Indonesia’s Energy Transition: A Case for Action

This in-depth look at the evolution of the country’s energy mix reveals that although Indonesia can accelerate its adoption of renewable energy, a policy overhaul is needed to recover lost ground.
Global Trends

The energy transition

A.T. Kearney’s Energy Transition Institute defines the energy transition (ET) as the ongoing shift of technologies and energy sources that targets sustaining economies through energy efficiency while minimizing the environmental impacts of energy production and consumption. Put simply, ET refers to the notion that the overall energy mix must change to reduce greenhouse gas (GHG) emissions. Generally, four trends are fueling this transition: improved energy efficiency, carbon capture and sequestering (CCS), fuel switching, and the adoption of renewable energy (RE) technologies. In this paper, we focus on the latter: RE technologies for generating electricity.

The energy transition refers to the notion that the energy mix must change to reduce GHG emissions.

Globally, hydro still accounts for the largest share of RE as of 2017: about 65 percent in terms of total electricity generation (see figure 1). However, more than 80 percent of the incremental electricity generation came from solar and wind, demonstrating the growing adoption of these two technologies.

Figure 1
Hydro leads electricity generation, but 80 percent of incremental capacity in 2017 was from solar and wind

Electricity generation from renewable technologies globally (TWh)

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Total 2016</th>
<th>Total 2017 Incremental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydro</td>
<td>4,060</td>
<td></td>
</tr>
<tr>
<td>Solar</td>
<td>443</td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td>1,123</td>
<td></td>
</tr>
<tr>
<td>Geothermal, biomass, other renewable energy</td>
<td>586</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>6,211</td>
<td></td>
</tr>
</tbody>
</table>

Notes: TWh is terawatt hours. Pure pumped storage capacity is excluded from hydropower capacity data. Sources: BP, A.T. Kearney analysis
Key drivers

It is important to understand the objectives for adopting RE. Factors that drive RE adoption in some cases could act as barriers in other cases, thus posing an inherent challenge.

Typically, there are four reasons for adopting RE:

**Climate change.** About 80 percent of global carbon dioxide (CO2) emissions are driven by fossil consumption.1 In 2015, the United Nations convened a Climate Change Conference in Paris to get countries to a binding and universal agreement on reducing the carbon footprint. This 21st-annual installment of the Conference of Parties (COP21) raised a call to action against climate change. In the wake of this meeting, many countries revised their plans and targets for their electricity generation mix. Indonesia, for example, announced it will reduce emissions by 29 percent by 2030 compared with business as usual.2 Expanding the share of RE in the energy mix is an important way for countries to achieve their COP21 commitments.

**Energy security.** In an effort to become more self-sufficient in their energy supply, most countries are aiming to reduce their dependence on fuel imports. China, for example, has been investing in a range of RE capacities, such as hydro, solar, and wind, to satiate its huge demand for energy without becoming more dependent on other countries. However, some countries, such as Poland, are increasing their share of electricity generation from coal, given its abundance in the country, which then becomes a barrier to adopting RE technologies.3

**Energy affordability.** The cost of electricity from RE sources of energy compared with conventional sources is a key consideration. Although generating power from fossil fuels is still cheaper than RE in many countries, some RE technologies have become commercially competitive. In fact, the cost of power generation from RE is dropping each year with improvements in technology, making it comparable to fossil fuels. A prime example is Denmark, where wind speeds are high enough to ensure that wind power generation costs are extremely competitive. In Germany, the average successful bid in the first tender for offshore wind parks is 44 cents per kWh.4 The fact that these prices are lower than the average grid price without any subsidies is a major milestone.

**Social and consumer acceptance.** Consumers’ preferences for improving their health and quality of life have driven some countries to shift toward RE. For example, in metropolitan cities such as New Delhi in India, there is immense social pressure to improve air quality.

Disruption of the energy value chain

The energy transition has disrupted the traditional utilities and oil and gas value chains, creating new opportunities and challenges.

The energy transition has disrupted the traditional energy value chain by opening new avenues and posing new challenges. Traditionally separate industries in distinct parts of the energy value chain are now converging with a significant competitive overlap. For instance, power utilities are shifting their business models from central to distributed generation. With the emergence of electric vehicles, the utilities are also competing with traditional oil and gas

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2 Intended Nationally Determined Contribution, Republic of Indonesia
3 About 78 percent of the total electricity generated in Poland in 2017 was from coal, according to BP.
4 Federal Grid Agency in Germany
companies to fuel vehicles. Oil and gas companies are moving from hydrocarbon to low-carbon sources. Shell, for example, has invested in wind, solar, and biofuels, and Total has invested in solar, batteries, and offshore wind.\(^5\)

Oil and gas companies are also becoming integrated energy players. For example, Shell has announced it could be the world’s largest power company by the 2030s. Automotive companies are investing in electric vehicles and slowly but surely replacing the internal combustion engine-based power train, which is having a profound impact on the traditional oil and gas industry. Similarly, more financial institutions are looking to reduce their investments in fossil fuel-based assets and focusing on divesting stranded assets to free up capital to invest in RE.

Emerging opportunities in the energy value chain are also attracting players that had no presence in the market until just a few years ago. For example, Tesla, Samsung, Panasonic, Sony, and Nissan are now among the key players in the energy storage market.

**Investment flows**

As investments continue to flow into RE around the world, costs are plummeting as a result of technology advances, increased scale, and improved learning effects.

The global electricity generation mix is expected to go through a massive transition over the next 30 years. In 2017, RE technologies accounted for about 27 percent of the global electricity generation mix, excluding nuclear. By 2050, this is expected to more than double to about 67 percent. Within RE, solar and wind are expected to have the largest share increase. Meanwhile, the share of coal in the power generation mix is expected to see the largest drop—from 38 percent in 2017 to only 10 percent in 2050 (see figure 2).

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\(^5\) In February 2019, Total, in partnership with Ørsted and Elicio, announced plans to submit a bid for the Dunkirk offshore wind farm project in France with a capacity of 600 MW.
To aid this transition, investments into RE technologies will be essential—to the tune of about $9 trillion total by 2050, according to Bloomberg. About 70 percent of that is expected to go into two technologies: wind and solar (see figure 3).

Investments into renewable energy technologies will be essential—to the tune of about $9 trillion total by 2050, according to Bloomberg. About 70 percent of that is expected to go into wind and solar.

Larger investments in RE led to increased RE capacities as well as greater funding for technical advancement. This created benefits from scale and learning effects and in turn help lower the cost of RE technologies.

**Figure 3**

*Wind and solar will fuel the renewable energy investment*

**Global investments**

(2018–2050)

- $11.5 trillion
- 33% Solar
- 40% Wind
- 5% Oil
- 2% Nuclear
- 3% Other
- 6% Hydro
- 11% Gas
- 2% Coal

Notes: Geothermal energy and biomass are reported under other. This analysis was done in 2017.
Sources: Bloomberg New Energy Finance; A.T. Kearney analysis

Scale and learning effect benefits have been observed every year for the past several years. Historically, global growth in solar and wind capacities has been consistently higher than forecasts (see figure 4 on page 5). The key reason for this forecasting error is the cost of RE technologies, which keeps falling faster than most predictions. In fact, the annual cost learning rate, which is defined as the percentage cost per watt reduction experienced for every doubling of cumulative installed capacity, has been 28 percent for solar and 19 percent for wind.
Indonesia’s Energy Transition: A Case for Action

Solar and wind capacities are on the rise

Global cumulative solar installations (GW installed)

Global cumulative wind installations (GW installed)


The levelized cost of electricity (LCOE) is a metric used to compare the cost of electricity generated from different sources on a consistent basis. Global LCOE from 2017 reveals that, on average, small and large hydro, solar PV utility scale, and onshore wind are well within range of LCOE for fossil fuels (see figure 5). The key takeaway is that power generation from RE is becoming increasingly cost-competitive compared with fossil fuels—a trend that is likely to continue.

Figure 5
Power generation from hydro, solar PV, and onshore wind is within range of fossil fuels

LCOE range for renewable operating facilities ($/MWh, 2017)

Notes: LCOE is levelized cost of electricity. PV is photovoltaic; CSP is concentrated solar power. The exchange rate assumption is €1 = $1.13. Sources: International Renewable Energy Agency (2017), International Energy Agency (2017), A.T. Kearney analysis
However, LCOE does not reflect the differing value propositions of technologies. RE development raises flexibility issues in the power grid, and because LCOE does not integrate the investments required to compensate for the intermittency of power supplied, the metric is not a fair comparison.

Solar PV utility scale and onshore wind costs are moving toward the cost of fossil fuel-based generation.

The International Energy Agency has introduced a new metric, value-adjusted LCOE (VALCOE), which combines the projected levelized costs of electricity with simulated energy value, flexibility value, and capacity value by technology. VALCOE is a more meaningful metric for cross-technology comparisons. An analysis of the 2017 VALCOE levels reveals that, on average, solar PV utility scale and onshore wind costs are moving toward the cost of fossil fuel-based generation. By 2040, the VALCOE of solar PV utility scale, onshore wind, and offshore wind is expected to be within the range of the VALCOE for fossil fuel-based power generation (see figure 6).

**Figure 6**

*Renewable technologies are likely to become more cost competitive with hydrocarbon power*

**VALCOE range for renewable operating facilities ($/MWh)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Nuclear</th>
<th>Solar PV</th>
<th>Wind onshore</th>
<th>Wind offshore</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>150</td>
<td>165</td>
<td>105</td>
<td>105</td>
</tr>
<tr>
<td>2040</td>
<td>110</td>
<td>105</td>
<td>105</td>
<td>115</td>
</tr>
</tbody>
</table>

Notes: VALCOE is value-adjusted levelized cost of electricity. PV is photovoltaic. Estimates are from the United States, the European Union, China, and India. Fossil fuel-based generation includes energy from coal and combined cycle gas turbines. Forecast is based on the International Energy Agency’s new policy scenario, which incorporates not only the policies and measures that governments around the world have put in place, but also the likely effects of announced policies.

Sources: International Energy Agency data from 2017; A.T. Kearney analysis
Policies and regulations

Supporting policies and stable regulations are essential for RE growth in any country.

Favorable policies and stable regulations are crucial for boosting investors’ confidence and attracting capital to the RE sector. While the RE regulations vary by country, the most common mechanisms to encourage investments include subsidized feed-in tariffs (FiTs), tradeable renewable energy certificates, and RE tendering schemes (see figure 7).

Figure 7

Feed-in tariffs are the most common regulatory approach to expand the use of renewable energy

<table>
<thead>
<tr>
<th>Regulatory policies</th>
<th>Fiscal incentives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed-in tariffs and premium payments</td>
<td>Electric utility quota obligation/ RPS</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Pegged to fossil fuel generation</td>
</tr>
<tr>
<td>Malaysia</td>
<td></td>
</tr>
<tr>
<td>Thailand</td>
<td></td>
</tr>
<tr>
<td>Philippines</td>
<td></td>
</tr>
<tr>
<td>India</td>
<td></td>
</tr>
<tr>
<td>China</td>
<td></td>
</tr>
<tr>
<td>Vietnam</td>
<td></td>
</tr>
</tbody>
</table>

Note: RPS is renewable portfolio standard, the amount of electricity electric utilities are required to generate from renewable energy.

For example, in 2017, Vietnam adopted a new FiT scheme to boost the development of solar and wind and reduce the country’s reliance on hydro. The proposed tariff was 9.35 cents per kWh for solar and 7.38 cents per kWh for wind. Initial indications reveal Vietnam’s growing interest in solar as a result of the new FiT scheme: the government expects 2 GW of solar capacity to be online by the end of the first half of 2019—more than twice the government’s 2020 target.⁵

A key trend over the past few years is the shift from traditional fixed-price mechanisms, such as FiTs, to more competitive mechanisms, such as tenders. This has been driven by the fact that policy makers have struggled to cope with challenges related to integrating the intermittent RE power into the grid. In 2017, RE power tenders were held in more than 29 countries.⁷ For some developing economies, these tenders have led to record low prices, which are competitive with traditional power generation technologies. India has adopted the tendering process in recent years, with two rounds of tendering for onshore wind energy held nationally in 2017, contracting a total of 2 GW, with the lowest bids below 4 cents per kWh. Developed economies

⁵ Vietnam Ministry of Industry and Trade, International Renewable Energy Agency
⁷ The Renewable Energy Policy Network for the 21st Century (REN21)
are following suit. Europe, for example, has a tiered system in which large projects are awarded through tenders and smaller scale projects are supported by feed-in policies.

This does not imply that FiTs will disappear anytime soon, but there is an emerging need to constantly revise FiT rates as RE costs evolve. For example, China reduced FiT rates in 2017 for utility-scale solar PV, with reductions based on the region. In India, Karnataka reduced its FiT for solar PV and wind while increasing the FiT for geothermal.

With multiple policies already instated, Indonesia appears to have a solid regulatory framework. However, the problem is in the policy specifics and the fact that some regulations continue to change.

### Renewable Energy in Indonesia

Renewable energy in Indonesia is far behind most countries and way below its true potential.

#### Context

The state of RE development needs to be seen in the context of Indonesia’s electricity consumption, which is expected to grow 6 to 7 percent per year between 2018 and 2027, driven primarily by strong macroeconomic and demographic fundamentals. Demand will also grow as a result of the government’s plan to raise the electrification ratio from 97.5 percent in 2018 to 99.9 percent by 2019 thanks to the 2,500 villages program.

In 2017, Indonesia’s installed power capacity was about 61 GW, with about 88 percent from fossil fuels (see figure 8). To meet demand, Indonesia’s national power utility Perusahaan Listrik Negara (PLN) plans to install additional 56 GW of power capacity between 2018 and 2027.

#### Figure 8

**Most of Indonesia’s power capacity comes from thermal energy**

**Total installed power capacity in Indonesia**

(GW, 2017)

<table>
<thead>
<tr>
<th>Source: Enerdata, A.T. Kearney analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fossil fuel-based power generation accounts for approximately 54 GW, translating to approximately 88% of the total capacity.</td>
</tr>
</tbody>
</table>

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6 Based on estimates from Fitch Solutions, Indonesia’s electricity demand is expected to grow 6.3 percent year over year from 2018 to 2027; PLN estimates this growth at 6.86 percent.

9 Based on PLN’s Rencana Umum Penyediaan Tenaga Listrik (RUPTL) 2018–2027
Indonesia’s RE targets

The first major step for every ET journey is setting a national RE target—a bold yet realistic one. In 2017, 179 countries had established a national, provincial, or state-specific RE target. In 2014, in line with the National Energy Policy (GR No. 79/2014), Indonesia’s Ministry of Energy and Mineral Resources, Energi Dan Sumber Daya Mineral (ESDM), set a target of reaching 23 percent of its primary energy mix from new and renewable energy (NRE) sources by 2025 (see figure 9). Of this, the largest share—23 percent—is targeted to be achieved from bioenergy, geothermal, and hydro. Solar and wind, both of which are shown under “other NRE,” are expected to constitute a small share, even in 2025.

Figure 9
Indonesia aims to get 23 percent of its energy from new and renewable sources

Indonesia’s target primary energy mix in 2025

<table>
<thead>
<tr>
<th>Source</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>30%</td>
</tr>
<tr>
<td>Oil</td>
<td>25%</td>
</tr>
<tr>
<td>Gas</td>
<td>22%</td>
</tr>
<tr>
<td>New and renewable energy</td>
<td>23%</td>
</tr>
<tr>
<td>Bioenergy</td>
<td>10%</td>
</tr>
<tr>
<td>Hydro</td>
<td>3%</td>
</tr>
<tr>
<td>Geothermal</td>
<td>7%</td>
</tr>
<tr>
<td>Other renewable energy</td>
<td>3%</td>
</tr>
</tbody>
</table>

Note: MTOE is million tons of oil equivalent.

PLN has also set a target for the electricity generation mix in 2025 (see figure 10 on page 10). Comparing the actual generation mix in 2017 with the targeted mix for 2025 reveals that the share of NRE is expected to increase significantly with the share of coal and oil dropping and the share of gas remaining largely unchanged.

Status of RE implementation

Implementation has been a problem, and actual realization in 2025 will likely fall short of the target.

Setting a national target is relatively easy; ensuring that implementation follows the target plan is challenging. Expanding the share of RE in the electricity generation mix obviously requires RE growth to be higher than the overall electricity growth rate. In 2013, out of the total 216 TWh electricity generated in Indonesia, RE accounted for about 12.26 percent. In 2017, out of the total

\[10\text{RE}21\]

\[11\text{The Ministry of Energy and Mineral Resources defines new and renewable energy as follows: “New” includes liquified coal, coal bed methane, gasified coal, nuclear, and hydrogen; “Renewable energy” includes geothermal, hydro, solar, wind, bioenergy, and ocean.}
260 TWh of electricity generated, RE accounted for 12.05 percent. This implies that between 2013 and 2017, RE generation growth lagged the total generation growth by about 0.4 percent. If this trend continues, the share of RE in the total electricity generation mix will remain unchanged or even shrink. Market estimates on the projected electricity generation mix, based on a realistic view of power capacity additions and retirements, reveal that unless Indonesia radically changes its implementation plan, the country will miss its 2025 NRE target by a big margin—reaching 12 percent instead of the 23 percent goal (see figure 11).

### Figure 10
**PLN is aiming for nearly a quarter of the energy mix coming from new and renewable energy sources**

**Comparison of electricity generation mix**

![Diagram showing electricity generation mix](image)

Sources: Rencana Usaha Penyediaan Tenaga Listrik (RUPTL) Perusahaan Listrik Negara (PLN) 2018–2027, A.T. Kearney analysis

### Figure 11
**Indonesia could fall short of its electricity target**

**Electricity generation forecasts (TWh)**

![Electricity generation forecasts chart](image)

Notes: TWh is terawatt hours. The 2025 national target is from the General Plan of National Electricity 2015–2034. Renewables include hydro.

Sources: BMI Research, Ministry of Energy and Mineral Resources of the Republic of Indonesia; A.T. Kearney analysis

12 Data based on BPs Statistical Review

13 Fitch Solutions
REMI ranking

A.T. Kearney’s Renewable Energy Maturity Index ranks Indonesia in the fourth quartile.

Next, we assess where Indonesia ranks in terms of overall RE development, using A.T. Kearney’s Renewable Energy Maturity Index (REMI), which provides an overall indication on the status of RE compared with the needs and potential for each country.

The Index is based on three parameters:

- The share of RE in total electricity generation
- The difference between the annual increase in the RE share and total electricity generated
- The share of electricity generated from RE in 2017 versus the 2030 target (Countries typically set targets based on available RE potential, electricity demand, and cost competitiveness across technologies. The International Renewable Energy Agency’s Reference Case 2030 targets were used for this analysis. For some countries for which the agency does not publish a 2030 target, appropriate national targets were used.)

Appropriate weightages were attributed to each parameter to derive the total scores for the top 50 electricity-producing countries with at least 5 TWh electricity generation from RE. The overall ranking shows that Indonesia is in the fourth quartile at the 39th position, behind China, Malaysia, Vietnam, and India (see figure 12).

Figure 12
Indonesia ranks lower than other countries in terms of renewable energy

Ranking of countries based on A.T. Kearney’s Renewable Energy Maturity Index

<table>
<thead>
<tr>
<th align="center">A.T. Kearney’s Renewable Energy Maturity Index is a function of the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td align="center">• The share of renewable energy in total electricity generation (weightage: 40%)</td>
</tr>
<tr>
<td align="center">• Change in this share in the past five years (weightage: 35%)</td>
</tr>
<tr>
<td align="center">• Renewable energy generation compared with Reference Case 2030 (weightage: 25%)</td>
</tr>
</tbody>
</table>

**Top 50 electricity generation countries with renewable energy of more than 5 TWh**

- Colombia
- Norway (Rank 2)
- Germany (Rank 3)
- Finland
- Sweden
- United Kingdom
- Canada
- Austria
- Brazil (Rank 9)
- Romania
- United States of America (Rank 11)
- Japan
- Peru
- Switzerland
- Chile
- Belgium
- Malaysia (Rank 17)
- China (Rank 18)
- Italy
- Poland
- Turkey
- Czech Republic
- Mexico
- Russian Federation
- Greece
- Australia
- Kazakhstan
- Vietnam (Rank 28)
- Portugal
- Argentina
- Thailand (Rank 31)
- South Africa
- South Korea
- Uzbekistan
- Philippines (Rank 36)
- France
- Pakistan
- India (Rank 38)
- Indonesia (Rank 39)
- Iran
- Ukraine
- Egypt

Notes: Venezuela has been excluded from this analysis because 2030 targets were not available. The International Renewable Energy Agency’s Reference Case 2030 was used to measure the 2030 targets for all countries except Chile, Romania, Peru, Norway, Greece, Switzerland, Austria, Philippines, Uzbekistan, Pakistan, Portugal, Finland, and Czech Republic; external sources citing 2030 targets were used for these countries. Although countries such as France have a high degree of nuclear energy, nuclear has been excluded from this analysis.


14 Based on 2017 data
15 Based on 2013 to 2017 CAGR estimates
16 The International Renewable Energy Agency (IRENA) is an intergovernmental organization that supports countries in their transition to a sustainable energy future and serves as the principal platform for international cooperation, a center of excellence, and a repository of policy, technology, resource, and financial knowledge on renewable energy.
Dissecting this ranking based on the three parameters used to calculate REMI reveals additional insights:

- In terms of the share of electricity generated from RE, Indonesia is in the third quartile. With about 12 percent of the electricity generation mix in 2017, RE is not significant in Indonesia. It is interesting to note that many of the countries that fare well based on this parameter have a high share of hydroelectricity.

- When comparing countries based on growth in electricity generation from RE against total electricity generation from 2013 to 2017, Indonesia is in the fourth quartile with the share of RE in the electricity generation mix remaining stagnant.

- Based on the percentage of electricity generated from RE in 2017 against the 2030 target (the International Renewable Energy Agency’s Reference Case 2030), Indonesia is again in the fourth quartile—implying that the country is far away from its 2030 ambitions and its true RE potential.

Implementation by technology

Adoption rates for solar and wind technologies in Indonesia have been minimal despite the country’s vast potential.

A 2017 assessment of the total potential for RE compared with actual installed capacity reveals a massive gap for solar and wind in Indonesia. To date, hydro and geothermal have accounted for most of the country’s electricity generation from RE, with a minimal presence for solar and wind. This is contrary to global trends that show an increasing adoption of solar and wind for power generation.

According to a 2015 survey by Rencana Umum Energi Nasional (RUEN), the total potential for solar in Indonesia is about 208 GW, while that from wind is around 61 GW. However, the installed capacity of solar and wind in 2017 was only 20 MW and 1 MW respectively, indicating significant potential for growth (see figure 13).

Figure 13

Solar and wind technologies have grown globally, but Indonesia’s success has been dismal

<table>
<thead>
<tr>
<th>Estimated total potential (MW)</th>
<th>2017 installed capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geothermal</td>
<td>29,544</td>
</tr>
<tr>
<td>Hydro</td>
<td>75,091</td>
</tr>
<tr>
<td>Solar</td>
<td>207,898</td>
</tr>
<tr>
<td>Wind</td>
<td>60,647</td>
</tr>
<tr>
<td>Ocean</td>
<td>17,989</td>
</tr>
</tbody>
</table>

*Installed capacity as a % of total estimated potential*

Note: As of 2015

The pipeline of RE projects in Indonesia indicates the trend is likely to continue; the total capacity of hydro and geothermal projects under construction or announced is much larger than the total capacity of solar and wind projects.

**Required investment**

**Indonesia needs to significantly increase RE investments to meet the country’s target.**

Investments are vital for RE development in any country, and Indonesia is no different. Based on RUEN’s published RE power capacity additions and A.T. Kearney’s industry experience on capex, we estimate that a capital investment of $62 billion will be required between 2018 and 2025, translating to about $8 billion a year.\(^\text{17}\) In comparison, the total investment into RE in Indonesia was about $0.6 billion in 2016 and $1 billion in 2017 (see figure 14).\(^\text{18}\)

**Figure 14**  
**Indonesia's renewable energy investment is much lower than required**

**Renewable energy capex requirements based on RUEN’s planned capacity additions ($ billion)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Planned capacity additions (MW)</th>
<th>Actual investments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>1,479</td>
<td>1 billion in 2017</td>
</tr>
<tr>
<td>2019</td>
<td>1,876</td>
<td>$0.6 billion in 2016</td>
</tr>
<tr>
<td>2020</td>
<td>2,238</td>
<td></td>
</tr>
<tr>
<td>2021–2025</td>
<td>28,996</td>
<td></td>
</tr>
<tr>
<td>Total until 2025</td>
<td>45,153</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Specific capex in $/KW assumed as follows: biomass = 1,660; geothermal = 3,185; hydro and mini hydros = 1,500; onshore wind = 2,342; solar = 2,134. Sources: International Renewable Energy Agency Renewable Energy Market Analysis: Southeast Asia, Rencana Umum Energi Nasional (RUEN); A.T. Kearney analysis

**Case for change**

**ET is not a choice but a must if Indonesia is to strike a balance across climate change, energy security, energy cost, and social acceptance.**

As of 2017, 51 percent of Indonesia’s power capacity was coal-fired. In addition, out of the 56 GW that PLN plans to add from 2018 to 2027, around 48 percent is expected to be coal-fired.\(^\text{19}\) This implies that the significance of coal in the generation mix is expected to remain substantial. However, given Indonesia’s pledge to reduce GHG emissions by 29 percent compared with

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\(^{17}\) Capex per MW  
\(^{18}\) Based on the Global Trends in Renewable Energy Investment 2018 report published by Bloomberg and UN Environment  
\(^{19}\) Based on PLN’s RUPTL 2018–2017
business as usual by 2030, there is a need for a partial transition of the energy mix towards RE to lower the country’s carbon footprint. With the generation mix currently planned for addition, it is difficult to see how Indonesia can reach its GHG emission target.

From an energy security perspective, RE can replace the gas, coal, and diesel that are currently used to generate electricity. Gas and coal volumes will then be available for export, while import volumes for diesel can be curtailed. These factors can improve Indonesia’s trade balance by lowering its current account deficit (CAD), which rose from $4.3 billion in 2015 to $8.8 billion in 2018. In turn, a lower CAD can strengthen the performance of the Indonesian rupiah against the US dollar. Hence, generating more electricity from RE will allow Indonesia to improve its fiscal stability in the long run.

Although Indonesia’s cost of energy from fossil fuels is generally lower than from RE, the latter is becoming more competitive as a result of rapidly falling costs. Redirecting subsidies from fossil fuels to RE technologies will help RE achieve grid parity sooner.

From a societal point of view, Indonesia aims to increase its electrification ratio to 99 percent in 2019. To do this, the country needs to focus on small and remote villages, as evidenced by the 2,500 villages program. Such locations are typically well-suited for RE, especially distributed generation opportunities for solar that can help lower the transmission capex.

In summary, expanding RE power generation is not a choice but a must for Indonesia’s long-term sustenance (see figure 15).

Figure 15
There is a strong case for using more renewable energy in Indonesia

Significance of renewable energy in power generation for Indonesia

Energy transition objectives

<table>
<thead>
<tr>
<th>Climate change</th>
<th>Energy security</th>
<th>Energy cost</th>
<th>Social acceptance</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The high share of coal (51%) is expected to stay high.</td>
<td>• Renewable energy can replace gas and coal, which could be exported; diesel use falls.</td>
<td>• Renewable energy costs are rapidly falling and will soon be lower than fossil costs.</td>
<td>• RE (especially solar) suited for distributed generation.</td>
</tr>
<tr>
<td>• Indonesia has pledged to reduce greenhouse gas emissions by 29% by 2030.</td>
<td>• There would be a positive impact on the current account deficit and exchange rate.</td>
<td>• Existing subsidies can be redirected to renewable energy if needed.</td>
<td>• Electrification rates will rise with lower capex for transmission.</td>
</tr>
</tbody>
</table>


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²⁰ First Nationally Determined Contribution Republic of Indonesia
Barriers to growth

There are four main barriers to the growth of RE in Indonesia: technological constraints, unfavorable policies and regulatory uncertainty, availability of private financing, and a conflict of interest in PLN's role.

Technological constraints

Lack of a widespread high-tension grid infrastructure and environmental factors create technological constraints in Indonesia.

The grid infrastructure has not yet pervasively penetrated the country because of multiple factors. First, Indonesia is an archipelago of about 17,000 islands, which poses a challenge for designing, constructing, and operating electricity networks. Second, adequate investments have not been made in the grid, especially for developing high-tension grids. As a result, other than Java–Bali, Indonesia does not have a grid that can accommodate large-scale variable output from RE power generation.

For effective RE development, demand, RE resource potential, and infrastructure availability (such as land and a distribution grid with connection points) need to be matched. However, this can be quite challenging as each of these three factors vary significantly across Indonesia’s islands. For example, average wind speeds 80 meters above ground are 3 to 4 meters per second in inland sites and 5 to 6 meters per second at coastal sites, but many of the coastal areas are densely populated and thus not favorable for wind farming. Another example is solar: land is limited and expensive in places such as Java, where insolation levels, demand, and grid capacity are high. And in areas where solar has great potential, such as Eastern Indonesia, developing large plants is not economically feasible because there is no grid connectivity and no sufficient demand.

In this context, it is also important to understand the tradeoffs between possible uses of land. For example, in parts of Sumatera, the insolation level is relatively high, but because many of these areas have palm-oil plantations, they are not accessible for developing solar farms.

Technological challenges have two main implications: effective RE generation solutions cannot always be developed in areas that have natural potential, and there is a high variability in LCOE for the same technology across different parts of the country.

Unfavorable policies and regulatory uncertainty

Unfavorable policies and regulatory uncertainty have been major barriers to the development of RE in Indonesia.

Unfavorable RE tariff scheme

To incentivize RE developers, Indonesia proposed FiTs under a series of ministerial regulations, including 04/2012, 17/2013, 12/2014, 17/2014, and 27/2014. Much like in any other country, the idea of the FiT scheme was to strike a balance between protecting developers’ interests and controlling the government’s subsidies to PLN. However, challenges between PLN and the RE developers have hampered the scheme’s execution.

Even with subsidies, PLN has been hesitant to purchase power at tariffs higher than fossil fuel power generation rates. One possible reason is that there is no clear allocation on how much RE-based power PLN can purchase in the long term. To address PLN’s concerns about recovering costs, the government devised new regulations MEMR 12/2017 and 50/2017.
According to this regulation, the tariff calculation can be split into two groups based on the RE technology:

- **Solar, wind, biomass, biogas, and ocean energies.** If the local average cost of power generation (biaya pokok pembangkitan, or BPP) is greater than the national BPP from the previous year, the tariff will be a maximum of 85 percent of the local BPP. If the local BPP is equal to or lower than the national BPP from the previous year, the tariff will be based on an agreement between the developer and PLN (see figure 16).

- **Hydro, waste, and geothermal energies.** If the local BPP is greater than the national BPP from the previous year, the maximum benchmark tariff is the local BPP. If the local BPP is equal to or less than the national BPP from the previous year, the tariff will be based on an agreement between the developer and PLN.

Figure 16

**Tariffs could help renewable energy compete with subsidized fossil fuels**

**Local average power generation cost (BPP)** (cents per kWh, 2017)

Although the intention of the regulation was to incentivize PLN, the net result has been the opposite: discouraging RE developers because capping the tariffs based on BPP renders many RE projects economically unfeasible. This is particularly true for the Java–Bali region, where the costs are higher and thus developers consider a tariff cap based on BPP as unviable. This is indeed a lost opportunity since Java–Bali is one region where the demand is high and there is grid connectivity, making it feasible for large RE power plants.
Capping the tariffs for solar and wind at 85 percent of the BPP implies that RE is made to compete against electricity generation from coal. Adding to the problem is the fact that the BPP is artificially low because coal used by PLN for power generation is subsidized. In comparison, Vietnam stipulated FiTs of 9.35 cents per kWh and 7.38 cents per kWh tariffs for solar and wind respectively in 2017—both higher than the tariff for power generated from conventional sources, which is estimated at 4.8 cents per kWh.

**Unrealistic local content requirement**

In Indonesia, the local content requirement (LCR) for solar power plants is 34 to 40 percent for goods and 100 percent for services. Such high and stringent LCRs do not really create a viable environment for RE development in Indonesia. Given the small scale of solar manufacturing in Indonesia, local producers of solar panels will be less competitive than international players, such as China or even Malaysia.

**Challenges with land acquisition and onerous permitting procedures**

Land acquisition issues have long plagued Indonesia for any type of power generation. Land permits need to be secured not only for generation, but also for transmission lines. Developers have to obtain multiple permits for power projects in Indonesia, including a business license (izin usaha) from the BKPM, an environmental permit (izin lingkungan), a location permit (izin lokasi), and the electricity business license (izin usaha penyediaan tenaga listrik). The process for securing such permits is often bureaucratic and sometimes exceeds the expected timelines for approval. For example, for geothermal projects in protected forest areas, developers have to secure a forest borrow permit (izin pinjam pakai) from the Ministry of Forestry. This permit is issued only for a single purpose, and the application process is complicated, requiring recommendation letters from the provincial governor, among other items. The Hulu Lais geothermal project is an example of a project that was delayed because of the time required to obtain permits and licenses from the Ministry of Forestry and the local governments.

**Government subsidies to fossil fuels**

The coal mining groups in Indonesia receive considerable government support in the form of loan guarantees, tax exemptions, and fiscal support. For example, the total amount of fiscal support for coal from Indonesia’s government was estimated to be at least IDR 9 trillion in 2015 (Source: Global Subsidies Initiative Report). This is a missed opportunity for Indonesia to invest heavily into RE - higher investment levels will lead to greater scale and hence increased chances of cost competitiveness in the long term.

In addition, through the domestic market obligation, the government mandates coal producers to sell coal at steep discounts to PLN for power generation. This implies that RE power needs to compete directly against subsidized coal-fired generation as the RE tariff is now based on the BPP. This effectively promotes the use of coal at the cost of RE.

In addition to unfavorable policies, constant changes in regulations impede growth of RE in Indonesia. For example, cancellation of the previously agreed tariff rates after Regulations 12/2017 and 50/2017 were enforced have caused displeasure among many RE developers. Changing regulations not only result in cancelation of RE projects but can also increase project costs as a result of higher-risk premiums that need to be factored into project economics.

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21 Indonesia’s Ministry of Industry
22 Global Subsidies Initiative report
Availability of private financing

Government funding into RE is restricted. For example, in 2015 and 2016, finance flows for clean energy to state-owned enterprises in Indonesia amounted to only IDR 2.8 trillion over two years.\(^{23}\) This is minuscule compared with the required total capital investment levels of $8 billion per year (about IDR 113 trillion). This reveals the criticality of private financing to boost Indonesia’s RE sector, especially given the ambitious target. Private financing is also important because most of Indonesia’s RE power capacity additions are expected to come from independent power producers, which will not be financed by the government. However, a few key challenges are coming in the way of attracting private financing for RE development in Indonesia:

High financing costs

Indonesia’s interest rates in 2018 were much higher than many other countries for several reasons, including high inflation, high country risk, and the government need to protect the strength of the Indonesian rupiah (see figure 17).

Lack of long-term funding options

Globally, RE projects typically have a debt-to-equity ratio of 70 to 80 percent, with banks and bonds as the two main sources of funding for private investments in power projects.\(^{24}\) However, in Indonesia, neither is particularly viable for RE development. Banks hold about 75 percent of the financial sector assets, but most limit the tenure of loans to eight years, which might not be adequate for RE projects. Further, as of 2017, Indonesia’s bond market is small (about 18 percent of the country’s GDP) compared with China (72 percent), Malaysia (101 percent), India (54 percent), and Thailand (76 percent).\(^{25}\)

Figure 17

*Interest rates in Indonesia are much higher than in peer countries*

**Annual interest rates**

(%, 2018)

![Graph showing interest rates in various countries](image)

Sources: Trading Economics, A.T. Kearney analysis

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\(^{23}\)Climate Policy Initiative report, November 2018

\(^{24}\)IRENA’s and Climate Policy Initiative’s Global Landscape of Renewable Energy Finance 2018 (Note: the global average reported debt-to-equity ratio in 2015 and 2016 was 69 percent for solar PV projects and 77 percent for onshore wind projects.)

\(^{25}\)Asian Development Bank, Economist Intelligence Unit
Lack of commercially credible project developers

Sarana Multi Infrastruktur, a government-owned infrastructure financing company, highlights a different challenge. In many cases, especially for projects in remote areas, RE developers are small local players that do not have the required financial strength or the credit history to satisfy lenders. SMI highlights instances where, despite having the required funding, the company was unable to invest in RE projects because of bankability issues. In addition, many larger developers are not interested in these projects because of the low economic attractiveness or fear of regulatory changes.

General lack of awareness of banks

Many banks in Indonesia are unaware of recent developments and trends in RE technologies, except for hydro and geothermal. For example, some banks have underestimated capacity factors for solar projects, which eventually leads to unfavorable project economics being projected and deals falling through. In addition, banks tend to use corporate lending mechanisms rather than project finance mechanisms, which limits a project’s debt-to-equity ratio.

Conflict of interest in PLN’s role

A closer look at PLN’s role in Indonesia’s energy sector reveals that PLN might not be fully incentivized to boost RE growth. PLN, which is the only power off-taker in Indonesia, is also the largest owner of fossil fuel generation assets. Historically, there have been many cases where PLN has not signed a power purchase agreement (PPA) with RE developers, even with FiT schemes.

The 2,500 villages program aims to provide access to electricity to about 0.5 million households in areas that have no or limited access—a prime example of an opportunity for renewable energy development.

There are multiple reasons why PLN might not be fully incentivized to promote RE development in Indonesia. First, purchasing more renewable energy might necessitate more subsidies (at least until scale and learning effects kick in), which would weaken PLN’s financial position. Second, PLN owns and operates more than 50 percent of the coal power plants in Indonesia, and rapid RE growth can pose a direct risk to these assets. Finally, small RE projects with variable output might expose PLN’s grids to stability issues.

The 2,500 villages program aims to provide access to electricity to about 0.5 million households in areas that currently have no or limited access to electricity, mainly in Papua or West Papua. This is a prime example of an opportunity for RE development. However, in multiple cases, to promote the use of diesel, PLN provides PPAs for diesel-powered projects in remote grids at rates above regional grid averages.
The Path Forward

There is a clear need for a policy overhaul that will unblock RE development in Indonesia.

What will it take for Indonesia to increase its power generation from RE sources and meet its 2023 target? Examples of how other countries have taken part in the ongoing energy transition can help answer this question and offer valuable lessons for the road ahead. We highlight two examples: Germany and Vietnam.

Case example: Germany

Indonesia should derive inspiration from Germany’s experience.

From around 2000, Germany encouraged a mass deployment of wind and solar technologies to reduce its carbon footprint and its dependence on nuclear technology. Initially, through the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz), Germany introduced FiTs, whereby large premiums were offered to incentivize RE generators along with a surcharge for consumers. Over time, these premiums were reduced as RE costs fell as a result of technological maturity and scale benefits. From 2004 to 2017, power purchase prices for commercial installations dropped by a factor of about 10. In the first half of 2018, Germany achieved about 41.5 percent generation from RE for electricity production, powered mainly by wind, followed by biomass, solar, and hydro. Consistent with this success, Germany has announced it will end its reliance on coal-fired power plants by 2038.

Also notable is the fact that Germany has taken an interest in developing RE not only within the country but also globally by establishing institutes such as the International Renewable Energy Agency. While we cite the specific case of Germany here, it is also worth noting that other countries have also accelerated the energy transition. For example, Denmark’s share of RE in power generation rose from 46 percent in 2013 to 68 percent in 2017.26

Case example: Vietnam

Recent developments in Vietnam offer valuable lessons for Indonesia.

Another relevant example for Indonesia is Vietnam, which has recently taken specific measures to boost RE development in solar and wind. Historically, the country’s energy mix has been dominated by hydro and gas, but the government realized the downside of overreliance on two technologies and decided to exploit its untapped potential in solar and wind.

A new plan was developed and aligned through a concerted effort by the prime minister, the Vietnamese Ministry of Industry and Trade (MOIT), and Vietnam Electricity (EVN), the power utility. The revised Power Master Plan VII issued by the prime minister in 2016 aims to increase the capacity of solar power to 850 MW and wind power to 800 MW by 2020 from current modest levels of 8 MW for solar and 189.2 MW for wind.27

In line with this vision, MOIT launched three initiatives in 2017 to boost RE development. First, EVN is obligated to purchase all on-grid solar and wind power for 20 years from commencement with a provision for extension. Second, Vietnam launched a standard PPA model for all solar projects. Third, Vietnam launched a FiT scheme that stipulates tariffs of 9.35 cents per kWh and

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26 BP’s Statistical Survey
27 Vietnam Renewable Energy Report 2018
7.38 cents per kWh for solar and wind respectively. These rates are much higher than conventional power tariff of about 4.8 cents per kWh.

The FiT scheme also regulates that the tariff will be paid by EVN in Vietnamese dong but is linked to a currency exchange rate announced by the State Bank of Vietnam, thus protecting developers from currency risks. In addition, the government has introduced incentives, such as tax incentives, no foreign participation restrictions, and state-funded credits as well as subsidies for environmental projects to boost RE development.

Finally, Vietnam has tried to strike a balance between specificity of regulations and flexibility to maximize value. MOIT has at times deviated from the stipulations to address bankability concerns from the developers, thereby passing a strong positive message to the market.

Although Vietnam still has challenges to overcome for solar and wind development, such as PPA bankability issues and the need for grid upgrades, company and local bank interest in investing based on the support mechanisms is growing. Early trends reveal that around 2 GW of solar projects are likely to be commissioned by the end of 2019.  

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**Potential key action required**

**Reassess the viability of MEMR 12/2017, and address ambiguities in the PPA model.**

The government devised the RE tariff cap under MEMR 12/2017 to incentivize PLN to sign more PPAs with RE developers and boost RE development in Indonesia, but the net effect has been the opposite. Because the BPP is largely a function of the cost of power generated from coal, which is heavily subsidized in Indonesia, RE now needs to compete with subsidized fossil fuels.

In addition, fossil-fuel based power generation PPAs typically allow a pass-through for fuel supply costs, and this is subject to market commodity prices. However, no such pass-through mechanism can be applied to power generation from RE. Hence, if the market prices for coal or gas fall globally, then the local BPP in Indonesia will also be lowered, thus forcing RE-based power generation to compete even more aggressively. MEMR 12/2017 also leaves ambiguity on whether the tariff calculation for wind, solar, and waste-to-energy projects will include transmission costs. There is also no mention of who is responsible for building the transmission line: PLN or the RE developer. Lastly, the regulation remains silent on whether any tariff escalation mechanisms will be provided to the RE developer. At the very least, such ambiguities should be removed so RE developers and lenders can better understand project risks and overall economics. Moreover, instead of basing RE tariffs on the average cost of power generation, Indonesia should devise an appropriate FiT scheme with tariffs from RE power generation higher than those from fossil-fuel generation, similar to what Vietnam recently instated for solar and wind.

**Redistribute part of the subsidies from fossil fuels to RE**

RE subsidies bring down the price of power generated from RE technologies, leading to greater adoption. Over time, this growth in scale, along with technology advancement and innovation, makes RE technologies more competitive than generating electricity from fossil fuels. Germany is the classic example of this, as highlighted earlier.

However, in Indonesia, large amounts of fiscal support are offered to coal producers and to PLN in the form of subsidies for electricity, which might have been the appropriate strategy a few

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years back when Indonesia was aiming to rapidly increase its electrification ratio. But with the electrification ratio reaching about 97.5 percent in 2018, the government should reconsider this strategy and instead allow larger subsidies to flow into RE for long-term economic sustenance and achievement of climate change goals.

**Revisit LCR and streamline approval processes required for land acquisition and licensing**

In Indonesia, the LCR for solar power plants is 34 to 40 percent for goods and 100 percent for services. Such high and stringent LCRs do not create a viable environment for RE development in Indonesia. LCRs are devised to protect national interests. However, maintaining a balanced view in this regard is crucial: LCR can be implemented once the market reaches a threshold maturity level and when there are large subsidies or substantial investment incentives present. Without these prerequisites, stringent LCRs can in fact render the market less competitive.

China successfully used LCRs to boost wind energy, but it also ensured the presence of fiscal incentives in the market. For solar projects, Malaysia has not specified any LCR. Vietnam also does not specify any national LCR requirements, although provincial requirements may differ. In Indonesia’s case, stringent LCR for RE technologies, such as solar, should be re-evaluated so that project economics can be made more viable.

Timely land acquisition is essential for any power project. To aid this effort, RE developers and PLN should involve local communities early into the project plan. The central government could play its part by not giving complete freedom to provincial and local governments and by identifying and allocating specific plots of land across Indonesia specifically for RE development.

Finally, processes to secure licenses and permits should be made more transparent and efficient with clearly defined requirements and timelines. This will also give a positive signal to the market and boost the confidence of RE developers.

**Make RE attractive for private investment**

To ensure growth of RE in Indonesia, private financing is crucial. Multiple actions are required. First, favorable policies and regulatory certainty should be instituted. Second, the government will need to expand the use of guarantees for RE projects, such as through the business viability guarantee letter or the Indonesia Infrastructure Guarantee Fund. Third, institutions such as Sarana Multi Infrastruktur need to be used effectively as they are uniquely positioned to combine government funding and private investment to devise customized loans. Finally, awareness levels of local commercial banks in Indonesia about RE technologies and adoption benefits need to be increased.

**Increase RE focus on off-grid projects and distributed generation**

With an estimated 45 percent of the population residing in rural areas, Indonesia is not likely to achieve its 23 percent RE target by 2025 without adequate focus on off-grid and distributed generation projects. The 2,500 villages program appears to be ideal for deploying RE, and to implement this plan, government intervention is required. Off-grid projects could be mandated to use the lowest-cost technology, which in many cases is RE rather than diesel. The government also needs to provide budgets for PLN to build distribution networks in remote locations where off-grid projects are being considered. Such infrastructure will help reduce the capital investment for off-grid projects since a major share of the investment is required to build distribution networks and the household connection points. Finally, to improve the commercial

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29Indonesia’s Ministry of Industry
viability of off-grid projects through scale benefits, the government and PLN could broaden the concession area (for example, by covering multiple villages in the same area).

**Incentivize PLN to focus on RE development**

At the heart of the issue of low RE development is the fact that no one agency is held accountable for the results. PLN is centrally positioned in Indonesia’s ET journey, and the government should make PLN accountable for RE realizations. The results should be periodically monitored by ESDM and the government, and appropriate steps should be taken as required. To ensure PLN’s success in this process, the government should provide PLN with the required tools and mechanisms. For example, subsidy amounts to PLN for RE growth should be identified, agreed upon, and approved in advance.

In addition, Indonesia needs to communicate the long-term benefits of RE adoption at the grass-roots level. It can be pivotal if the upcoming generations realize that RE is not a choice but a must for the country’s long-term sustenance.

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**Acknowledgements**

This report has been developed in collaboration with A.T. Kearney’s Energy Transition Institute, which provides leading insights on global trends in the energy transition, technologies, and strategic implications for both the private and public sectors.

A.T. Kearney sincerely thanks APINDO, the Directorate of New Renewable Energy and Energy Conservation, Pertamina, and Sarana Multi Infrastruktur for their input and insights for the development of this paper. In particular, we thank Shinta Kamdani, Wahid Sutopo, and Daniel Purba for their contributions. We acknowledge the guidance of our colleagues Richard Forrest, Roman Debarre, Hasan Shafi, and Shirley Santoso. We would also like to thank Srikant Govind, Rishab Guglani, Bharat Dudeja, Sahil Makkar, and Harshit Soni for their valuable contributions.
## List of Abbreviations

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<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>BPP</td>
<td>biaya pokok pembangkitan (electricity generation cost)</td>
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<td>CAD</td>
<td>current account deficit</td>
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<tr>
<td>CAGR</td>
<td>compounded annual growth rate</td>
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<td>CO2</td>
<td>carbon dioxide</td>
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<td>COP 21</td>
<td>Conference of Parties (United Nations Climate Change Conference in 2015)</td>
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<td>ESDM</td>
<td>Energi dan Sumber Daya Mineral Republik Indonesia (Indonesia’s Energy Ministry)</td>
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<td>ET</td>
<td>energy transition</td>
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<tr>
<td>FiT</td>
<td>feed-in tariff</td>
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<td>GHG</td>
<td>greenhouse gas</td>
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<tr>
<td>GW</td>
<td>gigawatt</td>
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<tr>
<td>IDR</td>
<td>Indonesian Rupiah</td>
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<td>IRENA</td>
<td>International Renewable Energy Agency</td>
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<tr>
<td>kW</td>
<td>kilowatt</td>
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<td>kWh</td>
<td>kilowatt hours</td>
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<tr>
<td>LCOE</td>
<td>levelized cost of electricity</td>
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<td>LCR</td>
<td>local content requirement</td>
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<td>MTOE</td>
<td>million tonnes of oil equivalent</td>
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<td>MW</td>
<td>megawatt</td>
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<tr>
<td>MWh</td>
<td>megawatt hours</td>
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<td>NRE</td>
<td>new and renewable energy</td>
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<td>PLN</td>
<td>Perusahaan Listrik Negara</td>
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<tr>
<td>PPA</td>
<td>power purchase agreement</td>
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<td>PV</td>
<td>photovoltaic</td>
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<td>RE</td>
<td>Renewable energy</td>
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<td>REMI</td>
<td>Renewable Energy Maturity Index</td>
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<td>REN21</td>
<td>global renewable energy policy network</td>
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<tr>
<td>RUEN</td>
<td>Rencana Umum Energi Nasional (General National Energy Plan)</td>
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<tr>
<td>RUPTL</td>
<td>Rencana Umum Penyediaan Tenaga Listrik (Electricity Supply Business Plan)</td>
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<tr>
<td>TWh</td>
<td>terawatt hours</td>
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<tr>
<td>VALCOE</td>
<td>value-adjusted levelized cost of electricity</td>
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