Navigating Indonesia's Power System Decarbonisation with the Indonesia Just Energy Transition Partnership

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Abstract

Indonesia is one of the fastest growing economies in the world and with its rapidly growing energy demand, abundant energy and mineral resources, it is set to play a key role in the global economic and energy landscape. Decarbonising its power system has been identified as a key enabler to achieve its pledge for net zero emissions by 2060, as coal power dominates its electricity mix. To support Indonesia's power sector decarbonisation efforts, the Just Energy Transition Partnership was established during a G20 summit in Bali, in November 2022. The first deliverable of the Just Energy Transition Partnership, which was supported by the IEA, is the Comprehensive Investment and Policy Plan, published in November 2023. It details an energy transition pathway for the power sector, proposes policy reforms, provides a framework for a just energy transition and outlines financing needs and requirements. In this report, we take stock of the current power sector landscape of Indonesia, summarise IEA's role in the JETP Secretariat and contributions to the work that led to the JETP's Comprehensive Investment and Policy Plan. We also provide an overview of the JETP pathway as well as analysis and recommendations for the effective decarbonisation of Indonesia's power sector.

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Executive summary

The decarbonisation of Indonesia's energy system involves a significant transformation. It implies shifting away from fossil fuels, which in 2021 accounted for 80% in the electricity mix, to higher shares of clean energy generation. This should be implemented while ensuring economic growth and equitable energy access to its population of 276 million people.

Several national and international efforts underpin Indonesia's decarbonisation objectives. Nationally, the Energy Law No. 30 of 2007 and the 2014 National Energy Plan guide the Indonesian government's efforts to reduce fossil fuel dependence. These are complemented by policies aimed at phasing out fossil fuel subsidies in line with Indonesia's goal to achieve net zero emissions by 2060.

In 2022, as part of the initiatives within the country's G20 presidency, the Indonesian government along with the International Partners Group (IPG) released the Joint Statement on the Just Energy Transition Partnership (JETP). The United States and Japan co-led the group, with members including Canada, Denmark, the European Union, France, Germany, Italy, Norway, and the United Kingdom. The JETP aims to mobilise USD 20 billion over the next 3-5 years to help Indonesia pursue an accelerated just energy transition that supports a trajectory that keeps a warming limit of 1.5°C above pre-industrial levels within reach.

The IPG members aim to mobilise USD10 billion, while the Glasgow Financial Alliance for Net Zero (GFANZ) Working Group will work to mobilise and facilitate at least additional USD 10 billion in private finance subject to catalytic public finance and with collective ambition by all parties. The GFANZ includes an initial set of institutions such as Bank of America, Citi, Deutsche Bank, HSBC, Macquarie, MUFG, and Standard Chartered. The JETP intends to also leverage the expertise, resources, and operations of the multilateral development banks.

The JETP developed a comprehensive investment plan, aiming to reach a peak in power sector emissions not above 290 $MtCO_2$ by 2030 and achieving net zero power sector emissions by 2050. In tandem, it seeks to speed-up renewables deployment, aiming for a minimum renewable share of 34% of total electricity generation by 2030.

In order to manage the day-to-day implementation of Indonesia's energy transition, the IPG and Government of Indonesia launched the Secretariat for the JETP. The Secretariat, which is hosted by the Ministry of Energy and Mineral Resources (MEMR) and supported by the Asian Development Bank (ADB), serves

as the coordinator for internal and external stakeholders on the JETP, and would play an important planning and project development function for the JETP.

Current policies drive an increase in power demand

The Comprehensive Investment and Policy Plan (CIPP) for Indonesia projects a significant increase in on-grid electricity demand, with an annual growth rate of 6.4% in 2022-2030 and 5.8% in 2022-2050. This is driven by rising incomes, higher cooling demand, industrialisation, and increased electrification of mobility.

In the CIPP, expanding industrial capabilities, transport electrification and hydrogen production lead to a shift in electricity demand. In 2022, the residential sector consumed 54% of on-grid electricity, the commercial sector 30%, and the industrial sector 16%. By 2050, these shares are expected to shift to 36% for residential, 29% for commercial, and 23% for industrial customers, with transport and hydrogen production accounting for the remaining 12%. Energy efficiency and demand response are identified as key measures to mitigate the impact of end-use electrification as well as in changes on the system's peak load.

In the CIPP, energy efficiency and demand response are identified as key measures to mitigate the impact of end-use electrification and changes on the system's peak load. However, the analysis falls short in providing a thorough evaluation of their contribution, indicating a need for more in-depth analysis using sophisticated stochastic-based approaches.

The JETP aims to accelerate decarbonisation

The JETP scenario envisions a significant increase in renewable capacity, which represented about 9 GW on-grid capacity in 2022. By 2030, solar PV and wind are expected to reach 29 GW and 9 GW, respectively, whereas hydropower remains the main source of renewable energy by installed capacity with 14 GW. Looking to 2050, the scenario foresees substantial expansion, with solar PV dominating at over 260 GW (55% of total installed capacity), wind power reaching about 44 GW, and hydropower surpassing 65 GW.

While the JETP scenario outlines an ambitious decarbonisation pathway, there are concerns that fast industrial development, particularly in nickel mining, may lead to new off-grid coal-fired plants outside of the power system development plan, posing a risk of locked-in emissions for decades. A comprehensive study of the off-grid power system is key to anticipate and mitigate its impact.

Achieving the JETP scenario depends on supportive policies for solar and wind deployment, including providing them with a favourable financial environment and reducing requirements to use locally manufactured goods or domestically provided services. To ensure that JETP's objectives are met, it is key to prioritise

solar and wind deployment and establish guardrails around these technologies. This involves implementing measures such as priority dispatch, addressing potential bottlenecks in connection queues, and enhancing overall system operations, including closer-to-real-time generation scheduling and dispatch.

Improving flexibility and system operations

In the JETP scenario, flexibility provision in the power sector evolves alongside the power system. Challenges related to system adequacy and flexibility can be mitigated with a range of solutions including: improved power system operations, dispatch and scheduling; and contractual flexibility and responsiveness of existing thermal plants. Over time, demand-side measures, such as time-differentiated tariffs and flexible EV charging, are highlighted for their potential to enhance flexibility, though the former is not explicitly modelled in the scenario.

Under the JETP scenario, meeting generation adequacy requirements shifts from traditional power plants to variable renewables, storage and demand-side response. To support this, several enhancements in power system operations will be needed to ensure secure operation at lowest cost. The country should adopt the latest planning techniques, based on stochastic assessments, which provide a clearer picture of the contribution of various investments in grids, storage, and generation towards a secure system. In operations, the country should reduce its minimum reserve capacity margin from 30% in 2023 to 10% by 2040 and deploy storage and smart EV charging, which will both increase the amount of variable renewables that can be deployed economically. Flexible EV charging could potentially reduce weekly peak load by 10-15%.

Ensuring affordability and resilience

The current reliance of Indonesia’s power system on fossil fuels and particularly coal-fired generation creates constraints that should be considered when devising a decarbonisation strategy. The following actions should be prioritised to support decarbonisation in Indonesia taking into account the existing thermal fleet:

- Review the structure of current coal power purchase agreements (PPAs) to define a phase-out strategy.
- Understand financial implications for PLN of reducing operation of their coal fleet. Indonesia's power decarbonisation needs a phased coal phase-out, including reduced operation of private and PLN-owned plants. This requires understanding PPAs, finances, subsidies, fuel contracts, and asset conditions to avoid deadlock and align with PLN's goals. Ensure the provision of flexibility is properly remunerated.
- Design robust scenarios with stochastic processes to improve system planning.

Chapter 1. The Indonesian energy landscape

Indonesia is a significant player in the global energy landscape

Indonesia is a significant player in the global energy landscape. The country is the sixteenth-largest economy in the world, and its economy was the fourth-fastest growing G20 member in 2022, behind only the Republic of Türkiye, India and Saudi Arabia. The cornerstone of Indonesia's energy sector has historically been its rich natural resource endowment, with abundant reserves of coal, oil, and natural gas, particularly coal. Indonesia is the fourth-largest coal producer and one of the biggest coal exporters in the world. In 2021, coal-fired generation made up 61% of the generation mix, and the country's coal exports reached approximately 470 million metric tonnes in 2022 (about 6% of global coal consumption).

In total, fossil fuels make up 81% of the electricity mix, and as a result, Indonesia is grappling with high carbon intensity in its electricity sector. The country's Energy Law No. 30 of 2007 and the 2014 National Energy Plan (NEP 14) have set targets to achieve a more sustainable electricity mix, aiming to increase the contribution of renewable energy to 23% of total electricity consumption by 2025 and at least 31% by 2050. These targets aim to reduce carbon emissions, mitigate climate change, and address the environmental impacts of fossil fuel use. Indonesia has also committed to achieve economy-wide net zero emissions by 2060.

The main challenges of the power system in Indonesia include:

- **High reliance on fossil fuels**. Indonesia's power system is heavily reliant on fossil fuels, particularly coal, which has led to high carbon intensity and significant greenhouse gas emissions.
- **Rapidly growing energy demand**. The country's rapid economic growth and population expansion have resulted in a substantial increase in energy demand, which the power system will need to meet reliably and at low cost.
- **Emissions reduction and energy transition**. Indonesia will need to reduce emissions to fight climate change and reduce local air pollutants, which requires a reduction in coal-fired generation.
- **Infrastructure development**. Indonesia will need to modernise system components to ensure secure power system operation, which will require significant capital investments.

Indonesia's energy transition can be supported by collaboration between the Indonesian government, international partners, energy companies, and local and international stakeholders. Such collaboration is needed to steer policy evolution, investments in renewable energy infrastructure, strategies to phase out coal generation, and establish regulatory frameworks to support the clean energy transition.

The Just Energy Transition Partnership (JETP) agreement, signed in November 2022, aims to accelerate the country's energy transition through a partnership between Indonesia and the international community, led by the United States and Japan, supported by the United Kingdom, Germany, France, the European Union, Canada, Italy, Norway, and Denmark. The JETP serves as a hub to channel investments and manage technical guidance between the various stakeholders. It emphasises the need for a detailed roadmap to reduce coal-fired power generation and increase the share of renewable energy in Indonesia's power generation to 34% by 2030 to align power sector emissions with the 1.5°C target, aided by an initial investment of USD 20 billion over the next three to five years.

The Indonesian government has established the JETP Secretariat to manage day-to-day implementation of Indonesia's energy transition. It intends to develop investment and policy plans to support the country in achieving its energy transition objectives. The Secretariat is supported by four independent working groups – with the Technical Working Group led by the IEA. This report gives technical insights into the development of Indonesia's power sector transition plan under the JETP taking place in 2023, based on the IEA's participation. Serving as a pivotal hub, it not only channels investments but also serves as a beacon for technical guidance. Together, these collaborative actions pave Indonesia's path toward a sustainable, low-carbon energy future, shaping a narrative of progress and environmental responsibility.

Report Scope and structure

This report presents an exploration of the Just Energy Transition Partnership (JETP), led by global partners and supported by the International Energy Agency (IEA), highlighting its pivotal role in phasing out coal energy and directing investments towards renewable infrastructure.

The report is organised into six parts. Chapter 1 sets the scene for Indonesia's energy system and its main challenges ahead. Chapter 2 focuses on the intricacies of its power system. Chapter 3 describes the creation and main goals of the Indonesian Just Energy Transition Partnership, and Chapter 4 summarises IEA's activities in supporting the JETP process. Finally, Chapter 5 provides a stocktake of the decarbonisation pathway presented in the JETP scenario, with Chapter 6 discussing some of the future steps to make the decarbonisation of the power sector a reality.

Chapter 2. The Indonesian power system

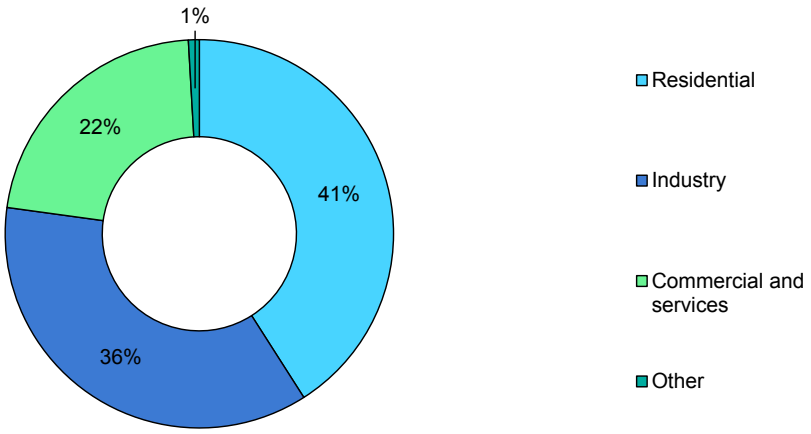
Indonesia has relied mainly on fossil fuels for electrification

Indonesia's power sector underpins the country's economic development and has seen rapid growth over the past three decades. Access to electricity is nearly universal, growing from about 50% in 1991 to around 99% today. Today, the country needs to strike a balance between economic growth, environmental concerns, and expanding secure access to electricity across a diverse archipelago of at least 17 000 islands.

In the early 20th century, Indonesia met its energy needs with small-scale diesel generators, predominantly serving urban centres and industrial zones. The limited availability of electricity hindered broader economic growth and social development. Following its independence in 1945, the government established state-owned utilities to centralise power generation and distribution. Entities like Perusahaan Listrik Negara (PLN) played a pivotal role in expanding electricity access across the archipelago. This phase witnessed the development of larger power plants and transmission networks, gradually extending electricity to rural and remote areas. The expansion from the mid-20th into the 21st century relied heavily on fossil fuels, especially coal and oil. The country's abundant coal reserves provided a readily available energy source, contributing significantly to power generation. However, this dependency on coal also leads to environmental concerns and high emission intensity for the power sector.

Electricity demand in Indonesia, which amounted to around 285 TWh in 2021, is divided roughly equally between two sectors – residential and industrial. Residential consumption accounted for 41% of annual electricity demand in 2021, its rising share driven by population growth and space cooling, while industry accounted for 36%. In terms of geographical distribution, the Java-Bali Island accounts for around 70% of national electricity demand, with Sumatra having a share of about 15%.

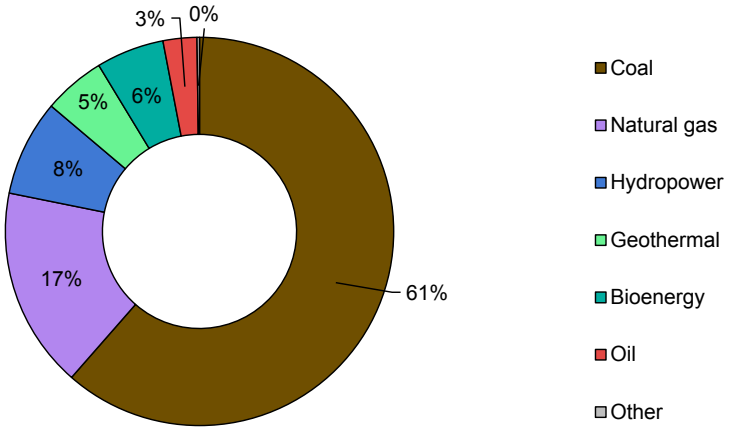
Electricity demand by sector in Indonesia, 2021



Source: IEA (2023), World Energy Balances, (accessed 10 December 2023).

The power sector in Indonesia has expanded significantly to keep pace with the growing economy and population. Indonesia's electricity generation, which amounted to near 310 TWh in 2021, primarily comes from thermal power plants, with coal accounting for around 61% of the country's electricity generation in 2021 and natural gas accounting for about 17%. Additionally, it boasts the world's second-largest geothermal capacity, offering a clean and renewable energy source. As of 2022, Indonesia had a total installed capacity of 83.8 GW, consisting of 42.5 GW from PLN and 41.3 GW from Non-PLN.

Electricity generation mix in Indonesia, 2021

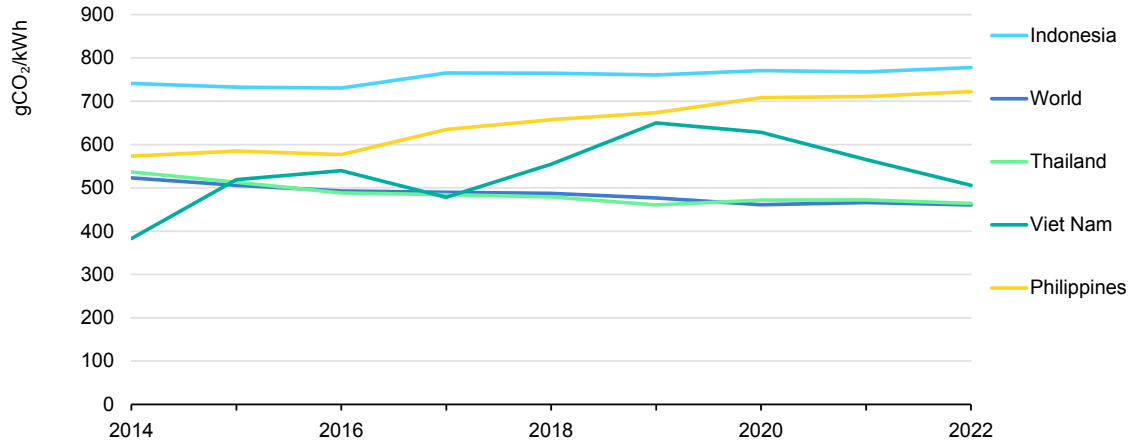


Source: IEA (2023), World Energy Balances, (accessed 10 December 2023).

The carbon dioxide intensity of electricity generation in Indonesia has been on the rise in recent years, remaining significantly above the global average. In 2022,

the CO_2 intensity from electricity generation in Indonesia reached around 780 gCO2e/kWh, up from 765 gCO2e/kWh five years earlier.

Power sector CO_2 emission intensity in selected countries and globally, 2014-2022



In recent years, the Indonesian government has introduced policy reforms to encourage investments in renewable energy and reduce the nation's reliance on fossil fuels. Initiatives such as the National Energy Policy, the Energy Resilience Policy, and the National Medium-Term Development Plan outline strategies for sustainable energy development and emphasise the importance of cleaner sources in the energy portfolio. Indonesia holds immense potential in renewable energy, particularly in solar, wind, hydro, and geothermal resources. The Geothermal Law and Feed-in Tariff policy are among the regulatory mechanisms designed to attract investments and promote renewable energy utilisation. The government is also working on phasing out and rationalising its fossil fuel subsidies as part of its efforts towards sustainable development, in addition to the targets for 23% and 31% of electricity to come from renewable sources by 2025 and 2050.

Policy, technical and economic risks to clean energy transitions

Indonesia faces multiple risks to its clean energy transition, in particular:

- **Technical**: systems with high shares of solar PV and wind power requires changes to operational practices like scheduling interval, gate closure, geographical resolution and thermal unit commitment to securely and cost-effectively accommodate their variability and uncertainty.
- **Regulatory**: tariffs need to be modernised in order to unlock flexibility to integrate renewables at lowest cost, including wholesale price formation, retail time of use

rates, demand response incentives, and specialised tariffs for electric vehicles (EVs), heat pumps and water heaters.

- **Contractual**: take-or-pay obligations in power purchase agreements diminish the incentives for thermal units to operate flexibly, reducing the system's overall efficiency and adaptability.
- **Financial**: there is limited access to funding from local financial institutions at a low cost of capital, which impacts renewables projects more severely due to their high proportion of upfront capital cost.
- **Geographical**: Indonesia's geography poses logistical barriers to infrastructure expansion and electricity distribution across its islands. While rural electrification initiatives have extended power access to remote regions, initiatives such as the "Indonesia Clean Energy Development" project and the "1 000 Islands for 1 000 MW" programme aim to bolster electricity availability in areas with a lack of service through microgrids, solar installations, and off-grid solutions.

Decarbonisation presents significant opportunities

Despite these risks, the clean energy transition also offers significant opportunities for the Indonesian power sector, including:

- **Environmental**: reducing greenhouse gas emissions and local air pollutants from coal phase-out will increase the health of the population and reduce the negative impacts of climate change, including sea level rise.
- **Energy security**: clean energy development can increase energy independence and security by relying to a larger extent on local resources and expertise.
- **Employment:** developing a supply chain for clean energy technologies can boost local employment in skilled manufacturing and construction.
- **Economic**: the country has abundant natural resources and huge potential for renewables, especially hydro, geothermal, and solar PV, which can be leveraged for clean electricity generation at low cost. Geothermal and hydro combined are expected to contribute 4.6 GW of the 10.6 GW additional renewable capacity needed to achieve the country’s target of a 23% share of renewables in power generation by 2025. For utility-scale PV, the Java-Bali system has a potential around 60 GW, compared to Sumatra, which has more rural areas and has a potential exceeding 600 GW.
- **Innovation**: new hardware, software and algorithms associated with a smart grid rollout will develop needed skills and enhance planning and operating practices, which should result in additional jobs and increase reliability, efficiency, customer experience, and grid productivity. In the long term, the smart gird can enhance resilience, customer engagement, sustainability, and self-healing.

Charting Indonesia's clean energy course: Policies and initiatives for a sustainable future

Indonesia has implemented several policies and regulations to steer the nation towards cleaner energy sources, including:

- **Foundational energy legislation**: the Energy Law No. 30 of 2007 and the 2014 National Energy Plan (NEP 14) establish the framework for Indonesia's energy policies and sector governance.
- **Presidential Decree No. 112/2022**: this decree outlines strategies to bolster renewable energy. It includes initiatives such as establishing competitive pricing mechanisms for renewable sources, offering tax incentives for renewable projects, and streamlining negotiation procedures for pricing agreements.
- **Law No. 16 of 2016**: through this law, Indonesia ratified the Paris Agreement under the United Nations Framework Convention on Climate Change. In its first Nationally Determined Contribution, the country set targets to significantly reduce its carbon footprint.
- **Just Energy Transition Partnership**: Indonesia along with international partners formed the Just Energy Transition Partnership, an initiative designed to accelerate the nation's clean energy agenda and economic advancement. This partnership outlines a comprehensive investment and policy roadmap, aimed at supporting Indonesia's shift towards renewable energy sources.

Chapter 3. The Indonesia Just Energy Transition Partnership

Origin of the Just Energy Transition Partnership

On November 15, 2022, during the G20 Summit's Partnership for Global Infrastructure and Investment event in Bali, President Joko Widodo and leaders of the International Partners Group – co-led by the United States and Japan, alongside Canada, Denmark, the European Union, France, Germany, Italy, Norway, and the United Kingdom – introduced a Joint Statement on the JETP. Developed within Indonesia's G20 Presidency, this USD 20 billion partnership aims to ensure an equitable shift in the nation's power sector to uphold the 1.5°C global warming limit. The JETP focuses on accelerating the decarbonisation of the country's power sector for maximum emissions reduction.

The joint statement outlines key objectives, with a pivotal focus on mobilising USD 20 billion in capital through a mix of instruments, including grants, concessional loans, market-rate loans, guarantees and technical assistance. This financial commitment aims to expedite the decarbonisation of Indonesia’s power sector, striving for ambitious cuts in emissions. Half of the funds are pledged by IPG members, further catalysing at least USD 10 billion in private finance, supported by the Glasgow Financial Alliance for Net Zero Working Group. The JETP, emphasises a blend of public and private investments to support Indonesia’s transition away from fossil fuels.

Objectives of the partnership

Key objectives of the JETP in Indonesia include:

- **Accelerating the transition to cleaner energy**. The JETP aims to fast-track Indonesia's decarbonisation, cutting greenhouse gas emissions. It aims to raise the share of renewable energy in power generation to 34% by 2030 and achieve net zero emissions in the power sector by 2050, which aligns with global climate goals. It also targets a 2030 emissions peak for the country's power sector, seven years earlier than currently projected.
- **Promoting sustainability**. Sustainability is a key pillar of the JETP, advocating for sustainable energy sources and practices in the power sector.
- **Ensuring an equitable and just transition**. The JETP emphasises a fair and inclusive transition, aiming to ensure that all segments of society will benefit. It

addresses social and economic impacts with support to affected communities and workers. It aims to formulate a comprehensive plan, in consultation with stakeholders, to identify and support vulnerable segments of Indonesia's population, particularly those connected to the coal industry, workers, and societal groups with a special focus on women, youth, and vulnerable populations.

- **Economic growth and development**. Supporting Indonesia's economic growth is central to the goals of the JETP. Leveraging the clean energy transition as an economic catalyst, the partnership aims to attract investments and foster innovation in the energy sector.
- **Collaborative international efforts**. Collaboration with international partners and stakeholders forms a cornerstone of JETP, pooling expertise and resources to tackle Indonesia's energy transition challenges collectively.
- **Mobilising both public and private financing**. The partnership aims to mobilise an initial USD 20 billion in public and private financing over a three-to-five-year period to support the deployment of renewable energy.
- **Policy development and implementation**. The partnership focuses on creating robust regulatory frameworks and strategic plans that will facilitate the transition to cleaner energy sources. The partnership aims to promote policies that help to halt the development of planned on-grid coal-fired power plants listed in the current electricity supply plan (RUPTL) for 2021-2030 and confirm a complete moratorium on any new on-grid coal power generation in accordance with the Presidential Decree on Renewable Energy, Perpres 112/2022. .
- **Coordinating stakeholders and planning**. Set up co-ordination platforms with development finance institutions and key stakeholders to solicit input to further develop the conceptual approach and leverage additional technical and financial support towards their most impactful uses in the JETP Investment and Policy Plan.

Key stakeholders and participating entities

The government of Indonesia and the IPG jointly officially inaugurated the launch of the JETP Secretariat on February 16, 2023. The Secretariat is tasked with overseeing the day-to-day implementation of Indonesia's energy transition towards a low-carbon, sustainable, and equitable future that aligns with the nation's economic growth trajectory.

Situated within the MEMR and backed by the Asian Development Bank, the Secretariat acts as the coordinating hub for both internal and external stakeholders engaged in the JETP. It also carries significant responsibilities in strategic planning and the development of projects integral to the JETP's success. In addition to the government's leadership through the Secretariat, the IPG plays a key role within the JETP framework to help steer Indonesia's energy transition.

The network of stakeholders also includes private entities, notably the Glasgow Financial Alliance for Net Zero Working Group. This coalition pools the expertise

of institutions including the Bank of America, Citi, Deutsche Bank, HSBC, Macquarie, MUFG, and Standard Chartered. Working alongside multilateral development banks, these private stakeholders aim to bolster the JETP's efforts, leveraging their financial capacity and industry knowledge.

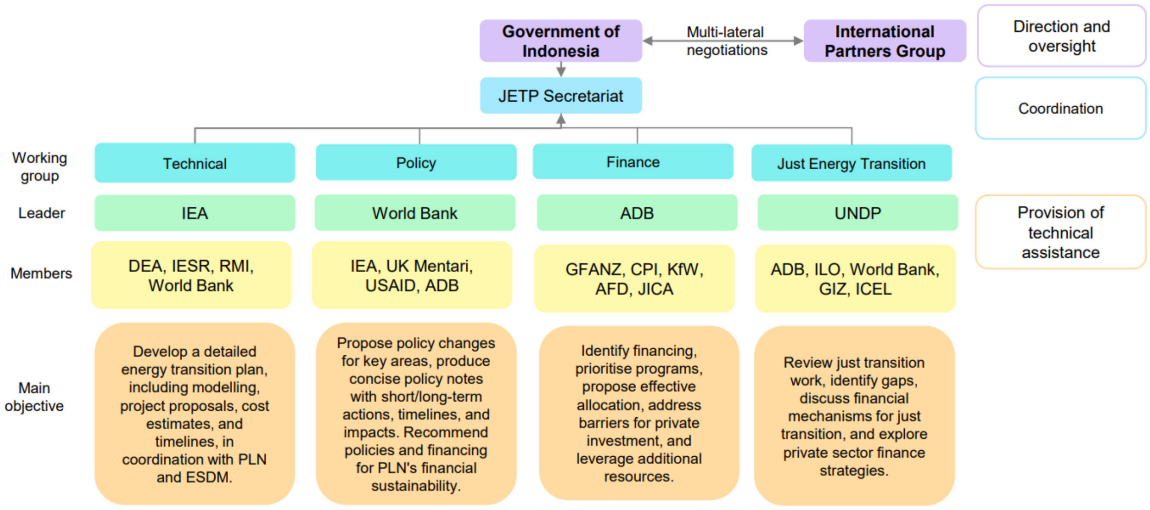
A critical focal point for the JETP is the formulation of a comprehensive investment plan known as the JETP Investment and Policy Plan. This strategic blueprint sets shared targets for Indonesia's power sector, emphasising milestones such as emissions peaking by 2030 and net zero emissions by 2050. An integral part of this plan involves the phased retirement of coal plants, supported by international assistance. Crucially, while the Joint Statement embodies significant political commitments, it does not entail a binding international accord. Rather, it serves to delineate the shared intentions and aspirations among the partnering entities.

Key projects supported by the partnership

The JETP actively supports a range of projects aimed at transforming the nation's energy sector:

- **Renewable energy development**. The partnership focuses on accelerating the development of renewable energy sources such as solar, wind, hydro, geothermal, and biomass. It supports renewable projects, contributing to a more diversified and sustainable energy mix.
- **Rural electrification and microgrids**. The JETP initiatives prioritise extending electricity access to remote and underserved regions through rural electrification programmes. These programmes include the installation of microgrids, solar power systems, and off-grid solutions to ensure equitable access to electricity.
- **Energy efficiency initiatives**. The JETP supports projects focusing on energy-saving technologies, efficient grid management systems, and the adoption of sustainable practices to optimise energy usage.
- **Coal plant retirements and transition support**. The partnership assists in planning and executing the retirement of coal-based power plants.
- **Policy and regulatory framework enhancement**. The JETP endeavours to improve the regulatory environment by supporting the formulation and implementation of policies conducive to clean energy transition. This includes establishing pricing mechanisms, tax incentives, and regulations that foster renewable energy development.

Governance of the JETP Secretariat and working groups



Notes: IEA = International Energy Agency; ADB = Asian Development Bank; UNDP = United Nations Development Programme; INDODEPP = Indonesia-Denmark Energy Partnership; IESR = Institute for Essential Services Reform; RMI = Rocky Mountain Institute; UK Mentari = Towards Indonesia's Low Carbon Energy Transition programme; USAID = United States Agency for International Development; GFANZ = Glasgow Financial Alliance for Net Zero; CPI = Climate Policy Initiative; KfW = KfW Development Bank; AFD = Agence Française de Développement ; JICA = Japan International Cooperation Agency; ILO = International Labour Organization; GIZ = Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH; ICEL = Indonesian Center for Environmental Law.

Chapter 4. Role of the IEA in the JETP CIPP

Supporting the process

The IEA's engagement in the JETP began early in 2023 with discussions regarding the terms of reference for the working groups. The IEA collaborated with the JETP Secretariat and the Asian Development Bank in formulating these terms of reference, along with defining the objectives for the working groups. Once finalised, an agreement was reached, which gave the IEA the mandate to lead the Technical Working Group and to participate in the Policy Working Group. IEA officials then travelled to Jakarta to oversee the official launch of the Technical Working Group.

The IEA's contribution involved extensive co-ordination with institutional partners, including all members of the Technical Working Group, the JETP Secretariat, and key Indonesian stakeholders, in particular PLN and MEMR. The overarching goal was to establish a shared view of the decarbonisation pathway for Indonesia. This process also included exchanging with specialists of other working groups, in particular those for policy and finance. The first draft of the CIPP was drafted at the June. At this stage, further crucial input from PLN and MEMR was expected to reflect the views of the government of Indonesia and enhance the pathway.

At the same time, during May and June, the IEA collaborated with PLN to assist them in formulating a power sector development pathway within the JETP framework and beyond. This collaboration culminated in the signing of a memorandum of understanding between the IEA and PLN in the second quarter of 2023. Subsequent bilateral discussions and a workshop at the end of May in Paris with modellers from PLN were instrumental in addressing modelling challenges and providing constructive feedback on the models that provide the analytical foundation for the CIPP. Following this, modelling inputs and assumptions among stakeholders were aligned within a week-long workshop during the first week of June. This process involved a modeller from the IEA visiting Indonesia and engaging collaboratively with the local team, helping to refine PLN's modelling, and conducting capacity-building sessions. By the end of the week, pathways under different scenarios were developed and utilised for financial modelling.

The secretariat held a workshop in which the IEA participated in the second week of June. The results were later presented to the government of Indonesia for

feedback. While the results belonged to PLN, the IEA's technical assistance during the workshop facilitated issue resolution. Additional workshops were conducted to address the feedback received, especially from MEMR.

Recognising the need for a unified approach, another workshop was organised in the middle of July to model the power sector development in Indonesia. The IEA worked extensively to build consensus among the Indonesian and international stakeholders, which led to a shared decision to use the MEMR energy model to optimise decarbonisation pathways. In the following two weeks, intensive information gathering was undertaken for both on-grid and off-grid scenarios. Key uncertainties, such as timing of coal retirements and level of renewable energy potential, were discussed within the Technical Working Group. Collaborations with the working groups on policy and finance ensured alignment between groups for the proposed changes. The results were synthesised into a pathway presented to IPG members, forming the basis for negotiations between the government of Indonesia and the IPG.

To account for uncertainties in the captive power sector, the study included separate analysis for on-grid and off-grid systems. The Technical Working Group delved into understanding uncertainties such as the costs of the technology, financial implications, transmission deployment costs and timelines, among others. This resulted in the development of a detailed scenario for the development of the power sector. Continuous communication with MEMR and PLN was key to securing political agreement on uncertainties and variables.

With the involvement of an official IEA representative stationed in Jakarta, a CIPP scenario was built. The scenario incorporated inputs from key stakeholders, including MEMR and PLN, as well as international organisations and aligns with the goals outlined in the JETP joint statement. Several iterations of the scenario were undertaken based on feedback from the IPG, the government of Indonesia, and the general public. This iterative process involved refining assumptions, particularly concerning investment requirements for existing coal power plants and contractual limitations. The final draft of the CIPP, encompassing the pathway and key investment areas, was officially launched in Jakarta in November 2023. The launch event provided a platform for extensive discussions with stakeholders.

Chapter 5. The JETP pathway

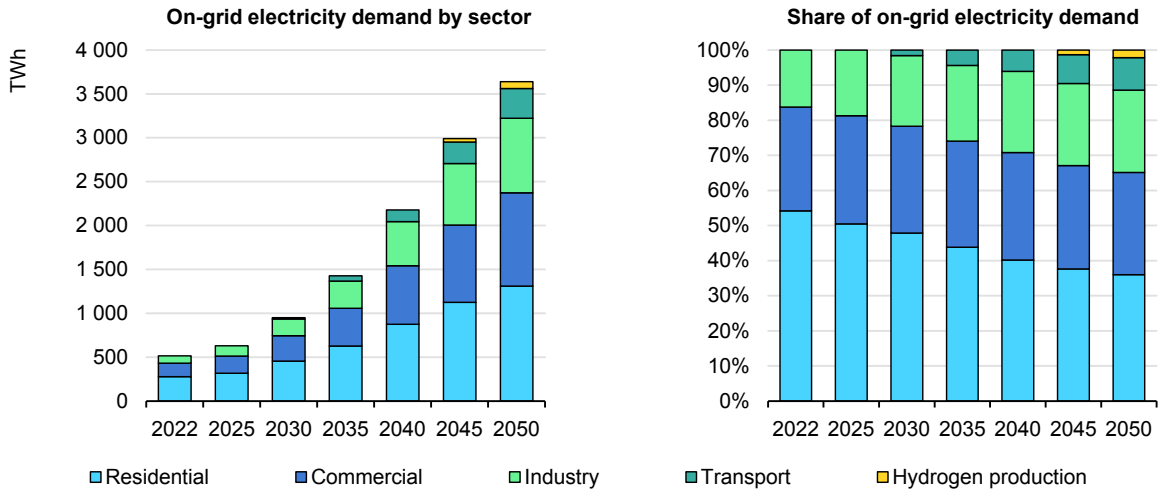
Energy efficiency can smooth the growth of on-grid electricity demand

Electricity demand in Indonesia is growing and changing in nature. The Comprehensive Investment and Policy Plan outlines demand projections for electricity in Indonesia. The projections integrate, in addition to the on-grid electricity demand from the low-growth scenario of the draft General National Electricity Plan 2023-2060, the demand from off-grid industrial facilities expected to connect to the grid in 2030, 2035, and 2040. Projections for on-grid demand take into consideration many factors such as industrialisation, growing income, low-emission hydrogen production and ambitious targets for electrification of end uses, notably in the transport sector. This will also see changes in the demand pattern over time. Demand grows at an annual rate of 6.4% from 2022 to 2030 and 5.8% from 2022 to 2050. In 2022, the residential sector consumed 54% of on-grid electricity, the commercial sector about 30%, and the industrial sector approximately 16%. In the pathway, by 2050 the shares will be 36% for the residential sector, 29% for the commercial sector and 23% for the industrial sector.

The CIPP anticipates a transformative shift in the relationship between economic growth and electricity demand. Out to 2035, electricity demand growth in the JETP pathway outpaces GDP growth, due to increased industrial activity and electrification in industry and transport. However, as stronger energy efficiency measures kick in during 2036-2040 and onwards, electricity demand growth becomes decoupled from GDP, with demand growing at a slower pace than the economy.

The infrastructure requirements of the power system are linked to peak electricity demand, which may be particularly affected by the uptake of EVs and higher space cooling demand. For example, in India, these two factors are the main contributors to the expected quadrupling of peak electricity demand by 2050. Energy efficiency may play a pivotal role in mitigating the increase in peak demand and reducing stress on electricity networks, as these end uses possess significant flexibility potential. Consequently, demand-side response measures can mitigate uncontrolled increases in peak demand and may also play a key role in meeting the increased flexibility requirements associated with the integration of large amounts of VRE.

On-grid electricity demand by sector in the Just Energy Transition Partnership Scenario, 2022-2050



Source: Indonesia JETP (2023), Comprehensive Investment and Policy Plan.

Renewables dominate generation capacity additions

In 2022, renewable energy represented just under 15% of on-grid generation in Indonesia, with solar and wind accounting for less than 5%. In the JETP scenario, capacity expansion envisions a favourable cost-competitive environment for VRE, achieved through the relaxation of current inhibiting policies such as requirements to use locally manufactured goods or domestically provided services. The renewable expansion is mainly led by solar PV, wind and hydropower, with bioenergy gaining prominence after 2040.

Variable renewables deployment is expected to come mainly from solar PV, which is projected to exceed 29 GW of installed capacity by 2030. PV then doubles to 77 GW by 2035 and maintains dominance through 2050, reaching over 260 GW and constituting 55% of the total installed capacity in the country. Wind power also experiences rapid growth, benefiting from favourable policies and financing, reaching 9 GW in 2030, more than 29 GW in 2040, and about 44 GW in 2050. It is possible that more wind resources could be tapped based on technologies designed to work under lower wind speeds, but this requires further study and analysis due to potential costs and impacts on competitiveness.

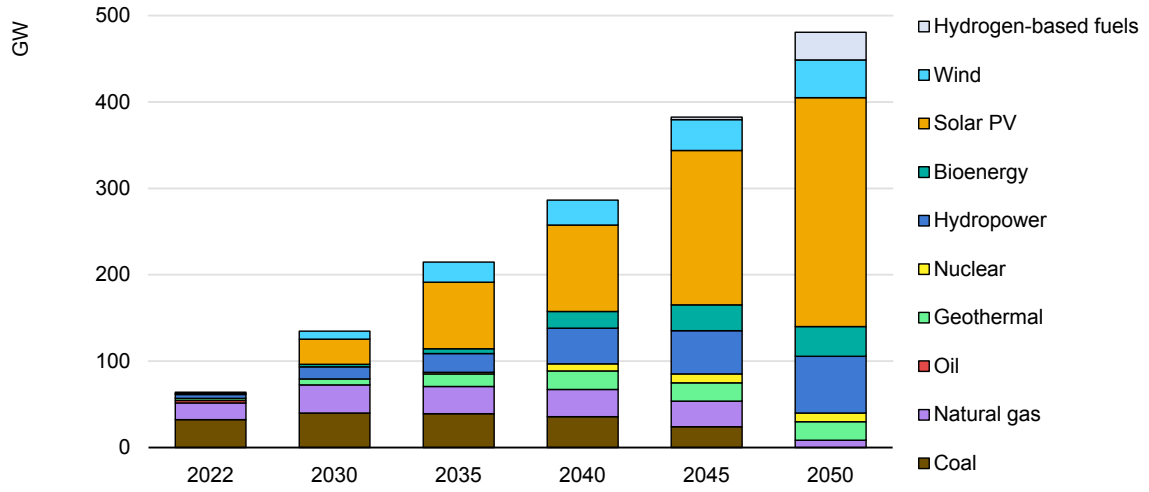
In 2030, hydropower leads renewables in electricity generation and surpasses 40 GW in installed capacity by 2040 and 64 GW by 2050. Hydropower enhances system flexibility, distributed across islands through expanded interconnectors.

Bioenergy takes on a larger role from 2040 onward, filling the gap left by retiring dispatchable coal generation.

One crucial aspect for enabling an effective clean energy transition in Indonesia is the expansion and modernisation of the transmission grid. Indonesia faces challenges with its relatively thin and weak power grid, resulting in issues of system stability and reliability. To realise the JETP scenario and seamlessly integrate the substantial amount of variable renewables, strengthening the backbone grid of power systems, such as Sumatra, is paramount. Additionally, interconnecting the dispersed power systems outside the Java-Madura-Bali and Sumatra systems is crucial, particularly for decarbonising the new industrial loads anticipated in the country.

The development of an interisland grid could yield additional benefits, including enhanced reliability, flexibility, and cost-effectiveness of power system operations. In this interconnected scenario, flexible resources could be shared among subsystems, facilitating a more optimal and efficient operation of the power system.

On-grid installed capacity by technology in the Just Energy Transition Partnership Scenario, 2022-2050

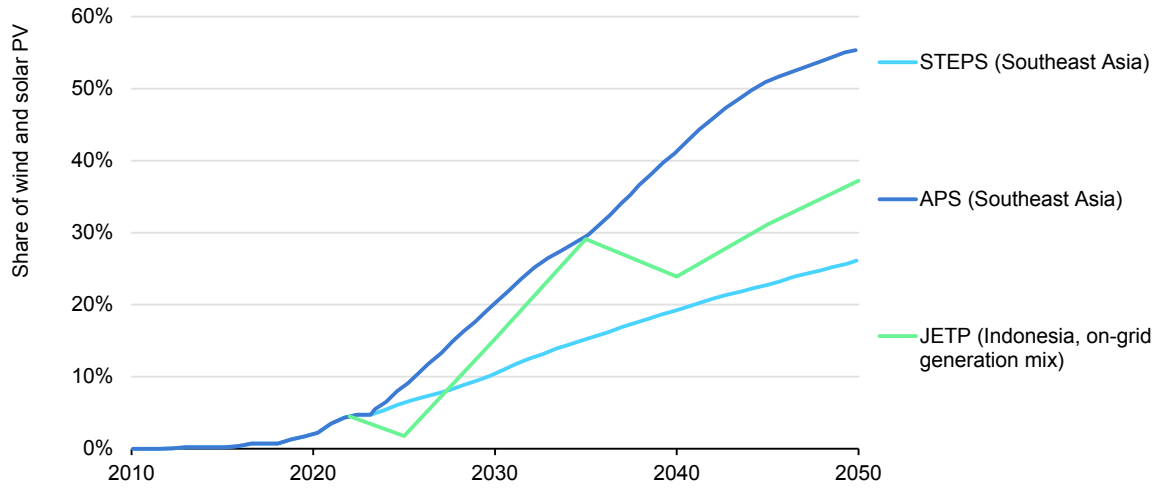


Source: Indonesia JETP (2023), Comprehensive Investment and Policy Plan.

The JETP scenario constitutes an accelerated decarbonisation pathway for the on-grid system in Indonesia. It projects shares of wind and solar of over 35% of the on-grid electricity generation in 2050, sitting in between the projections for Southeast Asia of two IEA scenarios – the Announced Pledges Scenario (APS) and the Stated Policies Scenario (STEPS). However, interests in fast industrial development, particularly for nickel mining and smelting, if not matched with on-grid supply growth, may trigger the development of new off-grid coal power

plants, which could lock in higher emissions in the country in the following decades. This issue requires in-depth analysis.

Wind and solar PV shares of total electricity generation in Southeast Asia in IEA scenarios, and of on-grid generation in Indonesia in the Just Energy Transition Partnership Scenario, 2010-2050



Notes: STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; JETP = Just Energy Transition Partnership.

Source: IEA (2023), World Energy Outlook 2023; Indonesia JETP (2023), Comprehensive Investment and Policy Plan.

Flexibility provision changes as the electricity mix evolves

Successful utilising Indonesia's renewable resources hinges on adapting practices for power sector planning and operations. The JETP scenario addresses challenges related to system adequacy and flexibility through strategic investments and operational measures. System adequacy has been assessed using a reserve margin metric, but this method is not the best fit for a system with a high contribution from solar and wind resources.

Indonesia currently sets high reserve margin criteria, contributing to the overbuilding of power plants. The JETP scenario proposes a more optimised approach, gradually reducing the minimum reserve capacity margin from 30% in 2023 to 10% by 2040, with no minimum thereafter. The scenario aims to optimise capacity expansion, with a shift toward relying on variable renewables and storage to meet peak demand by 2050.

Adopting more advanced techniques in power system planning, particularly those rooted in probabilistic assessments, has the potential to decrease system costs and align more effectively with decarbonisation objectives. These advanced

methods, based on stochastic methods, can enhance understanding of the roles played by variable renewables, demand response, and storage in ensuring system adequacy and flexibility.

As variable renewables increase, flexibility becomes crucial. The JETP scenario anticipates a rise from less than 1% solar and wind in 2022 to 36% by 2050. This requires investments in grid expansion and reinforcement, new interconnectors, and smart technologies. Storage, including utility-scale batteries and pumped hydro plants, also plays a growing role to address intraday variations and support solar PV and wind integration. Storage can absorb surplus energy during high production periods and discharge during peak demand. By 2040, solar PV and wind penetration levels align with countries in advanced phases of system integration of renewables today. Electric vehicle charging has the potential to reduce weekly peak demand JETP pathway.

Improved dispatch and responsiveness of existing coal power plants, alongside contractual flexibility, are key enablers in the scenario, with coal power utilisation rates dropping to 63% by 2030 and 50% by 2040. Demand-side measures, such as time-differentiated tariffs, are highlighted for their potential to enhance flexibility, but are not explicitly modelled in the scenario. Ultimately, achieving enhanced system flexibility in Indonesia requires sustained political will, international cooperation, and leveraging innovative technologies.

Chapter 6. Conclusions and outlook

The CIPP, developed with IEA's support, provides a common vision for MEMR and PLN, outlining increased targets for renewable deployment and power sector decarbonisation. Nonetheless some aspects of power system development will require more detailed planning and analysis. This includes the need for more analysis of off-grid power demand, which should take into account detailed studies of the demand for critical minerals, which is a key driver. Based on challenges and uncertainties identified in the development of the CIPP, in this chapter we identify a number of key recommendations.

Review current coal PPA structure to inform phase-out strategy

For on-grid decarbonisation it is necessary to understand the PPAs of existing coal-fired power plants. Analysing the operational and financial implications of integrating higher solar and wind shares is needed to facilitate the transition away from coal and align with broader energy transition goals. Analysis of the current coal PPAs has provided valuable insights into existing contractual obligations and potential penalties. The approach of "repurposing, retrofitting, and retiring" existing assets demands careful consideration of all financial implications. Considering these costs and assessing them against system-wide benefits resulting from improved flexibility and operational optimisation will be crucial for a successful coal phase-out strategy.

Understand financial implications for PLN limitations and incentives for reducing operation of their coal fleet

The decarbonisation of Indonesia's power system requires a strategy to phase out coal. This approach should involve reducing the operation of both privately-owned and PLN-owned coal power plant fleets. Understanding PPA contracts is essential for privately-owned assets. To create a successful strategy for phasing out PLN's assets, a deeper understanding of the financial implications of the proposals, including explicit and non-explicit subsidies and existing fuel contracts, is necessary. Simultaneously, granular information about the current state of assets, including age, type of technology used, and their condition, is required. This

information can be then used as a basis to structure the strategy and to understand potential additional costs and communicate effectively with the relevant stakeholders.

Improve operational practices to better remunerate flexibility

Increasing shares of VRE requires improved operational planning and operational practices. This includes having a centralised system-level forecast for variable renewables and bringing unit commitment dispatch closer to real-time. These measures would allow the system operator to consider the overall variability of solar and wind outputs across the entire system and accurately predict the available generation. This can reduce the requirement for reserves to balance solar and wind variability, allowing for more efficient and reliable system operation.

Iterative and probabilistic processes are necessary for robust planning

Planning the system for the next decades is a complex task with many uncertainties. Therefore, planning should ensure robustness with respect to these uncertainties. This can be achieved by using stochastic approaches and multiple scenarios complemented with sensitivity analysis for major assumptions. Scenarios should span a large set of possible futures, allowing for uncertainty in aspects such as the penetration of EVs, electrification of end uses in industry, and the anticipated impact of energy efficiency. Planning should not solely focus on demand or supply but incorporate feedback loops and iterations. This allows system planners to learn continuously from real-world outcomes and adjust strategies accordingly. By adopting a flexible and adaptive planning mindset, organisations can navigate uncertainties effectively and stay responsive to changing circumstances.

General annex

Abbreviations and acronyms

ADB	Asian Development Bank
CO_2	carbon dioxide
EV	electric vehicle
IEA	International Energy Agency
IPG	International Partners Group
JETP	Just Energy Transition Partnership
MEMR	Ministry of Energy and Mineral Resources
NDC	Nationally Determined Contribution
NEP 14	2014 National Energy Plan
PLN	Perusahaan Listrik Negara
PPA	Power Purchase Agreement
PV	photovoltaic
VRE	variable renewable energy

Glossary

gCO_2/kWh	grammes of carbon dioxide per kilowatt hour
GW	gigawatt
Gt	gigatonne
MW	megawatt
Mt	megatonne
TWh	terawatt hour
USD	United States Dollars

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