Net-Zero Transition: Opportunities for Indonesia

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83%

Share of zero carbon sources in Indonesia's 2050 NZS generation mix

$2-3.5 trillion

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25GWh

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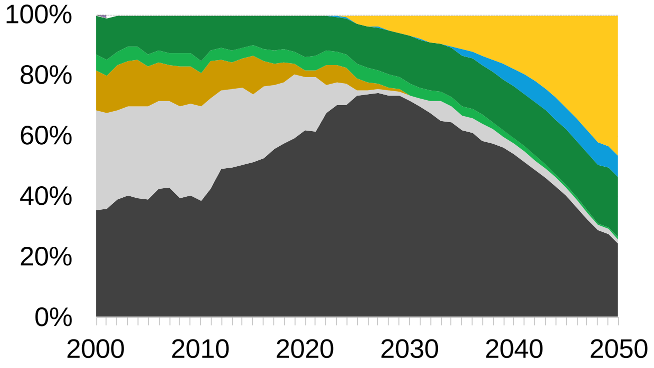
Indonesia is keen to spur global climate action as the 2022 host of G-20. The country itself is seeing increased momentum to decarbonize its energy sector. This report explores Indonesia's current progress, opportunities, and challenges as the global net-zero transition gathers momentum.

Indonesia needs to go big on renewables for power sector decarbonization

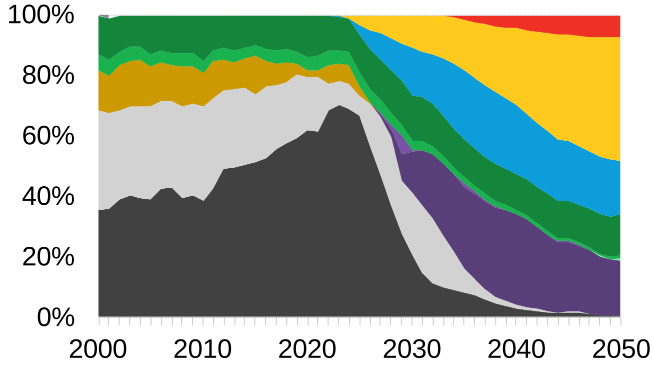
- **Indonesia's power demand grows three to five times by 2050:** Strong economic development, a growing population and rising urbanization see Indonesia's final power demand triple by 2050 from 2021's demand level in BloombergNEF's Economic Transition Scenario (ETS). In our Paris Agreement compliant Net Zero Scenario (NZS), deeper electrification of the energy sector pushes power demand growth even higher to a fivefold increase from 2021. To meet demand growth, Indonesia's power system needs to expand more than eightfold by 2050 in the ETS and 12-fold in the NZS, from the current 75GW of capacity in 2021.
- **Zero carbon generation sources to lead Indonesia's power capacity addition:** While coal has been the technology of choice to build out Indonesia's power system, zero carbon capacity will outpace the addition of new fossil fueled thermal power plants in BNEF's outlook. Indonesia adds an average 13GW of zero carbon capacity annually from 2022-50 in the ETS and 27GW per year in the NZS. This contrasts with the 3-4GW of fossil fueled thermal power capacity installed annually over 2022 to 2050 under both scenarios.

Figure 1: Indonesia power generation mix – Economic Transition Scenario



Source: BloombergNEF

Figure 2: Indonesia power generation mix – Net Zero Scenario



Coal, Gas, Oil, Coal with CCS, Gas with CCS, Solar, Wind, Geothermal, Hydro, Nuclear, Hydrogen, Bioenergy

Source: BloombergNEF

- **Indonesia's generation mix transforms:** Whether an economics-led pathway or one intended to achieve net-zero emissions by 2050, Indonesia's generation mix will flip from one dominated by fossil fuels to one where by 2050, zero carbon generation sources supply 74% and 83% of total generation in the ETS and NZS, respectively. Solar overtakes coal to be the largest source of electricity in the 2040s under both scenarios. To be on track for net zero, Indonesia will need to leverage all available zero carbon generation technologies including nuclear, hydrogen and carbon, capture and storage.

- **Emissions trajectory differs significantly between an economics-led and net-zero pathway:** In the ETS, Indonesia's power sector emissions only peak in 2039 at 372MtCO2e, tied closely to coal consumption in the power sector. Under the NZS, Indonesia's power sector emissions need to peak 15 years earlier than in the ETS, in 2024 at 279MtCO2e. Concerted policy intervention is needed to drive this acceleration.

Discussions on climate commitments need to focus on implementation frameworks

- **Indonesia's decarbonization targets lag its Group of 20 (G-20) peers**: Indonesia intends to achieve net-zero emissions by or before 2060. The country's target falls short of the 2050 target year recommended in the 2018 IPCC Special Report on 1.5 Degrees. Its clean energy targets can also be more ambitious. Indonesia targets only 23-25% of renewable energy generation in 2030, the lowest among G-20 countries.
- **Clear decarbonization pathway for clarity:** Indonesia released several potential decarbonization pathways to achieve its emissions target. The proposed targets are, however, inconsistent across the different roadmaps. Aligning these targets will provide clear guidance to market participants and help to focus efforts on the most important steps to enable Indonesia's net-zero future.
- **Regulatory and market reforms are needed to accelerate renewable energy growth:** Renewables in Indonesia face a myriad of regulatory and power market challenges. Indonesia has moved to ease some of these barriers but more needs to be done to level the playing field for renewables against coal power plants. While planning for a carbon tax, Indonesia also continues to subsidize coal for power generation which sends mixed signals to the market. Indonesia's procurement process for renewables is also opaque. A clearly defined auction and capacity pipeline can help to attract investments.

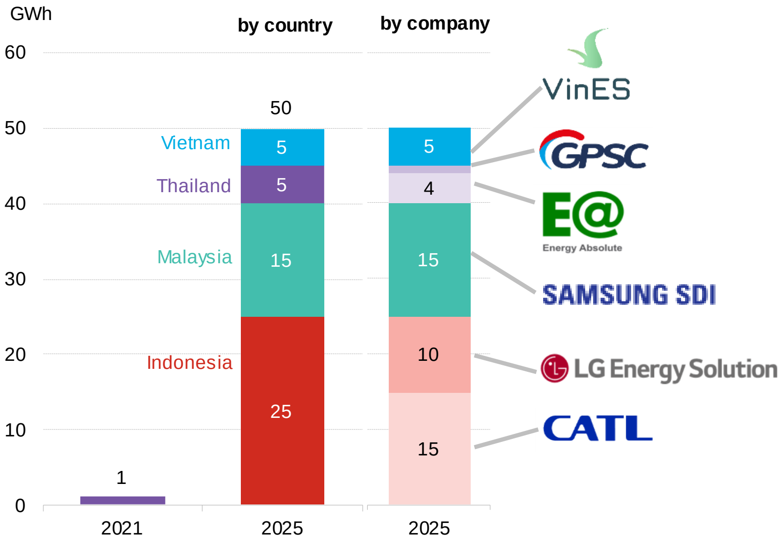
Indonesia's coal sector impacted by the global energy transition:

- **Indonesia's coal export market shrinks:** Indonesia is currently the world's largest exporter of thermal coal. Coal consumption in its largest export markets – China, Southeast Asia, India, Japan, and Korea – which accounted for over 90% of all coal exports from Indonesia in 2021, would decline by 50-80% during 2020-50 in the NZS. A just transition pathway for Indonesia's coal sector would require support for carbon capture and storage for domestic coal power plants.

Electric vehicle and battery manufacturing opportunity available for Indonesia

- **Indonesia's potential as a global battery manufacturing hub:** Global electric vehicle (EVs) sales are rising quickly, which will drive substantial growth in demand for lithium-ion batteries over the next three decades. Indonesia, which has about a quarter of all nickel reserves globally, can become a critical part of the global EV battery supply chain.
- **Two main barriers for Indonesia's EV battery manufacturing growth prospects:** Limited domestic demand for EVs hence batteries make it less attractive for manufacturers to build large manufacturing facilities in the country currently. The country's high reliance on coal power plants for electricity and the lack of corporate renewable procurement mechanisms also increase the environmental footprint for battery manufacturing. These challenges can be overcome by accelerating domestic EV demand and clean power adoption.

Figure 3: Proposed lithium-ion battery cell manufacturing capacity in Southeast Asia



Source: BloombergNEF, company press releases, news articles. Logos from company website.

Unprecedented levels of energy investment opportunities in Indonesia during 2020-50

- **$2-3.5 trillion investment opportunity to be unlocked:** Over the next three decades, Indonesia requires an annual average of $69 billion and $122 billion under the ETS and NZS respectively, equivalent to 5-10% of Indonesia's GDP in 2021. Under NZS, zero carbon generation sources in the power sector will be the biggest driver of energy supply investments. The investments need to be front-loaded, with 44% of total investments from 2022 to 2050 happening between 2026 and 2035 alone.
- **Indonesia needs to act quickly:** Implementing the necessary regulatory and market reforms to unlock investments is crucial. The Indonesian government needs to meet investors' interest in the market with a domestic investment environment that provides long-term clarity and a stable pipeline of opportunities.

Section 2. Indonesia energy transition to date

Indonesia, once considered a laggard in the global decarbonization agenda, is quickly establishing its desire for a net-zero future through pledges around early coal power plant retirements, more ambitious 2030 emission reduction target and the release of potential decarbonization scenarios and pathways.

While momentum is growing and progress is being made, the work is just beginning for Indonesia. The country's historical focus on coal power development to drive economic growth and the entrenched coal mining industry pose a big barrier in its decarbonization journey. Financial and technical solutions will be required to mitigate emissions from coal.

Indonesia's current progress, clean power targets and carbon pricing mechanisms are still lagging some of its Group of 20 (G20) peers. Its renewable energy market is also challenged by a highly regulated power market with policies that favor coal.

As targets are being set and pathways explored, implementation is now key to Indonesia achieving a net-zero emissions future. Indonesia needs to focus on translating its proposed goals into tangible action plans and reforms to attract investment into the country's decarbonization.

Decarbonization and climate commitments are making their way into Indonesia's government agenda and plans. Driven by pressure to shift away from fossil fuels and eager to capture opportunities from the global energy transition, Indonesia is now exploring opportunities such as carbon market mechanisms and electric vehicles to support the country's decarbonization pathway. This section looks at Indonesia's energy transition to date relative to the rest of G-20.

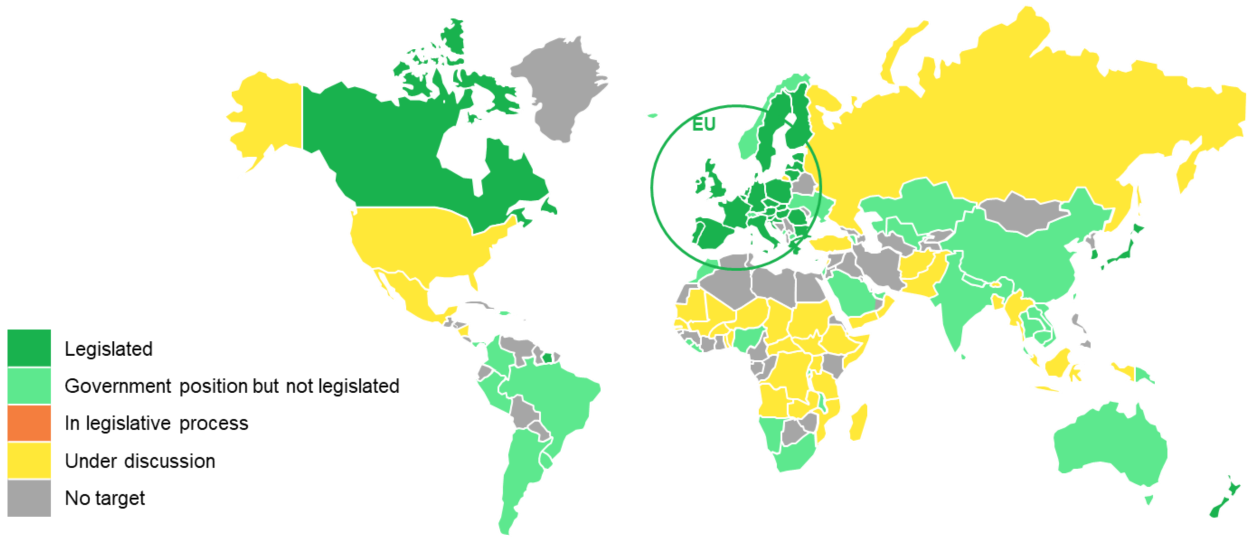
2.1. Net-zero targets

All G-20 countries have set some form of long-term climate commitment. In 2021, Indonesia joined its peers in considering targeting net-zero emissions by or before 2060. Several Indonesian ministries and international agencies have released potential net zero scenarios and pathways for the country. These are discussed further in Section 3.

Not all net-zero emission targets are equal and Indonesia's target lags some of its G-20 counterparts in several aspects. Unlike countries such as the UK and Japan, the Indonesian government has yet to legislate its net-zero target, making it less of a binding commitment than that of some of its peers. The 2060 target year referenced is domestically recognized as the official government position and adopted by several state owned enterprises such as PT Pertamina (Pertamina) and PT Perusahaan Listrik Negara (PLN).

Indonesia's by or before 2060 net zero target year is less ambitious than some of its G-20 peers. Germany has the most aggressive legislated target of achieving net-zero emissions by 2045. Indonesia's target also falls short of the recommendations from the 2018 IPCC Special Report on 1.5 Degrees which states that global net-zero emissions have to be achieved by mid-century to limit the global temperature increase to 1.5C above pre-industrial levels.

Figure 4: Global net-zero emission targets and status



Source: Governments, BloombergNEF

2.2. Power sector transition

Clean power targets lack ambition

The power sector is the largest contributor to emissions in Indonesia and one of the lowest-hanging fruits for the country's decarbonization efforts. Progress has been slow in Indonesia due to a highly regulated power market structure and overly optimistic historical demand projections leading to significant coal power capacity build out. In BNEF's G-20 Zero-Carbon Policy Scoreboard – Issue 2022 (web | terminal), Indonesia showed some improvements from 2021 but still scored the lowest in the power sector among all G-20 members.

Figure 5: Power – 2021 scores

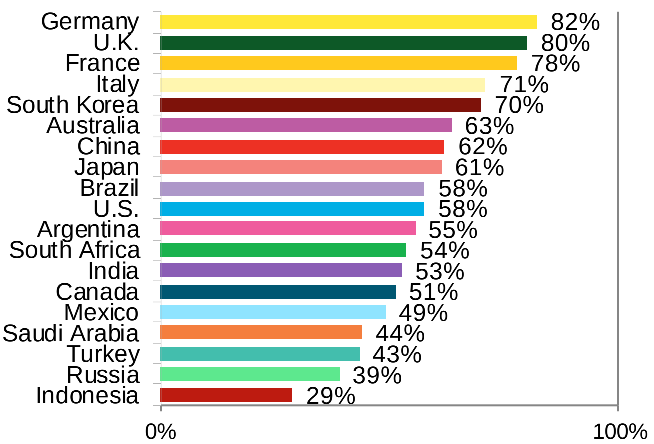
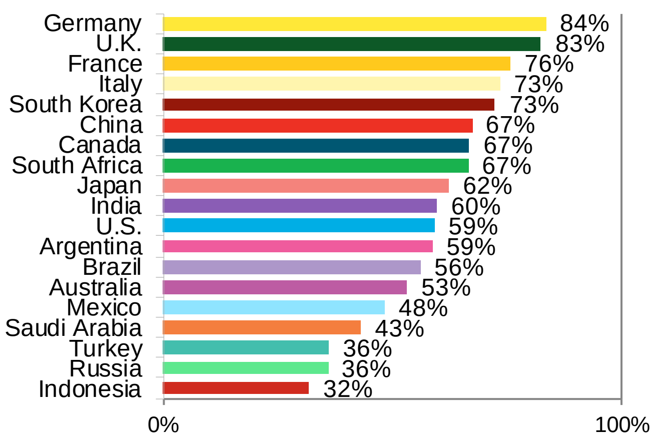


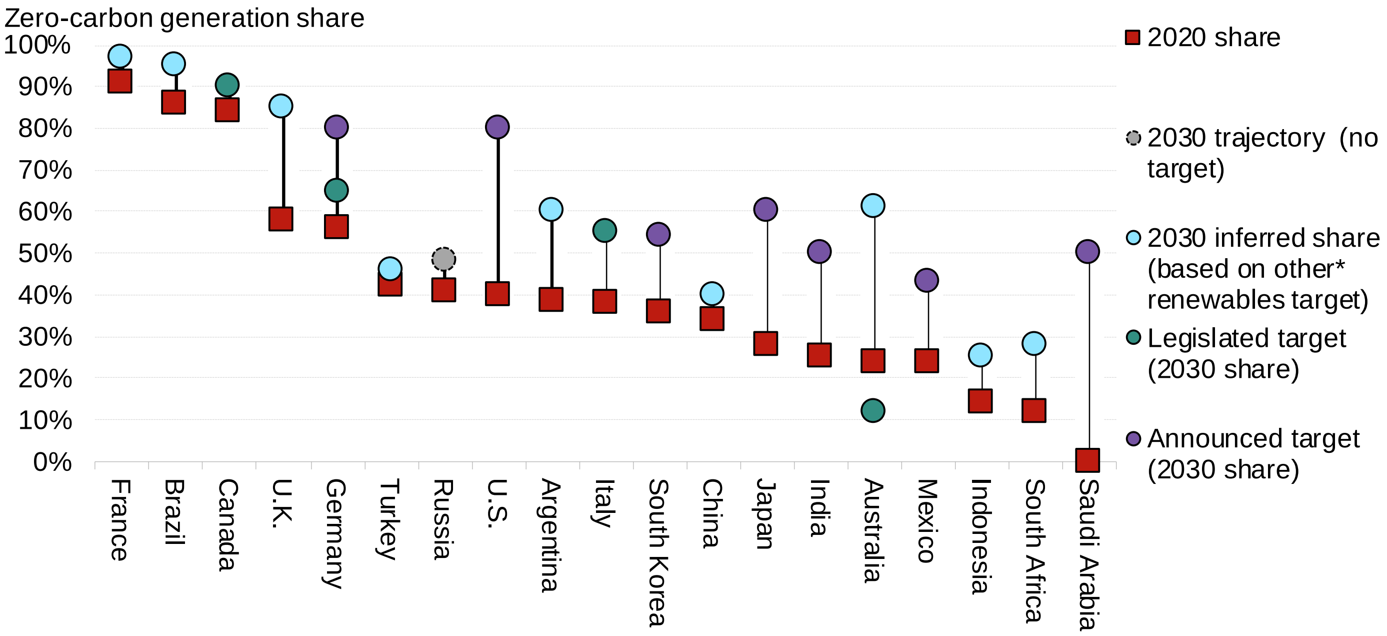
Figure 6: Power – 2022 scores



Source: BloombergNEF. Note: Unweighted scores. Where possible, the 2021 scores have been recalculated using the 2022 methodology and may differ from those in the published 2021 report.

Indonesia's clean energy targets under the state-owned utility, PLN's 2021 electricity supply business plan (known as the RUPTL) while higher than prior plans, are still relatively low. While some countries including China and India also have target years of 2060 and beyond, their progress on renewable energy deployment to-date is far more significant than that of Indonesia. India, although aiming to achieve net-zero emissions only in 2070, has a renewable energy target to reach 500GW by 2030. The country also targets for non-fossil fuels to account for 50% of power generation capacity in the same year (See 2H 2022 India Renewables Market Outlook (web | terminal). China aims to achieve 1,200MW of wind and solar capacity by 2030, a comfortable target given its 679GW of cumulative installed solar and wind capacity as of 2021. In contrast, Indonesia's latest RUPTL plans for only 4.6GW of solar and 0.6GW of wind capacity addition from 2021-30. It also targets only 23-25% of renewable energy generation in 2030, the lowest among G-20 countries (Figure 4).

Figure 7: G-20 nations' estimated share of zero-carbon power generation in 2030 based on government targets compared with 2020 shares



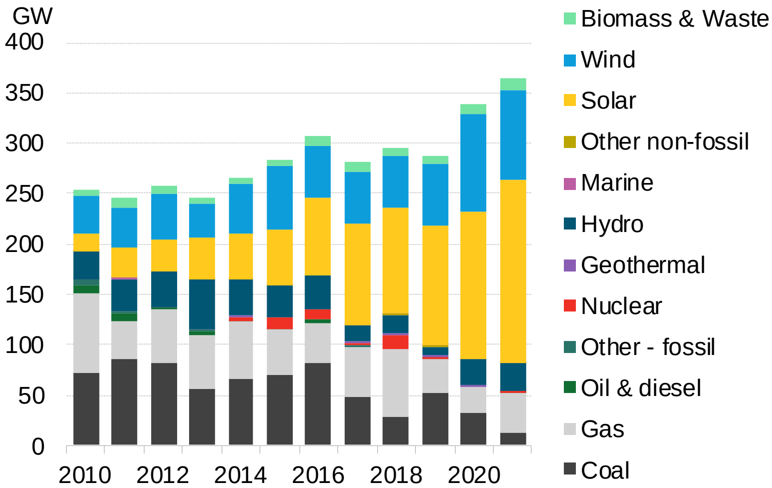
*Source: BloombergNEF. Note: * Other renewables targets include UK 2035 target, capacity-based goals and government scenarios for reaching an emissions target. If a target excludes nuclear, BNEF estimates have been added to the targeted renewables share*

Limited renewable investments and opportunities

Global power capacity addition has shifted from fossil fuels towards renewables over the last decade with solar out-installing all other technologies at 900GW. In 2021, total solar and wind capacity addition accounted for 272GW (75%) of global net capacity addition. In contrast, fossil fuels slumped to their lowest levels at 52GW (14%), with coal leading the decline.

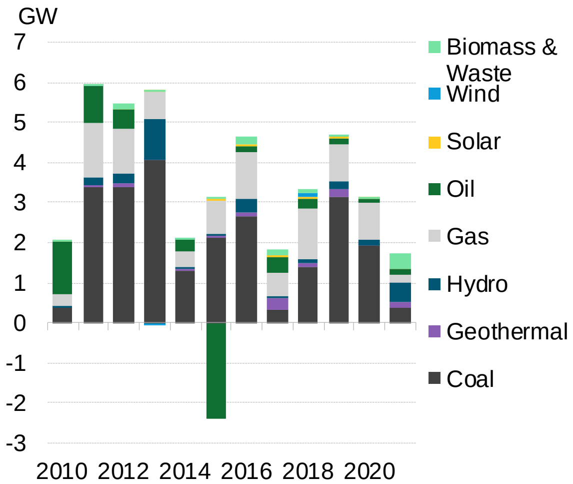
Fossil fueled thermal power plants are still dominant in Indonesia. Between 2012 and 2021, coal and gas power plants accounted for 62% and 24% of the country's power capacity addition respectively. Historical power development plans focused on leveraging the country's abundant coal resources and prioritized coal plant development to meet growing power demand in Indonesia.

Figure 8: Global annual capacity additions by technology



Source: BloombergNEF

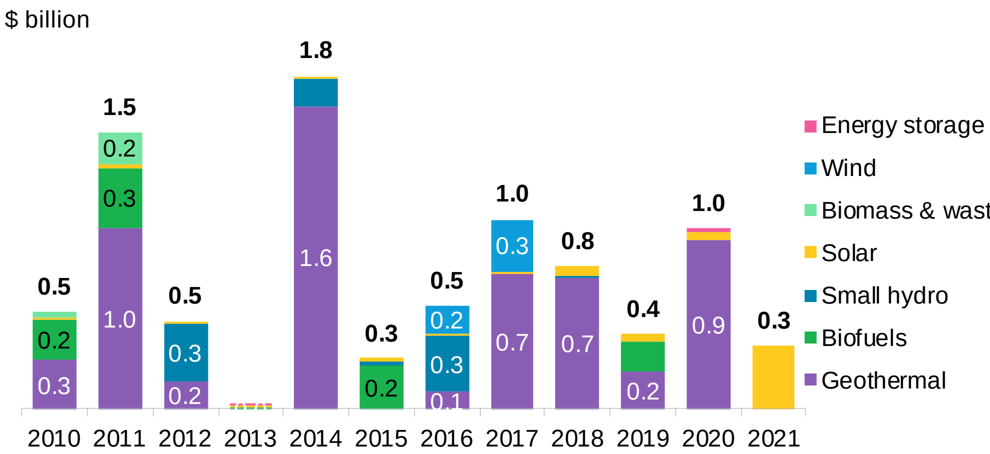
Figure 9: Indonesia annual capacity addition by technology



Source: BloombergNEF

Despite its sizable economy, Indonesia has attracted limited investment in renewables (Figure 10) due to a myriad of challenges. *See Scaling Up Solar in Indonesia (web | terminal).* Between 2012-21, Indonesia's renewable energy investments totaled just $6.7 billion, a mere 0.2% of global energy transition investment in the same duration. Renewable investments in Indonesia are dependent on sporadic deals and experience large annual fluctuations. The vast majority over the last decade targeted geothermal, which accounted for 65% ($4.37 billion) of total renewable investments from 2012-21. Over the last 10 years, Indonesia's solar and wind investments were negligible at just $1 billion, compared to the total global investment of $3.2 trillion. As of 2021, Indonesia has only 209MW of solar and 155MW of wind capacity installed.

Figure 10: Indonesia's annual energy transition investment



Source: BloombergNEF

Large-scale renewables

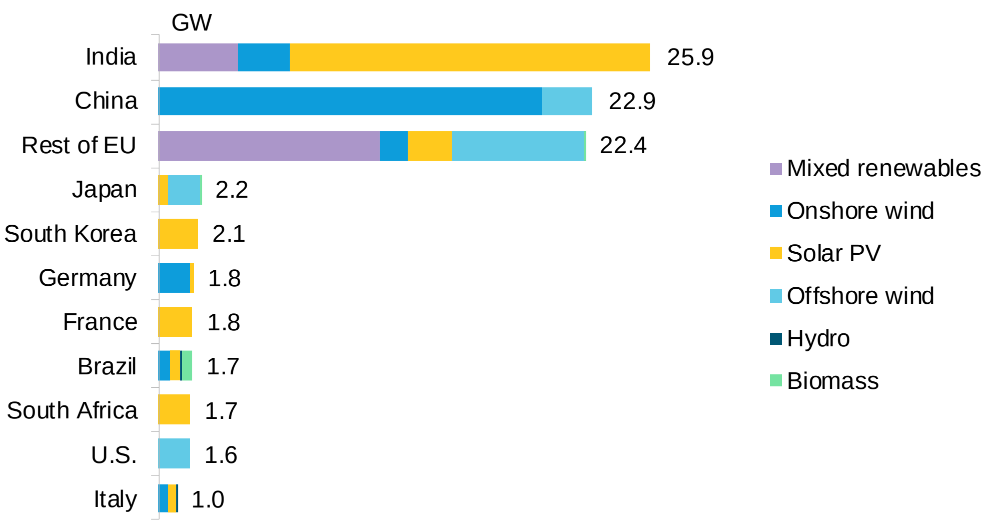
Auctions

The main policy instruments for promoting large-scale renewable projects across the G-20 are auctions and renewable portfolio standards. Cumulatively, auctions have allocated support to 463GW of renewables capacity across the G-20 nations and the EU, of which 85GW was contracted in 2021.

Indonesia has limited support schemes in place for renewables, although the government is trying to change that with the release of Perpres 112/2022. Indonesia does not have a renewable portfolio standards scheme and large-scale auctions have been limited after a 2013 large-scale solar auction by the Ministry of Energy and Mineral Resources (ESDM) was deemed unconstitutional by the Supreme Court. Since then, the only mechanism has been infrequent solar tenders by PLN.

Progress is being made on this front. The recent presidential regulation specified that for some technologies such as solar and wind, projects will be tendered based on a capacity quota to be determined by ESDM and implemented by PLN. Direct involvement by the ministry to determine the capacity quota to be awarded can help if the plans lay out a clear and firm pipeline of opportunities.

Figure 11: G-20 renewables auctions results of 2021

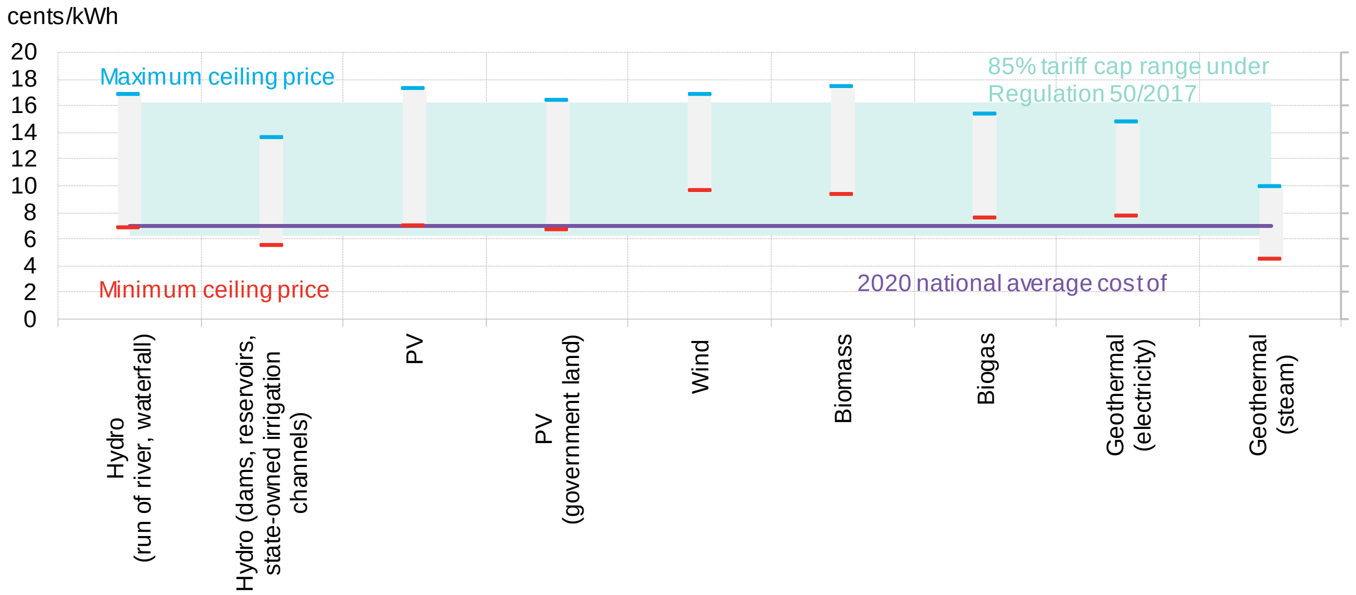


Source: BloombergNEF

Renewable energy tariffs

Administratively allocated fixed feed-in-tariffs are still supporting many existing renewables plants but have largely been phased out for new projects over 1MW across the G-20. Feed-in tariffs have played a small role in driving renewable energy build in Indonesia. The country's previous renewable energy tariff framework under Regulation 50/2017 pegged renewable energy tariffs to the local and national average cost of generation (Biaya pokok penyediaan or BPP). Previous tariff caps at 85% of the local BPP forced renewables to compete with subsidized coal power generation. These tariffs were considered too low in Indonesia's main demand centers. Indonesia had previously discussed the potential re-introduction of feed-in tariffs to boost renewable energy development, but instead released revised benchmark ceiling prices tiered by technology, operational year, capacity, ownership and location of the projects. While disappointing overall, this allows investors of comparatively costlier technologies, such as hydro and wind projects, to be able to negotiate a higher rate but the scale of development is still dependent on opportunities laid out by the ministry and PLN.

Figure 12: Ceiling price range for first 10 operational years of new private renewable projects



Source: BloombergNEF, Perpres 112 of 2022. Note: Ceiling prices shown are for new, privately developed projects, tiered by technology, project size and location.

Corporate power purchase agreements

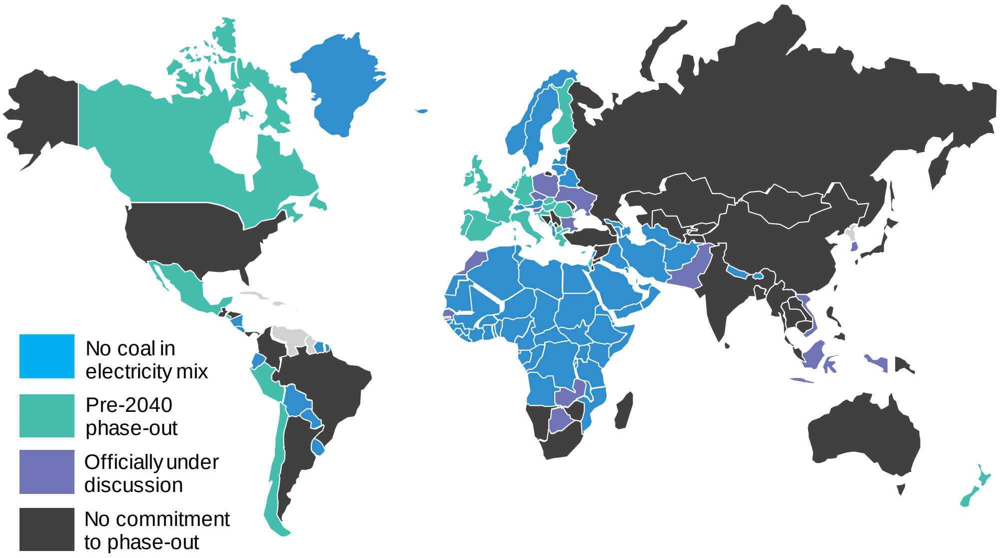
Corporate PPAs provide a significant route to market for renewable energy projects that do not receive government subsidies such as feed-in tariffs. Across the G-20, corporates signed PPAs with almost 30GW of renewable energy projects in 2021, setting a new record above the 2020 level of 23GW. The US leads the way, with 17GW capacity signed during the year, as its large technology companies are procuring clean power to meet their sustainability targets.

In contrast, Indonesia's power market structure is yet to allow for direct PPAs between companies and energy generators, but companies can still drive renewables growth by building or leasing onsite renewable power plants for self-consumption.

Fossil fuel phase-outs

Legislated phase-outs of fossil fuel generation, if well executed, have the advantage of providing a long-term plan for transitioning the power generation mix. France will be the first G-20 nation to phase out coal-fired power and plans to shut its last plants by end-2022. It will be followed by the UK in 2024, Italy in 2025, Canada and Argentina in 2030 and Germany in 2038. Indonesia is yet to make any formal coal phase-out pledges but discussions are underway, including PLN's proposed scenario of phasing out all coal plants by 2056.

Figure 13: Coal phase-out commitments across more than 27 countries



Source: BloombergNEF. Note: Countries in light gray are not covered by BNEF.

Transforming Indonesia's coal-dominated power system will require strong political will and investment. Years of overly optimistic power demand growth forecasts leading to aggressive coal plant build have resulted in a significant coal power fleet locked in long-term off-take contracts that could be financially costly for the state utility to terminate prematurely.

Under the 2021 RUPTL, Indonesia still expects new coal capacity addition until 2029, to provide 59-64% of power supply in 2030. This is despite the country's announcement of a coal moratorium in May 2021 to prohibit new coal plants except those that are under construction or financed. At COP26, Indonesia also signed the Coal to Clean Power Transition Statement but stopped short of agreeing to phase out coal by 2040. Instead, Indonesia will consider accelerating coal phase-out in the 2040s depending on international support.

The intention to phase out coal was reiterated in the newly issued presidential regulation 112 of 2022 on renewable energy. The president called for the formation of a roadmap for coal plant retirements but also left concessions for new coal plants to be built.

2.3. Carbon pricing

Carbon pricing has helped to cause fossil fuel plants to shut, even if there is no legislated coal or gas phase-out target in place. More than 60 carbon markets and taxes have been implemented globally, covering around a quarter of global greenhouse-gas emissions. A total of 13 G-20 countries have nationwide carbon pricing, and the US has several state-level programs. The EU member states and UK currently fare best with their higher carbon prices, and higher share of national emissions covered by carbon pricing.

Figure 14: Share of national emissions covered by carbon price

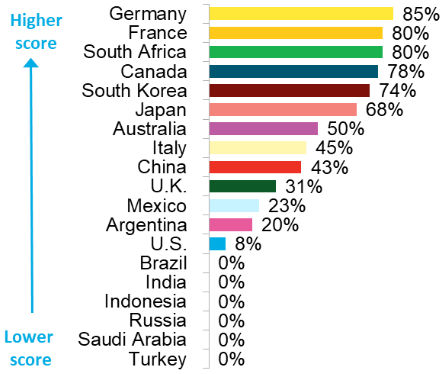


Figure 15: Price for carbon taxes and markets

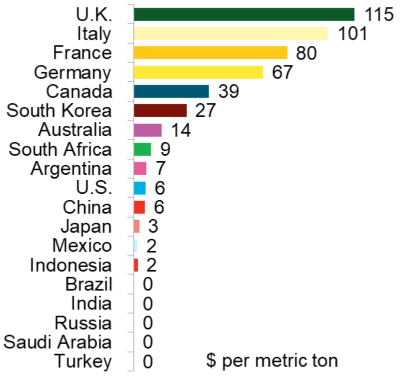
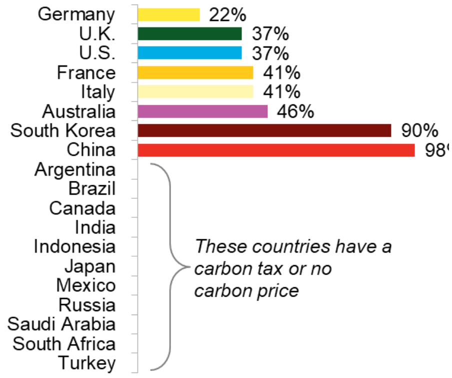


Figure 16: Share of free allocation for carbon markets

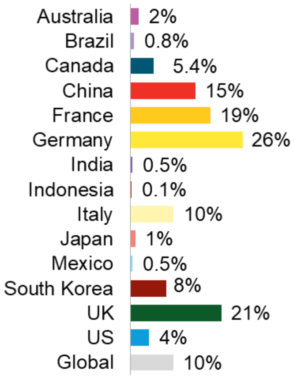


Source: Governments, registries, Bloomberg. Note: International, national or state/province-level policies only. Latest prices available. April 2022 price for Canada. Emission share takes account of overlapping schemes. For countries with multiple schemes, the price is a weighted average based on the emissions of each program.

Indonesia has a planned carbon tax starting at 30,000 rupiah ($2.1)/MtCO2e, applicable to coal power plants. The carbon tax initially slated for implementation in April 2022 was initially delayed to the end of 2022. The country, however, recently announced that it will be further postponed to 2025. The current level of $2.1/MtCO2e is unlikely to result in a switch away from coal to lower emitting power sources. Indonesia's carbon tax also co-exists with indirect subsidies for coal power generators.

2.4. Transport

Figure 17: EV share of passenger vehicle sales, 2021



Source: BloombergNEF

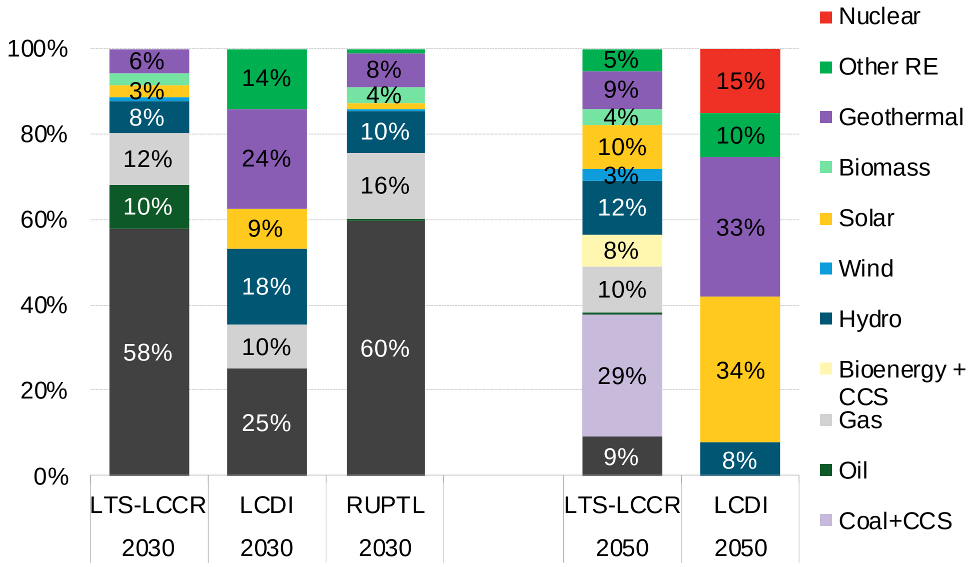
Energy use from road transport is also on the rise in most markets, rising 1.2% per year in the G-20. Oil derived fuels still dominate the fuel mix for road transport, averaging 96% in the G-20 in 2019. Rising greenhouse-gas emissions from road transport make cleaning up the sector a priority for governments.

In Indonesia, the transport sector is the second largest contributor to emissions after the power and heat sector. While Indonesia has been moving to establish local domestic electric vehicle (EV) and battery manufacturing, policy support to boost local EV demand has been limited so far. In 2021, electric vehicles comprised only 0.1% of new passenger vehicle sales in Indonesia compared to 26% in Germany and 10% globally. Lagging many of its G-20 peers, Indonesia currently has not had a fuel economy target nor EV purchase subsidies to drive domestic EV adoption. This contrasts with France, Germany and Italy which offer the most robust support for EVs. All three countries also introduced significant EV support in their respective Covid-19 stimulus packages in early 2020 which helped to drive sales.

Section 3. Indonesia's decarbonization plans

Net-zero discussions have been gaining momentum in Indonesia. Over the last two years, Indonesian government ministries and state entities have published decarbonization roadmaps for the country. However, the proposed pathways and targets in these roadmaps are inconsistent, and the country has yet to formally adopt a net-zero goal. The Low Carbon Development Initiative is the most ambitious document with the aim to replace all of Indonesia's power generation with clean sources.

Figure 18: Indonesia electricity generation mix under the country's energy roadmaps*



*Source: BAPPENAS, Indonesia Ministry of Environment and Forestry, PLN. Note: LCDI = Low Carbon Development Initiative; LTS-LCCR = Long-Term Strategy for Low Carbon and Climate Resilience 2050; RUPTL = PLN's Annual Electricity Business Plan. *For roadmaps with multiple scenarios, the scenario most favorable towards decarbonization is shown.*

3.1. Decarbonization plans

In 2021, Indonesia published three plans that now serve as reference documents for the country's goal of achieving net-zero emissions by or before 2060:

- Long-Term Strategy for Low Carbon and Climate Resilience 2050 (LTS-LCCR)
- Low Carbon Development Initiative (LCDI)
- PLN's 2021 Electricity Business Plan (RUPTL)

These plans include scenarios with common goals of reaching peak emissions by 2030 or earlier as well as net-zero emissions by 2060; however, they differ on the technology pathways. Under the low carbon scenarios of each document, the LTS-LCCR expects renewables to account for 20%[1] of electricity generation in 2030 while the LCDI expects 60%. PLN's RUPTL expects 24.8%.

[1] Estimated based on Figure 16 in the Indonesia LTS-LCCR 2050

The LTS-LCCR envisions coal as the primary electricity source even until 2050, whereas the LCDI assumes coal's role will diminish beyond 2035. PLN's RUPTL calls for coal retirements starting in 2030. As a country heavily reliant on coal, how to tackle emissions from coal is a key challenge for Indonesia.

Table 1: Summary of Indonesia's decarbonization scenarios

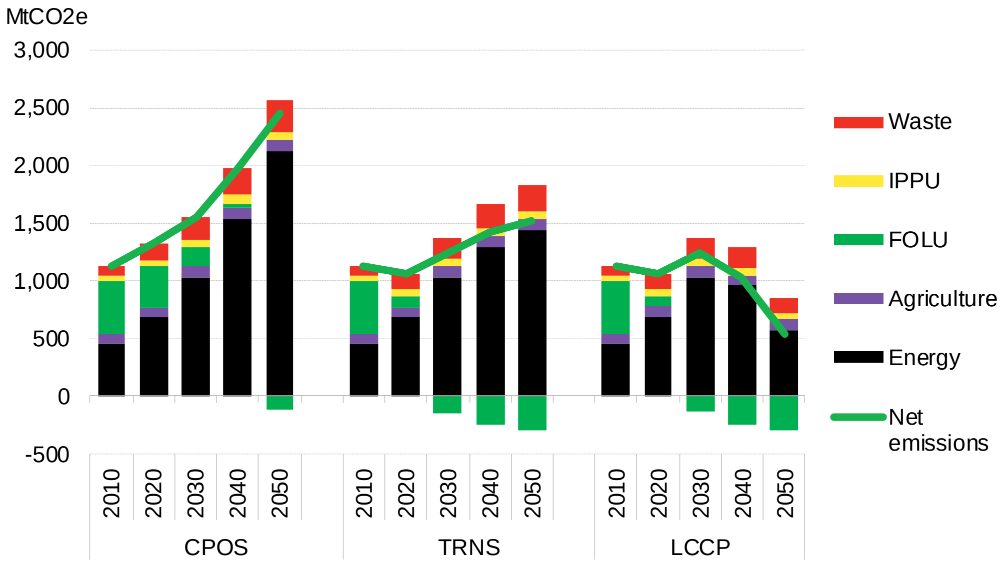
Policy document (Published date)	Description	Publishing agency	Sectors covered	Long-term scenarios included	Target renewable share in electricity	Coal power generation outlook	Year of peak emissions
Long-Term Strategy for Low Carbon and Climate Resilience 2050 (LTS-LCCR) (July 2021)	To balance emission reduction and economic development	President of Indonesia and Ministry of Environment and Forestry (KLHK)	1) Agriculture, forestry, and other land uses 2) Energy 3) Waste 4) Industrial Processes and Product Use	1) Current Policy Scenario (CPOS) 2) Transition Scenario (TRNS) 3) Low Carbon Scenario Compatible with Paris Agreement target (LCCP)	20% by 2030, 40% by 2060	58% in 2030, and 40% by 2060	Best scenario (LCCP): 2030
Low Carbon Development Initiative (LCDI) (September 2021)	Green recovery in the wake of COVID-19 pandemic	Ministry of National Development Planning (BAPPENAS)	1) Agriculture, forests and land use 2) Energy 3) Waste management and industry	1) A revised Reference Case 2) Three new scenarios to reach net-zero emissions (NZE) by 2045, 2050, and 2060	60.14% by 2030, 82% by 2060	25.1% in 2030, no coal generation by 2035	Net-zero scenarios: 2024
Annual Electricity Business Plan (RUPTL) (September 2021)	10-year business plan focusing on efficient investment in power projects	State Electricity Company (PLN)	Electricity	1) Optimal 2) Low carbon	25% by 2030	59% in 2030	Unclear

Source: LTS-LCCR, LCDI, RUPTL

3.2. Long-Term Strategy for Low Carbon and Climate Resilience 2050

The LTS-LCCR, formally submitted to the United Nations Framework Convention on Climate Change (UNFCCC), is the first plan to reference the goal of net-zero emissions by 2060, although its three scenarios – current policy scenario (CPOS), transition scenario (TRNS), low carbon scenario compatible with the Paris Agreement (LCCP) – still expect greenhouse-gas emissions in 2050 to range from 540 to 2,454MtCO2e.

Figure 19: Indonesia greenhouse gas emissions under the three scenarios included in the Long-Term Strategy for Low Carbon and Climate Resilience 2050



Source: LTS-LCCR, BloombergNEF. Note: IPPU refers to Industrial Processes and Product Use, FOLU refers to Forestry, and Other Land Uses. CPOS: Current Policy Scenario, TRNS: Transition Scenario, LCCP: Low Carbon Scenario Compatible with Paris Agreement target

Lowest emission pathway

The LCCP scenario of the LTS-LCCR calls for three measures to achieve emission reduction:

1. Implementation of energy-efficient solutions
2. Deployment of large-scale renewables, coal power plants outfitted with CCS/CCUS, and the use of biofuels in transport
3. Electrification of buildings and transportation

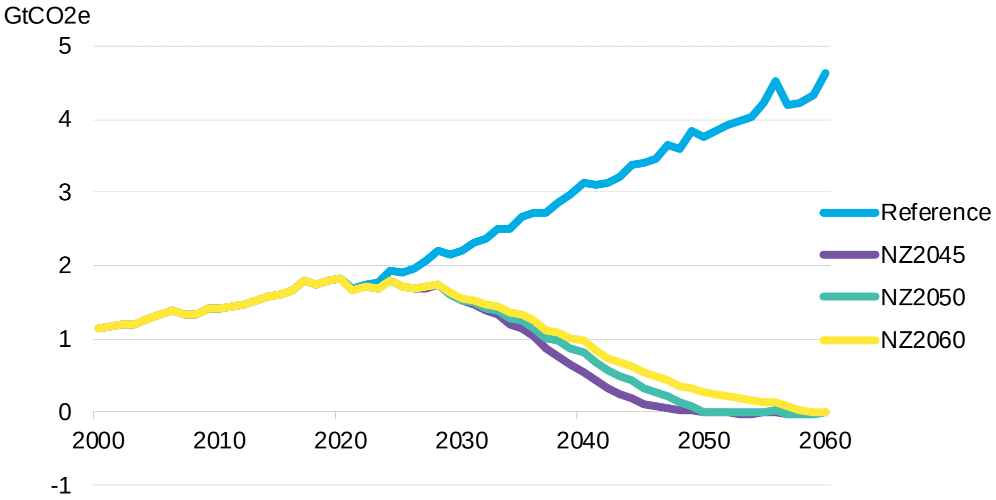
The long-awaited presidential regulation on the acceleration of the development of renewable energy for electricity supply (Perpres 112 of 2022) published on September 15, 2022, suggests the country is not yet ready to implement policies in line with the LCCP scenario of the LTS-LCCR. For more information on Perpres 112 refer to *Indonesia Holds Back on Coal Phase-Out, Renewables Support* (web | terminal).

3.3. 2021 Low Carbon Development Initiative

The 2021 LCDI prepared by the Ministry of National Development Planning is the second plan referencing net-zero by 2060. The LCDI was prepared in collaboration with external partners such as the United Kingdom Foreign Commonwealth and Development Office. Some of these external partners are involved in the International Just Energy Transition Partnerships, an initiative launched at COP26 to help decarbonization efforts of countries reliant on coal power.

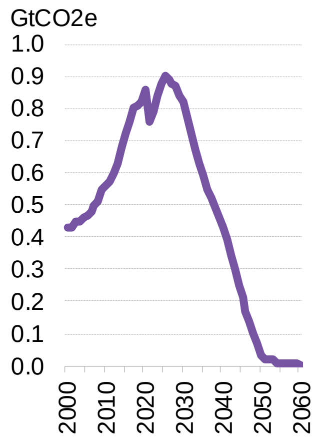
The 2021 LCDI net-zero scenarios do not represent a commitment to net-zero; rather they provide potential pathways to achieve the net-zero target, compliant with Indonesia's unconditional 2030 NDC target. All three net-zero scenarios envision Indonesia reaching peak emissions in 2024 at 1.8GtCO2e. The three net-zero scenarios consider similar technology pathways differing only on deployment timelines.

Figure 20: Indonesia annual greenhouse gas emissions, historical and outlook under reference and net-zero scenarios



Source: BAPPENAS, LCDI, BloombergNEF

Figure 21: Indonesia energy sector emissions under LCDI NZ2050 scenario



Source: BAPPENAS, LCDI

Pathways to net zero

The LCDI projects primary energy demand to more than triple to 31.9TJ in 2060 from 9.3TJ in 2021. From 2021-60, the LCDI forecasts two-thirds of the emissions reduction will come from the energy sector, as compared to 25% from the agriculture, forestry and other land use sector (AFOLU). Similar to the LTS-LCCR, the LCDI net-zero scenarios call for energy efficiency and decarbonization of the power sector. The LCDI differs from the LTS-LCCR by explicitly calling for introduction of a carbon price from 2022, electrification of road transport and development of a domestic hydrogen value chain to enable full electrification and the phase-out of biofuels.

In contrast to the LTS-LCCR preference for biofuels, the LCDI is very supportive of electric vehicles (EV) and envisages a future that consists of almost all EVs and hydrogen-fueled vehicles by 2060. The LCDI projects energy efficiency gains will help to achieve 10% energy savings per unit of GDP by 2060 against 2021 levels, with EV adoption being a main contributor. The LCDI highlights the need to balance competing land use for biofuels and food. Biofuels would need extensive land and can increase emissions due to peatland fires. From 2030, the LCDI proposes a phase-out of biofuels.

The LCDI factors in a carbon tax from 2022. Indonesia previously planned to implement a 30,000 rupiah ($2.02)/tCO2e on coal from April 2022, however implementation has been indefinitely postponed.

The LCDI also calls for phase out of fossil fuel subsidies by 2030. Indonesia's latest 2023 national budget issued on August 16, 2022, allocated 210.7 trillion rupiah ($13.8 billion) for energy subsidies - fuel, liquid petroleum gas and electricity – a slight increase from the 208.9 trillion rupiah ($13.7 billion) in the 2022 budget. Over the last decade, the Indonesian government has been gradually reducing fossil fuels subsidies, however a complete phase-out remains sociopolitically challenging as exemplified by this September's protests against reduction of subsidies for road fuel.

PLN's Electricity Supply Business Plan 2021-2030

While the LTS-LCCR and LCDI outline economy-wide decarbonization plans, PLN's RUPTL focuses only on the power sector. The latest iteration published on September 28, 2021, covers a planning duration up to only 2030 while considering Indonesia's NDC commitments and proposed 2060 net-zero goal. The RUPTL refers to the energy trilemma of energy security, energy equity and environmental sustainability. It states that renewable energy technologies are still not yet competitive against coal power generation in Indonesia. This is primarily due to Indonesia's current power market structure as well as indirect subsidies for coal power generation. We expect the levelized cost of electricity generation from utility-scale solar to become cheaper than new coal power plants in Indonesia by 2023. For more, refer to *See Scaling Up Solar in Indonesia* (web | terminal) and *1H 2022 LCOE Update* (web | terminal).

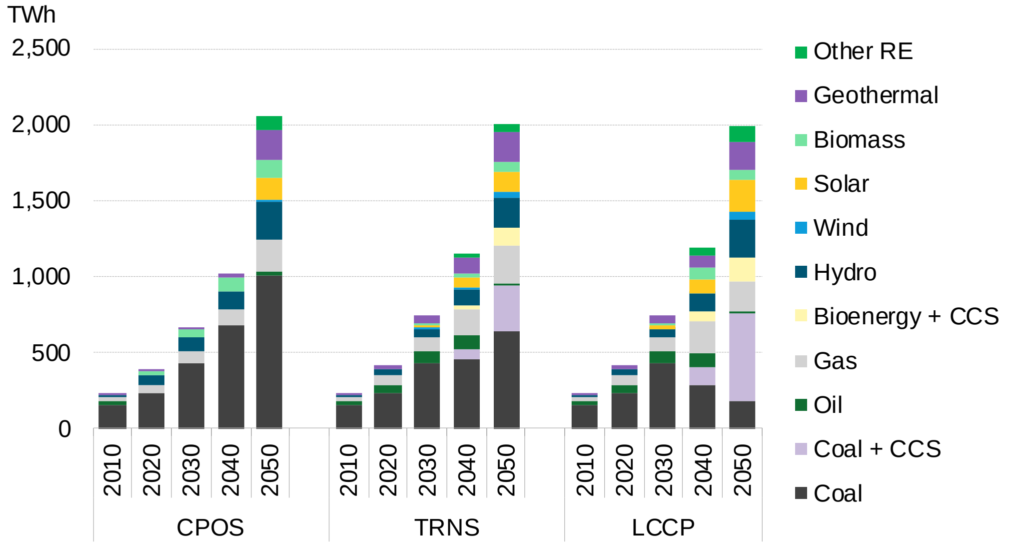
In the latest RUPTL, PLN commits to carbon neutrality by 2060. PLN forecasts that its emission will peak at 349MT in 2030 and follow a linear downward trajectory thereafter. The RUPTL does not detail the technology pathway post 2030. It expects emission reductions to be achieved via a combination of renewables, fuel switching and co-firing (diesel to biofuel, coal with biomass), exhaust gas re-use, and deployment of CCS/CCUS. For more on the latest RUPTL, refer to *Indonesia's Latest Power Plan May Miss Renewable Target* (web | terminal).

3.4. Power mix under the energy roadmaps

The three documents present distinct pathways to net zero.

LTS-LCCR

Figure 22: Indonesia power generation mix under CPOS, TRNS, and LCCP scenarios



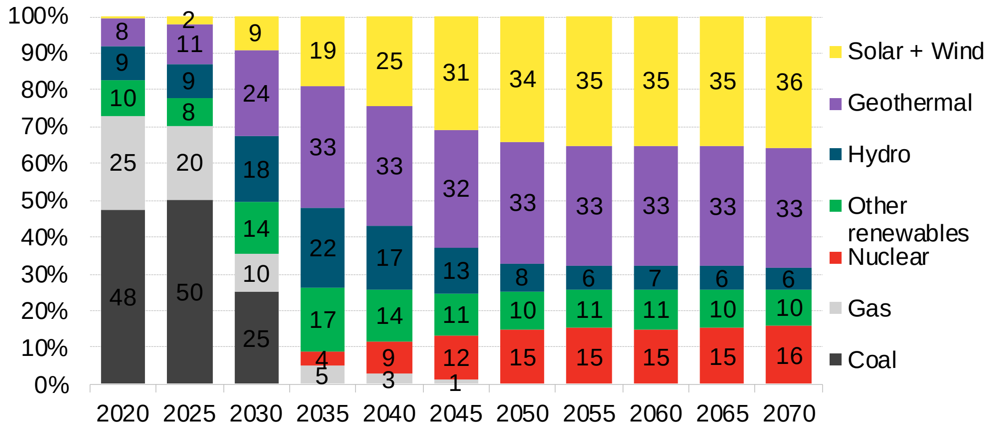
Source: LTS-LCCR. CPOS: Current Policy Scenario, TRNS: Transition Scenario, LCCP: Low Carbon Scenario Compatible with Paris Agreement target

In the LTS-LCCR, the power generation mix difference between the CPOS, TRNS, and LCCP scenarios is significant. Coal is the main energy source under CPOS, whereas TRNS and LCCP envision a reduced role for coal. All three scenarios expect thermal power plant capacity to continue growing until 2050. Even the lowest emission scenario, the LCCP, expects a compound annual growth rate (CAGR) of 4% for thermal power plants from 2020 to 2050. The LCCP scenario expects emissions from coal power plants are mitigated by retrofitting 76% of coal plants with CCS by 2050. The LCCP scenario aspires to achieve a power generation mix consisting of 43% renewables, 38% coal, 10% natural gas, and 8% biomass energy with carbon capture (BECCS) in 2050. The scenario also calls for smart micro grids and off-grid systems in areas with high renewables potential.

LCDI

The LCDI outlines the most aggressive decarbonization pathways for the power sector compared to the other roadmaps. To fully decarbonize the power sector, its three net-zero scenarios call for increasing the share of renewables in the power generation capacity from 18% in 2020 to 82% by 2053. The three net-zero scenarios also call for introduction of nuclear power from 2030, with nuclear power supplying the remaining 18% of electricity generation by 2060. In contrast to the LTS-LCCR, the LCDI looks to phase out coal power plants by 2035 and gas power plants by 2050.

Figure 23: Indonesia power generation capacity mix under the LCDI net-zero scenario



Source: LCDI, BloombergNEF. Note: The LCDI projects the same power generation mix for all of its net-zero scenarios.

Section 4. Indonesia's energy transition pathways

Indonesia faces a unique set of challenges on the decarbonization of its energy sector. The country not only has to contend with a deeply entrenched fossil fuel industry, but it also must balance its climate goals along with meeting increasing energy demand in an affordable and sustainable manner to power economic growth and development.

Indonesia is the world's fourth most populous country and has one of the fastest growing economies in the Asia-Pacific region. It also aims to achieve high-income country status by 2045, the nation's centennial year. The country's archipelagic nature adds to further logistical challenges and in national planning

Scenarios

This outlook builds on results from our forthcoming New Energy Outlook 2022. This year's report will present country-level harmonized pathways for nine economies that show what a credible pathway to net zero could look like. Full country and global results will be published at the end of November.

The New Energy Outlook (NEO) is BNEF's long-term scenario analysis on the future of the energy economy covering electricity, industry, buildings and transport and the key drivers shaping these sectors until 2050.

The New Energy Outlook 2022 covers two main scenarios:

- The **Economic Transition Scenario (ETS)** is our baseline assessment of how the energy sector might evolve from today as a result of cost-based technology changes. The ETS combines near- to medium-term market activity, the uptake of new consumer-facing energy products, least-cost system modeling and trend-based analysis to describe the deployment and diffusion of commercially available technologies. Technology transition only occurs in this scenario where it lowers system cost or offers an attractive pay-back proposition for consumers. Population and economic activities across the world continue to expand in line with historic trends and demographic shifts, taking into account changing demand for various industrial commodities, as well as consumer goods and utility.

  The ETS incorporates legislated and firm near-term policy, but does not assume either country-level, or corporate, long-run energy and climate objectives are met. In this way the ETS describes how the energy sector might evolve in the absence of further major climate policy intervention.
- The **Net Zero Scenario (NZS)** describes an economics-led evolution of the energy economy to meet net-zero emission in 2050 with no overshoot or reliance on carbon removal technologies post-2050. We take a sector-led approach to decarbonization. Countries' carbon budgets are largely determined by the sectoral make-up of their economies, and the expected growth in those sectors. Neither historical responsibility nor availability of finance are taken into consideration.

  The NZS combines faster and greater deployment of renewables, nuclear and other low carbon dispatchable technologies in power with the uptake of cleaner fuels in end-use sectors, most notably hydrogen and bioenergy. Carbon capture and storage (CCS) emerges towards the end of the decade, allowing fossil fuels to continue to be used in electricity generation and industry. Additionally, accelerated electrification and increased recycled materials production further contribute to emissions reductions. The NZS is therefore not an extension of the ETS. It describes a fundamentally different energy economy.

While the technological choices in the NZS are primarily guided by economics, we also account for country strategic priorities and strengths, firm and legislated existing policy, and local resources.

This report is the first in a series of country- and sector-focused reports providing a deep dive on the results of NEO 2022. Forthcoming notes will be published in 1H 2023.

4.1. Energy sector

Final energy demand

Indonesia's total final energy demand reaches 10,621PJ in 2050 under the ETS, equivalent to 61% growth from 6,681PJ in 2021 (Figure 26). In the NZS, final energy demand grows just 20% or an average of 1% annually over the same period, reaching 7,961PJ in 2050 (Figure 2).

Lower overall demand for energy under net-zero results mainly from greater electrification of final energy demand, which tends to be more efficient than fossil fuel combustion. Electric vehicles (EVs), for example, use one-third the energy compared to internal combustion engine vehicles and heat pumps only use a fraction of the energy to provide the same utility as a gas boiler.

Figure 24: Indonesia total final energy demand by fuel, Economic Transition Scenario

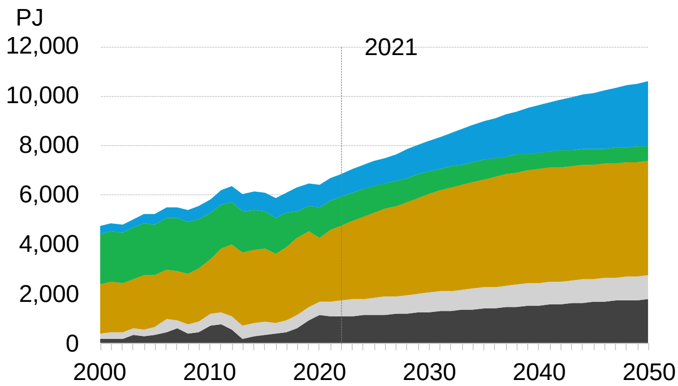
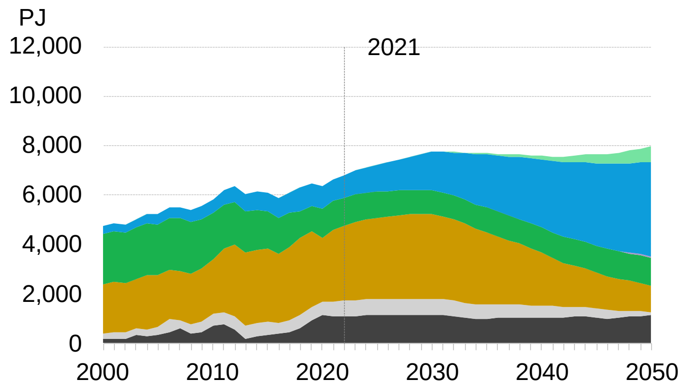


Figure 2: Indonesia total final energy demand by fuel, Net Zero Scenario



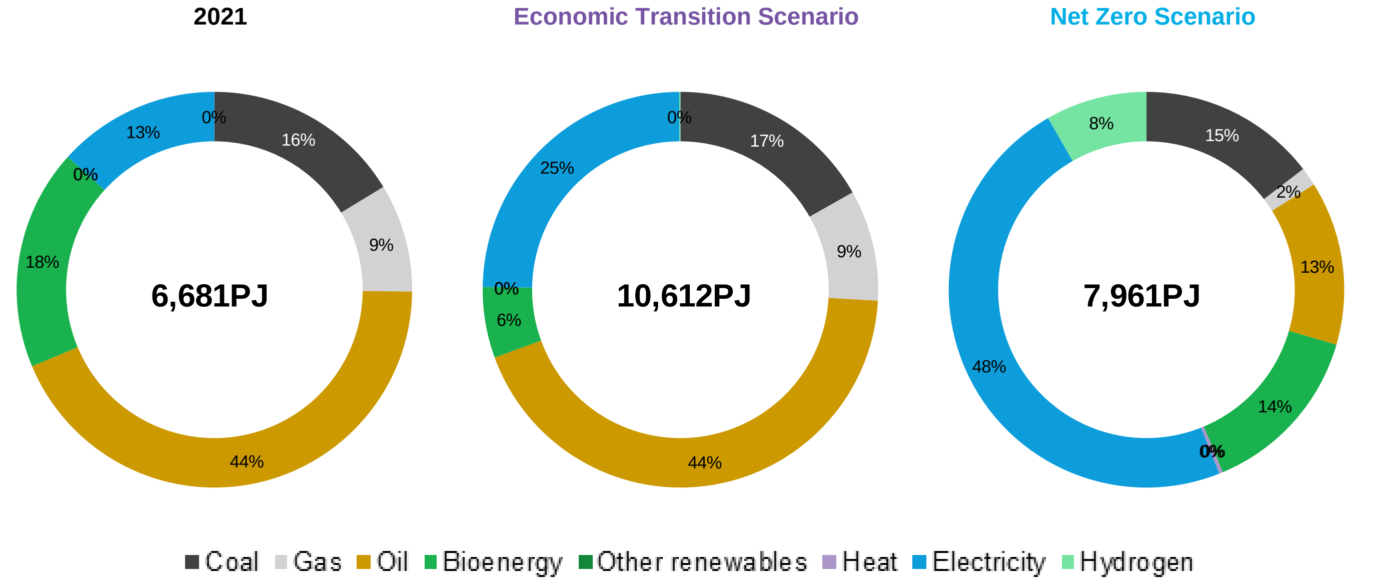
Coal Gas Oil Bioenergy Other renewables Heat Electricity Hydrogen

Source: BloombergNEF

Source: BloombergNEF

Electrification increases the energy efficiency of Indonesia's energy system, leads to lower final energy demand and is also easier to decarbonize. In the NZS, electricity quadruples from 2021 levels to supply 48% (3,799PJ) of total final energy in 2050 compared to just 25% in the ETS (Figure 30 and Figure 31). Decarbonization of Indonesia's power system will thus be critical for the country's net-zero emissions goal.

Figure 26: Indonesia final energy consumption by scenario



Source: BloombergNEF

Hydrogen development in Indonesia is still nascent, largely limited to feasibility studies or proposed pilot projects. Indonesia also does not yet have any regulatory or policy frameworks in place to accelerate clean hydrogen development in the country. Nonetheless, clean hydrogen plays a growing role in Indonesia's final energy demand from 2024 in the NZS, particularly in industry and for own use in the energy sector, including for fuel refining.

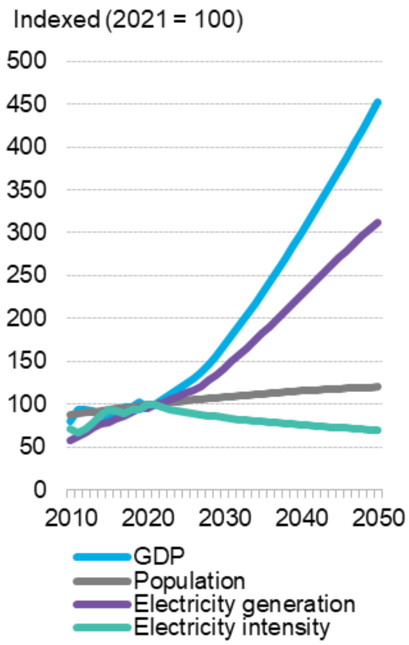
The focus on renewable energy is rising within Indonesia, helped by increasingly competitive economics and growing momentum among policymakers on decarbonization. NEO 2022 scenarios expect Indonesia's power mix to transform from one dominated by fossil fuel to one where solar becomes the largest source of electricity generation.

Economics alone are, however, insufficient to bring Indonesia to net-zero emissions in the power sector. Current barriers for zero carbon generation sources in the form of regulatory and policy structure (or the lack thereof) and power market structure hold back Indonesia's energy transition. To attract more investments into its power sector, the government needs to address these challenges and create an enabling environment for its power sector transition.

Electricity demand

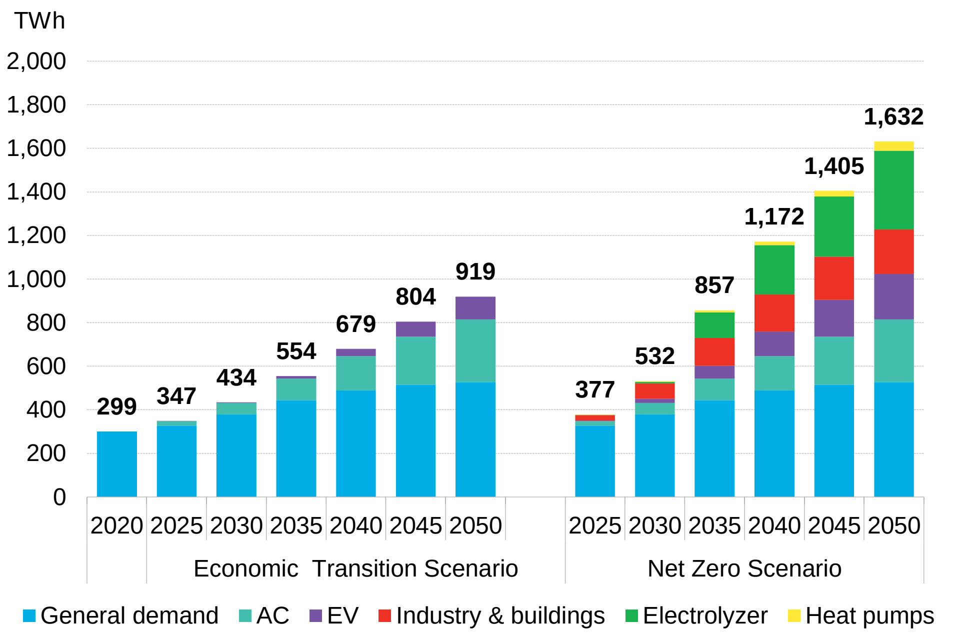
Indonesia's electricity demand has been constantly rising over the years, increasing at an average of 6% year-on-year over 2001-21. 2020 saw power demand drop slightly at 1% YoY due to the Covid-19 pandemic, but demand growth bounced back strongly in 2021. Strong economic and population growth continues to drive up electricity demand throughout the outlook period.

Figure 27: Indonesia's macroeconomics indicator and electricity generation



Source: BloombergNEF, World Bank

Figure 28: Final electricity demand by sector, Economic Transition Scenario and Net Zero Scenario



Source: BloombergNEF.

Between 2021 and 2050, Indonesia's gross domestic product (GDP) is expected to rise 352% at an average 5.3% year-on-year (YoY) growth and population increases by 20% (or 55 million people) (Figure 27). In the mid-2020s, power demand growth starts to decouple from GDP as increased energy efficiency and a gradual shift towards the services sector as Indonesia's economy develops lead to a decline in electricity intensity.

In the ETS, Indonesia's gross electricity demand (including losses) more than triples to 966TWh in 2050, up from 309TWh in 2021. Final electricity demand also grows to 919TWh by 2050 from just 306TWh in 2021 (Figure 28).

In 2043, Indonesia overtakes final electricity demand of Germany, of which it is currently about half the size in 2021. Rising urbanization in Indonesia drives increased adoption of air-conditioning (AC) across residential and commercial buildings. In 2050, AC power consumption makes up 31% of final electricity demand. Indonesia currently lacks any incentive to drive electric vehicle (EV) adoption domestically and contributes less to electricity demand growth in Indonesia. By 2050, EVs account for 11% of total final electricity demand from almost zero in 2022.

As more sectors electrify in the NZS, power demand increases even further. By 2050, final electricity demand reaches 1,632TWh, a fivefold increase compared to 2021 levels. This is based on even greater EV adoption compared to the ETS and electrification of industrial and buildings processes (including heat pumps) that does not occur in the ETS. Together, EVs, heat pumps and electrified industrial and buildings make up 28% of final electricity demand in 2050.

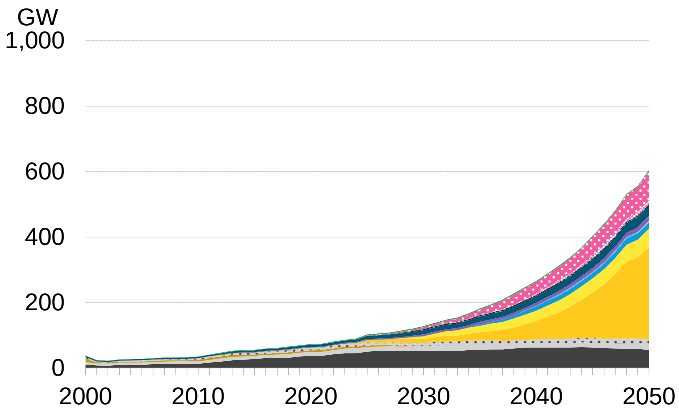
Hydrogen in our modeling plays a role in decarbonizing hard-to-abate sectors, and a limited role as back-up capacity in the power sector to balance the grid during critical hours.

We assume all hydrogen is produced and consumed locally, with the majority produced from grid-connected electrolyzers using low-carbon electricity. Electrolyzers in our proprietary NEFM-2 power model work as a fully flexible demand class able to deploy dynamically during least-cost hours, while meeting minimum yearly capacity factors. As such, electricity demand from electrolyzers grows to 361TWh by 2050 (Figure 28) to account for 22% of final electricity demand in the NZS. Between 2022 and 2050, the development of the hydrogen economy in Indonesia will require more than 4,000TWh of additional electricity. In addition to electrolysis, we assume 15% of hydrogen in Indonesia to be produced from fossil fuels with CCS ('blue' hydrogen).

Capacity and generation

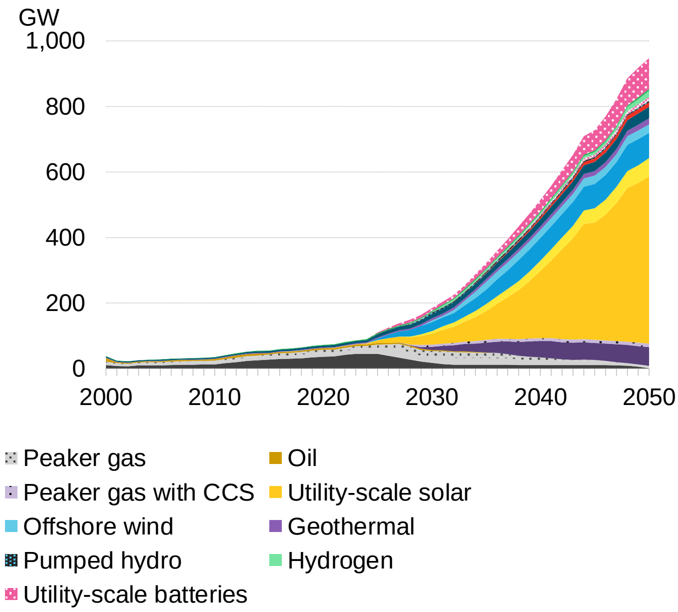
Indonesia's power demand growth will require a massive expansion of its power system. In the ETS, the country's installed power capacity expands more than eightfold to 605GW by 2050 in the ETS, up from 75GW in 2021 (Figure 29). In the NZS, installed capacity increases to 948GW by 2050 – a 12-fold increase from 2021 levels – to meet increased demand from deeper electrification of Indonesia's energy system (Figure 30).

Figure 29: Indonesia installed electric capacity, Economic Transition Scenario



Source: BloombergNEF

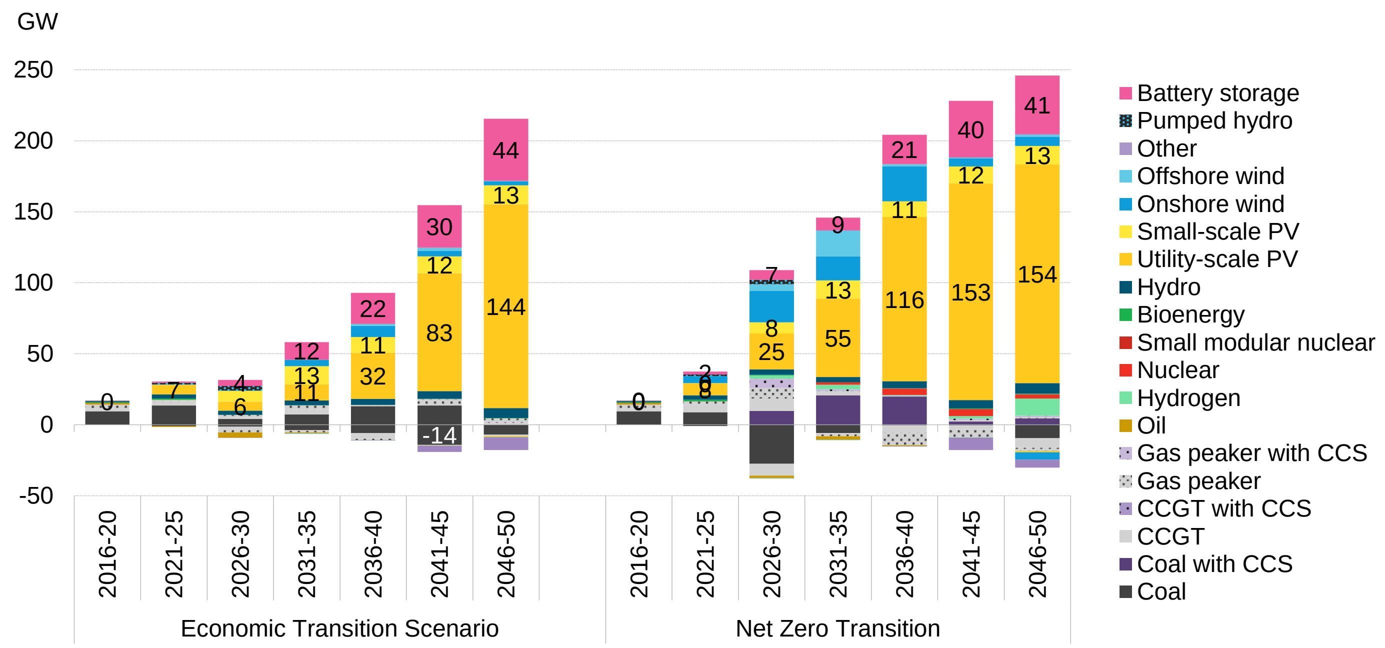
Figure 30: Indonesia installed electric capacity, Net Zero Scenario



Source: BloombergNEF

Over the last two decades, fossil fuels have been the technology of choice to build out Indonesia's power system. In both scenarios, a complete reversal of this trend is observed for new capacity additions (Figure 31). Over 2022 to 2050, zero carbon capacity outpaces the addition of new fossil fuel capacity additions in Indonesia. In the ETS, Indonesia adds an average 20GW of additional capacity annually between 2022 and 2050, of which zero carbon sources averages at 13GW/year compared to fossil fuels at 3GW/year. In the NZS, Indonesia sees an average 26GW of zero carbon sources and 4GW of fossil fuel capacity installed annually. In both scenarios, an average of 4GW of energy storage capacity is installed annually to support growing renewable penetration.

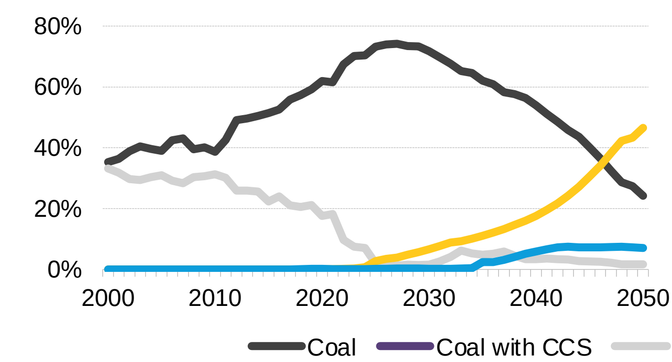
Figure 31: Indonesia gross capacity addition and retirement



Source: BloombergNEF. Note: Positive values are capacity additions, negative values are capacity retirements.

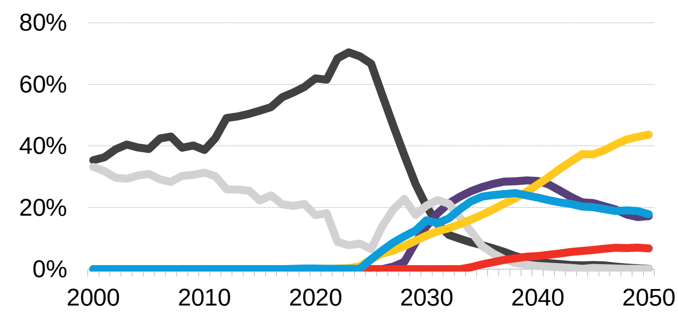
Indonesia's generation mix also sees a significant transformation (Figure 1 and Figure 2). Under the ETS, coal's share rises to a peak of 74% by 2027 and then declines to 24% in 2050. By then, the combined share of renewables in electricity supply reaches 74%. Under the NZS, Indonesia's electricity demand is set to grow fivefold by 2050, as electricity takes a greater share of final energy demand by, for example, replacing the role of oil as road transport fuel. 75% of 2050 electricity supply under the NZS would come from renewables, with the remainder supplied by coal power plants equipped with carbon capture and storage (17%) and nuclear (7%).

Figure 32: Share of electricity generation by technology, Economic Transition Scenario



Source: BloombergNEF

Figure 33: Share of electricity generation by technology, Net Zero Transition



Source: BloombergNEF

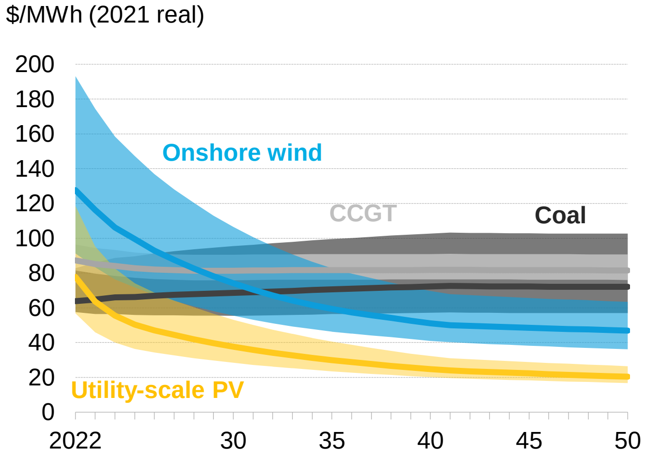
Renewables overtake fossil fuel in both capacity and generation

Renewables account for just 16% (11.6GW) of Indonesia's installed power capacity and 18% (56.2TWh) of generation in 2021. Hydro, geothermal and biomass together supply almost all of Indonesia's renewable power. Wind and solar are yet to take off in Indonesia with a combined 400MW of installed capacity contributing a mere 0.2% of power in 2021.

As Indonesia embarks on its decarbonization pathway, solar takes centerstage in the power system. In the ETS, solar makes up more than half of total gross capacity additions from 2022-50, to reach a cumulative 340GW by 2050, up from about 200MW in 2021. The lower capacity factor of the technology means more solar capacity needs to be added to replace every megawatt of a fossil fuel plant. Solar capacity additions in Indonesia will first be led by small-scale solar between 2026-35, after which utility-scale solar capacity additions start to accelerate with the majority of installations between 2041 and 2050.

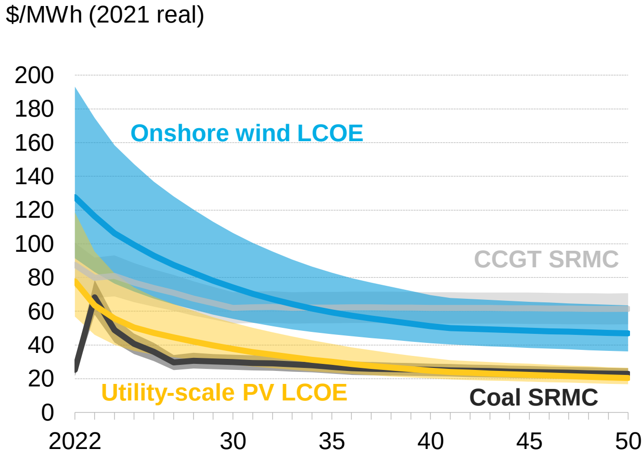
In the NZS, solar accounts for 59% of total gross capacity additions over 2022-50. In absolute terms, a total of 598GW of solar is added over 2022-50. Compared to the ETS, utility-scale solar capacity additions start to ramp up earlier from 2026 to meet the higher electricity demand while reducing grid emissions (Figure 31).

Figure 34: Indonesia levelized costs of electricity for new power plants



Source: BloombergNEF 1H 2022 Levelized Cost of Electricity

Figure 35: Indonesia LCOE of new PV and onshore wind vs. short-run marginal costs for coal and gas plants



Source: BloombergNEF 1H 2022 Levelized Cost of Electricity. Note: LCOE stands for levelized cost of electricity and SMRC refers to short-run marginal cost.

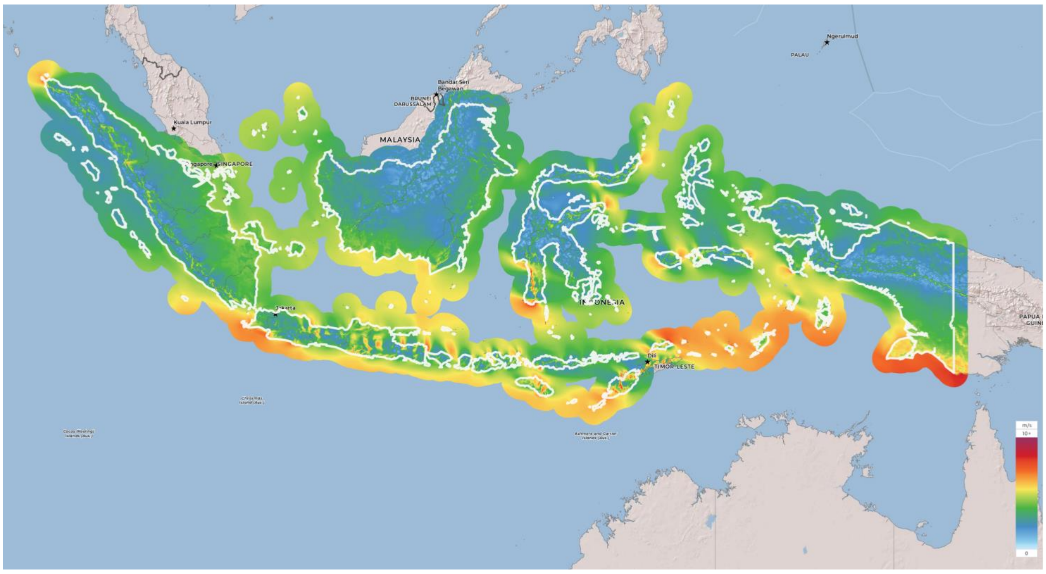
Wind plays a much smaller role in Indonesia's power mix compared to solar under both scenarios. Indonesia, which lies on the equator, has comparatively poorer wind resources (Figure 39). The country sees a mean wind speed of just 3m/s compared to 8.4m/s in Denmark, 6m/s in India and 4.8m/s in Vietnam. The lower wind speed, and hence capacity factor of a wind plant, lead to a higher generation cost than a coal-fired or solar power plant (Figure 34). A new wind plant only becomes cost competitive against a new CCGT and a new coal plant in 2029 and 2032 respectively. Wind plants are also not expected to undercut the marginal running cost of an existing gas or coal plant in Indonesia throughout the outlook period (Figure 35).

As a result of the comparatively poorer economics for wind plants in Indonesia, less capacity gets built compared to solar. In the ETS, onshore wind capacity additions between 2022 and 2050 account for just 3% (19.5GW) of total capacity additions in Indonesia. In 2021, Indonesia only has 154MW of installed wind capacity. Only 4GW of offshore wind capacity gets built over the same duration (Figure 31).

In the NZS, onshore and offshore wind capacity additions increase significantly over the ETS, but still pale in comparison to solar. 81GW of onshore wind and 26GW of offshore wind are added between 2022 and 2050, to cumulatively make up 11% of total capacity additions in the NZS.

The lower installed wind capacity is helped slightly by the technology's higher capacity factor compared to solar. In 2050, wind provides 7% (68TWh) and 18% (300TWh) in the ETS and NZS respectively, up from 0.4TWh in 2021.

Figure 36: Indonesia estimated wind speeds



Source: Global Wind Atlas. Note: Map shows mean wind speed at 100m. Offshore wind potential shown for up to 100km from shore.

Geothermal and hydro are technologies of interest in Indonesia's power sector planning. In 2021, the technologies provide a combined 14% of electricity. In Indonesia's current electricity supply business plan (RUPTL 2021), the proposed capacity additions of geothermal and hydro at 5GW and 3.4GW respectively, account for 50% of planned renewable energy capacity additions (excluding pumped hydro) between 2021 and 2030.

In the ETS, geothermal capacity increases more than sixfold between now and 2050 to reach a cumulative installed capacity of 15GW by 2050, up from 2.3GW in 2021. In the NZS, cumulative geothermal capacity reaches 18GW by 2050.

Indonesia also adds 26GW and 29GW of hydro capacity in the ETS and NZS respectively from 2022 to 2050, driving cumulative hydro capacity to between 32GW to 35GW in 2050 (Figure 31).

Development of geothermal and hydro plants, however, faces the challenge of longer development timelines and delays from land acquisition and financing challenges. Geothermal and hydro retains its share in Indonesia's generation mix under the ETS, providing one-fifth of the country's electricity demand in 2050 in the ETS and 13% in the NZS.

Fossil fuels

As renewables ramp up, fossil fuel, particularly coal, loses its dominance in Indonesia's power system. In the ETS, the share of coal capacity falls to 9% of total installed capacity by 2050 from 50% in 2021. Absent any policy intervention, Indonesia will continue to see new unabated coal build until 2045 in the ETS. 51GW of new coal capacity is added, expanding the coal fleet by 50% to total 55GW in 2050 (Figure 31).

CCS plays a key role in Indonesia's decarbonization scenario, with early deployment a priority to start abating emissions. In the NZS, Indonesia sees a cumulative 58GW of coal capacity in 2050, of which only 1GW is unabated. The remaining 57GW of coal plants are equipped with carbon, capture and storage (CCS) to mitigate emissions. While our modeling also shows closures of unabated coal plants, we expect that in reality a high proportion of new plants get retrofitted with CCS. Still, the share of coal in Indonesia's installed generating capacity falls to 10% by 2050, down from 50% in 2021, under the NZS.

The operational profile for coal plants also changes, from providing constant baseload today to supporting a renewables-led system as back-up during critical hours by 2050. Today, coal supplies over 60% of Indonesia's overall power demand. As renewables get more cost-competitive (Figure 34), the share of coal in Indonesia's generation mix shrinks to 24% in the ETS, peaking in 2039 at 379TWh. Even under the NZS with generation entirely from coal plants equipped with CCS, coal plants supply only 17% of Indonesia's 2050 power demand with a peak generation of 371TWh in 2040.

New coal build in Indonesia faces increasing challenge from the smaller pool of available financing for the technology, but also targets and national policies to prohibit new coal power plants. Indonesia is also exploring financing schemes to enable the early retirement of coal plants. Indonesia's plan to rely on CCS to mitigate emissions is, however, subject to other considerations such as the availability of carbon storage sites and associated infrastructures and the technical compatibility of the coal plants with CCS. Please see Section 4.2 for more details.

Gas retains its minor role in Indonesia's power system. Net CCGT capacity increases by just 2GW in the ETS and declines by 6GW in the NZS between 2022 and 2050, displaced by cheaper renewable technologies. A new solar plant in Indonesia today already outcompetes the marginal running cost of an existing CCGT plant. Instead, Indonesia's power system shifts towards gas-fired peaker plants to maintain grid flexibility and balance the growing share of variable renewables. Gas could play a part as a bridging fuel around 2025-35, as unabated coal generation ramps. As renewable penetration increases however, the overall share of gas generation plummets from 18% in 2021, to 2% in the ETS and almost zero in the NZS by 2050, squeezed by cheaper renewables and other flexible capacities (Figure 32 and Figure 33).

Other zero carbon technologies

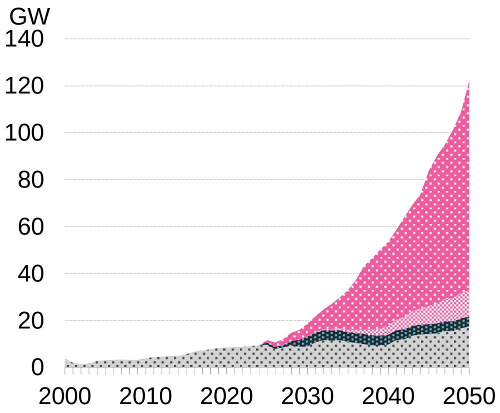
Despite the massive scale up, solar, wind, geothermal and hydro alone are not sufficient to enable a net-zero energy system in Indonesia. In the NZS, Indonesia needs to diversify its power mix, leveraging on all available technologies, including nuclear. Some 14GW of nuclear in the NZS support Indonesia's decarbonization of its power sector to supply 7% (114TWh) of total power demand in 2050 (Figure 31). Enabling nuclear capacity build as part of a broader energy mix will depend on overcoming several hurdles. Nuclear faces challenges in terms of sociopolitical acceptance, not just domestically but also regionally across the ASEAN region.

Flexible capacity

Indonesia's grid has been built for large, centralized baseload generation plants with little need for managing intermittency today. Variability in the grid today is managed through 9GW of existing peaker gas plants alongside the ramping up and down of coal and gas plants. As the penetration of wind and solar scales to more than 50% by 2050, new flexible capacities such as peaker gas with CCS and batteries are needed to manage variability. Under both scenarios, cumulative flexible capacity reaches 122GW by 2050, with batteries (Figure 37 and Figure 38). However, a similar overall amount of flexible capacity in the NZS is used to balance a significantly larger and more decentralized power system than the ETS.

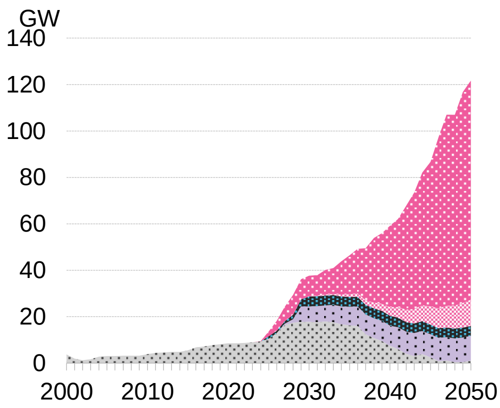
The NZS sees a larger build out of gas peaker plants in the 2030s compared to the ETS, when renewable energy penetration grows rapidly. The higher overall power demand in the NZS means that coal and CCGT plants are running at baseload levels for longer. During times of extended low generation from renewables, gas peakers become the technology of choice for the longer balancing duration, complemented by batteries for the shorter peaking periods.

Figure 37: Indonesia cumulative capacity of flexible sources, Economic Transition Scenario



Source: *BloombergNEF*

Figure 38: Indonesia cumulative capacity of flexible sources, Net Zero Scenario



Peaker gas | Peaker gas with CCS | Pumped hydro
Small-scale batteries | Utility-scale batteries

Source: *BloombergNEF*

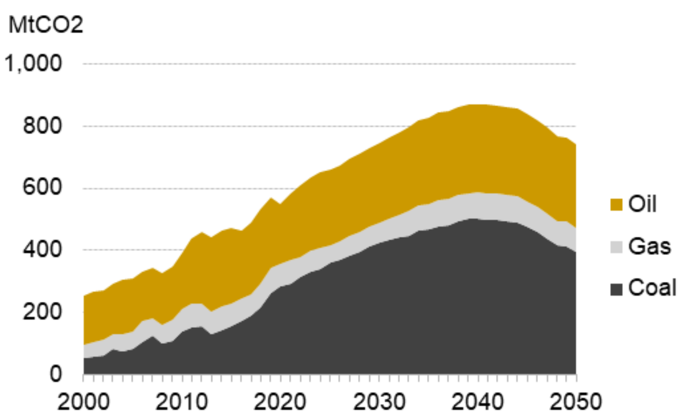
Energy sector emissions

The ETS and NZS result in drastically different future carbon (CO_2) emissions trajectory in Indonesia when compared to historical growth in emissions. Energy-related emissions in Indonesia have been increasing at an average 4.2% annually over 2000-21. In the ETS, total CO2 emissions over 2022-40 increase at half that speed at an average 2.1% YoY. Emissions peak at 870MtCO2e in 2040 under the ETS, before declining to 742MtCO2e in 2050. This represents a 27% growth in absolute emissions between 2021 and 2050, with coal power accounting for 65% of the increase in CO2 emissions during the outlook period (Figure 39).

Although this trajectory keeps Indonesia well within its enhanced 2030 unconditional national determined contributions target of a 31.89% emissions reduction against 2010 levels (an equivalent of 1,154MtCO2 emissions from the energy sector), it will not allow Indonesia to achieve a net-zero target by mid-century as recommended under the 2018 IPCC Special Report on 1.5 Degrees.

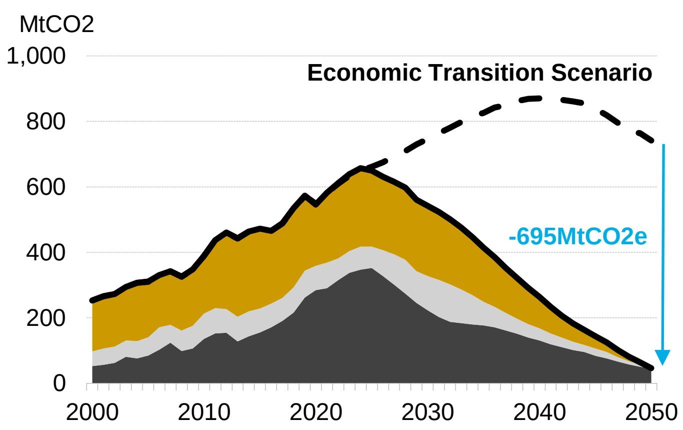
In the NZS, electrification, carbon capture and storage and some hydrogen enable a steep decline in energy-related emissions of an average 8% per year over 2022-50 – peaking at 657MtCO2 in 2024 and falling to just 46MtCO2 by 2050 (Figure 40). These residual energy-related emissions would need to be offset by carbon removals.

Figure 39: Total carbon emissions by source, Economic Transition Scenario



Source: BloombergNEF

Figure 40: Total carbon emissions by source, Net Zero Scenario



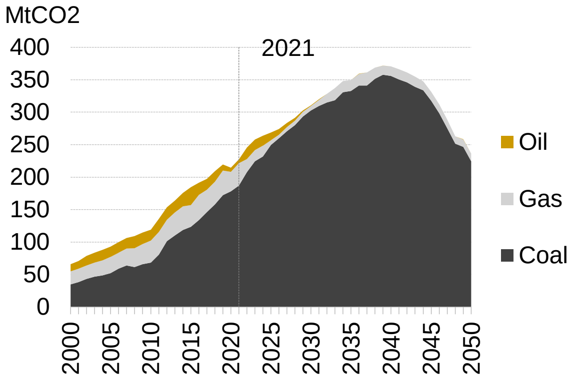
Source: BloombergNEF. Noted: Dotted line shows carbon emissions under the Economic Transition Scenario

In the NZS, emissions from the energy sector need to peak 16 years earlier (in 2024) to allow Indonesia to reach net-zero emissions by 2050. This highlights the need for immediate action to enable a rapid transition of Indonesia's energy sector. Firm targets, supportive policies and appropriate investment signals are required to help Indonesia set the stage for a massive scale up of existing and new clean energy alongside emissions abatement technologies. These will require investments at levels yet to be seen in Indonesia and the building of new infrastructures, some of which Indonesia is making progress on such as the development of an electric vehicle value chain in the country.

Power sector emissions

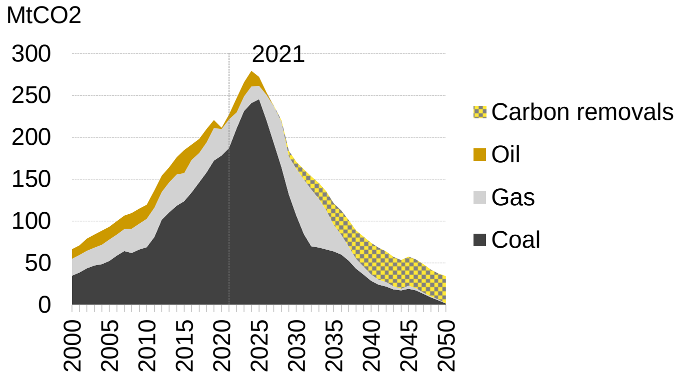
Despite the growing share of renewables in the ETS, Indonesia's power sector emissions only peak in 2039 at 372MtCO2 (Figure 41), tied closely to coal consumption in the power sector. Indonesia's power sector emissions see a vastly different trajectory under the NZS. Emissions from the power sector fall by 85% by 2050 against 2021 levels. Indonesia also sees power sector emissions peak in 2024, 15 years earlier than in the ETS at 279MtCO2 (Figure 42).

Figure 41: Indonesia power sector carbon emissions by fuel, Economic Transition Scenario



Source: BloombergNEF

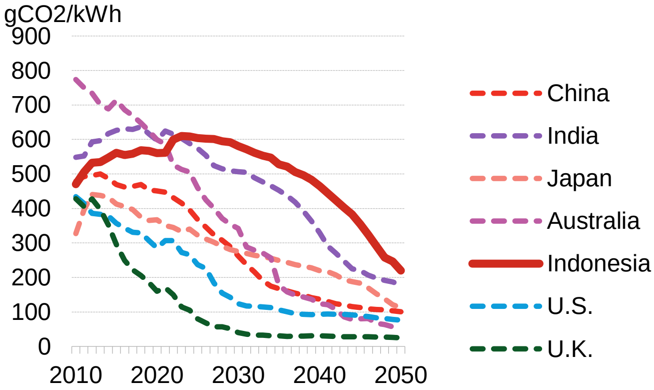
Figure 42: Indonesia power sector carbon emissions by fuel, Net Zero Scenario



Source: BloombergNEF

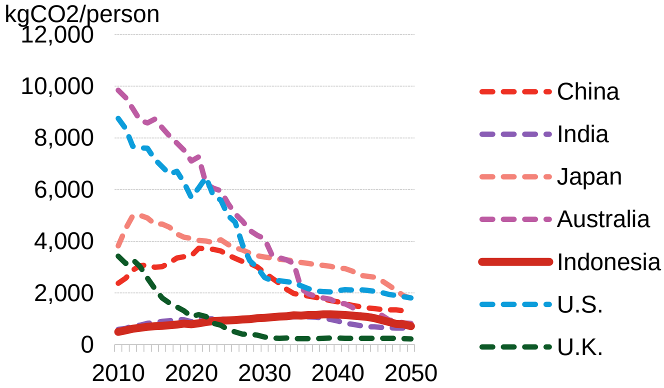
The emissions intensity of the Indonesian power grid declines to 220gCO2/kWh by 2050 from 562gCO2/kWh in 2021 under the ETS (Figure 43). However, it still does not decarbonize as fast as the power systems in many other major economies due to the continual use of coal throughout the outlook duration. Indonesia, however, has one of the lowest emissions per capita among major economies to 2050, following similar levels as that seen in Indonesia. Despite the massive growth in population and power demand expected in Indonesia, increased energy efficiency allows the country to keep emissions per capita low even as the economy grows (Figure 44).

Figure 43: Power CO2 emissions intensity in selected economies, Economic Transition Scenario



Source: BloombergNEF

Figure 44: CO2 emissions per capita in selected economies, Economic Transition Scenario

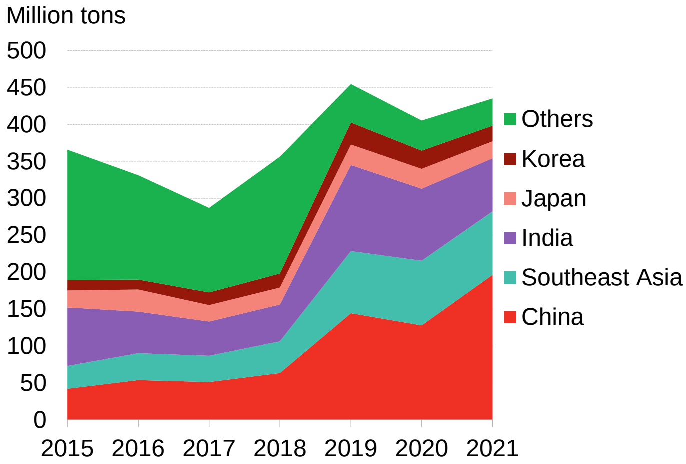


Source: BloombergNEF

4.2. Implications for Indonesia's coal sector

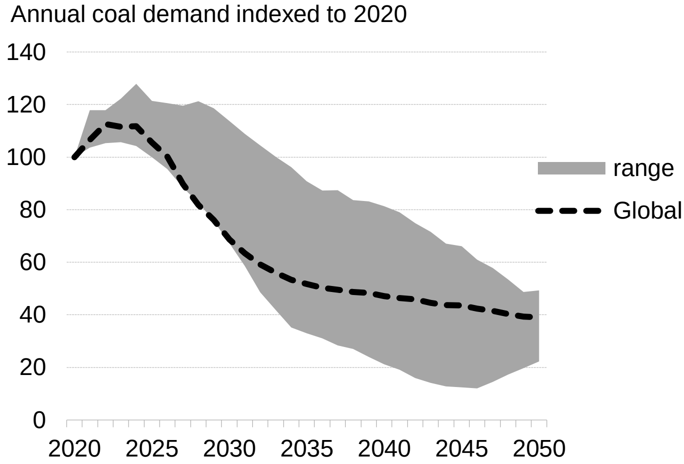
Indonesia is currently the world's largest exporter and third largest producer of thermal coal. The coal industry contributed some 1.8-2.7% of the country's GDP during 2015-20. In some provinces like East Kalimantan, which is the largest export center for coal in the country, the coal mining industry formed 35% of GDP during 2021. Coal also formed about 10-15% of the country's total exports during 2016-20. In addition, the top contributor to Indonesia's GDP in 2021 at 19% is manufacturing, which is mostly powered by coal. These factors make it difficult for the government to phase out coal from the energy system.

Figure 45: Indonesia coal exports by destination



Source: BloombergNEF, Handbook of Energy and Economic Statistics of Indonesia 2021, Vietnam General Statistics Office. Note: Southeast Asia includes Malaysia, Thailand, Philippines, and Vietnam.

Figure 46: Growth in coal consumption in Indonesia's major coal export markets, Net Zero Scenario



Source: BloombergNEF

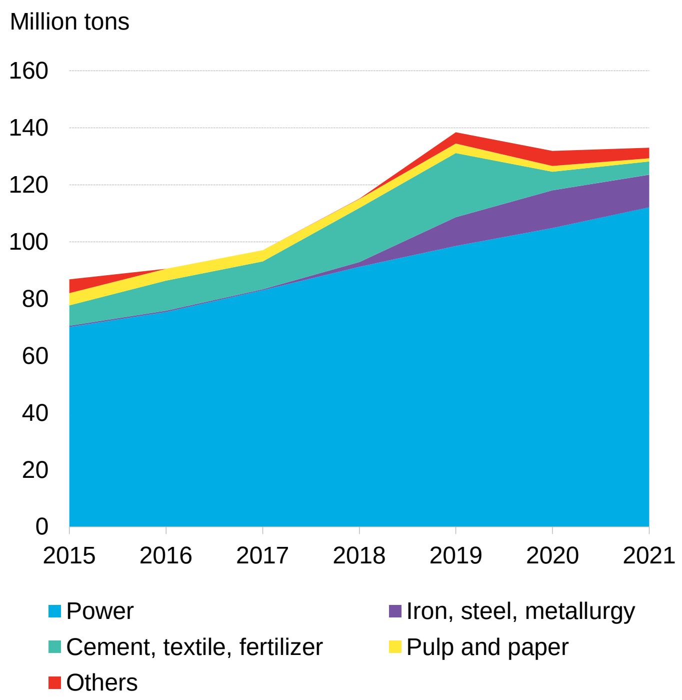
Indonesia exports about 400-450 million tons of coal annually and consumes about 130-140 million tons domestically. China, Southeast Asia, India, Japan and Korea accounted for over 90% of all coal exports from Indonesia in 2021 (Figure 45). Coal consumption in these markets will decline drastically over the long term as governments there adopt policies to reduce emissions to reach their own net-zero targets. In BNEF's Net Zero Scenario, coal consumption in these key markets declines by 50-80% during 2020-2050 (Figure 46). This could be detrimental for regions and companies that are heavily reliant on the coal industry today.

The local demand for coal in Indonesia is also primarily driven by the power sector, which is decarbonizing quickly. The power sector in Indonesia consumed some 112 million tons of coal in 2021, about 84% of total coal consumption in the country that year. The government is betting on co-firing coal with biomass and capturing CO2 emissions from new and existing coal power projects in the future to keep coal use in the country steady or even growing, while balancing its decarbonization goals. Co-firing biomass in coal power projects could reduce emissions marginally but would still be inconsistent with a net-zero emissions future.

Indonesia's plans to retrofit coal power projects with carbon capture and storage (CCS) could also face technical and economic challenges. Supercritical power plants that are more efficient are considered the ideal choice for CCS retrofits. In Indonesia, only about 6GW of supercritical coal power projects are operating currently. Additionally, small power projects that have a capacity below 300MW form some 20% of the total subcritical power capacity in 2021. Retrofitting small power projects with CCS would also not be economically attractive in most circumstances.

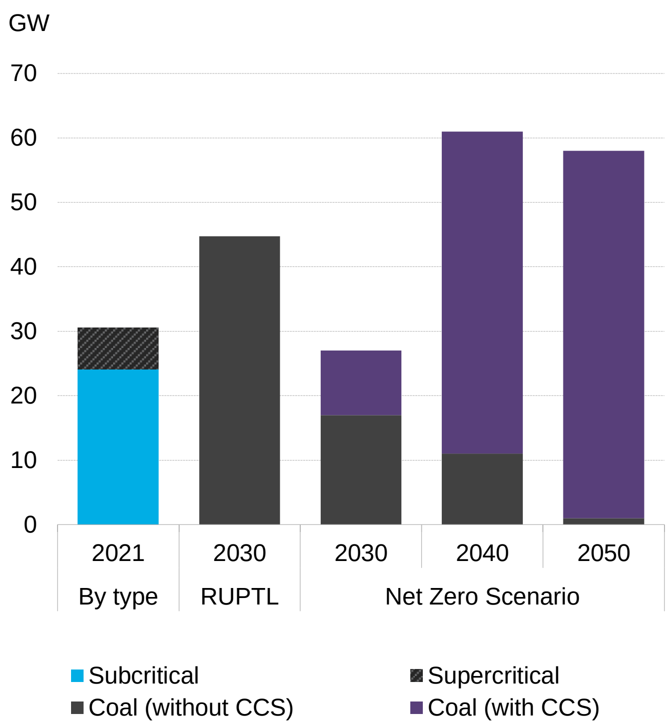
In BNEF's Net Zero Scenario, coal power capacity fitted with CCS grows to 10GW by 2030, 50GW by 2040 and 57GW by 2050. A large portion of existing coal power capacity in Indonesia might not be fit for retrofitting due to the factors discussed above. Therefore, PLN will need to ensure that coal power projects built through 2030 are already fitted with CCS or ready to fit them in the near future.

Figure 47: Annual domestic use of coal by sector



Source: Handbook of energy and Economic Statistics of Indonesia 2021

Figure 48: Installed coal power capacity in Indonesia, historical and outlook in various scenarios



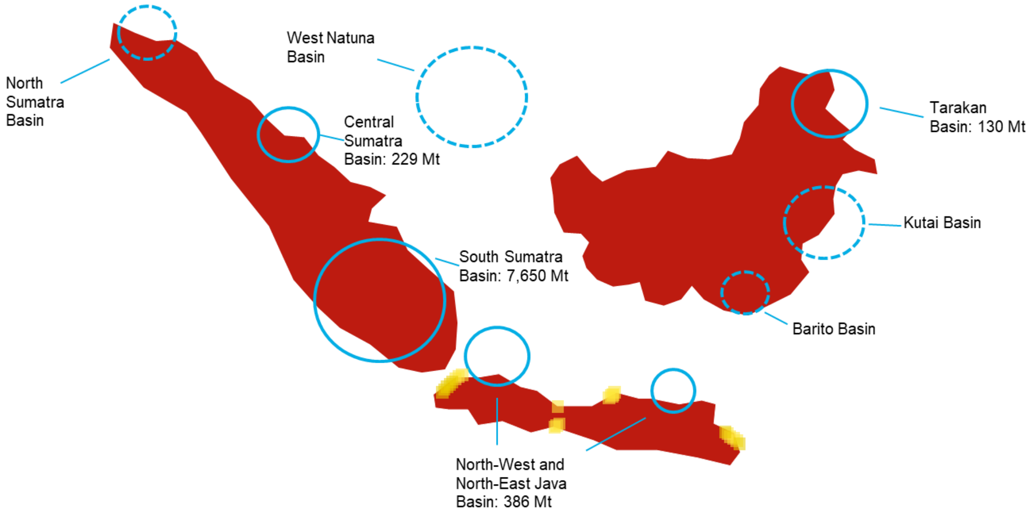
Source: BloombergNEF, PT Perusahaan Listrik Negara

Additionally, under the Net Zero Scenario, a large portion of the coal power capacity in Indonesia would also have to be retired in this decade, before the end of their economic lifetime. The government has already initiated discussions with multilaterals like the Asian Development Bank and initiatives like the Just Energy Transition Partnership to potentially accelerate the phase-out of coal power projects in the country.

Indonesia will also need to evaluate the availability of required carbon storage capacity and associated infrastructure. In the NZS, Indonesia requires a cumulative 6,531MTCO2 of carbon storage capacity between 2022 and 2050. The IEA estimates Indonesia has 8,395MTCO2 of carbon storage potential (Figure 50).

Proximity of coal plants to the storage site is also a challenge in the archipelagic country. Indonesia will need to tap all available carbon storage sites in the NZS making infrastructure investments an important priority to make Indonesia's CCS strategy viable.

Figure 49: Indonesia potential carbon storage capacity by areas



Source: BloombergNEF, IEA, ESDM. Noted: Partial map of Indonesia shown. Dotted border represents potential sites with undetermined storage capacity. Yellow squares represent coal units with capacity from 600MW.

Energy Transition Mechanism

Asian Development Bank (ADB) launched the Energy Transition Mechanism (ETM) for Indonesia at COP26 in 2021 after announcing that it will not finance additional coal-fired power plants a few months earlier. The ETM aims to accelerate decommissioning of coal-fired power plants, and the adoption of renewables by providing financial, technical and implementation support. This program aims to address the issue of long-term Power Purchase Agreement (PPA) contracts that might present a problem to decommission coal-fired power plants earlier than contract expiry.

The ETM will initially focus on two main schemes: 1) phase out of coal-fired power plants, and 2) scaling of renewables in the energy mix. Other later initiatives will include developing interconnected grids and efficiency solutions. ETM will utilize blended finance which invites different types of investors including Indonesia's only sovereign wealth fund (INA), multilateral development banks (MBD), and private and commercial lender/capital markets so that Indonesia can retain control over their domestic energy strategy.

PT Sarana Multi Infrastruktur (PT SMI)

PT SMI is a state-owned enterprise and a special mission vehicle under the Ministry of Finance. PT SMI's role in Indonesia is to accelerate infrastructure development. PT SMI has been given an important role in ETM and its role will vary based on the blended finance structure chosen. Three blended finance structures are proposed by PT SMI. The strategies are currently under discussion.

Climate Investment Funds (CIF)

CIF is a leading multilateral investor in developing countries. On October 27, 2022, CIF announced that it will provide a concessional loan of $500 million to Indonesia in cheaper and risk-bearing capital from its Accelerating Coal Transition investment program so that Indonesia can further attract more funding from multilateral and private lenders to fund its energy transition. The funding package is supposed to form an energy transition partnership being negotiated by

Indonesian government and wealthy countries, similar to what was agreed in South Africa's JETP. CIF's funds will be used to assist PLN to retire up to 2GW of coal-fired power plants five to 10 years earlier. The decommissioned coal assets will also be repurposed into renewable generating assets.

Table 2: Blended Finance Options

Results Based Lending	PLN Financing	IPP Acquisition and Refinancing
• PT SMI will raise funds from investors • Provide loan facility to PLN • Loan agreement will contain an exclusion list • Disbursement Linked Indicators will be monitored by PT SMI during loan period	• PLN will set up a special purpose vehicle (SPV) with selected coal-fired power plants (CFPP) • New PPA with SPV created to include early CFPP retirement • PLN to divest a majority portion of SPV • Strategic investor to receive funds that PT SMI raised • SPV will operate and retire CFPP early	• INA and PT SMI to acquire majority shares of CFPP from IPP, forming a SPV • PT SMI to raise funds • Blended finance loan (Commercial + Concessional + Government) comes with KPIs • Loan proceeds to be used to refinance CFPP • SPV to operate the CFPP until their retirement

Source: PT SMI

South Africa's Just Transition Energy Partnership

G-7 countries are in negotiations about new Just Energy Transition Partnerships –or JETPs –with India, Indonesia, Senegal and Vietnam. These initiatives build on the model of 'country platforms' that bring together governments and organizations to tackle barriers to climate action in specific nations. As they involve fewer participants than the COP process, which involves nearly 200 countries, these platforms are meant to accelerate action. In addition, by being country-led or owned platforms, the efforts can be tailored to the particular needs of the participants.

Announced at COP26, the first JETP brings together South Africa with France, Germany, the UK, the US and EU. Its aim is to help South Africa decarbonize its electricity system, promote a just transition away from coal, and explore new opportunities in, for example, green hydrogen and electric vehicles. At COP26, the partners agreed to raise "an initial amount" of $8.5 billion over the next three to five years, although few specific actions were announced. Progress has been relatively slow (see gray box below) but South Africa aims to devise a draft investment plan by July, comprising the projects and activities required to achieve a just transition, and finalize the plan in time for COP27 in November 2022.Other governments and philanthropic organizations wish to join the South Africa JETP, COP26 President Alok Sharma said at climate talks in Bonn on June 22. However, "[a]s part of a long-term transition it will require significantly more funding," Sharma said.

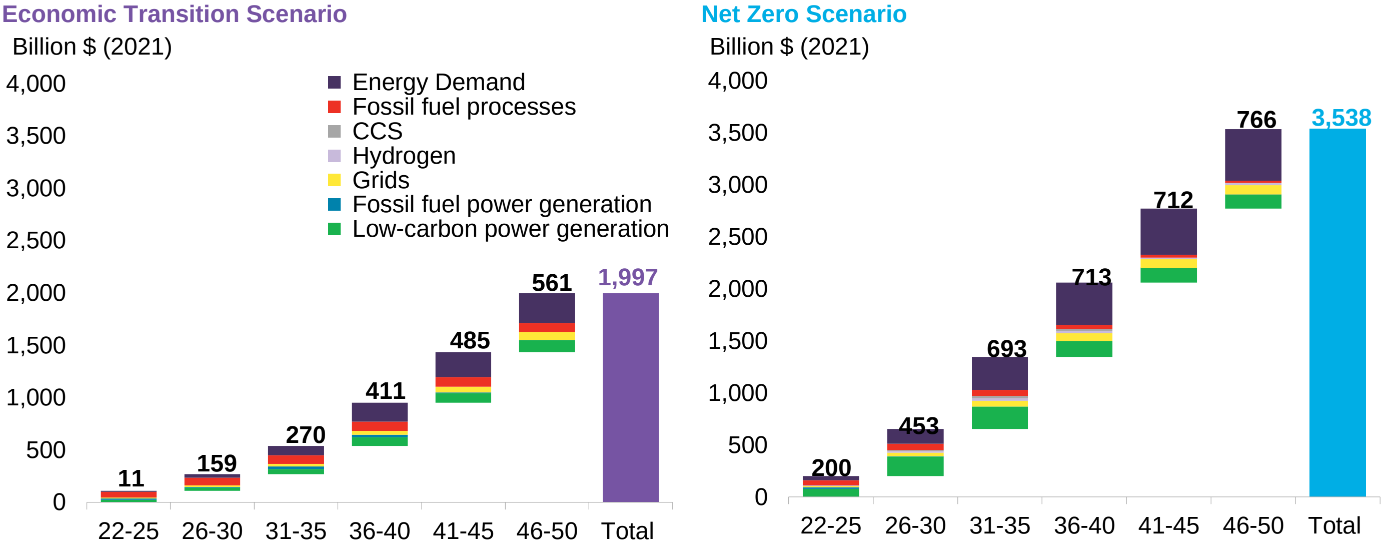
Progress on South Africa's JETP

As agreed, South Africa issued an update on the partnership six months after COP26 – and just before the G-7 summit. The government has taken steps to improve the low-carbon policy and regulatory framework, such as progress on the renewables support, a green taxonomy and more certainty on the carbon tax. Progress has been slower on devising a plan to ensure a just transition away from fossil fuels, and the government has undertaken a consultation on its draft just transition framework. Power market reform will also be a focus of the JETP, but progress has been very slow. State-owned player Eskom continues to dominate the sector, accounting for 90% of electricity generation, being the sole transmission system operator, and holding half of the retail market (with the other half held by the municipalities). A roadmap, released in 2019, envisaged that Eskom would undergo functional and then legal unbundling by 2021, but this has been much delayed. The first step is to create an independent system and market operator and in 3Q 2022, Eskom aims to secure creditor approvals and licenses from the regulator to allow the separation to proceed.

4.3. Energy sector investments

The rapid growth in Indonesia's economy in the coming decades would require large investments in the energy sector in both the ETS and NZS. In the ETS, Indonesia would require about $2 trillion in energy sector investments during 2022-2050, increasing to $3.5 trillion to align with net-zero by 2050 (Figure 50). Annual average investments during 2022-2050 are $69 billion in the ETS and $122 billion in the NZS – equivalent to 5-10% of the nation's GDP in 2021.

Figure 50: Indonesia energy investments in the ETS and NZS



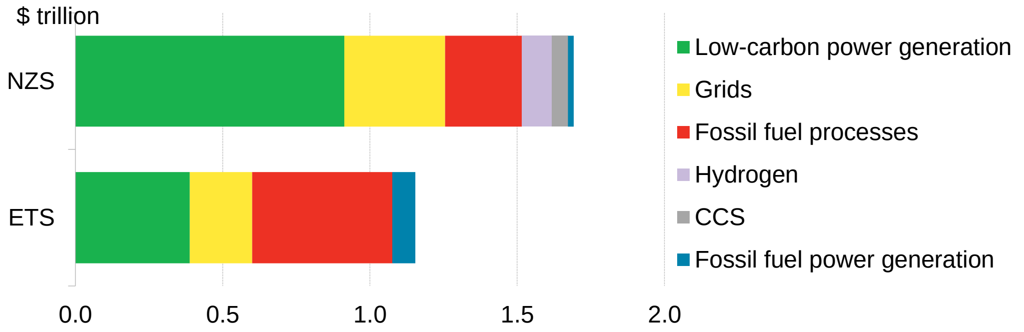
Source: BloombergNEF. Note: The bolded number shows the respective investment time period

Investments into the supply side of the energy system, which includes investments in power generation capacity, grid infrastructure, hydrogen infrastructure and the supply of coal, oil and gas, form 58% of the $2 trillion required in the ETS during 2022-2050 (Figure 51). In the NZS, supply side investments in Indonesia total $1.7 trillion, 47% higher than in the ETS.

To keep on track for net zero, Indonesia would require $913 billion investment in low carbon electricity during 2022-2050 (Figure 52). This represents over half of the supply-side capital required in this scenario. Investments in fossil fuel processes in the NZS, on the other hand, would only be $260 billion during the same period. In this scenario, the annual average investments in fossil fuels during 2022-2050 would need to fall to $9 billion from much higher levels in the past.

Indonesia would also require some $102 billion in investments in the production, transport, and storage of hydrogen and some $54 billion in CCS during 2022-2050 to achieve net zero emissions by 2050. This could also create opportunities for the country to develop new industries and technologies that are critical for global decarbonization. On the demand-side, which includes buildings, transport and industry, Indonesia's investment opportunity during 2022-2050 is $0.8 trillion and $1.8 trillion in the ETS and NZS, respectively. About 85% of this capital would be invested in the purchase of EVs to reduce emissions from the transport sector in these long-term scenarios.

Figure 51: Cumulative supply side investments in ETS and NZS during 2022-2050

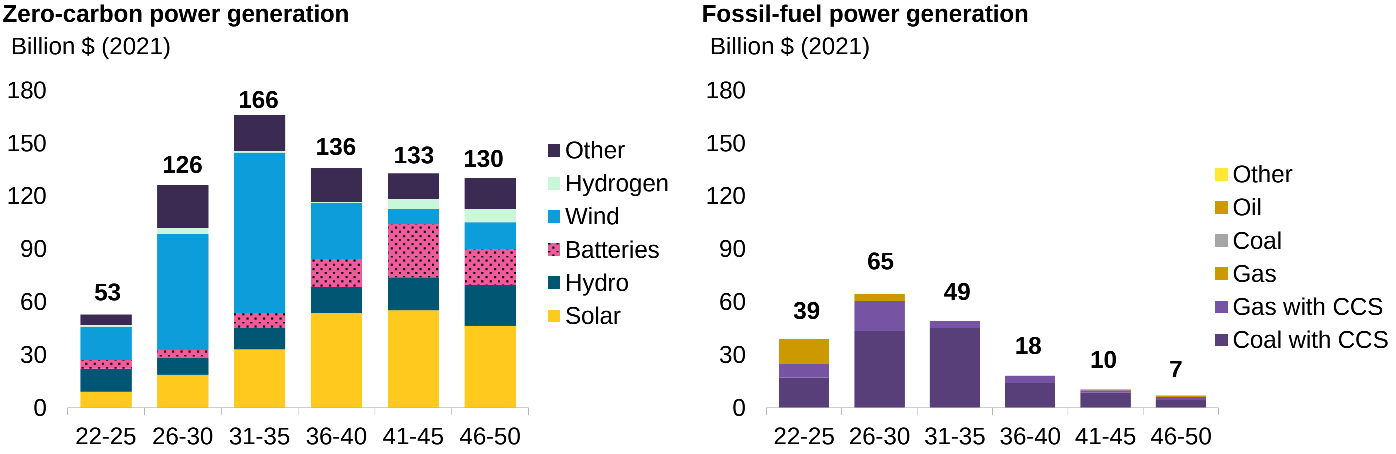


Source: BloombergNEF. Note: CCS – carbon capture and storage

Power generation and grid investments in the NZS

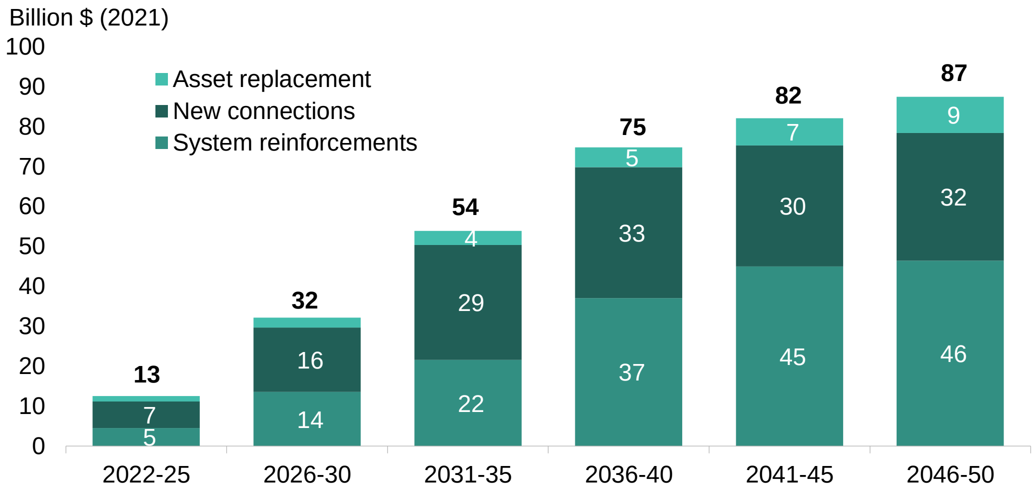
Capital spending for power generation and storage total $932 billion over the next three decades in the NZS, primarily loaded in the mid-2020s and early 2030s. About 80% of this capital would have to be diverted into zero-carbon power sources, with almost half going to solar and wind to achieve net-zero emissions by mid-century.

Figure 52: Power investment in Indonesia from 2022 to 2050, NZS



Source: BloombergNEF

Figure 53: Grid investment in the Net Zero Scenario from 2022 to 2050

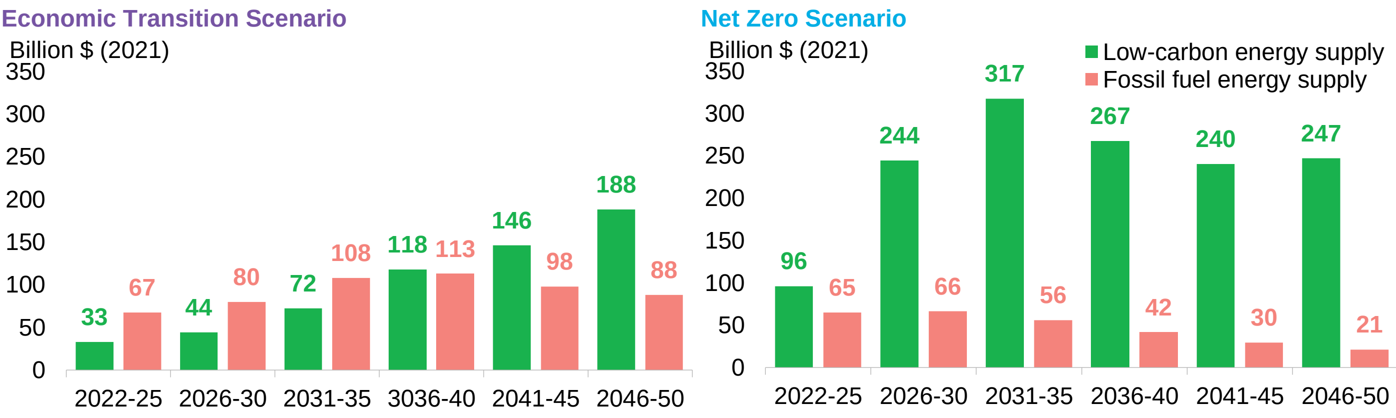


Source: BloombergNEF

Indonesia would also have to quickly expand and strengthen its electricity grid to prepare for a power system dominated by renewables in the 2030s and 2040s. The rapid shift to renewables will require the grid to adapt to new patterns and variability of supply and demand. In this scenario, the investment opportunity on the power grid totals $343 billion by 2050 – $257 billion into the distribution network and $87 billion into the transmission system (Figure 53). Some 49% of the total investment would need to be earmarked for system reinforcements of existing grid assets and an additional $147 billion for new connections in the NZS.

Low carbon versus fossil fuel energy supply investment

Figure 54: Low-carbon and fossil fuel energy supply investment in Indonesia from 2022 to 2050



Source: BloombergNEF

In the ETS, cumulative investments from 2022 to 2050 for low carbon energy supply and fossil fuel energy supply[2] exceed $601 billion and $554 billion, respectively. In this scenario,

2 Low-carbon energy supply investments include capital spending on renewable electricity capacity, batteries, coal and gas plants with CCS, grid infrastructure (asset replacements, new connections, and system reinforcements, carbon capture and storage (CCS) facilities, and hydrogen infrastructure. Fossil

investments into low carbon energy supply only starts to exceed fossil fuel energy supply investments after 2035. In the NZS, however, Indonesia's investments into low carbon energy supply ramps up quickly and exceeds investments into fossil fuels from now through 2050. The net-zero transition would be a $1.4 trillion investment opportunity in low carbon energy supply assets during 2022-2050 when compared to $280 billion in investments for fossil fuel energy supply projects.

4.4. Way forward for Indonesia

Decarbonization of Indonesia's power sector and the massive scaling up of zero carbon generation sources represent an immense investment opportunity for the country. It also allows new job creation to mitigate the potential loss of jobs from the coal sector due to the steep decline in coal consumption.

The Indonesian government has made progress on setting the scene for the scaling up of renewable energy development in the country such as a "greener" RUPTL and the recent release of its presidential regulation on accelerating renewable energy development. However, more needs to be done, especially within this decade, to ramp up renewables and ensure Indonesia will be on track to meet its net-zero emissions by 2060 or earlier goal. Some possibilities to accelerate decarbonization of its power grid include:

- Level the playing field for coal and renewable energy projects by re-evaluating both direct and indirect subsidies for fossil fuel plants. This allows different generation technologies to compete on an economic basis which can help to reduce overall supply cost over time. Implementing the discussed carbon market and tax as soon as possible will also help provide the necessary pricing signal.
- Have a clear pipeline of renewable energy auctions with determined capacity quota. This gives potential investors, developers and supply chain partners the long-term clarity and confidence they need to invest in the Indonesian market.
- Introduce schemes to enable corporates to procure renewable energy from PLN or directly from private utilities or renewable generators. Indonesia's growing manufacturing sector will likely face increasing pressure from its customers who are looking to clean up their supply chain. Tapping growing corporate demand for renewable energy can help to drive renewable energy project build in the country and boost Indonesia's attractiveness as a manufacturing hub.
- Plan for required grid infrastructure and required flexibility ahead of time to aid in the smooth integration of renewable energy. This will help to avoid the grid being a bottleneck in the scaling up of renewables and minimize grid operational challenges.
- Establish the required regulatory and policy framework for the development of new technologies such as CCS, nuclear and hydrogen. Depending on Indonesia's chosen decarbonization pathway, some or all these newer technologies will be a part of the country's future energy system. Conducting the necessary studies and engagement with stakeholders early will help to determine the feasibility and potential of the newer technologies. Establishing partnerships and strategic collaborations with other countries can also allow Indonesia to tap global technical and financial assistance.

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fuel energy supply, on the other hand, involves the upstream, midstream, and downstream processes of the coal, oil, and gas industries (drilling, extraction, production, transport, refinery processing) and unabated fossil fuel power generation from coal and gas powerplants

Section 5. Indonesia’s EV and battery manufacturing opportunity

Electric vehicle sales are rising quickly as governments across the world implement policies to reduce emissions from the transport sector. BNEF expects annual EV sales across various segments of road transport to increase manifold during 2020 to 2050 as favorable policies and improvements in battery technology support higher EV adoption everywhere. The rising demand for EVs will also drive substantial growth in the demand for lithium-ion batteries over the next three decades.

As automakers and battery manufacturers pursue technologies to make batteries cheaper and lighter, nickel-based cathodes will grow in importance. Indonesia, which has about a quarter of all nickel reserves globally, can therefore be an important part of this transition. However, two major factors could limit Indonesia’s growth prospects in this industry in the next five years.

First, the country’s high reliance on coal and gas power projects to generate electricity and the lack of policies to support companies in their renewable energy procurement goals will mean batteries manufactured in Indonesia produce more emissions than in other countries. This creates hurdles for companies that have their own decarbonization goals and could also limit access to export markets as more governments globally start regulating lifecycle emissions of imported products. Secondly, the slow growth of EV sales in the country leads to lower domestic demand for EVs and batteries, making it less attractive for manufacturers to build large manufacturing facilities in the country.

The government will need to address these challenges to attract more investments into this sector and to become a large EV and battery manufacturing center in Asia.

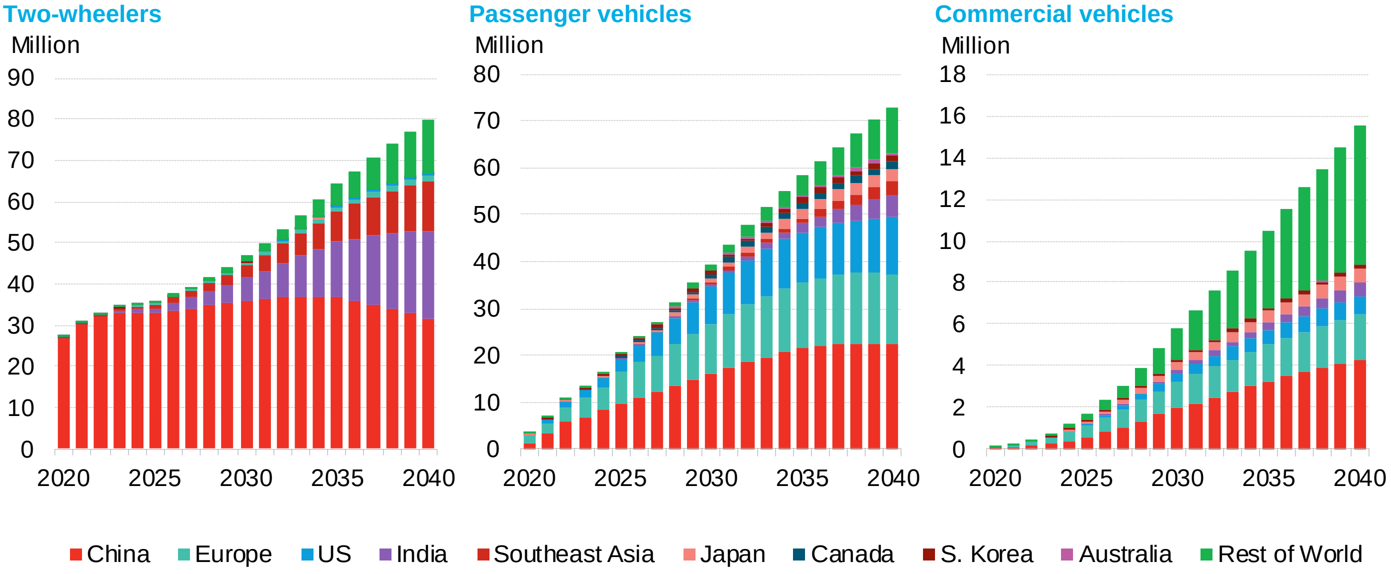
5.1. Global growth in electric vehicle demand

Electric vehicle sales have grown exponentially since 2015 across all vehicle segments. Annual sales of electric passenger and commercial vehicles grew 600-820% during 2015-2021 to about 6.6 million and 187,000, respectively. Electric two-wheeler sales have also grown to almost 31 million in 2021 from just over 20 million in 2015.

In BNEF’s long-term outlook, increasing policy support for zero emission drivetrains coupled with steady improvements in lithium-ion battery technology help accelerate EV sales over the next few decades. In BNEF’s Economic Transition Scenario (ETS) – a scenario driven by current policies and long-term economics of various drivetrains – annual electric two-wheeler sales triple between 2020 and 2040, while the sales of passenger and commercial EVs grow by 25 and 174 times, respectively (Figure 55).

In 2040, some 80 million electric two-wheelers, 72 million passenger EVs and 15 million commercial EVs are sold globally in BNEF’s ETS. Southeast Asia, where two-wheelers are the major mode of road transport, is the third largest market for electric two-wheelers globally over the next two-three decades and sales exceed 12 million there in 2040. In the passenger and commercial vehicle segment, China, Europe, and the US remain the three largest markets for EVs through 2040. These markets account for about 68% of passenger EV sales and 47% of commercial EV sales globally in 2040 in the ETS. Annual sales of electric two-wheelers and passenger vehicles in Indonesia increase to 5.2 million and 0.8 million, respectively, in 2040 in this outlook.

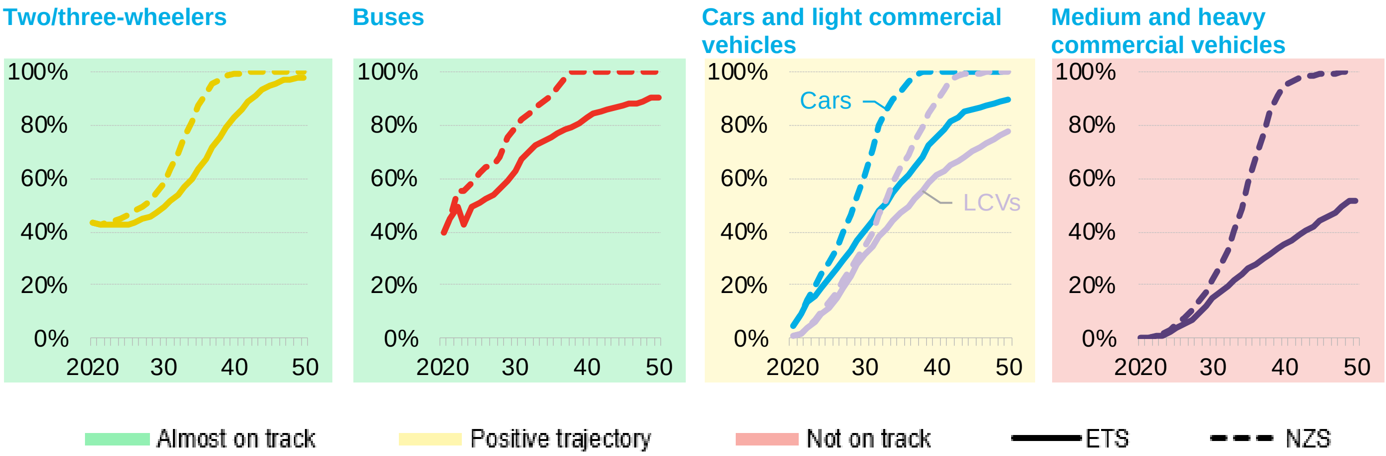
Figure 55: Global electric vehicle annual sales outlook by segment and market, Economic Transition Scenario



Source: BloombergNEF

Despite the high level of EV adoption in new vehicle sales by 2040, about 31% of all passenger cars, 25% of light commercial vehicles and 71% of medium- and heavy-commercial vehicles on the road globally are still powered by diesel or gasoline engines in 2050 in the ETS. This puts the 2050 net-zero commitments made by the majority of countries beyond reach and governments will need to further accelerate adoption to stay on track.

Figure 56: Zero-emission vehicle sales share outlooks – Economic Transition Scenario versus Net Zero Scenario



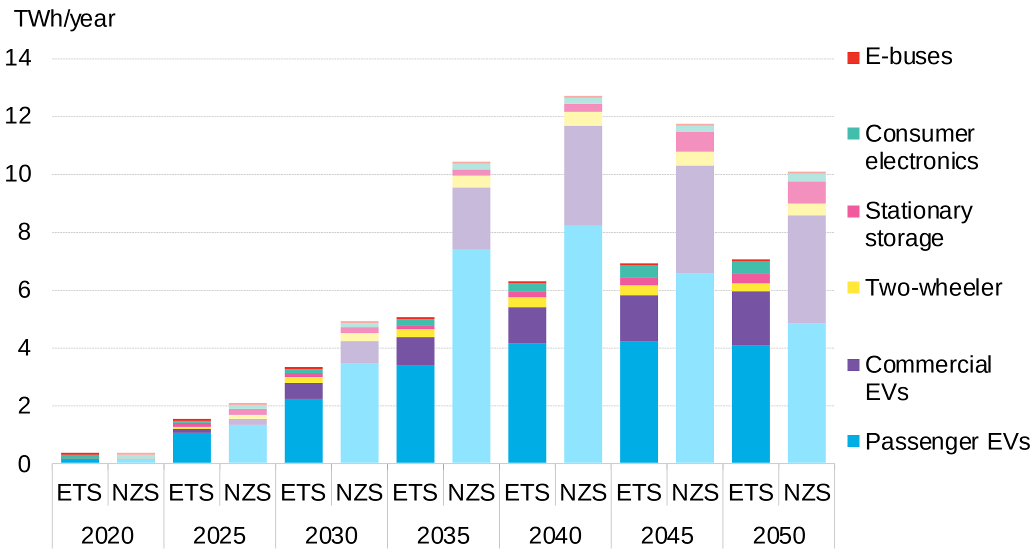
Source: BloombergNEF. Note: 'Zero-emission' includes battery-electric, plug-in hybrid electric and fuel cell vehicles, depending on the vehicle segment. Some values rounded. ETS- economic transition scenario, NZS – net zero scenario.

In BNEF's Net Zero Scenario (NZS), which models for all vehicles on the road globally to have zero tail-pipe emissions by 2050, the adoption of battery electric and hydrogen fuel cell vehicles should increase faster than the levels in the ETS (Figure 56). The speed varies between segments and markets. Two-wheelers, three-wheelers, and buses are closer to achieving net zero by 2050 than others. Passenger cars and light commercial vehicles are next, followed by heavier commercial vehicles which will need more policy support. The NZS will required drastic increase in EV sales in the 2030s and 2040s over the ETS, creating more opportunities and challenges for markets like Indonesia.

5.2. Lithium-ion battery demand

Rising demand for EVs will also drive the demand for lithium-ion batteries from 267GWh in 2020 to about 6,250GWh and 12,700GWh in 2040 in the ETS and NZS, respectively (Figure 57). More than two-thirds of this demand would be from passenger vehicles and about 20-27% from commercial vehicles.

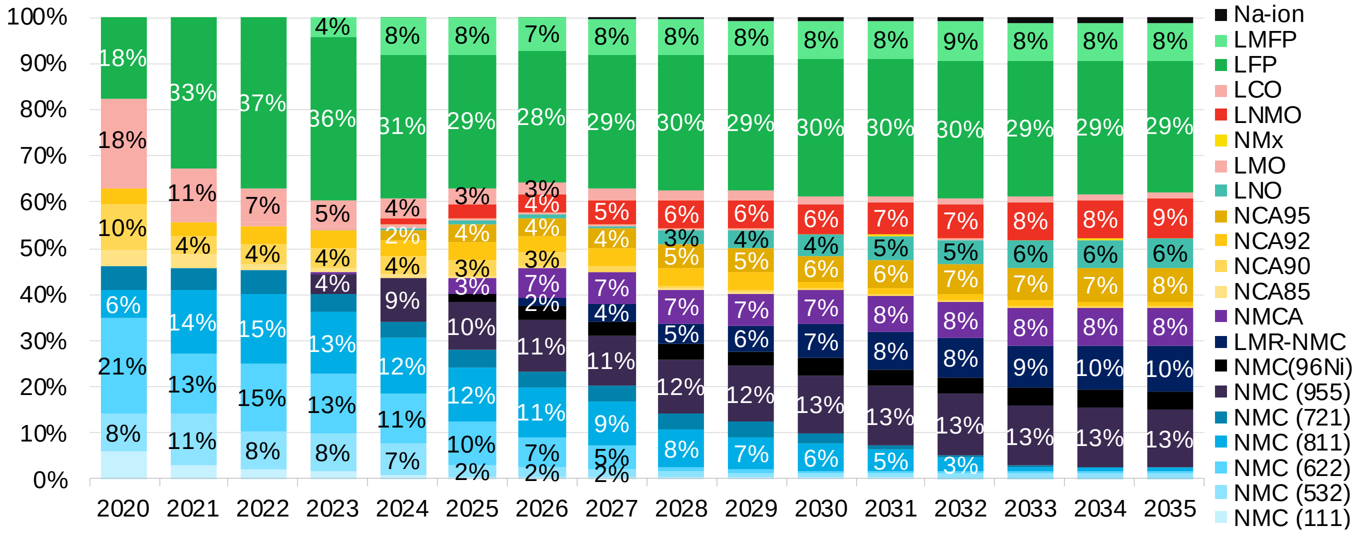
Figure 57: Battery demand outlook under BNEF's Economic Transition Scenario and Net Zero Scenario



Source: BloombergNEF. Note: Consumer electronics and stationary storage demand are assumed to be the same under both scenarios. ETS is the "Economic Transition Scenario" and NZS is the "Net Zero Scenario".

China, Europe, and the US, the three largest markets for passenger and commercial EVs through 2035, are also the largest markets for lithium-ion batteries during this period. They account for about 86% of the global lithium-ion battery demand in 2030 and 76% of the demand in 2035 in BNEF's ETS. A large portion of the proposed lithium-ion cell manufacturing capacity through 2030 is also therefore located in China, Europe, and the US.

Figure 58: Global battery cathode chemistry outlook



Source: BloombergNEF

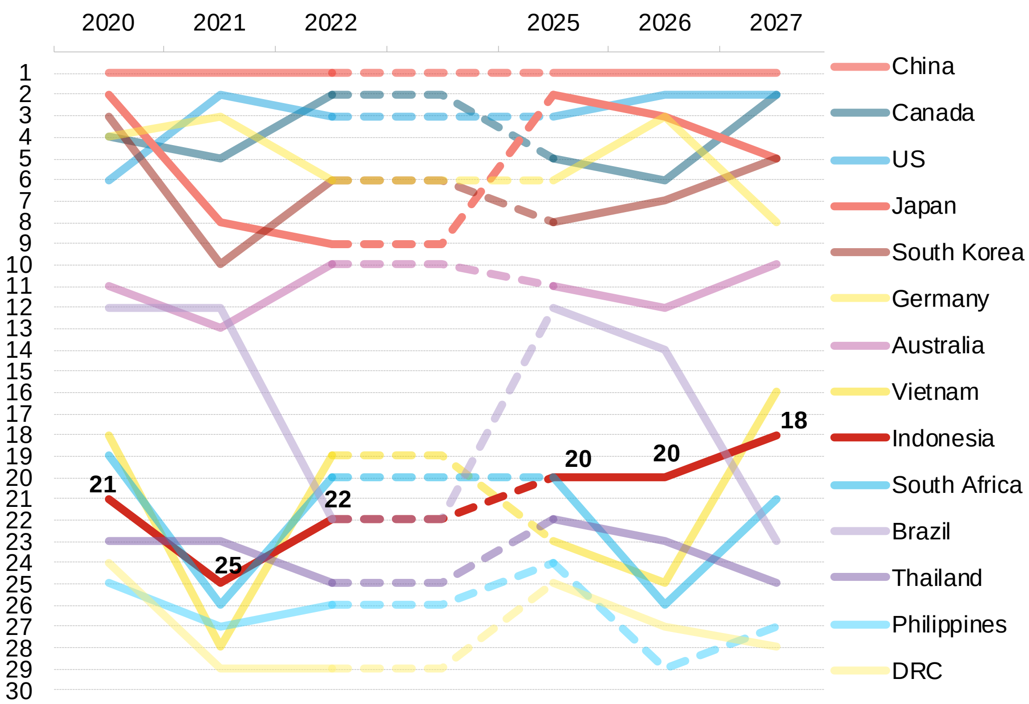
Automakers and battery manufacturers are looking to deploy new cathode and anode chemistries and other technology breakthroughs to make batteries lighter, compact, safer, and cheaper over the next 10 years. Indonesia has an opportunity to feed into this growing supply chain as companies pursue battery cathode chemistries that contain more nickel. In our outlook, about 61% of lithium-ion batteries shipped in 2035 use a cathode that contains nickel (Figure 58). The share of nickel within most of these popular cathode chemistries will also progressively increase as manufacturers shift towards high-nickel chemistries like NMC 955 and NCA 95. Indonesia, which has the world's largest nickel reserves, has an important role to play in this transition.

5.3. Indonesia as an EV and battery manufacturing destination

Indonesia is becoming an increasingly attractive country for companies across the lithium-ion battery manufacturing value chain due to its nickel resources. It has already received investment commitments of almost $15 billion from LG Energy Solution and CATL along the battery manufacturing value chain from mining to battery cell manufacturing. Automakers including Hyundai, Toyota, and Wuling have also committed investments for EV manufacturing facilities in the country. However, these are still small compared to investments flowing into markets such as China, Europe, and the US, despite Indonesia's dominant position in the nickel mining industry.

BNEF's annual Lithium-Ion Battery Supply Chain Rankings evaluates 30 countries and their attractiveness as a destination for battery manufacturing. In the latest edition of the report for 2022, Indonesia ranked 22 based on current progress (Figure 59). The ranking evaluates a country's performance in five categories – availability of raw materials, existing and proposed cell and component manufacturing capacity, environmental, social and governance (ESG) aspects and initiatives, downstream demand for batteries and EVs and the support for industry through innovation and infrastructure. These factors are also important for automakers looking to set up production units for EVs.

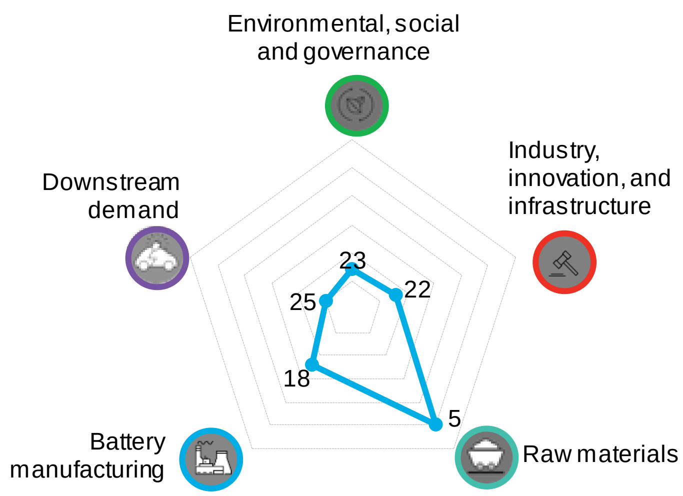
Figure 59: Indonesia's performance in BNEF's annual global lithium-ion battery supply chain rankings



Source: BloombergNEF. Note: Rankings for the 2020 edition of the report only had 25 countries. Countries grayed out are for visualization purposes only. Dotted lines do not represent rankings between 2022 and 2025 and are for visualization purposes only.

Indonesia's position in the battery supply chain rankings improves three spots to 18 by 2027, breaking into the top 20 for the first time since BNEF started the rankings in 2020. The country is becoming more attractive for battery manufacturing as it works on improving its performance on key categories, especially on ESG and support industries (Figure 60).

Figure 60: Indonesia country performance per category, 2022



Source: BloombergNEF

Availability of raw materials

Indonesia's key strength is still anchored on its raw mineral resources wealth. Nickel continues to be the main draw for manufacturers looking at setting up shop domestically. About a quarter of globally known nickel resources are in Indonesia and manufacturers are keen on securing supply given the restrictions on raw ore exports. Indonesia's focus in the past decade was in developing its stainless-steel industry on the back of its nickel. It has been largely successful in expanding its Class 2 nickel production capacity, needed for steel, which exceeded more than 1 million metric tons in 2021 and has overtaken China to be the largest producer globally.

Raw materials performance is based on direct supply to the battery industry, specifically in the capacity for battery chemicals. Indonesia has shifted its focus towards Class 1 nickel expansion, from which the pool of battery-grade nickel supply is sourced. While Indonesia remains within the top ranked countries, it has the capacity to improve further as more projects come online. It is still below Canada, Australia and China in Class 1 nickel mining capacity currently at around 100,000 tons. It is also below Russia, which is one of the largest Class 1 nickel producers globally that is not part of our rankings. It improves by 2027, reaching around 195,000 tons, overtaking Canada and Australia.

Indonesia's opportunities lie in expanding battery chemicals refining capacity. Despite its strength in mining capacity, it has no active commercial production of nickel and cobalt sulfate. It currently has around 800 tons of manganese sulfate capacity. Its position will grow significantly within five years, as several battery-grade chemicals refining projects come online and add to the country's refining capacity. One area that Indonesia lacks is still its need for lithium, which it does not have domestic reserves of, unlike other resources powerhouses China, Canada and Australia.

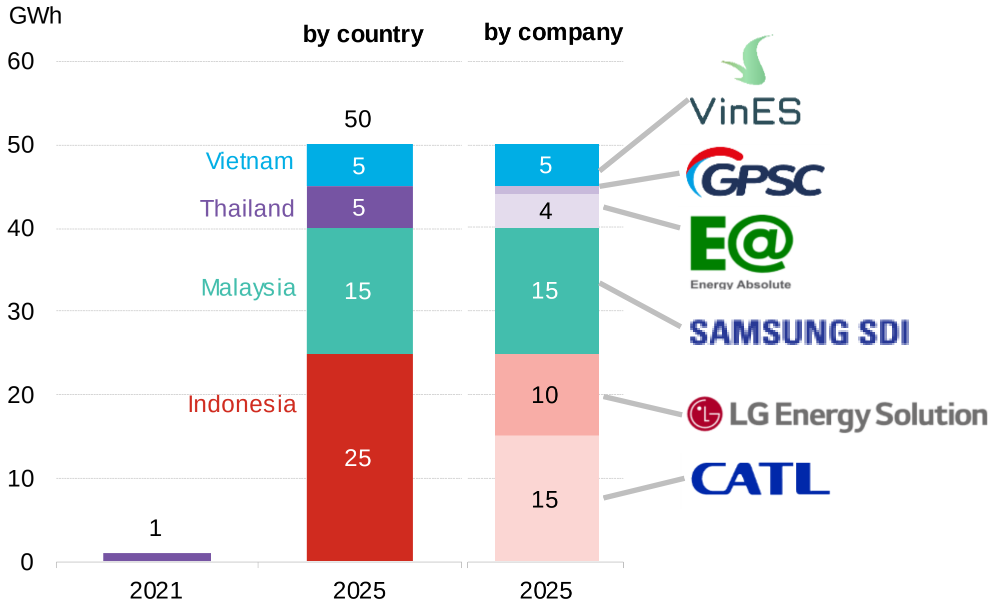
Several local and global mining companies have also committed to expand their nickel mining operations in Indonesia as well as to build high-pressure acid leaching facilities to produce nickel and cobalt intermediates that feed into downstream industries. PT Antam, a state-owned mining company, is forming several partnerships with companies from China and Korea through the Indonesia Battery Corporation to expand the country's nickel mining capacity. Private companies such as PT Huayou Nickel Cobalt and PT Vale are also planning to expand nickel mining activities in the country by 2030. These projects improve the country's ranking on raw material availability for 2027 and pushes it up to the fourth place in the list.

Cell and component manufacturing capacity

Indonesia currently ranks low on the score for existing cell and component manufacturing capacity. There are no operational lithium-ion cell or battery component manufacturing facilities in the country currently. However, companies including CATL, LG Energy Solutions, Tsingshan, BASF, Zhejian Huayou Cobalt and Posco have announced plans to invest in manufacturing facilities that will process and refine nickel and cobalt and produce cathode active materials and precursors in Indonesia. CATL and LG Energy Solution are also planning to set up at least 25GWh of lithium-ion cell manufacturing capacity in the country by 2025 (Figure 61), which could be expanded to 80GWh by 2030 if demand grows sufficiently. The government aims to have at least 140GWh of cell manufacturing capacity locally by the end of the decade and is negotiating new projects with several other companies for investments along the battery value chain.

These initial projects will establish a supply chain for lithium-ion batteries in the country and could help Indonesia have the largest cell manufacturing capacity in Southeast Asia by 2030. Indonesia's attractiveness as a lithium-ion battery and component manufacturing hub improves in the coming years due to these factors.

Figure 61: Proposed lithium-ion battery cell manufacturing capacity in Southeast Asia



Source: BloombergNEF, company press releases, news articles. Logos from company website.

Environmental, social and governance initiatives in the battery supply chain

The extraction and processing of raw materials and the manufacturing of lithium-ion battery components and cells are energy-intensive processes. Companies and governments that have set their own decarbonization goals are increasingly concerned about emissions from these activities.

Policy makers in Europe are also proposing regulations to estimate the lifecycle emissions of batteries deployed in the region to set long-term emissions reduction pathways for the sector. It is likely that many markets with strong decarbonization targets could adopt similar policies. Therefore, automakers and battery manufacturers could come under greater pressure to track and reduce emissions from the manufacturing of batteries and EVs.

Apart from environmental metrics, stakeholders in the supply chain are also concerned with ensuring that minerals entering their supply chains are responsibly sourced. Environment, social and governance (ESG) parameters are becoming an integral part of manufacturing and resources industries and are essential in evaluating a country's ability to effectively manage these sectors.

For this category, BNEF's supply chain ranking evaluates all countries based on the three sub-categories where environment, social and governance metrics are equally weighted. Environmental metrics include a country's renewable policy score (scored by BNEF's Climatescope renewable capacity tracker), carbon emissions intensity of the grid (projected by BNEF's New Energy Outlook), and the environmental health and ecosystem services scores from Yale's Global Environmental Performance Index. Country risks are also included based on the World Risk Report which measures exposure and vulnerability of a country to natural disasters.

Social metrics include indexes on equality by the United Nations Development Program as well as fundamental labor rights guarantees from the World Justice Project. Metrics for scoring countries on governance include government effectiveness and control of corruption from Worldwide

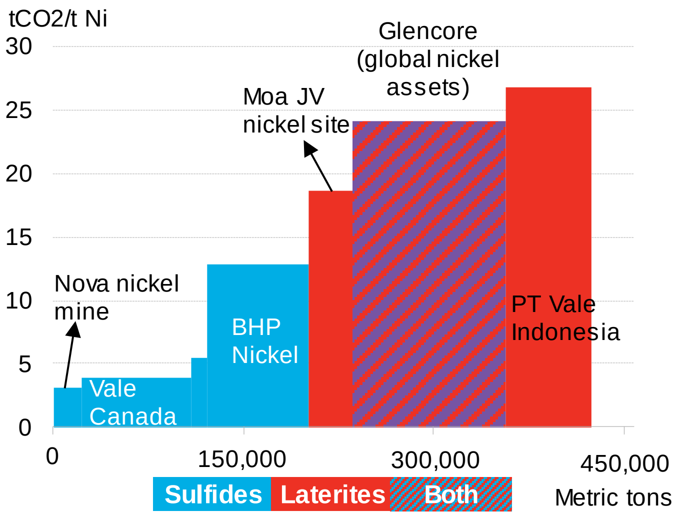
Governance Indicators. The addition of the social and governance metrics help judge a country's ability to build a supply chain based on responsible sourcing and production.

Indonesia's score on ESG overall is anchored by its relatively good scores on social and governance. This is still dragged down a bit by its environmental performance, which is ranked the lowest among the 30 countries included in BNEF's supply chain ranking. Coal power plants supplied some 61% of the total electricity generated in Indonesia in 2021, followed by gas power projects which contributed an additional 18%. The high share of coal and gas in the electricity generation mix significantly increases the emissions footprint of manufacturing activities in Indonesia. BNEF's manufacturing emissions model for battery making is highly linked to grid carbon emissions intensity and Indonesia has one of the highest among the countries in the ranking. It also does not have a carbon pricing mechanism in place but has announced plans regarding this scheme.

Indonesia's Class 1 nickel output is primarily from high-heat smelting processes that also require metallurgical coal as part of process inputs. This results in much higher emissions intensity of producing nickel compared to other regions (Figure 62). This is bound to improve, as the additional projects coming online are mostly hydrometallurgical processes that do not use carbon-based process inputs and do not require high-heat temperatures. It would still have higher emissions overall compared to nickel sulfide production centers such as Australia, Canada and Russia due to the nature of the processes tied to extracting nickel from the type of deposit present in these countries versus Indonesia's laterites.

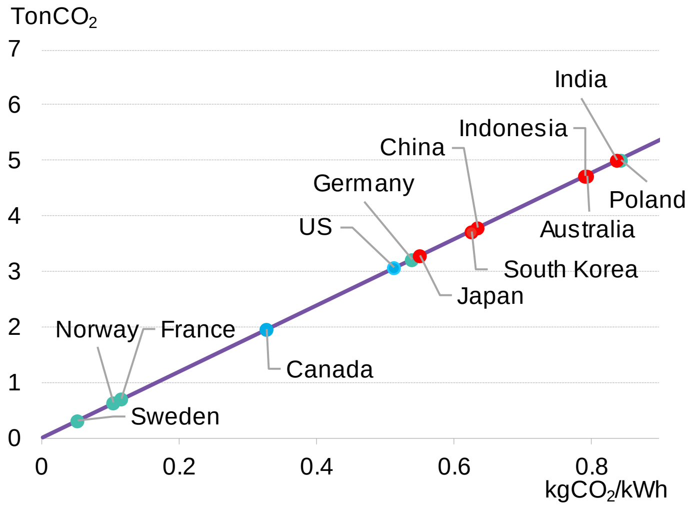
Additionally, the emissions from the production of precursors through the assembly of a 100kWh NMC 622 battery pack in Indonesia could also be roughly double the emissions of a similar battery manufactured in China or Germany (Figure 63). This could be a big hurdle for international companies looking to export batteries and EVs to markets like Europe.

Figure 62: Carbon intensity of select global Class 1 nickel producers, 2019



Source: BloombergNEF. Note: Includes direct and indirect emissions as reported from ore mining to intermediate production but excludes transport and logistics related emissions. Weighted average estimated from total global Class 1 capacity, not just of the producers represented on this chart.

Figure 63: Carbon footprint of producing a 100kWh NMC (622) battery pack in different markets, 2021



Source: BloombergNEF. Note: Does not include raw material extraction and processing

The country also has low scores on renewable energy policy due to the lack of support offered to clean power sources like solar PV and wind. PT PLN expects renewables to account for just 23-25% of total electricity generation in their business area in 2030 compared to 18% in 2021. Further, PLN expects solar and wind to account for less than 2% of total electricity generation in 2030 in its business plan. This is the least ambitious renewable energy plan among G-20 countries.

Companies also face hurdles in procuring renewable energy directly from IPPs or other services like rooftop PPAs. Existing regulations do not allow renewable energy procurement from third parties or offsite power projects in PT PLN's distribution zones. Several hydropower projects planned by the government to serve industrial zones for battery and component manufacturing are also facing severe delays. Some of the largest hydropower projects proposed almost a decade back under this program might only be fully operational by 2035. Industrial parks are planning to build coal projects in the interim to meet their power demand, which further increases costs and emissions.

Industry, innovation, infrastructure

Regulatory transparency, quality of infrastructure and the innovation ecosystem in a country are also key factors that enable countries to attract more investments and capture more value locally. BNEF uses several global datasets published by the World Economic Forum, OECD, World Bank, World Intellectual Property Organization, Fraser Institute and Heritage Foundation to arrive at a score for each country in this segment. Ranking in this category is assumed static between 2022 and 2027.

Availability of cheap power is one factor that could help improve Indonesia's attractiveness as a manufacturing hub, provided the emissions associated with power generation are also acceptable. Indonesia has the third cheapest industrial electricity cost in the ranking. Indonesia also scores highly in mining investment attractiveness due to generally favorable policies for the minerals sector.

Additionally, the government will need to evaluate mechanisms that can help train the local workforce for these new industries and promote the growth of local innovation hubs. Creating transparent policies and schemes that international investors can access is also crucial to improve the country's global attractiveness on this parameter. Indonesia has lower scores on research and development investment and technical capability of its workforce. These are essential factors in helping support a high-tech industry such as battery manufacturing.

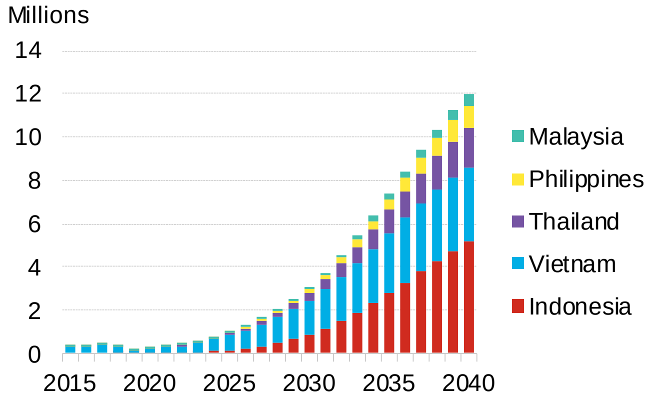
Downstream demand

Battery manufacturers and automakers are setting up production facilities near demand centers to reduce logistics costs and emissions. As a result, countries that have a higher end-demand for batteries, generally driven by the demand for electric vehicles, are more attractive to these companies.

Less than 800 electric cars were sold in Indonesia in 2021 compared to 6.6 million passenger EVs sold globally. EVs also accounted for well below 1% of all two-wheelers sold in Indonesia in 2021. As a result, the country scored low on domestic demand for EVs and batteries in 2022 in BNEF's ranking.

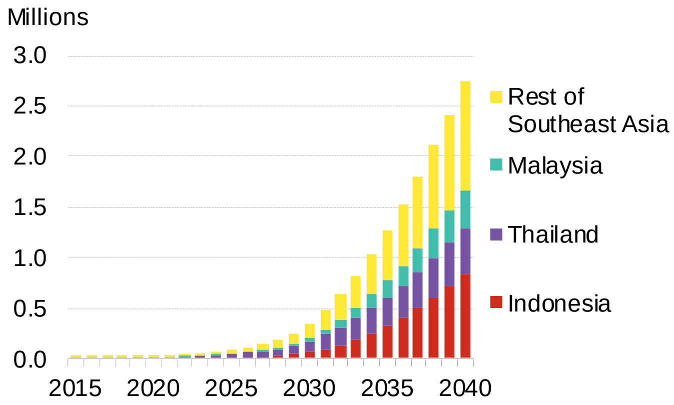
In the economic transition scenario, EVs still account for just 14% of annual two-wheeler sales and 6% of passenger vehicle sales in 2030 in Indonesia. Vehicles that are priced below $20,000 account for about 80% of all passenger vehicle sales in Indonesia currently. Similarly, the most popular two-wheelers sold in the country are priced around $1,000-1,500. In our outlook, battery prices will have to fall well below $100/kWh for BEVs to achieve upfront price parity with these affordable internal combustion engine vehicles sold in Indonesia. Therefore, EV adoption in Indonesia only takes off after 2030 in BNEF's ETS (Figure 64 and Figure 65).

Figure 64: Southeast Asia electric two-wheeler sales outlook by market



Source: BloombergNEF

Figure 65: Southeast Asia electric passenger vehicle sales outlook by market



Source: BloombergNEF

One potential route to increase end-demand is by becoming an export hub for EVs. Indonesia exported some 295,000 passenger and commercial vehicles in 2021 to other markets. Some 46% of these vehicles were exported to other Southeast Asian countries, while the Middle East and Africa accounted for an additional 28%. Indonesia could serve as a manufacturing center for EVs and batteries sold in these markets where local manufacturing capacity is limited. However, it must compete with countries like Thailand, Japan, Korea, and India that are also targeting exports to these markets. Establishing trade relations that could enable easier access to these destination markets could help make Indonesia more attractive to EV and battery manufacturers.

5.4. Way forward for Indonesia

The two most important factors holding back Indonesia in BNEF's global battery supply chain ranking are the relatively high environmental footprint of manufacturing industries in the country and the lack of domestic demand in the short term. The government has made significant progress since 2019 in implementing policies to support EV adoption and to attract local manufacturing. However, more needs to be done in the short term to accelerate EV adoption from its current trajectory and increase investment flows into the manufacturing sector. Some of the options include

- **To boost EV adoption:**
  - Introduce long-term fuel economy standards and/or zero emission vehicle mandates that will require automakers to sell more low emissions vehicles. This will also offer long-term certainty for investors on the demand for EVs and batteries in the country.
  - Support the roll-out of EV charging stations initially until there is a critical stock of charging stations across major cities and highways. Many markets like Germany, Singapore and India are also using competitive auctions to identify companies that will build charging stations in selected areas while incurring the lowest cost.

- Identify sectors like ride-hailing, taxi services, public transport services and urban delivery fleets where the use of EVs could reduce the operational costs and help bring down urban emissions. These segments would also have an outsized share in the total fuel consumption in the country. Accelerating EV adoption in these segments could lower the government's fiscal burden by reducing fuel subsidies and import bills for fuel. Setting more aggressive targets for the electrification of these segments and offering financial incentives to accelerate adoption could boost EV demand in the medium term. The government's plan to switch all vehicles owned by state-owned companies to EVs by 2025 is a step in the right direction.
- Establish trade relations with target markets like the Middle East, Australia, Africa and other similar markets with limited EV and battery manufacturing capacity to provide easy access for products manufactured in Indonesia.

- **To reduce the environmental impact of manufacturing:**
  - Introduce policies that will help accelerate the decarbonization of the electricity grid in Indonesia.
  - Introduce policies that will allow companies to procure renewable energy directly from third parties or the utility company through separate power purchase agreements. This offers companies the flexibility to procure electricity from the most economic clean power sources based on their own use cases and demand characteristics.

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