IESR
Institute for Essential Services Reform

Indonesia Energy Transition Outlook 2022

Tracking Progress of Energy Transition in Indonesia: Aiming for Net-Zero Emissions by 2050

Indonesia Energy Transition Outlook 2022

Tracking Progress of Energy Transition in Indonesia: Aiming for Net-Zero Emissions by 2050

IESR
Institute for Essential Services Reform

Jalan Tebet Barat Dalam VIII No. 20
Jakarta Selatan 1280 | Indonesia
T: +62 21 2232 3069
F: +62 21 8317 073

iesr.id iesr
www.iesr.or.id

Imprint

Indonesia Energy Transition Outlook 2022

Tracking Progress of Energy Transition in Indonesia : Aiming for Net-Zero Emissions by 2050

Authors (in alphabetical order):

Agus Praditya Tampubolon
Daniel Kurniawan
Deon Arinaldo
Farah Vianda
Dr. Handriyanti Diah Puspitarini
Icmi Safitri
Idoan Marciano
Julius Christian Adiatma
Lisa Wijayani
Dr. Marlistya Citraningrum
Melina Gabriella
Pamela Simamora
Dr. Raditya Yudha Wiranegara
Ronald Julion Suryadi
Rizqi Mahfudz Prasetyo

Reviewers:

Deon Arinaldo
Fabby Tumiwa
Pamela Simamora

Editor:

Fabby Tumiwa
Pamela Simamora

Please cite this report as:
IESR (2021). Indonesia Energy Transition Outlook 2022. Tracking Progress of Energy Transition in Indonesia : Aiming for Net-Zero Emissions by 2050. Jakarta: Institute for Essential Services Reform (IESR).

Publication:
December 2021

Foreword

In 2021, the energy transition suddenly found its way into Indonesia's energy policy. This energy transition was marked by a turning point in the government's position toward coal and long-term GHG emissions. To the surprise of many, in May, Indonesia's President ordered to stop building new coal plants, seeking to retire coal plants earlier, phase out the coal fleet gradually and accelerate renewable energy deployment and to reach NZE emission in 2060 or sooner.

Just before COP26, the government introduced carbon pricing regulation, adding the enactment of a carbon tax. In the COP26, Indonesia among others, supported Global Coal to Clean Power Transition, which seeks to end coal power plants in the 2040s, while accelerating the deployment of renewables. Returning from COP26, the President stressed the importance to accelerate energy transition to PLN and Pertamina but also highlighted the importance of affordability of energy price.

But before reaching decarbonization by the mid of century, the current government must accelerate renewable deployment to meet the target of 23% renewable energy mix by 2025 as stipulated in the 2014 National Energy Policy. Until today, the renewable share is only 11.2%, fall short than the target. In the last five years, renewables add 400 MW annually, only one-fifth of the capacity that has to be added annually to reach the 23% target by 2025. iven to renewable shorfall, government must undertake serious evaluation, finding and removing underlying causes of a low number of renewable energy projects investment in last six years. Meeting the renewable energy target by 2025 is a real test of the government's credibility and indicates its capability to attain more challenging decarbonization effort by 2060 or sooner.

This report presents an in-depth and comprehensive analysis of the progress of energy transition in Indonesia by examining progress in all energy sectors and technologies deployment, as well as enabling the environment to support the energy transition in Indonesia. For the second time, we use Energy Transition Readiness Assessment to review progress in energy transition and key drivers that could advance or stall the energy transition. Compare to last year, the result this year show some progress particularly in political commitment but it has not yet translated into implementation and improvement of key energy policy documents that guide sector planning dan development.

Finally, IESR proudly presents IETO 2022. We expect this document could provide information. spark public interest in energy transition, inform policymakers on areas that need to be improved to foster energy transition, and generate public debates. Enjoy reading!

December 15th, 2021

Fabby Tumiwa
Executive Director

Table of Contents

List of Abbreviations (1)

ADB : Asian Development Bank
ADPM : *Asosiasi Daerah Penghasil Migas*
ADPMET : *Asosiasi Daerah Penghasil Migas dan Energi Terbarukan*
AESI : *Asosiasi Energi Surya Indonesia*
AFOLU : Agriculture, Forestry, and Other Land Use
AIIB : Asian Infrastructure Investment Bank
APAMSI : *Asosiasi Pabrikan Modul Surya Indonesia*
APBD : *Anggaran Pendapatan dan Belanja Daerah*
APBN : *Anggaran Pendapatan dan Belanja Negara*
APDAL : *Alat Penyimpanan Daya Listrik*
BAU : Business-as-usual
BBNKB : *Bea Balik Nama Kendaraan Bermotor* (ownership tax)
BCA : Bank Central Asia
BECCS : Bioenergy with Carbon Capture and Storage
BESS : Battery Energy Storage System
BEV : Battery Electric Vehicle
BKPM : *Badan Koordinasi Penanaman Modal* (Indonesian Investment Coordinating Board/Ministry of Investment)
BMS : Battery Management System
BNI : Bank Negara Indonesia
BOE : Barrel of oil equivalent
BOPD : Barrels of oil per day
BPDPKS : *Badan Pengelola Dana Perkebunan Kelapa Sawit* (Palm Oil Fund Agency)
BPP : *Biaya Pokok Produksi*
BRI : Bank Rakyat Indonesia
C&I : Commercial and industrial
CAPEX : Capital Expenditure
CAT : Climate Action Tracker
CCS : Carbon Capture and Storage
CCUS : Carbon Capture, Utilisation and Storage/Sequestration
CEF : Credit Enhancement Fund
CF : Capacity Factor
CFPP : Coal-Fired Power Plant
CNG : Compressed Natural Gas
CNNC : China National Nuclear Corporation
CO2 : Carbon dioxide
CO2-EOR/EGR : Carbon dioxide Enhanced Oil/Gas Recovery
CO2e : Carbon dioxide Equivalent
COP : Conference of Parties
CPO : Crude Palm Oil
CSPF : Cooling Seasonal Performance Factor
DEN : *Dewan Energi Nasional* (National Energy Council)
DME : Dimethyl Ether
DMO : Domestic Market Obligation
DPP : *Dasar Pengenaan Pajak* (tax base)
DPG : Diesel Power Generator
EE : Energy Efficiency
EER : Energy Efficiency Ratio
EES : Electrical Energy Storage
EJ : Exajoules
EPC : Engineering, Procurement, and Construction
eq : Equivalent
ETM : Energy Transition Mechanism
ETS : Emission Trading System
EUR : Euro
EV : Electric Vehicle
FDI : Foreign Direct Investment
FiT : Feed-in-Tariff
G7 : Group of Seven

List of Abbreviations (2)

G20 : Group of Twenty
GCF : Green Climate Fund
GDP : Gross Domestic Product
GEF : Global Environmental Facility
GHG : Greenhouse Gases
GSEN : Grand Strategi Energi Nasional
Gt : Giga tonne
GW : gigawatt
GWh : gigawatt-hour
HBA : *Harga Batubara Acuan (*Indonesian coal price reference)
HEV : Hybrid Electric Vehicle
HPAL : High-Pressure Acid Leach
IBC : Indonesia Battery Corporation
ICE : Internal Combustion Engine
IIF : Indonesia Infrastructure Finance
IIGF : Indonesia Infrastructure Guarantee Fund
IKBI : Indonesia sustainable finance initiative
IMB : *Izin Mendirikan Bangunan*
IPCC : Intergovernmental Panel on Climate Change
IPP : Independent Power Producer
ISPO : Indonesia Sustainable Palm Oil
IUPLTU : *Izin Usaha Penyediaan Tenaga Listrik Umum*
JBC : Java-Bali Connection crossing
JCM : Joint Credit Mechanism
JPEN : Jateng Petro Energi
JV : Joint ventures
KUR : *Kredit Usaha Rakyat*
kWp : kilowatt-peak
LCCP : Low carbon scenario compatible with Paris Agreement
LCEV : low carbon emission vehicle
LCOE : Levelized Cost of Electricity
LCOS : Levelized Cost of Storage
LCRs : Local content requirements
LDV : Light Duty Vehicles
Li-ion : Lithium ion
LoI : letter of Intents
LPG : Liquefied Petroleum Gas
LTS-LCCR : Long-Term Strategy for Low Carbon and Climate Resilience
MBOPD : Thousand Barrels of Oil Per Day
MEMR : Ministry of Energy and Mineral Resources
MEPS : Minimum Energy Performance Standard
MHP : Mix Hydroxide Precipitate
MIGA : Multilateral Investment Guarantee Agency
MMBOEPD: Million Barrels of Oil Equivalent Per Day
MMBOPD : Million Barrels of Oil Per Day
MMSCFD : Million Standard Cubic Feet Per Day
MoF : Ministry of Finance
MoHA : Ministry of Home Affairs
MoI : Ministry of Industry
MoT : Ministry of Transportation
MSOE : Ministry of State-Owned Enterprises
MtCO2e : Million tonnes of carbon dioxide equivalent
MW : megawatt
MWp : megawatt-peak
MWh : megawatt hour
NDC : Nationally Determined Contribution
NJKB : *Nilai Jual Kendaraan Bermotor* (general market price)
NPP : Nuclear Power Plant
OEM : Original Equipment Manufacturers
OJK : Financial Services Authority

List of Abbreviations (3)

OPEX : Operational Expenditure
OTR : On the road
PBB : *Pajak Bumi dan Bangunan* (land and building tax)
PDF : Project Development Fund
PEN : *Pemulihan Ekonomi Nasional*
Perda : Peraturan Daerah
PHES : Pumped-hydro energy storage
PHEV : Plug-in hybrid electric vehicles
PKP2B : *Perjanjian Karya Pengusahaan Pertambangan Batubara*
PLN : Perusahaan Listrik Negara
PPh : *Pajak Penghasilan*
PPA : Power Purchase Agreement
PPU : Private Power Utility
PSN : *Proyek Strategis Nasional*
PV : Photovoltaics
PPP : Public Private Partnership
Q3 : Quarter 3
R&D : Research and development
RBDPO : Refined Bleached Deodorized Palm Oil
RE : Renewable Energy
REDD : Reducing Emissions from Deforestation and Forest Degradation
RPJMD : *Rencana Pembangunan Jangka Menengah Daerah* (Regional Medium Term Development Plan)
RUED : *Rencana Umum Energi Daerah* (Regional Energy Plan)
RUEN : *Rencana Umum Energi Nasional*
RUPTL : *Rencana Usaha Penyediaan Tenaga Listrik PT PLN* (PLN's Electricity Supply Business Plan)
SPBKLU : *Stasiun Penukaran Baterai Kendaraan Listrik Umum* (public battery swap station)
SPKLU : *Stasiun Pengisian Kendaraan Listrik Umum* (public charging station)
SKPD : *Satuan Kerja Perangkat Daerah* (local government work unit)
SME : small-medium enterprises
SMR : Small Modular Reactor
SOE : state-owned enterprise
SPEL : *Stasiun Pengisian Energi Listrik*
SRF : Solid Recovered Fuel
TCO : Total Cost of Ownership
tCO2e : Tonne of Carbon dioxide Equivalent
TKDN : *Tingkat Komponen Dalam Negeri*
TOE : Tonne of Oil Equivalent
TWh : terawatt hour
UID : *Unit Induk Distribusi*
USD : United States dollar
UU HPP : *Undang-Undang Harmonisasi Peraturan Perpajakan*
VA : volt-ampere
VAT : value-added tax
VGF : Viability Gap Fund
VRE : Variable Renewable Energy
WP&B : Work Plan & Budget
yoy : year-on-year

Executive Summary

Executive Summary

- This year marks a new milestone in our race to net-zero with the government of Indonesia announcing its commitment to reaching net-zero by 2060 and phasing-out CFPP by the 2040s (with international aid). An encouraging sign of progress is also seen in the policy and regulatory realm where key policies and regulations such as NDC, LTS-LCCR, and RUPTL 2021-2030 and regulation No. 26/2021 on rooftop solar PV were updated and improved. However, some issues linger. The LTS-LCCR's low carbon scenario still incorporates a high share of fossil fuels plus CCUS despite estimates showing that such technological options will become more costly than the renewables plus storage option. Furthermore, while renewables capacity addition increases in the newly released RUPTL 2021-2030, the overall generation mix is still dominated by coal for the next ten years.

- The long-awaited renewable energy law, Presidential Regulation on FiT, and regulation on energy conservation suffer more delays this year and are expected to be enacted next year. The delays extend uncertainty to investors who have long been in a wait-and-see mode.

- Renewable energy development remains sluggish this year with installed capacity only increasing by 386 MW by Q3 2021, far below what is needed to achieve the 23% target. Hydropower, geothermal, bioenergy, and solar PV contributed to an increase of 291 MW, 55 MW, 19 MW, and 21 MW respectively. Rooftop solar PV hit its highest annual growth at around 17.9 MW. In contrast, CFPP saw the lowest growth for the last 5 years at around 308 MW. In terms of generation, however, coal generation still dominated the power generation by accounting for around 66% of total power generation. Meanwhile, renewables only contributed to around 13%.

- Floating solar PV is on the rise with three new projects announced of more than 2.5 GWp: a 40 MWp floating solar PV at Nadra Krenceng reservoir and two floating solar PV projects totaling 2.5 GWp in Batam Island. The Batam project becomes a landmark for the Indonesian solar market as it becomes the first project of solar power exports from Indonesia to Singapore, opening a whole new market for renewables (solar) investors in Indonesia.

- Renewable energy continues its low investment trend by only receiving USD 1.1 billion of investment by Q3 2021, accounting for 30% of the total investment in the power sector this year. In the same period, fossil power generators received a total investment of USD 2.5 billion in the country.

- A major breakthrough came from the power sector with Indonesia joining the Philippines and Vietnam in ADB's Energy Transition Mechanism (ETM). The ETM is set to help these three countries stop their heavy reliance on coal by early retiring CFPPs. To date, at least 9.2 GW of CFPPs have been identified for early retirement under the ETM scheme. Pilot projects at three CFPPs with a total capacity of 1.77 GW were expected to start in 2022-2023.

Executive Summary

- The first phase of the Emission Trading System pilot project started this year. The pilot project received a lukewarm welcome from CFPP operators with only 32 out of 84 eligible operators participating in the pilot project. The ETS booked a total transaction of 42,455 tonnes of CO2 that was mostly traded at the lowest trading price of USD 2/tonnes CO2.

- In the transportation sector, the market penetration of electric vehicles remains low. By Q3 2021, BEV sales only reached 654 units or represented less than 1% of total car sales. If the trend continues, it would be difficult to achieve the government target of 2 million electric cars by 2030. Meanwhile, the development of public charging stations (SPKLU) and battery swap stations (SPBKLU) is also slow-moving. To date, there are only 187 SPKLU and 153 SPBKLU throughout Indonesia (mostly in Jakarta), lower than the target of 572 SPKLU and 3,000 SPBKLU.

- Biodiesel consumption reached 8.1 million kl and was expected to continue increasing to 9.2 million kl by the end of this year. Meanwhile, biodiesel exports increased from 28,000 kl in 2020 to about 100,000 kl in 2021. Pertamina successfully conducted a flight test using 2.4% bioavtur, sparking a new interest in bioavtur development in the country.

- B40 with 40% FAME will be road-tested next year, but there are still no targets for increased blending rate from the government. The B40 program faces persistent challenges for its high production costs and lack of financing sources for incentives or subsidies. To increase clean fuel penetration, the government should set up regulations on the mandatory biofuel targets, product quality standards, and incentive schemes.

- At the sub-national level, provinces such as Jakarta, Bali, Central Java, and Jambi have set up regulations and measures, such as instructions, gubernatorial or provincial regulations, and provincial budget allocations associated with climate action. One of the most popular measures adopted by the sub-national governments is the use of rooftop solar PV on public schools, youth and/or sport centers, health service buildings, and all government buildings. Given the fact that the national government has set a target to achieve net-zero by 2060, more sub-national governments should step up efforts in transitioning local economies towards low-carbon economies.

- Participation of the private sector in climate action has also emerged with around six local Indonesian companies having a net-zero target. Four out of six companies that have set such a target were fossil fuels companies with two of them being coal mining companies. Corporate responsibility in climate change mitigation was identified by all these companies as one of the main reasons for adopting such a target. This trend symbolizes a new era where fossil fuel companies start transitioning away from fossil fuels and diversifying their businesses to clean technologies.

Executive Summary

- To date, there are 13 banks joining the Indonesia sustainable finance initiative (IKBI). By Q1 2021, four banks that are members of IKBI have disbursed a total of IDR 30 trillion (USD 200 million) to renewable projects. Despite the rise in renewable energy financing, local banks still disburse their credit to coal projects. Between 2018 and 2020, these four banks had disbursed a total of IDR 166 trillion (USD 8.8 billion) of loans and underwritings to coal projects.

- Overall, the readiness of the Indonesian power sector to transition away from fossil fuels and towards renewable energy gets improved this year, although some aspects still need major refinement. Aspects such as political will and investment climate of renewable energy get low ratings. This is mainly due to the less ambitious NDC and some other unsupportive regulations as well as high market entry barriers for investors interested in investing in the Indonesian renewable market. Meanwhile, techno-economic and social aspects have seen some improvements with PLN incorporating more renewables into the RUPTL 2021-2030 and energy transition getting more support from the public.

- The year 2022 promises a better prospect for the energy transition in Indonesia with the government setting up new, stronger commitments for climate action and energy transition in 2021. Major policies such as net-zero emission target, CFPP moratorium, and carbon price implementation set the positive tone for the energy transition in the years to come. In implementing the newly released RUPTL 2021, it is expected that PLN will start auctioning renewable projects next year. Apart from PLN, sub-national governments, public and private companies, as well as individuals will continue participating in the energy transition through some efforts such as setting up a net-zero target, increasing public funds for renewables, and installing rooftop solar PV on buildings.

- Rooftop solar PV is projected to reach about 500 MW next year. In addition, it is also expected that there will be energy transition projects rolled out in various locations hosting G20 meetings next year. These projects include, for example, renewable energy installations and electric vehicle deployment.

- In the transportation sector, more electric two-wheelers adoption should be expected from the ride-hailing services as they started establishing partnerships with and investing in electric two-wheelers manufacturers. From these initiatives alone, there will be at least an addition of 25 thousand electric motorcycles on the road next year.

- To make 2022 a success story, the government needs to improve the investment climate through the betterment of policy and regulatory framework. The highly anticipated regulations such as Presidential Regulation on Renewable Energy Tariffs and Renewable Energy Law expected should be issued next year along with the Presidential Regulation on CFPP retirement to send a strong signal to the market that Indonesia is fully committed to the energy transition. The implementation of carbon pricing and a pilot project of CFPP early-retirement next year will set a new critical point for Indonesia's energy transition agenda.

Deep Decarbonization of Indonesia's Energy System: A Pathway to 100% Renewable Energy

- Deep decarbonization pathway
- Subnational government participation
- Private sector participation

Pamela Simamora

Deep decarbonization of Indonesia's energy system: Why it matters

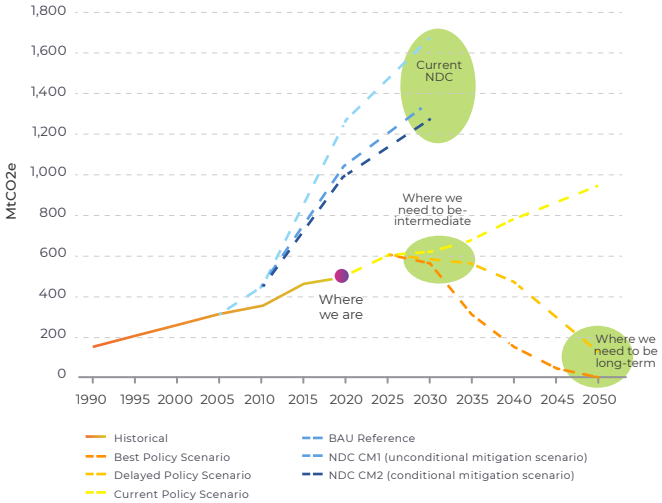
- Emission reduction to mitigate negative impacts of climate change has become a shared goal of the international community in recent years with more countries and businesses around the world committed to net-zero emissions, mostly by mid-century. The race to carbon or climate neutrality coincides with exacerbating extreme weather events, falling renewable energy costs, and increased awareness of climate change. To date, however, Indonesia is lagging behind other countries by only targeting 2060 to achieve net-zero emissions despite its status as an archipelago country that is vulnerable to climate change.

- Through its Nationally Determined Contribution (NDC), Indonesia aims to reduce greenhouse gases (GHG) emissions by 29% (voluntarily) or 41% (with international support) compared to the business-as-usual scenario by 2030. Current NDC, however, is far from what is needed to achieve the Paris Agreement.

- The energy sector has become the second largest emitting sector in Indonesia by contributing to 34% of total emissions in 2019 and is projected to turn into the largest emitter by 2030 if no decarbonization efforts are carried out.

- Considering the climate urgency, deep decarbonization should become one of the Indonesian government's top priorities for the next three decades. Decarbonization should also be seen as an opportunity to modernize the overall economy, avoid costs of climate damages, improve air quality, prevent premature deaths, reduce healthcare costs, increase energy efficiency, secure water and food availability, and preserve biodiversity.

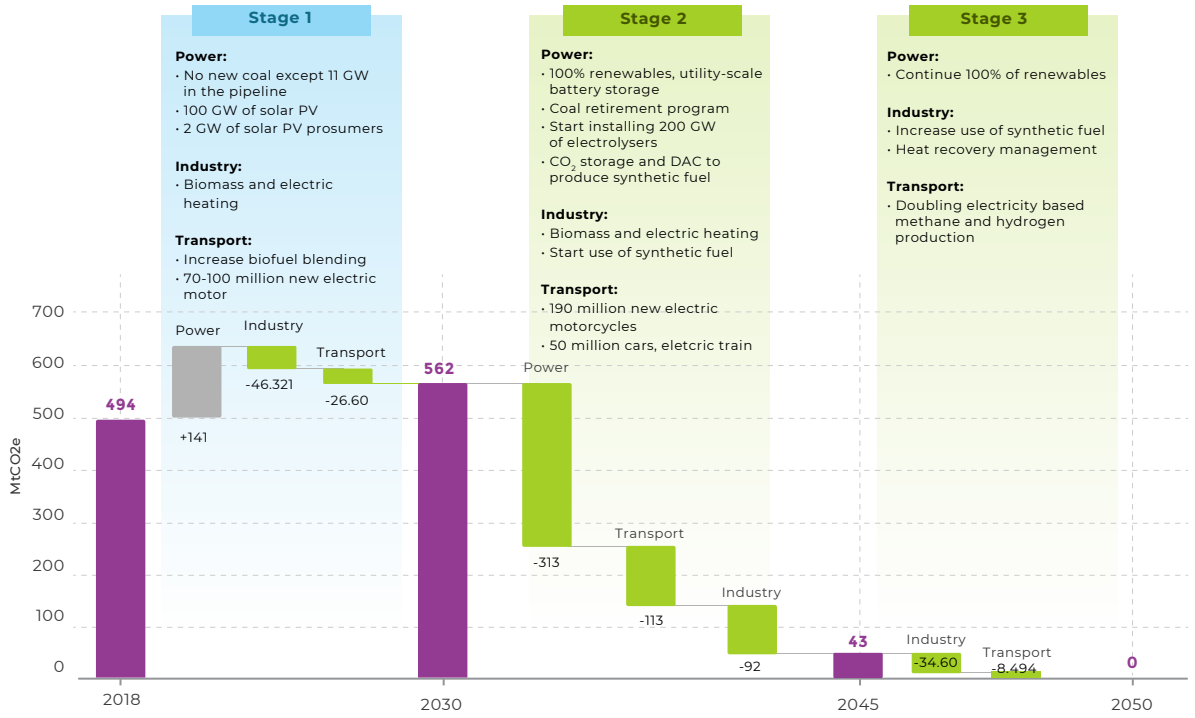
Energy sector historical emissions and emission reduction pathways in NDC



Source: IESR, Agora Energiewende & LUT University, 2021

A pathway to zero emissions by 2050: What it looks like for Indonesia

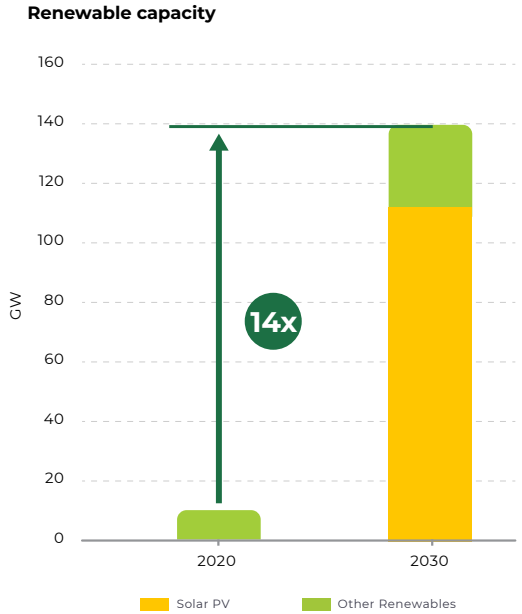
Decarbonization is a long, complex process that requires proper planning. In IESR's deep decarbonization study, the decarbonization process in the energy sector (power, transport, and industrial heat) was divided into three stages as depicted below (IESR, Agora Energiewende & LUT University, 2021).



Deep decarbonization requires dramatic changes in the energy sector within this decade

The pandemic has helped curb GHG emissions, mainly due to slowing economic activity. However, to achieve the deep decarbonization goal, structural changes are needed. The changes, particularly, need to happen this decade to keep up with the race to zero emissions. By 2030, Indonesia needs to see:

- Almost half of electricity is sourced from renewable energy, up from 14 percent today. Solar power contributes the largest to total power generation at around 24%.
- Renewable installed capacity increases to 140 GW, up from 10 GW today. Solar PV needs to grow by 10-11 GW per year, around a sixth of the growth come from rooftop solar PV. Power grid expands to more than 13 GW with some inter-island connections being established.
- Coal moratorium should be imposed to peak carbon emissions by 2025. Phasing out of more than 15 year- old-coal fired power plants will be carried out from 2025 onwards.
- Electric vehicles start to take off by accounting for 60% of market share in the motorcycle segment and 10% in the passenger car market. Electric heating is used in the industry to supply low temperature heat process with installation reaching 54 GW.



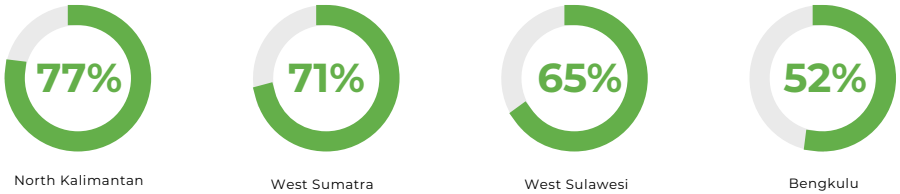
Multi-stakeholder participation is crucial to Indonesia's deep decarbonization journey: Sub-national governments need to step up

- The complexity of deep decarbonization necessitates both state and non-state stakeholder participation as well as collaboration in the process. While the central government is key to setting up national climate target and long-term climate strategy, the success of such an ambitious goal is also dependent on local action plans. Subnational governments, for instance, should set up a more ambitious regional energy plan (RUED) that reflects the needs to decarbonize the energy system, implement green building codes, develop and integrate public transport, use public procurement to help accelerate the use of renewable energy and electric vehicles, as well as provide incentives to stimulate the shift.

- Out of 20 provinces that have already set up their RUED, only four provinces put renewable energy as their primary source of energy in 2050 by contributing more than half of energy mix in that period. The rest remains largely dependent on fossil fuels, indicating a need for updating existing RUED to better reflect the relatively new central government's net-zero target. Furthermore, sub-national governments should put up a more ambitious regional medium term development plan (RPJMD) that highlights low carbon development goals. To date, however, only half of ten largest carbon emitting provinces in Indonesia have specific emission reduction targets in their RPJMD. With decarbonization becoming the national target, it is time for sub-national governments to step up efforts in climate action.

- To drive local energy transitions, sub-national governments may start setting up local initiatives such as 100% renewable energy islands, provinces, and cities that prove achievable when looking at similar initiatives commenced in other countries. Currently, Indonesia has had the Sumba Iconic Island initiative aimed to achieve 100% renewable energy on Sumba Island by 2025, but has no other similar initiatives despite the large renewable energy potential throughout the archipelago.

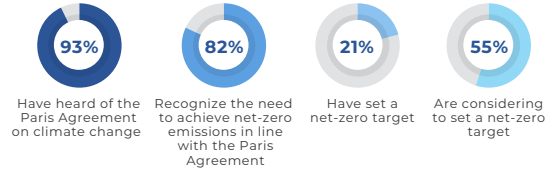
Renewable energy mix in 2050 (RUED)



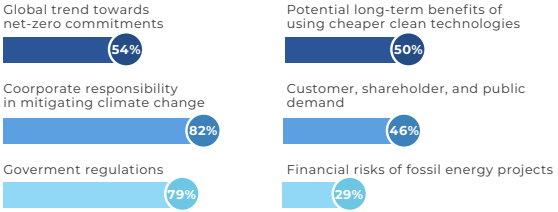
Private sector participation in climate action is still low

- Our survey of 28 Indonesian-origin (local) companies reveals that a majority of them have heard of the Paris Agreement, indicating a high level of corporate awareness of climate change. Furthermore, more than 80% of local companies surveyed either publicly or privately acknowledge the need to achieve net-zero emissions in accordance with the Paris Agreement.
- However, our survey also indicates much work still needs to be done to bridge the gap between companies' awareness and their climate action: in contrast to the global trend, only a fraction of local companies polled in our survey have set a net-zero target. Most are still considering to make one in the foreseeable future.
- It is important to note that ideally, net-zero targets should cover scope 1 (direct), 2 (indirect), and 3 (value chain) emissions. Out of six local companies that have committed to net-zero, only three include scope 3 emissions in their targets. Two companies only incorporate scope 1 emissions and the other one has yet to specify the scope of the target. Energy companies set a net-zero target in either 2060 or 2050, while technology companies set a more ambitious target by 2030.
- Interestingly, "corporate responsibility in climate change mitigation" came out as the main reason why local companies (will) adopt a net-zero target. Other reasons such as government regulations and global trend in net-zero targets also influence their decision in making such a bold commitment.
- All companies that have set a net-zero target claimed to have a roadmap to achieve such a target. Carbon removal and offset became the most popular solutions for achieving company net-zero pledges, followed by renewable energy use and energy efficiency improvements.

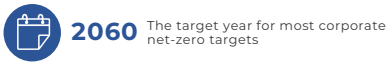
Net-zero commitments



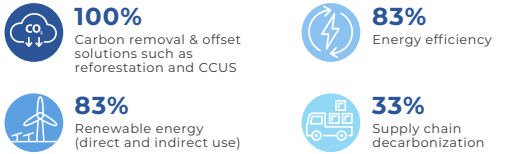
Main drivers of setting a net-zero target



Net-zero timeline



Ways of achieving net-zero targets



Fossil fuel companies have started to see the end of fossil fuel era, local banks lack awareness of climate change

- By category, there were six types of industries surveyed for this analysis: banking, coal IPP, coal mining, oil and gas, consumer goods, and technology companies. The selection of these industries was influenced by the fact that worldwide, companies in these sectors have become increasingly proactive in climate action. In our survey, two companies from the same corporate group that operate in a different industry were regarded as two different entities that may have a different net-zero target.

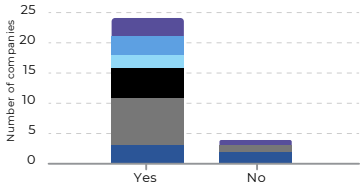
- Fossil fuel companies (oil and gas, coal mining, and coal IPP) represented around 60% of total respondents with the vast majority of the companies admitting that achieving net-zero emissions is necessary. Out of six companies that have had a net-zero commitment, four were from this category and two of them were coal mining companies. The trend may indicate that local fossil fuel companies have started to accept the fact that the era of fossil fuels will inevitably reach its end.

- Corporate responsibility in climate change mitigation was identified by all net-zero fossil fuel companies as one of the main reasons of adopting such a target. Other main drivers for net-zero in this segment included government policy, business expansion opportunities in new sectors, and financial risks associated with fossil energy projects.

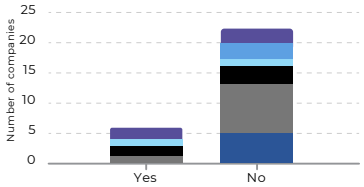
- Despite government intention to phasing out coal from the electricity mix by 2040, only one out of nine coal IPP surveyed has had a net-zero target. Five coal IPP indicated their plan to set a net-zero target in the near future while the remaining were indifferent to the commitment.

- Two local banks surveyed stated they never heard of the Paris Agreement before and never had any internal discussions on the matter in their respective banks. In contrast to the global trend, none of the local banks surveyed have a net-zero target with four out of five banks surveyed having no plans to set one. The peculiar trend is also consistent with the fact that the vast majority of these banks do not see financial risks of fossil projects as one of the main drivers of committing to net-zero.

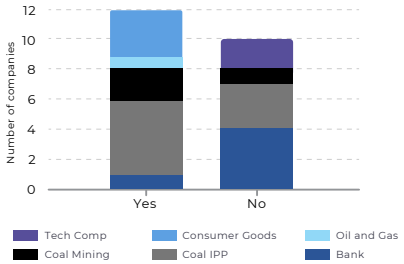
Recognize the need to achieve net-zero emissions



Have set a net-zero target



Consider setting a net-zero target



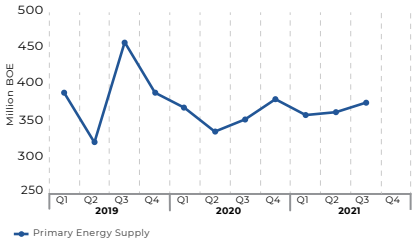
Energy sector overview

- Primary energy supply
- Major policy changes
- Investments realization in energy

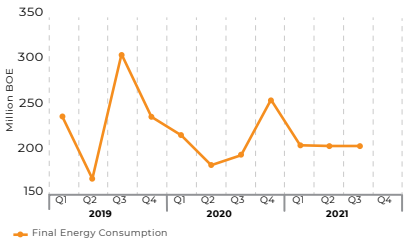
Deon Arinaldo

Energy demand rebounds as the economy recovers

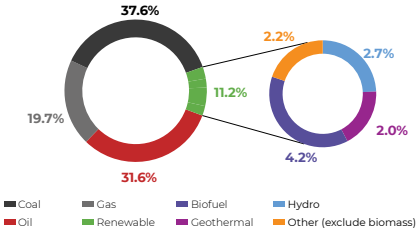
Primary energy supply (Q3 2021)



Final energy demand (Q3 2021)



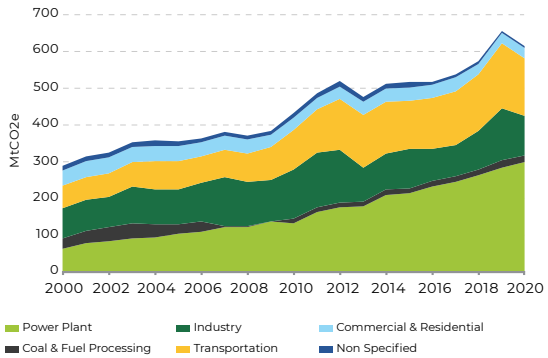
Indonesia primary energy mix (Q3 2021)



- Primary energy supply and final energy consumption in Q3 2021 increased by 3.7% and 3.4% respectively YoY, reflecting the overall economic recovery. The supply and consumption levels, however, were still lower than the pre-pandemic levels.
- Indonesian GDP grew by 3.24% in Q3 2021 after experiencing a decline of 2.03% in Q3 2020. However, this year's growth was lower than both the government and ADB growth projections at 3.7-4.5% and 3.5% respectively.
- The share of renewable energy in the primary energy mix only reached 11.2%, making the 23% renewable energy target harder to achieve in four years ahead.
- The economic rebound, a sharp increase in energy demand as countries prepared for winter, and limited energy supply had caused soaring energy commodity prices in the last months of 2021. In October, all fossil fuel prices surpassed average prices in the last ten years, with coal prices hitting its all-time high (World Bank, 2021). The price spikes received mixed reactions from stakeholders considering Indonesia's reliance on fossil fuels to produce energy and revenues.

The power sector is key in emission reduction from the energy sector

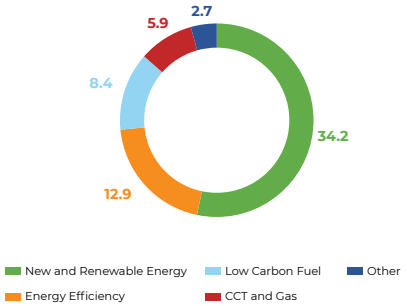
Energy sector emissions in 2000-2020



*2019 and 2020 emissions are from IESR calculation

Distribution of energy sector mitigated emissions against BAU in 2020

(MtCO2e)



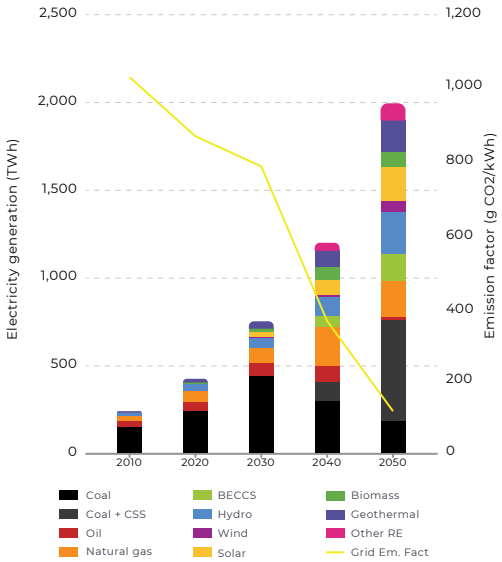
Source: MEMR, 2021

- It is likely that power plants become the main emitter in the energy sector in 2021 with more than 4,600 MW of new CFPP becoming online by the end of this year. These new CFPP alone will emit at least 27-32 million tonnes CO2-eq annually throughout their lifetimes.
- Our deep decarbonization study shows that emissions from the energy sector should peak by 2025 if Indonesia were to comply with the Paris Agreement. To achieve such a target, more efforts should be made to reduce emissions from power plants.
- Programs such as co-firing or clean coal technologies will only distract the energy transition with emission reductions from such programs being hardly significant. Supercritical power plants (SC) emit around 8% fewer emissions than subcritical coal plants. While “the most efficient” advanced ultra-supercritical CFPP (AUSC) still produce much higher emissions than gas power plants, with emission reduction at around 16.5% against subcritical power plants (Tramošljika et. al, 2021). Therefore, it is more advisable to phase out CFPP that are already old and inefficient.
- Climate mitigation in the energy sector will likely depend on the success of renewable energy and energy efficiency programs in the country. The two programs contributed to around 53% and 20% of a total of 64.36 million tonnes CO2-eq mitigated emissions in 2020 respectively (MEMR, 2021).

The LTS-LCCR's reliance on fossil fuels plus CCS could lead to higher energy costs

- The Indonesian government updated its NDC in July without any increase in mitigation targets. The update only came with a new set of activities in the adaptation strategy. Apart from the NDC, the government also released the Long Term Strategy for Low Carbon and Climate Resilience (LTS-LCCR) that sets a net-zero emissions target by 2070 before later changing it to by 2060 or sooner.
- In the LTS-LCCR, there are some scenarios used to model net-zero emissions in all sectors. Specifically, the Low Carbon Scenario Compatible with the Paris Agreement (LCCP) is claimed to be aligned with the Paris Agreement with emissions peaking by 2030 in all sectors including the energy sector.
- In the LTS-LCCR, fossil fuels still take up a significant share in power generation. CFPP combined with CCS/CCUS and co-firing CFPP combined with CCS (called BECCS) make up around 29% and 8% of total power generation respectively in 2060. This strategy is questionable considering that CCS prices are and will remain uncompetitive against renewable energy plus storage. If CCS is installed, the LCOE of supercritical CFPP will double from EUR 40 per MWh to EUR 80 per MWh (USD 92 per MWh) even if CO2 transport and storage costs are kept low at around EUR 10 per tonne. In this case, the cost of avoided CO2-eq is more than EUR 55 per tonne (USD 64 per tonne) (Ferrari et.al 2019).
- To make BECCS more competitive against other low carbon technologies (e.g. renewables and nuclear), high carbon prices are needed at around USD 240 per tonne CO2. The deployment of such a technology is also limited due to environmental and commodity price (e.g. food) constraints (Fajardy et.al. 2021).
- It is worth noting that the LTS-LCCR's generation mix is different from what has been prepared by the MEMR and PLN with the latter projecting a gradual decline of coal generation due to the coal moratorium. Pivoting on fossil fuels plus CCS indeed could lead to increased energy system costs.

Projection of electricity mix in the LCCP scenario



Source: MoEF, 2021

Renewables and energy efficiency become the main measures to achieve the NDC target

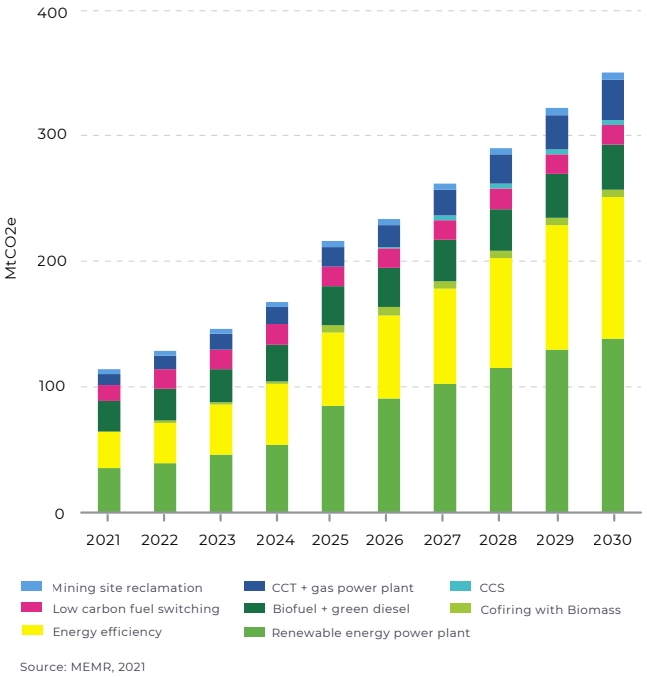
- Recently, the MEMR prepared a carbon emission mitigation plan in line with the NDC target for the energy sector. Under the optimistic scenario, the overall emissions from the energy sector still increase to 1,219 million tonnes CO2-eq by 2030 although the emission reduction against the BAU scenario reaches 350 million tonnes CO2-eq.

- The emission reduction is achieved through a few measures such as the use of renewables and the improvement of energy efficiency. Under the optimistic scenario, it is projected that energy efficiency and renewable energy (with 34 GW of renewables-based power plants) can reduce 113 million tonnes CO2-eq and 138 million tonnes CO2-eq respectively. About 20% of emission reduction from renewables is expected from rooftop solar PV and off-grid renewable energy projects that are not included in RUPTL.

- The biomass co-firing program that is applied to 19 GW of CFPP with a blending share of 5% needs around 9 million tonnes of feedstock annually. The emission reduction from such a program is only 5.94 million tonnes CO2-eq per year, contributing to 2% of the emission reduction target in 2030.

- At the same time, the MEMR also anticipated annual emission reduction at around 3.9 million tonnes CO2-eq through the utilization of CCS in Gundih, Sukawati, and Tangguh oil and gas fields from 2025 onwards. OCGI study shows that Indonesia's CO2 storage potential can reach 15.9 Gt CO2. To date, however, only 2.46 Gt CO2 has been discovered. The potential might further drop when economic viability is taken into consideration. In addition, the fact that more than 80% of the potential is located in Sumatra (OCGI, 2021) further limits its application in Indonesia since most CFPP are located in Java.

Projected mitigated emissions in the energy sector against BAU 2021-2030



Source: MEMR, 2021

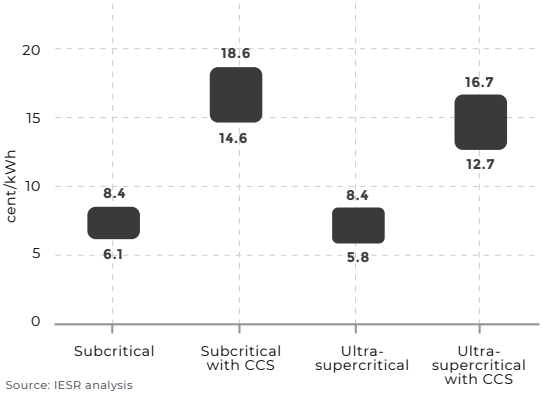
CCS/CCUS might be more suitable for the industrial sector than the power sector

- CCS/CCUS costs vary depending on the purity of CO2, storage locations and conditions as well as the distance between the source of the CO2 emissions (e.g. CFPP) and storage facility. Currently, commercial CCS projects are mainly for (blue) hydrogen production where CO2 source from gas fields and carbon storage facilities are in close proximity (McCulloch, 2021).

- However, a recent study shows that lifecycle emissions of blue hydrogen are only 9-25% lower than grey hydrogen. This is mainly due to the fact that when producing blue hydrogen, methane fugitive emissions also increase, reducing the overall emission reduction (Howarth & Jacobson, 2021).

- Located in a gas field, the Gundih CCS pilot project is expected to have relatively low project costs. Given the close proximity of the CO2 source and existing capture facility as well as the CO2 purity, the CAPEX and 10 year-OPEX are estimated to be around USD 49 million and USD 20 million respectively. This translates into USD 24-31/tonne CO2 abatement cost.

LCOE of CFPP plus CCS



Source: IESR analysis

- The use of CCS at power plants will directly compete against renewable energy plus storage. It is projected that the costs of avoided CO2 emissions of CFPP plus CCS range from USD 85-102/tonne CO2-eq in Indonesia (World Bank, 2015), doubling or even tripling the current LCOE of CFPP.

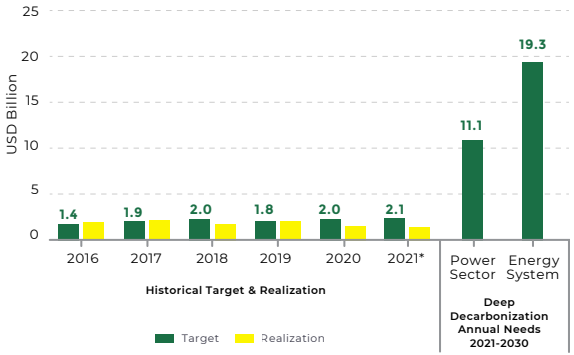
- Other than price issues, the reliability of CFPP plus CCS is also questionable. A well-known commercialized CFPP plus CCS project, the Petra Nova project, suffered frequent outages. Since its first operation in 2017, the power plant had experienced outages on 367 days before the CCS system was finally shut down in May 2020. It is reported that the outages were mainly caused by the CCS system and the dedicated natural gas power unit. Overall, the Petra Nova project failed to deliver its CO2 capture targets by only giving a net emission reduction of 70% instead of 90% as promised. The lower reduction was associated with the use of a natural gas plant to run the CCS system with the gas plant emitting 1.1 million tonnes of CO2 annually.

- Otherwise, CCS might be potentially used as a mitigation measure in cases where cheaper renewables and clean fuels are nonexistent. Harder-to-abate industries such as cement, steel, and chemical industries might also benefit from CCS, particularly when the abatement cost is still higher than USD 100/tonne CO2-eq (IEA, 2021).

More efforts are needed to boost investment in low carbon technologies

- Renewables investment only reached USD 1.12 billion by Q3 2021, accounting for 55% of the government target. Meanwhile, investments in battery manufacturing plants and EV manufacturing plants were only at around USD 2.75 billion combined. Similarly, the oil and gas, coal and mineral, and power sectors only attained 54%, 63%, and 43% of government targets respectively over the same period.
- Current renewables capacity is still far from what is needed to fully decarbonize the energy system by 2050. Our study shows that for the next ten years, Indonesia would need to increase the annual investment ten times bigger than current government targets.
- The inclusion of nuclear and new energy (e.g. coal gasification) in both the energy sector strategy (GSEN) and new and renewable energy law is seen as a distraction to renewables development in Indonesia. Both technologies are deemed as "immature" technologies for the country. Moreover, concern over increased GHG emissions from coal gasification is also often mentioned by stakeholders.
- There is an urgent need to boost investments in renewable energy and other low-carbon technologies such as EVs and batteries. The government then should improve the investment climate in the country through better regulatory and policy frameworks and increased participation of all stakeholders in the energy transition.

Energy sector investment realization vs needs to achieve net zero emissions by 2050



Energy Transition in the Fossil Energy Sector

Julius Christian Adiatma

Pamela Simamora

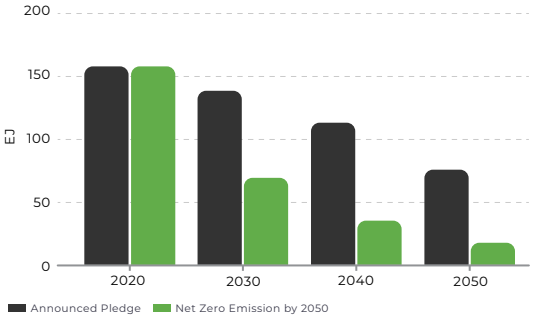
Ronald Julion Suryadi

- Coal sector
- Oil and Gas
- Fossil fuel companies in transition

A global trend away from coal will pose threat to the future of Indonesian coal

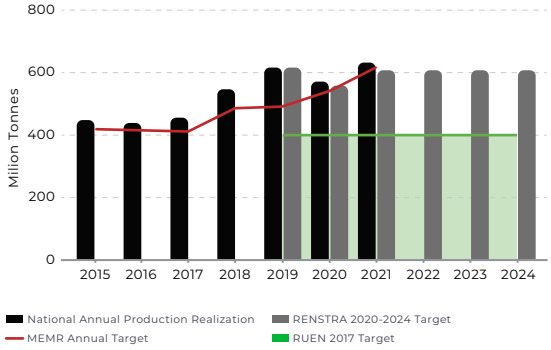
- Coal remains an important commodity for Indonesia. After a slight dip in 2020, coal production rebounded, following the increasing trend in recent years, from 461 million tonnes in 2015 to more than 600 million tonnes in 2021. This production rate far exceeded the RUEN target of 400 million tonnes per year.
- On the global landscape, commitment to move away from coal hit a new milestone. During the G7 Summit, the leaders of G7 countries agreed to end new direct government support for unabated coal power projects. Later at COP 26, forty countries signed a joint declaration to transition away from unabated coal in the 2040s. As a result, around 550 GW of coal plants around the world will be phased-out and 88 GW are likely to be cancelled due to "no new coal" financing pledges.
- The global trend of moving away from coal could threaten Indonesia's coal future, as coal demand might start to decline. IEA (2021) predicts that global coal demand will decrease by 9% in 2030 and by 50% in 2050 from the 2020 level if all countries fully implement their announced climate pledges as of mid-2021 (prior to COP26). The IEA's projection for net-zero emissions by 2050 displays an even more dismal outlook for coal as global demand will be halved by 2030.
- Given the global coal outlook as well as Indonesia's commitment to phasing out coal power plants in the 2040s with international support, demand for Indonesian coal will likely start falling off before 2030.

Global coal demand projection by IEA (2021)



Source: IEA, 2021.

Indonesia annual coal production

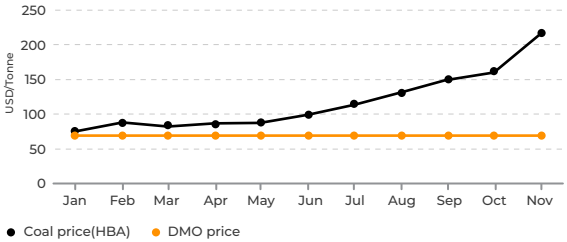


Source: MEMR, 2017; MEMR,2021; IESR's calculation
*2021 production realization is projected from month trend

Coal price volatility posed a risk to businesses, signaling a need to accelerate the energy transition

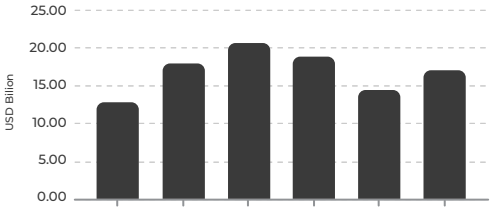
- Indonesia's coal reference price (HBA) set a new record high at around USD 215/tonne in November 2021. The high prices were mainly driven by increased coal demand from China and India as the global economy started to recover and coal supply was constrained amid extreme weather events such as flooding which disrupted coal production. Coal shortages were further worsened by Chinese policy that banned coal imports from Australia.
- Indonesia increased its coal exports with the value reaching USD 17.2 billion by September 2021, a 158.4% increase YoY. By the same period, the coal industry had contributed to around 13% of Indonesia's total export value.
- A disparity between international market prices and local prices that are capped at USD 70/tonne has made the 25% Domestic Market Obligation (DMO) hard to achieve. With price disparity, coal mining companies prefer exporting their coal to supplying the domestic market. As a result, only 46% of the 137.5 million tonnes of coal DMO quota in 2021 had been fulfilled by September 2021.
- To address the problem, the MEMR issued two ministerial decrees that regulate export bans and fines for coal companies that fail to meet DMO and caps coal price at USD 90/tonne for cement and fertilizer industries that struggled with soaring coal prices. The price volatility has exposed businesses to the risk of shortages and price increments. It is reasonable, therefore, for the government and industries to reduce their reliance on coal by shifting to clean energy.

Indonesia coal reference price (HBA) 2021



Source: MEMR, 2021.

Annual national coal export value



Source: BPS, 2021.

Development of coal to DME remains on the table despite economically non-profitable

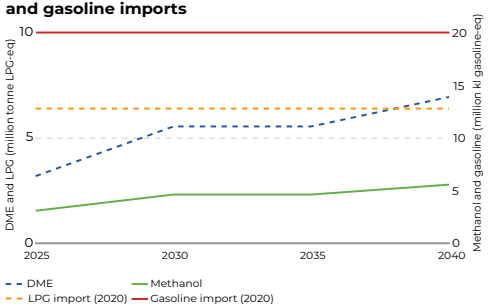
- Anticipating a future decline in global coal demand, the government aims to develop the coal downstream industry to increase domestic demand while substituting imported oil products, e.g. gasoline and LPG. The updated Coal and Mineral Law in 2020 and its derivative regulations have set the legal basis for this goal with large coal producers (PKP2B) being required to develop downstream industries to get their permit extended and provided with various incentives (e.g. 0% royalty) for companies that carry out the downstream activities.

- The MEMR has set up a roadmap for producing 4.6 million tonnes of DME and 7.9 million tonnes of coal-based methanol by 2025. The number would increase to 6.1 and 14.1 million tonnes respectively by 2045, translating to about 35 million tonnes of additional domestic coal demand. DME is aimed to replace about 60% of the LPG import by 2025. Meanwhile, methanol is planned mainly for gasoline blending and feedstocks for the petrochemical and biodiesel industries.

- The coal-to-DME projects would likely be exposed to volatility risks of commodity (e.g. coal and LPG) prices. Assuming a low coal price of USD 20/tonne, the DME production would be economically feasible only when the LPG price is above USD 551/tonne, much higher than the average price of LPG prices of USD 430/tonne in 2019. Thus, such a project will unlikely be feasible without government subsidies.

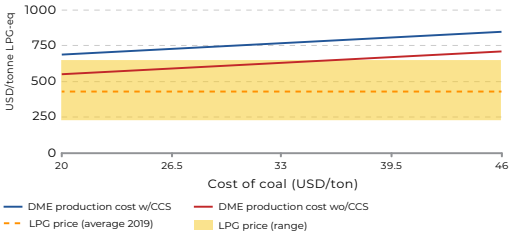
- The process of converting coal to methanol produces GHG emissions at around 3.2 kg CO2eq/kg methanol, and GHG emissions of DME production is estimated to be roughly similar (IRENA and Methanol Institute, 2021; Kajaste et al., 2018). By installing CCS technology to remove the additional CO2 emissions at the cost of USD 20/tonne CO2-eq, production costs of DME could increase by 20-25%, making it uneconomic even with low coal costs and high LPG prices.

DME and methanol production production target vs LPG and gasoline imports



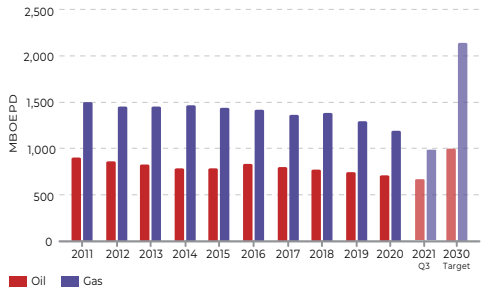
Source: MEMR, 2021

DME production cost in different cost of coal and CCS utilization scenario



Source: MEMR, 2021

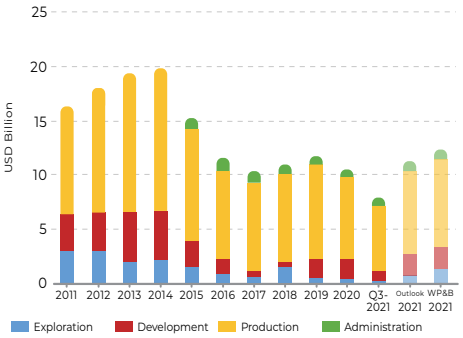
Indonesia oil & gas lifting realization



Source: SKK Migas, 2020

Gas converted to BOEPD (1 MBOEPD = 5.6 MMSCFD)

Indonesia oil & gas upstream investment value



WP&B: Work Plan & Budget

Source: SKK Migas, 2021

The government still puts its hope for oil and gas despite declining investment in recent years

- By Q3 of 2021, the oil and gas lifting reached 661 thousand barrels of oil per day (BOPD) and 5,481 million standard cubic feet per day (MMSCFD) or 93.8% and 97.2% of oil and gas targets set by the government respectively. The prognosis made by SKK Migas also shows that the lifting will only reach 680 thousand BOPD for oil and 5,529 MMSCFD for gas by the end of this year, lower than last year's realization. Overall, the oil and gas lifting volumes have seen a downward trend since 2016 and 2014 respectively.

- Oil and gas upstream investment has declined since 2014. By Q3 of 2021, total investment only reached USD 7.9 billion or 64% of the 2021 target. The figure also represents the lower attractiveness of this industry to both local and foreign investors with only two out of ten oil and gas working areas auctioned by the government in 2021 being sold. Furthermore, more global oil & gas companies are walking away from Indonesia as most low-risk resources have been exploited and these companies start transitioning to clean energy businesses. Given the trend, the lifting target will likely fall short.

- Despite the trend, the government has set ambitious targets of oil and gas lifting at 1 MMBOPD and 12 BSCFD in 2030 respectively. The oil target was set in the hope of cutting oil imports from 1.1 MMBOPD to 324 thousand BOPD in 2030 and saving an annual foreign exchange of USD 11.2 billion between 2021 and 2040. Such targets, however, will only delay the transition to clean energy and further increase the risk of stranded assets in the sector when oil and gas reserves start depleting and demand keep shrinking.

- To achieve these targets while at the same time reducing emissions from the oil & gas sector, the government aims to inject CO2 captured by carbon capture, utilization, and storage (CCUS) systems into oil and gas reservoirs - a practice called carbon dioxide enhanced oil/gas recovery (CO2-EOR/EGR). Such a practice, however, will likely face technical and financial barriers as the project feasibility is highly dependent on the reservoir geological and petrophysical characteristics and the cost of CO2 (ADB, 2019).

Indonesian fossil energy companies start diversifying their businesses into low-carbon industries

- As the global fossil fuel industry starts investing in low carbon energy, so do the Indonesian fossil fuel companies. Few companies have already set their net-zero emissions target and implemented emissions reduction initiatives such as GHG emissions reporting and renewable energy installation. More fossil fuels state-owned and private companies follow the transformation trend by diversifying into low carbon sectors.

Energy SOEs' business diversification strategy to low-carbon industries

Pertamina	Bukit Asam	PLN
Biofuel refinery	Solar PV	Renewable power
Renewable power: geothermal, solar PV, biogas power	Battery industry (through it's holding company: Mining Industry Indonesia)	Charging infrastructure
Green hydrogen		Battery industry
Battery industry		
Charging infrastructure		

- Pertamina, the state oil company, has established its renewable energy business line and recently entered the electric vehicle industry by building EV charging stations and establishing its battery business unit through its participation in the Indonesia Battery Corporation (IBC). Furthermore, the company is currently exploring a possibility to develop green hydrogen and advanced biofuel production technologies.

- Bukit Asam, a state-owned coal mining company, set a net-zero target by 2060 and aims to diversify 50% of its revenue from non-coal sectors by 2026. The company has started its solar PV business by getting involved in rooftop solar PV installation at Soekarno-Hatta airport last year. It is also seeking opportunities to develop a total of 430 MW solar power plants in its post-mining sites.

- Few private energy companies have also started diversifying their businesses into renewable energy (particularly solar PV) and the EV industry in alignment with their climate target. In particular, Indika Energy, one of the major coal holding companies in Indonesia, became the first Indonesian entity to join the Powering Past Coal Alliance and planned to close its last coal power plant by 2047.

- On the other hand, the government's strategy to develop coal downstream products such as DME and methanol to replace oil imports is in contrast with the trend of shifting to low carbon industries. Pertamina and Bukit Asam are both participating in the pioneer coal-to-DME projects, while other major coal companies are expected to follow suit in order to get their mining permit extended. This approach puts a double burden on fossil companies, especially the SOEs that need to invest in fossil energy to satisfy the government targets and in low carbon technologies to adapt to a changing market.

Energy Transition in the Power Sector

- Capacity addition and generation share
- Investment realization
- Power sector program toward Transition

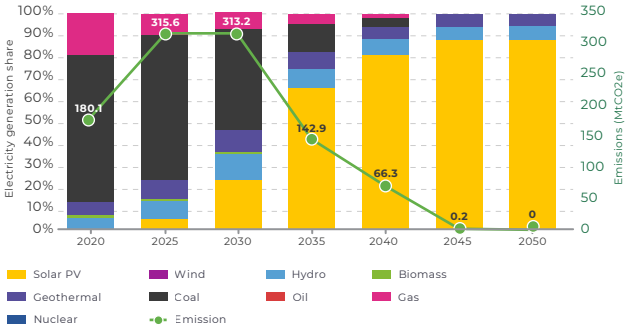
Farah Vianda

Dr. Raditya Yudha Wiranegara

Using 100% renewable sources in the power sector is technically and economically feasible; this decade is the crucial period to achieve the long-term decarbonization target

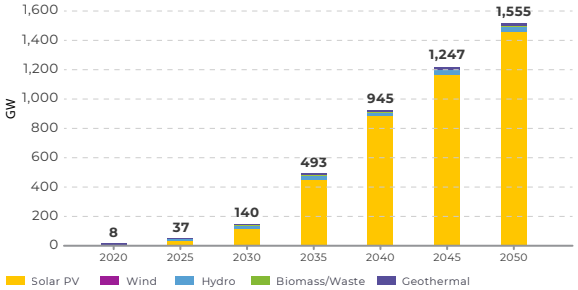
- Electricity generation accounts for more than 40% of total emissions in the energy sector, making decarbonization of this sector crucial to reach a net-zero target. Our deep decarbonization study shows that Indonesia should peak its emission from power generation in 2025 and no longer use fossil fuels in electricity generation by 2045 if the country were to achieve a zero-emission energy system by 2050.
- To align with the zero-emission scenario, at least 47% of the generation share should come from renewables by 2030. Solar power will become the backbone of the decarbonized power system, followed by hydropower and geothermal. In the next 10 years, solar PV capacity would multiply by a hundredfold to 108 GW to support the increasing electrification in the industrial and transportation sectors. From 2045 onwards, all power generation would be sourced from renewables. This is thanks to low-cost renewables that replace fossil fuels.
- Intermittency issues can be resolved by utilizing energy storage such as batteries and pumped hydro energy storage (PHES). As costs of batteries continue to decline, batteries become the most relevant electricity storage technology by 2050 utility-scale and prosumer batteries contribute a major share of the electricity storage output with about 870 TWhel by 2050.
- Inter-island grid interconnection will be key in a 100% renewable energy power system. Our study shows that by 2050 at least 158 GW transmission capacity needs to be built across Indonesia to enable power exchanges between islands.

Decarbonization pathway: Electricity generation share and power sector emissions



Source: IESR, Agora Energiewende & LUT University, 2021

Decarbonization pathway: Renewables installed capacity

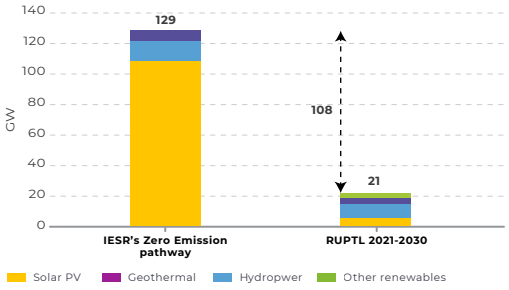


Source: IESR, Agora Energiewende & LUT University, 2021

The "Green" RUPTL is not green enough, fossil fuels still dominate the system planning

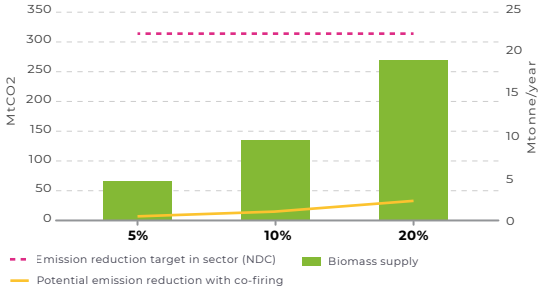
- The RUPTL 2021-2030 was claimed as the greenest RUPTL with planned renewables capacity additions reaching 20.9 GW or more than half of the total planned capacity addition for the next ten years. Through this newly released RUPTL, PLN aims to increase the share of renewables in power generation to 23% in 2025 from only 15% today. The renewables share, however, will only increase to 24.8% in 2030, giving a miniscule increase of 1.8% between 2025 and 2030. It is therefore questionable whether this "green" RUPTL is green enough to decarbonize the power system.
- Specifically, PLN plans to install at least 4.7 GW of solar PV and 4.2 GW of PHES for the next ten years. Meanwhile, CFPP will still play a key role in the power grid with the share of coal generation reaching between 59% and 64% in 2030 depending on the scenario. The apparently high reliance on coal is in contrast to the global trend to shift away from fossil fuels and further puts PLN at risk of stranded assets as renewables costs keep declining.
- PLN still puts co-firing as a strategy to both reduce carbon emissions from CFPP and increase renewable energy share in power generation. While low blending ratio-co-firing is a mature technology, it is gradually abandoned as other technologies become more efficient (IEEFA, 2021). Moreover, the implementation of co-firing often faces challenges such as the premium price of biomass, unavailability of feedstock, and technological challenges.
- It is also worth noting that the potential carbon reduction from co-firing is relatively low at around 5.4%, compared to the no co-firing scenario (Greenpeace, 2020). In addition, the current blending ratio is also low at around 5%, far below what PLN targeted at around 20%. It is advisable therefore for PLN to revisit its co-firing program before moving forward with its plan to implement co-firing nationwide.

Planned capacity addition until 2030: IESR vs RUPTL



Source: RUPTL 2021-2030 and IESR analysis

Potential emission reduction with co-firing scenario vs emission reduction target in the energy sector



Note: The calculation was based on the 2019 coal consumption in RUPTL 2019-2028. Currently, Indonesia is carrying out a co-firing pilot program with a 5% blending rate. The rate is expected to reach 20% by 2025.

Source: NDC, PSE UGM, RUPTL 2019-2028, IESR analysis

Regulatory improvement is crucial to stimulate renewables development and achieve the 2025 target

- By Q3 2021, coal capacity growth hit a record low of 308 ME, the lowest for the past five years. Despite the small growth, coal generation still dominated total power generation at around 66%. In the same period, renewables contributed to an increase of 386 MW and around 13.5% of total power generation. An addition of 9 MW of renewables was expected to come online by the end of 2021, giving a total renewables capacity of 395 MW. This growth is still far from what is needed to achieve the 23% target by 2025 where Indonesia should add at least 13 GW of renewable energy for the next four years or an average of around 3 GW per year.

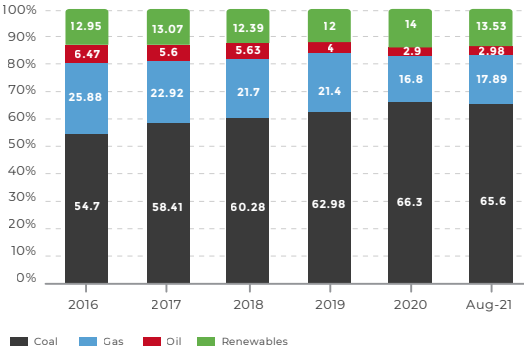
- This year, rooftop solar PV saw its highest growth so far at around 17.9 MW, contributing the most to a total solar addition of 21 MW. Meanwhile, geothermal, hydropower, and bioenergy added 55 MW, 291 MW, and 19 MW respectively. Apart from PLN, the private sector can help Indonesia achieve its renewables target particularly through the use of rooftop solar PV. In fact, the government, through its National Strategy Project, aims to increase rooftop solar PV deployment to 3.6 GW by 2025.

- To increase private investment, the government should improve the investment climate in the country. Specifically, some regulations that are long deemed as barriers should be either improved or replaced:

  - The benchmarking of renewables tariffs against BPP gives uncertainty to investors as the BPP is annually updated

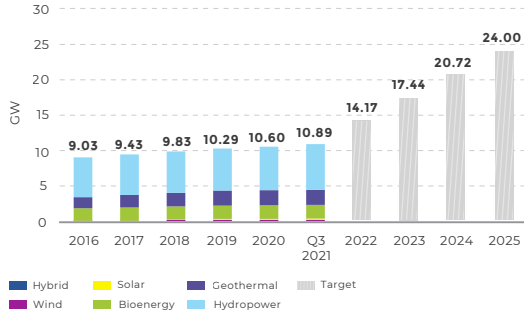
  - High local content requirements (LCRs), particularly for solar PV, burden developers since both local manufacturing capacity and quality are subpar.

Electricity generation share



Source: DGE Press Conference Oct 2021

Renewables installed capacity scenario to meet the 23% target by 2025



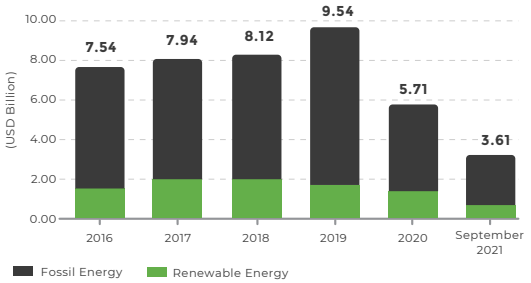
Note: MEMR targeted renewables installed capacity will reach 24.000 MW in 2025

Source: DGNREEC Press Conference Oct 2021, bisnis.com, and IESR analysis.

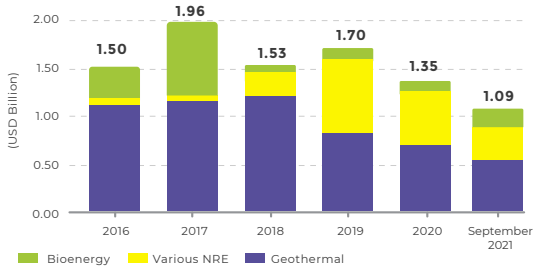
Fossil fuel investment still dominates the power sector, renewable investment is slow-moving

- As of September 2021, the power sector received USD 3.61 billion of new investment of which around USD 2.5 billion was from fossil fuel-based power generation. In the same period, renewables only accounted for USD 1.1 billion of total investment (Julian, 2021). In fact, renewables investments have never exceeded USD 2 billion for the past six years.
- According to the MEMR, the pandemic was the main cause of this year's low investment realization (Mulyana, 2021). Restrictions on the movement of people and goods had caused project delays although in some cases, projects were intentionally delayed to prevent the increase of unutilized power generation.
- The current investment trend is far lower than what Indonesia needs to deeply decarbonize its power sector. Our study shows that Indonesia needs to see at least USD 19-23 billion of investment in the power sector alone if the country were on track to fully decarbonize its entire energy system by 2050.
- In the same study, it is calculated that from 2020 to 2030, solar PV investment should be in the range of USD 2-7 billion annually to increase solar PV share in the total power generation to 24% by 2030. Meanwhile, hydropower and geothermal energy should receive USD 2.5-5 billion and USD 7-9 billion of annual investment respectively in the same period.

Fossil and renewable energy investments



Renewable energy investments



Source: DGE Press Conference Oct 2021, 2020 DGE Performance Report, 2020 DGNRECE Performance Report, Kontan

Uncertainty remains, the long-awaited Presidential Regulation on FiT is still underway

Procurement mechanism and tariff scheme of renewable electricity purchase

Mechanism	Tariff	Description
Direct Appointment	Feed-in Tariff (FiT)	New installation and Expansion ≤ 5 MW Hydro, Solar PV, Wind, Biomass, and Biogas
	Ceiling price	- New installation for hydro (>5 MW) and geothermal - Capacity expansion for geothermal, hydro, solar, wind, biomass, and biogas for all capacity - Excess power for for geothermal, hydro, biomass, and biogas for all capacity
	B2B Negotiation	- Hydro (peaker), biofuel, waste-to-energy, tidal
Direct Selection	Ceiling price	New installation for capacity >5 MW Solar PV, wind, biomass, biogas (if only 1 bidder, based on negotiation)

Source: Draft of Presidential Regulation on Renewable Electricity Purchase. IESR analysis.

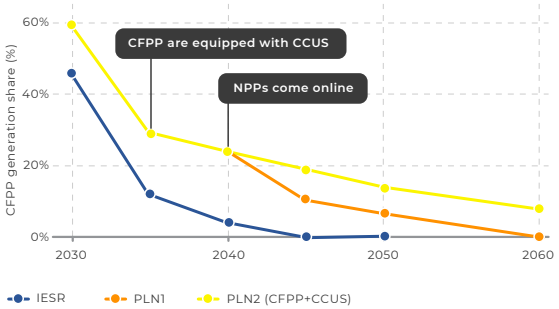
- For the last two years, the government has been preparing the Presidential Regulation (PR) on Renewable Tariffs that will replace the MEMR Reg. No. 50/2017 jo 4/2020 which benchmarking renewable tariffs against local BPP. The PR is expected to set new tariff schemes for renewables such as Feed-in-Tariffs (FiT), ceiling prices, and technology and capacity-based B2B negotiations, improving the bankability and profitability of renewable energy projects in Indonesia.
- Small-scale renewable projects will be offered FiT to increase their bankability. Meanwhile, geothermal projects that require high exploration costs and other large-scale projects will be given ceiling prices which takes locational factors into account to encourage renewable development in less-developed and remote areas.
- The draft PR has been circulated among key ministries but reportedly has long been waiting for the approval of the Ministry of Finance to get implemented. The wait is mainly due to the disagreement on one particular clause that requires the government to pay for the price gap between renewable prices and average costs of power generation as well as the concern over the impact of FiT on PLN's BPP and electricity tariffs. Nevertheless, it is expected that the regulation will be enacted next year. The delays however have made investors question government commitment to renewable energy development in the country.

PLN pledges to start phasing out coal-fired power plants in 2030 and achieve carbon neutrality by 2060

- PLN came up with two scenarios for achieving carbon neutrality by 2060. The first scenario is focused on the utilization of renewables plus storage and nuclear power to replace CFPP. Under this scenario, PLN starts phasing out its coal fleet from 2030 onwards. Meanwhile, the second scenario combines the use of renewables, nuclear power, and coal plus CCUS.

- IESR projection shows that 0% of CFPP and 100% of renewables utilizations are plausible by 2045 in the power sector (IESR, Agora Energiewende & LUT University, 2021). No PLN's scenarios, however, use 100% renewable energy. Instead, PLN decided to use nuclear power and CCUS to achieve its carbon emission target, reflecting concern over grid reliability if variable renewables dominate the power mix. While reasonable, this concern has increasingly been challenged in recent years as more studies show that the use of variables renewables can increase grid reliability, particularly when combined with energy storage, hydropower, and geothermal energy.

Projected CFPP utilization beyond 2030



Note: The RUPTL series using the low-carbon scenario, exclude imported fuel and renewables potential calculation. The IESR series using the Best Policy Scenario (BPS)

Source: RUPTL 2021-203, PLN and Deep Decarbonization of Indonesia's Energy System, IESR

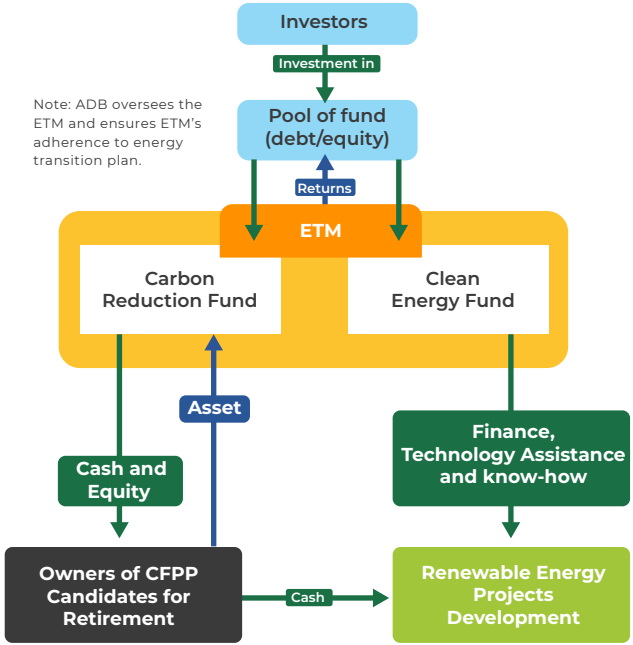
- The use of NPP, in this case, a small modular reactor (SMR), from 2040 onwards in both PLN scenarios should be revisited. Pilot projects of such technology in Argentina, China, and Russia have suffered from a series of delays and irregular design certifications (Schneider, 2021). CNNC (China National Nuclear Corporation) even admitted that the construction cost per kWh of their proposed SMR design, CNNC APC100, is 1.5 times higher than that of a large NPP (CNNC, 2019). All of these culminated in the uncertainty of the application of the technology.

- Moreover, in contrast to solar PV's LCOE and battery's LCOS that have fallen by 90% and 76% respectively, nuclear power LCOE has been increasing by 33% over the last 10 years (Colthorpe, 2020; Tachev, 2021). Future costs of nuclear power will likely remain high as IEA projected a mere 7% reduction of nuclear power LCOE for the next 20 years (IEA, 2021). In the same period, the LCOE of solar PV will decline by 58%. The government should then consider this cost projection to avoid costly power generation in the future.

- The idea of using CCS at CFPP should be taken cautiously. A joint- study by World Bank, ITB, and PLN has shown that in 2040 the LCOE of CFPPs plus CCS would be around USD 7.7 - 8.7 cents/kWh for a 90% capture rate (World Bank, 2015). In the same year, a utility-scale solar PV with 4-hour battery storage would only cost around USD 4 cents/kWh (EIA, 2021). Apart from costs, there is also technical consideration with previous CCS projects such as the Petra Nova project in Texas, USA, often facing technical challenges that later led to project termination.

CFPPs early retirement could be made possible by the aid of Energy Transition Mechanism (ETM)

- The current CFPP phase-out plan is still not ambitious enough, despite the government's hope on the possibility of achieving net-zero emissions earlier than 2060 (Sulistiyono, 2021). Our study shows that to achieve zero emissions in the energy sector by 2050, carbon emissions should peak by 2025.
- In another study by ADB, it is shown that to peak emissions by 2030, PLN should start setting up an early retirement plan for CFPP that are less than 20 years old (ADB, 2021a). This is in addition to inefficient and old CFPP such as Suralaya and Bukit Asam CFPP that have been listed as candidates for retirement.
- Considering the urgency of CFPP retirement, ADB has established a new mechanism called as the Energy Transition Mechanism (ETM). Under this mechanism, Indonesia, the Philippines, and Vietnam will be offered financial assistance from ADB to early retire their coal fleet. A pilot project has been planned for five to seven CFPP in these three countries (ADB, 2021a).
- ETM will help CFPP owners avoid major financial losses due to early retirement. There are two types of funding provided through the ETM. First, the carbon reduction fund will disburse cash and equity sourced from interested investors to CFPP owners. Second, the clean energy fund is used to provide financing and technical assistance to the three countries. It is worth noting that ADB restricts the use of ETM only for renewable energy development.



Note: continue to operate until agreed decommissioning date.

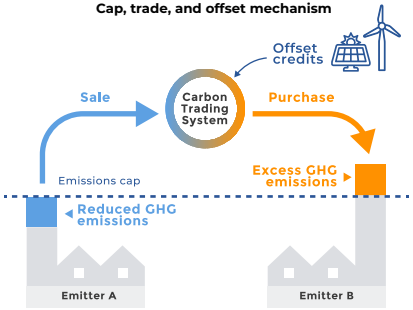
Source: World Energy Forum

The voluntary ETS pilot project faces challenges in its first year of implementation

Summary of the 2021 ETS pilot project

Type	CFPP	CFPP	Mine-Mouth CFPP
Installed Capacity (MW)	X > 400	100<= X <= 400	100<= X <= 400
Cap Value (ton CO2/MWh)	0.918	1.013	1.094
Number of participant	32 participants, consist of 18 buyers, 14 sellers		
Total transaction	42,455 tCO2 has been traded with the average price of USD 2/tCO2		
Recommended prices from the government	**Offset** USD 0.2-20/tCO2 (without CCS/CCUS) USD 40-60/tCO2 (with CCS/CCUS) **Trading** USD 2-8.5/tCO2		

Cap, trade, and offset mechanism



Source: MEMR, 2021

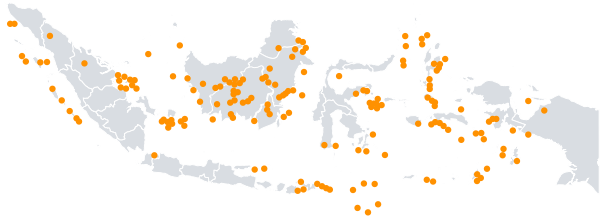
- In 2021, the government started piloting the voluntary Emission Trading System (ETS) at the CFPP nationwide. The government, however, did not set targets for the number of participants, the total amount of carbon transactions, and emission reductions resulting from this pilot project. As a result, from 84 eligible participants, only 32 CFPPs applied to the pilot carbon trading. As the pilot would likely continue next year, the MEMR as the entity that is carrying out the pilot project needs to promote the new system to more CFPP operators and inform them of objectives, procedures, benefits, and incentives of participating in such a program.
- Recently, Indonesia started a cap-and-trade system with an intensity-based cap principle as well as an offset mechanism. However, there are several issues associated with these system and mechanism:
  - Providing an offset mechanism for CFPP operators that fail to achieve the emission cap might encourage such operators to use offsets as their main strategy to reduce their overall emissions instead of reducing direct emissions from their own facilities (NIEPS, 2021)
  - The intensity-based cap principle is often considered less stringent than the absolute cap system, which sets a fixed amount of pollution permits. Some also consider this intensity-based cap system as a form of subsidy for output (ASPI, 2021, Wing, et al, 2006). When implementing the intensity-based cap system, it is important to continuously adjust and tighten the cap value periodically. Otherwise, the government should opt to use the absolute cap system to get fixed emission reductions.
- Learning from the 2021's pilot project, it is important for the government to involve an independent third party in monitoring the transaction between CFPP operators. Lack of supervision could result in fraud and false reporting. It has also been reported that as the ETS is voluntary -before finally becoming mandatory in 2024- most CFPP operators tend to choose the lowest trading price.

PLN's plan to replace Diesel Generators (DPGs) with renewables experienced a delay

- Up to 5,200 units of DPGs installed in 2,130 locations in Indonesia will be de-dieselized and replaced with a combination of renewables and energy storage. According to the RUPTL, 874.1 MW Solar PV+BESS projects will be implemented between 2021 and 2025, spread across Sulawesi, North Maluku, Maluku, West Papua, and Papua (PLN, 2021b). The conversion will be carried out in three phases and will cost approximately IDR 100 billion, as estimated by PLN (Ridwan, 2020).

- In the first phase, Solar PV+BESS will replace DPGs in 200 secluded, underdeveloped locations, with an equivalent capacity of ~225 MW (PLN, 2021a). The replacement is expected to consist of 660 MWp Solar PV and 1.8 GWh BESS. The auctions for the project should commence in 2021, with expected COD in 2023/2024 (Kompas, 2021).

Locations of Phase 1 DPGs Conversion Program



Source: RUPTL 2021-2030, PLN

- In the second and third phases, PLN will carry out the replacement of DPGs with an equivalent capacity of 500 MW and 1300 MW, respectively (Kompas, 2021). The auctions for the second phase are scheduled to commence in 2022, with expected COD in 2024/2025. The third phase is set to be auctioned in 2022/2023 and expected to complete in 2025/2026.

- Despite all of this planning, the first phase auctions will (probably) be held in 2022. PLN will offer Solar PV+BESS projects with a total generating capacity of 500 MW (Agung, 2021). There are no clear explanations yet for the delay. However, the delay in the publication of PLN's electricity supply business plan (RUPTL) could have been the cause.

- Nevertheless, PLN has initiated the de-dieselization program with two pilot hybrid projects. The first one was carried out in Semau, East Nusa Tenggara. The 1.8 MW DPG was integrated with 450 kWp Solar PV and 1.4 MWh battery lead-acid. During an observation between May and November 2020, the Solar PV capacity factor (CF) increases by ~49%. The generation share of the DPG decreases ~25%, whilst the Solar PV increases by ~140%. The cost of electricity generation (BPP) from the hybrid system is estimated to decline by ~7% by November 2020.

- Another unit with a generating capacity of 13.3 MW in Selayar, South Sulawesi, was integrated with 1.3 MWp Solar PV and an 876 kWh lithium battery. At the time of writing, the system is undergoing a series of trials, including integration with 380 kV system and energy export trials.

Co-firing in CFPP is yet to be proven as an effective measure to abate emissions and boost renewables share

Sumatra	Kalimantan	Sulawesi	Maluku & Papua	Java & Madura	Bali & Nusa Tenggara
13 CFPPs Total capacity: **2,315 MW** Biomass co-firing: **476 MW**	**10 CFPPs** Total capacity: **979 MW** Biomass co-firing: **248 MW**	**6 CFPPs** Total capacity: **478 MW** Biomass co-firing: **179 MW**	**3 CFPPs** Total capacity: **41 MW** Biomass co-firing: **34 MW**	**16 CFPPs** Total capacity: **14,854 MW** Biomass co-firing: **800 MW**	**4 CFPPs** Total capacity: **237 MW** Biomass co-firing: **43 MW**

Source: RUPTL 2021-2030, PLN

- According to the recently published RUPTL 2021-2030, PLN is considering a massive biomass co-firing operation to increase renewables share in the power generation mix. The company has identified a number of CFPPs for potential biomass and waste co-firing operations with a total generating capacity of 19 GW in 52 locations. The company envisaged a potential generating capacity of 2.7 GW from the co-firing operation by 2025, assuming a 10% mixture in the fuel inlet and 70% capacity factor (PLN, 2021b).
- Between 2020 and 2021, PLN has conducted trials in 26 locations for a 1-5% mixture of either biomass or waste (solid-recovered fuels (SRF)). Half of these, around 7 GW of total generating capacity, has already been running commercially (MEMR, 2021). About 362.8 MW or 5% of the total generating capacity comes from the co-firing operation of different types of fuels, namely sawdust, palm shell, SRF, wood chips, and rice husk.
- Co-firing has been touted by PLN as a way to increase renewables share in Indonesia's generation mix. Depending on the scenario, the use of co-firing operations will contribute to a 1-4% increase in renewables share. To achieve the target of 2.7 GW, around 14 million tonnes/year of biomass and waste are needed. Additional investment may be required to increase the biomass and waste mixture from 5% to 10–20%, which may eventually increase generation costs (PLN, 2021b).
- The reliability of biomass feedstock is key to ensuring continuous fuel supply to a co-firing operation in a CFPP. However, there is a potential conflict with the AFOLU sector efforts to reduce emissions in terms of land conversion that needs to be considered. In waste-based fuels, the challenge is the availability of waste collection and processing facilities, which are still underdeveloped (IEEFA, 2021). The pricing mismatch between PLN and biomass suppliers is also a concern surrounding the co-firing operation. Due to the formula used by PLN (as stipulated in Perdir PLN 01/2020) that is heavily in favor of coal, the capping price of the biomass is always lower than the supplier's expected prices, which already include the preparation and transportation costs. Furthermore, biomass is also subjected to taxation, which is not the case for coal.
- In light of these concerns, the government should reconsider implementing such an operation, as its contribution to the increase of renewable energy's share is no more than 4%. Moreover, the potential emission reduction of the co-firing operation is limited to 5.4%, which further raises doubts about the impact on Indonesia's net-zero emissions target.

Progress in Solar Power

Daniel Kurniawan

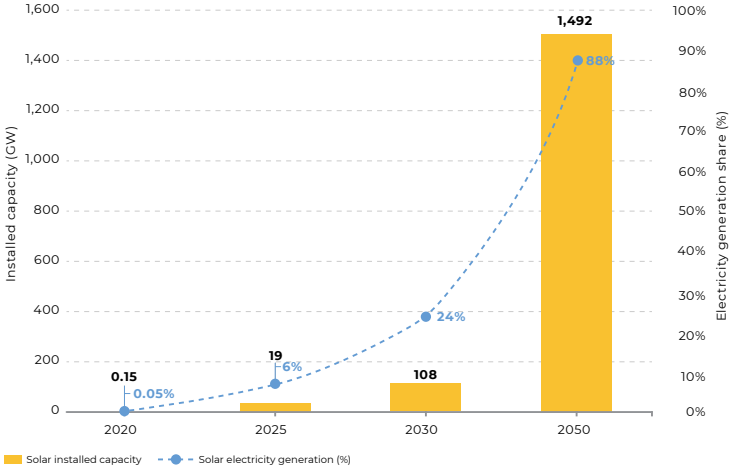
Icmi Safitri

- Utility-scale solar
- Distributed solar

Solar electricity generation should see a massive increase from only 0.05% in 2020 to 24% by 2030—if Indonesia were to follow a zero-emission energy system pathway by 2050

- Deep decarbonization of Indonesia's energy system necessitates significant emissions reduction by way of a rapid uptake of low-carbon power generation by 2030. This uptake would be largely met by utility-scale solar PV, primarily due to its improved cost competitiveness (USD 18/MWh by 2030, compared to USD 58/MWh in 2020). It would also entail:
  - Solar electricity generation share should see a massive increase from only 0.05% in 2020 to 24% by 2030, and eventually reach 88% in 2050—in which renewable energy should account for 50% of total electricity generation by 2030 and to reach 100% by 2050. Coal generation, on the other hand, should see a decline from ~60% today to 45% in 2030.
  - Installed solar PV capacity needs to ramp up to 19 GWp by 2025, 108 GWp by 2030, and 1492 GW by 2050. Utility-scale solar PV would account for ~80% of the required installed capacity, while the remainder would come from distributed (prosumer) solar PV. To achieve 108 GWp of installed solar PV capacity by 2030, it would require an average annual investment of USD 3.125 billion in 2022–2025 and USD 6.5 billion in 2026–2030.

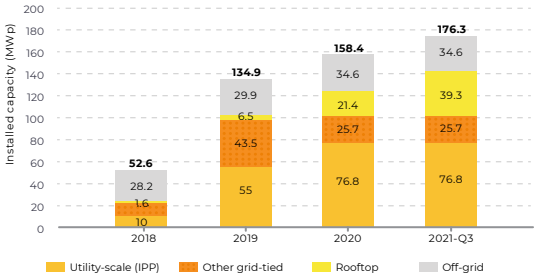
Solar electricity generation share and installed capacity
To align with a zero-emission energy system pathway by 2050



Source: IESR, Agora Energiewende, and LUT University. (2021).

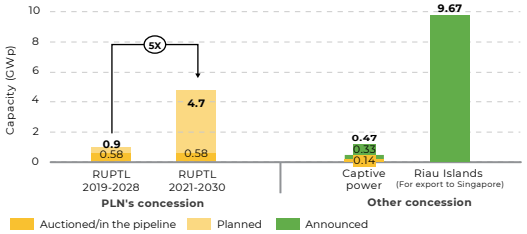
Solar PV capacity growth remains stagnant this year, but the outlook is bright with a fivefold increase in planned solar PV capacity and 9.67 GWp of announced development for power exports

Indonesia's installed solar PV capacity, 2018–2021



Source: MEMR's HEESI, PLN; IESR analysis.

Planned capacity addition in RUPTL 2021–2030 and announced development



Notes: Captive power is defined as power supply that is generated by an individual firm for its own use (via an operational license), or by a "Wilayah Usaha" holder other than PLN—a private power utility (PPU)—to be ultimately sold to its tenants (in an industrial estate or a special economic zone).
Source: IESR analysis.

- Capacity addition from utility-scale (IPP) solar PV stagnated this year due to the lack of projects being commissioned. Most IPP projects in the pipeline (585 MWp) are set to reach commercial operation only by 2023/2024. As of Q3 2021, the total installed solar PV capacity reached 176.3 MWp, where the addition of 17.9 MWp was entirely from rooftop solar PV. Outside PLN's concession, it is estimated that there were more rooftop solar PV installations that have not been recorded at around 20~30 MWp per year (primarily from the C&I sector).

- Despite the stagnancy, recent development shows a promising outlook. This is shown by the increased planned solar PV capacity in RUPTL 2021–2030 and the 9.67 GWp of announced solar PV capacity development of solar power exports to Singapore in Batam and the Riau Islands.

- In the RUPTL 2021–2030, planned solar PV capacity addition is increased by fivefold to 4.7 GW from 0.9 GW in the RUPTL 2019–2028. Around 63% percent of the planned capacity (2.9 GW) is allocated to the private sector (IPPs), giving a positive signal to the market for at least the next five years. Some of the planned capacity addition is also directed toward village electrification and diesel conversion program. The success of the solar PV program, however, will largely depend on whether PLN can translate the planning into auctions in the coming years.

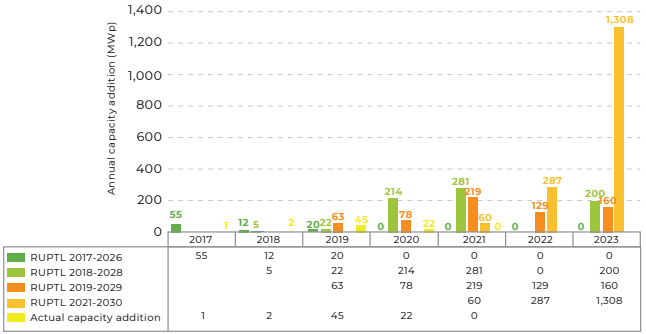
- Under GSEN, the government seeks to add 38 GW of renewables installed capacity by 2035. Solar PV is set to account for one-third of the addition, of which rooftop solar PV is targeted to account for 3.6 GWp by 2025. In a longer time frame, MEMR is also devising a net-zero emissions roadmap, in which solar PV is projected to be the primary (62%) power generator in 2060 where all electricity will come from 100% clean energy.

As planned solar PV capacity in RUPTL 2021–2030 increased, a well-designed systematic auction program would be pivotal in realizing the plan

- At least 4.7 GW of solar PV capacity addition is planned in RUPTL 2021–2030 for the next nine years, where 63% (2.9 GW) of the planned capacity is allocated to the private sector (IPPs). Learning from the previous RUPTLs, however, the plan would be meaningless if no auction is being held to realize it. Based on RUPTL 2019–2028, the total solar PV capacity addition should have reached 78 MW in 2020 and 219 MW in 2021. However, the actual commissioned projects from RUPTL 2019 were nowhere near that number due to the lack of auctions, even prior to the COVID-19 pandemic.

- Recent IESR analysis found that PLN's IPP solar PV auctions have been procured sporadically using one-off standalone auctions, often with differing rules and frameworks (IESR, 2021a). Between 2017–2020, only four solar PV auctions were held: Bangka 10 MWp, Bali 2x25 MWp, Cirata 175 MWp (145 MWac) FPV, and Indonesia Power's Hijaunesia (equity partner) solar PV auction—most have yet to secure a PPA. With recent success in bringing solar PV bids down to below USD 0.04/kWh, PLN and the government must be able to replicate the price discovery and accelerate solar PV uptake by creating a well-designed, scheduled solar PV auction to realize the planned solar PV capacity in RUPTL 2021–2030, thus creating market certainty for investors.

Actual utility-scale solar PV capacity addition compared to planning in previous RUPTLs



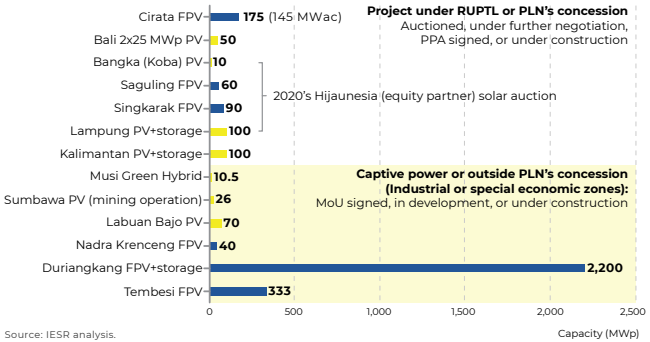
Source: PLN; IESR analysis. Notes: Actual capacity addition only includes capacity addition from utility-scale solar (IPP). Off-grid solar actual capacity addition is not included due to the difficulty in tracking and is also considered negligible by magnitude, whereas rooftop solar addition is excluded because it is not part of the planned capacity addition in RUPTL.

- The government should quickly ratify the presidential regulation on renewable electricity purchases so as to create regulatory certainty on tariff pricing for the upcoming RUPTL auctions. According to the draft, new solar PV tariffs will be structured based on the power plant capacity. For capacity ≤ 5 MWp, a fixed feed-in tariff with a location factor will be introduced, where a direct appointment mechanism will be used; whereas for capacity >5 MWp, a regulated ceiling price—more generous than the previous BPP-linked tariff pricing—will be introduced, where a direct selection (reverse auction) mechanism will be used. Both formulations are already moving toward the right direction and are expected to spur deployment for both small- and large-scale solar PV projects.

Floating solar PV is on the rise with three new announced developments totaling 2.5 GWp

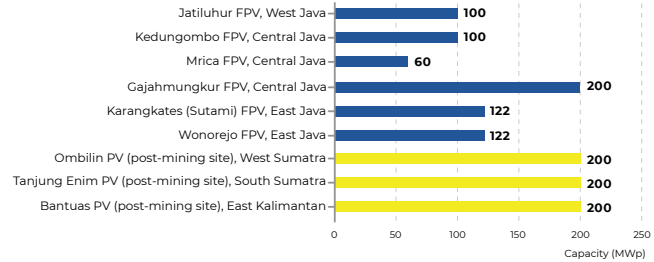
- Following the 2020's Hijaunesia (equity partner) solar PV auction that has revealed record-low bids from floating solar PV, three new floating solar PV developments were announced this year. All of the new announcements came from the captive power market (outside PLN's concession); these include:
  - A 40 MWp floating solar development at Nadra Krenceng reservoir, owned by state-owned Krakatau Steel's water treatment subsidiary in Cilegon, Banten. The project is currently under pre-construction for its first phase (16 MWp) which is set for commissioning by 2022.
  - Two floating solar projects totaling 2.5 GWp in Batam Island: a 2.2 GWp FPV project at Duriangkang reservoir and a 333 MWp FPV project at Tembesi reservoir. The former will also feature a 4 GWh battery energy storage system and is planned to export most of the capacity to Singapore via subsea cable (see next page).
- The project pipeline under RUPTL 2019 did not progress much since 2020 with the same 585 MWp in development. The Cirata project has entered construction (achieved financial close in August 2021) and is scheduled to reach commercial operation by November 2022. Projects from 2020's Hijaunesia solar auction, however, are still pending award. Ground-mounted projects have not seen much progress in the past two years, particularly for the Bali 2x25 MWp solar project that has not seen its PPA signed since 2019.
- Under RUPTL 2021–2030, at least six floating solar projects with a total of 704 MWp are listed as potential, mostly concentrated in Java. Development potential from post-mining sites should also not be overlooked. Moreover, three additional ground-mounted solar projects totaling 430 MWp on state-owned Bukit Asam's post-mining sites are currently being developed to be proposed to the next RUPTL.

Announced utility-scale solar PV project pipeline in Indonesia



Source: IESR analysis.

Potential utility-scale solar PV projects in RUPTL 2021–2030



Note: The list of potential shown here is not exhaustive of all listed in RUPTL 2021–2030.

Source: RUPTL 2021–2030, Bukit Asam; IESR analysis.

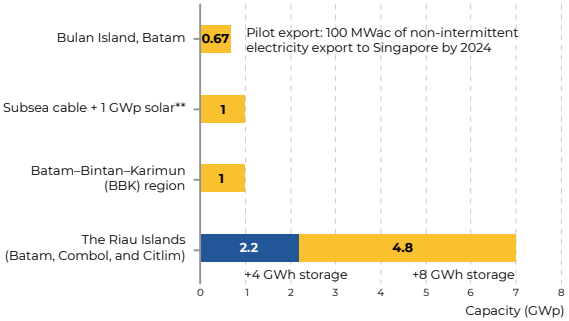
Singapore's clean electricity import demand has sparked interest in large-scale solar PV development in Indonesia

- Electricity exports to neighboring country Singapore have drawn strong interest from developers as the country plans to import 4 GW of low-carbon electricity by 2035. Singapore's electricity regulator Energy Market Authority (EMA) planned to issue two requests for proposal (RFPs), first in November 2021 (1.2 GW for operation by 2027), which has been issued, and the second in Q2 2022 (another 2.8 GW for operation by 2035). This has led to at least four development agreement announcements in Batam and the Riau Islands with a total announced solar PV capacity of 9.67 GWp and 12 GWh of battery energy storage capacity.

- Since 2019, the EMA has been working on trials and pilots to develop technical and regulatory frameworks for importing electricity to Singapore. These include a two-year trial to import 100 MW of electricity from Peninsular Malaysia via an existing interconnector (expected commencement by early 2022) and a regional power grid project covering Laos–Thailand–Malaysia–Singapore. Another project is a pilot import project of 100 MWac of non-intermittent electricity generated from a 670 MWp solar farm on Bulan Island, Batam, which was announced in October 2021 (expected commencement by 2024). The pilot is led by a Singaporean power generator and electricity retailer with several Indonesian partners.

- Three other announcements were also made in September–October 2021 that include an exclusive development agreement to develop a total of 9 GWp of solar PV capacity across Batam and the Riau Islands (see figure for details). The largest project, which includes the previously announced 2.2 GWp floating solar PV development in Duriangkang reservoir (Batam), was aimed to provide 1 GWac of non-intermittent electricity to Singapore by 2024.

Announced solar PV development driven by Singapore's electricity imports demand

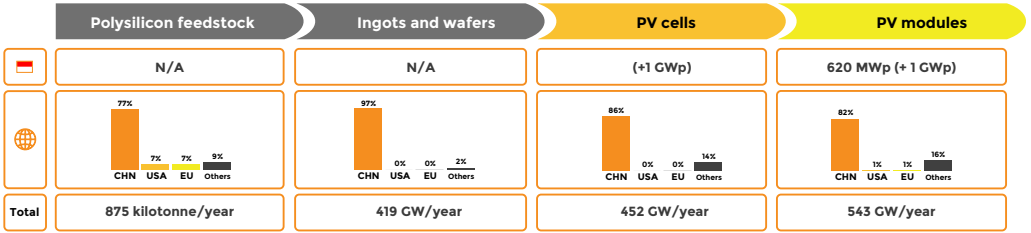


Notes: blue represents floating PV project. **Location unspecified
Source: Company press releases. IESR analysis.

- The development is expected to bring in at least USD 7.5 billion of investment from the solar farm alone, USD 3.6 billion from the battery energy storage systems, and an additional USD 90–120 million for the estimated 30~40 km ultra-high-voltage DC submarine power line. Separately, another ambitious 17–20 GWp solar export project from Australia to Singapore has also agreed to invest USD2.5 billion in Indonesia for passing a 4,200 km subsea power line through Indonesian waters. All this development could serve as a good learning experience for Indonesian local partners in building gigawatt-scale solar PV while waiting for the realization (auctions) of the domestic (RUPTL) market in years to come.

With projected demand for solar PV set to increase, Indonesia must prepare a long-term industrial policy to foster its domestic PV value chain

Indonesia's PV industry production capacities relative to global value chain, 2020



Note: Production capacities include plants that have been commissioned, are under construction, or have been announced.
Source: Ministry of Industry, APAMSI, BloombergNEF; IESR analysis.

- According to MoI, the current domestic PV module production capacity stands at 620 MWp (where 500 MWp is from 11 APAMSI members). However, its utilization only reaches 10% annually due to low demand. With the increased projected demand from RUPTL, Indonesia's local PV manufacturing must ramp up its production capacity (and quality) rapidly in the next three to five years to meet the demand.

- Local content requirements (LCRs) on solar PV projects, as imposed by MoI 5/2017, also add various challenges for utility-scale solar PV development. Currently, there is no single domestic supplier who can supply a 100 MWp project with 40% LCR of PV modules except one manufacturer. It is also important to note that the minimum LCR for PV modules should have been increased to 60% since January 2019, according to MoI 5/2017. However, it is unclear how this is being implemented. According to MoI's website, the highest achievable PV module LCR to date is only 47.50%.

- Due to the LCRs and the lack of maturity of the domestic PV value chain, current utility-scale projects face higher build costs from using local PV modules (USD 0.34/Wp vs. USD 0.25/Wp for imported PV modules). Domestic PV modules are also typically subpar in terms of efficiency due to using older cell technology (e.g. Al-BSF[1] vs. PERC[2] cell). As a result, projects are restrained to receiving cheap financing from international lenders who typically require the use of PV modules from certified "bankable" manufacturers or the so-called "Tier 1" PV module.

- One of the largest TOPCon[3] Chinese PV module manufacturers is reported to invest in a joint venture with state-owned LEN's subsidiary, where it plans to set up 1 GW of both cells and modules production capacity per year. While this might be a short-term solution to some of the previously mentioned challenges, Indonesia still needs to prepare a long-term industrial policy strategy to foster its domestic PV industry. Indonesia should at least prepare its own PV modules and cells production up to the "Tier 1" standard, given that the market higher up the value chain (wafers and polysilicon) is already very consolidated and the barrier to entry is high, making it virtually impossible to compete economically on the scale (BloombergNEF, 2021).

[1] Al-BSF: Aluminum back surface field cell. Al-BSF has been the PV cell industry standard until 2017 (commercial cell efficiency: 18~20%). Represented 15% of global cell production in 2020, will be obsolete after 2025.
[2] PERC: Passivated emitter and rear contact cell. PERC is the current PV cell industry standard, accounting for ~80% of global cell production in 2020 (commercial cell efficiency: 21~23%).
[3] TOPCon: Tunnel oxide passivated contact cell. The growing next-generation higher efficiency (23~25%) cell technology, currently still represents about ~3% of global cell production in 2020. (VDMA, 2021).

Rooftop solar PV grows steadily at 84% (YoY); the government has prepared a national rooftop solar PV program to achieve the 23% renewable energy target by 2025

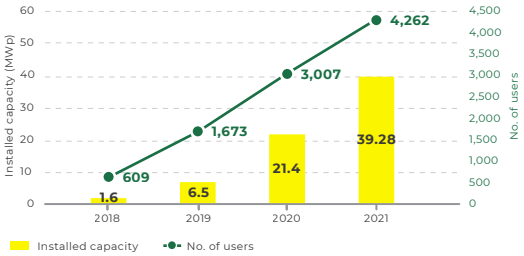
- By Q3 2021, the total installed rooftop solar PV capacity reached 39.28 MWp. Commercial and industrial (C&I) sector accounts for about half of the total installed capacity (18.5 MWp), followed by residential (27%), social (14.5%), and government (11%) sectors. Rooftop solar PV capacity addition in 2021, 17.9 MWp, was recorded as an all-time-high since 2018, not to mention an estimated addition of 20~30 MWp outside PLN's concession might still be unrecorded.

- C&I sector is motivated to install rooftop solar PV due to its sustainability commitment and economic incentives (savings). Solar PV developers in Indonesia offer a "zero-capex" scheme, allowing the sector to utilize solar electricity with lower tariffs (at least 10-15% lower than PLN's tariffs). Thus, megawatt-sized installations in the C&I sector have been made economically feasible.

- In terms of the number of users, there is a sevenfold increase from 609 in 2018 to 4262 this year. The largest user addition came from the residential sector (77%), which added 958 new users with 4.24 MWp by Q3 2021. As depicted in the growth trend, the number of new installations in the residential sector was the highest for the past 3 years. The C&I sector recorded 130 additional users in 2021 with 7.23 MWp of capacity addition.

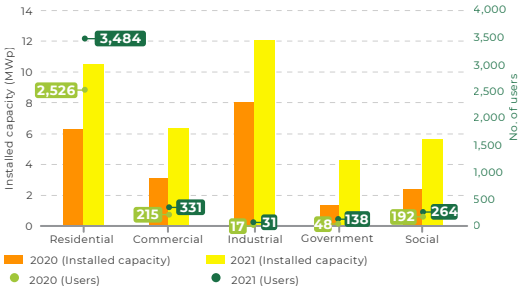
- The government has prepared a 3.6 GWp rooftop solar PV program in the National Strategic Projects (PSN) in order to achieve the 23% renewable energy target by 2025. Under the program, C&I and residential sectors are each expected to account for 2 GWp and 1.5 GWp, respectively. Additionally, Bappenas has also been working on a green recovery proposal to install rooftop solar PV on the government buildings, which aligns with IESR recommendation in 2020. The proposal aims to install 261.2 MWp by 2024, higher than PSN's rooftop solar PV target for government buildings (37.35 MWp).

Rooftop solar installed capacity and user growth 2018–2021



Source: MEMR; IESR analysis.

Rooftop solar growth by segment 2021



Note: Commercial refers to "Business" in PLN's consumer group
Source: MEMR; IESR analysis.

Installations grow significantly, but adoption challenges remain in the residential sector

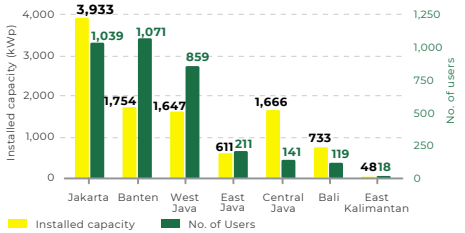
- Total installed solar PV capacity in the residential sector reached 10.54 MWp by Q3 2021, adding 4.86 MWp of new capacity this year. However, residential solar PV users are still concentrated in Java and Bali since these regions have better access to information, economic affordability, and availability of solar PV installers. Jakarta Province has the most installed capacity in the residential sector, thanks to the aforementioned advantages and its faster approval process compared to other regions.

- IESR market studies across Java–Bali found that there are 10–29% of market potential[4] in the surveyed six provinces/cities, totaling 3.5 million households or 6.5GWp of residential solar PV capacity. Saving on the electricity bill was the main reason people consider installing rooftop solar PV. Despite the huge potential, the studies also showed that 34-50% of the respondents are still unaware of the technology. More importantly, it was revealed that the high upfront cost and long payback period are two main concerns for adopting rooftop solar PV.

- In addition to price reservation, lack of information availability, lack of product knowledge, perceptions of expensive products, availability of reliable installers, and financing have also become barriers to wider adoption. Market studies found that 36–60% of respondents prefer to have a financing option (credit installment) to address the high upfront cost issue.

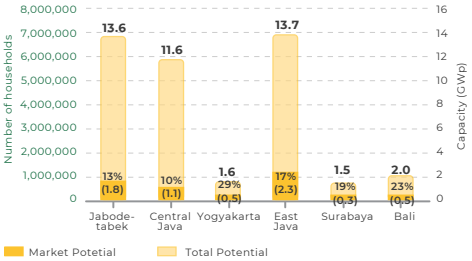
- To achieve the 1.5 GWp residential solar PV target by 2025 under PSN, commitment and participation from various stakeholders, including the government, private sectors, EPCs, and financial institutions are required. The regional government should encourage local initiatives to stimulate domestic solar PV capacity growth.

Residential rooftop solar installed capacity in 2021 by region



Source: PLN, MEMR; IESR analysis.

Residential rooftop solar market potential

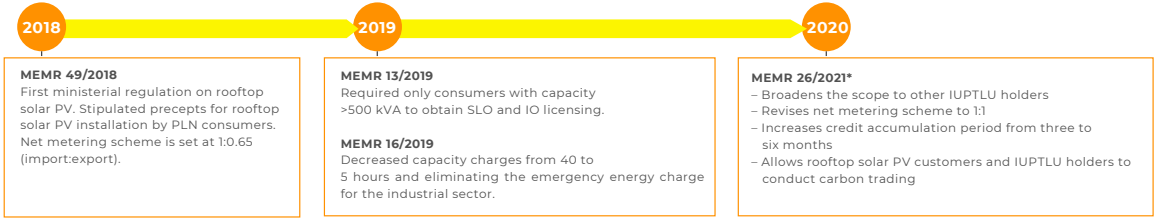


Notes: Total potential is estimated using a proxy from number of residential group electricity customer data from Statistics Indonesia, exclude customers of electricity subsidies, and assumed installation of 2 kWp per household. Market potential is further calculated by multiplying the total potential with potential adopter categories, which includes early adopters and early majority, from IESR market surveys.

Source: IESR analysis.

[4] Market potential is defined as early adopters + early majority in the diffusion of innovations theory

Third time's the charm: MEMR 26/2021 is expected to spur rooftop solar PV growth and bring regulatory certainty for potential rooftop solar PV consumers outside of PLN's concession



*Notes: Has been stipulated in August 13, 2021 and enacted in August 20, 2021, but still requires approval from the President following the release of Perpres 68/2021 (status: as of November 2021).
Source: IESR analysis.

- MEMR 26/2021 introduces several positive changes to the preceding regulation. The scope of the regulation is extended to include other IUPTLU holders (besides PLN) who own an electricity business concession, otherwise known as private power utilities (PPUs). This provides opportunities for commercial and industrial consumers who consider reducing their carbon footprints as there is now a regulatory certainty to adopt grid-connected rooftop solar PV within PPU-run industrial estates.

- The regulation also updates the net metering scheme from 1:0.65 to 1:1 and the credit accumulation period from three months to six months. MEMR 26/2021 includes provision for the rooftop solar PV system coupled with battery energy storage system, also at 1:1 net metering scheme. IESR analysis found that the improved scheme would reduce payback time by one to two years (see next page).

- MEMR 26/2021 amends the application process and approval period for rooftop solar PV installation. According to the previous regulation, the approval period is 15 working days. However, an IESR survey to 22 solar PV installers found that 31% of consumers required more than three months to complete the application, citing that the availability of net meter was the main obstacle for the completion. To respond to the issue, MEMR 26/2021 has integrated the application process through an electronic application, services, and reporting system, and shortened the approval period to just five working days.

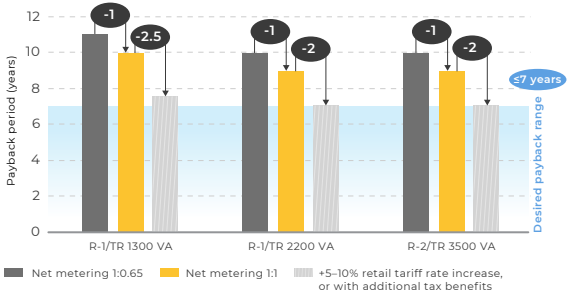
- Moreover, MEMR 26/2021 also lays the groundwork for "Rooftop Solar PV Customers" and IUPTLU holders to conduct carbon trading. While the details on carbon credit ownership and carbon trading mechanism are to be further regulated in a separate ministerial regulation, the clause will support emissions reduction in the sector. According to MEMR estimates, the emissions reduction potential from the 3.6 GWp PSN target by 2025 is nearly 2 billion tonnes of CO2.

The net metering policy has been improved, but more work is needed to accelerate residential solar PV adoption

- The previous net metering scheme (1:0.65) provided a simple payback period for average low-voltage household power users (i.e. 1300 VA, 2200 VA, and 3500 VA) at around 10–11 years. The newly enacted MEMR 26/2021 shortens the payback period by about one year (to 9–10 years) for all three groups. According to IESR market surveys, the majority of respondents expect a payback period of less than or equal to 7 years. IESR analysis also found that a 5–10% retail tariff rate increase could accelerate the payback period to 6.5–7 years.

- Although reducing the payback period into the desired range is important, it is not the only deciding factor in customers' rooftop solar PV adoption. Many customers will still face high upfront costs associated with purchasing a rooftop solar PV system. In this case, they may prefer to sign loan agreements with solar PV installers or adopt a third-party ownership/financing scheme such as a solar PV lease, which is currently available for C&I solar PV only. The latter, however, is a rare case, given that the market is still at an early stage and more information needs to be disseminated to the financial sector.

Payback periods for residential solar PV in Indonesia



Notes: 1300 VA, 2200 VA, and 3500 VA households are used to represent the average low-voltage household power users. The payback for 1300 VA household is a year longer due to having smaller allowable system that is capped at 100% of the power connection, hence lower electricity savings potential, all the while having almost the same monthly electricity bill with the rest.

Source: IESR analysis.

- According to solar PV EPCs, customers found that the current financing options are unattractive, mainly due to high-interest rates, which make the investment cost higher. In order to address the issue, the government could support financial institutions, particularly state-owned banks and regional development banks, to establish cheap financing options (low-interest rates and long-term soft loans) for households, similar to the Kredit Usaha Rakyat (KUR) program.

- The government could also offer tax benefits/incentives for households that installed rooftop solar PV systems. This could include land and building tax (PBB) reduction or exemption, which could be linked to green building schemes and property tax on sales. Moreover, RUEN has imposed obligations to luxury housing, residential, and apartment complexes to install rooftop solar PV at least on 25% of their roof space through the issuance of a building permit (IMB). However, the enforcement remains a challenge due to the lack of detailed derivative of the presidential regulation. This mandate could be revisited and enforced for new luxury residential and commercial buildings that will be built after 2024.

Progress in Energy Storage

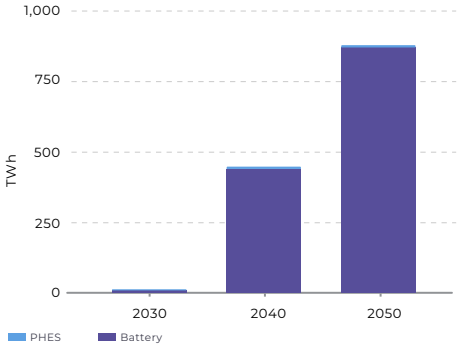
- Battery Energy Storage System (BESS)
- Pumped Hydro Energy Storage (PHES)

Dr. Handriyanti Diah Puspitarini

Electrical Energy Storage (EES) is key to increasing VRE penetration in the power grid

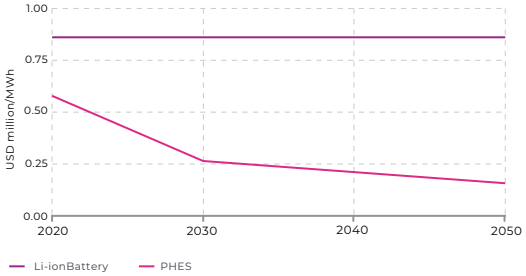
- Our deep decarbonization study shows that as renewables share grows in the power grid, the need for storage increases from 2030 onwards. EES can supply 30% of electricity demand in 2050 in Indonesia, supplying around 877 Twh of electricity. The EES systems used are batteries and pumped hydropower energy storage (PHES) with batteries playing a bigger role by contributing to 99% of the storage output. Utility-scale and prosumer batteries will make up a major share of the EES output by 2050.
- VRE's intermittency can affect grid stability. The latest regulation on grid code, MEMR Regulation No. 20/2020, requires all intermittent renewable energy power plants to continuously operate and generate uninterrupted power in a certain frequency range. Instead of utilizing battery or other storage technologies to cope with the intermittency issues, PLN chooses to optimize the use of thermal power plants.
- CAPEX of battery is currently at USD 0.58 million per MWh, and will be 73% lower in 2050 due to its high deployment. PHES, as a new storage technology that has not been widely used, has a constant CAPEX from 2020 to 2050 at USD 0.86 million per MWh (MEMR & Danish Energy Agency, 2020).

Energy storage needs in Indonesia until 2050



Source: IESR, Agora Energiewende & LUT University (2021)

Predicted CAPEX of Li-ion battery and PHES in 2020-2050



Source: MEMR & Danish Energy Agency (2020)

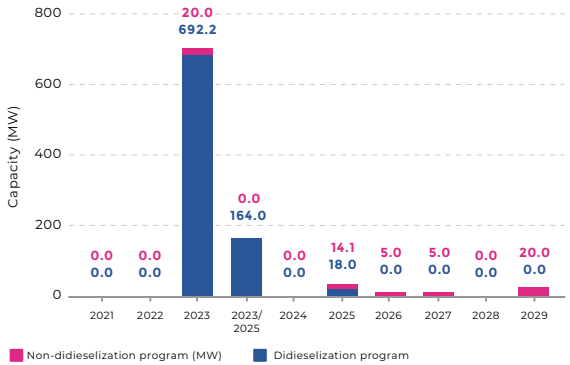
Battery Energy Storage System (BESS) application in Indonesia is still limited to the off-grid system

- PLN currently applies BESS to accommodate 24/7 electricity demand only for solar power using an off-grid system. It has not yet focused on BESS application for utility-scale VRE power plants. Moreover, the latest RUPTL does not give a clear annual target on the future utilization of BESS. It only lays out some projects that will use BESS such as 943.2 MW of planned solar power plants coupled with BESS in Sulawesi, North Maluku, Maluku, West Papua, and Papua, with the COD in 2022-2030. In addition, it also includes the de-dieselization plan, which needs at least ±660 MWp solar PV and a 1.8 GWh battery for the first phase.

- The electrification of dispersed residential areas in remote locations has been very challenging, especially in installing the distribution network. To achieve a 100% electrification rate target in 2022, MEMR plans to electrify 297 out of 433 villages in Maluku, Papua, and Nusa Tenggara. Under this plan, every household will have access to electricity by storing it in a small BESS (Alat Penyimpanan Daya Listrik, APDAL). APDAL can be charged independently in the charging station (Stasiun Pengisian Energi Listrik, SPEL) powered by solar, wind, or pico- to micro-hydropower plants. Its capacity varies from 300 Wh, 600 Wh, to 1,000 Wh, which can supply electricity demand from a household for about 3-7 days. Until September 2021, this system has been successfully applied in 12 villages through PLN's CSR program.

- In October 2021, three agreements were made by private companies to export solar power from Riau Islands to Singapore. The agreements aim to provide electricity from 8.67 GW solar power coupled with 12 GWh BESS and 1 GWac (firm capacity) of non-intermittent electricity to Singapore.

Planned off-grid solar PV plus storage projects



Source: RUPTL 2021-2030

Example locations of the off-grid system coupled by BESS for supplying electricity demand with 100% renewable energy

Location	Solar power capacity (kWp)	BESS capacity (kWh)
Sebira island	400 kWp	912 kWh
Kojadoi Village, East Nusa Tenggara	190 kWp	304 kWh
Messah island	530 kWp	~ 968 kWh
Semau island	450 kWp (+ PLTD 300 kVa)	2,900 kWh

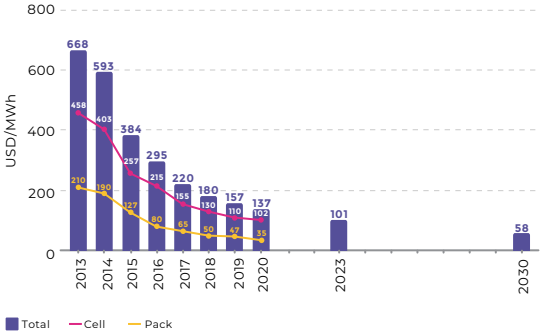
Future BESS costs are predicted to be lower than the current costs, making it viable to be adopted in Indonesia's power system

- Global average prices of Lithium-ion (Li-ion) batteries have dropped 89% from their 2010 value. This reduction was caused by its massive production and utilization in electric vehicles and stationary storage and the availability of more diverse and advanced materials. As a result, a Li-ion battery pack cost USD 137/kWh in 2020, with the cell cost USD 102/kWh and the pack cost USD 35/kWh. According to BloombergNEF (2020), the battery price can further drop to USD 58/kWh in 2030 if other materials such as solid electrolytes are used in the cells since its manufacturing cost is only 40% of the one that utilizes liquid electrolytes.

- Most of the batteries used in Indonesia are Li-ion batteries. However, PLN stated that it would start considering redox-based batteries from vanadium or cerium due to the high electricity generation cost of Li-ion batteries for utility-scale solar PV (13 cent per kWh for lithium, while only USD 3.5 cent per kWh for redox). According to Schmidt et al. (2020), LCOS of Li-ion battery was USD 200-500 per MWh in 2020 and is predicted to remain at USD 80-205 per MWh in 2050. Meanwhile, redox flow-based battery's LCOS was USD 185-400 per MWh in 2020, and will decrease to USD 90-200 per MWh in 2050. Although LCOS reduction of both technologies are similar, Li-ion might still dominate future battery technology due to several advantages: capability to fast-discharge (full discharge in under 8 hours), run at high-frequency, and extend its lifetime (when operated below its full capacity).

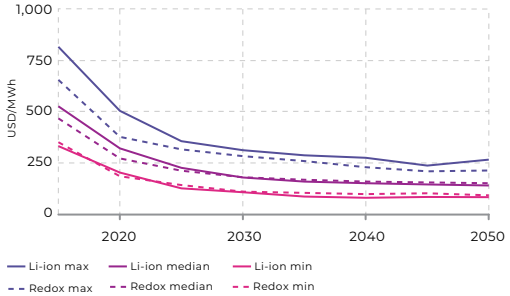
- Battery Management System (BMS) is also an important part of BESS, which monitors, controls, and optimizes battery performance. BMS' cost varies at a certain electricity output range. For instance, a residential BESS with 48 V, monitoring 14-16 Li-ion cells, and output of 7-20 kWh costs USD 250-500 (Corman, 2017). Since energy storage demand will increase in the future, BMS market growth is predicted to reach 15% to 19% in 2020-2030, and Asia-Pacific will be the fastest-growing market (Data Bridge Market Research, 2020; P&S Intelligence, 2021; Transparency Market Research, 2019).

The average price of Li-ion battery cell and pack from all sectors



Source: BloombergNEF (2020)

LCOS of Li-ion and Vanadium redox-flow batteries



Source: Schmidt et al. (2020)

Pumped Hydro Energy Storage (PHES) is the cheapest storage solution to reduce peak load and support high VREs penetration

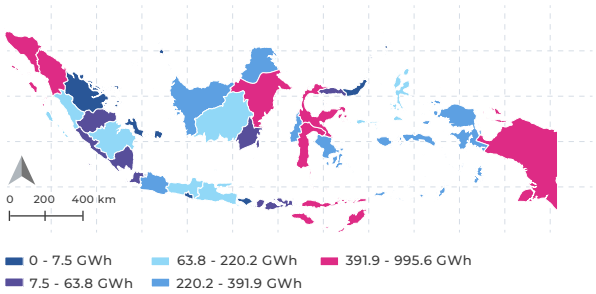
- Including Pumped Hydro Energy Storage (PHES) in the energy system could increase the penetration of renewable energy due to its high flexibility to complete the residual load or unmet demand and its long lifetime. According to RUPTL, PHES in Indonesia is aimed to reduce the peak load, improve the load factor, increase the capacity factor of coal-fired power plants, and act as a flexible generation to couple intermittent renewable energy plants.

- A major challenge to increase PHES installation and utilization in Indonesia is the substantial investment and comprehensive feasibility studies needed—including post-construction mitigation measures—since PHES is a new storage technology. Land acquisition is another issue faced in PHES development. The main advantages of PHES over BESS are its longer lifetime and larger produced energy. BESS' lifetime is only 20-25 years, whereas PHES can be operated for at least 50 years. PHES could also deliver more energy, about 2-150 GWh, within 6-18 hours. In addition, the LCOS of PHES is only USD 40-65 per MWh (Stocks et al., 2021). Thus, BESS is more cost-effective to deliver a small amount of energy, while PHES is more cost-effective to store and deliver a large amount of energy.

- Indonesia has 7,308.8 GWh of PHES potential based on renewable energy potentials mapping by IESR (2021). However, the planned installed capacity of PHES based on RUPTL is only 4.2 GW, with an unclear storage time.

- Upper Cisokan in West Java and Matenggeng power plants in Central Java are the two first pumped hydro storage power plants in Indonesia. Upper Cisokan, which is financed by AIIB, World Bank, and PLN, will start to operate in 2025 with a capacity of 1,040 MW, while Matenggeng is expected to start operating in 2028 with a capacity of 943 MW.

PHES potentials in Indonesia



Source: IESR (2021)

Planned new large, or, small hydropower, or PHES based on RUPTL 2021-2030

Region	Planned new large, or, small hydropower, or PHES (GW)	% in total electricity mix
Sumatra	3.1	31.80%
Java, Madura, and Bali Including: - Cisokan (1.04 GW) - Matenggeng (0.94 GW) - Dispersed in West Java (0.78 GW)	4.3	20.10%

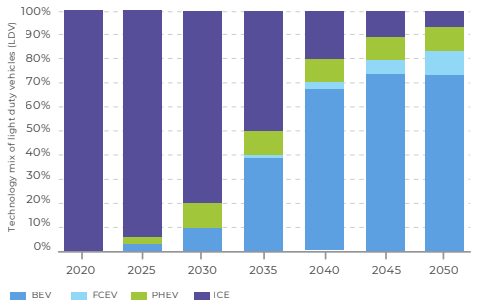
Progress in Electric Vehicles

- Status of adoption
- Regulations update
- EV price and TCO
- Charging infrastructure
- Local content requirement
- Industry/supply chain progress

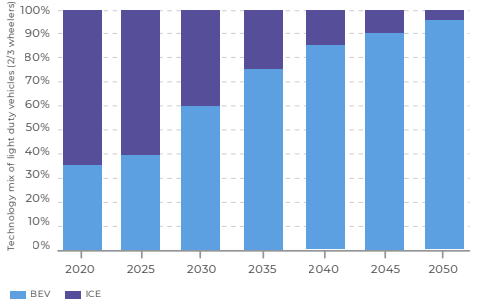
Idoan Marciano

Massive electrification of the road transport sector is a must to achieve zero emissions by 2050; EV to attain half market share in 2030

EV penetration rate for new LDV
To align with a zero-emission energy system pathway by 2050



EV penetration rate for new 2 and 3 wheelers
To align with a zero-emission energy system pathway by 2050



Source: IESR, Agora Energiewende & LUT University, 2021

- Electric vehicles (EVs) essentially emit far fewer emissions when coupled with renewable energy. Along with increased renewables uptake in the power sector, electrification of the transportation sector is paramount to achieving deep decarbonization of the energy system. This requires a sound strategy through measures such as road transport electrification.

- Adhering to IESR's zero-emission pathway, at minimum, 110 million of two- and three-wheelers, almost 3 million light-duty vehicles (LDV), i.e. cars and light trucks, and 2.4 million busses must be battery-powered (BEV) by 2030. The number has to rise to a total of 288 million of BEV for road transport by 2050. In the same year, BEV contributes to 73% market share of new LDV and 95% market share of new two- and three-wheelers sales. In this case, all BEVs accounts for 46% of energy demand from the transportation sector in 2050 (IESR, Agora Energiewende & LUT University, 2021).

- Establishing electric vehicles ecosystem is inevitable to realize the target. Charging infrastructure should be expanded. Fuel economy standards and disincentives for fossil fuel-powered vehicles are encouraged to push Original Equipment Manufacturers (OEMs) to develop new and cleaner technologies. Meanwhile, more financial and non-financial incentives such as subsidies, tax exemptions, free parking, and EV zones establishment are necessary to boost the demand. Public transportation and government vehicles are tactical entry points to introduce and popularize electric vehicles to the general public.

- The EV ecosystem should also include the industry and supply chain to support electrification. With several regional competitors (e.g. India and Thailand) eyeing to become EV and battery manufacturing hubs, the government needs to act boldly and quickly to attract more foreign investments and outcompete other countries. More joint ventures (JVs) would also be needed to set up the entire EV and battery supply chain as well as to accelerate innovation.

Sluggish adoption rate reveals persistent barriers: a call for a more harmonized and integrated national EV development roadmap

- Despite government push, electric vehicle adoption is still constrained by high sticker prices and lack of charging infrastructure, among other things. Moreover, the coronavirus pandemic has also taken a toll on the automotive industry and impeded the shift towards EV. This year's data shows that BEV sales only represented less than 1% of total car sales until September 2021 at around 654 units (Gaikindo, 2021a). Although this is an increase from last year's wholesale figure of 120 units (Gaikindo, 2021b), at this rate Indonesia will not come near the government target of 2 million electric cars by 2030.

- On the two-wheelers segment, the number of certified electric motorcycles almost tripled from last year. It must be noted that this figure does not directly translate into the number of sales, it only represents the number of EVs that passed the type test and were deemed ready to be on the road (an indicator of the total number of EVs). Similarly, the country will need to ramp up its efforts to increase electric motorcycles penetration. Given the sheer size and growth of its automotive market, Indonesia has big potential to develop its domestic EV industry.

EV adoption status and targets		
Certified vehicles (2020)	1,947 units	229 units
Certified vehicles (2021)	5,486 units	2,012 units
Targeted vehicles (2030)	13 M units	2 M units

Source: IESR, 2021; MoI, 2021

- While Indonesia has set ambitious targets for EV adoption, there are discrepancies found in the targets set by two different ministries. The Ministry of Industry (MoI) plans to produce 750,000 units of LCEV (low carbon emission vehicle), which includes electric cars and 2.45 million units of electric motorcycles in 2030. Whereas, the Ministry of Energy and Mineral Resources (MEMR) aims to have 2 million units of electric cars and 13 million units of electric motorcycles on the road by 2030. This target is part of a roadmap developed by MEMR to help Indonesia achieve its net-zero target. With different ministries having their own roadmap for EV development, it would be difficult to see coherent and consistent efforts from the government to increase EV penetration in the country. An integrated, well-designed national EV development roadmap should therefore be set up.

- More EV deployment initiatives between public and private stakeholders are surfacing. The MoI has partnered with a Japanese research institution to develop a pilot project deploying 300 electric motorcycles and micro EVs in Bandung City and Bali Province (MoI, 2021). There is also a collaboration between a state-owned enterprise (SOE), Indonesia Tourism Development Corporation, and an automotive company in the EV Mobility Project in Bali to deploy 25 BEVs and 5 PHEVs rental (Purnama, 2021). A major ride-hailing company and energy company have established a JV to deploy more electric motorcycles along with the necessary infrastructure. More similar collaborations should be encouraged by local governments and companies across Indonesia.

More robust and aggressive policies are needed to boost demand

1 Incentives

Government Reg. No. 74/2021 *(updating Government Reg. No. 73/2019) assigns luxury tax-based on emission level of vehicle, instead of engine size; BEV has 0% tax base whereas PHEV and HEV are taxed 15% tariff with tax bases depending on their emission.*

MoHA Reg. No. 1/2021 *(updating MoHa Reg. No. 8/2020) sets calculation and cap for EV tax and transfer fee. Derivative regulation by Jakarta Province,* ***Governor of Jakarta Regulation No. 3/2020****, specifies a 0% ownership tax (BBNKB) for BEV.*

Assessment:
All taxes need to be removed including import duty to cut down EV prices to around IDR 300-400 million. Financial incentives e.g. free parking and free road toll along with non-fiscal incentives e.g. bus lane allowance and EV special zones can attract more buyers.

2 Disincentives

A net-zero emission roadmap by MEMR addresses ban on conventional motorcycles by 2040 and conventional cars by 2050.

The government through ***MoF Reg. No. 120/2021*** *keeps prolonging luxury tax discount for conventional vehicles that ranges between 25-100% according to the engine size. This regulation is regarded as part of economic recovery program and has been running since March 2021.*

Assessment:
The government also needs to lay out plans to scrap ICE and to develop sustainable liquid fuels into the future to align with the zero emission target; luxury tax discount for conventional vehicles needs to be allocated instead for promoting electric vehicles.

3 Standardization

MEMR Reg. No. 13/2020 *details charging plugs standardization and electricity tariff policy for charging and public transport operators.*

MoT Reg. No. 45/2020 *regulates orderliness and safety of EV users by setting down technical specifications, allowable paths, and user requirements.*

Assessment:
More effort needs to be made to standardize battery swap stations and to ensure a strict safety requirements to avoid technical failures.

4 Conversion

MoT Reg. No. 65/2020 *legalizes the conversion of ICE motorcycles to electric in public repair shop that is authorized by the government. Regulation on conversion of ICE car to electric car (as well as for bus) is still planned to be enacted in 2021.*

Assessment:
After a pilot project, there are only three repair shops that are accredited to conduct conversion. The government needs to ensure quality and safety while helping to lower conversion cost to expand this effort into a large scale quickly.

More financial incentives should be provided to lower EV upfront costs and TCO

- With existing financial incentives, electric vehicle prices have decreased in recent years. However, they are still inadequate to support mass adoption. The cheapest electric car available —that is comparable to conventional cars— costs more than IDR 600 million. This poses challenges to EV deployment in Indonesia as the vast majority of conventional cars sold in the market cost less than IDR 300 million (Gaikindo, 2021a).

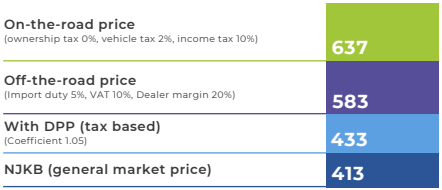
- Apart from the price margin, there are some taxes associated with the EVs, including import duty, VAT, income tax, and annual vehicle tax. Together, they contribute to an increase of upfront cost by more than 50% of the initial market prices.

- On the other hand, the purchase price of the cheapest electric motorcycle is IDR 19 million, slightly above the typical price of a popular conventional motorcycle. This provides a better case for electric motorcycles adoption in Indonesia given that 80% of households own motorcycles (Pwc, 2021).

- Throughout its lifetime, the low operational costs of EVs will provide cost savings for owners. A 6-year total cost of ownership (TCO) comparison between the cheapest electric car and conventional car with similar price ranges and models reveals that electric cars can be 15% costlier than conventional cars. Even without taking salvage value into account, the TCO of an electric car is still slightly higher than its sedan competitor. However, if all taxes are removed, its TCO would shrink by 25%, making it 20% cheaper than a conventional car.

- Meanwhile, electric motorcycles have a 6% lower TCO than conventional motorcycles. For both EV types, the TCO would be lower than conventional vehicles with longer driving distances. Therefore, it is reasonable and beneficial to adopt EV in public transportation and ride-hailing services.

Upfront cost of the cheapest private electric car in Indonesia to date
in IDR million



Source: IESR analysis

TCO comparison
in IDR million

	Car		Motorcycle	
	Electric	ICE	Electric	ICE
OTR price (IDR million)	637	533	19	17.8
Annual driving distance (km/year)	20,000	20,000	10,000	10,000
Annual fuel cost (IDR million/year)	4.7	15.3	0.6	1.3
Annual maintenance and insurance costs, and taxes (IDR million/year)	15	16.7	0.58	1.3
Salvage value (IDR million)	159	213	0.6	6.5
TCO (IDR million)	614	532	24.8	26.5

Source: IESR analysis

Electric vehicles are far ahead on efficiency but lacking in several other performance indicators

Comparison of technical performance indicators

Price range (IDR)	600-700 million		1-4.5 billion		16-30 million	
	BEV	ICE	BEV	ICE	BEV	ICE
Battery capacity (kWh)	38 - 40	-	50 - 100	-	1.38 - 1.78	-
Home charging duration (h)	12 - 17	-	6-9	-	4-8	-
Range (km)	300 - 310	600-1,000	300 - 650	600-1,200	50 - 60	260-500
Acceleration (sec) from 0-100 km for cars and 0-50 km for 2W	8-10	7-13	3-7	3-8	5	4-5.5
Top speed (km/h)	155 - 165	170-250	160 - 250	200-340	50 - 70	115-145
Fuel efficiency (km/lsp)	47 - 59	10-12.6	40-60	6-18	160-270	40-62
Seating capacity	5	5-8	5-7	2-8	2	2

Source: IESR analysis

- To increase their adoption, electric cars and motorcycles need to offer more benefits to vehicle owners without compromising vehicle performance. Automakers, for instance, should improve EV driving range that is still behind their conventional counterparts. In addition, further research on optimal battery sizes would also be necessary to allow mass adoption in the Indonesian market.
- In terms of top speed, both conventional cars and motorcycles outcompete electric vehicles that are in the same price range. Exemptions, however, can be seen in several types of electric cars priced above IDR 1 billion that can reach a speed of 225-250 km/h, suggesting a comparable performance between the two. In terms of acceleration, both types (electric and conventional) are in the same range.
- When all EV taxes are removed, prices can be 20% lower than initial prices. The acceleration of electric vehicles will also be ahead of conventional vehicles in the same price group.
- One of the main advantages of EVs is higher efficiency: electric motorcycles can be 4 times while electric cars can be 5 to 6 times more efficient than conventional vehicles.
- The limited number of EV models is also a factor affecting EV technical qualifications and marginal consumer adoption. More automakers, for instance, should produce EVs with larger seating capacities as this kind of model is generally more popular in the Indonesian market (Ipsos, 2020).

Expansion of charging network still falls short of the target, better government planning is required

- Most of the EV charging will be undertaken at home or work (IEA, 2021). However, the roll-out of public charging stations is crucial to abate the range anxiety —since it is still the public's main concern for EV adoption (Deloitte, 2021)— and to accelerate EV sales to make EV use more widespread in the future.

- The latest data shows that there are 187 public charging stations (SPKLU) spread across Indonesia including in Java, Bali, Nusa Tenggara, Sumatra, and Sulawesi with almost 50% of these SPKLU are located in Jakarta (MEMR, 2021) and over 50% are owned by the private sector (mainly on dealers' sites). While the figure doubled last year's number, it is still far from PLN's target of 572 SPKLU. Data on battery swap stations (SPBKLU) reveals that currently, there are only 153 SPBKLU in Indonesia or lower than the target of 3,000 units.

- The government has yet to produce better planning for the development of SPKLU and SPBKLU. Our analysis shows that the SPKLU business is still unattractive given the low utilization rate of EV charging. The government needs to take a lead in building a vast network of charging stations at this early stage of EV adoption. In addition to the currently available incentives such as lower electricity tariffs, lower prices of power infrastructure upgrades, and ease on business permits (MEMR, 2020), more incentives e.g. on land leasing should also be provided to help the charging operators secure lower costs. The government should also set up a plan for the development of SPKLU and SPBKLU that is based on realistic techno-financial analysis. This is a crucial step since both SPKLU and SPBKLU are viable options but come with different challenges.

- While there is already a company in China that runs battery-swap systems for electric cars, the operation scale is still limited. A quick qualitative assessment of the challenges indicates that this system is more appropriate for electric motorcycles. The electric motorcycles landscape is rife with new OEMs rather than legacy players that produce conventional motorcycles. This opens up opportunities for easier standardization. The government needs to further facilitate discussions between stakeholders to establish standardized electric motorcycles and batteries. Such discussions have taken place recently when four major OEMs established a consortium to develop a standardized system. Careful planning is also needed to develop charging infrastructure while suppressing costs.

Public charging stations stock vs targets

2020	93	9
2021	187	153
2021 target	572	3,000

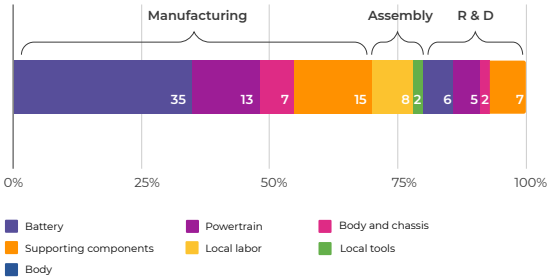
Source: MEMR, 2021

Disadvantages of SPKLU and SPBKLU implementation

SPKLU (plug-in charging)	*SPBKLU* (battery swap)
Longer charging duration (15 to > 60 minutes to reach full battery capacity depending on the charger power)	**High installation cost** (involves large number of batteries for the same number of EVs)
High capital cost for EV (vehicle with its battery will be purchased altogether upfront, instead of using battery leasing scheme)	**Tough and complex standardization process** (involves various incumbent OEMs to make a standard EV and battery, especially for electric cars)

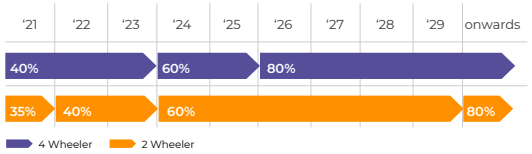
The development of domestic batteries is crucial as local content requirements tighten

Local content requirement of EV components (%)



Source: MoI, 2021

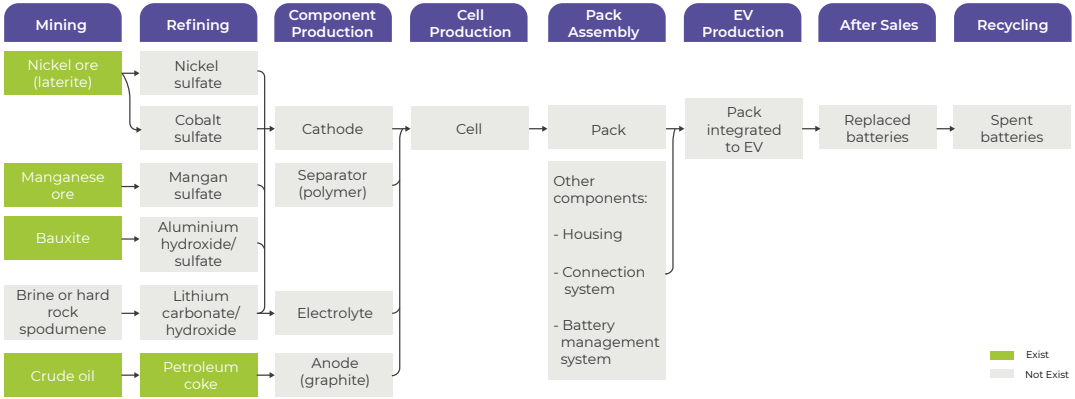
Local content requirement adjustment for years ahead (%)



Source: MoI, 2021

- According to MoI Reg. No. 27/2020, in 2021, locally-manufactured EVs must have a minimum local content of 35% (two-wheelers) or 40% (four-wheelers). Several electric two-wheelers manufacturers claim that they have managed to fulfill around 40%-47% of local content requirements (LCRs). However, they raise concerns about the government plan to tighten the requirements in the next three years. If the requirements increase to 60%, the manufacturing of batteries or electric drivetrains needs to be 100% local. The OEMs are not confident that they can fulfill the requirements by that time.
- Concerns about local content requirements for batteries are also mentioned by the first electric automaker in the country. Batteries as the main component of EVs have a big share of LCRs at around 35%. On the other hand, local large-scale battery manufacturing is crucial to lowering EV prices considering that batteries make up for around 40% of electric vehicles prices.
- In order to help OEMs to meet LCRs, MoI proposes a new local content calculation that puts more weight on assembly and R&D (each at around 20%), so that (electric cars) OEMs can meet the requirements by 2023 more easily. Since 60% LCRs will be imposed from 2024 onwards, the domestic battery industry is expected to start production as soon as possible. To date, however, there is only one battery cell manufacturer—JV between IBC and South Korean Battery Company—that will start production next year. It is also important to note that this manufacturer will exclusively sell their battery cells to one EV manufacturer, indicating more support from the government is needed to minimize the burden that other foreign OEMs have to bear. By doing so, more investments will likely come to Indonesia and help set up local EV manufacturing hubs.
- The LCRs are beneficial to establishing a production platform that is focused on the value-added of the domestic EV industry. At the same time, the government should also put attention to infrastructure and trade policies necessary to create competitive advantage and access to technology. As a result, production costs can be lowered (efficiency increases) as manufacturers can avoid additional costs associated with LCRs.

The battery value chain is progressing, local technologies need to scale up



Source: IESR analysis

- Apart from lithium, Indonesia is rich in mineral resources necessary to develop EV batteries. The battery value chain starts from the upstream side where existing mining companies supply mining products such as nickel laterite, manganese ores, etc. However, these companies currently have no processing and refining facilities to develop battery-grade materials such as high-purity chemicals that are important for Li-ion batteries (cathodes). As a major component of the cathodes, battery-grade nickel production needs to increase. Most of the locally-produced nickel is unsuitable for EV batteries that require Class 1 nickel (> 99.98% purity) (Campagnol et al, 2018) instead of Class 2 nickel that is often used in stainless steel production. Therefore, it is important for local mining companies to adopt new refining technologies necessary in Class 1 nickel production.

- To date, there is only one Class 1 nickel producer in Indonesia located in Obi Island, North Moluccas. The company just started its operation this year. The product produced by this company is an intermediate precursor, Mix Hydroxide Precipitate (MHP)—which can be converted to nickel and cobalt sulfate—from limonite (nickel laterite) using High-Pressure Acid Leach (HPAL) technology with an annual production capacity of 240,000 tonnes (2 out of 3 lines of production). In addition, our analysis shows that there is a growing trend of FDI on the upstream side where there are six more HPAL units that are currently under construction while more units are soon to be constructed including the ones owned by Indonesia Battery Corporation (IBC). Four of these HPAL units are scheduled to start operating by 2022. The government needs to take advantage of this trend by focusing on the technology and knowledge transfer within the mineral-processing industry; thus, increasing the overall domestic productivity and capability to establish homegrown technologies.

Downstream EV facilities have started to emerge while the upstream remains underdeveloped

Existing companies in domestic battery supply chain

	Raw materials suppliers	Battery cells producers	EV producers		Recycling company
			Car	Motorcycles	
Total company	1 (refining)	2	1	22	1
Total production capacity	240 kilotonne	10.25 GWh(*)	250,000 units(*)	1.04 million units	24 kilotonne(*)
Facility location	Maluku Utara	Jawa Barat, Jakarta	Jawa Barat	Varied	Sulawesi Tengah

(*) Plan to start soon

Source: IESR analysis; MoI, 2021

- Based on the MEMR projection, demand for EV batteries will increase to 114 GWh by 2030. However, this estimation was based on the constant current average capacity for electric cars (40 kWh) and motorcycles (2 kWh) and not on the future trend. There is no official target set up in the MoI's roadmap for local battery production. However, the MSOE puts a target for IBC to produce 140 GWh/year of which 90 GWh/year is used to serve the domestic market by 2030. It is worth noting that it is important for the government to consolidate all efforts by setting up a specific battery production target and incorporating this target into the national EV development roadmap.

- One local company has a battery cells production facility in Jakarta, but there is no information available on its operational status. Meanwhile, IBC is building a new battery plant by partnering with a South Korean battery company in Karawang. This facility is scheduled to start producing battery cells in 2024. An annual production capacity of 10 GWh is aimed in the first phase, which will be mostly used for the company's planned EV production in Indonesia (BKPM, 2021). Another partnership has also been signed between IBC and another Asian battery manufacturer. Together, they planned to establish the next battery factory by the end of 2021 with a total investment of USD 5 billion (Halim & Prasetya, 2021).

- On the EV manufacturing side, there is a slight improvement in the local production of EVs (cars and motorcycles). To date, there are 22 local electric motorcycles manufacturers whose production capacity increases almost 20% from last year. More companies announced their plans to build their first local factories in upcoming years. Furthermore, Indonesia now has its first domestic electric car manufacturing facility in Kota Deltamas, Cikarang, owned by a foreign automaker. The production will start in 2022 with a production target reaching 50,000 units/year in its first phase of operation before later increasing to 250,000 units/year in its second phase.

- One battery-recycling facility was scheduled for its groundbreaking at the end of this year. The plant was designed to yield up to 12,000 tonnes of crude nickel-cobalt hydroxide per year in the first phase, expanding to 24,000 tonnes per year thereafter. As the local supply of lithium-ion batteries is limited, the company is still struggling to obtain import permits for used batteries as the government restricts any imports of hazardous waste.

- With the advent of battery production in Karawang, several preparatory investments —mainly on supporting infrastructure—are also made in Central Java and Rebana development zone, located in the northeastern of West Java (Evan & Sebastian, 2021). This opens up more opportunities for foreign EV investors to develop the EV supply chain in Indonesia. These downstream facilities are also expected to stimulate more upstream facilities to meet domestic demand.

Progress in Clean Fuels

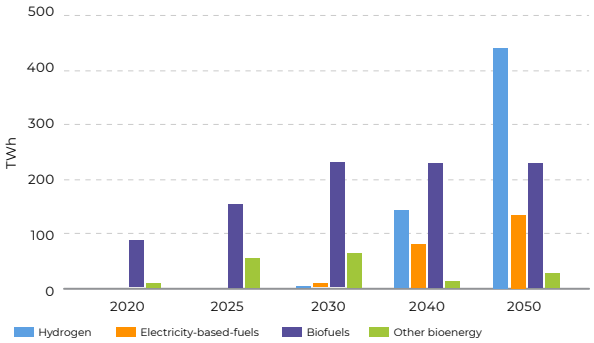
- Biofuels
- Bio-CNG
- Hydrogen

Julius Christian Adiatma

Sustainable biofuels, green hydrogen, and synthetic fuels are essential in the decarbonization of the transportation and industrial sectors

- Achieving a zero-emission energy system entails the utilization of clean fuels in addition to electrification. The use of clean fuels is necessary to replace fossil fuel consumption in the transportation and industrial sectors. While electrification is expected to dominate land transportation and most industrial uses, clean fuels are still needed to decarbonize the harder-to-abate segments such as aviation, marine transportation, and some industrial heat that requires very high temperatures.
- IESR, Agora Energiewende & LUT University (2021) suggests that both biofuels and green hydrogen will have a major role in the decarbonization of transportation and industrial sectors, while renewables-based liquid fuels and methane are also used in a lesser significance. The use of electricity-based fuels, and hydrogen, in particular, is expected to increase rapidly after 2030, as biofuels production will be limited by the availability of area.

Clean fuel demand projection 2020-2050



Source: IESR, Agora Energiewende & LUT University, 2021

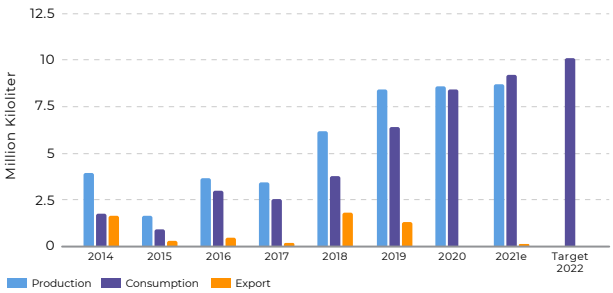
- In 2050, biofuels and hydrogen will each account for about 20% of the transportation energy demand, while electricity-based fuels will account for more than 10%. In the industrial sector, hydrogen and bioenergy will supply about 26% and 4% of the energy demand, respectively.
- The vast amount of green hydrogen requires rapid installation of electrolyzer from 2030 onwards to reach 229 GW capacity by 2050. More than USD 70 billion of investment for electrolyzer would be needed from 2030 to 2050.
- Currently, only biofuels have been well established. The type of biofuels is however still limited to biodiesel which is used for road transportation and power generation. It is important to note that the biodiesel program requires significant financial support from the government. Meanwhile, other clean fuel technologies have yet to enter the market as they are still economically uncompetitive.

Biodiesel blending remained at 30% due to economic constraints; an important milestone was seen in bioavtur

- This year, the government continued with the B30 blending since the expansion to B40 was economically prohibitive. It was also expected that biodiesel consumption would reach 9.2 million kl by the end of this year. As of November 2021, biodiesel consumption reached 8.1 million kl.

- Biodiesel exports only experienced a modest increase from around 28,000 kl in 2020 to about 100,000 kl in 2021, far less than the hundreds of thousands to million kiloliters in previous years. EU, the largest export market for Indonesian biodiesel, preferred importing used cooking oil (UCO) biodiesel from China as it is eligible for double counting in fulfilling the renewable fuel mandates (USDA, 2021). Demand from China, the second-largest market, has also been low due to the uncompetitive prices of biodiesel (USDA, 2021b).

Biodiesel production, consumption, and export (2014-2021)



Source: MEMR

- With the addition of 2 million kl capacity in 2021, total biodiesel production capacity has now reached 14.5 million kl and is expected to increase to 16 million kl next year. It means that in 2022, there will be about 3 million kl additional production capacity available at an 80% utilization rate. However, due to the high prices of CPO, export demand was still sluggish while domestic demand was stagnant. Thus, the utilization rate might have declined. Additional demand is needed to avoid the new plants becoming idle.

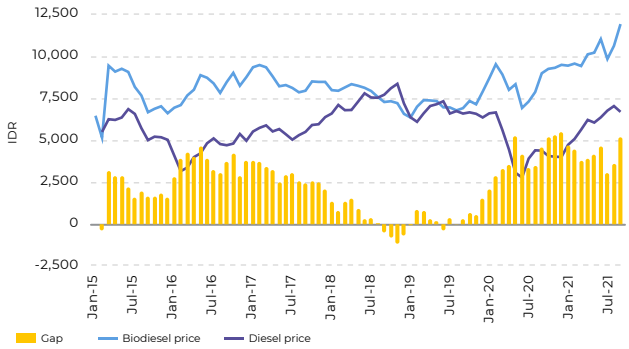
- Pertamina's 3,000 BPD (~130,000 kl/year) green diesel production facility in Cilacap was expected to start its operation in December 2021. However, there has not been any clear plan on green diesel introduction to the market as the capacity is not enough for a nationwide B40 blending. The second phase development, a 6,000 BPD plant, will be postponed to 2024 instead of 2022 due to economic constraints such as high CPO prices.

- An important milestone was achieved in bioavtur development as Pertamina successfully conducted a flight test using 2.4% bioavtur produced in Cilacap refinery via co-processing of palm kernel oil and crude petroleum oil. Further commercialization, however, will likely need additional policy support, including financial incentives. It is also worth noting that the progress in bioavtur blending has been slower than the target set in MEMR Reg. No. 12/2015: 2% in 2016, 3% in 2020, and 5% in 2025.

Biodiesel subsidies reached IDR 40 trillion due to a large price gap between biodiesel and conventional diesel

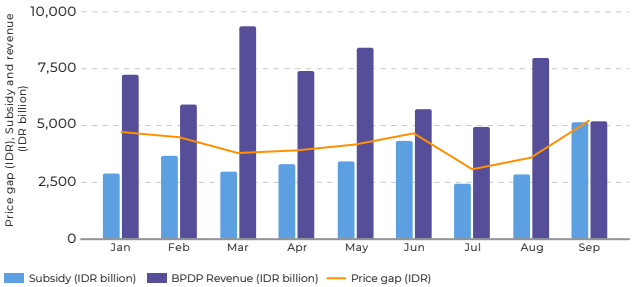
- Both crude oil and CPO prices increased much higher than predicted. Crude oil prices exceeded the pre-pandemic level at about USD 70/bbl in mid-year, while CPO prices have also hit a new record at USD 1223/ton (MoT reference price). As a result, the price gap between biodiesel and petrodiesel has remained relatively high at about IDR 3,500-5,000 since mid-2020.
- As expected, biodiesel subsidies increased from the previous year. It is estimated that until August 2021, IDR 25 trillion has been disbursed for biodiesel consumption. As a comparison, a similar amount of funds was disbursed for the entire 2020. As CPO prices have continue to increase, it is likely the subsidies will exceed IDR 40 trillion by the end of 2021.
- On the other hand, BPDPKS revenues have skyrocketed as CPO prices have been consistently above USD 1000/ton. Our calculation estimates that BPDPKS revenue reached IDR 57 trillion by August 2021. In contrast to what was expected last year, BPDPKS revenues exceeded fund disbursement this year.
- For the third time in thirteen months, the government revised the export levy of palm oil products. In June, the government decided to lower the maximum export levy to USD 175/ton from previously USD 255/ton when CPO prices were above USD 1000/ton. The purpose of this policy was to maintain CPO competitiveness in the global market and increase exports during high CPO prices.

Biodiesel price, diesel price and gap



Source: World Bank, MEMR, IESR's calculation

Biodiesel price gap, subsidy required, and export levy revenue



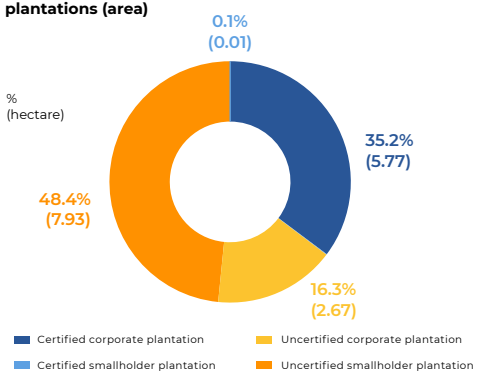
Source: IESR's calculation

Sustainability standards will be expanded to downstream products, despite slow implementation in the upstream

- IESR, Agora Energiewende & LUT University (2021) projects that biofuel demand will need to triple the current level before plateauing beyond 2030. This would require a robust policy and regulatory safeguards to ensure that biofuels are produced sustainably and aligned with the decarbonization goal.

- The presidential instruction on the palm oil moratorium was expired in September with no sign of extension. Although imperfect, the moratorium has achieved some results including the review and revocation of oil palm plantation permits in some regions. The Minister of Environment and Forestry verbally pledged to continue the moratorium of palm oil permits in forest areas, but nothing is put into policy. Madani Berkelanjutan (2021) estimates 1.73 million hectares of natural forest and 0.44 million hectares of peat ecosystem are at risk of being converted into plantations. To keep these forest areas intact, forest conversion in productive forest areas must be strictly prohibited in accordance with PP No. 23/2021.

Share of ISPO certified and uncertified palm oil plantations (area)



Source: BPDPKS

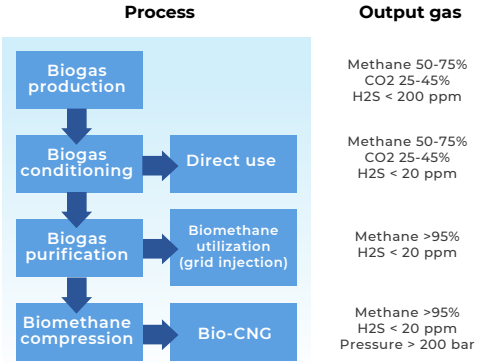
- After a year of implementation of Presidential Regulation No. 44/2020 on ISPO certification, the government has certified 139 plantations, a significant improvement compared to only 621 certifications over the 2011-2019 period. However, ISPO certified plantations only cover 35% of total plantation areas. By March 2021, only 5.8 million hectares of areas owned by palm oil companies (60% of the total company plantation areas) were ISPO certified, despite the latest regulation mandates that all areas must be certified. Meanwhile, for smallholder plantations, only 12,600 hectares were certified (0.18% of the total smallholder plantation areas).

- To improve the international acceptance of Indonesian palm oil products and ISPO certification, the Ministry of Industry planned to extend the ISPO certification to downstream export-oriented products such as RBDPO and palm kernel shell. Biodiesel, however, was excluded from this plan. The government aimed to finalize the plan in December 2021 and implement it voluntarily in 2022.

- In regards to bioenergy (including palm-oil biodiesel), the MEMR planned to conduct a pilot project for Indonesian Bioenergy Sustainability Indicators (IBSI) involving four biodiesel producers in the last quarter of 2021. The indicator will be separated from ISPO and cover environmental, social, and economic aspects throughout the whole lifecycle. IBSI is expected to be implemented voluntarily in 2022 depending on the result of the pilot projects.

The absence of regulatory framework hinders the utilization of BioCNG

- MEMR's strategic plan includes bio-CNG (compressed biomethane) development as an alternative energy source. Biomethane is obtained from the purification and compression of biogas that results in a product with similar specifications to conventional compressed natural gas (CNG). This upgrade will allow biogas to be used for wider purposes, including transportation, power plants, and industrial fuels.
- For palm oil producers, methane release from POME treatment is a significant contributor to GHG emissions. Methane capture or biogas production is an important tool to reduce GHG emissions. As the existing pricing of biogas electricity is considered unattractive, biogas upgrade to bio-CNG offers an alternative to harness the biogas excess.
- So far, there is only one company that produces bio-CNG at a commercial scale using palm oil mill effluent (POME) as the feedstock. The plant treats effluent from a 60 tons/hour palm oil mill and generates 1.2 MW electricity and 280 m3/hour biomethane both for its own consumption. The bio-CNG is used to replace diesel fuels used by trucks and diesel power plants. The company plans to build six other plants with USD 47 million investment over the next 2 years.



- One major challenge of bio-CNG development is the high costs of production and transportation. Sukardi & Brata (2021) estimated that bio-CNG production costs USD 10-14/MMbtu, higher than CNG's USD 6/mmbtu set by the government for power plant and industrial uses. This does not include the high transportation costs which limit the use of bio-CNG only in the close proximity of the production site. Consequently, the product has its own market limitation as bio-CNG from POME is usually produced in remote areas.
- There is currently no existing regulatory framework to support the market development of bio-CNG. On the other hand, the government needs commercial production to exist before issuing a regulation, leading to a chicken and egg situation. Government support has so far been limited to socialization, feasibility studies, and pilot projects, partnering with private organizations.

Hydrogen starts gaining attention despite lacking a clear future development strategy and regulatory framework

- Globally, clean hydrogen has become more popular in the past few years. The Hydrogen Council and McKinsey & Company (2021) reported that more than 200 clean hydrogen projects had been announced globally, involving more than USD 300 billion of investments for the next decade. Project sizes had increased dramatically from 0.5 MW in 2010 to 10 MW in 2020 with projects in the scale of hundreds of MW and GW have been announced. In late 2020, Chile started piloting the first industrial-scale production of hydrogen-based synthetic gasoline.

- The government of Indonesia has mentioned the opportunities for hydrogen development on some occasions. Unfortunately, it is not exclusively about the green hydrogen produced from renewables. Hydrogen is also perceived as a potential downstream product of coal and gas processing, which could actually emit more carbon emissions than direct combustion even when CCUS is implemented. Nevertheless, the government has yet to establish any clear target or development roadmap. This lack of regulatory support potentially hampers hydrogen development since the technology is relatively immature, and thus requires a lot of government support.

- There have been some hydrogen initiatives initiated by the private sector, although they are still limited to feasibility studies and pilot projects. The currently prohibitive costs of renewable energy and electrolyzer are deemed as a hindrance to hydrogen commercialization. As a benchmark, conventional hydrogen production from natural gas costs about USD 1-2/kg.

    - Pertamina Power Indonesia is exploring the opportunity to build a hydrogen production facility. It currently plans to start a pilot project of green hydrogen production from the excess power of the Ulubelu geothermal power plant. The pilot plant will have a capacity of 100 kg per day and is expected to begin producing 20 kg green hydrogen per day by the end of 2022. The hydrogen will be used as process feedstock in Pertamina's own refinery in Plaju. The green hydrogen production cost is estimated to be around USD 5.8/kg with the majority cost (~70%) being electricity costs[5], but the cost projection only covers the cost of electrolysis. The costs of supporting equipment such as gas compression, storage, and transportation have not been included in the estimation. Additionally, Pertamina is also exploring the possibility to conduct a pilot project of hydrogen-fueled trucks.

    - HDF Energy is developing a renewable energy system combining solar PV, batteries, hydrogen storage, and fuel cells with a capacity of 10 MW during the day and 2 MW during the night in Sumba Island. The batteries act as short-term (2-3 hours) storage, while hydrogen acts as storage to provide electricity during the night. The project is claimed to be cost-competitive against local generation costs (BPP) of USD 20.81 cents/kWh (in 2018). It is currently undergoing a feasibility study and is expected to come online in 2024. Similar projects with a total capacity of 35 MW daytime production are already planned in NTT, although they are still in earlier stages (preliminary studies and initial discussions). The local BPP, however, might decrease as the diesel power plant replacement program takes place, which makes the economic viability of the projects questionable.

[5] Assuming electricity cost of USD 75/MWh,1 MW electrolyzer cost of USD 1400/kW, H2 heating value of 33 kWh/kg, electrolysis efficiency of 58%, and plant utilization rate of 98%,

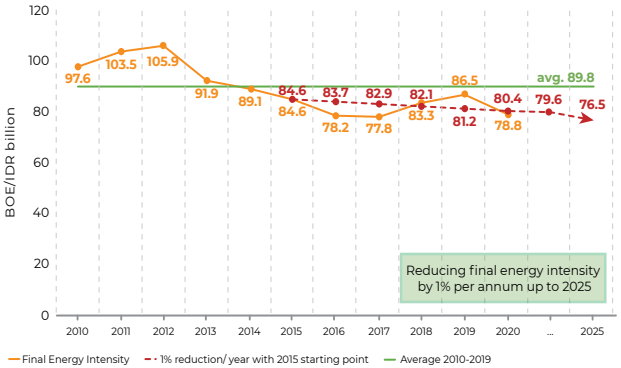
Progress in Energy Efficiency

- State and development of energy efficiency
- Investments realization in energy efficiency

Agus Praditya Tampubolon

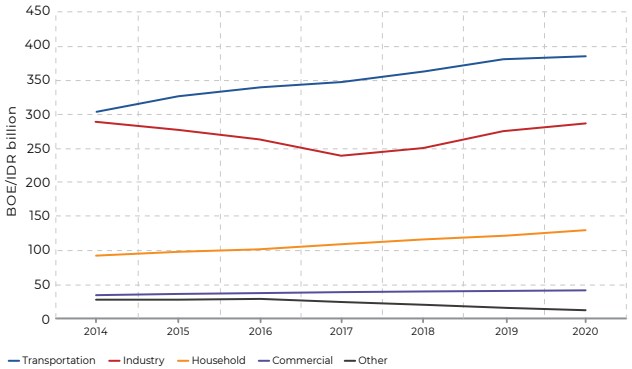
Final energy intensity lowered during the pandemic, energy conservation impact was limited

Final energy intensity



Source: Handbook of Energy and Economic Statistics of Indonesia 2020

Indonesia final energy consumption, moving average 5 (MA5) 2014-2020



Source: Handbook of Energy and Economic Statistics of Indonesia 2020

- Indonesia's final energy intensity in 2020 was 78.8 BOE/IDR billion or 9% lower than the 2019 level. This was due to a decrease in both energy consumption and GDP in 2020 during the pandemic. By sector, the industrial, transportation, and commercial sectors contributed the most to the reduction of Indonesia's final energy consumption in 2020.
- The moving average[6] of Indonesia's final energy consumption from the industrial, transportation, household and commercial sectors had steadily increased from 2014 to 2020. This indicates that the reduction in final energy consumption in 2020 was mainly due to a decrease in consumption as a result of COVID-19, and not so much because of the energy efficiency measures.

[6] In statistics, a moving average (MA) is a calculation used to analyze data points by creating a series of averages from different subsets of the complete data set (Investopedia). MA5 means the number of data subsets used are 5 data (in this case 5 years).

The new Minimum Energy Performance Standard (MEPS) and energy labeling have followed best practices

New Minimum Energy Performance Standard (MEPS) and labelling follow the international best practices

Number of stars	MEPS under MEMR Reg. 57/2017, in Btu/hr/W	MEPS under MEMR Min. Decree 103.K/EK.07/DJE/2021	
		in W/W	in Btu/hr/W (*equivalent*)
1	8.53 ≤ EER < 9.01	3.10 ≤ CSPF < 3.40	10.58 ≤ CSPF < 11.60
2	9.01 ≤ EER < 9.96	3.40 ≤ CSPF < 3.80	11.60 ≤ CSPF < 12.96
3	9.96 ≤ EER < 10.41	3.80 ≤ CSPF < 4.20	12.96 ≤ CSPF < 14.33
4	10.41 ≤ EER	4.20 ≤ CSPF < 5.00	14.33 ≤ CSPF < 17.06
5	N/A	5.00 ≤ CSPF	17.06 ≤ CSPF

Notes: EER : Energy Efficiency Ratio | CSPF : Cooling Seasonal Performance Factor

- The MEMR released Regulation No. 14/2021 on the implementation of MEPS for electrical appliances in June 2021 that regulates the implementation of MEPS and energy labeling for air conditioners, fans, refrigerators, and rice cookers. All standards for these appliances have already followed international best practices which are regulated in detail in four separated MEMR Ministerial Decrees. Specifically, the standard for air conditioners is already more stringent as can be seen in the table above.
- All appliances that are manufactured after June 2021 will follow this new regulation. To monitor the implementation, the MEMR will perform a spot check, i.e., randomly buy an electric appliance and test it in the laboratory to compare the result with the proper energy labeling.

New regulations, a training program, and a new 'one-stop energy solution' platform are set to increase energy efficiency and conservation

- Under the newly revised Government Regulation No. 70/2009 on energy conservation, the mandatory energy management program is expanded to energy consumers (from the industrial sector) with yearly energy consumption larger or equal to 4,000 TOE (previously 6,000 TOE), and from the building sector with energy consumption of 500 TOE per year. The revised draft of this regulation is still being synchronized in the Inter-Ministry Discussion and is targeted to be harmonized at the Ministry of Law and Human Rights (LINTAS EBTKE, 2021) by the end of this year.
- MEMR currently works closely with the IEA in the Energy Efficiency in Emerging Economies (E4) Program. One of the activities conducted in 2021 was training on energy efficiency indicators in the industrial sector. The activity was aimed at enhancing the knowledge and skills of the Indonesian policymakers in identifying energy efficiency needs and opportunities, developing and implementing appropriate energy efficiency policies, and measuring the impact of these policies.
- To support the implementation of energy conservation in Indonesia, the Directorate General of Renewable Energy and Energy Conservation of MEMR launched Sistem Informasi Konservasi Energi (SINERGI) in June 2021. SINERGI is a 'one-stop energy solution' platform, which provides comprehensive information on energy efficiency and energy conservation in Indonesia. The online platform is intended to bring convenience to industry players in energy management reporting, which covers energy conservation, energy efficiency, and energy-saving status.

Energy Transitions at the Sub-National Level

- DKI Jakarta
- Central Java
- Bali

Dr. Marlistya Citraningrum

Rizqi Mahfudz Prasetyo

Sub-national governments need to step up their actions to accelerate renewable energy development

- As mandated in RUEN, provincial governments have started to draft, enact, and implement their local energy plan (RUED). As of November 2021, 22 provinces have already enacted RUED into regulations (Perda), one province is undergoing registration process in the Ministry of Home Affairs, seven provinces are scheduled for legislative process, and four provinces are still drafting, but lacks budget for legislative process (Setiawan, 2021).

- The target of renewable energy mix in each province ranges from 11% to 55% in 2025. West Sumatera, North Kalimantan, and West Sulawesi are three provinces with the highest target, aiming for more than 23% (the national target) in 2025. However, existing RUEDs were derived from RUEN, which still accommodates more than 60% of fossil fuel mix in 2050. As the government set net-zero emission target by 2060 or sooner and RUEN is under review, provincial governments need to anticipate RUED's adjustment.

- On the other hand, several operational regulations and measures, such as instructions, gubernatorial or provincial regulations, and provincial budget allocations are needed for RUED to function. As of Q3 of 2021, they have been implemented by several provinces, such as Central Java and Bali, and Jakarta has policy instruments on climate issues. Those measures cover several aspects of energy transition, but specifically mentioned rooftop solar PV use in multiple sectors. Governor of West Java and West Nusa Tenggara also plan to issue a circular letter to support rooftop solar PV use as a part of their RUED implementation. Meanwhile, Governor of Jambi is preparing a regulation to pilot rooftop solar PV installation for poor households.

- To cope with impact of pandemic, Central Java has included a green economic recovery strategy by allocating government budgets for renewable energy installations for productive use (e.g. rooftop solar PV, solar water pump for agriculture, and biogas) targetting vulnerable groups for fiscal years 2021 and 2022.

- The growing trend of renewable energy in energy transition also prompted the association of oil and gas producing-provinces (ADPM) to incorporate renewable energy issues and strategies in its mission, and changed its name into the association of oil, gas, and renewable energy producing- provinces (ADPMET) in December 2020. The association highlighted the role of sub-national governments in energy transition within their respective jurisdictions, including promoting renewable energy business in province-owned enterprises (BUMD).

- Challenges for sub-national government to promote renewable energy development include the needs for derivative actions to implement RUED, limitation in legal authority, difference in development priorities, and budgeting—as budget allocation for sub-national governments is under the Ministry of Home Affairs' purview. For the latter, allocation for renewable energy is only applicable for remote areas and energy conservation, which makes it difficult for sub-national governments to justify their activities.

Sub-national governments strengthen energy transition locally through policy instruments

Government	Relevant regulations or policies	Year of issuance	Energy transition content-specific	Known background
DKI JAKARTA PROVINCE	Governor's Instruction No. 66/2019	2019	Mandatory rooftop solar PV on schools, youth and sports centers, health centers, government buildings	Air pollution management
	Governor's Instruction No. 17/2021	2021	Mandatory carbon mitigation and adaptation action (including efficiency, green building, low carbon transport, clean fuels, disaster management).	Climate disaster mitigation
	Governor's Regulation No. 90/2021	2021	Guidance for climate mitigation and adaptation implementation to achieve net zero emission in 2050 (energy sector covers energy efficiency & management, renewable energy & clean fuels utilization, public & non-motorized transport mainstreaming)	Climate disaster mitigation
CENTRAL JAVA PROVINCE	Governor's Circular Letter No. 671.25/0004468	2019	Appeal to government units, commercials & industries to install rooftop solar PV	Energy mix target and energy efficiency
	Provincial Secretary's Letter No. 671/4649	2019	Mandatory rooftop solar PV installation on government unit buildings for 2020	Energy mix target and energy efficiency
	Provincial Secretary's Letter No. 671/0015817	2021	Acceleration of rooftop solar PV installation on government buildings, C&I sectors	Energy mix target, energy efficiency, Central Java Solar Province initiative
BALI PROVINCE	Governor's Regulation No. 45/2019	2019	Mandatory rooftop solar PV on government buildings, hotels, restaurants, and luxury houses	Energy security and tourism branding
	Governor's Regulation No. 48/2019	2019	Promoting the shift to battery-based electric vehicles, domestic EVs manufacturing ecosystem	Energy security and low-carbon transportation
	Governor's Circular Letter to SKPD No. 17254/2021	2021	Instruction to leaders of government units and regents to install rooftop solar PV on government buildings, minimum 20% of installed capacity or roof area	Implementation of Governor's Regulation No. 45/2019

Jakarta is expected to implement more ambitious energy and climate measures, but its energy plan is unclear

- Challenges related to energy access and quality in the province are relatively minor. Only the communities in the Seribu Islands cluster (Kepulauan Seribu) lack high-quality energy access, as they mainly rely on diesel generator to generate electricity. To address this issue, in 2020, regional PLN (UID Jakarta Raya) completed the installation of 400 kWp ground-mounted solar PV in Sebira Island. The latest RUPTL also mentioned a system upgrade in the islands, including renewable energy development—but not under the de-dieselization program.

- Jakarta has not yet finished its RUED; it is scheduled for legislative process this year. As a consequence, Jakarta lacks indicative targets and indicators to measure its renewable energy achievements. In October, the governor issued a relevant gubernatorial regulation (No.90/2021) on low-carbon development planning, including NZE target at 2050, but still without declarative energy mix goal.

- Deployment of solar PV is supported by Jakarta Provincial Government through Governor Instructions No.66/2019 as a response to public outcry on the capital's worsening air quality. In the instruction, Energy and Industrial Department (at that time) was tasked to install rooftop solar PV on public schools, youth and/or sport centers, health service buildings, and all government buildings by 2022 and to revise regulations on green building to include incentives for rooftop solar PV users. After two years of its implementation, the instruction resulted in a cumulative installation of 2 MWp rooftop solar PV on 89 public schools. Most of the installations came from the 2019 provincial budget, and none from the 2021 budget.

- In 2021, the governor issued a climate-responsive policy instruction (No. 17/2021). This includes more standards on green building and its relevant incentives, the procurement of 100 electric buses by 2021, and the target of rooftop solar PV installations in 36 locations by 2022 (sites are unspecified). It is unclear whether the rooftop solar PV installation targets overlap with the previous instruction.

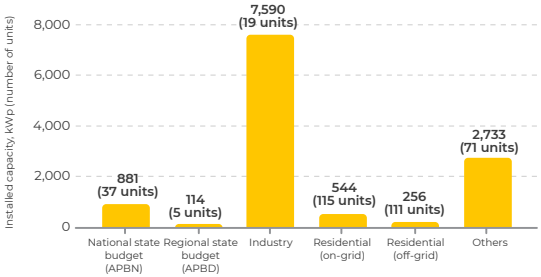
- Meanwhile, rooftop solar PV use in non-government buildings in Jakarta has increased. As of the third quarter of 2021, the number of rooftop solar PV users in the province is 1,222 users, the highest across the nation. The cumulative capacity was 7.27 MWp, second highest in the country. A combination of non-policy factors: improved access to information and socialization events, product and service providers, and financing options, the rising trend of "green lifestyle", as well as higher buying power contributed to the growth of rooftop solar PV utilization.

- Jakarta has the potential to showcase rooftop solar PV since it is also installed in some of the province's landmarks such as Istiqlal Grand Mosque (150 kWp, Ministry of Public Works' budget) and Jakarta's Catholic Cathedral (238 kWp, collective funding). Over 80 shopping centers in the city also have ample potential, at least 6.7 MWp just for 5 shopping malls. While a number of commercial buildings and malls have installed rooftop solar PV, to date there is only less than 1 MWp rooftop solar PV installation on those buildings.

Central Java Solar Province initiative supports green economic recovery in the region

- In 2019, Central Java Government launched Central Java Solar Province Initiative to support its RUED implementation. By 2021, the initiative will be expanded, involving other provincial agencies to cover trade and industrial sector, environment and forestry, and small-medium enterprises (SME).
- Albeit no specific regulations on solar energy enacted, the Central Java Government has allocated IDR 4.2 billion in 2021 for green economic recovery measures, i.e. a cumulative 154 kWp rooftop solar PV installations in four SME clusters and three Islamic boarding schools. As of October 2021, only two out of seven clusters were completed due to the pandemic. The recently approved 2022 budget includes the plan to continue carrying out these measures with IDR 5.2 billion-worth projects on rooftop solar PV installations in 14 clusters (four SMEs and 10 Islamic boarding schools) and three units of solar water pumps for agriculture.

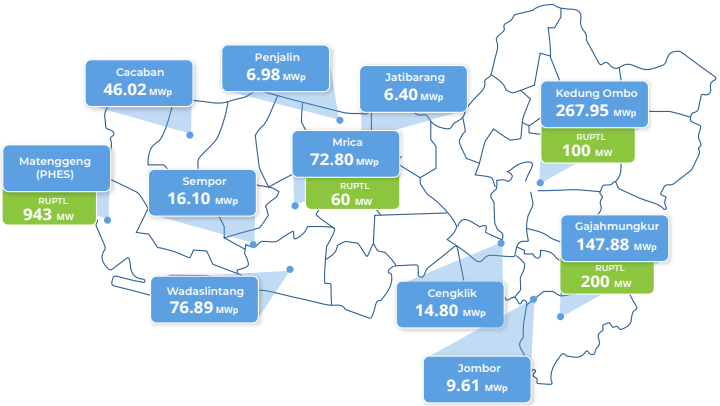
Cumulative solar installation in Central Java (Q3 2021)



Energy and Mineral Resources Department of Central Java, IESR analysis

- The collective efforts of Central Java Solar Province initiative have contributed to the increase of solar PV installation the region. As of November of 2021, Central Java added 7 MWp of solar PV installation (yoy), increasing the total installed capacity of solar PV to 12.1 MWp. The largest contributor is industrial sector (62%), mostly in megawatt-size installations.
- The growing interest of large industries in Central Java to use renewable energy, particularly solar PV, is attributable to the governor's circular letter in 2019 and renewed by provincial secretary in 2021, frequent socialization events on solar PV, and the availability of zero-capex scheme offered by solar PV developers. However, wider adoption is still challenging for smaller industries due to their limited capital for direct purchase and low economic scale for zero-capex scheme.
- To support Central Java Solar Province Initiative, Central Java's province-owned energy company, Jateng Petro Energi (JPEN), has begun to explore renewable energy business opportunities, started with rooftop solar PV projects.

Central Java could be the next hot spot for floating solar PV development in Java Island



Total technical potential of floating solar PV in Central Java (assuming 5% reservoir area)

723.07 MWp

Potential investment

USD 578.5 million

IESR (2021c; 2021d)

- In RUPTL 2021- 2030, the planned utility-scale solar power plants in Java-Bali system (distributed quota) reaches 1.5 GW, tripled from the previous plan (PLN, 2021). However, no specific quota was mentioned for Central Java. Based on IESR analysis, the province has a technical potential of 669 GWp ground-mounted solar PV, making it prospective for utility-scale solar PV development (IESR, 2021a).

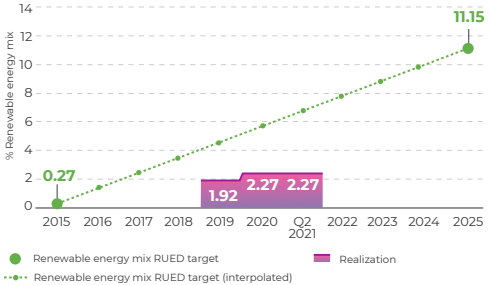
- In addition, Central Java also possesses significant floating solar PV potential. Among other provinces in Java-Bali power system, Central Java has the highest number of dams. IESR's technical potential mapping of 42 dams in the province yielded a potential of 723 MWp—assuming that 5% of reservoir area is utilized—and resulted in potential investment of USD 578.5 million (IESR, 2021c; 2021d). The most recent RUPTL has already identified potential for floating solar PV in Central Java: Kedung Ombo (100 MW), Gajah Mungkur (200 MW), and Mrica (60 MW). To anticipate utility-scale solar PV in the system, PLN also plans to develop a pumped-storage/hydro power plants in Matenggeng (943 MW) (PLN, 2021).

- Following PPA completion of Cirata's floating solar PV and Hijaunesia solar PV auction in 2020, investment attractiveness for floating solar PV has grown. This was evident in a number of letter of intents (LoI) received by Central Java government from solar PV developers after the province completed its floating solar PV potential assessment. The letters expressed the companies' interest to develop floating solar PV in several dams, such as Gajah Mungkur and Kedung Ombo. Moreover, Indonesia's Ministry of Investment is also keen on expanding renewable energy investment portfolio in the province.

Envisioning Bali Clean Energy: Regulations exist, but renewables growth remains low due slow implementation during the pandemic

- Bali's energy plan, RUED, only targets 11.15% of renewable energy in the energy mix by 2025—less than the national target—because its power system is connected to the larger Java-Bali network. There is a plan to upgrade the Java-Bali Connection crossing (JBC) to allow larger reserve sharing. It is mentioned specifically in the document that the government's priority is to use rooftop solar PV to achieve the target. Renewables included in the projected electricity capacity are solar energy (210 MW by 2025), small hydro (4.2 MW by 2025), and biomass (0.9 MW by 2025) (Government of Bali, 2020).

Renewable energy mix target in RUED Bali and it's realization (Q2 2021)



Source: Manpower, Energy, and Mineral Resources Department of Bali, IESR Analysis

- Bali was the first province in Indonesia that has enacted a specific gubernatorial regulation on clean energy (Gubernatorial Regulation "Bali Clean Energy" No. 45/2019). The regulation includes a mandatory use of rooftop solar PV for various buildings. In 2021, the government sees the strategic role of rooftop solar PV by issuing a governor circular letter (No. 17254/2021) for the use of rooftop solar PV on government buildings and state-owned enterprises. By the third quarter of 2021, renewable energy installations in Bali have reached 7.1 MW. The installations consist of solar PV and the mini-hydro power plants, whereas rooftop solar PV accounts for 3.4 MWp. A number of non-government rooftop solar PV installation in C&I buildings are currently under construction, with a total capacity of approximately 2 MWp.

- According to the RUED, cumulative installation of solar energy in Bali is projected to be 88 MW in 2021, consists of the existing 2 MW installation by province-owned enterprises, 2 x 25 MW utility-scale solar power plants planned in 2019 (IPP projects), and rooftop solar PV based on an unspecified "roadmap". Unfortunately, the province's current achievement is still far from the projection. This year's government installation only comes from 2021's national budget—IDR 7.3 billion for cumulative installation of 500 kWp rooftop solar PV on multiple government buildings, schools, and public facilities. Bali government has not yet allocated budget for rooftop solar PV installation this year, but has planned to accelerate Bali Clean Energy implementation by forming a "special taskforce" that will start functioning in 2022.

- In November 2021, Bali government in cooperation with Bappenas launched Bali economic recovery roadmap. The roadmap implores the mid-to-long term development strategy and action plan, including energy sector. It targets renewable energy mix of 22.96% in 2028 and 52.67% in 2045, higher than RUED's target. To achieve the target, Bali plans to accelerate the deployment of renewable power generation, energy efficiency, and electrification in cooking and transportation subsector. Based on the roadmap, Bali is expected to reduce the carbon intensity by 40-80% in 2045 from BAU and reach net-zero emission by 2060 or sooner (Bappenas, 2021).

Renewable energy resources in Bali are sufficient to meet its power demand in 2045

- Based on IESR analysis, Bali renewable energy potential could meet its power demand in 2045; thus, it will make Bali 100%RE—with appropriate policies and regulations, necessary incentives and support, and a good system planning. With projected electricity demand in 2045 amounted to 24 TWh, a cumulative capacity of 13 GW renewable energy is needed. The potentials, i.e. solar, small and micro-hydro, biomass, and wind, could yield up to 143 GW. In addition, a total potential of 559 GWh from PHES was identified; of which 5.9 GWh is classified as Grade A (IESR, 2021b).

- Based on the latest RUPTL, there will be no new development of fossil-fueled power plants in Bali from 2021 onwards- only a relocation of gas/gas-steam power plants from Java system. Other planned plants will be powered by renewables: solar (site-specific and Java-Bali distributed quota), micro-hydro, geothermal, and waste-to-energy, with the total capacity of 238 MW (PLN, 2021).

Renewable energy resources potential and generation to support Bali 100%RE

Renewable Power Plant Types	Capacity (GW)	Energy Generation (TWh)
Utility-scale solar PV	8.1	11.8
Rooftop solar PV	3.2	5
Biomass	0.3	1.8
Wind	0.9	2.8
Small, micro-hydro	0.4	2.8
Total	**12.9**	**24**

Source: IESR analysis

- Higher penetration of solar power in Bali system has minimum effect on grid stability and power quality. IESR analysis shows that with the existing condition and additional planned utility-scale and distributed solar power plants, disturbance on several solar power plants do not impose risks on power grid. Level of distributed solar PV penetration possible to be accommodated by power grid depends on areas assessed; tourism center area allows penetration up to 27% of its transformer capacity, while urban and suburban feeders are lower. It is feasible to increase level of penetration by operating high-voltage JBC or operation adjustment of existing conventional power plants and the planned utility-scale solar power plants.

- Rooftop solar PV's technical potential for residential buildings in Bali ranges from 3.2 to 10.9 GWp, assuming different access factors (IESR, 2019). Given the available potential, residential rooftop solar PV could play an important role in Bali's energy transition. Based on IESR's analysis, there is also an indication that rooftop solar PV installation for subsidized consumers (450 VA and 900 VA) is feasible as long as the maximum penetration is 20% of its feeder loads.

Financing Energy System Decarbonization

Lisa Wijayani

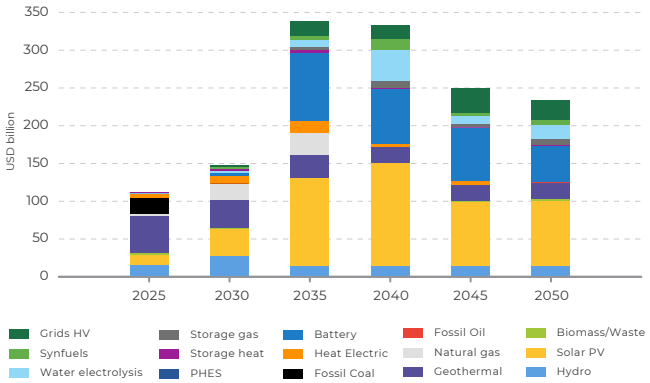
Melina Gabriella

- Investment need for decarbonization
- Fiscal incentives and government facilitation
- International and national financing facilities
- Innovative financing instruments

Massive investment is essential for reaching a zero emission energy system by 2050

- Decarbonization of energy sector will require significant investments in renewable energy, electric heating, clean fuels, power grids, and energy storage. Our study estimates investment needs of USD 20–25 billion per annum between 2020 and 2030 and around USD 40–60 billion per annum from 2030 to 2050.
- On average, USD 4.5 billion per year is required to meet the 108 GW solar PV target by 2030. Solar investment needs will peak between 2030 and 2040 with investment reaching USD 20–25 billion per annum. The share of rooftop solar PV in total solar investment will continue to increase to around 50% between 2045 and 2050.
- Investments in energy storage (electricity and heat) and clean fuels will need to take off from 2030 onwards. Accumulative investment in energy storage will peak between 2030 and 2035 at around USD 88 billion with investment in batteries making up the most of the figure. Meanwhile, investment in hydrogen will reach its highest point from 2035 to 2040 at around USD 7 billion per year, dominating clean fuels investment in that period.

Capex in 5-year Intervals



Source: IESR, Agora Energiewende & LUT University, 2021

- Inter-island connections of 158 GW from west to east will require a total investment of USD 92 billion between 2020 and 2050. Most investment will be well spent on Sumatra-Java connection that will have a capacity of around 52 GW in 2050, the highest capacity among inter-island connections in Indonesia.
- Annual investment in renewable energy has been consistently below USD 2 billion since 2016 with investment by Q3 2021 only reaching USD 1.12 billion. Considering the massive investment needs, the government needs to set supportive policies and regulations necessary to improve investment climate in Indonesia.

Fiscal incentives and government facilitation are still not optimal to attract RE investment, regulatory improvements are needed

- The national economic recovery (PEN) program has been implemented in response to the COVID-19 pandemic, mainly towards health and economic recovery. Total budget recovery for 2021 accounts for IDR 699.43 trillion, which is a slight increase compared to the 2020 budget that amounts to IDR 695.2 trillion (Fajria, 2021). Only 0.9% of the budget allocation in 2020 supported the energy transition, while the rest of the budget was mainly used for social protection and fiscal incentives for businesses in various sectors (Wijaya, et al., 2021).

- Fiscal incentives to support renewable energy installation projects have been implemented through 1) tax facilitation such as tax allowance and tax holiday for income and investment, 2) import duty exemption for machinery & equipment, and 3) land and building tax (PBB) reduction for geothermal (BKF, 2018). Fiscal incentive policy is expected to reduce the investment cost and attract investors to invest in renewable energy infrastructure, which also targets the development of geothermal infrastructures that are obliged to the high investment costs and project risk (Yanwardhana, 2021).

- Nevertheless, there are many constraints within the implementation of fiscal incentives that discourage investment. Tax allowance, tax holiday, and import duty exemption are yet to be effectively utilized by renewable energy (RE) developers. The developers are still reluctant to get their bookkeeping checked. In fact, RE developers should fulfill tax obligations and have no tax problems to be eligible to receive tax allowance. In terms of the tax holiday, RE developers can receive the benefits of 100% tax reduction for corporate income tax (PPh) for 5–20 years duration. Nevertheless, it is not effective since typically the developers have not yet received profit for the first five years of the project's implementation; thus, even without the incentive, the developers are not required to pay the income tax (Lestari, 2021).

- The government has also provided other investment facilitation support for infrastructure projects that are carried on through Public-Private Partnership (PPP), which includes renewable energy. These facilitations are given directly by the MoF—via VGF, PDF, and CEF—or through state-owned enterprises that are established to assist infrastructure development, such as BPDLH, PT. SMI, PT. IIF, and PT. PII. However, according to PT PII, there are only a few renewable energy projects that are assisted by these companies since there is a lack of mandates from the government.

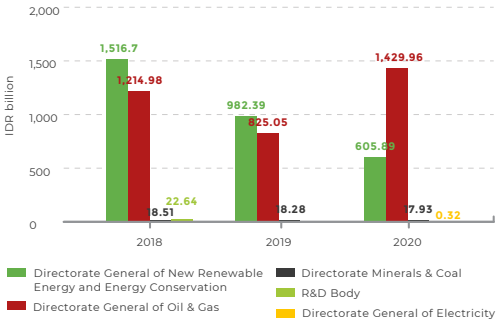
- The government should level the playing field between domestic and international investments by establishing a strong and competitive investment framework while allowing for a transparent, clear, and predictable investment process (OECD 2021). Too often, the procedures and requirements for renewable energy development are complex; thus, the supporting policies should also be reviewed to ease the business processes and facilitate investments in the country (IESR, 2021)

Climate budget tagging signals government effort in climate action, however the allocation is still far from what is needed

- The government has conducted climate budget tagging to mark the public financial support for climate change mitigation and adaptation, which includes activities in the energy and transportation sectors. However, this budget tagging has not been able to indicate the achievement of emission reduction in effect to the budget allocation. In fact, it helps facilitate the issuance of the nation's green bonds (UNDP, 2019). According to the climate budget tagging report of 2018–2020, Indonesia had spent IDR 102.65 trillion on average annually or 4.3% of the national budget for climate change.

- In 2020, the MEMR allocated IDR 2.05 trillion—a slight increase from the 2019 budget of IDR 1.83 trillion—to implement projects that have the potential to support decarbonization. Meanwhile, the MoT did not allocate anything for climate tagging in 2020 but had spent IDR 33.81 trillion in 2018–2019 for sustainable transportation infrastructure and the utilization of renewable energy in the transportation sector.

Budget allocation for mitigation 2018-2020



Source: MEMR

- The largest amount of the climate change budget in the APBN for the last five years has been used to fund the energy and transportation sectors of IDR 221.6 trillion (81.73%). Around IDR 49.5 trillion (18.27%) was used to fund other sectors (agriculture, forestry, and land, IPPU, waste). In spite of this, the current budget allocation and spending are still far from the budget estimation from the energy and transportation sectors that are required to achieve the NDC target and equal to the amount of IDR 318.18 trillion per year for 2020–2030 (MoF, 2020).

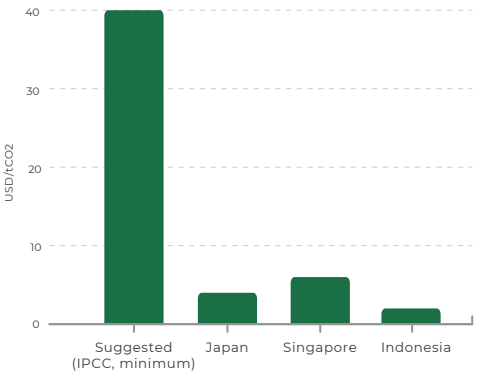
- This year, the government is also encouraging 11 sub-national governments to participate in the pilot program for regional climate budget tagging (Anggraeni, 2021). It is expected that in the future, every regional budget will have identification of activities allocated for climate efforts. It is believed that having both regional and national budgets allocation will give double power in addressing climate issues (Intan & Pratiwi, 2021). However, it should be noted that the government's effort will still be insufficient without support from other stakeholders.

Carbon tax can potentially help advance decarbonization efforts, however the initial tariff is too low to induce behavior change

- Indonesia intends to put a value on GHG emission/potential emission, which will be reflected through the implementation of carbon levies. The tax/levy is stated in the tax law or General Provisions and Tax Procedures (UU HPP). The carbon tax will be gradually implemented from April 1, 2022, onwards, initially on the coal-fired power plants with the cap-and-tax scheme. The tax can be paid using carbon certificates brought through the carbon market. Although not specifically stated, the carbon tax revenue should be used to finance decarbonization.

- Although the IPCC report (2018) suggested an average carbon tax of USD 40–80/tCO2 by 2020 and USD 50–100/tCO2 by 2030, Indonesia passed a tax law with a carbon tax of IDR 30/kg CO2-eq or USD 2.1. This tariff is significantly lower than the average tariff suggested since the purpose is to change behavior and induce transformation to renewable energy without disrupting the economy (Jiao & Sihombing, 2021). Furthermore, the tax will initially be implemented on coal power plants. Arguably, the tariff was set at such a low rate to ease resistance from the market, especially during post-pandemic growth (Ungku & Christina, 2021). It is said that the government aims to gradually increase the levy in the future and will expand to other sectors.

Comparison of carbon tax rate in Asia



Source: IESR analysis

- With carbon tax in place, Indonesia is the third Asian country and the second Southeast Asian country after Singapore that implements carbon tax. As of January 1, 2019, Singapore implemented a carbon tax of SGD 5 (USD 3.7) per tonne GHG emissions for any industrial facility that emits GHG more than or equal to 25,000 tonne CO2-eq/year. This rate was set to be applied until 2023. However, this year it is under review as the country is planning to raise the tax earlier and at a faster rate (Xu, 2021). Indonesia should learn from this experience in charging carbon tax to every sector that emits CO2 at a certain amount instead of a specific sector.

- European countries have a higher carbon tax rate compared to the rest of the world, with exception of Poland, Ukraine, and Estonia (Asen, 2021). Furthermore, in 2021, the European Union is planning to implement a carbon border tax of USD 86.87/tonne CO2-eq for some imports starting from 2026 (Figures et al, 2021). This will initially affect the production cost of high-carbon inputs such as steel and iron, which Indonesia also exports to the region.

International financing can facilitate decarbonization in the energy sector, yet there has been a limited number of energy transition projects being financed

- Indonesia allows international entities to provide financial assistance for various kinds of development projects that can come in a form of grants or soft loans. Some of the financial assistance is available to address climate issues, which include renewable energy installations. GCF and GEF Trust Fund are the most notable international funders for climate-related finance in Indonesia that have provided financing for renewables, including capacity building on project preparation. However, the number of renewable energy projects is still far from expected since many renewable energy projects cannot provide quality proposals to apply for international funding.

- GCF, a financing mechanism under UNFCCC, has provided support to catalyze Indonesia's climate financing and investment towards achieving a low-carbon economy. As of November 2021, GCF has approved approximately USD 453.9 million for renewable energy projects (MoF, 2021). In total, Indonesia received USD 0.54 billion from GCF. Meanwhile, GEF Trust Fund, the largest multilateral trust fund for the environment, has also given financial assistance to Indonesia. From 2010 to 2018, GEF has allocated about USD 50 million for climate-related projects in Indonesia (GEF Trust Fund, 2021). Among these, about USD 19 million is granted for energy-related projects such as energy efficiency and geothermal development.

- Besides these, Indonesia can access funding from multilateral organizations such as the World Bank or Asian Development Bank (ADB). ADB, for example, has provided around USD 1.5 billion project loans to RE projects in Indonesia from 2015–2020 (Dwicahyani et al., 2021). This is almost half of the total project loans ADB has given for the energy sector in Indonesia, which reached USD 3.7 billion in the same period. Furthermore, among the renewable energy that received ADB loans, Geothermal received USD 547.5 million, or about a third of the project loans. ADB is also committed to assisting Indonesia by partnering on a pilot study of the Energy Transition Mechanism (ETM), which would further advance decarbonization efforts in the country (ADB, 2021).

- There are also some bilateral donors from various countries such as Norway (through REDD+) or Japan (through JCM). As of June 2021, JCM financing programs supported the implementation of 34 projects and 37 technologies which amounted to JPY 26.7 billion (Ministry of the Environment Japan, 2021). The projects are in the form of, among others, sustainable transport, renewable energy (such as solar, small-scale geothermal power, mini-hydro, and biomass), and energy efficiency in commercial sectors (JCM, 2020). For sustainable transport, JCM has supported the retrofitting of 72 public buses in Semarang from diesel to hybrid engine with CNG system, with the expected GHG emission reduction reaching 2,667 tCO2/year.

Innovative financing instruments can help accelerate renewable energy deployment and early coal retirement

- Besides the funding sources that have been established to assist Indonesia's sustainability efforts, there are other innovative financing instruments such as green bonds/green Sukuk, Islamic finance (zakat and waqf), blended finance, and municipal bonds. **Green Bond or Green Sukuk** are issued by the government to finance and refinance eligible green projects including renewable energy and energy efficiency. Since 2018, the country has actively offered Green Sukuk annually in a form of global green Sukuk and retail green Sukuk. From the beginning to mid-2021, the government managed to secure Sukuk transactions with a total of USD 3.41 billion (MoF, 2021). Meanwhile, the renewable energy sector has received a total of USD 151.55 million for financing and refinancing projects. **Islamic Finance** also holds a significant role in various sustainable project fundings, including renewables. According to Indonesia Islamic Economic Masterplan 2019–2024, renewable energy has received some support through the Murabaha (the principle of buying and selling) scheme as well as donations through zakat. Bazas (National zakat agency) provided USD 350,000 for Micro-hydro power plant installations in Jambi (UNDP, 2017). Furthermore, there is a possibility of financial support for a synergy between the renewable energy sector and halal industries (halal food and beverages, halal cosmetics, halal tourism, etc).

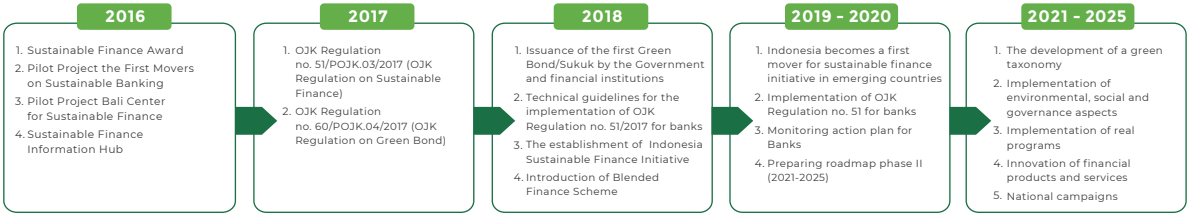
- **Blended finance** is catalyzed by the instruments such as concessional capital, guarantees, and risk insurance, technical assistance funds, and design-stage grants that can be used to finance renewable energy projects. In Asia, public guarantees and risk insurance can both, directly and indirectly, attract private investors for renewable energy projects (Bery, 2019). With a blended finance mechanism, finance mobilization from public and private sectors will be able to fulfill the budget needed in regards to Indonesia's climate financing reach to IDR 86,76 trillion per year (CNN, 2021). A blended finance approach is currently underway to foster the retirement of coal-fired power plants in Indonesia and the Philippines through the Energy Transition Mechanism (ETM). The ETM's capital is sourced from multilateral development banks, private institutional and long-term investors, and philanthropy (Evans, 2021).

- **Municipal bonds** are one of the options to provide funding for green projects including renewable energy at the municipal level and pertinent to accelerate the energy transition in Indonesia. West Java, Central Java, and DKI Jakarta have prominent green projects that can be funded through municipal bonds followed by strong fiscal capacity and good quality of human resources (Agung, 2021). However, many constraints still exist to boost municipal bonds, which are among others: complicated eligibility requirements and issuance procedures, high credit rating requirements, and lack of profitable projects. To date, no municipalities and provinces in Indonesia have issued municipal bonds.

- The innovative financing options mentioned above are capable of supporting renewable energy deployment in Indonesia. However, the interest rate is not captivating to attract investors to provide funding through this mechanism. Interest rates for green financing are similar to conventional financing while in fact, the risk is somewhat high to build renewable energy infrastructure. For investors who decide to invest their capital in green sectors, their decision is made due to the low risk that they foresee from this investment since the government will be involved in this financing system.

OJK's sustainable finance roadmap pushes financial institutions to provide more support to renewable energy projects

Sustainable finance roadmap's achievements & milestones



Source: OJK Sustainable Finance Roadmap II

- Financial Services Authority (OJK) has launched sustainable finance roadmap II (2021–2025) and at the moment is in the midst of implementing key priorities for 2021–2022, which include the development of green taxonomy. Green taxonomy will be used as guidance for investors and other relevant stakeholders to support sustainable business and investment in Indonesia. The taxonomy will classify sustainable financing and investment in Indonesia into at least 2 categories, namely: green sectors and green transition sectors (e.g mining). It is expected that Indonesia's green taxonomy will be finalized in 2022.

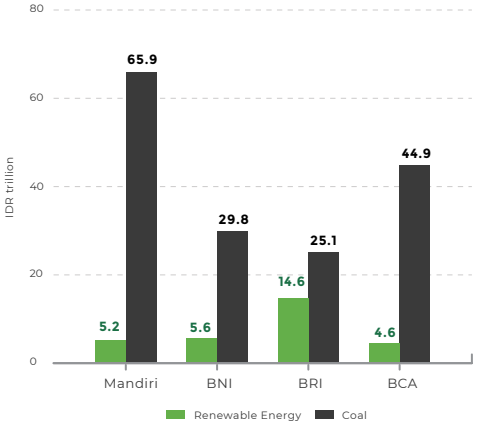
- The previous roadmap (2015–2021) has helped various financial institutions to understand sustainable finance principles and to identify numerous sustainable businesses. It has also helped in the development of incentive schemes and provided a series of training programs for the financial industry. Both roadmaps are critical to addressing the gaps between the financial and renewable energy sectors since the roadmaps provide knowledge and guidance to provide and/or access funding for renewable projects. However, the roadmaps have not provided any standardization, which could potentially increase ambiguity and discourage investors and businesses to participate in sustainable projects, including renewables.

- Compliance with the OJK's sustainable finance roadmap could enable entities such as energy companies to access financing from financial institutions that are unable to provide loans due to the development of fossil/conventional energy sources. PLN provides a notable example in which the SOE complied with the roadmap by releasing the Statement of Intent on Sustainable Financing Framework in 2020 which specified the PLN's implementation plan to support sustainable finance. The commitment is supported financially through a Green Loan of USD 500 million from MIGA for long-term RE financing and sustainable electricity infrastructure (Artanti, 2020). This is also considered to be the first green loan obtained by an Indonesian state-owned enterprise.

Local banks are progressing to finance renewable energy projects, but have been slow in moving away from fossil financing

- Indonesia's financial institutions are committed to supporting sustainable development, including financing renewable energy projects in the country. Currently, there are 13 banks joining the Indonesia sustainable finance initiative (IKBI).
- Of the 13 banks, Bank Mandiri, BCA, BRI, and BNI have been providing financial support towards renewable energy such as rooftop solar PV, mini-hydro, biomass, and biogas power plants. As of March–April 2021, Bank Mandiri, BCA, BRI, and BNI have disbursed IDR 5.2 trillion, IDR 4.6 trillion, IDR 14.6 trillion, and IDR 5.6 trillion of loans, respectively, to finance renewable energy projects.
- Despite the rise in renewable energy financing, commercial banks still disburse their credit on coal projects. Global Coal Exit List shows that for the period of October 2018 - October 2020, Bank Mandiri, BCA, BRI, and BNI have given a total of USD 8.8 billion (IDR 165.7 trillion) of loans and underwritings for coal in the 2 year period (Urgewald, 2021).
- Meanwhile, rooftop solar PV has started to gain financial support from commercial banks to contribute to the reduction of greenhouse gas emissions. As the leading national banks, both Bank Mandiri and BRI are collaborating with the national energy council (DEN) and PT. LEN in providing non-collateral credit with low-interest rates for the installation of rooftop solar PV for corporations and households (Setiawan, 2021). According to developers, prior to this collaboration, consumers have already been able to access credit facilities from various banks. However, there are only a few interests for this and early adopters tend to buy in cash.

Investment in coal vs renewable energy (Q1 2021)



Source: IESR calculation

USD 1 = IDR 14,233

Indonesia's Energy Transition Assessment

- Energy Transition Readiness Framework
- Highlight of 2020 Transition Readiness Framework

Dr. Handriyanti Diah Puspitarini

Julius Christian Adiatma

Transition readiness gets improved, although low ratings are still observed in political will and investment climate

- Continuing our work last year, this year, IESR assessed Indonesia's readiness to move away from fossil fuels and towards renewable energy-based energy systems in terms of regulatory, financial, techno-economic, and social aspects. Our assessment shows that some improvements can be seen in some aspects, although low ratings are still observed in some aspects such as the political commitment and investment climate aspects (Appendix A).
- The transition readiness framework (TRF) was assessed through: i) self-assessment based on available data, ii) surveys of stakeholders and the public, and iii) expert interviews. The assessment of each indicator was then translated into three ranks: low, medium, and high (more details in Appendix B).
- Comprehensive analyses of qualitative and quantitative data from policy and regulatory documents, press conferences, news, and webinars were carried out independently and validated by expert interviews.
- A survey was sent to stakeholders to assess their perspectives on Indonesia's energy transition readiness. As many as 13 developers and four banks operating in Indonesia participated in this survey. The results of this survey were used to complement the self-assessment (more details in Appendix C).
- To gauge public awareness and support for energy transition, an online survey was conducted to 1,000 respondents using organic sampling methodology without determining their backgrounds (age, job, and ethnicity). Survey questions and results are available in Appendix D.

Dimension	Political and Regulatory					Techno-Economic	
Variable	Political Will & Commitment			Regulatory Framework Quality		Power System Planning	Economic of Energy Transition
Indicator	Climate and energy policy alignment with Paris Agreement	Public finance allocation	Implementation of policy targets	The regulatory framework stability and attractiveness	Regulatory consistency between government bodies	Power system planning suitability with high RE	Cost competitiveness of renewable technology
Rating	Low	Low	Low	Medium	Medium	Medium	Medium

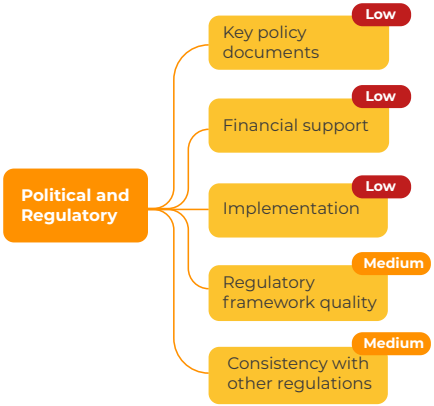
Dimension	Investment and Finance				Social	
Variable	Investment Climate for Renewable Energy Power Plant			Power Sector Investment Trend	Public awareness & acceptance	Human capital
Indicator	Investment risk	Ease of entry	Access to capital	Investment trend and sufficiency	Public awareness and support for renewables and coal phase-out	Integration of energy transition and employment policy
Rating	Medium	Low	Medium	Low	High	Medium

Policy and regulatory framework does not reflect a strong commitment to supporting decarbonization of the energy sector

- Climate ambition for the energy sector in the recently-updated NDC is still incompatible with the Paris Agreement. Climate Action Tracker (CAT) assessment on Indonesia's updated NDC (excluding land-use sector) indicates that the earth's temperature rise will exceed 4°C by 2100 if all countries follow Indonesia's target. Although the same assessment reveals that current energy policies will overachieve the NDC, it is still insufficient to keep the rise in temperature below 2°C.

- Even with such a low target, the government has been unsuccessful in putting necessary efforts to achieve the target. By Q3 2021, renewables capacity of 386 MW was nowhere near the government target of 1 GW as stated in the MEMR's Strategic Plan. In fact, for the past seven years, the government has not managed to achieve the renewable energy targets set in the plan.

- In terms of public fund allocation, the budget allocation in the national economic recovery program was evaluated. The Energy Policy Tracker (2021) found that the government allocated USD 6.5 billion for fossil energy, while only distributing USD 0.24 billion to clean energy. Another analysis from Climate Policy Initiative (2021) concluded that only 4% of the environmentally relevant economic stimulus in 2020 went into the green sector, while the rest was for dirty sectors (mostly energy).



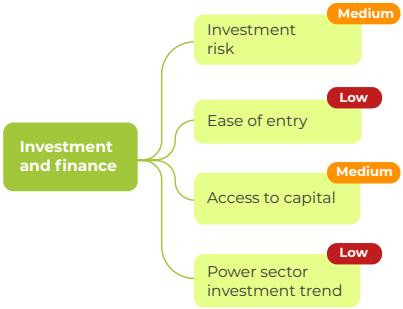
- Energy policies and regulations were evaluated in terms of their transparency, longevity, and consistency (TLC) -criteria for regulatory stability. Our assessment shows that the current regulatory framework is still unstable as PLN's RUPTL is updated almost every year, leading to frequent changes in the power system planning. It is also worth noting that apart from RUPTL, Indonesia also has some other policies and regulations that regulate the energy sector such as the state energy plan (RUEN) valid from 2017 to 2050 (34 years), regional energy plan (RUED) valid from 2020 to 2050 for most provinces (30 years), and LTS valid from 2021 to 2050 (30 years). Many stakeholders perceive that the policy-making process is oftentimes intransparent.

- Supporting regulations such as regulations on CFPP emission standards, energy efficiency, rural electrification, and RUED were identified as lacking. Specifically, emission standards for CFPP have not been enforced properly despite existing standards are still lower compared to global best practices.

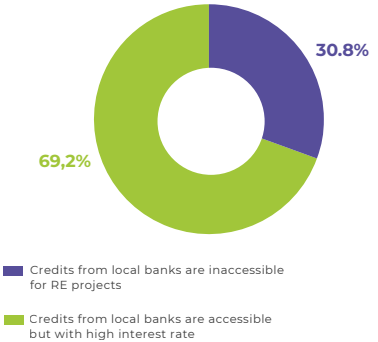
- Around 60% of developers surveyed considered the existing regulatory framework as unattractive. The rest thought otherwise but admitted that some regulations still need improvement. Most respondents perceived Regulation no. 50 and the long rule-making process of FiT as discouraging.

The investment climate is not improving, access to local finance is limited

- The investment climate in Indonesia is generally deemed by investors and other international organizations as unfavorable to renewable energy development. Indonesia was put in the repressed category in the Index of Economic Freedom 2021 as investment and market entry barriers were high in the country, making renewables investment difficult to take off. Meanwhile, in terms of investment risks, credit rating companies such as Moody's, S&P, Fitch, categorized Indonesia in medium investment grade.
- More than 90% of developers surveyed regarded the process of obtaining permits as time-consuming, leading to high transaction costs. Some developers cited that PLN's procurement mechanism needs to be improved as current rules and schedules of procurement and auction of renewables projects are both unclear and irregular. Around 70% of respondents also lamented about high loan interest rates offered by local banks, while the rest claimed that loans from local banks are often inaccessible. Lastly, around 85% of developers surveyed agreed that the current fiscal and financial support is still insufficient with most of them suggesting the government provide FiT, VGF, and soft loans to renewable projects.
- The investment trend of renewable energy is still not improving. By Q3 2021, renewables investment only accounted for USD 1.17 billion, an insignificant improvement from last year's figure. In contrast, investment in fossil fuel-based power plants doubled renewables investment at around USD 2.49 billion in the same period.
- Generally, financing institutions did not perceive renewables as a higher-risk investment than CFPP. Three out of five banks that responded to our survey agreed that investment risk of the two is comparable. Meanwhile, one bank considered CFPP investment to be riskier than renewables investment and another one thought otherwise.

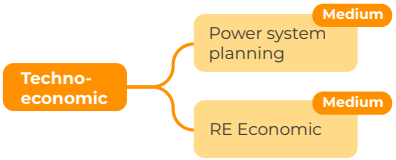


Stakeholders perspective on accessibility of credits from local banks

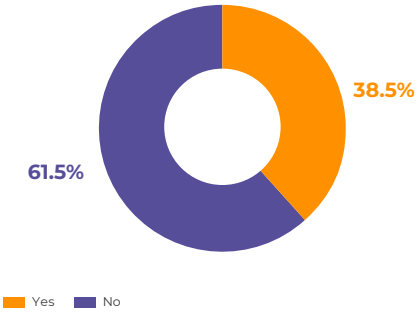


More renewable energy in system planning as renewables become cost-competitive

- The current power system planning is more accommodating for renewable energy with the share of renewables in the total capacity addition increasing from the previous RUPTL, accounting for 51.6% of planned capacity addition for the next ten years. Moreover, the new grid code has also taken into account a situation where penetration levels of VRE are high.
- The government recently announced its plan to stop building new CFPP (coal moratorium) and to retire all CFPP aged over 30 years old from 2030 onwards. Currently, the government is also setting up a plan to early-retire 9.2 GW of CFPP aged under 20 by 2030, providing more room for renewables in the power system.
- Renewable competitiveness has been increasing in recent years. Recently, a solar PV project bidding offered USD 0.04/kWh or lower than the average costs of coal generation at around USD 0.05-0.07/kWh. However, a combination of renewables plus storage still costs higher than coal generation although it is worth noting that costs of coal generation are artificially low as the government sets a coal price cap for power generation. If actual market prices are used at around USD 150/tonne (in September 2021), the costs of coal generation could reach USD 0.09-0.11/kWh.
- More than 60% of developers surveyed claimed that they had access to the least cost (mainly imported) technologies. However, most respondents lamented about insufficient local manufacturing capacity and subpar quality of locally manufactured renewable technologies that often lead to project unbankability. Moreover, it also revealed that some components are not available from local manufactures.



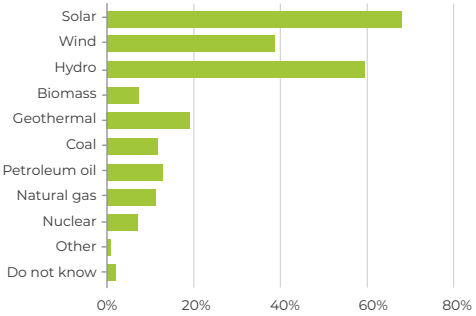
Stakeholders perspective on accessibility of best/least cost technology available

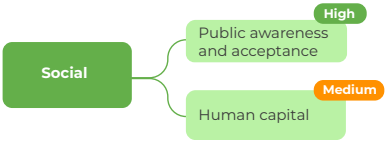


The energy transition gets support from the public, yet no strategy to prepare a workforce for the transition is in place

- Our online survey of 1000 Indonesians shows that a vast majority (80%) of respondents saw climate change as a (very) urgent problem to address, indicating a high awareness of climate change. However, only 31% thought that the government has responded to the problem (very) adequately.
- Most respondents picked solar (68%), hydropower (60%), and wind (39%) as energy sources that should be prioritized in power generation, suggesting high support for the energy transition. In contrast, only a few people thought that oil, gas, coal, and nuclear should be prioritized. Surprisingly, around 56% of respondents (strongly) agreed if Indonesia stops using coal to generate electricity.
- People were less supportive of an increase in electricity prices. Around 43% of respondents (strongly) disagreed with the implementation of surcharge on coal power generation, while the other 40% (strongly) agreed with such a measure. Furthermore, only 23% of respondents were willing to pay for more than a 5% increase in their electricity tariffs in support of the energy transition, around half of the respondents were only willing to pay up to a 5% increase, while the rest was not willing to pay at all.
- While the public seems eager to transition to renewable energy, the human capital might not be ready for it. The government has acknowledged the importance of a just transition in its climate policy documents. However, it is yet to establish a clear strategy on preparing the workforce for the transition, both in terms of supporting the affected workers in existing fossil industries and building the capacity of future workforce in low carbon industries.

Survey response to question: Which energy source do you think should be prioritized in Indonesian electricity generation?
(respondent could choose maximum 3 options)





Outlook

Dr. Handriyanti Diah Puspitarini

Julius Christian Adiatma

Pamela Simamora

Renewable energy is ready to flourish once the investment climate gets improved

- The year ahead promises a better prospect for the energy transition in Indonesia with the government setting up new, stronger commitments for climate action and energy transition in 2021. Major policies such as net-zero emission target, CFPP moratorium, and carbon price implementation set the positive tone for the energy transition in the years to come. As the time window to reach the 23% renewable energy mix target is getting shorter, concentrated government efforts must be deployed to meet this target.

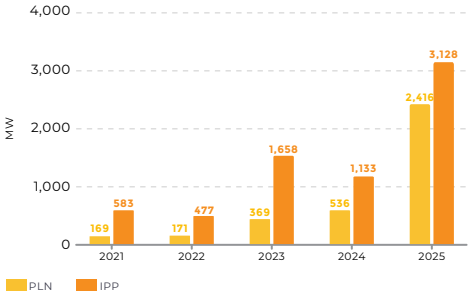
- As private sector participation is substantially needed, enhancing the quality and clarity of regulations is necessary to improve the investment climate. Highly anticipated regulations such as Presidential Regulation on Renewable Energy Tariffs, updated Government Regulation on Energy Conservation, and Renewable Energy Law expected to be issued next year along with the Presidential Regulation on CFPP retirement which is currently being discussed within the government will potentially improve the investment climate next year. Without major improvement in the investment climate, however, investors will likely take a wait-and-see approach and hold back from making any new investments.

- The implementation of the newly released RUPTL 2021 will also be crucial in setting a new milestone for the energy transition. An additional 10 GW of renewable energy-based power plants and 1,040 MWh of PHES systems are scheduled to come online by 2025, almost doubling the existing installed capacity. To meet the target in the most cost-effective way, PLN should roll out regular auctions for renewable energy projects at a scale that is large enough to help drive costs down.

- In addition, to improve the success rate of the auctions, the bankability of renewable projects needs to be improved. Previous experiences show that many of the PPA holders failed to obtain financing due to poor bankability. Renewable tariffs as well as better PPA terms are necessary for improving bankability. A more streamlined and timely permitting process and lower interest rates for project loans are also important factors to better the investment climate.

- Industrial capacity to produce renewable technologies needs to increase as developers still find local technologies costly or of poor quality, leading them to choose imported ones. For solar PV, in particular, a temporary LCR waiver for PV modules is essential to accelerate deployment as no manufacturers can comply with current regulations.

Planned new installation of renewables by PLN and IPP between 2021 and 2025



Source: RUPTL 2021-2030

Early coal retirement is pivotal to enable rapid energy transition, international support is key

- The current power system is highly occupied with fossil fuel-based power plants, mostly CFPPs, leading to a considerably high reserve margin (e.g. 59% in the Java-Bali grid). Moreover, while the government has decided to stop building CFPPs from 2028 onwards, there are still 14 GW of committed CFPP projects to be added in the next 10 years. Thus it is important for the government to plan for early retirement or cancellation of these CFPPs to provide more space for renewable energy addition. Other than GHG emission reduction, rapid renewable energy installation within this decade will help accelerate the renewable cost decline and prepare the workforce for the renewable-based power system in the future (Accenture, 2021).

- Among the 9.2 GW of CFPPs identified for the early retirement program through the ETM scheme, three CFPPs in Java and Sumatra with a total capacity of 1.77 GW were nominated for the early-retirement pilot project in 2022-2023 (ADB, 2021). The success of this pilot project will be a major milestone for Indonesia's energy transition agenda and influence the discussion of coal-phase out regulations.

- PLN's current plan targets retirement for CFPPs older than 30 years old to start after 2030, while about 7 GW will be over that age by 2030 (IEA, 2020). These plants are unlikely to be covered by the ETM scheme as they prefer plants aged between 6 to 15 years old. Government and PLN need to find other mechanisms to expedite the retirement plan for these CFPPs, especially since many of these plants are owned by PLN itself. There are 5 GW of the CFPPs project pipeline in RUPTL yet to start construction (mostly in Sumatra and Java-Bali systems). Canceling these projects could provide space for an additional 20 GW of solar PV capacity by 2030.

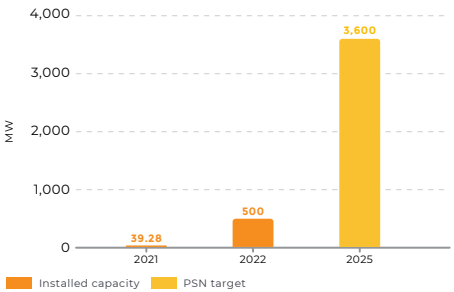
- The retirement and cancellation of these CFPPs will require a considerable amount of financial compensation. About USD 10 billion is needed for the early retirement of 9.2 GW under the ETM scheme. There is no estimation yet for the retirement of PLN's old CFPPs and the cancellation of the 5 GW projects. It is likely that next year, during the G20 summit, the government will demand more financial support from the international community, using the pilot project as a showcase. A plan for retirement and cancellation of these CFPPs along with the techno-financial estimation could help amplify the government's commitment to transition away from coal and attract more international financial support.

- In addition, the success of carbon pricing implementation for CFPPs in April 2022 will send a strong market signal to investors on Indonesia's commitment to the energy transition. This, alongside an improved climate for renewable energy investment, will attract more investment in renewable energy. This will also force fossil energy companies to innovate through efficiency improvements, fuel mixing, or diversification to renewable energy businesses to avoid penalties.

Sub-national governments, businesses, and citizens could assist in the acceleration of the energy transition, particularly through rooftop solar PV deployment

- Sub-national governments, the private industry, and homeowners could help boost demand for renewable energy next year. Rooftop solar PV deployment is one of the most effective ways that these actors could contribute. The government has set the target for 3.6 GW of rooftop solar PV installation by 2025. The rooftop solar PV installed capacity is projected to reach about 500 MW next year. In addition, about 300 MW of utility scale solar PV is expected to be installed by mining companies for their own use.
- Provinces such as Jakarta and Central Java have both allocated government budgets for rooftop solar PV installation in 2022. Meanwhile, other provinces such as Jambi, West Java, and West Nusa Tenggara will likely follow suit with discussion on this topic having taken place in 2021.
- More companies and households will install rooftop solar PV in 2022, especially once the improved net metering scheme becomes effective early next year. More local companies, as shown in our survey, recognize the importance of achieving net-zero emissions and are currently considering setting their net-zero target. Rooftop solar PV installation is one of the quickest measures that can be taken by companies to reduce their scope 1 and 2 emissions.

Installed capacity of rooftop solar PV in 2021-2022 compared to PSN target



Source: MEMR, IESR analysis. Note: Value for 2022 is predicted based on the current data documented by AESI

- Other than rooftop solar PV, businesses and individuals could also contribute to energy transition through energy efficiency measures. If enforced properly, the implementation of the new regulation on energy conservation has the potential to drive more businesses (industry and commercial consumers) to take energy efficiency measures.
- While the implementation of a carbon tax for wider participants is not expected for the next three years, businesses will likely start planning for emission reduction measures to avoid additional costs in the future.
- In addition, it is also expected that more energy transition projects will be rolled out in various locations hosting G20 meetings next year as a showcase to the world's leaders of Indonesia's commitment to the energy transition. These projects include, for example, renewable energy installations and electric vehicle deployment.

More electric two-wheelers to be deployed; the biofuel program stagnates with B30 due to its economics

- In the transportation sector, the reduction of fuel imports becomes the main policy focus of the government. This is achieved mainly through increased use of electric vehicles and biofuels as well as by building new oil refineries.
- More electric two-wheelers adoption should be expected from the ride-hailing services as they started establishing partnerships with and investing in electric two-wheelers manufacturers. From these companies alone, there will be at least an addition of 25 thousand electric motorcycles on the road next year. Moreover, more electric vehicle models will enter the Indonesian market both for two-wheelers and four-wheelers, providing consumers with more choices. While this might induce increased uptake by individual consumers in the two-wheelers segment, high prices will remain the main barrier for EV penetration in the car segment.
- After planning to ban conventional motorcycles by 2040 and cars by 2050, the government is also considering imposing a carbon tax on the transportation sector along with oil and gas refineries. If this plan becomes an official regulation, more investment in electric vehicles manufacturing and supply chain can be expected in upcoming years.
- In the biofuel segment, the government is looking to increase the blending ratio of biodiesel to B40. With biodiesel (FAME) production capacity increasing and production of green diesel (HVO) being insignificant until 2024, a B40 program with 40% FAME will become an attractive option. The government is planning to road-test a 40% FAME blending next year. Nevertheless, if high CPO prices persist, the government is unlikely to proceed with its B40 program, particularly as diesel imports are no longer an issue. Moreover, regulatory issues such as mandatory biofuel targets, product quality standards, and incentive schemes also need to be addressed before expanding the blending rate.
- Gasoline imports, on the other hand, are still a major issue but the government is yet to find a solution. Bioethanol blending to gasoline is still hindered by high production costs and the unavailability of fund sources for subsidies/incentive schemes. Since bioethanol has high octane number, there is a proposal from ITB to sell a 5% bioethanol - 95% Pertalite (RON 90 gasoline) as RON 92 gasoline. This blend costs lower than the market prices of RON 92 gasoline. While this proposal seems attractive to kickstart bioethanol deployment, it is unlikely to be executed as Pertamina claimed that the market price of RON 90 gasoline is lower than the actual costs. However, the actual price gap between the cost of RON 90 and RON 92 production is unclear.

References

Deep Decarbonization of Indonesia's Energy System

IESR, Agora Energiewende & LUT University. 2021. *Deep decarbonization of Indonesia's energy system: A pathway to zero emissions by 2050.* Institute for Essential Services Reform (IESR). URL.

Energy Sector Overview

Fajardy, M., Morris, J., Gurgel, A., Herzog, H., Mac Dowell, N. & Paltsev, S. 2021. *The economic of bioenergy with carbon capture and storage (BECCS) deployment in a 1.5 0C or 2 0C world.* Global Environmental Change, 68, 102262. URL.

Ferrari, N., Mancuso, L., Brunard, K., & Consonni F. 2019. *Effects of plant location on cost of CO2 capture.* International Journal of Greenhouse Gas Control, 90, 102783. URL.

Howarth, R.W. & Jacobson, M.Z. 2021. *How green is blue hydrogen?.* Energy Science and Engineering, 9(10), 1676-1687. URL.

IEA. 2021. *Carbon Capture, Utilisation and Storage: The Opportunity in Southeast Asia.* URL.

MEMR. 2021. *Kebijakan dan Rencana Pencapaian Target NDC Sektor Energi 2030. Directorate General of New, Renewable Energy, and Energy Conservation (DGNREEC).* MEMR.

McCulloch, S. 2021. *Opportunities for CCUS in Southeast Asia.* Head of CCUS Unit.International Energy Agency (IEA).

OCGI. 2021. *CO2 Storage Resource Catalogue updated.* URL.

Tramošljika, B., Blecich, P., Bonefačić, I., & Glažar, V. 2021. *Advanced Ultra-Supercritical Coal-Fired Power Plant with Post-Combustion Carbon Capture: Analysis of Electricity Penalty and CO2 Emission Reduction.* Sustainability, 13(2), 801. MDPI AG. URL.

World Bank. 2015. *The Indonesia Carbon Capture Storage (CCS) Capacity Building Program:CCS for Coal-fired Power Plants in Indonesia.* URL.

World Bank. 2021. *Commodity Markets.* URL.

Energy Transition in Fossil Energy

ADB. 2019. *Carbon Dioxide-Enhanced Oil Recovery in Indonesia: An Assessment of its Role in a Carbon Capture and Storage Pathway.* ADB. URL.

IEA. (2021). *World Energy Outlook 2021.* IEA. URL.

IRENA. 2021, January. *Innovation Outlook: Renewable Methanol.* URL.

Kajaste, R., Hurme, M., & Oinas, P. 2018. *Methanol-Managing greenhouse gas emissions in the production chain by optimizing the resource base.* AIMS Energy, 6(6), 1074-1102. URL.

SKK Migas. 2021, October. *Kinerja Hulu Migas Kuartal III Tahun 2021.* Buletin BUMI October 2021. URL.

SKK Migas. 2020, December. *Towards 1 Million BOPD & 12 BSCFD in 2030: Through massive, aggressive, and efficient activities.* URL.

Energy Transition in the Power Sector

ADB. 2020. *Renewable Energy Tariffs and Incentives in Indonesia: Review and Recommendations.* URL.

ADB. 2021a. *Energy Transition Mechanism Explainer: How ETM Will Support Climate Action in Southeast Asia.* Asian Development Bank. URL.

ADB. 2021b. *Japan Announces $25 Million for ADB-Led Energy Transition Mechanism in Southeast Asia.* Asian Development Bank. URL.

Agung, Filemon. 2021. *PLN mulai menawarkan 21 proyek energi baru terbarukan (EBT) pada tahun 2022.* Kontan. URL.

ASPI. 2021. *Dialogue Meeting on ETS Allocation-Meeting Summary.* URL.

Colthorpe, Andy. 2020. *Behind the numbers: The rapidly falling LCOE of battery storage.* Energy Storage News. URL.

CNNC. 2019. *Opportunities and Challenges in SMR and its Practice in ACP100.* China National Nuclear Corporation. URL.

EIA. 2021. *Levelized Costs of New Generation Resources in the Annual Energy Outlook 2021.* Energy Information Administration. URL.

Greenpeace. 2020. *Co-firing PLTU Batu Bara: Solusi Semu Emisi Gas Rumah Kaca.* URL.

IEA. 2021. *Net Zero by 2050 - A Roadmap for the Global Energy Sector.* International Energy Agency. URL.

IEEFA. 2021. *Indonesia's Biomass Cofiring Bet Beware of the Implementation Risks.* URL.

IESR, Agora Energiewende & LUT University. 2021. *Deep decarbonization of Indonesia's energy system: A pathway to zero emissions by 2050.* Institute for Essential Services Reform (IESR). URL.

Julian, Muhammad. 2021. *Hingga September 2021, realisasi investasi di sub sektor EBTKE mencapai US$ 1,12 Milliar.* Kontan. URL.

Kanak, Donald P. 2021. *How to accelerate the energy transition in developing economies.* World Economic Forum. URL.

References

Kompas. 2021. *PLN akan Bangun Pembangkit EBT Setelah Program 35.000 MW Selesai.* Kompas. URL.

MEMR. 2021a. *Rencana Co-firing pada PLTU.* URL.

MEMR. 2021b. *Press Conference on Quarter III 2021 Performance Achievements and Current Issues in the Electricity Subsector.* URL.

MEMR. 2021c. *Press Conference on Quarter III 2021 Performance Achievements and Current Issues in the New and Renewable Energy and Energy Conservation Subsector.* URL.

Nicholas Institute for Environmental Energy Solutions. *Cap and Trade FAQs.* Duke University. URL.

PLN. 2021a. *Rapat Dengar Pendapat Komisi VII DPR RI dengan PT PLN (Persero).* Perusahaan Listrik Negara.

PLN. 2021b. *PLN's electricity supply business plan (RUPTL) 2021–2030.* URL.

PWC. 2018. *Power In Indonesia Investment and Taxation Guide November 2018, 6th Edition.* URL.

Ridwan, Muhammad. 2020. *Bagaimana Ceritanya Konversi 200 PLTD PLN Perlu Dana Rp100 Triliun?.* Bisnis. URL.

Schneider, Mycle; Frogatt, Antony. 2021. *The World Nuclear Industry Status Report 2021.*

Sulistiyono, Seno T. 2021. *RI Bisa 100 Persen Terapkan Energi Terbarukan di 2050 Jika PLTU Distop Lebih Dini.* Tribun Bisnis. URL.

Tachev, Viktor. 2021. *ETA Special Report: 2021 Investment Risks of Coal Investment in a Carbon Neutrality-Seeking World.* Energy Tracker Asia.

Wing, Ian Sue, Ellerman, A. Danny, & Song, Jaemin. 2006. *Absolute vs. Intensity Limits for CO2 Emission Control: Performance Under Uncertainty.* URL.

Progress in Solar Power

Bappenas. 2021. *Green Recovery Roadmap Indonesia 2021 -2024: Building Back Better Low Carbon Development Post-COVID 19.* URL.

Bernreuter Research. 2020. *Solar value chain.* URL.

Bloomberg. 2021. *Secrecy and abuse claims haunt China's solar factories in Xinjiang.* URL.

BloombergNEF. 2021. *Solar PV Trade and Manufacturing: A Deep Dive.* URL.

BloombergNEF, IESR, and Bloomberg Philanthropies. 2021. Scaling Up Solar in Indonesia: Reform and opportunity. URL.

EMA. 2021. *First Request for Proposal (RFP1) to appoint licensed electricity importers (for delivery by 2027).* URL.

Fraunhofer ISE. 2021. *Photovoltaics report (July 27, 2021 version).* URL.

IESR. 2021a. *Hitting-Record Low Solar Electricity Prices in Indonesia.* URL.

IESR. 2021b. *PLTS Terapung sebagai Kunci Akselerasi Pengembangan Tenaga Surya Skala Besar di Indonesia.* URL.

IESR, Agora Energiewende & LUT University. 2021. *Deep decarbonization of Indonesia's energy system: A pathway to zero emissions by 2050.* Institute for Essential Services Reform (IESR). URL.

MEMR. 2020. *Handbook of Energy Economics and Statistics of Indonesia (HESSI) 2020.* URL.

PLN. 2021. *PLN's electricity supply business plan (RUPTL) 2021–2030.* URL.

VDMA. 2021. *International Technology Roadmap for Photovoltaic (ITRPV) 2020 Results (12th edition, April 2021).* URL.

Progress in Energy Storage

BloombergNEF. 2020. *Battery Pack Prices Cited Below $100/kWh for the First Time in 2020, While Market Average Sits at $137/kWh.* URL.

Data Bridge Market Research. 2020. *Battery Management System Market – Global Industry Trends and Forecast to 2027.* Data Bridge Market Research. URL.

IESR. 2021. *Beyond 443 GW: Indonesia's infinite renewable energy potentials.* Institute for Essential Services Reform (IESR). URL.

IESR, Agora Energiewende & LUT University. 2021. *Deep decarbonization of Indonesia's energy system: A pathway to zero emissions by 2050. Institute for Essential Services Reform (IESR).* URL.

Indonesia Battery Corporation. 2021. *Indonesia Battery Corporation Plan For the Development of Battery Energy Storage System.* The 4th Episode of MKI Smart Grid Webinar Series : "Unlocking New Business with Battery Energy Storage System."

MEMR. 2021. *Technology Data for the Indonesian Power Sector: Catalogue for Generation and Storage of Electricity*

P&S Intelligence. 2021. *Battery Management System Market Trends & Forecast By 2030.* P&S Intelligence. URL.

Schmidt, O., Melchior, S., Hawkes, A., & Staffell, I. 2019. *Projecting the Future Levelized Cost of Electricity Storage Technologies.* Joule, 3(1), 81–100. URL.

Transparency Market Research. 2019. *Battery Management System Market 2027.* Scope, Size, Share, Trends, Forecast. URL.

References

Stocks, M., Stocks, R., Lu, B., Cheng, C., & Blakers, A. 2021. *Global Atlas of Closed-Loop Pumped Hydro Energy Storage.* Joule, 5(1), 270–284. URL.

Progress in Electric Vehicles

BKPM. (n.d.). *Indonesia Battery Cell Industry - Electric Vehicle Battery Cell Factory in Indonesia.* URL.

Capagnon, N. et al. 2017. *The Future of Nickel: A Class Act.* URL.

Deloitte. 2021. *Full speed ahead Supercharging electric mobility in Southeast Asia.* URL.

Evans, K. & Sebastian, E. 2021. *Electric vehicles: powering Indonesia's next industrial growth.* Melbourne: The Australia-Indonesia Centre. URL.

Gaikindo. 2021a. Industri Nasional Perlu Transisi Menuju Mobil Listrik. URL.

Gaikindo. 2021b. Harga dan Infrastruktur Jadi Tantangan Mobil Listrik Indonesia. URL.

Halim, F. & Prasteya, M. 2021, September 20. China Segera Groundbreaking Pabrik Baterai Kendaraan Listrik di RI. URL.

IEA. 2021. Global EV Outlook 2021. URL. *IESR, Agora Energiewende & LUT University.* URL.

IESR, Agora Energiewende & LUT University. 2021. *Deep decarbonization of Indonesia's energy system: A pathway to zero emissions by 2050.* Institute for Essential Services Reform (IESR). URL.

IESR. 2021. *Indonesia Energy Transition Outlook 2021: Tracking Progress of Energy Transition in Indonesia.* Institute for Essential Services Reform (IESR). URL.

Ipsos. 2016. *Opportunities And Challenges In Indonesia's Automotive Industry.* URL.

MEMR. 2021. *187 SPKLU Siap Layani Kendaraan Listrik, Ini Sebarannya.* URL.

MEMR. 2021. *Peraturan Menteri Esdm Nomor 13 Tahun 2020 Tentang Penyediaan Infrastruktur Pengisian Listrik Untuk Kendaraan Bermotor Listrik Berbasis Baterai.* URL.

Ministry of Industry. 2021. *Investment of Electric Vehicles in Indonesia.* Webinar.

Ministry of Industry. 2021, July 30. *Webinar Internasional Kendaraan Listrik Yang Berkeselamatan "Safer Electric Vehicles".* Webinar.

Ministry of Industry. 2021, February 18. Pemerintah Akselerasi Pengembangan Industri Kendaraan Listrik Dalam Negeri. URL.

Purnama, R. 2021, March 31. *Dorong Mobil Listrik, Toyota Bikin Ekosistem di Bali.* URL.

Pwc. 2015. Riding Southeast Asia's automotive highway. URL.

Progress in Clean Fuels

Hydrogen Council & McKinsey & Company. 2021. *Hydrogen Insights: A perspective on hydrogen investment, market development and cost competitiveness.* URL.

IESR, Agora Energiewende & LUT University. 2021. *Deep decarbonization of Indonesia's energy system: A pathway to zero emissions by 2050.* Institute for Essential Services Reform (IESR). URL.

Madani Berkelanjutan. 2021. *Mengoptimalkan perlindungan hutan alam dan ekosistem gambut pasca-moratorium sawit untuk mencapai komitmen iklim Indonesia.* Yayasan Madani Berkelanjutan. URL.

Sukardi, R. and Brata, W.A. 2021. *Biomethane Utilization from Palm Oil Mill Effluent.* GIZ GmbH.

USDA. 2021. *European Union Biofuels Annual 2021.* URL.

USDA. 2021b. *China Biofuels Annual 2021.* URL.

Progress in Energy Efficiency

Letschert, Virginie E., Sarah K. Price, Ambereen Shaffie, Won Young Park, Nihan Karali, Nikit Abhyankar, Nihar Shah, and Ari Darmawan Pasek. *Accelerating the Transition to More Energy Efficient Air Conditioners in Indonesia., 2020.* URL.

Handbook of Energy and Economic Statistics of Indonesia 2020. URL.

Energy Transition in Subnational Level

Bappenas. 2021. *Peta Jalan Ekonomi Kerthi Bali Menuju Bali Era Baru: Hijau, Tangguh dan Sejahtera.*

Government of Bali. 2020. *Peraturan Daerah Provinsi Bali Nomor 9 Tahun 2020 tentang Rencana Umum Energi Daerah Provinsi Bali Tahun 2020-2050.* URL.

IESR. 2019. *Residential Rooftop Solar Potential in 34 Provinces in Indonesia. Institute for Essential Services Reform (IESR).* URL.

IESR. 2021a. *Beyond 207: Gigawatts: Unleashing Indonesia's Solar Potential. I nstitute for Essential Services Reform (IESR).* URL.

IESR. 2021b. *Beyond 443 GW: Indonesia's infinite renewable energy potentials. Institute for Essential Services Reform (IESR).* URL.

References

IESR. 2021c. *Potensi Teknis Pembangkit Listrik Tenaga Surya Terapung di Jawa Tengah. Institute for Essential Services Reform (IESR).* URL.

IESR. 2021d. *Kajian Pengembangan Investasi PLTS Terapung 2021.* unpublished.

PLN. 2021. *PLN's electricity supply business plan (RUPTL) 2021–2030.* URL.

Setiawan, V. F. 2021, November 18. *DEN Sebut 22 Provinsi Mempunyai Rencana Energi, Tak Termasuk Jakarta. Katadata.* URL.

Financing Decarbonization of Energy System

Agung, F. 2021, July 14. *Climate Policy Initiative soroti potensi pembiayaan EBT lewat obligasi hijau daerah.* Kontan. URL.

Anggraeni, R. 2021, March 30. *11 PEMDA Ikut Uji Coba regional climate budget tagging.* URL.

Artanti, A. A. 2020, December 28. *PLN Dapat Green loan USD500 Juta Dari Anggota Grup Bank Dunia.* URL.

Asen, E. 2021, June 3. *Carbon taxes in Europe.* Tax Foundation. URL.

Bery, A. 2019, June 26. *Blended finance – the key to financing clean energy in Asia? Convergence.* URL.

Evans, D. 2021, November 4. *ADB, Indonesia, Philippines, team up to replace coal with cleaner power.* Energy voice. URL.

Fajria, H. 2021. *Sri Mulyani: Strengthen State Budget Stimulus, Maintain Recovery Sentiment, Encourage Economic Growth.* Depok: Fakultas Ekonomi dan Bisnis, Universitas Indonesia.

Global Environment Facility (GEF). 2021. Projects. URL.

IESR. 2021. *Hitting record-low solar electricity prices in Indonesia.* URL.

IESR, Agora Energiewende & LUT University. 2021. *Deep decarbonization of Indonesia's energy system: A pathway to zero emissions by 2050.* Institute for Essential Services Reform (IESR). URL.

Intan, N., & Pratiwi, F. 2021, June 11. *Daerah Didorong ikuti program regional climate budget.* Republika Online. URL.

Kusuma, B. W. 2021, November 11. Kompas. URL.

Ministry of Finance. 2021. *Green Sukuk Allocation and Impact Report May 2021.* URL.

Ministry of Finance. 2020. *Laporan Anggaran Mitigasi Dan Adaptasi Perubahan Iklim Tahun 2018-2020.* URL.

OECD. 2021. *Clean Energy Finance and Investment Policy Review of Indonesia.* URL.

Setiawan, O. V. N. 2021, August 27. *Pasang plts ATAP masih mahal, Pemerintah upayakan bisa kredit bank.* URL.

UNDP. 2017, July 19. Indonesia's national zakat body extends first contribution to support sdgs. UNDP in Indonesia. URL.

UNDP.2019. *Climate Change Knowing what you Spend: A guidance note for Governments to track climate finance in their budgets.*

UN PAGE. 2021. *Green Stimulus Package for National Economic Recovery Energy Sector.* UN PAGE.

Wijaya, M. E., Hong, J. H., M. Z., Mecca, B. M., Haesra, A. R., K. K., . . . S. U. 2021. *Leveraging fiscal stimulus to improve energy transition: Case of South Korea and Indonesia.* Jakarta: Climate Policy Initiative.

Urgewald. 2021. *Global Coal Exit List.* Finance Data. URL.

Xu, S. 2021, July 16. *Singapore Says S$5 Carbon Tax 'A Start' as It Eyes Higher Levy.* Bloomberg. URL.

Yanwardhana, E. 2021, October 4. *Pemerintah Ngebor Panas Bumi, Biaya Investor Bisa Turun 60%.* CNBC Indonesia. URL.

Transition Readiness Framework

Climate Action Tracker. 2021. *Indonesia Country Summary.* URL.

Climate Policy Initiative. 2021. *Improving the impact of fiscal stimulus in Asia: An analysis of green recovery investments and opportunities.*

Energy Policy Tracker. 2021. *Indonesia.* URL.

IESR, Agora Energiewende & LUT University. 2021. *Deep decarbonization of Indonesia's energy system: A pathway to zero emissions by 2050.* Institute for Essential Services Reform (IESR). URL.

Outlook

Accenture. 2021. *System Value Analysis Indonesia.*

ADB. 2021. *Regional: Opportunities to Accelerate Coal to Clean Power Transition in Selected Southeast Asian Developing Member Countries.* URL.

IEA. (2020). *Attracting private investment to fund sustainable recoveries: The case of Indonesia's power sector.* International Energy Agency.

Appendix A - Comparison between Transition Readiness Framework in 2020 and 2021

Dimension	Political and Regulatory					Techno-Economic	
Variable	Political Will & Commitment			Regulatory Framework Quality		Power System Planning	Economic of Energy Transition
Indicator	Climate and energy policy alignment with Paris Agreement	Public finance allocation	Implementation of policy targets	The regulatory framework stability and attractiveness	Regulatory consistency between government bodies	Power system planning suitability with high RE	Cost competitiveness of renewable technology
Rating in 2021	Low	Low	Low	Medium	Medium	Medium	Medium
Rating in 2020	Low	Low	Low	Low	Low	Low	Low

Dimension	Investment and Finance				Social	
Variable	Investment Climate for Renewable Energy Power Plant			Power Sector Investment Trend	Public awareness & acceptance	Human capital
Indicator	Investment risk	Ease of entry	Access to capital	Investment trend and sufficiency	Public awareness and support for renewables and coal phase-out	Integration of energy transition and employment policy
Rating in 2021	Medium	Low	Medium	Low	High	Medium
Rating in 2020	Medium	Low	Medium	Low	N/A	Low

Appendix B - Energy Transition Readiness Framework (1)

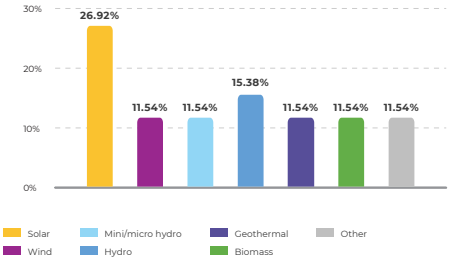
Dimension (s)	Variable (s)	Indicator	Key points to assess indicators	Assessment methodology	Source of data	Low	High
POLITICAL AND REGULATORY	Political will/ commitment	Key policy documents clearly stated the target to transition the energy/power system towards a low-carbon energy/power system that is aligned with the Paris Agreement	1. NDC target 2. KEN/RUEN 3. RPJMN/RPJPN 4. LTS 5. Grand energy strategy	Self-assessment	- NDC document - Climate Action Tracker - KEN/RUEN - RPJMN/RPJPN - LTS document - Grand energy strategy	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	Amount & percentage of public finance allocated for supporting the climate change and energy transition	- Self-assessment - Survey to RE developers	- Public finance 2021 - MEMR budget - Secondary data from news and webinars - Survey results	Total public finance allocated for RE is lower than fossil fuel (>10%)	Total public finance allocated for renewable energy is higher than fossil fuel
		Implementation of energy transition targets/plans	Government achievement in 2021 aligning with decarbonization targets in power sector	Self-assessment	- Directorate general of electricity quarterly report - Secondary data from news and webinars	Renewable installed capacity addition less than RPJMN target	Renewable installed capacity addition exceed the RPJMN target
	Regulatory framework quality	The existing regulatory support has accelerated RE deployment	1. Annual regulation stability assessment 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 constanly changing and viewed by stakeholders as a barrier	The regulatory framework in the power sector is stable (following transparency, lonevity, and certainty criteria) and able to attract investment
		The consistency between various government bodies regulations related to the deep decarbonizatoin in power system	1. Air quality regulations 2. Energy efficiency regulations Green building regulations 3. Rural electrification 4. regulations Availability of energy 5. transition supportive from sub-national level	Self-assessment	- Air quality regulations - Energy efficiency regulations - Green building regulations - Rural electrification regulations - RUED from 21 provinces	Other related regulations (e.g. regulations of air quality, energy efficiency, green building, 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, green building, rural electrification, and RUED) are in line with efforts to decarbonize the power sector
INVESTMENT AND FINANCE	Investment climate (for RE power plant)	Investment risk	1. Country credit ratings and risk premium 2. Availability of derisking instruments	- Self-assessment - Survey to financing institutions	- S&P, Fitch, Moody's, PWC country risk premia - Survey 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
		Ease of 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
	Power sector investment trend	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
		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	Self-assessment	- Secondary data from news and webinars - MoEF and MEMR press releases	Investment level is similar as previous year and insufficient to support power sector decarbonization and achieve the Paris Agreement target	Investment level is keep increasing and sufficient to support power sector decarbonization and achieve the Paris Agreement target

Appendix B - Energy Transition Readiness Framework (2)

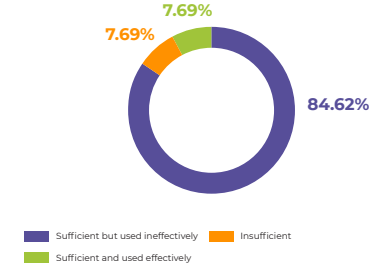
Dimension (s)	Variable (s)	Indicator	Key points to assess indicators	Assessment methodology	Source of data	Low	High
TECHNO/ ECONOMIC	Power System Planning	The power system planning with high RE integration	1. Planned installed capacity of RE plants compared to fossil fuel plants 2. Updated grid code and must run status for RE power plants	- 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 - 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
	Economics of energy transitios	Cost competitiveness of renewable technology	RE tariff compared to fossil fuel	- Expert interview - Survey to RE developers	Interview and survey results	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
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	Interview and survey results	The government has no specific strategy for green skills development	Integration of green skills development into government programs
		Capacity of human resources	Availability of potential workers, education (or human development index atau parameter umum human capital lain)	Self-assessment	- Ministry of labor and Ministry of Education, Culture, Research, and Technology reports - Central Bureau of Statistics data - ASEAN reports - OECD reports - World Economic Forum report	Population graduateed from tertiary school is below the averaged number of ASEAN countries (36%)	Population gradauted from secondary school, similar as OECD countries for people at the age of 25-34 years old (almost 45%)

Appendix C - RE developers' perception survey results (1)

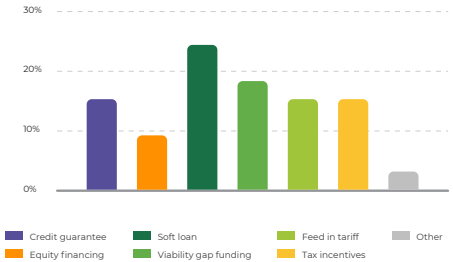
What is your core business?



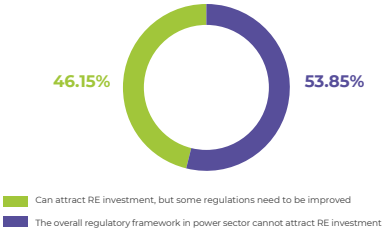
Do you think the government provides sufficient financial and fiscal support for power system transition/decarbonization?



What kind of financial/fiscal support do you think needs to be increased to accelerate energy transition in power sector?



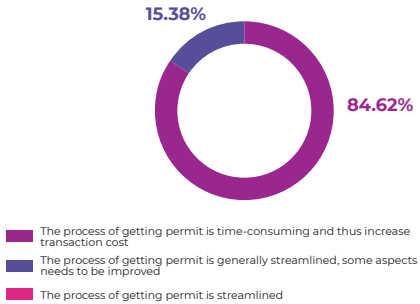
Do you think the existing regulatory framework in the power sector creates an attractive investment climate for renewable energy?



Appendix C - RE developers' perception survey results (2)

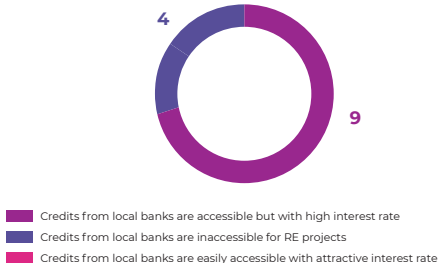
Which regulations need to be improved to attract more investment in renewable energy?
Accelerate NRE Law
Accelerate Development (REBID & REBED)
Government Reg in Energy Efficiency & Conservation
Regulations on FiT and simple PPA
The administrative coordination between Ministries, SOEs, central and local authorities
MEMR regulation 50/2017
Low visibility and centainty in procurement process
Feed in Tariff and incentives regulations
MEMR regulation 04/2020
Regulations that provide opportunities for the lower middle class to be able to install affordable PV mini-grid in the financing sector

How do you view the bureaucracy process in getting permits for RE deployment?



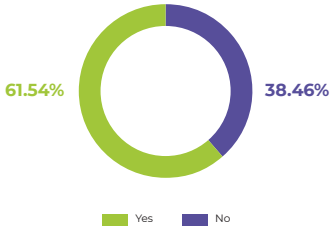
What needs to be improved in the process of getting permits for RE projects?
Streamline permitting process, one door policy or two doors policy
Online single submission
The division between central and local government since all regions have their own characters
If the procurement is held by the government (e.g. ESDM), after announcing is a winner, it is always 'assigned' to PLN
OSS system that continues to be improved, the reduction of permits that are 'technical recommendations' from the relevant agencies
Environmental Impact Analysis (AMDAL)
Ease, speed, simplicity, and certainty in all process
Commitment to grant permission based on the timeframe in the regulations
Procurement Process at PLN
Regulations on cross subsidies for the lower-middle class population
One stop service
The process at the regional PLN to start the discussion on all RE projects
Clear coordination between the central and the regional government

How do you view the access to credit from local banks for RE projects?



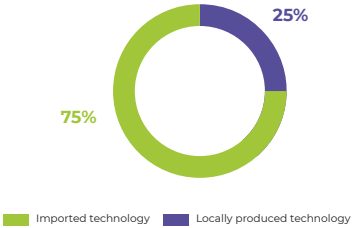
Appendix C - RE developers' perception survey results (3)

Do you think you are able to use RE technology with the most competitive cost in your projects in Indonesia?



If no, why?
GoI gives reliable RE potential survey
Tax holiday for 8 years
Free import duty
VAT, or PPN, for imported goods or raw materials to prepare equipment in Indonesia
GoI provides land or land for lease
Accelerate permitting process and other incentives to reduce the economic pricing
Yes, for indonesia, no compared to the rest of the world
Licensing fees
Land acquisition
Social issues
CAPEX is higher than global value so the price in unattractive
Low IRR
Government regulations still have not massively helped the development of PV mini-grid in the community

If yes, what technology do you use?



How do you think about the local manufacturer's RE production capacity and product quality?

Appendix D - Public's perception survey results (1)

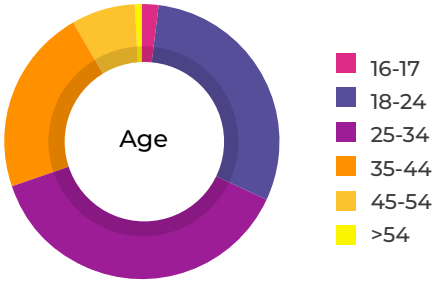
Total number of respondents

1000

Sex

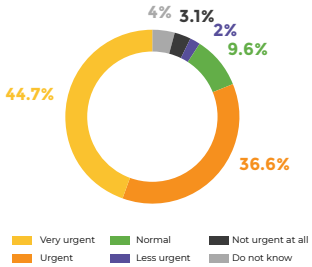
Male **43.2%**

Female **56.8%**

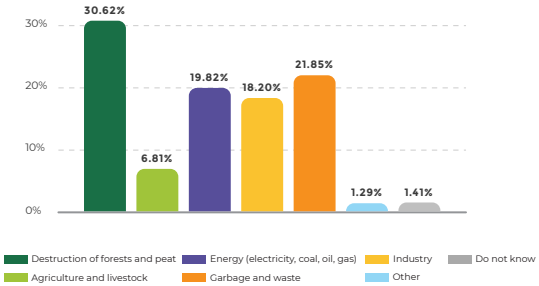


Appendix D - Public's perception survey results (2)

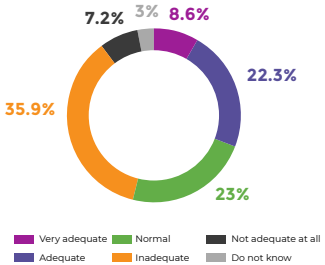
In your opinion, is climate change/global warming an urgent problem to solve?



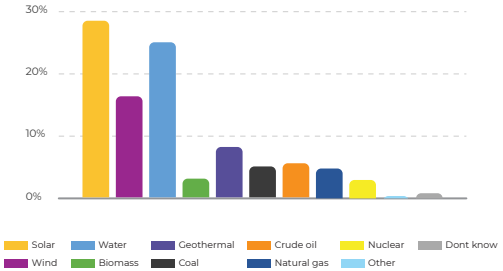
In your opinion, in Indonesia, which sectors contribute to climate change/global warming?



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

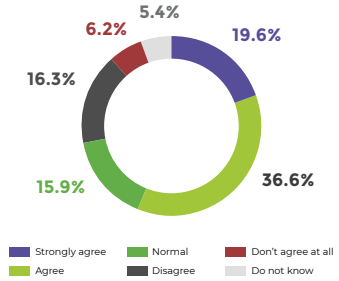


In your opinion, what energy sources should be prioritized in electricity generation in Indonesia?

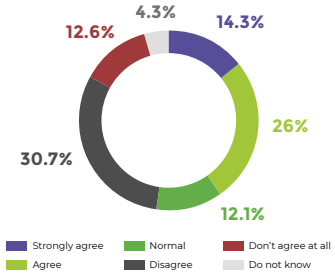


Appendix D - Public's perception survey results (3)

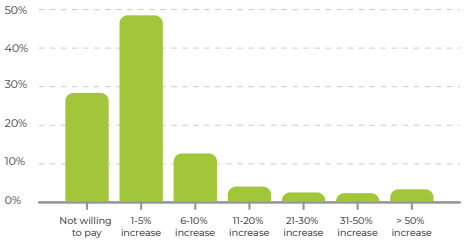
Do you agree that Indonesia will stop using coal for electricity generation?



Do you agree that electricity generated from coal is subject to additional taxes, which could result in an increase in electricity prices?



How much are you willing to pay for additional electricity costs to speed up the transition from fossil energy to renewable energy?



IESR
Institute for Essential Services Reform

Jalan Tebet Barat Dalam VIII No. 20
Jakarta Selatan 1280 | Indonesia
T: +62 21 2232 3069
F: +62 21 8317 073

iesr.id iesr
www.iesr.or.id