CHAPTER 7

INDONESIA COUNTRY REPORT

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1. Background

Indonesia is the largest archipelagic state in Southeast Asia comprising 17,504 islands scattered over both sides of the equator. The five largest islands are Java, Sumatra, Kalimantan (the Indonesian part of Borneo), New Guinea (shared with Papua New Guinea), and Sulawesi. The country shares land borders with Papua New Guinea, Timor-Leste, and Malaysia. Other neighbouring countries include Singapore, the Philippines, Australia, and the Indian territories of Andaman and Nicobar Islands.

Indonesia covers an area of 1.913 million square kilometres and is the world's 16th largest country in terms of land area. The 2010 population census showed that Indonesia's population reached 238 million people with an average population density of 124 people per square kilometre. It increased to 258 million people in 2015 and, by the end of 2016, reached 261 million people (World Bank, 2017).

Indonesia's gross domestic product (GDP) was US$988 billion (constant 2010 US$) in 2015, increasing at an average rate of 4.9% from 2014. This growth rate was the lowest experienced by the country since 2010. In 2016, real GDP increased slightly faster at 5.02%, reaching US$1,038 billion (constant 2010 US$). From 1990, GDP grew at an average rate of 4.7% per year to 2015. GDP per capita in 2015 was almost US$4,000 (constant 2010 US$) while it was only US$1,700 in 1990 (constant 2010 US$).

Indonesia is richly endowed with natural resources. The country's vast oil and gas reserves have made Indonesia a significant player in the international oil and gas industry. As of January 2017, its crude oil proven reserves were 3.17 billion barrels while natural gas proven reserves were 100.4 trillion cubic feet (TCF) or 2.8 trillion cubic metres (TCM) (Ministry of Energy and Mineral Resources, 2017). Indonesia is also a coal exporter with proven coal reserves of around 29.9 billion tons. In addition to fossil energy resources, Indonesia's non-fossil energy resources include hydro, geothermal, biomass, and other renewables such as solar and wind. For hydro, the estimated potential is around 75 gigawatts (GW) while the estimated geothermal potential is more than 28 GW. In total, renewable energy potential in Indonesia is around 441.7 GW. Out of this, only 2%, or around 9 GW, has been utilised.

2. Modelling Assumptions

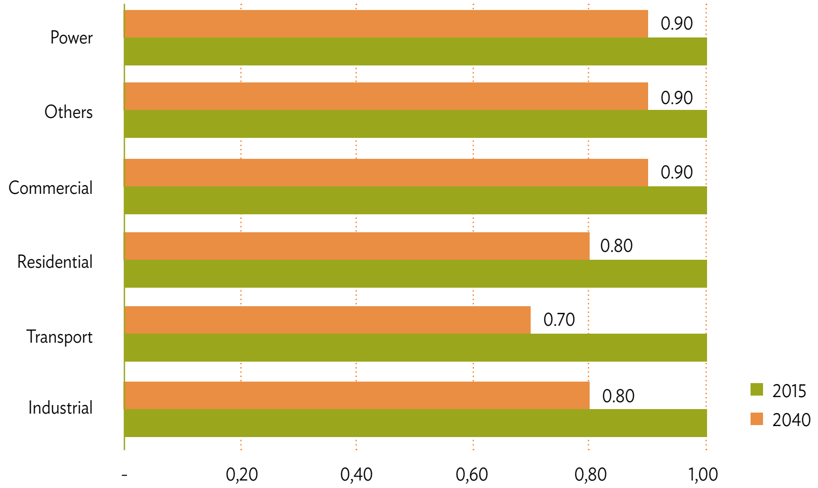
Indonesia's real GDP growth was 5.03% in 2016 and 5.07% in 2017 (Indrawati, 2018). The expected real GDP growth for 2018 is 5.4%. For 2019, the proposed state budget (APBN) 2019 targeted the real GDP growth in the range of 5.4%–5.8%. The National Energy Policy (KEN) of 2014 assumed an average annual growth rate (AAGR) of 8% from 2015 to 2025 and will slow down to 7.25% in 2035 and 6.5% in 2050.

Since the current real GDP growth is slower than that assumed in KEN, this study assumes that real GDP would grow at an AAGR of 5.8% in 2015–2040. This was based on the economic projections of the International Monetary Fund and the World Bank. For population, the growth assumption will be 0.8% per year over 2015–2040 period, based on the revised population projection of the Central Bureau of Statistics (2013).

The scenarios are like the previous EOSP reports (since 2013); i.e. Business-As-Usual (BAU) scenario and the five Alternative Policy Scenarios (APSs). These APSs reflected the additional policy interventions likely to be implemented. These are 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, etc. For Indonesia, the five APSs considered are as follows:

1) More efficient final energy consumption (APS1), with specific energy saving targets by sector (Figure 7.1). In addition, Article 9 of the 2014 KEN states that energy elasticity will be less than 1 by 2025 and that final energy intensity will also be decreasing at 1% per year. These goals and targets were also the energy saving targets for this year's study.

Figure 7.1: Energy Efficiency and Conservation Assumptions



Source: Author's assumptions.

2) More efficient thermal power generation (APS2), where higher improvement of existing coal-fired power plants and the introduction of cleaner coal technologies, were considered in the analysis. Also considered for this scenario are most efficient natural gas combined–cycle technologies.
3) Higher contribution of new and renewable energy (NRE) and biofuels (APS3) – In this case, higher penetration of NRE for electricity generation and utilisation of liquid biofuels in the transport sector is assumed compared to the BAU scenario.
4) Introduction or higher utilisation of nuclear energy (APS4), an assumption that it will be in operation after 2020. This is in line with the current plan where two units will be constructed after 2020, each with a capacity of 1,000 megawatts (MW).
5) The combination of APS1 to APS4 constitutes the assumptions of the APS (APS5).

3. Outlook Results

3.1. Business-As Usual (BAU) Scenario

3.1.1. Final energy consumption

Indonesia's total final energy consumption (TFEC) increased at an average annual rate of 2.9% between 1990 and 2015, increasing from 80 million tons of oil equivalent (Mtoe) to 163 Mtoe. Given the assumed economic and population growth, the growth in the TFEC will continue but at a faster rate of 4.4% per year in 2015–2040 in the BAU scenario (Figure 7.2).

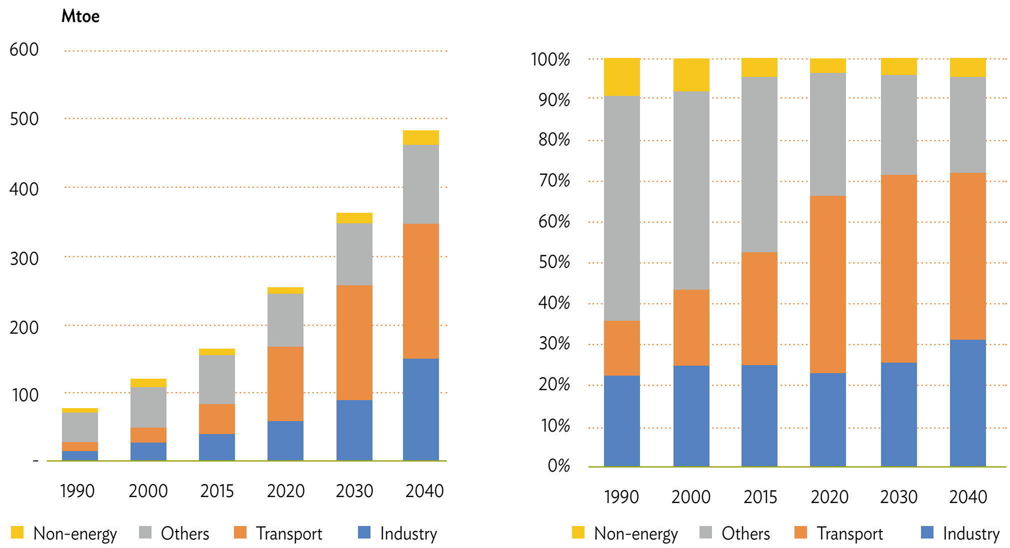
This growth stems from the rapid increase of the energy consumed in the transport and industry sectors. The transport sector is still heavily dependent on oil. In the past, the final energy consumption of the transport sector grew at an average rate of 5.8% per year over 1990–2015. This growth is expected to continue up to 2040 for the BAU scenario at a faster rate of 6.1% per year.

Final energy consumption in the industry sector grew at a slower rate than the transport sector in 1990–2015 (3.4% per year). It will still grow slower than the transport sector for the period 2015–2040 at an average rate of 5.3% per year.

Final energy consumption of the 'others' sector (mainly consisting of residential and commercial) grew at an average rate of 1.9% per year in 1990–2015. The final energy consumption of this sector is projected to experience a similar growth rate for the period 2015–2040.

The 'others' sector had the highest share in the TFEC in 1990–2015 because of the high consumption of biomass mainly in the residential sector. The share, however, decreased from around 55% in 1990 to 43% in 2015. This is mainly due to the rapid increase of the fuel consumption of the transport sector. The share will continue to decline in the future as household appliances become more efficient and households use more alternatives, such as natural gas and liquefied petroleum gas or LPG. The sector's share in the TFEC will decrease to 23% in 2040.

Figure 7.2: Final Energy Consumption by Sector (1990–2040)



Mtoe = million tons of oil equivalent.

Source: Author's calculations.

The share of the transport sector in the TFEC had increased from around 13% in 1990 to 27% in 2015. This share will continue to increase, reaching 41% in 2040. The combined share of oil and alternative fuels for transport will contribute more to the increase of the transport's share in the TFEC.

The industry sector's share in the TFEC was 23% in 1990–2015. This share is expected to increase to 32% by 2040 in line with the growth in industrial activities.

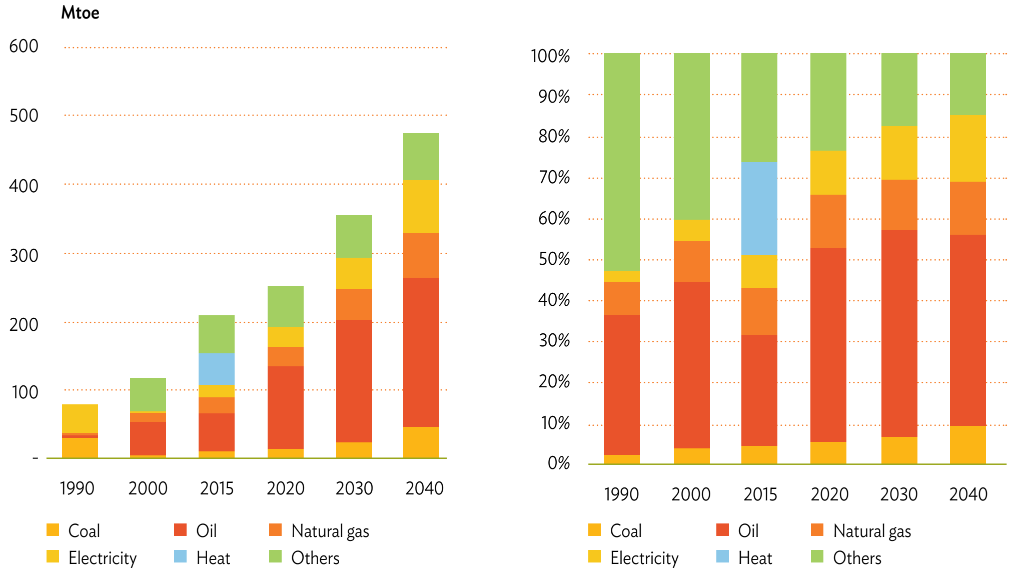
By fuel type, electricity experienced the fastest growth in 1990–2015, at an average rate of 8.1% per year. This rapid growth of electricity demand was due to the significant increase in the consumption of the industry and residential sectors, from 2.4 Mtoe in 1990 to 17.2 Mtoe in 2015. Coal is also increasing significantly over the same period as industry expands, particularly the cement industries. Total coal demand increased from 2 Mtoe in 1990 to almost 10 Mtoe in 2015, growing at an average rate of 6.2% per year.

As for natural gas and oil, the average annual growth of these fuels in 1990–2015 was 5.7% and 2.9%, respectively. Demand for other fuels (mostly biomass for households) increased by 13.5 Mtoe, at an average rate of 1.1% per year.

In the future, the demand for all fuels will continue to increase. For coal, demand will increase the fastest at an average rate of 6.4% per year to 45.6 Mtoe in 2040. Electricity is also expected to grow but at a slower rate than in the past. The AAGR for electricity demand would be 6.2% per year over the 2015–2040 period.

Natural gas and oil demand will grow at an average rate of 4.0% per year and 5.6% per year, respectively, between 2015 and 2040. Demand for other fuels will increase the slowest over the same period, at an average growth rate of 0.9% per year. This is mainly due to the decrease in the growth rate of biomass consumption of the residential sector.

Figure 7.3: Final Energy Consumption by Energy Type, BAU (1990–2040)



BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Author's calculations.

Oil will still play a major role in the country's final energy consumption although more alternative fuels will be consumed by the end-use sectors. The share of oil is expected to be around 46% in 2040, increasing from 34.5% in 2015. The remaining share will be that of coal (9.6%), natural gas (13.5%), electricity (16.3%), and others (14.6%).

3.1.2. Primary Energy Supply

Total primary energy supply (TPES) in Indonesia grew faster than the final energy consumption at about 3.4% per year, from 98.6 Mtoe in 1990 to 229.5 Mtoe in 2015. Amongst the major energy sources, the fastest-growing fuels 1990–2015 were coal and geothermal energy. Coal supply grew at an average annual rate of 10.8% while geothermal energy grew at 9.2% a year. Gas supply increased at a slower rate of 3.8% per year while oil grew slightly slower at 2.9% per year.

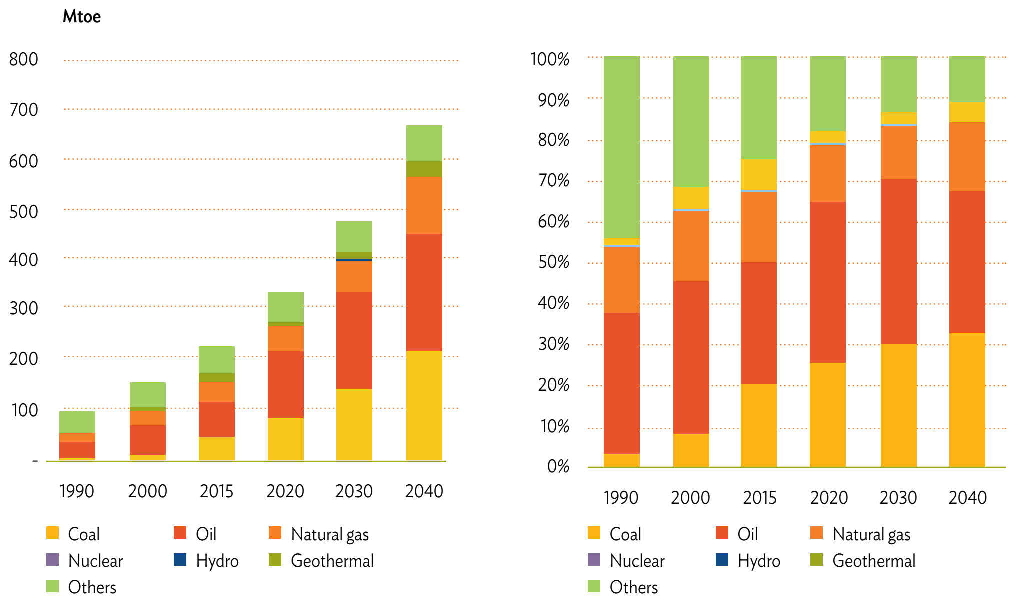
In the BAU scenario, Indonesia's TPES is projected to increase at an average annual rate of 4.4%, reaching 671.4 Mtoe in 2040. Coal is projected to continue growing but at a slower rate of 6.4% per year. Geothermal energy is also expected to increase over the same period. The new price structure for generating electricity from renewable energy will stimulate the development of geothermal energy, amongst others. The projected growth rate of geothermal energy until 2040 is 2.6% per year.

Hydro, including mini and small hydro, will also increase at the same rate of geothermal in 2015–2040. Consideration is being given to building more run-of-river-type hydro rather than reservoir type.

Oil is projected to increase at an average annual rate of 5.1% in 2015–2040. At the same time, natural gas supply will also increase but slower than oil at an average rate of 4.2% per year.

No uptake of nuclear energy is assumed in the BAU scenario. Thus, renewable energy will have a significant role in the future primary energy supply mix as the uptake of cleaner alternatives to oil increases. Other renewable energy resources include solar, wind, biofuels, and biomass.

Figure 7.4: Primary Energy Supply, BAU (1990–2040)



BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Author's calculations.

Oil constituted the largest fossil fuel share in the TPES, but the share had declined slightly from 33.8% in 1990 to 29.5% in 2015. The share of natural gas in the total mix slightly increased from 16% in 1990 to 17.5% in 2015.

Since both coal and geothermal rapidly grew in 1990–2015, the shares of these energy sources in the TPES have increased significantly. Coal share in the TPES increased from around 4% to 20% while geothermal share increased from 2% to 7.5%. Hydro's share remains the same at 0.5% over the same period. Since others, which include biomass, solar, wind, ocean, biofuels, and electricity, grew slower than the other fuels, its share declined from 44.1% in 1990 to 24.7% in 2015.

In the BAU scenario, oil's share will still be dominant throughout the 2015–2040 period, and its share in the TPES will reach 35% in 2040. Natural gas share will decrease slightly to 16.6% by the end of 2040, while coal share will increase to 32.5%.

Since the supply of hydro, geothermal, and 'others' is growing slower than fossil fuel sources, the shares will be declining over 2015–2040. Hydro's share in the TPES will decrease to 0.3% by 2040 and geothermal share, to 4.9%. The share of 'others' will reach 10.8% in 2040, from 24.7% in 2015

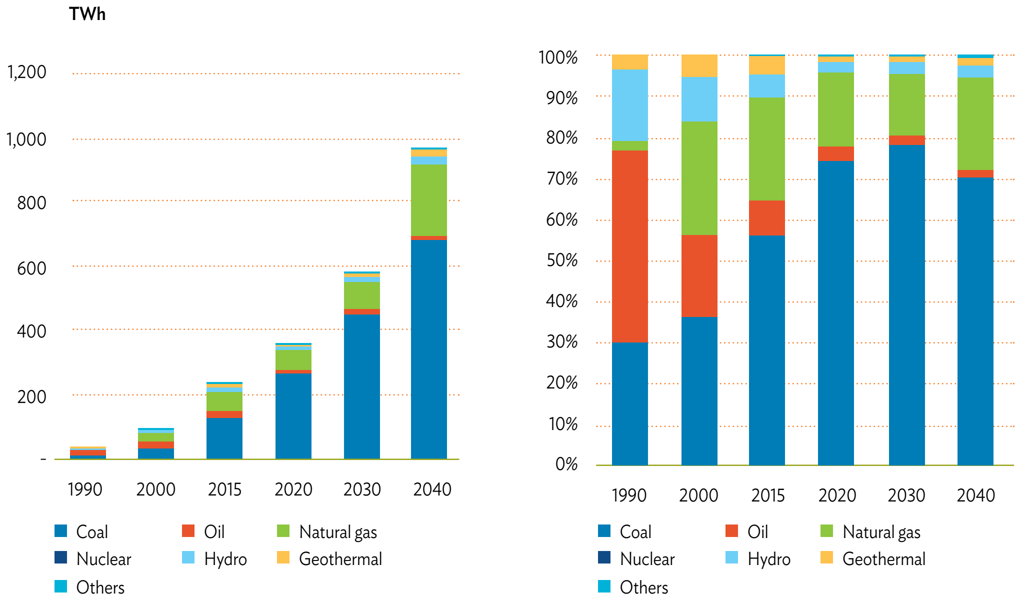
3.1.3. Power generation

Power generation output increased at an average rate of 8.2% per year over the past 2 decades, from around 33 TWh in 1990 to 233 TWh in 2015. The fastest growth occurred in the production of electricity from natural gas plants at 19.2% per year. This is due to the increase in gas turbine and combined cycle capacities as natural gas became increasingly available.

In the BAU scenario, to meet electricity demand, power generation is projected to increase at a slower rate of 5.9% per year reaching almost 969 TWh in 2040. By type of fuel, generation from 'others' will grow the fastest at an average rate of 10.9% per year. The main reason for this very rapid growth is that generation from these other sources was very small in 2015 but is expected to increase significantly as a result of the government's policy of increasing the use of NRE sources, including solar PV, wind, biomass, etc., classified as 'others'.

Generation from geothermal and hydro is also growing, but much slower than 'others', both at 2.6%.

Figure 7.5: Power Generation by Fuel Type (TWh) (1990–2040)



TWh = terawatt-hour.

Source: Author's calculations.

Power generation from natural gas will continue to increase but at a much slower rate of 5.4% per year while coal-based power generation will be growing at an average annual rate of 6.8%. No nuclear plant is considered under the BAU scenario.

The share of coal will remain dominant in the total power generation of the country. Its share in total power generation was lower than oil in 1990 (30%). The share increased over time as more coal-fired power plants were constructed. In 2015, the share increased to almost 56%, higher than that of oil. This share is expected to continue to increase in the future, reaching around 70% in 2040.

Oil had the largest share in power generation in 1990 (47%). By 2015, the share of oil declined to around 8.4% as production from coal and natural gas plants increased rapidly. Natural gas share in 2015 reached 25.2% and declined to 22.7% by 2040 under the BAU scenario.

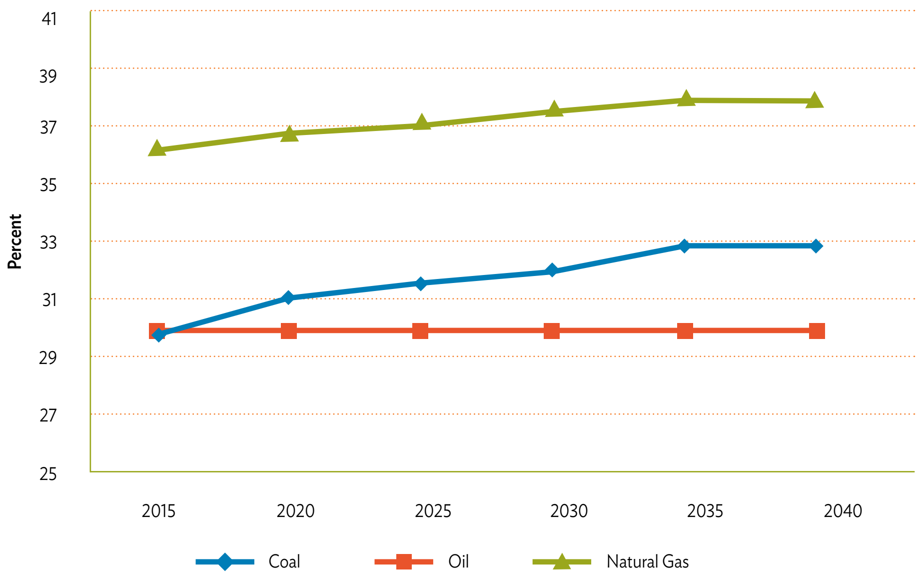
Hydro's share in the total electricity production of the country was 17.5% in 1990. The share declined to 5.9% in 2015. Under the BAU scenario, hydro's share is expected to continue to decline and reach 2.7% in 2040.

The share of geothermal and other renewables constituted about 4.5% of the power generation in 2015. The share of these renewables declined to 2.7% by 2040 under the BAU scenario.

The average thermal efficiency of fossil fuel–based power plants was around 32% in 2015. the BAU scenario assumes a slight improvement in the efficiency of coal and natural gas power plants causing the thermal efficiency of fossil fuel plants to increase to almost 35% in 2040.

By fuel, the thermal efficiency of coal-fired power plants will increase from 30% in 2015 to 34% in 2040 while natural gas is assumed to increase from 38% to 40%. Oil will remain less than 31% over the 2015–2040 period (Figure 7.6).

Figure 7.6: Thermal Efficiency, BAU (2015–2040)



Source: Author's assumptions.

3.1.4. Energy indicators

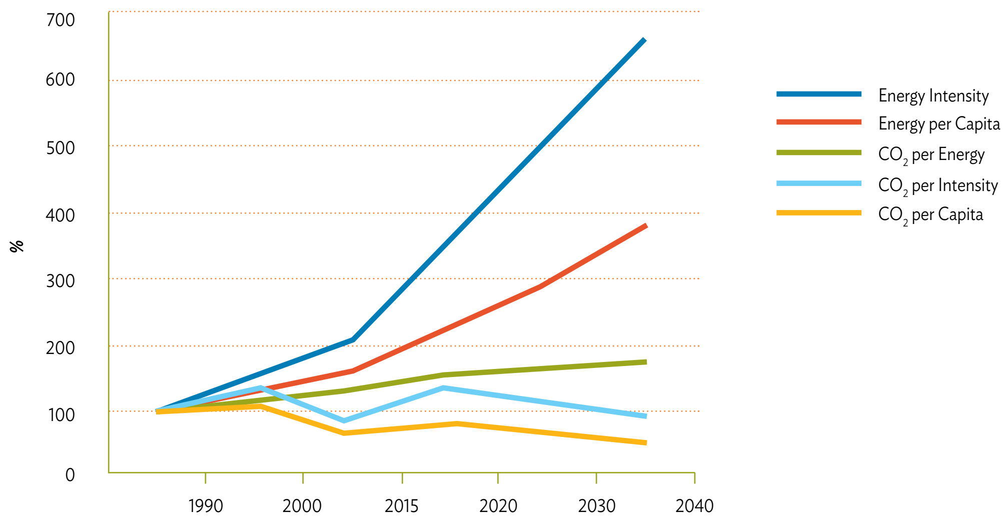
Indonesia's primary energy intensity (TPES/GDP) had been increasing until 2000. Since then, the intensity declined and reached a level of 232 toe/million 2010 US$ in 2015. The final energy intensity had been declining and reached a level of 165 toe/million 2010 US$ in 2015. These indicate that energy producers and consumers have started to effectively use energy by implementing energy conservation measures and greater utilisation of energy-efficient technologies.

In the BAU scenario, primary and final energy intensity is projected to decline at an average annual rate of 1.3% in 2015–2040. Primary energy intensity in 2040 will be around 166 toe/million 2010 US$ while final energy intensity will be 118 toe/million 2010 US$.

Thus, the energy intensity ratio (primary and final) is expected to improve by almost 29% in 2040 compared to 2015.

Per capita energy consumption, measured as the ratio of TPES to the total population, had been increasing since 1990, from 0.5 to 0.9 in 2015. This level of energy consumption per capita indicates improving energy access of society, which can be reflected by the electrification ratio. In 2015, the electrification ratio was around 88.5% and reached 94.8% in 2017. The government expected all households to have access to electricity by 2020.

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



Source: Author's calculations.

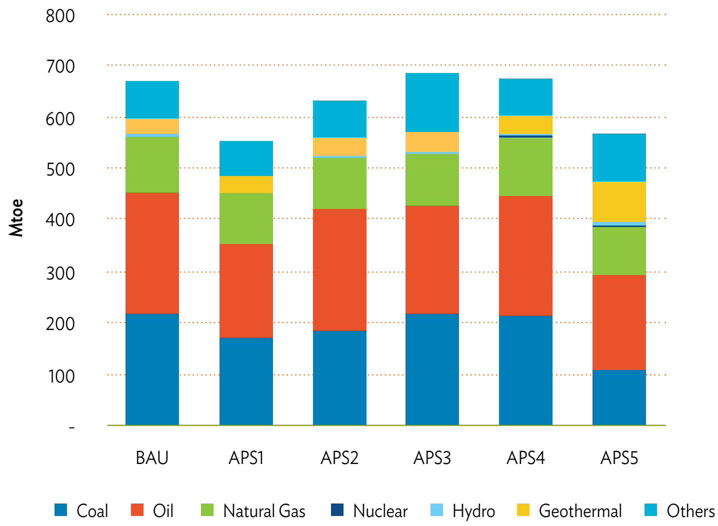
Under the BAU scenario, energy consumption per capita will continue to increase and will reach 2.1 toe per person in 2040. This result is in accordance with the existing national energy policy (2014), which targeted a level of 1.4 toe in 2025 and 3.2 toe in 2050.

In the BAU scenario, the elasticity of final energy consumption is expected to continue declining and will reach 0.8 in 2040. Elasticity lesser than 1 indicates that growth in final energy consumption will be slower than growth in GDP over the period 2015–2040.

3.2. Energy Savings and CO_2 Reduction Potential

The assumptions in the APS were analysed separately to determine the individual impact of each assumption in APS1, APS2, APS3, APS4, and the combination of all these assumptions, APS5. Figure 7.8 shows the changes in the TPES for all the scenarios.

Figure 7.8: Comparison of Scenarios of Total Primary Energy Supply by 2040



Mtoe = million tons of oil equivalent.

Source: Author's calculations.

Figure 7.8 illustrates that APS1 and APS5 have the largest reduction in primary energy supply in 2040 due to the energy efficiency assumptions on the demand side. Energy efficiency assumptions in APS1 could reduce the TPES in the BAU scenario by as much as 118 Mtoe or 17.6%. For APS5, the reduction will amount to 104 Mtoe or 15.5%.

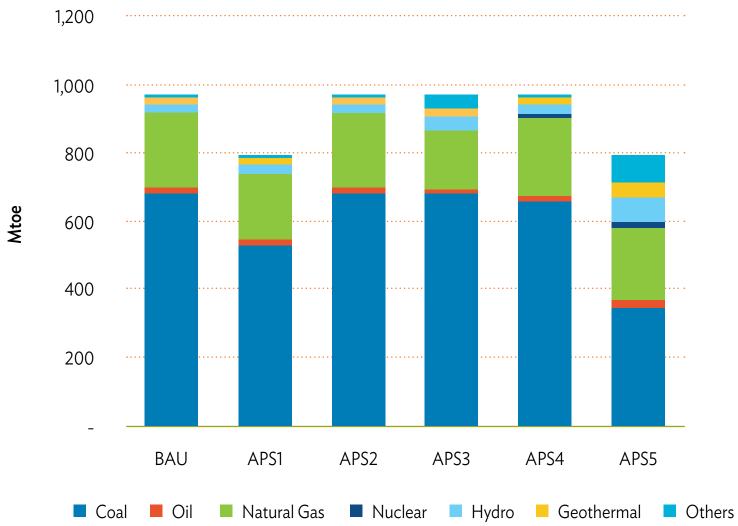
APS2, which assumes higher efficiency in thermal electricity generation, will also reduce the TPES in 2040 by 42 Mtoe or 6.2% compared to the BAU scenario. Since APS2 does not assume efficiency measures for the final sector, it will have a lower impact than APS1. Therefore, the reduction is due mainly to the use of more efficient power generation while some conventional plants ceased operation after reaching their technical lifetime.

For APS3, the TPES increased slightly as more renewable energy for power generation started operation and more biofuels were being consumed by the transport sector. The difference between APS3 and the BAU scenario for 2040 is only around 11.5 Mtoe or 1.7%.

The introduction of nuclear power generation after 2020 (APS4) will also increase the total primary energy mix of 2040 by only 1.4 Mtoe or 0.2% compared to the BAU scenario. The result indicates that the introduction of nuclear plants will reduce the consumption of fossil fuels (coal, oil, gas) in generating power. However, since the efficiency of nuclear plants is slightly lower than the average thermal efficiency of fossil fuel plants, then there can be no savings relative to the BAU scenario results.

Figure 7.9 shows the total electricity generation in 2040 in all scenarios. In APS1, due to the lower electricity demand, the shares of fossil-fired electricity generation will be lower than in the BAU scenario, 93% compared to 95%. In APS2, the share is the same as that of the BAU scenario. In APS3, due to the assumption of more renewable energy, the shares of fossil fuel–fired generation could be reduced by 5% while in APS4, nuclear energy could reduce fossil fuel share by almost 2%. In APS5, where all scenarios were combined, the reduction in the shares of fossil energy–based generation will be significant; i.e. almost 22% lower than the BAU scenario.

Figure 7.9: Comparison of Scenarios to Electricity Generation by 2040

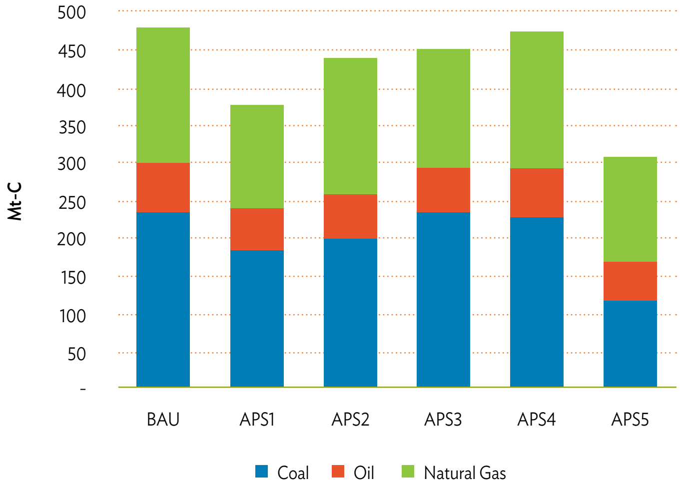


APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Author's calculations.

In terms of CO_2 emissions reduction, energy efficiency assumptions in APS1 could reduce emissions by 22% in 2040 compared to the BAU scenario. In APS2, the installation of more efficient new power plants could reduce emissions by 9%. Higher contributions from renewable energy could reduce emissions by 6% while nuclear energy could reduce emissions by 1%. All these assumptions combined (APS5) could reduce BAU scenario CO_2 emissions by 36% in 2040.

Figure 7.10: Comparison of Scenarios to CO_2 Emissions by 2040



APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mt-C = million tons carbon.

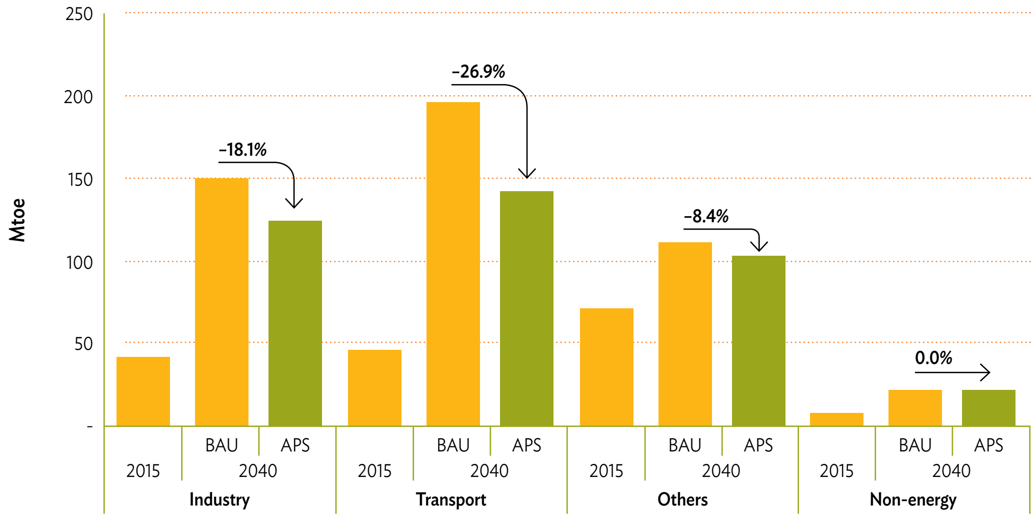
Source: Author's calculations.

3.2.1. Final energy consumption

In the combined APS (APS5), the TFEC is projected to increase at a slower rate than in the BAU scenario, increasing at an average rate of 3.5% per year from 162 Mtoe in 2015 to 388 Mtoe in 2040. Slower growth under the APS, relative to the BAU scenario, is projected across all sectors as a result of the government's EEC programme, particularly in the transport sector. The growth rate of energy demand in the transport sector is projected to increase by 4.8% per year compared with 6.1% per year in the BAU scenario. Figure 7.11 shows the TFEC by sector in 2015 and 2040 in both the BAU scenario and the APS.

Final energy consumption savings are estimated to be 27 Mtoe in the industry sector, 52 Mtoe in the transport sector, and 9.3 Mtoe in the residential/commercial ('others') sector by 2040 under the APS, relative to the BAU scenario.

Figure 7.11: Final Energy Consumption by Sector, BAU and APS (2015 and 2040)



APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

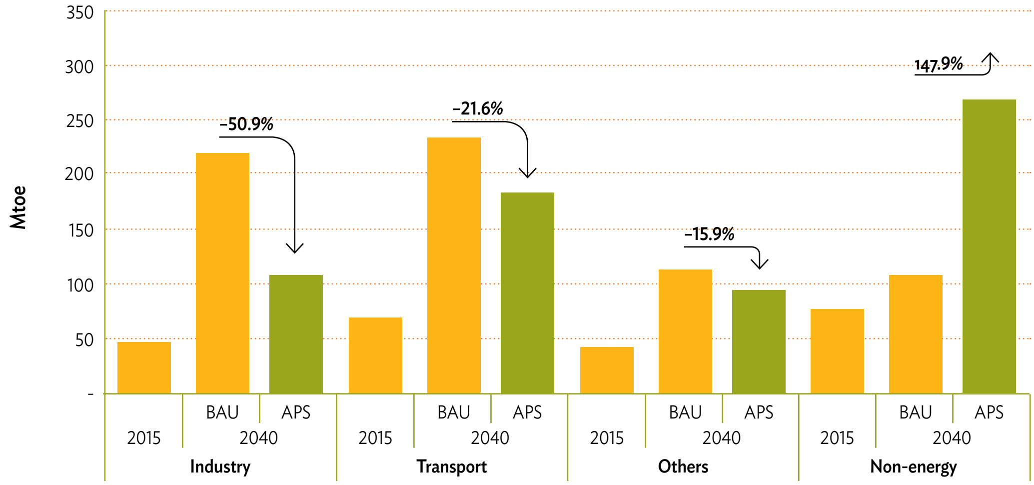
Source: Author's calculation.

3.2.2. Primary energy supply

In the combined APS (APS5), the TPES is projected to increase at a slower rate, relative to the BAU scenario, 3.7% per year to 567 Mtoe in 2040. All energy sources are projected to experience positive AAGRs. However, some will be slower than in the BAU scenario. The lower TPES relative to the BAU scenario reflects EEC measures on the demand and supply sides, with the use of more efficient technology for power generation.

In terms of fuel type, there are estimated savings of almost 111 Mtoe for coal, 50 Mtoe for oil, and 18 Mtoe for natural gas by 2040 under the APS, relative to the BAU scenario. In case of other resources (new and renewable resources, nuclear, and 'others'), the TPES in the APS in 2040 is 159 Mtoe higher than that in the BAU scenario.

Figure 7.12: Primary Energy Supply by Source, BAU and APS (2015 and 2040)



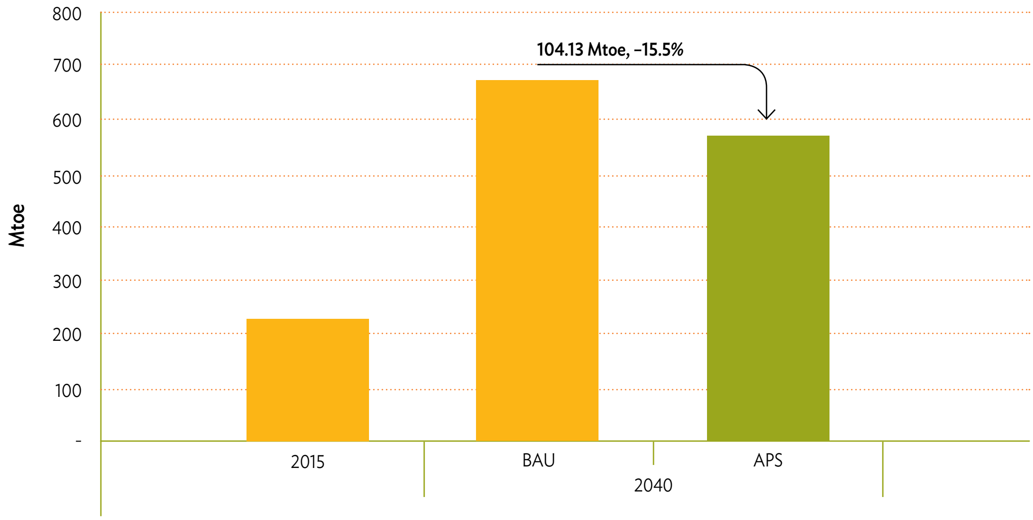
APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Author's calculations.

3.2.3. Projected energy savings

Total energy savings (the difference between the TPES in the BAU scenario and the APS) are 104 Mtoe in 2040. These could be achieved through the implementation of EEC and renewable energy targets and action plans of Indonesia, improved power plant efficiency, and introduction of nuclear energy. These are more than half of Indonesia's TPES in 2015, which is around 230 Mtoe.

Figure 7.13: Total Primary Energy Supply, BAU and APS (2015 and 2040)



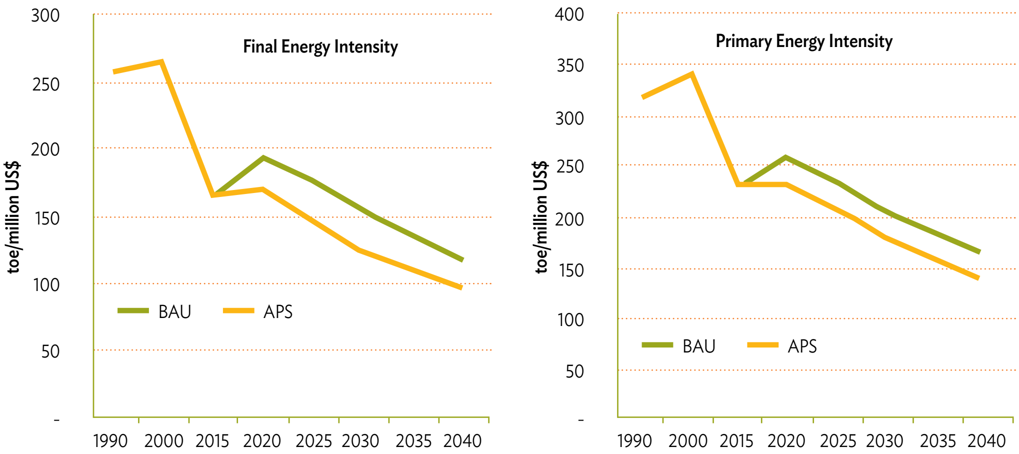
APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Author's calculation.

3.2.4. Energy intensities

The 2014 National Energy Policy emphasised the target of 1% per year reduction in final energy intensity up to 2025. Under the BAU scenario, the final energy intensity has been (and will be) on the decline at an average rate of 1.3 per year over 2015–2040. Implementation of the sectoral EEC targets under the APS will result in a faster declining rate for the final energy intensity, 2% per year over the projection period.

Figure 7.14: Energy Intensity, BAU and APS (1990–2040)



APS = Alternative Policy Scenario, BAU = Business-As-Usual, toe = tons of oil equivalent.

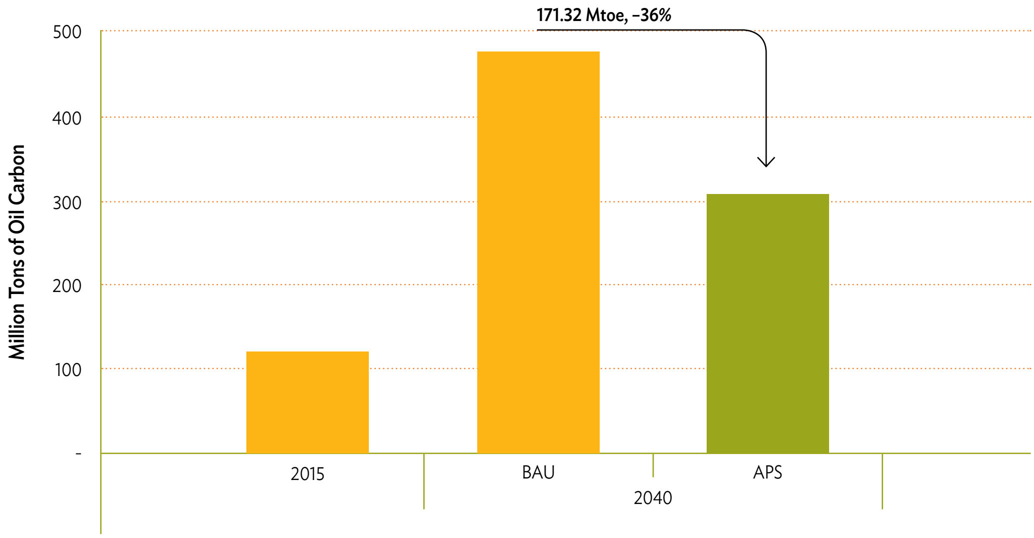
Source: Author's calculations.

In terms of primary energy intensity, the annual reduction will be similar, 1.3% under the BAU scenario. In the APS, the annual reduction in primary energy intensity will also be 2% under extensive implementation of the sectoral EEC targets.

3.2.5. CO_2 emissions from energy consumption

CO_2 emissions from energy consumption are projected to increase at an average annual rate of 5.6% from around 122 million tons of carbon (Mt-C) in 2015 to 476 Mt-C in 2040 in the BAU scenario. This is driven by the increasing use of carbon-intensive fuels, particularly the use of coal for power generation and industry, as well as oil in the transport sector.

Figure 7.15: CO_2 Emissions from Energy Consumption, BAU and APS (2015–2040)



APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Authors' calculation.

In the combined APS (APS5), the CO_2 emissions in 2015–2040 are expected to be 36% lower than in the BAU scenario. The inclusion of more energy conservation measures, higher efficiency, elevated renewable targets, and the inclusion of nuclear energy after 2020 would contribute to the reduced emissions. The government has committed to reduce CO_2 emissions in 2030 by 29% without international assistance, and 41% with international assistance. This study's result, which is 36% reduction, is above the committed target of 29%. However, to achieve the committed CO_2 reduction target of 41%, the combined target and action plan specified under APS5 must be more aggressive.

3.2.6. Review of Indonesia's Nationally Determined Contributions and APS results

Regarding climate change, Indonesia ratified the Paris Agreement through Law Number 16, year of 2016, which was submitted to the United Nations Framework Convention on Climate Change on 6 November 2016. This is a commitment amongst countries across the globe to reduce greenhouse gas (GHG) emissions. The commitment in Indonesia's NDC was to unconditionally reduce 29% of GHG emissions by 2030, and conditionally reduce up to 41% through international support. The percentage value is the sectors' reduction compared to the total BAU value of 2030. Table 7.1 shows the GHG emissions reduction target under the NDC. The CM1 is the countermeasure under the unconditional mitigation scenario, and CM2 is the countermeasure under the conditional mitigation scenario.

Table 7.1: NDC Emissions Reduction Targets for GHG

No	Sector	GHG Emissions Level 2010*	GHG Emissions Level 2030, (MtCO2e)			GHG Emissions Reduction			
		MtCO2e				(MtCO2e)		% of Total BAU	
			BAU	CM1	CM2	CM1	CM2	CM1	CM2
1	Energy*	453.2	1,669	1,355	1,271	314	398	11.0%	13.9%
2	Waste	88.0	296	285	270	11	26	0.4%	0.9%
3	IPPU	36.0	70	67	66	3	3	0.1%	0.1%
4	Agriculture	110.5	120	110	116	9	4	0.3%	0.1%
5	Forestry**	647.0	714	217	64	497	650	17.2%	23.0%
	TOTAL	**1,334.0**	**2,869**	**2,034**	**1,787**	**834**	**1,081**	**29.0%**	**38.0%**

BAU = Business-As-Usual, CM = countermeasure, GHG = greenhouse gases, IPPU = Industrial Processes and Product Use, $MtCO_2e$ = metric tons of equivalent carbon dioxide, NDC = Nationally Determined Contributions.

*Including fugitive, ** including peat fire

Source: Indonesia NDC and the Way Forward, Webinar NDC on 20 July 2017.

Based on the NDC, the energy sector is projected to emit GHG almost four times the 2010 level by 2030 if no countermeasures are taken (CM1). The sources of emissions are fuel combustion and fugitive emissions from fuel production. The industry and power generation will be the major emitters of GHG emissions in 2030. These sectors are the major consumers of coal in the country.

Based on the NDC emissions reduction target, the estimated GHG emissions reduction from energy (fuel combustion and including fugitive) will be 314 Mt-CO_2e under the CM1 condition (unconditional) and 398 Mt-CO_2e under the CM2 condition (conditional). This will be around 19% reduction and 23% reduction, respectively, from the BAU scenario emissions of the sector.

The CO_2 emissions in the current outlook will also increase almost four times over the planning period, from around 122 Mt-C (447 Mt-CO_2) in 2015 to 476 Mt-C (1,745 Mt-CO_2) in 2040 under the BAU scenario. Although slightly higher, the trend is like the NDC projection for 2010 to 2030. The CO_2 emissions under the APS for 2040 will be 1,117 Mt-CO_2, which is 12% lower than the projected level for the CM2 in the NDC. Compared to BAU, the APS will reduce the CO_2 emission by 628 Mt-CO_2, or 36% (Table 7.2). By implementing the efforts assumed under the APS (which is a combination of APS1, APS2, APS3, and APS4), the reduction in CO_2 emissions will be higher than the NDC target. These are promoting energy efficiency efforts in all final sectors, improving thermal efficiency of fossil power plants, increasing renewable shares in the transport and power sectors, and installing two units of 1,100 MW nuclear plants by 2040.

Table 7.2: CO_2 Emissions in 2030 and 2040 for BAU and APS

Fuel Type	GHG Emissions Level (Mt-CO_2)					GHG Emissions Reduction			
	2015	2030 BAU	2030 APS	2040 BAU	2040 APS	2030 (Mt-CO_2)	2040 (Mt-CO_2)	2030 (%)	2040 (%)
Coal	181	553	261	850	418	292	432	52.9	50.9
Gas	87	137	119	237	194	18	43	13.3	18.1
Oil	179	540	411	658	505	129	153	23.9	23.2
TOTAL	**447**	**1,230**	**790**	**1,745**	**1,117**	**440**	**628**	**35.8**	**36.0**

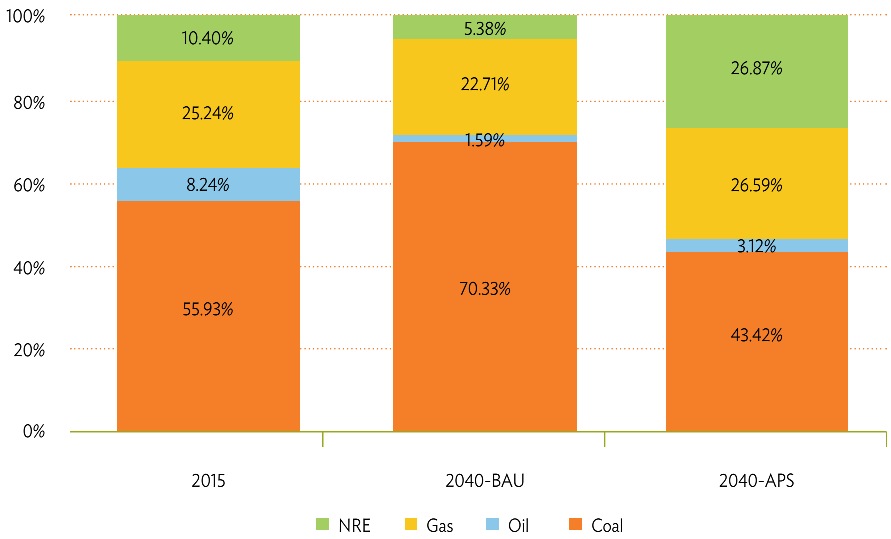
BAU = Business-As-Usual, CM = countermeasure, GHG = greenhouse gases, Mt-CO2 = metric tons of carbon dioxide.

Source: Author's calculation.

In 2030, the total CO_2 emission under the BAU scenario is around 1,230 Mt-CO_2, which is slightly below the CM2 level of the NDC. Thus, under the current outlook, the CO_2 emission level assumed for the CM2 will be achievable in 2030 under the BAU scenario assumption which are economic growth on average at 5.8% per year, average population growth of 0.8% per year, and implementation of the current energy policy which already assumed 1.3% reduction in energy intensity, and increased share of renewables including biofuels both in the transport and the power sectors as outlined in the biofuel road map.

The CO_2 emissions reduction is highest in the case of coal compared to oil and gas. Oil is mostly consumed by the transport sector and will remain dominant, despite the introduction of other alternatives to oil. Coal is mainly used in the power sector. The increasing share of NRE as outlined in the current energy policy will reduce the coal share significantly. Figure 7.16 shows the share of the different sources of energy in total electricity generation in 2040. The figure shows that the growth of electricity production from coal-fired power plants in the APS is slower than that of the NRE- and gas-based power plants. In the case of NRE-based power plants, solar- and biomass-based power generation will grow fastest, considering it was very small in 2015.

Figure 7.16: Power Generation Mix, BAU and APS (2015 and 2040)



APS = Alternative Policy Scenario, BAU = Business-As-Usual, NRE = new and renewable energy.

Source: Author's calculation.

4. Implications and Policy Recommendations

Indonesia's primary energy intensity (TPES/GDP) and final energy intensity (TFEC/GDP) have been declining as a result of greater utilisation of efficient energy technologies by both energy producers and consumers. Under the BAU scenario, the primary energy intensity declined at 1.3% per year over the projection period. Further adaptation of the sectoral target combined with the renewables' portfolio, efficient power plant technology, and introduction of nuclear energy, will enable the country's energy intensity to decline even more at 2.1% per year. The elasticity of primary energy supply is also projected to decrease to below 1.0 under the BAU scenario (0.8) and furthermore to 0.6 under the assumptions that the sectoral saving target and the other policy interventions under APS2, APS3, and APS4 are implemented fully as indicated in the combined APS (APS5) scenario.

The primary energy supply per capita is in the range of 1.7 to 2.2 toe/person for all scenarios by 2040. This is still below that of neighbouring countries like Thailand and Malaysia. The development of energy infrastructure, particularly in the remote and small island areas, will improve the electrification ratio and, hence, increase accessibility to energy.

Oil will still have the largest share in the total primary energy mix. The 2014 National Energy Policy sets the target of less than 25% in 2025, and of less than 20% in 2050. The transport sector, which is the main consumer of oil in the country, will be crucial for achieving these energy-saving targets. Government should further encourage the transport sector programme by improving the public transport system and promoting the use of alternative fuels and more efficient vehicles.

The current analysis which assumed increased use of alternative fuels and more efficient vehicles in the transport sector and efficient boilers in the industries resulted in oil consumption savings between the BAU scenario and the APS of as high as 23% in 2040.

The combined APSs (APS5) assumed implementation of programmes to achieve the sectoral energy-saving targets such as

- Promoting industrial energy efficiency through mandatory energy management for industries consuming more than 6,000 toe as mandated by Government Regulation no. 70/2009, through a system optimisation approach, and by adapting the ISO50001 as the reference for the national competent standard on energy managers.
- Saving 10% of electricity consumption through national campaigns and through regulations in the case of government buildings.
- Implementing 'Green Building' in existing and new buildings by formulating stricter legislation to improve the environment quality of buildings , and encouraging green buildings by adopting the standards in Regulation No. 02/PRT/M/2015 on Green Building issued by the Minister of Public Works and Public Housing. Both the governor of DKI Jakarta and the mayor of Bandung had already issued regulations on green buildings, Regulation No. 38/2012 and Regulation no. 1023/2016, respectively.
- Promoting the labelling and performance standards on electrical appliances in the residential sector through regulations that mandate energy efficiency labelling and minimum energy performance standards (MEPS) for appliances. Regulations are in place for compact fluorescent lamps or CFL and for air conditioning. MEPS and labelling for refrigerators, rice cookers, washing machines, water pumps, and LED lights will soon be finalised.
- Formulating funding mechanisms (private, public, or a combination of both) to promote efficient technologies and equipment. The main issue is the lack of financial support from commercial banks and other financial institutions. Provision of policies that will increase investment amounts and reduce strict collateral requirements of banks and other financial institutions is currently ongoing. In addition, policies and regulations to facilitate and support the establishment of energy-saving companies will also support funding for EEC projects.

Pursuing EEC programmes is one measure of reducing CO_2 emissions to achieve the committed target in the NDC of 29% (without international support) and 41% (with international support). Increasing the share of renewable energy sources in the supply mix, increased thermal efficiency of fossil fuel plants, and the introduction of nuclear energy, as implied in the APS, would further reduce CO_2 emissions. The assumptions in the APS will slow down CO_2 emissions compared to the BAU scenario. The reduction level is more than that targeted in the NDC for the energy sector; i.e. more than 440 Mt-CO_2 in 2030 compared to 392 Mt-CO_2 under CM2 of the NDC. Most of the reductions will come from reducing the use of coal, particularly in the power sector, and replacing it with renewable energy such as solar, hydro, and geothermal.

Both the BAU scenario and the combined APS (APS5) projected that renewable energy will play a major role in the country's energy mix. The government has implemented programmes and issued regulations to accelerate the development of renewable energy in Indonesia. The recent Ministry of Energy and Mineral Resources (MEMR) Regulation No. 50 Year 2017 provide more opportunities for the private sector to enhance the development of hydro, geothermal, PV, wind, municipal waste, biomass (agriculture estates), biogas, and ocean energy for on-grid electricity. MEMR Regulation no. 38 of 2016 provides opportunities for the private sector and local state-owned companies to develop small-scale power supply (off-grid/mini-grid) from renewable energy (mini/micro hydro, PV, etc.) to accelerate electrification in undeveloped rural, remote, border, and populated small island areas.

Through the Biodiesel Mandatory Roadmap (MEMR Regulation No. 12 of 2015), the government promotes biofuel use for non-electricity purposes, such as in the transport sector, as alternative for diesel fuel. Indonesia started Biodiesel Blending in 2008 with B2.5 then gradually increased to B5, B10, B15, and reached B20 in 2016. This mandate opens opportunities for the private sector to produce cleaner biofuel.

Further measures still need to be undertaken to attract increased private sector involvement. Examples are improving the transparency and awareness of government support mechanisms, enhancing financial institutions to participate in renewable energy projects, improving the mechanism for providing incentives to promote NRE sources, further collaborating with developed countries to promote low-carbon technologies, etc.

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