## 1.2. Indonesia

Comprised of 17,508 islands that stretch over 5,000 kilometres, Indonesia's large and diverse population was 258 million in 2016 (BPS, 2017). Population growth in 2014 was 1.35%, but it is expected to slow in the future as the Government of Indonesia resumes its national family planning programme. The gross domestic product (GDP) is estimated at US$878.3 billion in 2014 (BPS, 2017), with the economic activity tending to focus in the Java–Bali region where the majority of the population live. The size of its economy is currently the largest in Southeast Asia with a steady annual growth rate of 4%–6% in the past decade (BPS, 2017).

The country is transitioning from a commodities export economy (majority oil and gas based) into one supported by domestic manufacturing and investment, particularly after becoming a net oil importer in 2004. With a steadily growing economy, it is important for Indonesia to harness and manage sustainable sources of energy. The Ministry of Energy and Mineral Resources (MEMR) therefore forecasts that energy demand will grow by around 7% per year, with electricity demand alone projected to nearly triple between 2010 and 2030 (Center for Data and Information Technology MEMR, 2015).

### *1.2.1. Current Energy Policy*

Indonesia's National Action Plan (RAN-GRK), as stipulated in Presidential Regulation No. 61/2011, is based on the National Long-Term Development Plan (RPJMN) from 2010, long before the 21st session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21) in Paris in 2015. Therefore, the Government of Indonesia (2017) issued Presidential Regulation No. 22/2017 – or the so-called RUEN (General Planning for National Energy) – which not only focuses on emissions reductions but also comprehensively deals with infrastructure development in line with the dynamics of world climate change policy up to the years 2025 and 2050.

The recent RUEN regulation refers to the National Energy Policy (Kebijakan Energi Nasional, or KEN) in Government Regulation No. 79/2014. Within the KEN, the optimum target of new and renewable energy is set at 23% in 2025 and 31% in 2050. The new RUEN also aims to reduce the dependency on oil in the transportation sector to 83.5% in 2025 and 72.9% in 2015. This would be achieved by utilising more biofuel and natural gas and by encouraging the use of hybrid and electric vehicles through removal of the import duty on such vehicles. In addition to diversification of transport fuel, the RUEN also suggests various measures to build more public transport infrastructure such as high-speed railways and to develop a fuel economy standard for private vehicles before 2020.

To boost new and renewable energy penetration in the electricity sector, the MEMR issued Regulation No. 12/2017 on the Utilization of Renewable Energy Resources for Electricity Supply, which was further amended in MEMR Regulation No. 50/2017. The new regulations prescribe power purchase prices for all existing renewable energy (RE) types such as solar photovoltaic (PV), wind, hydropower, biomass, biogas, municipal waste, and geothermal. It uses the basic cost of electricity supply (CES) from the regional PLN (State Electricity Corporation) as its new reference price. These regulations obligate PLN to purchase power from RE plants at a maximum

value of 85% of the regional CES and business-to-business agreements in areas where the regional CES is lower than the national CES (see Table 2.1.2-1).

**Table 2.1.2-1 Electricity Purchase Tariff from Renewable Energy Plants (Government of Indonesia, 2017)**

| RE Type | Purchasing Method | Tariff | |
|---|---|---|---|
| | | **Regional CES > National CES** | **Regional CES ≤ National CES** |
| **Biogas** | Reference price (for ≤ 10 MW) | Maximum 85% x regional CES | 100% x regional CES |
| | Direct selection (for > 10 MW) | Price determined by direct selection process | |
| **MSW** | Reference price | Maximum 100% x regional CES | Mutual agreement |
| **Geothermal** | Reference price | Maximum 100% x regional CES | Mutual agreement |
| **Solar PV** | Auction based on award capacity | Maximum 85% x regional CES | 100% x regional CES |
| **Wind** | Auction based on award capacity | Maximum 85% x regional CES | 100% x regional CES |
| **Hydro** | Reference price | Maximum 85% x regional CES | 100% x regional CES |
| | Direct selection | Price determined by direct selection process | |
| | Reference price (for ≤ 10 MW) | Maximum 85% x regional CES | 100% x regional CES |
| | **Direct selection (for > 10 MW)** | **Price determined by direct selection process** | |

CES = basic cost of electricity supply, MSW = municipal solid waste, MW = megawatt, PV = photovoltaic, RE = renewable energy.
Source: Ministry of Energy and Mineral Resources (2017), MEMR Regulation No. 12/2017.

Related to the above regulation, the Minister of Energy and Mineral Resources issued the reference CES through MEMR Decision No. 1404 K/20/MEM/2017. The government set the national CES at Rp983 (US$0.0739) per kilowatt-hour (kWh) for 2016, down from the purchasing reference by PLN for the period 1 April 2017 to 31 March 2018 (Wulandari, 2017).

As regards the oil and gas business, the government has issued two regulations. The first one is Government Regulation No. 27/2017 to revise Government Regulation No. 79/2010 on operating costs and income tax in the upstream oil and gas business. The second is MEMR Ministerial Regulation No. 52/2017 to govern the gross split mechanism for the national upstream oil and gas business. The cost recovery that usually becomes the burden of the state budget is eliminated, and all operating costs are borne by the contractor. The government meanwhile still owns the country's natural resources, with SKK Migas as the operations

regulatory control body. The gross split uses a base split mechanism based on variable components and progressive components. Variable components include work area status, field location, reservoir depth, availability of supporting infrastructure, as well as $CO_2$ and $H_2S$ content. The progressive components comprise the price of petroleum, price of natural gas, and the cumulative amount of oil and gas production. The initial profit sharing for petroleum is 57% government and 43% contractors; as for natural gas, it is 52% government and 48% contractors. These two regulations in 2017 are expected to encourage efficiency and simplification of contractor administration and management for better performance as well as to improve the investment, and to provide legal certainty to the upstream oil and gas business activities.

*1.2.2. Energy Balance*

As shown in Table 2.1.2-2, Indonesia's total primary energy supply in 2016 was about 1,556 million barrels of oil equivalent (BOE). Most of it comes from fossil fuels: oil, coal, and gas. The share of other RE resources in the energy mix was below 9%: mostly hydropower (2.1%), geothermal power (1.1%), and biofuel (6.1%).[1] The biofuel is in the form of biodiesel blended with automotive diesel oil at 15% volume or popularly known as B15. The intention of the Indonesian government to introduce the biofuel in a blended form with corresponding fossil fuel was to maximise biofuel penetration to the market while avoiding customer preference toward the use of fossil fuel. The use of traditional biomass meanwhile has been prevalent for basic cooking and thermal purposes amongst millions of rural households. This accounts for about 20% in the primary energy supply of the country.

**Table 2.1.2-2 Energy Indicators of Indonesia**

| | Unit | 2015 | 2016 |
|---|---|---|---|
| Total primary energy supply | million BOE | 1,553 | 1,556 |
| Oil | % | 35.25 | 35.19 |
| Coal | % | 23.47 | 23.43 |
| Gas | % | 18.00 | 17.97 |
| Hydropower | % | 2.27 | 2.27 |
| Geothermal | % | 1.05 | 1.05 |
| Biomass | % | 19.93 | 20.06 |
| Biofuel | % | 0.04 | 0.04 |
| **Final energy consumption** | million BoE | 1,143 | 1,058 |
| Final commercial energy consumption (excl. biomass and non-energy use) | million BoE | 756 | 691 |
| Industry | % | 34.97 | 30.88 |
| Household | % | 14.62 | 16.62 |
| Commercial | % | 5.44 | 5.80 |
| Transportation | % | 40.63 | 43.89 |
| Other | % | 4.34 | 2.81 |
| Electrification ratio | % | 88.3 | 91.16 |
| Electricity consumption | million BOE | 124.3 | 132.4 |

BOE = barrel of oil equivalent.

Note: Temporary data for the year 2016.

Source: The data were collected from Center for Data and Information Technology MEMR (2017).

[1] Note that the share of biofuel here is misleading as it is in the form of B15 blend.

Indonesia's final energy consumption in 2016 reported by the MEMR was 1,058 million BOE with commercial energy use (excluding biomass and non-energy use) of about 691 million BOE. This figure has increased by nearly 50% since 2001. The share of this final commercial energy consumption is dominated by the transportation sector (43.89%), followed by the industry sector (30.88%), the household sector (16.62%), commercial use (5.80%), and other sectors (2.81%).

Total electricity consumption amounted 132.4 million BOE or 225,000 gigawatt-hours (GWh), mostly in the household sector, followed by the industry and commercial sectors. In the transportation sector, in contrast, the majority utilises oil as fuel products and much less electricity. The industry sector, apart from being a large consumer of electricity, mainly uses natural gas, oil, some coal, and biomass. The reduction of fossil fuel in the transportation sector and the use of traditional biomass are therefore necessary and feasible given the potential wealth of Indonesia's RE sources as presented in the following section.

*1.2.3. Energy Resources*

Indonesia's energy potential is diverse as it comprises oil, natural gas, coal, and renewables. Fossil energy in particular has been the driving force of economic growth in Indonesia. The coal reserve is about 120.5 billion tonnes; proven oil resources are at around 3.69 billion barrels and proven natural gas reserves at around 101.54 trillion cubic feet (tcf). This translates into 23 remaining years of oil reserves, 59 years of gas, and 146 years of coal at current production rates. Moreover, there is still abundant energy potential in the form of nonconventional gas such as coal bed methane (CBM) and shale gas.

Indonesia's RE sources are also considerable. Aside from holding 40% of the world's geothermal reserves (28,000 megawatts [MW]), the country also has significant potential for hydropower (75,000 MW), micro/mini hydropower (1,013 MW), solar (4.80 kWh/$m^2$/day), biomass (32,654 MW), and wind (3–6 m/s) (MEMR, 2004). Although relatively small in amount, uranium deposits are found in the Kalan region of Kalimantan.

Regarding the oil resources, Indonesia's fields are now depleting, discovery is slowing, and recovery is increasingly expensive. The MEMR estimated only 3.31 billion barrels of proven reserves in 2016. Crude oil production has been decreasing from 1.1 million barrels of oil per day (bpd) in 2004 to about 821.000 bpd in 2016. In the downstream oil business, Pertamina continues to dominate refining business, crude and fuel import, and other petroleum product supplies to the domestic market even after its monopoly over the retail market ended in 2004. In the upstream oil sector, however, Chevron is the largest domestic crude and condensate producer in Indonesia, followed by Pertamina and several international oil companies such as Total, Conoco Phillips, Exxon, and BP.

Indonesia consumed 1.48 million bpd of oil in 2015 for its domestic energy needs. This dependency, coupled with decreasing oil production, made Indonesia a net oil importer in 2004. Crude oil imports and refined products such as gasoline and transport diesel come are from Saudi Arabia, Malaysia, Nigeria, and Australia. The domestically refined output generally supplies the domestic market but only meets 70% of demand. As Indonesia exports its premium low sulphur

crude oil production to trade partners including the Republic of Korea, Singapore, and Japan, domestic refineries consequently use cheaper crude oil imported from Saudi Arabia, Nigeria, and the United Arab Emirates. The refinery capacity, however, has remained static since 2000. The eight oil refineries, all owned and operated by Pertamina, have a current refining capacity of 1.16 million bpd. Pertamina, therefore, is trying to expand its capacity by cooperating with Kuwait Petroleum and Saudi Aramco to provide an additional 600,000 bpd as well as entering into exploratory agreements with Thailand's PTT Global Chemical Public Company Limited.

In the gas sector, Indonesia has 104.7 tcf proven and another 48-tcf potential gas reserves, mostly discovered in Sumatra, Kalimantan, Maluku, Papua, and the West Natuna offshore fields. The majority of the gas is exported, which makes Indonesia the world's fourth largest liquefied natural gas (LNG) exporter after Qatar, Malaysia, and Australia. The domestic consumption is mainly for PLN and heavy industries for fertiliser production, power, and industry. The gas producers are therefore required to supply at least 25% of the produced gas to the domestic market in accordance with the government's policy on domestic market obligation.

The production is expected to rise from 2.8 tcf in 2011 to 4.1 tcf in 2025, an average 2.3% increase per year. Future fields for production already in the construction stage include East Natuna (West Kalimantan), Donggi-Senoro (Central Sulawesi), and Sengkang (South Sulawesi). In addition, there is a substantial nonconventional gas resource of 337 tcf of CBM (Stevens, Sani, and Hardjosuwiryo, 2001). The recoverable resource potential of this CBM is expected to be 56 tcf. Exploration activities unfortunately are far behind the initial commitment, although the government through SKK Migas has granted 54 development licences. As of March 2014, only 84 CBM wells had been drilled by 18 production sharing contractors (Len, 2014), which falls well short of the minimum drilling obligations of 384 core hole and pilot wells expected in 2013, and far behind the 420 committed by 2015. Conflict with the production of coal and disposal of wastewater as well technical difficulties are potential issues in the production of CBM.

Indonesia is also beginning to develop shale gas in Sumatra, Kalimantan, Papua, and Java. The exploitation of these nonconventional gas resources could supply domestic gas demand as Indonesia's LNG production is tied to export contracts. The Gas Development Master Plan estimates a recoverable resource potential of 142.5 tcf. The first licence for shale gas was issued to Pertamina in May 2013 for a potential field in North Sumatra, and as many as 30 production sharing contracts had been issued by 2015. The shale projects may be struggling to be profitable as drilling is costlier than in the United States and the infrastructure is not effective.

In the coal sector, total domestic reserves are estimated at 124 billion tonnes with a proven reserve of 31 billion tonnes, 70% of which is bituminous and sub-bituminous (mostly in Kalimantan and Java) and 30% low-grade lignite (mostly in Sumatra) (BPPT, 2015). The majority of the mines are open pit with most mining activity centred on the islands of Sumatra and Kalimantan. The government estimates that the reserves-to-production ratio is 80 years.

Law No. 4/2009 on Mineral and Coal Mining predominantly governs this sector. This law mandates domestic market obligations for Indonesian coal producers and provides more transparent and standardised tenders and licences for mining blocks. Policy and central

administrative responsibilities meanwhile remain in the hand of the MEMR and its Directorate General of Mineral and Coal, which have a mandate to work towards national goals set for coal per Presidential Decree No. 5/2006 on National Energy Policy and amended later by KEN Regulation No. 74/2014.

The majority of the coal produced is for export, and the domestic application is mostly for power generation. The figure in 2015 released by the MEMR shows that 461 million tonnes of coal were produced, with 366 million tonnes exported and 86 million tonnes utilised domestically. The coal price plummeted and the coal exports decreased in 2016. The strong performance of coal at the end of 2017 suggests an improvement in the export figures. The Indonesian benchmark coal price (Harga Batubara Acuan, or HBA) soared 9.6% month-on-month (m/m) to US$92.03 per tonne from US$83.97 in August 2017 (Indonesia Investments, 2017), which was the highest point since December 2016. Coal production is also buoyed by the increase of domestic consumption as the government has set up a 35,000 MW power plant development programme, in which the majority are coal-fired power plants.

In the biomass sector, Indonesia has significant potential for biomass energy generation from agricultural residues including rice husk, bagasse, rubber, and palm oil. The total biomass consumption in 2016 was 20% of the total energy mix in the country or nominally 307 million BOE (Center for Data and Information Technology MEMR, 2015). Its predominant use in the household sector has caused some concern as the inefficient stoves emit health-damaging pollutants into household environments, most directly affecting women and children. Indonesia is therefore partnering with the World Bank and launched the Clean Stove Initiative to scale up the access to clean and efficient cooking in Indonesia in 2012 (ASTAE, 2013). It focused on the 40% of the population located mainly in rural areas where the LPG conversion programme has limited impact and where the biogas option is unlikely to be suitable. The overall target of such an initiative would be delivering 10 million clean biomass-cooking stoves by 2020 and possibly transforming Indonesia's biomass-cooking stoves market towards achieving universal access to clean cooking by 2030.

Another potential use of biomass is for electricity generation, particularly from waste and oil palm. The resource potential from oil palm waste is about 246 million tonnes per year (Conrad and Prasetyaning, 2014). This value excludes oil palm fronds and oil palm trunk. Nevertheless, only around 60 MW of biomass-based power plants were operating on-grid as of 2012. The major challenge for commercial biomass utilisation is the availability of feedstock. To speed up the development of biomass-based power plants, the government issued Presidential Regulation No. 18/2016 to build waste-to-energy plants in seven major cities including Jakarta, Bandung, and Surabaya.[2]

In the electricity sector, Indonesia faces massive challenges in supplying electricity. A major electricity grid system covers the main islands of Java, Madura, and Bali. Other areas and islands have their own distributed electricity generation and transmission systems. Though out

[2] This regulation by the Government of Indonesia in 2016 is currently on hold, as it was successfully challenged in the high court.

Indonesia access to the electricity grid has improved from 65% in 2010 (Anthony, 2010) to 91% in 2016, this means nearly 25 million people do not have access to grid electricity. In addition, there is over-reliance on fossil fuels (coal, oil, and natural gas) as 88% of the total electricity generated came from fossil fuels in 2014 (PT PLN Persero, 2015). Of the total generating capacity of about 30.3 GW, only 9% comes from hydropower and 3% comes from geothermal and other renewable sources. From the perspective of the national primary energy mix, the electricity sector consumed about 20% of the total 132 million BOE in 2016 (Center for Data and Information Technology MEMR, 2017). Against this backdrop, utilising biomass and waste as either solid or liquid to partially or fully substitute medium fuel oil for electricity generation, along with other small-scale renewable technologies (hydropower and solar PV), may improve the national electrification ratio. Moreover, not only will this plan have the potential to reduce the use of liquid fossil fuels for electricity generation, but also provide electricity in remote areas.

To meet the 8.7% growth in electricity demand, a series of two Fast Track Programs (FTP), each at 10,000 MW, was introduced. The first FTP was delivered through Presidential Decree No. 71/2006 (later amended by Presidential Decree No. 59/2009). To further accelerate the fulfilling of electricity needs, the government has initiated the 35 GW Program from 2015 to 2019. It also follows up on several delayed projects from FTP 1 and 2. The plant capacity allocated for PLN is 14 GW, transmission lines of 50 kilometres, and substations at 743 locations. Of the total 35 GW power projects, 55%–60% will come from coal-fired power plants, while gas power plants make up 12 GW and the remaining approximately 9 GW are from hydro and geothermal, with a small fraction of solar PV and wind.

In the biofuel sector, the potential resources include biogas and well-known liquid biofuels such as biodiesel and pure plant oil derived from crude palm oil, and bioethanol derived from cassava and sugar cane. Though still using first-generation biofuels technology, developing liquid biofuel is a viable way to reduce oil imports given the country's status as the world's largest producer of palm oil of 40 million tonnes per year in 2020.[3] In addition, the use of biofuels offers an alternative to reduce oil imports, maintain the palm oil prices at acceptable level, and reduce carbon emissions.

The RPJMN 2015–2019, through Presidential Regulation No. 2/2015, aims to produce 4,300–10,000 kilolitres of biodiesel and 340–930 kilolitres of bioethanol by 2019. Penetration into the biofuel market is largely due to the mandatory biofuel blending rate (MEMR Regulation No. 20/2014), as presented in Table 2.1.2-3.

[3] Wright and Rahmanulloh (2016) reported that the post-2020 estimate is subject to the success of increasing crude palm oil yield per hectare as land expansion would be even more difficult. GAPKI (2016) projected that palm oil export may be reduced as domestic biodiesel increases.

**Table 2.1.2-3 Biofuel Mandatory Regulation in Indonesia (%)**

| **Biodiesel Sector** | **July 2014** | **2015** | **2016** | **2020** | **2025** |
|---|---|---|---|---|---|
| Micro, fishery, agrobusiness, transport as PSO | 10 | 10 | 20 | 30 | 30 |
| Transport as non-PSO | 10 | 10 | 20 | 30 | 30 |
| Industrial and commercial | 10 | 10 | 20 | 30 | 30 |
| Power plant | 20 | 25 | 30 | 30 | 30 |

| **Bioethanol Sector** | **July 2014** | **2015** | **2016** | **2020** | **2025** |
|---|---|---|---|---|---|
| Micro, fishery, agrobusiness, transport as PSO | 0.5 | 1 | 2 | 5 | 20 |
| Transport as non-PSO | 1 | 2 | 5 | 10 | 20 |
| Industrial and commercial | 1 | 2 | 5 | 10 | 20 |
| Power plant | – | – | – | – | – |

| **Other Biofuel (PPO/BioAvtur) Sector** | **July 2014** | **2015** | **2016** | **2020** | **2025** |
|---|---|---|---|---|---|
| Industry (low- and medium-speed engine) | 5 | 10 | 20 | 20 | 20 |
| Transport (low- and medium-speed engine) | 5 | 10 | 20 | 20 | 20 |
| Air transport | – | – | 2 | 3 | 5 |
| Power plant | 6 | 15 | 20 | 20 | 20 |

bioavtur = bio-aviation turbine, PPO = pure plant oil, PSO = public service obligation.
Source: Ministry of Energy and Mineral Resources (MEMR), Indonesia, 2014.

Currently, the government has implemented biodiesel blending B20 in the transportation and industry sector and B30 to B60 on electricity. The MEMR has also already launched a new market price index for biodiesel blended with subsidised fuel. The ministry is also preparing various stages to implement B30 in 2018 by conducting engine testing together with automotive engine manufacturers, automotive and expertise associations, as well as university and research institutions before full implementation in 2025.

As Indonesia has opted for mandatory biofuel regulation coupled with a biofuel blending scheme, the issue of the relatively higher price of biodiesel has been solved by implementing a levy on palm oil export. The levy of US$50 a tonne for palm oil and US$ 30 for processed products as of April 2015 collected by the newly formed Crude Palm Oil Fund Agency is used to offset the price difference due to the volatility of the biodiesel price when it is blended with diesel oil.

As for bioethanol, no fuel-grade ethanol has been produced after Pertamina ended its fuel ethanol-blending programme in 2010 due to inconsistent supply and price volatility. The price offered by Pertamina was too low despite a government effort to set up a monthly reference price of fuel-grade ethanol. Based on MEMR and the Indonesian Biofuel Producers Association (APROBI) data, there are only two companies that produce the fuel with a total capacity of 40 billion litres.[4] The MEMR Directorate General of Renewable Energy has been working on renewing the ethanol mandate for gasoline with octane value of 90 in several cities (Surabaya, Jakarta, and Bandung). However, this effort has fallen short due to the inability to seek a bioethanol subsidy in the 2017 fiscal year.

For pure plant oil, one issue is that its price has not been included in the palm oil fund scheme. Moreover, technical issues still remain in implementing pure plant oil blend with diesel oil in the electric utilities, particularly for the gas turbine application. In addition, the PLN as a state-owned enterprise for electricity has been trying to reduce its liquid fuel-based power plants and replace them with natural gas, coal, and geothermal power plants.

*1.2.4. Energy Issues in the Transportation Sector*

Presidential Decree No. 5/2006 on National Energy Policy (or KEN) is the Indonesian government's energy sector strategy. It emphasises diversification, environmental sustainability, and maximum use of domestic energy resources. The KEN was revised in 2014 by Regulation No. 74/2014, setting a larger target for new and renewable energy at 23% of the energy mix, with oil at 25%, gas at 22%, and coal at 30%, for a total of 400 million tonnes of oil equivalent by 2025 (Government of Indonesia, 2014). These KEN targets have become the government’s point of reference for setting energy sector policy, and every government body will have to set their programmes in this sector accordingly.

Figure 2.1.2-1 presents a visual impression of the magnitude of the structural shifts proposed in the KEN. Compared to Indonesia’s 2013 energy mix, coal generation is expected to triple by 2025, gas to more than double, and renewable energy to increase about eightfold. Independent

[4] PT Molindo Raya and PTPN IX are the two companies in East Java that have fuel-grade ethanol production facilities.

analyses, however, suggest that growth may be somewhat less given the oil fuel subsidy has been removed and the electricity tariff has been raised. A World Energy Outlook 2013 special report by the International Energy Agency forecasts a primary energy demand of 282 million tonnes of oil equivalent by 2025 (IEA, 2013).

As transportation was the largest sector using commercial final energy in 2016, properly managing it will be a key factor to meet the country's energy mix, particularly the 23% of renewable energy. Almost all of the energy consumption in the transportation sector is in the form of oil fuel and about 92% is consumed in the road transportation subsector (Center for Data and Information Technology MEMR, 2015). Increasing oil consumption every year would require more energy subsidies and consequently an increase of crude oil and oil fuel import.

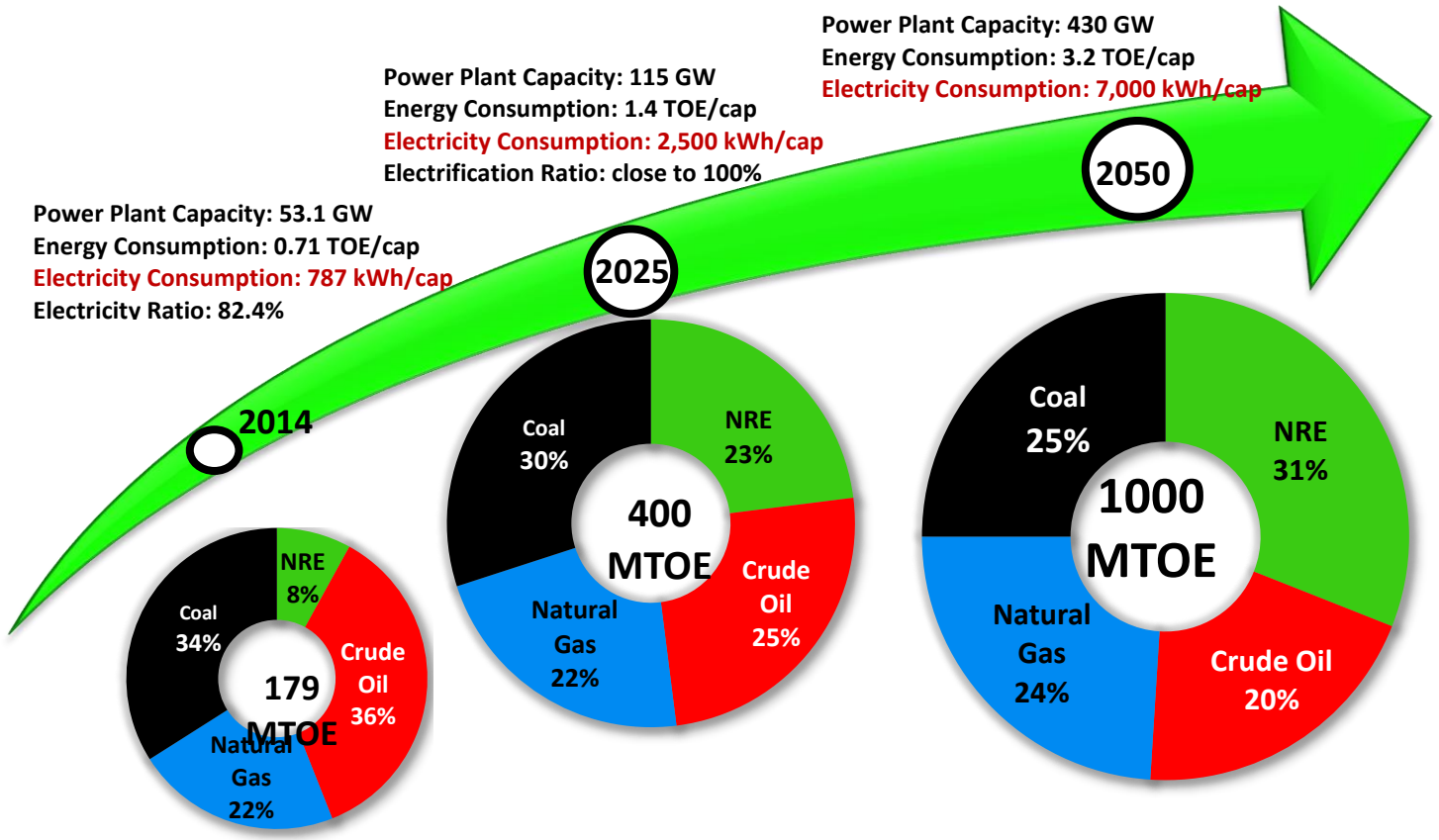
The rapid growth of motor vehicles, about 11% per year in the period 2000–2013 (BPS, 2015), is the primary contributor to the high growth rate of final energy consumption in the transportation sector. Private vehicles, including passenger cars and motorcycles, and commercial transport (buses and trucks) dominate the increase in motor vehicles. In Jakarta, for example, the number of private vehicles is 96.5% and serves 44% of the city's total commuting population. Public transport, on the other hand, comprises merely 3.5% and serves 56% of the city commuters (BPPT, 2015). Only 3% of public transport vehicles use the train or electric railway network of greater Jakarta. The subsidised prices of certain types of gasoline and diesel oil also contribute to the high growth of motor vehicles and oil fuel consumption in the road transportation subsector. The lack of convenient public transport has also exacerbated the situation.

This condition should be improved by removing the oil subsidy, substituting oil fuel with biofuel, gas, and electric vehicles, as well as shifting from primary use of private vehicles to mass transportation. The partial removal of oil fuel subsidies at the end of 2015, though it did not curtail the oil consumption growth, has reduced the burden on the state budget by Rp130 trillion in 2015.

The government has also been attempting to promote the shift from oil-based fuel to biofuel and gas in the transportation sector. Though faced with technical and commercial difficulties, the biofuel drive for transportation has been relatively successful for the past 10 years. The government has issued various policies tackling technical issues, setting up the biofuel standard, as well as trying to manage the price policy.

In the case of biodiesel, increasing the uptake in the market requires promoting higher-blend biodiesel such as B30. Thus, consensus with car manufacturers in implementing a higher blend should be explored further, either by carrying out a road or chassis dynamometer test by the government along with car manufacturers with emphasis on the long-term effect on the engines and preferably a distance of more than 100,000 kilometres. Moreover, a higher blend of biodiesel could be achieved by improving biodiesel quality via partial hydrogenation (H-FAME).

**Figure 2.1.2-1 Energy Projection of Indonesia up to 2025 and 2050**




GW = gigawatt, kWh = kilowatt-hour, MTOE = million tonnes of oil equivalent, NRE = new and renewable energy, TOE/cap = tonne of oil equivalent per capita.
Note: Projections according to National Agency for Assessment and Application of Technology (BPPT) Energy Outlook referring to the General Planning for National Energy (RUEN).
Source: BPPT (2015).

To ensure the quality and customer confidence, Indonesia could implement a scheme similar to the BQ-9000 programme in the United States. It is important for the biodiesel quality to meet the standard at every stage of the value chain to maintain customer confidence in the biodiesel quality so that it does not cause them engine trouble. In addition, Pertamina and other fuel retailer companies should build more adequate biodiesel blending facilities to ease the supply problem. This is particularly urgent in areas outside the island of Java.

In the case of ethanol for fuel transport, reintroducing the low-ethanol E5 blend is the key. The government should firmly mandate the fuel retailers to market E5 as the fuel subsidy has been partially removed. For the long-term measures, opening more sugar cane plantations in areas outside Java, particularly in Papua, Sulawesi, or Kalimantan, is necessary to increase the domestic supply of the raw material of ethanol. Success in forming Crude Palm Oil Fund Agency could be emulated for the case of ethanol by forming a similar agency to support the sugar cane products.

To increase pure plant oil consumption as mandated in the ministerial regulation, blending with diesel oil should be further promoted. This can be achieved by conducting tests on PLN's power plant facilities along with the government research institutions, as well as a consultation with the original equipment manufacturers prior to such tests. Moreover, the Crude Palm Oil Fund Agency should expand its role in supporting the sustainable crude palm oil products to include pure plant oil from palm oil.

Despite promising greenhouse gas savings and energy security, the reliance on the domestic palm oil industry and sugar cane plantation for Indonesia's biofuel growth presents enormous environmental and social costs. Given the recent expansion in oil palm plantation at the expense of tropical forest area (US EPA, 2012), additional plantation dedicated for biofuels will likely follow a similar trend. This plantation expansion suggests that there may be potential impacts due to land use change. Instead of being renewable and environment-friendly, this plan would potentially contribute significantly to greenhouse gases along with other potential impacts such as diverting land from food crops to energy crops, de-afforestation, and social change. Moreover, potential conflicts may arise between local people and companies seeking to build dedicated biofuel feedstock plantations over land use. Many warn that expanding domestic biofuel feedstock production will not only lead to the destruction of the forest but also hasten social conflict.

While conversion of oil fuel to biofuel has been relatively successful, the gas conversion in the transportation sector is another matter. It has faced various difficulties since its inception, centring on technical and infrastructure difficulties. Gas conversion has actually been carried out through implementation of compressed natural gas buses for the bus network in Jakarta since 2008 (600 in 2008 and another 3,000 in 2016). Taxis using compressed natural gas have also been around since the late 1980s but failed within 2 years due to limited gas infrastructure that made taxi drivers reluctant to drive CNG taxis as they have to travel quite distance to refill the gas. In 2007, there was a renewed effort to have a conversion kit but was again hindered by lack of gas filling stations. It is therefore important to fix the inadequate gas transportation and distribution

infrastructure. This may be a key to the success of gas conversion from fuel oil and the future development of the gas subsector.

Another measure to curb the oil fuel consumption in the transportation sector is to promote electric vehicles, particularly motorcycles. This is a particularly effective measure to reduce gasoline consumption, since motorcycles consume a majority of the gasoline and the number of motorcycles comprised almost 85% of the total 104 million vehicles in the country (BPS, 2015). Promoting electric vehicles has been included in the RUEN regulation, and additional presidential regulation special for electric vehicles is being formulated. The plan to introduce electric vehicles in Indonesia has received positive responses from various parties including academia, the ministry of industry, and PT PLN. This aspiration may require a boost for the local electric vehicle industry, supporting infrastructure such as charging stations, an adequate power generation and electricity grid, and research in electric-based transportation.

In addition to shifting the use of oil fuel in the transportation sector to other fuels for achieving the fossil oil reduction target, a viable alternative may be an integrated approach of oil reduction measures. The RUEN has recommended measures including construction of mass transportation infrastructure in the large cities, with the aim of reaching a market share of 30% for public transportation by 2025. The strategy also recommends mass rapid transit, light rail transit, and trams in 13 large cities. Moreover, the government plans to develop a fuel economy standard for private vehicles and to mandate it by 2020.

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