IESR
Institute for Essential Services Reform

Indonesia Energy Transition Outlook 2024

Peaking Indonesia's Energy Sector Emission by 2030: The Beginning or The End of Energy Transition Promise

Imprint

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Peaking Indonesia's Energy Sector Emission by 2030:
The Beginning or The End of Energy Transition Promise

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Foreword

Despite the desire to achieve energy security and increase renewables to avoid climate catastrophe, the prospects for the energy transition appear bleak at the moment.

This year has been extremely hot. Scientists predicted that 2023 would be the warmest year on record, as the global mean temperature for the first 11 months of the year reached a record high of 1.46 °C (2.63 °F) above the 1850–1900 average.

According to the Global Tipping Point report, which measures the integrity of the natural system, five important natural thresholds are already on the verge of being crossed. Another three may be reached by the 2030s if the world temperature rises 1.5 °C above pre-industrial levels.

We are at a watershed moment in our planet's history. If climate change and nature loss continue at their current rates, we may reach negative tipping points with increasingly dangerous and irreversible consequences, unlike anything we have ever seen. Unfortunately, despite constant warnings supported by scientific evidence, the world continues to ignore them. Greenhouse gas emissions reach new highs, temperature records fall, and the global climate impact worsens, bringing disaster and misery to people.

At the current rate, the world has only six years to reach the maximum carbon budget in order to avoid future 1.5°C warming. The window of opportunity is closing quickly, and we must act now to save our and future generations from an uninhabitable planet.

Indonesia is no different from the rest of the world. Our emissions rise even faster after a pandemic, with emissions from the energy sector increasing by 21% in 2022 due to additional captive and utility coal power plants, as well as transportation activities, reaching 715 $MtCO_2e$.

Despite the government's ambitious target of achieving a 23% renewable energy mix by 2030 in 2014, renewable energy deployment falls short from the target due to a lack of leadership and commitment from the top leader to establish a rigorous policy framework to accelerate renewable energy and balance the energy trilemma.

President Jokowi launched the 35 GW electricity acceleration program in 2015, with renewable energy power generation included as part of the target. The program began at Samas Beach, which was initially designated as a location for a wind energy project. However, PLN's plan from a year later prioritized coal power plants over renewable energy sources. Furthermore, this program is based on overestimated electricity demand due to high economic growth projection. This was worsened by the pandemic, resulting in overcapacity for PLN, which has prevented PLN from acquiring new renewable energy projects since 2019.

Renewable energy faced numerous challenges during President first term, with an average annual growth of only 400 MW. President Jokowi has stated his intention to pursue an energy transition during his second term. Despite his efforts, renewable energy addition only reached 2 GW from 2019 to 2022, bringing the total renewable generation to 12.5 GW by the end of 2022. Far from the supposedly operational of 23 GW should the National Energy Policy target is to be met. Based on data, the real share as of 2022 was less than 10%, lower than the official claim, and far short of the 23% target for 2025.

Foreword

But, this year is not all doom and gloom. Building on last year's momentum, the energy transition has slowly gained traction this year, marked by a shift in the power sector net zero target toward 2050. The Ministry of Energy and Mineral Resources (MEMR) has initiated inter-ministerial discussions earlier this year to prepare the Roadmap for the 2050 Coal Phase Out, as required by Presidential Regulation (PR) 112/2022. The JETP CIPP has been publicly launched the deal for the early retirement of Cirebon CFPP. The JETP CIPP has been publicly launched, and its targets are aligned with the updated National Electricity Development Plan (RUKN) 2023–2042. Simultaneously, the National Energy Council has updated the 2014 National Energy Policy to be aligned with the 2060 net-zero emission goal.

We also see two state-owned companies, PLN and Pertamina, taking real steps toward the energy transition by setting ambitious renewable energy targets and investing in new projects. Furthermore, an increasing number of corporations are demanding clean electricity and investing in renewable energy. The ecosystem is being steadily built inch by inch. If the current trends continue, we could see significant progress by 2025 or 2026.

In the face of such progresses, the transition in transportation and industry sectors remain in their infancy. A lack of leadership, urgency, and direction from the top has slowed the pace of decarbonization in these two sectors. More needs to be done to bring these two sectors up to the speed of the transition in the power sector.

I am delighted to present IETO 2024, which documents the progress of the energy transition in the power sector, industry, transportation, and building, as well as the enabling environment: policy, regulation, finance, clean technology adaptation, and public and sub-national participation. This IETO is the most comprehensive one, the result of collaboration and more than 7 months of research by 16 young and highly motivated IESR's analysts.

Although the energy transition in Indonesia has recently appeared bleak, we should celebrate every small step this country has taken toward phasing out fossil fuels and replacing them with clean energy in order to protect future generations from the catastrophic consequences of climate change.

Jakarta, December 2023

Fabby Tumiwa
Executive Director

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List of Abbreviations

3T	:	*Tertinggal, Terdepan dan Terluar* (Least Developed, Frontier and Outermost)
AC	:	Air Conditioning
ACCEPT II	:	ASEAN Climate Change and Energy Project: Phase 2
ACE	:	ASEAN Centre for Energy
ACGF	:	ASEAN Catalytic Green Finance Facility
ADB	:	Asian Development Bank
AEA	:	Ammonia Energy Association
AMDAL	:	*Analisis Mengenai Dampak Lingkungan* (Environmental impact assessment)
AP	:	Availability Payment
APBD	:	*Anggaran Pendapatan dan Belanja Daerah* (Sub-national Government Budget)
APBN	:	*Anggaran Pendapatan dan Belanja Negara* (National Government Budget)
APKINDO	:	*Asosiasi Panel Kayu Indonesia* (Indonesian Wood Panel Association)
APROBI	:	Indonesia Biofuel Producer Association
ARC	:	Appalachian Regional Commission
ASEAN	:	Association of Southeast Asian Nations
ASI	:	*Asosiasi Semen Indonesia* (Indonesian Cement Association)
ATR/BPN	:	*Kementerian Agraria dan Tata Ruang/Badan Pertanahan Nasional* (Ministry of Agrarian Affairs and Spatial Planning/National Land Agency)
ATSF	:	ASEAN Taxonomy for Sustainable Finance Version
Avg.	:	Average
AZEC	:	Asia Zero Emission Community
B2B	:	Business-to-business
B3	:	*Bahan Berbahaya dan Beracun* (Toxic and Hazardous Waste)
Bappenas	:	*Badan Perencanaan Pembangunan Nasional* (Ministry of National Development Planning)
BaU	:	Business as Usual
bbl	:	barrel
BCA	:	PT Bank Central Asia Tbk
BESS	:	Battery energy storage system
BEV	:	Battery Electric Vehicle
BF	:	Blast furnace
BGH	:	*Bangunan Gedung Hijau* (Green Building)
BI	:	Bank Indonesia (Bank of Indonesia)
BKPM	:	*Badan Koordinasi Penanaman Modal* (Indonesian Investment Coordinating Board)
BLU	:	*Badan Layanan Umum* (Public Service Agency)
BNI	:	PT Bank Negara Indonesia (Persero) Tbk
BoD	:	Board of Directors
BOE	:	Barrel oil equivalent
BOF	:	Basic oxygen furnace
BOPD	:	Barrel oil per day
BPDLH	:	*Badan Pengelola Dana Lingkungan Hidup* (Indonesian Environment Fund)
BPDPKS	:	*Badan Pengelola Dana Perkebunan Kelapa Sawit* (Oil Palm Plantation Fund Management Agency)
BPKP	:	*Badan Pengawasan Keuangan dan Pembangunan* (Finance and Development Supervisory Agency of the Recipient)
BPS	:	*Badan Pusat Statistik* (Statistics Indonesia)
BPUM	:	*Bantuan Produktif Usaha Mikro* (Micro Business Productive Assistance)
BRI	:	PT Bank Rakyat Indonesia (Persero) Tbk
BRIN	:	*Badan Riset dan Inovasi Nasional* (National Research and Innovation Agency)
c-to-c	:	Cummulative growth rate
CAGR	:	Compound Annual Growth Rate
CAT	:	Climate Action Tracker
CBC	:	Canadian Broadcasting Corporation
CCS	:	Carbon Capture and Storage
CCUS	:	Carbon Capture Utilization and Storage

List of Abbreviations

CEO	:	Chief Executive Officer
CFPP	:	Coal-fired Power Plant
CID	:	Chemical Industry Digest
CH_4	:	Methane
CIF-ACT	:	Climate Investment Funds-Accelerating Coal Transition
CIO	:	Climate Investor One
CIPP	:	Comprehensive Investment and Policy Plan
CMEA	:	Coordinating Ministry For Economic Affairs
CMM	:	Coal Mine Methane
CNBC	:	Consumer News and Business Channel Indonesia
CO_2	:	Carbon dioxide
CO_2e	:	Carbon dioxide equivalent
COD	:	Commercial operation date
CoP	:	Coefficient of Performance
COP	:	Conference of the Parties
COVID-19	:	Coronavirus disease
CPI	:	Climate Policy Initiative
CPO	:	Crude Palm Oil
CPS	:	Current Policy Scenario
CRR	:	Climate-related risk
CSPF	:	Cooling Seasonal Performance Factor
DAK	:	*Dana Anggaran Khusus* (Special Allocation Funds)
DBH-DR	:	*Dana Bagi Hasil-Dana Reboisasi* (Revenue Sharing Funds for Reforestation Funds)
DEN	:	*Dewan Energi Nasional* (National Energy Council)
DID	:	*Dana Insentif Daerah* (Regional Incentive Fund)
Ditjen EBTKE	:	*Direktorat Jenderal Energi Baru Terbarukan dan Konservasi Energi* (Directorate-General of New Renewable Energy and Energy Conservation)
DME	:	Dimethyl Ether
DMO	:	Domestic Market Obligation
DOE	:	Department of Energy of United States
DPO	:	Domestic Price Obligation
DRI	:	Direct reduced iron
E-bus	:	Electric bus
E2W	:	Electric 2-wheelers
E4W	:	Electric 4-wheelers
EAF	:	Electric arc furnace
EDF	:	Environmental Defense Fund
EDGAR	:	Emissions Database for Global Atmospheric Research
EE	:	Energy efficiency
EGR	:	Enhanced Gas Recovery
EJ	:	Exajoule
EMR	:	(Energy and Mineral Resources) *Dinas ESDM Provinsi*
EOR	:	Enhanced Oil Recovery
EPA	:	Environmental Protection Agency of United States
EPC	:	Engineering, procurement and construction
ESG	:	Environmental, Social and Governance
ESS	:	Environmental and Social Safeguard
ETM	:	Energy Transition Mechanism
ETMPTF	:	Energy Transition Mechanism Partnership Trust Fund
EU	:	European Union
EUI	:	Energy Usage Intensity
EV	:	Electric Vehicle
EV-Bus	:	Electric vehicle bus
FCY	:	Foreign currency
FDSA	:	Financial and Development Supervisory Agency
FF	:	fossil fuel
FiT	:	Feed-in Tariff
FPV	:	Floating photovoltaic
G20	:	Group of Twenty
GAPKI	:	*Gabungan Pengusaha Kelapa Sawit Indonesia* (Indonesian Palm Oil Association)
GAR	:	Gross as received

List of Abbreviations

GCF	:	Green Climate Funds
GDP	:	Gross Domestic Product
GEIPP	:	Global Eco-Industrial Parks Programme
GFANZ	:	Glasgow Financial Alliance for Net Zero
GHG	:	Greenhouse gas
GHP	:	Green Hydrogen Plant
GIZ	:	Gesellschaft für Internationale Zusammenarbeit (German Corporation for International Cooperation)
GJ	:	Gigajoule
GNI	:	Gross national income
GoI	:	Government of Indonesia
GR	:	Government Regulation (*Peraturan Pemerintah*/PP)
GREM	:	Geothermal Resource Risk Mitigation
GRI	:	Global Reporting Initiative
GRP	:	*Gunung Raja Paksi*
GT	:	gross tonnage
GW	:	Gigawatt
GWh	:	Gigawatt hour
GWP	:	Global Warming Potential
Ha	:	Hectare
HBA	:	*Harga Batubara Acuan* (Coal reference price)
HBD	:	Hydrogen Business Desk
HE	:	Hydrogen Europe
HEESI	:	Handbook Of Energy & Economic Statistics Of Indonesia
HFO	:	Heavy fuel oil
HPAL	:	High Pressure Acid Leaching
HRRI	:	The House of Representatives, Republic of Indonesia (DPR RI)
HVAC	:	Heating, ventilation, air conditioning
IBCWE	:	Indonesia Business Coalition for Women Empowerment
IBP	:	Indonesia Business Post
IDR	:	Indonesian Rupiah
IDX	:	Indonesia Stock Exchange
IEA	:	International Energy Agency
IESR	:	Institute for Essential Services Reform
IETO	:	Indonesia Energy Transition Outlook
IFA	:	Investment Focus Area
IFC	:	International Finance Corporation
IFHE	:	Indonesia Fuel Cell and Hydrogen Energy
IHI	:	Ishikawajima-Harima Heavy Industries
IIF	:	Indonesia Infrastructure Finance
IISIA	:	Indonesian Iron & Steel Industry Association
IMIP	:	Indonesia Morowali Industrial Park
INA	:	Indonesia Investment Authority
INDEF	:	Institute For Development of Economics and Finance
INDODEPP	:	Indonesia-Denmark Energy Partnership Program
IP	:	Investment Plan
IPG	:	International Partners' Group
IPP	:	Independent Power Producers
IPPU	:	Industrial Process And Product Uses
IRENA	:	International Renewable Energy Agency
JBKP	:	*Jenis Bahan Bakar Khusus Penugasan* (non-subdizied fuel/ compensated fuel)
JETP	:	Just Energy Transition Partnership
KBLI	:	*Klasifikasi Baku Lapangan Usaha Indonesia* (Indonesia Standard for Industrial Classification)
kcal/kg	:	Kilocalorie per kilogram
kl	:	kilolitre
KS	:	Krakatau Steel
kt	:	kilotonne
kW	:	Kilowatt
kWp	:	kilowatt peak
l	:	Litre

List of Abbreviations

LCA	:	Life Cycle Analysis
LCCP	:	Low Carbon Scenario Compatible with Paris Agreement
LCDI	:	Low Carbon Development Initiative
LCOE	:	Levelized cost of electricity
LCR	:	Local content requirement
LCY	:	Local currency
LEED	:	Leadership in Energy and Environmental Design
LNG	:	Liquified natural gas
LPG	:	Liquefied Petroleum Gas
LTS	:	Long term scenario
LTS-LCCR	:	Long Term Strategy for Low Carbon and Climate Resilience
LTSHE	:	*Lampu Tenaga Surya Hemat Energi* (energy saving solar lamps)
MAASP	:	Ministry of Agrarian Affairs and Spatial Planning
Mbbl	:	Million barrels
MBOE	:	Million barrels of oil equivalent
MDB	:	Multilateral Development Bank
MEMR	:	Ministry of Energy and Mineral Resources
MENTARI	:	*Menuju Transisi Energi Rendah Karbon Indonesia* (Towards Indonesia's Low Carbon Energy Transition)
MEPS	:	Minimum energy performance standard
MHI	:	Mitsubishi Heavy Industries
MIP	:	*Mitra Instansi Pengelola* (Managing Agency Partners)
mmbtu	:	Million british thermal unit
MMSCFD	:	Million Standard Cubic Feet per Day
MoA	:	Ministry of Agriculture
MODI	:	Minerba One Data Indonesia
MoEF	:	Ministry of Forestry and Environmental
MoF	:	Ministry of Finance
MoHA	:	Ministry of Home Affair
MoI	:	Ministry of Industry
MoT	:	Ministry of Transportation
MPWH	:	Ministry of Public Works and Housing
Mt	:	Million tonne
MTA	:	Manifold Times Admin
$MtCO_2e$	:	Million tonnes of carbon dioxide equivalent
MTJ	:	Million Terajoule
MW	:	Megawatt
N/A	:	Not available
NDC	:	Nationally Determined Contribution
NEA	:	Nuclear Energy Agency
NEP	:	National Energy Policy (*Kebijakan Energi Nasional*/KEN)
NET	:	National Electricity Networks
NEXI	:	Nippon Export and Investment Insurance
NRC	:	National Resources Canada
NREL	:	National Renewable Energy Laboratory (NREL)
NS	:	North Standard
NTT	:	*Nusa Tenggara Timur* (East Nusa Tenggara)
NZE	:	Net Zero Emission
OEC	:	Observatory of Economic Complexity
OJK	:	*Otoritas Jasa Keuangan* (Indonesia Financial Authority)
PA	:	Paris Agreement
PDF	:	Probability Density Function
PFAN-Asia	:	Private Financing Advisory Network-Asia
PGA	:	*Pantau Gambut* Administrator
PGEO	:	Pertamina Geothermal Energy PT Tbk
PI	:	*Pupuk Indonesia*
PLN	:	*Perusahaan Listrik Negara* (State Electricity Company)
PNBP	:	*Penerimaan Negara Bukan Pajak* (Non-Tax State Income)
PNRE	:	Pertamina New and Renewable Energy
POJK	:	*Peraturan Otoritas Jasa Keuangan* (Indonesia Financial Authority Regulation)
POWER	:	Partnerships for Opportunity and Workforce and Economic Revitalisation

List of Abbreviations

PPA : Power purchase agreement
PPN : *Pajak Pertambahan Nilai* (Value Added Tax)
PR : Presidential Regulation (*Peraturan Presiden*/PERPRES)
PSC : Production Sharing Contract
PSE : *Pusat Studi Energi* (Center for Energy Studies)
PSN : National Strategic Programs
PV : Photovoltaics
Q1 : Quarter 1
Q2 : Quarter 2
Q3 : Quarter 3
Q4 : Quarter 4
RE : Renewable energy
REC : Renewable Energy Certificate
RFP : Request for proposal
RKEF : Rotary Kiln-Electric-Furnace
RON : Research octane number
RPJMD : *Rencana Pembangunan Jangka Menengah Daerah* (Local government medium term development plan)
RPJPN : *Rencana Pembangunan Jangka Panjang Nasional* (National government long term development plan)
RPRKD : *Rencana Pembangungan Rendah Karbon Daerah* (Regional Low Carbon Development Plan)
RUED : *Rencana Umum Energi Daerah* (Regional Energy General Plan)
RUEN : *Rencana Umum Energi Nasional* (National Energy General Plan)
RUKN : *Rencana Umum Kelistrikan Nasional* (National Electricity General Plan)
RUPTL : *Rencana Umum Penyediaan Tenaga Listrik* (National Electricity Supply Business Plan)
SAF : Sustainable Aviation Fuel
SBH : *Sertifikasi Bangunan Hijau* (green building certification)
SDGs : Sustainable Development Goals
SE : *Surat Edaran* (Circulate Letter)
SEAI : Southeast Asia Infrastructure
SETI : Sustainable Energy Transition in Indonesia
SIINas : *Sistem Informasi Industri Nasional* (National Industry Information System)
SLEB : Super Low Energy Building
SLO : *Sertifikasi Laik Operasi* (certification of fit to operate)
SME : Small Medium Enterprises
SMI : *Sarana Multi Infrastruktur* (Multi infrastructure facilities)
SMR : Small modular reactor
SMR : Steam methane reforming
SNI : *Standar Nasional Indonesia* (Indonesian National Standard)
SPBKLU : *Stasiun Penggantian Baterai Kendaraan Listrik Umum* (Battery Swapping Station)
SPG : S&P Global
SPKLU : *Stasiun Pengisian Kendaraan Listrik Umum* (Plug-in Charging Station)
t : Tonne
TBI : *Taksonomi Berkelanjutan Indonesia* (Indonesia Sustainable Taxonomy)
TCFD : Task Force on Climate-related Financial Disclosures
TCO : Total Cost of Ownership
TEA : Traction Energy Asia
TGI : *Transportasi Gas Indonesia*
THI : *Taksonomi Hijau Indonesia* (Indonesia Green Taxonomy)
TJ : Terajoule
TOE : Tonne of oil equivalent
TRF : Transition Readiness Framework
TWh : Tera-Watt hour
UK : United Kingdom
UK FCDO : United Kingdom Foreign, Commonwealth and Development Office
UNFCCC : United Nations Framework Convention on Climate Change

List of Abbreviations

UoP	:	Use of Proceeds
US	:	United States
US DOE	:	United States Department of Energy
USAID	:	United States Agency for International Development
USD	:	US Dollar
UU	:	*Undang - Undang* (Law)
VA	:	Volt-ampere
VAT	:	Value Added Tax
VGF	:	Viability Gap Fund
VRF	:	Variable Refrigerant Flow
WHO	:	World Health Organization
WoodMac	:	Wood Makenzie
WRI	:	World Resources Institute
WWR	:	Window-to-Wall Ratio

Executive Summary

- Indonesia has set the target to reach NZE by 2060 or sooner, but the IESR model indicates that following the recent trends, GHG emissions from the energy sector will increase from 743 $MtCO_2e$ in 2022 to 963 $MtCO_2e$ in 2030 with no sign of peaking. **The recent energy sector policies are far from sufficient to suppress the emission generation**, as it is projected to cut only 20% of the projected emissions in 2030 and keep the increasing trend until 2060. The transition to a zero-emission energy system revolves around four fundamental pillars: **renewables utilization, electrification of various demand sectors, decline of fossil fuels, and the switch to low-carbon fuel alternatives.** These pillars' trends and conditions represent Indonesia's pathway toward mitigating climate change and achieving sustainable energy practices.

- **In contrast to the established target, the renewable energy growth remains sluggish** with only less than 10% contribution to the primary energy mix in 2022. RE contribution to the total energy supply mix primarily comes from biodiesel blends for transportation. Renewable electricity generation contributed only a third to the total RE production, mainly from hydropower and geothermal sources, while solar and wind contribution is negligible. Renewables deployment in the power sector is particularly lagging with only 1 GW additional installed capacity in 2023, out of the initial target of 3.4 GW targets established in 2021. Delays in hydro and geothermal projects pose further risks in meeting the 2030 targets. Several adjustments are needed to attract investment in renewables, such as improving the tariff structure and ensuring an equitable risk-reward profile for IPP partners.

- **Fossil fuel dominance in energy consumption remains prevalent and existing policy helps facilitate domestic consumption.** In 2022, coal accounted for almost half of the primary energy mix, followed by oil and gas products. Coal is primarily used in electricity generation and various industrial activities, while oil products, largely imported, are used mainly in transportation. Gas products are crucial for certain industries and residential cooking. Fossil fuel subsidy, through coal DMO policy and direct subsidy and compensation for petroleum fuels and electricity, has made fossil fuel remain attractive for domestic consumers while putting a significant burden on the public budget.

- **Indonesia's power sector remains heavily reliant on fossil fuel-based power plants**, particularly CFPPs, with existing on-grid and captive CFPPs of roughly 40 GW and expected to increase to 73 GW by 2030. As a result, GHG emissions from the power sector are projected to increase from approximately 414 $MtCO_2e$ in 2030, according to IESR model. The current JETP commitment to transform the power sector by retiring CFPPs and accelerating renewable deployment, if implemented successfully, is estimated to result in a cumulative emission reduction of 630 $MtCO_2e$ between 2022-2030. However, the latest draft of the upcoming update of national electricity plan (RUKN) unfortunately omits the option to early retire CFPPs despite its economic viability.

- **The government keeps counting on various ways to optimize fossil fuel production and utilization despite the uncertainties**, while the strategy preparing alternative fuel remains limited. Issuance of CCUS-EOR to improve oil and gas production, preparation of regulatory support for uneconomic coal downstream programs, and favoring biomass and ammonia co-firing to early retirement indicate Indonesia's persistence to optimize its fossil fuel resource. At the same time, the utilization of bioenergy as an alternative fuel to petroleum fuel and coal is growing but facing multiple challenges from socio-environmental and financial aspects. Moreover, low-carbon hydrogen development gains more interest, with at least 32 ongoing projects, mostly in the early development phase.

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- **Decarbonization strategy of the transportation sector consists of both electrification and low-carbon fuel alternatives** along with other "avoid" and "shift" measures, as outlined in the new MoT Decree No. 33/2023. Electrification, especially for private passenger vehicles, has become the focus of policymakers in the recent years, with more incentive packages provided, improving BEVs affordability for consumers. However, lack of infrastructure and travel range remain the main barriers to more rapid BEV adoption. Electrification is more challenging, economically and technologically, for other transportation modes, i.e., aviation, maritime, railway, buses, and logistics, where biofuel utilization is currently the preferred strategy.

- Although currently lower compared to neighboring countries, Indonesia's energy use intensity for commercial buildings is likely to increase with more appliance penetration. AC, in particular, will be a concern as the majority of ACs in the market have low efficiency (having 1 and 2 stars in MEPS rating), and no local manufacturers produce ACs with acceptable efficiency levels. **To foster wider implementation of existing green building and energy efficiency regulations, more incentive schemes are needed**. Moreover, existing MEPS regulations for other appliances (fan and rice cooker) should be upgraded to elevate their mitigation potential, as the IESR model projects that the existing MEPS will only have a marginal impact to emission reduction.

- **The IESR model highlights the potential of the current electric two-wheelers (E2W) and electric cooking policies to be the least cost measures** for GHG emission reduction in the energy sector. These two interventions are expected to avoid cumulatively 67 $MtCO_2e$ until 2030 while potentially saving a total of USD 12.5 billion compared to the no-policy scenario. Furthermore, fuel switching measures to low-carbon alternatives, i.e., utilization of natural gas for cooking and biodiesel B35 blending, have the potential to avoid another 67 $MtCO_2e$ cumulative emissions. These result indicate the importance of electrification and fuel switching on the demand side, alongside decarbonizing the power sector, to achieve deeper emission cut.

- Direct fossil fuel use still dominates energy consumption in the industrial sector, as coal supplied over half of the industrial demand in 2022. Meanwhile, electrification is growing slowly as electricity share remains low at only 12%. Several industries opt to utilize low-carbon fuel as their decarbonization strategies, such as biomass utilization in the cement industry and green hydrogen in the ammonia industry. **The lack of a measurable action plan in the current policies for emission reduction in the industrial sector leads to the industrial sector contributing half of the energy sector emission in 2060**, based on IESR model projection.

Executive Summary

- **Indonesia's energy transition readiness level remains stagnant, whereas a successful energy transition requires enabling conditions, such as political and regulatory frameworks, techno-economical, investment and financing, and social readiness, to drive system change.** Based on IESR's TRF assessment, the 2023 transition readiness level is unchanged from last year's assessment. Improvement was found in one indicator of political commitment and regulatory, such as JETP, PR No. 112/2022, and upcoming revised and new regulations. Yet, overall advancements are limited within the broader regulatory landscape. Techno-economic readiness mirrors last year's status with medium-rated planning and high-growing cost competitiveness, particularly solar PV and wind. Meanwhile, investment and finance readiness has not shown improvement due to low national credit rates, repressed investment freedom, and unclear policies, resulting in a mere 29.4% realization of the 2023 RE investment target by Q2 2023. Lastly, social readiness also remains unchanged with high public awareness but no significant progress on human capital preparation in energy transition.

- **The investment for energy transition has been lacking far behind the projected needs to achieve NZE, although there are opportunities for a more positive outlook.** Indonesia needs, on average, around USD 30-40 billion annually for energy transition. However, in 2022, investment in renewable energy and energy efficiency was only USD 1.6 billion, while investment in grid infrastructure was USD 2.4 billion. There are various potential channels for energy transition financing available, i.e., bilateral and multilateral supports, green sukuk, carbon tax, and carbon market. However, improvement is needed in terms of regulatory certainty (e.g., Indonesia Sustainable Taxonomy), project bankability, transparency and credibility, and environmental and social safeguards to unlock these potential finances into actual projects. Domestic banks' financing to renewable energy projects increased compared to the previous year, yet their portfolio in the mining sector remains higher. The initial launching of carbon exchange was welcomed with euphoria, although later proved to be lacking of demand.

- **Two landmark energy transition financing schemes, JETP and ETM, both have progressed this year with the launching of JETP's CIPP and signing of a non-binding framework agreement to early retire CFPP Cirebon 1 in 2035.** However, the CIPP revealed that at least USD 97 billion is needed to achieve its 2030 targets, a massive gap compared to the USD 22 billion commitment by IPG and GFANZ. Furthermore, finance allocation for the just aspect is very limited and unlikely to cover all just criteria considered in the CIPP. Meanwhile, ETM has managed to accumulate USD 2.5 billion commitment for CFPP early retirement. However, there is an issue of transparency and asset overvaluation ,overshadowing the choice of CFPP to be retired.

- **Provincial governments face challenges in finalizing RUEDs and implementing them to meet the renewable target.** As of October 2023, only 30 out of 38 provinces have issued regional energy planning (RUED) since 2018; each showcases different approaches in achieving their decarbonization targets. For instance, NTT achieved 15.74% RE mix in 2022 despite challenges in its archipelagic setup, limited infrastructure, and focus on other development sectors in the 3T area. Additionally, West Java achieved 25.81% RE mix in 2022 due to a combination of factors, including national priorities, strong infrastructure, and a strategic location meeting demand preferences, although greater investment efforts are needed. Withal, Bali aims for NZE by 2045 despite the current lag on RE mix achievement of 3.8% in 2022, highlighting the need to recalibrate local strategy. While subnational RE mix achievements are progressive, they mostly fall short of the national target of 23% by 2025, with 24% of total provinces trailing below their 2022 RE mix achievements. Recent regulation PR No. 11/2023 extended subnational governments' authority in RE development but might strain limited budgets, necessitating a balance with other priorities.

Ringkasan Eksekutif

- *Indonesia telah menetapkan target untuk mencapai NZE pada tahun 2060 atau lebih cepat, namun pemodelan IESR mengindikasikan bahwa dengan mengikuti tren yang ada saat ini, emisi GRK dari sektor energi akan meningkat dari 743 $MtCO_2e$ pada tahun 2022 menjadi 963 $MtCO_2e$ pada tahun 2030 dan belum menunjukkan tanda-tanda akan mencapai puncaknya.* ***Kebijakan sektor energi saat ini masih jauh dari cukup untuk menekan peningkatan emisi,*** *karena diproyeksikan hanya dapat mengurangi 20% dari proyeksi emisi pada tahun 2030 dan akan terus meningkat hingga tahun 2060. Transisi menuju sistem energi nir emisi berpusat pada empat pilar fundamental:* ***pemanfaatan energi terbarukan, elektrifikasi berbagai sektor permintaan (demand), pengurangan bahan bakar fosil, dan peralihan ke bahan bakar alternatif rendah karbon.*** *Tren dan kondisi pilar-pilar tersebut mencerminkan langkah Indonesia menuju mitigasi perubahan iklim dan mencapai praktik-praktik energi yang berkelanjutan.*

- ***Berbeda dengan target yang telah ditetapkan, pertumbuhan energi terbarukan masih lamban*** *dengan kontribusi kurang dari 10% terhadap bauran energi primer pada tahun 2022. Kontribusi energi terbarukan terhadap total bauran pasokan energi terutama berasal dari campuran biodiesel untuk transportasi. Pembangkit listrik dari energi terbarukan hanya berkontribusi sepertiga dari total produksi energi terbarukan, terutama dari sumber tenaga air dan panas bumi, sementara kontribusi tenaga surya dan angin sangat kecil. Penggunaan energi terbarukan di sektor ketenagalistrikan sangat lambat dengan hanya ada tambahan kapasitas terpasang sebesar 1 GW di tahun 2023, dari target awal sebesar 3,4 GW yang ditetapkan pada tahun 2021. Penundaan proyek-proyek pembangkit listrik tenaga air dan panas bumi menimbulkan risiko lebih lanjut dalam memenuhi target 2030. Beberapa penyesuaian diperlukan untuk menarik investasi di sektor energi terbarukan, seperti memperbaiki struktur tarif dan memastikan profil risiko-imbalan (risk-reward) yang adil bagi para mitra produsen listrik swasta (*Independent Power Producer, *IPP).*

- ***Penggunaan bahan bakar fosil masih mendominasi dalam konsumsi energi dan kebijakan yang ada saat ini membantu memfasilitasi konsumsi domestik.*** *Pada tahun 2022, batubara menyumbang hampir setengah dari bauran energi primer, diikuti oleh produk minyak dan gas. Batubara terutama digunakan untuk pembangkit listrik dan berbagai kegiatan industri, sementara produk minyak, yang sebagian besar diimpor, digunakan terutama untuk transportasi. Produk gas sangat penting untuk industri tertentu dan memasak di rumah tangga. Subsidi bahan bakar fosil, melalui kebijakan DMO batubara dan subsidi langsung serta kompensasi untuk bahan bakar minyak dan listrik, telah membuat bahan bakar fosil tetap menarik bagi konsumen domestik sekaligus membebani anggaran negara.*

- ***Sektor ketenagalistrikan Indonesia masih sangat bergantung pada pembangkit listrik berbasis bahan bakar fosil****, khususnya PLTU, dengan jumlah PLTU* on-grid *dan* captive *yang ada saat ini sekitar 40 GW dan diperkirakan akan meningkat menjadi 73 GW pada tahun 2030. Akibatnya, emisi GRK dari sektor listrik diproyeksikan akan meningkat dari sekitar 414 $MtCO_2e$ pada tahun 2030, berdasarkan pemodelan IESR. Komitmen JETP saat ini untuk mentransformasi sektor ketenagalistrikan dengan menghentikan PLTU batubara dan mempercepat penggunaan energi terbarukan, jika berhasil diimplementasikan, diperkirakan akan menghasilkan pengurangan emisi kumulatif sebesar 630 $MtCO_2e$ antara tahun 2022-2030. Namun, draf terbaru dari pemutakhiran Rencana Umum Ketenagalistrikan Nasional (RUKN), sayangnya tidak mencantumkan opsi untuk menghentikan PLTU batubara secara dini meskipun opsi tersebut secara ekonomi layak dan menguntungkan.*

- ***Pemerintah terus mengandalkan berbagai cara untuk meningkatkan produksi dan penggunaan bahan bakar fosil meskipun adanya ketidakpastian****, sementara strategi untuk menyiapkan bahan bakar alternatif masih terbatas. Penerbitan CCUS-EOR untuk meningkatkan produksi minyak dan gas, persiapan dukungan regulasi untuk program hilirisasi batubara yang tidak ekonomis, dan mengutamakan* co-firing *biomassa dan amonia untuk PLTU batubara yang dipensiunkan lebih awal, mengindikasikan kesungguhan Indonesia untuk mengoptimalkan sumber daya bahan bakar fosilnya. Pada saat yang sama, pemanfaatan bioenergi sebagai bahan bakar alternatif untuk bahan bakar minyak dan batubara terus berkembang, namun menghadapi berbagai tantangan dari aspek sosial-lingkungan dan keuangan. Selain itu, pengembangan hidrogen rendah karbon semakin diminati, dengan setidaknya 32 proyek yang sedang berjalan, sebagian besar dalam tahap pengembangan awal.*

Ringkasan Eksekutif

- ***Strategi dekarbonisasi sektor transportasi terdiri dari elektrifikasi dan alternatif bahan bakar rendah karbon*** *serta langkah-langkah "*avoid *(hindari)" dan "*shift *(beralih)", seperti yang diuraikan dalam Peraturan Menteri Perhubungan No. 33/2023. Elektrifikasi, terutama untuk kendaraan pribadi yang digunakan untuk transportasi penumpang, telah menjadi fokus para pembuat kebijakan dalam beberapa tahun terakhir, dengan lebih banyak paket insentif yang disediakan, meningkatkan keterjangkauan kendaraan listrik berbasis baterai bagi konsumen. Namun, kurangnya infrastruktur dan jarak tempuh masih menjadi hambatan utama untuk adopsi kendaraan listrik berbasis baterai yang lebih cepat. Elektrifikasi lebih menantang, baik secara ekonomi maupun teknologi, untuk moda transportasi lainnya, yaitu penerbangan, maritim, kereta api, bus, dan logistik, di mana pemanfaatan bahan bakar nabati saat ini merupakan strategi yang lebih disukai.*

- *Meskipun saat ini lebih rendah dibandingkan dengan negara-negara tetangga, intensitas penggunaan energi di Indonesia untuk bangunan komersial kemungkinan akan meningkat dengan semakin banyaknya penetrasi peralatan. AC, khususnya, akan menjadi perhatian karena mayoritas AC di pasaran memiliki efisiensi yang rendah (bintang 1 dan 2 pada rating Standar Kinerja Minimum Energi, SKEM), dan tidak ada produsen lokal yang memproduksi AC dengan tingkat efisiensi yang dapat diterima.* ***Untuk mendorong implementasi yang lebih luas dari peraturan bangunan hijau dan efisiensi energi yang ada, diperlukan lebih banyak skema insentif.*** *Selain itu, peraturan SKEM yang ada untuk peralatan lain (kipas angin dan penanak nasi) harus ditingkatkan untuk meningkatkan potensi mitigasinya, karena pemodelan IESR memproyeksikan bahwa SKEM yang ada saat ini hanya akan memiliki dampak terbatas terhadap pengurangan emisi.*

- ***Pemodelan IESR menyoroti potensi kebijakan kendaraan listrik roda dua (*electric 2-wheelers*, E2W) dan kebijakan memasak dengan listrik sebagai langkah yang paling murah*** *untuk mengurangi emisi GRK di sektor energi. Kedua intervensi ini diharapkan dapat menghindari emisi sebesar 67 $MtCO_2e$ secara kumulatif hingga tahun 2030 dan berpotensi menghemat total USD 12,5 miliar dibandingkan dengan skenario tanpa kebijakan. Selain itu, langkah-langkah peralihan bahan bakar ke alternatif rendah karbon, seperti penggunaan gas alam untuk memasak dan pencampuran biodiesel B35, juga berpotensi menghindari emisi kumulatif sebesar 67 $MtCO_2e$. Hasil ini menunjukkan pentingnya elektrifikasi dan peralihan bahan bakar di sisi permintaan, di samping dekarbonisasi sektor tenaga listrik, untuk mencapai pengurangan emisi yang lebih mendalam.*

- *Penggunaan bahan bakar fosil secara langsung masih mendominasi konsumsi energi di sektor industri, karena batubara memasok lebih dari separuh kebutuhan industri pada tahun 2022. Sementara itu, elektrifikasi tumbuh dengan lambat karena pangsa listrik masih rendah, yaitu hanya 12%. Beberapa industri memilih untuk menggunakan bahan bakar rendah karbon sebagai strategi dekarbonisasi, seperti pemanfaatan biomassa pada industri semen dan hidrogen hijau pada industri amonia.* ***Kurangnya rencana aksi yang terukur dalam kebijakan saat ini untuk mengurangi emisi di sektor industri menyebabkan sektor industri menyumbang setengah dari emisi sektor energi di tahun 2060****, berdasarkan proyeksi pemodelan IESR.*

- ***Tingkat kesiapan transisi energi Indonesia masih stagnan, padahal transisi energi yang sukses membutuhkan kondisi-kondisi yang mendukung, seperti kerangka politik dan peraturan, tekno-ekonomi, investasi dan pembiayaan, serta kesiapan sosial, untuk mendorong perubahan sistem.*** *Berdasarkan penilaian* Transition Readiness Framework *(TRF) IESR, tingkat kesiapan transisi tahun 2023 tidak berubah dari penilaian tahun lalu. Peningkatan ditemukan pada satu indikator komitmen politik dan peraturan, seperti JETP, Perpres No. 112/2022, serta peraturan baru yang akan direvisi dan yang akan datang. Namun, kemajuan secara keseluruhan masih terbatas dalam lanskap regulasi yang lebih luas. Kesiapan tekno-ekonomi serupa dengan status tahun lalu dengan perencanaan yang dinilai sedang dan daya saing biaya yang terus meningkat, terutama dalam pemanfaatan tenaga surya dan angin. Sementara itu, kesiapan investasi dan keuangan belum menunjukkan peningkatan karena rendahnya suku bunga kredit nasional, hambatan kebebasan investasi, dan kebijakan yang tidak jelas, yang mengakibatkan realisasi investasi energi terbarukan 2023 hanya mencapai 29,4% dari target investasi 2023 pada kuartal kedua tahun 2023. Terakhir, kesiapan sosial juga masih belum berubah dengan kesadaran masyarakat yang tinggi tetapi tidak ada kemajuan signifikan dalam persiapan sumber daya manusia dalam transisi energi.*

Ringkasan Eksekutif

- ***Investasi untuk transisi energi masih jauh dari kebutuhan yang diproyeksikan untuk mencapai NZE, meskipun ada peluang untuk prospek yang lebih positif.*** *Indonesia membutuhkan rata-rata sekitar USD 30-40 miliar per tahun untuk transisi energi. Namun, pada tahun 2022, investasi untuk energi terbarukan dan efisiensi energi hanya sebesar USD 1,6 miliar, sementara investasi untuk infrastruktur jaringan listrik hanya sebesar USD 2,4 miliar. Terdapat berbagai sumber pendanaan potensial untuk pembiayaan transisi energi yang tersedia, yaitu dukungan bilateral dan multilateral, sukuk hijau, pajak karbon, dan pasar karbon. Namun, masih diperlukan perbaikan dalam hal kepastian peraturan (misalnya,* Indonesia Sustainable Taxonomy*), kelayakan proyek, transparansi dan kredibilitas, serta perlindungan lingkungan dan sosial untuk membuka potensi pembiayaan ini menjadi proyek-proyek yang nyata. Pembiayaan bank domestik untuk proyek-proyek energi terbarukan meningkat dibandingkan tahun sebelumnya, namun portofolio mereka di sektor pertambangan tetap lebih tinggi. Peluncuran awal bursa karbon disambut dengan euforia, meskipun kemudian terbukti kurang diminati.*

- ***Dua skema pembiayaan transisi energi yang penting, JETP dan ETM, keduanya telah mengalami progres di tahun ini dengan diluncurkannya CIPP JETP dan penandatanganan perjanjian kerangka kerja yang tidak mengikat untuk memensiunkan lebih awal PLTU Cirebon 1 pada tahun 2035.*** *Namun, CIPP mengungkapkan bahwa setidaknya USD 97 miliar diperlukan untuk mencapai target 2030, sebuah kesenjangan yang sangat besar dibandingkan dengan komitmen USD 22 miliar dari IPG dan GFANZ. Selain itu, alokasi dana untuk aspek keadilan sangat terbatas dan tidak mungkin mencakup semua kriteria keadilan yang dipertimbangkan dalam CIPP. Sementara itu, ETM telah berhasil mengumpulkan komitmen sebesar USD 2,5 miliar untuk pensiun dini PLTU. Namun, ada masalah transparansi dan penilaian aset yang terlalu tinggi, yang membayangi pilihan PLTU untuk dipensiunkan.*

- ***Pemerintah provinsi menghadapi tantangan dalam menyelesaikan RUED dan mengimplementasikannya untuk memenuhi target energi terbarukan.*** *Hingga Oktober 2023, hanya 30 dari 38 provinsi yang telah menerbitkan Rencana Umum Energi Daerah (RUED) sejak tahun 2018; masing-masing provinsi menunjukkan pendekatan yang berbeda dalam mencapai target dekarbonisasi. Sebagai contoh, NTT mencapai 15,74% bauran energi terbarukan pada tahun 2022 meskipun terdapat tantangan dalam pengaturan wilayah kepulauan, infrastruktur yang terbatas, dan fokus pada sektor pembangunan lain di daerah 3T. Selain itu, Jawa Barat mencapai bauran energi terbarukan sebesar 25,81% pada tahun 2022 karena kombinasi beberapa faktor, termasuk prioritas nasional, infrastruktur yang kuat, dan lokasi yang strategis yang memenuhi preferensi permintaan, meskipun upaya investasi yang lebih besar masih diperlukan. Sementara itu, Bali menargetkan NZE pada tahun 2045 meskipun pencapaian bauran energi terbarukan saat ini masih tertinggal sebesar 3,8% di tahun 2022, yang menyoroti perlunya mengkalibrasi ulang strategi lokal. Meskipun pencapaian bauran energi terbarukan subnasional cukup progresif, namun sebagian besar masih jauh dari target nasional sebesar 23% pada tahun 2025, dengan 24% dari total provinsi berada di bawah pencapaian bauran energi terbarukan tahun 2022. Peraturan terbaru Perpres No. 11/2023 memperluas kewenangan pemerintah daerah dalam pengembangan energi terbarukan tetapi mungkin akan membebani anggaran yang terbatas, sehingga perlu diseimbangkan dengan prioritas lainnya.*

1.

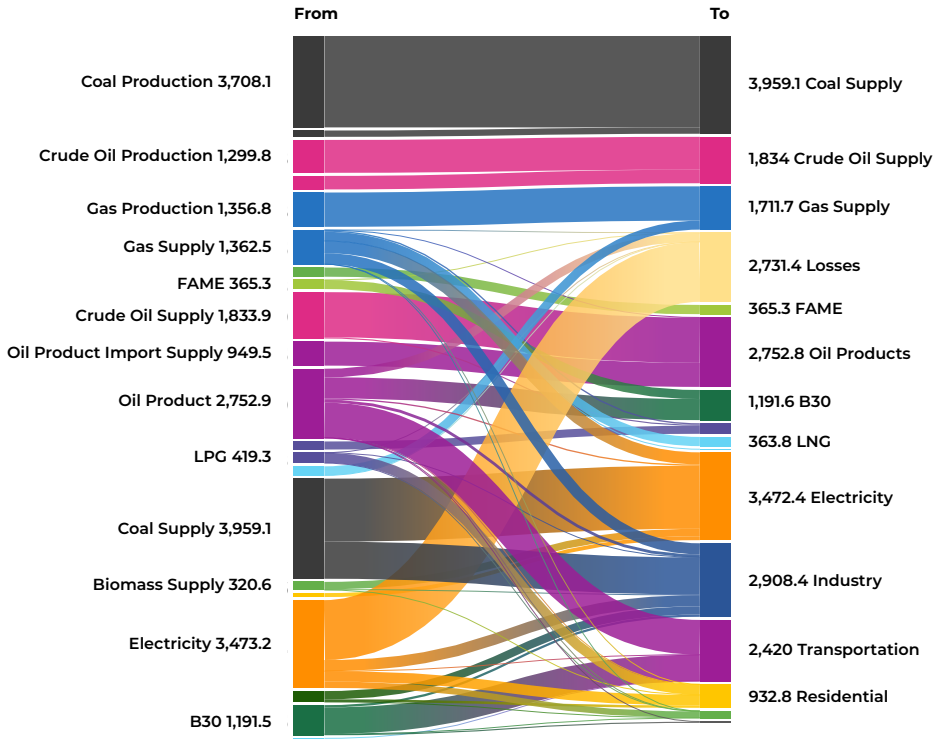
Indonesia’s Energy Sector Landscape on the Road to 2030 Decarbonization Target

Alvin Putra Sisdwinugraha, His Muhammad Bintang, Pintoko Aji

Contents:

Fossil fuel dominance on domestic energy consumption still prevails

Energy Flow Diagram for Indonesia's Energy System in 2022



Source: IESR IETO Model
Notes: Captive - this energy balance only covered energy generated by the industrial sector (Izin Operasi); unit in petajoule (PJ)

- Indonesia's 2022 energy flow diagram demonstrated the heavy dependence on fossil fuels. Coal is responsible for around 44.7% of all supply, with most of the domestic use of coal dedicated to electricity generation, while one third of domestic supply was used directly in industry and other sectors. Oil products, which are mostly imported, serve 35.2% of the total supply, mainly for the transportation sector. Gas products remain irreplaceable in certain industries and dominate residential cooking.
- Actual renewable energy supply makes up only 9.58% of the total energy supply mix. Bioenergy constitutes about two-thirds of this supply, primarily through biodiesel blending in transportation fuel. The remaining RE supply, equivalent, to 0.16 EJ was transformed into electricity, which dominated by hydropower and geothermal generation. Meanwhile, solar and wind contributions remain miniscule.
- Industry and transport remain the biggest energy consumers with 5.3 EJ, in which 91% of it is directly supplied by fossil fuels. Notable transformation losses were due to large share of fossil fuel in power generation, which inherits low efficiency due to combustion processes.

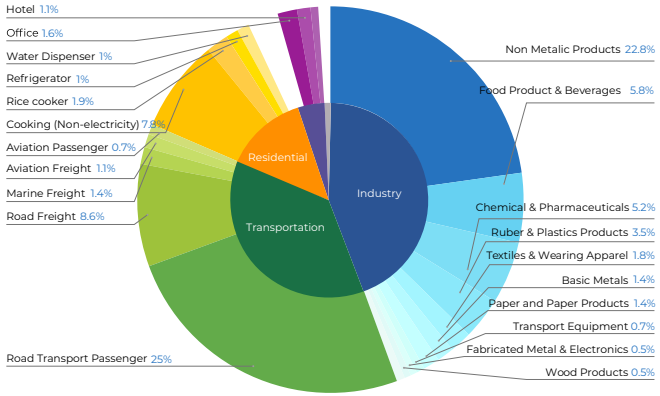
Transportation and industrial sectors remain the biggest energy consumers, raising concern about their high emission intensity

- The combined industry and transportation share of total energy sector direct GHG emissions is projected to reach 86% by 2030 and rise further to approximately 98% by 2060 under the No-Policy Scenario (NPS). In the industry sector, the non-metallic mineral industry (e.g., cement) is the leading energy consumer, followed by chemicals-pharmaceuticals and the F&B industry. Together, these three industries represent 78% of the sector's energy consumption and are the main contributors to GHG emissions. Without new interventions, emission intensity (EI) will only experience a relatively slow decline until reaching around 51 tCO_2e/TJ by 2060. Strategic decarbonization interventions in these three industries, such as reducing coal share in cement production (currently 95%), lowering natural gas utilization in basic chemical processes (e.g., ammonia) from the current level of 84%, and increasing the electrification rate (currently at 35%) in the F&B sector, hold significant potential for emissions reduction.

- Road passenger vehicles dominate the transportation sector energy consumption at about 68% and are responsible for 70% of the sector's total direct emissions. The remaining share mainly comes from freight transport, as railway, marine, and aviation passenger transportation collectively took less than 3% of shares in both energy consumption and direct emissions. Notably, gasoline and diesel-consuming road vehicles contribute to 90.5% of emissions, with NPS projection showing a direct emission of 176 $MtCO_2e$ in 2030.

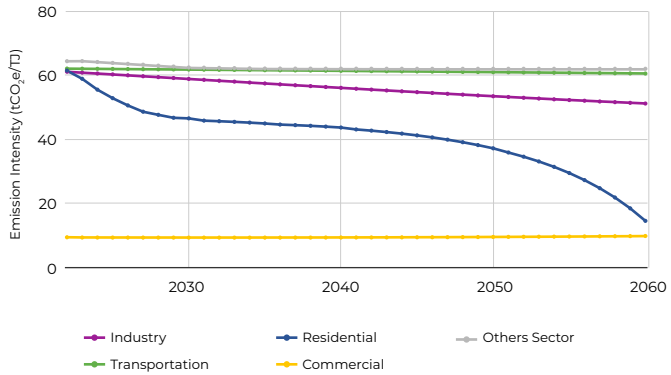
- Commercial buildings already exhibit low emission intensity (9.4 tCO_2e/TJ) due to high electrification at an 86% consumption share in 2022. In contrast, the residential sector possesses high emission intensity (61.5 tCO_2e/TJ) due to a 43% LPG consumption. However, due to the historical trend of more electric cooking and city gas stove adoption, residential emission intensity would naturally experience a gradual drop until 14 tCO_2e/TJ in 2060, according to NPS projection.

Energy Consumption Share by the End-Use Sectors



Source: IESR IETO model

Emission Intensity Projection by Sector in NPS

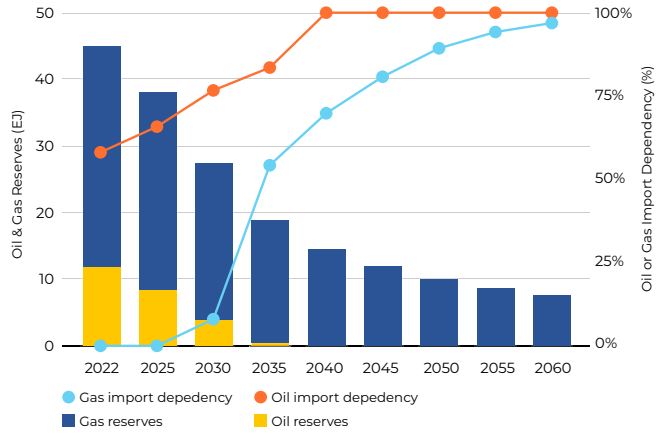


Source: IESR IETO model

Increased dependence on imported oil for transportation and looming gas insufficiency for nascent industries could jeopardize future energy supply security

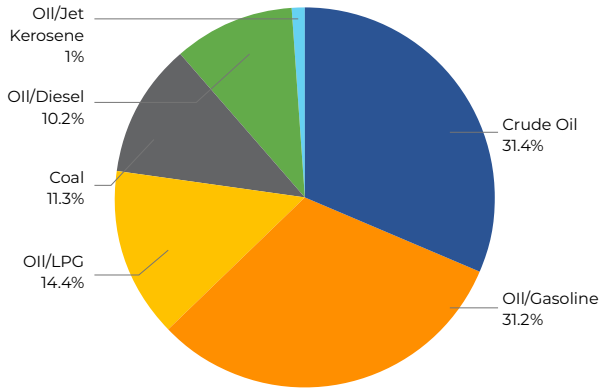
- Indonesia's energy security has shown an increasing concern as oil production continuously declines, and exploration activities lag behind the depletion of existing fields. Oil reserves are projected to be completely depleted by 2037 at the current level of consumption. Currently, the transport sector's energy consumption is 53.5% relied on imported fuel. In this context, the limited reserves of fossil fuels present a dilemma: choosing between maintaining energy security through imports or reducing import dependency while hastening reserve depletion.
- Despite anticipated sustained gas reserves, the trend in gas production is not commensurate with the rising demand Indonesia where Indonesia is projected to become a net gas importer by 2034, given the continuous -5.69% CAGR decline in production. The industrial sector consumes approximately two-thirds of the domestic supply, totaling around 0.44 EJ, while the rest is utilized for non-energy purposes. Notably, in industries such as basic chemicals, fertilizer, and pulp and paper, gas is irreplaceable and surpasses coal in demand.
- Energy imports are vulnerable to geopolitical tensions, and import disruptions could significantly impact Indonesia's energy supply and economic activity. The growing reliance on imports, currently at 15% (for oil and gas), will also pose a lasting financial burden due to subsidies required to address the gap between the global and domestic prices. It is worth noting that owing to the recent volatility of global oil price, the government spent over IDR 500 trillion to compensate for the fuel price.

Oil & Gas Reserves and Import Dependency



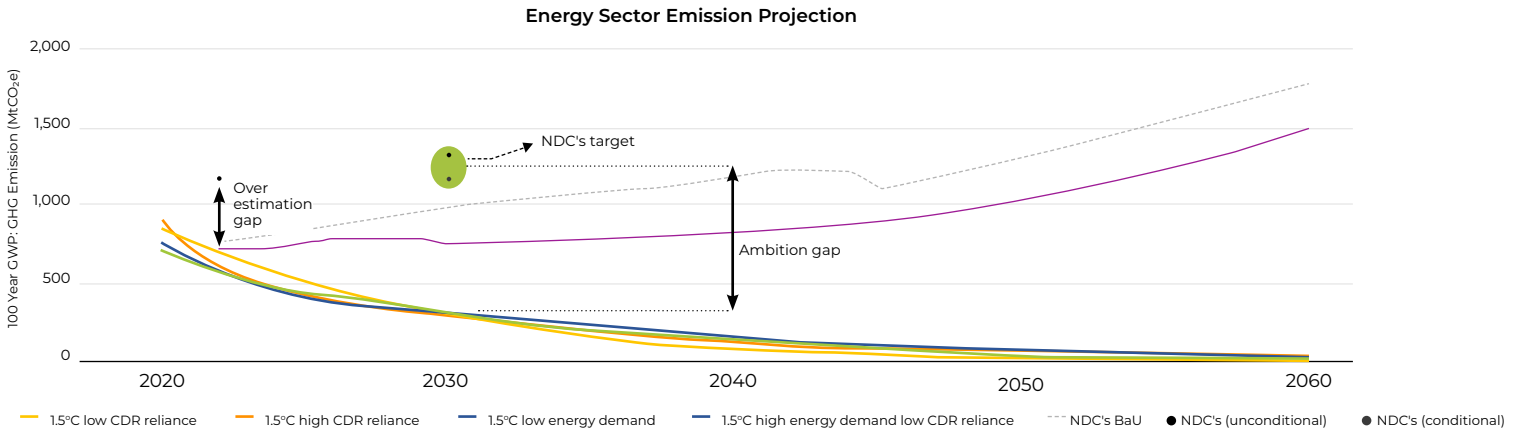
Source: IESR IETO model
Notes: Assuming no additional reserves, and all oil products and LPG are sourced from oil
The 2022 oil imports at 58.3% is including LPG

Oil & Gas Products Import



Source: IESR IETO model

The existing NDC target falls short by around a 989 $MtCO_2e$ to align with the Paris Agreement, while the projected energy sector emission in 2030 necessitates a 66% reduction



Source: IESR estimation; Indonesia Enhanced NDC, 2022; Climate Analytics, 2020
Notes : The expected GDP growth in the IETO model is 5% from 2022

- The GHG emission calculations from all combustion processes, including fugitive emissions, indicate an annual 743.5 $MtCO_2e$ emission in 2022, coming from energy demand and supply activity with 52.8% and 47.2% shares, respectively. If that starting point trends persist alongside population and GDP growth, the emission in NPS was expected to rise to 962.7 $MtCO_2e$/y by 2030, and further doubled by 2060.

- An adjustment of the nationally determined contribution's (NDC) BaU baseline is needed for the incoming update. The projected emission in 2030, based on recent actual conditions, is well below Indonesia's current NDC target, prompting objections to any future emission reduction effort claims. Nevertheless, a substantial gap exists between the current NDC target and the latest Climate Action Tracker (CAT) recommendation to limit emissions below 859 $MtCO_2e$ across all sectors (excluding LULUCF) by 2030 to align with the 1.5°C Paris Agreement (PA). For the energy sector, the NDC's cap in 2030 should be lowered by 989 $MtCO_2e$.

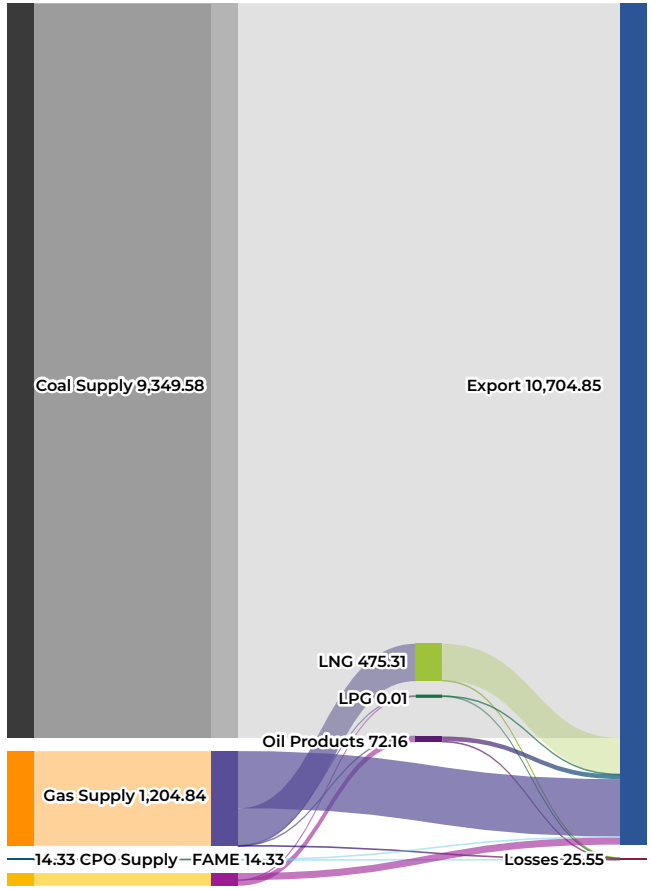
- Although still falling short to PA[1], recent policies and pledges[2] have the potential to cut about 20% of projected emissions in 2030. In the short term, the power sector will play a pivotal role energy sector emission reduction. Compliance of power sector's (PLN area) emission peak target before 2030 will slash 15.6% of total energy sector emissions. Further reductions are plausible with extra interventions, particularly in captive electricity generation, transport, and industry sectors, contributing to about half of emissions in 2022 and showing potential for further increase.

[1] There is remaining 638 $MtCO_2e$ gap in 2030 between the estimated energy sector emission with the fulfilment of current policies and pledges targets and Paris Agreement compatible emission assuming the energy sector cap at 322 $MtCO_2e$.
[2] The policies and pledges target used to estimate the emission is available in Appendix C.

Carbon originating from Indonesia can be traced in the atmospheres of other nations, particularly in the Asian region

- In recent years, Indonesia has represented around half of global thermal coal exports (Maguire, G., 2023). This condition indicates a substantial contribution to global emissions, particularly in top importing countries like China, India, and the Philippines. Assuming all exported coal in 2022 are used for electricity generation, it implies that roughly a billion tCO_2e of distributed GHG emissions were produced from Indonesian coal, equivalent to around 2.5% of global energy GHG emissions.
- The current international emission accounting system, which does not attribute the emission of exported fossil fuels to producing countries, faces growing criticism. Currently, most critics are directed at wealthy countries that claim their success in dwarfing domestic emissions while being major exporters of GHG in the form of oil and gas commodities. Indonesia, with its coal exports, will undoubtedly face similar pressure as the world approaches the endgame of energy transition.
- Exporting fossil fuels does not completely remove the burden on Indonesia to achieve its emissions reduction targets. The exported energy commodities in 2022 were estimated to emit 14.76 $MtCO_2e$ GHG (about 2% of energy sector emissions) during the extraction and transformation process from refineries and fugitives (methane)[3].
- The plan for downstreaming coal, envisaged as a solution for future declining exports, still encounters implementation challenges. For instance, the coal-to-DME industry, also expected to cut LPG imports, has a production cost higher than imported LPG with equivalent energy content, raising doubts about its financial viability (IESR, 2022). Moreover, DME production, five times more emission-intensive than that of LPG, requires CCUS integration. The stalled progress in DME industry development will likely to persist, given that the anticipated supporting Presidential Regulation is still in the drafting process.

Energy Flow of Exported Fuel from Indonesia



Source: IESR IETO Model
Notes: unit in PJ, CPO export was excluded

[3] This number is based on LEAP IBC emission factor database; other sources expect much higher emissions from fugitives (see Chapter 3).

2.

Trends and Transformation in Demand Side

Contents:

2.1.

Trends and Transformation in Industrial Sector

Abyan Hilmy Yafi, Dr. Farid Wijaya

Contents:

- Overview of energy consumption and GHG emission trends in the industrial sector
- Status on cement, iron and steel, and ammonia industries

INDUSTRY

TRANSPORT

BUILDINGS

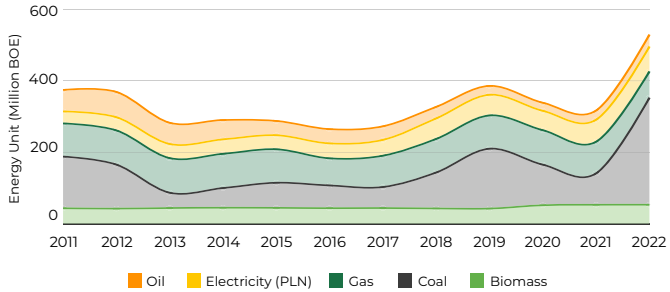
Industries' coal demand is increasing, supported by the DMO policy and affordable supplies

- The industrial sector accounted for 44% of national energy demand in 2022, most of which is coming from coal with a 56% share of the industry final energy consumption. The coal consumption has increased, resulting almost double the energy consumption share from the previous year (MEMR, 2023a). It is imperative to take into account the GoI's post-COVID-19 recovery program, as well as the anticipated shortfall in coal supply of 16% in 2021. These precautions makes the GoI increase the national coal production target and strengthen the DMO policy in 2022. Moreover, coal production in 2022 has exceeded the target by 3% to 687 Mt, rising from 2021's 614 Mt, resulting in an exceeding DMO coal target supply by 30% to 216 Mt, in which 40% is used for the industrial sector (MEMR, 2023b). It provided a plentiful domestic coal supply.

- The number of industries receiving DMO and DPO policies for coal is increasing. Ratified in early 2022, these policies provide protection against global price spikes of coal with a DPO price of USD 90/t (MEMR, 2022; MEMR, 2023c). The policies have helped secure the supply of lower-than-market-price coal to be consumed by almost all industries except smelters (MEMR, 2022; Agung, 2022). This results in coal being the cheaper fuel compared to other options, even taking into account the subsidy provided for natural gas and petroleum fuel (MEMR, 2023c; Pertamina, 2023; Komisi VII, 2022; Fauzan, 2023). It may further increase coal consumption in the industry. However, the DMO and DPO policies lead to potential losses to the state revenue and hamper efforts to reduce emissions in the industry.

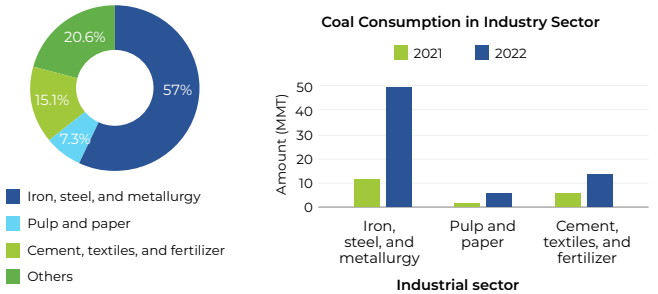
- In 2022, the GDP industry experienced an increase in the average growth rate of 5.01% 2022, the highest ever since 2015 (MoI, 2023a-b) with several energy-intensive industries developing rapidly, especially in sectors of iron, steel, and metallurgy driven by national strategy projects and industrial downstream policy (Islamiati, 2023; IISIA 2023; Permana, 2022; MoI, 2022; Rizky, 2023). In contrast to the industry growth, the demand for natural gas has declined annually by 2.4% and oil consumption by 7.2% since 2012 as prices rose steadily and a decrease in supply reserves (MEMR, 2023a). In this case, to ensure industry energy availability, renewable energy and electrification strategies must be encouraged.

Energy Utilization by Sources in Industry Sector



Source: IESR analysis, adapted from MEMR, 2023a.

Coal Demand Share by Sector in 2022 and the Amount of Demand Increases from 2021 to 2022



Source: MEMR, 2023a.

- Fuel switching to bioenergy clean fuels and transitioning to electrification is one of the decarbonization strategies towards green industry in achieving NDC and NZE. In 2022, there was an increased use of bioenergy and electricity in industrial energy consumption. However, as their consumption growth is insignificant compared to coal, there is a shift in electricity-energy consumption share from over 16% in 2021 to around 12% in 2022, while it is approximately 17% to 10% for biomass (MEMR, 2023a). The industry sector urgently needs to strengthen its decarbonization efforts. A roadmap would help guide the process.

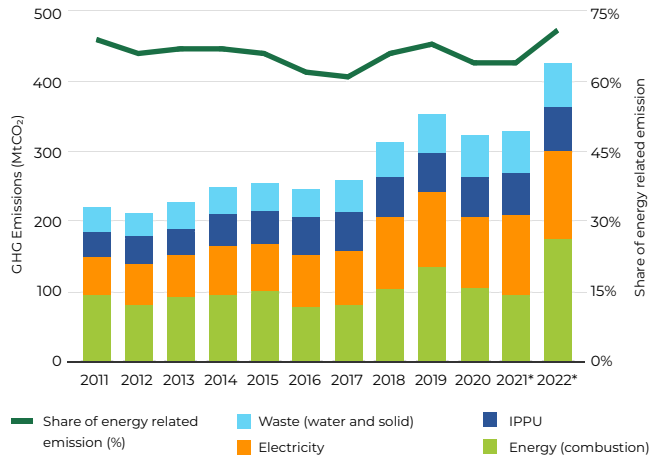
More attention and efforts are needed to control and reduce GHG emissions in industrial sector

- The GHG emissions of the industrial sector are estimated to reach 430 $MtCO_2e$ in 2022, a 30% increase over the previous year. The increase in emissions is primarily attributed to an increase in emissions from energy consumption, whose share rose by 5% to 71%. A notable change is the nearly doubling of emissions from combustion, while other emissions remain relatively unchanged. The increase in energy combustion share indicates the growth of industrial processes that require high heat energy. Unfortunately, these processes' demand leads to an increase in coal consumption that contributes to the emission of 174 $MtCO_2e$.

- By 2030, Indonesia has committed to reducing GHG emissions from the industrial IPPU sector by 7-9 $MtCO_2e$ and industrial waste by 26-28 $MtCO_2e$ (UNFCCC, 2022). However, these emission reduction efforts are not enough without a clear direction and target for energy consumption as it will have a significant impact on investment and operating costs. Energy consumption contributes to over 60% of Industries' GHG emissions, while more than the remaining half belongs to industrial waste. However, efforts to reduce those emissions are still limited to a few sectors and have not been enforced through binding regulation. Collaboration from at least three ministries, MoI, MEMR, and MoEF, is needed to resolve these issues.

- There are several policies and regulatory frameworks exist to support industrial decarbonization efforts. This year, the government issued GR No. 33/2023 on Energy Conservation, which replaces GR No. 70/2009. The new regulation expands the scope of energy conservation and management in industry by lowering the minimum threshold from 6000 TOE/year to 4,000 TOE/year. However, the applicability efforts must be mandatorily binding and controlled (MEMR, 2023). To build a green industrial ecosystem, the MoI supports manufacturing industries in implementing green concepts in economies, technologies, and products, supported by GR No. 28/2021. Up to November 2023, 35 standards were established out of 503 priority standards in 2024 (MoI, 2023; MEMR, 2023d). Further, MoI plans to create decarbonization roadmaps in 2023 and 2024 for nine sectors of high-energy emitting industries along with its incentives for energy transitions (Nurdifa, 2023).

Historical GHG Emission from Industrial Activities



Source: IESR analysis, adapted from MoEF, 2023; MEMR, 2023a.
*Note: *IESR analysis based on MOI, MEMR and MoEF available data.*

- Green industrial areas pilot projects through the GEIPP-Indonesia program are still in progress, involving the MM2100, Batamindo, and KIIC (MoI, 2023d), while others are in development (FDSA, 2023). Industrial sector is expected to implement more green industrial area strategies while improving emission control in-field implementation, including increasing compliance with the statutory provisions on industrial data reported in SIINAS under MoI Regulation No. 2 of 2019 (MoI, 2023e) and industrial compliance with MoEF emission quality standards (MoI, 2023f), which have so far been carried out on a limited basis and not strictly binding (APKINDO, 2023; MoI, 2023f). The situation needs to be improved with more attention from GoI in an effort to reduce emissions that are more binding.

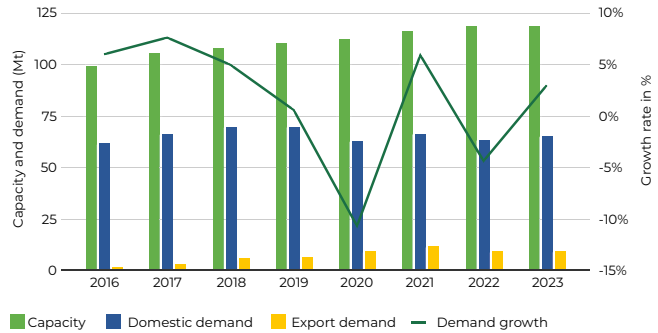
Emission intensity in the cement industry is dropping, pushed by an increasing thermal substitution rate

- Cement production capacity in Indonesia reached 116 Mt/year in 2022, but total cement production is only 57% of total capacity (Business Ranker, 2023; Asian Insiders, 2023). This condition happened in particular because domestic demand has continually stagnated since 2016 while exports remained limited (ASI, 2023; Kontan, 2023). This overcapacity can result in low utilization rates, which potentially leads to lower energy efficiency and higher GHG emissions (IEA,2023) since this industry consumes 3.7 Mt/year of coal (data until July 2022) (MEMR, 2022). Nevertheless, the cement industries are still interested in investing in East Kalimantan's new cement production facilities to support Indonesia's new capital city, which can absorb substantial cement consumption (Bisnis, 2023).

- From 2010 to 2022, the carbon intensity of the Indonesian cement industry was reduced from 725 $kgCO_2$/tonne cementitious to 631.70 $kgCO_2$/tonne cementitious, achieving an absolute emission reduction of 6.54 $MtCO_2e$ in 2022 or a decrease of 12.9% compared to BAU (MPWH,2023). The industry is addressing this issue by replacing coal with low-carbon fuels, such as biomass, RDF, and electrification powered by solar PV or the national grid (CNBC Indonesia, 2023).

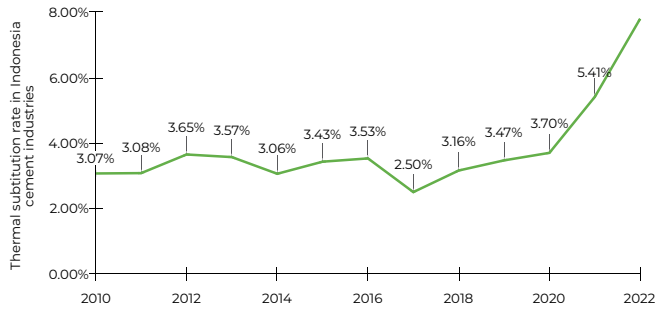
- The use of biomass is contributing to the rise in the thermal substitution rate (TSR), which was 7.8% in 2022 and is expected to reach 19.82% by 2030, with 1% increases in TSR reducing emissions by 2-3 $kgCO_2e$ for 1 Mt of cement (ASI, 2023). To fully realize this potential, the government must ensure a reliable and sustainable domestic supply of biomass. This is particularly crucial given the domestic price of biomass, which tends to be higher than coal for the same amount of energy, and the tendency of industrial players to export biomass due to more profitable export prices. (Riyandanu, et. al., 2023; Ningrum, 2022; Global Wood, 2023).

Indonesia's Cement Industry Capacity and Demand (Mt)



Source: Asosiasi Semen Indonesia, 2023

Trend of Thermal Substitution Rate in Indonesia Cement Industries (%)

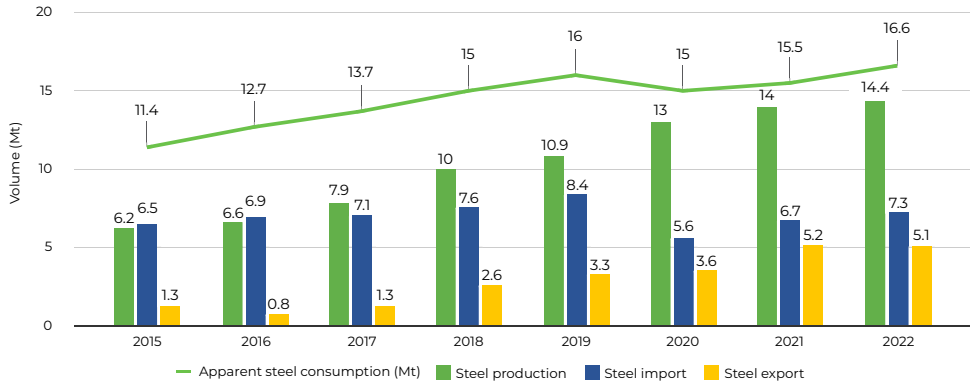


Source: Asosiasi Semen Indonesia, 2023

Indonesia's iron and steel industry needs to adopt low-carbon technologies to reduce emissions

- Despite fluctuating conditions in the global economy, Indonesia's iron and steel industry continues to grow. In 2022, the shortage of production numbers still occurred as a result of the continuous growth in domestic and export demands since 2015. Notably, this growth includes the anticipation of a potential demand of 9.5 Mt for Indonesia's new capital city mega project despite the challenges posed by imports (Bisnis, 2023). Moreover, it also may be hindered by the need to reduce emissions, in which the Indonesian iron and steel industry emits approximately 3.07 tCO_2e per tonne of steel or almost 2.2 times than the global average of 1.41 tCO_2e contributed by BOF-coal utilization (IISIA, 2022; MoEF, 2022; IEA, 2023). Consequently, Indonesia's iron and steel industry still needs to improve to catch up with the world average emissions and reach green industry standards.

Iron and Steel Production and Consumption



Source: Indonesia Iron and Steel Industry Association, 2023

- Referring to Indonesia ENDC commitments in 2022, the iron and steel industry is required to reduce IPPU emission with a minimum target of 0.6 $MtCO_2e$, further with a more ambitious target of 0.9 $MtCO_2e$ by 2030 from the 2010 projection growth as the reference (UNFCCC, 2022). Meanwhile, emissions from this industry are estimated to reach 20 $MtCO_2e$ in 2022, with 80% coming from energy consumption and 20% from the manufacturing process or IPPU (IISIA, 2023). As a result, this represents a significant challenge for the steel industry that must be supported and monitored. To achieve this, one of the efforts is the transition from BOF to EAF.

- Technology transition from BOF to EAF is of great significance, especially as a means of reducing GHG emissions through electrification and RE-generated electricity. It is known that BOF can produce emissions of 1.9-3.0 tCO_2e per tonne of steel compared to DRI-EAF of 0.7-1.4 tCO_2e and scrap-EAF of 0.06-0.5 tCO_2e (Demus,et. al., 2012; IISIA, 2023; IEEFA, 2022; SOTN, 2023). Since 1980, EAF has been adopted for producing iron and steel, but due to its cost-effectiveness, the BOF adoption was planned in 2008 and operated in 2012 (Djaja et. al., 2008; Bisnis, 2022). Currently, the capacities of EAF and BOF represent 36% and 64% of the total capacity, respectively. As a result of today's effort to reduce IPPU emissions, the iron and steel industry is required to shift from BOF to EAF or BOF with CCS/CCUS. In addition, it is also recommended to shift fuel from coal to biomass or other RE for BOF.

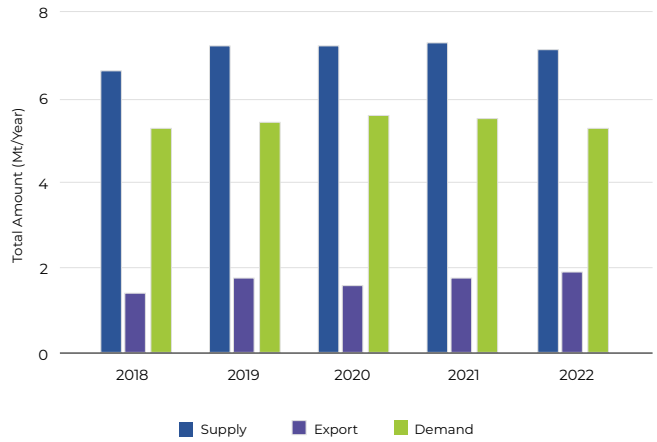
There is potential for developing the ammonia market by carrying out energy efficiency and transitioning to low-carbon emission ammonia

- Indonesia ranks 5th globally in the amount of ammonia production and is the 4th largest exporter of ammonia (OEC, 2023). Indonesia produces approximately 7.2 Mt/year of ammonia, with an average export growth rate of 6.7% since 2018 (MoI, 2023). Around 70% of the produced ammonia is utilized for fertilizer production. Recently, ammonia has also gained popularity as a carbon-free alternative fuel with a potential global demand in 2050 of up to 700 Mt/year or almost 4 times the 2020 demand (Gielen, 2022; WoodMack, 2022). Hence, ammonia production in Indonesia is expected to increase to meet the growing global and domestic appetite (RystadEnergy, 2023; SPG, 2023).

- However, the high production cost of low-emission ammonia remains an issue because the technology is still relatively new and requires a significant investment. The global average production cost of 'blue' ammonia is USD 600/t and 'green' at USD 730/t, which is higher than 'grey' at USD 470/t (Saygin, D., et. al., 2023). Moreover, potential emissions issues such as ammonia slip, NO_x, and N_2O are claimed to be more harmful to the atmosphere than CO_2 emissions (Njovu, G., 2023).

- In 2020, Indonesia's ammonia production requires an average energy intensity of approximately 37 GJ/t with natural gas-based production on a net-basis. This value is lower than the global average of 41 GJ/t but still significantly higher than the best available technology (BAT) for natural gas-based production with only 28 GJ/t and similar to BAT for coal-based production at 36 GJ/t energy consumption intensity (IEA, 2023). These values illustrate that the efficiency of energy intensity in Indonesia's ammonia production can be further enhanced, and along the way, decarbonization efforts can be arrived out to minimize the reduction of GHG emissions further.

Supply, Export and Demand of Ammonia In Indonesia



Source: MoI, 2023g

- As part of emission reduction efforts, ammonia production technology using green hydrogen powered by renewable energy electricity is being developed in conjunction with plans to capture CO_2 emissions through CCS/CCUS technologies. In addition, the MEMR is currently preparing a roadmap that may be finalized at the end of 2023 for the development and implementation of hydrogen and ammonia in Indonesia until 2060, which includes plans for the development and implementation of these technologies (MEMR, 2023e; GoI, 2023). If successfully implemented, it will likely lead to a faster transition towards decarbonization in various sectors, including transportation and industry.

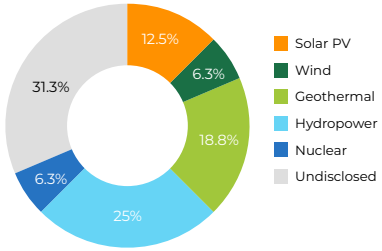
The rise of low-carbon emission ammonia projects offer opportunity to become self-reliant and exporter in the near future

- A number of industrial initiatives for low-carbon emission ammonia projects are under development. As of November 2023, there are at least 22 low-carbon ammonia projects identified, 14 of which are green ammonia and 8 are blue (detail in appendix D). Hydropower and geothermal dominate as the renewable energy sources for the green ammonia projects, contributing to 25% and 19% of the projects due to their high availability factor. A hybrid system with solar PV could give additional benefits, such as potential of lowering energy costs, diversified energy sources, and secure supplied energy (Dykes, K. et al., 2020; PtXHub, 2023). The number of ammonia production projects is expected to rise due to the growing global demand market and the potential for ammonia as a chemical energy storage (Jeerh, et. al., 2020; Aziz, et. al., 2023)

- Pupuk Indonesia has participated in developing a green industrial area in Lhokseumawe, Aceh, and developing low-carbon emissions ammonia production in the area. Pupuk Indonesia, supported by MoI and MSOE, has the vision of making Indonesia the future hub of the low-carbon emission ammonia world market. Pupuk Indonesia, representing more than 85% of Indonesia's ammonia production in 2022, has a target of CO_2 reduction from its ammonia production process of up to 4.8 $MtCO_2e$ by 2030 and 20 $MtCO_2e$ by 2050 (Pupuk Indonesia, 2022; Nurcahyadi, 2023). This target will be achieved by periodically increasing the production of low-carbon emission ammonia to substitute the current conventional 'grey' ammonia of 9 Mt/year by 2060 (Pupuk Indonesia, 2023a; Cahyoputra, L. AL., 2023).

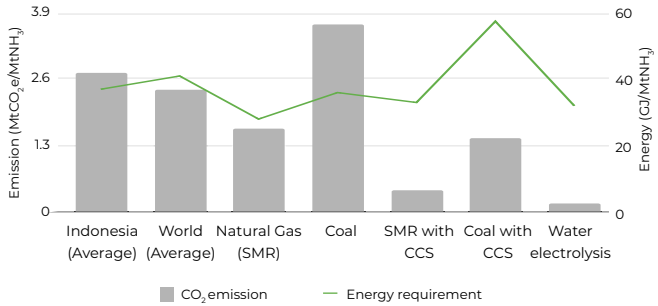
- Apart from that, the existence of low-carbon ammonia production areas in industrial areas has a positive impact on cutting the logistics cost for ammonia supply to surrounding industries. Thus, it may accelerate the adoption of low-carbon ammonia in replacing the role of fossil fuels in industries. Further, it could contribute to Indonesia's independence establishment through a reliable supply of ammonia and pave the way for developing other green industries.

The Use of Renewable Energy Sources in the Production of Green Ammonia



Source: IESR Analysis.

Best Available Ammonia Production Emission and Energy Requirement in 2022



Source: IESR Analysis, adapted from Tjahjono, M. et al., 2023; Nallapaneni & Sood, 2022; IEA, 2023, IEA, 2021; HE, 2023.

- In terms of usage, several industries that have committed to using ammonia are: PLN including its subsidiary, PJB, for co-firing in electric steam power plants (PLTUs); Pupuk Indonesia and its subsidiary as raw material for fertilizer; and GRP for producing green steel (Kusdiyanto, A., 2023; Indrawan, R., 2023; SL, L., 2023; GRP, 2023). Ammonia use in various sectors can contribute to the development of a more sustainable low-carbon ammonia ecosystem, which should continue to be supported.

2.2.

Trends and Transformation in Transportation Sector

Faris Adnan Padhilah, Rahmi Puspita Sari

Contents:

- Transport sector emission overview
- Decarbonization of public transport
- BEV adoption status update
- Charging infrastructure status update and utilization rate
- Battery supply chain updates

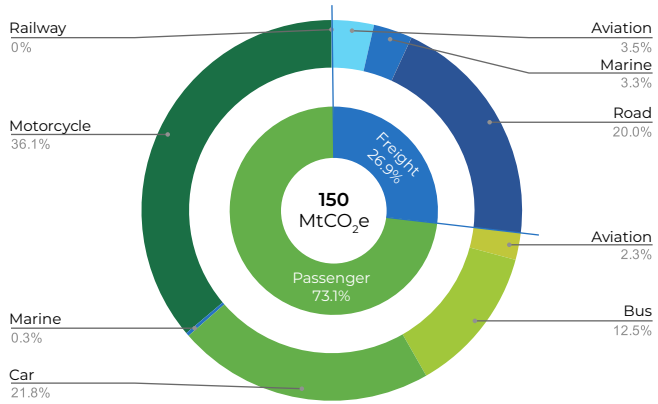
Private vehicle is the top greenhouse gas emission, logistic comes second but is often overlooked

- The transport sector plays a pivotal role in climate change mitigation and decarbonization. In 2022, global CO_2 emissions from transportation surged by over 250 $MtCO_2e$, reaching nearly 8 $GtCO_2e$ (IEA, 2023). In Indonesia, the transport sector stands as the country's second-largest contributor to greenhouse gas (GHG) emissions, accounting for 20% of indirect emissions, with road transport—both passenger and logistics—dominating at 90%.

- Motorcycles significantly contribute to transportation emissions, making up 36% of the total emissions, correlating with their substantial registration share at 85% of vehicles (details in Appendix F) (BPS, 2023). Their widespread usage, primarily due to affordability and speed, has made them the primary mode of transport, surpassing public transportation. Consequently, this issue has contributed to unresolved urban congestion.

- Rail, despite only took up the 0.06% of total emission, comes second in passenger activity as it exceeded 30 million passengers in August 2023 (BPS, 2023), further proving the ability of rail as the least emitting carbon-intensive mode. The Government of Indonesia has recognized the importance of public transportation, leading to inauguration of the high speed train and light rapid transit. Many other rail-based public transportations are currently on plan.

Indonesia Greenhouse Gas Emission Shares in Transportation Sector in 2022



Source: IESR Analysis

- Logistics account for 27% of transportation emissions but has so far been overlooked in transportation decarbonization strategies. Decarbonizing heavy transport has lagged due to challenges in electrification. Electric options are best suited for short-haul and lighter vehicles due to battery weight concerns (Gross, 2022). To fill the void, the use of biofuel or synthetic fuels could play a crucial role in decarbonization of heavy transport. Diesel fuel currently powers most trucks and buses in Indonesia, already reaching B35 by 2023. Urgent action is needed to ramp up alternative approaches to decarbonize logistics and marine and aviation transport sectors as they are also difficult to be electrified.

The need to elaborate specific reduction target in the MoT Decree 8/2023

- The MoT decree 8/2023, "Climate Change Mitigation Actions in the Transportation Sector to Achieve Nationally Determined Contribution Targets," outlines a comprehensive 38-point plan for decarbonizing the national transportation sector. This decree specifies mitigation plans, indicators, and the responsible executive bodies for each action (MoT, 2023)[1]
- This first decree dedicated to address decarbonization in the transportation sector, unfortunately, comprises actions without specific emission reduction targets, making it difficult to asses the decree's impact on national emission reduction goals, which called for derivative regulatory products that provide detailed plan, concrete steps, and quantitative emission target. The costs associated with the implementation of climate change mitigation actions in the transportation sector will be covered by the budgets of the related work units, as listed in the Budget Implementation List (DIPA), and how does this affect the local governments or the mechanisms through which it will be implemented remain unknown.
- The road transportation sector has been covered thoroughly in the decree, including the avoid (TOD, NMT),-shift (BRT),-improve (electrification, biodiesel) intervention into the action. The transition to BEV is done through the issuance of regulations for the implementation of BEV, utilization of BEV in public transportation and official vehicles, as well as construction of charging station facilities to support the use of BEV.
- Besides road transportation sector, the decree mostly focused on fuel improvements for vehicle interventions and the utilization of renewable energy for various implementations including for structure and supporting systems, such as lighting, offices, and navigation systems. While there is a focus on fuel enhancements in the railway sector, there is a noticeable absence of dedicated provisions concerning the transition to electric rail-based transportation.

Road Transportation Sector

- TOD development
- BRT and rail transport development
- Development of non-motorized transport
- Public transport fleet electrification and regeneration
- ERP implementation
- Implementation of long distance ferry
- Renewable energy utilization for supporting activity and infrastructure

Railway Sector

- Implementation of low carbon fuel for rolling stock
- Renewable energy utilization for supporting activity and infrastructure

Maritime Sector

- Implementation of low carbon fuel for maritime fleets and fleet regeneration
- Renewable energy utilization for supporting activity and infrastructure

Aviation Sector

- Implementation of biofuel for aviation fleets and fleet regeneration
- Renewable energy utilization for supporting activity and infrastructure

[1] Involves 17 land transportation and railway, 10 maritime, and 11 air transport mitigation action plans for transportation sector

Financial barrier for low emission calls for prioritizing the network expansion for modal shift rather than decarbonizing existing railway

- Total CO_2 emissions from rail remain under 1 $MtCO_2e$, accounting for only 0.06% of the transportation sector emissions. Railway transport stands as the longest-standing electricity-based transportation and one of the most energy-efficient modes compared to other technologies. Rail remains the most electrified transport subsector, although diesel consumption dominates the railway sector. In terms of energy consumption measured in gigajoules, diesel overwhelmingly accounts for 99% of energy consumption (KAI, 2022) despite covering only 33% of the distance traveled (KAI, 2022), further proving the inefficiency of diesel-uses.
- The barrier persists due to the cost associated with electrifying the existing network. For instance, the electrification of the Bekasi-Cikarang railways in 2017, covering 16.74 km, incurred costs of 2.3 trillion rupiah (Firdaus, 2017), and electrification of the Solo-Yogyakarta line, spanning 50 km with costs of 1.3 trillion rupiah (Rahayu, 2021). Financial analysis showed that transitioning to electricity for railways requires an initial investment cost of IDR 26,680-IDR 149,906 per vehicle kilometer but only saves about IDR 16,541 in energy costs. This means it might take 45 to 237 years to break even. Creating an entirely new electric rail system might be more financially feasible than retrofitting existing infrastructure.
- In the segment where electrification is not economically feasible, hydrogen emerges as a viable future technology. Alstom indicates that hydrogen fleets will reach lower TCO around 15 years due to lower maintenance costs despite requiring a 30% higher initial investment than diesel (Day, 2022). As of 2019, KAI and Alstom have an MoU to work together on the hydrogen-powered train, even though the continuation of this project remains unknown. The MoT decree 8/2023 also highlights the promotion of alternative fuels in rail-based transportation, which aligns with this approach.
- In 2023, Indonesia inaugurated high-speed train linking Jakarta to Bandung and the LRT Jabodebek. Based on current ridership assumptions, these infrastructure projects are projected to reduce 949 tCO_2e per day and 41 tCO_2e per day, respectively. The modal shift has proved to be reducing substantial emissions, under a tight budget, expanding capacity and enhancing network coverage and making the railway attractive for any traveler should remain upmost priorities.

Cost of Electricity Shifting Compared to Diesel alternative

Summary	Electricity (IDR/vkm)	Diesel (IDR/vkm)
Investment cost (upperbound)	149,906	not applicable
Investment cost (lowerbound)	26,680	
Energy Consumption Cost	27,193	43,734

Source: IESR Analysis

Annual Energy Consumption for Railway Activity Throughout the Years in PT KAI and Projection in RIPNAS 2030

Fuel	2019	2020	2021	RIPNAS (2030)
Electrical Energy Usage (kWh)	1,905.313	1,719,230	1,515,120	37,383,000
Diesel Usage (Liter)	206,019	164,558	201,364	2,809,000
Diesel Genset) usage (Liter)	3,000	3,000	2,000	
Biodiesel Fuel (B30) usage Liter)	257,072,594	180,297,826	197,522,249	

Source: (KAI, 2022, RIPNAS, 2015)

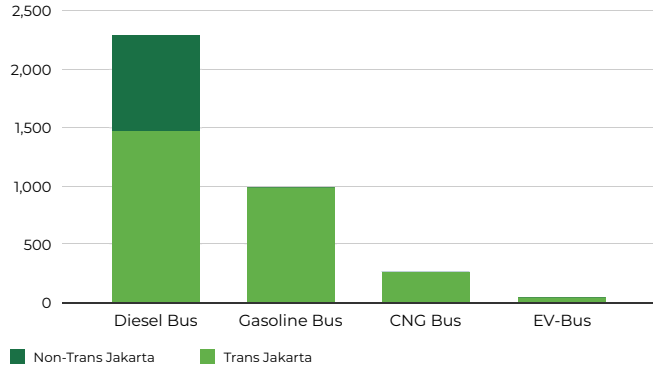
As EV-Bus TCO is more expensive, incentives to lower EV bus investment cost are needed to support EV-bus adoption

- Urban bus public transport is undergoing electrification, led by initiatives like TransJakarta, presently operating 52 electric buses out of 2,276. Their goal is to achieve a 100% Battery Electric Vehicle bus (EV-Bus) fleet by 2030, with a total of 10,047 EV-Buses. The TEMANBUS Program, initiated by the Ministry of Transportation, implements BRT services via a buy-the-services scheme. This program has piloted 17 EV-Bus fleets in Surabaya (MoT, 2022) and added 7 units in Bandung (Rahayu et al, 2023). Furthermore, local transportation authorities managing BRT programs in Surabaya (Kompas, 2022), Semarang, and planning for Bali (Muliantari, 2023) are also transitioning to EV-Buses.

- Despite EV-Buses offering lower maintenance and energy expenses compared to diesel counterparts, their higher initial investment, covering both bus and charging infrastructure costs, results in an 15-35% higher Total Cost of Ownership (TCO) (TransJakarta, 2023). This poses a challenge, particularly for BRT systems procured by local governments constrained by tight public transportation budgets. To address high TCO, TransJakarta has come up with a recommendation to make EV-Bus' TCO competitive with diesel buses. These include reducing EV-Bus prices, extending vehicle lifetime and contract periods to ten years, and enabling the conversion of capital expenditures (CAPEX) to operational expenses (OPEX), thereby distributing the financial burden over the contract duration (TransJakarta, 2023). Despite the new business model, reducing EV-Bus prices remains the most challenging. Incentives to lower EV-Bus investment cost is needed to support EV-Bus adoption.

- Electrifying long-haul or intercity bus is more challenging than urban buses due to limited driving range of EV-Buses, lack of charging infrastructure in intercity roads, higher cost, and uncertain government direction. The government is yet to decide whether to adopt EV-Bus strategy or improve fuel quality standards to EURO 6. Hence, bus operators are likely to stick to current EURO 4 vehicle standards until clearer directives are in place. Other countries has begun using EV-Buses for long-haul travel, especially in Germany, France, and Sweden, serves as an example of the potential for electric buses in intercity journeys.

The number of BRT fleet across several lines



Source: IESR analysis.

Comparison of TCO between ICE and BEV Bus

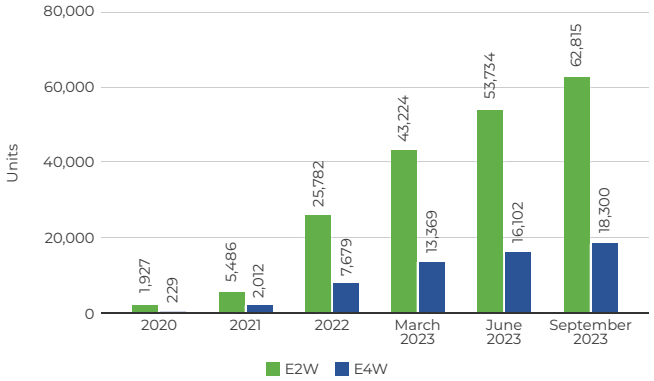
	Conventional	EV-Bus	EV-Bus to Conventional
TCO	Lower	Higher	15%-35% higher
Investment (including charging infrastructure)	25% of TCO	49% of TCO	200-250% higher
Energy cost	16% of TCO	5% of TCO	70% lower
Maintenance cost	26% of TCO	14% of TCO	46% lower

Source: TransJakarta, 2023.

Consumer perception of BEV price improves, however range anxiety remains the primary barrier to adopt

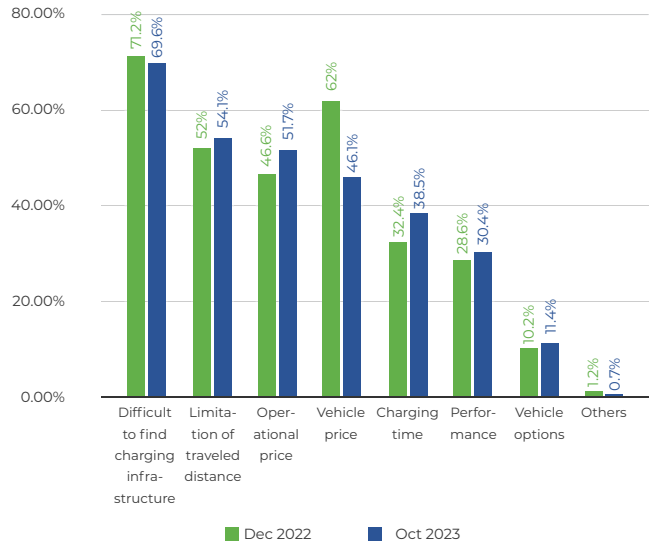
- Despite several incentives packages the government has launched this year, the effectiveness of the government assistance scheme to reduce BEV upfront cost is still unknown, especially in electric motorcycle (E2W) adoption. With the low reserved quota for the scheme, the number of E2W adoptions is growing compared to last year. Until September 2023, there are more than 37,000 new E2W on the road, with less than 1,400 E2W coming from government scheme. In 2023, the average BEV growth for 3 months are around 9,800 for E2W and 2,500 for electric car (E4W). With an adoption rate at this level, allocating all quotas of the government assistance program this year becomes quite challenging.
- The strict requirements such as recipients of people's business credit, recipients of micro-enterprise productive assistance (BPUM) and wage subsidy assistance, as well as recipients of 450VA to 900VA electricity subsidies in MoI Regulation No. 6/2023 limit the potential of E2W adoption through the government assistance scheme. From a total of 200,000 quotas of E2W in this scheme, 2,430 quotas are reserved until the late of August. As the requirements to obtain government assistance have already loosened since late August through MoI Regulation No. 21/2023, the registrant quota has more than doubled, with 5026 registrants in less than two months, increasing the total reserved quota to 7,456. In addition, the reimbursement scheme is sometimes delayed by up to 3 months, which is detrimental to E2W dealers and forces them to hold new units until the old unit replacement scheme is complete.
- Similar issues also occur in tax reduction for E4W where E4W dealers need to cover the VAT reduction first then claim to government through reimbursement scheme in each month or need to wait until the end of the year, depending on the amount reimbursed. As a result, their cash flow and operation are disrupted, making these fiscal incentives schemes inconvenient for several automotive dealers. Even though it causes inconvenience on the dealer side, tax reduction scheme has a shown the significant impact on E4W adoption rate as there are already more than 10,000 new E4Ws on the road in 2023. In comparison, the number of E4W adopted until last 2022 is only 7,679 units.
- Based on IESR surveys, difficulties to find charging station still becomes the biggest barrier to adopting the BEV with 69.2% of total respondents, followed by travel distance limitation and operational costs. Compared to last year, the barrier to adopting BEV from vehicle price has been reduced from 62% to 46.1%, indicating the impact of the government assistance scheme. The main barrier to BEV adoption is still the same as previous years, namely the difficulties to find charging infrastructure. Despite the charging infrastructure growth, the impact is negligible on BEV adoption.

BEV Adoption Status



Source: IESR analysis, MOT

Obstacles to BEV Uptake from a Consumer Standpoint



Source: IESR analysis

Low utilization rate leads to long payback period, therefore government incentives needed to boost SPKLU investment

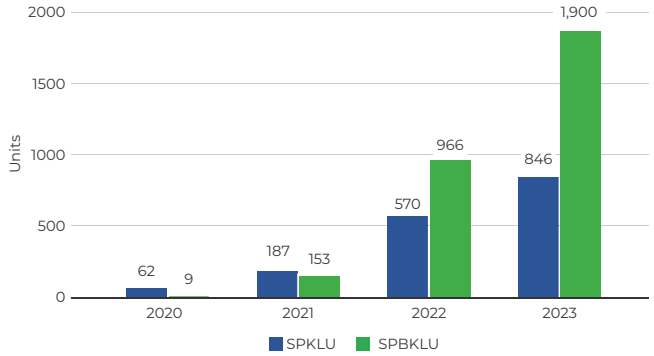
- The charging infrastructure number has also increased compared to 2022, Plug-in Charging Station (SPKLU) has grown from 570 to 846 units, SPBKLU from 966 to 1,700 units and there are more than 3,700 units of home charging. The share of E4W, which only reaches 0.05% compared to all cars, makes the utilization rate of charging infrastructure low and investment of SPKLU less attractive.

- Learning from other countries with mature BEV adoption, SPKLU existence might have a low utilization rate. The average global utilization rate for charging infrastructure ranges from 11-13%, while most used charging infrastructure can reach around 70% utilization rate[1]. As the coordinating Ministry of Maritime and Investment has a target of BEV sales reaching 10% of new vehicle sales shares in 2024, the number of SPKLU needed is at least around 157,000 to support the E4W (PWC, 2022). The number is 5 times bigger compared to the MEMR target of 31,000 SPKLU in 2030.

- Charging infrastructure and BEV adoptions problems are like chicken and egg problems. As the number of BEV adoptions is still low, the utilization rate of SPKLU will not be favorable for SPKLU owners as it has a long payback period. As the best practice scheme, the 13% utilization rate will result to around 3 to 8 years payback period, depending on the type of charger is installed. If SPKLU is utilized at 1% of its capacity, the payback period will vary from around 42 to 103 years. However, based on utilization rate data in Jakarta and West Java which are around 1.3% to 5.92% and 0.06% to 0.25%, the payback period will range from 18 to 50 years and 390 to 436 years, respectively. Long payback period will make the investment of SPKLU unattractive. In order to increase the utilization rate of SPKLU, the SPKLU owner should plan carefully and try to install SPKLU in crowded areas where people tend to spend hours there.

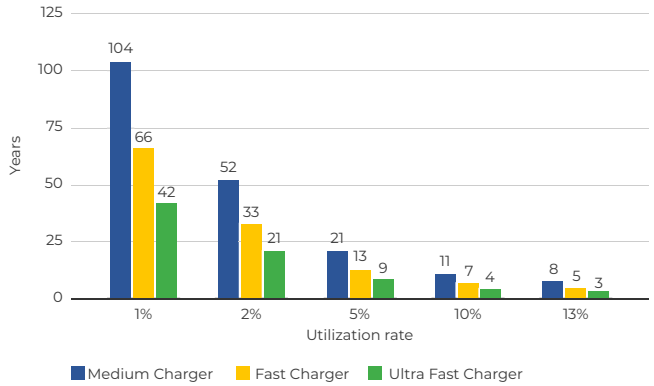
- Even if the adoption is increases this year, range anxiety as the main barrier to BEV adoption is not addressed well and creates hesitation for consumer to adopt BEV despite the incentives schemes. Therefore, the incentives to install charging infrastructure, such as giving government assistance to BEV charging companies for installing specific charging types, tax reductions, tax refund, and other types of fiscal and non-fiscal incentives, might help to boost charging infrastructure and eventually will lead to increase of BEV adoption.

Charging Infrastructure Growth Status



Source: IESR analysis

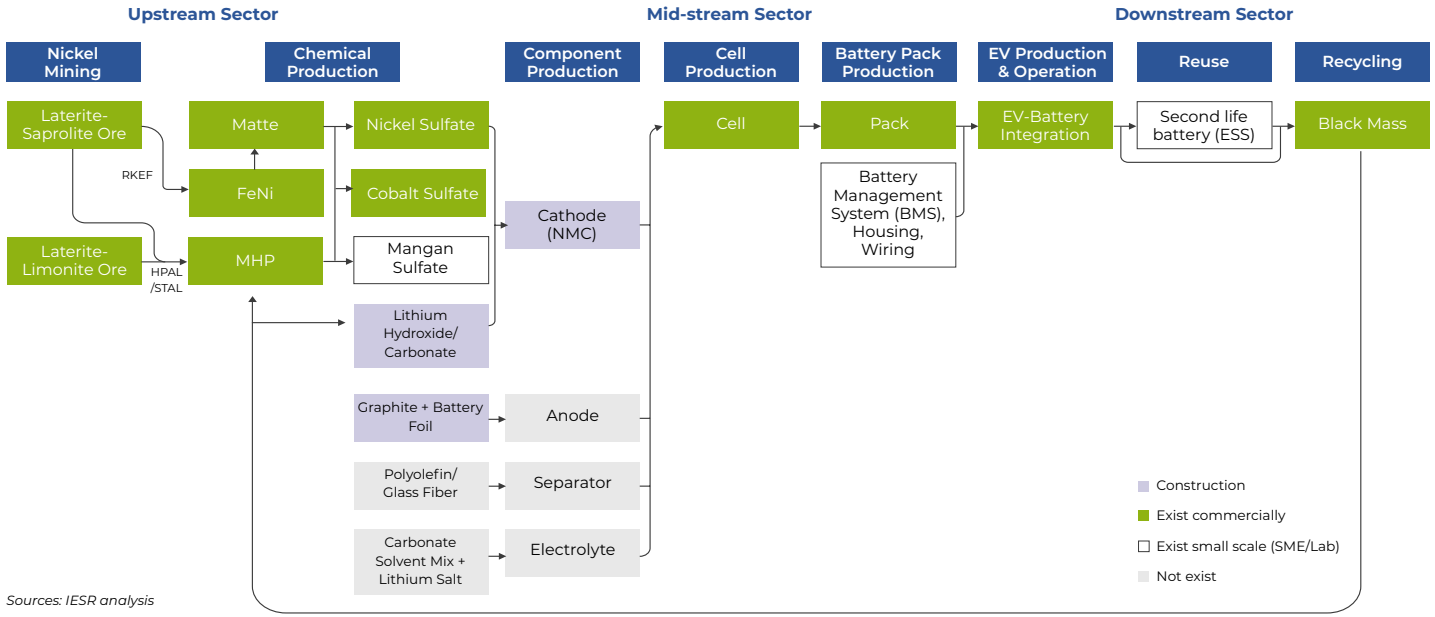
Payback Period of SPKLU Based on Utilization Rate



Source: IESR analysis

[1] Utilization rate means the average of car charged daily compared to maximum number of car charged daily with specific charging time

Other batteries component and recycling facilities urges special focus in Indonesia BEV battery supply chain



Sources: IESR analysis

- Indonesia has accelerated the completion of its end-to-end BEV batteries supply chain, especially in the upstream sector. In terms of nickel smelters, 43 RKEF and 4 HPAL smelters are already operating, 25 RKEF and 6 HPAL smelters are under construction, also 28 RKEF and 10 HPAL are still in planning process. In addition to that, marking a strategic move in this trajectory is the establishment of nickel sulfate and cobalt sulfate factories on Obi Island, both boasting an annual capacity of 240,000 tons of nickel sulfate. Indonesia Morowali Industrial Park (IMIP) already has two operational battery cathode factories with an annual production capacity of 120,000 tons and two additional facilities that are still under construction with equal annual production nickel-cobalt (Ni-Co) and nickel sulfide (NiS) as their products.

- The facility to produce battery anode side is being developed with the construction of lithium hydroxide, anode materials, and copper foil factories. A current battery cell factory, with a 10 GWh production capacity and a 1.1 billion USD investment, is poised for a substantial production uptick in early 2024 with the target of 30 million battery cells to power up around 180,000 E4W. On the other hand, the recycling facilities also already exist in IMIP are ready to produce battery cell from used batteries through the recycling process. However, current production is hindered by an insufficient supply of used batteries, prompting considerations of importing them from other countries to address the raw material shortfall. Yet, this proposition encounters substantial regulatory hurdles, as used batteries are classified as Toxic and Hazardous Waste (B3).

2.3.

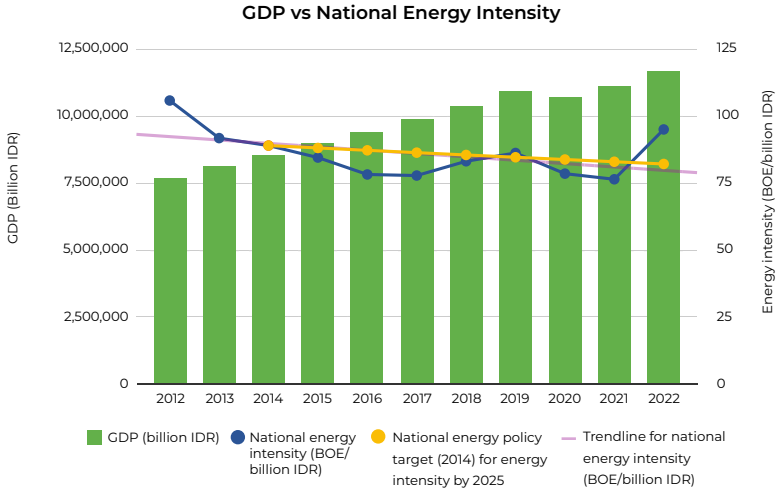
Trends and Transformation in Building Sector

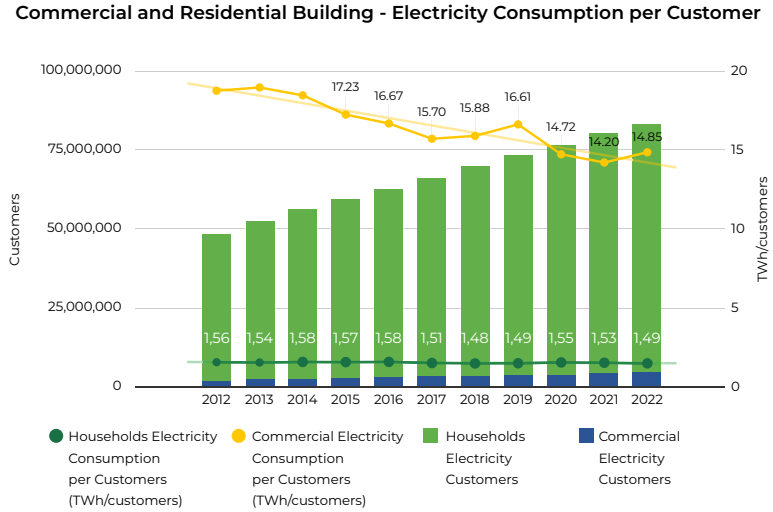
Fathin Sabbiha Wismadi

Contents:

- National energy intensity and building electricity consumption
- Comparison of Indonesia's energy use intensity with some ASEAN countries
- AC's MEPS improvement and availability in the market
- Tracking the progress of net zero building short-term goal

Unforeseen surge: Indonesia's call to action for a 14.5% energy intensity cut





Source: HEESI, 2022; Statistik PLN 2020-2022, IESR Analysis 2023

- Exceeding the target set by the National Energy Policy (GR 79/2014), Indonesia has consistently witnessed a yearly decline in its final energy intensity[1] over the last decade, outperforming the goal of a 1% annual reduction. However, because of a 31% increase in national energy consumption brought on by an 81% rise from the industrial sector, there is a 24% climb in energy intensity in 2022 compared to 2021 from 76.45 to 95.1 BOE/billion IDR. A 14.5% reduction in national energy intensity must be undertaken in 2023 in order to keep up with the NEP objective.

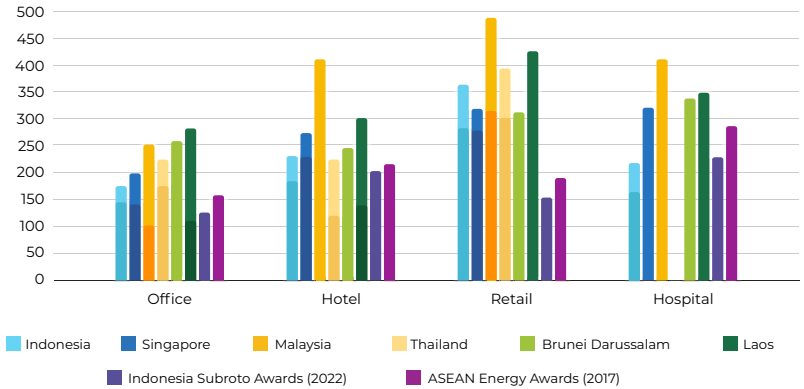
- The target for reducing emissions from the energy sector by implementing energy efficiency is 132.25 $MtCO_2e$, of which energy efficiency in the building sub-sector contributes to 65.8% of it (MEMR, 2023).

- Building sector electricity consumption per customer in the last decade has also decreased despite its customer growth. In this case, however, the commercial sector fell more significantly (-20.8%) than the household sector (-4.8%). This decrease suggests that initiatives to improve electricity efficiency in the commercial sector (e.g., regulation for green building, energy managers/auditors, and MEPS) are more intensive than those in the residential sector (e.g., MEPS on household appliances).

[1] Energy Intensity = energy consumption per gross domestic product (GDP). It measures energy efficiency in a country. Lower energy intensity means more efficient energy use.

Beyond complacency: Indonesia's lower EUI gives room for energy efficiency revolution

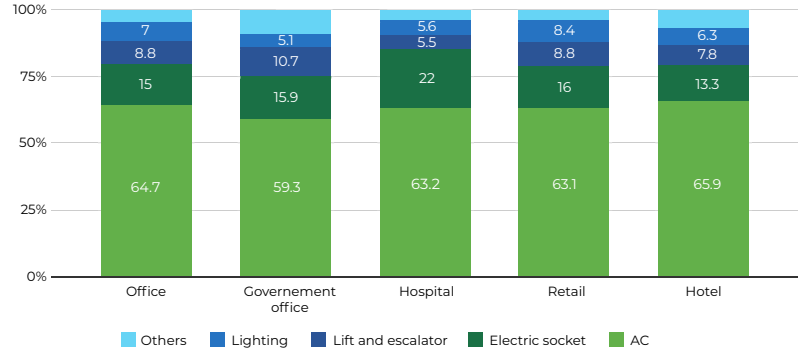
Comparison of EUI Benchmark by Building Type (kWh/sqm/year) in ASEAN



Notes: Darker shades refer to after energy efficiency measures

Source: IEA, 2023b; MEMR, 2020; MEMR, 2022a

Share of Commercial Energy Use



Source: MEMR, 2023a

- Indonesia exhibits a lower Energy Usage Intensity (EUI[2]) for commercial buildings compared to several ASEAN countries. However, this achievement should not foster complacency, considering factors such as the AC penetration in Indonesia, which is still below 10% (Kencana, 2023), indicating room for increased adoption of this energy-intensive appliance. This condition implies the EUI in Indonesia could rise over time. Therefore, the lower EUI should be viewed as an opportunity for proactive measures by the government and stakeholders to enhance building energy efficiency (EE) standards. A critical perspective, coupled with accurate measurements, is essential for continual improvements.

- Indonesia's EUI potential reduction after implementing EE measures is not as substantial as in other ASEAN countries. The average reduction in EUI for commercial buildings in ASEAN after EE measures is 33%, with Indonesia having the second lowest average at 22%, trailing only Singapore (20%). Indonesia's lower EUI reduction potential means much more work needs to be done to make substantial progress in commercial building EE.

- The use of AC was found to consume an average of 63% of energy in commercial buildings in Indonesia. This finding signifies an area where substantial improvements in energy efficiency can be achieved. HVAC control (adjustment based on temperature and occupancy) has the potential to save 24-32% on HVAC energy usage (IEA, 2023a). Every 1°C difference in average room temperature has an impact on energy costs of up to 6% (MEMR, 2023c).

[2] EUI (Energy Use Intensity) divides building electricity usage by building floor area. It measures building energy efficiency. The lower the value, the less energy (electricity) required for a building.

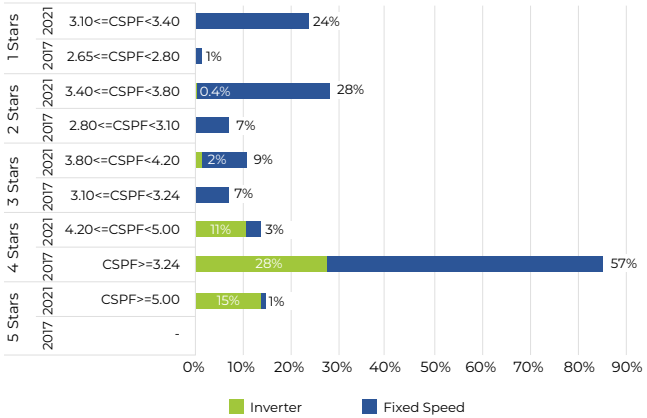
Local AC manufacturers lag behind: pressing need for efficiency upgrades

- The only appliances that have experienced an increase in their MEPS rating are ACs. In 2021, the efficiency value in the AC MEPS[3] rating increased by an average of 30%, and the highest AC rating was five stars (previously the highest number of stars was four) with a CSPF efficiency value >= 5.00 (54% increase) (MEMR Decree 103.K/EK.07/DJE/2021). With the rise in the MEPS rating, the distribution of available ACs has undergone a shift. Formerly, 85% of ACs in the market held the highest rating there is (4 Stars), of which 28% were inverter ACs. This number has now decreased to only 16% of ACs having the highest rating (5 Stars), with nearly all belonging to the inverter AC category (15%) (ACE,2021). This shift also occurred in ACs availability with 1 and 2 Stars, which previously only made up 8% to more than half of the ACs on the market today (52%). This change shows a significant market shift and the need for appliance manufacturers to accommodate this policy. Nonetheless, this change is inevitable if better energy efficiency in the building sector is to be achieved.

- Compared to several countries in ASEAN, it can be seen that despite its improvement on MEPS for AC, market readiness to accommodate this policy is still lacking. Based on SNI AC 6390:2020, the minimum efficiency level for the most common type of AC (single split (COP[2] 4.0-4.2) and VRF[3] (COP 3.81)) seems to be not widely available on the market as CoP that widely available in Indonesia is 3.7 (IEA, 2019). Encouragement for procuring AC with higher efficiency is not only needed for imports from international manufacturers but also locally manufactured ACs, as no local companies produce ACs with acceptable efficiency levels based on SNI.

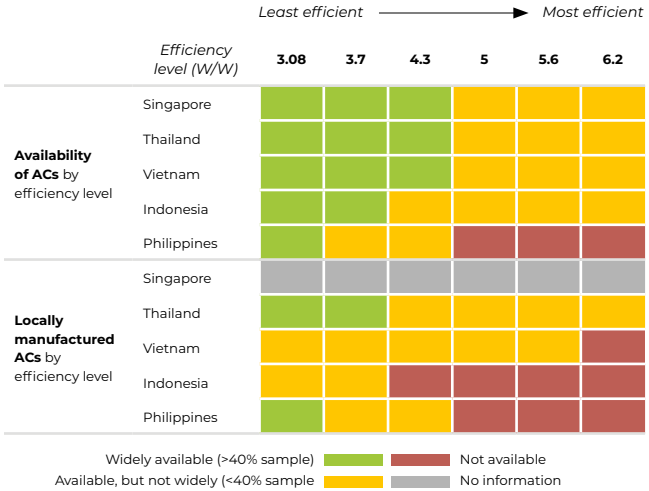
[3] MEPS = Minimum Energy Performance Standard. 2) CoP = Coefficient of Performance (W/W); a ratio of useful heating or cooling provided to work (energy) required. Higher COPs equate to higher efficiency, lower energy (power) consumption, and thus, lower operating costs. 3) VRF = Variable Refrigerant Flow.

Comparison of AC Efficiency Distribution Based on MEPS Rating in 2017 and 2021



Source: ACE, 2021

Air Conditioning Market Analysis in Selected Southeast Asia Countries



Source: IEA, 2019

Bold steps ahead: crafting incentives to propel green building uptake in 2025

	Key Actions Parameter	Baseline (2020)	Current Implementation (2023)	Short-term Goal (2025)
NEW BUIDLING	**Strengthen and further develop energy requirements in the building codes**	There are energy efficiency requirements for buildings (e.g., OTTV), but they are not enforced.	**PUPR Ministerial Decree 21/2021** on Green Building Performance Assessment regulates building energy efficiency by referring to SNIs. Effectively, this legislation has been applied across Indonesia, requiring energy efficiency in state buildings, both new and existing.	Building codes are being strengthened and enforced in **all municipalities**. Set targets that all public buildings are complying with codes.
	Develop, implement and incentivize national green building certification	Green Building Rating schemes exist but only few developers follow the schemes.	National Green Building Certification (BGH) has been developed with the **demand market target mostly for government buildings.** BGH incentives are the authority of the Regional Govt (PP 16/2021), but **its scheme is still being discussed at the Central Govt.**	Further development and support to Green Building Rating scheme; **many new buildings use the scheme voluntarily.**
EXISTING BUILDING	**Labeling scheme for existing buildings**	No system exist today.	There has been **no progress toward the development of building energy labeling/EPC scheme and realizing its procurement** target due to limited human resources and trained energy auditors.	Develop and implement a **scheme for Energy Performance Certificates (EPC)** for existing buildings.
BUILDING OPERATION	**Energy management in public and commercial buildings**	Current mandatory energy reporting is relevant for buildings with a consumption >6,000 TOE/ year (PP 70/2009).	Regulations have been developed for the mandatory energy management and reporting for buildings with **>500 TOE/year (PP 33/2023 about Energy Conservation)**. It has the potential energy saving of 66,000 TOE, or equal to IDR 0.9 trillion by 2030 (MEMR,2023).	Increase the scope in the energy management regulation to include smaller buildings
	Training of energy auditors and energy managers	There is not a sufficient number of qualified energy auditors.	MPWH has implemented **10 BGH Performance Assessment Training Batches**. The total number of participants who have passed is **361 people**. The training is still being carried out by the Central Govt and it is hoped that this training can be replicated by Regional Govt.	Develop a training system for **training of energy auditors and energy managers.**
BUILDING SYSTEM	**Minimum performance standards, MEPS**	Some standards are already developed (e.g. MEMR Regulation 57/2017).	In 2021-2022 MEPS for air conditioners (updated and improved), rice cookers, fans, refrigerators, and LED lamps have been issued. In 2023, MEPS will be finalized for TV and showcase. **In 2024, MEPS value will be revised and enforced.**	Continue to develop and **enforce existing Minimum Energy Performance Standards (MEPS).** A system for checking compliance is being developed.

No progress | Being addressed at the central government to improve its performance | Already progressing and will continue to be improved | Policy instruments are established, but their implementation is under development

Source: IESR Analysis, 2023 ; Roadmap Indonesia Building and Construction, 2022; MEMR, 2023; and MPWH, 2023

3.

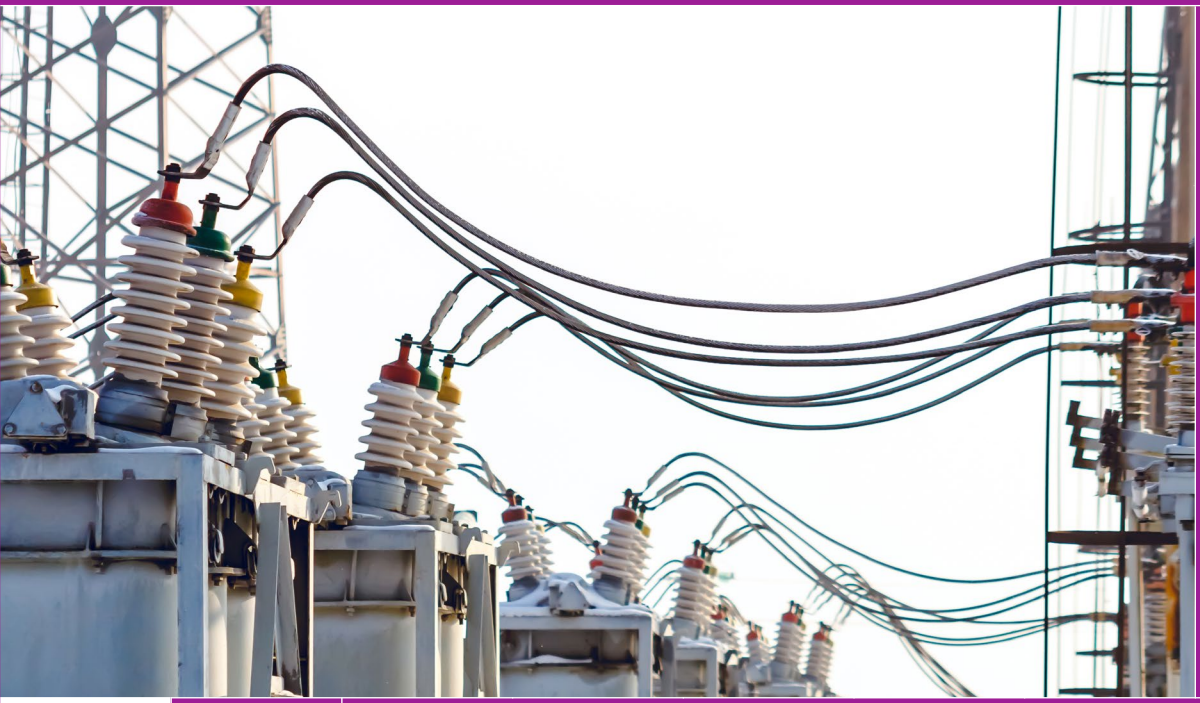
Trends and Transformation in Supply Side

Contents:

3.1.

Trends and Transformation in Power Sector

Akbar Bagaskara, Alvin Putra S, His Muhammad Bintang, Dr. Raditya Yudha Wiranegara

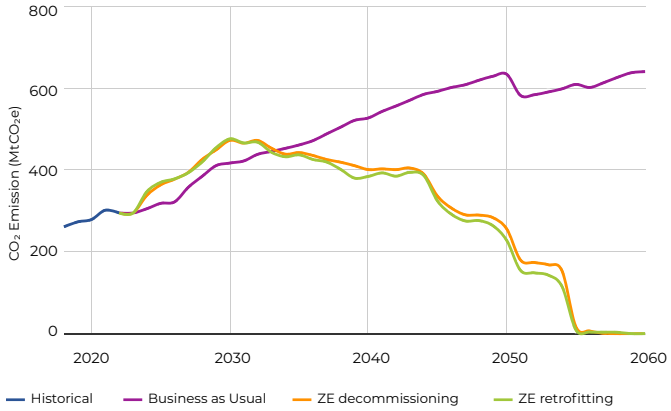


Contents:

Government is banking on retrofitting the fossil-based assets as a mean of achieving NZE despite the uncertainties surrounding it

- The government is currently preparing several official documents that would showcase Indonesia's long-term planning and initiatives in the power sector. The most expected one to be launched soon is the 2023-2060 MEMR's National Electricity Planning (RUKN) (Ministry of Energy and Mineral Resources [MEMR], 2023a). A variety of interventions for the fossil power plants have been embedded within the scenarios of the document.
- Three Zero Emissions (ZE) scenarios are proposed in the draft of the RUKN 2023-2060 (MEMR, 2023a). In these scenarios, the CO_2 emission within the power sector is estimated to peak between 473 and 478 $MtCO_2e$ in 2030. The emission growth is propelled mainly by the fossil power plants expansion for off-grid use (captive and PPU).
- No CFPP early retirement is considered in any of the scenarios. The CFPPs are either naturally retired or retrofitted to run on 100% biomass plus CCS and ammonia. Nevertheless, no new CFPP is allowed to be built, hence partially adhering to the PR 112/2022. In a similar fashion, the gas-turbine-based power generation will also be retired according to its economic lifetime or retrofitted with CCS or run on 100% hydrogen.
- According to the draft, the ZE retrofitting would have the least investment cost amongst the scenarios, totaling up to 850 billion USD by 2060. However, the absence of comparison in the scenario's cost of generation clouds the claim on the scenario being the least cost one. The uncertainty of fuel price due to lack of clarity on feedstocks for the fuel switching could become a looming challenge for the affordable generation cost.

Historical & Projected RUKN CO_2 Emission



Source: IESR analysis, MoFE (2023), MEMR (2023a), MEMRb (2023b)

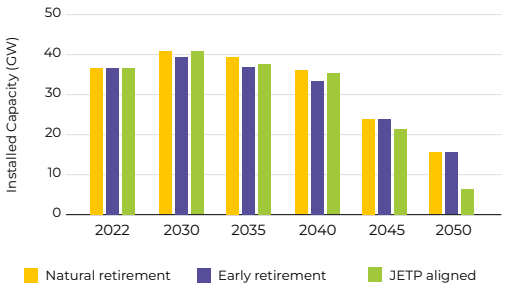
List of Scenario in RUKN Draft

ZE Scenario	Decommissioning	Retrofitting	CCS
Intervention for Coal Power Plants	Decommissioned	Fuel switching to biomass and ammonia	Fuel switching to biomass + CSS installation
Intervention for Gas Power Plants (Gas Turbine-based)		Fuel switching to hydrogen	CCS installation

Source: MEMR (2023a)

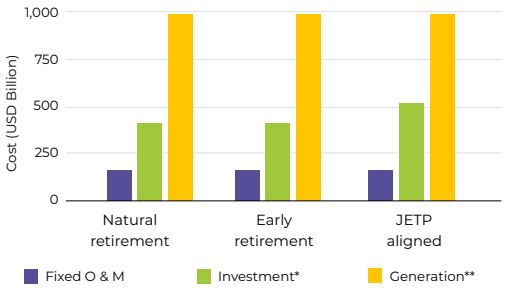
The government is caught in a rock and hard place situation when it comes to the retirement of on-grid CFPP retirement, although being techno-economically viable

CFPP Capacity Projection



Source: IESR analysis using PLEXOS

Projected Total System Cost 2022-2050



**Investment: power plant, storage, transmission, CFPP retirement*
***Generation: Variable O & M, fuel cost*

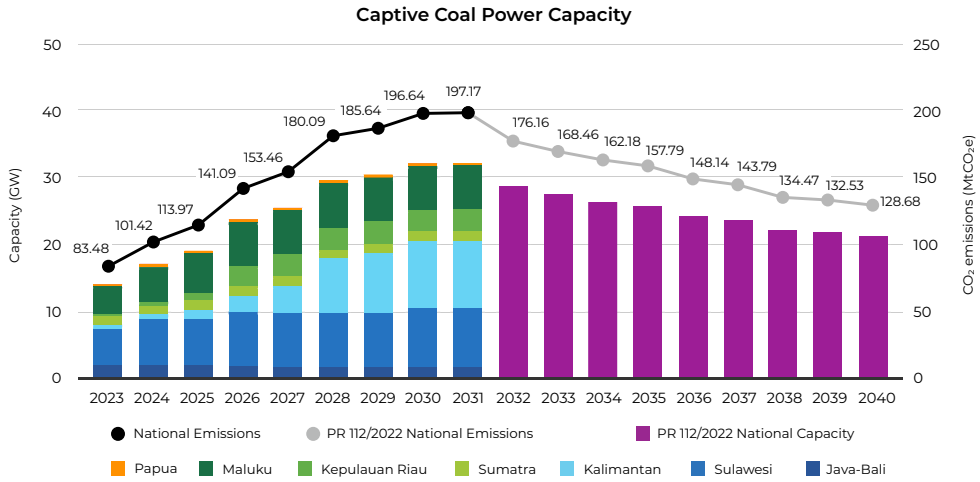
Source: IESR analysis using PLEXOS

- To date, the current capacity of on-grid CFPP has reached 35.5 GW, with a projected total capacity of 40.7 GW by 2030. The cancellation of Jawa 3 has slashed the pipeline down by 1.3 GW. PLN is also seeking ways to cancel the mine-mouth projects, Jambi 1 and 2 (Farida, 2022).
- The JETP joint statement comes with more ambitious targets, i.e., NZE by 2050 in the power sector and lower peak emissions for on-grid systems by 2030 at 250 $MtCO_2e$. The early retirement stated within the CIPP will see 1.7 GW of coal capacity reduction by 2040. Alternatively, based on IESR analysis, Indonesia should retired its CFPP capacity up to 6.8 GW within the same period to achieve this target.
- From a techno-economic perspective, early retirement of several CFPPs is a viable solution. The early retirement works by optimizing the amount of CFPP capacity that should stay in the grid. As our model result shows, even without emission constraints, 2.6 GW of CFPP should be retired by 2030, resulting in a lower generation cost. However, 15.2 GW of CFPP would still remain on the grid by 2050 since the retirement cost of that amount of CFPP is still not economically optimum. In the long-term perspective, enabling the early retirement option will save 2 billion USD compared to the Natural Retirement Scenario.
- Initially in the JETP's process, the MEMR and PLN have signaled a move to reconsider the CFPP early retirement option before 2030 due to lack of funding commitment and interest from investors. As an alternative, they would pursue the scenario in which the CFPP is being phased down, instead of phased out (Petromindo, 2023). However, during the COP, the GoI, alongside ADB and PT Cirebon Electric Power (CEP), has recently agreed on moving forward with the early retirement of Cirebon-1 by December 2035 (Kamalina, 2023). Furthermore, the MEMR has also hinted at an early retirement roadmap for other CFPPs with a capacity totaling up to 4.8 GW (Komalasari, 2023).
- The early retirement option, though, could still be more attractive. The savings that were previously modeled will increase if a mechanism that permits the retirement cost compensation to be utilized directly as an investment in the new replacement RE power plant exists. Alternatively, canceling CFPP in the pipeline could be the cheapest mitigation action, estimated to be 0.5-0.8 USD/tCO_2e (IESR, 2023). Around 2.9 GW of CFPP in the RUPTL 2021-2030 pipeline is still in the early process of development, thus requiring less fund to intervene.

Captive coal power plants are expanding with the likelihood of producing massive carbon emissions that could hamper reaching emission peak and NZE in the power sector

- Around 23 GW captive power capacity is currently operating, serving the energy needs of various industries (Just Energy Transition Partnership [JETP], 2023). Out of this capacity, 13-14 GW is powered by burning coal. The majority, 69.2%, in terms of capacity, comes from the nickel smelting industry. Such a huge figure has been propelled by the government's ambition to develop domestic mineral downstream industries, particularly ones that are contributing to BEV value supply chain.

- This particular coal power capacity is projected to grow over 20 GW by 2030 to shoulder the growing demand for the respected industries. Nickel smelters are making up the majority of the additional built capacity (JETP, 2023). By 2030, the emissions produced by these power plants are expected to be slightly above 197 $MtCO_2e$, about 41% of the power sector emissions in the RUKN ZE retrofitting scenario.



Source: IESR analysis, JETP (2023)

- PR 112/2022 includes a binding T&C regarding the expansion of off-grid coal power plants. These plant owners must commit to reduce their plant emissions by 35% after 10 years of operation. Therefore, by 2040, the total emissions for these captive coal power plants should be close to 129 $MtCO_2e$, provided that all of these plant owners are true to their commitments. To achieve such a level of emissions, the captive coal capacity needs to be reduced by 11 GW in 2040 and to be replaced by other forms of clean and low-carbon technologies to maintain the supply of energy.

- Despite being leftout from the upcoming CIPP, the secretariat has actually begun enlisting potential candidates for captive power-PLN grid connections, based on a study carried out by the MEMR, which shows a potential emission reduction of 10.5 $MtCO_2e$ per year from connecting 1.23 GW of captive power plants, both coal and gas-fired ones (JETP, 2023). The document also includes emission mitigation in the form of industrial processing technology switching, as in the case of the nickel smelting industry. A switch from RKEF to HPAL in the processing of nickel ores could significantly reduce the emissions per ton nickel produced, from 75 tCO_2e per ton nickel to 10 tCO_2e per ton nickel (Trimegah Bangun Persada [TBP], 2023). Other mitigation measures, including biomass co-firing, on-site renewable energy, and energy efficiency, should be further explored within the next leg of analysis of the document.

The government suggests co-firing as a solution for a least-cost transition despite the impending projected generation cost

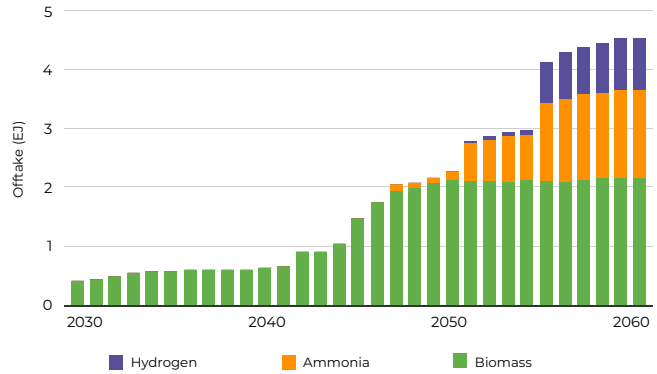
- In the scenario favored by the MEMR, all existing plants will be retrofitted, enabling them to run on ammonia, biomass, and hydrogen. In terms of current development, biomass co-firing has been implemented in several CFPP units. Meanwhile the ammonia and hydrogen are still in the early stages. A trial run with the technical assistance from IHI is currently taking place at PLN's 2x100 MW Gresik power plant (an oil-fired steam plant) for 0.3% ammonia co-firing (Azaria, 2023a). For hydrogen, MHI and PLN are still preparing for a trial run of 5% hydrogen co-firing at Muara Karang CCGT plant, utilizing its in-house hydrogen production capacity (Azaria, 2023b).

- As of September 2023, there are CFPPs in 41 locations that have been reportedly operating with biomass co-firing, consuming so far 668,689 tonnes of biomass (Perdana, 2023a). This number is short of the target of 1.08 Mt by the end of this year. Once more, the uncompetitive pricing of biomass within the domestic market remains the main obstacle to fulfilling the target (Perdana, 2023b).

- The 2.6 GW Drax power plant in the UK is an exemplary of coal-to-biomass conversion despite the caveats. Requiring almost 7 Mt of wood pellet (or 14 Mt of green wood) annually, the supply cannot be sourced domestically, hence relying on supply from North America (Friends of Earth International [FEOI], 2021). The power plant has also been heavily reliant on government subsidies. In 2022, the UK government poured 617 million GBP worth of taxpayers' money into the power plant (Lawson, 2023).

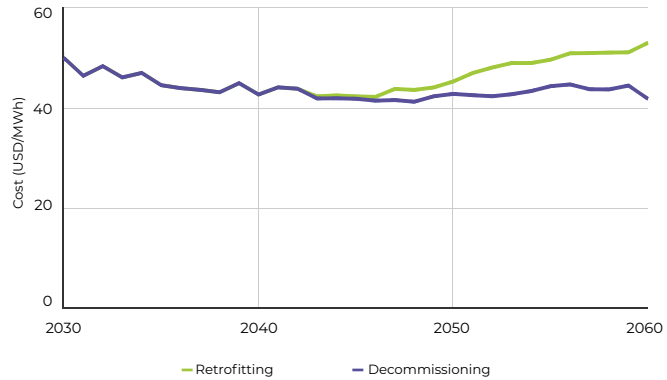
- Moreover, there is a significant obstacle facing the retrofitting situation from a system standpoint. Since alternative fuels are more expensive (MEMR,2023a) than BaU fuels, the generation cost will rise. Furthermore, the decommissioning scenario has reduced generating costs thanks to more RE deployment. Therefore, if the government wants to continue pursuing this course of action, the fuel price needs to be taken into account.

Fuel Offtake Projection of Retrofitting Scenario



Source: IESR analysis using PLEXOS, MEMR (2023a)

Generation Cost Projection



Source: IESR analysis using PLEXOS

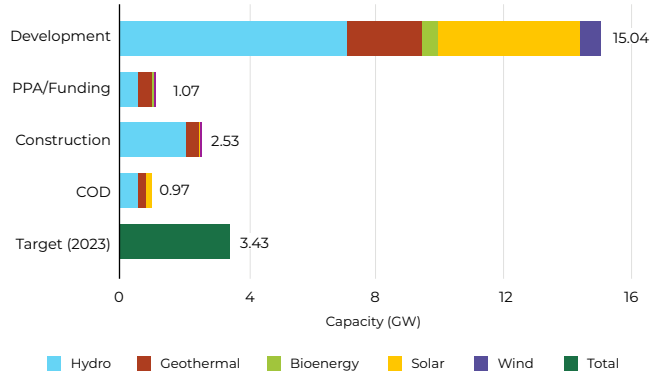
Long delays on hydro and geothermal projects risking timely RE development

- Renewable energy deployment shows concerning progress, with a visible gap to PLN RUPTL 2021-2030 as the latest electricity supply plan. As per the Q4 2023 analysis, out of 19.6 GW renewable projects stated in the RUPTL, only 0.97 GW have already reached commercial operation. This number still lags behind the 3.4 GW renewable energy capacity expected in 2023. PLN's strategy for RE deployment is heavily reliant on dispatchable renewable energy technologies such as hydro and geothermal. However, analysis of current projects in the pipeline shows an uphill challenge in developing these types of projects on time, with around 6-9 years deviation from the original plan stated in the earliest available PLN RUPTL. Such a long delay could jeopardize our renewable energy target of 52.55 GW in 2030 as stated in the latest RUKN draft.

- Many factors come into play in the delay of hydro and geothermal projects, for example, oversupply and socio-environmental concerns in the case of the Batang Toru hydropower project, the drilling problem in the Baturaden geothermal project, and PPA amendment in the case of Rajabasa geothermal project (Aranditio, 2023; Richter, 2021; Anam, 2022). Government support on minimizing project preparation risks is crucial to developing these types of projects timely. Existing programs such as the government drilling program and Geothermal Resources Risks Mitigation (GREM) by the World Bank also need to be reassessed to evaluate their effectiveness in mitigating such risks. For example, the recent auction of the Nage geothermal site as the result of the government drilling program only attracted a few participants due to unattractive rates and other perceived risks. Thus, needs to be re-auctioned (Ruang Energi, 2023).

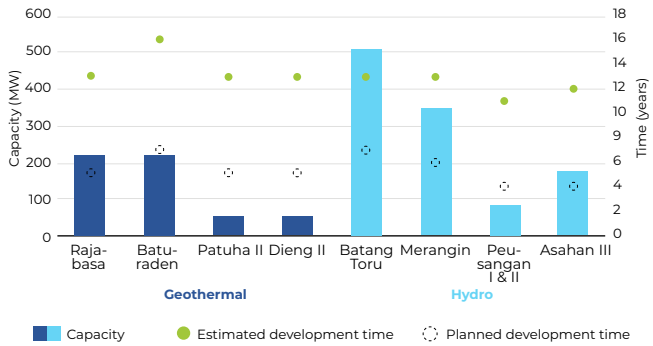
- On the other hand, variable renewable energy projects show encouraging potential to fast-track our renewable development. Thus it is worth considering for PLN to readjust its renewable development strategy accordingly. Sidrap and Jeneponto wind power plants only need 1-2 years from being included in the PLN RUPTL until fully operational, although it is well known that the preparation already started well before the inclusion. This circumstance is also apparent in the case of Cirata floating PV which only needs around 3 years from its PPA signing in 2020 to be fully operational in late 2023. Despite still being relatively slow compared to global practices, this deployment time can only improve with more experience as Indonesia is still relatively novice in developing such projects.

Renewable Energy Project Progress and Target, Q4 2023



Source: IESR analysis, RUPTL PLN 2021-2030

Capacity and Development Time of Planned Geothermal and Hydro Projects



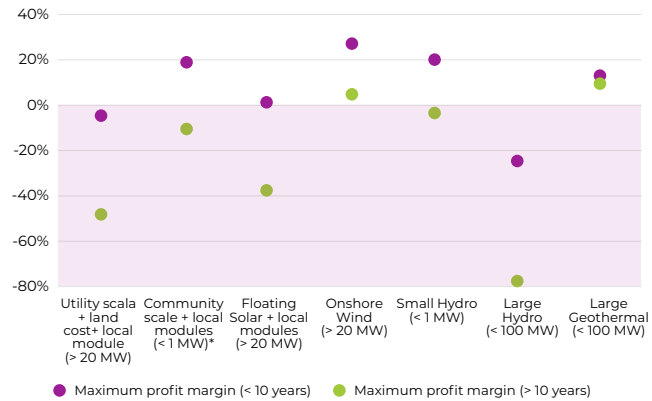
Source: IESR analysis. Planned development time from the earliest available PLN RUPTL, while estimated time from publicly available sources.

Improving renewable project attractiveness is crucial to rapidly deploy sizeable renewables online in 2030

- The 52 GW target in RUKN and 62 GW in the JETP CIPP by 2030 calls for a large number of renewable energy projects to come online in 7 years frame, an average of around 6 GW annually (MEMR, 2023a; JETP, 2023). Currently, PLN and its subsidiaries are currently in the process of procuring 2.7 GW of renewable projects, meaning that PLN needs to improve its procurement volume in the upcoming years (Wahyudi, 2023). Improvement in project attractiveness is one of the key drivers to put these projects into reality, and tariff schemes serve one of the key factors. However, the current ceiling price stipulated in PR 112/2022 may provide unattractive margin for developers when taking into account additionalities such as land acquisition cost, the use of locally-manufactured modules, and rising bank interest rates. The ceiling price mechanism must also be differentiated between specific application with different cost structures, such as floating PV (e.g., for FPV projects tendered in 2023) and hybrid power plant (e.g., PV + BESS for PLN's de-dieselization program).

- Project structure and procurement process also act as key considerations of project attractiveness. While standard auction approaches such as IPP partner selection through direct selection and EPC partner through direct appointment are available for PLN, equity partner "auction" with one of PLN's subsidiaries appears to be the preferred mechanism moving forward, as seen in the last few renewable projects offered by PLN under Hijaunesia scheme. Although this can be seen as an effort to provide better project preparation by PLN's subsidiary (e.g., land acquisition, grid connection), its implementation should ensure an equitable risk-reward profile. For example, an equity partnership with a shareholder loan with a predetermined interest rate to the IPP partner may discourage potential partners from participating in the auction. Thus, a public financing mechanism should be put in place to help balance the financial burden of IPP partner.

Maximum Profit Margin of Several Types of Renewable Projects



Source: IESR analysis. Land cost assumed at 10 USD/m², with current local modules assumed to be 30% more expensive than imported modules

Box 1. Lessons learned from Sidrap Wind Power Predicted Capacity Matrix (PCM) (Source: UPC Renewables, 2023)

Predicted Capacity Matrix (PCM) is a model to incorporate variability of wind resource (wind speed, direction, etc.) in the contracted energy supplied to the offtaker. One of the PPA clause stated that the model could be updated by technical third party whenever deemed necessary by either offtaker and developer. However, the latest update of PCM (v.4) requested by UPC Sidrap is not adopted by PLN in its power purchase billing, claiming a lost of revenue of around 1.1 million USD since 2019.

- A well-designed, standardized power purchase agreement (PPA) template can also help improve process efficiency and minimize project risks (e.g., failure in PPA negotiation). However, the concept of energy "guarantee" in the PPA clause will be particularly tricky for intermittent sources such as solar and wind. Current practices adopt the concept of projected available energy (PAE) through predicted capacity matrix (PCM) which takes into account weather prerequisites, but lessons learned from Sidrap Wind Power's PPA could provide valuable inputs to help standardize future PPAs.

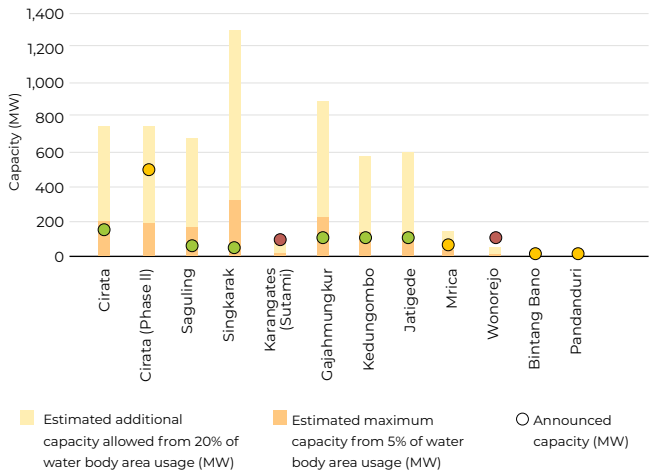
Assessment standards and permit efficiency will be crucial for floating solar projects after Cirata's success

- The inauguration of Cirata floating PV (FPV) is undoubtedly a big win for Indonesia's progress on solar PV development, after going through such a lengthy process going back to the MoU signing between the government of Indonesia and UAE in 2017. Several takeaways can be noted down to ensure improvements in the upcoming projects, as FPV is set to be at the forefront of solar power development in Indonesia, with around 400 MW of projects are being prepared, including projects in Karangkates, Gajahmungkur, Kedung Ombo, and Jatigede (Riyandanu, 2023; Uly, 2023).

- Agreement on phase II development of Cirata FPV has also been announced, expanding plant capacity up to 500 MW (Power Engineering International, 2023). The MPWH Regulation 7/2023 also supports the use of more than 5% of the water body area, removing the formal limitation previously stated in MPWH Regulation 6/2020. However, based on the publicly announced capacity, some projects in the pipeline could even use more than 20% of the water body area at the normal water level. This could potentially raise risks to water quality, aquatic biodiversity, and structural integrity of the dam. While the use of more than 20% of water body area is allowed with the obligation of obtaining recommendations from the Dam Safety Commission, a standardized assessment guide for technical and socio-environmental feasibility is needed to identify related risks while increasing process efficiency. It is mandated by the latest regulation to the General Directorate of Water Resources to provide such technical guide.

- Besides permits from MPWH as the main authority for dam/lake water body usage, the overall permit process for developing floating PV projects involved at least five other authority bodies from various levels, including local government, MoEF (KLHK), Ministry of Finance, MAASP (ATR/BPN), Ministry of Investment (BKPM). Potential overlaps with state-owned Perum Jasa Tirta who owns several reservoirs such as Karangkates (Sutami) and Wonorejo, also need to be considered. Such a permit-heavy process could potentially delay project development time, resulting in high uncertainty risks perceived by the project financiers. Streamlining the permitting process through an improved single-submission system could help resolve this bottleneck.

Floating PV Projects Capacity in the Pipeline



Source: IESR analysis. Water body areas from MPWH, while announced capacity from publicly available sources

Summary of Permits for FPV Projects in Development Phase

MEMR, PLN	BKPM, MoF (Kemenkeu)	MoEF (KLHK)	MAASP (ATR/BPN), MPWH (PUPR)	Others
Power Purchase Agreement (PPA)	· Business identification · Tax holiday/ allowance · Marine/land suitability · Environment permit	· Environment permit	· Dam use suitability and permit	· Recommendation from local government · Agreement with Perum Jasa Tirta

Source: IESR analysis

Export opportunities drive the emergence of solar manufacturing in Indonesia as domestic demand remains uncertain

- The rising global demand for renewable energy technologies calls for each country to strengthen its own supply chain, and establishing itself as the global leader of technology providers. This serves as one of the drivers for more established manufacturers to explore opportunities in countries with better access to export markets, such as Southeast Asia. Currently, Southeast Asia acts as a large net exporter of photovoltaic products with 64 GW in 2023, particularly with Vietnam, Malaysia, and Thailand which supports around 11% of global supply. This strategic position could also has an potential effect in the emergence of solar manufacturing in Indonesia (Sustainable Energy for All [SEForAll], 2023).

- Another key driver in the emergence of Indonesia solar manufacturing is the Green Corridor project between Indonesia and Singapore. Singaporean Energy Market Authority (EMA) is seeking to import 4 GW of renewable electricity from neighbouring countries (Tay, 2023). Indonesia's investment authorities mandate domestic manufacturing commitment in this project. Thus, the 2 GW module OEM in Batam is in the picture for electricity export by INSPIRA consortium, as well as Framework Agreement signing of solar manufacturing including Vena Solar and Suntech in Batam (Jhanesta, 2023; Suntech Power, 2023).

- On the other hand, domestic demand remains uncertain as only a limited numbers of solar projects are being procured in an irregular manner. This further discourages manufacturing investment to serve the domestic market solely; rather, they are more focused on export-oriented market. However, this emergence of solar manufacturing will be a big win in fulfilling local content requirement (LCR) of 60% by 2025, as stated in MoI Regulation 23/2023, if this manufacturing sites are able to be operational on schedule. To drive domestic-oriented manufacturing, demand certainty through a large volume of solar projects auction will be essential to invite Tier-1 manufacturers to invest in the scale that would be economically competitive against imported modules.

Solar Manufacturing Capacity in Indonesia and Southeast Asia

	POLYSILLICONE PRODUCTION	WAFER PRODUCTION	CELL MANUFACTURING	MODULE ASSEMBLY
(Planned)	Investment in integrated silica production by Xinyi Group	N/A	**5 GWp cell + 3 GWp module** in **Batang, Central Java** by SEG Solar (Tier-1) & ATW Solar	
			Total 3 GWp cell + module by 2026 in **Kendal, Central Java** by Trina Solar (Tier-1), Sinarmas, and Agra Surya Energi	
			Framework agreement signing by Vena Solar, Suntech, Powin, and REPT Battero in **Batam**	
	Investment by Mirah Green group in Wiraraja, Batam			**2 GWp module OEM** by INSPIRA consortium
				LESSO Solar plant **in Demak, Central Java**
(Current)	N/A	N/A	N/A	1.64 GW
(Current)	32 GT	10 GW	55 GW	70 GW

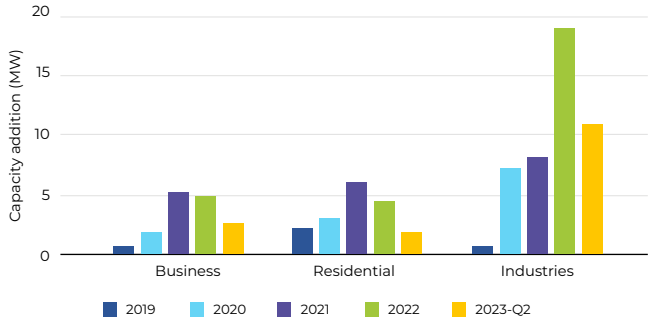
Source: IESR analysis, SEForAll (2023)

Despite kept being overlooked, better transparency is crucial to put upcoming rooftop PV regulation to success

- Besides the ever-stagnant National Strategic Project to install 3.6 GW of rooftop solar in 2025, unfortunately, there is still no concrete plan to incorporate rooftop solar into Indonesia's energy transition strategies. The latest RUKN draft is no exception, not including any specific measures for rooftop solar. Consequently, only around 100 MW of rooftop solar is installed as per Q2 2023 (MEMR, 2023c), falling far behind the 900 MW target in 2023. Major slowdowns are apparent in the residential and business sectors, with a 29% and 6% decline in capacity addition in 2022 compared to 2021 respectively. This is mainly driven by 15% capacity limitation imposed by PLN's internal circular. The industrial sector, however, does not experience the same hit by the capacity limitation, with a 132% increase in added capacity in 2022 compared to 2021. This growth rate is driven by corporate sustainability initiatives that requiring them to purchase green electricity directly.

- MEMR Regulation 26/2021 initially showed promises of a 1:1 export-import scheme with bill-saving credit for up to 6 months, increasing electricity bill savings and a faster payback period. However, this regulation was immediately countered by capacity limitation by PLN and the 1:1 net-metering did not come to pass. Thus, the upcoming revision attempts to find the middle ground with PLN on the system's capability concern. Electricity export to the grid is no longer allowed, and the installed rooftop solar capacity is allowed to go beyond 100% of the installed electricity capacity as long as the installation quota remains. The additional revision also exempts the need for a capacity charge. As the result of the upcoming revision, the residential sector will be highly unfavorable for grid-connected implementation with zero export scheme due to high curtailment in daytime, reducing their potential electricity bill saving by 40% compared to the 1:1 net-metering scheme stipulated by previous regulation. The impact of zero-export scheme on commercial and industrial consumers, however, remains minimal.

Solar PV Rooftop Annual Capacity Addition



Source: MEMR (2023c)

Electricity Bill Saving Comparison with/without Net-metering

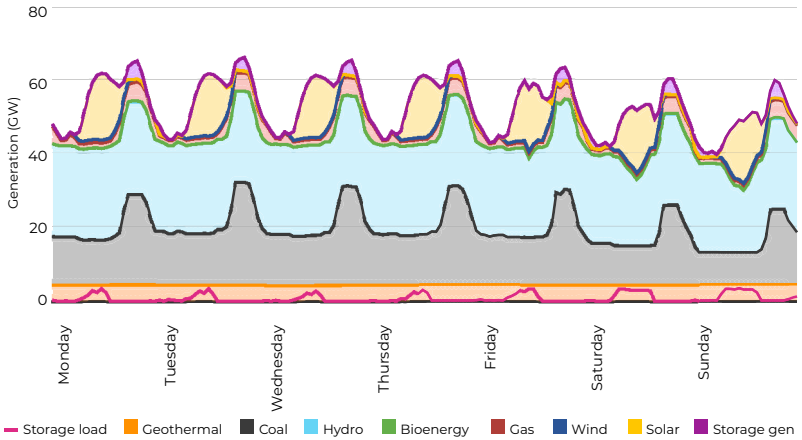
Study case		3.5 kWp residential	6.6 kWp commercial	200 kWp industrial
1:1 export - import scheme	IRR (%)	12.49%	9.81%	7.73%
	Total savings (USD)	15,303.60	24,660.66	532,644.72
Zero-export scheme	IRR (%)	4.94%	9.08%	7.73%
	Total savings (USD)	9,220.51	23,524.27	532,564.20
Savings difference (%)		-40%	-5%	-0.015%

Source: IESR analysis. Electricity price from October- December 2023 electricity tariff adjustment by PLN. Indonesian sectoral load curves from McNeil (2019).

- However, the upcoming quota-based system does raise a few concerns about quota determination transparency. This determined quota is submitted by PLN or other business license holder based on their own assessment and will be updated annually. Consumers are then welcome to submit their installation application only in January and July, which are also deemed insufficient. MEMR could assign a technical third party to ensure accountability on quota determination, as well as loosen up the installation application period. Another thing to note is the certainty of a transitional period for existing rooftop solar users, where they are bound to the previous version of the regulation for up to 10 years.

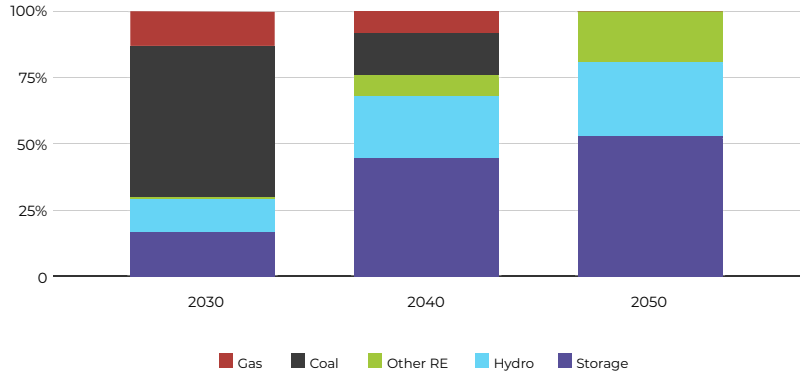
With the expected increase in RE share, the flexibility of power system has become more relevant than ever

National Hourly Operation During Week 40 in 2030



Source: IESR analysis using PLEXOS

Flexibility Provided to the Power System* in the JETP Pledges Scenario



**ramping up contribution*

Source: IESR analysis using PLEXOS

- With the expected increase of VRE in energy share by 2030, Indonesian power systems need to facilitate more flexible and responsive power networks. Flexibility requirements have been estimated based on the residual load curve. This is defined as the load that can be served by dispatchable technologies and is derived by VREs generation from the demand curve (European Commission, Directorate-General for Energy et al., 2019). The residual load curve indicates which part of the demand needs to be met by flexible technologies, e.g., thermal generation units, hydro-power, storage, even other renewable energy sources.
- A nationwide hourly operation for a specific week in 2030 was modeled by IESR with the JETP pledge as the objective. The hourly Java-Bali profile from 2019 is used in the simulation's load profile. Moreover, no modeling is done for contractual restrictions like those seen in gas power plants and CFPP. The findings demonstrate how numerous power plants need to operate more flexibly when they have a high level of VRE, particularly solar. The national hourly operation graph is an illustration of dispatchable technology fulfilling residual load curves.
- The flexibility sources are still reliant on fossil fuel-based power plants in 2030. However, It is mandatory to decrease emissions through the JETP pledge, including reducing the reliance on fossil fuel-based power plants. Thus, it is important to consider how flexibility sources are evolving. One possibility for a dependable and sustainable power supply is to switch flexibility sources from coal and gas to hydropower and storage (such as pumped hydropower and BESS).

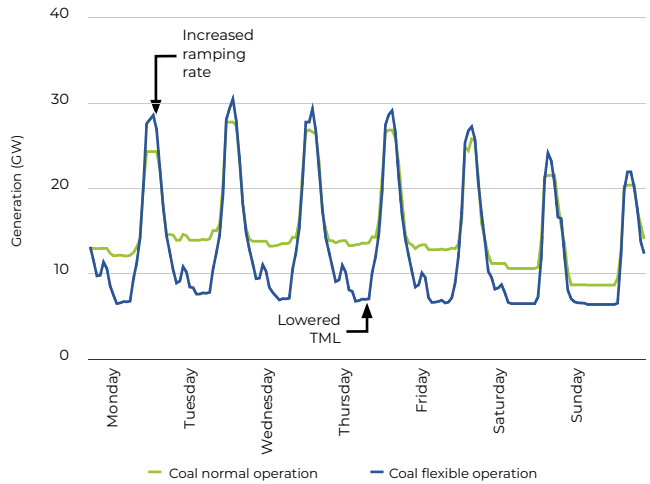
The existing thermal power plant holds flexibility potential while keeping the asset momentarily

- Due to limited interest in financing CFPP early retirement, JETP CIPP prefers to pursue the coal phase-down strategy (JETP, 2023). The term "coal phase-down strategy" describes lowering the amount of coal used in coal-fired power plants by decreasing their utilization. From a technical perspective, lowering the utilization of CFPP is tricky due to technical restrictions such as technical minimum loading. However, by lowering the technical minimum load (TML), the CFPP can offer additional value in keeping the power system running reliably at optimal cost. Additionally, CFPP can also improve the ramp rate and reduce its start/downtime to provide more flexibility benefits.

- Based on IESR analysis, operating the CFPP flexibly only slightly lowers the utilization of the unit. In total, flexible operation only reduces the annual generation by 9.5 TWh or 6% compared to normal operation. However, since the CFPP will be able to reduce its minimum generation and contribute more to the ramping capacity demands (an increase of 90%), the flexibility needs from other sources (derived by subtracting CFPP generation and VREs generation from the demand curve) will decrease. The graph of flexibility needs shows that during flexible operation, the graph gets less dynamic.

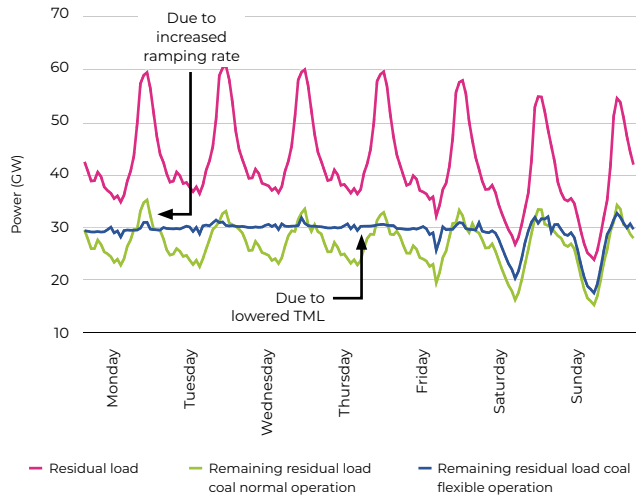
- Operating a thermal power plant flexibly may lead to lower utilization. For IPPs, the take-or-pay clause in their PPAs serves as fixed capacity payment that guarantees their capital recovery and fixed O&M cost whilst ensuring system adequacy (JETP, 2023). Hence, no compensation is actually required to cover the lower utilization to a certain extent. The challenge, however, lies in the penalties for breaching some of technical clauses in the PPAs, such as Availability Factor (AF) and heat rate, should the power plant operate below certain threshold as agreed by both PLN and IPP. Contract restructuring is therefore required, particularly on how to incentivize services beyond capacity, e.g., ancillary services and flexibility (JETP, 2023). Whilst that is being solved, it is only logical to carry out flexible operation on PLN-owned assets.

CFPP's Hourly Operation Week 40 in 2030



Source: IESR analysis using PLEXOS

Flexibility Needs Other than CFPP* Week 40 in 2030



**derived by subtracting CFPP generation and VREs generation from the demand curve*

Source: IESR analysis using PLEXOS

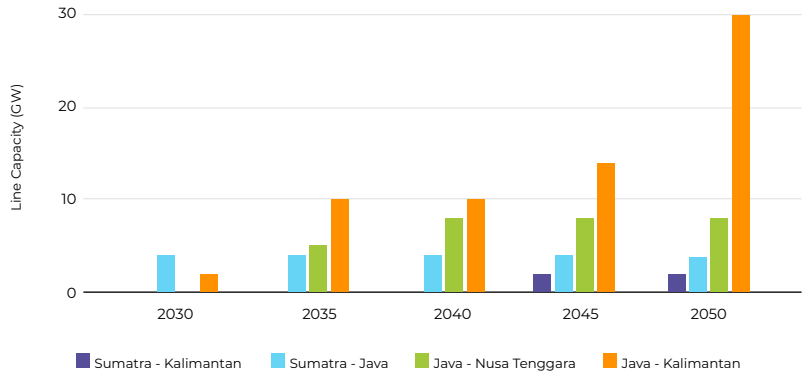
The Java-Bali system will eventually be unable to meet demand on its own using RE sources; interconnection could be a solution and offering the flexibility potential

- Most of the dispersed RE sources are located distant from the demand center, making RE deployment challenging. It is difficult to move the demand closer to the RE sources since it is related to the economic activity. For instance, almost 70% of Indonesian demand is located in the Java-Bali system (International Energy Agency [IEA], 2022). It will not take long for the RE potential sources of this system to become inadequate. As Indonesia shifts to RE in the JETP scenario, the expansion of power grids helps to integrate the dispersed source of RE.

- The interconnection between the Java-Bali system and other systems, including Sumatra, Kalimantan, and Nusa Tenggara, will help to bring additional renewable energy generation. As an example, early interconnection to Sumatra helps to unlock the hydropower potential since the development of power system in Indonesia is constrained by reserve margin. Furthermore, Kalimantan and Nusa Tenggara offer a vast amount of RE potential that can be tapped to maintaining an adequate supply of the Java-Bali system.

- In addition to supply adequacy, improved interconnection has several advantages consist of (1) increased system reliability, (2) increased system flexibility and load factor through the combination of various load patterns, particularly when integrating systems with different load profiles, and (3) optimizing the system's operating profile.

Flow Capacity Projection of Interconnection



Source: IESR analysis using PLEXOS

- There are several risks associated with building transmission lines that must be considered. For instance, (1) construction delays brought on by drawn-out stakeholder negotiations and land acquisition, and (2) PLN's limited expertise in HVDC island interconnection development. Therefore, as time passes, it is vital that the advancement of these initiatives be given top priority in the years to come.

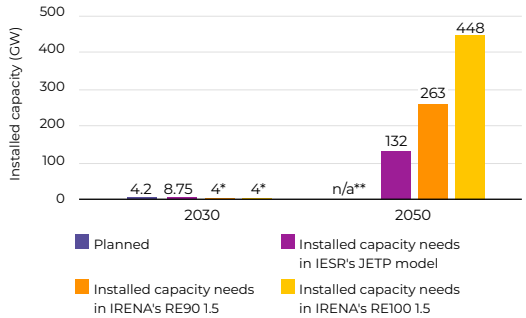
The planned pumped hydropower storage project is set to increase system flexibility in near term, and more storage is still required to accommodate future VRE penetration

- Energy storage system (ESS) is expected to be one of the backbones of future power grid flexibility in Indonesia. However, the planned capacity for Pumped Hydropower Storage (PHS) ESS projects currently stands at only 4.2 GW. Despite this low capacity, there is notable progress in terms of construction development and utilization planning. Beyond its initial purpose as a peaker generation, the Upper Cisokan PHS pilot project is also expected to be used for spinning reserve provision, which will be relevant to the future grid flexibility needs. The country's first PHS, with a targeted COD set for 2025, is still in the construction phase, specifically, in land acquisition process. Meanwhile, the second PHS project seems to be progressing based on a recently published project financing proposal document of 4x225 MW Matenggeng PHS with an estimated total project cost of 1.2 billion USD.

- Although the planned capacity of PHS would boost the RE share and increase system flexibility, it will still be insufficient to accommodate the required VRE penetration in the medium- and long-term. Taking into account the planned PHS capacity and excluding ESS for smoothing VRE output, IESR estimated that a total of 8.75 GW of any load-balancing ESS would be required by 2030 to allow 10% VRE penetration, aligning with the JETP pledge target. Furthermore, more than 132 GW and 281 GWh ESS capacity will need to be integrated to achieve 100% RE share in 2050. Notably, this value is lower than IRENA-RE100 1.5 scenario's suggested ESS requirement in 2050, totaling 448 GW, including 116 GW of PHS ([IRENA], 2022).

- The on-going PHS development in Indonesia faces big challenges, related to social and environmental issues. As most of the planned PHS projects are in Java, though in line with the current centralized electricity demand, the construction in such a populous region has a high risk of project delay. The land acquisition process is difficult, as can be learned from the Upper Cisokan project. The relatively high land cost and concern about the impact on natural biodiversity with endemic species already endangered in the island are also among the hurdles. Given the potential need to develop more PHS in the upcoming years, harnessing PHS greenfield outside Java with prerequisites such as inter-island interconnection should be highly considered for the future planning. While a large-scale PHS installation would enable more ambitious deployment of VRE, it is equally important to initiate plans for numerous small-scale PHS projects. These smaller installations, aside from matching the existing non-Java system supply-demand size, will enhance local capabilities for PHS construction and operation.

The Currently Planned Compared to Required ESS Capacity in Various Scenarios



IESR's JETP pledge model ESS distribution		
Region	Installed capacity needs (MW)	
	2030	2050
Java	6,961	90,964
Sumatra	722	12,026
Kalimantan	27	11,301
Sulawesi	377	5,253
Nusa Tenggara	532	10,800
Maluku	50	740
Papua	40	390

Source: IRENA (2022), Perusahaan Listrik Negara [PLN] (2021), and IESR analysis using PLEXOS

Notes:

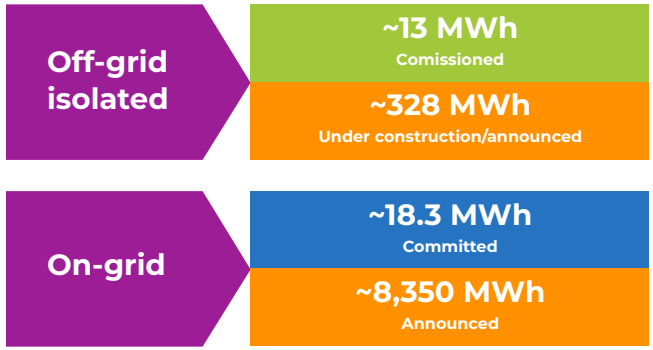
**The capacity is not explicitly stated in the report but mentioned in the report launching event in October 21st 2022*

***Planned capacity in 2050 is unknown as the referred RUPTL document did not an impart energy storage capacity addition plan beyond 2030*

To stretch the positive trend, government should encourage on-grid BESS deployment

- BESS deployment has grown in the order of megawatts with more installation capacity has been announced for several VRE projects. It includes 10 MW/10 MWh BESS to support the Tanah Laut wind farm that is projected to start operating by 2025 and a 8.3 MWh storage in the IKN 50 MW solar PV project, the groundbreaking of which commenced this November. Moreover, there is an ongoing re-tender process for a 322 MWh cumulative capacity of BESS in the phase 1 of the diesel conversion program that is targeted to come online by 2025.

- Recently, BESS integration on isolated hybrid systems and using LIB-BESS has becoming more frequent. The 3 MW/1.84 MWh BESS installed in Nusa Penida hybrid solar power plant system is an example that is often reported. The BESS in the system is used to support (smoothing the output) 3.5 MWp solar PV. Meanwhile, with a different type of BESS operation, the installed 1.3 MWh BESS charged by a relatively small 406 kWp solar PV capacity in the Bawean Island hybrid system works as a peaker gas power plant substitute. In both cases, VRE+BESS integration is reportedly lead to remarkable fossil fuel use and emission reduction, and there are discussions to develop similar projects.



Source: IESR analysis

- Although the installed capacity of BESS has increased and more advanced technologies (i.e., LIB) have been adopted, most of the implementations, including those in the pipeline, are still for smoothing purposes. There is a delay in BESS use while global implementation for on-grid, longer-duration applications such as load or energy shifting have been gaining traction and are expected to dominate the application mix of projects shortly. Reflecting on the sprout of BESS integration in the isolated hybrid system, it is necessary to immediately engage with research institutions to initiate several pilot projects of on-grid BESS, with various technologies and types of utilization, as the construction and operation experiences will certainly help unbearable deployment in the future.

- Updating grid code and mandating ESS installation for new VRE projects would stimulate ESS growth and bolster market signals to technology producers. In addition, it may decrease the burden of grid operator expenses on reliability costs due to the increase of generation intermittency. New standardization of storage requirements to support VRE integration will become increasingly important with recently suggested VRE targets. Determining the exact storage capacity needs requires an in-depth evaluation of the existing power system, but studies indicate that for up to a VRE penetration of 50%, which will be suitable with Indonesia's medium-term target, about 20% storage power capacity would be sufficient (Schmidt, 2023). It can be translated to the need of about 200 MW of ESS for each GW VRE installation. Regulating the minimum storage requirements will also help technology producers to identify the upcoming demand, prepare their production capacity, and achieve economies of scale. In return, the fulfillment of future demand potentially become least cost. Currently, the identified demand by industry is relatively low. For instance, IBC projected base-case battery demand for ESS is only 2.7 GWh/year in 2035.

3.2.

Trends and Transformation in Resource and Reserve (Non-power Sector)

Dr. Farid Wijaya, Ilham R. F. Surya, Julius Christian, Shahnaz Nur Firdausi

Contents:

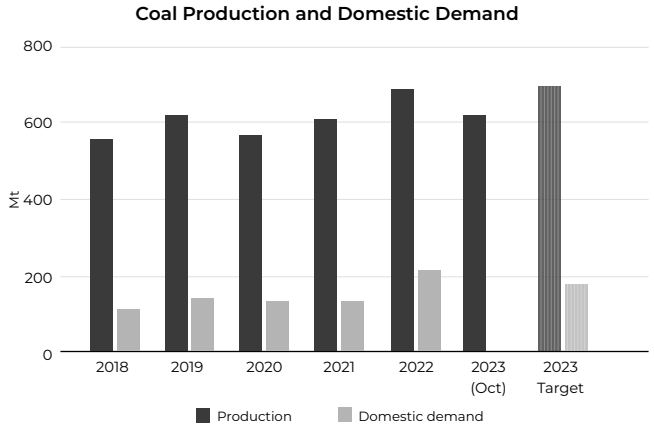
Coal production continues its increasing trend, while oil and gas remain falls short of the annual targets

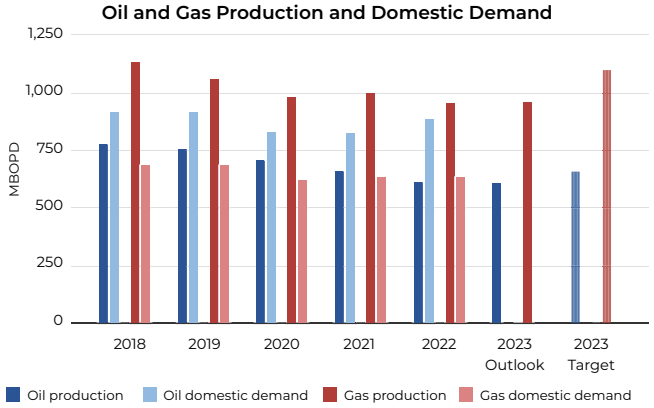
- After a temporary dip in 2020 due to the pandemic, Indonesia's coal production has increased and is expected to exceed 700 Mt in 2023, surpassing the initial plan of 695 Mt. By the end of October, MODI database has recorded 619 Mt production, with 264 Mt domestic consumption and 319 Mt export sales. For 2024, increasing demand from main importers, i.e., China, India, and Southeast Asian countries and stronger domestic demand from new smelters will likely result in further increase in production.

- Initially expected to start production in 2024, coal downstream projects are currently under threat as one of the main investors, Air Products, has withdrawn from both the DME project with PT Bukit Asam and the methanol project with BUMI Resources. BUMI Resources has since partnered with a Chinese company to develop coal-to-ammonia, hoping for a groundbreaking in early 2024. The government is drafting a Presidential Regulation on DME to provide support and improve the economic feasibility of the projects, but nothing has been issued by the end of 2023.

- Crude oil and natural gas production continues to decline due to aging fields and operational disruptions in some facilities. This year, oil and gas lifting is projected to fall short from the initial target by 8% and 13%, respectively. In contrast, the demand has returned to the pre-pandemic level resulting in increased imports. By October 2023, oil and gas imports have increased by around 6% (c-to-c) from the 2022 level (BPS, 2023). Current domestic demand for natural gas is less than 70% of the total lifting, but with the declining production trend and expected increased demand from industry and power sectors under the current policy, Indonesia is likely to be a net gas importer around the mid-2030s. Relying on gas as transition fuel might result in another import dependency.

- With the target of 1 million BOPD of oil and 12,000 MMSCFD of gas lifting in 2030, government strategies include offshore exploration shifting to eastern Indonesia, implementation of enhanced oil and gas recovery from existing fields, and exploration for unconventional hydrocarbons. For the past few years, the government has provided various incentives, including more flexible and attractive Production Sharing Contract (PSC) schemes. The policy improvement resulted in increased investment in upstream oil and gas in 2022 and 2023, although this has yet to translate into increased production.





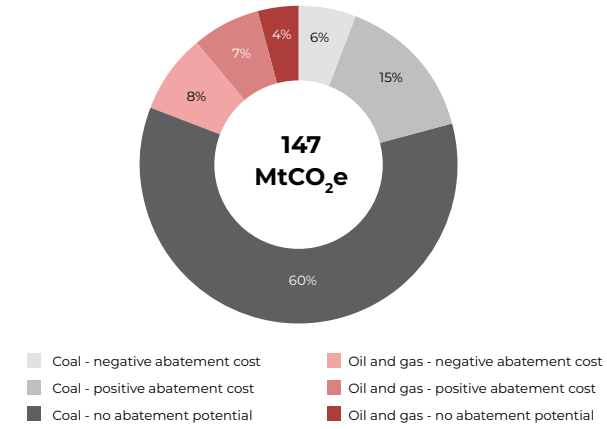
Source: MEMR, 2023; 2023c; MODI, 2023

Almost 150 $MtCO_2e/y$ fugitive emissions from fossil fuel production are underreported; only limited measures are established to curb it

- Fugitive emissions from fossil fuel production are major source of GHG emissions in Indonesia, but are often overlooked and likely underreported. EDGAR (2023) estimated methane (CH_4) and CO_2 comprise 97% and 3% of the fugitive GHG emissions. IEA (2023) estimated that CH_4 emissions reached 4.9 Mt in 2022[1], equivalent to 147 $MtCO_2e$[2], compared to only 18 $MtCO_2e$ in the official GHG inventory data. The report suggests that technically, 78% of the emissions in oil and gas has potential for abatement, and 40% has a negative abatement cost. Meanwhile, emissions from coal mines are harder to avoid with only 26% potential for abatement and 8% has negative abatement cost.

- IEA (2023) suggested zero routine flaring and venting as the most impactful measure to avoid methane emission, potentially cutting 20%. The government has set the target for zero routine flaring by 2030. Under MEMR Regulation No. 17/2021, routine flaring is prohibited only for downstream activity while still allowed for upstream activity, and there is no mention of the aim to achieve zero routine flaring. However, there is no data on the progress of the program, while data on the utilization of flare gas shows a declining trend since 2018 (MEMR, 2023c). Leak detection and repair have as high abatement potential, but have not yet been included as methane emission reduction strategies.

Indonesia's CH_4 emissions from fossil fuel production and potential for abatement in 2022 (IEA, 2023)



Source: IEA (2023)

- Early in 2023, MEMR issued a new regulation on the implementation of CCS/CCUS technology in upstream oil and gas, aimed at reducing CO_2 emissions and enhancing oil and gas production from depleted reservoirs. The economics of such projects will be case-specific, depending on the technical aspects, such as CO_2 source and reservoir characteristics, to regulatory aspects, such as contract schemes and carbon pricing. CO_2 capture is usually the largest cost component, especially when the source gas has low CO_2 concentration, such as power plant exhaust. Another major cost component is the drilling for injection wells, the amount of which depends on the reservoir characteristics (Rakhiemah & Xu, 2022; Filippov, 2022).

- For coal mining, post-mine reclamation appears to be the only mitigation action in the government's strategy, while there is no measure yet to reduce CH_4 emissions during production phase. IEA (2023) suggests that the installation of degasification wells or drainage boreholes to capture fugitive CH_4 is the most impactful measure, potentially abating 14% of the CH_4 emissions.

[1] Estimates from other sources range from 2.2 Mt to 11.2 Mt CH_4 per year. The value from IEA (2023) excludes the emissions from abandoned coal mines.
[2] GWP100 of CH_4 used here is 30 as recommended in IPCC AR5, as opposed to government official report that uses GWP100 of 21 (SAR).

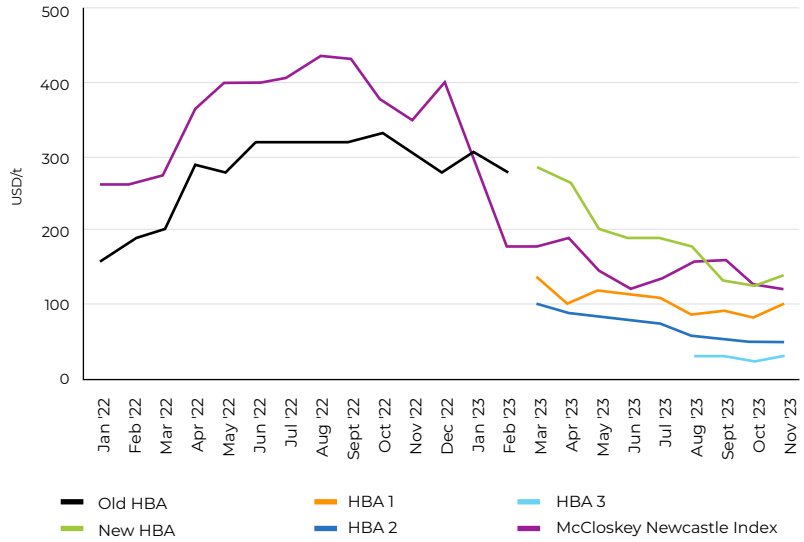
The coal HBA formula is adjusted twice to bridge disparity to the actual market price, but the new formula is less transparent

- Conflict between Russia-Ukraine has driven coal prices up to USD 430/t in 2022 (McCloskey Newcastle Index). This situation created a major discrepancy between old HBA (Indonesian coal price index), calculated based on four coal indices, and the actual Indonesian coal price. Indonesian coal price, which mainly serves the Asian market, has not seen as much price increase compared to the European indices. The price discrepancy is protested by the coal industry as the HBA was too high compared to the actual coal prices they sold, which leads to higher royalty fees.

- This discrepancy caused a concern from the coal industry in August 2023, MEMR stipulated new HBA formulation through MEMR Decree No. 227/2023, replacing the MEMR Decree No. 41/2023 that was released in February 2023. The new HBA is calculated based on real market prices from the previous month, which data is obtained from electronic non-tax state revenue (E-PNBP). While the new HBA formula should now better reflect the actual Indonesian coal price, the limited information regarding E-PNBP as the basis for calculation reduces its transparency.

- The new HBA also classified coal calorific value into four groups: HBA (6,322 kcal/kg GAR), HBA 1 (5,200 kcal/kg GAR), HBA 2 (4,200 kcal/kg GAR) and HBA 3 (3,400 kcal/kg GAR). The fluctuation trends for each calorific group differ from one another. For example, lower ranking coals, HBA 2 and HBA 3, which primarily serve domestic consumption where Domestic Market Obligation (DMO) price is applied, are more resilient from fluctuations and market dynamics.

HBA price and International Price Fluctuations (31 January 2022 - 13 November 2023)



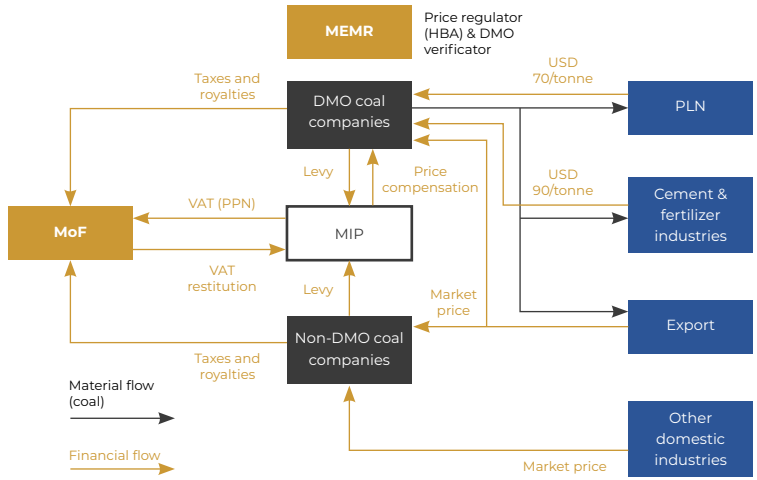
Source: MEMR, 2023a

- After last year's increase, global coal prices have been constantly declining and, by the end of 2023, will have reached the pre-war price of around USD 100 - 150/t. Although this price is still higher than the 2015 - 2019 prices. It is expected that price will stay at the current level until the beginning of 2024, pending geopolitical risks (i.e., import bans, war) or natural occurrences (i.e., El Nino).

MIP helps to achieve DMO target, which creates an unlevel playing field between coal and renewable energy

- To secure the 25% of domestic quota for coal, the Indonesian government aimed to establish coal BLU[3] (*Badan Layanan Umum*) in early 2023. However, the progress has been stalled. During the process, the BLU format changed into MIP (*Mitra Instansi Pengelola*), although it still maintains the objective of compensating DMO coal companies.
- According to interview with MEMR (2023b), the format change also entails responsibility differences within the institution. First, BLU shall make a mandatory spending on education and health, while an MIP does not. Second, BLU could utilize any surplus in the following financial year. In contrast, for MIP, surplus is regarded as the Administration of Non-Tax State Revenue (PNBP) and could contribute to government's profit. From the government standpoint, MIP (instead of BLU) better benefits the government since they do not need to make further expenses, and even government potentially earn a new revenue stream.
- As of the writing of this report (November 2023), the MIP draft is being finalized and will be legalized later in 2023 or early 2024 as a Presidential Regulation (*Peraturan Presiden*). The total expected amount to be collected and disbursed by MIP would be around IDR 137.6 trillion with assumption that the market price is above USD 200/t.

MIP New Proposed Scheme



Source: IESR analysis, 2023

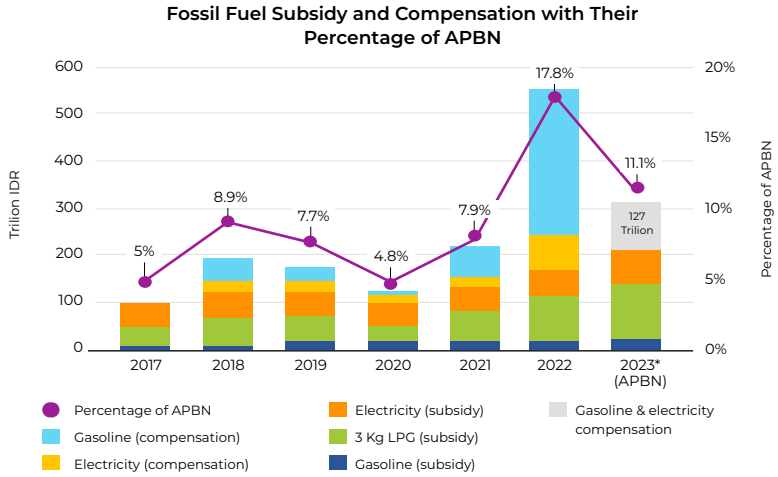
- By compensating the DMO prices, MIP helps fulfill the DMO quota by allowing PLN secures coal supplies for electricity generation at fixed prices, which currently are lower than the market prices. Lower prices lead to unlevel playing field between coal and RE due to price difference. This blocks RE growth because PLN, IPP, and industries have no incentive to switch to RE. Therefore, aligned with recommendation from JETP's CIPP, DMO reform starts with the abolishment of its ceiling price (DPO) and lump sum compensation for PLN originates from within the coal industry and not the APBN.
- DMO policy is like a double-edged sword because if coal market price drops below DMO price, MEMR Regulation no. 19/2018 regulates that the lowest price counts, meaning DMO price do not have to be met. However, when market prices are soaring, it may lead to illegal (unaccounted) coal exports. Moreover, based on our calculation, in 2022, DMO reduces potential national income in royalty (non-tax state revenue) up to IDR 33 trillion due to lower royalty percentage and huge price disparity between HBA price and DMO price for power producers (PLN and IPP) and cement - fertilizer industries.

[3] The BLU/MIP collects levies and disburses funds to compensate holders of IUP, IUPK, and PKP2B licences that fulfill the DMO obligation for thermal coal to bridge the price disparity between DMO prices and the actual market prices. MIP will consist of three to four national banks to manage the fund.

Fossil fuel subsidies and compensations increasingly adds stress to fiscal capacity but reforming it would require affordable alternatives in place

- COP26 mandated the phase-out of inefficient fossil fuel subsidies. However, the Indonesian government still strongly subsidizes fossil fuel use. In 2022, subsidy and compensation for the energy sector exceeded the initial budget of IDR 502.4 trillion by almost 10% (IDR 551.2 trillion) (MoF, 2023). The IDR 502.4 trillion budget was already three times higher than the initial plan of IDR 152.2 trillion. This amount is around 17.8% of total government spending, which shows an increasing trend from 2017 despite its ups and downs. It brings fiscal risks considering its growing trend, currency (IDR) depreciation, and rising global crude prices (INDEF, 2023).

- In 2022, in order to phase-out RON 88 gasoline use, the government made RON 90 (Pertalite) into non-subsidized fuel (JBKP). As a result, since JBKP fuel is compensated, Pertalite consumption surged from 10 to 27 million Kl in 2022, which contributed to the drastic increase of fuel compensation to go IDR 54.7 trillion above the threshold. Electricity compensation also exceeded the initial budget by 75%. Without intervention, these trends will likely continue because compensation is non-targeted (open). It also becomes the reason why plenty of compensated services are misdirected. In 2020, only 20% of Pertalite consumptions were directed at the rightful consumers (BPS, 2020).



Source: MoF, 2023;PLN, 2023; Pertamina, 2023

- Subsidies mentioned above have not taken into account the externalities of health and environmental damages, adding additional burden for the government and general public. In 2020, The externality costs for Indonesia's fossil fuel consumption were estimated to be close to USD 120 billion, more than ten times the subsidy itself, which were USD 11 billion (World Bank, 2023). Around 66% (USD 80 billion) of these externality costs came from local air pollution and GHG emissions, while the rest were from road congestion and forgone tax revenues.

- Fossil fuel consumptions are *inelastic*, with a 10% price increase is estimated to only reduce consumption by 2% in the short run (World Bank, 2023). Hence, simply raising fossil fuel price is not enough to curb its usage. Reforming fossil fuel subsidies should be accompanied by providing affordable and cleaner alternatives. The budget savings from the subsidy reform could open up fiscal space to help finance renewable energy development. MEMR estimates to reach 23% RE targets in 2025, Indonesia needs at least USD 8 billion (IDR 120 trillion) annually until 2025, much lower than the amount spent in subsidizing fossil fuels.

Fossil fuel producers have started to track their emissions and initiate decarbonization strategies, but some of them still lack systematic change

- Among fossil fuel producers listed in the IDX 200 (*n*=28) in 2022, only 21% have stated NZE or carbon neutrality targets between 2030 - 2060. On a positive note, the majority of them have began tracking at least their Scope 1 and Scope 2 emissions[4] (57%), despite 85% of them have not recorded their Scope 3 emissions yet which mostly due to difficulties in tracking third-party emissions.

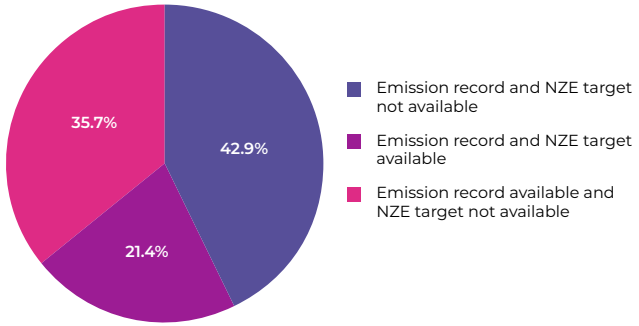
- Around 80% of fossil fuel producers have decarbonization strategies, referring to GRI 2016 standards on emission (code 305-5) and/or OJK Regulation no. 51/POJK.03/2017 (code F12). However, most of it is still limited to Scope 1. Furthermore, some of these companies reference Sustainable Development Goals (SDGs) and only a few reference the Paris Agreement or national NZE goals.

- Among the decarbonization initiatives at the company level, some are still individual-driven, intended for behavioral change, and not yet brings systemic change. For example, rewarding corporate awards, campaigning to switch off electricity appliances, and using less water. Moreover, some of the stated decarbonization efforts are also immeasurable since they did not state how much emission were saved from certain initiatives.

- Several companies recorded their annual absolute emission reductions, however, their total annual emissions are increasing at a bigger rate. For example, a coal-producing company noted their 2022 emission reduction strategy saves around 180,000 tCO_2e. However, between 2021 - 2022, their total emission increased from 558,000 tCO_2e to 830,000 tCO_2e. In other words, their decarbonization strategy could not catch up with their annual emission increase.

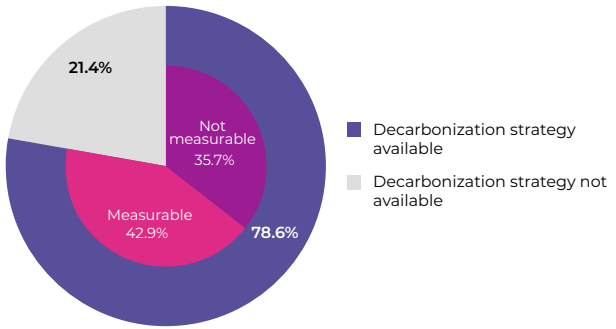
[4] Scope 1 is direct GHG emissions from sources that are owned or controlled by the company; Scope 2 is indirect GHG emissions that result from the generation of purchased or acquired electricity, heating, cooling, and steam consumed by the company; and Scope 3 is indirect GHG emissions not included in energy indirect (Scope 2) GHG emissions that occur outside of the organization, including both upstream and downstream emissions (GRI, 2022).

Availability of Scope 1 & Scope 2 Emission Record and Stated Net Zero Targets (2022)



Source: IESR Analysis, 2023

Availability of Decarbonization Strategy and Its Measurability (2022)



Source: IESR Analysis, 2023

Increasing trend in women representation in executive team roles as women CEOs bring more women to the team

- Between 2019 - 2021, women leadership in executive team roles within the *energy sector* IDX 200 companies increased (IBCWE, 2021). Despite only 2% of women occupying executive line roles (responsible for the commercial side of the company), women's roles in functional roles (non-commercial side) have also increased from 17% - 21% in the same period.
- Despite the progress, 50% of *energy* companies in IDX 200 in 2021 still do not have women in their executive positions. This condition is a missed opportunity because of women's unique contribution. Gender equality could lead to stronger business outcomes, bringing more innovation and higher productivity (USAID, 2023).
- The gender imbalance is apparent particularly in the mining sector. In some cases, coal mining companies are not giving equal opportunities to women and men in terms of career advancements (IESR, 2023). Women generally occupy administrative positions that do not have much promising career path in the company. Moreover, there are subconscious bias practices towards women employees in mining companies (Amor et al., 2020).
- Gender mainstreaming in the fossil fuel industry could start from the top executive position (CEO or Executive Director) because such a top position highly influences the hiring policy of the entire company. In 2021, among IDX 200 companies, 71% of female-led companies had a composition of more than 30% women in their executive team, three times more than companies with the same composition led by a male CEO (only 19% male-led companies had a composition of more than 30% women in their executive team) (IBCWE, 2021).
- In the government sector, MEMR has promoted gender mainstreaming programs, as reflected in leadership roles. There were 11 women who held director positions out of a total of 55 units in MEMR (20%) in 2021 (ACCEPT II, 2021). An improvement from 2011 as, at the time, only 12.7% of women occupied leadership roles. The overall participation of women employees in MEMR also increased from 22.8% in 2011 to 27.5% in 2021.

Percentage of Women Representation in Executive Team Roles in Indonesia IDX 200

Industry	2019	2020	2021
Non-primary goods	34%	28%	29%
Health	23%	27%	27%
Technology	20%	20%	23%
Finance	19%	16%	15%
Industry	17%	18%	15%
Property	15%	18%	15%
Primary goods	11%	10%	13%
Energy	11% (8th)	12% (7th)	13% (7th)
Raw materials	6%	6%	10%
Transport	9%	10%	10%
Infrastructure	8%	9%	9%

Source: IBCWE, 2021

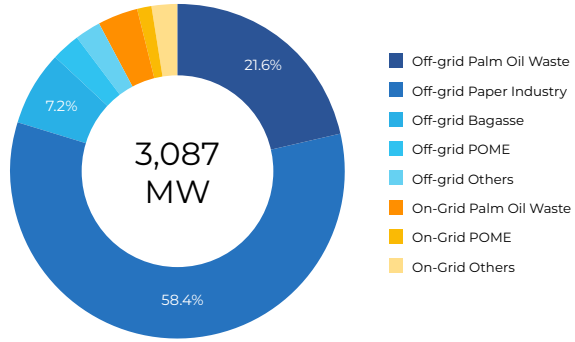
While the growing potential of waste for off-grid plants can be maximized, forest-based feedstock must be controlled

- The bioenergy utilization has been growing rapidly, especially biomass for grid power generation has reached 3,087 MW in 2022, up 35% from 2021 (MEMR, 2022). The growing amount of industrial and agricultural waste can be further optimized to enhance bioenergy off-grid power generation. Off-grid paper industry holds the largest share of bioenergy power plants, reaching 1.8 GW, followed by 0.67 GW from off-grid palm oil industry. The utilization has not yet reached its maximum potential, considering that for instance, Riau and South Sumatra Provinces have 5.87 GWe and 2.56 GWe of industrial waste potential, respectively (DEN, 2022p).

- On-grid bioenergy power plant development faces challenging issues. The RUPTL plans to develop a 0.6 GW combined capacity of bioenergy power plants in 66 locations with USD 1.4 billion of total investment. However, only seven projects have completed the procurement phase (Petromindo, 2023). Furthermore, there was a lack of interest from investors in the previous two PLN tenders. Therefore, PLN intends to re-auction bioenergy power plant projects in 19 locations with 101.1 MW cumulative capacity in 2023-2024. Nevertheless, it is hard to expect that the projects will run if the hindrances are not addressed. For instance, the increasing price of biomass feedstock could not compete with subsidized fossil fuel prices, making the staging price of electricity sales unattractive. Moreover, it is hard for developers and feedstock providers to set an agreement during the bidding process due to its uncertainty and 20 years feedstock supply security considerations for PPA.

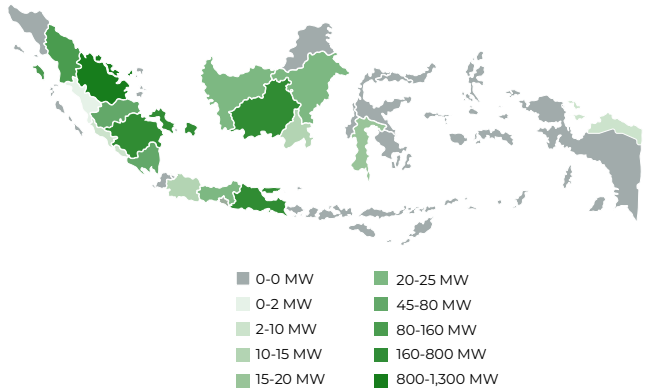
- Bioenergy sources must be controlled so as not to exacerbate the current deforestation problem, and also to control the restoration of previously uncontrolled and abandoned land. For instance, Medco Group announced in June 2023 that it would continue deforestation of up to 2,500 ha in Papua Province to construct biomass plants. It received a total of USD 9.4 million in "green funding" from PT Sarana Multi Infrastruktur (SMI) and the Indonesian Environment Fund (IEF) (Mongabay, 2023). As a result of this project, traditional local residents have faced a variety of problems, such as job loss, food insecurity, and malnutrition (Climate Home News, 2023).

Installed Capacity of Bioenergy-Based Power Plants Based on Source Types



Source: MEMR, 2022.

Bioenergy Power Plant Distribution 2022

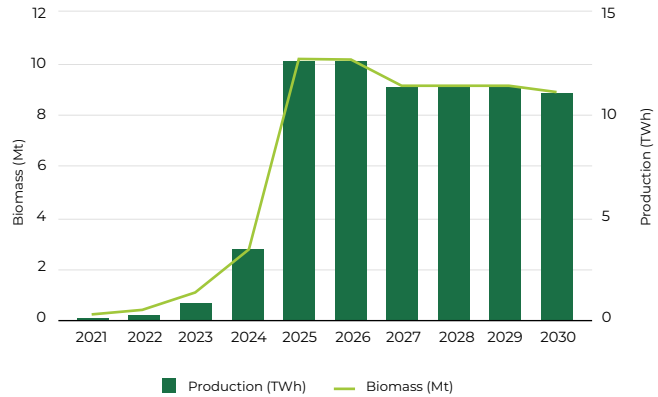


Source: MEMR, 2022.

Biomass co-firing alert: feedstock economic and environmental concerns amid decarbonization effort

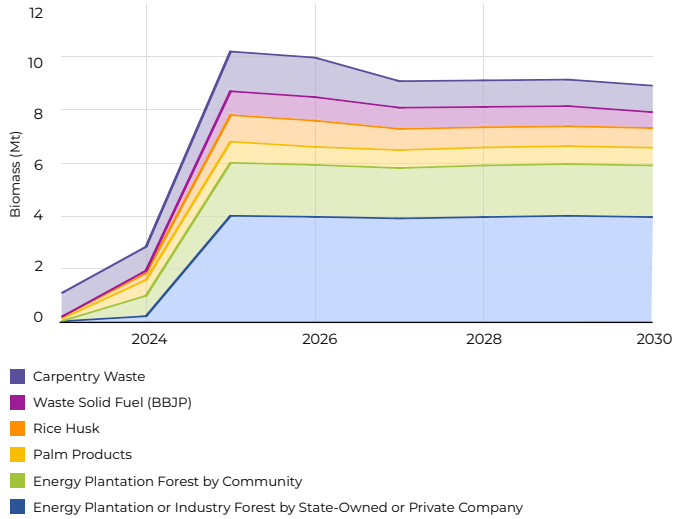
- PLN has reduced its biomass co-firing target in 2023 due to feedstock availability issues, from 2.74 TWh with 2.2 Mt of biomass (EBTKE, 2022) to 0.95 TWh and 1.05 Mt of biomass (PLN, 2022). To cover biomass supply, PLN has signed a supply agreement contract of 1.27 Mt to fulfill the target, and by July 2023, biomass co-firing was implemented in 41 CFPPs with 0.48 Mt of biomass.
- The potential loss of forest carbon sink and land clearing carbon offset for biomass feedstock generation must be critically evaluated, especially from "hutan tanaman energi" (HTE). It could be contradictory to Indonesia's plan to achieve FOLU net sink by 2030. To achieve the 10.2 Mt of biomass co-firing target by 2025, 0.7 million ha of HTE is needed. There are chances that primary forest areas would be utilized as HTE which reduces its carbon sink and other environmental services. Furthermore, there are issues related to HTE land burning and forest clearing by the private sector (Wicaksono, R. A., 2023).
- Despite having 500 Mt of satellite based contingent biomass resource, only 2 Mt is proven to be available as feedstock, yet it is still not economically viable (PLN, 2023). Biomass producers refuse to follow the DMO price set by PLN and prefer to export it at a higher price instead (Mebi, 2023). MEMR Ministerial Regulation Draft on co-firing set the highest benchmark price (HPT) for biomass co-firing of 1.2 times the price of Free on Board (FoB) coal. This price set is competitive for wood chips and waste-sourced feedstock, but it is still not appropriate compared to wood pellets and palm shells. Furthermore, the provision of biomass will cause an increase in the Cost of Supply (BPP) of electricity where in the RAPBN for the 2024 fiscal year, electricity subsidies are planned to increase by 7%, one of which is due to an increase in the use of biomass fuel for co-firing PLTU (MoF, 2023).

Roadmap of Co-Firing CFPP by PLN



Source: PLN EPI, 2022

Roadmap of Biomass Feedstock for Co-Firing by PLN



Source: PLN, 2023

Emission transparency report remains absent, rising questions on the effectiveness of biodiesel program as climate mitigation effort

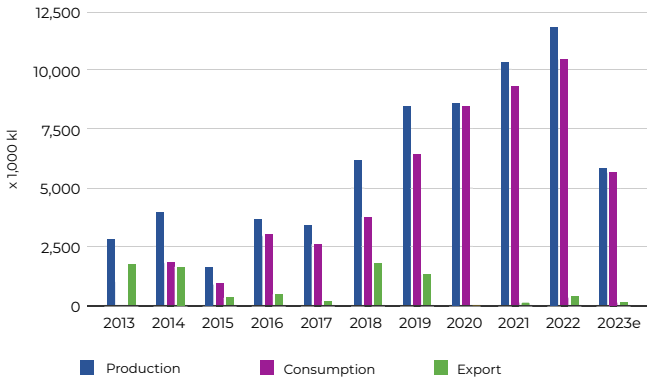
- In 2022, Indonesia was the third largest biofuel producer in the world, with production of 174,000 BOE/day (Muhamad, N., 2023; Statista, 2023). The country is using biofuels, mainly biodiesel, with bioethanol and bioavtur on the way (Pertamina, 2023b; MEMR, 2023d; GAPKI, 2023). The biodiesel production continues to rise. From 2021 to 2022, it has increased by 15%. By 2022, the reduction in emissions from biodiesel utilization estimated to reach 28.14 million $MtCO_2e$ (MEMR, 2022). Since August 2023, 119 gas stations across Indonesia have started using Biodiesel B35 with a blend rate of 33.9% (Pertamina, 2023b), which is expected to absorb 13.15 million kl (Ekarina, 2023; GoI, 2023a). Currently, B40 is still in the testing phase for heavy equipment, marine vessels, agricultural tools and machinery, and train sectors (MSI, 2023, MEMR, 2022).

- Even though biodiesel is considered carbon neutral, depending on biodiesel type, ratio, purity, overall energy consumption, and the main CO_2 emission contributor from land clearing and use for plantations, the lifecycle CO_2 emission can be worse than that of fossil fuel (Osorio-Tejada, J. L., Llera-Sastresa, E., & Scarpellini, S., 2022). Referring to the lifecycle assessment (LCA) data, both biodiesel B20 and B30 have varying CO_2 emission LCA. Compared to conventional diesel of 2.68 kg of CO_2/l, the biodiesel emission range can be 10% lower or 3 times higher as mixture. Meanwhile, it can reach 7 times higher for pure biodiesel B100 (Widyarini, P., 2022; Septiani, M., 2022; NRC, 2014).

- In addition, Nitrogen Oxide (NO_x) emissions are mandatory to be monitored, as they remain undetected despite their increase in value, which is affected by the type, ratio, and purity of the biofuels as well as the load and model of engines (Chen, H. et. al., 2018; Zhang, Y., et al, 2021; NS, 2022). It is important to control NO_x emissions, as they may produce N_2O, which has 265 times climate warming effect than CO_2 (EPA, 2023, Zhu, J. et al., 2017). Additionally, increasing biodiesel ratio can increase NO_x emissions (Mahmood, A. S., et. al., 2021).

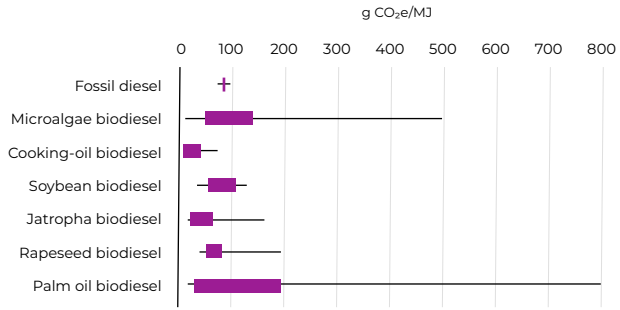
- Other negative impacts of biodiesel as an alternative fuel should be considered. It may include issues from oil plant plantation, purity-quality issues, and high-priced production and purification processes for the direct user if supplied without subsidy, as well as technical limitations from biodiesel utilization as alternative fuels (Ciolkosz, D., 2016; Simbi, I., et. al., 2022). These issues raise the question of the effectiveness of biodiesel as a climate change mitigation action.

Biodiesel Production, Consumption, and Export



Source: APROBI, 2022; Sipayung, T., 2023

Life Cycle GHG Emissions for Biodiesel as a Diesel-Alternative



Source: Osorio-Tejada, J. L., Llera-Sastresa, E., & Scarpellini, S., 2022.

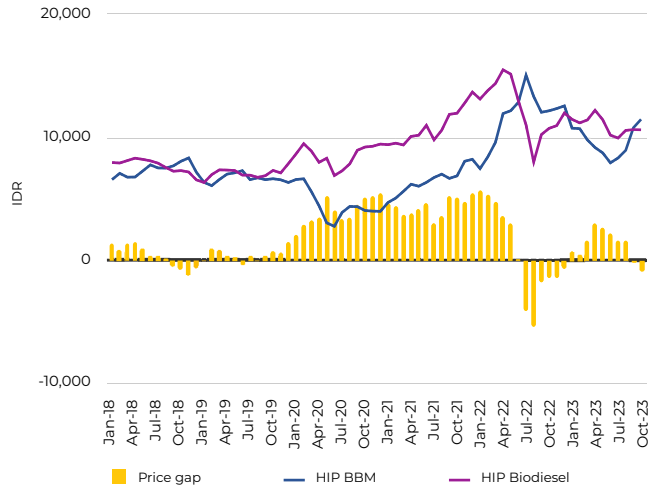
Increased palm-oil based biodiesel utilization faces potential challenges in financial and environmental sustainability

- Financially, the sustainability of the biodiesel program depends on subsidies taken from palm oil products' levies as Oil Palm Plantation Fund Management Agency (BPDPKS) revenue. Without subsidies, the price of biodiesel will fluctuate following the global market, and it may be higher than expected. The subsidy has reached more than IDR 18.7 trillion until September 2023. While BPDPKS revenue is still sufficient to cover the price gap between diesel and biodiesel from CPO levies, there are months that the subsidy required exceeds the revenues generated.

- The average amount of biodiesel consumption during January-July 2023 was 0.95 million kl per month. It increased 13% since B35 implementation, reaching an average of 1.08 million kl per month in August-September. If BPDPKS revenue remains constant and biodiesel blending increases to 40%, then the subsidy will create a risk of deficit in the BPDPKS fund. Meanwhile, Pertamina is targeting the production and supply of B50 biodiesel starting in 2025, increasing the risk of an even larger deficit (MTA, 2023). Moreover, the BPDPKS fund allocation for the rejuvenation of palms plantation is limited to only around 2.9% of the 2022 budget realization, while 95% were spent for biodiesel subsidies. The high allocation of BPDPKS fund for biodiesel subsidies has a negative impact on the abandonment of land rejuvenation after oil palm plantations with the classic reason that 'there is no funding'.

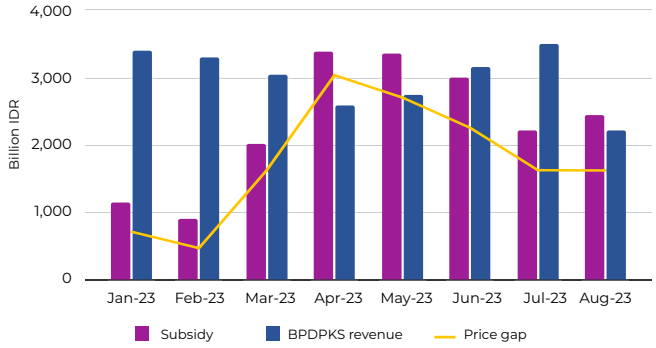
- Reflecting also on the problem of BPDPKS fund allocation for rejuvenating oil palm land, alternative raw materials besides oil palm plantations must be developed. As palm oil has so many uses with similar CO_2 absorption to forest vegetation, this reason always becomes a justification for opening larger palm oil plantations. In fact, many environmental issues arise from the opening of oil palm plantations, ranging from deforestation, damage and pollution to land and water, the potential for more chronic GHG emission from the land clearing process, damage to biodiversity, negative impact to local social-economic, violation in land recovery and rejuvenation, potentially higher LCA of biofuels CO_2 emission, and so on (Nurhidayati, I., 2023; Rahayu, S., Qarni, W., & Harahap, R. D., 2023; PGA, 2023; Ran, 2023), are often ignored. These environmental issues must be of concern and encourage the development of sustainable and genuinely eco-friendly raw materials. Apart from that, abandonment or uncontrolled land rejuvenation of plant oil plantations must be a priority in efforts to reduce carbon emissions, including the need to reduce and even withdraw biodiesel subsidies.

Market Index Price (HIP) of Vegetable Fuel (BBN) and BBM-diesel



Source: MEMR, 2022; IESR Analysis

BPDPKS Revenue and Biodiesel Subsidy Allocation



Source: IESR Analysis

More environmentally friendly and conflicts-interest free raw materials for bioethanol and bioavtur are needed for better sustainability

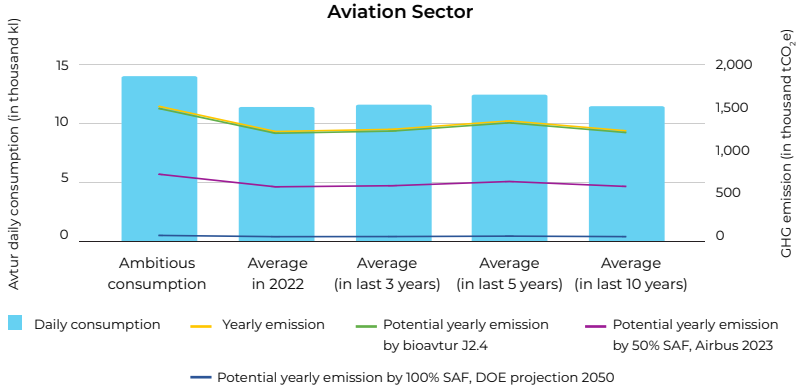
- Bioavtur J2.4, a mixture of kerosene and 2.4% palm oil, has received recognition as a sustainable aviation fuel (SAF) (MEMR; 2023e; Mahardika, L. A., 2023). As of October 2023, it had successfully tested on commercial flights under SOE cooperations, Pertamina and Garuda Indonesia; and it is planned to be commercially available in 2024 (GAPKI, 2023; Muthe, B.D., 2023; BRIN, 2023).

- Bioavtur produces 1.5% lower than fossil avtur (Pertamina, 2023c). With ambitious 14 kl/day consumption, it could reduce aviation emissions by 24 $ktCO_2e$/year (CNN Indonesia, 2023). Further, the SAF program encourages used cooking oil as a bioavtur source to increase supply diversification and source security (Ernanto, B., 2023). The use of palm oil-based bioavtur will be faced with the same environmental problems as biodiesel and, therefore, requires the development of other sources.

- Since July 2023, Indonesia has launched a bioethanol 5% or E5 derived from molasses sugar cane as a gasoline mixture named Pertamax Green RON 95. Up to November 2023, It has been supply-tested at 17 public fuel filling stations in Jakarta, and 12 in Surabaya and the surrounding area, with total daily consumption reaching 5 kl (GoI, 2023b; Pertamina, 2023b). Moreover, Pertamina plans to replace Pertalite RON 90 by adding 7% bioethanol to create Pertamax Green RON 92 (Pertamina, 2023b).

- A lesson learned from the adoption of a gasoline mixture E85 containing 51-85% ethanol in Canada and the United States showed that it could reduce net emissions by up to 75% (CBC, 2008). Thus, bioethanol content in Indonesia may increase to E10, E20, and to an undetermined limit with a potential emission reduction estimated up to 43% (ITB, 2023). It is important to pay attention to the implementation since vehicles are vary in type, capacities, and age. Furthermore, the diverse economic capabilities of users might lead to dependence on fuel subsidies, such as happened with biodiesel subsidies. Nevertheless, bioethanol realization at a slower pace than expected. The MEMR Regulation No. 12/2015 stipulates that bioethanol in transportation, E5 for PSO and E10 for non-PSO, should be achieved by 2020 while Indonesia just started with E5 in 2023.

Potential Emission Reduction Projected from the Avtur Consumption in the Aviation Sector



Source: IESR Analysis, adapted from MEMR, 2023. Pertamina, 2023, U.S. Dept. of Energy, 2023; Airbus, 2023

- Bioethanol implementation at the national level is subject to potential supply limitations, as the capacity to produce bioethanol at 40 thousand kl remains very low relative to the projected demand of around 696 thousand kl, and it is limited to East Java and Jakarta only (Wahyudi, N. A., 2023). Launched in June 2023, PR No. 40/2023 stipulated the acceleration of the national sugar security program to achieve sugar self-sufficiency by 2028 and to raise bioethanol production to a minimum of 1.2 million kl by 2030 (MoA, 2023; GoI, 2023). Land use needs to be taken into consideration when developing this program in order to minimize its impact on the environment and biodiversity. Moreover, Indonesia still imports sugar, and sugar is an attractive commodity for consumption as food and for high-priced export (MITI, 2023; MoFA, 2021; Jadhav, R., 2023; OECD, 2023). A consideration should be given to the possibility of finding alternative raw materials for the production of bioethanol.

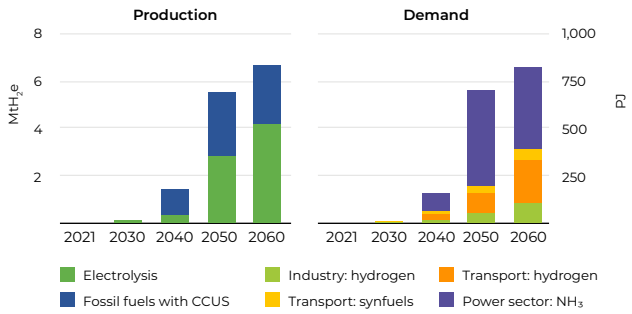
Hydrogen demand, production, and supply-price gaps need to be addressed in the context of Indonesia's commitment

- The effectiveness of hydrogen to mitigate emission and its cost depends on the production route of hydrogen. Indonesia has been producing and utilizing high-carbon emission 'grey' hydrogen for a long time (PLN, 2023b). Efforts are underway to reduce national GHG emissions by the transition to low-carbon emission 'blue' and 'green' hydrogen. The IEA projects that Indonesia will need 6.3 Mt/year of hydrogen by 2060 under its Announced Pledge Scenario (IEA, 2022, MEMR, 2023f). Meanwhile, the demand is expected to reach nearly 1.8 Mt/year in 2040 to substitute the 'grey' hydrogen and will keep growing to 36.2 Mt/year by 2060 (IFHE & BRIN, 2023; HBD, 2022; IEA, 2022). Therefore, in 2060, there may be a gap of 30 Mt/year between overall projected domestic demand and government production targets, which will be dependent on government policy and industry initiatives.

- Today, global 'grey' hydrogen production cost ranges at USD 0.98-2.93/kg (Schelling. K., 2023). Meanwhile, the global production cost of low-carbon emission hydrogen remains relatively high, ranging from USD 2.5-12/kg, and is expected to reach USD 2.5-4/kg by 2030 (Schelling. K., 2023). In comparison, Indonesia's production cost is even relatively higher, ranging from USD 5–10/kg in 2023, even though some onsite production costs may reach as low as USD 2.3/kg with certain conditions. Further, Indonesia's production costs target is below USD 3/kg in 2050 (MEMR, 2023; BRIN, 2023). Nevertheless, it is still far from the global benchmark of USD 2/kg in 2030 and USD 1/kg in 2050 (Collins, L., 2023). The cheaper the hydrogen production cost, the better to encourage hydrogen technology adoption, especially domestically.

- The Indonesia's Hydrogen National Strategy and hydrogen road map are expected to be published at the end of 2023 by MEMR as derivative part of the country's general national energy plan (RUEN). The following are some of the purposes of hydrogen demand: (DEN, 2023, MEMR, 2023):
  - Industrial demand is expected to reach up to 4.2 Mt/year in 2060
  - The heavy transportation sector may require 930.6 GWh (28.2 Mt/year) in 2060.
  - The adoption in buses may reach up to 6 GWh or 0.21 Mt/year in 2040
  - It is planned to use electric rail cars powered by hydrogen fuel or batteries to replace conventional trains with undisclosed details
  - By 2060, 77% of national RE power plants will use 5% hydrogen and 11% ammonia as fuel.

Low Emissions Hydrogen Production and Demand in Indonesia in the Announced Pledges Scenario, 2021 – 2060



Source: IEA, 2022

- In doing so, Indonesia shows its commitment to developing low-carbon hydrogen fuel, and hydrogen may become an integral part of its decarbonization effort, which must continue to be encouraged. Hydrogen is a versatile energy, however, it is unclear how to project the demand as it is still in the nascent development stage. The shift in technology for hydrogen adoption, including hydrogen embrittlement prevention (Ilyushechkin, A., et. al., 2023; Agora Energiewende, 2022), should also be taken into account. The use of hydrogen as a carbon solution also competes with other carbon solutions, especially in transport (with EV) and power (with RE).

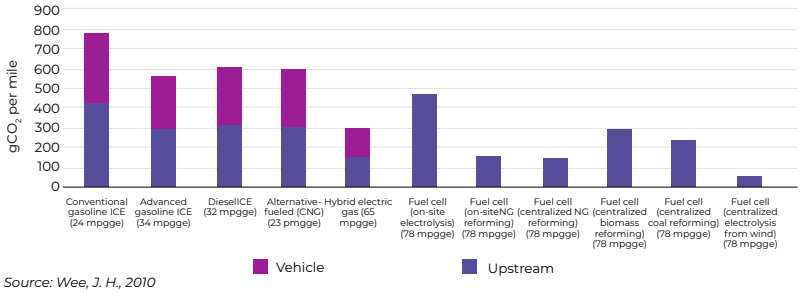
The use of hydrogen as an alternative fuel must be clearly directed and controlled to avoid worse emissions impacts

- Until 2023, at least 32 hydrogen projects have been identified, of which 27 are for low-carbon emission 'green' and 'blue' hydrogen production and 5 for distribution and utilization. Some of the projects may comprise a number of projects with undisclosed details (see details in the appendix E). More than half of the total hydrogen production projects are integrated with ammonia production. Further hydrogen may be produced in a variety of forms (McCurdy & Podal, 2023; Nemmour, A., et. al., 2023; Rambhujun, N., et al., 2020). All this data explains the magnitude of the industry initiative for hydrogen adoption, which needs to be monitored and controlled using a clear policy and regulatory framework for safety reasons.

- Hydrogen infrastructure is also being developed, including hydrogen pipelines in Banten and West Java, subsea pipelines from Indonesia to Singapore, as well as hydrogen-based vehicle ecosystems. As 'free' carbon emission fuels, hydrogen is projected for transportation (fuel cell), generator cooling systems and the use of co-firing or conversion into ammonia for steam power plants (PLTU) (combustion) (Setiawan, V. N., 2023a; Wee, J. H., 2010). Co-firing ammonia with natural gas is reasonable since it generates 'free' carbon emissions with the potential of less NO_x emission than hydrogen (Giacommazi, E & Messina, G., 2021; Douglas, C., 2022; Goldmeer, J., 2021; Devkota, S., 20222). However, emission-related environmental impact should be studied further and be minimized, so research support is necessary for its safe implementation.

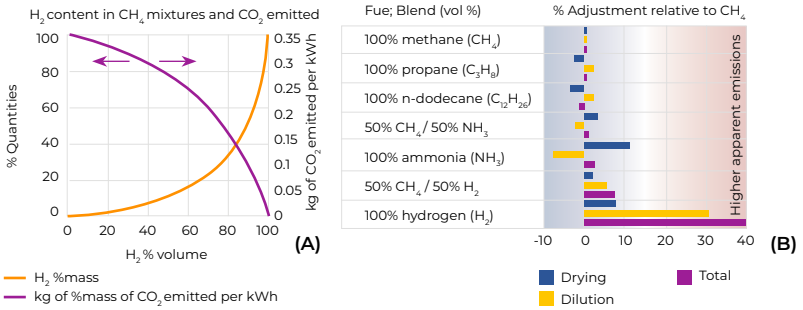
- A simplified hydrogen value chain is needed, especially its connection with RE power plants, to reduce electricity network investment and hydrogen distribution and logistics costs. Since October 2023, Indonesia started producing low-emission 'green' hydrogen under Pertamina's GHP with a production capacity of 51 t/year, further increased by 199 t/year from PLN-owned GHP (PLN, 2023c, MEMR, 2023g). They adopt powering GHP through the NET with generated RE electricity from geothermal and solar PV and is certified by REC (Setiawan, V. N., 2023b; MEMR, 2023g). Through a similar system, RE-power plants can be integrated with RECs, and the generated electricity can be transmitted through NET while encouraging NET expansion.

CO_2 Emissions Per Mile for Cars Fuel Compared Well-to-wheels



Source: Wee, J. H., 2010

(A) CO_2 Emissions with Hydrogen Fuel Blend (B) Indirect NO_x Emissions from Hydrogen, Ammonia Fuel Blend, in Gas Turbines



Source: Giacommazi, E & Messina, G., 2021; Douglas, C., 2022.

- Nevertheless, the most important concern from the hydrogen value chain is hydrogen storage safety from leak. The hydrogen release into the atmosphere contributes to climate change at a rate about 12-34 times greater than CO_2 (Kurmayer, N.J., 2023; EDF, 2022). The leak, unused, unburned or accident that may release hydrogen to atmosphere can backfire in efforts to reduce CO_2 emissions. Therefore, it is mandatory that hydrogen value chain adoption be controlled. Other chemical forms can be considered for development as a safer alternative.

4.

Energy Transition in Subnational

Anindita Hapsari, Fathin Sabbiha Wismadi, Martha Jesica Solomasi Mendrofa

Contents:

- Subnational energy transition efforts progress
- Energy transition updates in West Java, NTT, and Bali

Provinces grapple with fiscal constraint and policy changes from the central government, posing difficulty in achieving the 23% national target by 2025

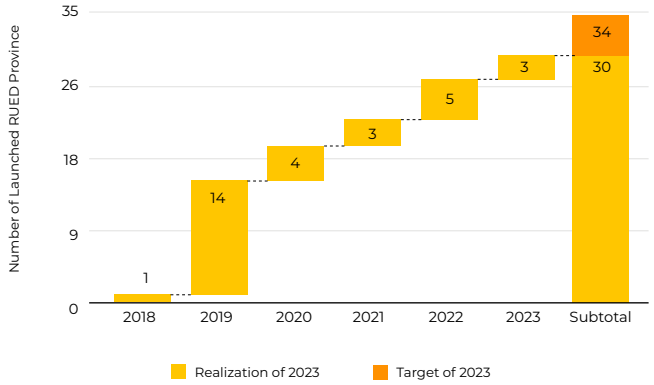
- Regional governments' authority in RE development has expanded due to the new regulation, PR No. 11/2023. With recent changes, provinces are now overseeing biomass and biogas utilization, diverse RE management, and energy conservation under their business permit purview. Previously, provinces managed geothermal permits and biofuels but lacked spending authority for RE development programs (Law No. 23/2014). However, derivative MoHA Decree for budget tagging is needed to ensure legal basis for implementation and is currently underway, expected to be effective the soonest for fiscal year 2025. Further, PR No. 15/2023 newly added renewables infrastructure program for affirmative areas that indicated by low development indicators within the 2023 specific transfer fund (Physical DAK), currently benefiting only NTT province. For provinces with limited funds, added responsibility on RE development may strain budgets, requiring a balance with other concurrent matter.

- The ongoing update of GR No. 79/2014 of KEN (*Kebijakan Energi Nasional*), initiated in 2022, is set to be completed this year. The upcoming KEN draft will include points related to the 2060 NZE target, the use of natural gas as a fossil fuel transition, and nuclear energy is no longer the latest option, while RUEN and RUED, referring to KEN, will subsequently undergo adjustments. Provincial government is allowed to perform RUED review and adjustment prior to upcoming RUEN by referring to the latest draft of KEN and with consultation with National Energy Council or DEN (Kontan, 2023; DEN, 2023).

- In 2023, DEN established 34 RUED targets (excluding 4 new provinces)[1], with 30 provinces having issued RUED by Q4-2023. Regarding the renewable energy mix target in the 2025 & 2030 RUED, each province has various efforts to achieve it through subnational target derivative measures, such as circular letters, governor regulations, NZE commitment declaration, and increasing cooperation with other parties (e.g., to attract RE investment).

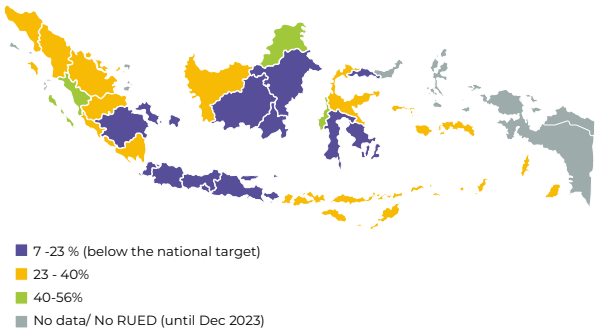
- Each province has a different RE mix target by 2025. Currently, most provinces are falling short of their individual goals, revealing a significant disparity between their current renewable energy content and the 2025 target. To make significant progress toward meeting the provincial targets and contribute to national target, it is pertinent to review their plan and construct strategic adjustments.

Number of RUED Province Realization in 2023



Source: DEN, 2023

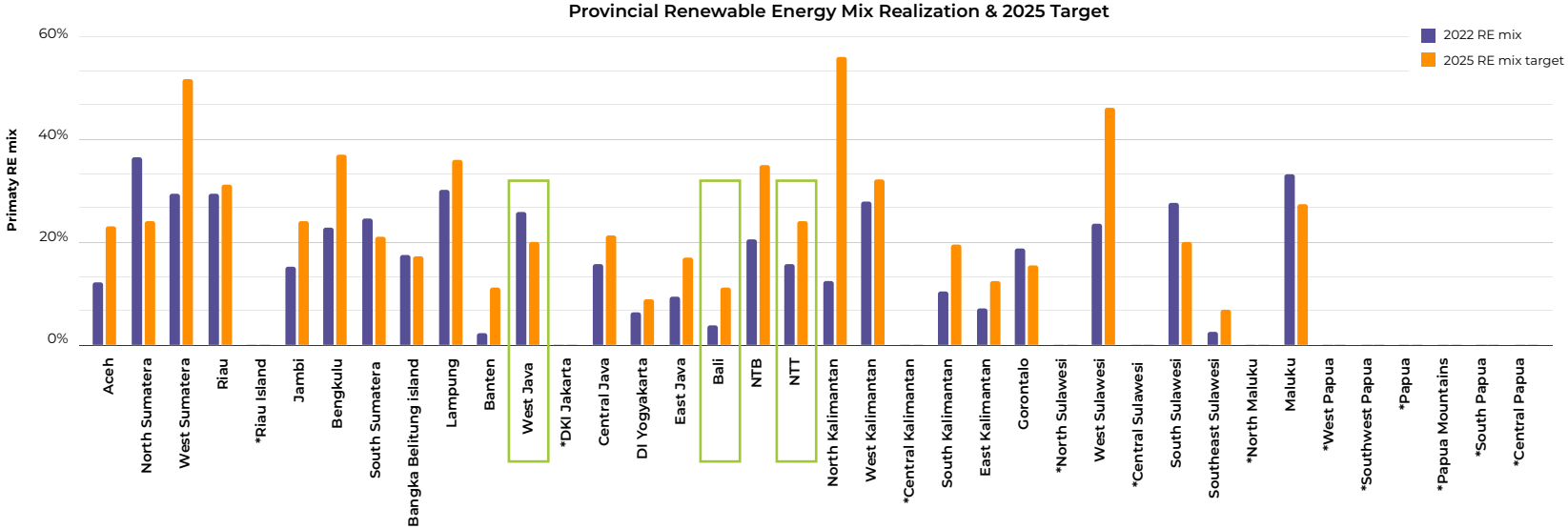
Provinces RE Mix Target in 2025



Source: IESR Analysis from Data DEN, 2023

[1] Four new provinces, namely South Papua, Central Papua, Mountainous Papua, and West Papua, were newly formed in 2022 and are currently in the process of drafting regional regulations.

Tracking RE Mix in 2022: 24% of Provinces Trail Below Average



**) RUED does not yet exist or results have not been reported*

Source: DEN, 2023; IESR Analysis of latest RUED, 2023

In 2023, seven provinces have exceeded their 2025 renewable energy targets (North Sumatra, South Sumatra, Bangka Belitung, West Java, Gorontalo, South Sulawesi, and Maluku). Their high achievement is mostly contributed by the existence of large scale national renewable energy projects (hydro, geothermal). With 2 years remaining until 2025, many of the provinces' renewable energy share is under half of their target. Additionally, 12 provinces are either in the process of implementing RUED or currently calculating their results. Furthermore, based on various factors, such as 2022 RE primary realization achievement and noteworthy developments in provinces, the following pages will provide a detailed elaboration on East Nusa Tenggara (NTT)[2], West Java, and Bali.

[2] Based on East Nusa Tenggara EMR Office 2022 document RE Mix realization

Transforming NTT's energy landscape: a call for strategic and focus collaboration between central and local governments in 3T regions

- NTT, as the province with the highest number of 3T districts in Indonesia, poses long time, difficult energy access challenges. Prior to 2017, NTT had the lowest electrification ratio in the country, primarily due to its high geographical obstacles, including numerous remote and scattered population areas, leading to a significant reliance on diesel power plants - 86% of power plants in NTT are powered by diesel (PLN, 2022). The government and PLN have prioritized least-electrified areas for energy access connections, including with pre-electrification program of energy saving solar lamp (LTSHE), also PLN's village electrification (lisdes) and de-dieselization program.

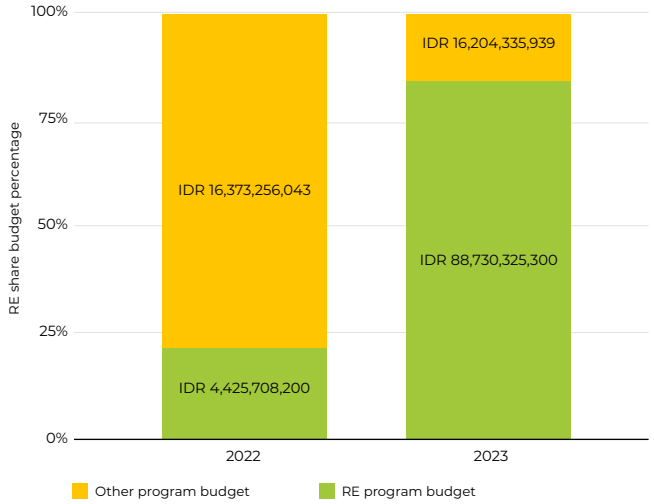
- NTT and Papua were two provinces receiving largest unit of LTSHE during 2017 - 2019, with NTT received 21,558 units (MEMR, 2020). The distribution did contribute to NTT's improved electrification ratio, although LTSHE was heavily criticized for not providing high quality energy access, only for basic lighting (IESR, 2019).

- Although NTT's renewable energy mix reached 37.3% in 2022, this figure still includes the use of firewood, mostly for cooking. Without firewood and LPG, the actual renewable energy mix is only 15.74% (NTT EMR Office, 2023). While firewood is technically renewable energy, its use for cooking leads to indoor pollutants and adverse health impacts; thus NTT needs to resort to other clean, renewable energy to increase their mix.

- This year, the NTT EMR Office received an APBD allocation of IDR 104 billion, with IDR 88 billion allocated for RE development from the Special Allocation Fund (DAK) (Woso, 2023). This funding is directed at communal solar power plant development on Sumba Island, NTT. While it is a substantial increase compared to 2022, there is no other budget allocation from provincial budget. DAK is intended to provide subnational governments with balance funds for sectors otherwise difficult to self-finance.

- With the renewable energy-targeted DAK, NTT is able to build renewable energy power plants in their effort to increase energy access. It also opens the opportunity to decrease firewood share in the energy mix.

Share of Program Budget on NTT EMR Office



Source: IESR Analysis from Provincial Government of East Nusa Tenggara Documents, 2023

- The challenges in increasing renewable energy share in NTT are multifaceted: its archipelagic nature and scattered population makes it logistically difficult and expensive, the market is underdeveloped, limited financing options, to the necessity to develop local human resources. Tackling these challenges requires a holistic strategy and collaboration between different stakeholders.

West Java's high achievement of a 25.81% RE mix is a combination of national interest, good infrastructure, and preferred demand location - with room to increase investment in the province

- At 26% RE share in primary energy mix, West Java is one of the provinces that have already exceeded the 2025 renewable energy target in their RUED. The high share of renewable energy mostly comes from hydropower (2 GW) and geothermal (1.2 GW), the highest installed capacity among all provinces (MEMR, 2021; 2023), followed by biodiesel. This high RE share is driven by the central authorities, i.e. PLN's electricity supply planning and central government's B30 program.

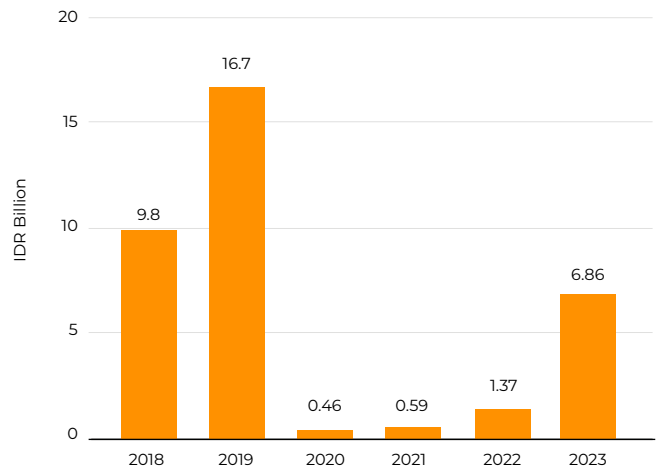
- Despite the high RE share, the capacity of renewable energy power plants has stagnated, only grown by 2% since the RUED stipulation in 2019. The utilization of renewables other than geothermal and hydropower is very limited. It is in contrast with the fact that West Java is blessed with abundant RE with a total potential of 175 GW. It has an enormous solar potential (156 GW), the largest geothermal potential (4.7 GW), and third largest wind potential (12.7 GW) in Indonesia.

- Between 2022 and Q1-2023, West Java Province government has shown policy support for renewable energy and EV, including provincial regulation on tax for EVs (Regional Regulation No/ 9/2019 and Governor Regulation No. 43/2021), circular letter for rooftop solar use in industrial (SE No.66/RT 03.03/PEREK), and establishing a Regional Energy Forum.

- From total installed capacity of 27.60 MW in 2023, West Java has 9 MW of solar rooftop installation, as the province holds position as top national contributor (Ekonomi Bisnis Indonesia, 2021; West Java EMR Office, 2023). The installed capacity represents only 0.08% of West Java's 2022 electricity consumption of 56.2 TWh. The installation is driven by industrial users, given that each factory is able to implement rooftop solar systems on megawatt scale.

- The government is also highly driven to attract renewable energy investment through their annual investment summit (West Java Investment Summit/ WJIS), for 3 years in a row since 2019, selected renewable energy projects were featured. From 2022 to Q3-2023, IDR 1.7 trillion was invested in eight RE projects, including IDR 1.3 trillion for the 145 MW Cirata Floating PV (West Java EMR Office, 2023). The remaining went to various smaller projects of mini hydro (9 MW) and solar PV (7 MW).

RE Program Budget in the West Java EMR Agency



Source: West Java EMR Office, 2023

- Other than the large renewable energy projects, the provincial government also provides support for small-scale renewable energy projects such as installation of 9 unit rooftop solar in public buildings and 345 biogas units during 2018-2022. Government budget for RE program has increased tenfold since 2020, but have not yet reached the level before pandemic. During the budget restriction in 2020-2022 there were no RE unit installation and focusing only for revitalization program of RE installations and developing RE feasible studies, but the program has returned.

With the current RE mix standing at only 3.8%, more policy support and collaborative actions are needed to achieve Bali's net zero by 2045 aspiration

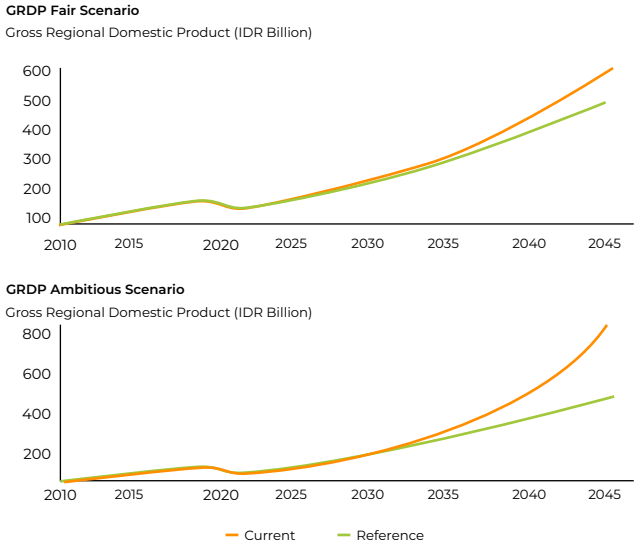
- Bali, with a modest 3.8% renewable energy mix in 2022, sets an ambitious target of decreasing emission significantly by 2045 through its RPRKD and to achieve NZE by the same year through the Bali Net Zero 2045 initiative. While the government has developed policy support such as Bali e-mobility plan, governor regulation on Bali Clean Energy and EVs, and circular letter encouraging public to install rooftop solar, the relatively modest budget allocation in the 2020-2023 APBD for Bali's RE program raises pragmatic concerns about execution feasibility. Coupled with drastic budget spending for pandemic impact alleviation during the past 3 years, it is apposite to construct careful planning to navigate these challenges effectively (IESR, 2023).

- While not the best in Indonesia, Bali hosts RE potential much higher than its current utilization rate, mainly from solar (22 GW) and wind (1.5 GW). Moreover, the recent Bali low carbon development plan (RPRKD) suggests that energy transition would result in higher economic growth compared to BaU. It even projects that moving to 100% new RE installed generation after 2020 (ambitious scenario) will create more emission reduction and economic growth than the gas-oriented transition (fair scenario). Therefore, the next update on energy planning document, i.e. RUED, should reflect on this and integrate higher RE targets.

- Despite the tremendous potential and benefits of shifting to RE, challenges exist in promoting RE development in Bali. Notable renewable energy projects in Bali are limited, two solar power plants (1 MW each) in Bangli and Kubu face technical and governance problems. Tendered 2 x 25 MW solar plants by PLN and won by private company has yet to start construction. Moreover, there is a cultural barrier in developing large scale geothermal and hydro at certain areas considered sacred.

- Bali has currently implemented two EV regulations (Governor Regulation No. 48/2019 and Governor Instruction No.11/DISHUB/2021), that support accelerating public use in EV and released an E-Mobility Action Plan in 2022, with the goal of reducing emissions by 2026, with 140,000 E2W, 5,719 E4W, and 50 e-buses. A plan to develop low-emission zones in 7 cities such as Besakih, Nusa Penida, Denpasar City is also being supported. In Q2-2023, there are 2759 E2W units and 389 E4W units, but no information is provided for e-bus (WRI Indonesia, 2023).

Bali Province GRDP Projection with Fair and Ambitious Scenarios in RPRKD Modeling



Source: Bappenas, 2022

- Regulations for RE development, such as for solar plant and EVs, actually already exist, but a scheme is needed to strengthen existing regulations. Achieving Bali NZE 2045 requires strong supports from the government, including at national and city level, non-state actors, and the society. Development of NZE pathway, issuance of regulations, schemes to strengthen existing regulations, other policy measures, identification of viable projects, and progressive public outreach are paramount.

5.

Energy Transition Financing Trend

Ilham Rizqian Fahreza Surya, Putra Maswan

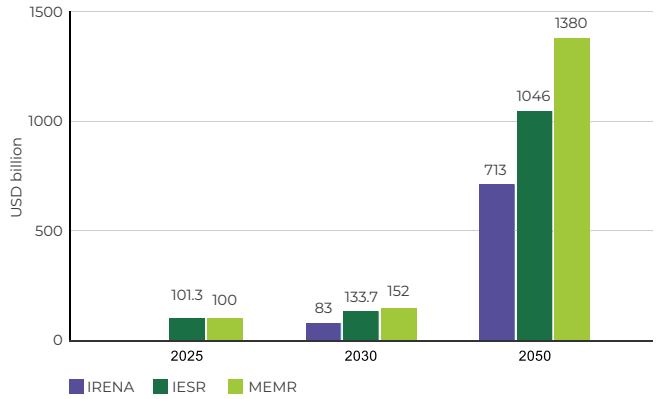
Contents:

Indonesia needs substantially more investment to reach the 2050 target, accelerating the bankable RE project pipelines and bolstering market-based incentives for innovative financing instruments are key

- Different projections on power sector investment under various NZE scenarios, such as MEMR's NZE by 2060, IRENA's 85% RE by 2050, and IESR's 100% RE by 2050, indicated that Indonesia needs cumulatively around USD 800 - 1,380 billion investment up to 2050, or around USD 30-40 billion annually on average (IESR, 2022a; IRENA, 2022; MEMR, 2023). Despite the differences among those projections, they all agree that solar PV will be the primary energy source in the future, and consequently, investment in solar PV takes the largest chunks of investment need. The share for other renewables varies among the projections, but generally hydropower and wind take around 15% of the capacity.

- The investment in renewable energy and power infrastructure has been far below the projected needs. In 2022, investment in renewable energy and energy efficiency was only USD 1.6 billion, while investment in grid infrastructure was USD 2.4 billion. Although investment realization has been lacking, there are multiple financing sources waiting for projects. This report has identified around USD 26 billion of potential financing sources are available since 2022 to support Indonesia's energy transition through various channels, i.e., bilateral and multilateral supports (including JETP and ETM) and domestic funds (such as Green Sukuk and Carbon Tax).

Total RE Investment Needs for Power Sector (in USD billion)



Source: IESR, 2022a; MEMR, 2023; IRENA, 2022

- Despite relying on solar energy in MEMR, IESR, and IRENA's projections, investment in solar energy between 2015-2021 has been underwhelming, especially compared to hydropower, which dominated the RE investment (CPI, 2023). Hydropower amassed roughly USD 6.9 billion in that period, while solar power only accumulated around USD 500 million investments. From the financiers' perspective, the main hindrance is the lack of readiness in deployable project pipelines, leading to difficulty in convincing investors to put their money. Strong coordination between PLN, regulators, project developers, and financial providers–both private and public–is required to prepare a healthy pipeline and increase bankable projects.

Presidential Regulation No. 112/2022 gives international investors confidence, leading to an increase in *project preparation*-focused pledges and an opportunity to attract more private financing

- Over the Q1 2022- Q3 2023 period, there is an additional of at least USD 1.7 billion new bilateral support commitment, on top of the USD 14 billion previously identified in IESR (2022) for the Q4 2021 and Q1 2022 period. The latest bilateral financing support reveals a growing interest in the project preparation-focused supports. Such projects mostly delve into energy efficiency and RE development for solar PV, geothermal, and hydropower. This trend especially escalated after the announcement of JETP and the PR No. 112/2022 came into effect. The latter gives international investors confidence to carry out RE projects in Indonesia.

- Some of the project preparation-focused pledges that we identified include investment by private sectors. This trend is in line with the Climate Finance Delivery Plan (2021); climate finance from developed countries until 2025 prioritizes financing through MDBs and private finance. PR No. 112/2022 is the first step, and, as the next step, building successful project pipelines could further entice more private investments.

- Private sectors (RE developers) could also utilize the ongoing trend favoring multilateral financing by accessing financing through Green Climate Funds (GCF) projects in Indonesia, such as GREM and CIO, as well as platforms such as ADB Southeast Asia Innovation Hub and Private Infrastructure Fund, ASEAN catalytic Green Finance Facility (ACGF), USAID PFAN-Asia, and IRENA Climate Investment Platform. However, RE developers are not familiar with fulfilling the required project eligibility documents, e.g., Environmental and Social Safeguards (ESS), internal audit results, and fiduciary standards, which require facilitation by both public and private stakeholders.

Updates on New Bilateral Support (Q1 2022 - Q3 2023)

Country	Name	Amount for Energy sector	Type	Focus
United Kingdom	MENTARI Energy Efficiency Strand - MENTARI EE	USD 11.7 million	Programme	Project preparation
	MENTARI Extension	USD 3.3 million	Programme	Project preparation
	UK-FCDO Low Carbon Development Initiative (LCDI)	USD 29.2 million	Grant	Policy reform (development)
Australia	Startup and SMEs climate funds	USD 50 million	Investment	Investment assistance and capacity building
Republic of Korea	Green Energy Partnership Toward Sustainable Energy Transition	N/A (under negotiation)	Agreement	Policy reform (green economy-based development)
Denmark	Indonesia-Denmark Energy Partnership Program (INDODEPP)	USD 5.2 million	Programme	Capacity building and policy reform (RE bureaucracy modernization)
Japan	Asia Zero Emission Community (AZEC)	N/A	Programme	Investment assistance
	PLN-Nippon Export and Investment Insurance (NEXI) cooperation	USD 500 million	Loan	Project preparation
United States	Indonesia-U.S. Bilateral Clean Energy Working Group	N/A	Agreement	Project preparation and investment assistance
	Net Zero World	N/A	Public-Private Partnership	Project preparation
UAE	PGEO-Masdar Cooperation	USD 360 million	Investment	Project preparation
	PNRE-Masdar Cooperation	USD 47 million	Investment	Project preparation
Singapore	Indonesia-Singapore Electricity Export	N/A	Agreement	Project preparation
Germany	GIZ SETI Programme	USD 744.5 million	Programme	Project preparation

Note: Programme funds support government initiatives, agreements are initial framework for cooperation that does not yet include nor signal immediate disbursement of funds. Meanwhile investment in this context refers to those aimed to leverage private investments.

Source: IESR Analysis

Insufficient JETP fund in financing energy transition in Indonesia, especially to finance the Just Transition

- The JETP's CIPP was officially launched by the JETP Indonesia Secretariat in November 2023 to mobilize USD 21.7 billion JETP funds, provided by IPG countries and GFANZ, to support energy transition in Indonesia. The plan comes with the Investment Focus Area (IFA), which is built to channel the funds to the priority project in the effective and efficient way as possible under the various financing instruments. The instruments include grants, concessional and non-concessional loans, bank guarantees, and equity investments.

- Indonesia needs at least USD 97.3 billion to finance the IFAs until 2030 under JETP as stated in the CIPP, and this number would increase after more IFA calculations are incorporated into the list. It shows a significant financing gap compared to the USD 21.7 billion JETP fund. The USD 21.7 billion comprises of USD 11.7 billion in public funds provided by IPG countries and USD 10 billion from GFANZ under the private or commercial fund schemes.

- To date, only public funds have been directed and projected to the IFAs along with each financing instrument category, whilst the private funds are not dispersed into any category yet. Public funds are divided into USD 4.2 billion designated and USD 7.3 billion non-designated categories. Designated refers to the allocation fund is agreed upon by the IPG countries and no agreement is settled yet for non-designated on the projection number allocated by the JETP Secretariat. Thus, if less than half of the total fund is committed to the IFA, it could create a risk for further disagreement on remaining fund allocation and failure to investment realization.

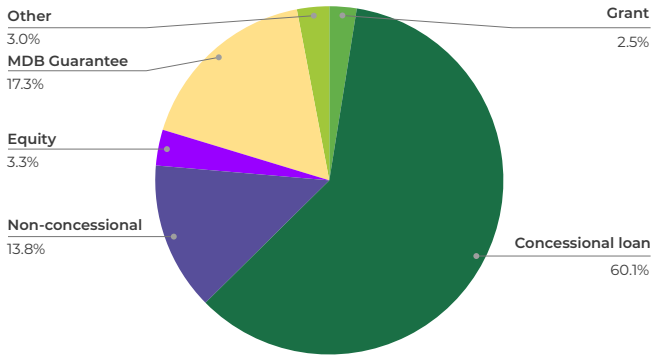
- JETP financing for Just Transition is limited and unlikely to cover all just aspect criteria stated in the CIPP, considering the transition process that will take place for three to five years. To date, only USD 353 million, or only 0.4% of the total JETP fund, has been allocated for the transition purposes in the plan. The USD 200 million estimation of the Just Transition financing needs only cover the assessment stage, but the number would surge as the intervention stage and other just aspects are incorporated. In addition, since a few of Just Transition activities are profitable, these aspects should be funded considerably under a suitable financing instrument that would not inflate the liability of the state budget.

JETP Investment Focus Area (IFA)

Category	units	Investment needs (USD)	Public fund allocation	
			Designated (USD)	Non-designated (USD)
All IFA eligible			598.1	1,844.2
All IFA eligibile except early retirement CFPP			N/A	4,351.4
IFA1 Transmission lines and grid deployment	-8,000-14,000 kmc	19,700	771.6	540.4
IFA2 CFPP early retirement	1.7 GW	1,100	1,672.6	32.4
CFPP managed phase-out	55.8 GWh	1,300		
IFA3 dispatchable renewable energy deployment acceleration	16 GW	49,200	850.7	533.9
IFA4 variable renewable energy deployment acceleration	40 GW	25,700		
IFA5 renewable energy value chain enhancement	N/A	TBD		
Just transition	N/A	200*	353.1	
Total		97,300	4,246.1	7,315.6

** Minimum estimation before all just criteria incorporated in the CIPP*
*** All monetary amount presented in 2019 USD million*
Source: JETP CIPP (JETP Secretariat, 2023)

Breakdown of Public Fund in Types of Financing Instrument Used



Source: JETP CIPP (JETP Secretariat, 2023)

Energy Transition Mechanism (ETM) provides various finance mechanisms to early-retire CFPPs; transparency is required to avoid overvaluation of retired CFPPs

- Early retirement of CFPP is a crucial aspect of energy transition and climate mitigation, but it will require significant investment. ETM is one of the existing platforms used to explore options to retire CFPPs early. So far, it has managed to accumulate USD 2.5 billion (USD 500 million from CIF-ACT and USD 2 billion from MDBs).
- PLN's subsidiary owned the CFPP Pelabuhan Ratu (3x350 MW) and IPP-owned CFPP Cirebon-1 (660 MW) have been chosen as the first ETM early retirement projects under *portfolio* and *synthetic models*, respectively. Both CFFPs are relatively young, with only about ten years of operation. The funds for the projects will come from a mix of concessional and private sector capitals channeled through the ADB. Concessional funds will include donor-supported funds to ADB's ETM Partnership Trust Fund (ETMPTF) and a portion of Indonesia's allocation from the Climate Investment Funds.
- The implementations of ETM's *synthetic model* towards Cirebon-1 as of Q3 2023 still have some drawbacks. ETM does not implement any payment caps under this model to CFPP operators to accelerate retirement. Consequently, the operating companies, including PLN, face risks of paying back loans at a highly inflated rate. Moreover, ETM payments towards the IPP and PLN consist of loans, i.e., the USD 500 million of soft loans expected to leverage USD 4 billion of investments, which can potentially create additional financial burdens and compound high levels of foreign debt.
- The decision to early-retire Pelabuhan Ratu, valued at USD 870 million, is enigmatic, as the required fund is around USD 800 million per GW. This value is almost twice as expensive as the Cirebon-1 early retirement, valued at USD 250-300 million. Owned by PLN's subsidiary, Pelabuhan Ratu is classified as a state-owned asset, where sometimes its board of directors (BoD) could influence its valuation. Therefore, it can lead to asset overvaluation. This situation results in the stipulation of MSoE Regulation 2/2023, which obliges the use of external appraisal for state-owned asset valuation. However, under the regulation, the BoD could still overrule the external valuation under certain conditions.

Transaction Models to Accelerate Retirement/Repurposing of CFPPs

Acquisition Model[1] (SPV Level)
ETM acquires share capital in CFPP
ETM to take role as owner and operator of the coal plant
ETM agrees an early termination date with the utility and operates the plant until that date and then closes it or repurposes
Most suitable for **IPP plants with international bankable PPA**

Synthetic Model (SPV Level)
ETM invests senior/junior debt and/or other mezzanine capital to the CFPP
Equity ownership and operational responsibility kept with the current asset owner
Investment conditional on early termination being contractually agreed with owner and utility and appropriate security being provided
Most suitable for **IPP plants with international bankable PPA**

Portfolio Model (Corporate Level)
ETM provides funding to the corporate sponsor with CFPPs and greenfield clean energy projects
Sponsor guarantees greenfield clean energy projects will be built and coal plants retired ahead of schedule
Incentives (such as penalty interest) can be used to ensure that the transition occurs
Most suitable for **Utilities with a portfolio of plants**

Note: (1) The Synthetic model is the transaction model used by the ETM to support Cirebon-1 phase-out; (2) Acquisition model to be used only in exceptional scenarios
Source: ADB, 2023

Some regulations on carbon pricing are still missing but the implementation is still in the early stage which leaves room for improvements

- There are seven main legal instruments regulating carbon pricing in Indonesia. However, there are regulations related to the implementation that are still pending. First, despite being mandated by Law No. 7/2021, the carbon tax roadmap is still in preparation with no set finalization date. Secondly, despite being referenced in GR No. 98/2021 and MoEF Regulation No. 21/2022, emission cap values for sectors other than electricity are not yet defined. In addition, the MoF is still formulating carbon tax base and tariff. All-in-all, without the promulgation of an implementation roadmap, the timeframe for a full implementation of carbon pricing mechanism remains unclear.

- Indonesia will proceed with the initial carbon tax rate of IDR 30,000/tCO_2e. In line with international best practices, the Indonesian Government should incorporate a gradual increase of the carbon tax rate, which outlines milestones and targets for each adjustment.

- Revenue generated from the carbon tax and carbon trading will be registered under the APBN. On the other hand, Law (UU) No. 7/2021 on Tax Harmonisation only stipulates that carbon tax revenue "can be allocated to climate change management". Therefore, the carbon transaction revenue will not be earmarked. Although carbon revenues are likely to flow through the Indonesian Environment Fund (BPDLH), plans for revenue allocation have not been finalized as of Q4 2023. It is important for Indonesia to establish a transparent monitoring system of the use of carbon market funds and maximise its use for green infrastructure.

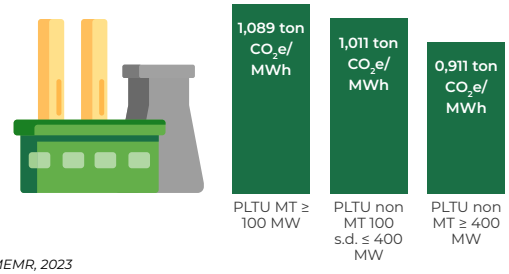
- Indonesia launched its domestic carbon exchange in September 2023. On the first day, due to its euphoria, the transactions reached IDR 29.2 billion. However, until the end of October 2023, the total transaction was only increased by IDR 200 million, highlighting the lack of demand. To further strengthen the market and balance supply and demand, Indonesia must offer incentives for companies to buy carbon credits and also take precautions to ensure that carbon prices remain competitive.

- Validation, credibility, and data transparency are fundamental aspects that should be carefully monitored. MoEF should use transparent and internationally recognized calculation methodologies of carbon credits traded through carbon market to avoid double counting and ensure accountability. In addition, to prevent companies from merely purchasing carbon credits to offset their emissions, Indonesia should develop a mechanism that requires every carbon purchase to be accompanied by emission reduction strategy (GRI 305-5). In principle, carbon credits should only offset most unavoidable emissions.

Regulation	Highlights
Law No.7/2021	Set carbon tax rate of IDR 30/kilogram CO_2e, elaborating the basis of the upcoming carbon tax and carbon trade roadmaps.
GR No. 46/2021	Stipulates that carbon trading revenue "can" be one of the source of fundings for environmental rehabilitation efforts
GR No. 98/2021	Procedures and principles to calculate, set, and utilize carbon economic value, including validation and verification processes
MEMR Regulation No. 22/2019	Guideline on the inventorization and mitigation of GHG in the energy sector
MoEF Regulation No. 21/2022	Guidelines and procedures to set carbon economic value used as reference for carbon trading in the carbon exchange market
MEMR Regulation No. 16/2022	Procedures of carbon economic value implementation in the electricity generation subsector
OJK Regulation No. 14/2023	Outlines the definitions of carbon units traded and parties that can conduct carbon trading, IDR 100 billion of capital required to partake in carbon trading, role of OJK as overseer of the carbon exchange.
Regulations in Development as of Q3 2023:	
MoF Regulation on tariff and tax base of carbon tax	
MoF Regulation on carbon tax implementation procedure and mechanism	
GR on carbon tax roadmap	
GR on subject and allocation of carbon tax	

Source: IESR Analysis. 2023

Emission Cap for CFPP for Carbon Trading



Source: MEMR, 2023

More market-based incentives are required to bolster Green Bonds issuance; RE projects need better reporting to attract more Green Sukuk allocation

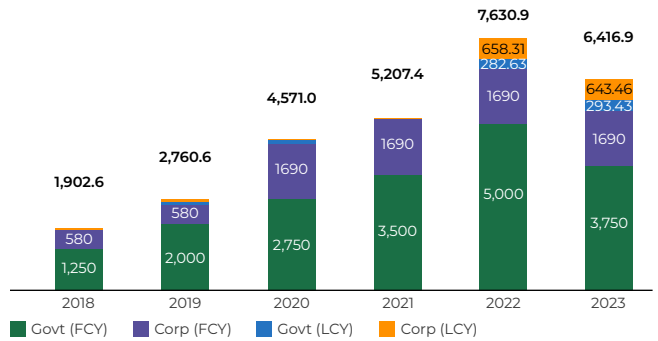
- The green bonds market in Indonesia has reached an all-time high of USD 7.6 billion in 2022 and reached USD 6.4 billion in March 2023. From the demand side, the Indonesian Stock Exchange estimated that the number of investors of green bonds in Indonesia would reach more than 10 million investors in early 2023. Between Q4 2022 and Q2 2023, there were several issuances of green bonds from state-owned and private entities with a total amount of around USD 1.6 billion.

- POJK No. 60/2017 allows OJK to establish regulations to implement market incentives and disincentives to make green bonds more lucrative. The OJK Board of Commissioners Decision No. 24/KDK.01/2018 stipulates registration fees for public offering of green bonds at 25% of the standard fees for conventional bonds. However, more attractive incentive is required, such as full registration fee waivers as implemented by Thailand. Subsidy scheme practices, carried out by the Hong Kong Monetary Authority and Monetary Authority of Singapore are one of the best practices to reduce green bond issuance fees. The introduction of tax incentives for green projects, through low or fixed tax rates, can also ensure long-term certainty for investors and green bond issuers.

- The utilization of Green Sukuk Use of Proceeds (UoP) for RE and energy efficiency fluctuated between 2018 and 2022, with the majority were allocated for refinancing of projects implemented in previous years rather than for the development of new ones. This trend highlights the potential to incorporate UoP into the capital of new projects. Furthermore, refinancing existing projects is sometimes perceived as providing no additional benefits to the environment compared to financing new projects and hence considered as greenwashing.

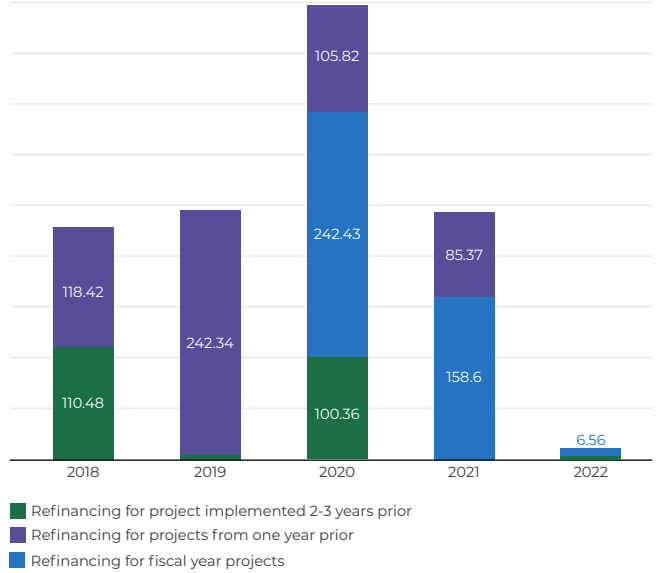
- Most of Green Sukuk UoP was allocated towards transportation-related projects (USD 680 million) instead of RE power plants (USD 405 million), indicating that currently projects in the transportation sector are more feasible for Green Sukuk UoP compared to RE projects. To increase allocation of green Sukuk UoP to RE, the energy sector needs to improve its measurement, reporting, and verification to better highlight the lucrativeness of renewables.

Indonesian Green Bonds Outstanding by Issuer Type (USD million)



Source: Asian Bonds Online, 2023 (Accessed July 2023)

Green Sukuk UOP Allocation for RE (2018-2022) (USD million)



Source: Ministry of Finance, 2019 - 2023

National banks upped their investment in RE but are still involved in fossil fuel financing; adopting the TCFD framework would elevate their climate commitments

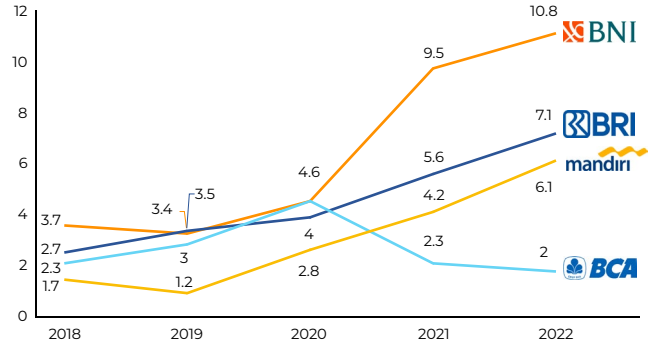
- RE financing from the top four national banks with the highest total asset value has grown from IDR 21.6 trillion in 2021 to IDR 26 trillion in 2022, showcasing a 20.3% increase between 2021 and 2022. Bank Mandiri has the highest increase in RE financing (IDR 1.9 trillion), followed by BRI (IDR 1.5 trillion) and BNI (IDR 1.3 trillion). In contrast, BCA showed a further decrease in RE financing by IDR 0.3 trillion.

- Still, loans channeled for the mining sector, including coal, was 30.9% higher than RE financing. Audited annual financial reports in December 2022 show that these four banks channeled loans to the mining sector for a total of IDR 34.05 trillion in 2022, consisting of IDR 14.3 trillion (Mandiri), IDR 12.3 trillion (BNI), IDR 3.7 trillion (BCA), and IDR 3.6 trillion (BRI).

- To increase transparency in climate-related risk disclosure, Task Force on Climate-related Financial Disclosures (TCFD) provides framework that could be followed by companies and financial institutions. Of the four banks with the highest asset value per 2023 (BRI, BCA, Mandiri and BNI), only Mandiri and BRI have implemented four areas of the framework. These banks have implemented the TCFD framework but their climate-related risk (CRR) has not yet addressed the power sector let alone RE, despite the power sector being the highest contributor to the country's emissions.

- PLN has released its TCFD report (2022), but several gaps still exist. Although PLN has an Energy Transition and Sustainability Division, its specific roles and linkages with other departments are not yet clearly reported and specific KPIs have not been disclosed. Furthermore, the PLN TCFD report has not included all PLN assets' climate risk, which makes the total potential losses due to climate change unclear. Despite the development of climate scenarios, PLN has not yet made explicit links between climate scenarios and how mitigation strategies should be implemented. Thus, there is room of improvements for PLN to enhance the report and disclose more detailed information.

Credit Mobilisation towards RE from Banks with the Highest Total Asset Value (2018-2022) (IDR Trillion)



Source: IESR Analysis

TCFD Framework Elements and its Implementation in Indonesian Banks and PLN

TCFD Framework Guidance				Bank Mandiri	Bank BRI	PLN
1. Governance	1A. The boards' oversight the climate-related risks (CRR) and opportunities	1B. The management's role in assessing and managing CRR and opportunities		1A. ✓ 1B. ✓ (Implemented and reported)	1A. ✓ 1B. ✓ (Implemented and reported)	1A. ✓ 1B. X The management's specific role especially with other departments is not yet clear, KPIs are not yet specific.
2. Strategies	2A. CRR and opportunities identified over the short-, medium-, and long-term	2B. The impact of CRR and opportunities on business, strategy & financial planning	2C. Resilience of the strategy, taking into consideration different climate scenarios, including a 2°C or lower	2A. ✓ 2B. ✓ 3C. ✓ (Implemented and reported)	2A. ✓ 1B. ✓ 2C. X	2A. ✓ 2B. X 2C. X Climate scenarios are available but not yet clearly linked with PLN's strategies
3. Risk Management	3A. The organization's processes for identifying and assessing CRR	3B. The organization's processes for managing CRR	3C. Processes for identifying, assessing, and managing CRR integrated into overall risk management	3A. ✓ 3B. ✓ 3C.✓ (Implemented and reported)	Implemented limitedly (ESG risk policy was implemented only for palm oil, pulp, and paper sectors).	3A. ✓ 3B. ✓ 3C: X Identification & assessment of physical climate risks have not been applied to all assets.
4. Metrics and Targets	4A. Disclose the metrics used by the organization to assess CRR & opportunities in line with its strategy & risk-management	4B. Disclose scope 1-3 GHG emissions, and the related risks	4C. Describe the targets used by the organization to manage CRR and opportunities and performance against targets	4A. ✓ 4B. ✓ 4C: Implemented limitedly only for carbon initiatives (planting of forests & trees)	4A, ✓ 4B: Implemented limitedly (scope 3 intensity is still being developed) 4C. ✓	4A. ✓ 4B. X 4C: X Emissions have been identified, and targets of emission reductions have been set without clear pathways or plans to reach the targets.

Source: TCFD, 2021; Bank Mandiri, 2023; BRI, 2022; PLN, 2022

The on-progress Indonesia Sustainable Taxonomy considers some fossil-based activities with 'green' labels, raising concern of 'greenwashing'

- As of November 2023, OJK is currently developing the Indonesia Green Taxonomy (THI) into a Indonesia Sustainable Taxonomy (TBI). Departing from the THI, the first version of the TBI will focus on the energy sector before covering other NDC sectors and is expected to be released in early 2024. The updated taxonomy aims to broaden the scope of sustainable finance, which incorporates transition finance to promote low-carbon economy. Social aspects, quantitative criteria, and clear assessment questions are the enhancements of TBI, which was adopted from the ASEAN Taxonomy for Sustainable Finance Version 2 (ATSF V2) launched in March 2023.

- TBI would replace the 'traffic light' classification with 'green' and 'transition' categories. However, the 'transition' category potentially creates a blurred line between the environmentally harmful activities to fall into the 'transition' or even 'green' activities. For example, new and existing CFPPs are now being considered into 'transition', while early retirement of CFPPs could be considered 'green' or 'transition' depending on the retirement target. In addition, there are no time limits or deadlines to be eligible as transition activities and self-judgement is used to perform the assessment. To avoid greenwashing risks and maintain Indonesia's taxonomy credibility, precise definition of 'green' and 'transition' activities, tight criteria, and external assessor must be carefully considered by OJK during the design and implementation.

- To ensure continued credibility of TBI, OJK is considering a life-cycle emission assessment in the next iteration, specifically for critical activities like early retirement of CFPPs, including the screening of its preceding value chains. Ideally, CFPP retirement should only be categorized as green in TBI when it is directly replaced by RE projects and when the CFPP is not powering other high-emission activities, such as captive smelters.

- For now, taxonomy is a voluntary guideline for financial institutions to identify the green portfolio of their business. However, some financial institutions struggle to utilize taxonomy in their business due to lack of capacity and no incentive from the government. As the government is also considering developing taxonomy law, TBI would fill the gap for financial institutions and improve its adoptions.

Key Highlights of Indonesia Green Taxonomy (THI) and Indonesia Sustainable Taxonomy (TBI) Draft

Aspect	THI V.1 (2022)	TBI V.1 (Draft per 29 Oct 2023)
Category	Red: Harmful activities Yellow: Not significantly harmful Green: Bring advantages to the environment and meet technical ministries criteria	Green: Align with Paris Agreement target and Indonesia's NZE target Transition: Do not align with Paris Agreement target but shifting to green activity
Activities	919 subsector based on Standard for Industrial Classification (KBLI).	Focus on energy-related activities
Social Principles	No detailed criteria for social aspect	Enhancement of social aspect including human rights, labour, and economic impact to community around investment area
Screening Criteria	No metrics measurement; relies on government policies to categorize sectors	Quantitative and qualitative assessment
External Policy	Do not consider any on-going policies	Incorporates NDC, NZE target, early retirement roadmap, JETP, ETM, and downstreaming program into activity categorization

Source: OJK, 2023/

Activities Categorization on TBI Draft

Green	Transition
Electricity Generation: Solar, wind, tidal, hydro, geothermal, gas, bioenergy, nuclear, early retirement of coal plants (2040), and CCS.	Electricity Generation: Hydro, geothermal, gas, bioenergy, early retirement of coal plants (2050), new and existing coal plants
Mining, quarrying, and extraction: silica sand quarrying, critical minerals mining, uranium and thorium mining	Mining, quarrying, and extraction: Coal mining, coal gasification, silica sand quarrying, critical minerals mining, uranium and thorium mining

Source: OJK, 2023.

Socio-Economic risks of the energy transition should be considered holistically to implement a Just Transition

- Ensuring a Just Transition would entail high financial costs towards creating green jobs and ensuring worker support packages, i.e., reskilling, social packages, and job transfer support. In Indonesia's net-zero 2050 scenario, estimated job creation ranges from 1.8 to 2.2 million in RE, BEV technology, and waste management (Bappenas, 2022). At the same time, the energy transition is projected to lead to job losses between 2025-2050 job losses from fossil power plants (including manufacturing, construction, operation, fuel production) around 185,000 but at the same time job creation from RE, storage and grid could reach 3 million (IESR, 2022a). Additionally, the lesson learned from different cases across countries is that the *rehiring packages* are the most substantial support, where the company policies play a significant role in the implementation.

- As of November 2023, Ministry of Manpower is still developing a comprehensive transition roadmap for labors. Ideally, the roadmap should consist of and identify the appropriate range and volume of skilled workers and competencies to support the energy transition, while also maps formal and informal workers impacted from the transition. The government should collaborate with the RE business sector and labor associations to gather employment data and skill requirements for better labor transition policies.

- As mentioned previously, JETP allocation funds for the just labor transition focus will be based on assessments at the project level through programs implemented under three approaches: *custodianship* (stakeholder consultations and support, skills development, job impact monitoring); *policy* (workers' compensation policy development, social protection, strengthening social and environmental safeguards), and *research* (filling data gaps, technology transfers, and promotion of gender equality and circular economy). It is important to streamline each transition activity or project with these frameworks, ensuring adequate standards and implementation of impact assessments and identifying opportunities to acquire alternative sources of financing to implement socio-economic mitigation measures.

Summary of International Practices Related to the Financial Costs for a 'Just Transition'

Cases	Costs	Types of Support
Spain Endesa Power Plant	USD 164,937	Training for Endesa coal plant operators (500 people) as an employment requirement in RE power plants.
Australian Federal Government Support for Hazelwood Power Station	USD 17.64 million	Retraining programs and job-seeking assistance, creating 500 local jobs, diversifying the regional economy and building high-skill workers.
Canada Alberta Coal Community Transition Fund	USD 4.99 million	Funds allocated for approved projects in Alberta, encompass support for community transition planning, implementation of economic strategies aiding local businesses, such as coaching and training.
Pledges by China's State and Regional Shanxi Governments for worker training and job creation in response to coal and steel closures in Shanxi Province.	USD 1.69 billion	Support job transfers, retraining, early retirement and the creation of public service jobs. Successfully re-employed 31,600 workers in the region.
Poland Eastern Wielkopolska Coal Phase-out Program	USD 66.25 million (Avg.)	Improving private sector employee qualifications, support in finding employment and relocation for miners and family members, provision of trainee pensions and bridging allowances, vocational counseling, retraining programs, psychological support.
United States' Appalachian Regional Commission Investment via Partnerships for Opportunity and Workforce and Economic Revitalisation (POWER) Initiative	USD 46.4 million	Support 57 projects that will create/retain 9,187 jobs, workforce development area includes training projects focus on the upward mobility through upskilling, retooling and establishing distinct career pathways, as well as increasing labour participation rates targeting underemployed workers.
Greece 2021 Recovery and Resilience Plan, including energy and climate transition in 4 regions.	USD 1.79 billion	Green skills improvement through training programs in cutting-edge technologies, with a focus on vocational training and human resource certification actions and job-search assistance.
United Kingdom Green Jobs Taskforce implementation of its Ten Points Plan for a Green Industrial Revolution	USD 15.42 billion	Expected to create 250,000 green jobs including engineers, fitters, construction workers, among many others by 2030. Sectors for new investment include offshore wind, hydrogen, advanced nuclear, zero emissions vehicles, green buildings and CCUS.
South Africa Just Transition Calculation of Cost up to 2043	USD 101 million	Workers compensation, retraining, and relocation.

Note: There are four categories of scope from these cases: those that are aimed at specific power plants (Spain and Australia), those targeting specific regions (Canada, China, and Poland), initiatives targeting several regions (United States, Greece), and national initiatives (United Kingdom and SA estimation).
Sources: IEA, 2022; ARC, 2021; Pogoda, 2021; Government of Spain, 2020; WRI, 2021; Cruywagen et al., 2020); Government of Alberta (n.d.).

Rehiring/Support Package (National Average/Worker)

Spain	Australia	Canada	United States	Poland	United Kingdom	South Africa
USD 12,739	USD 45,115	USD 25,316	USD 15,467	USD 7,025	USD 34,340	USD 22,100

Sources: IESR, 2022b; Bhushan, 2023.

6.

IESR's Energy Transition Readiness Assessment

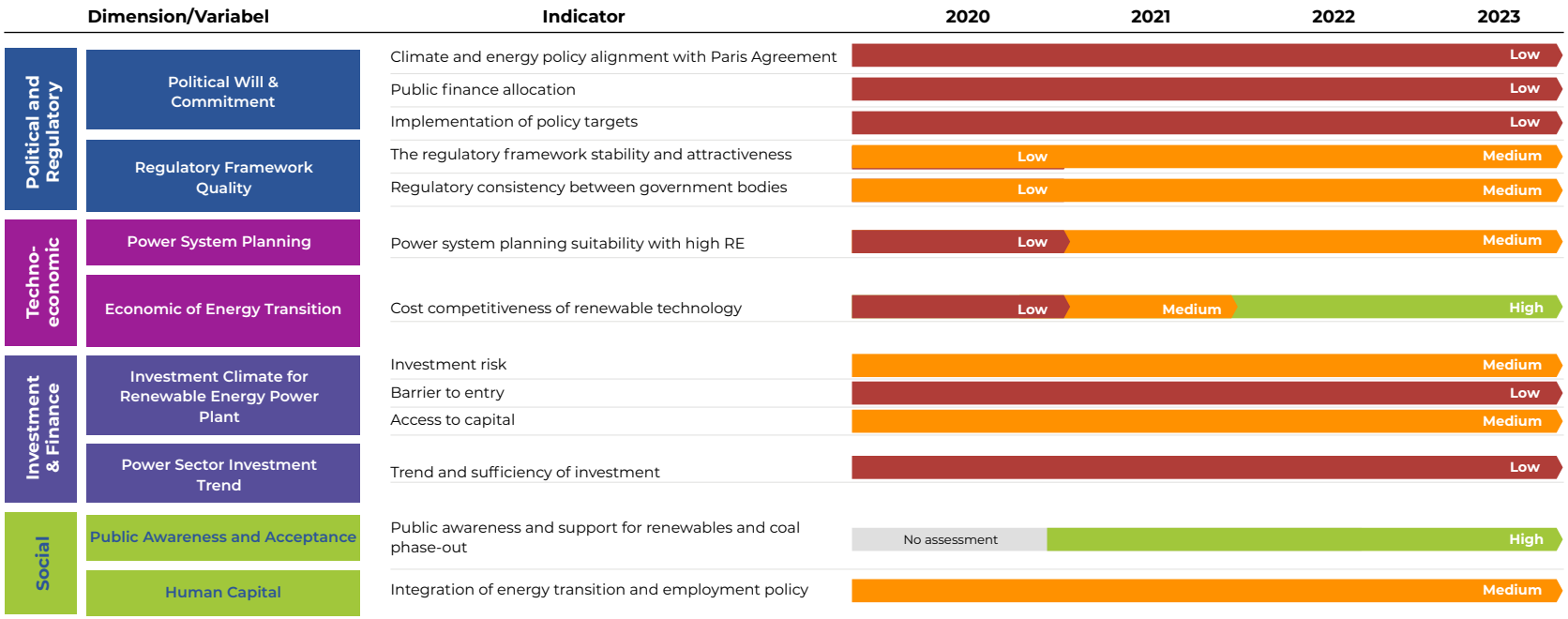
His Muhammad Bintang, Martha Jesica Solomasi Mendrofa

Contents:

- Energy transition readiness framework assessment
- Highlights on 2023's transition readiness framework

Despite the recent updates on political commitment, enabling environment of Indonesia's energy transition in power system still shows limited progress

- Since 2020, IESR has built a comprehensive framework to assess Indonesia's power system transition readiness. This assessment consist of 4 dimension of indicators: 1) Political and Regulatory; 2) Techno-economic; 3) Investment and Finance; and 4) Social (the details are presented in the Appendix G).
- Over the past four years, limited progress has been observed in crucial areas such as political will and commitment, regulatory framework, investment climate, and human capital policy. Even with the newest government commitment this year, the 2023 TRF rates appear to be consistent with the last year's evaluation due to minimal updates in comparison to the broader energy transition regulatory landscape. The absence of improvement in the overall assessment indicates that the existing commitments have not yet harnessed the full technical potential of the power system transition. Below are the findings of the 2023 readiness assessment:



Indonesia's policy trajectory for power system transition is expanding, but enhancing financing access and streamlining regulation are needed to bridge the implementation gap

- Indonesia's commitment to emission reduction is growing, as seen from the evolving policies. The upcoming 2025-2045 RPJPN targets a 70% RE mix by 2045, aligning with the Enhanced NDC that targets NZE by 2060 or sooner. This plan emphasizes economic growth and addresses emission reduction through initiatives like the green economy transformation, with further specifics awaited. The government is currently revising the 2014 KEN to elaborate more on decarbonization targets in energy sectors. This revision, set for publication next year and followed by a new version of RUEN, signals increased government commitment. Additionally, Indonesia has intensified its commitment through the JETP to peak power emissions in the PLN grid to 250 $MtCO_2$ by 2030, which is equivalent to increase RE mix target of 44% in 2030. Despite the higher commitment target, only 15% has been achieved according to MEMR (Setiawan, 2023), highlighting the need for swift implementation through technical guidance such as clear allocation direction and comprehensive criteria for designated areas.

- Despite the fiscal policy scheme, Indonesia's current fiscal capacity is insufficient to meet the financing needs for transition, for example, around USD 965 billion to achieve RPJPN decarbonization effort by 2045 according to Bappenas (Sukmana, 2023) or more than USD 500 billion to achieve NZE 2060 target (MoF, 2023). Only 2-4% of public finance is allocated for clean energy until 2020 (Energy Policy Tracker, 2021; IESR, 2022), while it was recently suggested that up to 30% of APBN might aid decarbonization (Hakim, 2023). In addition, 60% of surveyed developers in 2023[1] expressed agreement on the insufficiency of public financing for power system transition. This fact emphasizes the need for enhanced access to various financing sources, including innovative, international, and private financing.

- In the implementation to achieve RE installation targets, challenges that have been causing project delays need to be evaluated so that targets committed in RUPTL are met by 2030. From the RUPTL's 2 GW target in 2023, only about 340 MW capacity of RE projects has been commissioned by Q3. Most of them are also projects with delayed COD, including the 145 MW Cirata solar PV. Notably, a huge share of this year's target was expected to come from the projects in dedieselization program, which are under-delivered. PLN has just carried out the program's reauction process after last year's RFP failed to reach PPA.

Climate and energy policy alignment with Paris Agreement rating: Low

Public finance allocation rating: Low

Implementation of policy targets rating: Low

Climate-Related Fiscal Policy in Indonesia

State Revenue	State Expenditure	Budget Financing
Tax Incentives	**Central Gov**	**Green Sukuk**
VAT cut	Line Ministries spending	Global green sukuk
Property tax cut	Deconcentration fund, i.e., physical DAK, DID, DBH-DR	Retail domestic green sukuk
Tax allowance & tax holiday	Disaster risk financing	**SDG Bond**
Luxury tax cut for EV	**Subnational Gov**	**Project financing PPP**
Import duties exemption	Local transfer fund	PDF / AP and VGF
Non-tax revenue	Allocation funds	Direct lending
Carbon tax to CFPP	Sharing fund	Subsidiary loan
		Guarantee

*Source: Compiled from MoF Presentation on Indonesia ET Policy (*Kacaribu 2023*)*

[1] The results of the 2023 IESR developers survey are presented in Appendix H

The updating process of several key policies is dragging and poses uncertainty of pathway to comply with new climate ambitions

- Several energy sector's key policies have met the stability criteria of readability, longevity, and resiliency from short-term political changes. However, energy-related regulations such as KEN (2014-2050) and RUEN (2017-2050), which have been in place for a while and have a long validity period, are currently in the process of being revised to better accommodate climate commitment, concurrently with the drafting of the New and Renewable Energy Bill. Additionally, this revision will also influence local energy regulation certainty, as 30 provinces already have RUED, requiring adjustment based on upcoming KEN and RUEN. Although these new regulations will clarify long-term plans and implementation in the energy sector, the long waiting process has caused hesitation and disinclination in the development of RE.

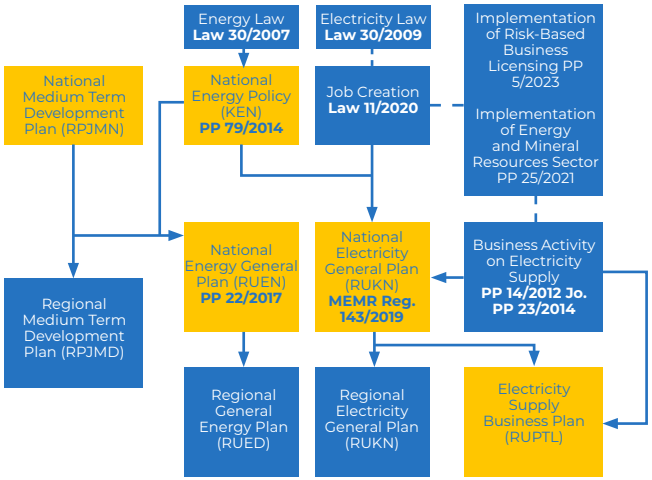
- In terms of attractiveness, half of ten surveyed developers considered the overall regulatory frameworks could attract RE investment, but still required some improvements. Most of them expressed the need of tariff improvement (in PPA), and believed incentives such as FiT, tax holiday, and viability gap fund would increase the project economics and attract more investors. For the ease of doing business, some developers were not content with the complexities of obtaining licences and permits, such as AMDAL and water utilization permits for hydro project, and PLN's SLO for solar PV project. One solar PV developer, specifically, pointed out the recent capacity limitation as one of the current regulations needs to be revised to increase the attractiveness of RE investment.

- There is no meaningful new regulation related to air quality, energy efficiency and conservation, as well as rural electrification from other government bodies to support power sector decarbonization.

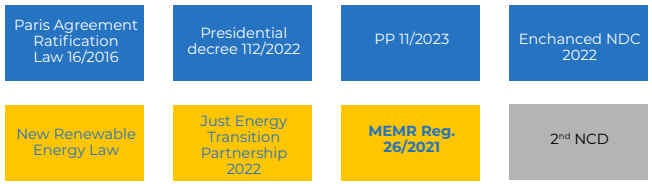
The regulatory framework stability and attractiveness rating: Medium

Consistency with other regulations rating: Medium

Indonesia's Regulatory Framework for Energy and Electricity Planning



Several supporting regulations and commitments to reduce GHG and increase renewable energy deployment



Source : IESR analysis from several references

Note: yellow: under revision or drafting process; grey: intended to be drafted

RE deployment target keeps on improving; however, the RE operation, procurement, and development rules have not adapted to accommodate the target achievement

- The assessment of the power system planning suitability with high RE results in a rating of medium. It considered the RE installation plan, grid code suitability, and fossil power plants retirement and replacement plan. For the RE installation plan, the high rating has been obtained since the establishment of PLN's 2021-2030 RUPTL where RE dominates the capacity addition for the next ten years. Further, PLN just revealed its plan to update RUPTL with a longer period of up to 2040, which likely follows its recent sustainability strategy document, expecting a total RE share of 52% and 69% by 2040 and 2060, respectively.

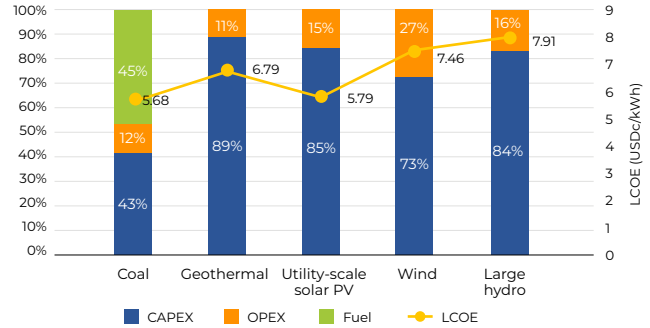
- A new grid code is needed to accommodate future power system with the targeted RE penetration. It should provide a detailed guideline on how to integrate and control the intermittency given the increasing share of VRE in the latest target. One important aspect that will need to be added is a long-term system flexibility. The code to ensure the security, quality, and economic operation of power system was last updated in 2020, when it was issued for the first time regulates the VRE. To date, there have been no clear que on when the new code will be released.

- Fossil power plant retirement is essential not only to meet the emission reduction targets but also to make room for RE penetration, particularly in the overcapacity condition. The GoI is still working on the coal early retirement roadmap and this effort is supported by a recent PMK regulation on potential CFPP retirement funding. However, recent JETP CIPP documents suggest that the appetite for early retirement is diminished.

Power system planning suitability with high RE rating: Medium

Cost competitiveness of renewable technology rating: High

LCOE and the Cost Component Contribution



Source: IESR analysis

- RE technology competitiveness keeps increasing, particularly, the variable solar PV and wind where several projects have recently reached PPA of less than 6 USDc/kWh. However, they are still not in the same playing field with CFPP ones which generation costs have been used as a benchmark. Many VRE projects with low PPAs do not yet comprise costly energy storage technology which is very likely become a prerequisite for future projects. In contrast, the generation costs of CFPP that are mainly from its fuel costs has been significantly brought down by the DMO price regulation.

- The ceiling price in PR No. 112/2022 is currently in the evaluation process. While PLN revealed several mini-micro hydro power plants has reached PPA with agreed price of less than 80% of the regulated price, other RE developments have been sluggish. An 80% of surveyed developers was not satisfied and believed that the existing regulation can be improved, despite suggestion that it is better than previous one (MEMR No. 50/2017). Besides the pricing adjustment due to global condition (e.g., increased interest rate), supplementary regulation and support mechanism such as risk distribution schemes are required to enable low but bankable pricing.

Absence of improvement in Indonesia's climate investment deters interest, urging clearer regulations to enhance investment attractiveness for RE businesses and financiers

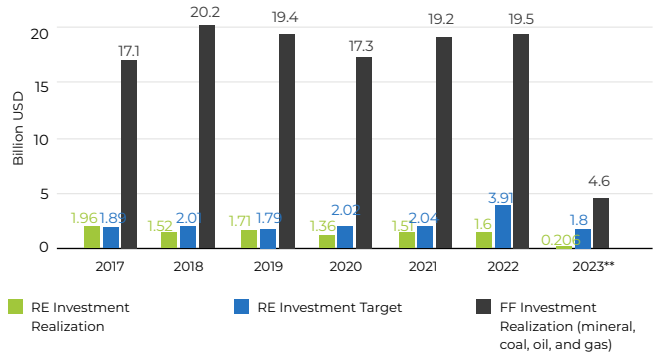
- Indonesia's investment risk for RE shows no changes from the previous year, which remains in the *lower-medium* grade according to OJK updates on Indonesia's sovereign credit ratings 2023. Similarly, investment freedom index of Indonesia remains *repressed*, making the investment landscape in Indonesian projects unattractive in general. At the project level, 60% of surveyed developers in 2023 expressed that the permitting procedure for RE projects is time-consuming and adds up to the transaction cost, highlighting the need for improvements in certain aspects, including the clarity of PLN's permits and regulations, certainty and consistency of land use/acquisition regulations and power procurement, process on local authorities recommendation, economics and bankability of purchase agreement, and clearer incentives (e.g., tax and VGF).

- RE investment target by MEMR in 2023 is USD 1.8 billion, yet only around 29.4% of it has been obtained until the latest data of Q2 2023. This year's target for RE investment is also 46% lower than last year's target. The value of RE investments consistently lags behind FF investments, with no significant increase observed over the past six years. Investment in both RE and FF declined in 2020 due to market uncertainty during the global COVID-19 pandemic, but it gradually recovered after 2020.

- Additionally, bank financing for the renewable sector in Indonesia remains limited compared to the funds allocated to fossil energy. Until late 2022, Indonesian banks directed 80-90% of their investments towards FF, and the same trend was found among the foreign banks (PRAKARSA, 2022). Further, according to our finding from interview with national banks in 2023, GoI regulation about ET financing (i.e., Green Taxonomy, PR No. 112/2022) is comprehensible and adoptable in essence, but in practice, it is incoherent with the existing international commitments and other national development rules. Another factor contributing to an unattractive investment climate in Indonesia is the high credit interest rate from the local and national banks compared to the foreign banks (BI, 2023). This fact is supported by the statement of 80% of the surveyed developers in 2023 who viewed that loans from local banks are accessible but with high interest rates.

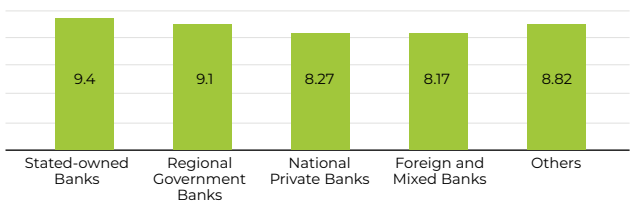
Investment risk rating: Medium	Access to capital rating: Medium
Barrier[2] to entry rating: Low	Trend and sufficiency of investment rating: Low

Indonesia's RE vs FF Investment Realization 2017-2023



Source : IESR Compilation of MEMR and KataData, *2023*

Credit Interest Rates (%) by Bank's Group in September 2023



Source: BI, 2023

[2] Barrier to entry is consistently assessed within the context of energy transition readiness, wherein a high barrier to entry results in a low rating in the TRF

The public's awareness and support on energy transition agenda are robust but not followed by adequate government strategy for preparing employment in transition

- A significant portion of Indonesians are well-informed about climate change, as 93% of the public[3] in 2022 and 2023 agreed that climate change is an urgent matter. Respondents with diverse educational backgrounds show similar opinions on the urgency of climate change, underscoring its significance across society. Action is important to follow after gaining awareness, but it is still lacking as only a few people have done environmental action (Leiserowitz et al., 2023), calling for continuous public engagement to drive meaningful actions. Awareness of climate changes empowers informed decisions, such as reducing carbon footprint and opting for RE sources, and can lead to greater public support for climate-related policies. Additionally, this year's survey in Indonesia shows a near-even split between publics who find government climate policies inadequate and those who don't, with a slight edge for the latter by 3.7%. Public argues that deforestation and peatland degradation are the leading factors contributing to climate change, followed by energy, waste, and industry.

- In line with the prevailing public awareness of climate change, a substantial 86.3% of public surveyed in 2023 also know about energy transition. Around 64.4% of the public argued that coal as a source of electricity generation should be gradually substituted with renewable sources due to its high emissions. Solar energy stands as the preferred electricity source by Indonesia's public, with 47.4% selecting it as their top choice among all energy sources, followed by wind and hydro.

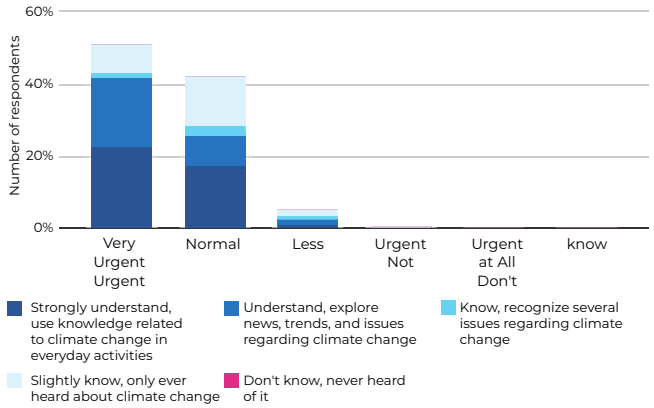
- On the human capital side during energy transition, the current regulatory framework has shown limited progress from last year. Indonesia plans to integrate the Green Economy Index into national development planning, potentially creating 1.8 million green jobs in 2030 (Bappenas, 2023), and the Ministry of Manpower is also developing an employment transition roadmap. However, the implementation details of these plans are not yet adequate. Additionally, RE technician certifications decreased by 8% in 2022 compared to 2021 (MEMR, 2023). Surprisingly, research trends in energy transition and renewable energy also show slight variation, with a decrease in research trends this year compared to last year.

[3] The results of the 2023 IESR public survey are presented in Appendix I

Public awareness & acceptance rating: High

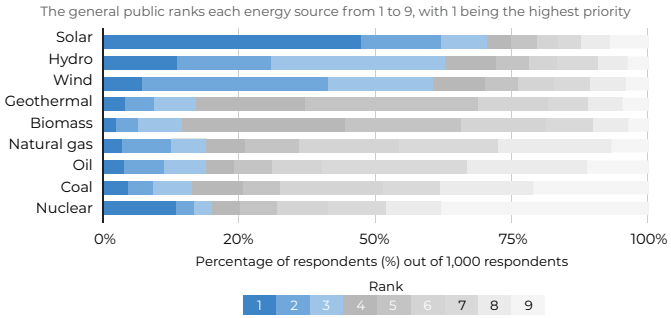
Integration of energy transition and human capital policy rating: Medium

Public's perception on climate change urgency varies on their level of knowledge



Source: IESR Analysis from 2023 Public Survey, 2023

Public opinion of the energy sources that Indonesia should prioritizes in generating electricity



Source: IESR Analysis from 2023 Public Survey, 2023

7.

Unpacking Current Policies Impact: Identifying the Gap to Achieve Paris Agreement

Alvin Putra Sisdwinugraha, His Muhammad Bintang, Pintoko Aji

Contents:

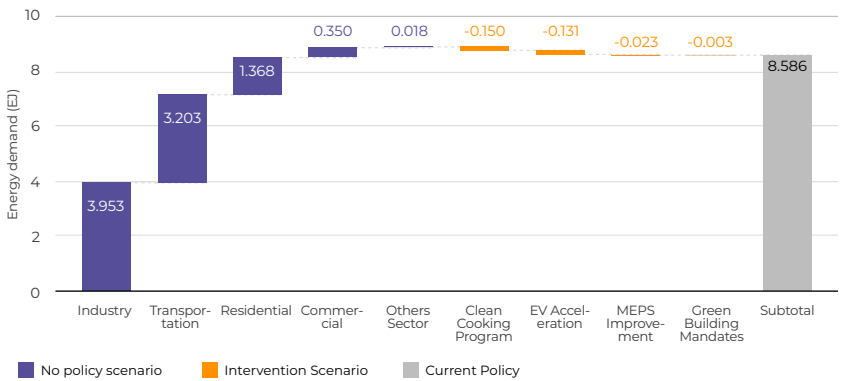
- Energy sector's current policy implementation analyses
- Highlights on Indonesia's energy sector GHG emission projection
- Sectoral policy gap to meet climate commitment

Implementation of current policies is inadequate to suppress energy demand projection, yet plans to overhaul the power sector could provide a significant reduction in overall emission

- The current energy sector policies (CPS) implementation is projected to result in an increase of final energy demand from 6.62 EJ in 2022 to 8.59 EJ in 2030, only 3.4% lower from the baseline projection (NPS). This figure highlights the limited amount of demand-side interventions available in the current policy, with only clean cooking targets, electric vehicles acceleration, MEPS and green building standards have measurable action plans. The energy demand reduction will lead to 38 $MtCO_2e$ total emissions avoided in 2030, only 4% of the baseline projection of 965 $MtCO_2e$.

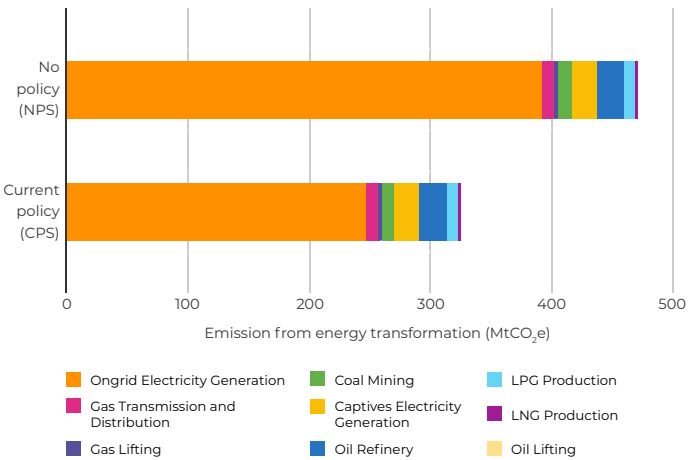
- While a significant reduction in energy demand and GHG emissions could not be achieved through the currently available demand-side measures, intervention in energy supply could generate a more substantial emission reduction. CPS projection shows around a 20% reduction from the NPS baseline in 2030. This reduction is mainly driven by a 27% reduction of emission intensity in the power sector (from 0.26 tCO_2e/TJ in 2022 to 0.19 tCO_2e/TJ in 2030) in order to meet the on-grid power sector emission target of 250 $MtCO_2e$ in 2030.

Final Energy Demand Projection in 2030



Source: IESR IETO Model

Emission from Energy Transformation in 2030

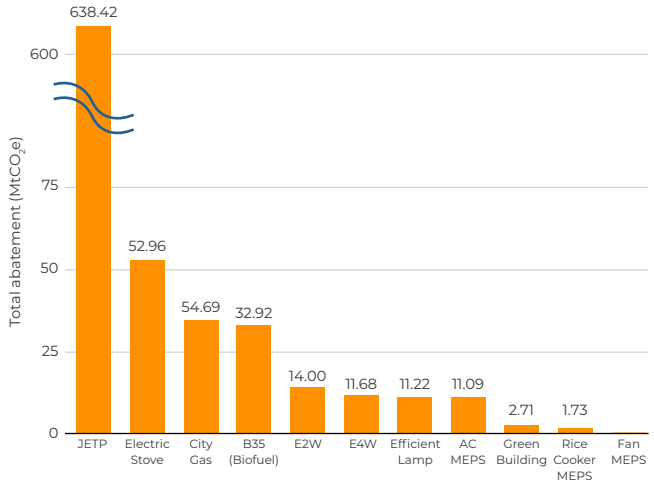


Source: IESR IETO model
Notes: 100-Year GWP CO_2e

Power sector transformation provides the largest abatement without additional cost, while E2W and clean cooking are the least-cost measures

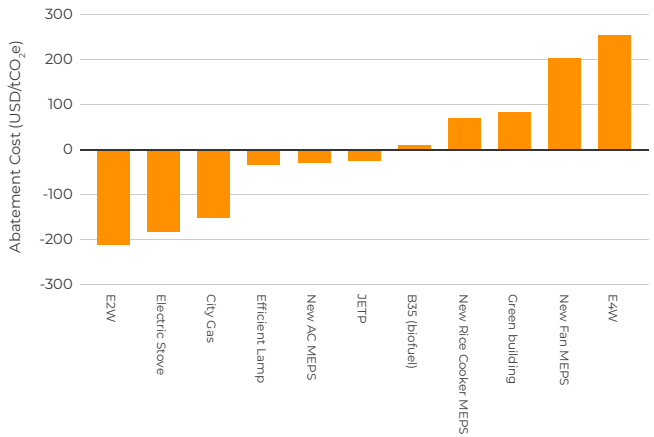
- The current policy and commitment-based intervention measures comprise of two interventions on the supply side (JETP pledge and B35 blending targets) and other interventions focused on the demand side.
- Meeting the JETP targets holds significant cumulative abatement potential, reaching 638.4 $MtCO_2e$ (cumulative), with a negative abatement cost of 24.7 USD/tCO_2e between 2022 and 2030 compared to a no-policy scenario. However, achieving the specific goal of an annual on-grid emission of less than 250 $MtCO_2e$ by 2030 requires successful integration across all five investment focus areas (IFA). This entails phasing down coal usage, ensuring grid infrastructure readiness, fostering an enabling environment for renewable deployment, and accessing low-cost financing from committed international partners.
- The IESR model highlights the promising benefits of adopting clean cooking and E2W, not only enhancing overall energy efficiency but also reducing oil product imports. These two interventions could avoid a considerable amount of emission while yielding a remarkable impact on system savings. Cumulatively, the potential system cost savings during the 2022-2030 period could reach up to 17.8 billion USD compared to the no-policy scenario. Nevertheless, success depends on changing user behavior and preparing the supporting infrastructure.
- Contrary to the anticipated cost-effectiveness of intervention through enhancing MEPS for appliances, our model indicates that the implementation, in fact, raises system costs. The system cost increase is due to the significantly higher investment costs for intervention than the savings from efficiency, especially in Indonesia, where electricity costs are relatively inexpensive.

Cumulative Abatement 2022-2030 of CPS vs NPS



Source: IESR IETO model

Abatement cost 2022-2030 of CPS vs NPS



Source: IESR IETO model

The building sector policies update with supports for R&D is crucial to curb emissions while ensuring the availability of low-cost technology and the competitiveness of domestic appliances industry

- The most significant reduction in emissions from the building sector in the near term will result from implementing the clean cooking measures. The NDC-based clean cooking strategy aims to accelerate and targets about 32% share of electric stoves and 17.7% of city gas use in residential buildings by 2030. The emissions could potentially be reduced by up to 29.4 $MtCO_2e$ or 46% by 2030 compared to that of NPS, which still relies on LPG. Additionally, electric stoves are expected to provide extra benefits by reducing indoor air pollution.

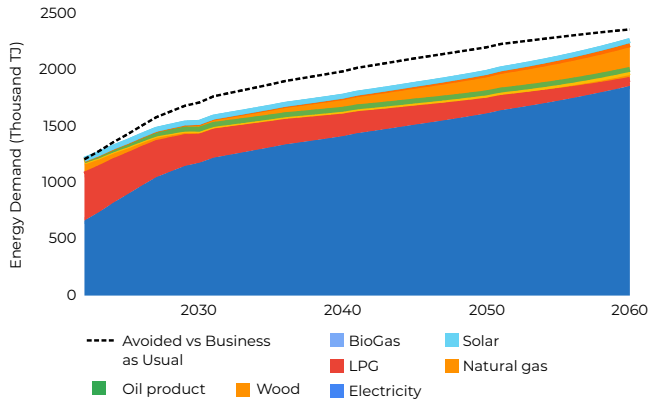
- Under the CPS, enhancing the efficiency of key residential appliances (fan, AC, refrigerator, and rice cooker) through MEPS has a marginal impact, resulting in only a 1.7% reduction in electricity consumption and a 1.97% decrease in emissions indirectly by 2030. To enhance the emission reduction potential from energy efficient appliances, the government needs to improve MEPS standards to align with regional benchmarks. Providing fiscal and non-fiscal support for research and development is crucial to lower the production cost of MEPS-compliant appliances. Additionally, interventions are required to influence consumer behavior, including market surveillance and collaboration with stakeholders such as retailers and e-commerce.

- Enforcing the green building[1] standards for new commercial constructions, as mandated by MPWH Regulation No. 21/2021, results in a modest 0.95% reduction in electricity demand and a 0.94% decrease in (indirect) emissions by 2030 compared to NPS.

- The newly enacted GR. No. 33/2023, mandating energy management and reporting for buildings with a 500 TOE energy consumption threshold, holds promise for assessing and mitigating energy consumption in buildings. The regulation is estimated to cover 17.4% of buildings, primarily hotels and malls, implementing energy management and reporting practices. In the next decade, the government has to work on preparing the ecosystem (e.g., human resources, standard, implementation guidance, awareness raising, etc.) to support the implementation while progressively lowering the threshold to include more buildings.

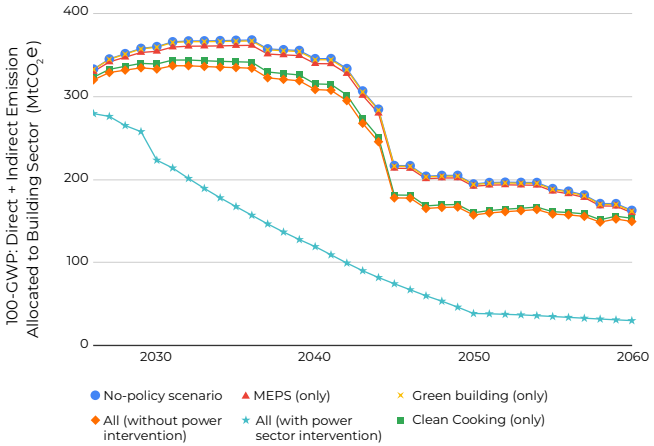
[1] In green building, energy efficiency becomes key to minimizing energy needs for operational comfort through passive design, efficient appliances, and/or on-site renewable use.

Buildings Energy Demand Projection under CPS



Source: IESR IETO Model

Projected GHG Emissions from Buildings Sector



Source: IESR IETO Model

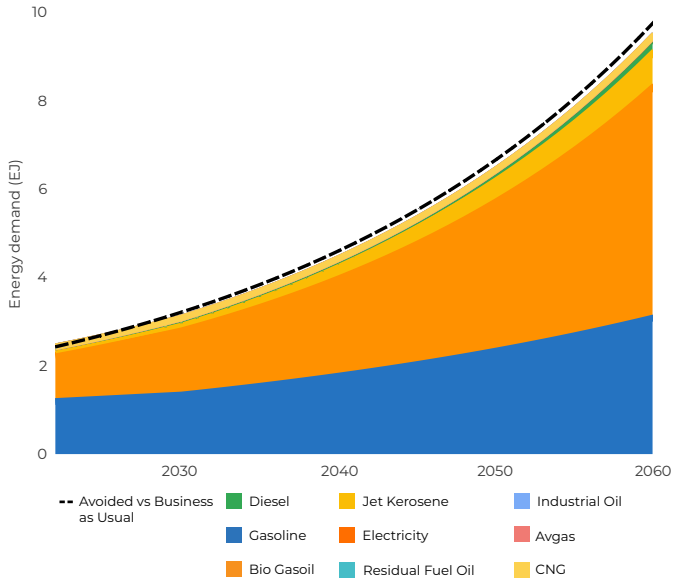
Adding 86 million BEVs until 2030 could only maintain the fuel import at the current level

- In Indonesia's transportation sector, challenges extend beyond emissions to include heavy reliance on oil imports and congestion. Despite ambitious targets for BEV adoption and higher biodiesel ratios, the IESR model findings indicate that the impact on decarbonization remains limited. Even with established policies (BEVs acceleration and B35), the projected outcomes foresee only a moderate 4.1% reduction in energy consumption and 7.9% in direct emission reduction by 2030. When considering the indirect emissions from power generation for BEVs, the overall emission decrease is only 4.8%. Importantly, achieving a meaningful reduction in emissions requires implementing interventions in the transportation sector alongside the decarbonization of the power sector, following the JETP target. The combination potentially results in a 5.6% reduction in transportation sector overall (direct and indirect) emissions by 2030.

- The concerning dependence on oil imports emphasizes the need for rapid fuel switching or electrification implementation to curb this trend. In 2022, Indonesia imported 53.5% of its consumed oil, totaling about 2.22 EJ. Without swift transport sector intervention, the IESR model projections suggest a potential increase to 76.1% reliance by 2030 and a 100% complete importation by 2037. Meanwhile, the IESR model indicates that the full compliance of current policy target of 15 million BEV adoption and B35 only has limited impact, with import growth slowing by 8.8% by 2030. Hypothetically, maintaining current oil import levels by 2030 needs a substantial 48.5% BEV penetration. However, achieving this would necessitate 100% BEV sales and scraping around 39 million ICE motorcycles and 6 million cars within the next six years, which is highly unlikely.

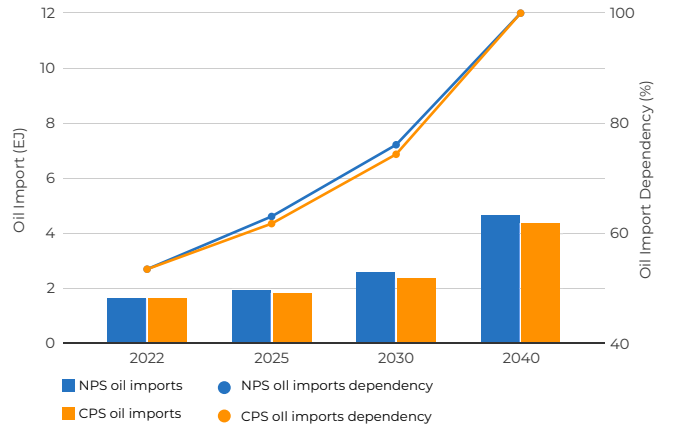
- Considering the inadequacy of fuel switching or electrification to decarbonizing the transportation sector and reducing oil imports, it is necessary to explore alternative approaches that involve transportation demand management (TDM) measures. It includes the development of compact city and TOD concepts, expansion of NMT facilities, and improving the appeal of public transportation. While the newly issued MoT Decree No. 8/2023, which outlines a comprehensive 38-point strategy for climate change mitigation actions, potentially accommodates those novel approaches, it is essential to firstly translate the strategies into quantifiable transportation and energy models.

Transportation Energy Demand Projection



Source: IESR IETO model

Oil Import and Dependency Projection



Source: IESR IETO model
Notes: does not include LPG

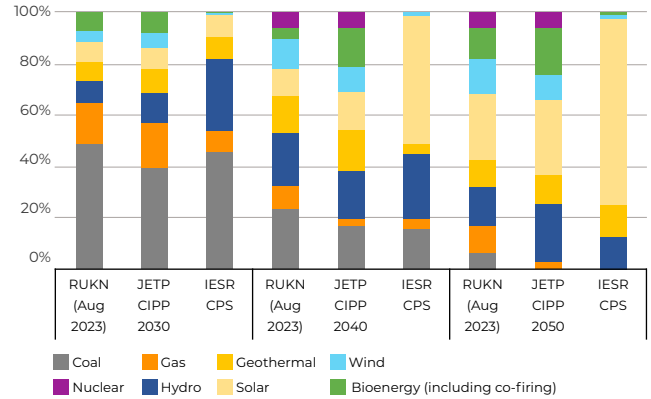
Enhanced support on RE is essential to reach the 2030 emission target, but abating emissions from captive plants requires a detailed action plan

- CFPP early retirement offers a system-wide solution to achieve a PLN system-only JETP emission target of 250 $MtCO_2e$ by 2030 and lower operational costs, while flexible operation of existing CFPPs set to provide a short-term solution. However, to scale up renewable procurement, PLN must enhance project attractiveness through improved tariffs and procurement mechanisms. Strengthening the local supply chain will also help drive the project's economics, driven by the promising position of Indonesia in the global photovoltaic market. Our model indicates that more dispatchable RE installations are needed before 2030 due to inadequate infrastructure and planning to accommodate a large amount of VRE. Thus, improved project preparation initiatives, including land acquisition and risk mitigation for exploration, are crucial to minimize delays and uncertainties.

- The IESR IETO model CPS projection identifies solar as the most cost-effective solution beyond 2030, suggesting a more aggressive adoption compared to the RUKN and JETP CIPP pathway. Reinforcing grid infrastructure and operation is also crucial with a higher RE share, especially post-2030. In the long run, the interconnection between islands will give better access to the untapped renewable and flexibility sources. BESS is currently limited to power output smoothing purposes, but such energy storage technologies as utility-scale batteries and pumped hydro are gradually gaining importance, mainly driven by declining costs, strategic pilot projects, and improved grid code.

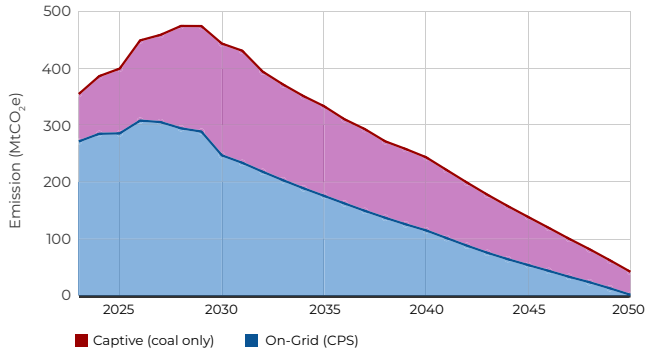
- Ultimately, it is plausible for on-grid emissions to reach its 2030 target and go towards NZE by 2050. However, captive coal power plants (including non-PLN concessions) still pose a big challenge, with the CPS of the IESR IETO model projecting at least 196 $MtCO_2e$ in 2030 from captive coal usage. The total power sector emission will be inflated to be a minimum of 446 $MtCO_2e$ in 2030, creating a dilemma between industrial downstream and climate commitment. PLN should prepare for offtaking large captive demand while improving renewables generation in the mix, and MEMR should develop on-site renewable energy roadmaps for non-connectable sites. In a broader sense, options such as power wheeling should be considered as a solution for limited captive sites.

Generation Mix Projection Comparison



Source: IESR IETO Model, MEMR (2023b), JETP (2023)

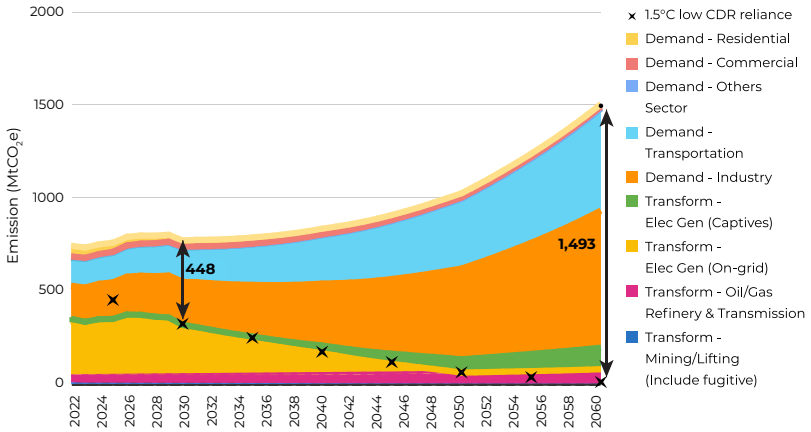
Power System Emission Projection (Current Policy Scenario)



Source: IESR IETO Model

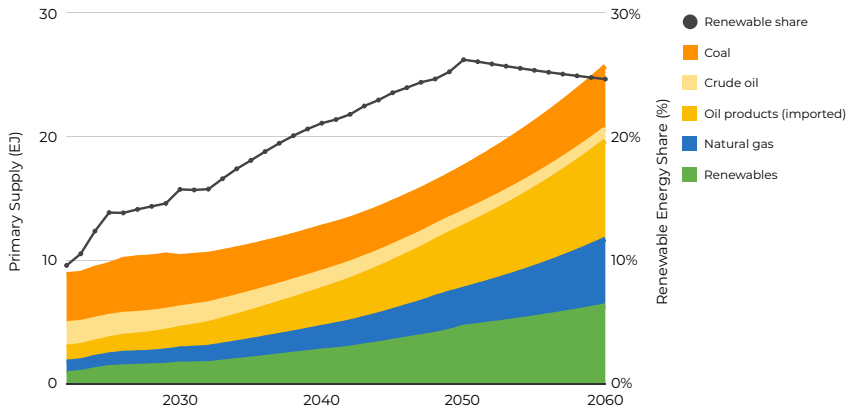
Significant gaps persist from the current policies with the goal of reaching NZE by 2060; measures in non-power sector should be enhanced for long-term mitigation strategy

Energy Sector GHG Emissions Projection under CPS



Source: IETO Model

Primary Energy Supply and Renewables Share Projection under CPS



Source: IETO Model

- In the climate context, achieving NZE commitment by 2060 necessitates unwavering efforts to promote a cleaner energy system. However, under the current policy, GHG emissions from the energy sector are projected to keep increasing until 2060. If all CPS measures are applied, a significant gap with 1.5°C pathway of about 448 $MtCO_2e$ is expected by 2030 and 1493 $MtCO_2e$ by 2060. While it is important to prioritize implementable mitigation measures with readiness to scale up within this decade, there is also an urgent need to bolster existing policies with more ambitious strategic measures for the long term. The latter includes the adoption of biomass/hydrogen in the industry, promoting captive renewables, and embracing sustainable mobility pathways.

- The increase in fossil fuel supply is unavoidable in CPS, even with the robust implementation of coal reduction in the electricity mix mandated by PR No. 112/2022 and the JETP pledge. Although there is an anticipated coal usage peak for power generation by 2027, leading to a shift to renewables, this offers only temporary relief from fossil fuel dependency. Persistent challenges exist in limited interventions across industries, transportation, and captive fossil fuel usage. Without prompt improvements to existing policy, the goal set by the preceding energy policy – a 23% RE share by 2025 – will not be met, with realization potentially delayed to 2044. Moreover, while the power sector (excluding captive) aims for almost 100% RE by 2050, the overall RE share in primary energy is predicted to peak at 25%. This estimation underscores the current lack of initiatives and targets for decarbonizing the non-power sector, particularly in transportation and industry.

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Appendices

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- Appendix B - IESR IETO Model Key Assumption
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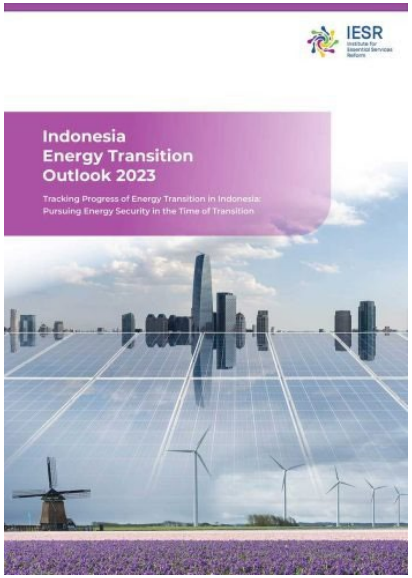
Appendix A - IETO 2023, ISFO 2023 and ISEO 2023



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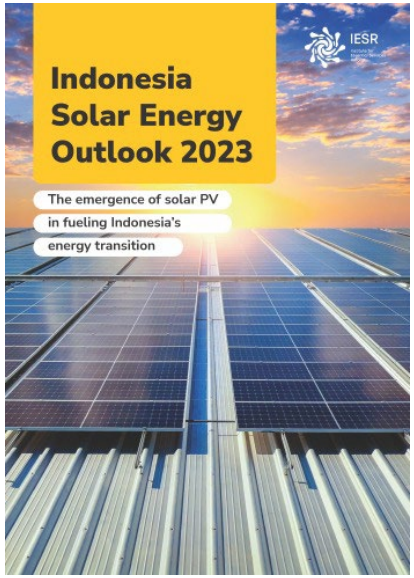

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Appendix B - IESR IETO Model Key Assumption

- The No Policy Scenario (NPS) follows historical trends and not integrating post-2020 climate mitigation policies and targets. The second scenario, Current Policy Scenario (CPS), is focused on evaluating the outcome of implementing actionable current policies and pledged targets.

General Parameters (Key Assumptions)		
Parameters	Description	Reference
GDP	GDP growth, per sector of GDP income & expense, sectoral/sub-sectoral shift.	BPS. (2023). Gross Regional Domestic Product 2015-2022
Population	Used as a key driver for projections using a bottom-up approach for demand activities.	BPS. (2023). Indonesia Population Projection 2020-2050
Socio-economy	Average size of urban/rural household, urbanization rate, urban/rural household per building ratio, 4 appliances penetration.	BPS. (2022). Socioeconomic Survey 2012-2022
Workforce	Workforce participation rate, level of unemployment, labor force per sub-sector.	BPS. (2022). Labor Market Indicators Indonesia 2018-2021
Electrification	The electrification ratio used refers to those with on-grid PLN electricity access.	PLN. (2023). Statistik PLN 2014-2022.
Household behaviour	Number of appliances, usage frequency, average hours of use, penetration.	CLASP. (2020). Indonesia Residential End Use Survey.
Modeling Structures		
Sector	Model Approach	Data References
Industry	The top-down and bottom-up approach, which involves determining the share of fuel use and energy intensity, was developed using the report on fuel and electricity consumption in each industry (4-digit business classification). This information was adjusted by considering HEESI energy consumption and GDP (value added) per subsector.	BPS. (2022). Statistics of Indonesia Manufacturing Industry 2021
Residential	Bottom-up: Energy consumption is determined through surveys of appliances and cooking activities, and the results are calibrated using HEESI.	Clasp. (2020). Indonesia Residential End Use Survey BPS. (2022). Socioeconomic Survey 2012-2022
Commercial	Top-down: Energy consumption values are derived from HEESI, disaggregated by commercial building type and classes within each type (office, hotel, hospital, retail, other public buildings), as per EUI benchmarking surveys, which include the shares of electricity and other fuel consumption.	B2TKE-BPPT. (2020). Benchmarking Specific Energy Consumption in the Commercial Building
Transportation	Top-down: Energy consumption is HEESI-based and subsequently disaggregated for transportation modes using MoT demand data, which includes passenger-kilometers and tonnage, along with wholesale and on-road shares for various vehicle types.	MoT. (2023). Data Operasional Statistik Perhubungan; BPS (2023). Number of Motor Vehicle by Type. Gaikindo. (2023). Wholesales 2022.

Appendix C - IESR IETO Model Current Policies

Current Policy Scenario			
Sector-Subsector	Description	Scenario Variables (Interpreted within the model)	Reference
Transportation - Road Transport: Passenger	Accelerating Programs of BEV for Road Transportation	Order for the issuance of a policy package for fiscal assistance, including the requirements for the provided EV support, and instructions for the preparation of a roadmap (target 2.197.780 unit for E4W & 13.469.000 unit for E2W in 2030).	Presidential Regulation No. 55/2019
Supply - Biodiesel Blending	B35 - Biogasoil	The blending of biodiesel type with a 35% percentage (B35) into biogasoil will come into effect on February 1, 2023.	Circular Letter from the Directorate General of New Renewable Energy and Energy Conservation (EBTKE) No: 10.E/EK.05/DJE/2022
Building - Appliances	MEPS and Labelling for Air Conditioners	Improvement for the latest EER star regulation Ministerial Regulation No.57/2017 to MEMR Decision No. 103/2021 (17% energy intensity reduction)	MEMR Decree No. 103/2021 Clasp. (2023). Mepsy: The Appliance & Equipment Climate Impact Calculator.
Building - Appliances	MEPS and Labelling for Refrigerators	First MEPS program for rice cooker and most of all products lolos MEPS (0.5% energy intensity reduction)	MEMR Decree No. 113/2021; Clasp. (2020). Indonesia Refrigerator Market Study and Policy Analysis
Building - Appliances	MEPS and Labelling for Fans	First MEPS program for fans (1.2% energy intensity reduction)	MEMR Decree No. 114/2021; Clasp. (2020). Indonesia Fan Market Study and Policy Analysis
Building - Appliances	MEPS and Labelling for Rice Cookers	First MEPS program for rice cooker and most of all products lolos MEPS (.7% energy intensity reduction)	MEMR Decree No. 115/2021; Clasp. (2020). Indonesian Rice Cooker Market Study and Policy Analysis
Building - Appliances	EE (appliances)	The action pledges to save 15,187 GWh of electricity; additional savings actions outside new MEPS be added by promoting the adoption of efficient lamps (LED).	Enhanced NDC Republic of Indonesia (2022)
Building - Commercial Sector: Electricity Use	Green Building	Applied to new buildings, including office (class 5), class A hospitals (class 9a), retail (supermall and supermarket) (class 6), and public buildings (government and education) (class 5 & 9b), to meet and compete with the IEA efficient building assessment potential.	MPWHR Regulation No. 21/2021; Government Regulation No. 16/2021
Demand - Residential: Cooking Activity	Induction electric stove	Total 18,170,000 units	Enhanced NDC Republic of Indonesia (2022)
Demand - Residential: Cooking Activity	Gas Pipeline Network Expansion	Utilization for natural gas for cooking up to 10 million connection (buildings)	Enhanced NDC Republic of Indonesia (2022)
Supply - On-grid Electricity Generation	Power Sector Decarbonization	Energy transition pathway for the power sector: accelerating CFPP retirement and RE projects	JETP Indonesia (2023). Comprehensive Investment and Policy Plan (CIPP)

Appendix D - Summary of the Latest Low Emission Ammonia Project Update in Indonesia (1)

No	Partners	Technology	Target	Year	Status
1	Jasa Daya Chevron (Chevron); Pertamina Geothermal Energy (PGE)	Green hydrogen and ammonia in geothermal working area (WKP) in the Way Ratai region, Lampung Province.	Unknown, an estimated 100 MW of possible geothermal reserve can be converted into 55 MW with exploration commitments totaling USD 28.85 million.	2023	MoU; a feasibility study is currently underway
2	Perta Arun Gas (PAG); Aslan Energy Capital Pte Ltd, Singapura (AEC)	Development of blue ammonia processing facilities in the Arun Lhokseumawe Special Economic Zone (KEK), Aceh Province with local CCS utilizing the Arun reservoir	Blue ammonia production is planned at 600 kt/year in 2028.	2023	Development cooperation agreement (DCA)
3	Kilang Pertamina Internasional (KPI) Pertamina; BP Beau. Ltd.	CCUS for blue ammonia in Teluk Bintuni in West Papua, Indonesia.	CCUS implementation to support blue ammonia production.	2023	MoU, Joint study agreement (JSA)
4	Pupuk Indonesia; Pupuk Iskandar Muda (PIM); Augustus Global Investment GmbH (AGI)	Development of green hydrogen and ammonia in the Iskandar Muda Industrial Area (IMIA), Lhokseumawe, Aceh.	Produces 95.8 t/day of green hydrogen. AGI will invest USD 500 million for this development project.	2023	MoU; feasibility study was completed by Black & Veatch (BV). Construction plan start on 2024; production on 2026
5	Tripatra Engineering; Kaltim Parna Industri (KPI); NextChem	Green ammonia powered with hydropower in Bontang, East Kalimantan.	Utilizing Stami Green Ammonia Technology with initial capacity of 300 t/day with the possibility of further expansion.	2023	MoU; a feasibility study is currently underway. Expected to be on stream in 2027
6	Pertamina NRE; Chevron New Energies	CCUS for ammonia production in East Kalimantan.	CCUS implementation to support green ammonia production.	2023	MoU; Joint study agreement (JSA) and discussion on field candidate are currently underway
7	Pupuk indonesia ; PLN; Acwa Power	Green hydrogen and ammonia plant powered with a 80 MW wind (PLTB) Banyuwangi-1 and 120 MW solar power plant Pamekasan (PLTS) in Gresik, East Java.	Produces 33 kt/year of green hydrogen and 120 kt/year of green ammonia and increases electricity capacity originating from clean energy by 200 MW. Absorbing Investment value of up to USD 1.35 billion.	2023	MoU; Joint study agreement (JSA) is underway
8	PGN Pertamina NRE	Green hydrogen, ammonia, and biomethane.	-	2023	MoU

Appendix D - Summary of the Latest Low Emission Ammonia Project Update in Indonesia (2)

No	Partners	Technology	Target	Year	Status
9	Pertamina NRE; TEPCO HD; NEDO	Green hydrogen and ammonia utilizing geothermal energy in Lahendong area, Tompaso, and Kotamobagu, North Sulawesi.	Generating up to 865 MW, aiming to finalize it by 2024, with an estimated production capacity of 1 Mt/year of green ammonia. Pertamina NRE allocates USD10 billion to this project.	2023	MoU; a feasibility study is currently underway
10	Pupuk Indonesia; Toyo Engineering	The existing PIM-2 ammonia-urea factory located in Lhokseumawe, Aceh, to become a hybrid green ammonia factory.	-	2023	MoU; a feasibility study is currently underway
11	Pupuk Indonesia; Toyo Engineering; IHI	Green ammonia dan ammonia co-Firing in the Petrokimia Gresik industrial area, East Java.	-	2023	MoU; a feasibility study is currently underway
12	Pupuk Indonesia; IHI	Green ammonia utilizing geothermal power in East Java and assessment of the feasibility of co-firing ammonia with generator boilers on the same site.	-	2023	MoU; a feasibility study is currently underway
13	Pupuk Kalimantan Timur; Pertamina NRE; Copenhagen Atomics; Topsoe; Alfa Laval; Aalborg CSP	Green ammonia powered by a small modular reactor (SMR) nuclear power plant in Bontang, East Kalimantan, with thorium as raw material.	The initial capacity of 1 GW electrolysis capacity to produce green hydrogen and 1 Mt/year of green ammonia for utilization of 210-270 kt thorium with an estimated investment of USD 4 billion.	2023	MoU; a feasibility study is currently underway
14	Pupuk Iskandar Muda (PIM); Mitsui	Blue ammonia with CCS in Lhokseumawe at arun field.	The 825 kt/year blue ammonia plant is scheduled to operate in 2029.	2023	MoU; a feasibility study is currently underway
15	Pupuk Indonesia; Inpex	Blue ammonia with CCUS on Yamdena Island, Maluku Province,	Blue ammonia production is expected to commence in 2030 at a capacity of 660 kt/year.	2023	MoU; a feasibility study; A pre-FEED activity will follow in 2025; Expected to be on stream in 2030
16	Pertamina NRE; Chevron New; Energies Keppel Infrastructure	Green hydrogen and ammonia from geothermal in Sumatera	The initial capacity of 40 kt/year with 250 - 400 MW of geothermal energy and the potential to be scaled up to 80 and 160 kt/year	2023	MoU

Appendix D - Summary of the Latest Low Emission Ammonia Project Update in Indonesia (3)

No	Partners	Technology	Target	Year	Status
17	Pupuk Indonesia; Pertamina; Mitsubishi	Blue/green hydrogen and ammonia value chain and CCUS development.	730 kt/year of ammonia.	2022	MoU
18	Green Ammonia Indonesia (GAI)	Green ammonia production from hydropower in the Green Industry Zone, North Kalimantan.	300 kt/year of green Ammonia with an on-stream target of 2028. Investment funds worth USD 300 million.	2022	MoU, feasibility study and market sounding are currently underway
19	Parna Raya; Namhae Chemical; Posco International	Green ammonia production from hydropower and ammonia storage development.	-	2022	MoU
20	Panca Amara Utama (PAU); ITB; Mitsubishi; JOGMEC	CCUS for ammonia production at Banggai, Luwuk, Central Sulawesi.	19 million $MtCO_2e$ for 20 years toward 700 kt/year of ammonia production target of 2025.	2021	MoU for joint study. A feasibility study is currently underway (Jul 2023)
21	Kaltim Parna Industri (KPI); ITB	CCUS for ammonia production in East Kalimantan.	10 million $MtCO_2$ for 10 years, on stream target of 2027-2028.	2021	Currently under pre-feasibility study (surface facilities)
22	North Kalimantan Provincial Government; Fortescue Future Industries	Green hydrogen and ammonia industry from hydropower and solar PV. The project will include transportation infrastructure and distribution in Kaltara, North Kalimantan.	Produces green hydrogen of 650 kt/ year for conversion into 3.7 Mt of green ammonia.	2021	MoU, cooperation agreement, preliminary study, and feasibility study are currently underway

Source: IESR Analysis, compiled from CID, 2023; Pertamina, 2022; Tripatra, 2023; Rahayu, C.A., 2022; Suryahadi, A., 2023; Elvira, V., 2023; Corbeau, A.S. & Kaswiyanto, R. P., 2023; Mitsubishi, 2021; Bromage, A.; Meade, M.; Ye, C.; & Kelana, A,, 2023; Lannucci., E., 2021; Chevron, 2023a; Chevron, 2023b; Pupuk Indonesia, 2023, Toarik, M., 2023; Nur, A., 2023; Asiatoday, 2023; Kusnadi, 2023; Parnaraya, 2022; UMA, 2022; Lea, A., 2023; PLN, 2023a; PLN, 2023b; Audrey, A. W., 2023; Muslimawati, N., 2023; Teodoro, R., 2023; BP, 2023; Syariati, M., 2023, Ventura, B. C.,, 2023; Laksana, B. S., 2023; Nur, A., 2023; Syahputra, E., 2023; IBP, 2023; Jhanesta, W., 2023.

Appendix E - Summary of the Latest Low Emission Hydrogen Project Update in Indonesia (1)

No	Partners	Technology	Target	Year	Status
1	PLN Indonesia Power; USTDA	A 462Mw facility using NuScale's SMR technology including for clean hydrogen production Evaluation of the technical and economic viability of the proposed nuclear power plant in West Kalimantan	Funding amount of USD 1 million for assessment	2023	MoU, Joint study agreement (JSA)
2	Pertamina NRE; Transportasi Gas Indonesia (TGI)	Development clean hydrogen transportation business including utilization of pipelines for hydrogen transportation to Singapore	-	2023	MoU
3	Pertamina NRE; Toyota;	Development of a hydrogen-based vehicle ecosystem such as passenger car	-	2023	MoU
4	Pertamina NRE; Pertamina Patra Niaga	Development of hydrogen filling infrastructure including hydrogen refueling stations	-	2023	Intention of MoU
5	PLN	Development of hydrogen technology and electricity generation with renewable generators utilizing intermittent renewable energy sources (solar or wind) and long-term electricity storage using hydrogen include 22 Renewstable® projects developed by HDF Energy and DFC collaboration	-	2022	MoU
	HDF Energy	Development of of 22 Renewstable ® power plants in Indonesia	Investment amount of USD 1.5 billion including project in Sumba island, a 10 MW Renewable® power plant	2022	MoU
6	Pertamina NRE; Krakatau Steel; Rukun Raharja (RAJA)	Green hydrogen pipeline development (Green Hydrogen) in Banten and West Java	-	2022	MoU, Joint study agreement (JSA)
7	Pertamina NRE; IGNIS; Sembcorp Energy Indonesia	Green Hydrogen development in Sumatera	-	2022	MoU, Joint study agreement (JSA)

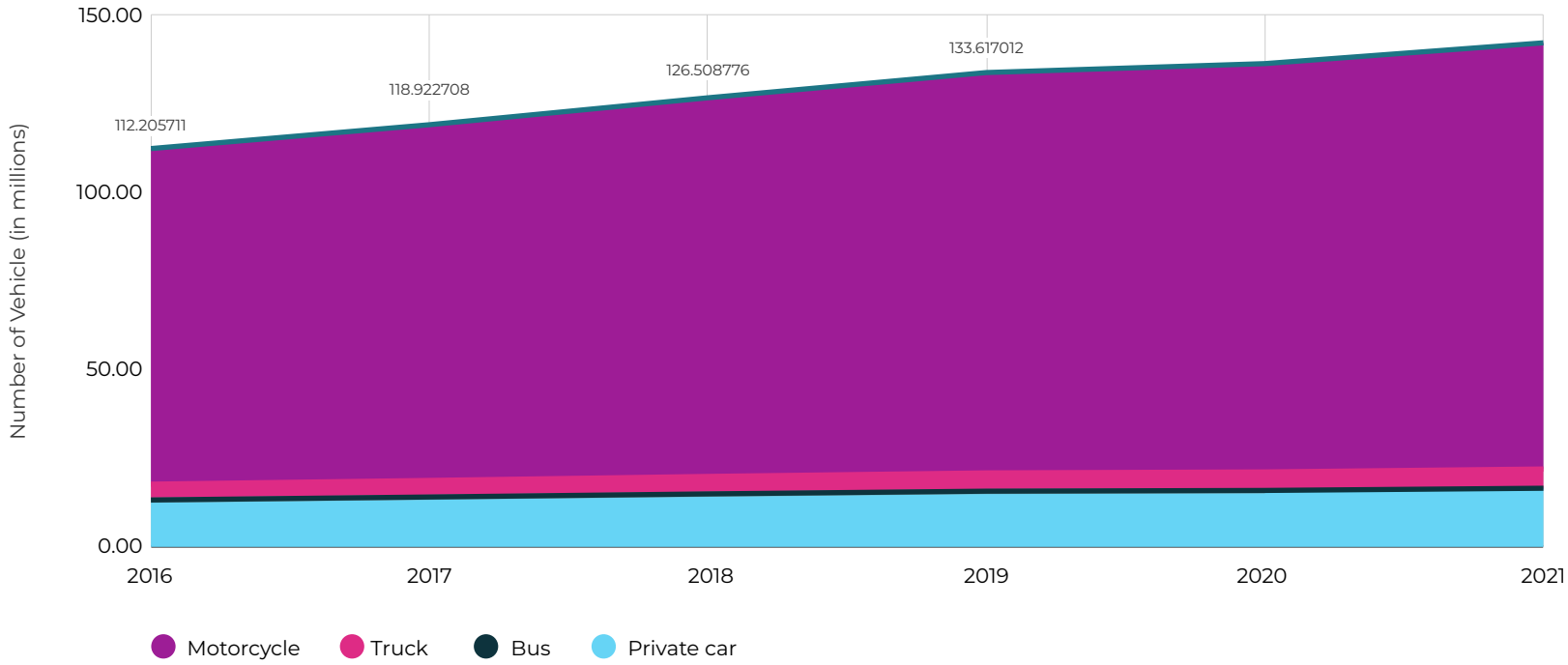
Appendix E - Summary of the Latest Low Emission Hydrogen Project Update in Indonesia (2)

No	Partners	Technology	Target	Year	Status
8	Pertamina NRE ; IGNIS Energy; Holdings Krakatau Steel	Integrated blue/ green hydrogen plant powered with a wind (PLTB) and solar power plant (PLTS) in the offshore area in the Krakatau Steel industrial area, Cilegon	500 MWp An electrical production capacity of 500 MWp - 1.5 GWp with a CO2 storage capacity of 61 $MtCO_2e$.	2022	MoU, Joint study agreement (JSA)
9	Pertamina Geothermal Energi (PGE)	Green hydrogen development with geothermal power in the Ulubelu Geothermal Working Area (WKP) in Lampung.	Target production: 100 kt/day with potential of 40 Mw geothermal power through the application of cogeneration technology	2022	Pilot project currently underway, commencement of production planned on end of 2023
10	PLN NP	Green hydrogen development with geothermal and solar PV power	51 Mt/year green hydrogen, with four electrolyzers and energy consumption of 2,795 MWh	2022	commencement of production (COD) has begun in October 2023

Sumber: IBP, 2023*;* MEMR, 2023h*;* PLN, 2023*;* MoFA, 2023*;* Yurika, 2022*;* Pertamina, 2022*;* SBR, 2022*;* Affandi, M. A., 2022*;* PABUMNews, 2023*;* Martkettrack, 2023*;* Owo, 2023*;* TGI, 2023*;* Syahputra, E., 2023*;* KS, 2023*;* Pupuk Indonesia, 2023*;* Chandak, P., 2022*;* U.S.Embassy, 2023.

Low emission hydrogen project update that integrated with ammonia production are located in table: **Summary of the latest low emission ammonia project update in Indonesia**

Appendix F - Number of Registered Motorized Vehicles by Vehicle Type 2016 - 2021



Appendix G - IESR's Energy Transition Readiness Framework (1)

No	Dimension (s)	Variable (s)	Indicator	Key points to assess indicators	Assessment methodology	Source of data	Low	High
1	Regulatory framework quality	Political will/ commitment	Key policy documents clearly stated the target to transition the energy/power system towards a low-carbon energy/ power system that is aligned with the Paris Agreement	1. NDC target 2. NZE target 3. KEN/RUEN 4. RPJMN/RPJPN 5. LTS 6. PR No.112/2022 7. JETP Coordinatory	Self-assessment Expert interview	NDC document Climate Action Tracker KEN/RUEN RPJMN/RPJPN LTS document PR No. 112/2022 JETP-CIPP document	Current key policy target is insufficient to decarbonize power sector and limit global warming below 2 C	Current key policy target is sufficient to decarbonize power sector and limit global warming below 1.5 C
			The government provides financial and fiscal support for power system transition/ decarbonization	1. Amount & percentage of public finance allocated for supporting the climate change and energy transition 2. Developer perspective for effectiveness of fund	Self-assessment Survey to RE developers	Public finance 2022 MEMR budget Secondary data from news and webinars Survey results	Total public finance allocated for RE is lower than fossil fuel (>10%) and public fund/fiscal support considered inadequate	Total public finance allocated for renewable energy is higher than fossil fuel and public fund/ fiscal support considered adequate
			Implementation of energy transition targets/plans	Government achievement in 2023 aligning with decarbonization targets in power sector	Self-assessment Expert interview	Directorate general of electricity quarterly report Secondary data from news and webinars	Renewable installed capacity addition less than RUPTL target	Renewable installed capacity addition exceed the RUPTL target
		Regulatory framework quality	The existing regulatory support has accelerated RE deployment	1. Annual regulation stability assessment (regulatory changes in 2022) 2. Regulation attractiveness to increase the implementation of RE	Self-assessment Survey to RE developers	Regulatory changes frequency in 2016-2021 Survey results	The regulatory framework in the power sector is constantly changing and viewed by stakeholders as a barrier	The regulatory framework in the power sector is stable (following transparency, longevity, and certainty criteria) and able to attract investment
			The consistency between various government bodies regulations related to the deep decarbonization in power system	1. Air quality regulations 2. Energy efficiency and conservation regulations 3. Rural electrification regulations 4. Availability of energy transition supportive RUED	Self-assessment	Air quality regulations Energy efficiency regulations Rural electrification regulations RUED	Other related regulations (e.g. regulations of air quality, energy efficiency, rural electrification, and RUED) are not in line with efforts to decarbonize the power sector	Other related regulations (e.g. regulations of air quality, energy efficiency, rural electrification, and RUED) are in line with efforts to decarbonize the power sector

Appendix G - IESR's Energy Transition Readiness Framework (2)

No	Dimension (s)	Variable (s)	Indicator	Key points to assess indicators	Assessment methodology	Source of data	Low	High
2	Investment and finance	Investment climate (for RE power plant)	Investment risk	1. Country credit ratings and risk premium 2. Stakeholders perspective on investment risks	Self-assessment Interview to financing institutions	S&P, Fitch, Moody's, PWC country risk premia Interview results	Country risk premium is high and instruments to derisk investment in RE power projects are unavailable	Country risk premium is low and instruments to derisk investment in RE power projects are available
			Barriers to entry	Investment freedom for foreign and local sources	Self-assessment Survey to RE developers	Investment freedom index from heritage foundation Survey results	Investment freedom index is low and permit process is considered as a barrier to RE development	Investment freedom index is high and new RE project permit/license project is streamlined
			Access to capital	Easiness to get credit	Self-assessment Survey to RE developers	Getting credit parameter in the WB ease of doing business Survey results	The ease of getting credit is high and local banks provide capital with unattractive interest rates for renewable energy projects	The ease of getting credit is high and local banks provide capital with attractive interest rates for renewable energy projects
		Power sector investment trend	The sufficiency of RE investments	1. Level of investment realization compared to investment needed 2. RE investment growth 3. Investment of RE compared to FF plants 4. JETP Investment Plan	Self-assessment	Secondary data from news and webinars MoEF and MEMR press releases JETP-CIPP Document	Investment level is similar as previous year and insufficient to support power sector decarbonization and achieve the Paris Agreement targe	Investment level is keep increasing and sufficient to support power sector decarbonization and achieve the Paris Agreement target
3	Techno-economic	Power System Planning	The power system planning with high RE integration	1. Planned installed capacity of RE plants compared to fossil fuel plants 2. Updated grid code and must run status for RE power plants 3. Fossil fuel retirement plan 4. Fossil fuel replacement plan, e.g. 3.7 GW out of 9.2 GW and dedieselisation programmes	Self-assessment Expert interview	Directorate general of electricity quarterly report Secondary data from news and webinars Latest grid code regulation compared to the previous one Recent RUPTL Interview results	Planned RE capacity is lower than planned fossil capacity, power system planning and grid codes prevent flexibility and higher integration of RE into the grid	Planned RE capacity is higher than planned fossil capacity, power system planning and grid codes allow flexibility and higher integration of RE into the grid
		The economic of energy transition	Cost competitiveness of renewable technology	1. RE tariff compared to fossil fuel 2. RE vs FF LCOE/S 3. Stakeholders perspective: accessibility of best/least cost technology available	Desk study Expert interview Survey to RE developers	Interview and survey results IESR LCOE/S study	RE tariff is higher than fossil fuel and developers are unable to use the most competitive RE technologies in their projects.	RE tariff is lower than fossil fuel and developers are able to use the most competitive RE technologies in their projects, which locally produced.

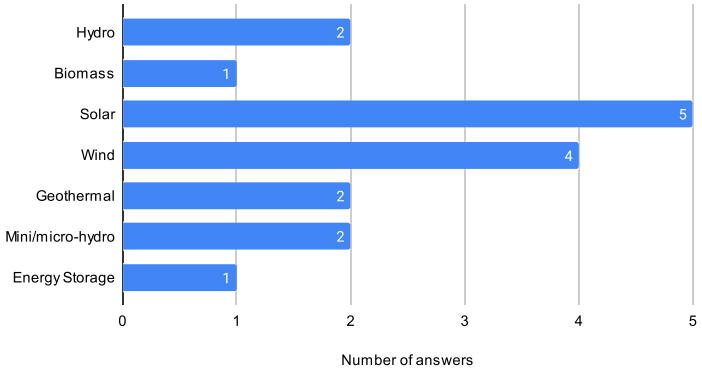
Appendix G - IESR's Energy Transition Readiness Framework (3)

No	Dimension (s)	Variable (s)	Indicator	Key points to assess indicators	Assessment methodology	Source of data	Low	High
4	Social	Public awareness & acceptance	General public supports on energy transition	Public awareness of climate change, support for renewable energy deployment, and support for coal phase out	Public survey	Survey results	Public is not aware on climate change, support for renewables, support for coal phase out	Public is aware on climate change, support for renewables, support for coal phase out
		Human capital	Government strategy	1. Government strategy/plan for employment in energy transition 2. Government plan for mitigating transition impact on employment	Self-assessment Expert interview	Strategic Plan of Ministry of Manpower Long- and short- term national development planning Interview results	The government has no specific strategy for green skills development	Integration of green skills development into government programs
			Capacity of human resources	1. Availability of potential workers 2. RE technician certification 3. RE research topic in top ten university in Indonesia	Desk study Self-assessment	Ministry of labor and Ministry of Education, Culture, Research, and Technology reports Ministry of National Development Planning/ National Development Planning Agency (Bappenas) reports Central Bureau of Statistics data ASEAN reports OECD reports World Economic Forum report Solar technicial certification from MEMR University's repository	Population graduateed from tertiary school is below the averaged number of ASEAN countries, and not yet skilled (and familiar with) to enter green jobs	Population graduated from secondary school similar as OECD countries and skilled (and familiar with) to enter green jobs

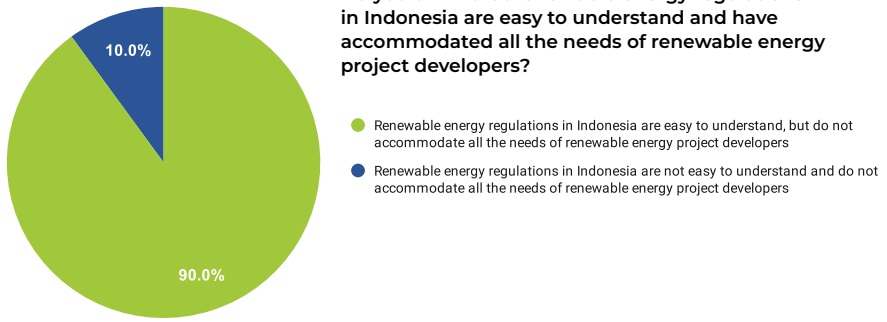
Appendix H - RE Developers' Perception Survey Results (1)

This survey was completed by 10 renewable energy developers in 2023

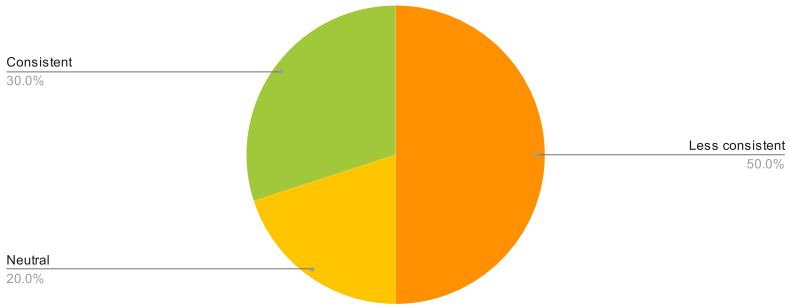
What is your main business?



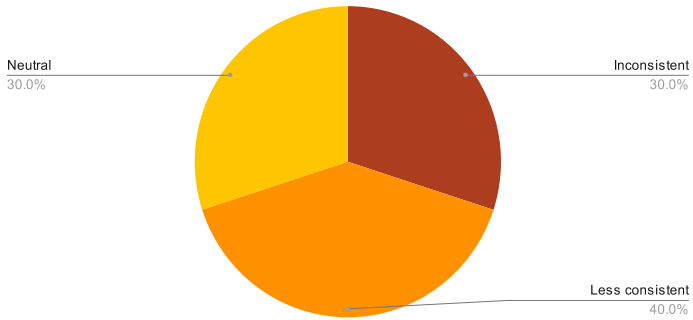
Do you think that renewable energy regulations in Indonesia are easy to understand and have accommodated all the needs of renewable energy project developers?



What is your opinion regarding the consistency of content between regulations that have been established regarding energy transition in Indonesia?

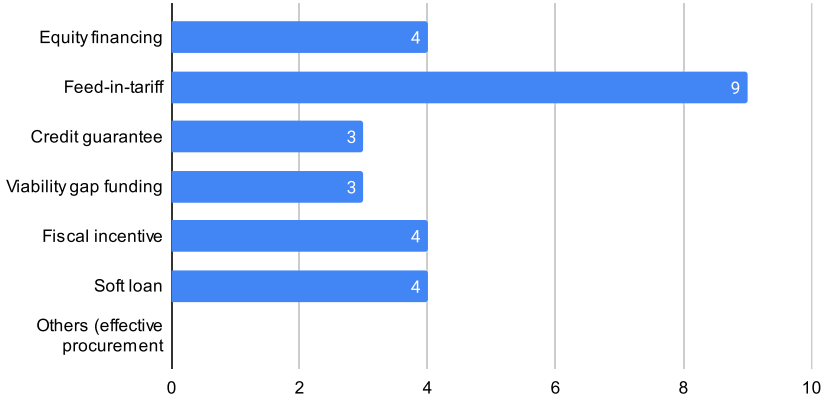


What is your opinion regarding consistency in the implementation of renewable energy development in Indonesia?

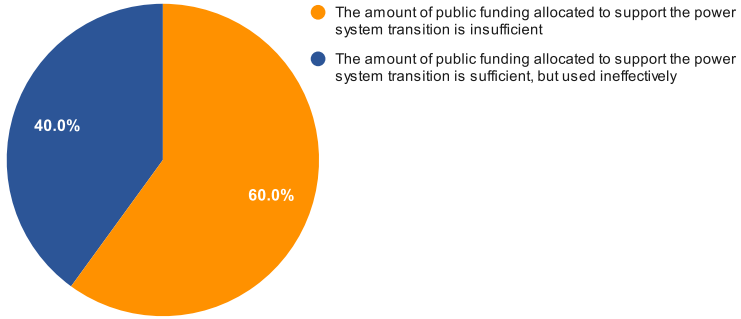


Appendix H - RE Developers' Perception Survey Results (2)

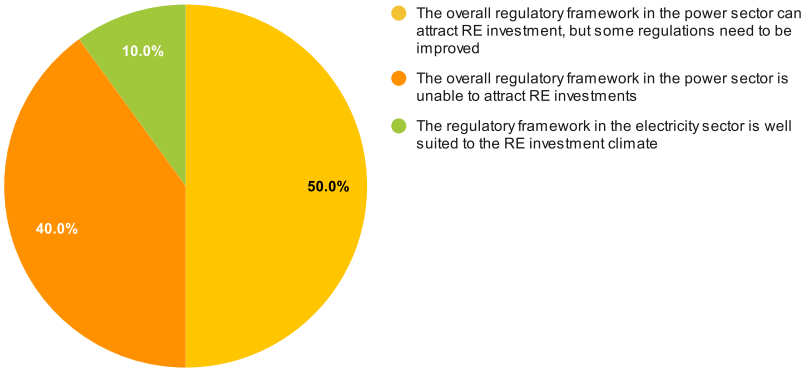
Financial or fiscal support needed to accelerate energy transition in power system



What is your opinion regarding government support in financial and fiscal terms for the transition/decarbonization of the electricity system?



How do you think about the existing regulatory framework in the electricity sector (i.e. tariff setting, incentives, taxation, etc.) in creating an attractive investment climate for renewable energy?

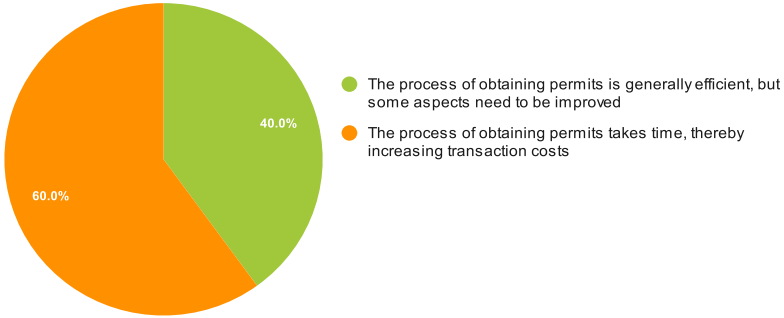


Which regulations need to be improved to attract more investment in renewable energy?

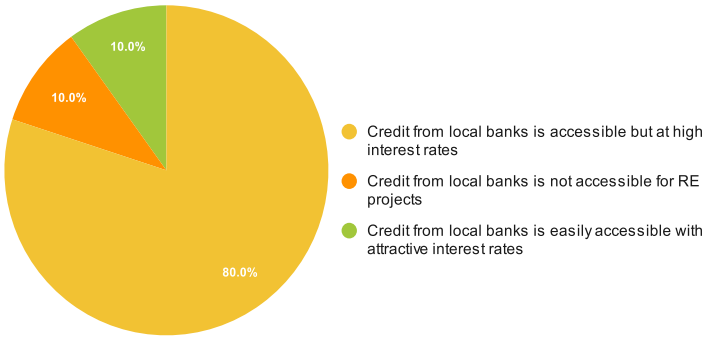
- Regarding the economics and bankability of the purchase agreement
- Clear incentives for advancing electricity services, particularly from competitive local RE sources.
- Coordination among entities handling land acquisition, power procurement, and ensuring legal certainty.
- Enhancement in electricity purchase rates and local content policies.
- Enhancement in local content policies.
- Addressing limitations on PLTS capacity value concerning installed power load.
- More attractive Feed-in Tariffs, tax holidays, and government viability gap funding.
- Improvement in development regime, specifically feed-in tariff aspects and support for local content to avoid restrictions.

Appendix H - RE Developers' Perception Survey Results (3)

What is your view on the bureaucratic process in obtaining permits for RE development?



What is your opinion on access to credit from local banks for RE projects?

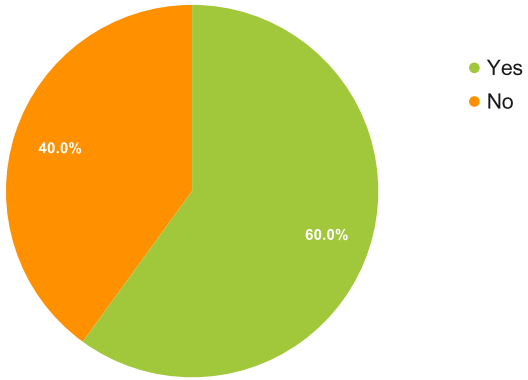


What needs to be improved in the process of obtaining permits for RE projects, if any?

- SIPPA is too long and complicated
- PLN's clarity
- Certainty and clarity of the rules, accountability of the people issuing the rules, penalties for lack of implementation
- Online version of regional RDTR will really help with the location permit process
- Land acquisition and AMDAL
- Local content
- Maximize the OSS process without many multi-level approval layers
- Approval process from PLN and SLO from ESDM
- Speeding up the process of technical recommendations from regional bodies

Appendix H - RE Developers' Perception Survey Results (4)

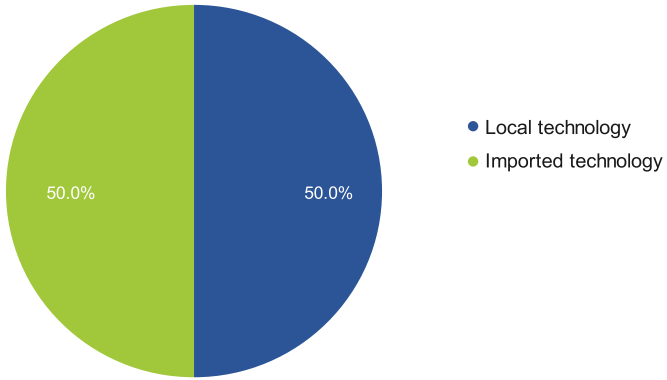
Do you think you can use renewable energy technologies at the most competitive costs in your projects in Indonesia?



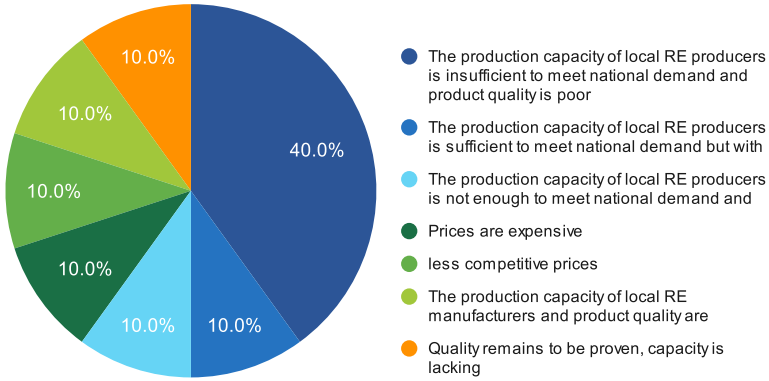
If you answered "No", why? (e.g. LCR, import tax, etc.)

- LCR
- LCR, import taxes, basic prices which are already high but cannot be covered by tariffs
- Capital funds are expensive
- Local content

If you answered "Yes", what technology did you use?

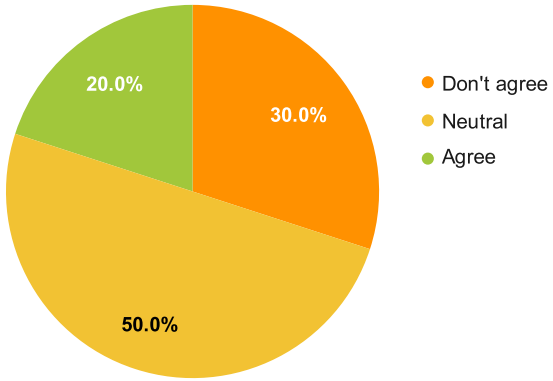


What do you think about RE production capacity and product quality of local manufacturers?



Appendix H - RE Developers' Perception Survey Results (5)

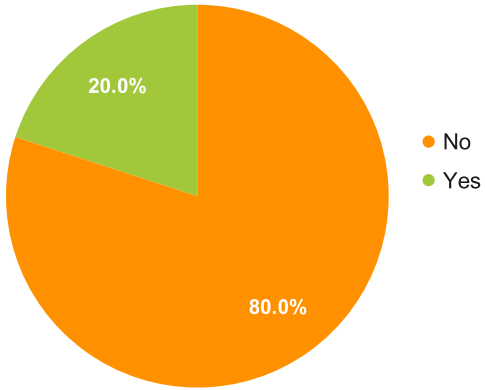
PR 112/2022 can accelerate the development of RE power plants in Indonesia



What kind of impact have developers felt since the ratification of Presidential Regulation 112/2022?

- Limited progress, particularly in the procurement process with PLN as the offtaker.
- Scant incentives utilized.
- Discussions primarily centered around mega projects, neglecting RE distributed projects.
- Slight improvement from the previous BPP regulations.
- Minimal impact due to the absence of technical regulations for implementation at PLN.
- Only one project (Wind/Solar) successfully executed a PPA almost two years after the decree issuance

Are you satisfied with the existence of Presidential Regulation 112 of 2022?



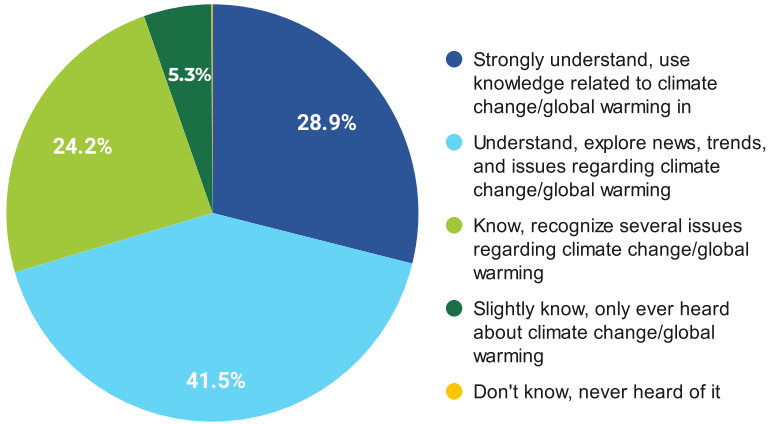
What improvements are needed in Presidential Regulation 112/2022?

- Streamlining procurement procedures and introducing FIT for larger-scale projects.
- Establishing stronger incentives.
- Regulating PLN under an independent authority.
- Enhancing tariffs to better support EBT developers.
- Ensuring effective implementation by PLN.
- Seeking investor flexibility and attractive investment rates.
- Revising buying and selling prices for PLTP.
- Adjusting ceiling tariffs to align with current global conditions, such as high-interest rates.

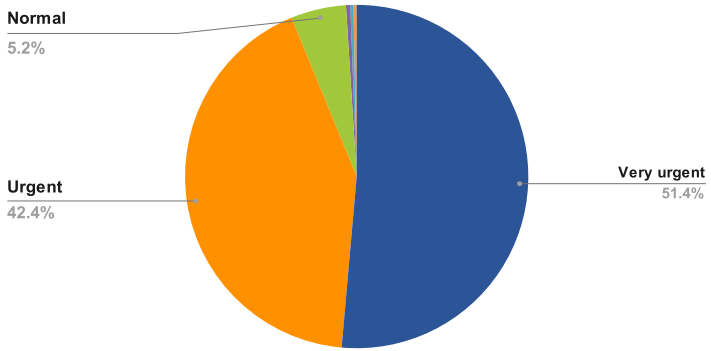
Appendix I - Public Survey Result (1)

This randomized survey was completed by 1000 Indonesian public in 2023

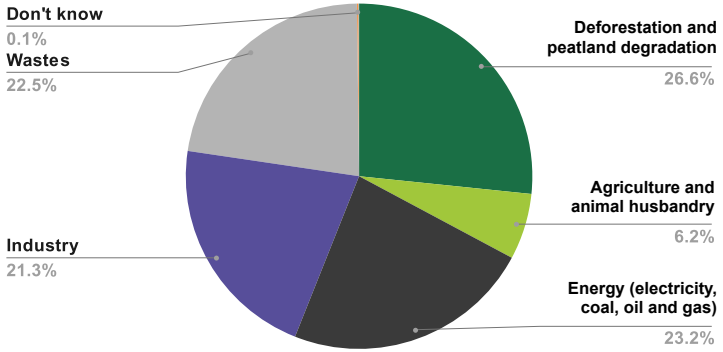
How is your knowledge about climate change/global warming?(%)



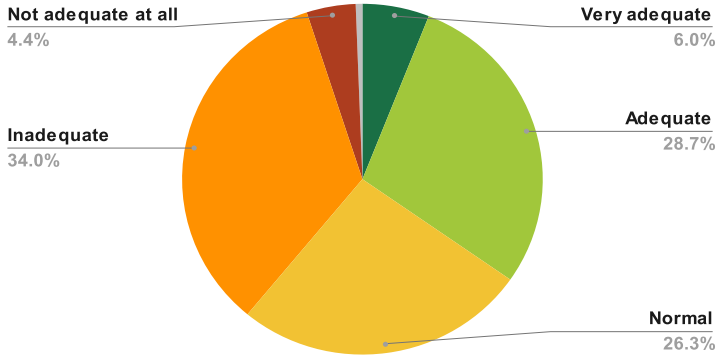
In your opinion, is climate change/global warming an urgent problem to be resolved?(%)



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

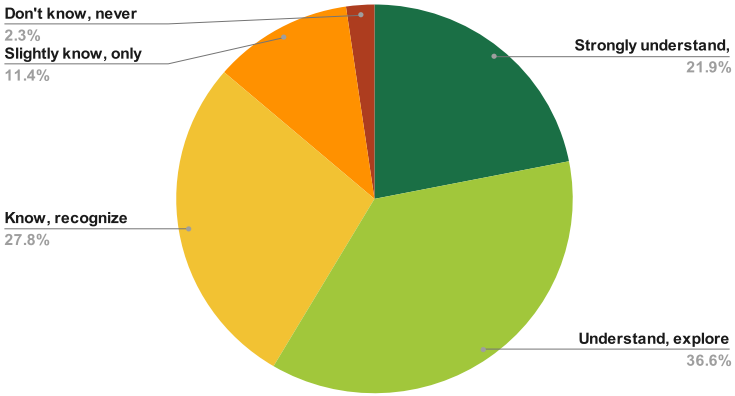


In your opinion, are the current policies of the Indonesian government to deal with climate change/global warming sufficient?(%)

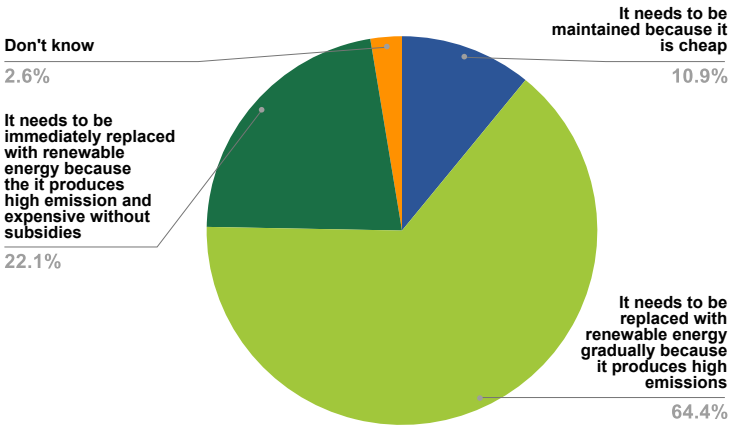


Appendix I - Public Survey Result (2)

How is your knowledge regarding the energy transition?(%)



What do you think about the use of coal as an energy source for electricity generation in Indonesia?(%)



In your opinion, what energy sources should be prioritized in generating electricity in Indonesia? (Rank 1 is the best/most priority choice, the smaller the number, the higher the ranking)

Answers	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6	Rank 7	Rank 8	Rank 9	Mean	Rank
Solar	474.0	146.0	86.0	44.0	46.0	39.0	44.0	51.0	70.0	3.0	1
Hydro	136.0	172.0	319.0	93.0	63.0	49.0	76.0	54.0	38.0	3.7	2
Wind	72.0	342.0	191.0	96.0	60.0	67.0	67.0	65.0	40.0	3.8	3
Geothermal	40.0	55.0	77.0	200.0	317.0	127.0	73.0	64.0	47.0	5.0	4
Biomass	24.0	39.0	83.0	298.0	213.0	156.0	86.0	65.0	36.0	5.0	5
Natural gas	35.0	91.0	63.0	73.0	97.0	186.0	180.0	208.0	67.0	5.8	6
Oil	39.0	75.0	77.0	50.0	70.0	92.0	265.0	220.0	112.0	6.1	7
Coal	46.0	47.0	70.0	95.0	67.0	190.0	103.0	171.0	211.0	6.2	8
Nuclear	134.0	33.0	34.0	51.0	67.0	94.0	106.0	102.0	379.0	6.4	9

In your opinion, what are the main factors in selecting energy sources that need to be prioritized? (Rank 1 is the best/most priority choice, the smaller the number, the higher the ranking) (Number below represent the amount of respondent)

Answers	Rank 1	Rank 2	Rank 3	Mean	Result
Availability	393.0	467.0	140.0	**1.7**	**Rank 1**
Sustainability (clean)	363.0	234.0	403.0	**2.0**	**Rank 2**
Affordability (price)	244.0	299.0	457.0	**2.2**	**Rank 3**

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