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Institute for Essential Services Reform

Indonesia Energy Transition Outlook 2026

Rhetoric or Reality: Aligning Economic Growth with Energy Transition

Imprint

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Foreword

From Words to Action: Indonesia Energy Transition at a Crossroads

The 2026 edition of Indonesia Energy Transition Outlook (IETO) indicates that Indonesia's energy transition stands at a crossroads. A lot of promises, inconsistency between promises and actions, and coal fight back!

Despite the country having one of the world's largest proven renewable energy resources—enough solar potential to power the entire Southeast Asian region—coal still dominates its electricity system at over 65 percent. This contradiction has defined Indonesia's energy transition for years. Despite repeated commitments to move toward cleaner power, progress remains slow and uneven. Progress seems to stay in the moment.

The world is changing fast, creating both urgency and opportunity. The global energy landscape has shifted dramatically. In 2024, solar and wind energy grew at unprecedented rates, with renewables adding more electricity than fossil fuels for the third consecutive year. Solar capacity increased by 32 percent, becoming the fastest-growing energy source on the planet. For the first time in modern history, low-carbon power sources—renewables and nuclear combined—provided more than 40 percent of global electricity. Coal is retreating in developed economies. The United Kingdom closed its last coal plant this year. Despite the shifting of the Federal Government's policy on renewable energy, the United States continues to install renewable energy faster than ever. Globally, investments in clean energy reached $2.1 trillion in 2024, outpacing fossil fuel investments by ten to one.

This matters for Indonesia because it shows renewable energy is now cheaper and faster to build than fossil alternatives. Solar costs have collapsed by 35 percent, and battery storage prices continue declining steeply. The economics no longer favor coal. Yet Indonesia's energy system has not adjusted to this reality.

Indonesia's situation is uniquely challenging. The country is the world's largest coal exporter, with recently built coal power plants designed to operate for decades. Nearly all plants are less than 15 years old, meaning they will operate well into the 2040s or 2050s unless deliberately retired. Coal interests run deep through the economy and politics. Coal is also a source of revenues for national and sub-national governments that incentivize coal production and consumption, both for export and domestic use. The new administration uses "energy sovereignty," eight percent economic growth, and down-streaming as an excuse to continue using coal and building new coal plants.

These structural obstacles explain why Indonesia missed its renewable energy target for nine consecutive years. The goal was 23 percent by 2025. Instead, renewables reached about 16 percent by mid-2025, and the government revised targets downward to 17-19 percent in the new National Energy Policy and shifted the emission peak from 2030 to 2035 in the Second NDC.

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The new administration has signaled different ambitions. At the G20 Summit, President Prabowo Subianto stated Indonesia would phase out fossil fuels within ten to fifteen years and deploy 100 percent renewable energy. Such commitments matter when made internationally. Yet between announcement and deliverylies a vast gap. Indonesia's Comprehensive Investment Plan for the Just Energy Transition Partnership identifies 400 projects needed to redirect the electricity system, but implementation has been halting for two years.

Three main obstacles block progress. First, infrastructure is the binding constraint—Indonesia's grid is fragmented and insufficient for high proportions of variable renewables. Storage capacity barely exists. Second, policy coordination across government agencies remains weak, and competing interests and priorities among agencies make execution slow. The central government sets renewable targets while the state electricity company PLN still plans coal generation and other fossil fuels. The diesel generator's replacement program has been stalled for three years, without a clear target for how it will be executed and completed. Third, financing is tight. Indonesia faces billions funding gap for energy transition projects. While the $20 billion Just Energy Transition Partnership provides useful capital, most arrives as loans rather than grants, and yet the implementation is stalled.

Despite these constraints, genuine opportunities exist.

Indonesia possesses 7,700 gigawatts of solar potential, with just less than 1 gigawatt deployed. This is perhaps the greatest untapped resource of any country today. As costs fall, simple economics will drive solar expansion. Indonesia is already the world's second-largest producer of geothermal electricity and can expand that capacity significantly. Wind resources in eastern Indonesia remain underutilized. Together, these resources could power a modern economy.

Second, Indonesia has become critical to the global energy transition supply chain. The country produces nickel, cobalt, and other minerals essential for batteries and electric vehicles. Multiple foreign automakers are building EV manufacturing facilities. Over 14 percent of vehicles sold in Indonesia in early 2025 were electric, nearly zero just years ago.

Third, renewables are economically superior in many parts of Indonesia. Solar is already cheaper than new coal generation when comparing true costs. Battery storage prices have fallen so sharply that new business models are viable. Industrial operations near renewable sites can access cheap, reliable power, creating an immediate incentive for private investment. Solar and BESS can easily replace diesel power to provide more reliable power at a lower cost in many islands in the country.

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Fourth, Indonesia's leadership has articulated clear targets. President Prabowo's statements about fossil fuel phaseout create political space for change and a directive to build 100 GW of solar PV with battery. The direction is set, though speed remains uncertain. Sub-national governments are keen to utilize their renewable energy resources and come up with bold initiatives, like the ones in Bali, NTB, and NTT.

But implementation requires specific action: market reforms to level the playing field between renewables and fossil fuels; removing fossil fuel subsidies, accelerated grid infrastructure investment; alignment of policy documents across government agencies; enhanced budget authority for provincial governments; and strengthened financial mechanisms for project guarantees. These recommendations appear repeatedly in government strategy documents. The obstacle is political will and bureaucratic coordination, not technical knowledge.

Indonesia cannot return to business as usual. Global coal demand is projected to decline after 2024, and we have seen that coal exports this year are down more than 20 percent. Europe, Japan, China, India, and other major customers are reducing coal imports. The transition is coming regardless. The question is whether Indonesia shapes it or is shaped by it.

The global energy transition demonstrates that rapid transformation is possible. Pakistan went from zero solar share to 30 percent in six years. Within a decade, the global power system will look fundamentally different. Indonesia has the resources, technology, capital, and political commitment to lead this transformation. It also has structural barriers that make swift change difficult. How Indonesia navigates this tension will determine its economic competitiveness and climate resilience for generations to come. The moment is now. The tools exist. The capital is available. What remains is political courage and institutional execution, don't be just "omon-omon".

IETO 2026 provides a comprehensive assessment of the state of Indonesia's energy transition, and I believe, has become one of the primary information sources for tracking the progress of energy transition in the country. I hope you, the reader, will find it useful, and more than that, it could drive transformational change in our energy system.

Jakarta, November 2025

Fabby Tumiwa

Chief Executive Officer (CEO)

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List of Abbreviations

AC	: Air Conditioner
ADB	: Asian Development Bank
APBD	: *Anggaran Pendapatan dan Belanja Daerah* (Subnational Government Budget)
APBN	: *Anggaran Pendapatan dan Belanja Negara* (National Government Budget)
ARED	: Accelerated Renewable Energy Development
ASEAN	: Association of Southeast Asian Nations
B35	: Biodiesel 35%
B40	: Biodiesel 40%
Bappenas	: *Badan Perencanaan Pembangunan Nasional* (National Development Planning Agency)
BAU	: Business-as-usual
BCA	: Bank Central Asia
BESS	: Battery Energy Storage System
BEV	: Battery electric vehicle
BF-BOF	: Blast Furnace–Basic Oxygen Furnace
BF-BOF-CCS	: Blast Furnace–Basic Oxygen Furnace with Carbon Capture and Storage
BGH	: *Bangunan Gedung Hijau* (Green building)
BNI	: Bank Negara Indonesia
BOE	: Billion Oil Equivalent
BoS	: Balance of Systems
BP Taskin	: *Badan Percepatan Pengentasan Kemiskinan* (Agency for the Acceleration of Poverty Alleviation)
BPP	: Biaya Pokok Penyediaan Tenaga Listrik (Electricity Generation Cost)
BPS	: *Badan Pusat Statistik* (Statistics Indonesia)
BRI	: Bank Rakyat Indonesia
BRT	: Bus Rapid Transit
BTS	: Buy-The-Service
CAFE	: Corporate Average Fuel Economy
CAGR	: Compound Annual Growth Rate
CBAM	: Carbon Border Adjustment Mechanism
CCS	: Carbon Capture and Storage
CCUS	: Carbon Capture Utilization and Storage
CFPP	: Coal-fired Power Plants
CIPP	: Comprehensive Investment and Policy Plan
ckm	: circuit kilo meter
CMEA	: Coordinating Ministry for Economic Affairs
CO2	: Carbon dioxide
COP	: Conference of the Parties
COP	: Coefficient of Performance
COVID	: Corona Virus Disease
CSPF	: Cooling Seasonal Performance Factor
CSR	: Corporate Social Responsibility
DEA	: Danish Energy Agency
DKI	: *Daerah Khusus Ibukota*
DMO	: Domestic Market Obligation
DPO	: Domestic Price Obligation
DRI	: Direct Reduced Iron
DRI-EAF	: Direct Reduced Iron–Electric Arc Furnace
DRI-EAF-CCS	: Direct Reduced Iron–Electric Arc Furnace with Carbon Capture and Storage
DTKTE	: *Dinas Tenaga Kerja, Transmigrasi, dan Energi* (Department of Manpower, Transmigration and Energy)
E&M	: Energy and Material
E2W	: Electric Two-Wheeler
E4W	: Electric Four-Wheeler
EAF	: Electric Arc Furnace
EBTKE	: *Direktorat Jenderal Energi Baru Terbarukan dan Konservasi* Energi (Directorate General of New, Renewable Energy, and Energy Conservation)

EDGE	: Excellence in Design for Greater Efficiencies
EEA	: European Economic Area
EHP	: Electric Heat Pump
ENDC	: Enhanced Nationally Determined Contribution
EPC	: Engineering, Procurement, and Construction
ESG	: Environmental, Social, and Governance
ESS	: Energy Storage Systems
ETM	: Energy Transition Mechanism
ETS	: Emissions Trading System
EU	: European Union
EUI	: Energy Use Intensity
EV	: Electric Vehicle
FKD	: *Forum Konsultasi Daerah* (Regional Consultation Forum)
FOLU	: Forestry and Land-use
Gas-GT	: Gas-Gas Turbine
Gas-IC	: Gas-Internal Combustion
GBCI	: Green Building Council Indonesia
GDP	: Gross Domestic Product
GEI	: Global Efficiency Intelligence
GEM	: Global Energy Monitor
GHG	: Greenhouse gas
GOI	: Government of Indonesia
GR	: Government Regulation
GW	: Gigawatt
GWh	: Gigawatt-hour
HBI	: Hot Briquetted Iron
HBI-EAF	: Hot Briquetted Iron–Electric Arc Furnace
HCS	: Home charging service
HEFA	: Hydro-processed Esters and Fatty Acids
HEV	: Hybrid electric vehicle
HIVOS	: Humanist Institute for Cooperation with Developing Countries
HPT	: Heat Pump Technology
HV	: High Voltage
ICAO	: International Civil Aviation Organization
ICE	: Internal combustion engine
ICEV	: Internal Combustion Engine Vehicle
IDR	: Indonesian Rupiah
IDXCarbon	: Indonesia Carbon Exchange
IEA	: International Energy Agency
IEEFA	: Institute for Energy Economics and Financial Analysis
IETO	: Indonesia Energy Transition Outlook
IEU-CEPA	: Indonesia-European Union Comprehensive Economic Partnership Agreement
IISIA	: Indonesian Iron & Steel Industry Association
IKN	: Ibu Kota Nusantara (Nusantara Capital City)
ILO	: International Labour Organization
IMO	: International Maritime Organization
IPP	: Independent Power Producer
IPPU	: Industrial Processes and Product Use
JETP	: Just Energy Transition Partnership
KBLI	: *Kode Baku Lapangan Usaha Indonesia* (Standard Classification of Indonesian Business Field)
KBMI	: *Kelompok Bank Berdasarkan Modal Inti* (Bank Group based on Core Capital)
KEN	: *Kebijakan Energi Nasional* (National Energy Policy)
KLH	: *Kementerian Lingkungan Hidup* (Ministry of Environment)
KPMG	: Klynveld Peat Marwick Goerdeler
kV	: Kilo Volt
kWh	: Kilo Watt Hour
kWp	: kilowatt-peak
LCE	: Low Carbon Electricity
LCGC	: Low Cost Green Car
LCOH	: Levelized Cost of Hydrogen

LCOS : Levelized Cost of Storage
LFP : Lithium Ferro (iron) Phosphate
Lge : Liter gasoline equivalent
LIBs : Lithium-ion Batteries
LNG : Liquefied Natural Gas
LPG : Liquefied Petroleum Gas
LSS : Large-Scale Solar
LV : Low Voltage
MBOE : Million Barrel of Oil Equivalent
MCIT : Ministry of Communication and Information Technology
MEMR : Ministry of Energy and Mineral Resources
MEMR : Ministry of Energy and Mineral Resources
MEPS : Minimum Energy Performance Standards
MoFR : Ministry of Finance of the Republic of Indonesia Regulation
MoI : Ministry of Industry
MoT : Ministry of Transportation
MPW : Ministry of Public Works
MPWPH : Ministry of Public Works and Public Housing
MR : Ministerial Regulation
MRV : Measurement, Reporting, and Verification
Mt : Million tonne
MtCO2e : Million tonnes of CO2 equivalent
MTOE : million tonnes of oil equivalent
MTPA : Million Ton Per Annum
Musrenbang : *Musyawarah Perencanaan Pembangunan* (Development Planning Forum)
MV : Medium Volt
MVA : Mega Volt-Ampere
MW : Megawatt
MWp : Megawatt-peak
NDC : Nationally Determined Contributions
NE : New Energy
NRE : New and Renewable Energy
NZE : Net-zero emission
ODOL : Overdimensioned overloaded
OECD : Organisation for Economic Co-operation and Development
OJK : *Otoritas Jasa Keuangan* (Indonesia Financial Authority)
PBJT : *Pemanfaatan Bersama Jaringan Transmisi* (Joint Utilizataion of Transmission Network)
Perda : *Peraturan Daerah* (Regional Regulation)
Pergub : *Peraturan Gubernur* (Governor Regulation)
PHEV : Plug-in Hybrid Electric Vehicle
PIH : *Pusat Industri Hijau* (Green Industry Center)
PII : PT Penjaminan Infrastruktur Indonesia
PKB : *Pajak Kendaraan Bermotor* (Motorized Vehicle Tax)
PLN : Perusahaan Listrik Negara
PLTS : *Pembangkit Listrik Tenaga Surya* (Solar Power Plant)
POME : *Pelaporan Online Manajemen Energi* (online energy management reporting)
PPA : Power Purchase Agreement
PPnBM : *Pajak Penjualan Barang Mewah* (sales tax on luxury goods)
PR : Presidential Regulation
PSN : *Program Strategis Nasional* (National Strategic Program)
PTBAE : Persetujuan Teknis Batas Atas Emisi (Emission Cap allowance)
PV : Photovoltaic
PWYP : Publish What You Pay
Q1 : Quarter 1
Q2 : Quarter 2
RAC : Room Air Conditioner
RE : Renewable Energy
REC : Renewable Energy Certificates

RHAN	: *Roadmap Hidrogen dan Amonia Nasional* (National Hydrogen and Ammonia Roadmap)
RIPIN	: *Rencana Induk Pengembangan Industri Nasional* (National Industry Planning)
RKP	: *Rencana Kerja Pemerintah* (Government Work Plan)
RPJMN	: *Rencana Pembangunan Jangka Menengah Nasional* (National Medium-Term Development Plan)
RPJPD	: *Rencana Pembangunan Jangka Panjang Daerah* (Regional) Long-Term Development Plan
RPJPN	: *Rencana Pembangunan Jangka Panjang Nasional* (National Long-Term Development Plan)
RUED	: *Rencana Umum Energi Daerah* (Regional Energy General Plan)
RUEN	: *Rencana Umum Energi Nasional* (National Energy General Plan)
RUKD	: *Rencana Umum Ketenagalistrikan Daerah* (Regional Electricity General Plan)
RUKN	: *Rencana Umum Ketenagalistrikan Nasional* (National Electricity General Plan)
Rumah PATEN	: *Rumah Perancangan Aksi Transisi Energi Nasional* (Indonesia Energy Transition Implementation Joint Office)
RUPTL	: *Rancangan Usaha Penyediaan Tenaga Listrik* (Electricity Supply Business Plan)
SAF	: Sustainable Aviation Fuel
SAIDI	: System Average Interruption Duration Index
SAIFI	: System Average Interruption Frequency Index
SECI	: Solar Energy Corporation of India
SIH	: Standar Industri Hijau (Green Industry Standard)
SME	: Small and Medium Enterprises
SMI	: PT Sarana Multi Infrastruktur (Persero)
SNDC	: Second Nationally Determined Contribution
SPBKLU	: *Stasiun Penukaran Baterai Kendaraan Listrik Umum* (Public swapping stations)
SPKLU	: *Stasiun Pengisian Kendaraan Listrik Umum* (Public chargers)
SRE	: Stable Renewable Energy
Subs.	: Substation
T&D	: Transmission and Distribution
TOE	: Tonnes of Oil Equivalent
TRL	: Technology Readiness Level
TWh	: Tera Watt Hour
UNFCCC	: United Nations Framework Convention on Climate Change
US	: United States (of America)
USD	: US Dollar
VA	: Volt-Ampere
VAT	: Value-added Tax
VRE	: Variable Renewable Energy
WHO	: World Health Organization

Executive Summary

Introduction

- Indonesia is wasting a huge opportunity from RE to achieve its sustainability pledge, and the growth and energy independence envisioned in Asta Cita by continuing fuel subsidies, inconsistent planning, poor inter-agency coordination, and opting for nuclear instead. Indonesia's aspiration of 8% annual economic growth by 2029 risks 17% higher emission in 2040 than the low growth scenario due to continuing reliance on fossil fuels. With the 1.5°C's carbon budget depletes as early as 2040, it becomes almost impossible to accomplish the country's share of responsibility of keeping temperature increasing by 1.5°C unless it decouples economic growth from fossil fuels soonest. With only 9% of energy security budget allocated for renewable energy (RE) development in the newest national energy policy while having countrywide total renewable energy potential exceeding 3 TW, huge RE potential remains untapped.

Power Sector

- IESR assesses the sector's energy transition state by the degree of renewable energy mix, progress of fossil fuel phase-out, and existence of supportive grid infrastructure. The use of fossil fuels, which emitted above 350 $MtCO_2e$ in 2024, continues to dominate Indonesia's power sector. Coal-based power capacity has the biggest share of installed capacity (80 out of 120 GW total capacity of all power plants, on grid and captive). Emissions from coal are expected to continue rising, with MEMR Regulation No. 10/2025, a legal basis for early retirement of CFPPs, fails to support more concrete acts.
- Rising electricity demand (10.3%, 3.4%, and 6.3% CAGR from 2020-2024 for the high-, medium-, and low voltage segments, respectively) necessitates power capacity expansion. Although advances in technology allow a dramatic reduction of solar power plant construction time and a rapid deployment rate of utility battery storage, among all, renewable energy has not been incorporated more into the power supply plan. Its share in on-grid power generation fell to only 11.5% in 2024. In contrast, PLN's RUPTL 2025-2034 plans for an addition of 16.6 GW of fossil capacity, including 1.4 GW of new coal projects.
- The President's ambitions of 100% renewable electricity within a decade and 100 GW of rural solar under the Koperasi Desa Merah Putih program are yet to be included in any formal planning. IESR urges more concrete ways to realize the ambition due to promising results from a study that simulates Timor and Sumbawa's 100% renewable systems by 2050 from solar PV and batteries. Such systems could lower generation cost by 3% in Timor and 21% in Sumbawa, even under the DMO policy.

Industrial Sector

- Indonesia's industrial emissions have nearly doubled over the past decade (more than 480 $MtCO_2e$ in 2024) due to rising coal use, which accounted for 59% of total energy demand of the sector in the same year. This publication use electrification, hydrogen and bioenergy adoption, energy efficiency adoption, and energy management implementation as the main parameters to track energy transition state for the sector.

- While it is already known that 72% of the emission reduction potential lies within cement, iron and steel, and fertilizer, limited efforts in fuel switching, increasing energy and materials efficiency, and process improvement, coupled with outdated Sertifikat Industri Hijau (SIH) and non-existent emission intensity-based management, have prevented progress in decarbonizing its industrial sector.

Transport Sector

- Passenger transport accounted for 74% while freight transport claimed the remaining 26% of the 180 MtCO_2eq total greenhouse gas emissions from the Indonesia's transport sector in 2024. IESR employs fleet electrification, fuel economy efficiency, modal shift, decarbonization of shipping, and uptake of sustainable aviation fuel as the parameters to measure energy transition progress of the sector.
- High cost of Battery Electric Vehicle (BEV) due to no incentives, weak vehicle turnover policy (age limit, national scrappage scheme), and non-optimal placement of charging facilities slow down fleet electrification. Meanwhile, the average fuel economy standard of 6 Lge/100 km remains above the NZE-aligned fuel economy target for 2024 (5.06 Lge/100 km), showing most vehicles are not efficient enough and the need for the standard's revamp. Though it could cut significant emissions, modal shifts for passenger transport (Buy the Service) and freight transport (trucks to rail) exist only on a small scale and thus have a minimal effect. Lastly, the ongoing domination of fossil fuels in shipping and aviation due to biodiesel's restricted applicability for ships and limited production of Sustainable Aviation Fuel (SAF) further undermine decarbonization efforts.

Building Sector

- The building sector consumed 17% of the Indonesia's final energy consumption in 2024 through household (13%) and commercial (4%) activities and emitted 4.2% of the total emission in 2023. IESR tracks the state of energy transition of the sector through electrification, Minimum Energy Performance Standard (MEPS), adoption of energy management, and uptake of green building.
- Continuing preference for gas and LPG for cooking, the biggest energy-consuming activities in households, has undermined electrification efforts. Meanwhile, the government's approval for air-conditioners with a very low Cooling Seasonal Performance Factor (CSPF) to exist wastes much energy and highlights a very low standard of appliances' MEPS. With regards to the energy management obligation, only 4.4% of the mandatory commercial buildings and 1.2% of government buildings complied in 2024. Finally, if the current trend continues, green building can only reduce 6% of the 2030's mandatory green building emission reduction target, even after totaling private (voluntary) and mandatory certification (BGH).

Transition Readiness Framework

- Indonesia's energy transition remains slow due to policy incoherence, limited financing, and weak institutional and human capital capacity. Despite President Prabowo's strong commitment to 100% renewables and net-zero goals, progress is constrained by inadequate fiscal support and fragmented governance. Strengthening policy alignment, financing, and workforce development is crucial to accelerate the transition.

Political Commitment and Governance

- President Prabowo repeatedly affirmed Indonesia's commitment to the Paris Agreement and the national target of achieving net-zero emissions through verbal, institutional, and budgetary commitments. He promised to phase out all fossil-fueled power plants within 15 years and develop 75 GW of renewable energy (RE) capacity. The government has become more proactive since, yielding additional 15% RE power plant capacity from 2024, and a more ambitious National Energy Policy (KEN) than its predecessor.
- However, the draft of SNDC's RE mix target of only 19%–23% by 2030, decreasing State Budget (APBN) allocation for energy security in 2026 (only IDR 37.5 trillion for RE development), delayed emission peak for energy sector from 2030 to 2035-2038, increased bureaucratic complexity due to multi-layered regulatory framework, and a modest target of 36–40% for new and renewable energy (NRE) by 2040 in the newest KEN show realizing Asta Cita's accelerated economic growth and energy sovereignty through renewable development is farfetched.

Investment and Finance

- Fossil fuel subsidies, projected to total IDR 1,023 trillion between 2022 and 2026, continue to reinforce Indonesia's dependence on fossil fuels energy. Meanwhile, budget allocations for the EBTKE subsector remain minimal and declined in 2024, signaling low policy priority, weakening investor confidence, and contributing to stagnant renewable capacity growth. On the private side, renewable energy financing rose 23% in Q1 2025 to IDR 36 trillion across Indonesia's four largest banks but remains far below the IDR 267 trillion directed to mining, reflecting the continued dominance of extractive industries amid persistent policy and procurement bottlenecks.
- International support, including JETP, remains slow, with only USD 1.2 billion approved out of USD 20 billion committed, supporting just 143 MW of capacity due to a limited project pipeline. To attract more international capital, Indonesia must enhance its investment climate through clearer regulations, stronger policy certainty, and a robust pipeline of bankable projects. Meanwhile, Indonesia's carbon market shows potential but remains underdeveloped, with only USD 4.9 million in total transactions and prices averaging USD 3.6 per ton, far below the global benchmark of USD 50–100, offering minimal impact in financing the energy transition.

Public Participation and Acceptance

- Overall, Indonesians support the idea of clean energy but lack trust and opportunities to take part, highlighting the need for clearer policies, better communication, and stronger public engagement. Public participation remains procedural rather than meaningful. Two major examples are development planning forums (musrenbang) and energy policy consultation forums that are often dominated by elites and lack real community influence, while the drafting process of the recent Second Nationally Determined Contribution (SNDC) included public consultations but lacked transparent reports on responses.
- As for public acceptance, a recent 2025 online-based survey for 1000 respondents across Indonesia revealed that most Indonesians (91%) viewed climate change as urgent, and 86% were aware of the energy transition. The public saw renewable options such as solar, wind, and hydro as accessible and uncontroversial, while nuclear energy emerged as the least preferred source.
- Despite such high public acceptance, media narratives fail to gain an advantage over it to communicate the energy transition as a social transformation involving everyone. Media coverage focuses more on technical, economic, and policy implementation issues-- mainly sourced from government and industry--and rarely touches justice and community impacts of the energy transition. To create a more balanced and impactful discourse, Indonesia's energy transition communication strategy needs to diversify its messengers and reframe its narrative.

Technology Advancement

Renewables and Storage

- Indonesia should focus on commercially proven renewable technologies—such as solar, battery storage, and wind rather than high-risk and unproven options like ammonia co-firing and carbon capture. With falling technology costs, 333 GW of commercial-ready solar, wind, and micro hydro projects nationwide, and total potential capacity of highly profitable projects (EIRR >10%) over 170 GW for solar and wind energy combined, adopting renewables could cut PLN's operational expenses per electricity produced and accelerate Indonesia's clean energy transition.
- Managing the risks related to renewable technologies to accelerate decarbonization and maintaining global competitiveness is imperative. While the country's solar PV manufacturing capacity has expanded to 14.6 GWp for modules and 9.5 GW for cells as of September 2025, weak domestic demand, rising trade risks, and import duties favoring imported modules threaten long-term growth. Hence, diversifying export markets, boosting local solar deployment, and scaling production are a must.
- Battery industry is expanding with growing lithium-ion use and new gigafactories, but gaps in midstream production (materials processing to cell manufacturing) keep it reliant on imports. With dropping global battery prices, Indonesia can take advantages and grow its battery and energy storage (BES) industry by revamping restrictive regulations and scaling human resource capacity.

Low Emission Alternative Fuels and Biofuels

- Pushing biodiesel blending targets higher (from B35 to B45) for more emission reduction would require costly new refinery capacity and significantly more land areas for plantations due to low palm oil yields. Subsidy funds from palm oil export levies must instead be allocated for improving productivity of plantation to prevent excessive land areas expansion.
- Indonesia's effort to implement Sustainable Aviation Fuel (SAF) falls short albeit having enough production capacity to meet half of jet fuel needs. SAF's more costly prices and weak policy support are the reasons.
- Indonesia's current levelized cost of green hydrogen (LCOH), ranging from USD 3.86 to 13.2 per kg, remains uncompetitive without any incentive support. However, demand is projected to rise almost sevenfold to 11.7 Mt per year by 2060, highlighting strong potential for scaling up renewable electricity. Globally, production costs could fall to USD 1.5–2.0 per kg by 2050, driven by declining electrolyzer costs and increasingly affordable renewable energy.

Electric Vehicles and Mass Transportation

- Smart charging and Vehicle-to-Grid (V2G) technologies help stabilize the grid and cut costs. By managing when and how EVs charge, these systems could reduce up to 5.42 million tons of CO_2 and save around USD 1 billion per year by 2030. To realize these benefits, Indonesia must invest in smart charging infrastructure, supportive regulations, and pilot projects to test and scale the technology.
- Fast charging technology (350 kW) benefits short-haul electric heavy-duty vehicles (HDVs) because it is more cost-efficient (a payback period less than 12 years even for 30% utilization rate) compared to battery swap and slow charging. On the contrary, the battery swap mechanism is preferable for long haul HDV due to the flexibility it offers. Incentives can help solve non-homogenous battery packs currently available on the market.

Energy Efficiency in Industry and Buildings

- The levelized cost of heat (LCOH) for commercial-scale electric industrial heat pumps operating at an ambient temperature of 30ºC with temperature lifts of 15 to 45ºC is lower than coal, subsidized gas, or low-to-medium-priced biomass boilers. Although lower, import taxes, installation and maintenance cost, and operational reliability of the grid (possibility of needing diesel backups) could increase total costs.
- While piped gas and induction stoves are cleaner than biomass, kerosene, and other conventional fuels and cost cheaper than unsubsidized LPG annually, high upfront costs and infrastructure requirements slow their adoption.

Energy Transition at the Subnational Level

- Subnational energy transition ambitions remain constrained by centralized planning, limited fiscal instruments, and a weak political mandate to act at scale. In 2025, 33 of 38 provinces allocated a total of IDR 426.7 billion for renewable energy, a marginal number compared to the total provincial government budget. The 2026 budget allocation could be lower because of the reduction of central-to-regional transfer funds.
- Bali, East Kalimantan, and Jakarta illustrate this uneven progress. In 2025, Bali had achieved less than 3% of its 11.15% renewable energy target despite possessing over 21 GW of solar potential. East Kalimantan, Indonesia's coal stronghold, is on track to meet its 12.3% target, though mainly through nationally driven projects rather than a provincial shift from coal. Meanwhile, Jakarta's strong fiscal capacity has enabled rooftop solar installations to reach 34 MWp, already surpassing its 2025 target of 25 MWp through private, blended financing, and regional budget allocations.

Outlook and Way Forward

- IESR's modeling shows Indonesia's 2035 SNDC target is achievable mainly due to optimistic growth assumptions rather than real mitigation. With slower actual growth, emissions may fall below targets even without new efforts, signaling performative progress. Even with "Extra Effort" measures, 2060 emissions remain far above targets, as mitigation remains overly focused on the power sector while other sectors lag.
- Indonesia's fragmented governance and growth-oriented policies constrain emission reduction. IESR's modeling shows that increasing renewables to 77% of the energy mix could halve 2060 emissions to 619 $MtCO_2e$, proving increased renewable penetration in the primary energy mix can decouple growth from emissions, suggesting that the SNDC emission projection should be more ambitious.
- Indonesia must pair renewable growth with a clear fossil phase-out to achieve real decarbonization. IESR's modeling shows RE mix reach only 20.8% by 2030 without such measures. Achieving 77% by 2060 requires stronger institutional reform, transparent coal and oil retirement plans, and industrial policy shifts toward low-carbon "powershoring." Structural and governance reforms are essential to turn the net-zero pathway into a concrete, achievable strategy.

Ringkasan Eksekutif

Pendahuluan

- *Indonesia menyia-nyiakan peluang besar dari energi terbarukan (ET) untuk memenuhi komitmen keberlanjutannya, serta pertumbuhan dan kemandirian energi yang dicanangkan dalam Asta Cita, dengan terus melanjutkan subsidi bahan bakar, perencanaan yang tidak konsisten, koordinasi antarlembaga yang buruk, dan memilih opsi nuklir. Aspirasi Indonesia untuk mencapai pertumbuhan ekonomi tahunan sebesar 8% pada tahun 2029 berisiko menghasilkan emisi 17% lebih tinggi pada tahun 2040 dibandingkan dengan skenario pertumbuhan rendah karena ketergantungan yang berkelanjutan pada bahan bakar fosil. Dengan menipisnya sisa anggaran karbon untuk membatasi kenaikan suhu hingga 1,5°C sedini tahun 2040, hampir mustahil untuk memenuhi tanggung jawab negara dalam menjaga kenaikan suhu tersebut kecuali jika Indonesia segera memutus keterkaitan antara pertumbuhan ekonomi dan penggunaan energi fosil. Dengan hanya 9% dari anggaran ketahanan energi dialokasikan untuk pengembangan ET dalam kebijakan energi nasional terbaru, sementara potensi total energi terbarukan di seluruh negeri melebihi 3 TW, potensi ET yang besar masih belum dimanfaatkan.*

Sektor Ketenagalistrikan

- *IESR menilai kondisi transisi energi pada sektor ini berdasarkan derajat bauran energi terbarukan, kemajuan penghapusan bertahap bahan bakar fosil, dan keberadaan infrastruktur jaringan pendukung. Penggunaan bahan bakar fosil, yang menghasilkan emisi di atas 350 MtCO$_2$e pada tahun 2024, terus mendominasi sektor ketenagalistrikan Indonesia. Kapasitas pembangkit listrik berbahan bakar batu bara memiliki porsi terbesar dari total kapasitas terpasang (80 GW dari total 120 GW kapasitas seluruh pembangkit listrik, baik* on-grid *maupun* captive*). Emisi dari batu bara diperkirakan akan terus meningkat, seiring dengan kegagalan Peraturan MEMR No. 10/2025, yang merupakan landasan hukum untuk pensiun dini PLTU batu bara, dalam mendukung tindakan yang lebih konkret.*
- *Peningkatan permintaan listrik (10,3%, 3,4%, dan 6,3% CAGR dari 2020–2024 masing-masing untuk segmen tegangan tinggi, menengah, dan rendah) menuntut perluasan kapasitas pembangkit. Meskipun kemajuan teknologi memungkinkan pengurangan drastis waktu konstruksi PLTS dan tingkat penyebaran baterai utilitas yang cepat, energi terbarukan belum terintegrasi lebih jauh ke dalam rencana pasokan listrik. Porsinya dalam pembangkitan listrik on-grid turun menjadi hanya 11,5% pada tahun 2024. Sebaliknya, RUPTL PLN 2025–2034 merencanakan penambahan 16,6 GW kapasitas fosil, termasuk 1,4 GW proyek batu bara baru.*
- *Ambisi Presiden untuk mencapai 100% listrik terbarukan dalam satu dekade dan 100 GW tenaga surya pedesaan melalui program Koperasi Desa Merah Putih belum dimasukkan dalam perencanaan formal apa pun. IESR mendesak cara yang lebih konkret untuk mewujudkan ambisi tersebut mengingat hasil studi yang menjanjikan dari simulasi 100% sistem terbarukan di Timor dan Sumbawa pada tahun 2050 dari PLTS dan baterai. Sistem tersebut dapat menurunkan biaya pembangkitan sebesar 3% di Timor dan 21% di Sumbawa, bahkan di bawah kebijakan DMO.*

Sektor Industri

- *Emisi industri Indonesia hampir dua kali lipat selama dekade terakhir (lebih dari 480 MtCO$_2$e pada tahun 2024) akibat meningkatnya penggunaan batu bara, yang menyumbang 59% dari total permintaan energi sektor ini pada tahun yang sama. Publikasi ini menggunakan elektrifikasi, adopsi hidrogen dan bioenergi, adopsi efisiensi energi, dan implementasi manajemen energi sebagai parameter utama untuk melacak status transisi energi di sektor ini.*

- *Meskipun sudah diketahui bahwa 72% potensi pengurangan emisi berada dalam sektor semen, besi dan baja, serta pupuk, namun keterbatasan upaya dalam peralihan bahan bakar, peningkatan efisiensi energi dan material, serta perbaikan proses, ditambah dengan Sertifikat Industri Hijau (SIH) yang sudah ketinggalan zaman dan tidak adanya manajemen berbasis intensitas emisi, telah menghambat kemajuan dekarbonisasi sektor industri.*

Sektor Transportasi

- *Transportasi penumpang menyumbang 74% sementara transportasi barang menyumbang 26% sisanya dari total 180 $MtCO_2e$ emisi gas rumah kaca dari sektor transportasi Indonesia pada tahun 2024. IESR menggunakan elektrifikasi armada, efisiensi konsumsi bahan bakar, pergeseran moda (modal shift), dekarbonisasi pelayaran, dan adopsi bahan bakar penerbangan berkelanjutan sebagai parameter untuk mengukur kemajuan transisi energi sektor ini.*
- *Tingginya biaya Kendaraan Listrik Berbasis Baterai (KLBB/BEV) akibat kurangnya insentif, kebijakan peremajaan kendaraan yang lemah (batas usia, skema scrappage nasional), dan penempatan fasilitas pengisian daya yang tidak optimal memperlambat elektrifikasi armada. Sementara itu, standar rata-rata efisiensi konsumsi bahan bakar sebesar 6 Lge/100 km masih berada di atas target efisiensi konsumsi bahan bakar yang selaras dengan NZE untuk tahun 2024 (5,06 Lge/100 km), menunjukkan bahwa sebagian besar kendaraan tidak cukup efisien sehingga diperlukan perombakan standar. Meskipun dapat memangkas emisi secara signifikan, peralihan moda untuk transportasi penumpang (Buy the Service) dan transportasi barang (truk ke kereta api) hanya ada dalam skala kecil sehingga dampaknya minimal. Terakhir, dominasi berkelanjutan bahan bakar fosil dalam pelayaran dan penerbangan karena terbatasnya penerapan biodiesel untuk kapal dan terbatasnya produksi Bahan Bakar Penerbangan Berkelanjutan (SAF) semakin melemahkan upaya dekarbonisasi.*

Sektor Bangunan

- *Sektor bangunan mengonsumsi 17% dari konsumsi energi final Indonesia pada tahun 2024 melalui kegiatan rumah tangga (13%) dan komersial (4%) dan menghasilkan 4,2% dari total emisi pada tahun 2023. IESR melacak kondisi transisi energi sektor ini melalui elektrifikasi, Standar Kinerja Energi Minimum (SKEM/MEPS), adopsi manajemen energi, dan adopsi bangunan hijau.*
- *Preferensi yang terus berlanjut terhadap gas dan LPG untuk memasak (aktivitas yang mengkonsumsi energi terbesar di rumah tangga) telah melemahkan upaya elektrifikasi. Sementara itu, persetujuan pemerintah untuk tetap beredarnya pendingin ruangan dengan Cooling Seasonal Performance Factor (CSPF) yang sangat rendah memboroskan banyak energi dan membuktikan bahwa SKEM peralatan masih rendah. Terkait kewajiban melakukan manajemen energi, hanya 4,4% bangunan komersial yang wajib dan 1,2% bangunan pemerintah mematuhinya pada tahun 2024. Terakhir, jika tren adopsi bangunan gedung hijau saat ini diteruskan, hanya 6% dari target pengurangan emisi menurut peta jalan BGH akan tercapai pada tahun 2030. Padahal, itu sudah menggabungkan jumlah bangunan yang tersertifikasi swasta (sukarela) dan wajib (BGH). Jika hanya menghitung adopsi BGH saja, jumlahnya akan jauh lebih kecil lagi.*

Kerangka Kesiapan Transisi (Transition Readiness Framework)

- *Transisi energi Indonesia tetap lambat karena inkoherensi kebijakan, pembiayaan yang terbatas, dan kapasitas kelembagaan dan sumber daya manusia yang lemah. Meskipun komitmen kuat Presiden Prabowo terhadap target 100% energi terbarukan dan net-zero, kemajuan terkendala oleh dukungan fiskal yang tidak memadai dan tata kelola yang terfragmentasi. Memperkuat keselarasan kebijakan, pembiayaan, dan pengembangan tenaga kerja sangat penting untuk mempercepat transisi.*

Komitmen Politik dan Tata Kelola

- *Presiden Prabowo berulang kali menegaskan komitmen Indonesia terhadap Perjanjian Paris dan target nasional untuk mencapai emisi nol bersih melalui komitmen lisan, kelembagaan, dan anggaran. Beliau berjanji untuk menghentikan semua pembangkit listrik berbahan bakar fosil dalam 15 tahun dan mengembangkan 75 GW kapasitas energi terbarukan (ET). Pemerintah telah menjadi lebih proaktif sejak saat itu: menghasilkan tambahan 15% kapasitas pembangkit ET dari tahun 2024, dan Kebijakan Energi Nasional (KEN) yang lebih ambisius daripada pendahulunya.*
- *Namun, rancangan target bauran ET SNDC yang hanya 19%-23% pada tahun 2030, alokasi Anggaran Pendapatan dan Belanja Negara (APBN) yang menurun untuk ketahanan energi pada tahun 2026 (hanya IDR 37,5 triliun untuk pengembangan ET), puncak emisi sektor energi yang tertunda dari 2030 menjadi 2035–2038, peningkatan kompleksitas birokrasi karena kerangka regulasi berlapis-lapis, dan target moderat 36%-40% untuk energi baru dan terbarukan (EBT) pada tahun 2040 dalam KEN terbaru menunjukkan bahwa merealisasikan percepatan pertumbuhan ekonomi dan kemandirian energi Asta Cita melalui pengembangan terbarukan masih jauh dari harapan.*

Investasi dan Pembiayaan

- *Subsidi bahan bakar fosil, yang diproyeksikan mencapai total IDR 1.023 triliun antara tahun 2022 dan 2026, terus memperkuat ketergantungan Indonesia pada energi dari bahan bakar fosil. Sementara itu, alokasi anggaran untuk sub-sektor energi baru, terbarukan, dan konservasi energi tetap minimal dan menurun pada tahun 2024, menandakan rendahnya prioritas kebijakan, menurunkan kepercayaan investor, dan berkontribusi pada stagnasi pertumbuhan kapasitas terbarukan. Di sisi swasta, pembiayaan energi terbarukan naik 23% pada Kuartal I 2025 menjadi IDR 36 triliun di empat bank terbesar di Indonesia tetapi ini masih jauh di bawah IDR 267 triliun yang disalurkan ke pertambangan, yang mencerminkan dominasi berkelanjutan industri ekstraktif di tengah hambatan kebijakan dan pengadaan yang ada.*
- *Dukungan internasional, termasuk JETP, masih lambat. Hanya USD 1,2 miliar yang disetujui dari USD 20 miliar yang dijanjikan, yang hanya mendukung kapasitas 143 MW, karena terbatasnya proyek yang direncanakan. Untuk menarik lebih banyak modal internasional, Indonesia harus meningkatkan iklim investasinya melalui regulasi yang lebih jelas, kepastian kebijakan yang lebih kuat, dan portofolio proyek yang layak kredit. Sementara itu, pasar karbon Indonesia menunjukkan potensi tetapi masih belum berkembang. Total transaksi hanya mencapai USD 4,9 juta dan harga rata-rata USD 3,6 per ton, jauh di bawah patokan global USD 50–100, sehingga dampaknya terhadap pembiayaan transisi energi sangat minim.*

Partisipasi dan Penerimaan Publik

- *Secara keseluruhan, masyarakat Indonesia mendukung gagasan energi bersih tetapi kurang memiliki kepercayaan dan kesempatan untuk berpartisipasi, menyoroti perlunya kebijakan yang lebih jelas, komunikasi yang lebih baik, dan keterlibatan publik yang lebih kuat. Partisipasi publik masih bersifat prosedural alih-alih bermakna. Dua contoh utama adalah forum perencanaan pembangunan (musrenbang) dan forum konsultasi kebijakan energi yang sering didominasi oleh elit dan kurang memiliki pengaruh yang nyata ke komunitas. Sementara itu, proses penyusunan Second Nationally Determined Contribution (SNDC) mengadakan konsultasi publik tetapi tidak disertai pelaporan yang transparan mengenai tanggapan yang diberikan.*
- *Terkait penerimaan publik, survei daring terbaru tahun 2025 terhadap 1.000 responden di seluruh Indonesia mengungkapkan bahwa sebagian besar masyarakat Indonesia (91%) memandang perubahan iklim sebagai sesuatu yang mendesak, dan 86% menyadari transisi energi. Masyarakat*

memandang opsi energi terbarukan seperti tenaga surya, angin, dan air sebagai sumber yang mudah diakses dan tidak kontroversial, sementara energi nuklir muncul sebagai sumber energi yang paling tidak disukai.

- *Meskipun penerimaan publik tinggi, narasi media gagal memanfaatkannya untuk mengomunikasikan transisi energi sebagai transformasi sosial yang melibatkan semua orang. Liputan media lebih berfokus pada isu teknis, ekonomi, dan implementasi kebijakan, terutama bersumber dari pemerintah dan industri, dan jarang menyentuh keadilan dan dampak komunitas dari transisi energi. Untuk menciptakan wacana yang lebih seimbang dan berdampak, strategi komunikasi transisi energi Indonesia perlu mendiversifikasi penyampainya dan membingkai ulang narasinya.*

Kemajuan Teknologi

Energi Terbarukan dan Penyimpanan

- *Indonesia sebaiknya berfokus pada teknologi terbarukan yang telah terbukti secara komersial—seperti tenaga surya, penyimpanan baterai, dan angin—alih-alih opsi berisiko tinggi dan belum terbukti seperti amonia co-firing dan penangkapan karbon. Dengan biaya teknologi yang menurun, 333 GW proyek tenaga surya, angin, dan mikrohidro yang siap secara komersial di seluruh negeri, dan total potensi kapasitas proyek yang sangat menguntungkan (EIRR >10%) lebih dari 170 GW untuk energi surya dan angin, adopsi energi terbarukan dapat memangkas biaya operasional PLN per unit listrik yang dihasilkan dan mempercepat transisi energi bersih Indonesia.*
- *Mengelola risiko terkait teknologi terbarukan untuk mempercepat dekarbonisasi dan mempertahankan daya saing global sangatlah penting. Meskipun kapasitas produksi panel surya nasional telah meningkat menjadi 14,6 GWp untuk modul dan 9,5 GW untuk sel surya per September 2025, permintaan domestik yang lemah, meningkatnya risiko perdagangan, dan bea masuk yang menguntungkan modul impor mengancam pertumbuhan jangka panjang. Oleh karena itu, diversifikasi pasar ekspor, peningkatan penggunaan panel surya lokal, dan peningkatan skala produksi sangatlah penting.*
- *Industri baterai sedang berkembang pesat seiring meningkatnya penggunaan litium-ion dan pembangunan fasilitas produksi skala besar baru, tetapi kesenjangan dalam produksi midstream (dari pemrosesan material hingga manufaktur sel) membuatnya bergantung pada impor. Dengan turunnya harga baterai global, Indonesia dapat memanfaatkannya dan mengembangkan industri baterai dan penyimpanan energi (BES) dengan merombak regulasi yang membatasi dan meningkatkan kapasitas sumber daya manusia.*

Bahan Bakar Alternatif Rendah Emisi dan Biofuel

- *Mendorong target pencampuran biodiesel lebih tinggi (dari B35 ke B45) untuk pengurangan emisi yang lebih besar akan membutuhkan kapasitas kilang baru yang mahal dan lahan perkebunan yang jauh lebih luas karena rendahnya hasil panen minyak sawit. Dana subsidi dari pungutan ekspor minyak sawit harus dialokasikan untuk meningkatkan produktivitas perkebunan guna mencegah perluasan lahan yang berlebihan.*
- *Upaya Indonesia untuk mengimplementasikan Bahan Bakar Penerbangan Berkelanjutan (SAF) kurang berhasil meskipun memiliki kapasitas produksi yang cukup untuk memenuhi setengah dari kebutuhan bahan bakar jet. Harga SAF yang lebih mahal dan dukungan kebijakan yang lemah adalah alasannya.*
- *Biaya rata-rata hidrogen hijau (LCOH) Indonesia saat ini masih belum kompetitif (berkisar antara USD 3,86 hingga USD 13,2 per kg) karena*

tiadanya insentif. Namun, permintaan diproyeksikan meningkat hampir tujuh kali lipat menjadi 11,7 juta ton per tahun pada tahun 2060, yang menunjukkan potensi kuat untuk meningkatkan skala listrik terbarukan. Di lingkup global, biaya produksi dapat turun menjadi USD 1,5–2,0 per kg pada tahun 2050, didorong oleh penurunan biaya elektroliser dan semakin terjangkaunya energi terbarukan.

Kendaraan Listrik dan Transportasi Massal

- *Teknologi pengisian daya pintar (*smart charging*) dan* Vehicle-to-Grid *(V2G) membantu menstabilkan jaringan listrik dan memangkas biaya. Dengan mengelola kapan dan bagaimana kendaraan listrik (EV) mengisi daya, sistem ini dapat mengurangi hingga 5,42 juta ton CO2 dan menghemat sekitar USD 1 miliar per tahun pada tahun 2030. Untuk mewujudkan manfaat ini, Indonesia harus berinvestasi pada infrastruktur pengisian daya cerdas, regulasi pendukung, dan proyek percontohan untuk menguji dan meningkatkan teknologi.*
- *Teknologi pengisian daya cepat (350 kW) menguntungkan kendaraan berat listrik (HDV) jarak pendek karena lebih hemat biaya (periode pengembalian modal kurang dari 12 tahun bahkan untuk tingkat pemanfaatan yang hanya 30%) dibandingkan dengan pertukaran baterai dan pengisian daya lambat. Sebaliknya, mekanisme pertukaran baterai lebih disukai untuk HDV jarak jauh karena fleksibilitas yang ditawarkannya. Insentif dapat membantu mengatasi* battery pack *non-homogen yang saat ini tersedia di pasar.*

Efisiensi Energi dalam Industri dan Bangunan

- *Levelised Cost of Heat (LCOH) untuk pompa panas industri listrik skala komersial yang beroperasi pada suhu sekitar 30°C dengan kenaikan suhu 15 hingga 45°C lebih rendah daripada boiler berbahan bakar batu bara, gas bersubsidi, atau biomassa dengan harga rendah hingga menengah. Meskipun lebih rendah, pajak impor, biaya pemasangan dan pemeliharaan, serta keandalan operasional jaringan (kemungkinan perlunya mesin diesel cadangan) dapat meningkatkan total biaya.*
- *Meskipun gas pipa dan kompor induksi lebih bersih daripada biomassa, minyak tanah, dan bahan bakar konvensional lainnya dan biayanya lebih murah daripada LPG tanpa subsidi setiap tahun, biaya awal yang tinggi dan persyaratan infrastruktur memperlambat adopsi mereka.*

Transisi Energi di Tingkat Sub-Nasional

- *Ambisi transisi energi subnasional masih terkendala oleh perencanaan terpusat, instrumen fiskal yang terbatas, dan mandat politik yang lemah untuk bertindak secara luas. Pada tahun 2025, 33 dari 38 provinsi mengalokasikan total Rp426,7 miliar untuk energi terbarukan, jumlah yang sangat kecil dibandingkan dengan total anggaran pemerintah provinsi. Alokasi anggaran tahun 2026 kemungkinan lebih rendah karena berkurangnya dana transfer pusat ke daerah.*
- *Bali, Kalimantan Timur, dan Jakarta menunjukkan kemajuan yang tidak merata ini. Pada tahun 2025, Bali baru mencapai kurang dari 3% dari target energi terbarukan sebesar 11,15% meskipun memiliki potensi surya lebih dari 21 GW. Kalimantan Timur, basis utama batu bara Indonesia, berada di jalur yang tepat untuk mencapai target 12,3%, meskipun sebagian besar melalui proyek-proyek nasional, alih-alih peralihan secara sadar dari batu bara. Sementara itu, kapasitas fiskal Jakarta yang kuat telah memungkinkan pemasangan panel surya atap mencapai 34 MWp, yang telah melampaui target tahun 2025 sebesar 25 MWp melalui pembiayaan swasta, pembiayaan campuran, dan alokasi anggaran daerah.*

Prospek dan Arah ke Depan

- *Pemodelan IESR menunjukkan target SNDC Indonesia tahun 2035 dapat tercapai terutama karena asumsi pertumbuhan yang optimis daripada aksi mitigasi nyata. Dengan pertumbuhan aktual yang lebih lambat, emisi mungkin turun di bawah target bahkan tanpa upaya baru, menandakan kemajuan yang bersifat performatif. Bahkan dengan langkah-langkah "*Extra Effort*", emisi tahun 2060 tetap jauh di atas target, karena mitigasi masih terlalu berfokus pada sektor ketenagalistrikan sementara sektor lain tertinggal.*
- *Tata kelola Indonesia yang terfragmentasi dan kebijakan yang berorientasi pada pertumbuhan menghambat pengurangan emisi. Pemodelan IESR menunjukkan bahwa peningkatan energi terbarukan hingga 77% dari bauran energi dapat mengurangi separuh emisi tahun 2060 menjadi 619 $MtCO_2e$. Hal ini membuktikan bahwa peningkatan penetrasi energi terbarukan dalam bauran energi primer dapat memisahkan pertumbuhan dari emisi, yang menunjukkan bahwa proyeksi emisi SNDC seharusnya lebih ambisius.*
- *Indonesia harus memadukan pertumbuhan energi terbarukan dengan penghapusan bahan bakar fosil yang jelas untuk mencapai dekarbonisasi yang nyata. Pemodelan IESR menunjukkan bauran energi terbarukan hanya mencapai 20,8% pada tahun 2030 tanpa langkah-langkah tersebut. Untuk mencapai bauran 77% pada tahun 2060, dibutuhkan reformasi kelembagaan yang lebih kuat, rencana pensiun batu bara dan minyak yang transparan, serta pergeseran kebijakan industri menuju "*powershoring*" rendah karbon. Reformasi struktural dan tata kelola sangat penting untuk mengubah jalur net-zero menjadi strategi yang konkret dan dapat dicapai.*

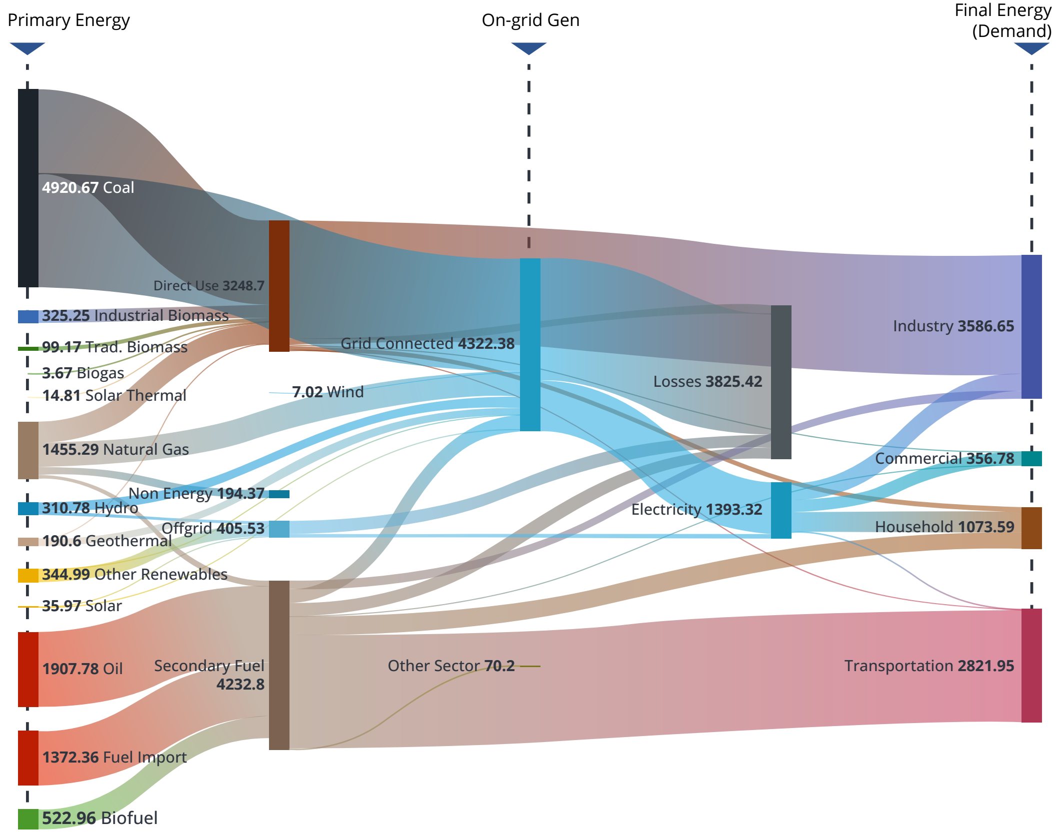
Chapter 1: Introduction

Abraham Octama Halim and Pintoko Aji

Indonesia's fossil-fueled energy system demands a decisive and radical departure from coal and oil to reach its climate and energy independence goals

- Indonesia's total primary energy supply reached 12,289 PJ in 2024, with coal and oil still forming the backbone of the energy system. Coal contributes around 40.4% of total primary energy, both directly and through coal-fired power generation, while oil products meet about 39.3% of final energy demand, primarily in the transport sector (90.6%).
- This heavy reliance on coal and oil defines Indonesia's high-emission structure and reveals the deep carbon lock-in embedded in its economy. Transitioning away from this fossil dominance is not merely a matter of replacing fuels but requires a structural shift toward a low-carbon, efficient, and resilient energy system.
- On the other side, the government's reported 14.68% share of new and renewable energy does not necessarily reflect the actual portion of renewables powering Indonesia's energy system. The figure arises from methodological differences using (partial energy content) assumed conversion efficiencies for non-combustible sources (such as solar, wind, hydro) and input-based calculations rather than direct energy use. This approach inflates the share numerically, creating an impression of progress that may obscure the continued expansion of fossil fuels in Indonesia's energy system.

Indonesia Energy Balance, 2024

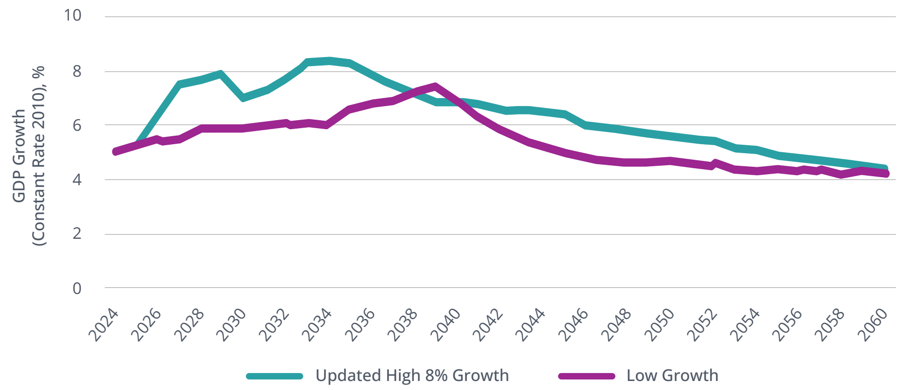


Source: Adapted from HEESI (MEMR 2025), unit in PJ

- Fuel imports, accounting for 21% of primary energy, further complicate Indonesia's pursuit of energy independence, which is one of the President's Asta Cita priorities. Dependence on imported fuels heightens vulnerability to global price fluctuations and places additional fiscal pressure on the state, particularly across industry, transport, and household sectors.

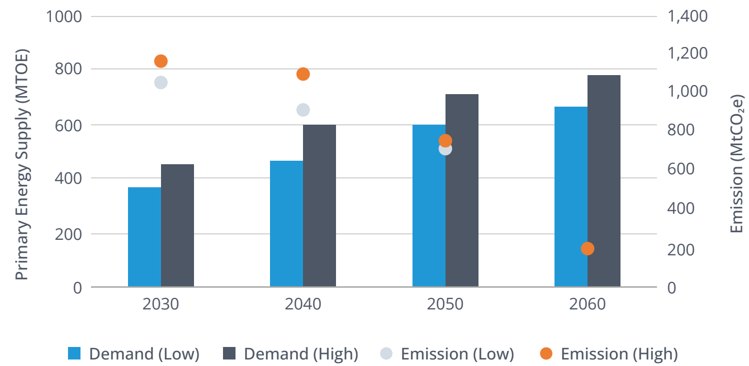
Indonesia's drive for rapid growth enhances economic prospects but risks higher emissions due to increased energy demand

Economic Growth Assumption in KEN 2025



Source: DEN, 2025

KEN Energy Demand and Emission Projection

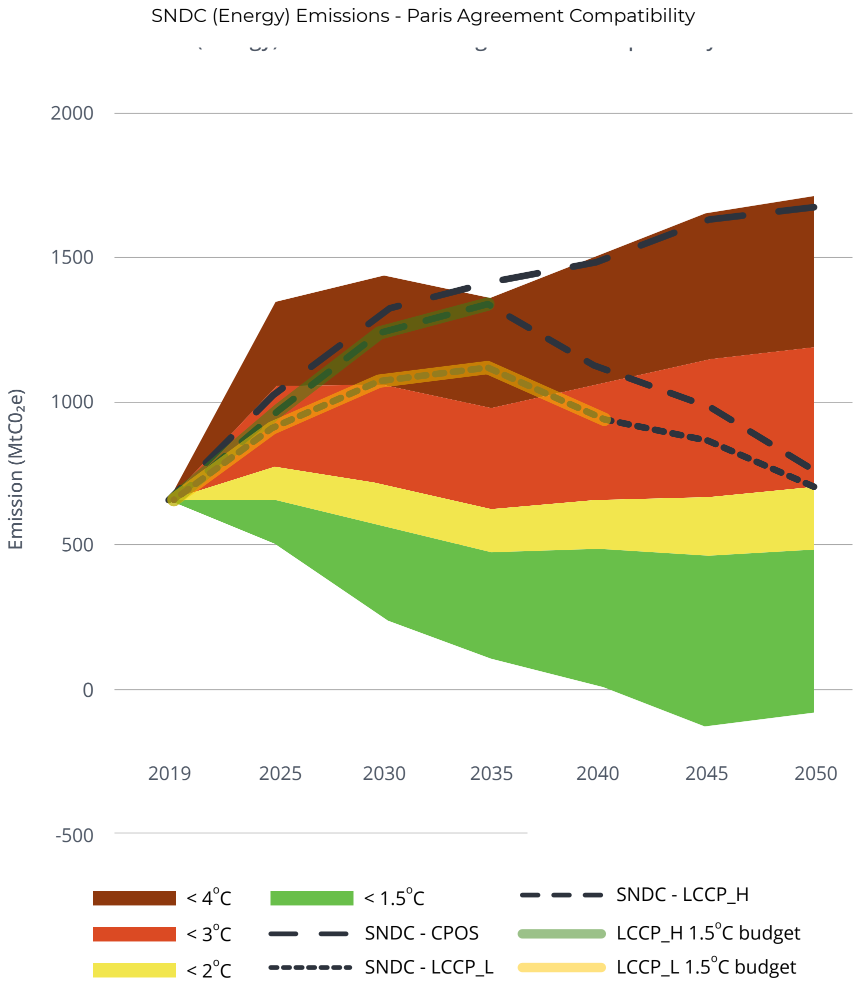


Source: KEN 2025

- The National Long-Term Development Plan (RPJPN) 2025-2045 outlines the vision of Golden Indonesia 2045, which aims to raise Indonesia's per capita income to developed-country levels, strengthen global leadership, enhance human resource competitiveness, and reduce poverty, inequality, and greenhouse gas (GHG) emission intensity to reach net zero.
- As the first phase of this long-term vision and a reflection of the current president's ambitions, the National Medium-Term Development Plan (RPJMN) 2025-2029 targets 8% annual economic growth by 2029, with industrial downstreaming as one of the main priorities.
- This strategy is expected to increase energy demand due to higher electricity consumption per capita and greater demand from energy-intensive industries such as nickel and aluminum processing. To date, these industries still heavily rely on fossil fuels, for both electricity and industrial processes.
- In the Golden Indonesia 2045 vision, the energy sector is expected to deliver decarbonization, energy independence, and support for high economic growth. The National Energy Policy (KEN) 2025 models two energy demand scenarios based on different growth assumptions, with only the high-growth scenario achieving the 8% economic growth target by 2029.
- Both KEN scenarios project emissions to peak in 2035. However, the high-growth scenario leads to higher emissions due to increased energy demand, with the greatest difference occurring in 2040 with 27% higher demand and 17% higher emissions than in the low-growth case. Pursuing higher growth, therefore, carries the risk of increasing cumulative emissions and eroding Indonesia's carbon budget, making alignment with the 1.5°C target more difficult.

Indonesia risks exceeding its carbon budget before 2050 unless emissions decline far earlier than current plans

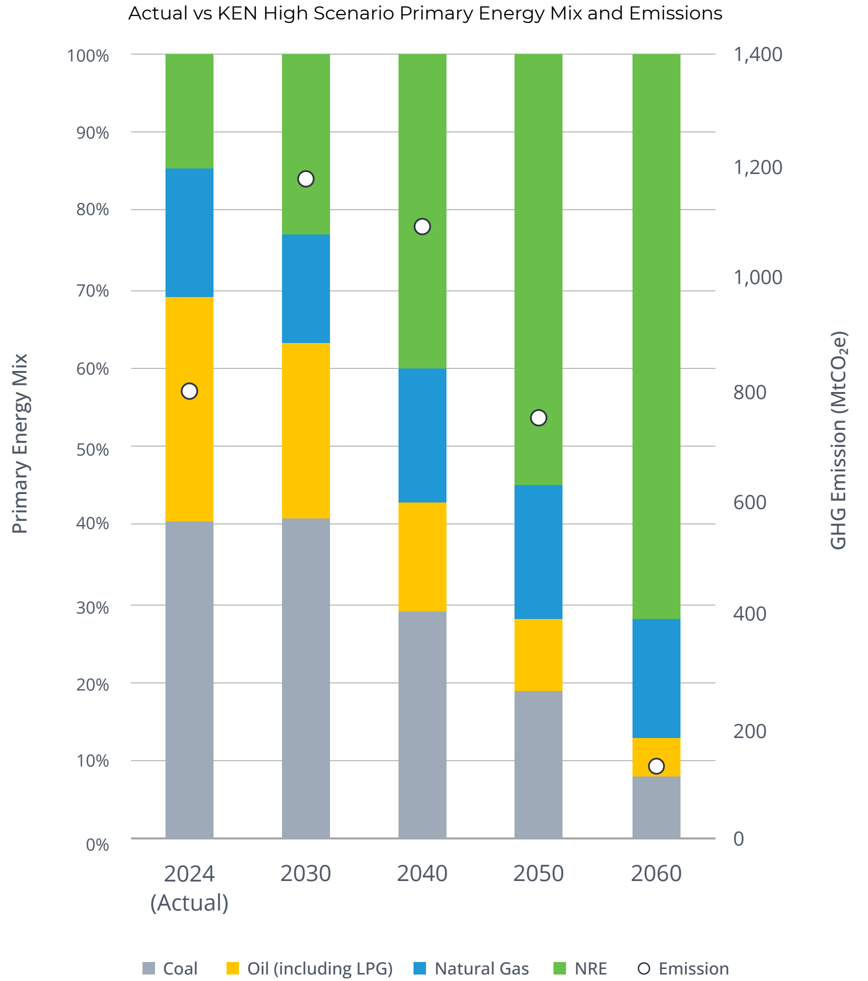
- Cumulative emissions are crucial when viewed in the context of the carbon budget. Achieving net-zero emission (NZE) by 2060 is not enough; the pathway taken to reach it is equally, if not more, important. The climate responds not to when NZE is achieved, but to the total amount of carbon emitted over time. Indonesia therefore needs to carefully consider the climate impacts of higher cumulative emissions, even if the net-zero target is met by 2060.
- Using the Climate Action Tracker fair-share framework and considering non-energy emissions based on the Long-Term Strategy for Low Carbon and Climate Resilience 2050 (LTS-LCCR 2050), the estimated remaining carbon budget for Indonesia's energy sector is about 21.2-22.8 billion tCO_2e for a 1.5°C pathway and 28.5-30 billion tCO_2e for a 2°C pathway.
- Using the energy emissions projection in the latest SNDC, Indonesia's 1.5°C carbon budget would be depleted around 2038-2042 (18-22 years before NZE in 2060), while the 2°C budget would last only until around 2044-2051. This indicates that the country's existing energy and economic pathways, if unaltered, will exceed the planetary limits within the next two decades. Realigning the KEN 2025 targets and the Second Nationally Determined Contribution (SNDC) toward a truly Paris-aligned commitment is more urgent than ever.
- In practical terms, the 1.5°C-aligned pathway reminds us that emissions reduction efforts must begin immediately. Every additional economic activity, whether in industry, households, transport, or power generation must progressively phase out fossil fuels. Climate change itself does not directly force us to stop growing our economy; rather, it reminds us that if we choose to continue, decoupling growth from carbon is non-negotiable.



Source: Adapted from CAT & SNDC 2025

Balancing Indonesia's economic ambitions with decarbonization and energy resilience goals remains a persistent policy challenge

- The higher emissions projected under the KEN 2025 high-growth scenario show that Indonesia's energy planning still struggles to decouple economic growth from emissions, even though this could be achieved through energy efficiency measures and low-carbon solutions, particularly renewable energy. Expanding renewables would allow Indonesia to meet rising energy demand while advancing decarbonization and energy resilience, the other key goals of the energy sector.
- KEN projects emissions to fall to 129 $MtCO_2e$ by 2060, with the forestry and land-use (FOLU) sector expected to offset the remainder. However, depending on FOLU for carbon absorption poses risks and requires strong cross-sector coordination.
- The KEN identifies diversifying energy sources and maximizing domestic resources as paths to energy resilience. Renewable energy must play a central role, considering Indonesia's abundant resources, but actual progress remains slow. Renewables contributed only 14.65% of the national primary energy mix in 2024, prompting the new KEN to postpone the 23% RE mix target from 2025 (as stated in the previous KEN) to 2030.
- Although the high-growth scenario increases renewable deployment, it remains insufficient for deep emission reductions. Fossil fuels are projected to remain dominant through 2060, perpetuating high subsidies and weakening energy independence. The same moderate stance appears in the SNDC, which includes "clean coal technology" and natural gas as mitigation measures, signaling continued reliance on fossil energy.
- As a result, while the Golden Indonesia 2045 vision aspires to integrate economic growth, decarbonization, and energy independence, current policy continues prioritizing short-term economic expansion at the expense of long-term decarbonization goals.

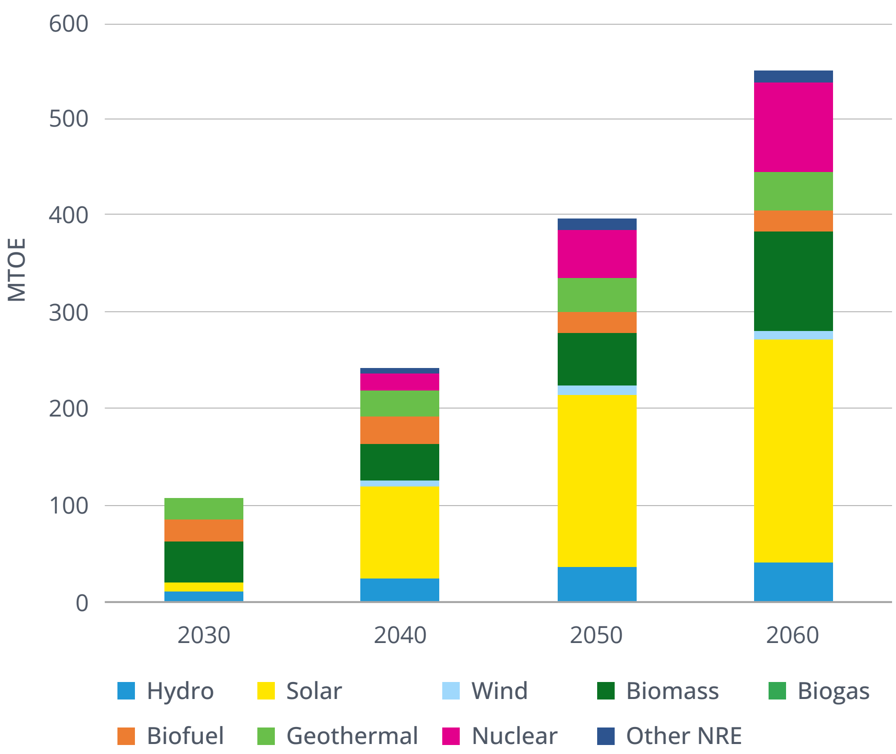


Source: IESR analysis from HEESI 2024 and KEN 2025

KEN 2025 introduces a major pivot toward nuclear energy, setting a new precedent that sidelines Indonesia's abundant renewable potential

- Another notable shift in the KEN 2025 update is the increased role of nuclear energy in Indonesia's primary energy projection. In the high-growth scenario, nuclear is projected to contribute 0.5% of primary energy by 2030, rising to 12% (94 MTOE) by 2060, making it the third-largest NRE source after solar PV and biomass. This marks a sharp change from the previous KEN, where nuclear was considered a "last option" with renewable energy sources being prioritized.
- The KEN 2025 document does not provide a clear rationale for this shift. As the overarching framework for national energy planning, KEN's direction sets a precedent: both the RUKN 2025-2060 and RUPTL PLN 2025-2034 now include nuclear prominently, despite no major change in modeling assumptions apart from economic growth. When asked, PLN and the Directorate General of Electricity cited the need for alignment with KEN.
- This shift favoring nuclear over renewables occurs despite Indonesia's vast untapped RE potential. IESR's analysis identifies approximately 333 GW of economically viable solar, wind, and micro-to-mini hydro capacity across more than 530 locations, while the MEMR estimates the country's total RE technical potential to exceed 3 TW.
- While nuclear may be favored for its dispatchability and inertia, it carries significant uncertainties given the absence of domestic experience and proven technological readiness. Indonesia would be better served by accelerating renewable development and exploring grid-balancing solutions, such as grid-forming inverters and stable renewable sources like hydropower and geothermal, to address system reliability concerns.

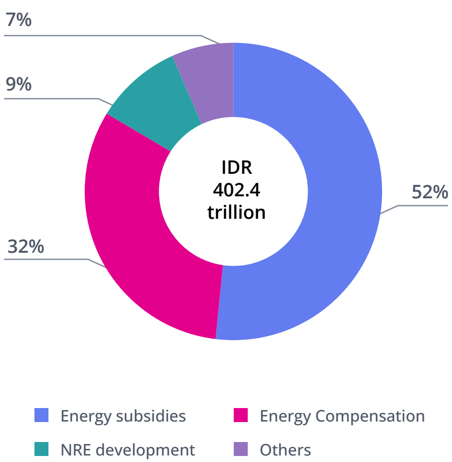
NRE in KEN Primary Energy Projection, High Scenario



Source: KEN 2025

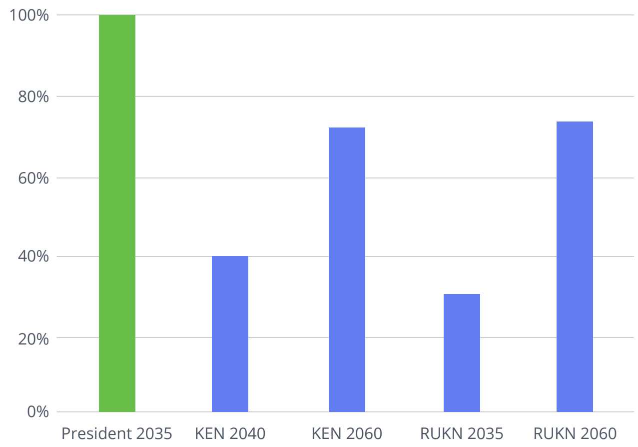
Despite strong rhetoric, Indonesia's energy transition progress remains constrained by subsidies, weak planning, and limited coordination

2026 Energy Security Budget Allocation



Source: MoF, 2025, CNBC Indonesia 2025

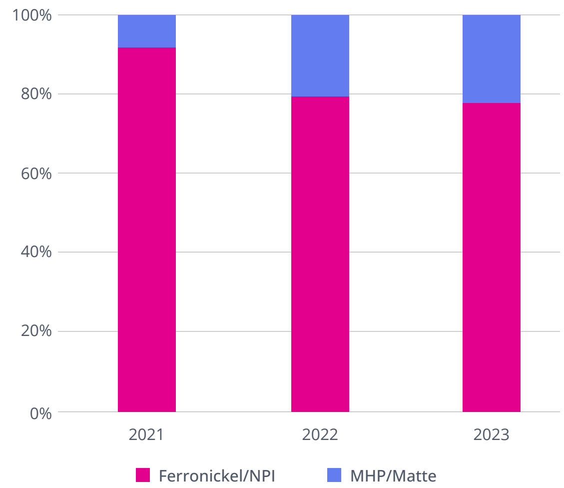
NRE Mix Target Comparison



Note: in KEN, the NRE share is in primary energy supply, while in RUKN, it is in electricity generation.

Source: IESR analysis from KEN 2025, RUKN 2025-2060

Indonesia Nickel Product Output Share



Source: APNI, 2024

- Despite frequent statements about balancing economic growth and decarbonization, actual implementation shows a clear disconnect from the rhetoric. The 2026 energy security budget still directs most spending to subsidies and compensation, while only 9% goes to renewable development. Ambitious claims of achieving 100% renewable energy within the next decade are not supported by planning documents, with the KEN and RUKN falling well short of that goal. Downstreaming, especially in nickel, is claimed as part of the green industrial agenda to maximize opportunities in EV battery manufacturing, yet production remains dominated by ferronickel and NPI for stainless steel rather than battery-grade materials. The expansion of captive CFPPs to power these industries further undermines the decarbonization narrative pushed by the President.
- Amid these conflicting priorities, weak coordination, and limited transparency, it is increasingly difficult to gauge Indonesia's real progress in the energy transition. The Indonesia Energy Transition Outlook (IETO) 2026 seeks to clarify this picture by evaluating the alignment between economic ambitions and energy transition commitments. It tracks progress across energy subsectors, reviews enabling conditions, and highlights emerging subnational initiatives, aiming to present a clear view of Indonesia's transition landscape and practical recommendations for policymakers, industry, and civil society.

Chapter 2:
Energy System Transition Indicators by Sectors

Contents

2.1. Progress in the Power Sector

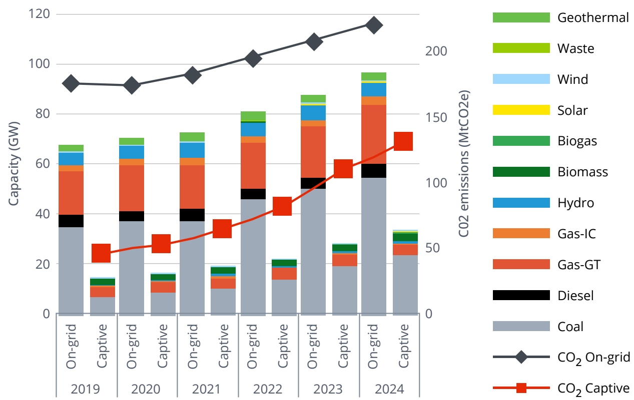
Abraham Octama Halim, Alvin Putra Sisdwinugraha, and Dwi Cahya Agung Saputra

Energy Transition Indicators:

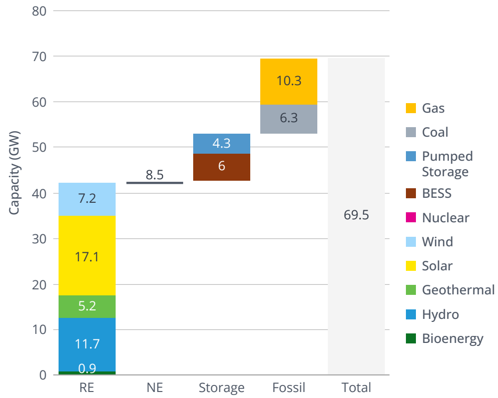
- Increasing Renewable Energy Mix
- Fossil Fuel Phase-Out
- Supportive Grid Infrastructure

Indonesia's power sector remains heavily reliant on coal, with emissions continuing to rise as future plans prioritize fossil fuels and "new energy" over renewables

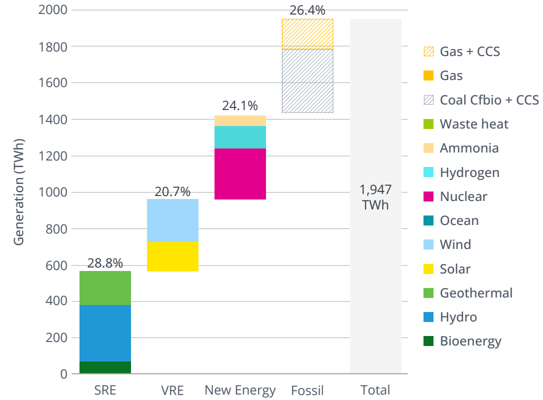
Indonesia power plant installed capacity and CO_2 emissions



RUPTL 2025-2034 Capacity Addition, ARED Scenario



RUKN 2060 Generation Mix



Note: Does not include 3 GW rooftop solar quota, includes hybrid CFPP

Source: IESR analysis from public data on-grid and captive power plants

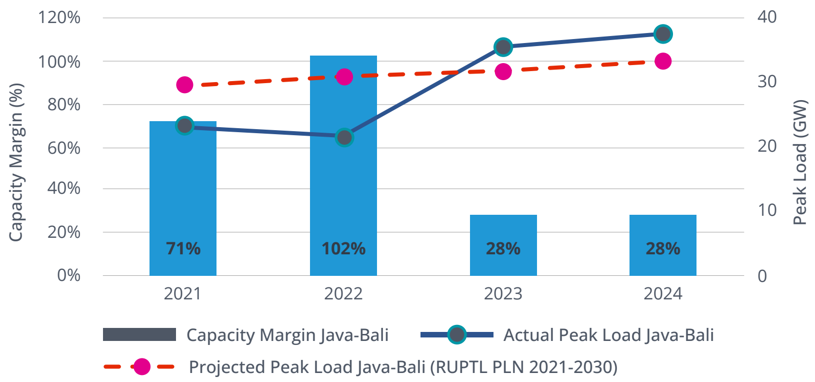
Source: RUPTL 2025-2034 (PLN. 2025a)

Source: RUKN 2025-2060 (MEMR. 2025b)

- Indonesia's power sector remains dominated by fossil fuels, particularly coal, which continues to drive both capacity expansion and rising GHG emissions. Based on IESR calculations, emissions reached 352.63 $MtCO_2e$ in 2024, with on-grid and captive sources growing at CAGR of 3.9% and 19.1%, respectively, between 2019 and 2024. Much of this increase, particularly in the captive sector, stems from coal-based power supporting downstream industrialization (Tanahair, 2025).
- GHG emissions are projected to rise further over the next decade as PLN's RUPTL 2025-2034 still includes the addition of fossil-fuel power plant. While 42.1 GW of renewables are planned, 16.6 GW of fossil-based capacity will also be added, including 1.4 GW of new coal projects, even though Presidential Regulation No. 11/2022 prohibits the construction of new on-grid coal plants. These projects are described as mine-mouth CFPPs and renewable hybrids, but their compliance with the regulation remains uncertain.
- In the RUKN 2025-2060, achieving net zero emissions (NZE) by 2060 is presented as theoretically possible, yet more than half of the 2060 electricity mix still depends on "new energy" (nuclear, hydrogen, and ammonia) along with fossil-fuel plants equipped with carbon capture and storage (CCS). These technologies are favored for their dispatchability and ability to provide system inertia, but they carry significant uncertainties. Nuclear has no operational track record in Indonesia, and CCS projects worldwide have so far delivered limited results, with no large-scale example proving commercially viable at the scale required for deep decarbonization (S&P Global, 2025).

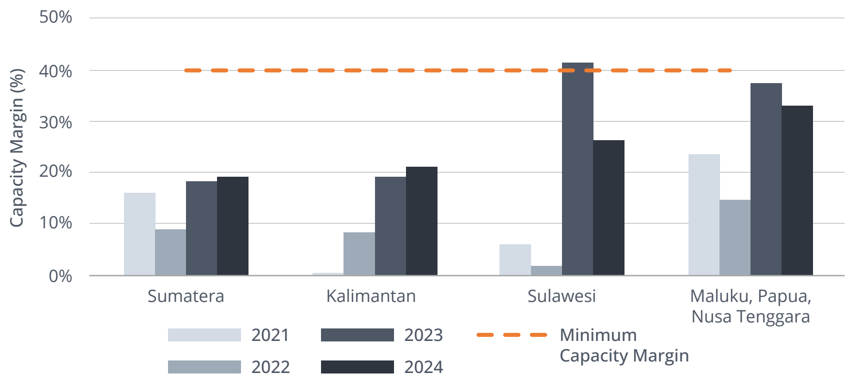
Capacity expansion using renewables and storages offers a more scalable and faster alternative to address rising electricity demand

Peak Load and Capacity Margin of Java-Madura-Bali Power System, 2021-2024



Source: IESR analysis from PLN Statistics 2021-2024

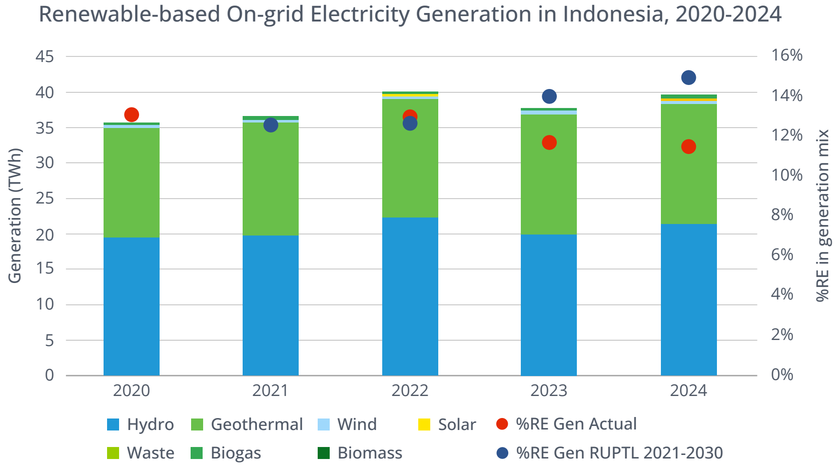
Capacity Margin of Indonesia's Power System by Region, 2021-2024



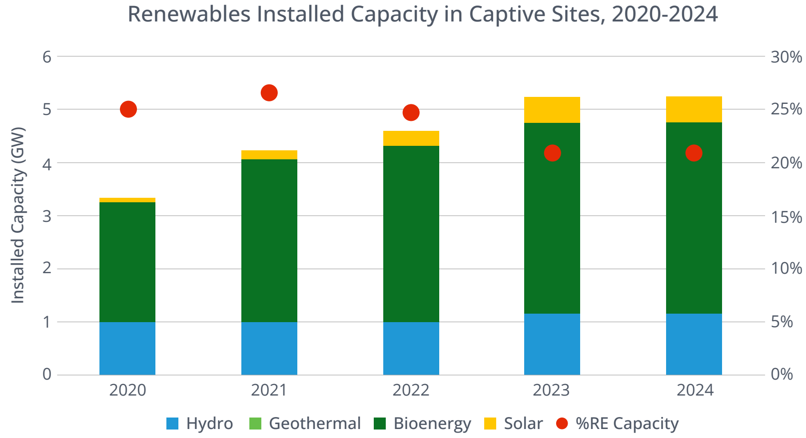
Source: IESR analysis from PLN Statistics 2021-2024

- To ensure system adequacy, PLN applies a static minimum reserve margin of 35% for the Java-Madura-Bali (Jamali) system and 40% for other regions. In previous years, capacity expansion far exceeded these thresholds, reaching 102% in 2022 due to overestimated demand. PLN has often cited this as a reason to delay adding new capacity, including renewables.
- However, as peak load in the Jamali system has rebounded after COVID-19, the reserve margin has fallen below 30%. Over the past two years, peak demand has increased by 32% annually, while net power capacity has grown by only 5%. With demand expected to continue rising, overcapacity is no longer a valid barrier to RE project development in the Jamali system.
- Outside Java-Bali, many systems are also experiencing capacity shortfalls. In 2024, Sumatra's reserve margin stands at 19%, while Kalimantan and Sulawesi are at 21% and 26%, respectively. Expanding power capacity is now critical to maintaining supply security and reliability.
- Solar and wind, combined with energy storage, enable faster capacity additions than fossil-fuel plants due to their shorter development timelines and modular characteristics. The construction time for solar power plants has decreased by nearly 75% over the past seven years (IESR, 2024), while utility battery storage has shown rapid deployment rate worldwide (Rayner, 2025). This speed allows the power system to adapt quickly to rising demand and policy targets while avoiding delays and stranded-asset risks associated by fossil power plants.

Renewable energy growth is stalling due to weak procurement frameworks, unclear regulations, and high investment risks



Source: IESR analysis from HEESI 2024 (MEMR.2025a) and RUPTL 2021-2030



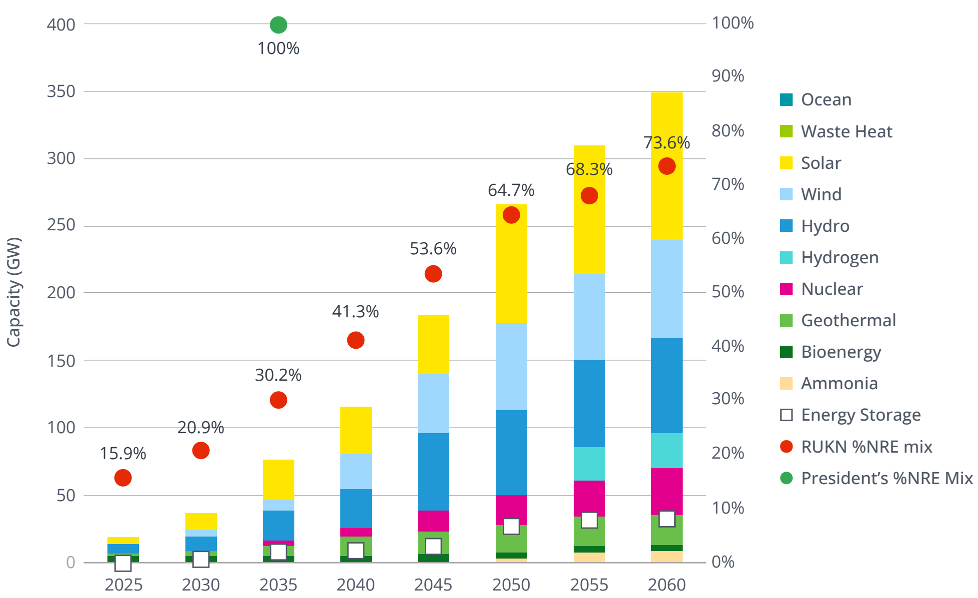
Source: IESR analysis from RUKN 2025-2060 Appendix A.2. (MEMR, 2025b)

- Instead of showing progress, the share of renewable energy in Indonesia's on-grid power generation mix has actually declined, from 13.1% in 2020 to 11.5% in 2024. This trajectory falls short of the "Optimal Scenario" outlined in the RUPTL 2021-2030, which projected a 15% RE share in the generation mix by 2024.
- The gap between resource potential, system planning, and actual deployment highlights persistent challenges in turning policy ambition into projects. PLN taken initial steps to increase RE procurement volume through the 250 MW Mentari Java solar PV project (Petromindo, 2025). However, auction schedules remain inconsistent, eligibility criteria are unclear, and developers face higher risks as they must manage three separate sites.
- In the captive power sector, renewables accounted for only 20.9% of installed capacity in 2024, a decline from 26.6% in 2021. Industries continue to rely primarily on captive CFPPs to meet their electricity demand, as Presidential Regulation No. 112/2022 excludes captive plants from the ban on new CFPPs.
- Among renewable options, captive owners tend to favor hydropower and bioenergy. Biomass is particularly preferred for its co-firing and baseload capability, as well as the use of readily available residues for fuel.
- Other RE options are constrained by limited on-site resources, and while owners recognize RE as beneficial for competitiveness, they remain cautious when adoption requires costly long-distance transmission to access RE-rich sites.

Pursuing 100% renewable electricity supports Indonesia's goals for energy security and economic competitiveness, but is not yet reflected in the current national electricity plan

- The expansion of new and renewable energy is central to Indonesia's RUKN 2025-2060 pathway to achieving NZE, with its share in the generation mix projected to rise from 15.9% in 2025 to 73.6% in 2060.
- Recent presidential statements have set even higher ambitions, including 100% renewable electricity within the next decade (Tempo, 2025) and 100 GW of rural solar power under the Koperasi Desa Merah Putih program (CNBC Indonesia, 2025), which nearly matches the RUKN's 2060 solar target (109 GW).
- These ambitions align with the President's vision of national energy independence, which seeks to reduce reliance on imported fossil fuels and strengthen domestic energy security. Achieving these goals would mark a major shift from the current dependence on coal and oil that continues to undermines this vision. However, the 100% RE target has yet to be integrated into long-term planning documents such as the RUKN, which remain far from this goal.

RUKN 2025-2060 NRE Installed Capacity and Generation Mix Projection



Source: RUKN 2025-2060 (MEMR.2025b) and Tempo (2025)

- The urgency for this transition is increasing. As long as the domestic price obligation (DPO) policy remains in place, electricity from fossil fuels, particularly coal, will remain artificially cheap compared to market prices. Because tariffs have stayed unchanged for the past decade, efforts to maintain them will continue to favor fossil power, locking Indonesia into long-term carbon dependence and delaying the shift to renewable and low-carbon technologies essential for decarbonization.
- This situation could also weaken Indonesia's competitiveness in a global economy that increasingly values low-carbon production. This is particularly critical for rapidly growing sectors such as data centers, which are projected to contribute 20% of GDP by 2045 under the National Digital Economy Strategy 2030 (CMEA, 2025).

Weak and inconsistent regulatory follow-up to Presidential Regulation no. 112/2022 hinders Indonesia's coal power early retirement

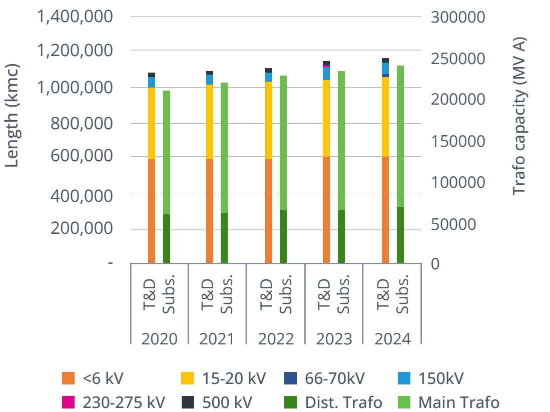
Inconsistencies between Presidential Regulation No. 112/2022 and MEMR Regulation No. 10/2025

Indicator	Presidential Regulation No. 112/2022on Acceleration of Renewable Energy Development for Electricity Provision	MEMR Regulation No. 10/2025 on Energy Transition Roadmap in the Power Sector
Policy Mandate	The Presidential Regulation mandates the Minister of Energy and Mineral Resources to develop a roadmap for the early retirement of coal-fired power plants (CFPPs).	The Minister of Energy and Mineral Resources is mandated to develop a roadmap for energy transition in the power sector.
Structure	In the context of energy transition within the power sector, the mandate for early retirement of CFPPs is outlined in the initial section (Article 3) of the Presidential Regulation.	In the MEMR Regulation, procedures related to the early retirement of CFPPs are outlined at the end of the regulation (Articles 11-17), indicating lower priority.
Substantial	In principle, the Presidential Regulation mandates the acceleration of the CFPP early retirement by establishing the criteria, restrictions on the development of new CFPPs, and provisions fot fiscal support.	The MEMR Regulation stipulates further details on the criteria and procedures for implementing CFPP early retirement, rather than listing the CFPPs eligible for early retirement.

- The Minister of Energy and Mineral Resources issued MEMR Regulation No. 10/2025 as a legal basis for early retirement of CFPPs, but it does not explicitly outline a roadmap for this process. Instead, it focuses on a broader energy transition roadmap in the power sector, positioning CFPPs early retirement as the last option. The regulation also does not specify a list of CFPPs eligible for early retirement, but rather details the criteria and procedures required to implement such a process.
- The availability of funding is established as the primary prerequisite for initiating the early retirement process, starting from conducting feasibility studies to obtaining approval from the relevant minister. Consequently, the focus of this regulation has shifted from accelerating the early retirement of CFPPs to merely providing a mechanism to mitigate the financial risks. This is inconsistent with the mandate of Presidential Regulation No. 112/2022 and poses a significant barrier to advancing the energy transition agenda in the power sector.
- In addition, since the issuance of MEMR Regulation No. 10/2025, the progress of the Cirebon-1 CFPP early retirement has remained unclear, despite receiving financial support from the Asian Development Bank (ADB) through the Energy Transition Mechanism (ETM) program (Warta Ekonomi, 2025).

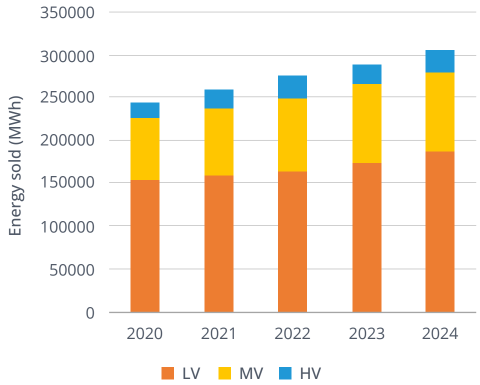
The development of transmission and distribution infrastructure has stagnated due to PLN's financial constraints

Power System infrastructure Development, 2020-2024



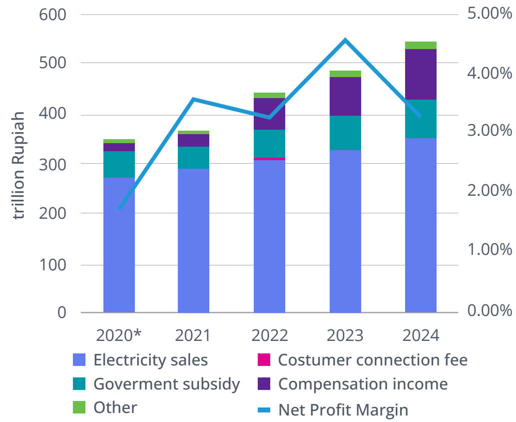
Source: IESR analysis from Electricity Statistics 2024 (MEMR, 2025d)

Electricity Consumption in Different Voltage Levels, 2020-2024



Source: IESR analysis from Statistics PLN 2024 (PLN, 2025b)

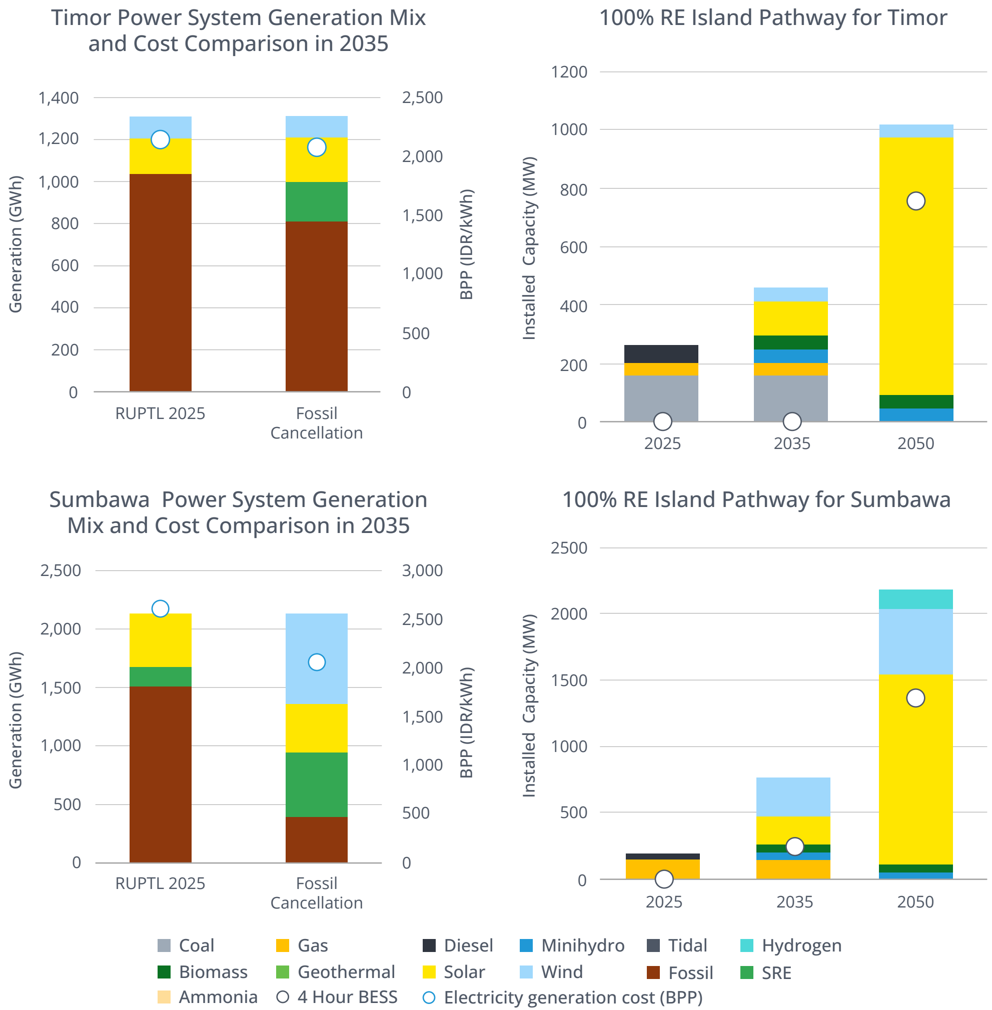
Revenue Stream and Net Profit Margin of PT PLN, 2020-2024



Source: IESR analysis from Statistics PLN 2024 (PLN, 2025b)

- Between 2020 and 2024, Indonesia's power infrastructure expanded, but still fell short of meeting rising electricity demand. Transmission and distribution (T&D) lines grew at annual rates of 10.1% and 1.5%, or about 6,242 ckm and 17,269 ckm per year, while substation capacity increased by 3.1% for main substations and 2.9% for distribution substations. Despite PLN's efforts to strengthen the grid, the pace of expansion continues to lag behind demand growth, threatening system reliability.
- Electricity consumption rose faster, with CAGRs of 10.3%, 3.4%, and 6.3% at the high-, medium-, and low-voltage levels. The strong growth in high and low voltages reflects rising industrial and residential loads, especially from energy-intensive downstream sectors. The slower expansion of distribution infrastructure indicates emerging bottlenecks, which may explain PLN's restrictions on rooftop solar PV connections due to grid stability concerns than technical limits.
- Financial constraints further exacerbate the issue. PLN's average net profit margin of 3.28% between 2020 and 2024 limits its ability to fund new infrastructure. Around USD 35 billion is needed to deliver the transmission and distribution projects in the RUPTL 2025-2034, but low internal rates of return of 2-4% make financing difficult. This reflects a structural imbalance in which PLN bears most grid costs while tariffs and policies emphasize affordability over cost recovery. Without reforms and risk-sharing mechanisms to improve project bankability, PLN's ability to expand and integrate renewables will remain limited.

Renewable-based modeling scenarios in Timor and Sumbawa show lower generation costs, improved energy security, and the need for region-specific transition strategies

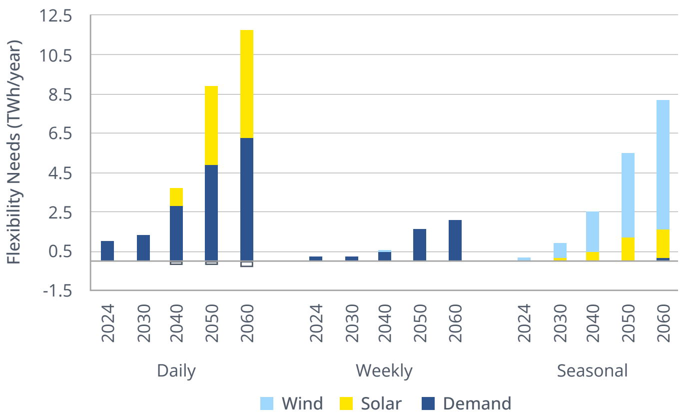


Source: IESR (2025a, 2025b)

- Long-term power system planning studies by IESR show that canceling planned fossil power plants and expanding renewables can reduce generation costs while supporting decarbonization.
- In Timor, a "fossil cancellation scenario" projects generation costs 3% lower than PLN's RUPTL 2025-2034, with renewables supplying 38% of electricity by 2035. In Sumbawa, canceling planned coal and gas plants could lower costs by 21% and raise the renewable share to 81.7% by 2035, even under current DMO policies (IESR, 2025a & 2025b).
- Beyond cost savings, renewables improve energy security through "distributed resilience," where decentralized systems can stay stable and recover faster from disruptions. IESR projects 100% renewable systems in both islands by 2050, mainly through solar PV and batteries, with 881.6 MW of solar in Timor and 1.44 GW in Sumbawa. Relying on local renewable resources enables island systems to become more independent, resilient, and protected from interconnection disturbances.
- These studies highlight that Indonesia's power system transition cannot follow a one-size-fits-all model. Each region needs to optimize its local renewable resources while developing interconnections strategically. Interconnection should primarily support large systems to enhance integrated operational flexibility.

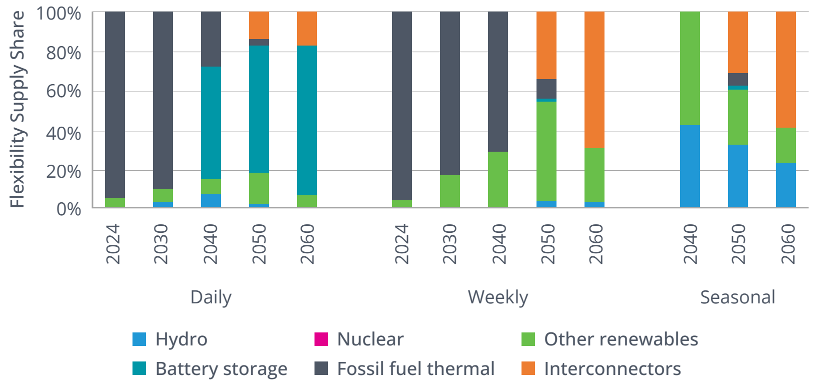
As VRE penetration rises, existing fossil plants should be utilized to provide system flexibility, while long-term solutions should also leverage energy storage and interconnections

Flexibility Requirements in Sulawesi Power System in 2024-2060



Source: IESR, 2025c

Flexibility Supply in Sulawesi Power System in 2024-2060



Source: IESR, 2025c

- Power system flexibility is the ability of the grid to respond to changes in supply and demand, maintaining reliability as demand and VRE generation, like solar and wind, fluctuate daily and seasonally.
- As solar and wind capacity increase under the RUKN 2025-2060, requirements for power system flexibility are expected to grow accordingly. Higher VRE penetration leads to greater fluctuations in net load, which must be balanced by other dispatchable generators in the system.
- In Sulawesi, IESR's RUKN-aligned modeling shows flexibility needs increasing across all timescales as solar and wind expand. By 2060, daily flexibility demand driven by solar PV is projected to reach 7.5 TWh, while seasonal flexibility, influenced by onshore wind, could increase more than fiftyfold compared to 2024 levels.
- Various technologies can provide power system flexibility. In the short term (2025-2030), flexible operation of existing fossil plants will remain necessary, though rigid PPAs with take-or-pay clauses can limit flexibility and lead to renewable curtailment when net load falls.
- In the longer term (2040-2060), fossil plants will be replaced by other flexibility sources. By 2060, with solar and wind projected to supply 42% of electricity (119 TWh) in Sulawesi, daily flexibility supply will come from BESS, interconnections, and other renewables, while seasonal needs will be met mainly by interconnections, other renewables, and hydropower.

Strategic measures in the power sector must be taken by the government and relevant stakeholders to align with the 1.5°C scenario

Energy Transition Indicator	Gap Identification	Recommendations	Opportunities and Benefits
Increasing renewable energy mix	Irregular procurement schedule, a lack of transparency in developer eligibility criteria	Beyond large-scale projects like the 250 MW Mentari Java Solar PV, Indonesia needs predictable and competitive auctions with clear schedules and enforceable compliance rules, following successful examples such as the Solar Energy Corporation of India(SECI) and Malaysia's Large-Scale Solar (LSS) program.	• Overcapacity no longer an obstacle to renewable energy expansion • Renewable energy plants such as solar can lower electricity costs while achieving decarbonization
	Misalignment between national electricity planning documents with President's ambitious statements regarding 100% RE	The President's statements signal Indonesia's strong commitment to the energy transition, but this must be backed by clear regulations, stronger cabinet coordination, and private sector involvement. Granting the 100% RE goal a National Strategic Program (PSN) status with a dedicated task force could speed up implementation.	• Harnessing renewable energy potential can strengthen energy independence, one of the main priorities of the President
Fossil fuel phase-out	Inconsistent policies on the early retirement of CFPPS	Revisions to MEMR Regulation No. 10/2025 should be made to align with the Presidential Regulation mandates. An early retirement of the CFFPs roadmap should include a list of eligible CFPPs to be early retired and be developed through public participation.	• Early retirement or fossil fuel pipeline cancellation, coupled with massive VRE integration, can reduce electricity costs and subsidies. • Align with President's targets to achieve 100% clean energy in 2035. • Operating existing fossil fuel assets flexibly, in particular CFPPs with supercritical steam-cycle technology, can enable higher VRE integration. Along with the implementation of international price of carbon tax, the tariff increase from operating the CFPPs flexibility can be minimized, whilst still incentivizing such an operation.
Supportive grid infrastructure	Slow buildout and difficulties in securing financing for infrastructure development	MEMR Regulation No 11/2021 stipulates on the joint utilization of transmission network (Pemanfaatan Bersama Jaringan Transmisi, PBJT) through a leasing mechanism. Under the current regulatory framework, PBJT is possible to be implemented by PLN through a green premium tariff scheme by aiming at some industries that have a clear target to achieve net-zero emissions.	• A new revenue stream from green premium tariff scheme would help alleviate PLN's financial constraint. • One of the non-PLN business area holders will adopt PBJT mechanism by involving an IPP that supply directly to customers by utilizing the existing transmission network.

2.2. Progress in the Industrial Sector

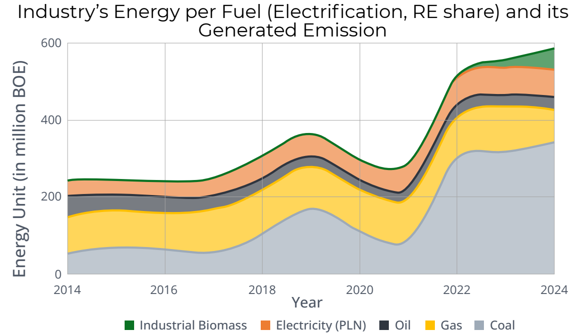
Dr. Farid Wijaya and Faricha Hidayati

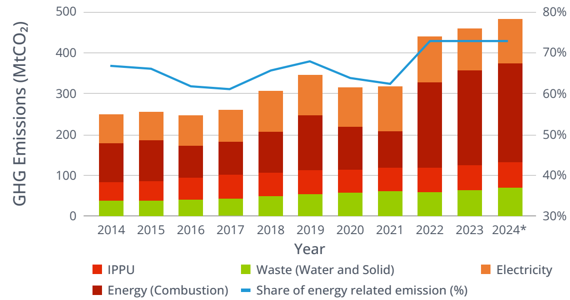
Energy Transition Indicators:

- Increasing Electrification Share
- Hydrogen And Bioenergy Adoption
- Energy Efficiency Adoption
- Energy Management Implementations

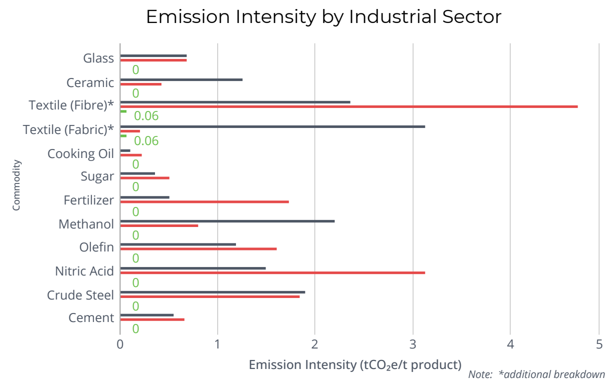
Industrial decarbonization requires electrification and emission intensity-based management to minimize fossil fuels utilization

- Over the past decade, industrial energy demand has grown at a CAGR of 9.2%, nearly reaching 600 MBOE by 2024. During this time, the energy mix shifted heavily toward coal, and the energy share of electricity (12.42%), natural gas (14.7%), and oil (5.4%) reached last decade lows in 2024. The DMO and market price caps supported coal demand to reach 340 MBOE, or 59% of 2024 total energy demand, with a 20% CAGR since 2014 (MEMR, 2025a).
- The 2024 energy demand trend resulted in GHG emissions exceeding 480 $MtCO_2e$, a new decade-high and nearly double the 2014 level. This increase is primarily driven by fossil fuel combustion, which accounts for more than half of emissions. Specifically, the rising coal energy demand makes it increasing difficult to meet NDC and NZE carbon reduction targets, as well as their associated renewable energy technologies and costs.
- GHG emissions can be reduced through electrification as the direct use of electricity produces zero Scope 1 emissions. The emission intensity from supplied electricity has steadily declined by 0.2% annually over the last decade, and a further decrease is expected in line with the 2025-2050 RUKN, as well as NZE (MEMR, 2025b; IESR, 2024). Therefore, electrification is essentials for sustained decarbonization by using renewable electricity, either with PLN and its Renewable Energy Certificate (RECs) or independent power generation.
- Using emissions intensity as a benchmark is crucial for managing emission reduction efforts. Numerous Indonesian industries exhibit emission intensities that exceeding the global average, particularly in the textile (fiber), fertilizer, and nitric acid sectors, which are still double the average (MoI, 2025a-b). This demonstrates the long and challenging path Indonesia faces in reducing emission intensity to zero for its NZE commitment.
- Initiatives to align GHG emissions reduction efforts are outlined in the 2025 draft of the Industrial Decarbonization Roadmap for 9 Industrial Sectors. Referring to the defined GHG emission reduction trajectory, achieving the 1.5°C target or carbon budget remains challenging. To effectively track and manage sustainable decarbonization initiatives, emission intensity-based management is needed.





Source: IESR Analysis adapted from MEMR 2025a; IESR, 2024; MoF, 2024

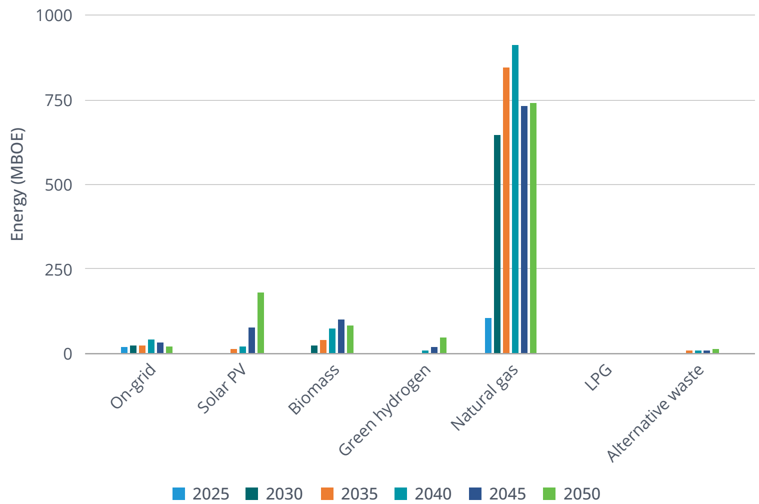


Source: IESR Analysis adapted from MoI 2025a-b

Demand for hydrogen and biofuels is projected to increase significantly but lag behind natural gas

- Emission reduction initiatives have increased demand for carbon-neutral bioenergy as a fossil fuel alternative. In 2024, biomass demand hit 21 MTPA (41 times higher than 2021 levels), while the B35 policy drove biodiesel demand to 2.6 billion liters. The upcoming 2025 B40 policy is expected to raise the industrial demand share from 36% to 48% (MEMR, 2025a; Aprobi, 2025). While biogas utilization increased 22-fold from 3.51 m³ in 2022 to 2024, this represents only a 0.2% rise from 2023, with 2024 usage split between biogas boilers (88.6%) and biomethane production (11.7%)(MEMR, 2024).
- Over the past five years, 1.75 MTPA of natural gas-derived hydrogen has been used by industry to produce fertilizer and ammonia (92%) and oil refinery (2%) (MEMR, 2023). To reduce emissions from those industries and the entire industrial sector, the national hydrogen and ammonia roadmap (RHAN) envisions a complete transition to low-carbon hydrogen by 2035–2045 and 6.5 MTPA of industrial hydrogen demand by 2060, mainly used for urea/ammonia/methanol (40%), steel (over 28%), and refineries (6%) (MEMR, 2025). Achieving the industrial hydrogen economy envisioned by the roadmap requires establishing standards, certification, and risk safety planning across the supply chain to enable massive, sustainable adoption, which is still falling short in the present state.

Required low-carbon emission fuel and electricity to achieve NZE in 9 Sector of industry from 2030 to 2050 - Draft Roadmap

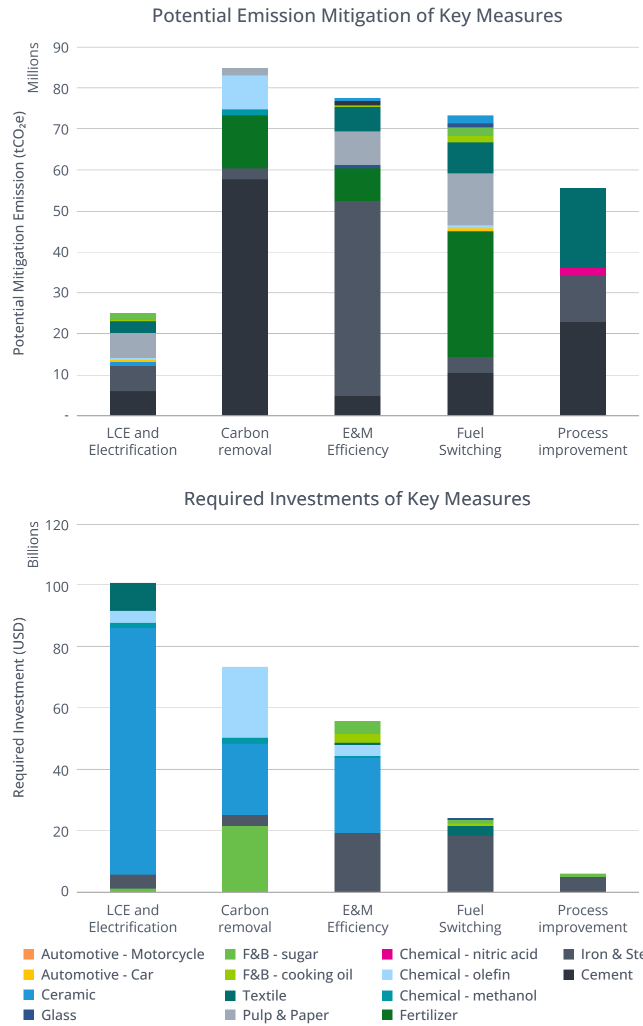


Source: Adapted from MoI, 2025a-b

- In addition to the RHAN, the 2025 draft Industrial Decarbonization Roadmap for 9 Industrial Sectors projects that low-emission hydrogen demand will increase from 0.2 MTPA by 2030, attaining 2.33 MTPA of low-carbon emission hydrogen by 2050, a 31% CAGR (MoI, 2025a-b). This information supports integrated planning to ensure low-carbon fuel supplies and reduce the risk of an energy crisis due to increased demand, supply chain disruptions, and price volatility that may occur, similar to those experienced in fossil fuels.
- Biomass utilization is also projected to rise to 6.7 MTPA by 2030 and 23.30 MTPA by 2050, a 6.4% CAGR. Meanwhile, alternative waste fuels are also projected to grow to 3.09 MTPA by 2050, with a CAGR of 4.4% (MoI, 2025a-b). While demand for biomass and alternative waste fuels as a fossil fuel alternative is rising due to emission reduction goals, their supply chain requires stricter standards and controls to mitigate unsolved negative environmental impacts, including uncontrolled CO_2 emissions, which remain a subject of debate.
- A major risk involves the projected surge in natural gas demand as a substitute for coal and oil, which is expected to peak at over 900 MBOE in 2040 and then decrease to nearly 740 MBOE in 2050. This projection represents 1,000% and 870% of the industrial demand for natural gas in 2024, respectively, and far exceed Indonesia’s 2024 production of 321 MBOE (MEMR, 2025a; MoI, 2025a-b). Whether this projection is realistic remains uncertain, as it would also require large-scale massive CCS/CCUS deployment to remove CO_2 emission to achieve NZE.

Decarbonizing Indonesia's industries demands large investments, but strategic implementation of mitigation measures can keep price impacts manageable

- The MoI's Industrial Decarbonization Roadmap estimates that total emissions to be mitigated across nine priority sectors between 2025 and 2050 amount to 316.1 $MtCO_2e$. Around 72% of this reduction potential is concentrated in three sectors: cement, iron and steel, and fertilizer, underscoring their pivotal role in achieving Indonesia's industrial decarbonization objectives. Key mitigation measures include carbon removal technologies, energy and material (E&M) efficiency, and fuel switching, which are projected to contribute 27%, 24%, and 23% of the total mitigation potential, respectively (MoI, 2025a-b).
- To support this transition, total investment needs between 2025 and 2050 are estimated at approximately USD 260 billion. The largest investment requirements are associated with low-carbon electricity and electrification (39%), carbon removal (28%), and E&M efficiency (21%). However, from a cost-effectiveness perspective, fuel switching, E&M efficiency, and process improvement provide the highest emission reduction per unit of investment. Prioritizing these strategies would help optimize capital allocation and reduce the financial burden of industrial decarbonization in the near to medium term.
- Price volatility remains a key factor influencing the success of the decarbonization agenda. While additional capital expenditure may have limited impact on production costs in lower-emission industries such as textiles, food, and automotive, energy-intensive industries are expected to face significant cost increases: glass (72.6%), ceramics (33.2%), fertilizer (30%), iron and steel (12-29%), olefins (17%), and cement (15%). These increases are primarily driven by the cost of green hydrogen and the deployment of carbon removal infrastructure. Ensuring a stable investment environment, fiscal incentives, and access to affordable low-carbon energy will therefore be essential to maintaining industrial competitiveness while advancing deep decarbonization.

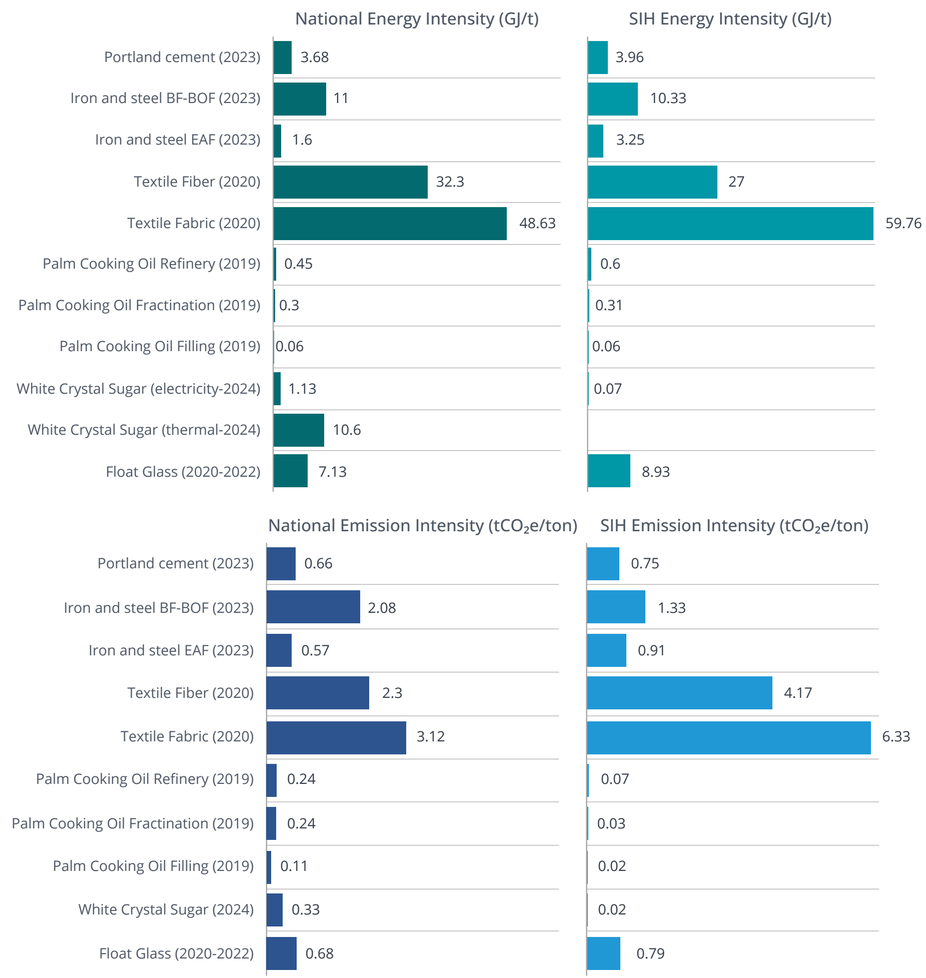


Source: MoI (2025), LBNL (2024) - IESR Analysis

Indonesia can recover missed energy efficiency gains by enforcing compliance and revising industry benchmarks

- Industrial facilities consuming 4,000 TOE or more annually are required to implement energy management systems under Government Regulation (GR) No. 33/2023, supported by Ministerial Regulation (MR) No. 8/2025. The regulation mandates at least a 1% annual improvement in energy performance over three consecutive years. If properly enforced, this policy could drive substantial energy savings and efficiency gains across major industries. IESR estimates that the 4,000 TOE threshold applies to facilities producing around 45 ktpa of cement, 1.9 ktpa of textiles, and 14.3 ktpa of white crystal sugar, with 1.9 ktpa of fabric equal to 7.6 to 19 million square meters depending on grammage.
- The Green Industry Standard (Sertifikat Industri Hijau, SIH) complements this framework by setting maximum energy intensity thresholds for products classified as green. As of July 2025, 62 SIHs have been issued, awarding 149 certificates to industrial facilities. Each SIH outlines minimum environmental and governance standards for commodities under five-digit KBLI codes.
- Energy and emission benchmarks for key sectors such as cement, steel, textiles, sugar, palm oil, and flat glass are already established under SIH. However, IESR analysis shows that most industries perform close to or above existing benchmarks, indicating that current SIH standards no longer reflect actual industry progress. To maintain relevance and effectiveness, the government must update SIH criteria in line with the MoI's decarbonization roadmap. Making SIH mandatory under the national industrial plan (RIPIN), supported by strong incentives and penalties, is essential to transform voluntary commitments into enforceable action and to accelerate Indonesia's green industry transition.

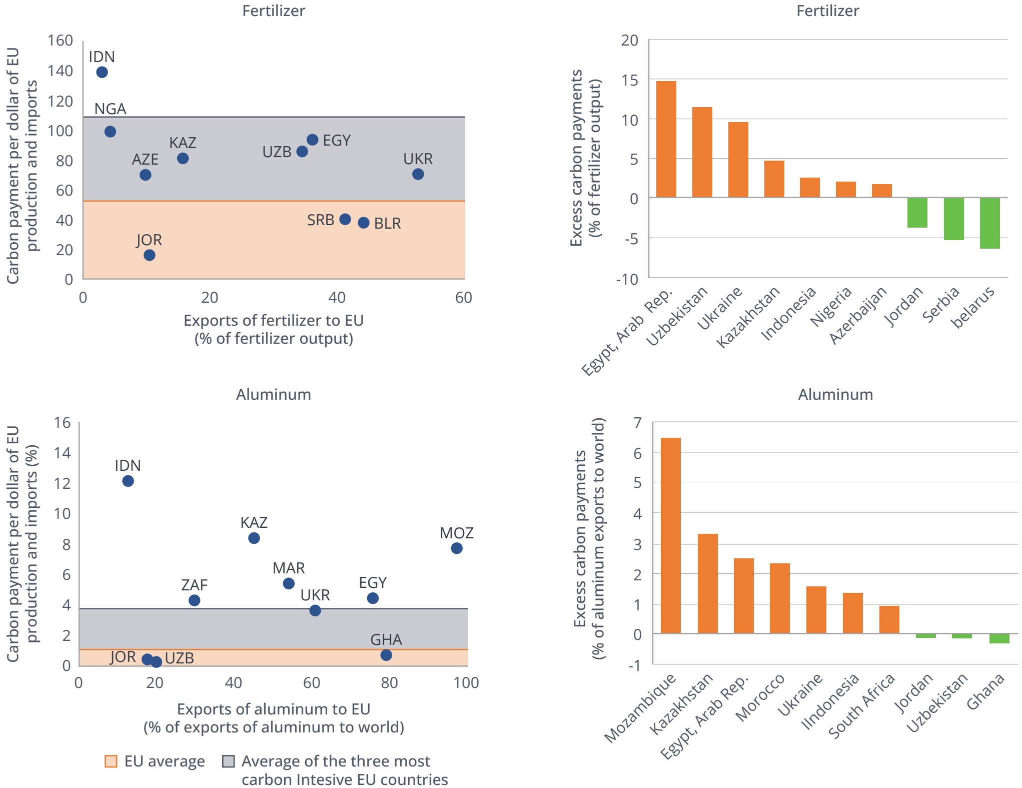
Actual and SIH Standards Energy and Emission Intensity Comparison



Source: IESR analysis from SIH regulations and MoI's industrial decabonization roadmap

Carbon Border Adjustment Mechanism threatens competitiveness of Indonesian exports with a potential tariff burden of up to 0.02% of 2022 nation's GDP

- With the Carbon Border Adjustment Mechanism (CBAM) entering its definitive phase on January 1, 2026, several key Indonesian export commodities to the EU—such as cement, iron and steel, aluminum, and fertilizers—will be directly impacted. This poses a trade competitiveness risk for Indonesia, as the current emission intensity of impacted commodities remains well above the EU ETS levels. For example, secondary steel production in Indonesia has an emission intensity of 0.57 tCO_2e/ton steel, while the current ETS cap for secondary steel produced with EAF is 0.215-0.268 tCO_2e/ton steel, depending on the product types (European Commission, 2021).
- In terms of aluminum and fertilizer, their competitiveness will also be affected under current practices. According to the World Bank, the CBAM Trade Exposure Index for these two commodities from Indonesia is +4.3 for fertilizers and +1.35 for aluminum (Maliszewska et al., 2025). Positive index values indicate that additional tariffs will be imposed on imported goods to the EU, with higher index values reflecting greater overall tariff burdens. Overall, the study reveals that CBAM will impose a tariff burden of up to 0.021% of Indonesia's GDP in 2022.



Source: Carbon Border Adjustment Mechanism (CBAM) Exposure Indices, 2025

- With other countries are exploring similar mechanism to CBAM, Indonesia must act fast to strengthen its commitment in pursuing the NZE goal by 2060, or earlier if possible. It has been estimated that low-carbon economic practices have shown positive impacts on national income and economic resilience—projected to boost GDP by up to 5.11% by 2060, compared to only 1.1% under a business-as-usual scenario (MoI, 2025a--b).

Strategic measures must be implemented to facilitate the industrial transformation into green industry

Energy Transition Indicator	Gap Identification	Recommendations	Opportunities and Benefits
Increasing electrification share	• Industry growth supported by affordable fossil fuel policy and supply. • Low-carbon electricity and electrification are underemphasized. • Weak emission intensity control.	• Minimum electricity share obligation to total energy demand. • Maximum emission intensity along with mandatory reporting mechanism, integrated under the MoI's industrial decarbonization roadmap.	• Reduce fuel consumption and switch Ato electricity use. • More strategic and controlled emission control. • Building a electricity-based green industry.
Hydrogen and bioenergy adoption	• Still in early planning and strategy. • Supply risks, limitations in terms of technical, technological, standards and policies. • High reliance to natural gas and others fossil fuels.	• The MoI's industrial decarbonization roadmap could facilitate mandatory policy, standard, and market cap for hydrogen and bioenergy supply and utilization, ensuring their future adoption.	• Establishing hydrogen and bioenergy economy and ecosystem for industry sector. • Less reliance to natural gas and others fossil fuel.
Energy efficiency adoption	• Technical issue and taxonomy scope to maximize energy efficiency implementation in various industries. • Realization and validation of energy efficiency efforts.	• Certification and standardization of energy-efficient products, services and processes. • Provision of guidelines for energy utilization based on green industry standard requirements.	• More robust industrial standard and control. • Realizing energy efficiency as low-hanging fruit and a basic standard of knowledge.
Energy management implementations	• Mandatory only for high energy consumption industries. • Implementation from the outset is frequently disregarded.	• Early implementation through volunteer recognition and validation. • Habitual practice in energy management.	• Grounding the implementation of energy management. • Medium-and long-term benefits in energy management awareness.

2.3. Progress in the Transport Sector

Rahmi Puspita Sari and Ilham Rizqian Fahreza Surya

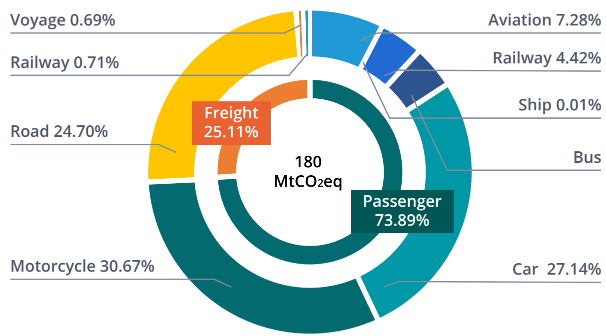
Energy Transition Indicators:

- Electrification
- Efficiency
- Modal Shift
- Shipping Decarbonization (Maritime)
- SAF Uptake

Transport emissions continue to rise with no peaking under current policies

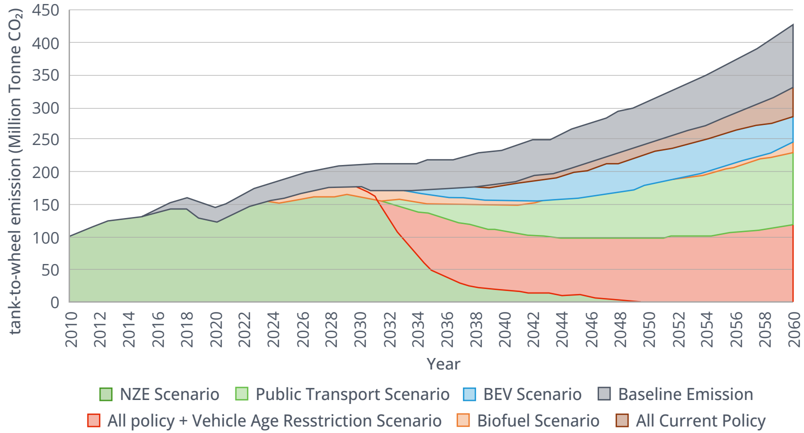
- Indonesia's transport emissions are projected to reach 180 $MtCO_2e$ in 2024, driven by continued mobility growth. Road transport volume is expected to reach 3.2 trillion vehicle-kilometers by 2050 (3.27% annual growth rate), while vehicle ownership is projected to increase from 155 million units in 20251 to 234 million units by 2050 (IESR, 2025). Under all current-policy scenarios, emissions continue to rise beyond 2050, reaching 485 $MtCO_2e$ annually. A 2030 emissions peak is only possible when current policies are combined with vehicle age restrictions or strengthened under a net-zero scenario where all policy ambitions are maximized.
- Passenger transport remains the largest source of sectoral emissions (73.89%). Modal shift and electrification have been the primary mitigation strategies. The most notable modal shifting program is the Buy the Service (BTS) program, which was initiated by Ministry of Transportation to deploy a BRT network in eight cities which has successfully shifted 62% of users from motorcycles (IESR, 2025). However, the program faces continuity risks, as operations in Bandung, Banjarmasin, and Medan have been transferred to regional governments (Adri, 2025).
- In 2025, the Ministry plans to expand the BTS program with IDR 177 billion in subsidies across 12 corridors. Yet, the scale of change remains insufficient. IESR's analysis shows that increasing public transport's modal share from 16% to 60% could cut emissions by up to 101 $MtCO_2e$.
- On electrification, incentives for electric two-wheelers (E2Ws) proved effective in 2023, with 80% of sales benefiting from subsidies (IESR, 2025). However, the suspension of incentives in 2025 created policy uncertainty and demand collapsed, with sales dropping by more than 80% year-on-year in Q1 2025.

Green House Gas (GHG) Share in Indonesia's transsport sector (2024)



Source: IETO Model (2025)

Transport sector emission projection under various scenario



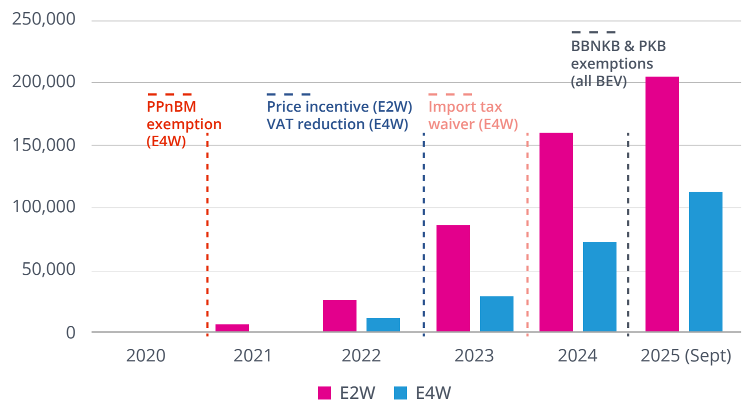
Source: IESR Model (2023)

- Overall, as of 2025, transport transition policies remain fragmented and program-based. An integrated approach was first introduced through Minister of Transportation (MoT) Decree No. 8/2023 on Transport Decarbonization for the Nationally Determined Contribution (NDC), which outlines a list of actions under the Ministry of Transportation. However, no further updates or implementation progress have been published as of 2025.

Rising passenger transport emissions demand a strong vehicle stock turnover policy package to accelerate BEV adoption

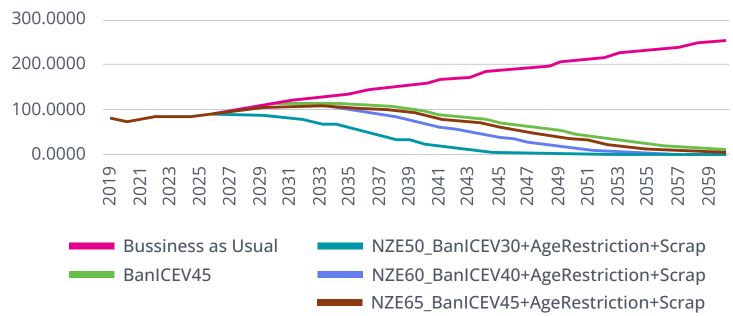
- In 2025, BEV cars (E4W) and motorcycles (E2W) show contrasting trends: E4W sales hit a record 35,749 units by June, while E2W sales fell 80% year-on-year in Q1. The Enhanced Nationally Determined Contribution (ENDC) targets 7.23 $MtCO_2$ (29 MBOE) cuts by 2030 (MEMR, 2023), yet current trends would yield only 92 $MtCO_2$ cuts from 15 million E4Ws and 47 million E2Ws by 2060. Stronger policies such as purchase subsidies, fuel price hikes, and phase-out mandates could lift BEV adoption to 82 million E4Ws and 142 million E2Ws by 2060 (IESR, 2025).
- While boosting new BEV sales is vital, accelerating vehicle turnover is more effective for long-term adoption and deep decarbonization. The government's potential 2045 ICE sales ban (Gaikindo, 2024) would force automakers and consumers to fully switch to BEVs within 2-3 decades, but it must be managed carefully to allow industry adjustment. However, because ICE vehicles could still be sold for many years before the ban takes effect—and many remain in use for over 10 years (Sitinjak et al., 2023)—emission reductions would still be delayed as private vehicle stock continues to grow.
- Although most vehicles in Indonesia are under 10 years old, 25–35% are over 11 years (JUTPI, 2019). Hence, a strong turnover policy—combining age limits and a national scrappage scheme—is needed to complement an ICE sales ban (Sitinjak et al., 2023; Möring-Martínez et al., 2025). However, these might not be required if vehicles are being retired 'naturally'.
- Indonesian private vehicles are assumed to retire at age 25, hence sales ban in 2045 would be able to drastically reduce emission by 2060 and leaving 8 $MtCO_2$ emission, yet delaying NZE to 2067. Achieving NZE at 2060 would require accelerating the sales ban to 2040 and applying age restriction of 25 year to cars and 20 year to motorcycles. Subsequently, quicker NZE at 2050 would require 2030 sales ban, age restriction and scrappage.

Number of BEVs on the road and key regulations



Source: IESR analysis, 2025

Projected emissions from passenger vehicles under sales ban and age restriction scenarios (energy use emission)

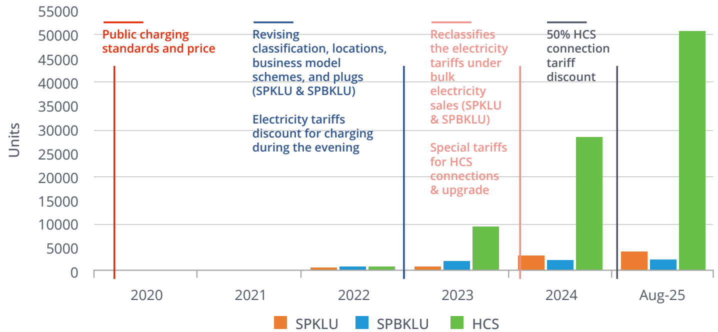


Source: IESR analysis, 2025

Despite growing, non-strategic placement of public chargers undermines opportunity charging and keeps home charging dominant

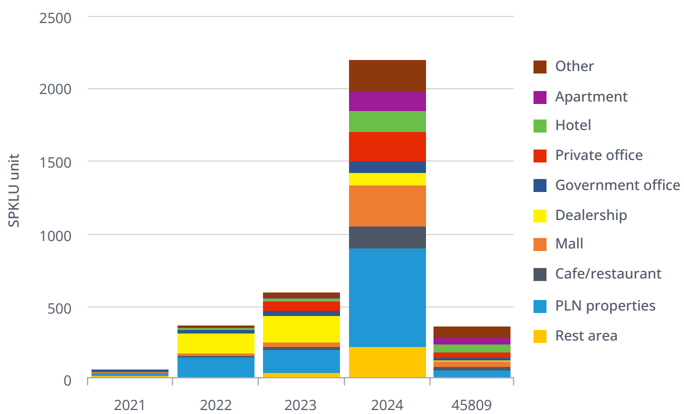
- BEV growth must be matched by charging infrastructure expansion. In 2060, 1 SPKLU (public chargers) must serve every 16 E4Ws and 1 SPBKLU (battery-swapping stations) serves 13 E2Ws. Delivering this public network alone requires around IDR 6,000 trillion in investment by 2060 (IESR, 2025). These investments exclude home charging, despite it being the preferred option for most BEV owners to charge, which therefore merits its own set of supportive measures.
- Home charging service (HCS) dominates BEV use, consuming three times more electricity than public charging (28 GWh vs 9 GWh). Over 28,000 installed home chargers give a 1:3 car-to-charger ratio. As 99% of Indonesians living in single-family homes (ICCT, 2024). This differs from the EU, where 53% of the population lives in houses while 46% lives in flats (EU, 2021).
- PLN promotes HCS through two main incentives; a 30% discount on electricity rates for off-peak charging (10 PM–5 AM) and reduced fees for capacity upgrades to 7,700–11,000 VA, which are required for HCS. For the latter, in 2024, PLN offered a heavily discounted upgrade—costing around IDR 702,000 for eligible customers—while in 2025, the incentive changed to a 50% discount scheme, bringing upgrade costs to about IDR 1.5–3.5 million depending on initial capacity.
- Public charger rollout remains misaligned with user behavior. As of June 2025, over 35% were installed at PLN offices (>1,000 units) and 140 at government buildings—far more than at offices (325), malls (351), or apartments (194). Strategic site growth only picked up in 2024. While 284 plugs along toll roads help long trips, they are less essential for daily use. Since 73% of E4W users charge every 1–3 days (Populix, 2025), non-strategic chargers are unlikely to offset home charging.
- Public charger users strongly prefer ultrafast options (>200 kW), which make up only 11% of total installed public chargers but account for half of all transactions and 60% of total energy supplied (IESR, 2025). This reflects a “refuel-and-go” habit at charging depots rather than opportunistic charging at workplaces or shops. Rollout and incentives should therefore shift toward residential, workplace, and lifestyle locations with varied charger power levels.

Charging infrastructure growth and key regulations



Source: IESR analysis, 2025

SPKLU annual growth based on location

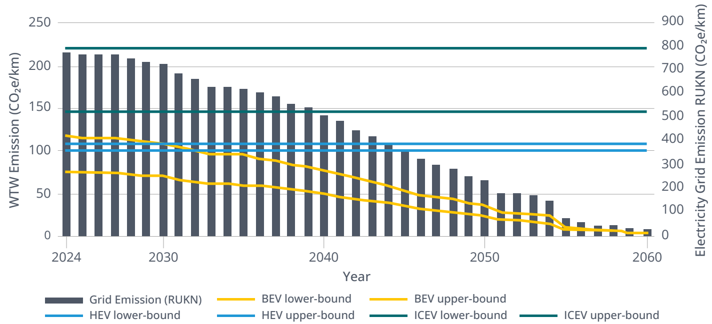


Source: IESR analysis, 2025

HEVs are suitable only as a short-term transitional technology, while BEVs are essential for long-term decarbonization

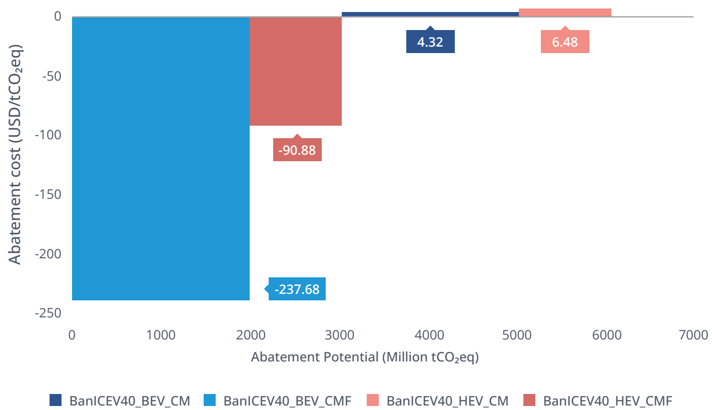
- BEV and HEV are both lower-carbon, higher-efficiency alternatives to internal combustion engine vehicle (ICEVs), but they differ in their suitability across short- and long-term decarbonization needs. HEVs remain dependent on fossil fuel, so their emissions do not fall with increasing renewable energy penetration. As of 2025, BEVs already emit less across most conditions (~73–115 gCO_2e/km) compared to HEVs (~98–107 gCO_2e/km) and ICEV (107-220 gCO2e/km). Only the upper-bound BEV cases (~115 gCO_2e/km) slightly underperform against upper-bound HEVs (~107 gCO_2e/km). Once grid emissions fall below the break-even level of 721 gCO_2/kWh, in which IESR projects around 2030 under the RUKN scenario, all range BEVs will outperform HEVs even in worst-case conditions, and BEV emissions could decline to as low as ~3–4 gCO_2e/km by 2060 under this scenario.
- The marginal abatement cost curve (MACC) provides a comparison which technology offers the greatest economic advantage and higher abatement potential. Both BEVs and HEVs show similar short-term and long-term suitability result. When only capital cost and maintenance cost considered, BEV at USD 4.32/tCO_2 and HEV at USD 6.48/tCO_2, which indicates that BEV is slightly more cost-efficient even before fuel savings are counted. However, once fuel savings are included (CMF), BEV perform better with cost saving of USD 237.68/tCO_2 while HEV is only around –USD 90.88/tCO. BEV also delivers more than double the abatement of HEV (2,002.57 MtCO2e and 1,031.45 MtCO2e, respectively) while also achieving higher net savings in absolute terms (–USD 475.96 billion and –USD 93.73 billion, respectively).
- The emissions and cost profiles of BEVs and HEVs are influenced by their availability in the market and the fuel price, through calculation of CAPEX and OPEX. For example, BEV currently has better sales in lower price range in compare with HEV (IESR, 2025). Also, fuel price are set using the customer market price which include both fuel and electricity subsidies, that once removed, would change the landscape. However, under current market and pricing conditions, BEVs offer a more economical and lower-emission pathway compared to HEVs.

WTW Emissions of ICEV, BEV, HEV v



Source: IESR Analysis (2025)

Abatement and Unit Cost Comparison between BEV and HEV

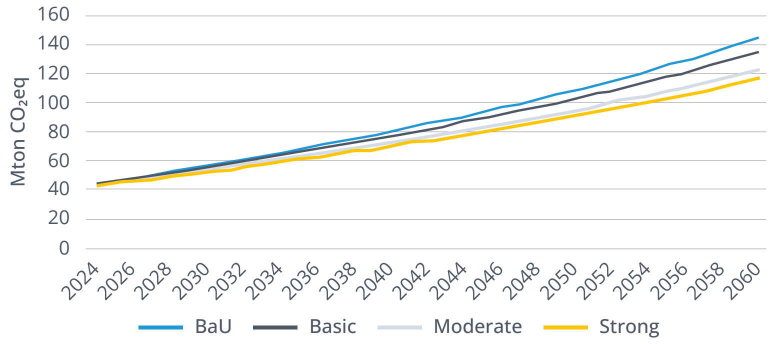


Source: IESR Model (2025)

Truck dominance underscores the need to shift freight to rail and electrify last-mile delivery

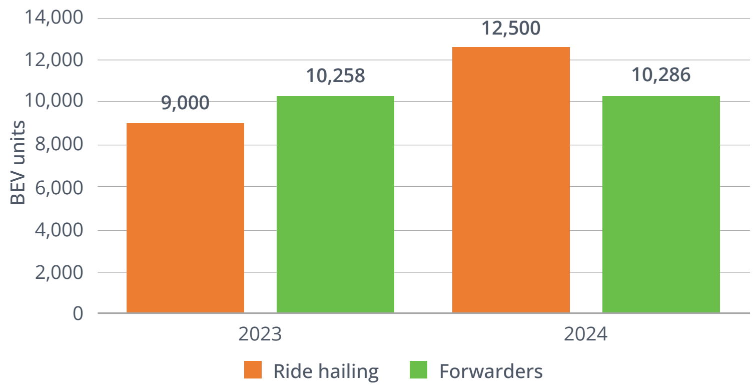
- Trucks dominate Indonesia's freight sector, carrying over 91% of total goods. Although they make up less than 4% of road vehicles, they produce 30% of road transport GHGs (IESR, 2025) and 11% of motorized air pollutants (KPBB, 2024) due to diesel use and slow fleet turnover.
- Shifting freight to rail through intermodal systems could cut emissions—rail uses 16% less energy and emits 46% less carbon than trucks (IFEU & SGKV, 2009; Craig, Blanco & Sheffi, 2013). On top of that, intermodal freight helps to ease road congestion, curbs road accidents, reduces over-dimensioned/overloaded (ODOL) trucks and prevents road-dependent lock-in (GIZ, 2021; Halim, 2023).
- In Java, rail freight remains minimal at 1.74% (8.49 Mt) of total freight share in 2020 (GIZ, 2021). MoT targets 534 Mt in Java-Bali and nearly 1 billion tons nationwide by 2030—about 15–17% of projected freight (Ministry of Transport, 2011). However, rail still struggles to compete with trucking due to higher costs, slower transit times, and limited reliability (GIZ, 2021).
- Re-simulations of GIZ's scenarios show that combining infrastructure expansion, fiscal reforms, stricter road freight rules, and market incentives could cut emissions by up to 20% by 2060. Achieving this shift hinges on improving rail service quality—particularly in terms of safety and reliability (Halim, 2023). However, realizing the projected 1,200% increase in rail freight by 2030 will require major investment in terminals, locomotives, and wagons to overcome current infrastructure gaps.
- Decarbonizing Indonesia's logistics requires a dual approach: shifting long-haul freight to rail and electrifying last-mile delivery. Globally, last-mile transport accounts for 30–50% of delivery-related CO_2 and could see emissions rise by 60% by 2030 (SDC, 2025; WEF, 2024). Electrifying vans and two-wheelers can cut urban emissions, improve air quality and ensures rail's efficiency gains are not offset by last-miles emissions. Yet electric logistics fleets remain below 2% in Indonesia (TechInAsia, 2025).

Re-simulation of projected freight transport emissions on Java across policy scenario



Source: IETO Model, 2025; GIZ, 2021

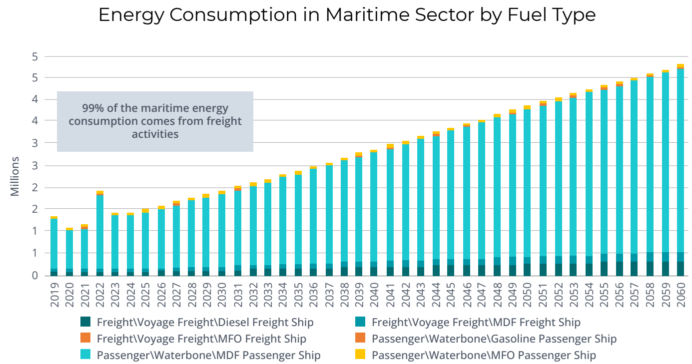
Last-mile logistics vehicles in Indonesia



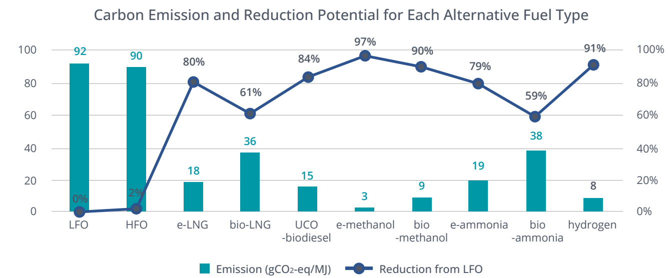
Source: IESR analysis, 2025

Decarbonization efforts in the maritime sector remain unclear, with no robust regulatory framework or firm alternatives

- Indonesia's maritime sector contributes only 0.79% of national transport emissions, but its decarbonization pathway remains unclear. Nationally, passenger maritime transport accounts for 5% of passenger movement (Mulyono, 2018) compared with maritime freight movement which accounts for 24.2%. In eastern Indonesia, maritime dependence is stronger, with passenger shares at 28% and freight relying on maritime transport at 79.7%.
- Indonesia's MoT Decree 8/2023 outlines rough mitigation in maritime (efficiency, renewable energy, low-carbon fuels), but Indonesia has no robust legal maritime emissions target in the SNDC or equivalent commitments in public sources (Setyo et al, 2024).
- Biodiesel has been introduced under the national B40 mandate by 2025, completely dominating the shares of diesel nationally. However, diesel accounts for only 7% of the total energy consumption in maritime activities as of 2025, therefore the biodiesel mandate has had limited impact on overall decarbonization. Maritime energy use is dominated by maritime fuel oil (MFO) at 88%, with marine diesel fuel (MDF) at 5%
- Amongst current decarbonization options for maritime sector, e-methanol and hydrogen offer the largest emission reductions when produced from renewable energy, with carbon intensities of 3 gCO_2-eq/MJ and 8 gCO_2-eq/MJ and reductions of 97% and 91% compared with conventional maritime fuels (LFO) respectively (Zhang et al, 2024). Used cooking oil (UCO) biodiesel and bio-methanol also provide high reductions, at 15 gCO_2-eq/MJ and 9 gCO_2-eq/MJ and reductions of 83.70% and 90.22%, but their use depends on sustainable feedstock supply. Another study also finds that hydrogen and e-ammonia are overall the suitable maritime fuel alternative based on multi-criteria analysis (Global Maritime Forum, 2021)
- Maritime decarbonization is becoming more urgent as of 1 January 2024, when the European Union Emissions Trading System (EU ETS) began covering shipping sector. This means companies operating voyages that touch EU/EEA ports must monitor, report, verify emissions, and surrender EU allowances (EUAs), including non-EU ships (EU, 2024). Thus, to sustain trade, an Indonesian fleet may face additional carbon compliance costs. This makes it urgent for Indonesia to establish a regulatory framework to address new ETS system and to identify the most effective decarbonization pathway in maritime sector.



Source: IESR Analysis (2025)

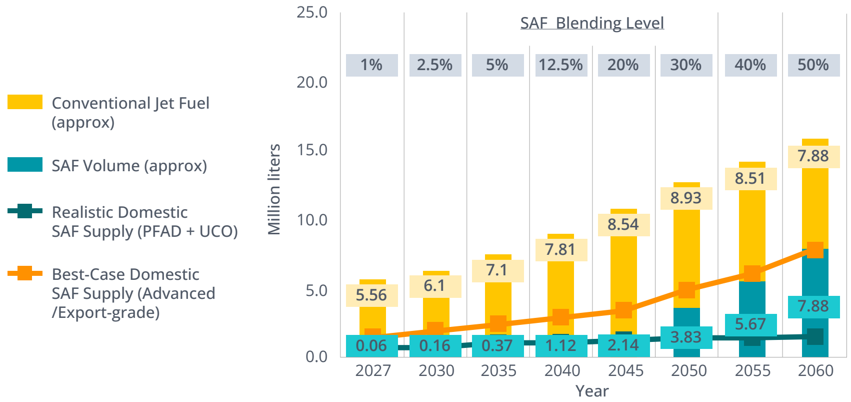


Source: Zhang et al, 2024

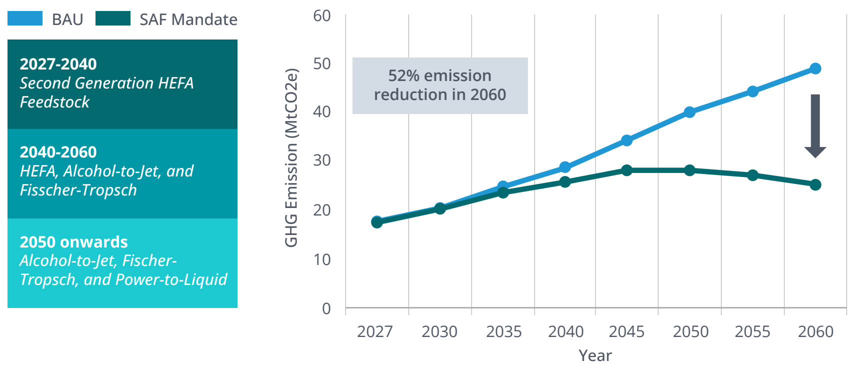
Rising air traffic and regional dependence on aviation increase the importance of Indonesia's SAF transition

- Aviation contributed 7.28% of national transport emissions in 2024, up from 6.8% in the previous year, equivalent to a 7.1% year-on-year increase (IESR, 2024). Indonesia drives 7.5% of air traffic growth in the Asia-Pacific region (ICAO, 2024). Road transport dominates nationally with a 70% passenger modal share in 2024 (IESR, 2025), but regional patterns differ sharply. Aviation accounts for 43.7% of mobility in Maluku-Papua, compared to 4.5% in Kalimantan and 5.0% in Sulawesi (Mulyono, 2018). These disparities limit modal shift options and make adopting Sustainable Aviation Fuel (SAF) essential.
- Indonesia's aviation sector still relies almost entirely on fossil-based fuels, with Avtur alone supplying about 99% of aviation energy use in 2024 (HEESI, 2023). The government first attempted to introduce SAF blending through MEMR Decree No. 12/2015, which set targets of 2% by 2016, 3% by 2020, and 5% by 2025 (MEMR, 2015). None of these targets have been met as of 2025.
- To revive the effort, Indonesia launched the SAF Roadmap in 2024, which is based on the previous decree until 2035 (Republic of Indonesia, 2024). For 2040 and beyond, the roadmap is informed by on international case studies. The roadmap targets flights to use at least 1% SAF blending by 2027, rising to 2.5% by 2030, and reaching 50% by 2060. The demand for SAF is projected to be served using Hydro-processed Esters and Fatty Acids (HEFA) feedstock. However, for higher blending in 2040 and above, alcohol-to-jet, Fischer–Tropsch, and power-to-liquid are required. If implemented fully, Indonesia is projected to reduce aviation sector emissions of cumulative 229.1 MtCO_2e between 2027 and 2060 or 52% emission reduction by 2060.

SAF Projection according to National SAF Roadmap



Emission Projection according to National SAF Roadmap



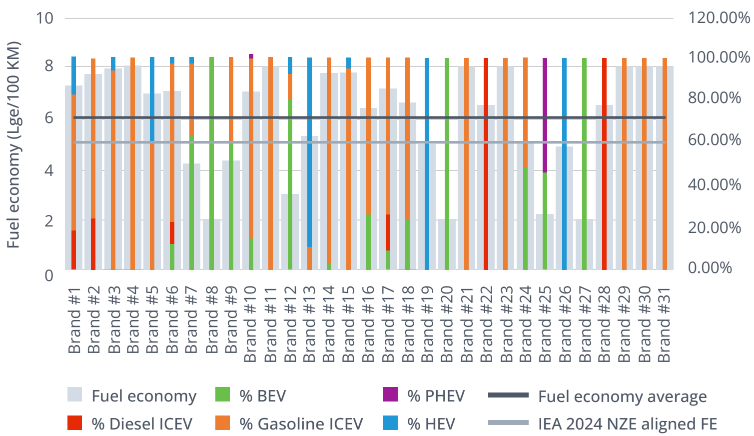
Source: Sustainable Aviation Fuel Roadmap (2024)

- However, the main challenge remains the limited production capacity of SAF. Under the realistic supply projection, domestic SAF demand can only be met until 2045, while under the best-case scenario it can be met until around 2054, assuming Indonesia's HEFA feedstock can be fully utilized for SAF production (Republic of Indonesia, 2024).

Lacking fuel economy standards and uneven efficiency progress highlights the need for fleet standards and sales mandates

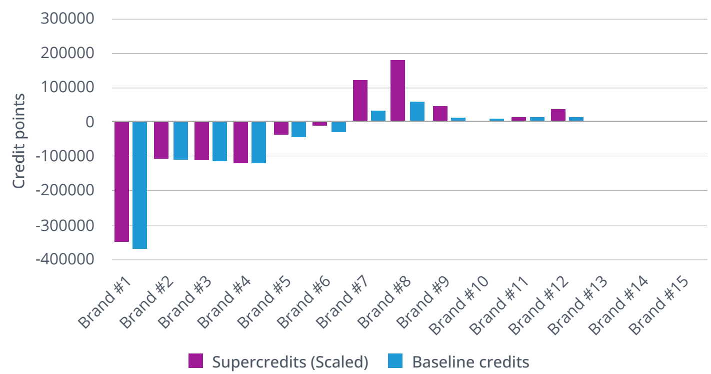
- Flooding the market with energy-efficient vehicles is key to transport decarbonization. An effective entry point is by introducing fuel economy standards (CAFE), which require all manufacturers to improve fleet efficiency (Lge/100 km).
- In 2024, 31 car brands sold over 490,000 passenger cars, but only 11 brands—mostly BEV-focused—met the 5.06 Lge/100 km NZE-aligned fuel economy target for 2024 (IEA, 2021). Average fleet fuel economy remains above 6 Lge/100 km across different powertrains, showing uneven progress in efficiency and electrification.
- If Indonesia were to enforce fuel economy compliance, one instrument would be credits, which measure fleet-average performance and sales from each brand. When converted to credits, brands collectively fall short by over 680,000 credits. Only a few BEV-focused brands generated modest surpluses (~100,000), but these were outweighed by major deficits among top-selling brands. The quickest way to close this gap is by replacing gasoline ICEs (8.0 Lge/100 km) with BEVs (2.0 Lge/100 km).
- Under a supercredit system like India's CAFE scheme (where BEVs count as 3 units, PHEVs 2.5, and HEVs 2), compliance could be met with far fewer vehicles. For instance, about 40,000 BEVs instead of 121,000 without supercredits. Supercredits accelerates paper compliance and boosts reported surpluses, but it does not deliver equivalent real-world improvements in fuel efficiency or emissions.
- A sales mandate addresses the current imbalance where most brands lag in electrification. By requiring each manufacturer to sell a minimum share of cleaner vehicles (BEV, HEV, PHEV), it ensures real deployment rather than paper compliance. To align with ENDC targets of BEV adoption, manufacturers must sell BEVs at least 10% of total sales in 2025, rising by about 7% each year to reach 44% by 2030 (IESR, 2025).

Corporate fuel economy for car brands based on 2024 sales



Source: IESR Analysis

Simulated corporate credit points based on 2024 sales



Source: IESR Analysis

Energy Transition Indicator	Gap Identification	Recommendations	Opportunities and Benefits
Fleet Electrification	• Large share of vehicles still use fossil fuel (gasoline and diesel) • Barriers to BEV adoption stem from limited and non-strategic placement of charging infrastructures • BEV emission reduction potential depends on the Grid renewable energy penetration	• Adopting a fossil fuel vehicle stockout plan with sales ban • Prioritize installations in malls, cafes /restaurants and apartments to allow opportunity charging and encourage adoption. • Incentivize installations of ultrafast (>200 kW) public chargers, aligning with consumer preference • Increase renewable energy penetration specifically in the grid	• Reduce oil imports and free up national fiscal space • Improve urban air quality
Fuel Economy Efficiency	• Lack of corporate fuel economy standards • Uneven corporate average fuel economy performance across different brands • Aggregate fuel economy performance misaligned with the NZE scenario	• Adopt corporate average fuel economy standards for Indonesia and develop enforcement mechanism (i.e. credit system, etc) • Adopt sales mandate for clean vehicle (HEV, PHEV, BEV) for each manufacturer	• Save energy use (oil and electricity) • Accelerate NDC target for BEV adoption
Modal shift	• High use of high-emitting trucks for freight transport • Rail underutilized due to costs, slower transit times, and reliability issues	• Expand infrastructure, reform fiscal policy, and apply market incentives to encourage intermodal freight	• Reduce freight emissions • Ease road congestion, curbs road accidents, reduces over-dimensioned/overloaded (ODOL) trucks • Prevents road-dependent lock-in
Shipping Decarbonization (maritime)	• No clear long-term fuel pathway (biofuel vs electricity vs hydrogen/ammonia) causing uncertainty for vessel investment	• Develop and adopt national maritime decarbonization roadmap aligned with IMO 2050 targets	• Strengthen competitiveness of international routes
Sustainable Aviation Fuel Uptake	• Feedstock availability and sustainability risk hinder large-scale deployment	• Prioritize aviation-only feedstock (UCO, tallow, non-food crops) to avoid competition with biodiesel in road transport	• Helps Indonesia comply with International Civil Aviation Organization's Carbon Offsetting and Reduction Scheme for International Aviation (ICAO CORSIA) and maintain international flight competitiveness

2.4. Progress in the Building Sector

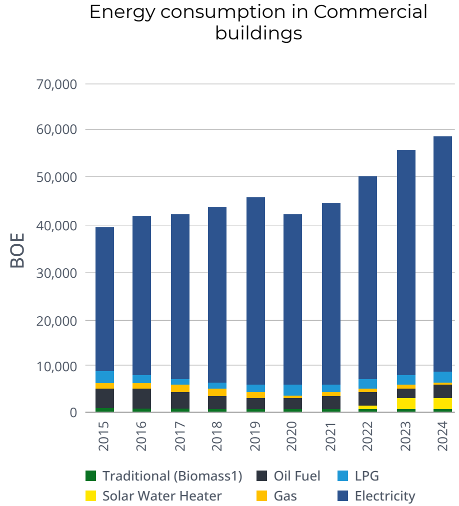
Maharani Dyah Alfiana and Malindo Wardana

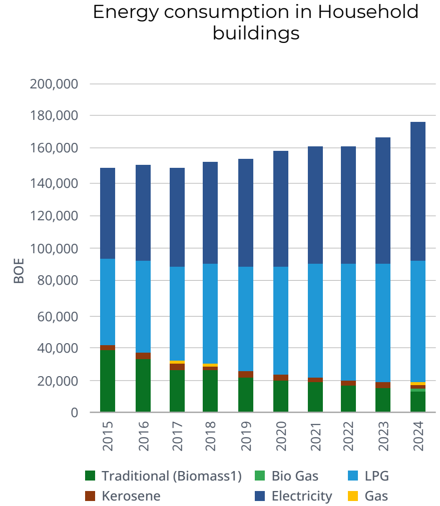
Energy Transition Indicators:

- Electrification
- Minimum Energy Performance Standard (MEPS)
- Energy Management
- Green Building

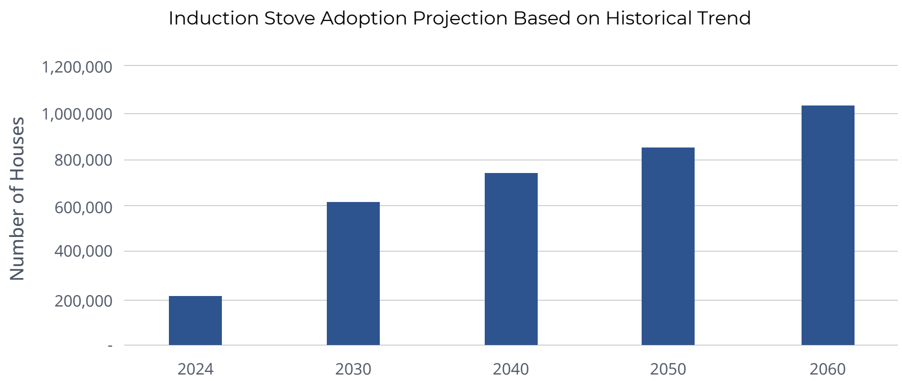
Electricity consumption is rising, yet the continued use of LPG and gas for cooking and heating hinders a comprehensive shift to electric energy

- The building sector accounts for 4.2% of Indonesia's CO2 emissions in 2023 (IEA, 2023). This figure is likely to rise as Indonesia's construction industry continues to expand, with annual growth projected at 7.2–7.5% until 2030 (ASEAN Briefing, 2025).
- Non-electricity energy sources accounted for 11.4% in commercial and 52% in household (including traditional biomass), primarily used for cooking and water heating. Meanwhile, electricity consumption continues to rise, with a CAGR of 5.4% in commercial buildings and 4.8% in household buildings between 2015 and 2024.
- In commercial buildings, efforts to replace gas and LPG with solar water heaters have begun and grown steadily over the past three years. Their use increased by 104% from 2022 to 2023 and 26.4% from 2023 to 2024, which coincided with a 52% decline in gas use in 2023 (MEMR, 2025a). While solar water heaters have emerged as a promising low-emission alternative, their adoption remains limited due to high upfront costs.
- Household energy consumption continues to be dominated by cooking needs, with LPG and gas accounting for 88.6% of total use in 2024, representing a 14.5% increase in LPG consumption between 2019 and 2024. Over the past decade (2014–2024), electric stoves have accounted for less than 1% of total cooking fuel use, lagging behind kerosene (2.3%) and firewood (8%) (BPS, 2025).
- If the growth of induction stoves in household sectors adoption follows historical trends, only about 1 million households are projected to use induction stoves by 2060, far below the government target of 43.4 million (MEMR, 2025b). Without stronger policies and infrastructure support, achieving the national target will remain infeasible.





Source: MEMR, 2025

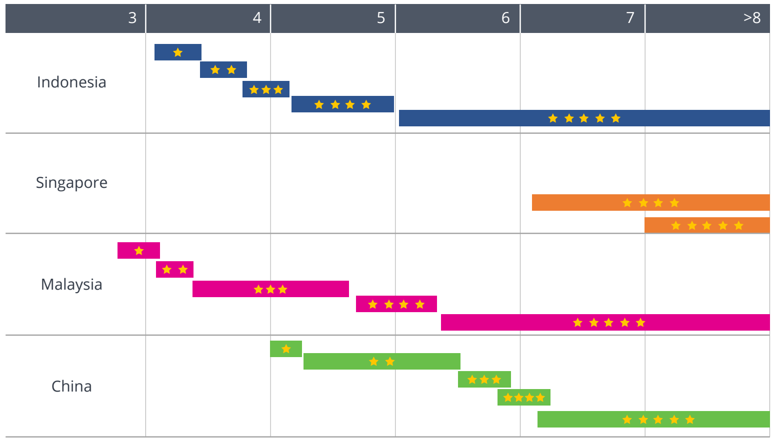


Source: IESR Analysis, 2025

Weak efficiency standards below ASEAN's benchmark enable dumping of outdated ACs and delay major energy and emission savings

- The efficiency of air conditioner (AC) use remains a major concern. 72% of the 6.2 million AC units sold in ASEAN in 2021 have low efficiency. Indonesia and Malaysia still allow units with a Cooling Seasonal Performance Factor (CSPF) of 3.01 and 3.1 in 2025, while Singapore has advanced to require above 6.09. Indonesia (97%) and the Philippines (78%) lead in low-efficiency room air-conditioner (RAC) sales. Around 93% of ACs imported from China into ASEAN fall below China's MEPS, showing that outdated products are being dumped (Clasp, 2023).
- This efficiency gap persists because low-efficiency (1-star and 2-star) models remain available and more affordable for consumers. In 2024, the Ministry of Energy agreed to phase out 1-star units, supported by the Minister of Industry Regulation No. 6/2024. The Trade Minister Regulation No. 8/2024 weakened these restrictions by removing import approvals and eliminating the requirement for technical considerations. However, these restrictions were reinstated through regulation No. 16/2025 in September 2025 requiring compliance with applicable technical standards.
- In 2026, Malaysia plans to raise its AC MEPS to 4.1 CSPF, followed by 6.09 CSPF in 2030 (LBNL, 2025). By pushing the Indonesian policy to adopt the ASEAN MEPS level of CSPF 6.09 by 2026, the country could achieve 14.04 TWh energy savings along with a substantial reduction in emissions of 49.82 $MtCO_2e$ by 2030. The gradual phase-out of 1-star products is unlikely to pose challenges for manufacturers, as they generally adapt to market demand and comply with national policies. However, without strict enforcement, stronger inter-agency coordination, and standard MEPS upgrades or bans on low-efficiency models, the policy will remain ineffective.

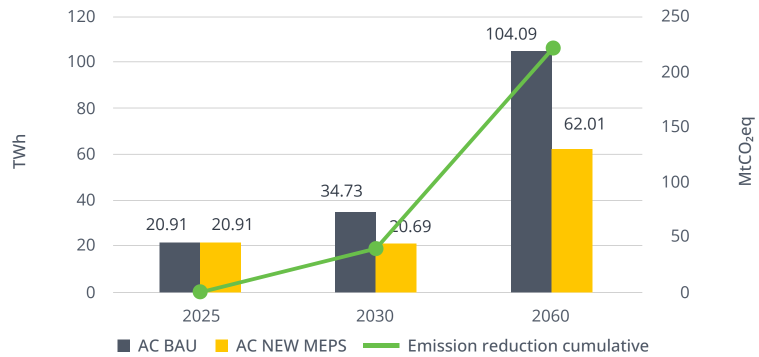
Air Conditioner MEPS Comparison
CSPF and Number of Stars for Efficiency



Singapore, Malaysia, and China tier based on Cooling Cap (<4500W)

Source: ASEAN, 2021, LBNL, 2025, SAMR, 2019

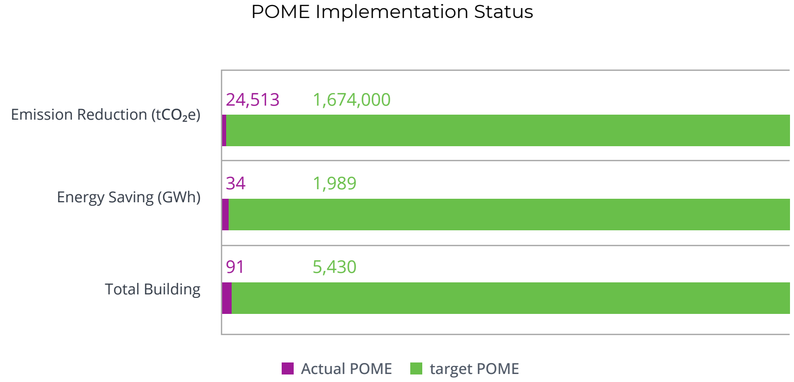
Air Conditioner Demand and Emission Projection under BAU and New MEPS Scenarios



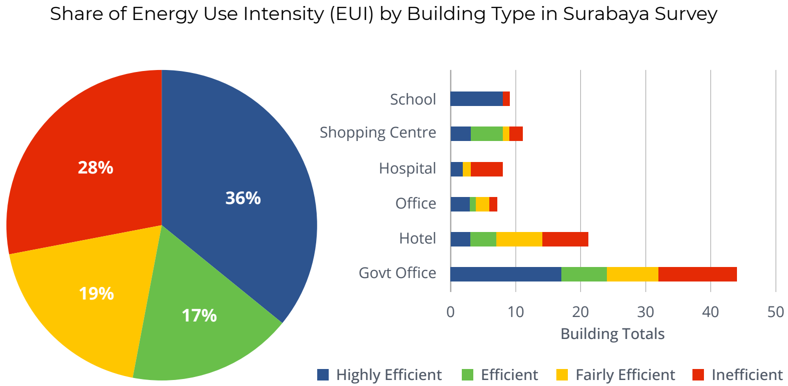
Source: IESR Analysis, 2025

Limited awareness and lack of enforcement hinder the progress of energy management implementation

- Compliance with Government Regulation No. 33/2023 on energy management remains low due to limited awareness, concerns over upfront investment, and a lack of enforcement. Since the regulation was issued, only 4.4% out of 679 commercial buildings and 1.2% out of 4,751 government buildings have complied and reported progress to POME, an online energy management portal managed by MEMR. This very low compliance has resulted in only 1.5% of the emission reduction target being achieved. If full compliance were achieved, it could save 1.989 GWh of energy and reduce 1.67 $MtCO_2e$ emission (MEMR, personal communication, August 5, 2025).
- Examples from Surabaya illustrate the gap between policy and practice. Even in a major city with a progressive sustainability vision, only 27 out of 100 sample non-residential buildings have implemented energy management to achieve efficient energy use. Among these 27, only 15 buildings have appointed certified energy managers. As the EUI serves as a key metric for monitoring efficiency levels, the survey revealed that inefficient hotels and hospitals often lack an energy manager and energy management implementation, or operate in older buildings.
- Meanwhile, many companies and organizations have delayed or neglected energy management because of additional costs. The regulation mandates appointing a certified energy manager and a certified auditor to verify. While such a manager can be from internal, the cost of certifying the personnel could deter the move. Meanwhile, government officials trained in energy management often feel it adds extra responsibility for their workload, often without adequate incentives.



Source: MEMR, 2025



Source: IESR Analysis, 2025

- Based on our correspondence with MEMR, no enforcement actions have been taken against non-compliant buildings to date. MEMR has been focusing on more persuasive approaches via socialization and technical assistance activities. The absence of enforcement risks continuing low compliance.

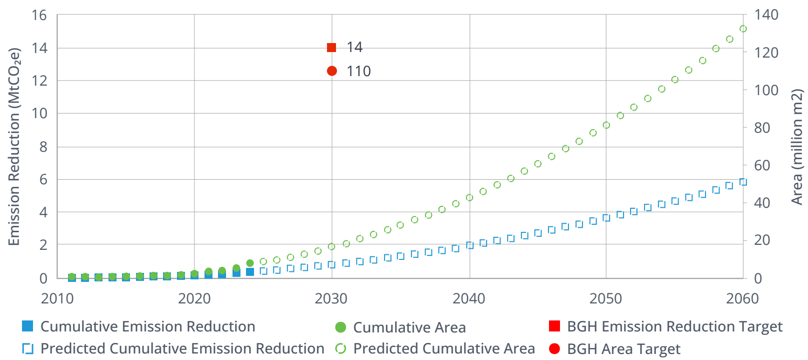
Only 6% of the mandatory emission reduction target can be achieved in 2030, even after totaling all types of green building certifications

Differences Between Green Building Certifications

Parameter	Greenship	EDGE	Bangunan Gedung Hijau (BGH)
Mandatory Status	Non-Mandatory. Available certifications: New building, existing, interior space, homes, neighborhood.	Non-Mandatory: Can be used for various buildings.	Mandatory for buildings in Class 4, 5, 6, 7, 8, 9a, 9b. Voluntary otherwise.
Empirical Energy Savings vs Business as Usual (BaU)	Up to 68%. Median = 32%	≥20%. Median = 30%	No data. Designed to consume 25% less energy.
Increase in Cost (Rupiah/m2 or %)	No data.	Median = 6% of total construction cost	New building = 0.8 to 1.25 million Rupiah/m2.
Payback Period (Year)	No data.	Median = 7 years	No data.

Source: IESR analysis (GBCI, personal communication, September 18, 2025) (MPW, personal communication, August 5, 2025)

Cumulative Area and Emission Reduction

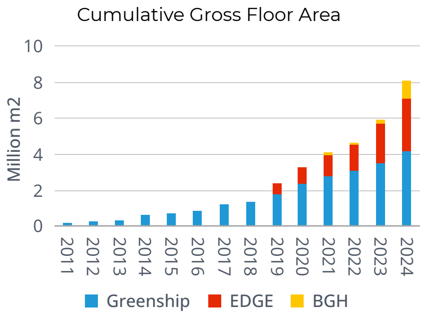


Source: IESR analysis (GBCI, personal communication, September 18, 2025) (MPW, personal communication, August 5, 2025)

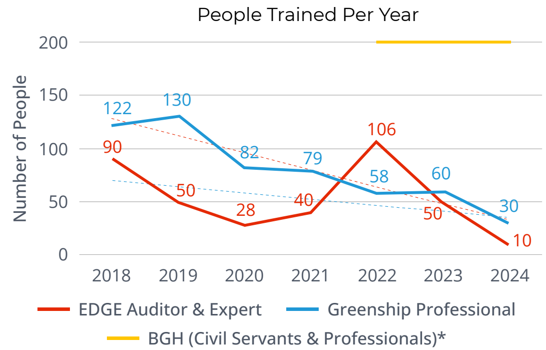
- A green building uses fewer resources (energy, water usage, and the embodied energy of materials) than a conventional building (EDGE, 2025), thus reducing GHG emissions from its operations. In Indonesia, both the Government of Indonesia (GoI) and private entities issue different certifications. GoI issues the Bangunan Gedung Hijau (BGH), which mandates certain building types to be certified. Meanwhile, private certification is non-mandatory.
- The Green Building Roadmap (MPWPH, 2023) aims to achieve a floor area of approximately 110 million m² for mandatory buildings by 2030. Such a target would avoid 14 MtCO$_2$e. Although the roadmap target is for BGH (the state certification), it is Indonesia's only existing target of green building uptake for now. Thus, it becomes the only benchmark in this section.
- The total area of all types of certifications (BGH, Greenship, EDGE, and others) was close to 7.5 million m² in 2024. The calculation excludes residential buildings, which are very few. When extrapolated to 2030, the total area would grow to about 16.5 million m² (only 15% of the roadmap's target). If the trend continues, the total area would only match the 2030 roadmap's target of 110 million m² in 2056.
- Cumulative emission reduction in 2024 from green buildings operation is estimated to be 0.35 MtCO$_2$e. If the current trend continues, there will be only 0.79 MtCO$_2$ reduction by 2030 (6% of the roadmap's target of 14 MtCO$_2$e). By 2060, only 6 MtCO$_2$e could be reduced cumulatively.

Declining number of professionals in voluntary certifications, absence of incentive regulations, and limited local government capacity hamper the uptake of green building

- Voluntary green building certifications are expected to grow as more companies adopt sustainability-oriented values. A 2024 survey of 281 certified projects found that the main motivation for obtaining certification was value alignment with sustainability (39%), followed by a desire to be a market pioneer (32%) and external requests such as client demands or competitions (18%). Only 11% cited energy or water efficiency improvements as their main driver (PT Yodaya Hijau Bestari, personal communication, October 3, 2025). With global business increasingly shifting toward sustainability, demand for private certifications is likely to continue rising.



Source: IESR analysis (GBCI, personal communication, september 18, 2025) (MPW, personal communication, August 5 2025)

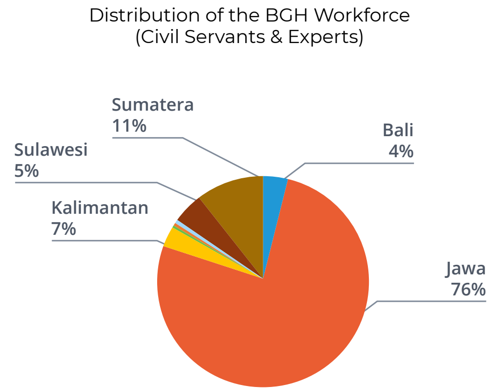


Source: IESR analysis (GBCI, personal communication, september 18, 2025).
**people trained per year for BGH is estimate.*

- However, this growth faces a challenge due to the declining number of trained professionals (graph titled "People Trained Per Year"). Since voluntary certification has dominated Indonesia's total certified green building area since 2011, the shortage of skilled practitioners could hinder future expansion and slow progress toward higher standards.

- BGH adoption could face a slowdown despite gaining interest. The uptake of BGH (the mandatory certification), which started in 2021, showed an increasing trend until 2024 (MPW, personal communication, August 5, 2025). Massive training programs held by the ministry during 2022-24 yielded 601 trained people, helped accelerate growth, and brought public attention to it. A 2025 survey done by IESR in Surabaya of 199 non-residential buildings showed that as many as 82% such buildings expressed interest and were somewhat interested in adopting BGH.

- However, concentrated experts, absence of incentive regulations, limited local government capacity, and limited fund allocation from the government are hampering its growth. As of August 2025, BGH's experts were present in only 13% of Indonesia's cities, and more than three-quarters of all trained personnel (civil servants and experts) were in Java. Only DKI Jakarta, Semarang, Gianyar, and Denpasar updated/have been updating local regulations to account for BGH implementation, while only Gresik Regency, Tangerang City, DKI Jakarta, Denpasar, and Sleman Regency can perform assessments without central government support (MPW, personal communication, August 5, 2025). Lastly, changes in state budget allocation would impact the personnel training plan. With such limitations, BGH uptake in the upcoming years is predicted to be slow.



Source: IESR analysis (MPW, personal communication, August 5, 2025)

Energy Transition Indicator	Gap Identification	Recommendations	Opportunities and Benefits
Electrification	• Limited financial support and economic attractiveness	• Provide targeted incentives, such as for solar water heater deployment and special electricity tariffs for induction stove	• Emission reduction through the shift to cleaner energy • Access to modern technologies that enhance safety and convenience
Minimum Energy Performance Standard (MEPS)	• Weak MEPS enforcement and potential influx of low-efficiency technologies • Low inter-ministerial coordination	• Align national MEPS with ASEAN standards • Ensure more effective and coordinated implementation across agencies; establish a coordinated task force	• Reduced electricity consumption and operating costs through adoption of high -efficiency appliances • Prevent low-efficiency product dumping and improve market quality
Energy Management	• Slow progress of energy management compliance, especially among entities consuming > 500 TOE	• Impose stricter sanctions on non-compliant buildings, while enhancing outreach, training, and certification programs for energy managers through participation in government initiatives	• Lower building operational costs • Creation of green job opportunities in energy auditing and management
Green Building	• Voluntary certifications: Decreasing number of trained professionals. • Mandatory certification: Limited and concentrated experts, absence of incentive regulations, limited local government capacity, and risk of changes in state budget allocation to support BGH training. • Both: No central database for all certified private and BGH green buildings.	• Provide a mechanism to recognize voluntary certifications under the mandatory one (BGH). • Build a central database for both private and BGH certifications via cooperation with the private sector, such as the Green Building Council Indonesia. • Focus on supporting local governments in incorporating green building into local regulations, including incentive schemes coupled with tax reduction. Once local regulations are in place, ensure their enforcement.	• When the government recognizes voluntary certifications under the mandatory one (BGH), the private sector can enjoy incentive schemes. This will help spur green building uptake. • The cooperation will also pave the way for the development of a central database listing all green buildings. Easier analysis of the green building's impact on emission reduction will ensue. • Incorporation of green building techniques into tertiary level curricula will help increase public awareness.

Chapter 3:
Enabling Environments for the Energy Transition

Contents

3.1. Transition Readiness Framework

Putra Maswan

Despite strong political commitment, advancing regulatory clarity, financing support, and human capital development is essential to achieving tangible progress in Indonesia's energy transition

- The Transition Readiness Framework (TRF) assesses Indonesia's energy transition readiness across four dimensions, political commitment and governance, investment and finance, public participation, and technology advancement, covering key sectors: power, industry, transport, and the buildings. IESR has conducted this assessment since 2021 to track progress and identify gaps.
- Overall, incoherent policies, limited financing support, and insufficient human capital capacity remain key factors behind the stagnant progress of Indonesia's energy transition. Strengthening these areas are essential to accelerate the impact of ongoing energy transformation initiatives.
- Politically, President Prabowo has reaffirmed Indonesia's commitment to the Paris Agreement and pledged to achieve 100% renewable energy and NZE under the Asta Cita vision, which emphasizes self-sufficiency, economic growth, and international cooperation. However, progress remains slow due to weak institutional capacity to translate political commitments into actionable measures. The lack of fiscal support and incentives to develop renewable energy and clean technology markets further constrains progress. A slight change is observed in the domestic technology supply chain and cost competitiveness, now rated "medium," driven by stronger supply chains for solar PV and battery technologies, while many other technologies remain economically unfeasible.
- Beyond regulation and funding, human capital development must advance in parallel with technological progress. Building a skilled workforce will not only strengthen public awareness and participation in the transition but also foster innovation in clean energy technologies.

Transition Readiness Framework (TRF) Rating

Dimensions	Variables	Rating 2024	Rating 2025
Political Commitment and Governance	Political Commitment	Low	Low
	Regulatory Framework	Low	Low
	Institutional & Governance	Low	Low
Investment and Finance	Investment for Energy Transition	Medium	Medium
	Finance for RE	Low	Low
Public Participation and Community Acceptance	Human Resource	Medium	Medium
	Public Participation	Medium	Medium
	Media Narratives	N/A	Medium
Technology Advancement	Ecosystem Support	Medium	Medium
	Domestic Supply Chain	Low	Medium
	Cost Competitiveness	High	Medium

Source: IESR analysis

3.2. Political Commitment and Governance

Angga Kusuma Wijaya

Contents:

- Political Commitment
- Regulatory Framework
- Institutions and Governance
- TRF Rating

Indonesia's energy transition under the Prabowo administration demonstrates sustained commitment amid global uncertainty

- On January 20, 2025, the newly elected President of the United States (US), Donald Trump, signed an Executive Order to withdraw the US from the Paris Agreement for the second time. The US withdrawal has created a leadership vacuum in global climate governance—prompting emerging economies such as China and Brazil to assert greater influence (Carbon Brief, 2025). In addition, it also generates broader repercussions that cause other countries to reassess their climate commitments. In Indonesia, this uncertainty has been reflected in pessimistic statements by the country's officials, questioning the Indonesia's obligation to the Paris Agreement (Kata Data, 2025; Antara, 2025). Such ambiguity risks undermining policy coherence, weakening investor confidence, and ultimately hindering Indonesia's ability to achieve a timely and effective energy transition.
- Despite the uncertain geopolitical landscape and ambiguous statements by some officials, Indonesia under President Prabowo has reaffirmed its commitment to the Paris Agreement and to achieving NZE. At the 2024 G20 Summit, Prabowo announced plans to phase out all fossil-fueled power plants within 15 years and develop 75 GW of renewable energy capacity (Setkab, 2024). He later reiterated this goal alongside Brazilian President Lula, suggesting Indonesia could achieve 100% renewable energy within 10 years, sooner than the initial projection of 2040 (Tempo, 2025). In subsequent addresses, including the 2025 State of the Nation Address and the UN General Assembly (UNGA), Prabowo emphasized Indonesia's commitment to a full renewable transition by 2035 and NZE by 2060 or earlier (Kumparan, 2025; VOI, 2025). These consistent statements signal strong political commitment and aim to reassure both domestic and international clean energy investors.
- The Prabowo–Gibran administration's political direction is outlined in the Asta Cita vision, which aspires to realize a "Golden Indonesia 2045". Central to this vision is the pursuit of national energy self-sufficiency by reducing dependence on imports and prioritizing domestic—particularly renewable—energy sources (Prabowo-Gibran's Vision and Mission, 2024). This goal aligns with the administration's target of 8% annual economic growth within five years. To advance this agenda, President Prabowo has strengthened international cooperation, including a 2024 bilateral visit to China that led to agreements between PLN and major Chinese firms on sustainable energy (Tempo, 2024). Furthermore, Indonesia's decision to join BRICS reflects a strategic move to enhance energy independence and support its broader development objectives (Reuters, 2024).

Political Commitment to Energy Transition

POLITICAL COMMITMENT
Expressed Commitment
2024 G20 Rio Summit [November 19, 2024]
Joint Statement with the Brazilian President [July 9, 2025]
2025 State of the Nation Address [August 15, 2025]
UNGA Speech [September 22, 2025]
Institutional Commitment
The National Energy Policy (KEN)
The National Electricity Plan (RUKN)
The Electricity Supply Business Plan (RUPTL)
MEMR Regulation No. 10 of 2025 (The Electricity Sector Energy Transition Roadmap)
MEMR Regulation No.5 of 2025 (Guidelines for PPAs from Renewable Energy-based Power Plants)
Budgetary Commitment
Law on the State Budget (APBN) for the 2026 Fiscal Year

Source: IESR Compilation, 2025

Despite strong commitment, Indonesia's energy transition progress remains constrained by incoherent policies and limited fiscal support

- While the President's expressed commitments signal strong political will, they must be institutionalized through credible policies. In 2025, Indonesia faced a crucial moment to demonstrate such commitment through the submission of its Second Nationally Determined Contribution (SNDC), which was repeatedly delayed to align with the new administration's economic growth target (Kompas, 2025). The SNDC draft, submitted to the United Nations Framework Convention on Climate Change (UNFCCC) on October 27, 2025, sets Indonesia's renewable energy mix target of 19%–23% by 2030—falling short of the global benchmark to reach 79% by the same year (Climate Analytics, 2024)—and projects the energy sector's emissions peak by 2035-2038, pushing back the earlier 2030 peak target (UNFCCC, 2025). This delay risks prolonging fossil fuel dependence, undermining policy credibility, and increasing long-term transition costs, thereby weakening Indonesia's leadership in regional and global climate governance.

Indonesia's Energy Transition Targets Compared to Global Benchmarks

Indicator	Paris Agreement/ Global Benchmark	Indonesia's Target (as of 2025)
Renewable energy share in power mix	79% by 2030	19–23% by 2030 (SNDC draft)
Energy sector emission peak	By 2030	2035–2038
Renewable energy share (policy)	100% by 2040 or earlier (Prabowo's target)	36–40% by 2040 (Revised KEN)
Annual renewable capacity addition	~10 GW/year	0.876 GW added (first half of 2025)
Estimated annual investment requirement	USD 30–40 billion	USD 2.4 billion (2026 state budget allocation)

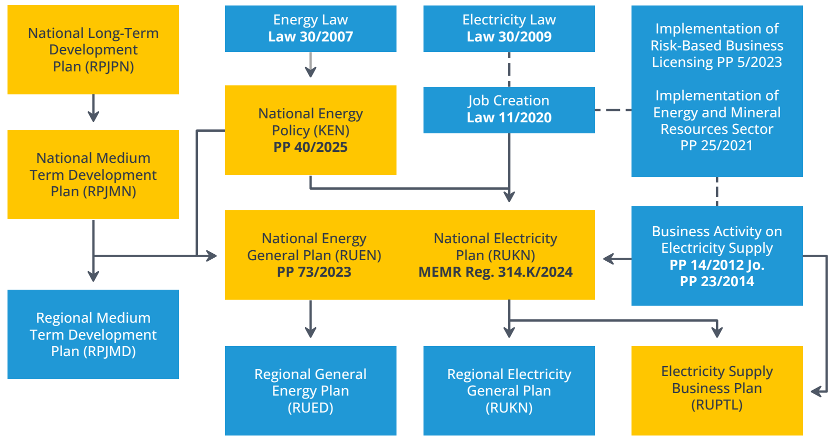
Source: IESR Analysis, 2025

- President Prabowo's strong commitment has prompted his administration to adopt a more proactive approach. In the first semester of 2025, the MEMR reported an additional 876.5 MW of renewable energy power plant capacity, representing an increase of 15% from 2024 (ESDM, 2025). However, this progress remains significantly below the government's Comprehensive Investment and Policy Plan (CIPP) benchmark of approximately 10 GW of new capacity per year by 2030 (IESR, 2023). The government also introduced a revised KEN with more ambitious targets than its predecessor; however, it remains inconsistent with Prabowo's pledge for 100% renewable energy, instead setting instead a goal of 36–40% NRE by 2040 (GoI, 2025). Moreover, ambiguous statements from the Minister, particularly regarding the coal phase-out timeline in public media (CNN Indonesia, 2025), exacerbate policy uncertainty and risk undermining investor confidence in the renewable sector.

- Furthermore, Indonesia's fiscal commitment remains inadequate to support a rapid energy transition. The 2026 State Budget (APBN) allocates IDR 402.4 trillion for energy security, covering renewables, energy subsidies, tax incentives, and rural electrification (Setneg, 2025). This figure declined from IDR427.7 trillion in 2025 (Antara, 2024). Notably, renewable energy development received only IDR 37.5 trillion (USD 2.42 billion) (CNBC Indonesia, 2025), far below the USD 30–40 billion annual investment estimated as necessary for the transition (IESR, 2023). This fiscal imbalance highlights the gap between Prabowo's ambitious climate rhetoric and the government's limited budgetary prioritization, constraining Indonesia's progress toward a sustainable energy transition.

Indonesia’s multi-layered renewable energy governance provides a comprehensive framework, yet policy misalignments continue to hinder coherent implementation.

Indonesia’s Regulatory Framework for Energy and Electricity Planning



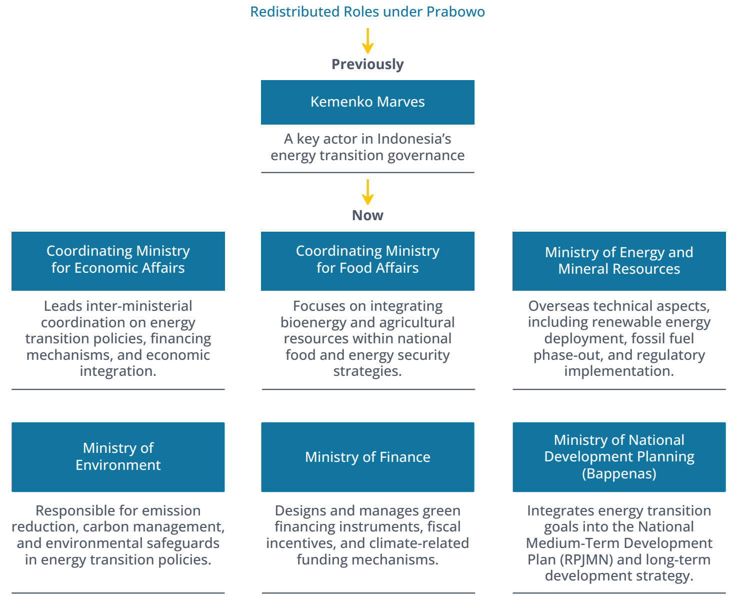
Source: IESR Analysis, 2025

- Indonesia’s renewable energy governance operates within a multi-layered regulatory framework encompassing long-term planning, enabling legislation, and implementation mechanisms. At the planning level, the KEN establishes overarching energy goals, including renewable energy mix targets, while the National Energy General Plan (RUEN) translates these objectives into measurable strategies and sectoral roadmaps. These are further reinforced by derivative plans, such as the RUKN, RUPTL, RPJPN, and RPJMN, and operationalized through regional frameworks like the RPJPD, RPJMD, RUED, and RUKD to align national and subnational implementation [see Figure 4]. Collectively, these instruments form the strategic foundation for accelerating Indonesia’s renewable energy deployment.
- To enable the transition, the government has introduced key legal instruments. For example, the Law on New Energy and Renewable Energy and Presidential Regulation No. 112/2022 outlines renewable energy tariff mechanisms and limits further reliance on coal in power generation. This is complemented by Ministerial Regulation No. 10/2025, which outlines the power sector roadmap to achieve NZE by 2060 or earlier. However, the regulation falls short of enabling early coal retirement, as it relies on transitional measures such as biomass co-firing and CCS that may prolong fossil fuel dependence. Moreover, the policy lacks an ambitious clean energy strategy and reflects ongoing compromises between fossil fuel interests and renewable energy priorities.
- Despite these frameworks, Indonesia’s energy regulatory framework still reflects notable misalignments. The revised KEN sets an emissions peak by 2035 and targets clean energy development comprising 70–72% of the energy mix by 2060, while still leaving a significant role for fossil fuels (GoI, 2025). This trajectory diverges from the RPJPN, which envisions a 70% renewable share by 2045 as part of the Golden Indonesia 2045 agenda (RPJPN, 2025). These inconsistencies stem from shifting policy priorities and institutional constraints, as KEN targets are often revised to align with political and economic considerations rather than long-term planning objectives. Consequently, the lack of coherence across policy frameworks generates mixed signals and hampers coordination between national and subnational actors in translating targets into coherent and implementable strategies.

Institutional restructuring and new task forces reflect Indonesia's evolving yet fragmented approach to managing the energy transition

- Indonesia's energy transition continues to face major institutional challenges. A key change shaping its governance is the dissolution of the Coordinating Ministry for Maritime and Investment Affairs (Kemenko Marves), which previously served as a central actor in energy transition governance. Its functions have since been redistributed among several ministries, including the Coordinating Ministries for Economic Affairs and Food Affairs, as well as technical ministries such as Energy and Mineral Resources (ESDM), Environment (KLH), Finance, and National Development Planning (Bappenas) [see Figure 4]. This restructuring has increased bureaucratic complexity and fragmented decision-making processes, undermining policy coherence in areas such as energy security, coal phase-out planning, and subsidy reform.
- This reorganization has affected the governance of several major programs, including electric vehicle development, carbon pricing, and the coal phase-out under the Just Energy Transition Partnership (JETP). Many initiatives now lack a clear institutional lead, resulting in overlapping mandates and parallel efforts among agencies. For example, energy subsidy reform has been approached differently by ESDM—focusing on supply-side management—and the Poverty Eradication Acceleration Agency (BP Taskin)—emphasizing demand-side relief. These divergent approaches reveal persistent coordination gaps and illustrate the broader structural challenges of managing a cross-sectoral agenda such as the energy transition (ISEAS, 2025).

Energy Transition Coordination



Source: IESR Compilation, 2025

- To address these gaps, the Prabowo administration has introduced several new task forces to strengthen coordination and accelerate the transition. Presidential Decree No. 1/2025 established the Downstreaming and Energy Security Task Force, reporting directly to the President and overseeing mineral and coal downstreaming, agriculture, and energy security, including renewable energy development (Kompas, 2025). Similarly, the Energy Transition and Green Economy Task Force, created under Coordinating Economic Ministerial Decree No. 141/2025, brings together multiple ministries to design strategies and reforms that promote renewable investment and advance Indonesia's participation in the JETP and Energy Transition Mechanism (ETM) (The Jakarta Post, 2025). While these task forces provide important institutional platforms, there is a significant risk that they may add another bureaucratic layer rather than streamline coordination, unless they can establish clear mandates and cut across ministry silos effectively.

Despite President Prabowo's strong political commitment and ambitious vision for a sustainable, self-sufficient energy future, Indonesia's energy transition continues to face major obstacles due to policy incoherence, limited budget allocation, and institutional fragmentation

- President Prabowo has reaffirmed Indonesia's commitment to the Paris Agreement, pledging an accelerated transition toward 100% renewable energy and NZE. Guided by the Asta Cita vision, his administration emphasizes energy self-sufficiency, economic growth, and strengthened international cooperation to advance a sustainable energy future. However, Indonesia's energy transition remains hindered by incoherent policies, to translate these ambitions into credible action. Despite the existence of a high-level policy document on energy transition, the broader policy environment shows weak alignment with Paris Agreement pathways and persistently poor implementation of transition targets and plans. These structural weaknesses undermine policy credibility and erode investor confidence in Indonesia's clean energy development.
- Indonesia's energy transition roadmaps and regulatory frameworks reflect significant inconsistencies across existing policies. The low quality of existing regulatory support, coupled with a lack of alignment between sectoral roadmaps and decarbonization targets, reinforces a persistent disconnect between national objectives and the necessary instruments to achieve them. This situation is further compounded by weak supportive non-energy regulations, which limit coordination across sectors essential for an economy-wide transition. Collectively, these shortcomings send conflicting signals to policymakers and stakeholders, complicating efforts by national and subnational actors to translate high-level ambitions into coherent and actionable decarbonization strategies.

TRF Rating for Political Commitment and Governace

Variable(s)	Indicator(s)	Rating
Political Commitment	Existence of high-level policy document on energy transition	Medium
	Alignment of key national climate and energy policies with Paris Agreement	Low
	Implementation of energy transition targets/plans	Low
Regulatory Framework	Quality of existing regulatory support	Low
	Alignment of sectoral roadmaps and regulation with decarbonization target	Low
	Supportive non-energy regulations	Low
Institutional & Governance	Corruption level	Low
	Institutional capacity	Low
	Leadership	Medium
	Accountability	Low

Source: IESR Analysis

- Indonesia's energy transition governance is undermined by institutional fragmentation, leading to overlapping mandates and inconsistent approaches across key policy domains. Although the corruption level is assessed as low, reflecting minimal documented integrity risks in the sector, this is overshadowed by a lack of institutional capacity, characterized by weak coordination, limited resources, and governance shortcomings that hinder effective planning and execution. Leadership is rated medium, as political support for the transition exists but is inconsistently translated into clear policy direction. Accountability remains low, with limited transparency and unclear institutional responsibilities. Together, these governance deficiencies constrain effective implementation and ultimately slow Indonesia's progress toward a just and sustainable energy transition.

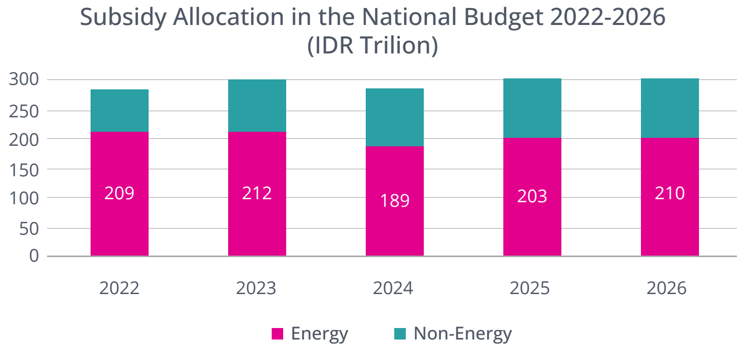
3.3. Investment and Finance

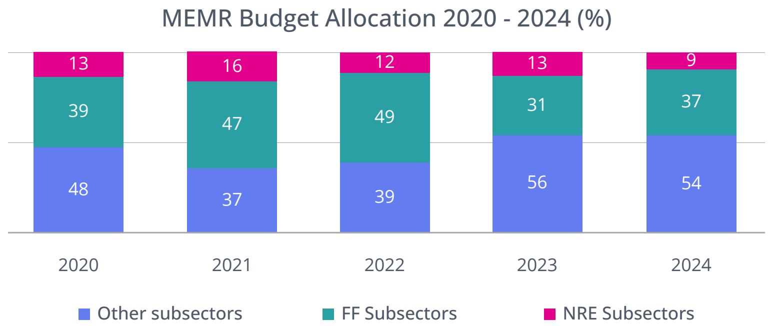
Aditia Rabbani Pramusakti and Putra Maswan

Contents:

- Public Financing and Support
- Private Investment
- International Support
- Carbon Market

Growing fossil fuel subsidies strain the budget, reinforce fossil fuel dependence, and hinder renewable energy scale-up





**FF Subsector: Ditjen Minerba and Ditjen Migas* ***NRE Subsector: Ditjen EBTKE*

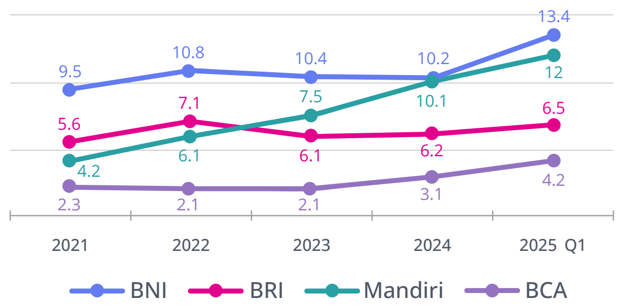
Sources: MoF (2025); MEMR (2025)

- The government allocates about two-thirds of total subsidies to energy primarily for fossil fuels, which are projected to reach IDR 1,023 trillion by 2026—accumulated in just five years. These subsidies have placed a growing burden on the national budget and continue to reinforce Indonesia's dependence on fossil fuels. Without comparable incentives for renewables, scaling up renewable energy will remain challenging in a market that favors fossil fuels, making renewables less attractive for investment. This is reflected in MEMR's 2024 investment realization, where fossil fuels continued to dominate energy sector investments, leaving the renewable energy subsector with only a small and stagnant share over the past five years (MEMR, 2025a).
- Examining state budget allocations for MEMR, the EBTKE subsectors received only 12% of the total MEMR budget on average over the past five years, compared to more than 40% allocated annually to coal mining and oil and gas subsectors. In 2024, EBTKE received only IDR 642 billion or about 9% of the total MEMR budget, decline from prior year, with half of this amount directed toward renewable energy infrastructure development (MEMR, 2025b). Continued high support for fossil fuels, combined with low EBTKE funding, undermines competitiveness, signals a lower policy priority that weakens investor confidence in renewables, and contributes to stagnant renewable capacity growth, delaying both energy diversification and climate goals.
- Institutionally, Indonesia has established several platforms to support energy transition financing. The government created the ETM as a country platform and appointed SMI as the country manager under MoFR 103/2024. The mandate of PII has also been expanded under MoFR 05/2025 to provide guarantees as de-risking instruments for clean energy projects. In addition, Indonesia established the sovereign wealth fund, Danantara, under Government Regulation 10/2025, with clean energy included as one of its investment priorities. However, despite these initiatives, there is still no clear budgetary implication or dedicated public funding allocation to significantly scale up investment in renewable energy projects to date.

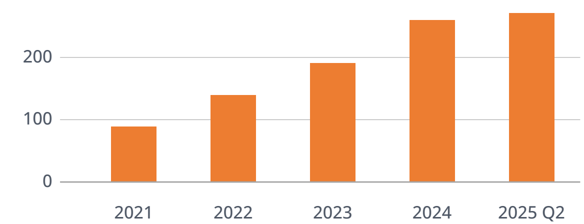
Private financing for renewables is rising with stronger green investment commitments, but remains small compared to the mining sector

- Private financiers from Indonesia's four largest commercial banks are showing growing interest in renewable energy projects, with financing rising by 23% in Q1 2025, reaching IDR 36 trillion. This positive trend reflects stronger Environmental Social Governance (ESG) commitments among lenders and falling costs in renewable development, particularly in solar and wind, which have boosted confidence in renewable energy investments. However, this figure remains small compared to the mining and quarrying sector, which continues to expand rapidly, reaching IDR 267 trillion by mid-2025. This indicates that extractive industries still dominate Indonesia's financing landscape.
- On the other hand, despite growing interest, commercial banks remain highly selective in financing renewable energy projects due to perceived risks (EY, 2025). Banks generally favor large-scale projects that offer greater cost efficiency, as small-scale projects often entail similar administrative costs but yield lower returns. They also prioritize sponsors with strong credit histories to minimize credit risks. Consequently, while large-scale developers face no difficulty accessing private financing, especially from international banks, small-scale developers continue to struggle.
- In practice, small-scale developers are often charged higher interest rates and required to provide greater collateral to compensate for perceived risks, despite their need for affordable financing. In 2025, the government allocated up to IDR 200 trillion as a stimulus fund to national banks to provide lower-interest loans for national strategic development projects (MoF, 2025b). In the future, this scheme could be strategically deployed to support small-scale developers and renewable energy projects, aligning with the country's national objectives for energy security.
- The private sector is ready to accelerate investment, but policy and procurement frameworks remain a bottleneck (Halimatussadiah et al., 2024). The limited number of scalable and bankable projects in the pipeline continues to hinder commercial banks from expanding renewable energy lending, largely due to a lack of transparency and delays in PLN's tendering process. Several stakeholders also note growing competition between commercial banks and development finance institutions (DFIs) for viable deals (IEA, 2025a), with DFIs holding an advantage through more flexible loan tenures and financing facilities. Therefore, the government must address these barriers by ensuring a steady pipeline of bankable projects to attract and mobilize greater private financing, while channeling DFIs funds toward emerging technologies to reduce competition and enhance market efficiency.

Bank Credit Allocation for Renewable Energy Projects, 2021–2025 (IDR Trillion)



Bank Credit Allocation for Renewable Energy Projects, 2021–2025 (IDR Trillion)

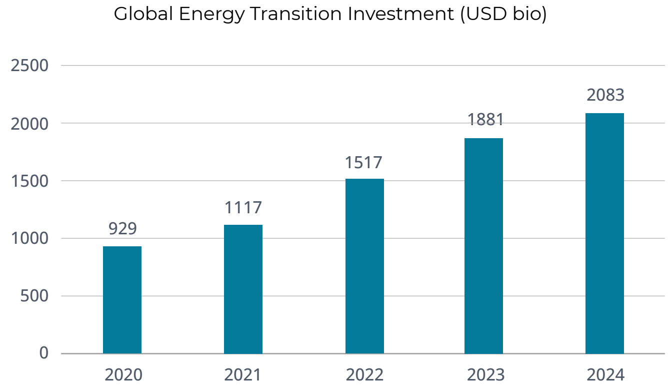


Note: Banks in KBMI 4 (Core Capital > IDR 70 trillion)

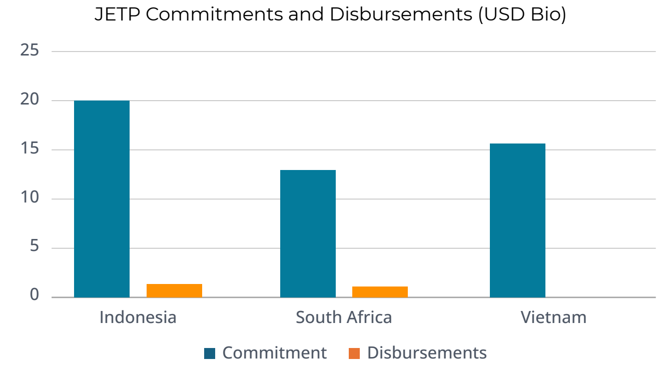
Sources: OJK (2025): IESR analysis from various sources (e.g Bank websites and media outlets)

Indonesia's international investment is falling short of targets, underscoring an urgent need for policy improvements and a pipeline of bankable projects

- At the global level, investment in the energy transition reached a new peak of $2.1 trillion in 2024, more than double the amount invested in 2020. Despite this milestone, the annual growth rate was 11% last year, falling from 24-29% in the 2021-2023 period. This slowdown was due to declining investment from 'emerging' sectors (e.g. nuclear, CCS). However what kept overall investment to grow was the 'mature' sectors (power grids, energy storage, RE & EV) that showed strong consistent investment flow. However, current global annual investment is only 37% of what is needed annually this decade to remain on a trajectory for net-zero emissions by 2050 (BNEF, 2025).
- Mirroring this global trend, Indonesia is also struggling to meet its investment targets (MEMR, 2025). Indonesia's largest and most prominent international investment scheme is the JETP. Total JETP financing approved to date stands at USD 3 billion from the International Partners Group (IPG), covering 46 programs and 4 projects. The approved project financing consists mainly of concessional loans of up to USD 138 million, supporting 143 MW of renewable energy (JETP, 2025). Entering its third year since launch, this level of progress is very slow when measured against the program's total committed finance of USD 21.4 billion as well as Indonesia's renewable energy capacity targets. This stagnation is due to the limited number of bankable projects eligible for the committed funding.
- From 2022-2024, the Southeast Asia region received 7.5% of international finance invested into Developing Countries (IEA, 2025b). With this limited amount of funds, Indonesia must not only compete with neighboring regional countries, but also with the rest of the developing world. Indonesia have not yet fully tapped into the growing global energy transition trend and must act tactically and strategically to navigate these investment shifts and close its funding gap. Indonesia must improve its domestic investment climate by streamlining regulatory frameworks, enhancing policy certainty, and developing a robust pipeline of bankable projects to attract international capital. Furthermore, with Western investment slowing down, Indonesia should proactively leverage South-South Cooperation, particularly by engaging China as a key partner to fund and accelerate its energy transition ambitions.



Source: BNEF (2025)

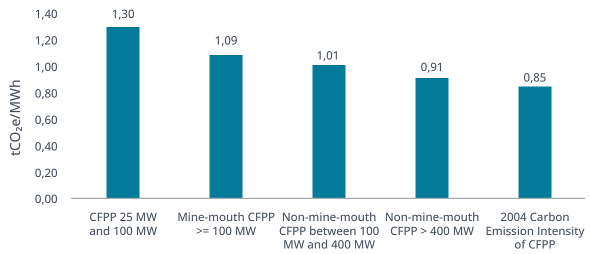


Source: IEA (2025)

Carbon pricing has the opportunity to increase energy transition finance, though prices remain below global benchmarks

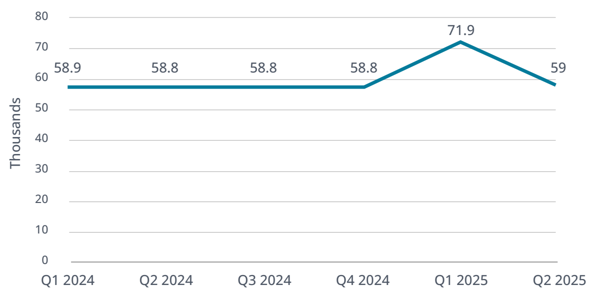
- In early 2023, Indonesia launched its mandatory carbon market or Emissions Trading System (ETS) targeted at coal-fired power plants connected to the PLN grid. Intensity caps (PTBAE) were established to determine the emission allowance ceiling for installations, which could then be traded in auctions. As of 2025, there are 245 registered participants and a combined installed capacity of 54 gigawatts, but there has been limited trading of carbon units and tax payments (MoE, 2025). The emission thresholds are set very high, resulting in very few facilities exceeding them (IEEFA, 2025). As a result, the ETS has not succeed in limiting CFPP emissions, nor has it provided additional funds to finance the transition of Indonesia's power sector towards cleaner technologies.
- Globally, carbon markets are growing, with carbon-related transactions generating over USD 100 billion in revenue in 2024 (World Bank, 2025) . Meanwhile, Indonesia's secondary voluntary market, the IDXCarbon, had a total transaction of only USD4.9 million (IDR78 billion) since its launch two years ago. To date, just eight projects have been listed, and only 132 participants are registered to trade, with the average carbon price around IDR 60,000 or around USD 3.6 per ton (IDX, 2025). The global benchmark for carbon credits is at USD 50-100 per ton by 2030 to meet Paris Agreement goals (CPLC, 2017). This shows that improvements are required for Indonesia's carbon market to mature.
- Last year, during COP29, there was a finalization of the Article 6 mechanism, which established the operational frameworks for bilateral/multilateral transfers of carbon credits between countries, enabling nations to trade carbon emissions to fulfill their Nationally Determined Contributions (UNFCCC, 2024). The Government of Indonesia has shown appetite for such carbon pricing mechanisms, with the affairs of the economic value of carbon now institutionalized within the new Climate Change Deputy of the Ministry of Environment as well as through the recently issued Presidential Regulation (PR) No. 110/2025, which refines and clarifies PR No. 98/2021, showing good progress.
- As a powerful mechanism for cutting emissions, generating revenue, and attracting investment, carbon pricing holds great potential for Indonesia, but strategic reforms are essential to tap into the global carbon market. We must not only lower the current carbon caps but also impose a significant carbon tax, setting it at a level that both changes behavior and reflects the urgency of our climate goals. Furthermore, Indonesia should strengthen its carbon market institutions, enhance its regulations and standards, and establish robust and credible monitoring, reporting, and verification (MRV) data collection to ensure transparency, accountability, as well as actual offsetting, and avoid greenwashing.

Carbon Emission Cap vs 2024 CFPP Emission Intensity



Source: IEEFA (2025)

Average Carbon Unit Price (IDR/tCO_2e)



Source: IDXCarbon (2025)

The renewable energy market shows growth potential but remains constrained by limited public support, financing barriers, and uncertainty in the project pipeline

- Overall, despite increasing private sector interest and the growing potential of the renewable energy market, government fiscal support has remained stagnant, while uncertainty in the project pipeline continues to pose a challenge. Renewable energy investment increased by 20% to USD 1.8 billion in 2024 compared to 2023 (MEMR, 2025a). However, this remains significantly below the estimated annual investment requirement of USD 9.1 billion (UNFCCC, 2021).
- On the investment side, Indonesia's risk profile remains stable with a slightly positive outlook, according to major international credit rating agencies, which is unchanged from the previous year (OJK, 2025). Bureaucratic processes, however, remain complex. Several developers noted that uncertainty in processing times increases capital expenditures that could otherwise be avoided, although documentation requirements have become more manageable.
- Access to capital also shows little improvement from last year. Large developers report minimal financing constraints once PPAs are secured and often secure better financing terms from international banks, while national banks tend to charge higher interest rates. In contrast, small-scale developers continue to face difficulties accessing financing due to their project size and higher perceived risks. Consequently, overall investment indicators are assessed at a medium level, reflecting these mixed conditions.
- From the financing aspect, international financial support, particularly aid and grants, remains limited. The stagnation of JETP financing, exacerbated by the U.S. withdrawal, has disrupted the flow of international funds. This reflects a broader global slowdown in climate and energy transition finance, resulting in a low rating for international support. At the national level, government budget allocations for renewables declined compared with the previous year; signaling weak support for clean energy deployment. Overall, government financial support is assessed at a low level.

TRF Rating for Investment and Finance

Variable(s)	Indicator(s)	Rating
Investment for Energy Transition	Investment risk level	Medium
	Bureaucracy	Medium
	Access to capital	Medium
Finance for RE	International support	Low
	Public budget allocation	Low

Source: IESR Analysis

3.4. Public Participation and Acceptance

Martha Jesica Solomasi Mendrofa

Contents:

- Regulation and Implementation of Public Participation
- Public Awareness
- Media Narratives
- Human Capital Preparation
- TRF Rating

Public participation is recognized in national energy regulations, but practice remains largely formalistic and calls for more specific measures

- Public participation is a cornerstone of just energy transition, ensuring both procedural and recognition justices. Indonesia has a multi-layered development planning forum (musrenbang) from village to national levels, intended to gather aspirations from local communities. Yet, musrenbang participation often remains symbolic, hindered by elite dominance, weak knowledge integration and learning, and absence of community control (Akbar, et al, 2020; Ibrohim & Ismanudin, 2025).
- The same pattern persists in energy sector. Law No. 30/2007 on Energy mandates the public's right to access energy and outline the public's contribution in energy policymaking and development. Other policies, such as RUEN and RUKN, mention public participation with varying levels of detail. However, the regulations remain vague on how public participation should be implemented. This lack of clarity is also evident in demand-side decarbonization regulations, which either omit public participation altogether or fail to specify how it should be facilitated (see Table 1).
- Recent updates in KEN and RUPTL mark progress in broadening public participation. GR No. 40/2025 on National Energy Policy (KEN) mandates energy access as national priority, emphasizing infrastructure improvement for information and service and local energy resources utilization for regional economic growth. KEN also allows the public to participate as electricity provider through PPA. The Electricity Supply Business Plan (RUPTL) 2025-2034 considers community involvement and just transition principles. However, both updated documents still lack clear implementation and accountability measures, such as timelines, reporting mechanism, and feedback procedures.

Table 1. Summary of Public Participation on Energy Planning

Regulation	Direction / Mandates on Public Participation
Law No. 30/ 2007 on Energy	Right to access energy; communities can contribute to energy planning and development
GR No. 40/2025 on National Energy Policy (KEN)	Improving public access to energy is a national priority, pursued through better information and service provision and by leveraging local energy resources to foster regional economic growth. The Public is able to take part as electricity providers through PPA
PR No. 22/2017 on National Energy General Plan (RUEN)	RUEN/RUED must be transparent and participatory, involve inputs from gov't (central & local), associations, universities, and experts
Law No. 16/2016 on Ratification of the Paris Agreement on the UNFCCC	Strengthen education, awareness, participation, and access to climate information
Law No. 59/2024 on National Long-Term Development Plan (RPJPN) 2025-2045	Mentions non-gov't stakeholder roles (deliberation, partnerships, aspirations, finance, etc.) in long-term development
PR No. 12/2025 on the National Medium-Term Development Plan (RPJMN) 2025-2029	Serves as guideline for public participation in national medium-term development
PR No. 109/2024 Government's Work Plan (RKP) 2025	Mentions inclusive development, ensure women, vulnerable groups, and indigenous peoples to participate in decision-making
GR No. 45/2017 on Public Participation in Regional Government Administration	Guarantees public access to information, mandates capacity building, participation functions as a means for community input
PR No. 112/2022 on Acceleration of Renewable Energy Development for Electricity Supply	Public participation not explicitly regulated
MEMR Decree No. 85.K/TL.01/MEM.L/2025 on National Electricity General Plan (RUKN)	Electricity provision led by state but allows private/community roles; public rights mentioned (e.g., distributed generation, prosumers)
MEMR Decree No. 188.K/TL.03/MEM.L/2025 on the Ratification of the Electricity Supply Business Plan (RUPTL) of PT PLN (Persero) for 2025 to 2034	Community involvement and inclusivity mentioned (indigenous peoples, gender, labor rights), but mechanisms unclear
PR No. 55/2019 on the Acceleration of the Battery Electric Vehicle Program for Road Transportation	No explicit public participation; focus on industry and infrastructure
Minister of Public Works and Public Housing Regulation No. 21/2021 on the Assessment of Green Building Performance	Community participation considered in green building planning
GR No. 70/2009 on Energy Conservation	Public input in conservation master plan and the public responsible for fostering energy-saving culture.

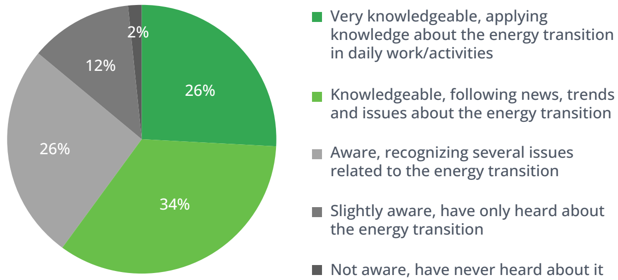
Source: IESR Compilation

- In practice, public access to consultation forums is limited, with little publicly available data on attendance and how the feedback shapes decisions. For instance, the current drafting of the SNDC in 2025 included public consultations but provided no transparent report on the responses. Similarly, the 2023 JETP CIPP draft received over 250 comments within only 14 days and offered minimal follow-up information. These patterns reveal that public participation in Indonesia is still formalistic (PWYP, 2024), revealing a gap between regulatory mandates and implementation.
- Moreover, there is also a gap between the ideal of public participation and Indonesia's regulatory mandates, because compared to international standards (such as OECD 2022 Guidelines), public participation is mostly consultative with limited influence over final decisions. It highlights the need for more specific and stronger institutional measures to ensure participation becomes a substantive driver of Indonesia's energy transition.

Public awareness on energy transition is high, yet confidence in government policy and active participation remains limited

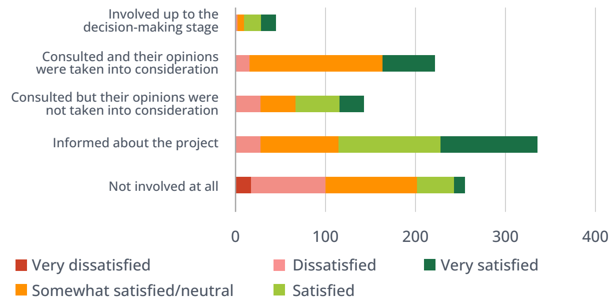
- Most Indonesians in 2025 (91% of those surveyed1) agreed that climate change is an urgent matter, with similar views across socioeconomic groups, underscoring its relevance across society. Likewise, 86% of the public surveyed in 2025 also reported knowing about the energy transition. Most commonly, respondents associate the energy transition with the adoption of renewable energy, while fewer recognize its broader systemic dimensions, such as the coal phase-out. When asked specifically about coal, 57% agree that coal should be gradually replaced with renewables due to its high emissions. Together, these findings suggest that while public awareness of climate change and the energy transition is high, understanding of their interconnections remains limited.
- When asked about renewable technology preferences, solar emerges as the most preferred source of electricity, ranked highest by 68% of the public (see graph in the Appendix B), followed by wind and hydropower. In contrast, nuclear energy was ranked the lowest, with 78% of public placing it as the least preferred source. These preferences reflect the public's sentiment and acceptance of renewable options such as solar, wind, and hydro, as it is widely seen as accessible and uncontroversial.
- Public opinions in the government's policies to support the energy transition are ambivalent. Only 28% of the public view existing policies as adequate, while roughly the same share consider them inadequate (28%) and neutral (29%). This ambivalence or mixed sentiment shows cautious public optimism, mainly caused by a lack of clarity in policy implementation.
- Similarly, public participation in energy planning and implementation remains limited. About 25% of public have never been involved in energy planning and implementation, 35% reported only received information, and 22% consulted and their opinion considered. Although with this little room for participation, around one-third of the surveyed public express satisfaction with current engagement mechanisms. This relative satisfaction may reflect low expectation of participation and gap between awareness and active involvement.
- Taken together, these insights reveal that Indonesia's public is increasingly aware, but has not yet fully participated in energy transition. The challenge ahead lies not in convincing citizens of the urgency of climate change and energy transitions, but in deepening systemic understanding, strengthening trust in policy processes, and ensuring meaningful public participation.

Public Awareness about Energy Transition based on 2025 Survey



Source: IESR Public Survey, 2025

Degree of Public Participation and its Satisfaction based on 2025 Survey

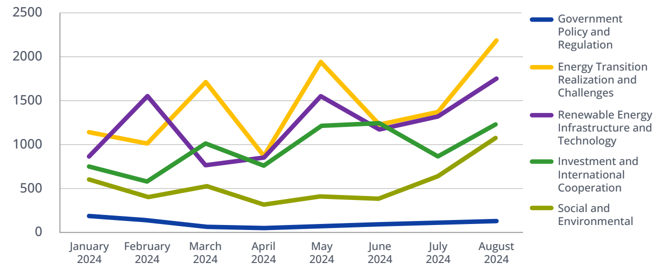


Source: IESR Public Survey, 2025

Media narratives on Indonesia's energy transition focuses on technical, economic, and policy aspects, calling for more diverse field and broader sources

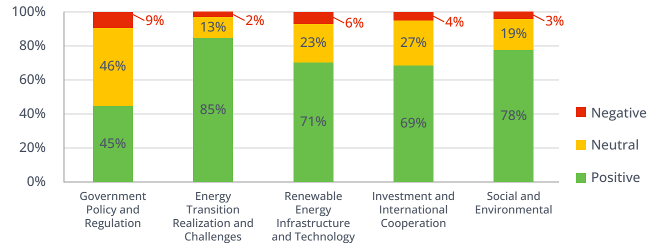
- Based on IESR Media Monitoring (2025), coverage of Indonesia's energy transition heavily shaped by proximity to power, where narratives are largely curated by the government and industries. Among five categories (see Figure 3) national media predominantly focus on the realization and challenges, signaling that media and public attention highly focus on the real implementation and achievement of energy transition policy. Meanwhile, coverage of government policies and regulations, and social and environmental narratives remains low (see Figure 3). This happens because media outlets often treat policy as newsworthy only when linked to strategic announcements, while social and ecological dimensions, which are essential to understanding just energy transition, remain underreported.
- Most media reports carry a positive sentiment (see Figure 4), focusing on institutional progress and technological innovation, which reinforce an optimistic, growth-centered narrative. Neutral reports tend to be descriptive rather than investigative, while negative sentiment, though less frequent, mainly reflects public frustration over failed projects or governance lapses.
- As mentioned, many media news are sourced from the government and industry, which narrows public discourse by framing the energy transition as a technocratic and economic issue rather than a societal transformation. Civil society, academics, local media, and communities often remain peripheral, despite their potential to surface stories. Our observation from several media monitoring activities shows that one of the challenges for local media in contributing to the energy transition coverage is the complexity of the issue and the generally low level of energy literacy among journalists and the public, leading them to focus on more economically relatable issues.
- To rebalance the conversation, Indonesia's energy transition communication strategy must diversify its messengers and reframe its narrative. The government, particularly MEMR and MCIT, should take the lead in reshaping the overall narrative and amplifying community voices, while simultaneously creating more space for media and public engagement. This also includes empowering local journalists through capacity-building on energy literacy, integrating community-based perspectives, and leveraging civil society networks to tell stories.

Trend in Numbers Based on Narratives in National Media
January 2024 - May 2025



Source: IESR Media Monitoring Data, 2025

Distribution of National Media News Sentiment Based on Energy Transition Narratives in the Period January 2024 - May 2025

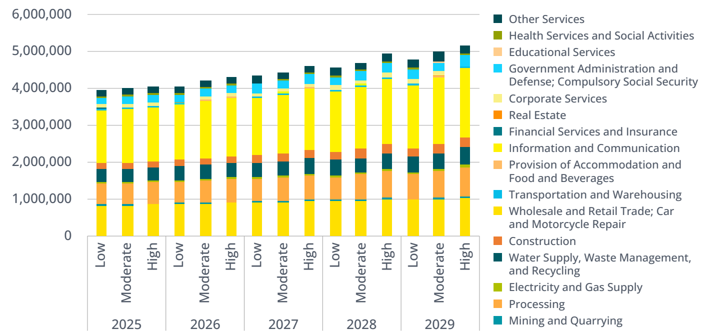


Source: IESR Media Monitoring Data, 2025

Indonesia has set out a Green Workforce Roadmap, projecting up to 72 million green jobs by 2029, but current training programs still fall short of energy transition needs

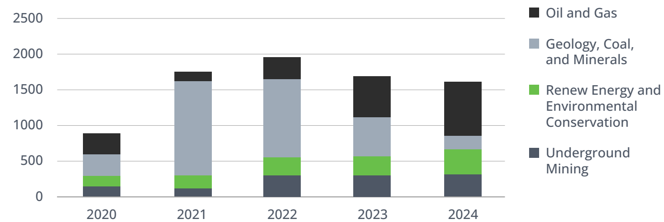
- Workforce development policy has a wide-ranging impact on public, affecting economic, social, and sustainable development dimensions. In the In April 2025, Bappenas published Indonesia's Green Workforce Development Roadmap, envisioning a high-quality green workforce to support the green economy and the "Golden Indonesia 2045" vision. The roadmap prioritizes 8 sectors: renewable energy, forestry and land use, industrial processes and product use, waste management and recycling, sustainable agriculture, sustainable transportation, sustainable tourism, and coastal and marine. By 2025, green jobs are projected at 55.3 million under a low-growth scenario, rising to 65.8 million by 2029. Under a high-growth scenario, this could reach 72 million jobs by 2029. The immediate actions and targets are outlined in Phase I (2025–2029), which focuses on building a strong foundation through awareness campaigns, education integration, policy alignment, and national standards development. Given the interdisciplinary nature of green workforce development, effective implementation requires accelerated, multi-sectoral coordination led by Bappenas and operationalized by the Ministry of Manpower.

Number of Green Jobs based on Indonesia Green Workforce Development Roadmap 2025



Source: Bappenas Roadmap on Green Jobs Development, 2025

Composition of Vocational Training by the MEMR for Public in 2020-2024



Source: MEMR Performance Report 2020-2024

- Efforts to prepare Indonesia's workforce for the energy transition are progressing, as seen through various vocational training and certification programs. However, implementation remains fragmented, with initiatives spread across multiple ministries with weak coordination and limited alignment with industry needs (ILO, 2023). The Ministry of Manpower has launched vocational training and certification programs in renewable energy and energy efficiency, often in partnership with the MEMR. For example, training centers now include modules on solar PV installation, maintenance, and basic energy efficiency practices. Yet, renewable and energy conservation trainings remain few in scale compared to other energy training and are highly technical rather than interdisciplinary. On a broader scale, RKP 2025 includes vocational training as key activities, but none of them specifically address the potential workforce demand related to the energy transition. This progress and its limitation in execution indicate room to develop specific energy transition curricula and incorporate them into annual, medium- and long-term programs.
- A national survey by Coaction Indonesia found that while 95% of Indonesian youth (aged 17–35) recognize the importance of environmental protection, over 70% expressed interest in pursuing green jobs once they understood the concept, highlighting strong interest among future workers if awareness and education efforts are strengthened.

Moderate regulation and media discourse exist as a foundation for public awareness, however, stronger human capital development and robust public participation mechanisms are urgently needed to advance a just energy transition

- Building on last's year assessment, Indonesia's energy transition readiness framework this year also assesses the social dimension, specifically the public awareness and participation, media narratives, and human capital development – as elaborated in the previous slides.
- Public participation is generally rated from medium to high. The regulatory landscape scores medium due to the presence of supporting regulations, though they remain suboptimal compared to international standards and face gaps in implementation. Public awareness and support are assessed as high, reflecting significant public aware about energy transition, whereas public participation and satisfaction are rated low based on the survey results, indicating that engagement remains limited despite growing awareness.
- Regarding the media narratives, it is ranked medium although media coverage on the energy transition has expanded and increased visibility, analyses reveal that it remains largely shaped by government and industry narratives, with limited representation of diverse or grassroots perspectives.

TRF Rating for Public Participation and Acceptance

Variable(s)	Indicator(s)	Rating
Human Resource	Capacity of Human Resource	Low
	Government program for preparing just energy transition	Medium
Public Participation	Regulatory landscape to support public participation in energy transition	Medium
	Public awareness and knowledge on energy transition	High
	Public involvement and its satisfaction (participatory process) in energy planning	Medium
Media Narratives	Media discourse to support energy transition	Medium

Source: IESR Analysis (2025)

- Moreover, human capital is ranked medium as both the overall capacity and government programs for preparing a just energy transition are still developing. About 45% of the population has completed secondary education and 36% tertiary education (BPS, 2025), while the number of renewable energy technician certifications continues to rise. Encouragingly, over 70% of respondents expressed interest in pursuing green jobs once they understood the concept, showing strong potential if awareness and education efforts are strengthened. However, the overall government efforts are also progressing, but the impact and implementation remains fragmented.

3.5. Technology Advancement

Abraham Octama Halim, Alvin Putra Sisdwinugraha, and His Muhammad Bintang

Contents:

Indonesia should prioritize commercially-proven renewables technologies instead of high-risks options in the power sector

- A combination of policy and market mechanisms has placed clean technology in a favorable position for global power sector deployment. The global market share for clean technology has reached USD 550 billion, with investments in 2025 projected at USD 3.3 trillion despite policy turbulence and geopolitical tensions (IEA, 2025a). This demonstrates that clean technology advancement has gone beyond climate commitments and has become a viable business opportunity.
- Such technology maturity has also influenced technology progress landscape in Indonesia. For example, several solar manufacturers have already adopted N-type TOPCon technology, a leading technology for solar module. While initially driven by local content requirement policy, geopolitical shifts has become the main driver over the past 2 years. The rise of the electric vehicle industry has also driven domestic battery manufacturing capacity, which may have spillover effects for grid-scale battery applications in the power sector.
- Given a wide range of clean technologies needed to decarbonize Indonesia's electricity system, pilot projects for several emerging technologies are also underway. These include ammonia co-firing and carbon capture technologies, which are expected to play significant roles in decarbonizing coal and gas power plants, according to RUKN 2025-2060. However, such high-risk technologies have relatively unproven technical capabilities and limited market scalability, even on a global level. Given Indonesia's limited short-term financial capacity, the country should focus on strengthening domestic supply chains for mature renewable technologies (TRL 9-10) first, which already have commercial applications, to accelerate the power sector transition.

Summary of Indonesia's clean technology progress

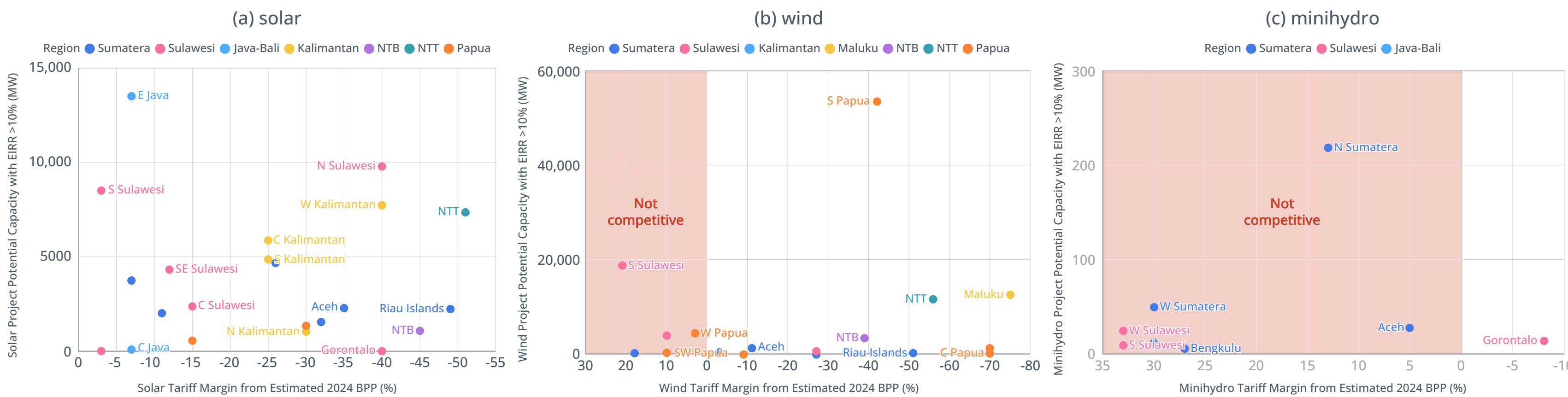
Technology maturity level	Power sector technology	Global technology progress status	Indonesia 's technology progress status	Indonesia 's technology progress rating
Market uptake (TRL 9-10)	Crystallin-silicon based solar photovoltaic technology	N-type TOP Con technology lead the market with 60% share in 2024, mass efficiency >25% . Reliance on Chinese products decline due to manufacturing capacity expansion in other countries.	Four manufacturing claimed to produce N-type TOPCon cells, although mostly serve overseas market.	Medium
	Battery energy storage system	Lithium-ion technology leads the technology landscape, while several research on alternative technologies (lithium-sulphur, lithium-air and sodium-ion) already underway.	Cathode production capacity of 270 ktpa and battery cell production of 10.1 GWh/year (IESR, 2024)	Medium
	Wind technology	Manufacturers are shifting toward larger turbines size and low-speed applications.	Only produce supporting components such as tower (IESR, 2025a)	Low
	Tidal energy	Commercial project application in UK, France, South Korea, and Canada.	Undergoing study with international partners. First commercial operation target in 2028 as per RUPTL PLN 2025	Low
Demonstration (TRL 7-8)	Carbon storage in depleted oil & gas reservoirs	Chemical absorption technology has 85-90% capture rate. Several pilot project has been executed in US, Denmark, and Australia.	On going study in 5 PLN's power plant. Arun CCS pilot project is also underway.	Medium
	Ammonia co-firing in coal power plants	A 20% ammonia co-firing rate was achieved at a 1 GW coal-fired unit in April 2024 for 520 hours by JERA (Japan) (JERA, 2024)	A 3% ammonia co-firing rate testing in Labuan coal power plant for 8 hours. (MEMR, 2025a).	Medium
Concept and prototyping (TRL <6)	Light-water small modular nuclear reactor	Hainan Linglong One (ACP100) is the first SMR to get approval from IAEA, with cold testing completed in October 2025 (WNN, 2025)	Undergoing study with NuScale (US), pilot project planned in West Kalimantan (BRIN, 2023). First commercial project is planned for 2032.	Medium

Source: Adapted from IEA (2025a) and multiple sources

Indonesia's renewables costs are already lower than electricity generation costs in most grid systems, presenting an opportunity for operational cost savings

- Technological advancements and project learning curves have made Indonesia's renewable energy cost-competitive. For example, the cost of solar energy installation in Indonesia has dropped by 57% the last 5 years (IRENA, 2025). The economic viability of such renewable projects has also been assessed using geospatial mapping (IESR, 2025b), resulting in 333 GW of commercially ready solar, wind, and micro hydro projects. This assessment applies the renewable ceiling price tariff set in Presidential Regulation no. 112/2022, which replaced the electricity generation cost (biaya pokok pembangkitan/BPP)-based tariff calculation in the previous MEMR Regulation no. 4/2020.
- Using the ceiling price tariff structure, solar energy projects costs are significantly lower than the electricity generation costs in 24 major grid system across Indonesia, with the solar tariff potentially 50% lower. Similarly, wind energy projects have the potential to be even more cost-competitive with the current electricity generation in 14 grid systems, even with larger margin (potentially 75% lower). The total potential capacity of highly-profitable projects (EIRR >10%) reaches 91 GW and 86 GW for solar and wind energy, respectively. While mini-hydro projects are not as cost-competitive as other technologies, they could still be about 8% cheaper than the current electricity generation cost in few systems. By capitalizing on renewables' cost competitiveness, PLN could lower its operational costs per unit of electricity produced, which have risen by at least 26% over the past four years (PLN, 2025b).

Renewable cost competitiveness compared with local electricity generation cost in various grid systems for:

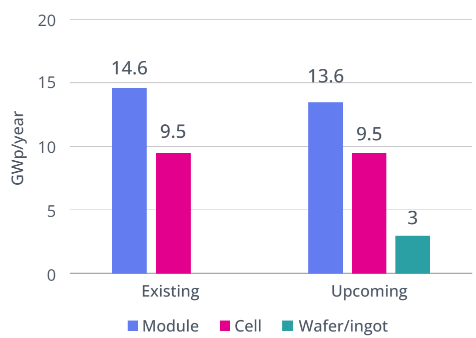


Source: Adapted from IESR (2025). The estimated 2024 BPP assumes a 26% uniform increase across all grid systems from the 2021 BPP, based on PLN's operational cost per electricity produced increase, calculated from PLN (2025). The renewable tariff assumes only the first 10-year tariff in Presidential Regulation 112/2022.

Indonesia's solar PV supply chain expansion can drive both global competitiveness and domestic decarbonization—if risks are managed effectively

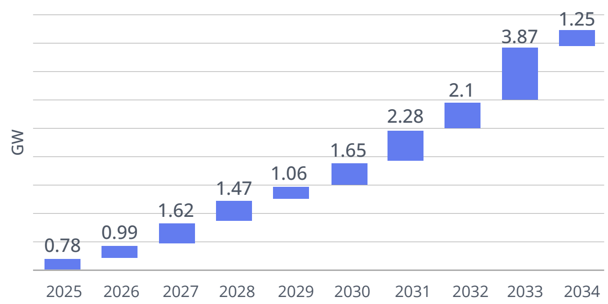
- Indonesia's solar PV manufacturing capacity has surged since 2023, reaching 14.6 GWp for modules and 9.5 GW for cells by September 2025, with plans to nearly double the production capacity along with the addition of a 3 GW wafer and ingot plant. Growth, driven by Chinese foreign investment and favorable trade conditions, has positioned Indonesia as a key regional exporter after the U.S. excluded it from the April 2025 tariffs on other Southeast Asian solar products.
- However, domestic demand remains weak, with the RUPTL projecting an average of only 1.7 GW per year of solar additions over the next decade, well below current production capacity. Exports dominate instead, with 4.7 GW shipped to the U.S. in the first half of 2025, a 165% increase from 2024, making Indonesia the region's largest exporter. This shows that industry growth is primarily driven by external markets rather than domestic demand. However, risks are mounting, as the U.S. has opened anti-dumping and anti-subsidy investigations into imports from India, Indonesia, and Laos (International Trade Administration, 2025). To safeguard the sector, Indonesia needs strategies to diversify export markets, strengthen domestic demand (e.g. by leveraging the 100 GW rural solar program), and advance trade diplomacy.
- To sustain growth, Indonesia must improve cost competitiveness by (1) achieving economies of scale through higher domestic and global demand, including leveraging the IEU-CEPA for EU market access, and (2) revising import duties that currently favor imported modules over local production. Without such measures, existing capacity may become unsustainable, limiting Indonesia's ability to build a strong solar supply chain for its energy transition.

Indonesia Solar PV Supply Chain Production Capacity Estimation (per September 2025)



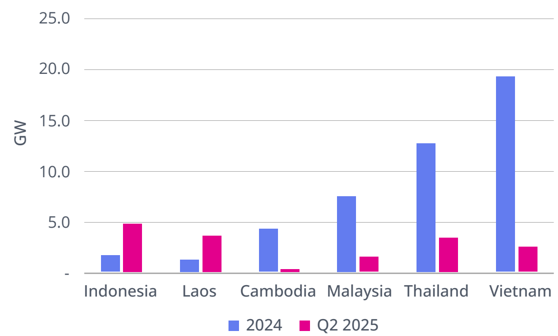
Source: IESR analysis from Sinovoltaics (2025) and company press releases

RUPTL 2025-2034 Solar PV Capacity Addition



Source: RUPTL 2025-2034 (PLN, 2025a)

US c-Si Solar Panel Imports from SEA



Source: Solar Power World (2025) from US ITC data

Indonesia needs a long-term roadmap with a strong investment strategy to elevate its status from merely an import market to a producer-consumer of battery technology

- Lithium-ion batteries (LIBs) are now the most popular technology for energy storage systems (ESS) in Indonesia's power sector. Since 2015, growing private sector investment in LIB-based batteries has accelerated the shift away from lead-acid batteries. PLN has also expanded its use of LIBs, doubling the total installed capacity with the 14.2 MWh BESS at the IKN's 50 MW Solar PV project that has been operating since early 2025. This indicates that LIBs have been technically proven and economically affordable from PLN's perspective.

Summary of the Current Battery Supply Chain Status in Indonesia

Upstream

Value Chain	MRL
Nickel mining & processing	7 - 9
Cobalt mining & processing	7 - 8
Manganese mining & processing	6 - 7
Lithium mining & processing	2 - 4

Midstream

Value Chain	MRL
Cathode production	6 - 7
Anode production	7 - 8
Electrolyte & separator production	2 - 4
Battery cell production	7 - 9

Downstream

Value Chain	MRL
Battery pack production	7 - 9
EV balance of system (BoS) production	6 - 7
BESS balance of system (BoS) production	5 - 6
Reuse and Recycling facilities	2 - 4

Note: MRL = Manufacturing Readiness Level; 1-4 = Research to Prototype; 5-7 = incomplete value chain or small-scale production; 7-10 = mass production capability; White = commercially unavailable; Yellow = limited commercialization; Green = exist commercially

Source: IESR analysis with scoring scale adapted from INEMI, 2022

- With global "excessive" production capacity of around 1.5 TWh (Volta Foundation, 2025) driving cost competition, LIBs are expected to maintain their dominance in Indonesia's medium-scale ESS market (kWh–MWh scale). However, the Government's ambition to increase the electrification level in numerous isolated systems—such as the 2,130 sites included in the de-dieselization program—also opens opportunities for non-LIB technologies with long-duration storage capabilities, including redox flow and high-temperature batteries, which are beginning to see wider access in the country.

- Indonesia's LIB supply chain is gradually taking shape with around 10 GWh/year of domestic cell production from one gigafactory and several smaller manufacturers. In addition, another gigafactory—designed for a total production capacity of 15 GWh by 2028—is under construction. By segment, most activity is concentrated in the upstream (mining to smelting), followed by downstream industries (battery packs). Meanwhile, the midstream segment (materials processing to cell manufacturing) has recently begun large-scale operations in areas such as Karawang and Kendal. Despite this progress, significant gaps remain in separator, electrolyte, and lithium precursor production.

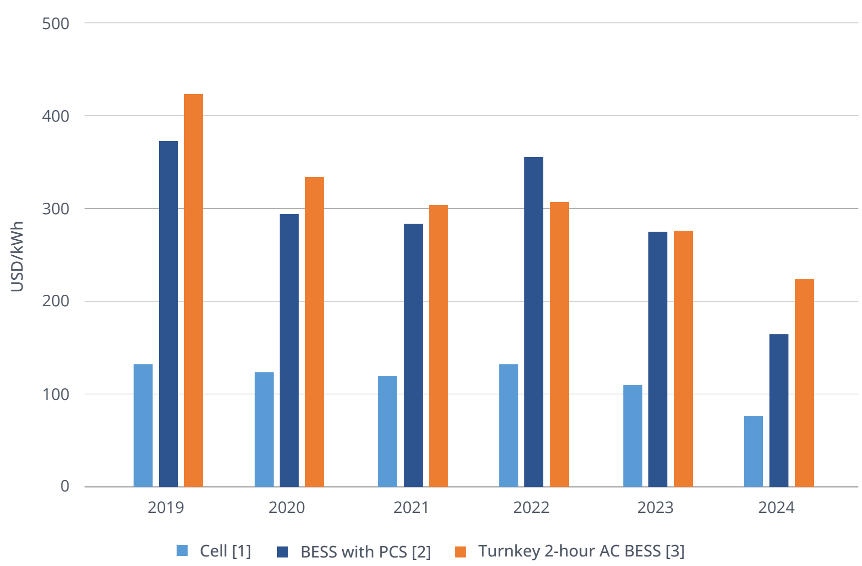
- The development of this supply chain has been closely tied to the government's ambition to leverage its nickel resources. However, the battery market has proven highly dynamic and subject to rapid shifts, as seen from the strong move toward non-nickel LFP-based LIBs for EVs. Building on this lesson, Indonesia needs to prepare a long-term roadmap for early investment in next-generation technologies (e.g., sodium-ion and lithium-sulfur batteries) that better align with its resource base and future demand.

- To reduce global market risks and secure its domestic supply chain, Indonesia should also expand ESS component production capacity, including packs, inverters, and system integration as demand for these components is now clearly reflected in planning documents (i.e., RUPTL and RUKN 2025). Growing demand from the transport and power sectors also makes battery reuse and recycling increasingly urgent. "Second-life battery" schemes show strong potential, but require enabling rules. A practical starting point would be establishing regulations on cell labeling and collection procedures for end-of-life batteries.

Cost competitiveness and stakeholder experience with battery products have improved, but existing legislation has held back local off-takers from taking advantage of the global oversupply

- Indonesia could take advantage of the current low-price window for batteries to stimulate domestic ecosystem development by advancing planned near-term BESS projects, strengthening downstream industries (e.g., BoS manufacture and EPCs), and fostering end-users demand. Last year, global battery cell prices fell by nearly 30% compared to 2023, the largest decline in the past decade. In the stationary storage market, BESS costs have also declined to USD 165/kWh, fueling a record level of global annual deployments with 169 GWh of new installed capacity (Volta Foundation, 2025). BNEF indicated this was driven by LIB production overcapacity that is 2.5 times higher than annual demand and low raw material prices in 2024, but notes that LIB prices may rise again in the coming years due to geopolitical tensions and tariffs on battery metals (BloombergNEF, 2024).
- Several regulations in Indonesia still make it difficult to fully capture the benefits of today's low battery prices. At least, additional costs come from shipping and an 11% VAT. Moreover, PLN as one of the main offtakers of this technology is typically prohibited from direct purchasing, which introduces extra vendor margins that can vary widely. Given this, domestic production capability, which potentially cost-competitive with low electricity and labor costs, needs to be strengthened, and the product be made accessible to local offtakers.

Global Battery Prices Declining Trend (2019 to 2024)



Note:
[1] = BNEF battery cell historical prices from weighted average survey value. In real 2024 USD
[2] = BNEF BESS prices including DC-block battery enclosures and power conversion system (PCS). In real 2024 USD
[3] = BNEF reported CapEx for large turnkey two-hour energy storage. Including battery rack, BOS+EMS, PCS, Transformer, System integrator margin, and expenses. 2024 value is estimate. In real 2023 USD

Source: BloombergNEF, 2024 and Volta Foundation, 2025

- Data from Indonesia's technology catalogue document (Danish Energy Agency & MEMR, 2024), updated multiple times with input from local industry players, suggests that the country's BESS cost decline trajectory (currently estimated at USD 470/kWh) is broadly in line with global trends. The local stakeholders also have been building more advanced understanding of the technology through project development, research, and lessons learned from abroad. For example, PLN is gaining operational experience and battery testing capabilities, enabling it to distinguish product quality and apply higher quality standards in procurement. Nevertheless, scaling up human resource capacity, inclusively, will be critical to run the recently announced 100 GW solar PV + 320 GWh BESS program. In addition, BESS capacity targets in long-term planning documents such as the RUKN also will only materialize if locally accessible BESS costs fall to around USD 230/kWh by 2050, underscoring the need for strong industry readiness.

3.5. Technology Advancement

Rheza Hanif Rizqianto and Shahnaz Nur Firdausi

Contents:

- Renewables & Storage
- **Low Emission Alternative Fuels & Biofuels**
- Electric Vehicle & Mass Transportation
- Energy Efficiency in Industry & Buildings
- TRF Rating

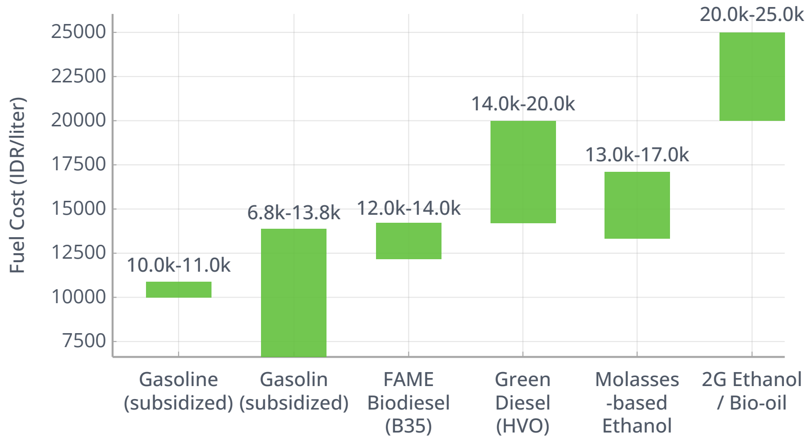
Refocusing Biodiesel Funds for Higher Yields and Sustainable Production

- First-generation biofuels are produced from food-based crops and conventional oil sources, using mature, widely deployed technologies. In Indonesia, the dominant biofuels are biodiesel or FAME (Fatty Acid Methyl Ester) from crude palm oil (CPO) and bioethanol from molasses.
- The main process in producing biodiesel is transesterification. The technology is mature, scalable, and widely deployed in Indonesia; with conversion rate ~90–95% efficiency of oil to biodiesel. Indonesia has over 18 million kiloliters/year of installed biodiesel production capacity in 2024.The current 35% biodiesel blending program (B35) is estimated to reduce over 35 million tons of CO_2 per year if replacing fossil diesel at full national scale. The main process in producing bioethanol is fermentation and distillation. The technology is mature, with fermentation yield ~80–90%, but Indonesia lacks adequate sugar feedstock to scale. The distillation is energy-intensive (biggest cost and efficiency challenge). Indonesia has only ~41,000 kiloliters/year of bioethanol production, very low due to molasses shortage and underinvestment.
- Indonesia's biodiesel program faces rising economic pressure as subsidies increase alongside higher blending targets. Funded by palm oil export revenues, these subsidies are threatened by shrinking export volumes as domestic CPO demand rises to 5.05 million tons in 2025. Export earnings are projected to fall from USD 36 billion in 2024 to USD 27 billion in 2029, with levy revenues also declining (Madani, 2025).
- Refineries, now at 85% capacity, can sustain B40, but B45 would push them near maximum limits, requiring new capacity or technology—both costly. Nearly 95% of BPDPKS funds already go to biodiesel subsidies, leaving little for upstream improvements, especially for smallholders. At current yields of 3.8 tons/ha, biodiesel demand could force 3.7–4.7 million hectares of new plantations, pushing total plantation area close to or beyond the environmental carrying capacity limit of 18.15 million hectares. Raising productivity to 6 tons/ha would eliminate the need for expansion, aligning economic, environmental, and social goals (Madani, 2025).

GHG emissions comparison

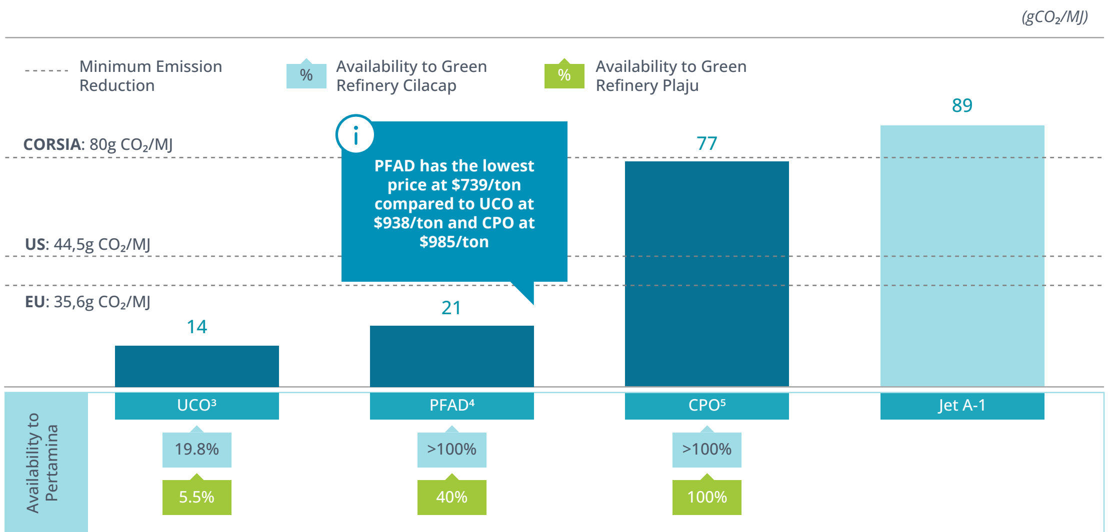
Fuel Type	Fossil Diesel	Biodiesel (CPO)	Fossil Gasoline	Bioethanol (Molasses)
Emissions (gCO_2e/MJ)	~95	~35–55 (60–70% reduction)	~93	~40–60 (40–60% reduction)

Indicative Fuel Cost Range in Indonesia (2024-2025)



Bridging the Gaps in Indonesia's SAF Development through Technology Roadmap and Feedstock Diversification

Life Cycle Assessment Emissions from Alternative SAF Feedstocks

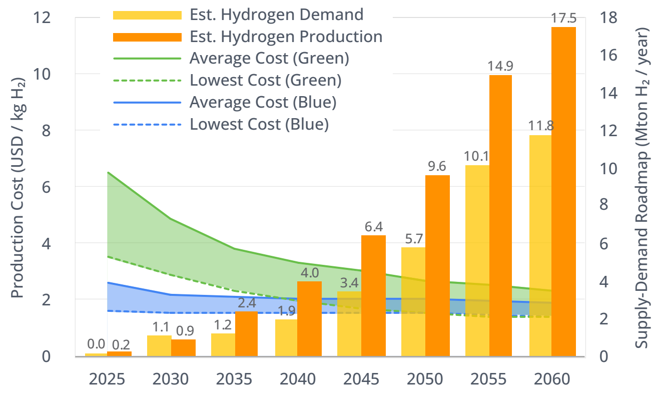


- Under the new Sustainable Aviation Fuel (SAF) Roadmap, Indonesia is targeting 1.39 million kiloliters of SAF uptake between 2027 and 2035. Currently, Indonesia has a co-processing production capacity of 347 million liters per year, utilizing a 2.4% blend of RBDPKO (Refined, Bleached, and Deodorized Palm Kernel Oil) to produce the J-2.4 SAF. However, SAF derived from Palm Kernel Oil (PKO) without methane capture fails to meet International Civil Aviation Organization (ICAO) Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) sustainability standards and remains costlier than conventional jet fuel (Kemenkomarves, 2024).
- Indonesia's SAF production remains dependent on the Hydro-processed Esters and Fatty Acids (HEFA) pathway, primarily using PKO as feedstock. However, PKO's link to palm oil production results in suboptimal life-cycle assessment (LCA) outcomes. To improve sustainability, Indonesia must explore next-generation HEFA feedstocks such as Palm Fatty Acid Distillate (PFAD) and Used Cooking Oil (UCO), both categorized as waste-based materials. Yet, challenges persist in ensuring adequate quantity and quality, particularly for UCO, which suffers from collection inefficiencies and is largely exported abroad (Kemenkomarves, 2024).
- In August 2025, Pertamina conducted its first commercial flight using SAF produced from UCO, blended at 2.5% with fossil-based jet fuel at the RU IV Cilacap Refinery in Central Java (GAPKI, 2025). Pertamina is also developing a new catalyst to enable UCO co-processing up to 3% blending. However, The domestic supply of PFAD and UCO currently meets less than 20% of total feedstock needs. The absence of a SAF technology development roadmap creates uncertainty for producers and discourages efforts to develop new production technologies or alternative feedstocks, slowing the diversification of Indonesia's SAF production base (Kemenkomarves, 2024).
- Although Indonesia's existing SAF production capacity could meet more than 50% of the estimated jet fuel demand for international flights, this potential remains largely untapped due to the limited number of offtakers willing to adopt the fuel. Domestic SAF demand remains extremely limited due to weak enforcement of blending mandates. Airlines lack economic incentives to adopt SAF, further constraining production growth and market development (Kemenkomarves, 2024).

Indonesia's hydrogen remains fossil-based, but the roadmap targets a shift to low-carbon production led by renewable-powered electrolysis

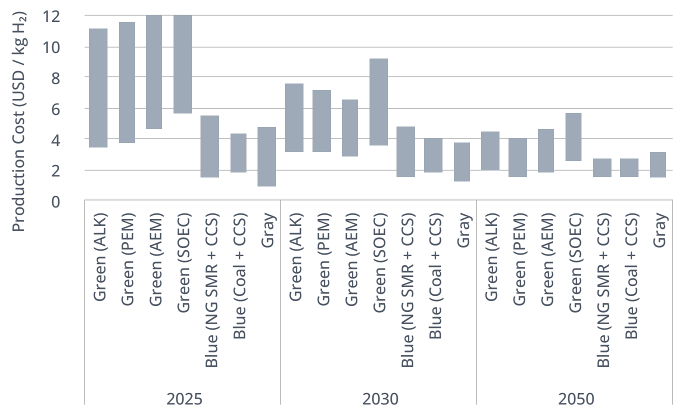
- Indonesia consumes about 1.75 million metric tons of hydrogen annually, largely concentrated in fertilizer production, with smaller volumes used in ammonia synthesis, oil refining, and other industrial processes (MEMR, 2023). The government's National Hydrogen and Ammonia Roadmap (RHAN), launched in 2025, identifies hydrogen's role across industry, power generation, gas networks, and transport (MEMR, 2025b). It projects low-carbon hydrogen demand to increase nearly sevenfold to 11.7 Mt per year by 2060. Initial applications will focus on road transport, co-firing hydrogen or ammonia in power plants, blending in gas pipelines, and continued reformative use in fertilizers and refineries.
- Indonesia's hydrogen production remains fossil-based, dominated by gray hydrogen from natural gas via steam methane reforming (SMR), which emits 10-13 kg of CO_2-e per kilogram of hydrogen (Chan et al, 2025; IEA, 2024; Suleman et al, 2016). The RHAN envisions a gradual shift toward low-carbon pathways, including electrolysis, SMR with carbon capture and storage (CCS), coal or biomass gasification with CCS, and bio-based hydrogen production. Among these, electrolysis is expected to take the lead, supplying around 85% (15Mt) of total hydrogen by 2060, supported by Indonesia's vast renewable energy potential that paves the way for green hydrogen development.
- Green hydrogen, produced through electrolysis that splits water into hydrogen and oxygen using renewable electricity, represents the cleanest production pathway, with emissions as low as 0–4.34 kgCO_2e per kilogram (IEA, 2024; Pawłowski et al., 2023; Cetinkaya et al., 2012). Four main electrolyzer types are commercially available: Alkaline (ALK), Proton Exchange Membrane (PEM), Anion Exchange Membrane (AEM), and Solid Oxide Electrolyzer Cell (SOEC). ALK and PEM systems currently dominate global deployment, while AEM (TRL 7) and SOEC (TRL 8) remains at an earlier stage of commercialization (IEA, 2025c).
- Current green hydrogen cost, without any incentive support, is uncompetitive compared with other hydrogen production options, including gray (natural gas), black (coal), and blue (fossil-based with CCS) hydrogen. Global green hydrogen production costs were 2 to 8 times higher than gray hydrogen, ranging from US$3.5 to US$12 per kg (IEA, 2025c; BloombergNEF, 2025). In Indonesia, the estimated levelized cost of green hydrogen (LCOH) is currently projected to range between US$3.86 and US$13.2 per kg, depending on energy source, electrolyzer type, project scale, and location.

Low-Carbon Hydrogen Cost Trajectories and Supply–Demand Roadmap in Indonesia (2025–2060)



Source: IESR analysis; MEMR, 2025

Levelized Cost of Hydrogen (LCOH) Outlook by Production Technology in Indonesia (2025-2050)

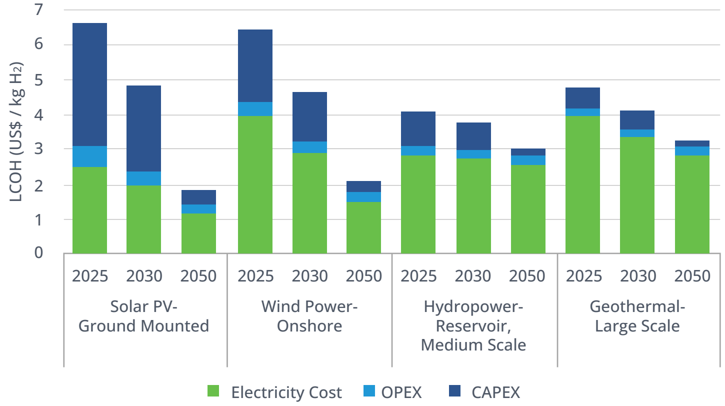


Source: IESR analysis; IEA, 2025; MEMR, 2025

Improved electrolyzers and its steadily declining costs are driving green hydrogen production costs down, alongside RE deployment

- The cost of hydrogen production is primarily determined by two key factors: the price of renewable electricity and the electrolyzer technology. Electricity typically represents 40–70% of total green hydrogen production costs, meaning cheaper renewable power directly translates into lower hydrogen prices. Electrolyzer systems remain the largest source of capital expenditure, with efficiency, durability, and manufacturing scale dictating future cost trajectories. Beyond technology, non-technical factors such as financing, infrastructure, and market demand also shape hydrogen costs.
- As RE prices have shown declines over the past decade, improving electrolyzer performance and scaling up manufacturing have become key levers for cost reduction. Today's ALK, PEM, and AEM electrolyzers achieve 52–67% efficiency (LHV basis), while SOEC can reach up to 85% by using high-temperature steam, with overall electrolyzer performance expected to improve further as technology advances (IEA, 2025; Şahin, M. E., 2024; Nasser et al., 2022). With manufacturing scale-up and material innovation, electrolyzer capital costs are projected to decline from the current US$750–2,450/kW to around US$200–950/kW by 2050 (IEA, 2025; Khalil, 2025; DNV, 2022). The declining cost of electrolyzers could lower the green hydrogen production cost to about US$1.5–2.0 per kilogram under favorable RE and operational conditions.
- Infrastructure integration, particularly pipeline and port development, will be central to achieving hydrogen cost parity across regions. Storage costs range from about US$0.25-1.8 per kilogram, with surface tanks remain costly due to compression and liquefaction needs, while geological options offer lower-cost, large-scale storage (Burke et al., 2024; GOV UK, 2023). Transport costs depend heavily on distance: pipelines are the most cost-effective for short to medium ranges (up to around 1,000 km), adding US$0.1–1 per kilogram (Hydrogen Council, 2021; European Comission, 2021). For long-distance or export routes, shipping hydrogen as ammonia or liquefied hydrogen (LH_2) is more practical, at around US$0.8–2.0 per kilogram.

Levelized Cost of Hydrogen (LCOH) Breakdown by RE Source in Indonesia (2025-2050)



Estimated Additional Hydrogen Transport Costs by Distance and Mode

		Cost: Distribution 0-50 km	Distribution 51-100 km	Transmission 100-500 km	Transmission >1,000 km	Transmission >5,000 km
Pipelines	Retrofitted	<0.1 USD/kg			0.5-2 USD/kg	
	New	<0.1 USD/kg		0.1-1 USD/kg	1-2 USD/kg	
Trucking	Compressed	<1 USD/kg		1-2 USD/kg		
	Liquid	0.5-1 USD/kg		1-2 USD/kg		
Shipping	Ammonia				1-2 USD/kg	>2 USD/kg
	Liquid				1-2 USD/kg	>2 USD/kg

Source: Hydrogen Council, 2021; Burke et al., 2024

- Accelerating hydrogen transition will require decisive policies, targeted incentives, and clear certification frameworks to reduce risks, attract investment, and make hydrogen more competitive. Coordinated national planning across ministries, SOEs, and industries is essential to align infrastructure, demand creation, and financing mechanisms.

3.5. Technology Advancement

Faris Adnan Padhilah and Reananda Hidayat Permono

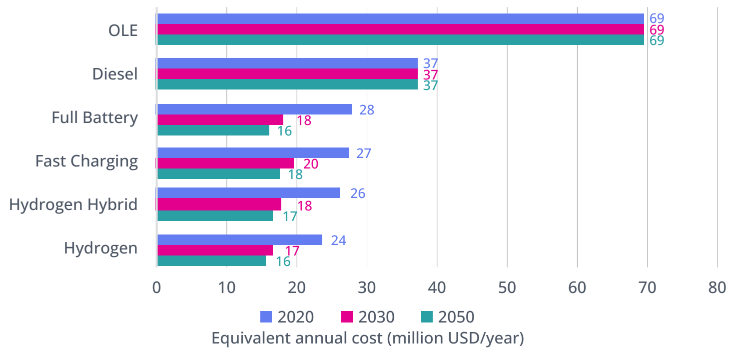
Contents:

- Renewables & Storage
- Low Emission Alternative Fuels & Biofuels
- **Electric Vehicle & Mass Transportation**
- Energy Efficiency in Industry & Buildings
- TRF Rating

Electrification is the best option to railway decarbonization, however low traffic lines needs to shift to fast-charging battery and hydrogen systems

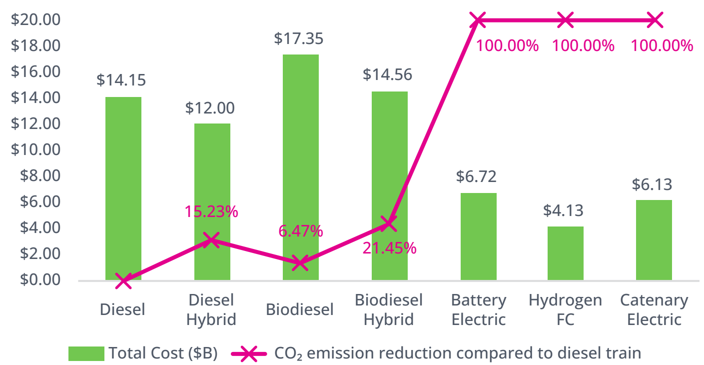
- In 2024, Indonesian railway passengers reached 424 million, a 14% increase from the previous year. The sector consumed about 172,000 kiloliters of subsidized diesel (AntaraNews, 2024) and emitted 470,000 tons of CO_2. Although its share in transport emissions is small, rail decarbonization is crucial for the net-zero target. PT KAI has begun using biofuel (B35) and pursuing electrification, the latter offering deeper long-term emission cuts.
- Electrification via overhead catenary (OCS) costs around USD 1 million per track-km, with USD 10,000 annual maintenance. It delivers major emission reductions as grids decarbonize but is less effective with high grid emission factors (Bullock & Lawrence, 2022) and depends on reliable power supply. In Indonesia, OCS is limited to commuter lines in Jakarta and Solo–Yogyakarta (IESR, 2023).
- For lower-traffic routes, battery trains present a cheaper alternative to OCS. The UK's GWR set a record in 2025 with a 320 km run on battery, reducing emissions by 80% compared to diesel (Perišić, 2025). Still, barriers include the high cost of battery units and replacements, added train weight, and charging requirements for long-distance travel. Hydrogen trains are another option, avoiding OCS costs but facing challenges in energy efficiency, green hydrogen supply, and the need for a fueling infrastructure network. Moreover, combining two or more power train (hybrid) approaches are increasingly explored, such as diesel–OCS (Vectron, 2024), hydrogen–battery, fast-charging with smaller batteries, OCS–battery, and even triple-fuel combinations.
- Ultimately, the choice of technology depends on many factors, such as balancing cost-effectiveness, emission reductions, and operational needs. OCS remains the most efficient option for high-traffic corridors, offering lower long-term operating costs and deep GHG cuts as the grid decarbonizes. Small batteries with fast charger and hydrogen trains are better suited for lower-traffic lines where OCS is not economical as they require lower investment cost than OCS and provide greater system-level savings for the systems, though their infrastructure requirements must be addressed (Zenith F, et al, 2019; Aredah, A., et. Al, 2024).

Annual cost comparison of different train technology in Nordland



Source : Zenith F, et al, 2019

OPEX and CO_2 emission reduction of technologies compared to diesel train

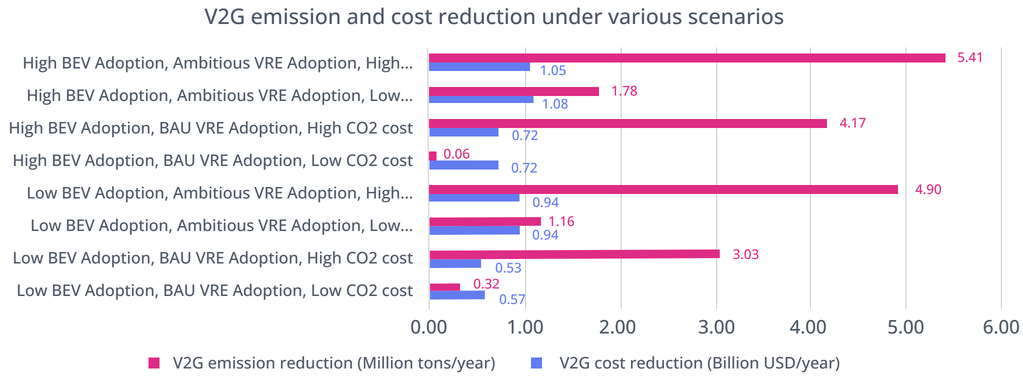


Source: Aredah, A., et. Al, 2024

Smart Charging and V2G Scheme Mitigate 5.42 Million Tons of CO_2 and Save USD 1 Billion per year

	Smart Charging Benefit For System	
CO_2	300 000 ICE Vehicles	Avoided annual CO_2 emissions (equivalent)
€	470 M€ - 520 M€	Operational cost of the power system
	600 000 EVS (1.4 - 1.7 TWH)	Non-spilled RES, (equivalent consumption)

Source : (ELIA Group, 2020)



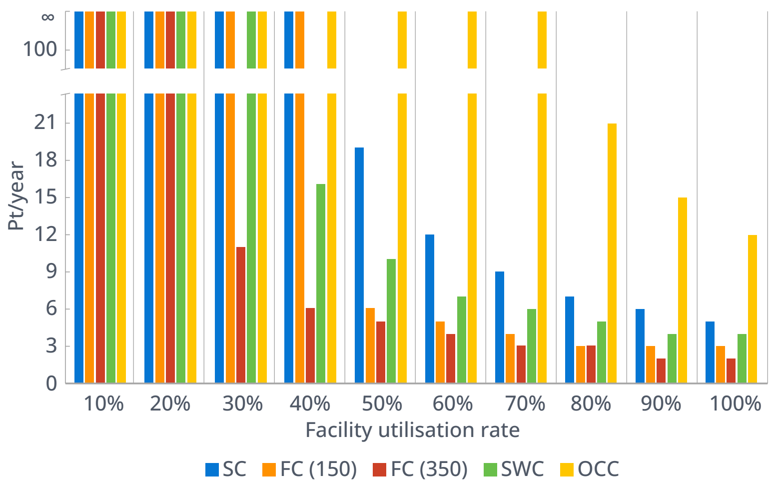
Source: (Kataoka et al., 2025)

- In recent years, the adoption of BEVs has increased, surpassing 100,000 in mid-2025. The rapid rise of BEVs presents a critical juncture for power systems, where unmanaged charging could strain the grid, but intelligent Vehicle-Grid Integration (VGI) can turn BEVs into a powerful asset for decarbonization. By leveraging smart charging and Vehicle-to-Grid (V2G) technologies, particularly when coupled with solar PV in infrastructures like smart parking lots, BEVs can balance renewable energy fluctuations and unlock significant economic value for grid operators, consumers, and businesses alike.
- Smart charging involves shifting BEV charging from high-demand times to periods when electricity demand is low or when power is generated from renewable sources. Moreover, it is also essential to adjust the charging events to suit different places, such as overnight at households and offices during the day. It is expected that implementing smart charging by 2030 can reduce the annual CO_2 emissions from power systems by approximately 600,000 tons per year, or equivalent to 300,000 ICEV yearly emissions, save around EUR 500 million in power system cost, and optimize around 1.4 - 1.7 TWh of electricity comes from renewable energy sources (ELIA Group, 2020).
- The use of V2G also reduces CO_2 emissions compared to smart charging and uncontrolled charging. Smart charging can mitigate emissions to 1.53 million tons of CO_2 annually, while V2G can further reduce emissions up to 5.42 million tons of CO_2 per year in 2030. Moreover, V2G can also reduce production costs by up to USD 1 billion annually. The cost and CO_2 emission reduction are maximized when there is a high number of BEVs on the road and ambitious VRE (Kataoka et al., 2025)
- Despite the promising future of V2G and smart charging, Indonesia needs to prepare several key elements for effective implementation. Investment in a robust and digitalized charging infrastructure, prioritization of smart charging capabilities, grid readiness, a precise regulatory framework, and a market structure for selling electricity to the grid. Even with all of these, launching a pilot project in urban centers is still needed to demonstrate its viability, create public awareness, and provide crucial data to improve the approach.

Fast chargers technology is suitable for short-haul electric HDVs, while for long haul HDVs, battery swapping station is a promising technology

- Charging station installation strategies for short-haul and long-haul electric HDVs differs due to their operational differences. Depot charging is sufficient for short-haul HDVs (regional trip, up to 300 km per day) since vehicles return to the depot at the end of the day and are charged there overnight. The best technology to achieve the quickest payback period for short-haul HDVs is the fast charging (350 kW) mode. The technology achieves a payback period less than 12 years after investment with only a 30% utilization rate, compared to other technologies like battery swapping (16 years with 40% utilization rate) and slow charging (18 years with 50% utilization rate) (Wang, Z., et al., 2023). Besides choosing the right charging technology, the utilization rate of the charger is also important to ensure the long-term viability of charging service providers.

Impact of facility utilization rate on payback period



Source: Wang, Z., et al., 2023

- Meanwhile, long-haul HDVs need public charging infrastructures in major road corridors to take advantage of their mandatory 45-minutes rest every four hours, as stated in Indonesia's Road Traffic and Transportation Law. A trial of an inter-provincial electric bus route has been conducted for Jakarta-Yogyakarta trip (Kalista, 2025). The 541-km route is equipped with two charging pit-stops in Cikamurang and Ajibarang rest areas, with a charging duration of nearly an hour per charging time (Kumparan, 2025). The one-way trip, lasting around 12-14 hours including two charging sessions, consumes 450 kWh of electricity. It costs around IDR 900 thousands for the charging fee or 10-20% cheaper than using diesel.

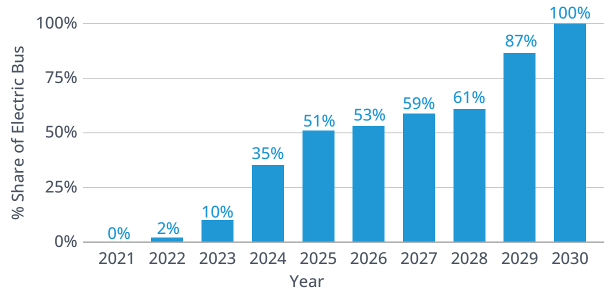
- Utilizing ultra-high-power charging infrastructures (1 MW chargers) would reduce downtime for long-haul HDVs. However, installing a single charging station with ten 1 MW chargers would require a high-voltage power line sufficient to support a town with 20,000 inhabitants (Sader, et al., 2025). It may also pose challenges for the electricity grid, such as fluctuations in power quality or supply-demand imbalances that can cause grid congestion at the local level (IEA, 2024).

- Battery swapping technology becomes more practical for long-haul HDVs as it requires minimal changes to vehicle operations and allows slower battery charging with minimal vehicles downtime. Financial incentives to accelerate battery swapping deployment could be beneficial since the inhomogeneity of battery packs across manufacturers adds cost and complexity to battery swapping.

Lagging electric bus price decline makes target impossible to achieve, more ambitious policies are needed

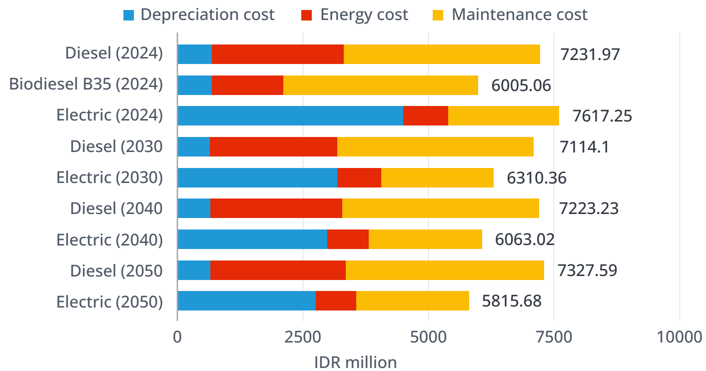
- Compared to electric trucks, accelerating electric bus adoption in Indonesia might be faster since it operates under a Public Service Obligation (PSO) scheme, meaning that national and local governments are significantly involved in the public transportation development. The Ministry of Transportation (MoT) has even set a target to electrify 90% of urban mass public transportation in Indonesia by 2030, or equal to 45,000 electric bus units (Detik Oto, 2024). Currently, 376 electric buses operate in five cities in Indonesia with an unbalanced distribution: 300 and 60 electric buses operate in Jakarta and Medan, respectively, while other cities (Surabaya, Semarang, and Yogyakarta) only owns 2-12 electric buses (Kompas, 2025). Transjakarta has a determined timeline to transform all of its ICE buses to 10,047 electric buses by 2030 (Transjakarta, 2022).
- In terms of adoption, the cost of electric bus still becomes a barrier for bus operators. In 2024, the TCO (total cost of ownership) of electric buses was still 5% and 27% higher than diesel and biodiesel buses (MEMR and DEA, 2024). The TCO of electric bus for 10 years use in the same period almost reach seven times higher than diesel bus due to a higher depreciation cost, which accounts for around 60% of total TCO. Depreciation cost consists of several items that will become cheaper over time, including upfront cost, charging infrastructure cost, and resale value depreciation. While biodiesel buses have the lowest TCO of all bus options, they benefit from the government's fuel subsidy policy. This indicates that the key barrier to accelerating electric bus adoption in energy costs, highlighting the need for supportive regulations to ensure fair competition between ICE and electric buses.
- However, in the near future, the TCO of electric buses will continue to decline due to technological advancement that enhance energy efficiency and reduce upfront and infrastructure costs. It is projected that electric buses will reach TCO parity by 2030 and could be 20% lower than diesel buses in 2050. The transition to electric buses is not only an environmental issue but also an economic opportunity, especially for public transport operators.

Transjakarta electric bus target to 2030



Source: modified from Transjakarta, 2022

Current and projection of TCO of diesel and electric buses, for 10 years of use



Source: modified from MEMR and DEA, 2024

3.5. Technology Advancement

Muhammad Dhifan Nabighdazweda

Contents:

- Renewables & Storage
- Low Emission Alternative Fuels & Biofuels
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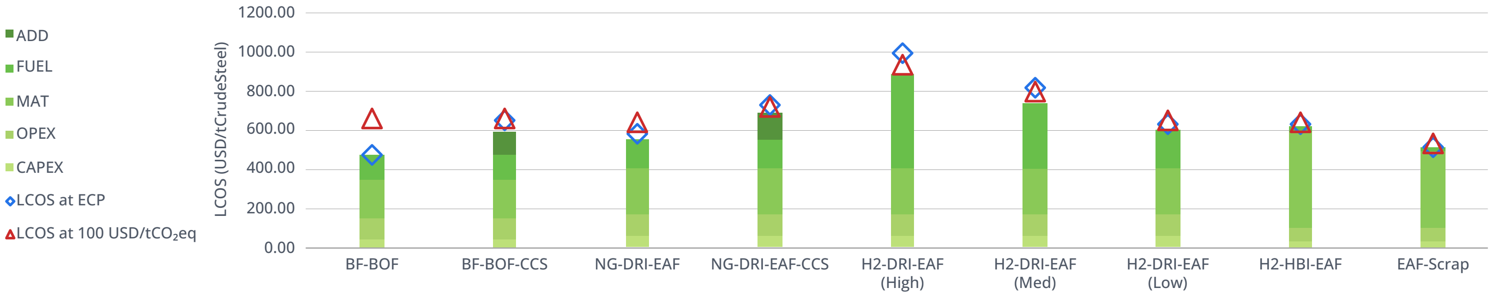
- **Energy Efficiency in Industry & Buildings**
- **TRF Rating**

Deep decarbonization steel production technologies in Indonesia are at least 1.2 times more costly than conventional BF-BOF routes and remain uncompetitive without targeted policy support



	BF-BOF	BF-BOF-CCS	NG-DRI-EAF	NG-DRI-EAF-CCS	H2-DRI-EAF (High)	H2-DRI-EAF (Med)	H2-DRI-EAF (Low)	H2-HBI-EAF	EAF-Scrap
Approximate Emission Intensity ($tCO_2eq/tSteel$)	1.90	0.74	0.89	0.36	0.55	0.55	0.55	0.24	0.24
Approximate Equlibrium Carbon Price	0	95	41	135	214	140	65	74	20

Notes:
The equilibrium carbon price refers to the carbon price at which the alternative technology achieves the same levelized cost of steel (LCOS) as the BF-BOF route.

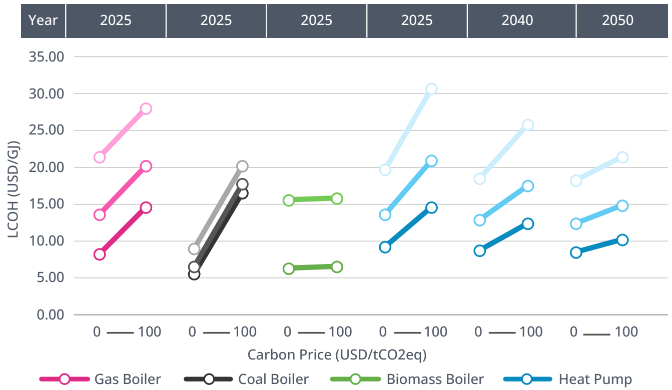
Sources : IESR Analysis from GEI, 2024; OECD and GEI, 2024; TransitionZero, 2024; AgoraIndustry, 2021; IISIA, 2025; KPMG, 2024; ADI Analytics, 2021 fuel market price

- At present, BF-BOF remains the only primary steelmaking route in Indonesia due to its lowest levelized cost of steel (LCOS). This cost advantage stems from coal prices that are at least 20% or 70% lower per unit of energy than subsidized natural gas and industrial electricity, respectively. To achieve deep decarbonization, the first step would be to expand the share of Scrap-EAF, which could reduce emissions intensity of up to 75% (based on grid electricity) or 95% (based on renewable electricity). However, Scrap-EAF currently contributes only about 30% of national steel output (GEM, 2025; IISIA, 2025), with no announced expansion plans. This limitation is likely due to insufficient domestic scrap availability and stringent scrap import policies (IISIA, 2025; IISIA, 2020).
- Further mitigation requires integrating carbon capture and/or fuel or process substitution, though not all are viable for deep decarbonization. Hydrogen injection as a replacement for pulverized coal, for example, would only provide marginal emission reductions (TransitionAsia, 2025), while emerging technologies such as molten oxide electrolysis remains in TRL 1-3. Viable options considered in LCOS analysis include BF-BOF-CCS or DRI-EAF-CCS, or H_2-DRI-EAF or H_2-HBI-EAF. However, even with a carbon price of USD 100/tCO_2eq, each of these routes still results in LCOS above USD 690/tSteel.
- In its most optimistic estimate, IEA (2025) projects hydrogen costs could fall from USD 6/kg to USD 2/kg. Nevertheless, H_2-based routes would still remain less competitive than BF-BOF-CCS, without carbon costs. Given asset lifetimes of up to 40 years (Rissman, 2024), retrofitting existing BF-BOF with CCS may appear more attractive. However, CCS faces ongoing challenges in capture efficiency and performance (IEEFA, 2024), with project economics dependent on transport and storage costs. If high capture efficiency, low-cost green hydrogen, or >65% Fe ore (for DRI) remain unfeasible for domestic production, importing HBI from countries with cheaper H_2-DRI production may present a more feasible alternative in iron and steel deep decarbonization.

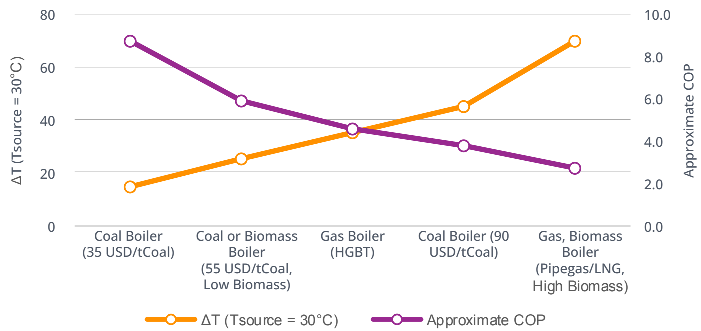
Heat pumps may be more cost-effective than thermal fuels for low-temperature industrial heat in Indonesia, particularly in industries with available waste heat sources

- Commercial-scale electric industrial heat pumps are increasingly becoming more affordable, efficient, and versatile, improving their economic case and viability (HPT, 2023; DEA and MEMR, 2024). Current commercial units (>0.1 MW) can achieve temperature of up to 160°C, with maximum lifts of up to 70°C, depending on system design, capacity, and configuration (HPT, 2023; EHP, 2025).
- This cost-effectiveness of heat pumps is typically determined by its coefficient of performance (COP), which depends on the intended heat sink and available heat source. Approximate calculations for Indonesia indicate that, with an ambient 30°C heat source and temperature lifts of 15°C - 45° yield, COP values in the range of 3.8 - 8.7, making its levelized cost of heat (LCOH) lower than coal, subsidized gas, or low-to-medium-priced biomass boilers. For lifts above 45°C, heat pumps may already be cost-competitive with non-subsidized pipeline gas, LNG, and high-priced biomass.
- Access to low-temperature waste heat sources, such as wastewater streams, can improve cost-effectiveness through lower temperature lifts. Thus, the application of heat pumps would be particularly suitable in sectors such as food and beverages, textiles, and pulp and paper, where both process heat applications and waste heat at 60 - 100°C are abundant.
- Nevertheless, the LCOH estimate may underestimate several constraints. First, the underdeveloped domestic supply chain, technology providers, and experienced EPC contractors, along with high import taxes could increase installation, maintenance, and overall costs. Second, high capital expenditure may lengthen payback periods. Third, operational reliability may be affected by PLN's grid, with current SAIDI and SAIFI averages of 5.34 hours/customers and 3.23 times/customers (PLN, 2025) (subject to regional variations). This may necessitate costly diesel backup systems, increasing total costs.

LCOH Comparisons across Technologies under Different Carbon Prices



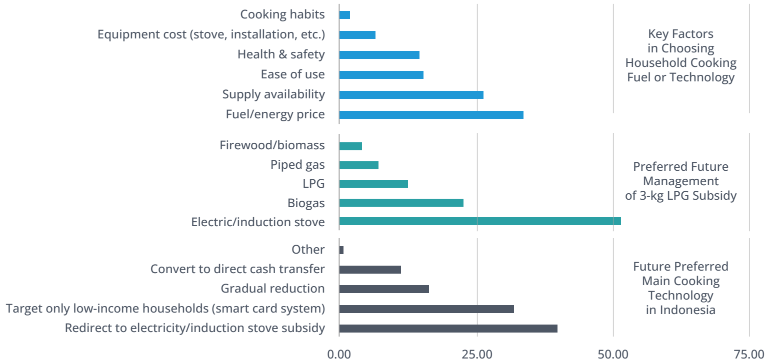
Heat Pump Parity with Conventional Boilers



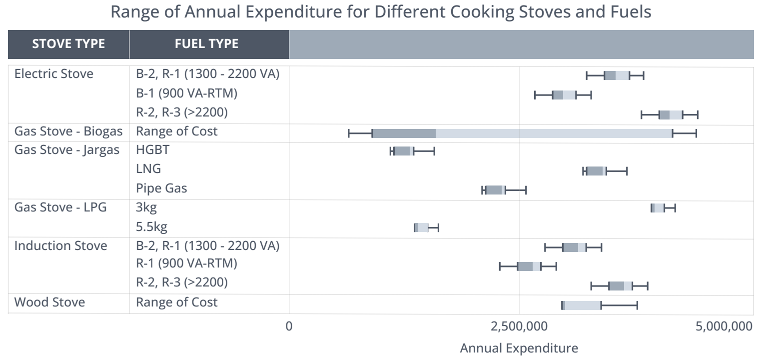
Sources: IESR Analysis from MEMR & DEA, 2024; Other fuel market prices

- From an environmental perspective, heat pump emissions depend on the carbon intensity of electricity. At current grid factors, a COP of 2 or 3.5 will result in emissions roughly the same as coal or natural gas boilers, respectively. However, by 2040 - 2050, projected grid decarbonization could reduce associated emissions by around 33% - 77%, making it more viable.

Cleaner fuel transitions in Indonesia provide health and cost benefits but remain constrained in many areas by fuel prices, supply limitations, and usability barriers



Sources: IETO 2026 Survey



Sources: IESR Analysis from MEMR & DEA, 2024; HIVOS & IESR, 2025; Arnani, 2025, other fuel market prices

- Survey results indicate that fuel price and supply availability are the primary and secondary determinants of household cooking fuel choice, while health and safety considerations rank fourth. In Indonesia, most households rely on subsidized LPG (3 kg), whose price is nearly half that of non-subsidized cylinders (5.5 kg or 12 kg), making it the second-cheapest option compared to firewood. Even approximately 85% of high-income groups (decile 7 – 10) in Java and Bali also use subsidized LPG (BPS, 2025; Sambodo et al., 2025). Despite the health benefits of transitioning from biomass, kerosene, and other conventional fuels that contributes to indoor air pollution and respiratory ilnesses (WHO, 2024), many eastern and rural regions continue to depend on these fuels (BPS, 2025). This is likely due to the limited supply of cleaner fuels and high transactional and logistical costs caused by limited distribution (Pambudi, 2015).
- Annual expenditure comparison shows that both pipeline gas and induction cooking are cheaper than unsubsidized LPG, even under assumptions of the highest gas prices (LNG-based) or the highest residential electricity tariff (R-3, or 5,500 VA). However, additional upfront and infrastructure costs may increase expenditure. Examples include household pipeline gas connections costing IDR 75,000 per meter beyond 15 meters (Sukmana, 2025), electricity capacity upgrades of IDR 1-3 million (Arnani, 2025), and new pipegas connections that costs the government roughly IDR 12 million per household (MEMR, 2021). Similar capital intensity also applies to expanding or upgrading electricity transmission and distribution, as well as to biogas systems, where costs depend heavily on livestock ownership (Fajar, 2016; Kompas, 2020).
- Usability ranks as the third determinant of adoption. Although induction stoves are regarded as the most desirable future cooking technology, requirements such as changing utensils, extended cooking time, and small cooking volume are viewed as disadvantages (Sambodo et al., 2025). To improve cost signals and support the transition away from subsidies, respondents generally favor reallocating LPG subsidies to electric or induction stove programs or targeted assistance to low-income households.

Indonesia's current technology readiness remains at a medium level due to the limited progress from pilot and demonstration stages toward full-scale deployment

- Across sectors, many technologies such as ammonia co-firing, carbon capture, tidal energy, small modular reactors, and hydrogen electrolysis are still being tested at small scales and lack proven commercial viability. While these initiatives show technical potential, they lack consistent funding, institutional follow-up, and integration with industrial and utility planning, partly because of limitations in the planning documents. As a result, projects like the 3% ammonia co-firing test in Labuan, the Arun CCS pilot, the West Kalimantan SMR study, and the first domestic SAF production in Cilacap remain limited to pilot or study phases without a clear continuation plan and tangible impact to support the national decarbonization target. This pattern echoes previous experiences, where Indonesia once had the chance to produce its own BEV in the early 2010s, but failed to do so due to inconsistent policies, lack of industrial support, and financial support, and an absence of the mindset to become a technology owner.

TRF Rating for Technological Advancement

Variable(s)	Indicator(s)	Rating
Ecosystem Support	Power system Compatibility	Medium
	Green industrial estate	Medium
	Electrification infrastructure	Low
Domestic Supply Chain	Domestic supply chain of low carbon technologies	Medium
Cost Competitiveness	Cost competitiveness of RE power plant	Medium
	Cost competitiveness of electric vehicles	Medium
	Cost competitiveness of green appliances	Medium
	Cost competitiveness of green industry	Medium

Source: IESR Analysis

- High costs and structural barriers further constrain technology competitiveness and market uptake. Despite solar and wind showing lower generation costs, other technologies such as BESS, green hydrogen, SAF, and green steel remain expensive due to limited economies of scale, high capital costs, and dependency on imported components. Weak domestic supply chains, fragmented coordination among ministries, and unclear investment frameworks delay project execution. The lack of midstream industries, such as electrolyzers, battery materials, BEV components, and industrial heat pump manufacturing, restricts Indonesia's ability to localize value chains and optimize its costs, ultimately hindering the transition pace.

- To move beyond pilot projects, Indonesia must prioritize scalable deployment strategies instead of isolated demonstrations. This includes establishing national-level flagship projects that combine public and private financing, mandating technology uptake in key sectors such as power, transport, and industry, and setting clear local content and performance benchmarks. The government should also redirect incentives from short-term subsidies toward investment in manufacturing readiness, research and development partnerships, and technology transfer to strengthen the domestic innovation base.

- Policy alignment, institutional development, and human resource readiness are equally critical. The government should develop an integrated cross-ministerial roadmap that links clean technology development with industrial policy, carbon pricing, and fiscal incentives. Workforce development programs focused on future energy technologies are needed to keep pace with technological advancement. Strengthening grid readiness, accelerating permitting, and enabling long-term power purchase agreements can also attract private capital. Regional demonstration hubs can be scaled into industrial corridors through blended finance and public-private partnerships. By shifting focus from experimentation to implementation and building skilled manpower, Indonesia can accelerate from medium readiness toward full transition maturity, ensuring that technological innovation translates into measurable decarbonization impact.

Chapter 4:
Energy Transition at the Subnational Level

Muhamad Yudistira Rahayu and Rizqi Mahfudz Prasetyo

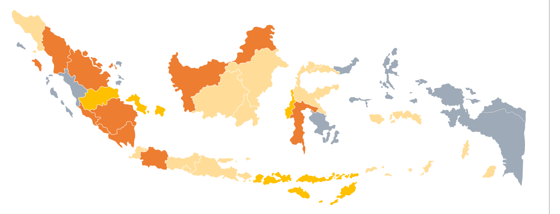
Contents

Provincial ambition to advance renewable energy development remains reliant on and dependent on national dynamics

- A total of 37 governors were elected in 2024 (excluding the Special Region of Yogyakarta). Each governor enters office with a vision and mission to guide provincial policy, programs, and budgets for the next five years. Yet only the Governors of Aceh, Jambi, Bali, and South Kalimantan explicitly mention renewable energy, energy transition, climate, or emission reduction. This reflects how governors are politically rewarded by short-term economic output, visible infrastructure delivery, and job creation as key performance signals, rather than decarbonization. Under these incentives, climate policy is treated as optional rather than strategic.
- Provincial governments often come up with high renewable energy ambitions on paper, but lack fiscal tools, with a low political mandate to act at scale, and often rely on external efforts. By 2025, 34 provinces have enacted a Regional Energy Plan (RUED) as a regional renewable energy target and a guide for renewable energy budgeting and programming. Among those, only 8 provinces had already surpassed their 2025 renewable energy mix targets by 2023, while most are unlikely to reach their own RUED targets. However, provincial progress toward these targets is uneven, mostly driven by renewable energy development by PLN's RUPTL or other private initiatives.
- Many RUEDs were drafted as five-year documents. By 2025, 20 provinces will already have RUEDs that have exceeded that five-year horizon, and, in principle, could be updated. This presents an opportunity to align subnational targets with Indonesia's net-zero narrative and with freshly enacted National Energy Policy (KEN). In practice, however, the update process is structurally constrained. Presidential Regulation 73/2023 requires provincial RUEDs to refer to the National Energy Plan (RUEN), which is still being revised and is scheduled for completion in 2026. Provinces cannot formalize updated RUEDs until the new RUEN is finalized, so subnational ambition is therefore gated by central timing.
- At the same time, provinces face a misalignment with renewable energy mix target between KEN and National Long Term Development Plan (RPJPN). The RPJPN, which is translated into Regional Long Term Development Plan (RPJPD), is implemented through a joint circular of Bappenas and the Ministry of Home Affairs. As a result, RPJPD targets and RUED targets often do not align, and in several cases, the RPJPD target is more optimistic than the RUED. Provinces are therefore assigned rhetorical responsibility for the energy transition, but operate within a planning system that remains highly centralized.

Provincial RUED status by 2025

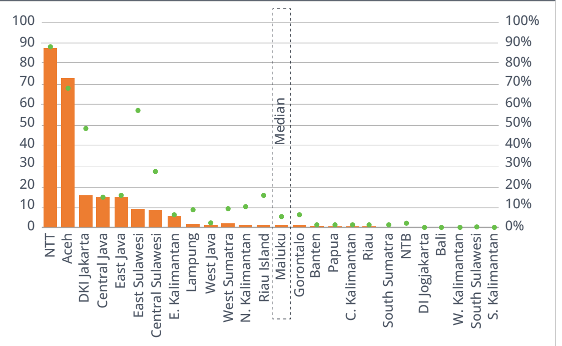
RE mix realization 2023



Province with RUED 5+ yrs, Province with RUED, Province without RUED (see excel for data)

Source: IESR analysis based on DEN (2025)

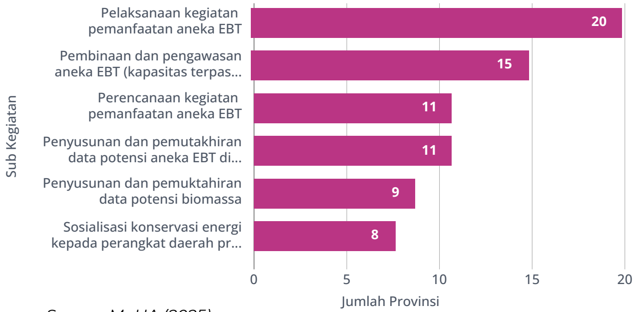
RE mix achievement, target in RUED vs RPJPD



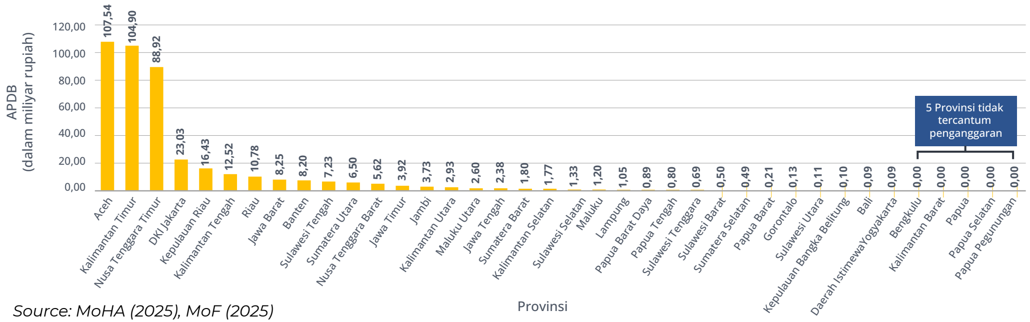
Vertical axis: RE target (%), Horizontal axis: nama provinsi
bar chart berupa stacked bar antara target tahun 2050 (RUED) vs target RPJPD 2045, **data point** (titik), data capaian RT tahun 2023

Source: IESR analysis based on RUEDs & RPJPDs, DEN (2025)

Provincial government struggle to finance renewable energy implementation due to lack of political will and fiscal constraints



Source: MoHA (2025)



Source: MoHA (2025), MoF (2025)
Catatan: di atas angka alokasi anggaran bisa dikasih data persentase dari total APBD

- Provincial governments are responsible for renewable energy development as a provincial obligation under Presidential Regulation 11/2023, along with Ministry of Home Affairs Decree No. 900/2024 and Regulation No. 15/2024. The regulation enables budget tagging on 10 types of activities to be carried out starting in 2025. In its first year of implementation, however, only 33 (thirty three) provinces tagged part of their budgets for renewable energy, totaling IDR 426.73 billion, mainly for renewable energy infrastructure construction, supervision, and technical data update (MoHA, 2025).
- Provinces are being made responsible for the transition without reliable funding. The allocated budget often serve mainly to show alignment with national targets or to finance last-mile electrification within tight fiscal space. Spending is fragmented and mostly preliminary, provinces often fund studies mapping, training, or small off grid solar for underserved communities rather than scalable generation, storage, or system-level solutions. Most provinces are therefore funding preparatory or symbolic steps, not structural change. With several government-funded renewable energy infrastructures left stranded, the sustainability and continuity of their annual program needs to be taken into consideration.
- Of the 33 provinces that allocated renewable energy budgets, the top three are Aceh, East Kalimantan, and East Nusa Tenggara that account for 70% of total subnational renewable spending. Even there, renewable energy spending is marginal with an average of only around 0.1% of total provincial budget. Renewable energy development is seen as a strategic option rather something vital they can afford to elevate alongside health, education, and basic services.
- This financing mandate gap is widening under fiscal recentralization. Central transfers to regions are being reduced, the 2026 State Budget allocates IDR 649.99 trillion in regional transfers, about 30% below the IDR 919.87 trillion in the 2025 State Budget (Salam & Rahayu, 2025). With tighter fiscal space and rising basic-service obligations, renewable energy becomes discretionary and therefore vulnerable. The national government is assigning responsibility for the energy transition while retaining control of the money. Without protected transition-oriented transfers, results-based grants, or new provincial revenue tools, “provincial leadership” will remain procedural, not transformative.

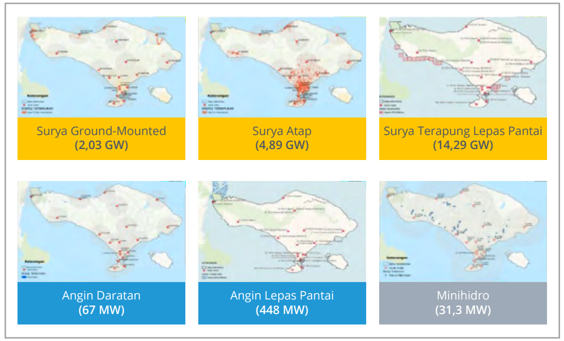
Bali's Renewable Energy Transition Faces Implementation Gaps Despite Vast Technical Potential

- Bali's RUED (Local Regulation 9/2020) sets a renewable-energy share of 11.15% by 2025 and 20.10% by 2050, while actual progress only 2.72% lags far behind, revealing the core implementation challenge rather than a lack of resource potential (Bali Provincial Government, 2020) . According to IESR studies, solar remains the anchor resource with about 21 GW of technical potential across ground, rooftop, and offshore floating sites, complemented by wind (515 MW), geothermal (127 MW), municipal solid waste (59 MW), and mini-hydro, balanced by BESS and roughly 90 GWh of pumped-hydro potential (IESR, 2025).
- By 2045, Bali's roadmap envisions scaling from early deployment of 1.5 GW renewables and up to 5.8 GWh of storage in 2025–2029 to a fully renewable system of 13–17 GW and 33–54 GWh of storage, achieved through phased additions of renewable capacity and supporting infrastructure (IESR, 2025).
- Bali Governor Circular Letter No. 5/2022 on mass rooftop solar installation holds strong symbolic value, signaling the province's intent to lead on clean energy. Momentum is strongest where local government units, civil society, private sector, and progressive hospitality groups align on efficiency and rooftop solar (PLTS atap), supported by growing financing appetite for standardized and bankable portfolios. Yet progress is slowed by interconnection bottlenecks, shifting net-metering rules, opaque queueing, quota mechanics, and fragmented permitting that raise soft costs for small projects. Legacy fossil contracts and rigid public procurement further entrench delay even where PV-storage economics are favorable.
- To move forward, a PLN–provincial agreement must guarantee transparent interconnection timelines and prioritize access for government facilities, SMEs, and the tourism sector. Readiness also means establishing a permanent delivery unit with grid, finance, and legal capacity; a ring-fenced Bali interconnection queue with transparent service-level agreements; a tourism green levy to co-fund storage; and a public dashboard that tracks compliance and penalties. Without these enabling instruments, the governor's call risks remaining a ceremonial gesture rather than a catalyst for real change.
- Ultimately, Bali's transformation is not only technical or economic; it must also be cultural, rooted in the Balinese philosophy of Tri Hita Karana, which promotes harmony among humans, nature, and the divine. By framing renewable energy and circular practices within this cultural ethos, Bali can turn its vulnerability into leadership in Indonesia's energy transition journey. Bali's mid-2025 blackout was more than an inconvenience, it was a stress test of the island's energy politics that underscored the importance of energy independence.

Projection of Primary Energy Source Mix in Bali, 2015-2050 (Pemerintah Provinsi Bali, 2020)

Primary Energy Source	2015 (%)	2025 (%)	2050 (%)
Coal	19.63	3.32	0
Gas	4.39	56.23	34.85
Oil	75.71	29.3	45.05
Renewable Energy	0.27	11.15	20.1
Total	**100**	**100**	**100**

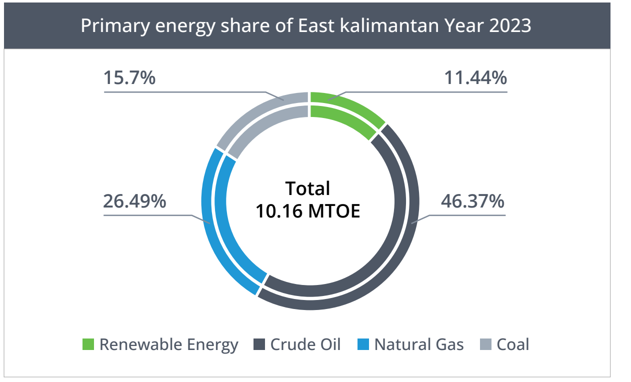
Result of Renewable Energy Potential Mapping in Bali Province (IESR, 2025)



Being Indonesian 'coal-giant', East Kalimantan energy transition progress is driven by national policy and collaborative efforts from various stakeholders

- East Kalimantan, Indonesia's largest coal-producing province, reports a 2024 renewable energy mix of 11.84% and expects to meet its RUED target of 12.39% percent this year. This is presented as proof that a coal-based economy can also deliver renewables. However, much of the recent increase comes from politically visible projects, especially solar development for the new national capital IKN, which separated from East Kalimantan, rather than from a broad restructuring of the provincial economy. The improvement in the renewable energy mix is driven partly by nationally led assets hosted in East Kalimantan, not by a decisive shift away from coal in provincial industry.
- To formalize its renewable energy agenda, East Kalimantan issued Governor Regulation No. 5/2023 on the Enhancement of New and Renewable Energy Programs. This regulation is binding on the provincial bureaucracy. It sets renewable energy as a program priority, instructs provincial agencies to coordinate, and calls for incentives and integration of renewable energy into planning. However, it does not impose enforceable obligations on the state utility or private industry. It primarily serves as an instrument for internal alignment within the provincial government, and by itself, cannot reduce coal dependency as the backbone of the regional economy.
- Provincial spending on renewable energy is the highest among other provinces, but it could be higher. The government allocated IDR 104.9 billion for renewable energy, placing East Kalimantan among the highest spenders nationally (MoHA, 2025). Yet, it accounts for less than 1% of the regional budget (APBD). Funds were used for off grid charging stations, solar street lighting, rooftop solar, and biogas systems in remote areas. These programs matter for social inclusion, diesel displacement, and enhancing energy access but still mostly small scale and service-oriented.
- The province is also assessing floating solar PV on post mining voids (Hanafi, 2025). Mine pits offer sizable technical potential. IESR preliminary analysis showed a technical potential of 1.5 GW from over 500 locations. However, the deployment is still long term. Land status, post mining liability, and permitting remain split across ministries, and that inter-ministerial misalignment slows progress.

Primary energy share of East Kalimantan Year 2023



Source: Pemerintah Provinsi Kaltim (2024)

Table Renewable energy installed capacity of East Kalimantan Year 2024

No	Type	Size/Installed Capacity (MW)
1	Solar	14.00
2	Biomass	6.30
3	Biogas	4.00
Total		**24.3**

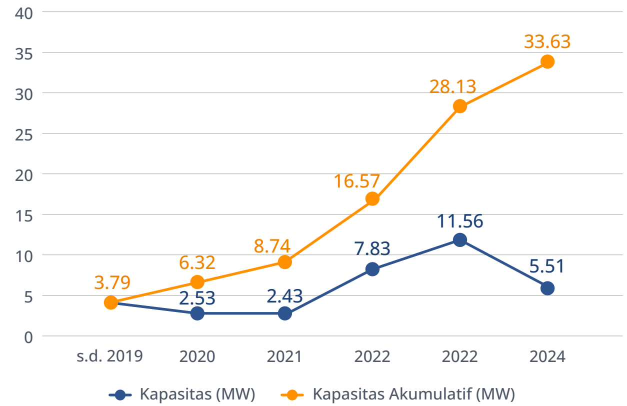
Source: Bappeda Kaltim (2024)

- East Kalimantan has also established a Regional Consultation Forum, FKD, on energy transition and economic transformation (Bappeda Kaltim, 2025). Built with strong support from external transition programs, this forum signals a narrative shift. Renewable energy is now being discussed as part of the province's future economic base. Whether that translates into actual investment authority, rather than consultation, is still unresolved.

Urban Energy Transition Under Constraints: How Jakarta Leverages Fiscal Instruments and Limited Land to Achieve Net Zero by 2050

- Jakarta has set ambitious climate goals by cutting 30% greenhouse gas emissions by 2030 and achieving net-zero by 2050, anchored in the Regional Low Carbon Development Plan (Governor Regulation No 90/2021) and Governor's Instructions No. 66/2019 and No. 17/2021, which mandate accelerated renewable-energy adoption. Beyond mitigation, these targets serve a reputational purpose: in the 2022 Global Power City Index Jakarta ranked 45th out 48 cities, underscoring the need to strengthen climate action, integrate renewables, and lower per-capita emissions to enhance global competitiveness.
- As a hyper-dense, flood-prone metropolis, Jakarta has almost no spare land for utility-scale renewables, while higher logistics costs in the Kepulauan Seribu islands challenge equitable rollout. Rooftop solar (PLTS atap) is the practical keystones. It repurposes public roofs, schools, hospitals, malls, factories, and apartments into distributed generation where demand already exists, shortens delivery times through modularity, and creates visible, education-rich sites that normalize adoption.
- By 2050 the province envisions 200 MW of rooftop solar, 100 MW of waste-to-energy, and selective deployment of emerging options such as hydrogen-based power, alongside mass electrification (50% of households on electric stoves and 75% of vehicles electric or hydrogen). Encouragingly, rooftop capacity of roughly 34 MWp already exceeds the 2025 RUED target of 25 MWp. Public facilities have led early deployment: by 2025, 186 buildings of schools, offices, health centers, commercials about 4.576 MWp (DTKTE DKI Jakarta Province, 2025).
- Diverse financing has enabled this first wave, including APBD allocations for public assets, partnerships supporting feasibility studies and financing for 27 hospitals, and private CSR (DTKTE DKI Jakarta Province, 2025). Backed by strong provincial fiscal capacity, yet diffusion remains uneven: government roofs and select institutions dominate while low-income neighborhoods and the islands lag due to tenure, roof quality, and logistics.
- Reliance on ad-hoc CSR is catalytic but not durable. Small-customer interconnection and permitting must be stable and time-bound. To translate momentum to households and SMEs, Jakarta should pivot from capex to service models such as rooftop-as-a-service and on-bill repayment. The city should facilitate aggregators to bundle small roofs, cut soft costs, deploy credit guarantees and interest buydowns for sub-10 kWp systems, and create inclusive windows for kampung and Kepulauan Seribu that pair PV with roof rehabilitation, wiring safety, and efficient cooling. With policy, finance, and operational durability, Jakarta can turn today's pilots into an equitable, self-sustaining market aligned with its 2050 net-zero path.

Jakarta rooftop solar implementation 2024
(DTKTE Jakarta Province, 2025)



Renewable Energy Development Targets in
DKI Jakarta Province (DTKTEDKI Jakarta Province, 2025)

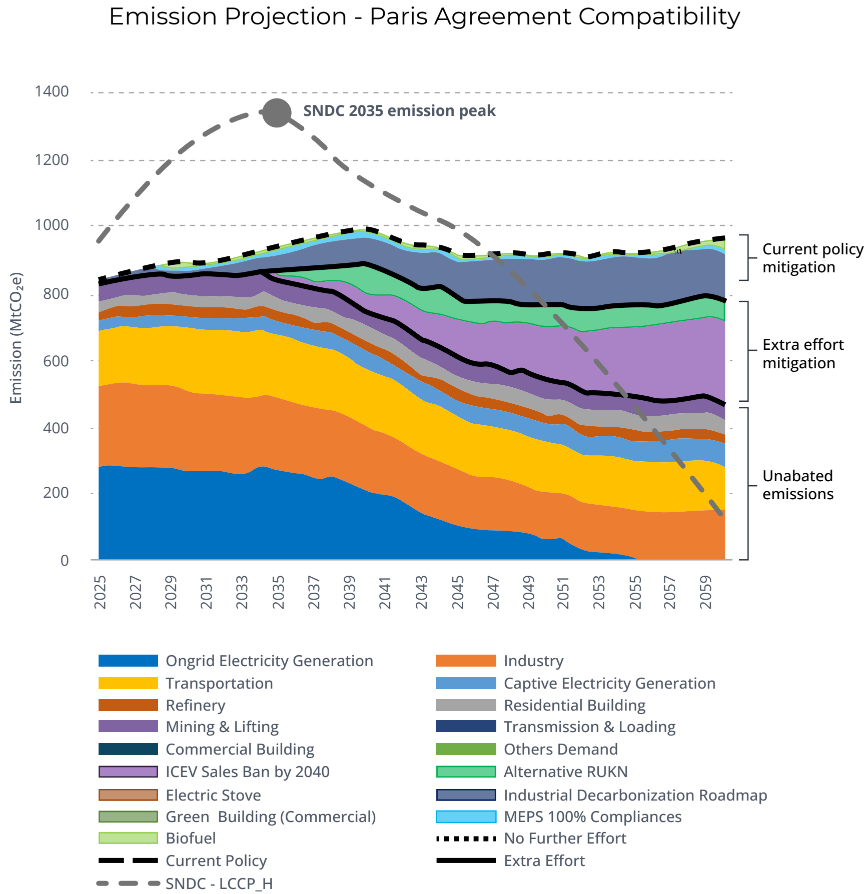
Power Plant Type	Existing (2022)	Target RUED 2025 (MW)	Target RUED 2030 (MW)	Target RUED 2050 (MW)
Solar Power Plant (PLTS)	16.57	20	32.5	200
Waste-to-Energy Plant	10.4	25	35	100
Wind Power Plant (PLTB)	0	0.5	0	2
Hydrogen Power Plant (PLTH)	0	0	0	100
Total	**26.97**	**45.5**	**67.5**	**402**

Chapter 5:
Outlook and Way Forward

Abraham Octama Halim and Pintoko Aji

Achieving NZE requires turning top-down commitments into coordinated actions, ensuring that currently excluded sectors are brought into Indonesia's mitigation roadmap

- IESR's energy system modeling highlights a fundamental discrepancy in Indonesia's climate commitment under the SNDC. The 2035 emission target of 1,336 $MtCO_2e$ appears attainable largely because it assumes 8% annual economic growth by 2029. IESR's projection, based on data from the World Bank, IMF, OECD, SEI (SSP-4), and national energy statistics, shows that emissions will already fall below the SNDC projection from 2025 to 2035, even under a "No Further Effort" scenario, as actual growth is expected to be slower. Indonesia therefore risks presenting a performative success, where emission reduction is achieved through slower growth rather than genuine mitigation.
- Beyond 2035, the SNDC envisions a steep decline in emissions to 2060 but provides no clear policy action plan or cross-sector governance framework to achieve it. IESR's "Current Policy" scenario, which includes ongoing measures such as biofuel blending, MEPS, green building programs, and limited industrial decarbonization (9 sectors only), still lead to emissions of 780 $MtCO_2e$ by 2060, far above the SNDC target of 129 $MtCO_2e$. This gap reflects weak institutional coordination and the absence of a unified policy mechanism to link economic, industrial, and energy planning.
- The "Extra Effort" scenario introduces stronger measures such as higher electric stove adoption, deeper power sector decarbonization, and a 2040 ban on ICE vehicle sales, reducing emissions to 472 $MtCO_2e$ by 2060. Yet this still falls short of the SNDC target. The remaining emissions are concentrated in unmitigated sectors including industries outside of the 9 mapped subsectors, freight, aviation, marine transport, household cooking, and captive power. Even if the grid achieves net-zero by 2060, these sectors show that fossil dependence remains deeply embedded in everyday and industrial activities, indicating that mitigation remains overly centered on the power sector rather than system-wide.



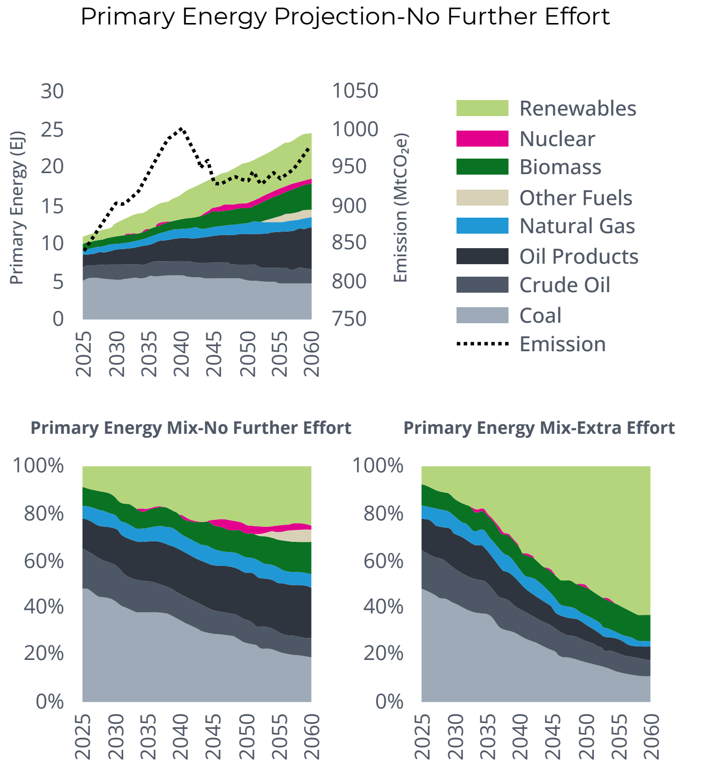
Expanding the renewable share in the primary energy mix is key to decoupling emissions from economic growth and make Indonesia's "Golden" vision truly "Green"

Indonesia's Projected GDP Income vs Emission Production

- Balancing economic growth with emission reduction has become Indonesia's central energy policy dilemma. While the country's ambitions are high, governance remains fragmented across ministries with overlapping mandates, weak enforcement, and inconsistent priorities between national planning and ministries. Political incentives still favor rapid industrialization and resource downstreaming, often sidelining decarbonization measures that could constrain near-term growth or fiscal revenue.
- Economic growth does not inherently require higher emissions, but achieving "green growth" demands a structural policy realignment. Demand-side mitigation and energy efficiency must be prioritized so that rising output does not translate into rising energy use. Meeting new demand with fossil fuels will only lock in emissions. Instead, Indonesia must pair aggressive renewable deployment with a managed phase-out of fossil generation and fuel use.
- IESR's modeling clearly shows how increasing the renewable energy mix affects emissions and growth. In the "No Further Effort" scenario, renewables reach only 41-43% of the primary energy mix by 2060, causing emissions to keep rising alongside GDP and reach 1,104 $MtCO_2e$ under the 8% economic growth assumption. In contrast, the "Extra Effort" scenario, with 77% renewables in the mix, achieves comparable GDP growth while bending emissions down to about 436 $MtCO_2e$ by 2060.
- This suggests that the SNDC target could be made more ambitious if Indonesia increases its RE share in the primary energy mix, as higher RE penetration can reduce emissions without constraining economic growth and effectively decouple GDP from emissions.

A credible NZE pathway demands explicit cross-sectoral fossil fuel phase-out in addition to renewable energy expansion

- Higher renewable shares in the energy mix must come not only from new capacity but from systematically phasing out fossil energy. Without a coordinated fossil retirement plan, renewable growth risks becoming cosmetic, masking rather than replacing fossil use. The "No Further Effort" scenario, which follows the RUKN plan, results in NRE reaching only 20.8% of the primary mix by 2030, below the KEN target of 23%, with emissions likely peaking as late as 2040. This shows that renewable expansion alone cannot deliver real mitigation.
- The "Extra Effort" scenario performs better, raising renewables to 22% by 2030 and 77% by 2060, compared to 41% under "No Further Effort." Progress is driven by deeper power sector decarbonization and transport electrification through the 2040 ICEV ban. To accelerate this further, Indonesia should extend mitigation to industry and buildings by setting minimum electrification targets and aligning energy efficiency standards (MEPS) with ASEAN benchmarks.
- Achieving genuine decarbonization requires institutional reform as much as technological progress. This includes a transparent coal retirement roadmap aligned with Presidential Regulation No. 112/2022, an oil phase-down linked to transport electrification, and comprehensive transition plans for industry and buildings. Policy predictability must improve through integrated planning among MEMR, PLN, and Bappenas and a consistent renewable procurement framework. Existing decarbonization bodies such as PIH, Satgas TEH, and Rumah PATEN must be empowered with clear mandates and accountability.



- Industrial policy must also shift direction. Instead of prioritizing high-emission downstreaming of metals and fossil-based inputs, Indonesia should adopt a "powershoring" strategy: leveraging its vast RE potential to attract and build energy-intensive, low-carbon value chains. This means positioning itself in sectors like battery materials, electrolyzers, and green hydrogen, which require abundant and cheap clean energy. This would align industrial growth with the long-term energy transition rather than competing against it.
- Embracing these structural and governance reforms will unlock Indonesia's potential. This integrated approach ensures rapid, meaningful renewable expansion, transforming the net-zero pathway from an optimistic assumption into a verifiable national strategy and securing a resilient, sustainable future.

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Appendices

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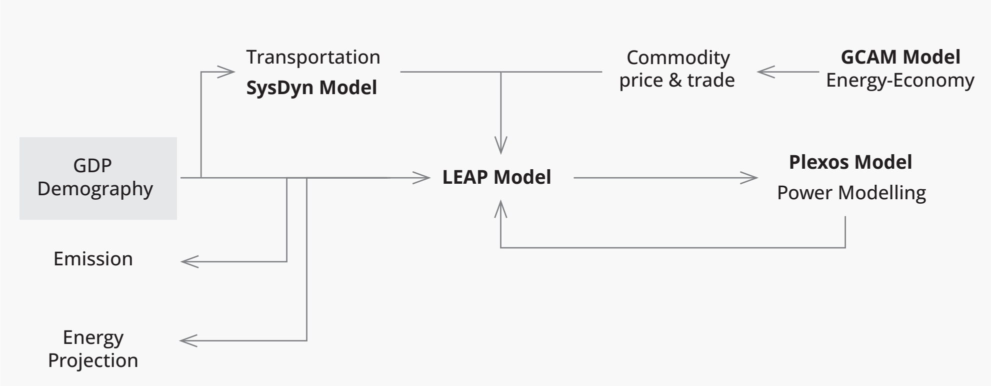
- Appendix D – IESR's Transition Readiness Framework

Appendix A - IESR's Energy System Model (1 of 3)

IESR IETO model structure



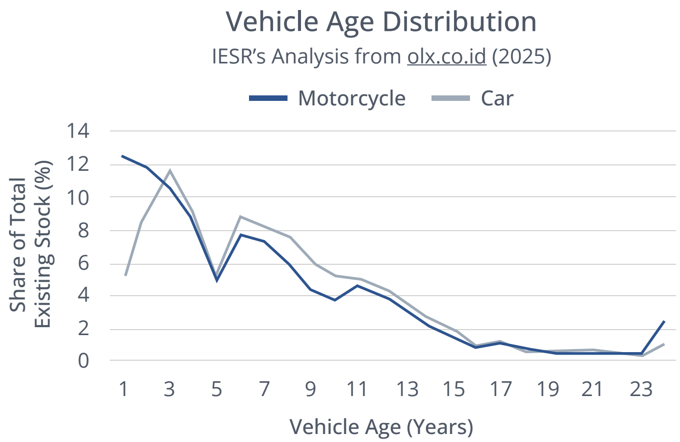
Non-Combustible Power Plant Efficiency Assumption

Types of Power Plant	Efficiency
Hydro power (PLTA)	33%
Micro- Mini- Hydro (PLTMH, PLTM)	25%
Geothermal (PLTP)	33%
Solar PV (PLTS, PLTS Atap)	13%
Wind (PLTB)	25%
Solar Powered Public Street Lighting & Energy Saving Lamp (PJU TS & LTSHE)	100%
Bioenergy (PLTBm, PLTBg, PLTSa)	25%
Hybrid (PLTHybrid)	13%
Tidal (PLTAl)	25%
Nuclear (PLTN)	27%

Note: These assumptions were used to convert the non-combustible power generation to primary energy

- LEAP Cloud Data Server: Population and Urbanization projections are based on the World Population Prospects 2019 (UN, 2019) & Population Pyramid.
- LEAP Cloud Data Server: GDP PPP (constant 2017 international dollars) incorporates both short-term projections (accounting for COVID-19 impacts) and long-term projections based on Shared Socioeconomic Pathway 4 (Publisher: World Bank, IMF and OECD with additional analysis by SEI, 2021); BPS Gross Domestic Product Income & Expenses 2019-2024.
- The demand-side model was developed using a bottom-up approach, drawing on data from multiple sources, including Residential End-Use Survey, Appliance Market Study (Fan, Lighting, Refrigerator, Rice Cooker) & MEPS Regulations, National Socio-Economic Survey 2011-2024 (appliances penetration), IESR's commercial building floor area projection, Benchmarking of Specific Energy Consumption in Commercial Buildings, Green Building Cost, Mandatory Building based on MPWH regulation. The model also incorporates IESR's transport system dynamics model with stock turnover restructuring in LEAP, as well as an industrial model developed by disaggregating HEESI industrial energy data using manufacturing statistics from 2019–2022 and forecasts for 2023–2024. The industrial decarbonization pathway was further informed by 9 subsectors decarbonization roadmap.
- The framework involves multi-model interaction, with LEAP (Low Emissions Analysis Platform) serving as an integrator. This includes:
  - ◊ A CGE-based (GCAM) model to generate commodity prices projection,
  - ◊ A system dynamics (Vensim) model to capture mobility behavioral patterns, and
  - ◊ PLEXOS® for capacity expansion and detailed power system analysis

Appendix A - IESR's Energy System Model (2 of 3)



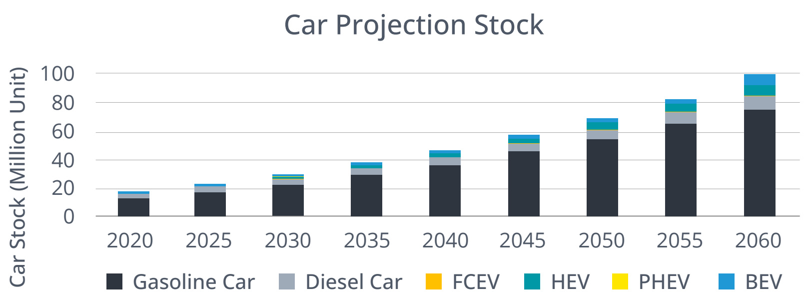
$$Stock_{t,v} = Stock_{t-1,v} + Sales_{t,v} - \ Retirement_{t,v} - Scrap_{t,v}$$

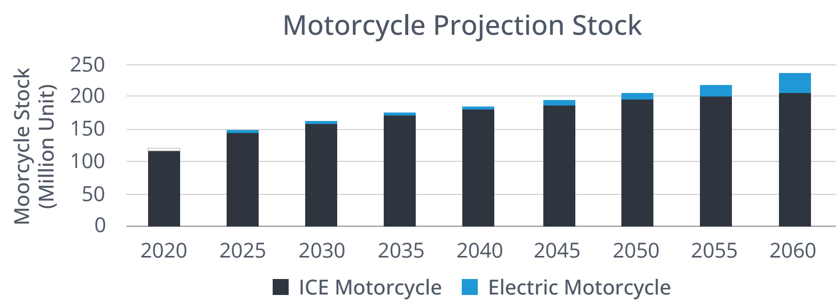
$$Sales_{t,v} = SalesSD_{t,v} + Addition\_Sales_{t,v} + (1 - \%Stockout)\ x\ Retirement_{t,v} + SalesfromStockout_{t,v}$$

$$Sales_{v,t} = x_v\ .Sales_t$$

$$x_v\ = sales\ share\ of\ v$$

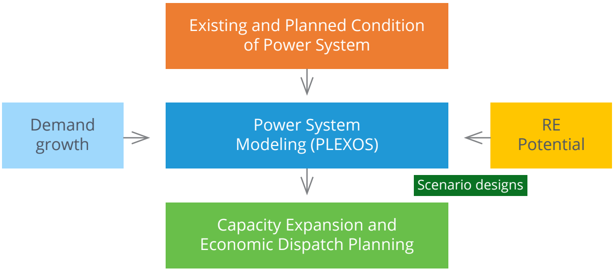
- The index "v" represents the vehicle type, while "t" indicates the year. The SalesSD is input from the SysDyn (SD) model, and Additional Sales are added to keep the projected total stock consistent with SD-based mobility projections.
- Sales from Stockout are added to replace vehicles that have reached the end of their useful life, with an assumption stock depletion rate of 97.7% for vehicles aged 24 years or more since their first year of sale, based on the tail end of the e-commerce-based vehicle age distribution.
- In policy scenarios such as bans on ICEV sales, age restrictions, or scrappage, controls are applied to vehicle sales rather than existing stock. Therefore, the share of vehicle sales is treated as an adjustable variable in the simulation.
- The projection results of motorcycle and car using the stock turnover method for the business-as-usual scenario are shown below.





Appendix A - IESR's Energy System Model (3 of 3)

General Approach



PLEXOS simulation parameters

Simulation parameter	Value
Horizon	2025-2060
Optimization step	2 years, 1year overlap
Load chronology	Sampled
Load details	Hourly (8760 data points)
Sampled days	365
VRE Profile details	Hourly (8760 data points), sampled per node

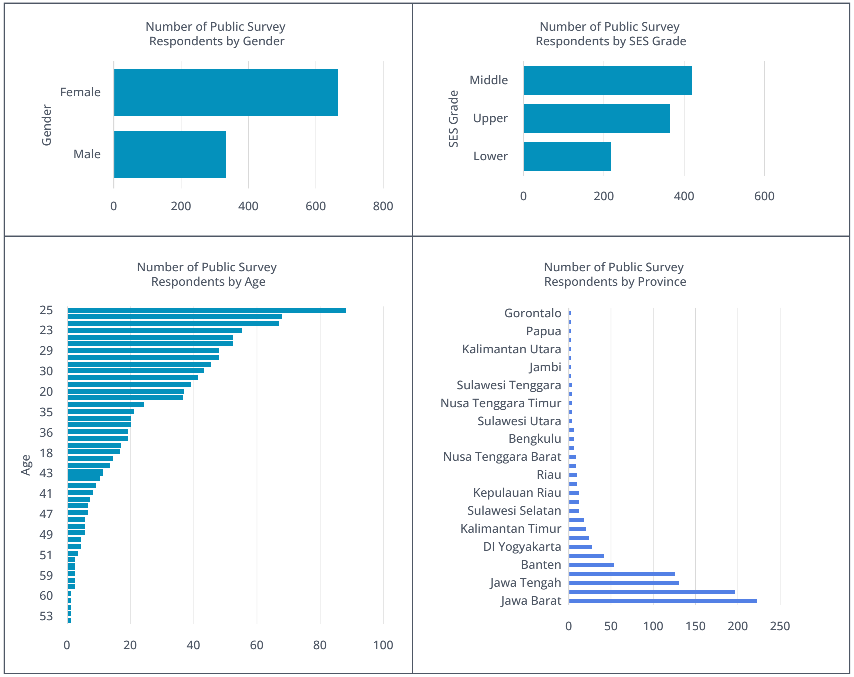
Summary of Scenario Design

Scenario	Current Policy (RUKN)	Least-cost Optimised (Opt)
Demand	On-grid electricity demand and load profile based on RUKN 2025-2060 and RUPTL 2025-2034	
Reliability Criteria	Reserve margin (30% in 2023, linear decline until 10% in 2060)	
Techno-economic Parameters	MEMR's Technology Data Catalogue 2024	
Fossil Power Plant Scenario	Coal & gas: retrofitting **mandatory** following RUKN; Diesel: shutdown **mandatory** by 2033	Coal & gas: retrofitting **optional** at the end of lifetime; Diesel: shutdown **mandatory** by 2033
Capacity Expansion 2025-2034	Following RUPTL 2025-2034	
Capacity Expansion 2035-2060	Following RUPTL 2025-2034	Fully Optimised
Emission Constraint	None	

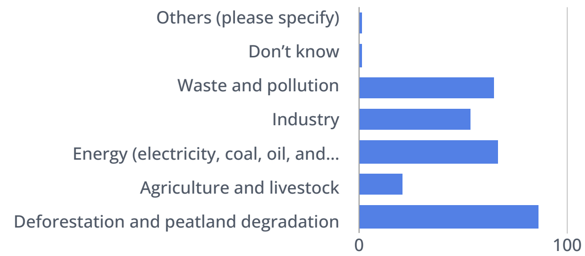
- Indonesia's power system is represented by 8 regions and 29 nodes in the PLEXOS model. Each large island is represented as a region, while the subsystems within the island are the nodes. Maluku, Papua, and Nusa Tenggara (MPNT) region are modelled as a single node per island system, with a total of 17 nodes. Existing and planned interconnections between nodes and regions follow the plans outlined in the RUKN 2025-2060 document.
- Power plant techno-economic parameters and fuel price in the power system model refers to MEMR's 2024 Technology Data for the Indonesian Power Sector.
- The on-grid demand used in the model refers to the demand projection from RUKN 2025-2060, which is separated into captive and on-grid demand. From 2025-2034, the model uses demand projection from RUPTL 2025-2034 as the on-grid demand, and the difference between RUKN and RUPTL demand is assumed to be the captive demand. From 2035-2060, the on-grid demand is the result of subtracting the 2034 captive demand from the RUKN demand. This assumes there are no new addition of captive demand from 2034 onwards. The resulting 2025-2060 on-grid demand projection is distributed proportionally to the model regions.

Appendix B – IESR Public Survey Result 2025 (1 of 2)

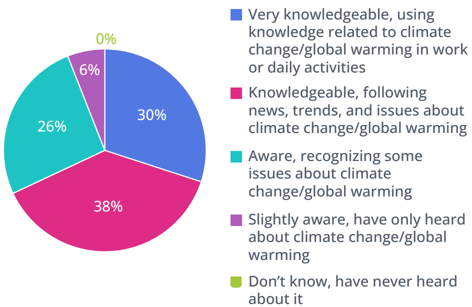
Demographic Status of the 1,000 Respondents



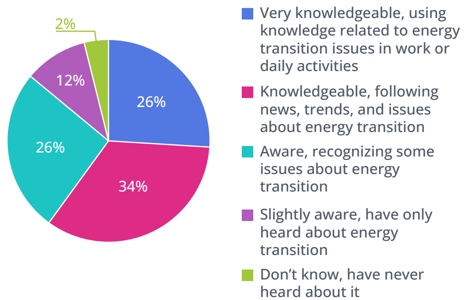
In your opinion, which sectors in Indonesia contribute to climate change/global warming? (%)



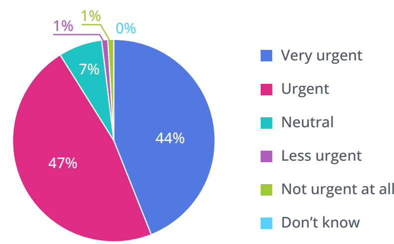
How would you describe your knowledge about climate change/global warming? (%)



How would you describe your knowledge about energy transition? (%)

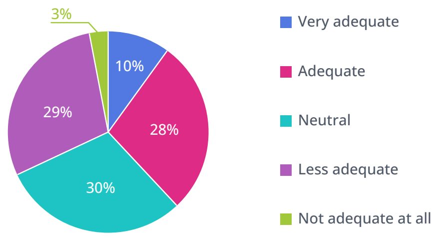


In your opinion, is climate change/global warming an urgent issue that needs to be addressed? (%)

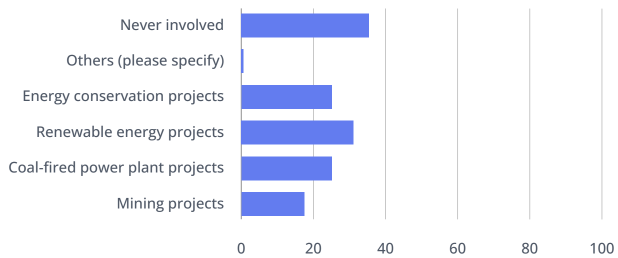


Appendix B – IESR Public Survey Result 2025 (2 of 2)

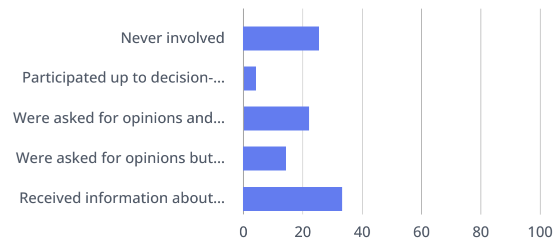
In your opinion, are the current Indonesian government policies to promote energy transition adequate? (%)



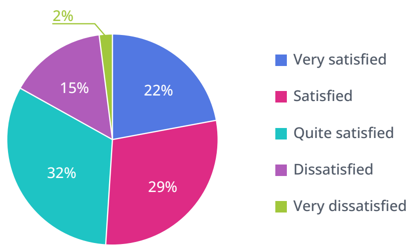
Have you or your community ever been involved in decision-making or consultations related to energy transition? (%)



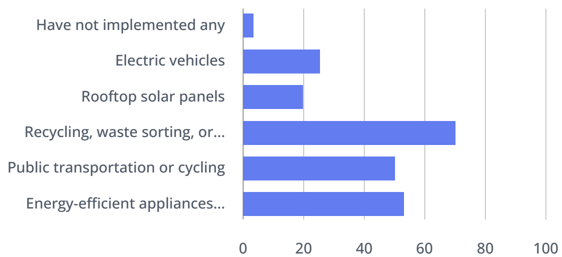
To what extent were you or your community involved in the planning and implementation process of energy transition projects? (%)



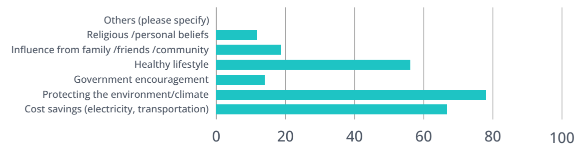
How satisfied are you with the opportunities for public participation in energy planning? (%)



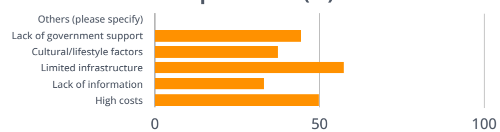
What low-carbon practices have you implemented or used in your household? (%)



What are your main motivations for adopting low-carbon practices? (%)



What are the main barriers you face in adopting low-carbon practices? (%)



Appendix C – IESR Solar Supply Chain Industry Mapping, September 2025

Existing Module Manufacturers

No.	Company Name	Production capacity (MWp/year)
1	PT SEI	75
2	PT Surya Utama Putra	45
3	PT Adyawinsa Electrical	40
4	PT Jembo Energindo	50
5	PT Swadaya Prima Utama	40
6	PT Azet Surya Lestari	45
7	PT Deltamas Solusindo	30
8	PT Santinitlestari Energi Indonesia	50
9	PT Indodaya Surya Lestari	30
10	PT Wijaya Karya Industri Energi	50
11	PT Sankenindo	45
12	PT Bernadi Utama	30
13	PT Cahaya Mas Cemerlang	10
14	PT Avecode International	24
15	PT Indonesia Solar Global (ISG)	75
16	PT ZEF Energy	20
17	PT Pana Indo Alkestama	20
18	PT Surya Semesta Cemerlang	20
19	PT Cipta Mentari Utama	70
20	PT Hanover Solar Indonesia	25
21	PT Sky Energy Indonesia	12
22	PT ZNShine Techlan Solar Indonesia (Ex-PT Canadian Solar)	500
23	PT IDN Solar Tech	800
24	PT Apollo Solar Indonesia	500
25	PT Atelier Solar	800
26	PT Lesso Solar	1200
27	PT Trina Mas Agra Indonesia (TMAI)	1000
28	PT Dunia Solar Indonesia	2000
29	PT REC Solar Energy Indonesia/NE Solar Indonesia	3500
30	Sun Tech Power Indonesia	1000
31	Thornova Solar	2500

Existing and Upcoming Module Manufacturers' Production Capacity (GWp/year)

Company	Existing	Upcoming
PT REC Solar Energy Indonesia/NE Solar Indonesia	3.5	4.5
PT Thornova Solar Indonesia	2.5	-
PT Dunia Solar Indonesia	2	-
PT Lesso Solar	1.2	-
PT Trina Mas Agra Indonesia (TMAI)	1	-
Suntech Power Indonesia	1	1
SEG Solar Indonesia	-	5
LONGi Solar Indonesia	-	1.6
Others	3.4	1.5

Existing and Upcoming Cell Manufacturers' Production Capacity (GWp/year)

Company Name	Existing	Upcoming
Nusa Solar	3	-
NE Solar Indonesia	2.5	5.5
SunTech Power Indonesia	1	1
SEG Solar	2	3
TMAI	1	-

Appendix D – IESR's Transition Readiness Framework (1 of 7)

Dimension(s)	Variable(s)	Indicators	Assessment Point	Assesment Method	Source of Data	Rating guideline
Political Commitment and Governance	Political Commitment	Existence of high-level policy document on energy transition	Availability of policy documents issued by high-level government institutions, eg. President and ministries	Desk research	SNDC document KEN/RUEN RPJMN/RPJPN PR No. 112/2022 MEMR Regulation No. 10/2025	High: Several clear, government-endorsed documents define energy-transition goals, timelines, and implementation pathways. Medium: Some documents exist but are partial, outdated, or lack clear implementation detail. Low: No coherent high-level policy exists, or existing documents do not clearly define the energy transition or decarbonization goals.
		Alignment of key national climate and energy policies with Paris Agreement	Consistency between national climate and energy policies and the goals of the Paris Agreement	Desk research	SNDC document KEN/RUEN RPJMN/RPJPN PR No. 112/2022 Climate Action Tracker Climate Analytics Comprehensive Investment and Policy Plan (CIPP)	High: Policies clearly follow Paris-aligned pathways with specific targets and credible implementation measures. Medium: Policies reference Paris goals but show inconsistencies, slower timelines, or gaps in implementation. Low: Policies diverge from Paris trajectories, lack aligned targets, or rely heavily on fossil fuels.
		Implementation of energy transition targets/plans	1. MEMR performance report of 2025 on renewable energy development 2. Amount of public finance allocated for supporting energy transition	Desk research	MEMR Report; APBN 2026	High: Clear, measurable progress with targets largely on track and policies effectively implemented. Medium: Some progress, but implementation is uneven, delayed, or only partially meeting targets. Low: Minimal progress, frequent delays or reversals, and outcomes diverge from planned milestones.

Appendix D – IESR's Transition Readiness Framework (2 of 7)

Dimension(s)	Variable(s)	Indicators	Assessment Point	Assesment Method	Source of Data	Rating guideline
Political Commitment and Governance (cont.)	Regulatory Framework	Quality of existing regulatory support	1. Assessment of annual regulatory stability 2. Evaluation of how regulatory frameworks enhance the uptake of renewable energy	Desk research	KEN RUEN RUKN RUPTL RPJPN RPJMN RUED RUKD PR No. 112/2022 MEMR Regulation No. 10/2025	High: Clear, coherent, and well-enforced regulations that lower investor risk and efficiency support the transition. Medium: Regulations offer some support but show gaps, inconsistencies, or weak enforcement. Low: Regulations are contradictory, frequently changed, poorly enforced, or create barriers that hinder transition progress.
		Alignment of sectoral roadmaps and regulation with decarbonization target	Integration of sectoral planning instruments and regulatory measures into long-term emission-reduction pathways	Desk research	KEN RUEN RUKN RUPTL RPJPN RPJMN RUED RUKO PR ND. 112/2022 MEMR Regulation No. 10/2025	High: Sectoral plans closely match national decarbonization targets with clear pathways and consistent timelines. Medium: Sectoral plans reference decarbonization goals but show gaps or partial inconsistencies. Low: Sectoral plans do not align with decarbonization targets or contain contradictory measures.
		Supportive non-energy regulations	Assessment of environmental, fiscal, and governance regulations that indirectly support decarbonization	Desk research	Law on the 2026 State Budget; Presidential Decree No. 12/2025; Ministerial Decree No. 141/2025	High: Strong non-energy regulations that clearly reinforce climate and transition goals (e.g., carbon pricing, environmental standards, fiscal incentives). Medium: Some supportive regulations exist, but they are partial, inconsistent or weakly implemented. Low: Few non-energy regulations support the transition, or existing ones create obstacles or lack relevance.

Appendix D – IESR's Transition Readiness Framework (3 of 7)

Dimension(s)	Variable(s)	Indicators	Assessment Point	Assesment Method	Source of Data	Rating guideline
Political Commitment and Governance (cont.)	Institutional & Governance	Corruption level	Review of corruption-related governance metrics that may hinder transition policies and implementation	Desk research	Indonesia Corruption Watch (ICW) Transparency International Indonesia (TII) reports on corruption risks in the mining, infrastructure, and renewable energy sectors	High: Strong documented corruption risk in energy sector (e.g., major corruption cases, systemic risk) Medium: Moderate risk per corruption-risk assessment but not widespread scandal or systemic failure Low: Minimal documented corruption risk or cases in energy transition governance
		Institutional capacity	The ability of institutions to plan, coordinate, and implement energy transition policies	Desk research	KEN RUEN MEMR progress reports RPJMN, sectoral plans	High: Strong coordination across agencies, sufficient resources and expertise, and solid governance to support transition implementation Medium: Moderate institutional capacity, but gaps remain in coordination, resources, or technical skills Low: Weak coordination, limited expertise and resources, and governance shortcomings that impede transition planning and execution.
		Leadership	Evaluating political leaders' commitment, direction, and consistency in driving the energy transition	Desk research	Commitments Expressed by High-Level Officials, e.g. President and Ministers	High: Clear long-term vision backed by sustained policies, coordinated institutions, and decisive implementation Medium: Political support exists but is inconsistent, with mixed policy signals or uneven follow-through. Low: Limited political will, weak policy direction, or actions that contradict transition goals.
		Accountability	Assessment of mechanisms that ensure transparency, reporting, and enforcement of energy transition commitments	Desk research	KLHK public consultation Ministry of Energy and MEMR progress reports Bappenas monitoring documents	High: Clear responsibilities, transparent reporting, strong oversight, and consistent enforcement Medium: Basic accountability structures exist but are uneven, partially transparent, or weakly enforced. Low: Limited transparency, unclear responsibilities, weak oversight, and poor enforcement of commitments.

Appendix D – IESR's Transition Readiness Framework (4 of 7)

Dimension(s)	Variable(s)	Indicators	Assessment Point	Assesment Method	Source of Data	Rating guideline
Investment and Finance	Investment for Energy Transition	Investment risk level	1. Country credit ratings and risk premiums 2. Stakeholders perspective on investment risks	Interview, Desk research	S&P, Fitch, Moody's, PWC country risk premia, and interview results	High: Low country risk premium; de-risking instruments for RE power projects are available. Medium: Moderate country risk premium; de-risking instruments are available. Low: High country risk premium; de-risking instruments are not available.
		Bureaucracy	Ease of doing business and bureaucracy process	Interview, Desk research	Investment freedom index from heritage foundation, and interview with commercial banks and RE developers	High: Strong investment freedom; permitting new RE projects is streamlined. Medium: Moderate investment freedom; permitting is manageable. Low: Low investment freedom; permitting acts as a barrier to RE development.
		Access to capital	Easiness of credit access and process	Interview, Desk research	Interview with commercial banks and RE developers, ASEAN Centre for Energy article	High: Local banks offer attractive interest rates for all renewable energy projects. Medium: Local banks offer better rates for selected renewable energy projects. Low: Local banks offer high interest rates for all renewable projects.
	Finance for RE	International support	1. Level of JETP financing realization compared to commitment 2. RE investment growth	Desk research	JETP Progress Report 2025, and RE investment realization from MEMR	High: JETP investment realization exceeds 50% of initial commitments. Medium: JETP realization exceeds 20% of initial commitments. Low: JETP realization is below 20% of initial commitments.
		Public budget allocation	1. Level of state budget allocation for RE subsectors compared to fossil fuels subsectors 2. Subsidy and incentive for RE	Desk research	MEMR performance report 2024 on state budget allocation, and MoF state budget allocation for subsidy and incentive	High: State budget rises by more than 50% from the previous year and is sufficient to support the energy transition. Medium: State budget increases by less than 50% from the previous year to support the energy transition. Low: State budget remains unchanged or declines and is insufficient to support the energy transition.

Appendix D – IESR’s Transition Readiness Framework (5 of 7)

Dimension(s)	Variable(s)	Indicators	Assessment Point	Assesment Method	Source of Data	Rating guideline
Public Participation and Community Acceptance	Human Resource	Capacity of Human Resource	1. Availability of potential workers, education (or human development index atau parameter umum human capital lain)	Desk research	Kemenaker and Kemendikbud reports regarding the percentage of working people that have secondary education (e.g. Figure 1.6 in Renstra Kemenaker)	High: 45% of the population gradautes in secondary school (OECD countries, for people at the age of 25-34 y.o) Medium: 36% of population graduates from tertiary school (averaged number of ASEAN countries) Low: below the average of ASEAN countries
			2. RE technician certification	Desk research	EBTKE	High: number of certificates produced is 10% higher than previous year Medium: number of certificates produced is 5% higher than previous year Low: number of certificate produced is the same as previous year
		Government program for preparing just energy transition	1. Government strategy/plan for employment in energy transition	Desk research	Renstra Kemenaker, RPJPN, RPJMN, and specific roadmap for any plan green skills/jobs development	High: GoI mentions the expected number of green jobs needed in the roadmap Medium: GoI only mentions that there will be a lot green jobs needed in the future Low: GoI doesn't mention annything
			2. Government plan for mitigating transition impact on employment	Desk research	Official policy documents addresses impact of energy transition on employment	High: GoI plan to obligate the use of at least 50% of total workers of the affected workers (e.g. from coal industries) works renewable energy sector and there are trainings from government to prepare each individual Medium: GoI state that there is a plan, but unclear Low: GoI doesn't state anything

Appendix D – IESR's Transition Readiness Framework (6 of 7)

<table>
<tr><th>Dimension(s)</th><th>Variable(s)</th><th>Indicators</th><th>Assessment Point</th><th>Assesment Method</th><th>Source of Data</th><th>Rating guideline</th></tr>
<tr><td rowspan="5">Public Participation and Community Acceptance (cont.)</td><td rowspan="4">Public Participation</td><td>Regulatory landscape for public participation in energy transition</td><td>1. Check public participation mandates in all energy transition related regulation</td><td>Desk research</td><td>Presence of laws/regulations that mandate consultation; clarity of procedures; enforcement; timelines for public comment</td><td>High: clear legal mandates + routine, documented consultations
Medium: legal basis exists but limited operationalization
Low: no or superficial mandates</td></tr>
<tr><td>Public awareness and support in energy transition</td><td>1. General public awareness and supports on energy transition</td><td>Survey</td><td>Public awareness of climate change, support for RE, and support for coal based on survey</td><td>High: at least half of respondents aware of climate change, support renewables and coal phase out
Medium: at least half of respondents only fulfill one or two of the criterias
Low: at least half of respondents don't aware of cc and don't support renewables/coal phase out</td></tr>
<tr><td rowspan="2">Public participation in energy transition</td><td>1. General public satisfaction in energy planning</td><td>Survey</td><td>Public participation on energy planning based on survey</td><td>High: more than half of respondents satisfied
Medium: at least half of respondents satisfied
Low: less than half of respondents satisfied</td></tr>
<tr><td>2. General public contribution in low carbon practices</td><td>Survey</td><td>Public contribution in low carbon practices based on survey</td><td>High: more than half of respondents contributed/ participated
Medium: at least half of respondents contributed/ participated
Low: less than half of respondents contributed/ participated</td></tr>
<tr><td>Media narratives</td><td>Media discourse for energy transition</td><td>1. Media coverage, source, and tones</td><td>Desk research</td><td>Media monitoring report (from SEA)</td><td>High: broad, balanced media coverage with diverse voices
Medium: coverage exists but framed by limited actors
Low: scarce or narrow framing dominated by single actor</td></tr>
</table>

Appendix D – IESR's Transition Readiness Framework (7 of 7)

Dimension(s)	Variable(s)	Indicators	Assessment Point	Assesment Method	Source of Data	Rating guideline
Technology Advancement	Ecosystem support	Power system acompatibility	Grid capability to accomodate renewable energy and other low carbon technologies	Desk research	IRENA Renewable Power Generation Cost, Laporan Statistik PLN, National Hydrogen and Ammonia Roadmap	High: Strong target on grid capabilityimprovement to support RE and low carbon technology; Medium: Has target on grid capability improvement to support RE and low carbon technology; Low: No improvement on grid capability
		Green industrial estate	industrial zone readiness for clean technology deployment	Desk research	Check Ministry of Industry and Coordinating Ministry of Economy Report	High: Most of the industrial estate has emission reduction target; Medium: Several industrial estate has emission reduction target; Low: No effort on emission reduction target in industrialestate
		Electrification infrastructure	charging infrastructure coverage and grid capacity for electrification	Desk research	RUPTL, Laporan Statistik PLN	High: Established infrastructure to support RE and low carbon technologies and strong policy support; Medium: Developing infrastructure to support RE and low carbon technologies with moderate support; Low: Limited infrastructure to support RE and low carbon technologies and weak support
	Domestic supply chain	Domestic supply chain of low carbon technologies	manufacturing capacity and domestic content share versus imports	Desk research	ISEO 2025, News, Powering the Future - An Assessment of Energy Storage Solutions and The Applications afor Indonesia	High: >70% domestic content; Medium: 40-70% domestic content; Low: <40% domestic content
	Cost competitiveness	Cost competitiveness of RE power plant	Cost comparison to current technology option	Desk research	IRENA Renewable Power Generation Cost	High: Cost competitive without subsidies; Medium: Competitive with moderate subsidies; Low: Requires substantial subsidies
		Cost competitiveness of electric vehicles	Cost comparison to current technology option	Desk research	Academic Journals, Interview with private stakeholders	High: Cost competitive without subsidies; Medium: Competitive with moderate subsidies; Low: Requires substantial subsidies
		Cost competitiveness of green appliances	Cost comparison to current technology option	Desk research	Overview of the Electric Cooking Landscape in Indonesia, Central Statistic Bureau, Academic Journals	High: Cost competitive without subsidies; Medium: Competitive with moderate subsidies; Low: Requires substantial subsidies
		Cost competitiveness of green industry	Cost comparison to current technology option	Desk research	Techno-Economic Analysis of Decarbonization Technology Options for The Energy End-Use Sector in Indonesia, Laporan Statistik PLN	High: Cost competitive without subsidies; Medium: Competitive with moderate subsidies; Low: Requires substantial subsidies

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