CHAPTER 7

Indonesia Country Report

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March 2021

This chapter should be cited as:
Malik, C.L. (2021), 'Indonesia Country Report', in Han, P. and S. Kimura (eds.), *Energy Outlook and Energy Saving Potential in East Asia 2020*, Jakarta: ERIA, pp.102-121.

CHAPTER 7

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1. Background

Indonesia covers an area of 1,913,000 square kilometres and had a population of 264.6 million people in 2017 (World Development Indicators, 2019), up by 1.5% per year from 178.6 million in 1990.

Gross domestic product (GDP) was US$1,090 billion (constant 2010 United States [US] dollars) in 2017, increasing by an average of 4.8% per year from 1990. The service sector is a major contributor to GDP (43.6%), followed by industry (39.4%), agriculture (13.2%), and other activities (3.8%). GDP per capita in 2017 was about US$4,120 (constant 2010 US dollars), whilst in 1990 it was only US$1,734 (constant 2010 US dollars).

Indonesia is richly endowed with natural resources. Its vast oil and gas reserves have made it a significant player in the international oil and gas industry. Reserves, however, continue to deplete as the scale of oil and gas exploration is small and the success rate of exploration is low. The oil and gas investment climate have not been conducive and the use of enhanced oil recovery technology to boost oil production is not yet optimal. As of January 2018, proven reserves of crude oil were 3.15 billion barrels, whilst those of natural gas were 96.1 trillion cubic feet or 2.7 trillion cubic metres (Center for Data and Information Technology-Pusdatin, 2018). Indonesia exports coal and had about 39.9 billion tons of proven coal reserves by the end of 2018.

Non-fossil energy resources include hydro, geothermal, biomass, and other renewable sources such as solar and wind. Estimated hydro potential is about 94.3 gigawatts (GW), whilst estimated geothermal potential is more than 28.0 GW (National Energy Council, 2019). In total, renewable energy potential is about 442 GW for power plants, of which only 2% or 9 GW have been utilised.

Utilisation of new and renewable energy (NRE) for power plants is low due to high production cost, which makes competing with coal power plants difficult. The lack of renewable energy power plant components and the difficulty of obtaining low-interest financing have also slowed renewable energy development.

2. Modelling Assumptions

Real GDP growth was 5.02% in 2017 and reached 5.17% in 2018. In 2019, it slowed slightly to 5.02% (Central Bank of Indonesia, 2019). Expected real GDP growth for 2020 was 5.4%, but the coronavirus disease (COVID-19) pandemic has slashed it to 2.1%. The economy is expected to bounce back to 4.3% growth in 2021.

The National Energy Policy (KEN) of 2014 assumes an average annual growth rate of 8.00% from 2017 to 2025, which will slow to 7.25% in 2035 and 6.50% in 2050. Since current real GDP growth is slower than that assumed in the KEN, this study assumes that real GDP will grow by an average of 4.8% per year from 2017 to 2050. This rate is in line with the long-term vision of about 5% per year for Indonesia to become a high-income economy by 2045.

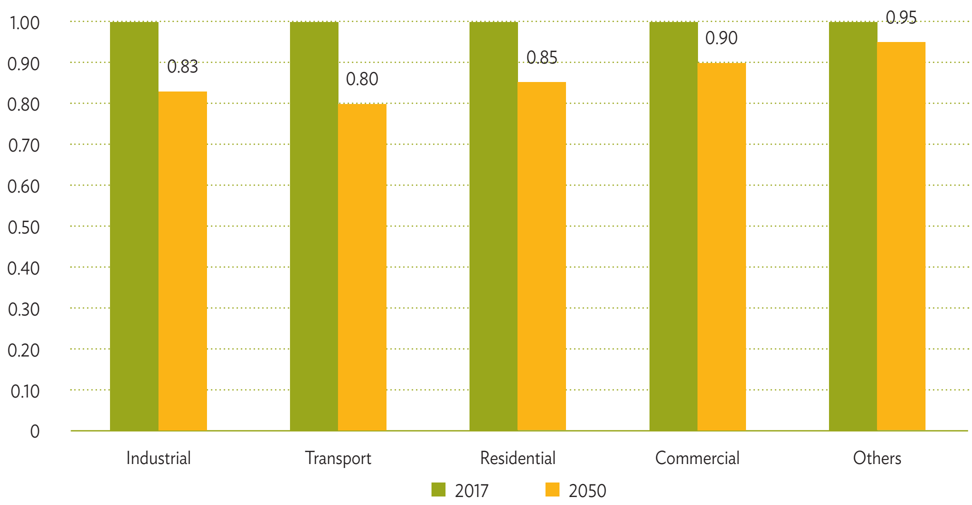
The population growth assumption is 0.8% per year from 2017 to 2050, based on the revised projection of the Central Bureau of Statistics (BPS).

The business as usual (BAU) scenario and the five alternative policy scenarios (APSs) are similar to those in the previous reports of ERIA on the analysis of energy saving potential in East Asia; the latest one was in 2019. The APSs reflect additional likely policy interventions such as energy efficiency and conservation (EEC) targets and action plans, efficiency improvement in power generation plants, more aggressive adoption of renewable energy, and introduction of nuclear energy. The five APSs are as follow:

(i). APS1. More efficient final energy consumption, with energy-saving targets by sector (Figure 7-1). Article 9b of the KEN states that energy elasticity (with regard to GDP) will be less than 1 in 2025 and that final energy intensity will be reduced by 1% per year up to 2025. These targets are considered for this year's study.

(ii). APS2. More efficient thermal power generation, significant improvement of existing coal power plants, introduction of cleaner coal technologies, and more-efficient natural gas combined-cycle technologies.

Figure 7.1. Energy Efficiency and Conservation Assumptions



Source: Author.

(iii). APS3. Higher contribution of NRE and biofuels, higher penetration of NRE for electricity generation, and utilisation of liquid biofuels in transport. The scenario assumes that article 9f of the KEN will be fulfilled, i.e. NRE share reaches 23% by 2025 and 31% by 2050, and the share of liquid biofuels in road transport is 30% from 2020 onwards.

(iv). APS4. Introduction or higher utilisation of nuclear energy. The assumption was that nuclear energy would be used after 2045, but it is now the last option. The existing plan has been delayed, but the study still assumes that two 1,000-megawatt nuclear power plants will be constructed by 2045.

(v). APS5. The combination of APS1 to APS4. The APS5 results are represented as the APS.

3. Outlook Results

3.1. Business as Usual Scenario

3.1.1. Final Energy Consumption

Total final energy consumption (TFEC) increased by an average of 3.2% per year from 1990 to 2017, from 69.31 million tons of oil equivalent (Mtoe) to 163.58 Mtoe. Given the assumed economic and population growth, TFEC will continue to grow slightly faster, by 3.5% per year, from 2017 to 2050 under BAU.

3.1.1.1. Final Energy Consumption by Sector

Growth stems from the rapid increase of energy consumed by transport and industry. Transport is still heavily dependent on oil. Transport's final energy consumption grew at an average of 6.9% per year in 1990–2017. Growth is expected to continue until 2050 under BAU but more slowly, by 5.1% per year.

Industry's final energy consumption grew more slowly than transport sector in 1990–2017 (2.8% per year) and will continue to do so in 2017–2050 (3.8%).

The final energy consumption of 'others' (mainly the residential and commercial sectors) grew by an average of 2.2% per year in 1990–2017 and is projected to slow to an average of 1.7% per year in 2017–2050.

'Others' had the highest share in TFEC in 1990–2017 because of high consumption of biomass, mainly in the residential sector. The share, however, decreased from about 55% in 1990 to about 42% in 2017. The share is expected to continue to decrease because demand from 'others' will grow more slowly than that from transport and industry. The share of 'others' in TFEC will decrease to 23.6% in 2050.

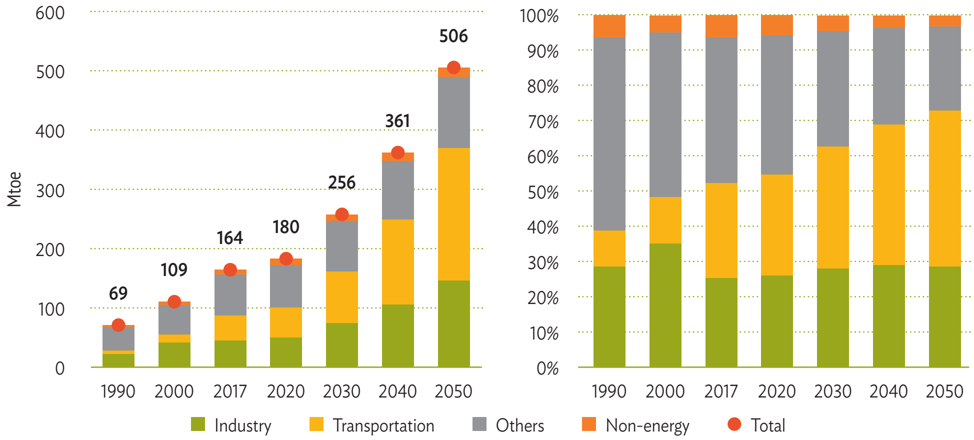
Transport's share in TFEC increased from about 10.3% in 1990 to 26.7% in 2017. The share will continue to increase to 44.7% in 2050. The combined share of oil and alternative fuels for transport will contribute to the increase of transport's share in TFEC.

Industry's share in TFEC was 28.4% in 1990 and decreased to 25.4% in 2017. This share is expected to increase to 28.4% by 2050 in line with growth in industry

3.1.1.2. Final Energy Consumption by Fuel Type

Electricity grew the fastest in 1990–2017, by an average of 8.0% per year, due to the significant increase in industry and residential consumption, from 2.4 Mtoe in 1990 to 19.2 Mtoe in 2017. Coal increased significantly over the same period as industry expanded, particularly cement. Total coal demand increased from 1.44 Mtoe in 1990 to 8.25 Mtoe in 2017, growing by an average of 6.7% per year.

Figure 7.2. Final Energy Consumption by Sector



Mtoe = million tons of oil equivalent.

Source: Author.

Natural gas and oil grew by an average of 4.4% and 4.0%, respectively, in 1990–2017. Demand for other fuels (mostly biomass for households) increased by 15.82 Mtoe over the same period, by an average of 1.3% per year.

Demand for all fuels will continue to increase. Demand for oil will increase at the fastest pace, by an average of 4.5% per year to 275 Mtoe in 2050, mainly driven by transport growth. Electricity demand is expected to grow but more slowly, by an average of 4.2% per year in 2017–2050.

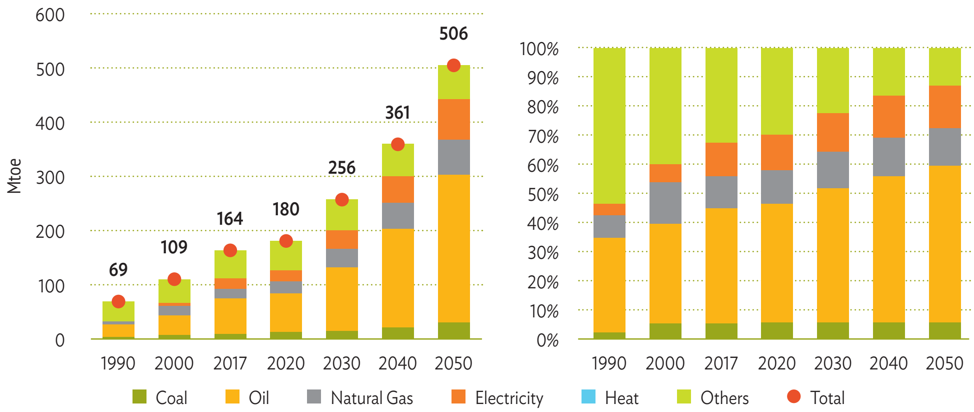
Natural gas and coal demand will grow by an average of 4.0% and 3.8% per year, respectively, in 2017–2050. Demand for other fuels will increase at the slowest pace over the same period, by an average of 0.7% per year, mainly due to declining residential consumption of biomass.

Oil will still play a major role in final energy consumption although more alternative fuels will be consumed by end-use sectors. The share of oil is expected to be about 54% in 2050, increasing from 40% in 2017. The remaining share will be composed of coal (5%), natural gas (13%), electricity (15%), and others (13%).

3.1.2. Primary Energy Supply

Total primary energy supply (TPES) grew by about 3.2% per year, from 102 Mtoe in 1990 to 236 Mtoe in 2017. The fastest-growing fuels in 1990–2017 were coal and geothermal energy. Coal supply grew by an average of 10.3% per year whilst geothermal energy grew by 9.4% per

Figure 7.3. Final Energy Consumption by Energy, Business as Usual



Mtoe = million tons of oil equivalent.

Source: Author.

year. Oil supply increased more slowly, by 2.9% per year, whilst gas had the slowest growth rate at 1.2% per year during the same period.

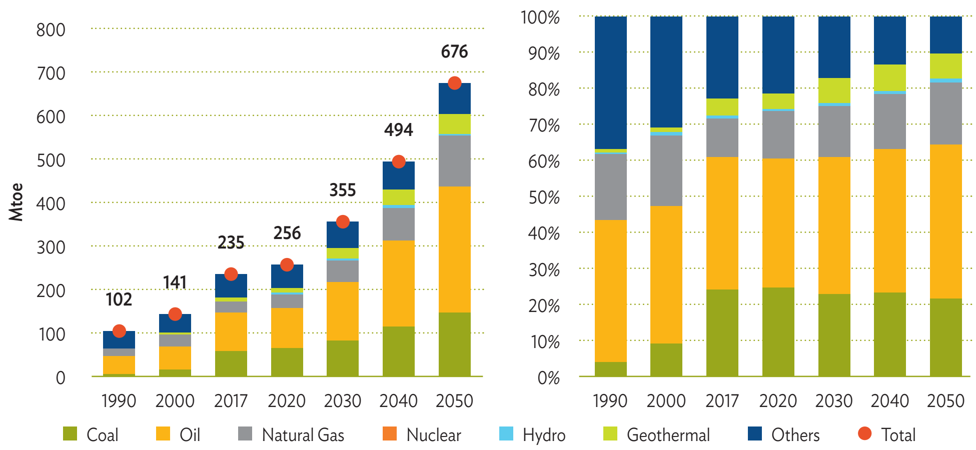
Under BAU, TPES is projected to increase by an average of 3.3% per year, reaching 676 Mtoe in 2050. Coal is projected to continue growing but more slowly, by 2.9% per year. Geothermal energy is expected to increase. The new price structure for generating electricity from renewable energy, as given in article 20 of the KEN, should stimulate the development of geothermal energy. Geothermal energy is projected to grow by 4.5% per year until 2050.

Hydro, including mini and micro hydro, will also increase over 2017–2050 but at a slower rate than geothermal, at 4.2% per year. It is assumed that more run-of-river hydropower plants will be constructed than reservoir hydropower.

Oil is projected to increase by an average of 3.8% per year in 2017–2050 and natural gas by an average of 4.7% per year.

BAU assumes no uptake of nuclear energy. As a result, renewable energy will be significant in the primary energy supply mix as the uptake of cleaner fuels increases. Other renewable energy resources include solar, wind, biofuels, and biomass.

Figure 7.4. Primary Energy Supply, Business as Usual



Mtoe = million tons of oil equivalent.
Source: Author.

Oil constituted the largest share in TPES, but it declined slightly from 39.7% in 1990 to 36.6% in 2017. The share of natural gas in the total mix decreased from 18.2% in 1990 to 10.9% in 2017.

Since coal and geothermal energy grew rapidly in 1990–2017, their shares in TPES increased significantly. Coal's share in TPES increased from about 4.0% to 24.2% whilst geothermal's increased from 1.0% to 4.7%. Hydro's share increased slightly from 0.5% to 0.7% in 1990–2017. Since 'others', including biomass, solar, wind, ocean, biofuels, and electricity, grew more slowly than other fuels except natural gas, their share declined from 36.8% in 1990 to 23.1% in 2017.

Oil's share in TPES will remain dominant, from 37.0% in 2017 to 43.1% in 2050. Coal's share will decrease slightly from 24% in 2017 to 21% in 2050. The share of natural gas will increase to 17% in 2050 from 11% in 2017.

Hydro's share in TPES will increase from 0.7% in 2017 to 0.9% in 2050, whilst geothermal's will increase from 4.7% to 6.9%. The share of 'others' will reach 10.5% in 2050 from 23.0% in 2017.

3.1.3. Power Generation

Power generation output increased by an average of 7.9% per year, from about 32 TWh in 1990 to 255 TWh in 2017. In 1990, most generation output was still from oil-based plants (38%). Coal's share was below oil's at 30%. As coal became more available and government policy was to move away from oil for power generation, coal's share in the generation mix increased significantly to 58% in 2017. Coal power generation reached 148 TWh in 2017, increasing rapidly by 10.6% per year.

Natural gas became more important with the expansion of gas turbine and combined-cycle capacity. The share of natural gas, however, was lower than that of coal (22% in 2017), although electricity generation from natural gas increased at the fastest pace, by 10.9% per year, reaching 56 TWh in 2017.

Under BAU, power generation is projected to reach 941 TWh by 2050, increasing by an average of 4% per year (Figure 7-5). Generation from 'others' will grow at the fastest pace, by an average of 10.6% per year. The main reason is that generation from 'others' was small tiny in 2017 but is expected to increase significantly as a result of the policy to increase the use of NREs, including solar photovoltaic (PV), wind, and biomass, amongst others. Hydro and geothermal generation are growing but slower than generation from 'others', by 4.2% and 4.5%, respectively.

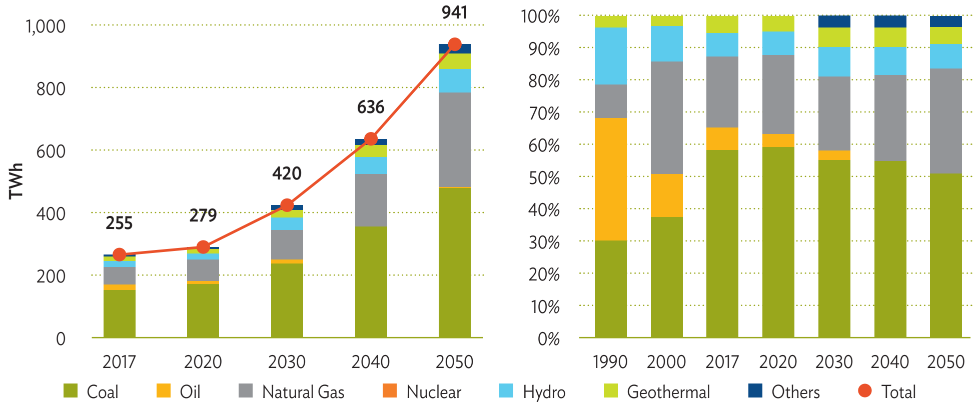
Power generation from natural gas will continue to increase at an average rate of 5.3% per year, whilst coal-based power generation will grow by an average of 3.6% per year. BAU does not include nuclear plants.

The share of coal will remain dominant in total power generation and is expected to continue to increase but eventually even out at 50.8% in 2050.

The share of natural gas will increase to 32.7% by 2050, whilst that of oil will continue to decline to 0.1% by 2050. The assumption is that oil-based plants (diesel plants) will be replaced with other fossil fuel or renewable sources except where substitution is not feasible.

The total share of renewable energy in the generation mix will reach 17.0% by 2050, with hydropower at 7.7%, geothermal at 5.7%, and other renewables at 3.0%.

Figure 7.5. Power Generation by Type of Fuel (TWh)



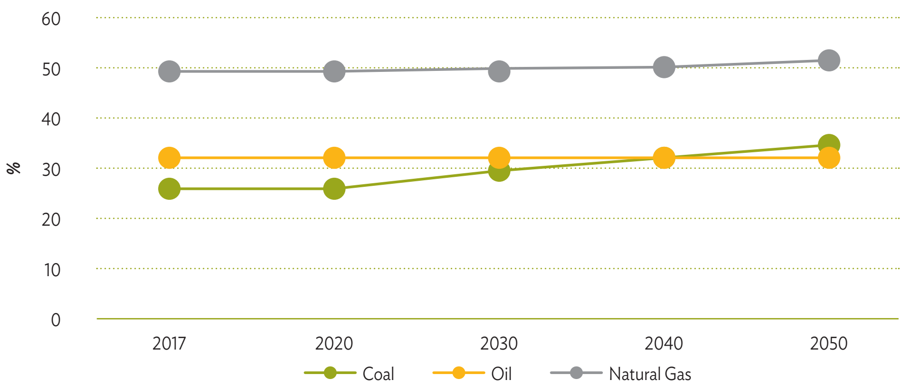
TWh = terawatt-hour.

Source: Author.

The average thermal efficiency of fossil fuel–based power plants was about 30% in 2017. Under BAU, coal and natural gas power plants are assumed to become more efficient, causing thermal efficiency of fossil fuel plants to increase to 40% by 2050.

The thermal efficiency of coal-fired power plants will increase from 26% in 2017 to 35% in 2050, whilst that of natural gas will increase from 49% to 51%. Oil will remain at 32% in 2017–2050.

Figure 7.6. Thermal Efficiency, Business as Usual



Source: Author.

3.1.4. Energy Indicators

Primary energy intensity is measured as the ratio of TPES and GDP, which is the unit consumption of primary energy per million US$ (constant 2010 US dollar). The primary energy intensity has been declining since 1990 and reached 215 tonnes of oil equivalent (toe)/million 2010 US$ in 2017.. Final energy intensity (TFEC/GDP) started declining after 2000 and reached 150 toe/million 2010 US$. These figures indicate that energy producers and consumers have started to use energy effectively by implementing energy conservation measures and using more-efficient energy technologies.

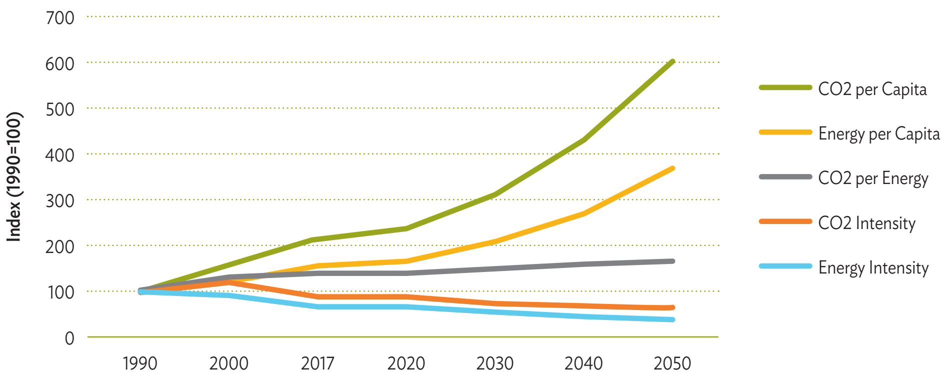
Under BAU, primary and final energy intensity are projected to decline at an average rate of 1.5% per year over 2017–2050. Primary energy intensity in 2050 will be about 132 toe/million 2010 US$, whilst final energy intensity will be 99 toe/million 2010 US$. The energy intensity ratio (primary and final), therefore, is expected to improve by about 40% in 2050 compared with 1990.

Per-capita energy consumption, measured as the ratio of total primary energy supply to the total population, increased from 0.6 in 1990 to 0.9 in 2017, indicating that energy access is improving. In 2017, the electrification ratio was about 95.4% and reached 98.3% by 2018 (Ministry of Energy and Mineral Resources, 2019). The government expected that all households would have access to electricity by 2020.

Under BAU, energy consumption per capita will continue to increase and will reach 2.1 toe per person in 2050, which is lower than the KEN target of 3.2 toe in 2050.

Under BAU, the elasticity of final energy consumption with regard to GDP in 2017–2050 will reach 0.72. Elasticity below 1 indicates that growth in final energy consumption will be slower than growth in GDP in 2017–2050.

Figure 7.7. Energy Intensity and Other Energy Indicators (1990=100)



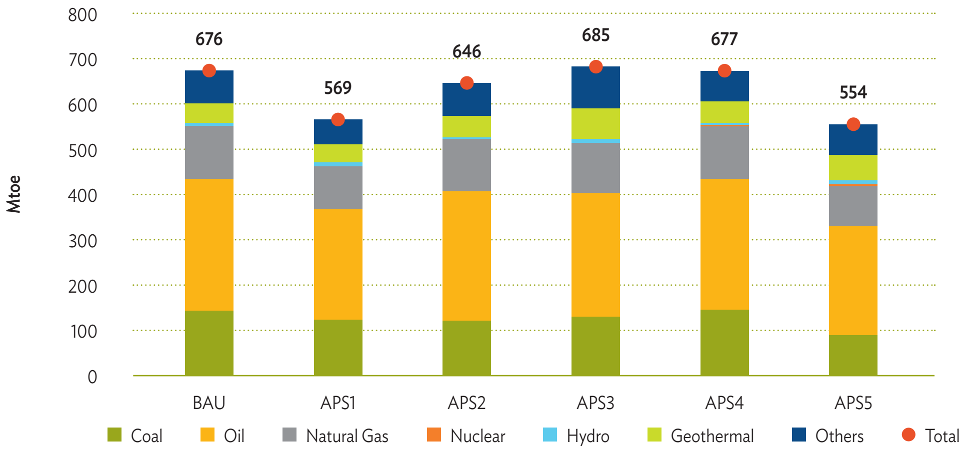
CO_2 = carbon dioxide.

Source: Author.

3.2. Energy Saving and Carbon Dioxide Reduction Potential

The assumptions in APS1 to APS5 were analysed separately to determine their individual impacts. Figure 7-8 shows the changes in TPES under all scenarios.

Figure 7.8. Comparison of Scenarios' Total Primary Energy Supply by 2050



APS = alternative policy scenario, BAU = business as usual, Mtoe = million tons of oil equivalent.

Source: Author.

APS1 and APS5 have the largest reductions in primary energy supply in 2050 due to demand-side energy efficiency assumptions. The assumptions could reduce BAU TPES by as much as 108 Mtoe or 16.0% under APS1 and by 122 Mtoe or 18.1% under APS5.

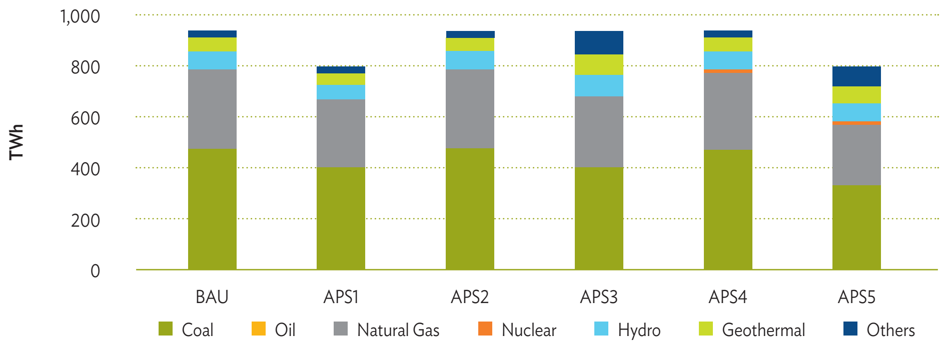
APS2, which assumes higher efficiency in thermal electricity generation, will reduce TPES in 2050 by 30 Mtoe or 4.4% compared with BAU. APS2 does not assume efficiency measures in the final sector, so it will have less impact than APS1. Therefore, the reduction is due mainly to the use of more-efficient power generation, whilst some conventional plants ceased operation after reaching the end of their technical life.

Under APS3, TPES increases slightly as more renewable energy is used to generate power and more biofuels are consumed in transport. The difference with BAU in 2050 is only about 8.8 Mtoe or 1.3%.

Nuclear power generation will be introduced only after 2045 under APS4. As a result, the increase in TPES in 2050 will not be significant, only 0.26 Mtoe or 0.04% as compared with BAU. Nuclear plants will reduce the consumption of fossil fuels (coal, oil, gas) in generating power. Considering that nuclear plants are slightly less efficient than fossil fuel plants, there might be no savings relative to BAU.

Total electricity generation in 2050 under all scenarios is shown in Figure 7.9. In APS1, lower electricity demand results in less production of electricity. Since the difference between APS1 and BAU is the amount generated, the generation mix is the same. Fossil fuel generation still dominates, at 83.6%, whilst renewable energy (hydro, geothermal, others) generation accounts for 16.4%.

Figure 7.9. Comparison of Scenarios' Electricity Generation by 2050

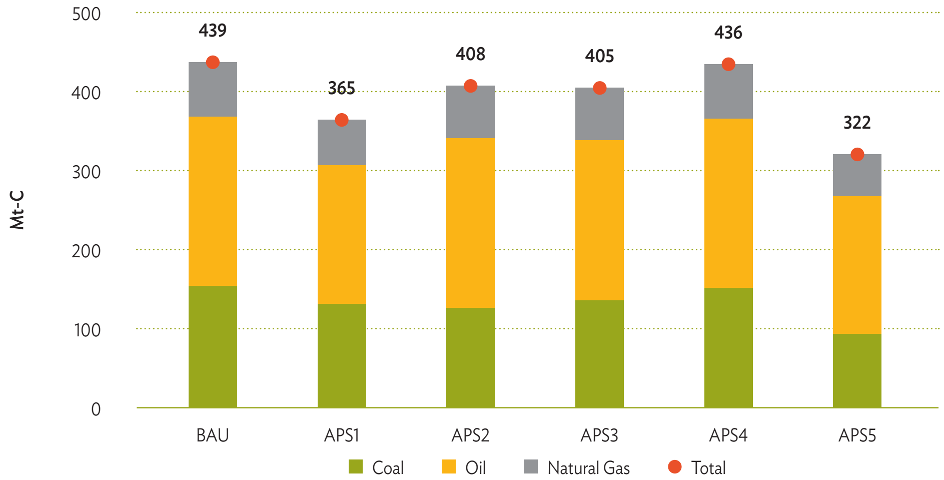


APS = alternative policy scenario, BAU = business as usual, TWh = terawatt-hour.

Source: Author.

Under APS2, the share of fossil fuel–fired generation will be the same as under BAU since the differences lie only in fuel efficiency of fossil fuel power plants. Under APS3, which assumes more renewable energy, the share of fossil fuel–fired generation will be reduced to 72.7%, whilst under APS4, nuclear energy will reduce the fossil fuel share slightly to 82.3%. Under APS5, the share of fossil fuel–based generation will be significantly reduced to 12.4%.

Figure 7.10. Comparison of Scenarios' Carbon Dioxide Emissions by 2050



APS = alternative policy scenario, BAU = business as usual, Mt-C = million tonnes of carbon equivalent.

Source: Author.

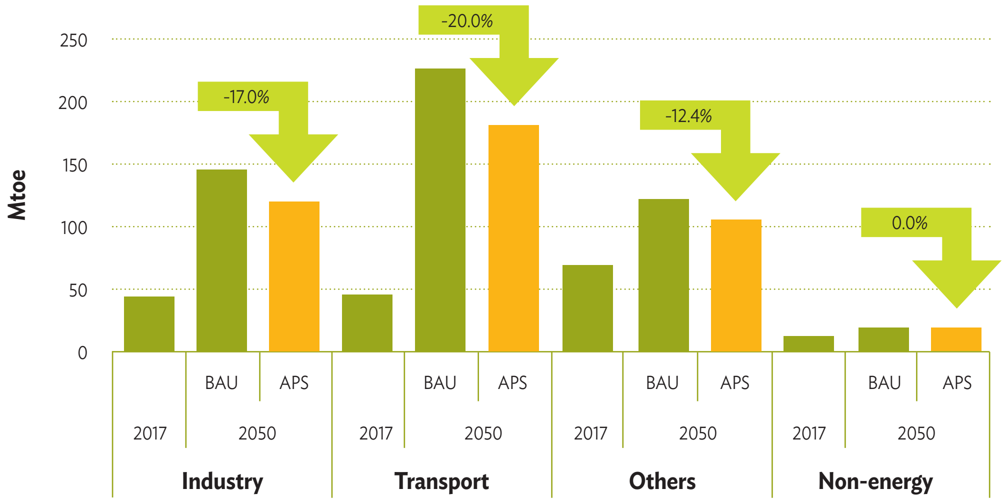
Under APS1, carbon dioxide (CO2) emissions could be reduced by almost 11% in 2050 (Figure 7-10). Under APS2, the installation of more-efficient power plants could reduce emissions by 4.5%. More renewable energy could reduce emissions by 5%, whilst nuclear energy could reduce them by 0.4%. APS5 could reduce emissions by 17.3% in 2050.

3.2.1. Final Energy Consumption

Under APS, TFEC is projected to increase more slowly than under BAU, at an average of 2.9% per year, from 163.58 Mtoe in 2017 to 421.79 Mtoe in 2050. Slower growth under APS is projected across all sectors because of the government's EEC programme, particularly in transport. Energy demand in transport is projected to increase by 4.4% per year compared with 5.1% per year under BAU. Figure 7-11 shows TFEC by sector in 2017 and 2050 under BAU and APS.

Savings of 24.46 Mtoe in industry, 45.3 Mtoe in transport, and 14.82 Mtoe in the residential and commercial ('others') sectors are assumed by 2050 under APS.

Figure 7.11. Final Energy Consumption by Sector, Business as Usual and Alternative Policy Scenario



APS = alternative policy scenario, BAU = business as usual, Mtoe = million tons of oil equivalent.

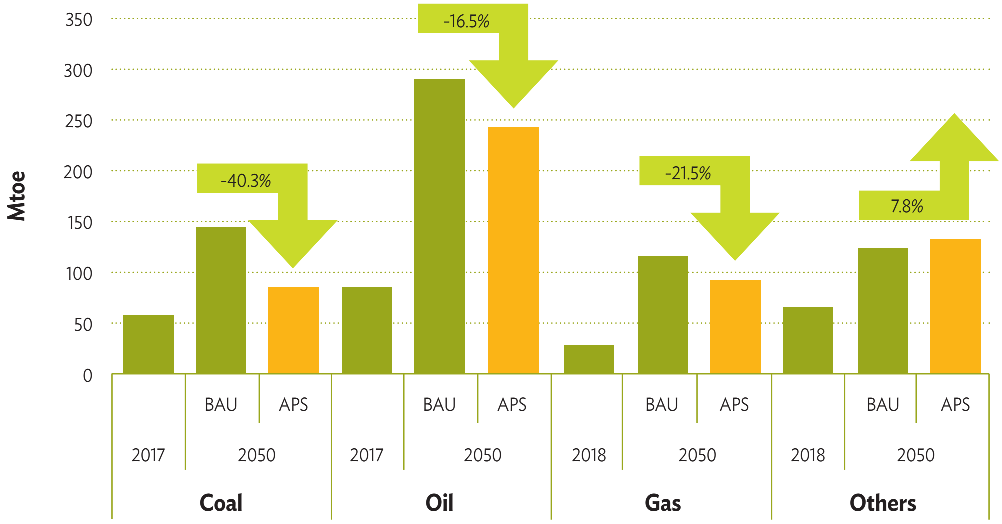
Source: Author.

3.2.2. Primary Energy Supply

Under APS, TPES is projected to increase more slowly than under BAU, by 2.6% per year to 554.32 Mtoe in 2050. All energy sources are projected to experience positive average annual growth rates. However, some will be slower than under BAU. A lower TPES relative to BAU reflects energy efficiency and conservation measures on the demand side. On the supply side, this will include the use of more-efficient technology to generate power.

Savings of almost 58.46 Mtoe for coal, about 48.11 Mtoe for oil, and 25.12 Mtoe for natural gas by 2050 are assumed under APS. In the case of other resources (new and renewable resources, nuclear, and 'others'), TPES under APS in 2050 is 9.64 Mtoe higher than under BAU.

Figure 7.12. Primary Energy Supply by Source, Business as Usual and Alternative Policy Scenario



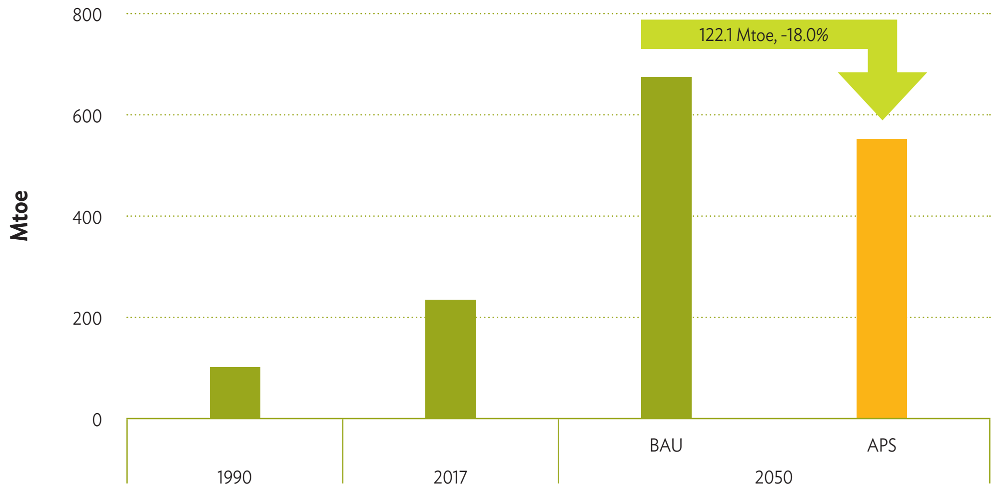
APS = alternative policy scenario, BAU = business as usual, Mtoe = million tons of oil equivalent.

Source: Author.

3.2.3. Projected Energy Savings

Total energy saving (the difference between TPES under BAU and under APS) from implementing EEC and achieving renewable energy targets, improving power plant efficiency, and introducing nuclear energy is 122.05 Mtoe in 2050, more than half of TPES in 2017, which was about 235.26 Mtoe.

Figure 7.13. Total Primary Energy Supply, BAU and APS



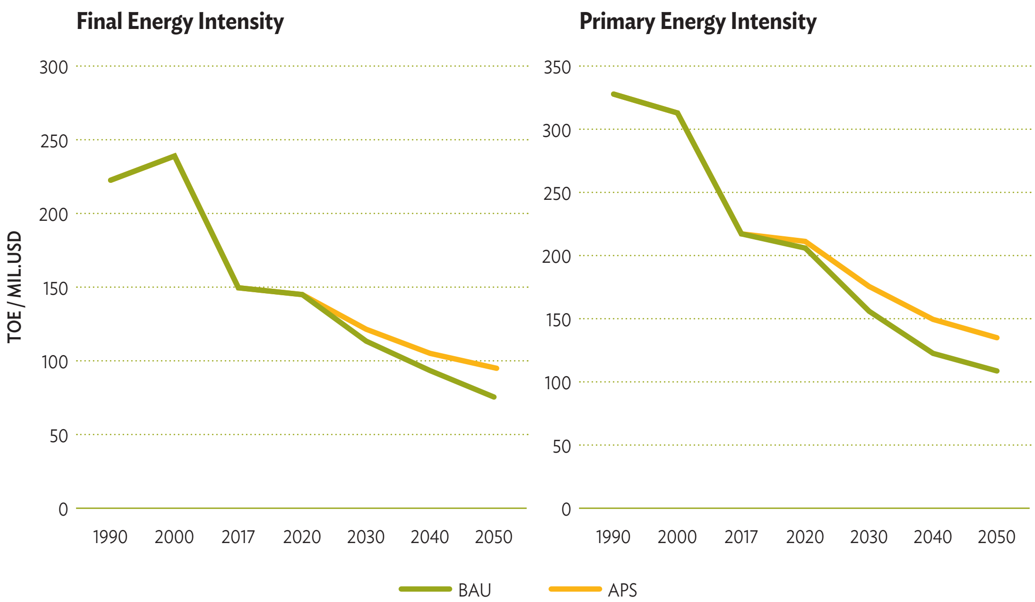
APS = alternative policy scenario, BAU = business as usual, Mtoe = million tons of oil equivalent.

Source: Author.

3.2.4. Energy Intensities

The KEN targets 1% per year reduction in final energy intensity up to 2025. Under BAU, final energy intensity will decline by an average of 1.3% per year in 2017–2050. Achieving sector EEC targets under APS will hasten the decline of final energy intensity to 1.8% per year over the projection period.

Figure 7.14. Energy Intensity, BAU and APS



APS = alternative policy scenario, BAU = business as usual.

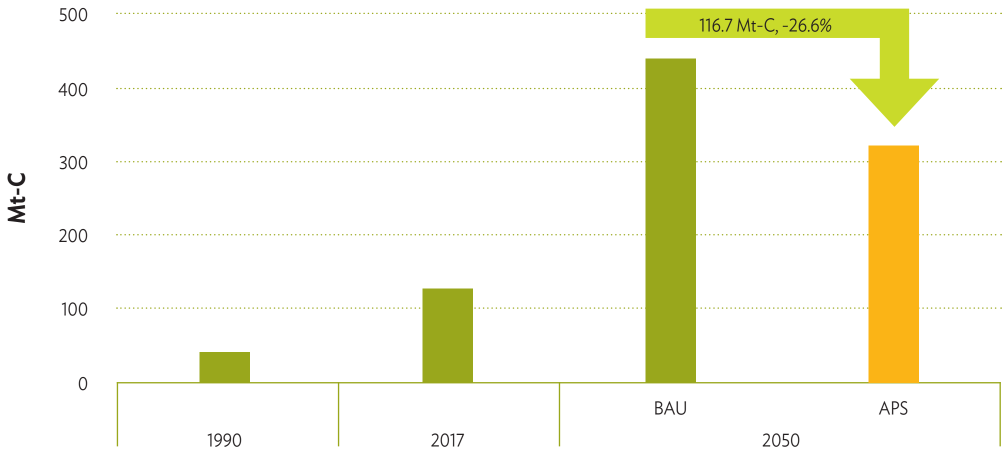
Source: Author.

Primary energy intensity will be reduced by more than 1.5% per year under BAU and by 2.1% per year under APS if the EEC sectoral targets are achieved.

3.2.5. Carbon Dioxide Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase by an average of 3.8% per year from about 127.2 million tonnes carbon (Mt-C) in 2017 to 438.5 Mt-C in 2050 under BAU. The increase is driven by the increasing use of carbon-intensive fuels, particularly coal in power generation and industry and oil in transport.

Figure 7.15. Carbon Dioxide Emissions from Energy Consumption, BAU and APS



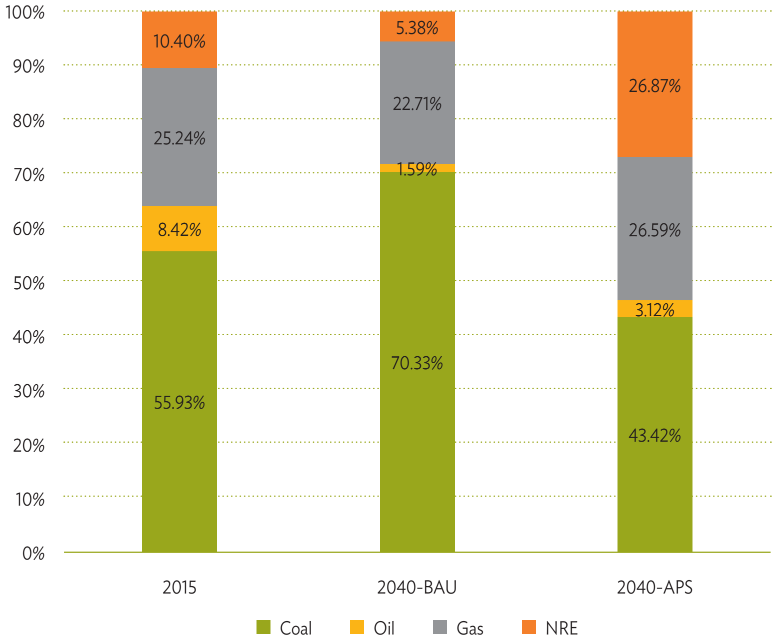
APS = alternative policy scenario, BAU = business as usual, Mt-C = million tonnes of carbon equivalent.

Source: Author.

Under APS, CO_2 emissions in 2050 are expected to be 26.6% lower than under BAU because of greater energy conservation, higher efficiency, elevated renewable targets, and the inclusion of nuclear energy after 2020. The government has committed to reduce CO_2 emissions in 2030 by 29% without international assistance and by 41% with international assistance. This study's CO_2 emission reduction result is lower than the committed target of 29%, indicating that the combined target and action plan under APS will not be sufficient and must be more aggressive.

CO_2 emission reduction is highest in case of coal replacement, as compared with oil and gas. Most oil is consumed by transport. Although alternatives to oil have been introduced in transport, oil will still be dominant. Coal is mainly used in the power sector. Increasing the share of NRE as outlined in the KEN will significantly reduce the coal share. Figure 7-16 shows the share of the different sources of energy in total generation of electricity in 2050. Growth of electricity production by coal-based power plants is slower than that by NRE- and gas-based power plants in BAU and APS. Solar- and biomass-based power generation grows at the fastest pace.

Figure 7.16. Power Generation Mix, BAU and APS



APS = alternative policy scenario, BAU = business as usual.

Source: Author.

4. Implications and Policy Recommendations

Primary energy intensity (TPES/GDP) and final energy intensity (TFEC/GDP) are declining because producers and consumers are using efficient energy technologies. Under BAU, primary energy intensity declined by 1.5% per year over the projection period. Further adaptation of the sectoral target combined with the renewable portfolio, efficient power plant technology, and introduction of nuclear energy, will reduce energy intensity even more, by 2.1% per year. Elasticity of primary energy supply is projected to decrease to below 1.0 under BAU (0.7) and further to 0.5 under APS2, APS3, and APS4 if they are implemented fully.

Primary energy supply per capita is 1.7–2.1 toe/person under all scenarios by 2050, which is less than that of Thailand and Malaysia. Developing energy infrastructure, particularly in remote areas and small islands, will improve the electrification ratio, i.e. accessibility to energy.

Oil will still have the largest share in the total primary energy mix. The KEN sets targets of less than 25% in 2025 and less than 20% in 2050. This analysis, which includes electric vehicle (EV) and biofuel targets for transport and efficient boilers for industry, concludes that saving in oil consumption between BAU and APS could be as high as 23% in 2050.

Considering that transport is the major consumer of oil, programmes to reduce oil use will be important. These include improving public transport, increasing the use of alternative fuels such as biofuels and natural gas, and encouraging the production of more-efficient vehicles. In 2019, the President issued a decree on accelerating the battery-powered EV programme. Derivative regulations on the operational aspects of the programme are being deliberated by ministries and state agencies. Some issues still being discussed include the electricity tariff for charging stations.

EVs will reduce oil consumption but require more electricity generation. If more coal is used to generate electricity for EVs, they will have a negative impact on the environment. The EV promotion policy should, therefore, require building NRE-based power plants.

The KEN targeted NRE shares of 23% and 31% of TPES for 2025 and 2050, respectively. APS results show that the NRE share will be about 24% of TPES by 2050.

Solar energy can help Indonesia attain 100% green electricity by 2050. Decreasing costs of setting up solar PV farms and the availability of large areas to install them encourage the promotion of solar energy, which contributed only 1.7% to total electricity production in 2019. The renewable energy regulation (to be issued soon) will improve the investment climate in the renewable energy sector by revising the formula for the feed-in tariff in the bidding process.

The government is revising Government Regulation No. 70/2009 on Energy Conservation. An important change is mandatory energy management for industries consuming more than 4,000 toe, down from more than 6,000 toe.

Some technologies being considered to enhance energy efficiency in industry include high-efficiency boilers, efficient electric motors, cogeneration, and waste heat recovery for power generation (WHRPG). Two cement factories are applying WHRPG, in Padang in West Sumatra and Gresik in East Java.

Pursuing energy efficiency and conservation programmes and accelerating renewable energy development will further reduce CO_2 emissions. Under APS, CO_2 emissions will be about 27% less than under BAU by 2050.

References

Center for Data and Information Technology-Pusdatin (2018), *Handbook of Energy and Economic Statistics of Indonesia 2017*. Jakarta: Ministry of Energy and Mineral Resources of Indonesia.

Central Bank of Indonesia (2019), '*Indonesian Financial Statistics (SEKI), Real Sector, Table 7_2 on Gross Domestic Product by Industrial Origin at 2010 Constant Prices*'. http://www.bi.go.id/en/statistik/seki/terkini/riil/Contents/Default.aspx (accessed 15 March 2020).

Central Bank of Indonesia. 2019. *Synergy, Transformation, and Innovation, Towards an Advanced Indonesia. Indonesia Economic Report 2019*. Jakarta: Bank Indonesia.

Central Bureau of Statistics (2017), '*Statistical Yearbook of Indonesia 2017*'. https://www.bps.go.id/publication/2017/07/26/b598fa587f5112432533a656/statistik-indonesia-2017.html (accessed 18 March 2020).

Central Bureau of Statistics (2018), '*Proyeksi Penduduk Indonesia 2015-2045 Hasil SUPAS 2015 (Indonesia Population Projection)*. 5https://www.bps.go.id/publication/2018/10/19/78d24d9020026ad95c6b5965/proyeksi-penduduk-indonesia-2015-2045-hasil-supas-2015.html (11 May 2020).

Central Bureau of Statistics (2018), 'Ekonomi Indonesia Triwulan iv-,2017. Berita Resmi Statistik, 5 February 2018.

https://www.bps.go.id/pressrelease/2018/02/05/1519/ekonomi-indonesia-triwulan-iv-2017--tumbuh-5-19-persen.html (accessed 4 March 2020).

'Intended National Determined Contribution Republic of Indonesia'. http://www4.unfccc.int/submissions/INDC/Published%20Documents/Indonesia/1/INDC_REPUBLIC%20OF%20INDONESIA.pdf (accessed 7 September 2017).

Jarrett, P., P. Vujanovic, and R. Dutu (2017), '*OECD Economic Surveys. Indonesia. October 2018. Overview.*' http://www.oecd.org/economy/surveys/Indonesia-2018-OECD-economic-survey-overview.pdf (accessed 4 March 2020

Lapitskiy, I. (2017), '*Indonesia GDP Growth Forecast 2017–2017 and up to 2060, Data and Charts*'. http://gambia.opendataforafrica.org/yubthm/indonesia-gdp-growth-forecast-2017-2017-and-up-to-2060-data-and-charts (accessed 4 March 2020).

Ministry of Energy and Mineral Resources (2019), *Statistik Ketenagalistrikan Tahun 2018*'. https:// www.djk.esdm.go.id/index.php/statistik-ketenagalistrikan (accessed 16 May 2020).

National Energy Council (2018), *Indonesia Energy Outlook 2018*. Jakarta: Secretariat General National Energy Council.

Republic of Indonesia (2014), *National Energy Policy 2014, Government Regulation No. 79 year 2014*. http://www.den.go.id/ (accessed 10 December 2019).

World Bank. Data Bank: World Development Indicators. https://databank.worldbank.org/source/world-development-indicators (accessed 12 December 2019).