Chapter 7

Indonesia Country Report

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CHAPTER 7

Indonesia Country Report

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1. Background

Indonesia is the largest archipelagic state in Southeast Asia comprising of 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, East Timor, and Malaysia. Other neighbouring countries include Singapore, the Philippines, Australia, and the Indian territories of Andaman and Nicobar Islands.

Indonesia covers an area of nearly two million square kilometres and is the world's 16th largest country in terms of land area. According to the 2010 population census, Indonesia had 237.6 million people, making it the world's fourth most populous country. Its average population density in 2010 was 124 people per square kilometre. The population continued to increase after 2010, reaching 245.4 million in 2012, resulting in a population density of 128 people per square kilometre, and by the end of 2013 the population had reached nearly 250 million.

Indonesia's economic growth from 2010 to 2013 was around 6 percent per year. In 2012, its real GDP increased by 6.2 percent, year-on-year, reaching US$427.6 billion (constant 2005 US$), and in 2013 it reached US$452.3 billion (constant 2005 US$), growing by 5.8 percent, year-on-year.

From 1990 to 2012, GDP growth registered an average 4.9 percent per year. GDP per capita in 2012 was around US$1,730 (constant 2005 US$), a considerable improvement from 1990, when it was only US$840 (constant 2005 US$).

Indonesia is richly endowed with natural resources. It had previously been a member of the Organization of Petroleum Exporting Countries (OPEC), but the increasing demand for oil products made the country a net importer of oil. Indonesian crude oil proven reserves have declined sharply, particularly in the late 1980s – they amounted to 11.6 billion barrels in 1980, 9 billion barrels in 1988, 5.4 billion barrels in 1990, and 4.2 billion barrels in 2009, and as of January 2014 were estimated at around 3.7 billion barrels.

Indonesia is the world's largest liquefied natural gas (LNG) exporter. Its natural gas proven reserves were 2.9 trillion cubic metres (TCM) in 1990, declined slightly to 2.5 TCM in 2005, but increased to 2.9 TCM (around 103.35 trillion cubic feet) in 2012. Indonesia is also a coal exporter with proven coal reserves of around 31.4 billion tonnes at the end of 2013.

In addition to its 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 GW and the estimated geothermal potential is more than 28 GW.

Indonesia's total primary energy consumption was almost 219 Mtoe in 2012. Oil represented the largest share of primary energy consumption in 2012 at around 34.8 percent, followed by 'others' (mainly biomass) at 24.5 percent, natural gas at 18.1 percent, and coal at 14.7 percent, with the remaining share of 7.9 percent representing hydro and geothermal.

Indonesia had around 45 GW of installed electricity generating capacity and generated around 196 TWh of electricity in 2012. The state electricity company of Indonesia, PT PLN PERSERO, owns and operates generation plants with a combined capacity of about 33 GW in 2012, composed of: 27 percent oil, 35 percent coal, 25 percent gas, 11 percent hydro, and 2 percent geothermal. There are also wind and solar power plants, but the total capacity of these resources is still small.

2. Modelling Assumptions

The government expects GDP growth of 5.7 percent in 2015 and assumes it will continue to increase, to 6.6 percent in 2016 and 8 percent in 2019. The National Energy Council (DEN) assumes average annual growth of 8 percent from 2015 to 2025, and that it will slow to 7.25 percent in 2035 and 6.5 percent in 2050. Official projections are for average annual growth of around 7.6 percent from 2012 and 2035.

However, for the purpose of this study we use the projections of the International Monetary Fund and the World Bank, which assume an average annual growth rate of 5.6 percent from 2012 to 2035 period for Indonesia.

Population growth is assumed to increase at an average 0.9 percent per year between 2012 and 2035. This is based on the assumptions of the revised population projection of the Central Bureau of Statistic (BPS) and is lower than the assumption used in the previous study (1 percent per year).

The scenarios will basically be similar to those used in last year's report, i.e. the Business-as-Usual (BAU) scenario and the five Alternative Policy Scenarios (APS). These APS reflected the additional policy interventions likely to be implemented, such as energy efficiency and conservation (EEC) targets and action plans; efficiency improvements in power generation plants; more aggressive adoption of renewable energy; and introduction of nuclear energy. The current study will also analyse the impacts of these policy interventions, not only combined, but also separately.

In the case of Indonesia, the five APS considered are as follow:

a) More efficient final energy demand (APS1), with specific energy saving targets by sector (Table 7-1), were considered as the basis for analysis.

Table 7-1. Energy Conservation Potential to 2025

Sector	Energy Consumption Per Sector Year 2012 (Million BOE) *)	Potential of EC	Target of Energy Conservation Sectoral (2025)
Industry	305 (39,7%)	10 – 30%	17%
Transportation	311 (40,4%)	15 – 35%	20%
Household	92 (12%)	15 – 30%	15%
Commercial	34 (4,4%)	10 – 30%	15%
Others (Agriculture, Construction, and Mining)	26 (3,4%)	25%	-

source: Draft National Energy Conservation Master Plan (RIKEN) 2011

Note:
- exclude biomass and non-energy used
- *) temporarily data on December 2013

Source: Harris (2014), 'Energy Efficiency Implementation To Reduce GHG Emission', paper presented at the Workshop on Technology Transfer for Low Carbon Technology in Indonesia, Directorate Energy Conservation, DGNREEC, MEMR.

In addition, Article 9 of the 2014 National Energy Policy (KEN) stated that energy elasticity achievement shall be less than 1 (one) in 2025 and that the reduction in final energy intensity of 1 percent per year will be achieved up to 2025. These goals and targets have also been considered as the energy saving target for this year's study.

b) More efficient thermal power generation (APS2), where higher improvement of existing coal power plants and the introduction of cleaner coal technologies have been considered in the analysis. In addition, more efficient natural gas combined-cycle technologies were also considered for this scenario.
c) 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 are assumed compared with the BAU scenario.
d) Introduction or higher utilisation of nuclear energy (APS4), where the assumption was it will be in operation after 2020, similar to the previous study. This is in line with the current plan, which involves construction of two units after 2020, each with a capacity of 1,000 MW.
e) The combination of APS1 to APS4 constitutes the assumptions of the APS (APS5).

3. Outlook Results

3.1 Business-as-Usual Scenario (BAU)

3.1.1. Final Energy Demand

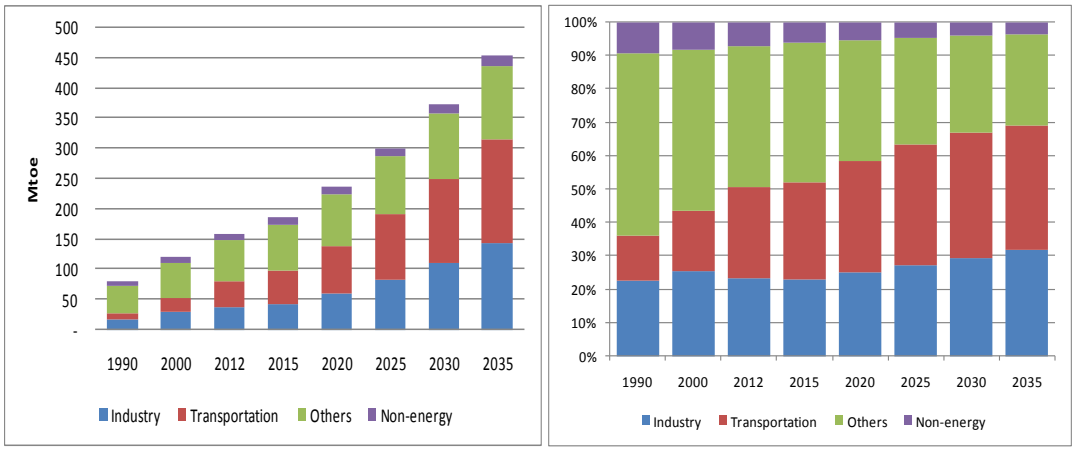
Indonesia's final energy demand increased at an average annual rate of 3.2 percent between 1990 and 2012, increasing from around 80 Mtoe to 159 Mtoe. Given the assumed economic and population growth, the growth in final energy consumption will continue, but at a faster rate of 4.7 percent per year between 2012 and 2035 in the BAU scenario.

This growth stems from the rapid increase of energy consumed in the transportation and industrial sectors. The transportation sector is still heavily dependent on oil. From 1990 to 2012, final energy demand of the transport sector grew at an average rate of 6.6 percent per year, which made it the sector with the highest growth. It is expected it will continue to grow up to 2035 under the BAU scenario, but at a slightly lower rate of 6.1 percent per year.

Final energy consumption in the industrial and other sectors (mainly consisting of the residential and commercial sectors), grew at an average rate of 3.3 percent and 2.0 percent per year, respectively from 1990 to 2012. Final energy demand of these sectors for 2012 to 2035 is projected to increase more rapidly under the BAU scenario, at an average annual growth rate of 6.06 percent and 2.7 percent, respectively.

The 'others' sector had the highest share in total final energy demand from 1990 to 2012, because of the high consumption of biomass mainly in the residential sector, but the share fell from around 55 percent in 1990 to 42 percent in 2012. It is expected that the share will continue decline as household appliances become more efficient and households increasingly use alternatives such as natural gas and LPG. The sector's share in total final energy demand will fall to 27 percent in 2035.

Figure 7-1. Final Energy Demand by Sector



Source: Author's calculation.

The transportation sector's share in total final energy demand increased from 13.4 percent in 1990 to 27.4 percent in 2012. This share will continue to increase and is expected to reach 37.5 percent in 2035. The combined share of oil and alternative fuels for transport will contribute more to the increase of the transport sector's share in total

final energy demand. Oil was the main fuel used in the transport sector, and oil consumption of the sector is expected to grow at an average rate of around 6.0 percent per year. Alternatives for oil such as biofuel will also contribute significantly, growing at an average 15.0 percent per year from 2012 to 2035.

The industrial sector's share in total final energy demand amounted to 23 percent on average from 1990 to 2012, and its share is projected to increase to 31.8 percent by 2035, in line with an expected growth in industrial activities.

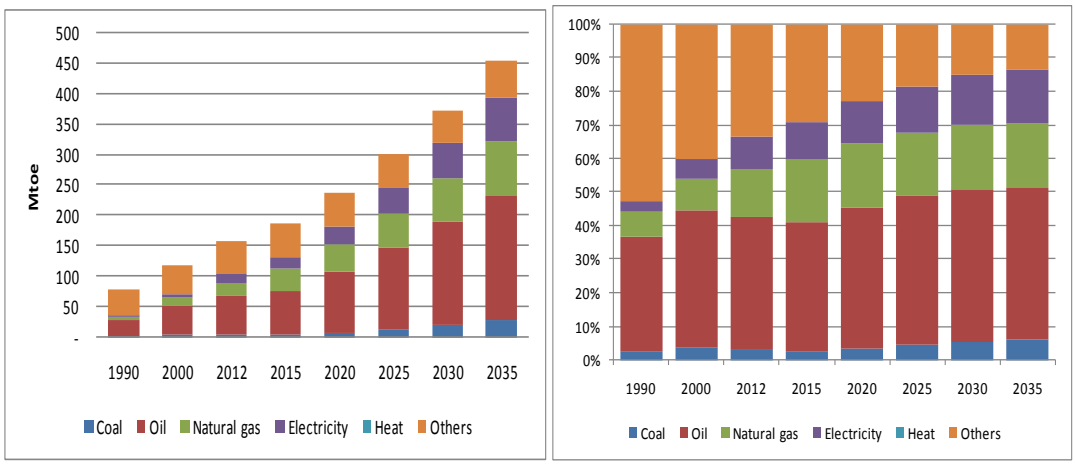
By fuel type, electricity experienced the fastest growth from 1990 to 2012, increasing at an average rate of 8.6 percent per year. This rapid growth of electricity demand was due to the significant increase in consumption of the industrial and residential sectors, from 2.4 Mtoe in 1990 to 15.1 Mtoe in 2012. The electrification ratio improved from 28 percent in 1990 to 77 percent in 2012. Coal also increased significantly over the same period as industry expanded, particularly the cement industry. Total coal demand increased from 2.1 Mtoe in 1990 to 4.7 Mtoe in 2012, growing at an average rate of 3.7 percent per year.

As for natural gas and oil, average annual growth of these fuels from 1990 to 2012 period was 6.3 percent and 3.9 percent, respectively. Demand for other fuels (mostly biomass for households) increased by around 11 Mtoe, at an average rate of 1.1 percent per year.

Demand for all fuels is projected to continue to increase. Demand for coal will grow fastest, at an average rate of 8.3 percent per year, to 29.1 Mtoe in 2035. Electricity is also expected to grow, but at a slower rate than in the past. The average annual growth rate for electricity demand is expected to be 7.1 percent per year from 2012 to 2035.

Natural gas and oil demand will grow at an average rate of 6.0 percent per year and 5.2 percent per year, respectively, between 2012 and 2035. Demand for 'other' fuels will see the slowest increase over the same period, growing at an average 0.5 percent per year. This is mainly due to a fall in the growth rate of the residential sector's biomass consumption.

Figure 7-2. Final Energy Demand by Fuel, BAU



BAU = Business-as-Usual.
Source: Author's calculation.

In terms of fuel, oil will continue to play a major role in the country's final energy demand, although more alternatives fuels will be consumed by the end-use sectors. It is expected that the share of oil will be around 45 percent in 2035, increasing from 39.7 percent in 2012. The remaining shares will be coal (6.4 percent), natural gas (19.3 percent), electricity (16.1 percent), and others (13.2 percent).

3.1.2. Primary Energy Consumption

Primary energy consumption in Indonesia grew faster than final energy demand, at about 3.7 percent per year, from 99 Mtoe in 1990 to 219 Mtoe in 2012. Amongst the major energy sources, the fastest growing fuels between 1990 and 2012 were coal and geothermal energy. Coal consumption grew at an average annual rate of 10.5 percent and geothermal energy increased at 10.1 percent a year. Gas consumption increased at a slower rate, of 4.3 percent per year, and oil consumption rose slightly more slowly, at 3.8 percent per year.

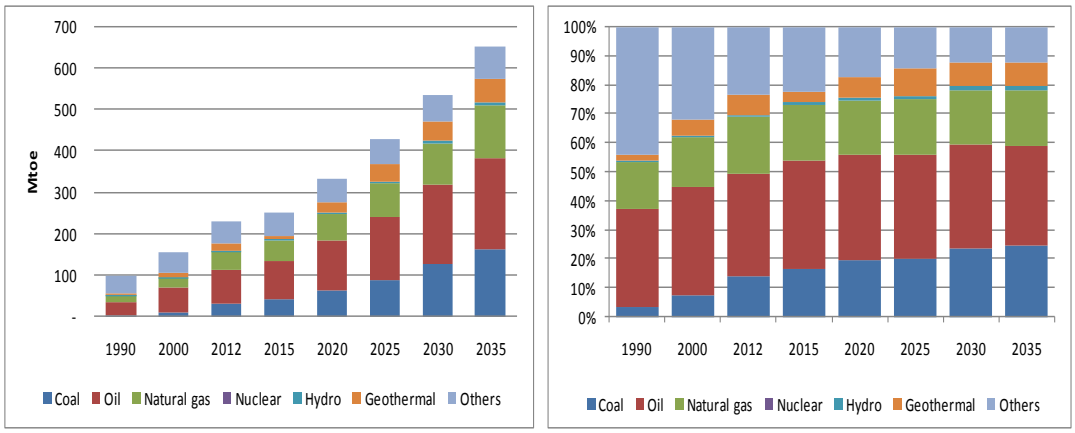
In the BAU scenario, Indonesia's primary energy consumption is projected to increase at an average annual rate of 4.8 percent, reaching 652 Mtoe in 2035. Coal is projected to continue to grow, but at a slower rate of 7.3 percent per year over the projection period. Geothermal energy is also expected to increase over the projection period, but more slowly than over the past two decades because of the difficulties of expanding exploration in protected forest areas. Exploration will also become more expensive as the areas to be explored become smaller and are increasingly located in difficult terrains, such as those in the eastern part of Indonesia. The projected growth rate of geothermal energy until 2035 is projected to be 5.4 percent per year.

Hydro, on the other hand, will increase at a faster rate, of 8.7 percent per year between 2012 and 2035, compared with the period from 1990 to 2012, as more hydro plants will be built, such as in East Kalimantan. Consideration is being given to building more run-of-the-river type hydroelectricity, rather than the reservoir type.

Oil consumption is projected to increase at an average annual rate of 4.6 percent from 2012 to 2035, and natural gas consumption is expected to increase slightly faster, at an average rate of 5.5 percent per year.

It is assumed that there will be no uptake of nuclear energy 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 7-3. Primary Energy Consumption, BAU



BAU = Business-as-Usual.
Source: Author's calculation.

From 1990 to 2012, oil constituted the largest share of total primary energy consumption, increasing from 33.8 percent to 34.8 percent. The share of natural gas in the total mix also increased slightly, from 16.0 percent in 1990 to 18.1 percent in 2012.

Since both coal and geothermal experienced rapid growth from 1990 to 2012, the shares of these energy sources in the total fuel mix increased significantly. Coal's share in the total primary energy mix increased from 3.6 percent to 14.7 percent and that of geothermal from 2.0 percent to 7.4 percent. Hydro's share remained constant. Since the 'others' – which include biomass, solar, wind, ocean, biofuels, and electricity – grew slower than the other fuels, its share declined from 44.1 percent in 1990 to 24.5 percent in 2012.

In the BAU scenario, oil's share will continue to be dominant throughout the 2012–2035 period and the share of oil in the total primary energy mix will still be just below 33 percent in 2035. The share of natural gas share will increase to 20.7 percent by the end of the projection period.

Hydro's share in the total primary energy mix will remain below 2 percent, even though hydro is projected to grow faster than geothermal.

3.1.3. Power Generation

Power generation output increased at an average rate of 8.5 percent per year over the past two decades, from 32.7 TWh in 1990 to almost 195.9 TWh in 2012. The fastest growth occurred in the production of electricity from natural gas plants, at 20.3 percent per year. This was due to the increase in gas turbine and combined cycle capacities as natural gas became increasingly more available.

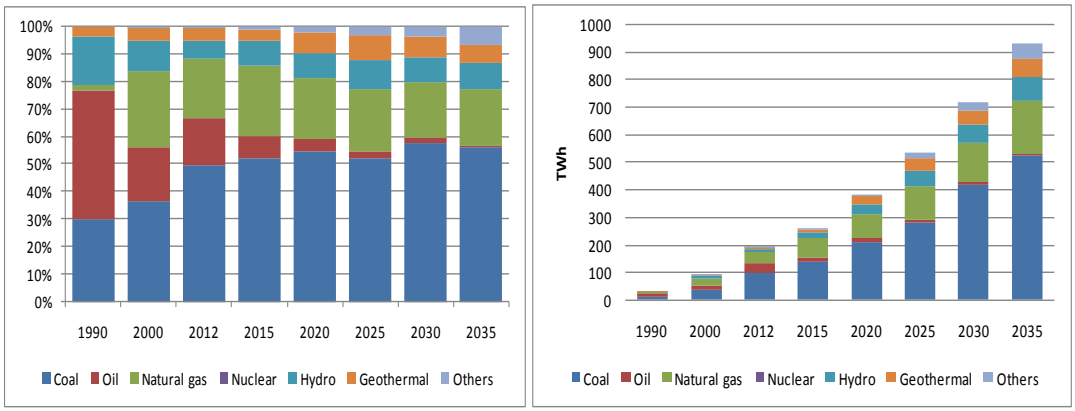
In the BAU scenario, to meet the demand for electricity, power generation is projected to increase at a slower rate, of 7 percent per year, reaching 936 TWh in 2035. This study included the electricity imports of PT PLN as implied in the General Plan of Electricity Development (RUPTL) 2015–2024. Electricity imports will increase from 758 GWh in 2015 to 1,503 GWh in 2024, and it is assumed they will remain at this level until 2035.

By type of fuel, generation from 'others' will see the fastest growth, at an average rate of 25.9 percent per year. The main reason for this very rapid growth is that generation from these other sources was very small in 2012, but is expected to increase significantly as a result of the government's policy to increase the use of new and renewable energy sources including solar PV, wind, and biomass, which are classified as 'others'.

Generation from geothermal and hydro are also growing fast, but much slower than 'others', at 8.6 percent per year and 8.7 percent per year, respectively.

Power generation from natural gas will continue to increase, but at a much slower rate, of 6.8 percent per year, and coal based power generation is projected to grow at an average annual rate of 7.6 percent. No nuclear plant is considered under the BAU scenario.

Figure 7-4. Power Generation by Type of Fuel (TWh)



Source: Author's calculation.

The share of coal will remain dominant in Indonesia's total power generation. The share of coal in total power generation was lower than oil in 1990 (29.9 percent), but it increased after that as more coal power plants were constructed, and by 2012 the share had increased to 49.9 percent, higher than that of oil. Under the BAU scenario, this share is expected to continue to increase, and by 2035 the share of coal in total power generation will be 56.1 percent.

Oil had the largest share in power generation in 1990 (46.9 percent), but by 2012 it had declined to 16.8 percent, as production from coal and natural gas plants increased rapidly. The share of natural gas reached 21.8 percent in 2012, but will decrease slightly, to 20.8 percent in 2035 under the BAU scenario.

Hydro also an important role in Indonesia's overall electricity production, its share amounting to 17.5 percent in 1990, but by 2012 it had declined to 6.5 percent. Under the BAU scenario, hydro's share is expected to increase to 9.4 percent in 2035.

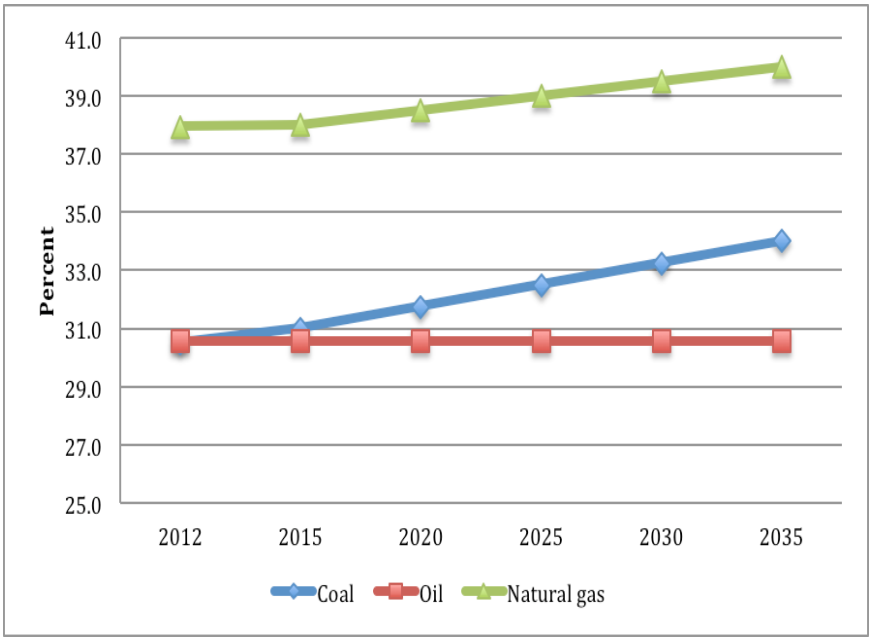
The shares of geothermal and other renewables together constituted about 5 percent of total power generation in 2012. The role of these renewables is expected to increase significantly and their combined share is projected to increase to 13.2 percent by 2035.

The average thermal efficiency of fossil fuel-based power plants was 32.1 percent in 2012. In the BAU scenario, it was assumed that the efficiency of coal and natural gas power plants will increase to 35.4 percent in 2035.

By fuel, coal power plants' thermal efficiency is projected to increase from 30.5

percent in 2012 to 34 percent in 2035 and natural gas is assumed to increase from 37.9 percent to 40.0 percent. Oil will remain below 31 percent over the 2012–2035 period.

Figure 7-5. Thermal Efficiency, BAU



BAU = Business-as-Usual.
Source: Author's calculation.

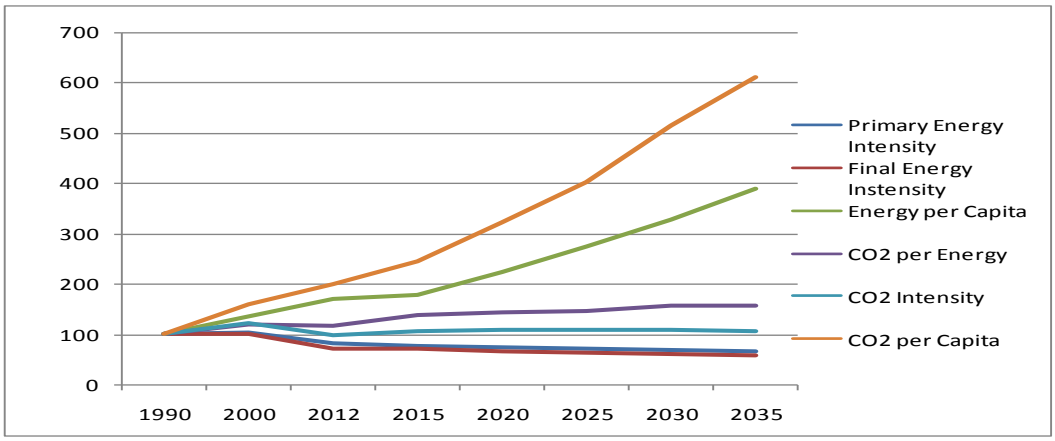
3.1.4. Energy Indicators

As a developing country, Indonesia's primary energy intensity (TPES/GDP) had been increasing up until 2000. Since then, it has declined and reached a level of 513 toe/million 2005 US$ in 2012. Similarly, final energy intensity declined and reached a level of 372 toe/million 2005 US$ in 2012. These figures are an indication that energy producers and consumers have started to use energy more effectively through the implementation of energy conservation measures and greater utilisation of efficient energy technologies.

In the BAU scenario, primary and final energy intensity are projected to decline at an average annual rate of 0.7 and 0.9 percent, respectively, from 2012 to 2035. Primary energy intensity in 2035 is expected to be around 437 toe/million 2005 US$ and final energy intensity 305 toe/million 2005 US$. Thus, the energy intensity ratio is expected to improve by almost 19 percent (primary) and 18 percent (final) in 2035 compared with 2012.

Per capita energy consumption, measured as the ratio of total primary energy consumption to total population, increased from 0.55 in 1990 to 0.89 in 2012. This level of energy consumption per capita is an indication that people's energy access improved. The electrification ratio was around 77 percent in 2012 and increased to 84.3 percent in 2014, indicating that around 16 percent of households still have no access to electricity. The main reason is that there is still a lack of energy infrastructure development, particularly in the remote areas and the outer islands due to the high investment cost.

Figure 7-6. Energy Intensity and Other Energy Indicators (1990=100)



Source: Author's calculation.

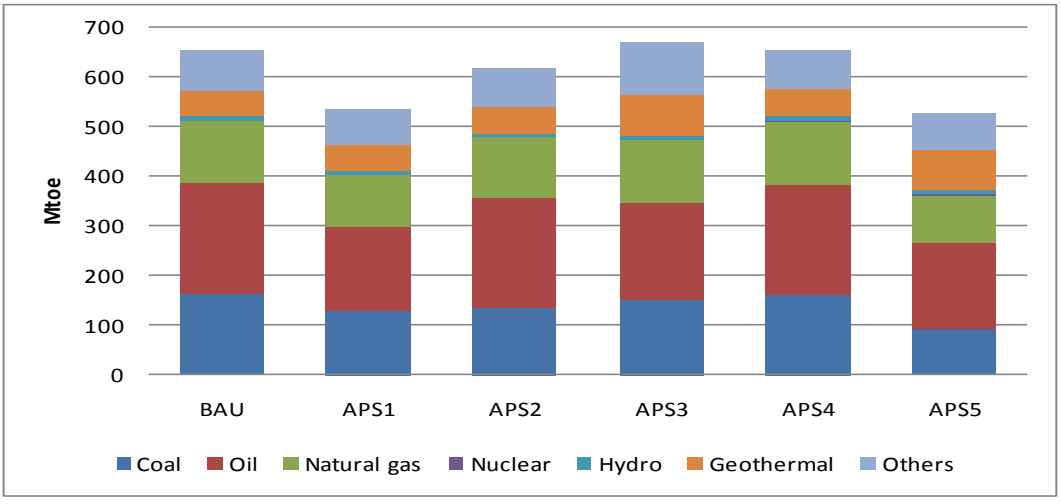
Under the BAU scenario, energy consumption per capita will continue to increase and will reach 2.14 toe per person in 2035. This result is in accordance with the existing national energy policy (2014), which targeted a level of 1.4 TOE in 2025 and 3.2 TOE in 2050.

In the BAU scenario, the elasticity of final energy consumption is expected to continue to decline and reach 0.84 in 2035. Elasticity below 1.0 is an indicator that growth in final energy consumption will be slower than growth in GDP from 2012 to 2035.

3.2. Energy Saving and CO_2 Reduction Potential (APS)

As mentioned above, the assumptions in the APS were analysed separately to determine the individual impacts of each assumption in APS1, APS2, APS3, APS4, and the combination of all these assumptions, APS5. Figure 7-7 shows the changes in total primary energy supply in all the scenarios.

Figure 7-7. Total Primary Energy Supply, All Scenarios, 2035



BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

In Figure 7-7, APS1 and APS5 have the largest reduction in total primary energy supply due to the energy efficiency assumptions on the demand-side. Energy efficiency assumptions in APS1 could reduce total primary energy supply in BAU by nearly as much as 119 Mtoe or 18.2 percent.

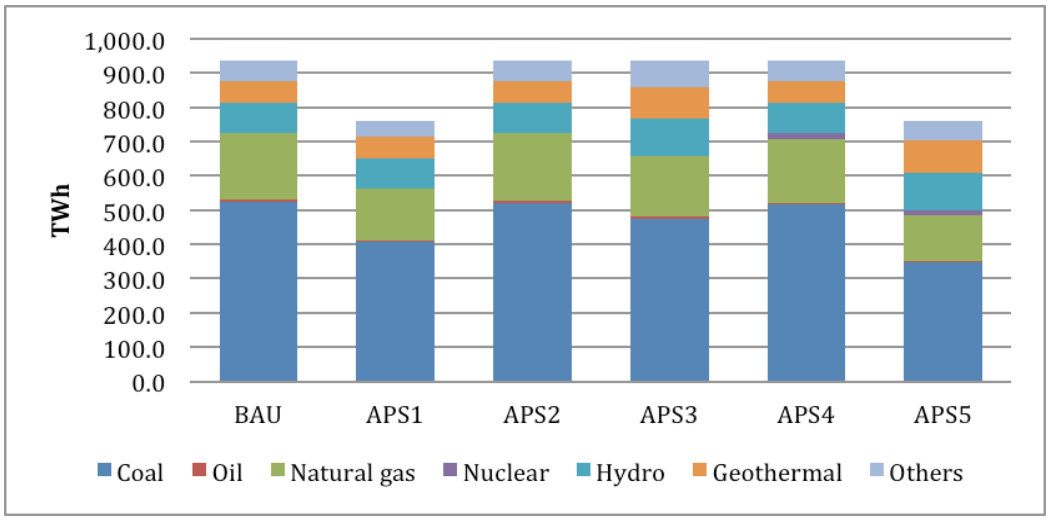
APS2, which assumes higher efficiency in thermal electricity generation, will also reduce total primary energy supply in 2035 by 31.7 Mtoe or 4.9 percent, as compared with the BAU scenario. Under APS2, no efficiency measures were assumed for the final sector, so its impact will be lower than APS1. Therefore, the reduction is due mainly to the use of more efficient power generation, with some of the conventional plants ceasing operations having reached the end of their technical lifetime.

For APS3, the total primary energy supply will increase slightly as more renewable energy for power generation will be used and more biofuels will be consumed in the transportation sector. The difference between APS3 and the BAU scenario for 2035 is 17.4 Mtoe or 2.7 percent.

The introduction of nuclear power generation after 2020 (APS4) will increase the total primary energy mix in 2035, but only by 2.7 Mtoe or 0.4 percent compared with BAU. The result indicates that the introduction of nuclear plants will reduce consumption of fossil fuels (coal, oil, gas) in generating power. However, considering the efficiency of nuclear plants is slightly lower than the average thermal efficiency of fossil plants, there may be no savings relative to the BAU results.

Figure 7-8 shows total electricity generation in 2035 in all scenarios. In APS1, due to the lower electricity demand, the shares of fossil-fired electricity generation were lower than in the BAU scenario – 74.0 percent compared with 77.6 percent. In APS2, the share is the same as that of BAU. In APS3, due to the assumption of more renewable energy, the shares of fossil fuel-fired generation could be reduced by 7.5 percent, and in APS4 nuclear energy could reduce the fossil fuel share by 2 percent. In APS5, where all scenarios are combined, the reduction in the shares of fossil energy-based generation will be significant, i.e. almost 13.8 percent lower than under the BAU scenario.

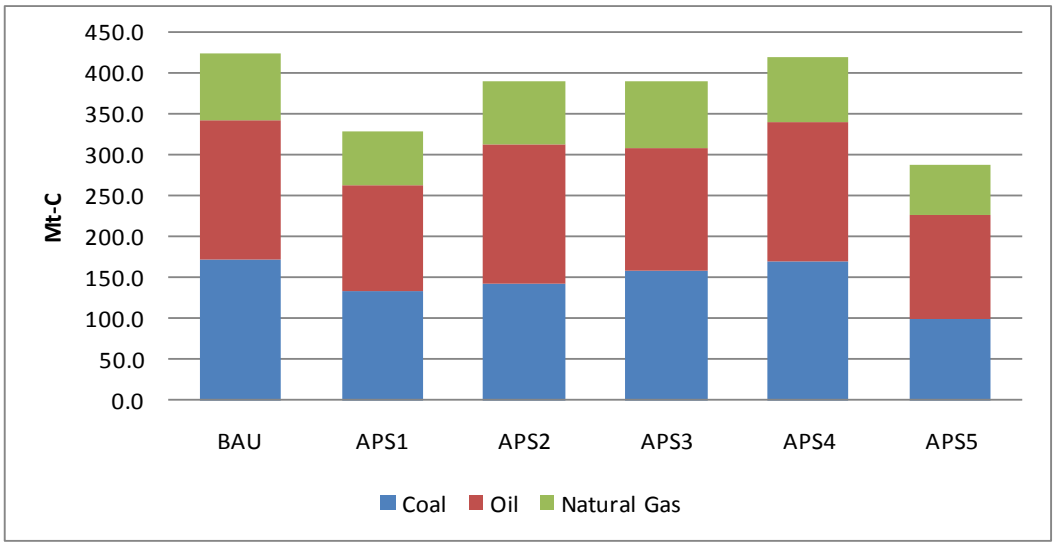
Figure 7-8. Electricity Generation, All Scenarios, 2035



BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

In terms of CO_2 emission reduction, the energy efficiency assumption in APS1 could reduce emissions by 22.7 percent in 2035 compared with the BAU scenario. In APS2, the installation of more efficient new power plants reduces emissions by 7.9 percent. Higher contributions from renewable energy could reduce emissions by 8.4 percent and nuclear energy could reduce emissions by 0.9 percent. All these assumptions combined (APS5) could reduce BAU CO_2 emissions by 32.3 percent in 2035.

Figure 7-9. CO_2 Emission, All Scenarios, 2035



BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

3.2.1. Final Energy Demand

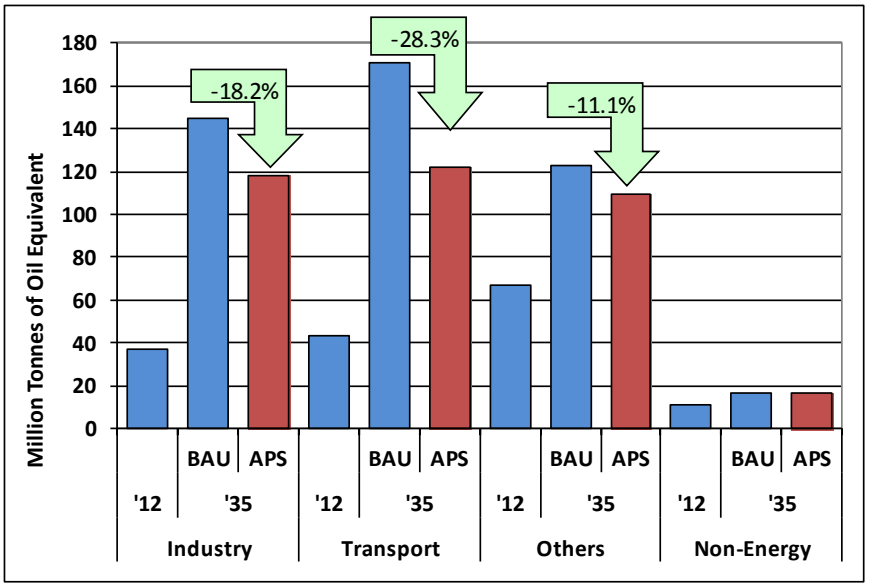
In the combined APS (APS5), final energy demand is projected to increase at a slower rate than in the BAU scenario, increasing at an average rate of 3.7 percent per year from 159 Mtoe in 2012 to 367 Mtoe in 2035. Slower growth under the APS, relative to the BAU scenario, is projected across all sectors as a result of the government programme for energy efficiency and conservation, particularly in the transport sector. Growth of energy demand in the transport sector is projected to increase by 4.6 percent per year compared with 6.1 percent per year under the BAU scenario. Figure 7-10 shows final energy demand by sector in 2012 and 2035 under the BAU scenario and APS.

In terms of final energy consumption savings, saving of almost 26 Mtoe are expected in the industry sector, savings of nearly 48 Mtoe in the transport sector, and of around 14 Mtoe in the residential/commercial (other) sector by 2035 under the APS, relative to the BAU scenario.

3.2.2. Primary Energy Consumption

In the combined APS (APS5), primary energy consumption is projected to increase at a slower rate relative to the BAU scenario, at 3.9 percent per year, to 525.2 Mtoe in 2035. All energy sources are projected to experience positive average annual growth rates, but some of these will be lower than under the BAU scenario. The lower consumption relative to the BAU scenario reflects energy efficiency and conservation measures on the demand side and the supply, with the use of more efficient technology for power generation.

Figure 7-10. Final Energy Demand by Sector, BAU and APS



BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

In terms of the fuel type, a saving of 68.1 Mtoe is estimated for coal, a saving of almost 51.6 Mtoe for oil, and around 31.6 Mtoe for natural gas by 2035 under the APS, relative to the BAU scenario. In case of other resources (new and renewable resources, nuclear, and others) the APS consumption in 2035 is 17.8 Mtoe higher than under the BAU scenario.

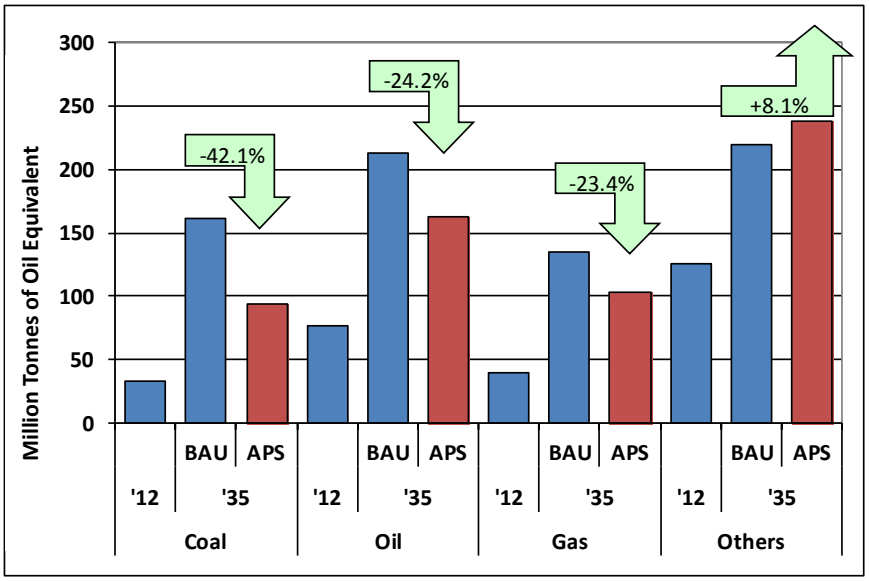
3.2.3. Projected Energy Savings

The total energy savings (the difference between primary energy demand in the BAU scenario and the APS) that could be achieved through the implementation of EEC and renewable energy targets and action plans of Indonesia, improved power plant efficiency, and the introduction of nuclear energy, amount to 126.4 Mtoe in 2035. This is more than a half of Indonesia's primary energy consumption in 2012, which was around 219 Mtoe.

3.2.4. Energy Intensities

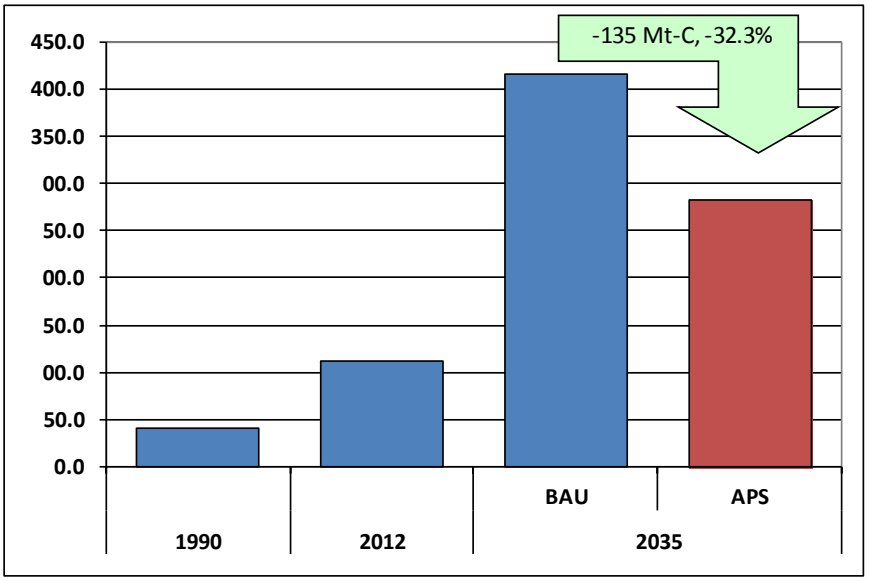
The 2014 national energy policy emphasised the target of a 1 percent annual reduction in final energy intensity up to 2025. Under the BAU scenario, the final energy intensity will decline at an average rate of 0.86 per year from 2012 to 2035. This indicates that further extensive implementation of the sectoral EEC targets under the APS will result in a faster declining of final energy intensity – 1.8 percent per year over the projection period.

Figure 7-11. Primary Energy Demand by Source, BAU and APS



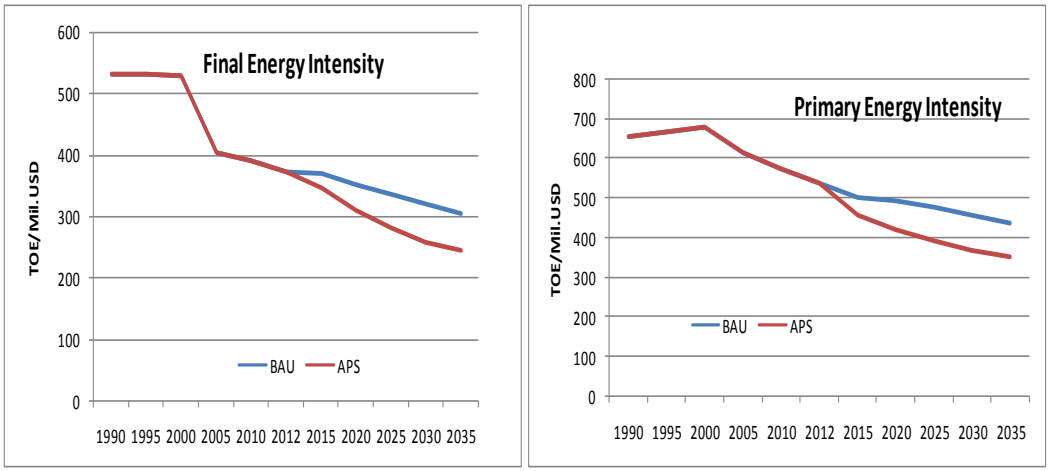
BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

Figure 7-12. Total Primary Energy Demand, BAU and APS



BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

Figure 7-13. Energy Intensity, BAU and APS



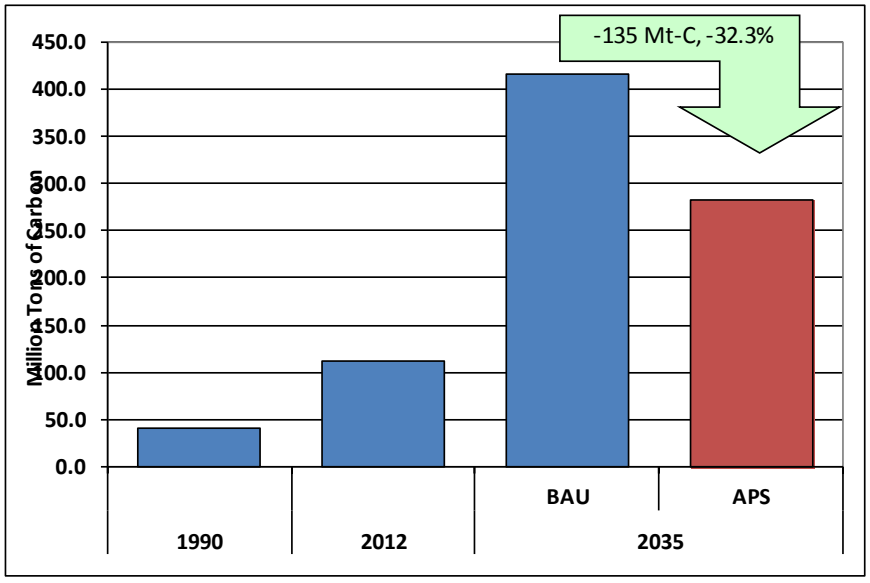
BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

In terms of primary energy intensity, the annual reduction will be 0.7 percent under the BAU scenario and 1.6 percent in the APS, due to extensive implementation of the sectoral EEC targets under the latter scenario.

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 5.9 percent, from around 111.1 Mt-C in 2012 to 417.2 Mt-C in 2035 in the BAU scenario. This will be driven by an 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 7-14. CO_2 Emissions from Energy Combustion, BAU and APS



BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

In the combined APS (APS5), CO_2 emissions from 2012 to 2035 are expected to be 32.3 percent lower than under the BAU scenario. Contributory factors to this reduction of CO_2 are more energy conservation, higher efficiency, and elevated renewable targets assumed in the APS, and the inclusion of nuclear energy after 2020. The government has committed to reduce CO_2 emissions by 2025 by 26 percent without international assistance and by 41 percent with international assistance. This study result is above the committed target of 26 percent. However, to achieve the committed CO_2 reduction targets of 41 percent, the combined target and action plan specified under APS5 would not be sufficient, and must be more aggressive, therefore.

4. Implications and Policy Recommendations

Indonesia's primary energy intensity, total primary energy supply per unit of dollar GDP (TPES/GDP), and final energy intensity, total final energy consumption per unit of dollar GDP (TFEC/GDP), have been declining as a result of greater utilisation of efficient energy technologies both by energy producers and consumers. Under the BAU scenario, final energy intensity declined at an average 0.86 percent per year over the projection period, which nearly achieved the 1 percent goal stated in the 2014 National Energy Policy. Adopting the sectoral target under APS1 combined with the renewable portfolio, efficient power plant technology, and introduction of nuclear, will allow the country's energy intensity to decline further, at 1.8 percent per year. The elasticity of final energy consumption is also projected to decrease to below 1.0 under the BAU scenario (0.84), and further, to 0.7, 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).

Primary energy consumption per capita is in the range of 1.7 to 2.2 toe/person for all scenarios by 2035. This is still lower than neighbouring countries like Thailand and Malaysia, and there are still people without access to energy, as indicated by the electrification ratio of 84.3 percent in 2014. Development of energy infrastructure, particularly in the remote and small island areas will improve the electrification ratio, and hence increase access to energy.

Oil will continue to have the largest share in the total primary energy mix. The 2014 National Energy Policy sets a target of less than 25 percent in 2025 and less than 20 percent in 2050. The transport sector, which is the main consumer of oil in Indonesia, will be crucial for achieving these energy saving targets. The government should further encourage the transport sector programme through:

- Removing oil subsidy;
- 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, more efficient vehicles in the transport sector, and more efficient boilers in the industrial sector, resulted in savings of oil consumption between the BAU scenario and the APS as high as 27 percent in 2035. Developed countries in the region, such as Japan and Australia, should increase efforts to introduce newly improved technologies to developing countries as early as possible.

The combined APS (APS5) assumed implementation of programmes for achieving the sectoral energy saving targets. In this regards, the following measures will be necessary:

- Enhance policy to move away from subsidies, but with the option of assisting low-income households. This includes restructuring of electricity tariffs towards a more market-based electricity pricing mechanism.
- Better enforcement of regulations on EEC in the industrial sector.
- Encourage revitalisation programmes of industries to improve performance of boilers, burners, etc.
- Expand labelling and performance standards on appliances in the residential sector.
- Develop a regulatory framework to increase participation of the private sector and Energy Service Companies (ESCOs) in EEC.
- Formulate a funding mechanism to develop efficient technologies and equipment.
- Increase public awareness of EEC.

Pursuing energy efficiency and conservation programmes are some of the measures needed to reduce CO_2 emission to achieve the committed target of 26 percent (without international support) and 41 percent (with international support). Increasing the share of renewable energy sources in the supply mix, increasing thermal efficiency of fossil fuel plants, and introduction of nuclear energy, would result in further reductions in CO_2 emissions.

Both the BAU scenario and the combined APS (APS5) projected that renewable energy will have a major part in the country's energy mix. Efforts to enhance renewable energy have been undertaken by the government, such as inclusion of geothermal and hydro resources in the second crash programme for the acceleration of a 10,000 MW power development; domestic obligation (DMO) on biofuels; provision of Feed-in-Tariff (FIT) for geothermal, solar, hydro, and biomass power generation; finalisation of the FIT for wind energy sources; and fiscal incentives to promote renewable energy development, etc. Nonetheless, further measures, also to attract greater private sector involvement, need to be taken, such as increasing the transparency and awareness of government support mechanisms, enhancing financial institutions to participate in renewable energy projects, and further improving the existing revolving fund for geothermal and expand it to other renewable energy sources.