policy.
- Ensure Free, Prior, and Informed Consent (FPIC).

PART I

UNHEEDED WARNINGS: FOREST BIOMASS THREATS TO TROPICAL FORESTS IN INDONESIA AND SOUTHEAST ASIA

Introduction

With climate goals for tripling renewable energy, unless guardrails are put in place, critical forests in Southeast Asia and beyond could face significant threats of being burned in place of coal.

A 2021 letter signed by more than 500 scientists and economists predicted that if “the world supplied just an additional 2% of its energy from wood, it would need to double its commercial wood harvests.” They further warned that industrialized countries have created **“a model that encourages tropical countries to cut more of their forests** – as several countries have pledged to do – that undermines the goals of globally accepted forest agreements.”²⁵

This preliminary threat assessment of forest impacts from co-firing plants, energy plantation forests, and wood chip mill haul zones in Indonesia supports this dire warning.

Burning wood for energy in Indonesia, Japan, and South Korea is a threat to tropical forests across Southeast Asia.



Following the harvesting season in late September 2023, a field of acacia trees in Tien Cam commune of Vietnam's central Quang Nam province was intentionally burned to ready the land for the upcoming planting season. Image credit: Thanh Nguyen for Mekong Eye

Japan and South Korea are the world's second and third largest wood pellet markets after the UK. From 2012 to 2021, the two countries accounted for more than a quarter of global wood pellet imports. In that period, South Korea's wood pellet imports surged from 122.4 thousand tonnes to 3.4 million tonnes with an import value of \$439 million.²⁶ From 2016 to 2021, wood chip imports to Japan jumped from 9,000 tonnes to 405,000 tonnes; wood pellet imports grew from 295,000 tonnes to 2.649 million tonnes.²⁷ By 2022, Japan and South Korea imported the most wood pellets outside of Europe with 4.4 million tonnes and 3.9 million tonnes, respectively.²⁸

Southeast Asian countries have responded to their demand by accelerating wood pellet and wood chip production. From 2012 to 2021, Vietnam's wood pellet production grew from 50 thousand tonnes to 3.5 million tonnes; Malaysia's production jumped from 40 thousand tonnes to 710 thousand tonnes, while Indonesia's production increased from 20 thousand tonnes to 330 thousand tonnes.²⁹ Japan's total pellet demand is expected to double to 12 million tonnes in the next three years.³⁰ In 2023, Japan imported more than 2.8 million tonnes of wood pellets from Vietnam.³¹

Meanwhile, an analysis of wood pellet market prices and imports made a direct link between South Korea's co-firing mandates and increased imports from Southeast Asia.³² Changes in sustainability certification for palm kernel shells (PKS) for biomass in Japan have also increased a focus on wood pellets.³³

Carbon Accounting Loopholes Drive Wood Energy Demand

Historically, UNFCCC and IPCC carbon accounting has excluded forest biomass from the energy sector, along with emissions from the destruction of long-established forests.³⁴

Carbon accounting rules for forest biomass are starkly different from those for fossil fuels. Emissions for fossil fuels are counted in the energy sector of the country that burns it, but biomass emissions are counted where the trees are grown – increasingly in the Global South. As a result, countries that supply wood pellets are penalized for the loss of their forest carbon sinks.



Wood pellets pile. Image credit: Daniel Vincek via Adobe Stock

These rules enable carbon accounting that obscure the full emission picture. For example, in 2020, the EU was able to count 596 million tonnes of CO₂ – close to what Germany's economy emits – of direct biomass emissions as 'zero' energy sector emissions. Had they been counted in the same manner as fossil fuels, the EU's energy sector emissions would have jumped by more than 22%.³⁵ **In 2022, these rules enabled Korea to transfer 5.8mt CO₂ of its mitigation burden to supply countries, mostly Global South countries, including Vietnam, Indonesia, and Malaysia.**³⁶

The Myth of Green Forest Bioenergy

Biomass power plants emit 50% – 60% more CO₂ per megawatt-hour than modern coal plants.³⁷ Burning wood with coal further increases carbon emissions – and would require significant amounts of wood for most coal plants.

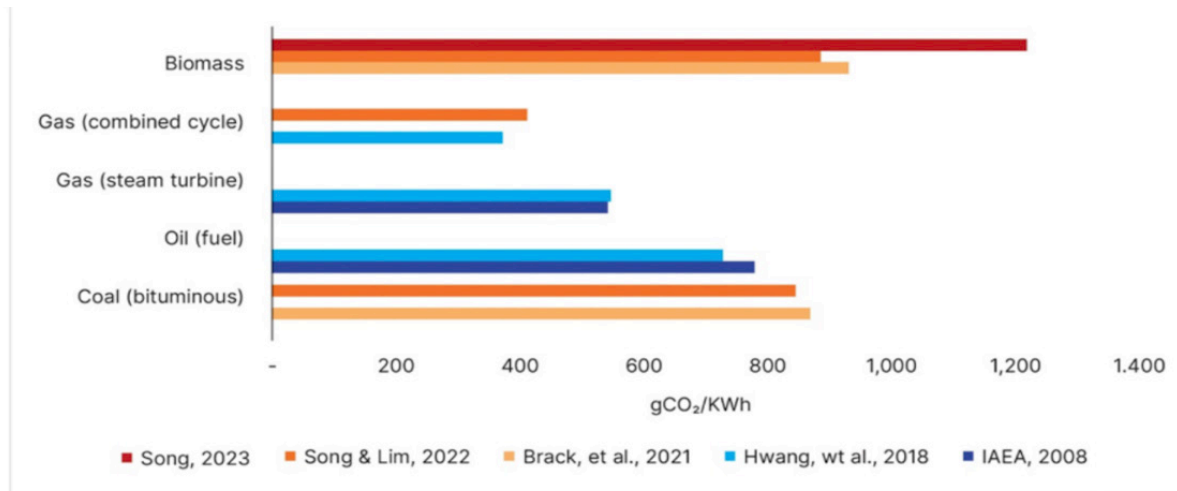
Wood energy will increase CO₂ levels in the short term and could trigger irreversible climate impacts.³⁸ A comparison of emissions from fossil and wood fuels found that wood chip, natural gas, and light fuel oil production were similar. **Emissions from wood pellets are substantially greater than from fossil fuels.**³⁹



Emden biomass power plant, Germany. Image credit: Oliver Tjaden via Flickr. [CC BY-NC-ND 2.0](#)

At the same time, replanted forests will not have enough time to offset the emissions. “Carbon debt payback time” is how long it takes regrowth to remove carbon emissions after wood is burned for energy. If wood displaces coal, the carbon debt payback time is estimated between 40 and 115 years.⁴⁰ **Payback estimates for tropical forests range from 30–120 years for non-peat soils, and more than 900 years for forests growing on peatlands in Southeast Asia.**⁴¹

Figure 3. Carbon Emissions Per Unit of Electricity by Energy Source



Sources: Song, 2023; Song & Lim, 2022; Brack, et al., 2021; Hwang, et al., 2018; IAEA, 2008 (as cited in Hwang, et al., 2018); compiled by authors.

[From: Song, H. et al. (2024). Burning forests, boiling climate: Woody biomass harms global biodiversity. SFOC. <https://forourclimate.org/insights/10>]

Tree Plantations Will Not Achieve Emissions Goals

Natural forests turned into plantations can never offset the carbon taken from the original forest.⁴² It is estimated that if all 350 million hectares proposed by the 2021 Bonn Challenge regrew as natural forest, they would sequester about 42 billion metric tonnes of CO₂ by 2100. Once those lands are turned into tree plantations, carbon storage drops to about 1 billion metric tonnes.⁴³ **Even if all the land area in the tropics was covered by tree plantations, it would still only sequester ~1.7 years of emissions.**⁴⁴ Single-species plantations, especially of eucalypts and pines, will also grow more vulnerable to fire as the earth warms, which will produce higher emissions.⁴⁵ Meanwhile, the impact of tree plantations on biodiversity is long-term: plantations typically remain less biodiverse than natural vegetation even thirty years after planting.⁴⁶

The Role of Subsidies

The wood pellet market is fueled by lucrative government subsidies that fund a false climate solution that is accelerating emissions, destroying biodiversity, and displacing effective strategies, such as solar and wind.⁴⁷ In South Korea, for example, government biomass subsidies are so aggressive they are driving away investment from low-emission technologies.⁴⁸

South Korea's wood pellet demand is largely driven by its Renewable Energy Portfolio Standard (RPS) scheme through Renewable Energy Certificates (RECs).⁴⁹ According to Solutions for Our Climate, from 2015 to 2022, the yearly average of trade value of biomass RECs reached \$339,528,514. Currently, biomass comprises 63.7% of South Korea's bioenergy portfolio; 75% of its biomass is forest feedstock.⁵⁰ This year, 69 climate and environmental organizations from around the world urged South Korea to eliminate the RECs for biomass power. The letter noted that the REC system favors biomass over solar and wind energy.⁵¹

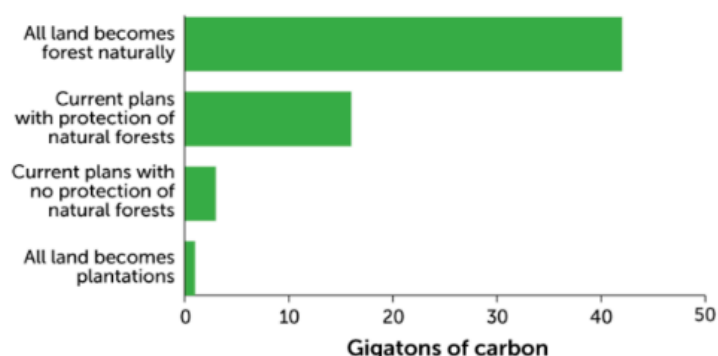
The year following the 2011 Fukushima Dai'ichi nuclear power plant accident, Japan established its Feed-in Tariff (FIT) subsidy program, which included biomass. About half of Japan's coal plants are co-fired with biomass.⁵² By March 2023, general wood (mainly imported biomass fuel) had already reached 3.5 million kW, which is more than half of the 6.9 million kW introduced under the FIT.⁵³

Figure 4. Amount of Carbon Sequestered by 2100 in four Bonn Challenge Scenarios

Levels of protection

The Bonn Challenge aims to globally reforest 350 million hectares of land. Allowing all to regrow naturally would sequester 42 gigatons of carbon by 2100. Pledges of 43 tropical and subtropical nations that joined by 2019 — a mix of plantations and natural regrowth — would sequester 16 gigatons of carbon. If some of the land is later converted to biofuel plantations, sequestration is 3 gigatons. With only plantations, carbon storage is 1 gigaton.

Amount of carbon sequestered by 2100 in four Bonn Challenge scenarios



SOURCE: S.L. LEWIS ET AL/NATURE 2019; GRAPHS: T. TIBBITTS

Cautionary Tale: UK Green Subsidies Fell Old Growth Forests



A logging truck in Canada. Image Credit crebb via Flickr. [CC BY-NC-ND 2.0](#)

The UK's funding of the biomass industry for close to 25 years serves as a cautionary tale of what can happen on a global scale. Since 2000, the UK has provided more than \$28 billion in subsidies to burn wood for energy. Subsidies for biomass generators are tied to government sustainability criteria that take into account feedstock forests and life cycle greenhouse gas emissions, from cultivation and harvest to transportation and processing. However, the lack of government oversight over long supply chains hinders transparency of the industry's compliance to these sustainability criteria.⁵⁴ One investigation proved that in 2023, the country's largest wood burning generator sourced more than 40,000 tonnes, or more than 1,100 large truck loads, of logs from old-growth forests in Canada.⁵⁵ Another documented that it still **emits four times more carbon dioxide than the last remaining coal-fired power station.**⁵⁶

By 2027, the UK's green subsidies could evolve into tax-funded carbon capture schemes that still burn forests. The biomass industry has received subsidies as bridge funding until it develops the capacity to inject wood emissions underground in a process called "bioenergy with carbon capture and storage," or BECCS.⁵⁷ It is estimated that a single company's BECCS project would need \$56.43 billion in subsidies over 25 years – and would still add \$2.23 billion to energy bills every year.⁵⁸



Logging aftermath in Canada. Image credit: Guy Sagi via Adobe Stock

PART II

DOUBLE TROUBLE FOR INDONESIA'S FORESTS: FOREIGN DEMAND AND DOMESTIC CO-FIRING

Accelerating carbon emissions from burning coal and wood, combined with wood energy deforestation, could create a double catastrophe for Indonesia.⁵⁹

JETP Indonesia

In 2023, the Just Energy Transition Partnership Secretariat (JETP Secretariat) was established to mobilize an initial \$20 billion over 35 years⁶⁰ for Indonesia to cap total power sector emissions at 290-million-ton CO₂eq, accelerate renewable energy use to at least 34% of power generation by 2030, and reach Net Zero Emissions in the power sector by 2050.

In November 2023, its Comprehensive Investment and Policy Plan (CIPP) opened to public comment. The lack of clarity and transparency around captive coal was a major concern, since it appeared that Indonesia's energy transition was fueled by coal. Conservative estimates (which exclude captive gas power plants) put Indonesia's on-grid annual emissions at around 401-437mt CO₂ by 2030 – far above the net zero emission target of 250mt.⁶¹ Indonesia's plans to expand its coal capacity could support up to 21GW of planned captive coal power – and threaten its ability to meet decarbonization targets under Paris Climate Agreement goals by adding 53mt of CO₂ emissions.⁶²

The year before the JETP was signed, the country's coal consumption grew 33%, contributing to a 20.3% increase in the country's greenhouse gas emissions over 12 months.⁶³ **By 2023, Indonesia's coal dependency surpassed both Poland and China.**⁶⁴ As long as they provide “added value of natural resources,” building new coal-fired power plants is permitted under the national industrial development plan.⁶⁵

From 2014-2019 three Japanese financial institutions were among the top five funders of Indonesian coal projects, with the Japan Bank for International Cooperation (JBIC) providing \$4.7 billion, or a quarter of the JETP, for the construction of coal plants.⁶⁶

Indonesia's Cascade of Deforestation and Forest Degradation

A vast tropical archipelago along the equator, Indonesia is home to the world's third-largest rainforest and such endemic, critically endangered species as the Sumatran tiger, orangutan and rhinoceros, as well as the Sulawesi crested black macaque, the Sumatran elephant, and Sunda pangolin. Indonesia also provides habitat for one of the most diverse primate populations in the world, with at least 64 of the earth's 516 primate species.⁶⁷



The Celebes crested macaque (Macaca nigra), also known as Sulawesi crested macaque, in Tangkoko national park, Sulawesi island. Image credit: feathercollector via Adobe Stock

Since 1950, more than 74 million hectares of Indonesia's forest — an area twice the size of Germany — have already been cleared or degraded by industrial expansion.⁶⁸ From 2013 to 2023, 69% of tree cover loss occurred in natural forests. As a result, **Indonesia has lost more trees than the other nine south-east Asian countries combined.**⁶⁹



Aerial over Sekumpul waterfall surrounded by dense rainforest and mountains shrouded in mist at sunrise, Bali, Indonesia. Image credit: Studio-FI via Adobe Stock

Wood Energy Threats to Indonesia's Forests



A wood pellet holding yard in Gorontalo Port, Indonesia. Image courtesy of Auriga Nusantara

Global factors, such as biomass subsidies in South Korea and Japan, could accelerate deforestation in Indonesia, as it positions itself as a global wood pellet supplier.⁷⁰ According to Auriga Nusantara, from 2013-2023 Indonesia exported 14.2 million tonnes of wood chips, largely to China and Japan. Their data shows that last year, Indonesia's wood chip exports to Japan reached 868,147.13 tonnes, compared to 8030.48 tonnes to South Korea. While government data do not indicate the use of wood chips in destination countries, a significant percentage, if not all, is expected to be burned.

Figure 5. Indonesia's Wood Pellet Export, 2021-2023

Destination	Year (ton)			TOTAL
	2021	2022	2023	
South Korea	49.8	21,401.3	68,025.1	89,476.2
Japan	54.0	3,440.7	52,734.7	56,229.4

Auriga Nusantara (2024): Ministry of Environment and Forestry databases did not capture any wood pellet exports prior to 2000.

Figure 6. Indonesia's Wood Chip Exports

Destination	Year (ton)			TOTAL
	2021	2022	2023	
South Korea	7,075.6	5,795.9	8,030.4	20,902.1
Japan	87,5726.5	634,926.4	868,147.1	2,378,800.1

Auriga Nusantara (2024): last three years from Ministry of Environment and Forestry databases.

While the export numbers are small in these early stages, it is clear that energy companies, including palm oil and fossil fuels, are entering the wood energy business. In particular, many of the same companies that supply coal to Indonesia's coal-firing power plants now operate vertically integrated supply chains for co-firing wood with coal.⁷¹ At the same time, wood pellet exports have steadily increased since the government began tracking this data. The Ministry of Environment and Forestry database has no records of wood pellet exports prior to 2020.

Threats to Forests in Kalimantan

The forests of Kalimantan, the Indonesian region of Borneo, are habitats for some of the highest plant diversity on earth, along with such iconic species as the Bornean orangutan, the Proboscis monkey, the Sumatran rhinoceros, the Sumatran elephant, and the sun bear.⁷² Field visits suggest the region, particularly North Kalimantan, is targeted for wood pellet industry expansion.



Malayan sun bear looking moody and tired, Sepilok, Borneo, Malaysia
Image credit: Lillian via Adobe Stock

SYSTEMATICALLY REPLACING BIODIVERSITY

While predominantly in Indonesia, South Korea's systematic replacement of highly biodiverse forests for low-species plantations is global. Since 1993, the Korea Forest Service assisted more than 43 Korean companies to establish at least 529,144 hectares of wood plantations (for diverse purposes) in 14 countries, including Vietnam and Cambodia.⁷³ The vast majority –78% in terms of area– are located in Indonesia.^{74 75}



Borneo Orang Utan. Orang Utan at Camp Lakey rehabilitation center, Tanjung Puting National Park, West Kalimantan. Image courtesy of Auriga Nusantara



Sumatran Rhinoceros (*Dicerorhinus sumatrensis sumatrensis*) named Ratu at Sumatran Rhino Sanctuary, Way Kambas, Lampung Province, Sumatra Island, Indonesia. Image credit 26Isabella via Wikipedia. [CC BY-SA 3.0](#)

In East Kalimantan, for example, PT Kyungdong Minerals, operates a wood pellet plant run by South Korean company Kyung Dong Energy, which has produced up to 60,000 tonnes of wood pellets a year since 2015.⁷⁶

According to Auriga Nusantara, another wood biomass concession in East Kalimantan, PT Jaya Bumi Paser, cleared almost 2,000 ha⁷⁷ last year.⁷⁸ The company, a subsidiary of Indika Energy (a giant in Indonesia's coal industry) manages a

23,590-hectare industrial forest concession.

In 2022, PT Jaya Bumi received a US\$27.5 million loan from Bank DBS Indonesia for its wood pellet production.⁷⁹ Indika Energy's subsidiary, Indika Nature, expects to produce 150,000 tonnes of wood pellets per year for export to Japan.⁸⁰



PT Jaya Bumi Paser converts forest to develop monoculture bioenergy plantations in East Kalimantan. Picture was taken in May 2024. @Auriga Nusantara

Last year, PT Malinau Hijau Nusantara, a subsidiary of coal producer Mitrabara Adiperdana (MBAP), secured funding for a plant to produce wood pellets for export in a 19,000 hectare concession in Malinau, North Kalimantan.⁸¹



HTI plantation in PT Adindo Hutani Lestari concession in North Kalimantan. Image credit Yudi Nofiandi/Auriga Nusantara

GORONTALO CASE STUDY:

Exporting Deforestation to South Korea and Japan

Sulawesi, the habitat of 17 endemic primate species,⁸² offers an illustrative case of how Korean and Japanese wood pellet and wood chip demand threatens biodiversity in Indonesia. **By 2025, a cascade of industrial expansion is projected to cause Central Sulawesi to lose a forest cover equivalent to more than three times the size of the island of Bali.**⁸³ The resulting loss of habitat for species with limited ranges, such as the recently-identified Jatna's tarsier, is particularly critical.⁸⁴

Gorontalo province, a stopover site for at least 49 migratory bird species,⁸⁵ has transformed into **a hub of deforestation for wood pellet exports to South Korea and Japan.** According to Auriga Nusantara, from January to August of this year, two palm oil companies cleared **1,032 hectares for wood pellet production.** More than 27 thousand hectares are threatened within the haul zone; **96% (26,707 hectares) are intact forest.**

While PT Banyan Tumbuh Lestari (BTL) and PT Inti Global Laksana (IGL) originally had permits for palm oil, they are now in the wood pellet business. According to field visits and investigations by the NGO Auriga Nusantara, once they clear highly biodiverse forest areas, they replace them with monocultures of gliricidia trees (*Gliricidia sepium*).

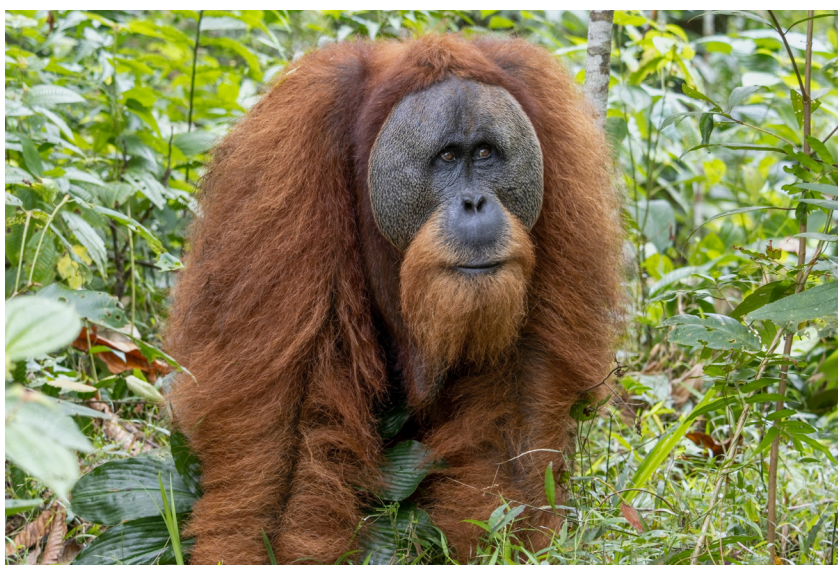
While there was prior deforestation, the last two years have seen a marked acceleration in forest loss for wood pellet production. According to Auriga Nusantara (2024), last year, 1,372 hectares of forest were cleared.⁸⁶ Since the second quarter of 2023, BJA has supplied around 10,000 tonnes a month to Japan.⁸⁷



A Jatna's Tarsier in Indonesia. Image credit: Tom Kirschey via iNaturalist. [CC BY-NC 4.0](#)



A beautiful bird of paradise. Image credit: Beltsazar via Adobe Stock



A hairy Tapanuli orangutan. Image credit: Edgardm/Wirestock Creators via Adobe stock

The companies are supplying logs of such species as Jambu-Jambu (*Eugenia* sp) and Nyatoh (*Madhuca* sp) that PT Biomassa Jaya Abadi (BJA) processes for export by Hanwa Co. Ltd, a Japanese company recognized as a 'key market player' in the Southeast Asian wood pellet market.^{88 89}

While most production is based in Gorontalo, seven companies are involved in processing and exporting wood pellets to South Korea and Japan from three provinces, including Central Java and East Java.^{90,91}



*A wood pellet cargo ship in the port of Gorontalo, Indonesia.
Image courtesy of Auriga Nusantara*

Wood pellet production presents a critical threat to the species endemic to this region. Between 2000 and 2017, the Gorontalo Macaque had already lost 800,000 hectares of its forest habitat.⁹²



Pristine and intact forests are cleared to develop monoculture bioenergy plantations in the concession of PT Banyan Tumbuh Lestari and PT Inti Global Laksana in Gorontalo of northern Sulawesi to supply PT Biomassa Jaya Abadi's wood pellet mill located within the concessions. May, 2024. @Auriga Nusantara/Bagus Sugiarto



Gorontalo villagers protesting wood pellet activities of PT BJA (Biomasa Jaya Abadi). September 13, 2022. Photo by: Barakati.id

Social Conflicts with the Wood Pellet Industry

As Indonesia's woody biomass industry expands, conflicts with local communities are on the rise.

In 2022, villagers in Gorontalo protested against wood pellet producer PT Biomasa Jaya Abadi for damaging their roads, for the impact of its port on their local fishing area, and for a lack of corporate social responsibility.⁹³



Deforestation in PT Banyan Tumbuh Lestari Concession. Image courtesy of Forest watch Indonesia.

Burning Forests for Domestic Energy

Indonesia aims to **triple** its biomass consumption in power generation to 2.83 million metric tonnes in 2024, from 991,000 tonnes consumed last year.⁹⁴ According to Auriga Nusantara, nearly 23 million hectares of Indonesia's forests are already granted for extractive concessions, including 7.3 million hectares (8.7%) for forest conversion concessions (timber plantations, oil palm, and mining) and 15.6 million hectares (18.6%) for logging concessions that are degrading forests.⁹⁵



Gorontalo port Indonesia. Image courtesy of Auriga Nusantara

Trend Asia estimates that Indonesia's biomass goals will require 2.33 million hectares of additional land, nearly half of which will require clearing standing forests. The 10% co-firing coal mandate could accelerate deforestation as high as 2.1 million hectares a year.⁹⁶

Using biofuel for a 10% reduction in coal at Indonesia's largest power plants could **trigger the deforestation of an area roughly 35 times the size of Jakarta — resulting in CO2 emissions almost five hundred times higher than current levels.**⁹⁷ This year, six power plants (Paiton 1 & 2, Indramayu, Rembang, Ropa, and Adipala) co-fired with wood pellets; and another four (Angrek, Bolok, Tembilahan, and Tarahan) with wood chips.⁹⁸



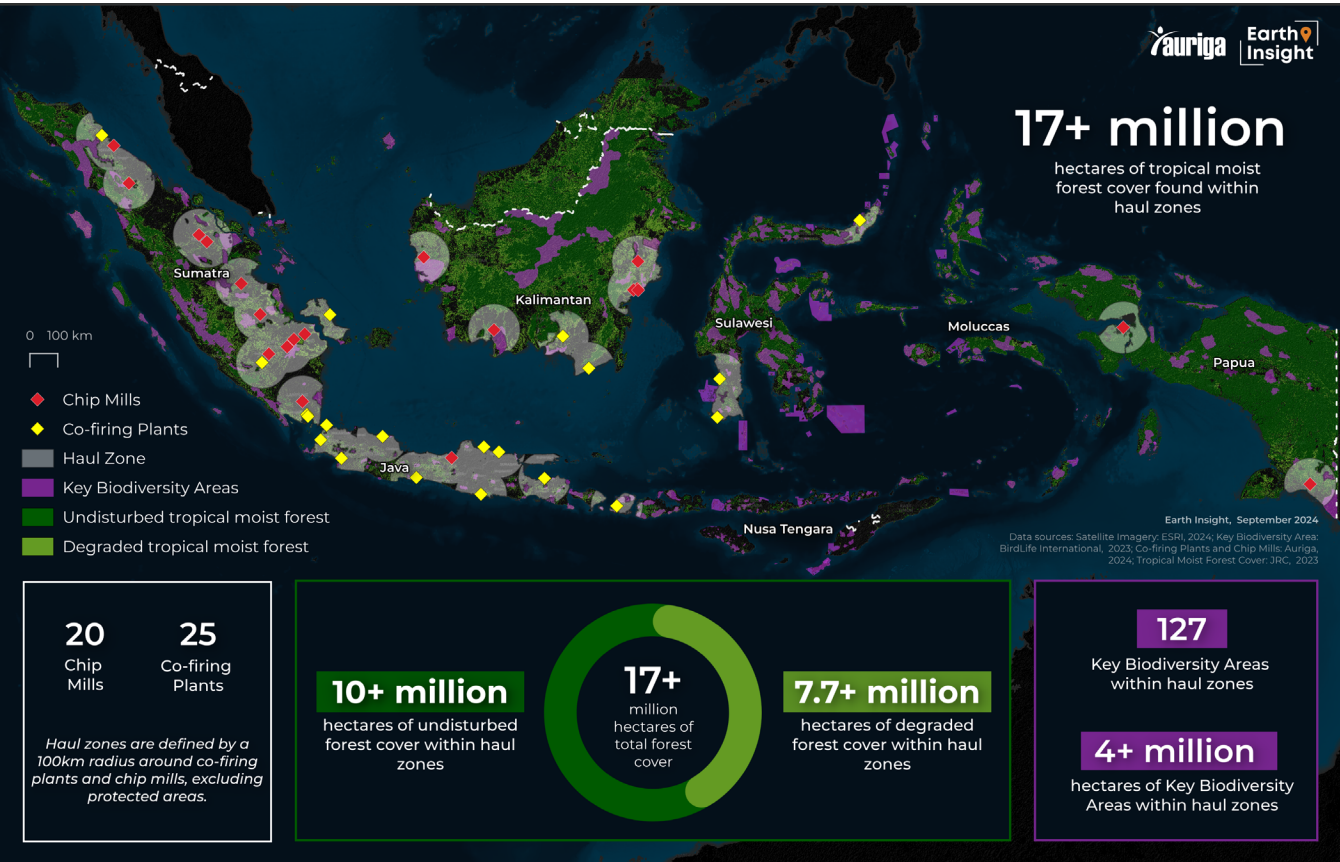
East Kalimantan Deforestation, PT WKL. An aerial view of the deforestation expansion of PT Wana Kaltim Lestari (WKL), East Kalimantan, Indonesia. Image credit: ©Ekselsa/Auriga Nusantara

PART III

SPATIAL ANALYSIS

This threat assessment validates the dire warning from 2021: More than **10 million hectares of undisturbed forest cover** are located inside the haul zones of Indonesia’s co-firing plants and wood chip mills.

Map 4. Indonesia Bioenergy: Co-Firing Plants and Chip Mills



The haul zone assessment is based on a 100-kilometer buffer around each co-firing plant and chip mill point, clipping the land to remove marine areas and Protected Areas. Excluding Protected Areas allowed us to reflect the habitats at risk and highlight threats to non-protected forests and ecosystems.

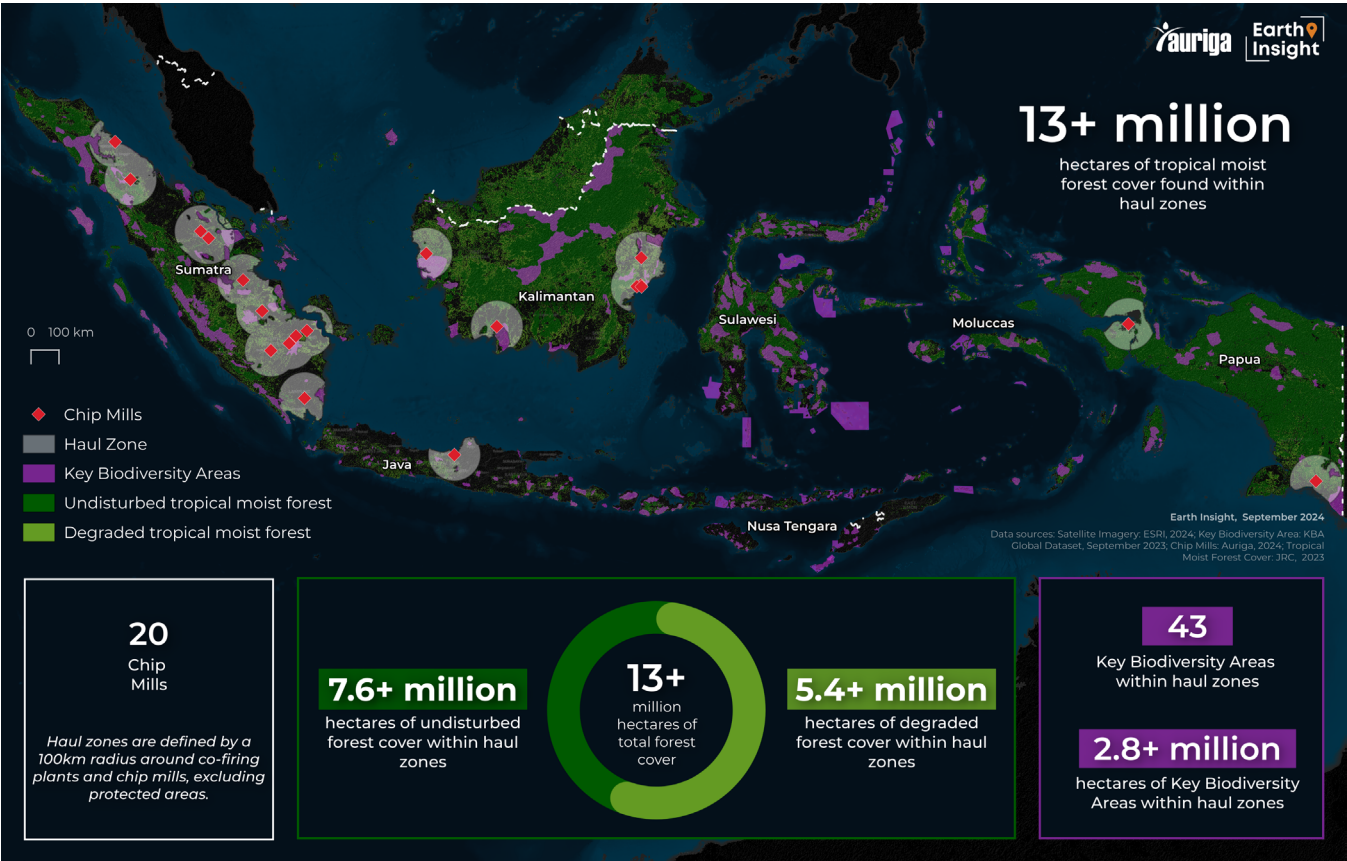


An Aerial image of deforestation in Indonesia. Image courtesy of Auiga Nusantara.

It is important to note that the exclusion of Protected Areas does not imply the absence of illegal activities, such as logging, within these regions. Earth Insight’s analysis focuses on legally available lands, but does not fully account for the unauthorized activities within Protected Areas.

More than 13 million hectares of Tropical Moist Forest are within the haul zones of chip mills – with more than half classified as undisturbed forest cover.

Map 5. Indonesia Bioenergy Chip Mills

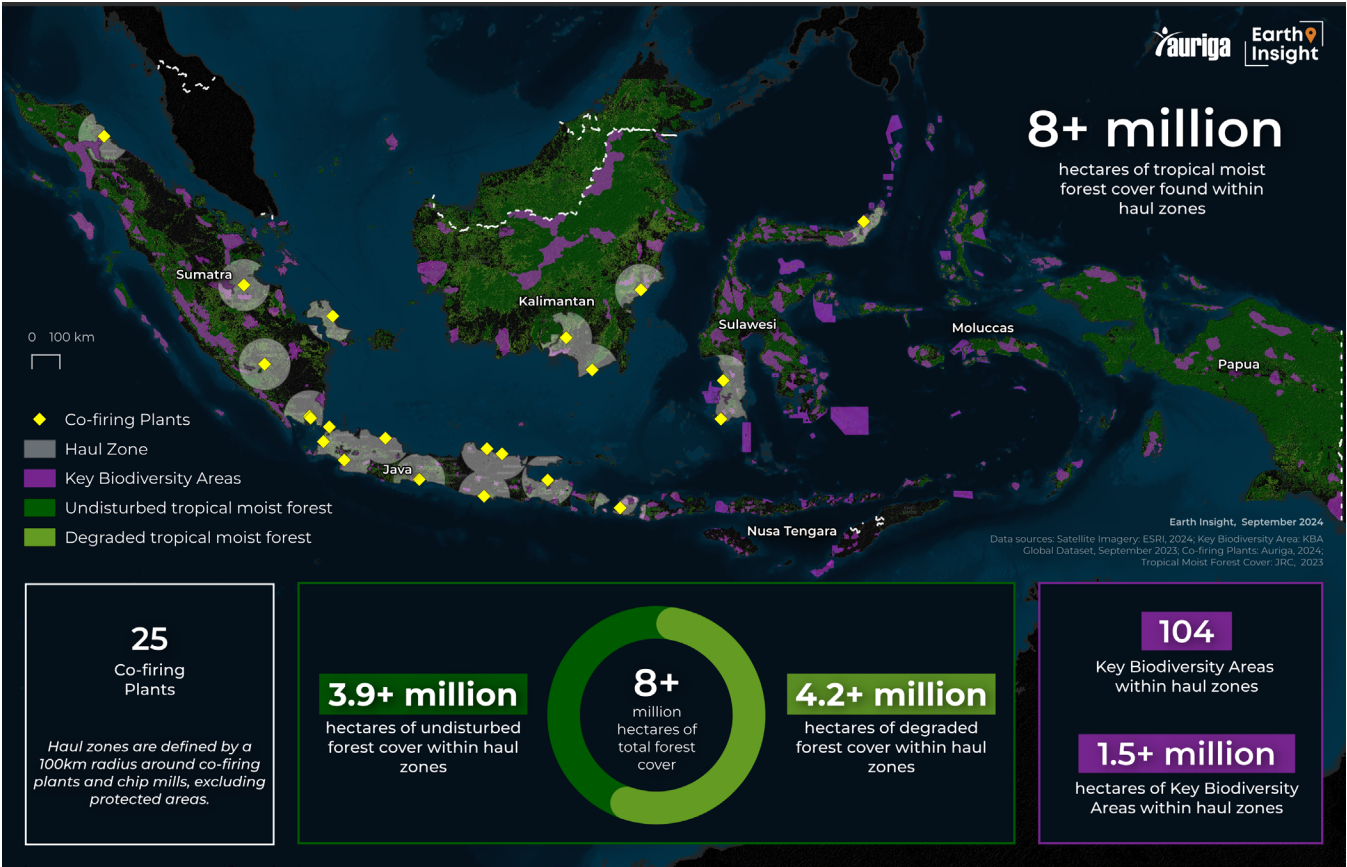


Chip mills contain the largest area of Tropical Moist Forest cover within their haul zones (131,000+ km²).



Deforestation in PT Banyan Tumbu Lestari Concession. Image courtesy of Forest Watch Indonesia

Map 6. Indonesia Bioenergy: Co-Firing Plants



Cascade of Deforestation and Degradation:

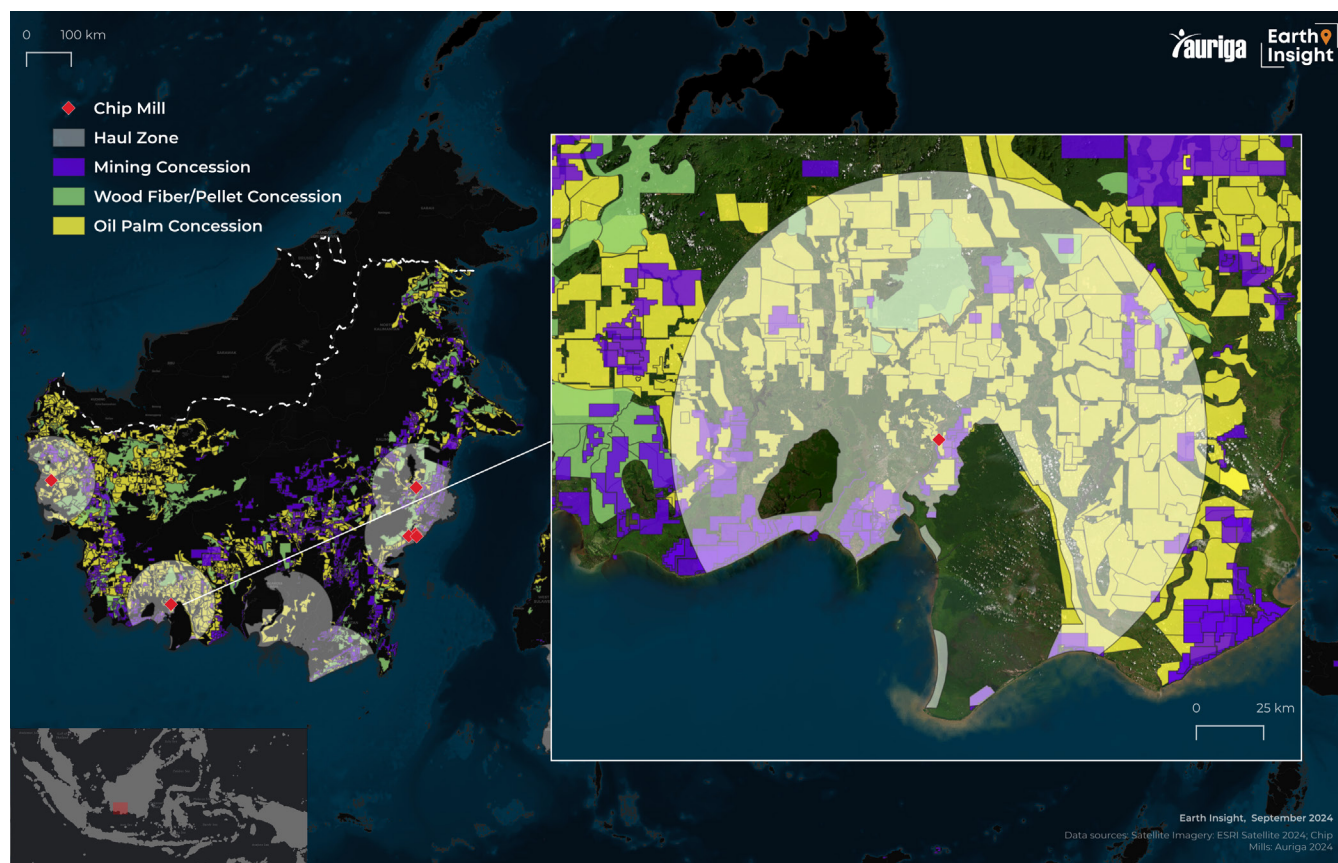
Many haul zones include mining (coal), wood fiber concessions, and nearby oil palm plantations. Provinces, such as East Kalimantan, are a microcosm of a global trend in which separate industrial expansion concessions overlap and build on previous deforestation. The Dayak Modang of East Kalimantan offer an illustrative example of how cumulative forms of extractive expansion in the same landscape erode the food security and social cohesion of Indigenous peoples and local communities.



East Kalimantan landscape in Indonesia. Image courtesy of Auiga Nusantara.

The maps and analysis indicate that more than 3.9 million hectares of undisturbed forest cover are within the haul zones of co-firing plants, with more than 1.5 million hectares in 104 Key Biodiversity Areas.

Map 7. Concessions Within Haul Zones



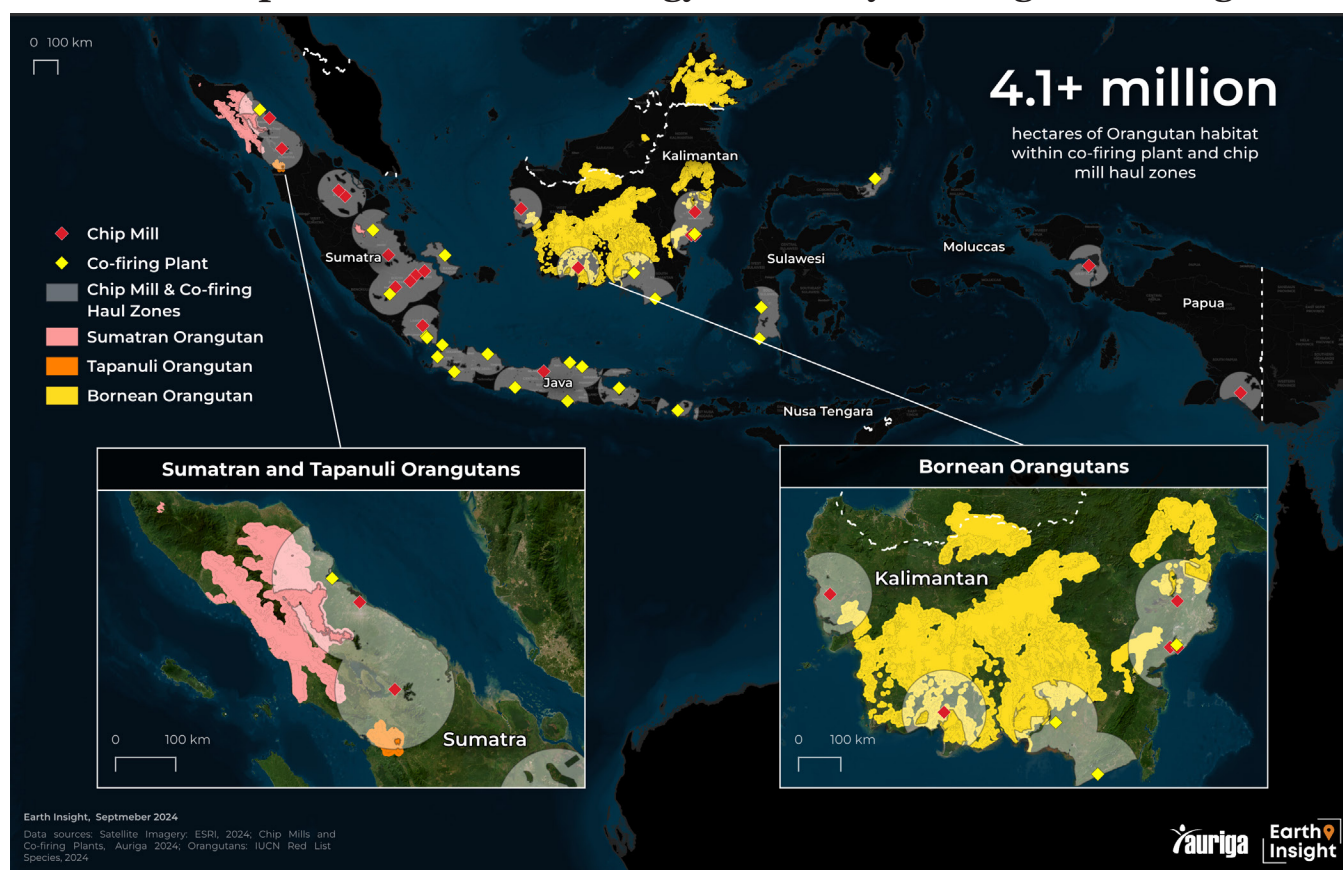
A forest in Indonesia. Image courtesy of Auiga Nusantara.

Overall, there are more than 10 million hectares of undisturbed forests in the haul zones of wood chip mills and co-firing plants combined. The maps also show haul zones significantly overlap with the habitat of Sumatran Orangutans and Tapanuli Orangutans in Sumatra and of Bornean Orangutans in Kalimantan. In Indonesian Borneo, critically endangered species, such as the Bornean Orangutan and Helmeted Hornbill, have already lost more than a third of their habitats.⁹⁹



Female Sumatran Orangutan, Pongo abelii, with cub sitting on a branch, Gunung Leuser National Park, Sumatra Image credit: vladislav333222 via Adobe Stock

Map 8. Indonesia Bioenergy: Critically Endangered Orangutans



Wood Energy Threatens Forests Across the Region

A recent Open Letter to the Asian Development Bank noted that energy policies create a woody biomass demand that threatens forests across Southeast Asia, including Indonesia, Vietnam, the Philippines, and India.¹⁰⁰



A Working field on harbor with cranes in North Vietnam.
Image credit: Huntergol via Adobe Stock

Agency signed an MOU with Vietnam to collaborate on carbon neutrality through the use of forest resources.¹⁰⁵

The private sector is quickly following suit, particularly to the southern province of Binh Dinh, which exports 500,000 tonnes of wood chips a year¹⁰⁶ and plans to expand forest plantations to more than 50,000 hectares by 2030.¹⁰⁷ Last year, Japan's Hanwa Co, Ltd was the moderator of the "SE Asia Wood Pellet Producers Panel Discussion Session" at the 7th Biomass & BioEnergy Asia conference in Vietnam, which included the topic, "Export Markets South Korea, Taiwan & China & Opportunities for SE Asian Supplies." The conference offered a site visit to a Uniexport's new Nam Tan Uyen wood pellet plant in Binh Duong Province, which produces 160,000 tonnes a year.¹⁰⁸ Uniexport currently operates seven plants that produce more than 800,000 tonnes of biomass.¹⁰⁹

Wood chip exports constituted the bulk (76.9%) of Vietnam's total woody biomass exports: In the first half of 2024, Vietnam's woodchip export reached nearly 9.1 million tonnes, compared to 2.6 million tonnes of wood pellet exports.¹¹⁰

While only 15% of the 2.35 m ha. of acacia that Vietnam planted by 2020 was certified as responsibly sourced by the Forest Stewardship Council (FSC), few Japanese and Korean importers reportedly require FSC certificates.¹¹¹

Conclusion

There are no math tricks that can justify burning forests for energy. Science has clearly proven the vital role of tropical forests for climate stability, biodiversity, and human survival. The value of natural ecosystems cannot be reduced to only a single metric: carbon.¹¹²

The 2021 warning from 500 scientists and economists has been followed by similar fact-based calls for rational climate policies. The answers are readily present in true climate solutions, such as solar and wind energy. The only question is when their warnings will be heeded.

Last year Japan imported 2.6 million tonnes of wood pellets from Vietnam.¹⁰¹ Vietnamese wood pellet exports to South Korea have likewise grown exponentially from approximately 30.3 thousand tonnes to 2.1 million tonnes.¹⁰² Given such demand, the Vietnamese Wood Pellet Association expects **Vietnam's wood pellet exports to reach up to 10 million tonnes a year by 2027.**¹⁰³

Last year, Vietnam announced a project with South Korea for "low-emission forestry" to "create value from forest ecosystems."¹⁰⁴ In a move to strengthen its wood pellet supplies, this year, Japan's Forestry



Wood ready for export in Vietnam.
Image credit: Paul via Adobe Stock

PART IV

SOLUTIONS FRAMEWORK

“The coal that drove 200 years of the industrial revolution took 400 million years to accumulate. How can we possibly expect to grow enough trees to stuff all the carbon back again in just a few decades?”¹¹³

A Global Call to Action: Forests need to be protected, not burned. As the 500 scientists and economists wrote in 2021, forest preservation and restoration should be key tools for both achieving 2050 carbon neutrality goals and addressing the global biodiversity crisis. In a letter addressed to the Asian Development Bank, a wide coalition of environmental groups noted that wood bioenergy violates the principle of a just energy transition as co-firing coal with biomass entrenches the use of this fossil fuel and threatens the forests of the communities that depend on them.¹¹⁴ Governments and institutions should divert the billions of dollars currently funding the false climate solution of burning wood into true renewable energy, such as solar and wind.



An Aerial image of deforestation in Indonesia. Image courtesy of Auiga Nusantara.

The following is a compilation of expert recommendations:

Global

- Report and account for bioenergy CO₂ emissions in a manner similar to fossil fuels.
- Exclude biomass from subsidies meant to support true low emissions.
- Include the threat from the international trade in wood pellets in IUCN species assessments and CITES regulation.
- Designate ‘no go’ areas including Indigenous peoples’ and local communities’ lands and areas of endemic or threatened species, including key biodiversity areas, for industrial expansion, including bioenergy extraction and cultivation.
- Complete High Carbon Stock/High Conservation Value assessments before expanding cultivation. Adopt corporate policies of no deforestation, no peat, no exploitation (NDPE).
- Ensure Free, Prior, and Informed Consent (FPIC).

ADB

- Recognize that its commitment to early retirement and decommissioning of coal resources means a coal phase-out. Its support for co-firing contradicts this commitment.
- Eliminate support for coal project operators that rely on woody biomass or other co-firing options to phase out.
- Exclude support for new wood biomass projects and divest from existing financing to wood biomass, including: 1) projects that allow fossil fuel project operators to ‘repurpose’ facilities via ‘fuel-switching’ to biomass and other resource and GHG intensive technologies; 2) projects involving energy generation from forest wood (including forest residues and wood from tree plantations); 3) BECCS; and 4) new feedstock supply chains for wood biomass facilities, including a) harvesting wood for wood pellets, woodchip or log wood, and b) pellet mills.
- Identify wood biomass as a high-risk sector and conduct enhanced due diligence on all existing support to the sector during divestment from financing both coal and burning of woody biomass to ensure the social and environmental impacts of both wood biomass facilities and feedstock supply chains, including degrading and destructive impacts on natural ecosystems and their biodiversity and the impact on communities, including Indigenous peoples will be stopped and remedied.

Korea

- Immediately remove REC weightings for all utility-scale biomass for future facilities, irrespective of the origin of feedstocks or combustion type.
- Phase out, by 2025, the legacy REC weightings given to facilities that began operations prior to 2018 and have been subject to interim measures.
- Phase out, by 2028, the current REC weightings given to facilities that commenced operations between 2018 and 2023.
- Disclose the CO₂ emissions of biomass power in the country’s GHG accounts.
- Shift support to clean, affordable, and readily available renewable energy, such as solar and wind power.

Japan

- Reform policy for carbon accounting transparency through a centralized system that details fuels in biomass power generation and counts CO2 emissions at the power plant level.
- Achieve a coal exit as soon as possible, regardless of biomass co-firing.
- Eliminate subsidies for biomass power generation; fund low emissions solutions.

Indonesia

- Indonesia should protect all remaining natural forest in the country, including to avoid its conversion to monoculture biomass concession.
- Indonesia's national industrial development plan for 2015-2035 should be reformed to focus on solar energy, which could provide as much as 50-60% of installed electricity generation.¹¹⁵
- Ban the building of new coal fleets, including coal-fired power.
- Improve supply chain transparency by differentiating between purchase country and destination country.
- Limit wood chip and pellet supplies from industrial wood concessions: Industrial wood fiber concession-holders that are not yet supplying pulp mills.
- Fully implement free, prior and informed consent (FPIC) of impacted communities, with a right to veto forest energy plantations on their lands, even those already converted.

APPENDIX: METHODOLOGY

All analyses and mapping were conducted in QGIS. The metrics and data presented in this document represent the best estimates based on available information and methodologies used during the analysis.

Co-firing Plants

29 total co-firing plants in the database, but only 25 are geolocated. A 100 km buffer is placed around each point and is clipped with global land boundaries. The buffer distance was verified by Auriga. Protected areas were excluded from the haul zones.

Chip/Pulp Mills

21 total chip and pulp mills in the database, but only 20 are geolocated. A 100 km buffer is placed around each point and is clipped with global land boundaries. Protected areas were excluded from the haul zones.

Tropical Moist Forest Cover

The forest cover area within the co-firing and chip mill buffer zones was calculated by intersecting the JRC Tropical Moist Forest cover raster (Bourgoin et al., 2023) with the co-firing and chip mill buffer layers, then summarizing the number of pixels within the buffers.

Forest Loss

The forest loss area within co-firing plants and chip mills was calculated by intersecting the 2023 Hansen Global Forest Change product (Hansen et al, 2013) with the buffer zones, using Zonal Histogram, and then summarizing the number of pixels of forest loss per year within the buffer zone area.

Key Biodiversity Areas

The overlap between the Key Biodiversity Areas and the co-firing plant/chip mill buffer zones was calculated by running an intersection between the layers and summing the overlapping areas. The number of Key Biodiversity Areas was calculated by counting the unique number of KBAs across the overlapping geometries.

Protected Area Data

The protected areas data used in this analysis are from the World Database of Protected Areas (UNEP-WCMC and IUCN, 2023). The database identifies a range of classes which reflects their primary management objectives (Dudley 2008).

Ia - Strict nature reserve

Ib - Wilderness area

II - National park

III - National monument or feature

IV - Habitat and species management area

V - Protected landscape or seascape.

VI - Protected area with sustainable use of natural resources

Not applicable/no classification

Onshore Protected Areas

Protected areas with IUCN categories I - IV were selected based on IUCN recommendations that no oil and gas extraction should occur in these protected areas. Protected areas that did not have a IUCN category but were designated “National Parks” were recategorized as IUCN category II to account for the gaps in reported attribute data for certain countries. Duplicate and overlapping protected area features were removed before running the area-based analysis. Marine Protected Areas were removed using `Marine != 2` to preserve protected areas in coastal and tidal landscapes as well as terrestrial protected areas. This layer was overlaid with the haul zone layer to exclude Protected Areas within haul zones.

Endnotes

- 1 Wedel, P. (2019). *When we lost the forest, we lost everything*. Human Rights Watch. <https://www.hrw.org/report/2019/09/23/when-we-lost-forest-we-lost-everything/oil-palm-plantations-and-rights-violations>
- 2 Jong, H. (2021). Indonesia's bid to control deforestation wildly off-target, experts say. Mongabay. <https://news.mongabay.com/2021/04/indonesia-net-zero-emission-deforestation-target/>
- 3 Over 500 scientists to world leaders: do not burn trees for energy. (2021). Land and Climate Review. <https://www.landclimate.org/over-500-scientists-to-world-leaders-do-not-burn-trees-for-energy/>
- 4 Simet, A. (2024). Opportunities Ahead. Biomass magazine. <https://biomassmagazine.com/articles/opportunities-ahead>
- 5 Aguilar, F. (2023). UNECE/FAO Data Brief: Wood Pellets and wood fuel. UN/FAO. <https://unece.org/sites/default/files/2024-02/2023-data-brief-we-20230205-for%20website.pdf>
- 6 Republic of Indonesia. (2021). Electricity Business Plan 2021-2030. PT PLN. https://gatrik.esdm.go.id/assets/uploads/download_index/files/38622-ruptl-pln-2021-2030.pdf
- 7 Squire, C.V. et al. (2024). The viability of co-firing biomass waste to mitigate coal plant emissions in Indonesia. *Commun Earth Environ*. <https://doi.org/10.1038/s43247-024-01588-0>
- 8 Adhiguna, P. (2021). Indonesia's biomass co-firing bet: Beware of implementation risks. Institute for Energy Economics and Financial Analysis. <https://ieefa.org/resources/indonesias-biomass-co-firing-bet-beware-implementation-risks>
- 9 Oh, J. et al. 2024. Exploring the import allocation of wood pellets: Insights from price and policy influences under the renewable portfolio standard. *Forest Policy and Economics*. <https://www.sciencedirect.com/science/article/abs/pii/S1389934124000339>
- 10 Ibid. 2024. *Forest Policy and Economics*.
- 11 NGO Joint Statement: Co-firing of biomass in coal plants or conversion of coal power plants to dedicated biomass power plants is greenwashing. (2023). Mighty Earth. <https://mightyearth.org/article/ngo-joint-statement-co-firing-of-biomass-in-coal-plants-or-conversion-of-coal-power-plants-to-dedicated-biomass-power-plants-is-greenwashing/>
- 12 Luong, K. et al. (2024). Vietnam Export Wood Pellet and Woodchip in the first half of 2024. Forest Trends/Vietnam Wood Pellet Association. https://mkresourcesgovernance.org/wp-content/uploads/2024/08/20240815_Vietnam-export-wood-chip-and-pellet_Q2-2024_EN.pdf
- 13 Auriga Nusantara. (2024). Original data compilation from the Indonesian Ministry of Environment and Forestry databases. No records of wood pellet export data prior to 2021.
- 14 Cavallito, M. (2022). Coal-to-Biomass transition fuels deforestation in Indonesia. *Renewable Matter*. <https://www.renewablematter.eu/articles/article/coal-to-biomass-transition-fuels-deforestation-in-indonesia>
- 15 Forest Watch Indonesia. (2024, July 29). Tinkering with the National Energy Mix Target: A Portrait of the Tumultuous Biomass Project. [Press release]. <https://fwi.or.id/en/tinkering-with-the-national-energy-mix-target-a-portrait-of-of-the-tumultuous-biomass-project/>
- 16 Republic of Indonesia. (2021). Electricity Business Plan 2021-2030. PT PLN. https://gatrik.esdm.go.id/assets/uploads/download_index/files/38622-ruptl-pln-2021-2030.pdf
- 17 Trend Asia. (2022, Nov 10). Supposedly 'green' biomass energy plantations threaten deforestation in world's second largest rainforest. [Press release]. <https://trendasia.org/en/supposedly-green-biomass-energy-plantations-threatens-deforestation-in-worlds-second-largest-rainforest/>
- 18 Muhajir, M. (2022). The looming deforestation threat from energy wood plantation. *Trend Asia*. <https://trendasia.org/en/the-looming-deforestation-threat-from-energy-wood-plantation/>
- 19 Huda, S. et al. (2016). Limboto Lake: A migration stopover and a permanent habitat. *Jakarta Post*. <https://www.thejakartapost.com/news/2016/05/05/limboto-lake-a-migration-stopover-and-a-permanent-habitat.html>

Endnotes

- 20 Note: Hanwa's web page notes it is "involved in a wood pellet manufacturing plantation business in Indonesia." Stable Supply of Biomass Fuel. Hanwa Co. Ltd. <https://www.hanwa.co.jp/en/csr/business/fuel.html>
- 21 Biomass Energy Basics. (2024). Partnership for Policy Integrity. <https://www.pfpi.net/biomass-basics/>
- 22 Liefmiliu. *et al.* (2024, April 5). South Korea must take the lead in climate action by eliminating Renewable Energy Certificates for biomass power. Trend Asia. <https://trendasia.org/wp-content/uploads/2024/04/Open-letter-to-South-Korean-government-re-biomass-REC.pdf>
- 23 Voegelé, E. (2024). Report: Taiwan power producer to open tender in 2024 for 1.7M metric tons of wood pellets. Biomass magazine. <https://biomassmagazine.com/articles/report-taiwan-power-producer-to-open-tender-in-2024-for-17m-metric-tons-of-wood-pellets>
- 24 Global Forest Coalition. (2023). Open Letter to the Asian Development Bank (ADB). <https://globalforestcoalition.org/adb-coal-exit-must-not-entail-support-of-the-false-solution-of-wood-bioenergy/>
- 25 Raven, P. (2021). Over 500 scientists to world leaders: do not burn trees for energy. Land and Climate Review. <https://www.landclimate.org/over-500-scientists-to-world-leaders-do-not-burn-trees-for-energy/>
- 26 Oh, J. *et al.* (2024.) Exploring the import allocation of wood pellets: Insights from price and policy influences under the renewable portfolio standard. Forest Policy and Economics. <https://www.sciencedirect.com/science/article/abs/pii/S1389934124000339>
- 27 Sasatani, D. (2023). Japan Biomass Annual 2023. USDA Foreign Agricultural Service. https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Japan%20Biomass%20Annual%202023_Tokyo_Japan_JA2023-0071.pdf
- 28 Aguilar, F. (2023). UNECE/FAO Data Brief: Wood Pellets and wood fuel. UN/FAO. <https://unece.org/sites/default/files/2024-02/2023-data-brief-we-20230205-for%20website.pdf>
- 29 Oh, J. *et al.* 2024. Exploring the import allocation of wood pellets: Insights from price and policy influences under the renewable portfolio standard. Forest Policy and Economics. <https://www.sciencedirect.com/science/article/abs/pii/S1389934124000339>
- 30 Simet, A. (2024). Opportunities Ahead. Biomass magazine. <https://biomassmagazine.com/articles/opportunities-ahead>
- 31 AsemconnectVietnam. (2024). In 2023: Wood pellet export earned nearly 680 million USD. <https://asemconnectvietnam.gov.vn/default.aspx?ID1=2&ZID1=8&ID8=135680>
- 32 Oh, J. *et al.* 2024. Exploring the import allocation of wood pellets: Insights from price and policy influences under the renewable portfolio standard Forest Policy and Economics. <https://www.sciencedirect.com/science/article/abs/pii/S1389934124000339>.
- 33 Nakazawa, M. (2021). Focus on wood biomass fuel, coconut shells (PKS) and wood pellets (Indonesia). Japan External Trade Organization. https://www-jetro-go-jp.translate.goog/biz/areareports/2021/053f5bfaafa14821.html?_x_tr_sl=ja&_x_tr_tl=en&_x_tr_hl=en&_x_tr_pto=sc
- 34 Searchinger, T. *et al.* (2009). "Fixing a Critical Climate Accounting Error." *Science*. <https://www.science.org/doi/abs/10.1126/science.1178797>
- 35 Fern. (2021). At the Crossroads: Wood Pellets Market 2022-23. https://www.fern.org/fileadmin/uploads/fern/Documents/2023/At_the_crossroads_-_Wood_pellets_market_2022_2023.pdf
- 36 Liefmiliu. *et al.* (2024, April 5). South Korea must take the lead in climate action by eliminating Renewable Energy Certificates for biomass power. Trend Asia. <https://trendasia.org/wp-content/uploads/2024/04/Open-letter-to-South-Korean-government-re-biomass-REC.pdf>
- 37 Biomass Energy Basics. (2024). Partnership for Policy Integrity. <https://www.pfpi.net/biomass-basics/>
- 38 Sterman, J. *et al.* (2018). Does replacing coal with wood lower CO₂ emissions? Dynamic lifecycle analysis of wood bioenergy. *Environ. Res. Lett.* <https://iopscience.iop.org/article/10.1088/1748-9326/3/3/034001/pdf#>

Endnotes

- 39 Bates, J. *et al.* (2009). Carbon Factor for wood fuels for the supplier obligation. AEA Technology plc. <https://assets.publishing.service.gov.uk/media/5a799d4ee5274a684690ad54/3153-final-report-carbon-factor.pdf>
- 40 Sterman, J., *et al.* (2022). Does Wood Bioenergy Help or Harm the Climate? Bulletin of the Atomic Scientists. <https://thebulletin.org/premium/2022-05/does-wood-bioenergy-help-or-harm-the-climate/>
- 41 Gibbs, H. *et al.* (2008). Carbon payback times for crop-based biofuel expansion in the tropics: the effects of changing yield and technology. *Environ. Res. Lett.* <https://iopscience.iop.org/article/10.1088/1748-9326/3/3/034001/pdf#>
- 42 Sterman, J., *et al.* 2018. Does replacing coal with wood lower CO2 emissions? Dynamic lifecycle analysis of wood bioenergy? *Environ. Res. Lett.* <https://iopscience.iop.org/article/10.1088/1748-9326/aaa512>;
- 43 Gramling, C. (2021). Why planting tons of trees isn't enough to solve climate change. Society for Science and the Public 2000-2024. <https://www.sciencenews.org/article/planting-trees-climate-change-carbon-capture-deforestation>
- 44 Aguirre-Gutiérrez, J. *et al.* (2023). Valuing the functionality of tropical ecosystems beyond carbon. *Trends in Ecology & Evolution*. <https://doi.org/10.1016/j.tree.2023.08.012>
- 45 Bond, W. *et al.* (2019). The trouble with trees; afforestation plans for Africa. *Trends in Ecology & Evolution*. https://www.pure.ed.ac.uk/ws/portalfiles/portal/107269643/107269446_Lehmann._AAM.pdf
- 46 Tudge, S. *et al.* (2023). Global trends in biodiversity with tree plantation age. *Global Ecology and Conservation*. <https://doi.org/10.1016/j.gecco.2023>
- 47 Sabin Center for Climate Change Law. (2024). Korean Biomass Plaintiffs v. South Korea. <https://climatecasechart.com/non-us-case/korean-biomass-plaintiffs-v-south-korea/>
- 48 Jong, H. (2023). Emissions and deforestation set to spike under Indonesia's biomass transition. Mongabay. <https://news.mongabay.com/2022/09/emissions-and-deforestation-set-to-spike-under-indonesias-biomass-transition/>
- 49 Song, H. (2024). Subsidized Deforestation: Overview of Biomass Power in South Korea. SFOC. <https://www.gef.or.jp/wp-content/uploads/2024/06/34460cc916ec8c439d5e0697cd448429.pdf>
- 50 Ibid. (2024). SFOC.
- 51 SFOC. (2024, April 5). Global NGOs call on South Korean government to remove renewable credits for biomass energy. [Press release]. <https://forourclimate.org/newsroom/951>
- 52 Friends of the Earth Japan. *et al.* (2023). Co-firing of Biomass in Coal Plants or Conversion of Coal Power Plants to Dedicated Biomass Power Plants is Greenwashing. Foejapan. https://foejapan.org/wpcms/wp-content/uploads/NGO-Joint-Statement_biomass-co-firing_20230424corrected.pdf
- 53 Natural Resources and Energy Agency. (2024). Biomass Power Generation January 2024. Government of Japan. https://www.meti.go.jp/shingikai/santeii/pdf/092_02_00.pdf
- 54 The Government's Support for Biomass (Summary). (2024.) National Audit Office. <https://www.nao.org.uk/wp-content/uploads/2024/01/Summary-the-governments-support-for-biomass-.pdf>
- 55 Crowley, J. (2024). Drax: UK power station still burning rare forest wood. BBC. <https://www.bbc.com/news/science-environment-68381160>
- 56 Mayo, F. (2024). The largest emitters in the UK: annual review. Ember <https://ember-climate.org/insights/in-brief/the-largest-emitters-in-the-uk-annual-review/>
- 57 Simet, A. (2024). Opportunities Ahead. Biomass magazine. <https://biomassmagazine.com/articles/opportunities-ahead>
- 58 Government Approval of Drax's BECCS project will cause more forest destruction. (2024, Jan.16). Biofuel Watch. [Press release]. <https://www.biofuelwatch.org.uk/2024/government-approval-of-draxs-beccs-project-will-cause-more-forest-destruction-campaigners-warn/>
- 59 Jong, H. (2023). Emissions and deforestation set to spike under Indonesia's biomass transition. Mongabay. <https://news.mongabay.com/2022/09/emissions-and-deforestation-set-to-spike-under-indonesias-biomass-transition/>

Endnotes

- 60 ADB. (2024). Indonesia: Institutional and Capacity Building Support for the Just Energy Transition Partnership Secretariat. Asian Development Bank. <https://www.adb.org/projects/57050-001/main>
- 61 Simamora, P. (2023). Feedback on the JETP CIPP. Ember. <https://ember-climate.org/insights/policy-paper/jetp-cipp-comments/>
- 62 Peh, G. (2024). Indonesia's coal companies: Some diversify; others expand capacity. Institute for Energy Economics and Financial Analysis. <https://ieefa.org/resources/indonesias-coal-companies-some-diversify-others-expand-capacity>
- 63 Climate Rights International. (2024). Nickel Unearthed: The Human and Climate Costs of Indonesia's Nickel Industry. CRI Indonesia Report. <https://cri.org/reports/nickel-unearthed/>
- 64 Rangelova, K. *et al.* (2024). Indonesia and the Philippines coal dependency surges past China and Poland. Ember. <https://ember-climate.org/insights/in-brief/indonesia-philippines-coal-surges-past-china-poland/>
- 65 Ibid. (2023). Ember.
- 66 Jong, H. (2023). Indonesia pushes carbon-intensive 'false solutions' in its energy transition. Mongabay. <https://news.mongabay.com/2023/12/indonesia-pushes-carbon-intensive-false-solutions-in-its-energy-transition/>
- 67 Supriatna, J. *et al.* (2020). Deforestation on the Indonesian island of Sulawesi and the loss of primate habitat. *Global Ecology and Conservation*. <https://www.sciencedirect.com/science/article/pii/S2351989420307460>
- 68 Milko, V. (2024). Deforestation in Indonesia spiked last year but resources analysts see better overall trend. Associated Press. <https://apnews.com/article/indonesia-climate-deforestation-palm-oil-nickel-48a4503e383a52e4dbbee81209c87887>
- 69 Russell, R. (2020). Forests in South-east Asia: Can they be saved? European Parliamentary Research Service. [https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/652068/EPRS_BRI\(2020\)652068_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/652068/EPRS_BRI(2020)652068_EN.pdf)
- 70 Fern. (2021). At the Crossroads: Wood Pellets Market 2022-23. Fern. https://www.fern.org/fileadmin/uploads/fern/Documents/2023/At_the_crossroads_Wood_pellets_market_2022_2023.pdf
- 71 Indradi Y. *et al.* (2024). The hijackers of the energy transition. Trend Asia. <https://trendasia.org/en/the-hijackers-of-energy-transition/>
- 72 Scotson, L. *et al.* (2017). Projecting range-wide sun bear population trends using tree cover and camera-trap bycatch data. *PLoS One*. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5621681/>
- 73 Sojung, Y. (2016). Forest service launches work in 14 countries. Korea.net <https://www.korea.net/NewsFocus/policies/view?articleId=135426>
- 74 Korea Forest Service. (2023). Forest Statistical System. KFSS. <https://kfss.forest.go.kr/stat/ptl/fybMng/popup/selectFrstyYrBooklemFileView.do?iemSeq=1592&fileSeq=5401>
- 75 Based on field visits by Auriga Nusantara in 2024.
- 76 Note: Company website indicates: "Produced/supplied by the Indonesian plant (East Kalimantan), where the annual output of the latest facility reaches up to 60,000 tons." In Wood Pellet. (2015). Kyung Dong Development. http://www.kd-energy.com/en/business/biomass_03.asp
- 77 Auriga Nusantara. (2024). Indonesia Deforestation 2023. Simontini. https://simontini.id/presentation/Indonesia_deforestation_2023-presentation.pdf
- 78 Note: Auriga Nusantara analyzed Indonesian government reports and monthly data from the University of Maryland's GLAD Alert to identify potential tree cover loss, then overlaid it with December 2022's forest cover as defined through Planet's imagery analysis using the FAO standard.
- 79 Bank DBS Indonesia provides energy transition financing for Indika Energy. (2024). DBS Bank Ltd. https://www.dbs.com/newsroom/Bank_DBS_Indonesia_provides_energy_transition_financing_for_Indika_Energy

Endnotes

- 80 Modi, A. (2024). Indonesian coal producer Indika Energy is venturing into biomass, as it diversifies into more environmentally-friendly businesses and reduces its reliance on conventional fuel revenues. Argus Media. <https://www.argusmedia.com/en/news-and-insights/latest-market-news/2572087-indonesian-coal-producer-indika-eyes-biomass-market>
- 81 Yuliardi, S. (2024). MBAP Melalui Anak Usahanya MHL, Bangun Pabrik Wood Pallet Terintegrasi dengan Kapasitas 150 Ribu Ton, Menyasar Pasar Jepang. *wartaekonomi.co.id* <https://wartaekonomi.co.id/read534026/mbap-melalui-anak-usahanya-mhl-bangun-pabrik-wood-pallet-terintegrasi-dengan-kapasitas-150-ribu-ton-menyasar-pasar-jepang>
- 82 Supriatna, J. *et al.* (2020). Deforestation on the Indonesian island of Sulawesi and the loss of primate habitat. *Global Ecology and Conservation*. <https://www.sciencedirect.com/science/article/pii/S2351989420307460>
- 83 Cowan, C. (2021). On islands that inspired theory of evolution, deforestation cuts uneven path. *Mongabay*. <https://news.mongabay.com/2021/10/on-islands-that-inspired-theory-of-evolution-deforestation-cuts-uneven-path/>
- 84 Zakaria, Z. *et al.* (2022). Habitat preferences and site fidelity of *Tarsius supriatnai* in agricultural area and secondary forest of Popayato-Paguat Landscape (Gorontalo, Indonesia). *Biodiversitas Journal of Biological Diversity*. 10.13057/biodiv/d230762
- 85 Huda, S. *et al.* (2016). Limboto Lake: A migration stopover and a permanent habitat. *Jakarta Post*. <https://www.thejakartapost.com/news/2016/05/05/limboto-lake-a-migration-stopover-and-a-permanent-habitat.html>
- 86 Note: Auriga Nusantara, field visits and data compilation in 2024.
- 87 Tam, S. (2023). Japan's June Biomass Imports Rise on Year. Argus Media. <https://www.argus-media.com/en/news-and-insights/latest-market-news/2474909-japan-s-june-biomass-imports-rise-on-year>
- 88 Forest Watch Indonesia (2024, March 23). Energy Transition Business: Alert!!! New Deforestation Drivers in Gorontalo. [Press release]. Forest Watch Indonesia. <https://fwi.or.id/en/energy-transition-business-alert-new-deforestation-drivers-in-gorontalo/>
- 89 Southeast Asia Wood Pellet Market Size Worth USD 454.73 Million by 2032 | CAGR: 8.7%. (2024). Polaris Market Research and Consulting, Inc. [Press release]. <https://www.polarismarketresearch.com/press-releases/southeast-asia-wood-pellet-market>
- 90 Forest Watch Indonesia (2024). Tinkering with the National Energy Mix Target: A Portrait of the Tumultuous Biomass Project. Forest Watch Indonesia. <https://fwi.or.id/en/tinkering-with-the-national-energy-mix-target-a-portrait-of-of-the-tumultuous-biomass-project/>
- 91 Ibid. 2024. Forest Watch Indonesia.
- 92 Supriatna, J. *et al.* (2020). Deforestation on the Indonesian island of Sulawesi and the loss of primate habitat. *Global Ecology and Conservation*. <https://www.sciencedirect.com/science/article/pii/S2351989420307460>
- 93 Trikora Village Community Rejects PT Activities. BJA. (2022). Redaski Barakati. <https://barakati.id/masyarakat-desa-trikora-tolak-aktivitas-pt-bja/>
- 94 Indonesia's biomass consumption target in 2024 nearly triples. (2024). Reuters. <https://www.reuters.com/sustainability/climate-energy/indonesias-biomass-consumption-target-2024-nearly-triples-2024-01-18/>
- 95 Earth Insight (2023). Three Basins Report: Fossil Fuel, Mining, and Industrial Expansion Threats to Forests and Communities. <https://earth-insight.org/report/three-basins-report/>
- 96 Muhajir, M. (2022). The looming deforestation threat from energy wood plantation. *Trend Asia*. <https://trendasia.org/en/the-looming-deforestation-threat-from-energy-wood-plantation/>
- 97 Cavallito, M. (2022). Coal-to-Biomass transition fuels deforestation in Indonesia. *Renewable Matter*. <https://www.renewablematter.eu/articles/article/coal-to-biomass-transition-fuels-deforestation-in-indonesia>

Endnotes

- 98 Forest Watch Indonesia. (2024). Tinkering with the National Energy Mix Target: A Portrait of the Tumultuous Biomass Project. <https://fwi.or.id/en/tinkering-with-the-national-energy-mix-target-a-portrait-of-of-the-tumultuous-biomass-project/>
- 99 Ocampo-Peñuela, N. et al. (2021). Impacts of Four Decades of Forest Loss on Vertebrate Functional Habitat on Borneo. *Frontiers in Forests and Global Change*. <https://www.frontiersin.org/journals/forests-and-global-change/articles/10.3389/ffgc.2020.00053/full>
- 100 Global Forest Coalition. (2023). Open Letter to the Asian Development Bank (ADB). <https://globalforestcoalition.org/adb-coal-exit-must-not-entail-support-of-the-false-solution-of-wood-bioenergy/>
- 101 Ministry of Economy, Trade and Industry. (2024). Timber Industry results, 2023. Government of Japan. https://www.rinya.maff.go.jp/j/boutai/attach/pdf/mokuzai_yunyuu_genjou-31.pdf
- 102 Oh, J. et al. 2024. Exploring the import allocation of wood pellets: Insights from price and policy influences under the renewable portfolio standard. *Forest Policy and Economics*. <https://www.sciencedirect.com/science/article/abs/pii/S1389934124000339>
- 103 Hong, S. (2023). Vietnam's wood pellet exports to reach 10mn t in 2027. *Argus Media*. <https://www.argusmedia.com/ja/news-and-insights/latest-market-news/2453747-vietnam-s-wood-pellet-exports-to-reach-10mn-t-in-2027>
- 104 Chi, Q. (2024). Vietnam and Korea strengthen cooperation to develop multi-use forestry industry. *Vietnam Agriculture*. <https://vietnamagriculture.nongnghiep.vn/vietnam-and-korea-strengthen-cooperation-to-develop-multi-use-forestry-industry-d391617.html>
- 105 Giseburt, A. (2024.) Biomass power grows in Japan despite new understanding of climate risks. *Mongabay*. <https://news.mongabay.com/2024/07/biomass-power-grows-in-japan-despite-new-understanding-of-climate-risks/>
- 106 Binh Dinh: One of Vietnam's wood and export centers. (2024). *Forest Product Association of Binh Dinh*. <http://fpabinhdinh.com.vn/en/binhdinh-one-of-vietnams-wood-and-furniture-export-centers/>
- 107 Binh Định to develop wood processing industry. (2024). *Vietnam News*. <https://vietnamnews.vn/economy/1658834/binh-dinh-to-develop-wood-processing-industry.html>
- 108 Fu, H. (2023). 7th Biomass & BioEnergy Asia Conference Set to Ignite Sustainable Biomass Production in SE Asia. *Center for Management Technology*. <https://www.einpresswire.com/article/664523973/7th-biomass-bioenergy-asia-conference-set-to-ignite-sustainable-biomass-production-in-se-asia>
- 109 Uniexport. Our Plants. [Company website]. <https://uniexport.vn/our-plants/>
- 110 Luong, K. et al. (2024). Vietnam Export Wood Pellet and Woodchip in the first half of 2024. *Forest Trends/Vietnam Wood Pellet Association*. https://mkresourcesgovernance.org/wp-content/uploads/2024/08/20240815_Vietnam-export-wood-chip-and-pellet_Q2-2024_EN.pdf
- 111 Uyên, V. (2023.) Smoke, mirrors, wood pellets. *Mekong Eye*. <https://www.mekongeye.com/2023/11/19/vietnam-pellets-energy/>
- 112 Aguilar, F. (2023). UNECE/FAO Data Brief: Wood Pellets and wood fuel. *UN/FAO*. <https://unece.org/sites/default/files/2024-02/2023-data-brief-we-20230205-for%20website.pdf>
- 113 Bond, W. et al. (2019). The trouble with trees; afforestation plans for Africa. *Trends in Ecology & Evolution*. https://www.pure.ed.ac.uk/ws/portalfiles/portal/107269643/107269446_Lehmann._AAM.pdf
- 114 Global Forest Coalition. (2023). Open Letter to the Asian Development Bank (ADB). <https://globalforestcoalition.org/adb-coal-exit-must-not-entail-support-of-the-false-solution-of-wood-bioenergy/>
- 115 IEA. (2022). An Energy Sector Road Roadmap to Zero Net Emissions in Indonesia. *International Energy Agency*. <https://iea.blob.core.windows.net/assets/b496b141-8c3b-47fc-adb2-90740eb0b3b8/AnEnergySectorRoadmaptoNetZeroEmissionsinIndonesia.pdf>



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