CHAPTER 7

Indonesia Country Report

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1. Background

Indonesia covers an area of 1,913,000 square kilometres, with a population that increased by an average of 1.4% per year—from 178.6 million in 1990 to 270.6 million people in 2019 (World Development Indicators, 2021).

Gross domestic product (GDP) was $1,204.5 billion (constant 2010 United States [US] dollars) in 2019, an average increase of 4.3% per year from 1990. The service sector is a major contributor to GDP (44.7%), followed by industry (38.5%), agriculture (12.8%), and other activities (4.1%). In 2019, GDP per capita was about $3,877 (constant 2010 US$), whilst in 1990 it was only $1,488 (constant 2010 US$).

Indonesia is richly endowed with natural resources. Its vast oil and gas reserves 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 has not been conducive and the use of enhanced oil recovery technology to boost oil production is not yet optimal. As of January 2019, proven reserves of crude oil were 2.48 billion barrels, whilst those of natural gas were 49.7 trillion cubic feet (Center for Data and Information Technology-Pusdatin, 2019). Indonesia exports coal and had about 36.3 billion tonnes of proven coal reserves by the end of 2019.

Non-fossil energy resources include hydro, geothermal, biomass, and other renewable sources such as solar and wind. Estimated hydro potential is about 95 gigawatts (GW), whilst estimated geothermal potential is 23.9 GW. In total, renewable energy potential is about 3,643 GW for power plants, of which only 0.3% or 11.6 GW have been utilised. The use 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 2019 but decreased to -2.07% in 2020 due to the corona virus disease (COVID-19) pandemic. In 2021, GDP growth slightly increased to 3.8% (Central Bank of Indonesia, 2021), in line with the decline in Covid cases and an increase in vaccines. Expected real GDP growth for 2022 was 5.2%. The National Energy Policy (KEN) of 2014 estimated an average annual growth rate of 8.00% from 2017 to 2025, which would slow to 7.25% in 2035 and 6.50% in 2050. Since current real GDP growth is slower than what the KEN expected, this study estimates that real GDP will grow by an average of 4.8% per year from 2019 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. The business as usual (BAU) scenario and the five alternative policy scenarios (APSs) are similar to those in the previous ERIA reports 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. Below are the five APSs:

(i) APS1. More efficient final energy consumption, with energy-saving targets by sector. 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.
(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 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.

In addition to the 5 APS, this year we formulated the Low Carbon Energy Transition (LCET) scenario. In this scenario, fossil fuel consumption in the industry, transport, and commercial sectors will be replace with hydrogen. For transport sector, a shift from Internal Combustion Engine (ICE) vehicles to Battery Electric Vehicles (BEVs) is necessary decarbonize the emission in transportation sector. Additionally, transitioning from coal-based power generation to a combination of gas and renewable energy, using Carbon Capture Storage (CCS) for coal and gas power, is vital.

3. Outlook Result

3.1. Business-as-Usual Scenario

3.1.1. Final Energy Consumption

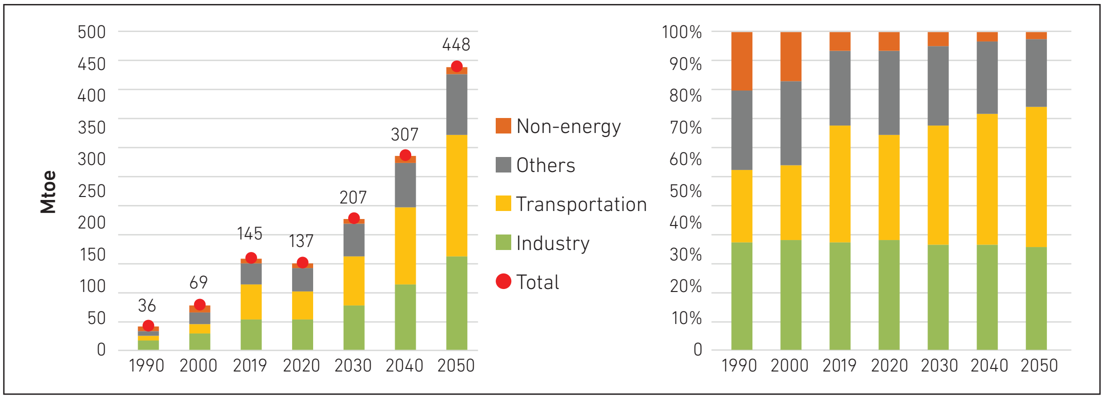
Total final energy consumption (TFEC) increased by an average of 4.9% per year from 1990 to 2019, from 36.43 million tonnes of oil equivalent (Mtoe) to 144.78 Mtoe. Given the assumed economic and population growth, TFEC will continue growth slowly, by 3.7% per year from 2019 to 2050 under BAU.

a. Final Energy Consumption by Sector

Growth in total final energy consumption is mainly due to 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 6.7% per year in 1990–2019. Growth is expected to continue until 2050 under BAU but only by 4.3% per year. Transport's share in TFEC increased from about 22.6% in 1990 to 36.9% in 2019. The share will continue to increase to 45.9% in 2050. Industry's final energy consumption grew more slowly than transport sector in 1990–2019 (4.8% per year) and will continue decrease in 2019–2050 (3.6%). Industry had the highest share in TFEC in 1990–2005, but in 2019–2050 transport had the highest share. In 2050, the share of transport sector in TFEC is expected to be about 43.5%, while the share of industry is estimated to remain the same from 1990 to 2050 at 33%.

The final energy consumption of 'others' (mainly the residential and commercial sectors) grew by an average of 4.6% per year in 1990–2019 and is projected to slow to an average of 3.4% per year in 2019–2050. The share of 'others' in TFEC in 1990 was about 25.2% and is expected to decrease to 21.6% in 2050. The combined share of oil and alternative fuels for transport will contribute to the increase of transport's share in TFEC. Figure 7.1 shows TEFC by sector for 1990–2050.

Figure 7.1 Final Energy Consumption by Sector, 2019–2050
(Mtoe)



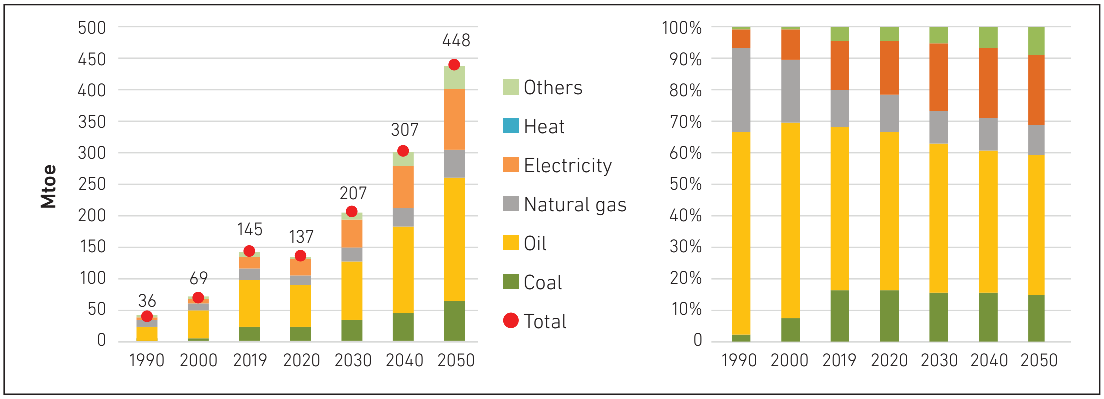
Mtoe = million tonnes of oil equivalent.

Source: Author's calculations.

b. Final Energy Consumption by Fuel Type

Coal grew the fastest in 1990–2019 because in this period the cement and metal industries as major consumers started to expand rapidly. Total coal demand increased from 0.82 Mtoe in 1990 to 23.4 Mtoe in 2019, growing by an average of 12.3% per year. Electricity, increased significantly by an average of 8.1% per year, due to the significant increase in industry and residential consumption, from 2.4 Mtoe in 1990 to 22.5 Mtoe in 2019. Natural gas grew an average of 1.9% and oil by an average of 4.1% in 1990–2019. Demand for all fuels will continue to increase. While oil will still play a major role in final energy consumption, more alternative fuels will be consumed by end-use sectors (Figure 7.2). The share of oil is expected to be about 44.9% in 2050, slightly lower than its share in 2019 (52.3%). The remaining share will be composed of coal (14.9%), natural gas (9.9%), electricity (22.3%), and others (86.2%)

Figure 7.2 Final Energy Consumption by Fuel, 1990–2050
(Mtoe)



Mtoe = million tonnes of oil equivalent

Source: Author's calculations.

3.1.2. Primary Energy Supply

Total primary energy supply (TPES) grew by about 3.7% per year, from 79 Mtoe in 1990 to 229 Mtoe in 2019. The fastest-growing fuels in 1990–2019 were coal and geothermal. Coal supply grew by an average of 11.5% per year, whilst geothermal grew by an average 9.1% per year. Oil supply increased more slowly, by 4% per year, whilst gas had the slowest growth rate at 0.8% per year during the same period.

Under BAU, TPES is projected to increase by an average of 3.5% per year, reaching 664 Mtoe in 2050. The biggest growth in 2050 will come from solar and wind at about 10.2%, driven by the development of renewable energy power generation, including solar rooftops on commercial and residential buildings. Geothermal energy is projected to grow by 4.4% per year until 2050. Hydro, including mini and micro hydro, will also increase from 2019 to 2050, but at a slower rate than geothermal, at 4.3% per year.

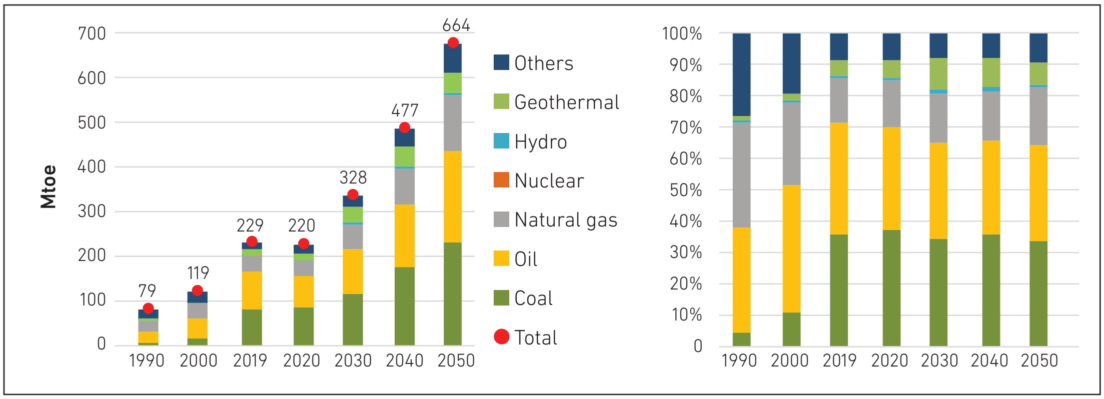
Natural gas is projected to increase an average 4.4% per year in 2019–2050. Oil is projected to increase by an average of 3% per year and coal an average of 3.3% per year.

The BAU model 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

Oil constituted the largest share in TPES at about 33.8% in 1990 and 35.9% in 2019. The share of natural gas in the total mix decreased from 33.2% in 1990 to 14.2% in 2019. Coal's share in TPES increased from about 4.3% in 1990 to 35.5% in 2019. Geothermal share decreased from 1.2% to 5.3% in 1990–2019.

In 2050, the oil's share in TPES is projected to decrease from 35.9% to 30.6%. Coal's share will decrease slightly from 35.5% in 2019 to 33.9% in 2050. The share of natural gas will increase to 18.4% in 2050 from 14.2% in 2019. Hydro's share in TPES will increase from 0.7% in 2019 to 0.9% in 2050. Same with hydro, the geothermal share will increase from 5.3% to 7.1%. The share of 'others will reach 9.1% in 2050 from 8.4% in 2019 (Figure 7.3).

Figure 7.3 Primary Energy Supply, 1990–2050
(Mtoe)



Mtoe = million tonnes of oil equivalent

Source: Author's calculatios.

3.1.3. Power Generation

Power generation output increased by an average of 7.8% per year, from about 33.1 terawatt hour (TWh) in 1990 to 293.8 TWh in 2019. In 1990, most generation output was still from oil-based plants (37.2%), followed by coal power plant (29.5%). 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 59.4% in 2019. Coal power generation reached 174.5 TWh in 2019, increasing rapidly by 10.5% 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 (21.2% in 2019), although electricity generation from natural gas increased at the fastest pace, by 10.5% per year, reaching 62.3 TWh in 2019.

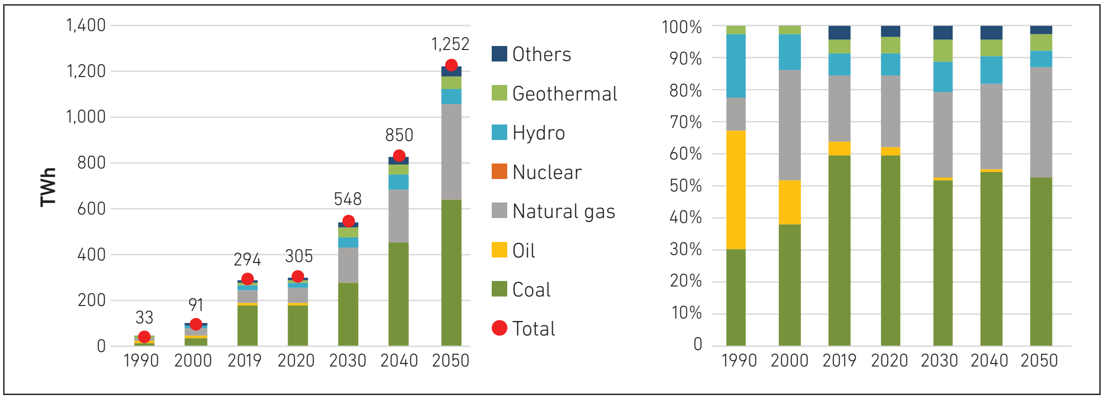
Under BAU, power generation is projected to reach 1252 TWh by 2050, increasing by an average of 4.8% per year (Figure 7.4). Hydropower and geothermal generation are growing, by 4.3% and 4.4%, respectively. Generation from 'others' will grow, but slower than hydropower and geothermal by an average of 4% per year.

Power generation from natural gas will continue to increase at an average rate of 6.4% per year, whilst coal-based power generation will grow by an average of 4.3% per year. The BAU scenario does not include nuclear plants.

The share of coal will remain dominant in total power generation and is expected to continue to increase about 51.8% in 2050. While the share of natural gas will increase to 34.5% by 2050, oil will continue to decline to 0.1% by 2050. The assumption is that oil-based plants (diesel plants) will be replaced with natural gas or renewable sources except where substitution is not feasible especially in remote area.

The total share of renewable energy in the generation mix will reach 13.5% by 2050, with hydropower at 5.8%, geothermal at 4.3%, and other renewables at 3.4%.

Figure 7.4 Power Generation by Type of Fuel, 1990–2050
(TWh)



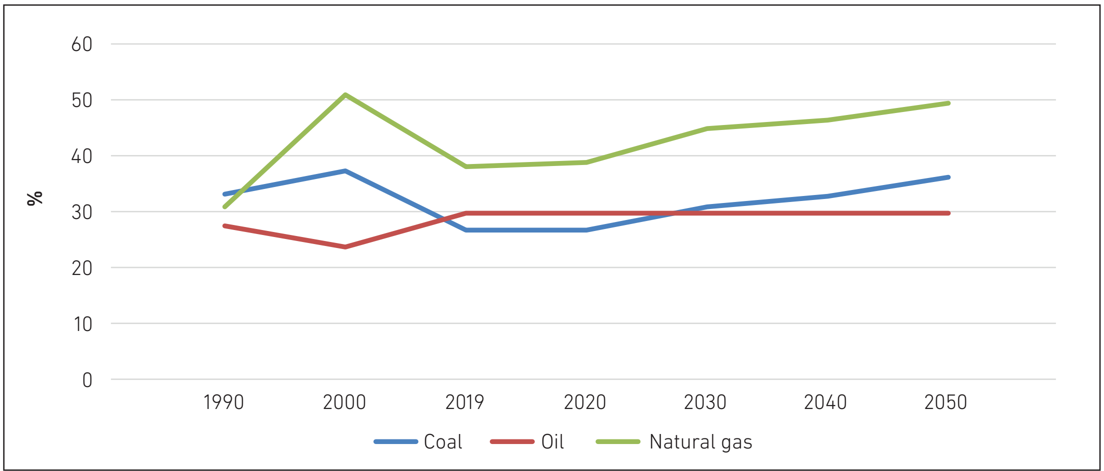
TWh = terrawatt hour.

Source: Author's calculations.

The average thermal efficiency of power plants based on fossil fuel was about 28.2% in 2019. Under BAU, coal and natural gas power plants are assumed to become more efficient, causing thermal efficiency of fossil fuel plants to increase to 39% by 2050. The thermal efficiency of coal-fired power plants will increase from 26% in 2019 to 35% in 2050, whilst that of natural gas will increase from 37% to 48%. Oil will remain at 29% in 2019–2050 (Figure 7.5).

Figure 7.5 Thermal Efficiency, Business as Usual, 1990–2050

(%)



Source: Author's calculations.

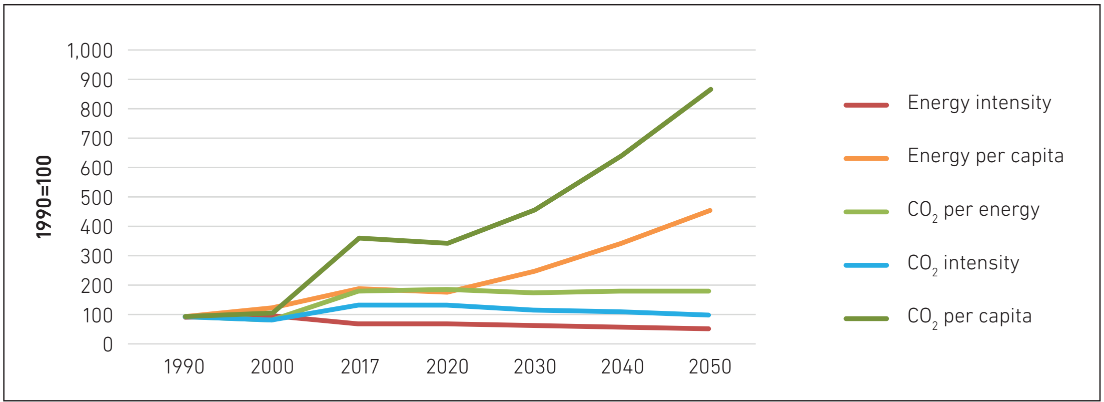
3.1.4. Energy Indicators

Primary energy intensity is measured as the ratio of total primary energy supply (TPES) and GDP, which is the unit consumption of primary energy per $1 million (2010 USD constant). Primary energy intensity has been declining since 1990, reaching 189.9 tonnes of oil equivalent (toe) in 2019. Final energy intensity (TFEC/GDP) started declining after 2000, reaching 120 toe per $1 million (2010 USD constant). 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.

In 2019–2050 primary energy intensity under BAU is projected to decline at an average rate of 0.9% per year during, while final energy intensity will decline at an average rate of 0.8% per year (Figure 7.6). Primary energy intensity in 2050 will be about 140.9 toe/$1 million (2010 USD constant), whilst final energy intensity will be 95.2 toe/$1 million (2010 USD constant). Per-capita energy consumption, measured as the ratio of total primary energy supply to the total population, increased from 0.4 in 1990 to 0.8 in 2019, indicating that energy access is improving. In 2015, the electrification ratio was about 88.3% and reached 98.9% by 2019 (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 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 2019–2050 will reach 0.8. Elasticity below 1 indicates that growth in final energy consumption will be slower than growth in GDP in 2019–2050.

Figure 7.6 Energy Intensity and Other Energy Indicators, 1990–2050



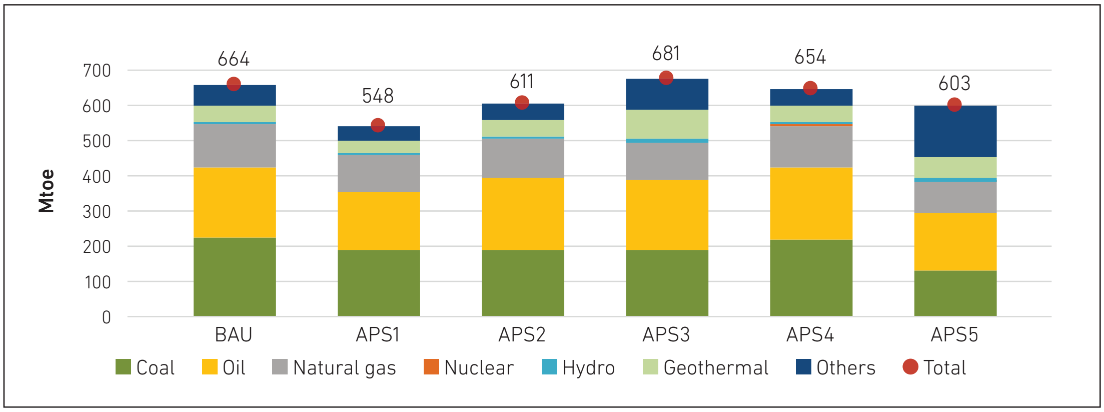
CO_2 = carbon dioxide.

Source: Author's calculations.

3.2. Potential for Energy Savings and Reduction of Carbon Dioxide Emission

The assumptions in APS1 to APS5 were analyzed separately to determine their individual impacts. Figure 7.7 shows the changes in TPES under all scenarios.

Figure 7.7 Comparison of Scenarios' Total Primary Energy Supply by 2050
(Mtoe)



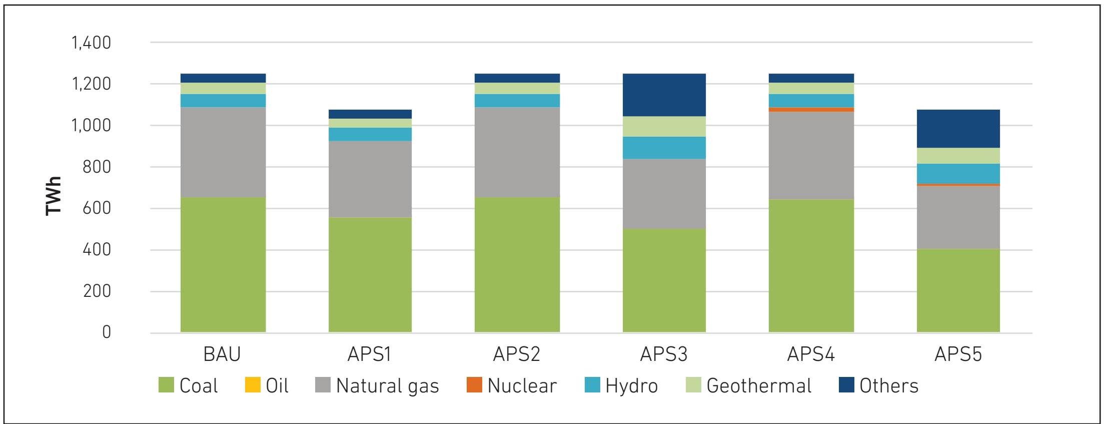
APS = alternative policy scenarios; BAU = business as usual; Mtoe = million tonnes of oil equivalent.

Source: Author's calculations.

APS1 and APS5 have the largest decreases in primary energy supply by 2050 due to demand side energy efficiency, reducing BAU TPES by up to 17.5% (116.3 Mtoe) and 9.1% (60.7 Mtoe) respectively. APS2's higher efficiency in thermal electricity generation results in a 7.9% (52.7 Mtoe) TPES reduction from BAU. Without efficiency measures in the final sector, it has less impact than APS1. The reduction is due to more efficient power generation, whilst some conventional plants cease operation after reaching the end of their technical life. APS3 sees a slight TPES increase of 2.5% from BAU as more renewable energy is used to generate power and more biofuels are consumed in transport. The introduction of nuclear power generation in 2045 under APS4 only increases TPES from BAU by 1.5% (9.7 Mtoe) in 2050. Though nuclear plants would reduce the consumption of fossil fuels (coal, oil, gas) in generating power, they are slightly less efficient than fossil fuel plants, resulting in no savings from BAU.

Total electricity generation in 2050 under all scenarios is shown in Figure 7.8. In APS1, lower electricity demand results in less electricity production. Since the difference between APS1 and BAU is the amount generated, the generation mix is the same. Fossil fuel generation still dominates, at 86%, whilst renewable energy (hydro, geothermal, others) generation accounts for 14%.

Figure 7.8 Comparison of Scenarios' Electricity Generation by 2050
(TWh)



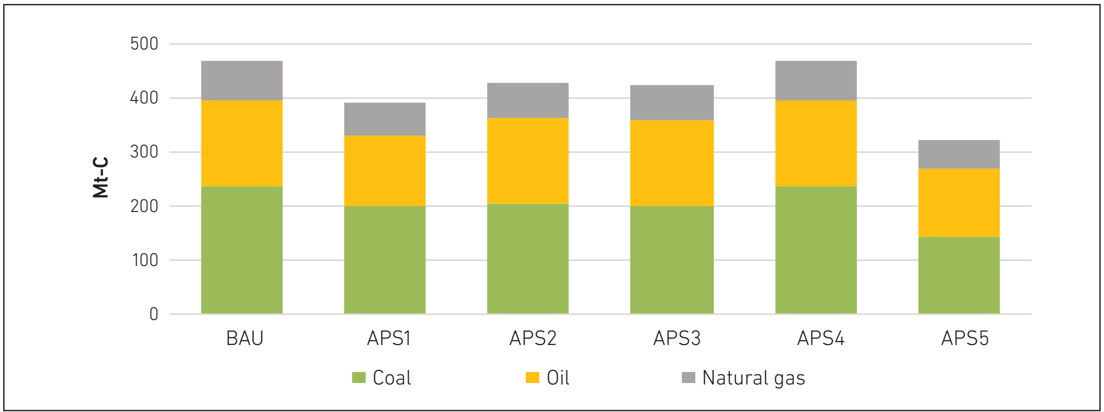
APS = alternative policy scenarios; BAU = business as usual; TWh = terrawatt hour.

Source: Author's calculations.

Under APS2 and BAU, the share of fossil fuel-fired generation will be the same since the differences lie only in the 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 67%. Under APS4, nuclear energy will slightly reduce the fossil fuel share to 85%. With APS5, the share of fossil fuel-based generation will be significantly reduced to 20.5%

Under APS1, carbon dioxide (CO_2) emissions could be reduced 77.5 million tonnes of carbon (Mt-C) or about 16% in 2050 (Figure 7.9). Under APS2, the installation of more-efficient power plants could reduce emissions by 41 Mt-C (9%). More renewable energy could reduce emissions by 46.5 Mt-C(10%), whilst nuclear energy could reduce them by 2.7 Mt-C(1%). APS5 could reduce emissions by 150 Mt-C 32% in 2050.

Figure 7.9 **Comparison of Scenarios' Carbon Dioxide Emissions by 2050**
(Mt-C)



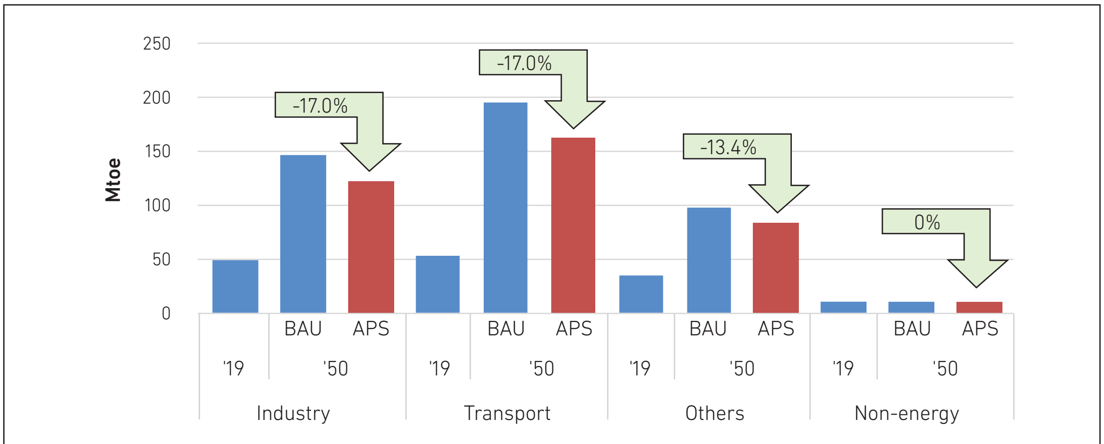
APS = alternative policy scenarios; BAU = business as usual; Mt-C = Million Ton Carbon.

Source: Author's calculations.

3.2.1. Final Energy Consumption

TFEC is expected to increase at a slower rate under APS, averaging 3.4% annually from 144.8 Mtoe in 2019 to 377.3 Mtoe in 2050. This is due to the government's energy efficiency and conservation (EEC) program, which will result in slower growth across all sectors, particularly in transport. Transport energy demand is expected to increase by 4.1% annually, compared to 4.7% under BAU. Figure 7.10. shows TFEC by sector in 2019 and 2050 for both scenarios. The APS assumes savings of 25 Mtoe in industry, 33 Mtoe in transport, and 13 Mtoe in the residential and commercial ('others') sectors by 2050.

Figure 7.10 **Final Energy Consumption by Sector, Business as Usual, and Alternative Policy Scenario**
(Mtoe)



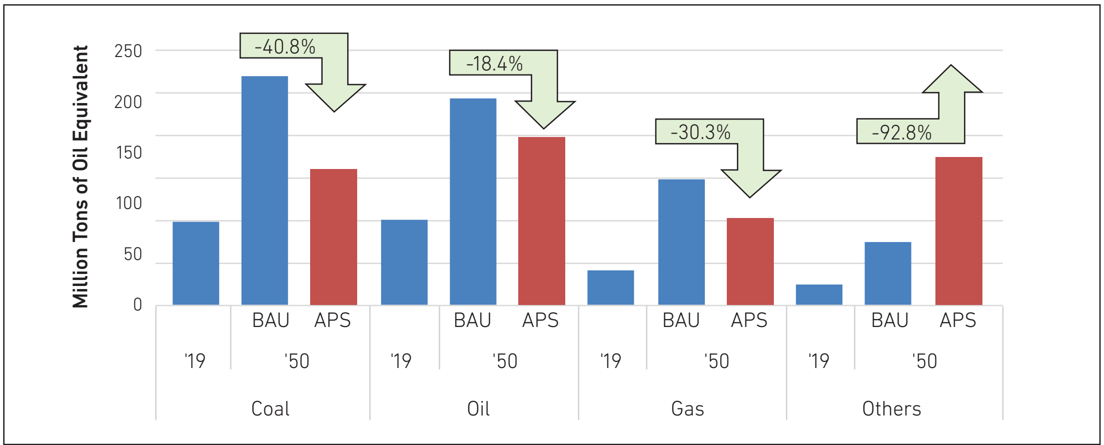
APS = alternative policy scenarios; BAU = business as usual; Mtoe = million tonnes of oil equivalent.

Source: Author's calculations.

3.2.2. Primary Energy Supply

TPES is projected to increase by 3% annually to reach 541 Mtoe in 2050 under APS, reflecting energy efficiency and conservation measures on the demand side, as well as more-efficient technology for power generation on the supply side. Under the APS, Indonesia is expected to save almost 91.7 Mtoe on coal, about 37.3 Mtoe on oil, and 37.1 Mtoe on natural gas by 2050. Additionally, TPES under APS for other resources (new and renewable resources, nuclear, and 'others') is 53.4 Mtoe higher than under BAU in 2050. See Figure 7.11.

Figure 7.11 Primary Energy Supply by Source, Business as Usual, and Alternative Policy Scenario, 2019–2050
(Mtoe)



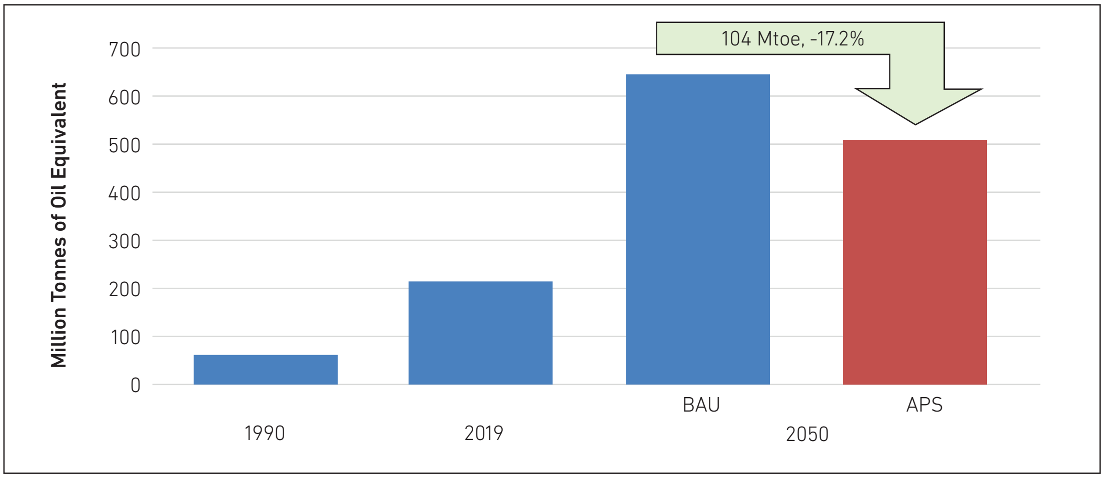
APS = alternative policy scenarios; BAU = business as usual.

Source: Author's calculations.

3.2.3. Projected Energy Savings

Total energy savings—the difference between TPES under BAU and APS is 104 Mtoe in 2050, almost half than TPES in 2019, which was about 221 Mtoe. The difference is achieved by implementing EEC and achieving renewable energy targets, improving power plant efficiency, and introducing nuclear energy.

Figure 7.12 Total Primary Energy Supply, BAU and APS, 1990–2050
(Mtoe)



APS = alternative policy scenarios; BAU = business as usual; Mtoe = million tonnes of oil equivalent.

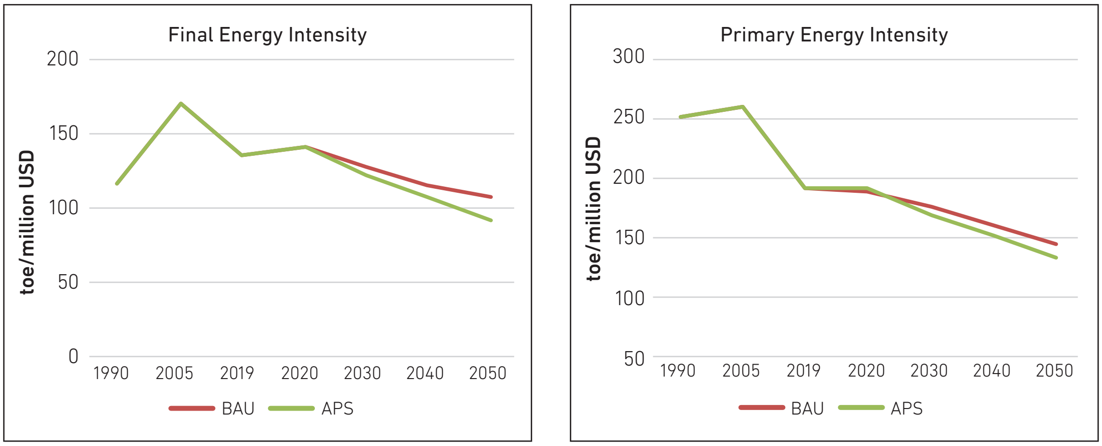
Source: Author's calculations.

3.2.4. Energy Intensity

The National Energy Policy (KEN) targets an annual reduction of 1% in final energy intensity up to 2025. Under BAU, final energy intensity will decline by an average of 0.8% per year in 2019–2050. Achieving sector EEC targets under APS will hasten the decline of final energy intensity to 1.3% per year over the projection period.

Primary energy intensity will be reduced by more than 1.1% per year under BAU and by 1.7% per year under APS if the EEC sector targets are achieved. See Figure 7.13.

Figure 7.13 Energy Intensity, 1990–2050



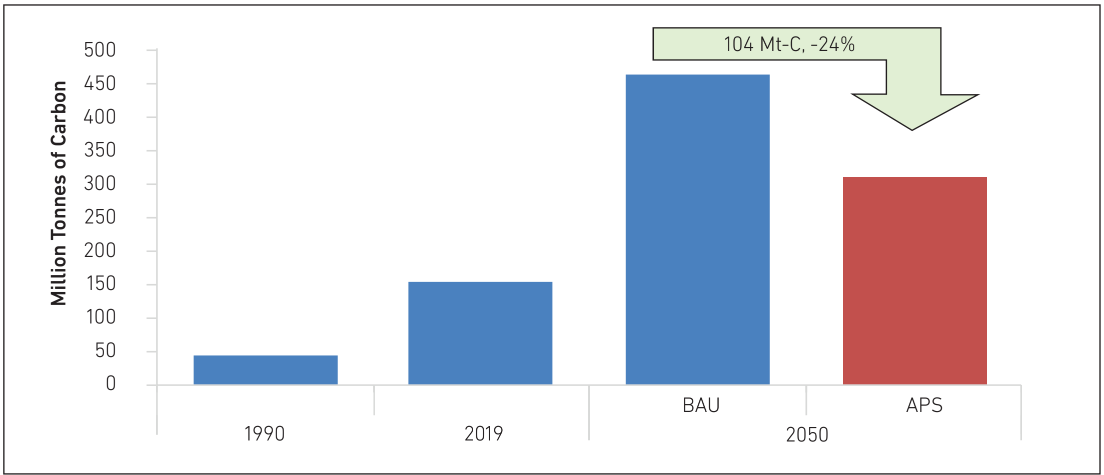
APS = alternative policy scenarios; BAU = business as usual; toe = tonnes of oil equivalent.

Source: Author's calculations.

3.2.5. Carbon Dioxide Emission Reduction

Under BAU, Carbon dioxide emissions from energy consumption are projected to increase by an average of 3.8% per year. This is equivalent to about 163.6 million tonnes carbon (Mt-C) (Figure 7.14). The increase is driven by the increasing use of carbon-intensive fuels, particularly coal for power generation and industry and oil for transport.

Figure 7.14 Carbon Dioxide Emissions from Energy Consumption, Business as Usual and Alternative Policy Scenarios, 1990, 2019, and 2050
(Mt-C)

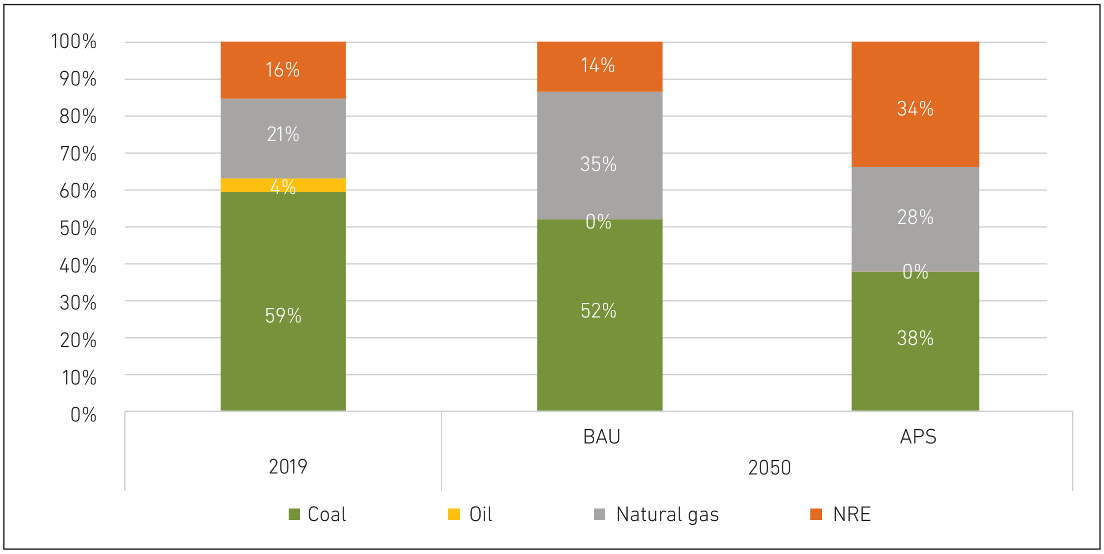


APS = alternative policy scenarios; BAU = business as usual; Mt-C = million tonnes of carbon.
Source: Author's calculations.

With the onset of greater energy conservation, higher efficiency, elevated renewable targets, and the inclusion of nuclear energy in 2045, CO_2 emissions in 2050 under APS are expected to be 31.9% lower than under BAU. 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. Compared to oil and gas, replacing coal, which is mainly used in the power sector, reduces the most CO_2 emission. Increasing the share of new and renewable energy (NRE) as outlined in the KEN will significantly reduce the use of coal. Despite the introduction of alternatives, oil remains the dominant fuel source in transport.

Figure 7.15 displays the share of each energy source used to generate electricity in 2050. Coal-based power plant electricity production grows slower than NRE- and gas-based power plants in both BAU and APS. Solar- and biomass-based power generation exhibit the fastest growth rates.

Figure 7.15 Power Generation Mix, BAU and APS, 2019 and 2050
(%)



APS = alternative policy scenarios; BAU = business as usual; NRE = new and renewable energy.

Source: Author's calculations.

3.3. Low Carbon Energy Transition Scenario (Carbon Neutral)

The Low Carbon Energy Transition (LCET) is a new scenario in Outlook Energy Saving Potential (OESP) 2022 that was created to achieve net zero emission. Through the Long-Term Strategy for Low Carbon and Climate Resilience (LTS-LCCR) 2050 published by the Ministry of Environment and Forestry, Indonesia aims to reduce greenhouse gas (GHG) emissions to 540 million tonnes of carbon dioxide equivalent (Mt-Co_2e) by 2050 and Indonesia sets the emission peaking target of national GHG emissions in 2030. Target emissions in 2050 can be achieved through the net sink of the forest and land-use sector. Carbon neutrality should be achieved by reducing emissions in Energy, Waste, and Industrial Processes and Product Use (IPPU) sector. To reach this goal, forestry must continue efforts to increase the amount of carbon absorbed by forests to achieve and maintain net sink, even after 2030. Second, significant changes in the energy sector are needed. This includes increasing the use of renewable energy sources, improving energy efficiency, reducing coal consumption, and implementing carbon capture and storage (CCS) and carbon capture, utilization, and storage (CCUS).

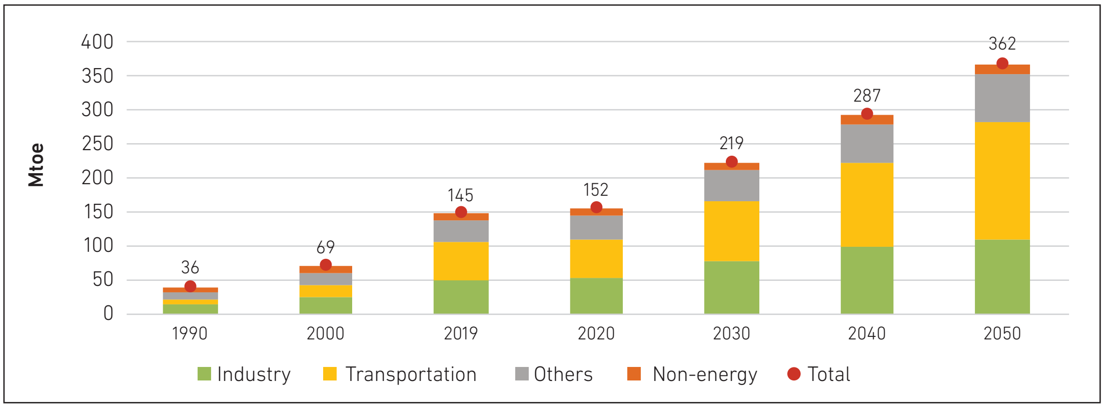
To achieve net zero emission in 2060, the LCET scenario requires substituting fossil fuel with hydrogen, especially in industry and transport, increasing the use of electronic vehicles (EVs) and biofuel for road transport, applying CCS and CCUS in power generation, and optimising renewable energy sources—including nuclear—in power generation.

Starting in 2035, new hydrogen fuel will replace fossil fuel in industry and road transport. Hydrogen, EVs, and biofuel (biodiesel and bioethanol) will replace In road transport, gasoline and diesel oil. The power generation will achieve decarbonisation by implementing CCS/CCUS technology in coal and gas power generation from 2040. Nuclear generation also will introduce in 2040. In addition Renewable power generation will be increase sharply start 2030 (hydro, geothermal, biomass, solar, wind, municipal solid waste and ocean)

3.3.1. Final Energy Consumption

Final energy consumption in the LCET scenario is projected to increase by an average annual growth rate of 3% from 2019–2050. By 2050, the final energy consumption will reach about 362 Mtoe. This amount will be 4% lower than in the APS5 due to the slow growth of final energy consumption in the industrial sector.

Figure 7.16 Final Energy Consumption by Sector, Low Carbon Energy Transition Scenario 1990–2050
(Mtoe)

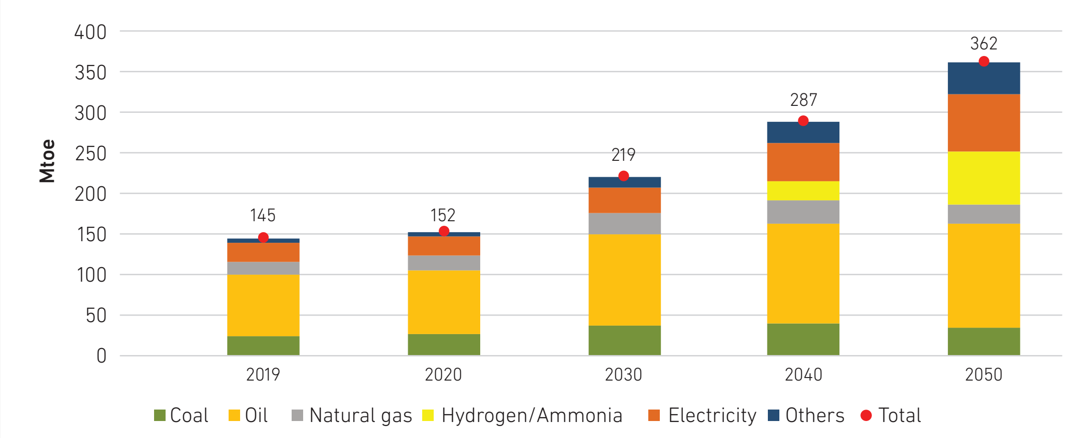


Mtoe = million tonnes of oil equivalent.

Source: Author's calculations.

Figure 7.17 shows the final energy consumption by fuel. In 2050, share of fossil fuel consumption in the LECT scenario (coal, oil, and natural gas) will only be 51% of the final energy consumption. The TFEC in LCET is about 68% lower than in APS5. In terms of fuel, share, oil consumption will decrease from 51% in 2019 to 36% in 2050. In the case of coal, the share will decrease from 17% to 9 % over same period, while natural gas will also decrease from 10% to 7%. In LCET, substituting fuel oil with hydrogen, increasing biofuel and electricity in transport sector, and using hydrogen in industry will greatly reduce the use of coal, oil, and gas in the future. Hydrogen consumption is expected to reach about 24.7 Mtoe in 2040 and increase to 64 Mtoe in 2050 (18%).For electricity, it was 22.5 Mtoe in 2019, and is expected to increase to 72 Mtoe in 2050, while (biofuel) increase will reach 40 Mtoe in 2050.

Figure 7.17 **Final Energy Consumption by Fuel, Low Carbon Energy Transition Scenario, 2019 – 2050**
(Mtoe)



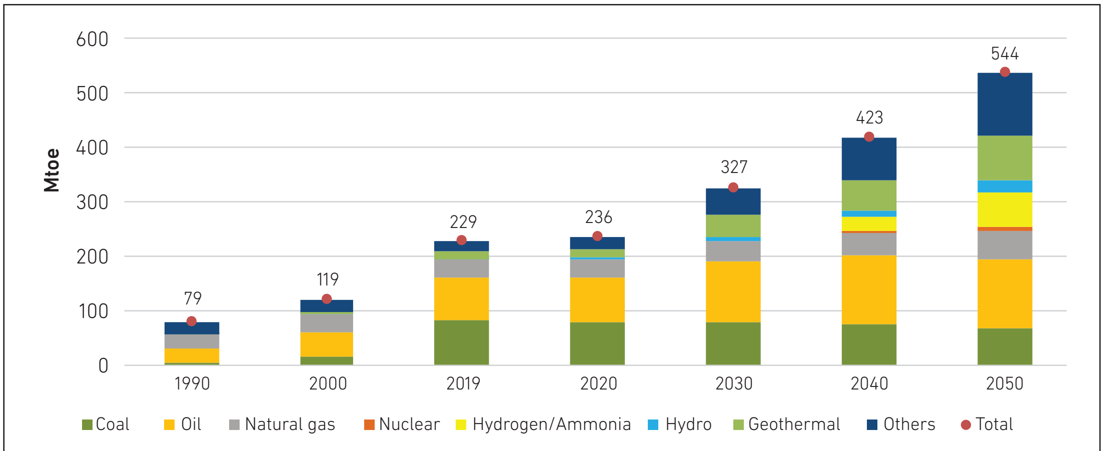
Mtoe = million tonnes of oil equivalent.

Source: Author's calculations.

3.3.2. Primary Energy Supply

The TPES of LCET is projected to reach 544 Mtoe in 2050 (Figure 7.18). Compared to the TPES in APS5 (603 Mtoe), TPES of LCET will be lower 10%. Although TPES in LCET is lower than APS5, the share of renewable energy for LCET will reach 54.2%, higher than APS5 (36.3%). This higher share of renewable energy in TPES of LECT is in line with the government plan to increase renewable generation (geothermal 15%, biomass 12.4%, hydro 4% and nuclear 1.5%.

Figure 7.18 **Primary Energy Supply by Fuel, Low Carbon Energy Transition Scenario 1990–2050**
(Mtoe)



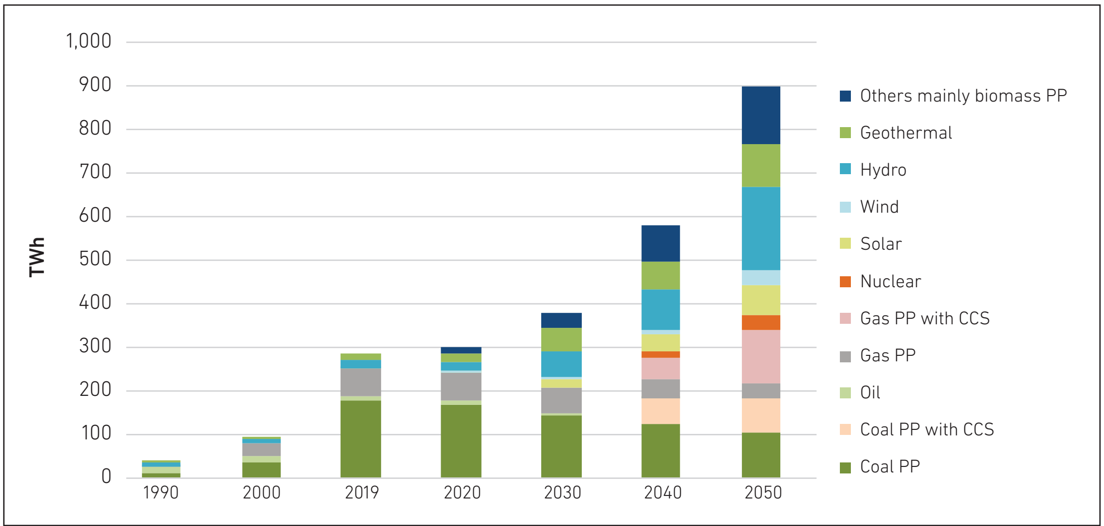
Mtoe = million tonnes of oil equivalent.

Source: Author's calculations.

3.3.3. Power Generation

In 2050, under the LCET scenario, the total electricity generation displayed in Figure 7.19 is 896.3 TWh, which is lower than the APS5 total of approximately 1071 TWh. By 2050, the share of coal power plants is about 19.9%, followed by gas at 17.9%, and oil at only 0.1%. Renewable energy would reach 62% (hydro at 21.5%, biomass 14.7%, geothermal 10.8%, solar 7.6%, wind 4.1%, and nuclear 3.4%) by 2050. Coal power plants are major emitters of CO_2. The government has decided to phase out coal power plants except for those that use clean coal technology. Under LCET, the assumption is that CCS/CCUS technology will be combined with not only coal power plants but also gas power plants to achieve net zero emission in 2060.

Figure 7.19 Electricity Generation by Fuel,
Low Carbon Energy Transition Scenario 1990–2050
(TWh)



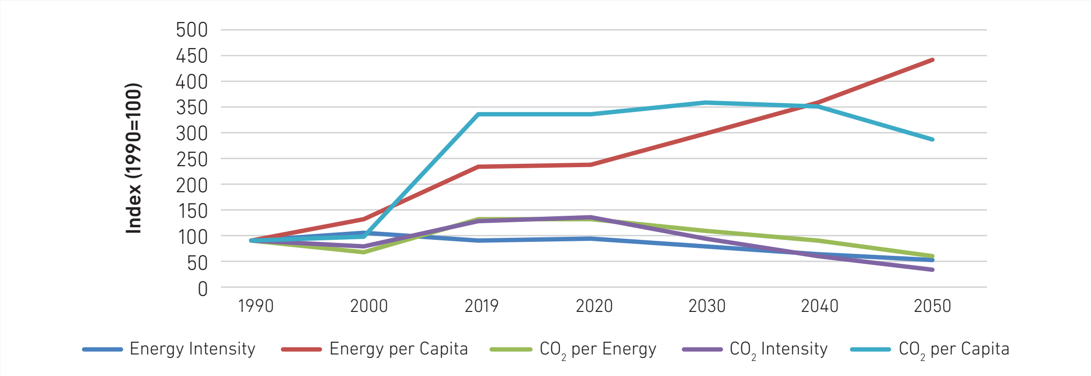
CCS = carbon capture and storage; PP = power plant; TWh = terrawatt hour.

Source: Author's calculations.

3.3.4. Energy Indicators

Figure 7.20 shows that only energy per capita increases from 1990–2050. Beginning in 2030, CO_2 emission per capita decreases, in line with the use of renewable energy in all sectors, including power generation.

Figure 7.20 Energy Indicator Index, Low Carbon Energy Transition Scenario 1990–2050



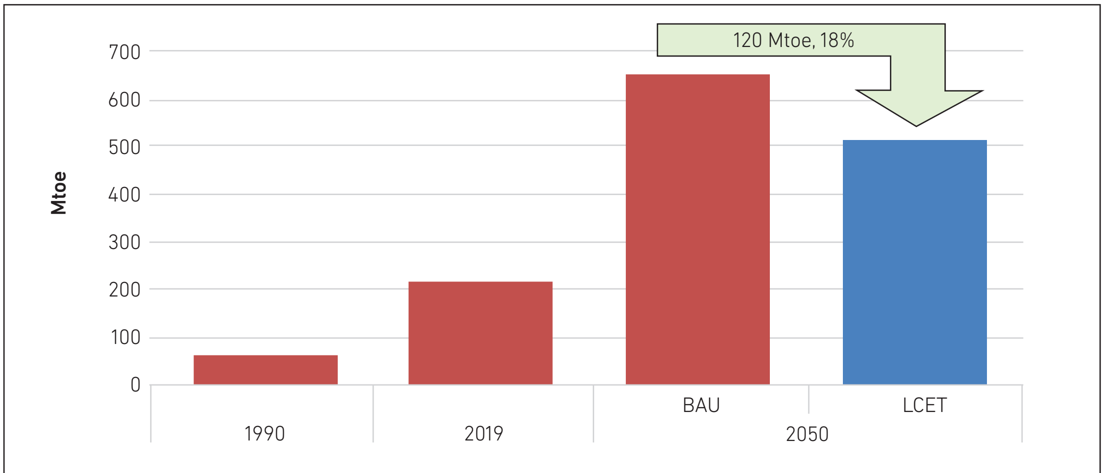
CO_2 = carbon dioxide.

Source: Author's calculations.

3.3.5. Energy Saving Potential

The LCET scenario presents a potential savings in total primary energy supply of 120 Mtoe (18%) compared to BAU scenario if all initiatives under the LCET scenario are implemented.

Figure 7.21 Primary Energy Supply, BAU and Low Carbon Energy Transition Scenarios 1990, 2019, and 2050 (Mtoe)



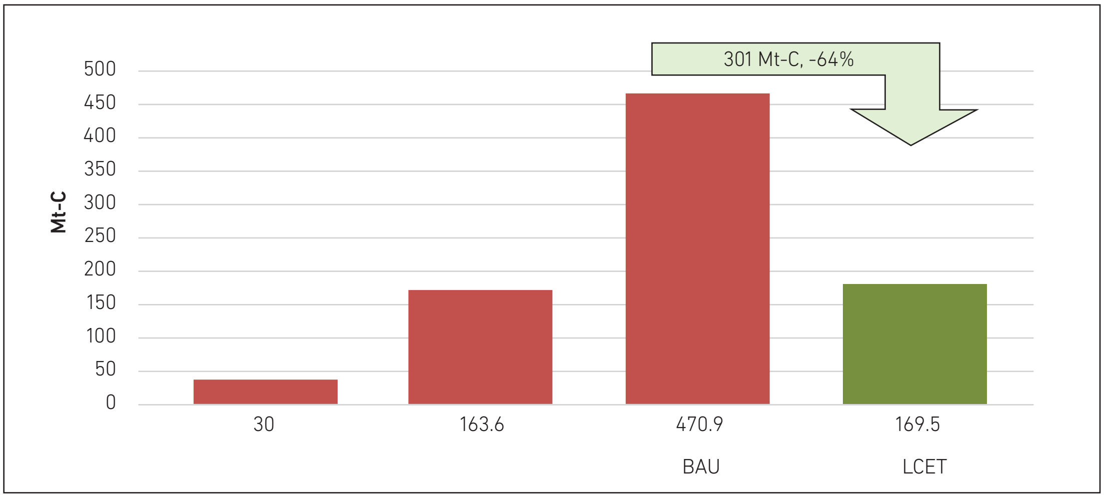
BAU = business-as-usual; LCET = low carbon energy transition; Mtoe = million tonnes of oil equivalent.

Source: Author's calculations.

In 2050, total CO_2 emission under the LCET scenario is 169.5 Mt-C, while in BAU scenario at 470.9 Mt-C. There is emissions reduction in LECT Scenario about 301 Mt-C or 64% compare BAU. Furthermore, total CO_2 emission in 2050 under LCET scenario only 5.8 Mt-C higher than total emission in 2019.

Figure 7.22 CO_2 Emission Reduction, BAU and Low Carbon Energy Transition Scenarios 1990, 2019, and 2050

(Mt-C)



BAU = business as usual; LCET = low carbon energy transition; Mt-C = million tonnes of carbon.

Source: Author's calculations.

4. Implications and Policy Recommendations

Economic recovery due to the impact of Covid-19 is still a concern for all countries, including Indonesia. The energy sector also experienced a decline in final energy consumption, including electricity consumption. As a result, an electricity surplus makes it difficult to include new and renewable energy in the electricity grid system.

However, Indonesia has committed to reducing its emissions to achieve zero emission by 2060. Efforts to reduce emissions in power generation and final energy use must be encouraged in all sectors.

Currently, electricity supply in Indonesia is mostly from coal. Reducing emissions must, therefore, be focused on transforming it to renewable energy generation, including solar, wind, biomass, municipal solid waste, and nuclear. However, to meet the electricity demand in 2050, CCS technology must be used to generate additional fossil fuel (coal and gas).

To reduce energy usage in transportation, industry, and other sectors, the energy efficiency policies for equipment used must be improved. For electrical appliances, regulations must mandate energy efficiency labels and minimum energy performance standards (MEPS) for appliances such as refrigerators, rice cookers, washing machines, and water pumps should be regulated. Currently, only compact fluorescent lamps (CFL) and air conditioning are regulated.

To reduce emissions in transportation, the use of electric vehicles on a large scale must be increased. Currently, while there is an appeal for the use of EV cars, especially for office cars, EV is now being used by several taxis (motorcycles and cars). However, the number of EVs is insignificant compared to conventional vehicles. Policies have been put in place to encourage EV use such as reduced purchase tax and lower interest rates, additional free power at home, and reduced import taxes for producers. Despite this, stronger efforts are needed to make EVs more affordable. Reducing emissions in transportation can also be done through the use of biofuels, such as B30 (30% of biofuel and 70% of diesel), which is being tested for the implementation of the B40 (40% of biofuel and 60% of diesel).

As the use of solar photovoltaic technology and electric cars increases, so does the need for batteries as electricity storage. A domestic battery industry must be developed to increase growth in the industrial sector.

Meeting the challenges posed by the need to develop clean energy, especially CCS technology, requires costly investments. For Indonesia to achieve its emission reduction target, policy support from the government must provide and coordination between ministries are critical.

In 2050, carbon emissions will be 169.5 million carbon ton or around 594 . With the expected carbon net sink by forestry at 540 million CO_2 ton, the current LCET-CN will not achieve carbon neutrality by 2050. However, Indonesia is targeting carbon neutrality by 2060, giving the country more time to utilise low carbon energy technologies such as hydrogen/ammonia and CCS/CCUS to meet its goal.

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