ISSN 2527-3000

DEN

SECRETARIAT GENERAL
NATIONAL ENERGY COUNCIL

INDONESIA ENERGY OUTLOOK 2019

ISSN 2527 3000

DEN

SECRETARIAT GENERAL
NATIONAL ENERGY COUNCIL

INDONESIA ENERGY OUTLOOK 2019

INTRODUCTION

Indonesia Energy Outlook (IEO) 2019 has been published by Secretariat General of the National Energy Council since 2014. To obtain current data and information as well as future development plan of energy, related internal units in the Ministry of Energy and Mineral Resources and other units outside the Ministry of Energy and Mineral Resources have been involved.

In formulating IEO 2019, Secretary General of the National Energy Council has coordinated with internal unit in MEMR especially Pusdatin (Center for Data and Information of MEMR) in relation to current energy data. Meanwhile, Directorate General of Oil and Gas, Directorate General of Mineral and Coal, Directorate General of Electricity, and Directorate General of New and Renewable Energy and Energy Conservation take part in formulating future energy development plan data such as city gas development plan, biofuel mandatory, and power plant development plan. Besides that, in order to obtain the demand projection per sector, there has been coordination with external units including Ministry of Industry in relations to electric car development plan, Ministry of Transportation in relations to mass transportation development plan, and Ministry of Environment in relations to emission reduction plan. To enrich the data in each industrial sub sector, *Asosiasi Semen Indonesia* (ASI/Indonesia Cement Association), *Asosiasi Produsen Pupuk Indonesia* (APPI/Indonesian Fertilizer Producers Association), and *Asosiasi Aneka Keramik Indonesia* (ASAKI/Indonesia Ceramic Industry Association) have been involved. Thus, the calculation of energy intensity per industrial sub sector is more accurate.

In improving the quality of energy demand and supply projection, Secretary General of the National Energy Council will strengthen the cooperation with related units in the future. Thus, the book of IEO will be a reliable and trusted reference.

Jakarta, September 2019
Secretary General of the National Energy Council

Djoko Siswanto

INTRODUCTION

Indonesia Energy Outlook 2019 is a study on future energy demand and supply projection in various situation and condition based on the trend developing assumption by using energy planning modeling application.

The model to analyze the energy demand and supply is LEAP (Long-range Energy Alternatives Planning System) as an energy planning modeling application to analyze integrated demand and supply condition. Besides that, Balmorel is also used a special energy planning modeling application to calculate electricity with optimization approach.

Furthermore, the formulation of IEO is continuously improved both in terms of the latest data and information as well as the methodology. Based on the analysis, there is an increase of accuracy in the final energy demand projection in 2016, 2017 and 2018 from IEO 2016 to IEO 2017. From the comparison, there is a smaller disparity between final energy demand projection and final energy consumption realization (0.1% accuracy).

Indonesia Energy Outlook 2019 needs further improvement in the future. Constructive critics and suggestions are required to improve the next IEO. We sincerely hope that this book would be beneficial for the government, regional government, investors in energy sector, and Indonesian people for the purpose of developing energy in Indonesia.

Jakarta, September 2019
Head of Energy Policy Bureau

Sugeng Mujiyanto

EDITORIAL BOARD

ACKNOWLEDGEMENTS

We would like to convey our gratitude to all related parties for the inputs and suggestions in formulating IEO 2019:

- Members of National Energy Council from stakeholders,
- Permanent Representative of National Energy Council Members from the government,
- Embassy of Denmark and Danish Energy Agency.
- Directorate General of Oil and Gas, Directorate General of Electricity, Directorate General of Mineral and Coal, Directorate General of New Renewable Energy and Energy Conservation, Data and Information Center of MEMR (Pusdatin KESDM), PT PLN and PT PGN,
- Energy experts for their assistance in writing IEO 2019.

DISCLOSURE

IEO 2019 is an analysis on the long term national energy demand and supply projection (2019-2050) with particular assumptions which are developed for the purpose of future energy scenario planning. The assumptions and projections are based on energy technology development both fossil energy and renewable energy based on current data and condition. The data in this IEO is derived from official publication, temporary data, or updated data by the sources.

ISSN 2527 3000

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

IEO 2019 presents national energy demand and supply projection in 2019-2050 based on social, economy and technology development assumption in the future by using 2018 baseline data.

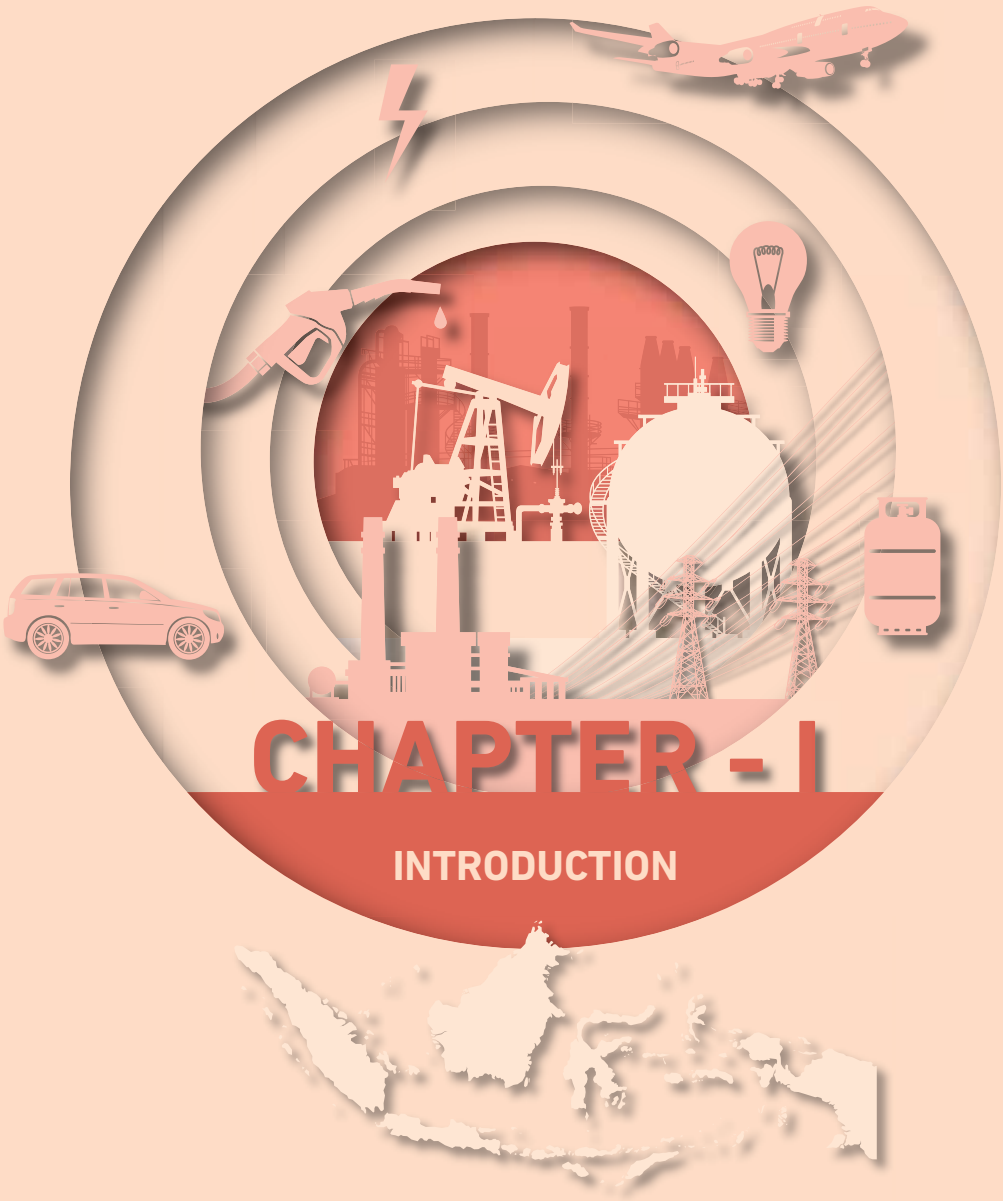
The energy demand and supply analysis is conducted based on LEAP (Long-range Energy Alternatives Planning System), while the electricity supply calculation is carried out based on Balmorel modeling. LEAP is an energy planning modeling application to take an integrated energy demand and supply analysis. Meanwhile, Balmorel is an energy planning modeling application especially in electricity supply side with optimization approach.

Population growth, economic growth and energy price are the basic assumptions which are developed to obtain an illustration of energy demand up to the year 2050. Beside these basic assumptions, there are additional assumptions related to current energy policies such as RUEN and Biofuel mandatory which become the consideration in the future energy demand projection. There are also assumption and target in developing electricity such as in RUPTL, RIPIN and NDC.

The energy demand and supply projection for the period of 2019-2050 uses 3 scenarios namely Business as Usual (BaU), Sustainable Development (PB) scenario, and Low Carbon (RK) scenario. These three scenarios use the same Gross Domestic Product Growth are 5.6% per year and rate of population growth 0.7% as basic assumption. Several important assumptions in IEO 2019 are biodiesel and bioethanol target, city gas for household distribution, electric vehicle target, and induction stove and Dimethyl Ether (DME) utilization for LPG substitution. The power plant refers to target in RUPTL for BaU scenario, RUEN for PB scenario, and earth temperature increase above 2 degree Celsius for RK scenario.

The national final energy demand in 2025 in BaU scenario, PB scenario and RK scenario is 170.8 MTOE, 154.7 MTOE and 150.1 MTOE. The final energy demand in 2050 with the same scenario is 548.8 MTOE, 481.1 MTOE and 424.2 MTOE. In 2025, the energy demand for all scenarios will be dominated by transportation sector of about 35% and in 2050 will be dominated by the industrial sector of about 37-42%.

The electricity demand in 2025 in each scenario grows of about 11% to 12% reaching 576.2 TWh (BaU), 537 TWh (PB) and 520.7 TWh (RK). In 2050, it will grow about 6% to 7% reaching 2,214.1 TWh (BaU), 1,917.9 TWh (PB) and 1,625.2 TWh (RK). The energy demand until 2050 in all scenarios will be dominated by household, followed by industry and commercial sector.



CHAPTER - I

INTRODUCTION

1 INTRODUCTION

The annually published IEO is the result of a study to present the national energy condition especially energy demand and supply projection up to 2050. For modeling, data in 2018 is used as the baseline year with realistic economic growth assumption of the average of 5.6% as stated in 2045 Indonesia Vision (Bappenas). Besides that, the calculation assumption also refers to other Government's energy-related policies such as KEN, RUEN, RUPTL, RIPIN, NDC, Renstra of Ministry of Energy and Mineral Resources, Ministry of Transportation and Ministry of Industry, as well as Biofuel Mandatory.

The main data source in IEO 2019 is Handbook of Energy and Economic Statistic Indonesia (HEESI) 2018, RUPTL 2019-2028, Statistic Indonesia, and data from a number of industrial associations such as *Asosiasi Produsen Pupuk Indonesia* (APPI/Indonesian Fertilizer Producers Association), *Asosiasi Semen Indonesia* (ASI/ Indonesia Cement Association), and *Asosiasi Aneka Keramik Indonesia* (ASAKI/ Indonesia Ceramic Industry Association).

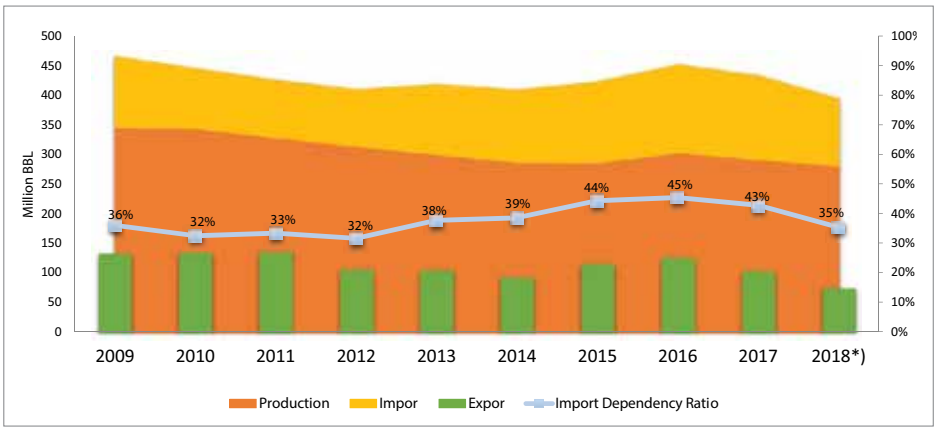
1.1 Current Energy Condition

In 2018, the total primary energy production consisting of oil, gas, coal and renewable energy was 411.6 MTOE. Around 64% or 261.4 MTOE from the total production especially coal and LNG was exported. Besides that, Indonesia also imported energy especially crude oil and petroleum products of 43.2 MTOE and small volume of high rank coal to meet industrial sector's need.

The total final energy consumption (without traditional biomass) in 2018 was around 114 MTOE derived from 40% transportation, 36% industry, 16% household, 6% commercial sector and 2% other sectors.

1.1.1 Oil

Crude Oil production in the last 10 years shows a decline from 346 million barrel (949 thousand bpd) in 2009 to 283 million barrel (778 thousand bpd) in 2018. The production decline is due to the mature oil production wells, while number of new production wells are relatively limited. To meet the oil refinery demand, Indonesia is importing crude oil especially from Middle East. Indonesia's oil import dependency is around 35% (Figure 1.1)



Source: Ministry of EMR, processed by Secretariat General of NEC, 2019
Note: Import Dependency ratio = Import divided by Domestic Supply (Production+Import-Export)
*) Temporary Data

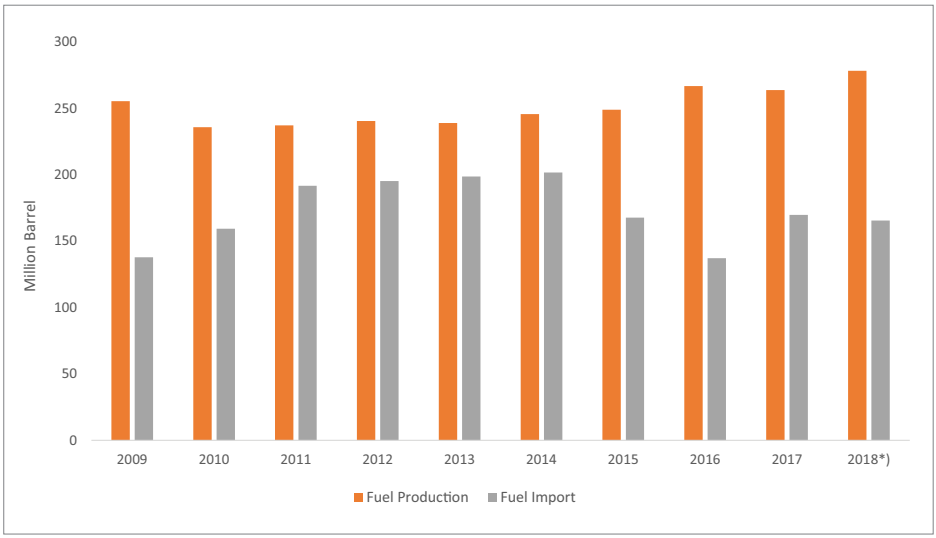
Figure 1.1 Crude Oil Import Dependency Growth

In order to promote investors to invest their capital in oil and gas upstream sector, the government in the end of 2015 has revised Government Regulation (GR) No. 79 of 2010 to GR No. 27 of 2017 on Cost Recovery and Taxation in Upstream Business. The revision of this GR is aimed at creating a more interesting oil and gas upstream business in the midst of world competition tightness through tax deduction in exploration and exploitation period such as free of custom duty, VAT, and import tax.

Besides that, the government has also issued Government Regulation No. 8 of 2017 on Gross Split PSC as a new scheme in oil and gas upstream contract. With this new scheme, the capital and risk in oil and gas upstream activity are fully borne by contractor. Until February 2019, there have been 40 new contracts with gross split scheme consisting of 14 tender blocks, 21 termination blocks, and 5 amended

blocks. Furthermore, gross split policy is also supported by GR No. 53 of 2017 on Gross Split PSC Taxation which eliminates taxes from exploration until production phase in the first year.

In demand side, fuel consumption including biodiesel in 2018 reached 465.7 million barrel/year fulfilled from the production of domestic refineries and from the import. The production of fuel from domestic refinery is around 278.1 million barrel and from import is around 165.4 million barrel. The development of fuel production and import in the last 10 years can be seen in Figure 1.2.

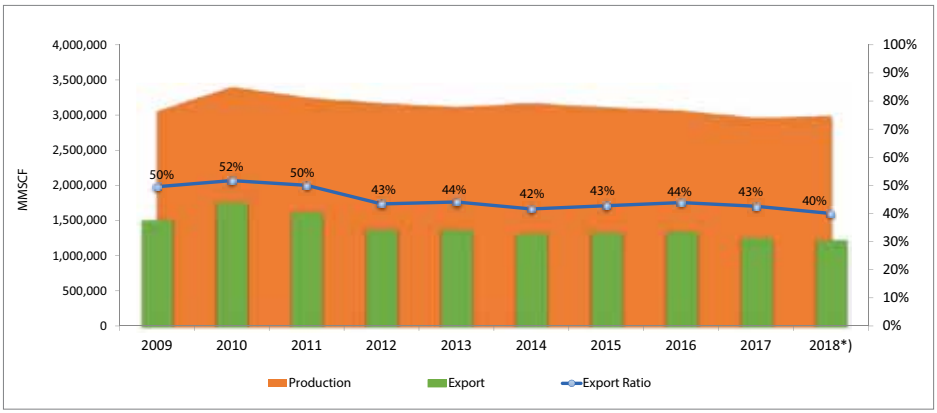


Source: HEESI, 2018
Note : *) Timporary Data

Figure 1.2 Fuel Production and Import

1.1.2 Gas

In 2018, gas production reached 2.9 million MMSCF which was utilized to meet domestic demand in industry (as feed stock or energy), power plant, city gas (household and commercial) and gas lift of 1.7 million MMSCF. Furthermore, gas is also used as export commodity in the form of LNG and piped gas of 1.2 million MMSCF. The share of gas export (through pipeline or LNG) in the total gas production declined from 50% in 2009 to 40% in 2018 (Figure 1.3).



Source: HEESI, 2018
Note: Export ratio = Export divided by Production
*) Temporary Data

Figure 1.3 Gas Production and Export Growth

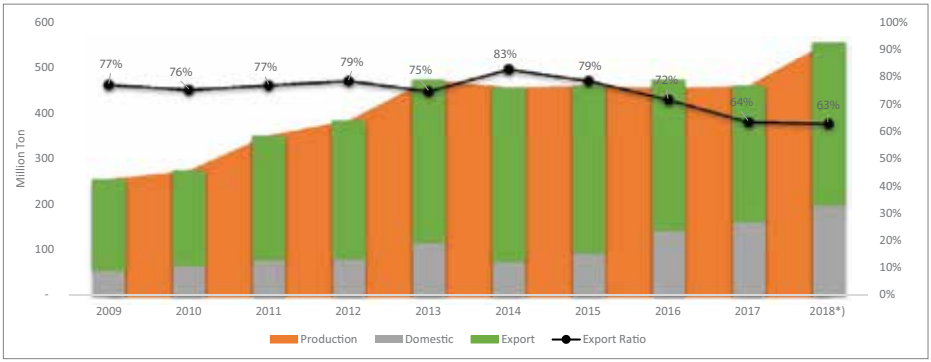
Gas primary energy also includes LPG consumption which was fulfilled from the production of LPG refinery and LPG import. In 2018, LPG consumption reached 7.5 million Ton which was fulfilled from domestic LPG production of 2 million Ton (26%) and imported LPG of 5.5 million Ton (74%). The success of kerosene to LPG conversion program gives an impact on the increasing LPG consumption while LPG supply from LPG refinery and domestic oil refinery is limited. The increasing LPG consumption especially subsidized 3 kg of LPG needs to be anticipated by the government since there is a lot of subsidized 3 kg LPG used by non-low-income person. To reduce the increasing volume of LPG import, the government is currently formulating a program to substitute LPG with DME (Dimethyl Ether) from coal and to substitute LPG with induction stove.

1.1.3 Coal

Indonesia coal production is predicted to be increased, especially to meet domestic demand (power plant and industry) and export.

The development of coal production in 2009-2018 increased significantly with the production of 557 million ton in 2018. From the total production, the percentage of coal export reached 357 million ton (63%) which was mostly exported to meet the demand in China and India. The high percentage of Indonesia coal export has made Indonesia one of the biggest coal exporters in the world beside Australia.

Meanwhile, the domestic coal consumption was 115 million Ton or smaller than the domestic coal consumption target of 121 million Ton. One of the factors which cause the low realization of coal consumption is that the operation of several Steam Power Plant in 35,000 MW program is not according to the plan and declining of the industry activities. The overview of coal production, consumption and export in the last 10 years can be seen in Figure 1.4.



Source: HEESI, 2018
Note: *) Temporary Data

Figure 1.4 Coal Production Realization and Export

1.1.4 New and Renewable Energy

a. New and Renewable Energy Potential

The declining fossil energy production especially crude oil and the global commitment in reducing greenhouse gas emission have encouraged the government to increase the role of new and renewable energy continuously to maintain energy security and independence. As stated in Government Regulation No. 79 of 2014 on National Energy Policy, new and renewable energy mix target is at least 23% by 2025 and 31% by 2050. Indonesia has respectable potential of new and renewable energy to meet the primary energy mix target as seen in Table 1.1 below.

Table 1.1 Renewable Energy Potential

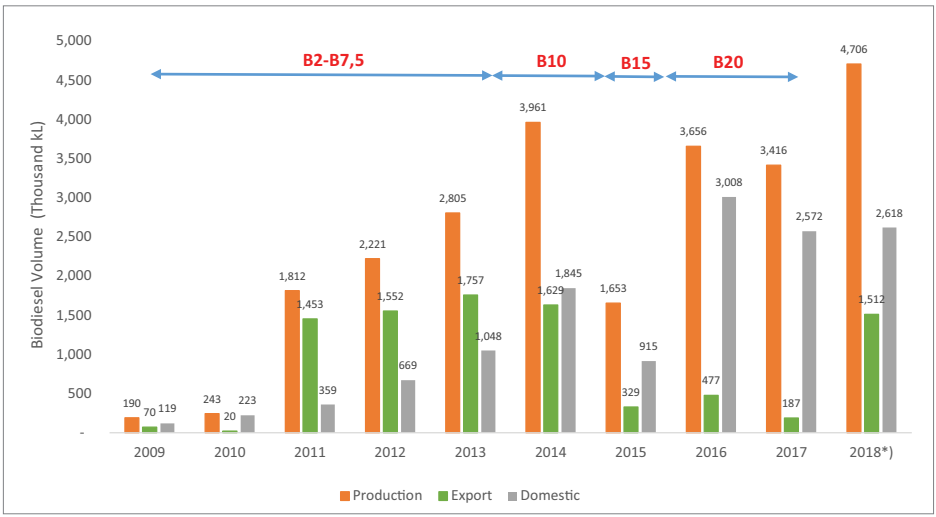
Energy Source	Potential*)
Hydro	94.3 GW
Geothermal	28.5 GW
Bioenergy	Bio PP : 32.6 GW and
	Biofuel : 200 Thousand bpd
Solar energy	207.8 GWp
Wind	60.6 GW
Ocean energy	17.9 GW

Source: DG of NREEC, 2018
Note: *) Temporary Data

The total renewable energy potential is equivalent to 442 GW for power plant, while 200 thousand bpd (barrel per day) of biofuel and biogas are used as fuel in transportation, household, commercial sector and industry. NRE for power plant in 2018 was 8.8 GW or 14% from the total 64.5 GW of power plant capacity (fossil and non-fossil).

The low NRE utilization for electricity generation is due to the high NRE power plant production cost. Thus, it is difficult to compete with fossil fuel power plant especially coal. Furthermore, the lack of support to domestic industry concerning renewable energy power plant components and the difficulty in obtaining low interest-financing have contributed to the slow development of renewable energy.

NRE utilization in transportation especially biodiesel has been increasingly developing following the biofuel mandatory policy which says that the mix of biofuel in oil fuel in transportation should reach 20% (B20). Biodiesel production, export and utilization growth are seen in Figure 1.5.



Source: DG of NREEC
Note: *) Temporary Data

Figure 1.5 Biodiesel Production, Export and Utilization Growth

b. NRE Supporting Policy

In order to accelerate NRE development, the government has stipulated a number of policies including:

Presidential Regulation No. 4 of 2016 (Article 14) on Electricity Infrastructure Acceleration states that the acceleration in electricity infrastructure should prioritize the utilization of new and renewable energy. The Central Government and/or Regional Government may give support in the form of fiscal incentive, simplification in permits or non-permits, electricity purchasing price stipulation from each new and renewable source, establishment of business entity to supply electricity to PT PLN (Persero), and/or subsidy.

Presidential Regulation No. 66 of 2018 on the Second Amendment of Presidential Regulation No. 61 of 2015 on Collection and Use of Palm Oil Plantation Funds which mandates the use of biodiesel for PSO and Non-PSO as mentioned in Article 18 paragraph (1b).

Minister of Finance Regulation No.177/PMK.011/2007 on Duty Free of Imported Goods for Upstream Oil and Gas Business and Geothermal.

Minister of Finance Regulation No.177/PMK.011/2007 on Procedures for Management and Accountability of Geothermal Fund Facilities.

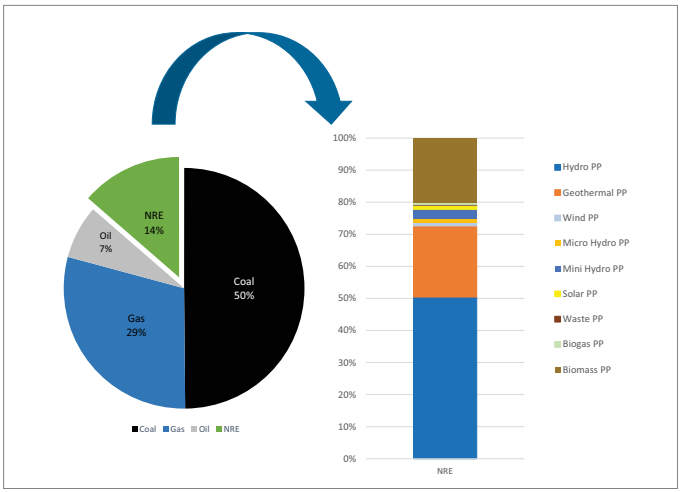
Minister of Energy and Mineral Resources Regulation No. 49 of 2017 as the refinement of Minister of Energy and Mineral Resources Regulation No.10 of 2017 on Principles in Electricity Sales and Purchase Agreement.

Minister of Energy and Mineral Resources Regulation No. 50 of 2017 as the revision of Minister of Energy and Mineral Resources Regulation No. 12 of 2017 on Renewable Energy Utilization for Electricity Supply to create a better investment climate by promoting efficiency and affordable electricity price.

Minister of Energy and Mineral Resources Regulation No.49 of 2018 on the Utilization of Roof Top Solar PV by PT Perusahaan Listrik Negara (PLN) Consumer.

1.1.5 Electricity

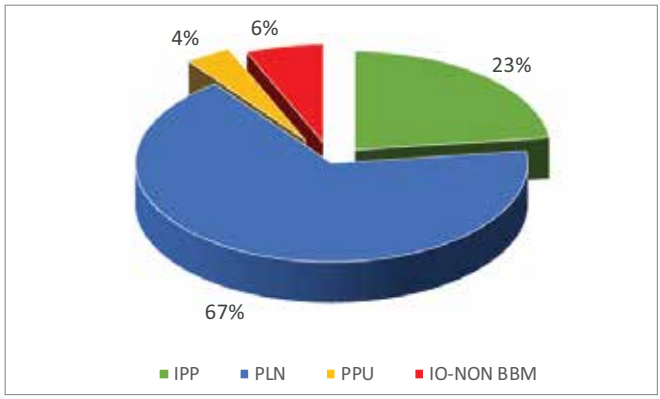
Indonesia power plant capacity in 2018 reached 64.5 GW or it increased 3% compared to the capacity in 2017. The power plant installed capacity in 2018 was mostly dominated by fossil fuel power plant especially coal (50%) followed by gas (29%), fuel (7%) and renewable energy (14%) as shown in Figure 1.6



Sumber : HEESI, 2018

Figure 1.6 Power Plant Installed Capacity per Energy Source Year 2018

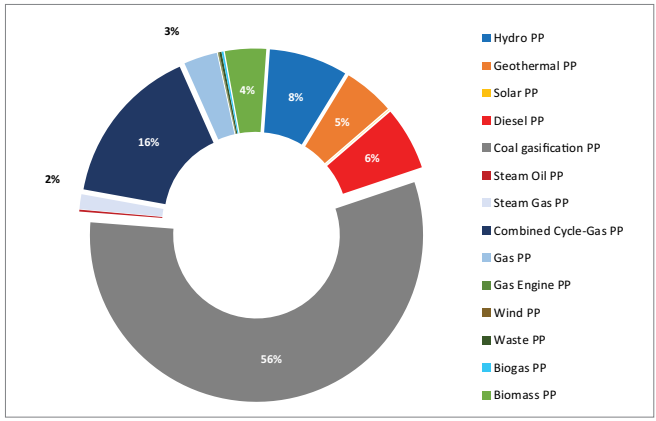
Most power plants are operated by PLN reaching 43.2 GW (67%), while power plants operated by IPP reaching 14.9 GW (23%). The power plant generated by Private Power Utility (PPU) and non-fuel Operation Permit (IO) reached 2.4 GW (4%) and 4.1 GW (6%) as seen in Figure 1.7.



Source : Directorate General of Electricity, 2018

Figure 1.7 Power Plant Capacity Year 2018

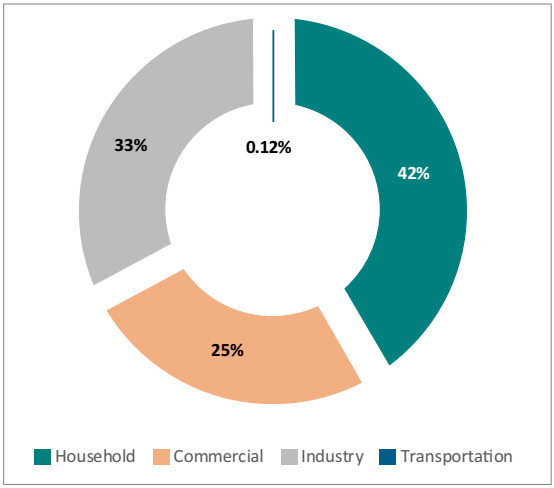
In 2018, power plant production reached 283.8 TWh which was derived from 56.4% coal, 20.2% gas, 6.3% fuel and 17.1% NRE (Figure 1.8).



Source : HEESI, 2018

Figure 1.8 Electricity Production per Energy Source Year 2018

Electricity from PLN and non-PLN which is already connected to PLN network (on grid) supplied 97.8 thousand GWh (42%) for household, 76.9 thousand GWh (33%) for industry, 59.5 thousand GWh (25%) for commercial sector, and 274 GWh (0.12%) for transportation especially commuter train of as shown in Figure 1.9.



Source : HEESI, 2018

Figure 1.9 Electricity Sale 2018

1.2 Projection Accuracy

The outlook is always updated with both the latest policy information and also the methodology. Based on the analysis, there is an increase of accuracy in the final energy demand projection in 2016, 2017 and 2018 from IEO 2016 to IEO 2017. From the comparison, the final energy demand projection in IEO 2017 shows smaller disparity than the final energy demand projection in 2016 (decreases 0.1% on average).

1.3 Methodology

1.3.1 Modeling Analysis Framework

The modeling analysis is divided into three stages namely analysis on final energy demand, energy transformation, and primary energy supply. The final energy demand analysis is carried out by using the assumptions of GDP growth, population growth, policy, strategic plan (Renstra) and roadmap on current energy development. The primary energy supply analysis is carried out by considering the

utilization of various energy sources and energy resources potential including the applicable policies and the current energy technology development. Meanwhile, the energy transformation analysis is carried out by considering RUPTL, RUEN, and emission reduction. The modeling analysis framework is shown in Figure 1.10.

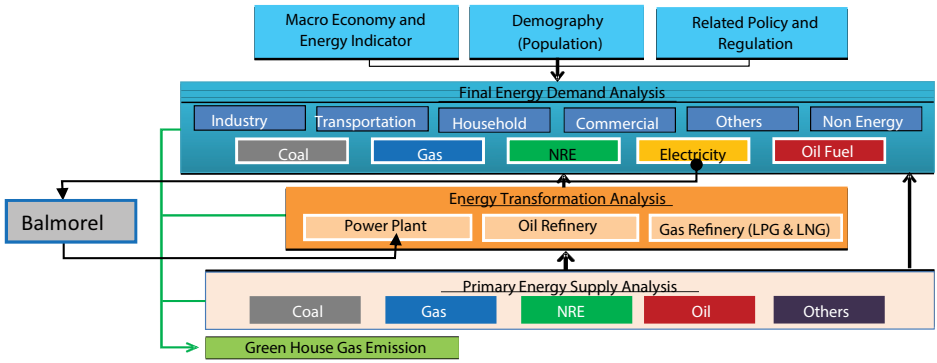


Figure 1.10 Modeling Analysis Framework

The energy supply and demand analysis is carried out based on calculation of LEAP model as a simulation model in energy planning which can conduct an integrated energy supply and demand analysis. In LEAP model, energy demand projection is calculated based on the multiplication of energy consumption activity and energy consumption intensity. Energy activity is described by economic growth, population and production. Meanwhile, energy intensity is the level of energy consumption per GDP or per population or per production in particular period. Energy intensity can be considered as fixed during simulation period or declining to show energy efficiency increase.

Based on analysis framework in Figure 1.10, the parameter in projecting final energy demand is social economic data including population and economic growth, historical data in energy consumption (energy intensity and energy consumption pattern) due to living standard improvement which is influenced by GDP increase projection and more efficient technology. The energy data in 2018 is used as the baseline data while data history in the last five years is used to see the trend.

The calculation of fuel supply for power plant and types of power plant uses Balmorel model as the energy planning modeling application especially for electricity supply with optimization approach (least cost). Electricity demand per sector from LEAP model will become the input in projecting fuel supply for power plant in Balmorel model. The correlation between LEAP and Balmorel in calculating energy demand is shown in Figure 1.11.

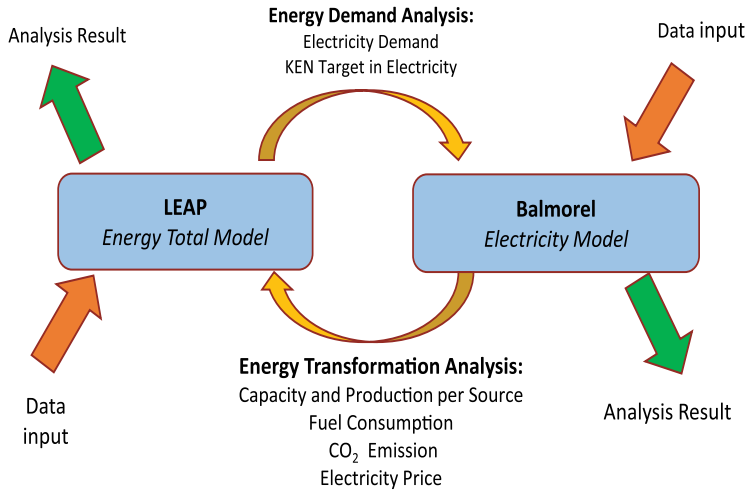


Figure 1.11 LEAP and Balmorel Synergy

1.3.2 Energy Projection Scenario

1.3.2.1 BaU Scenario

Data from Statistics Indonesia shows that Indonesia economy real growth in 2017 and 2018 is 5.07% and 5.17%. Based on State Budget 2019, Indonesia economic growth in 2019 is targeted to reach 5.3%. Besides that, Bappenas's publication data on Indonesian Vision 2045 predicted that Indonesia economic growth until the year 2045 is around 5.6%. This has become one of the considerations in formulating long term Indonesia energy demand scenario since statistically every economic growth comes together with energy demand growth.

This scenario also uses targets in KEN and RUEN, RIPIN 2015-2035 and Renstra of each ministry which is adjusted to the current realization. The development of electric vehicle as well as substitution LPG to induction stove, city gas, and DME substitution for household are also considered in the future energy demand projection.

The assumptions in electricity supply analysis using Balmorel model to count power plant until 2028 uses power plant capacity based on RUPTL (not including planned-power plant). For power plant after 2028, the addition of power plant is conducted with optimization model. Another assumption used is primary energy price which refers to the book of Technology Catalogue (Secretariat General of National Energy Council and DEA's publication) for power plant and World Energy Outlook 2017 (IEA) for fossil energy price.

1.3.2.2 PB Scenario

PB scenario mostly uses RUEN assumptions with the same economic and population growth assumption in BaU scenario. Furthermore, it is also considering the target of 30% biodiesel and 20% bioethanol utilization by 2025 based on Minister of Energy and Mineral Resources Regulation No.12 of 2015. In 2050, the target of biodiesel and bioethanol utilization is assumed to be 30% and 50% respectively. The use of electric vehicle and induction stove is assumed to be bigger than in BaU scenario. The city gas development is assumed to reach 1 million household connections per year starting from 2020.

For power plant, PB scenario fulfils the primary energy target set out in RUEN; moreover, it is assumed that 10% of power plant capacity from Coal Steam Power Plant are converted to Biomass Power Plant, and the use of rooftop solar in 25% of the luxury houses.

1.3.2.3 RK Scenario

RK scenario is formulated with the assumption of higher greenhouse gas emission reduction than the government's target. This scenario implies that higher contribution by Indonesia in supporting the global effort (based on Paris Agreement) to prevent earth temperature increase above 2 degree Celsius. In RK scenario, the target of biodiesel and bioethanol utilization in 2025 is the same with the target in BaU and PB scenario. The target increases to 100% (B100) biodiesel and 85% (B85) bioethanol by 2050. The city gas development will be also optimized to more than 1 million household connections starting from 2020. The use of electric vehicle and induction stove is also assumed to be higher than in BaU and PB scenario. Energy conservation is projected to be higher, in line with the world and domestic's tendency in using more energy saving products. An overview of the detailed assumptions used in the three scenarios can be seen in Table 1.2.

Table 1.2 Scenario Assumption

Assumption	BaU	PB	RK
Economic Growth	5.6% (Based on 2045 Indonesian Vision – Bappenas)		
Population Growth	0.7 % (Based on Statistics Indonesia – Bappenas 2045)		
Biodiesel Target	2025: 20%	2025: 30%	2025: 30%
	2050: 30%	2050: 30%	2050: 100%
Bioethanol Target	2025: 5%	2025: 20%	2025: 20%
		2050 : 50%	2050: 85%
City gas development	Year 2025 : 4.7 Million household connection	The development of 1 Million household connection/Year starting from 2020	The development of > 1 Million household connection/Year starting from 2020
Substitution of LPG to Induction Stove	2025: 0.5%	2025: 1%	2025: 2%
		2050: 2%	2050: 5%
LPG substitution with DME	2050: 20%	2025: 20%	2025: 20%
Electric Car Target (% toward total vehicle population)	2025: 0.01%	2025: 0.01%	2025: 0.5%
	2050: 0.07%	2050: 0.24%	2050: 1.18%
Electric Motorcycle Target (% toward total vehicle population)	2025: 1.38%	2025: 1.44%	2025: 1.18%
	2030: 1.5%	2030: 1.7%	2030: 3%
Power Plant	RUPTL	RUEN	Emission reduction > RUEN
		Swtiching 10% capacity of Steam PP to Biomass PP	Switching 30% capacity of Steam PP to Biomass PP
		25% luxury houses use Rooftop Solar	30% luxury houses use Rooftop solar

1.3.3 Modeling Assumption

1.3.3.1 Population Growth

Population growth highly influences energy demand volume and composition, both directly and indirectly from its impact to economic growth. In the last two decades, Indonesia population growth rate tends to decline. Based on Indonesia population projection publication year 2010-2045 (Statistics Indonesia-Bappenas 2014), Indonesia population growth will be above 1% in the period of 2015-2020. Then it will decline to below 1% in the period of 2020-2040 and below 0.5% after 2040.

The energy consumption in household is distinguished between rural and urban people since the energy consumption pattern between the two is different. The urban people consume more energy due to the increase of GDP per capita and the availability of electric household appliances.

1.3.3.2 Economic Growth

Energy demand is closely related to economic activity. Thus, the economic growth assumption will be very sensitive toward energy demand projection from the three developed scenarios. Indonesia economic growth in the last five years tends to decline from 5.6% in 2013 to 5.17% in 2018. It is due to the slowing global economy, uncertainty in global financial markets, and the declining world trade volume.

The economic growth assumption is adjusted to the economic growth assumption in "2045 Indonesian Vision" published by Bappenas. Indonesia economic growth in next following years will be supported by the increasing domestic demand including consumption and investment as well as better export growth in manufacture sector, as the main energy consumer in the industry.

1.3.3.3 Energy-related Policy Assumption

The energy demand projection also considers several current energy-related policies, including:

1. **National Energy Policy**

   National Energy Policy (KEN) mandates renewable energy mix target in primary energy mix to reach at least 23% by 2025 by minimizing the use of oil at least 25% by 2025. Besides that, energy efficiency is also targeted to decline 1% per year in the effort to promote energy saving in all sectors. Several targets in KEN that also become considerations in energy demand projection are optimization of domestic gas consumption and fossil energy priority for national industry raw material.

2. **National Energy General Plan**

   National Energy General Plan (RUEN) is the mandate of Law No. 30 Year 2007 on Energy. Based on Article 17 Paragraph (1) of this Law, the government formulates the draft of RUEN based on KEN. The target in RUEN which becomes the consideration in energy demand projection is city gas, electric vehicle target, primary energy mix of power plant, and the use of DME to substitute LPG.

3. **Strategic Planning of MEMR**

   Several programs of MEMR Strategic Planning (Renstra) which are considered in calculating energy demand projection are city gas, kerosene to LPG conversion program, fuel to gas conversion in transportation, and biofuel mandatory.

4. **Strategic Planning of the Ministry of Transportation**

   A number of programs in the Strategic Planning of the Ministry of Transportation which become the considerations in the energy demand projection are such as the operation plan of BRT (Bus Rapid Transit), Mass rapid Transit (MRT), and Light Rail Transit (LRT) which are currently being constructed in Jakarta and Palembang. There are also considerations on the use of biofuel especially for land transportation, gas fueled vehicle and electric vehicle (electric bus) in Jakarta.

5. **Strategic Planning of the Ministry of Industry**

   The Strategic Planning of the Ministry of Industry also becomes a consideration in calculating energy demand projection such as upstream petrochemical industry with gas as its raw material, smelter, as well as electric and hybrid transportation mode industry from upstream to downstream.

6. **RUPTL 2018-2027**

   Power plant capacity data which refers to RUPTL 2019-2028 includes the development planning for power plant in construction stage with the consideration that power plant operation is based on COD (Commercial Operation Date) plan.

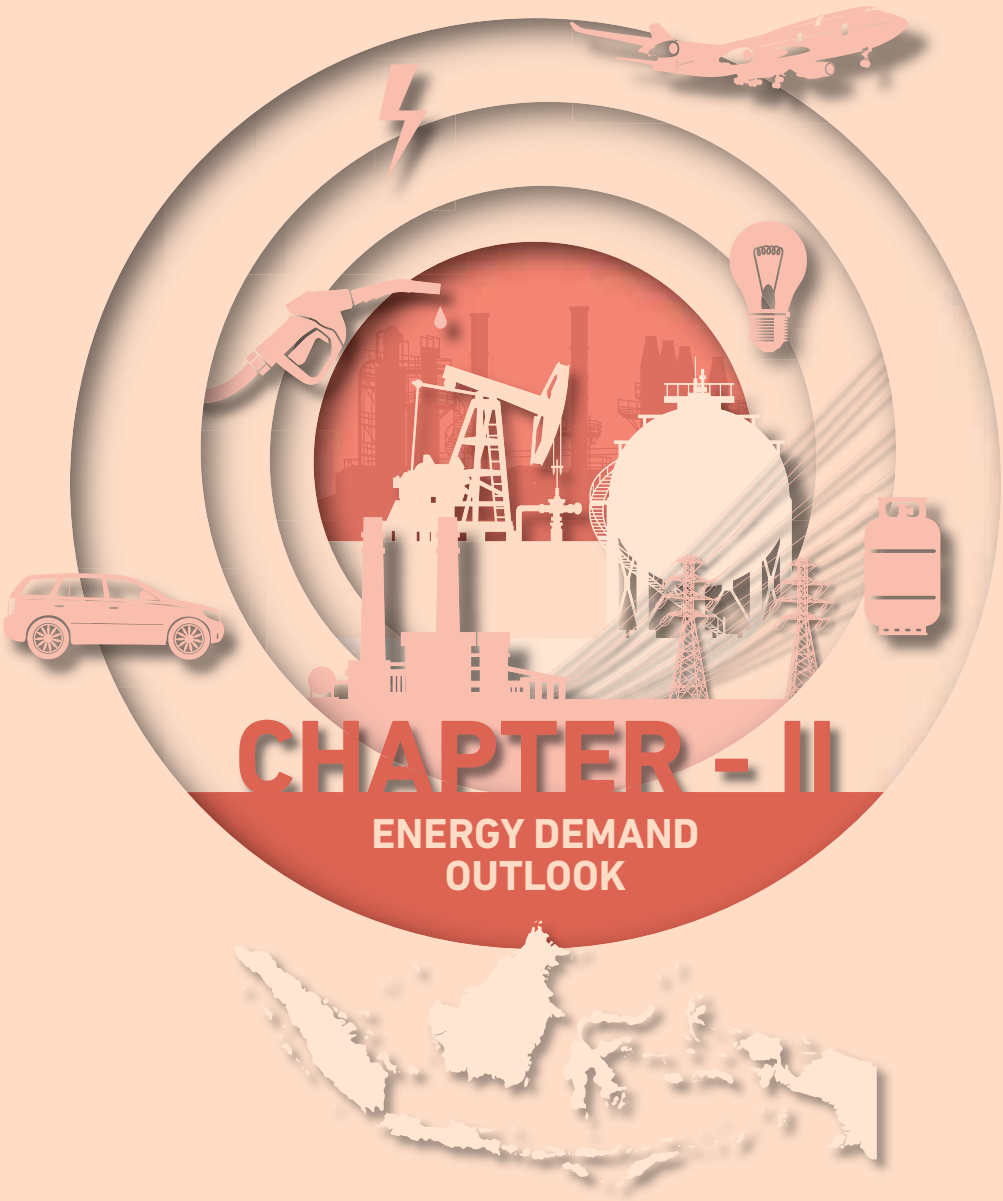
7. ***Biofuel Roadmap***

   Biofuel mandatory is considered as one of the assumptions in final energy demand projection in transportation, industry, commercial sector and power plant

8. **Special Industry**

   In energy demand projection analysis, industry is specifically divided into two types based on data availability. They are special industry and other industry. Special industry for this outlook analysis consists of energy consuming industry such as fertilizer industry, cement and ceramic industry. In order to count energy demand projection in special industry, energy consumption intensity data from a number of industrial associations is used. The associations are *Asosiasi Produsen Pupuk Indonesia* (APPI/Indonesian Fertilizer Producers Association), *Asosiasi Semen Indonesia* (ASI/Indonesia Cement Association), and *Asosiasi Aneka Keramik Indonesia* (ASAKI/Indonesia Ceramic Industry Association). Besides that, production growth in each industry is also a reference in the energy demand projection analysis.

Meanwhile, other industry includes food and beverage industry, textile, wood, metal, non-metal, engine, and other industries which use GDP per industry type approach in calculating the energy intensity.



CHAPTER - II

ENERGY DEMAND OUTLOOK

2 ENERGY DEMAND OUTLOOK

Energy demand projection 2019-2050 is derived from calculating intensity and activity per energy source in each sector by using 2018 as baseline data. Increasing and decreasing of energy trend in each scenario is calculated based on assumptions in Table 1.2 of Chapter I.

The national final energy demand in BaU, PB and RK scenario will increase with an average annual growth of 5.0%, 4.7% and 4.3% respectively. Thus, the demand in 2050 is 548.8 MTOE, 481.1 MTOE, and 424.2 MTOE respectively. The final energy demand saving in PB scenario compared to BaU scenario in 2050 is 12%, while the final energy demand saving in RK scenario compared to BaU scenario in 2050 is 23%. The comparison of energy demand in three scenarios is shown in Figure 2.1.

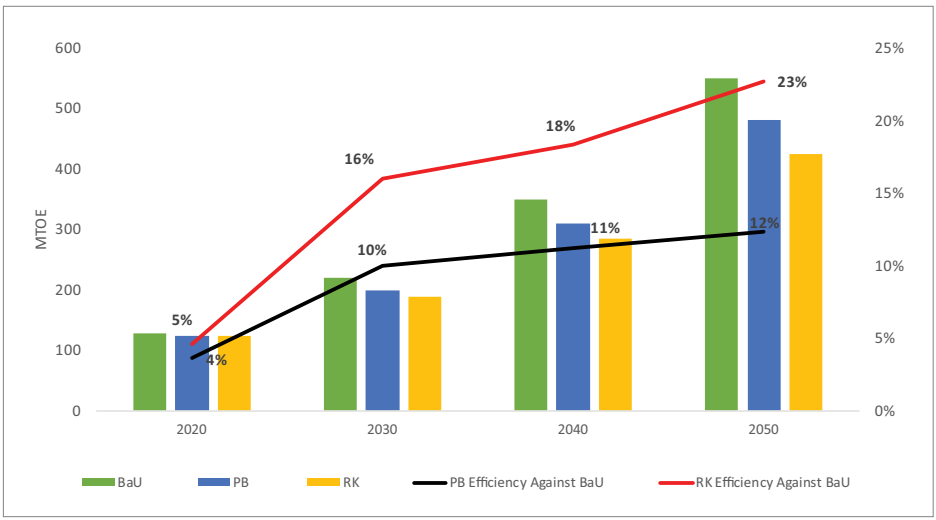
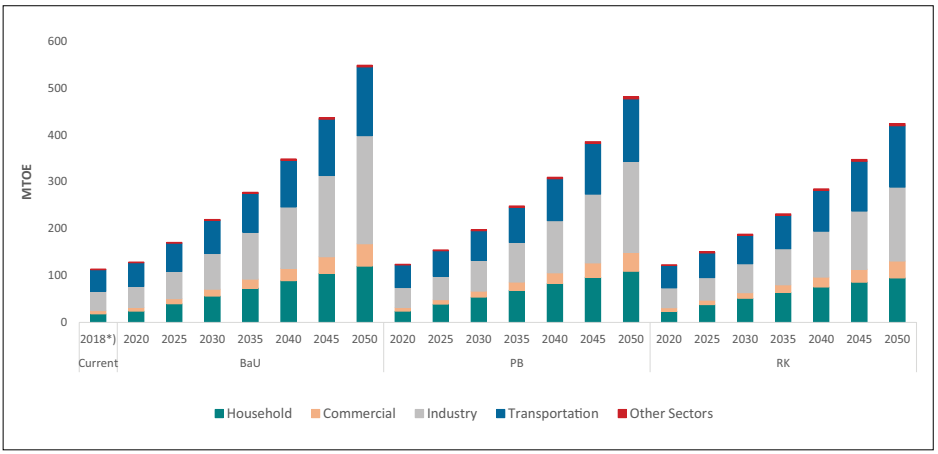


Figure 2.1 Comparison of Final Energy Demand Three Scenarios

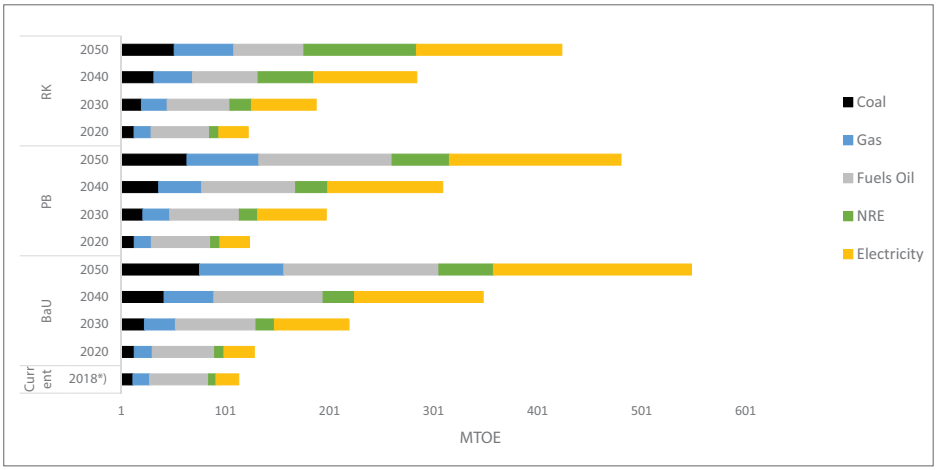
Final energy demand until 2050 will still be dominated by industry and transportation, same with 2018 condition. The increase of industrial activity and vehicle activity give a significant contribution in the increase of energy demand in both sectors. The demand in industry is projected in line with the industrial growth projection in "2015 Indonesia Vision" while energy demand in transportation is influenced by vehicle growth, fueled vehicle to electric vehicle substitution program, biodiesel and bioethanol mandatory program, and the shift from private car to mass transportation. In 2050, industry will dominate other sectors until the share reaches 42% in BaU scenario, 40% in PB scenario, and 37% in RK scenario. The biggest energy demand after industry is transportation, household, commercial sector and other sectors as seen in Figure 2.2.



Note: *) Temporary Data

Figure 2.2 Final Energy Demand per Sector

Final energy demand by type energy show the electricity demand in 2050 will be more dominant at 35% (BaU), 34% (PB) and 33% (RK) respectively. The high electricity demand is influenced by the increasing use of electronic appliances especially in household as well as the substitution of generator in industry and commercial sector to on-grid transmission. The trend of final energy utilization from 2018-2050 is shown in Figure 2.3.



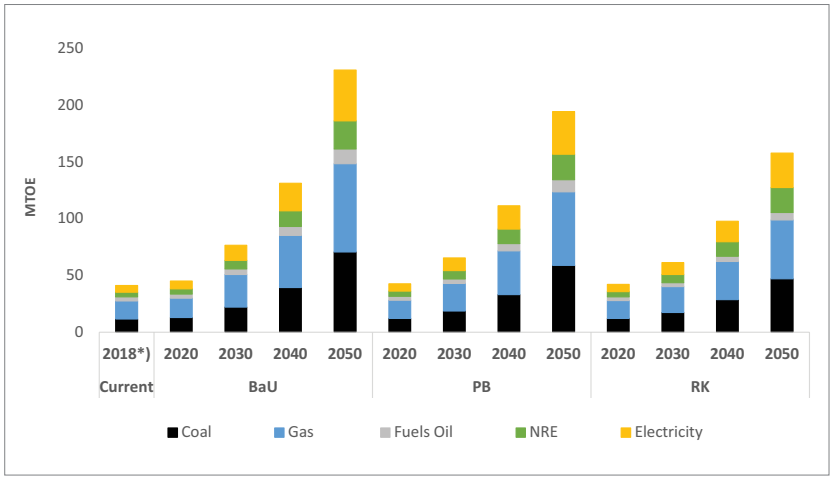
Note: *) Temporary Data

Figure 2.3 Final Energy Demand per Energy Source

2.1 Industry

Gas and coal are still the main energy sources in industry until 2050. Gas is mostly used to meet the demand of metal, fertilizer (as feed stock) and ceramics industry. These three industries consume around 83% of gas from the total gas demand in industry. Meanwhile, coal is 90% consumed by cement industry. NRE is especially used for food and paper industry. Several food industries still use biomass as fuel, while paper industry uses renewable energy such as palm oil shell, rice straw, biogas and black liquor to substitute coal. NRE demand trend in food industry will decline in line with the declining of biomass utilization. However, the trend of NRE demand in paper industry is projected to increase.

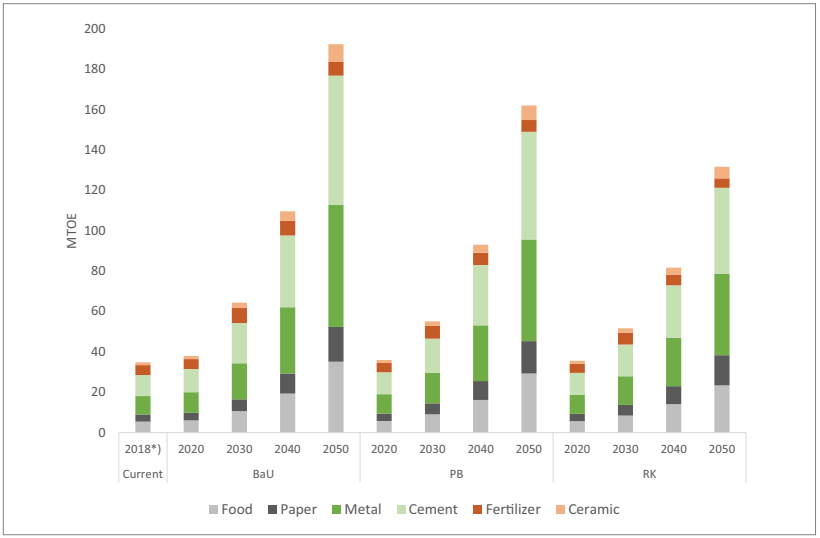
In 2050, energy demand in industry will reach 230.9 MTOE (BaU), 194.3 MTOE (PB) and 157.7 MTOE (RK). Energy demand in industry per energy source can be seen in Figure 2.4.



Note: *) Temporary Data

Figure 2.4 Energy Demand in Industry by Energy Source

There are 6 (six) industrial sub sectors which highly consume the energy such as cement, metal, food and beverage, fertilizer, ceramics and paper industry. The total energy demand in these six industries contributes 87% of the total energy consumption in industry. The development of energy demand in six major industrial sub sectors is shown in Figure 2.5.



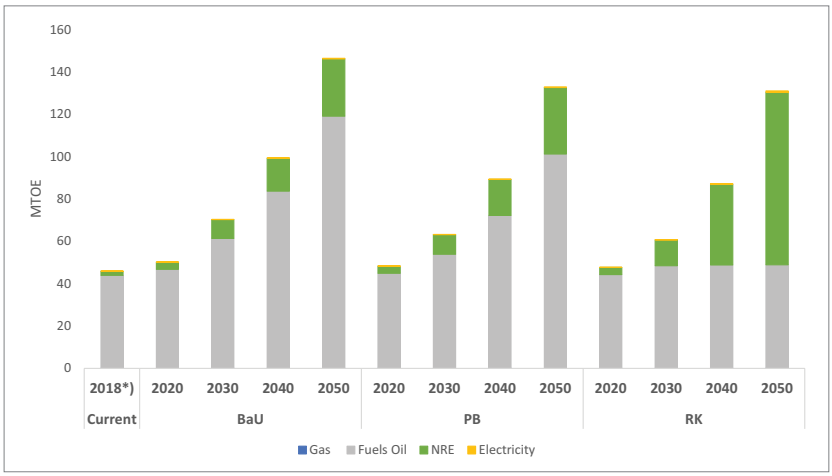
Note: *) Temporary Data

Figure 2.5 Energy Demand in Six Major Industry Sub Sectors

2.2 Transportation

Gasoline, diesel, gas, avtur, avgas, biodiesel, bioethanol, and electricity are energy sources consumed in transportation. In 2018, the biggest energy demand in transportation is fuel (96%), while the rest is biodiesel and gas. To reduce fuel consumption in transportation which is mostly supplied from import, the government has issued a policy to substitution of fuel to biofuel. Currently, the realization is the implementation of B-20 (the mixture of 20% biodiesel in diesel oil). Another policy in transportation is the substitution of fuel to gas and electricity, but the implementation is still far from expected. Thus, the share of oil in BaU and PB until 2050 will still be high. In RK scenario, the oil demand in 2050 will decline due to the implementation of 100% green diesel and 85% bioethanol. The oil demand share will be 37% while NRE demand share will increase to 62% in RK scenario in 2050.

The use of electric vehicle in three scenarios had much effect on electricity demand since the number of electric vehicles is assumed to be smaller than conventional vehicles. More detail explanation on electric vehicle is described in Chapter IV. The description of energy demand in transportation is in Figure 2.6.



Note: *) Temporary Data

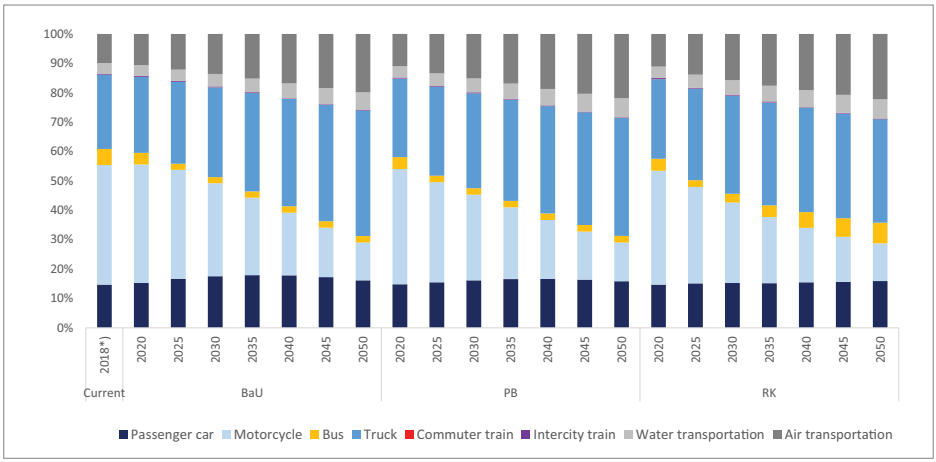
Figure 2.6 Energy Demand in Transportation

In 2018, the biggest energy demand in transportation is motorcycles (41%). It is influenced by the number of motorcycles which has reached more than 118 million units. In 2050, it is projected that the comparison of the trend of the number of motorcycle in each household will be the same the current trend where each household has 2 motorcycles. Thus, the energy demand share of motorcycle will decline due to the shift of passengers to mass transportation (MRT, LRT, electric train). As a whole, there is an increasing energy consumption of mass transportation from 11.5 MTOE in 2025 into 41.3 MTOE in 2050 (BaU); 11.1 MTOE in 2025 into 41.0 MTOE in 2050 (PB); and 11.0 MTOE in 2025 into 47.2 MTOE in 2050 (RK). Nonetheless, the number of motorcycles is still quite high since it is still the most favorite mode of transportation especially in big cities with the consideration that it has faster time-travel compared to other vehicles.

In all scenarios, energy demand in air transportation has the highest growth during the projection period of 6% in average. Thus, the demand of avtur increases from 4.5 MTOE in 2018 to 27.6 MTOE in 2050. This condition is encouraged by the increasing people's welfare and the rapid development in tourism sector which drives people to travel.

Meanwhile, truck shows an increase of energy demand at the average of 5% in the projection period in all scenarios. Thus, the energy demand share is still high until 2050 of about 43%. It is the biggest among other types of vehicle. The trend of digital economy and the increasing online transaction (e-commerce) become a trigger of energy demand increase in trucks since the distribution of goods usually uses trucks.

For passenger-vehicle mode of transportation, there is an increase trend of energy demand, but the growth can be reduced by the utilization of a more energy saving technology. Thus, energy demand in 2050 increases from 6.7 MTOE in 2018 to 23.7 MTOE in BaU, 21.1 MTOE in PB, and 20.9 MTOE in RK. The energy demand based on the mode of transportation in three scenarios can be seen in Figure 2.7.



Note: *) Temporary Data

Figure 2.7 Energy Demand by Mode of Transportation

2.3 Household

Energy demand in household is influenced by the increasing number of household of about 70.6 million in 2025 and 80 million in 2050. Besides that, the urbanization rate also drives the increasing of energy demand in the future. Based on Statistics Indonesia projection, the urbanization rate will reach 67% in 2035 from 49.8% in 2010 (Figure 2.8).

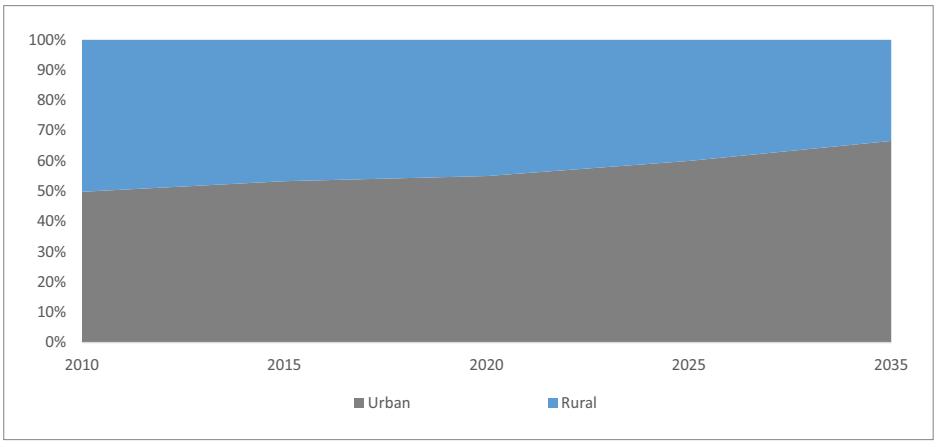
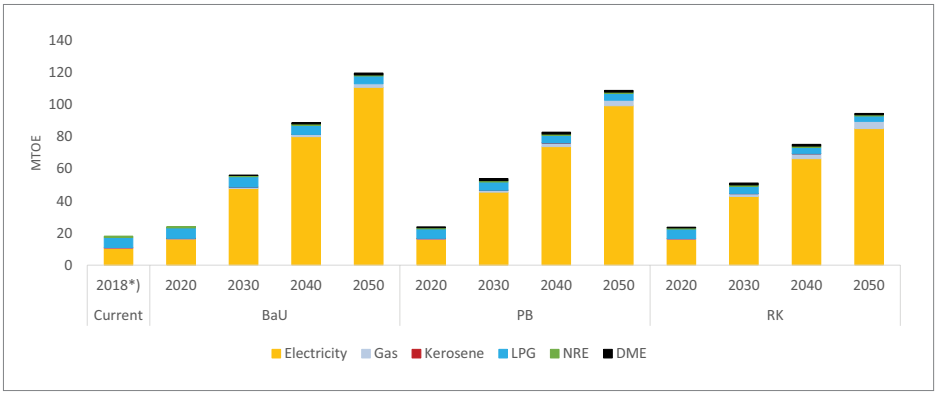


Figure 2.8 Projection of Rural and Urban People's Share until 2035

The energy demand in household in 2050 will reach 120 MTOE (BaU), 109 MTOE (PB) and 94.7 MTOE (RK). The dominant type of energy consumption on household in 2050 is electricity. The electricity demand increases from 60% in 2018 to 90% in 2050. The increasing of electricity demand is driven by the increasing use of electronic appliances in household such as AC, refrigerator, water pump, and induction stove. Meanwhile, LPG demand in BaU, PB and RK in 2050 will be 4.8 MTOE, 4.3 MTOE and 3.4 MTOE respectively, in line with the substitution program from LPG to city gas, induction stove and DME.

The city gas for household program based on RUEN will reach 4.7 million household connections that it is used as a reference in gas demand projection. To meet the target of city gas development in RUEN in 2025, there is a need to connect 1 million household connections per annum. In BaU, it is assumed the same with in RUEN. In PB, the growth is 1 million households connection/year. In RK, the growth is more than 1 million household connections/year. Based on the projection, gas demand in BaU, PB and RK in 2050 will reach 2.2 MTOE, 3.4 MTOE and 4.5 MTOE respectively.

The kerosene to LPG substitution is still included as assumption in this outlook which is projected to be completed in 2022. The energy demand projection in household is shown in Figure 2.9.



Note: *) Temporary Data

Figure 2.9 Energy Demand Projection in Household

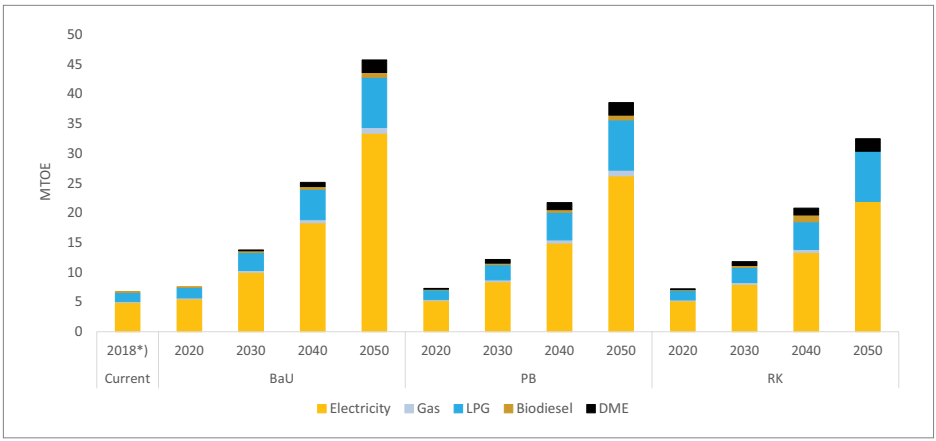
2.4 Commercial Sector

Energy demand in commercial sector includes offices, hotels, restaurants, hospitals, and other services. Energy for commercial sector are electricity, LPG, diesel, gas, biodiesel, and DME. Energy demand in commercial sector is dominated by electricity of about 60% to 70%. The electricity consumption in commercial sector is mostly used for AC, water pump, and lights.

Furthermore, LPG demand share is still high of about 22% from the total energy demand in commercial sector. LPG in commercial sector is used for cooking especially in hotel and restaurant.

In 2050, the share of diesel and biodiesel demand in commercial sector is around 5% and 2% respectively, that used for generator as backup power supply.

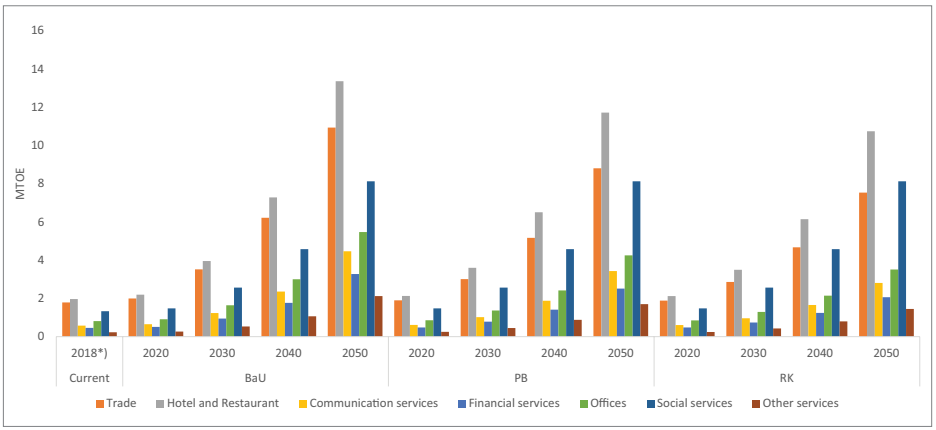
The total final energy demand in commercial sector in 2050 is 47.7 MTOE (BaU), 40.5 MTOE (PB) and 36.2 MTOE (RK). The growth of energy demand in commercial sector can be seen in Figure 2.10.



Note: *) Temporary Data

Figure 2.10 Energy Demand in Commercial Sector by Energy Source

Energy demand in commercial sector in all scenarios show similar trend. Almost 50% of energy demand is consumed by trade, hotel and restaurant sub sector. While the remaining 50% is consumed by social services, communication services, financial services and offices sub sector. The overview of final energy demand per commercial sub sector can be seen in Figure 2.11.



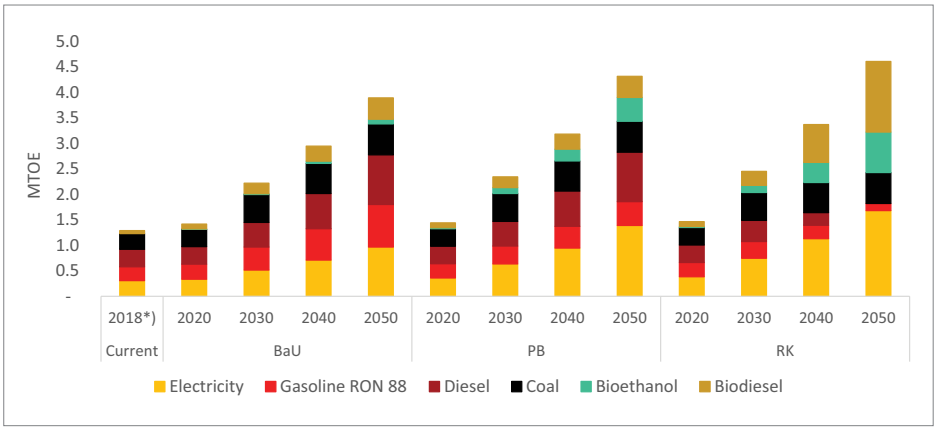
Note: *) Temporary Data

Figure 2.11 Final Energy Demand in Commercial Sector by Energy Source

2.5 Other Sectors

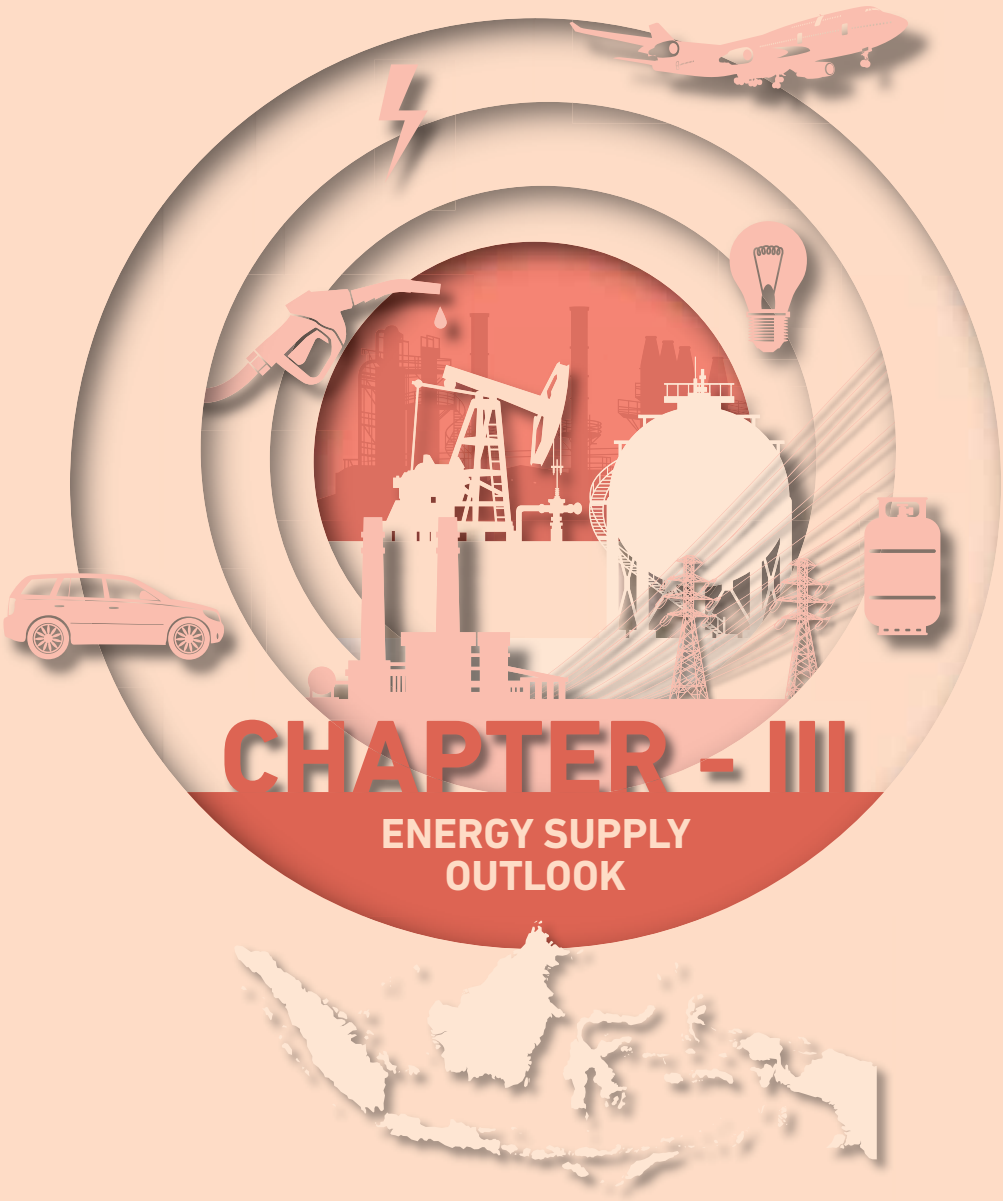
Other sectors consist of three sub sectors, namely agriculture, mining and construction. Energy demand in other sectors includes coal, diesel, biodiesel and electricity. Coal is used in mining, while diesel and biodiesel are used for generator as backup power supply. Electricity is mainly used for lights and other electronic appliances.

The energy demand share in mining sector will decline from 43% in 2018 to around 27% in 2050. One of the factors is the limited coal and mineral reserves. On the other hand, the energy demand share in construction sector will increase from 26% in 2018 to 42% in 2050 which is influenced by population and economic growth. The total final energy demand in other sectors in 2050 is 3.9 MTOE (BaU), 4.3 MTOE (PB), and 4.6 MTOE (RK). The growth of final energy demand in others sectors can be seen in Figure 2.12.



Note: *) Temporary Data

Figure 2.12 Final Energy Demand by Commercial Sub Sector



CHAPTER - III

ENERGY SUPPLY OUTLOOK

3 ENERGY SUPPLY OUTLOOK

Primary energy supply projection in the period 2019-2050 is formulated based on assumption and data in RUEN such as energy potential, fossil energy production as well as coal and gas export limitation policy. Primary energy supply for power plant is included in the modeling based on power plant capacity assumption based on RUPTL which produces primary energy demand for each power plant.

Primary energy supply in BaU scenario in 2025 and 2050 is projected to reach 314 MTOE and 943 MTOE. A number of policies have been implemented such as energy diversification, energy efficiency, and environment to give an impact on a more rational primary energy supply growth. In the last several years, the government has revoked energy subsidies such as subsidy for gasoline RON 88 (premium) and electricity for high income households. It is predicted that the increase of economic activity will not influence the increase of fuel and electricity price. Thus, the energy demand will keep increasing especially fossil energy demand such as coal, gas and crude oil. These three fossil energy sources are still the main options to meet the national energy demand until 2050.

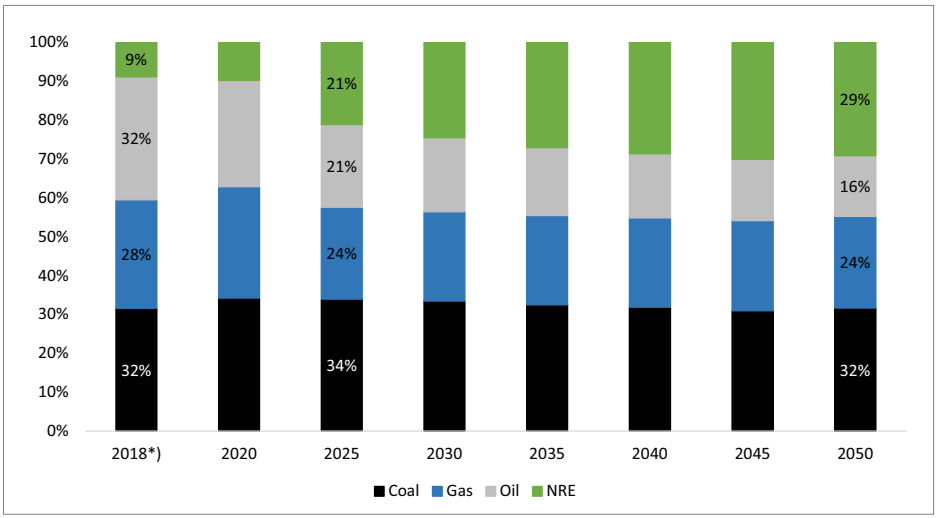
From its source of energy, coal supply including briquette will increase to 298 MTOE or the share will increase around 32% in 2050. Coal is prioritized as raw material in coal gasification and coal liquefaction as well as DME for an added value. On the other hand, coal for power plant is projected to be limited only for mine mouth Steam Power Plant.

The total gas demand includes piped gas, LPG and LNG will increase to 222 MTOE in 2050 or 24% from the total primary energy supply which is prioritized to meet domestic gas demand. The increase of domestic gas utilization is carried out through national gas infrastructure development such as gas pipeline network

based on Gas Transmission and Distribution Network Master Plan as well as Floating Storage Regasification Unit (FSRU) for LNG utilization in the area far from gas sources and city gas for household in the area near gas sources.

Oil demand in 2050 will increase to 147 MTOE. Thus, its share in primary energy supply will decrease to 16%. The increasing oil demand is influenced by the increasing use of oil in transportation both in the form of blend of biodiesel and bioethanol as well as fuel (gasoline, diesel and avtur).

NRE demand in 2050 will reach 275 MTOE and its share will increase up to 29%. The increase of NRE supply is conducted through optimization of utilization on solar cell, biomass, geothermal and hydro for power plant as well as through substitution of fuel to biofuel especially in transportation. The growth of energy mix in projection period can be seen in figure 3.1.



Note: *) Temporary Data

Figure 3.1 Primary Energy Mix Growth by BaU Scenario

In PB scenario, the primary energy supply is smaller than in BaU scenario of about 828 MTOE in 2050. On the other hand, NRE share in primary energy mix in PB scenario is bigger than in BaU scenario of about 23% in 2025 and 32% in 2050. This number is based on target in KEN and RUEN. The comparison of primary energy mix in PB scenario in 2025 and 2050 can be seen in Figure 3.2.

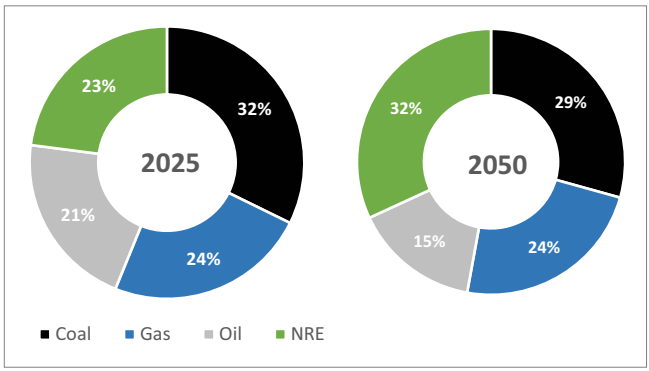


Figure 3.2 Primary Energy Mix Comparison by PB Scenario

In RK scenario, NRE share in primary energy mix will increase significantly of 36% in 2025 and 58% in 2050. The implementation of high biofuel mix (E85 and B100) is one of the factors which contribute the high NRE share in RK scenario. B100 is projected to be utilized in 2050 which enables the availability of technology that produces POME with limited land and high production. The comparison of primary energy mix in RK scenario in 2025 and 2050 can be seen in Figure 3.3.

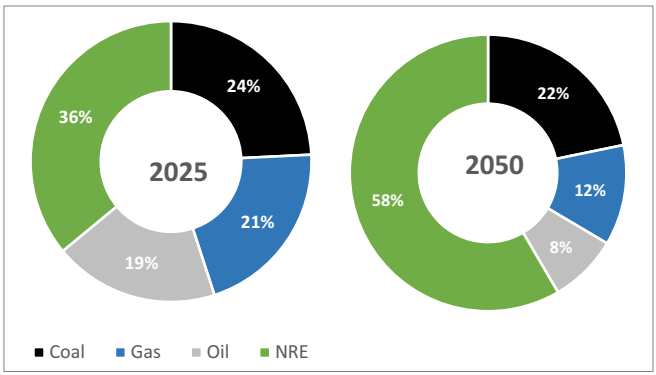
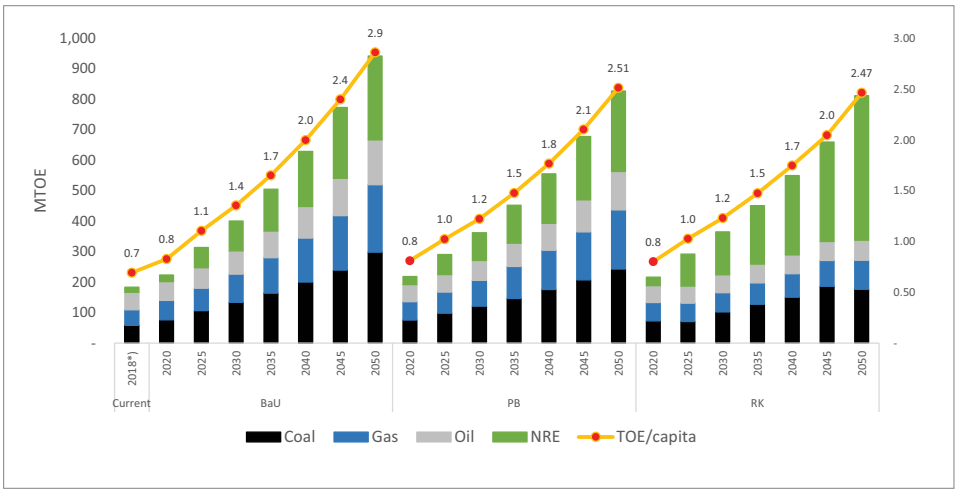


Figure 3.3 Primary Energy Mix Comparison by RK Scenario

KEN targeted primary energy supply per capita in 2025 and 2050 of 1.4 TOE/capita and 3.2 TOE/capita respectively. The projection of primary energy supply per capita in BaU scenario is still below the target of KEN of 1.1 TOE/capita in 2025 and 2.9 TOE/capita in 2050. Furthermore, primary energy supply per capita in PB and RK scenario in 2050 is smaller than in BaU of 2.51 TOE/capita and 2.47 TOE/capita respectively. This condition occurs since the economic growth assumption in KEN is higher than the economic growth assumption in three scenarios. The projection of primary energy supply per capita for three scenarios can be seen in Figure 3.4.

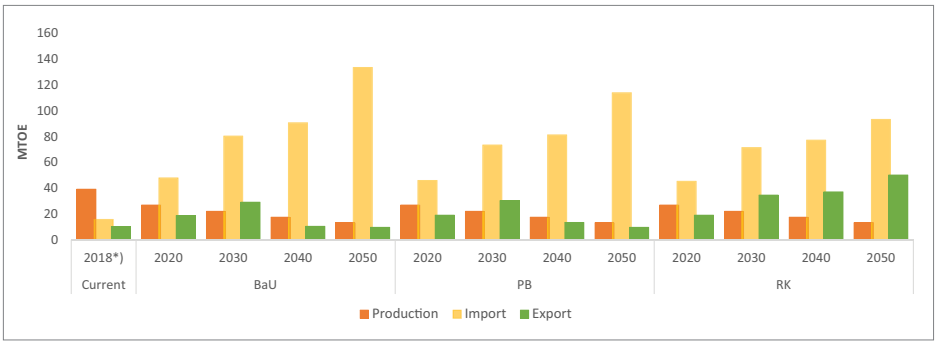


Note: *) Temporary Data

Figure 3.4 Primary Energy Supply Projection per Capita

3.1 Oil Supply

To meet the demand in each sector and power plant until 2050, it needs 146.6 MTOE (BaU) of oil supply. It increases four times from oil supply in 2018 of 54.8 MTOE. Meanwhile, to meet the oil needs in the PB and RK scenarios, the supply of oil is needed at 127.1 MTOE and 106.4 MTOE respectively. Crude oil production for the three scenarios in 2050 shows a declining trend especially influenced by the small number of oil and gas exploration and the low success rate of exploration by oil companies. Moreover, the oil and gas investment climate are less conducive for business players and the implementation of Enhanced Oil Recovery (EOR) technology to boost oil production is not yet optimal. The trend of oil supply in projection period is shown in Figure 3.5.



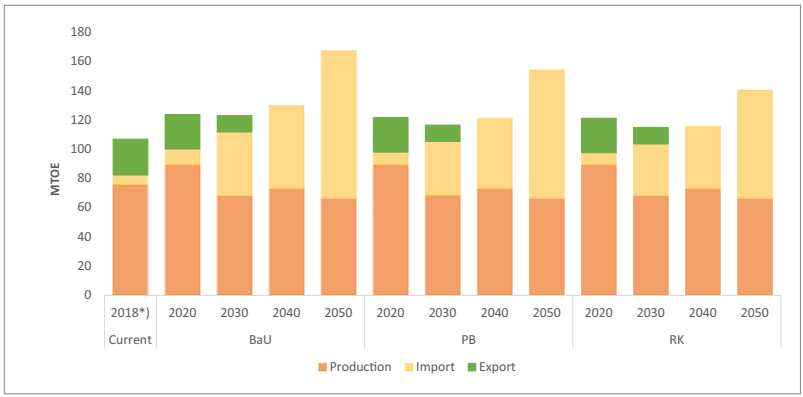
Note: *) Temporary Data

Figure 3.5 Crude Oil Supply Trend

3.2 Gas Supply

Based on the projection, gas supply in 2050 will reach 167.4 MTOE in BaU scenario or increases three times from the condition in 2018. In PB and RK scenario, gas supply for each scenario is 154.2 MTOE and 140.3 MTOE. Similar with oil, domestic gas supply also shows a decline since new gas reserves are not discovered yet. Gas production declines from 75.4 MTOE in 2018 to 66.3 MTOE in 2050 in three scenarios.

In optimizing gas for domestic needs, the government will stop gas export after all export contract ends. Thus, in 2040 Indonesia will be no longer a gas exporter. Gas demand will keep increasing especially in industry and power plant, as a result, in 2020, Indonesia will need to import gas. In 2050, gas import is projected to reach 101.1 MTOE (BaU), 87.8 MTOE (PB) and 74 MTOE (RK). Besides that, LPG import also shows an increase from 6.8 MTOE in 2018 to 14.9 MTOE (BaU), 13.4 (PB) and 11.4 (RK). The difference of import volume in each scenario depends on assumption of LPG to induction stove substitution and LPG to DME substitution. The overview of gas supply in projection period can be seen in Figure 3.6.

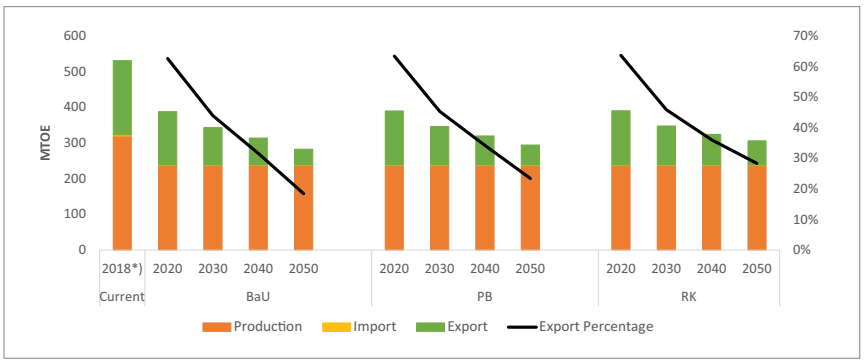


Note: *) Temporary Data

Figure 3.6 Gas Supply

3.3 Coal Supply

As the country with the five biggest coal reserves in the world (39.9 billion Ton, coal is still the main energy resources for power plant and industry. Thus, the whole coal supply will be derived from domestic production, except high calorie coal which is needed by steel industry. In the effort to secure the supply and to use domestic coal, the government based on RUEN will limit coal production at 400 million Ton/year to reduce coal export. In 2050, coal export will be 44 MTOE (BaU), 55.8 MTOE (PB) and 67.6 MTOE (RK) or it declines from 170.3 MTOE in 2018. The projection of coal export to production comparison also shows a decline from 64% in 2018 to 18% (BaU), 23% (PB) and 28% (RK) in 2050. Coal supply projection can be seen in Figure 3.7.



Note: *) Temporary Data

Figure 3.7 Coal Supply Projection

3.4 NRE Supply

Most NRE is utilized for power plant and the rest is used for transportation, industry, commercial and other sectors as raw material of biodiesel and bioethanol blends. NRE supply comes from geothermal, water, solar, wind, biomass, waste, bioethanol and biodiesel. Besides being used for power generation, biomass is also used in the industrial sector as a substitute for coal. In 2050 NRE supply will reach 275.2 MTOE (BaU), 264 MTOE (PB) and 477 MTOE (RK). The increasing NRE supply in RK scenario in 2050 is influenced by 100% biodiesel and 85% bioethanol mixture program. The illustration of NRE supply is shown in Figure 3.8.

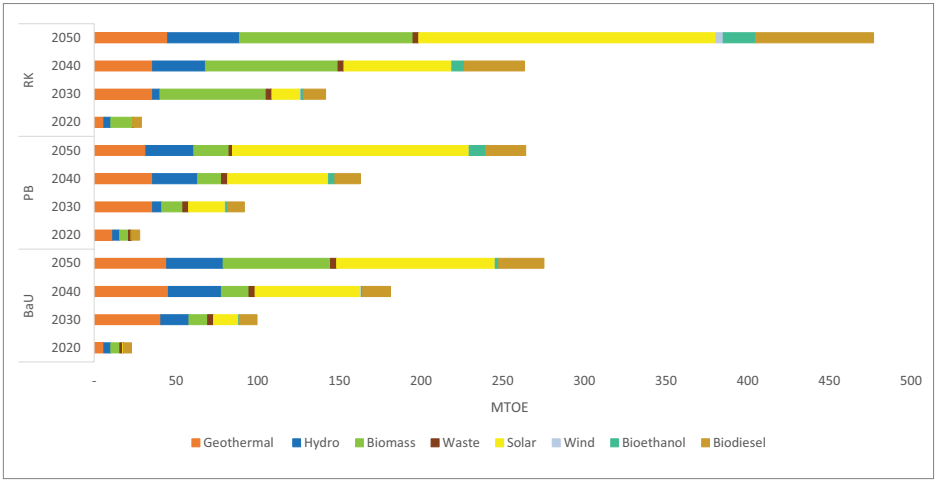
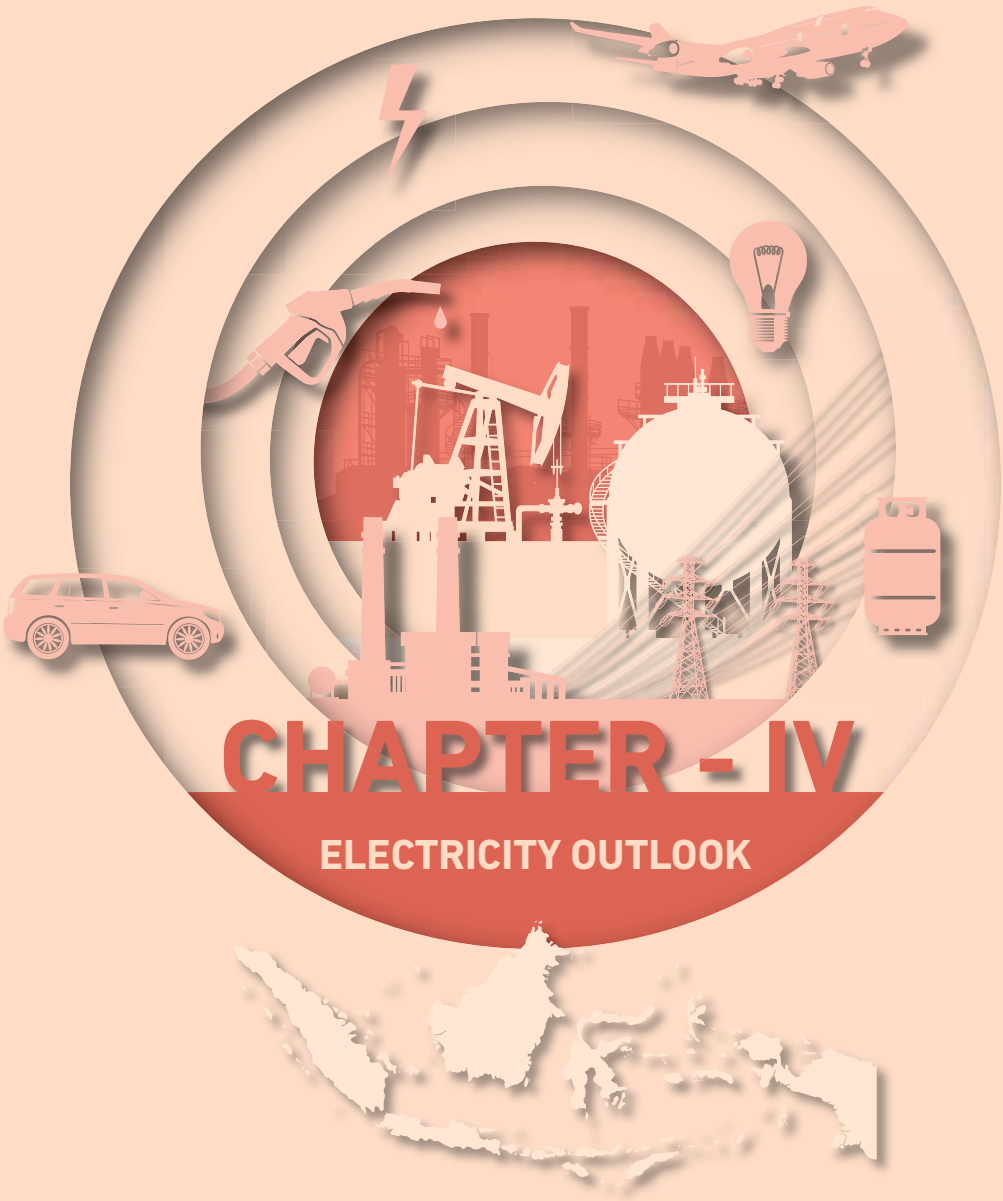


Figure 3.8 NRE Supply



CHAPTER - IV

ELECTRICITY OUTLOOK

4 ELECTRICITY OUTLOOK

4.1 Electricity Demand

Electricity demand always grows higher than other energy sources. Electricity demand growth is projected to reach 2,214 TWh (BaU), 1,918 TWh (PB) and 1,626 TWh (RK) in 2050 or increases 9 times from the electricity demand in 2018 of 254.6 TWh. Electricity demand growth rate in the three scenarios is around 7% (BaU), 6.5% (PB) and 6.0% (RK) per year during 2018-2050.

Electricity consumption pattern in three scenarios during projection period is relatively the same in which the biggest consumer is household followed by industry, commercial sector, transportation and other sectors. Electricity demand share in household will increase from 49% in 2018 to 58% (BaU), 60% (PB) and 61% (RK) in 2050 despite of energy saving in several electronic appliances such as inverter in AC and energy saving lamp (CFL). This condition is mainly influenced by the growth of household from 67 million in 2018 to more than 80 million in 2050. Furthermore, the increasing people's income also encourages the use of electronic appliances such as air conditioner (AC), refrigerator, washing machine, TV, and induction stove. The increasing use of AC, in particular, is driven by the global warming.

Similar to household, the increase of electricity demand in commercial sector is also driven by the use of AC and lamp as well as LPG and electricity for cooking especially in hotels and restaurants. Electricity demand in commercial sector will increase 7 times in 2050 to 389 TWh (BaU), 305 TWh (PB) and 255 TWh (RK).

Electricity demand in industry will increase from 70 TWh in 2018 to 521 (BaU), 436 TWh (PB) and 352 TWh (RK) in 2050. Electricity demand in industry is mostly used for metal, chemical, food, and textile industry. The launching of "Making Indonesia 4.0 Roadmap" with 5 main technologies namely Internet of Things, Artificial

Intelligence, Human–Machine Interface, Robotic and Sensor as well as 3D printing will influence the electricity demand in industry as all these industries require electricity as their energy supply.

Electricity demand in transportation is used by MRT, LRT, monorail, electric car, electric motorcycle and electric bus. Although electricity demand in transportation has the lowest share compared to other sector, its annual average growth is the highest of about 9%, in line with the development of electric vehicles by domestic industry starting from 2025. In 2025, it is assumed that there will be 2 million units of motorcycles, 2000 units of cars, and 600 units of buses (BaU scenario). In PB scenario, it is assumed that there will be 2 million units of motorcycles, 2,500 units of cars and 4,500 units of buses. In RK scenario, it is assumed that there will be 3 million units of motorcycles, 127 thousand units of cars, and 4,500 units of buses. The increase in the number of buses in the PB and RK scenarios is affected by the increasing use of buses as a mode of public transportation, although the number of motorcycles and cars has also increased. The comparison of electric vehicles in three scenarios can be seen in Figure 4.1.

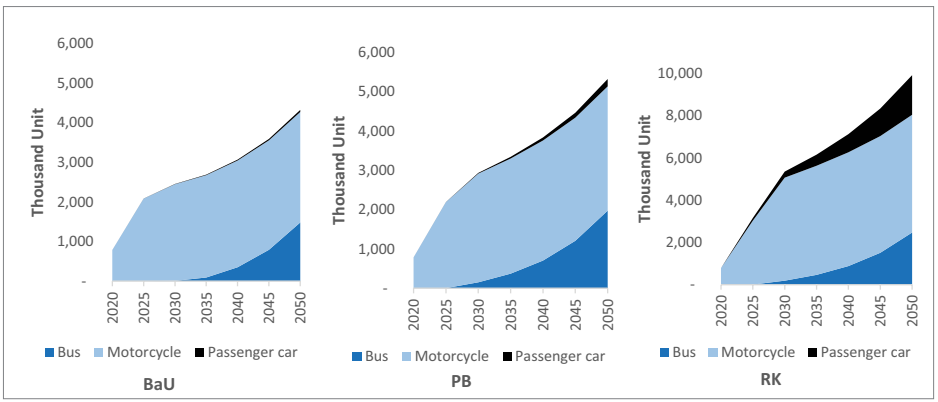


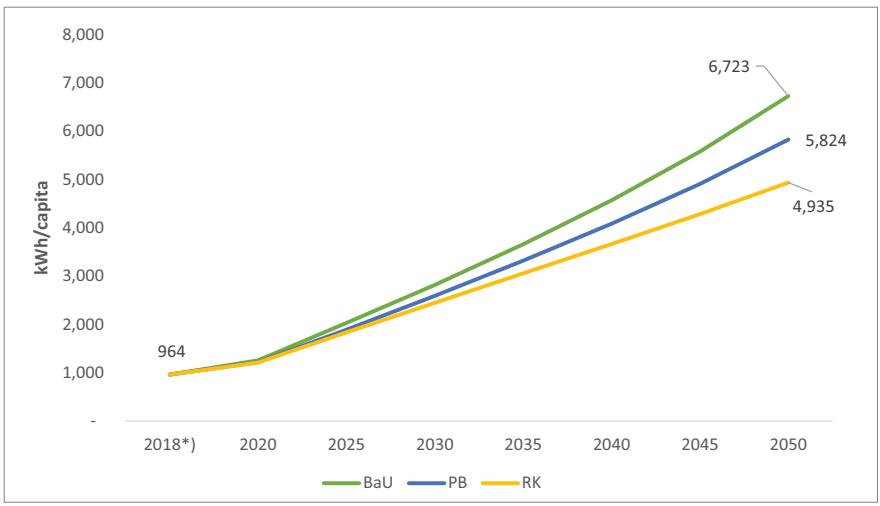
Figure 4.1 Comparison on the Number of Electric Vehicle

The total electricity demand in transportation (including buses and electric trains) will increase to 2.51 TWh (Bau), 2.50 TWh (PB) and 7.11 TWh (RK) in 2050. Electricity demand per sector in three scenarios can be seen in Figure 4.2.

Note: *) Temporary Data

Figure 4.2 Electricity Demand by Sector

Basically, electricity demand increase and population growth will give an impact on electricity demand per capita. Electricity demand per capita in 2025 will reach 2,030 kWh/capita (Bau), 1,892 kWh/capita (PB) and 1,834 kWh/capita (RK). In 2050, it will reach 6,723 kWh/capita (BaU), 5,824 kWh/capita (PB) and 4,935 kWh/capita (RK). This condition is still below the target of electricity per capita in KEN of 2,500 kWh/capita in 2025 and 7,500 kWh/capita in 2050. The growth of electricity consumption per capita in all scenarios can be seen in Figure 4.3.



Note: *) Temporary Data

Figure 4.3 Electricity Consumption Growth per Capita

4.2 Electricity Production

To meet electricity demand which will be 9 times higher than the demand in 2018, the electricity production in 2050 will reach 2,562 TWh (BaU), 2,167 TWh (PB) and 1,838 TWh (RK) with the assumption that the loss in transmission and distribution is around 10%.

Electricity production from coal power plant is still dominant in the future, but the share in the total electricity production is declining from 57% in 2018 to 41% (BaU), 39% (PB) and 32% (RK) in 2050. On the other hand, the share of electricity production from NRE power plant will increase from 12.4% in 2018 to 27% (BaU), 28% (PB) and 63% (RK) in 2050.

The program to reduce the use of fuel in power plant has impacted the declining electricity production from diesel power plant with the share of less than 0.05% in 2050 for three scenarios. Diesel power plant is prioritized in remote areas and frontier islands. Electricity production by energy source in three scenarios can be seen in Figure 4.4.

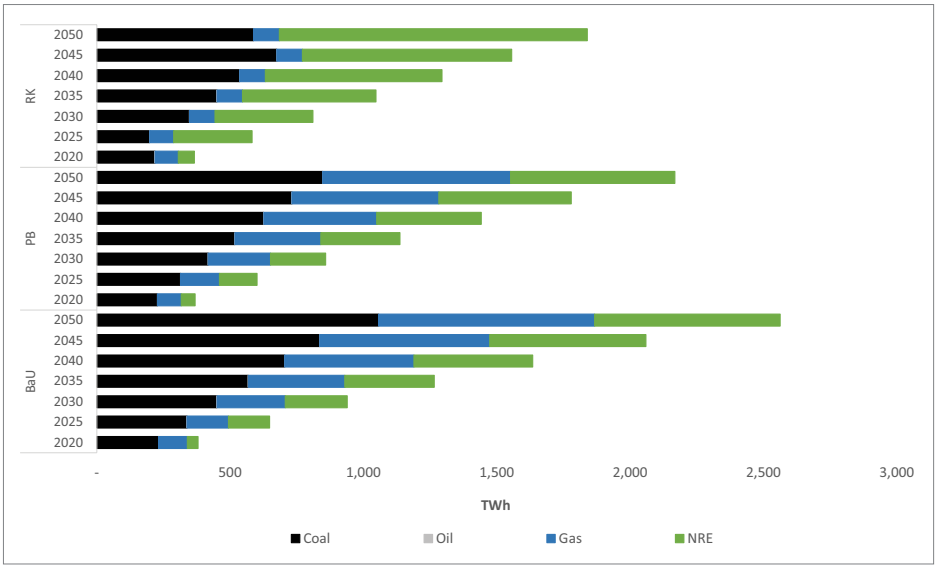


Figure 4.4 Electricity Production by Energy Source

In 2025, electricity production from NRE power plant will reach 154 TWh (BaU), 141 TWh (PB), and 294 TWh (RK) especially from hydro power plant, geothermal power plant and biomass power plant. In 2050, the biggest electricity production in BaU scenario is derived from solar power plant, biomass power plant and hydro power plant. It is influenced by equal solar potential in all areas, the affordable price of electric components in solar power plant, the solar rooftop program for luxury houses, and the use of energy saving solar lamp (LTSHE). Furthermore, palm oil shell, rice husk, straw and wood pellet are intensively used to supply fuel in biomass power plant. Meanwhile, the geothermal production is relatively stable after reaching its maximum potential in 2025.

In 2050, the biggest electricity production from NRE in PB scenario is from solar power plant of 421.3 TWh (68%) followed by hydro power plant of 109.5 TWh (18%) and geothermal power plant of 73.6 TWh (12%). The high electricity production from solar power plant is due to the use of solar rooftop in 25% of the existing luxury house. It is also influenced by the battery industry in several provinces to support electricity production from solar power plant. To support the production of hydropower plant, pump storage is used so that the electricity production of hydropower plant increases. Thus, electricity production from hydro power plant is increasing. Meanwhile, geothermal power plant has reached its peak production in 2030. In 2050, the production from geothermal power plant will reach 73.6 TWh (12%).

In RK scenario, electricity production from solar power plant is still dominant, followed by hydro power plant and biomass power plant with the electricity production of 529 TWh (53%), 166 TWh (17%) and 157 TWh (16%). The increase of electricity production in hydro power plant is influenced by the emission reduction. Thus, the production from coal and gas power plant will decline almost 50% in 2050 compared to in BaU scenario. The declining electricity production from fossil fuel-based power plant leads the projection of hydro power plant and solar power plant as the base load which is supported by the adequate storage infrastructure. The electricity production projection from NRE power plant for three scenarios is shown in Figure 4.5.

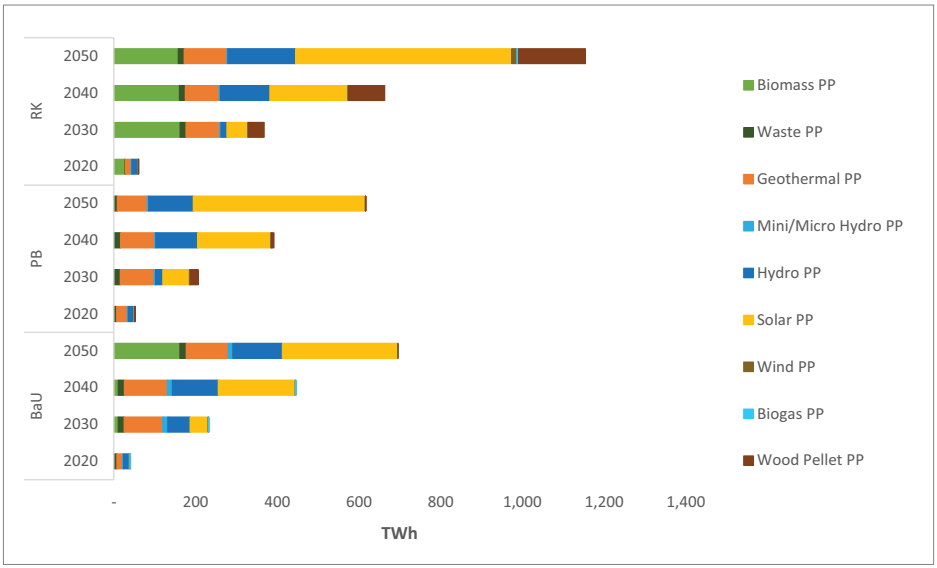


Figure 4.5 Electricity Production Projection from NRE Power Plant

4.3 Total Power Plant Capacity

The selection on the type of power plant to produce electricity during the projection period is based on the principle of least cost or cost effective. The least cost will be achieved by minimizing net present value which consists of investment cost, fuel cost as well as operation and maintenance cost. The selection on the type of power plant in BaU scenario uses the least cost principle and accommodates the plan to add the capacity based on RUPTL 2019-2028 in which the status is in construction and feasibility study.

The total power plant capacity in BaU scenario in 2050 will reach 552.5 GW with the biggest portion from NRE 258.9 GW followed by coal 152.5 GW and gas 141 GW. The rest is from oil. The share of coal power plant capacity will be declining. On the other hand, the share of NRE power plant capacity will be increasing as shown in Figure 4.6.

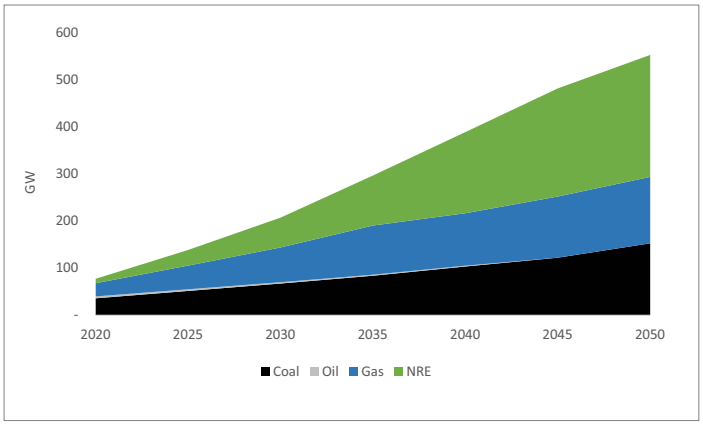


Figure 4.6 Power Plant Capacity Share by BaU Scenario

The installed power plant capacity in 2050 will increase 10 times compared to the installed capacity in 2018. In 2025, the capacity from NRE power plant is mainly derived from hydro power plant (40%) and geothermal power plant (29%). The capacity of solar power plant will grow faster since the electricity price from solar power plant is more economic. Thus, the capacity in 2050 will reach 187 GW (72%) from the total power plant capacity. The capacity of power plant in BaU scenario can be seen in Figure 4.7.

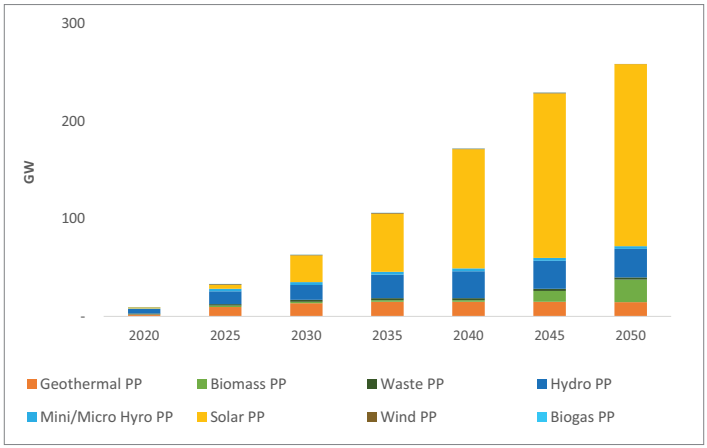


Figure 4.7 Power Plant Capacity by BaU Scenario

The power plant installed capacity in PB scenario in 2050 will reach 580 GW where the capacity composition pattern per energy source is almost the same in BaU scenario. This power plant capacity consists of 340 GW from NRE power plant,

122 GW from coal power plant, 118 GW from gas power plant, and the rest from oil power plant. The share power plant capacity per energy source in PB scenario can be seen in Figure 4.8.

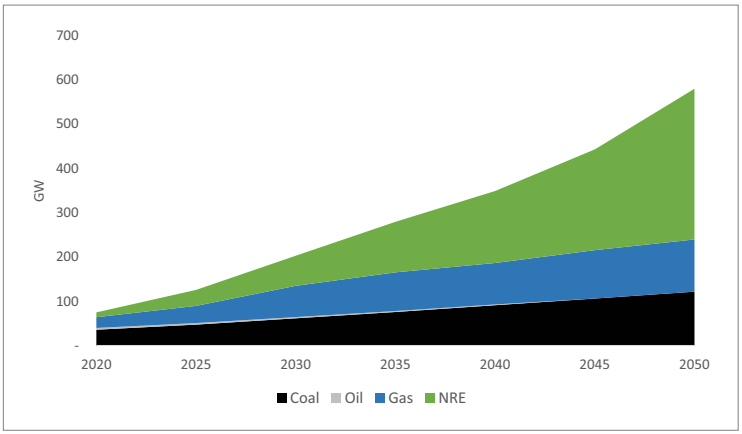


Figure 4.8 Power Plant Capacity Share by PB Scenario

In 2025, NRE power plant capacity is derived from geothermal and solar. In 2050, similar to BaU scenario, the power plant capacity will be dominated by solar power plant of 296 GW. The NRE power plant installed capacity in PB scenario can be seen in Figure 4.9.

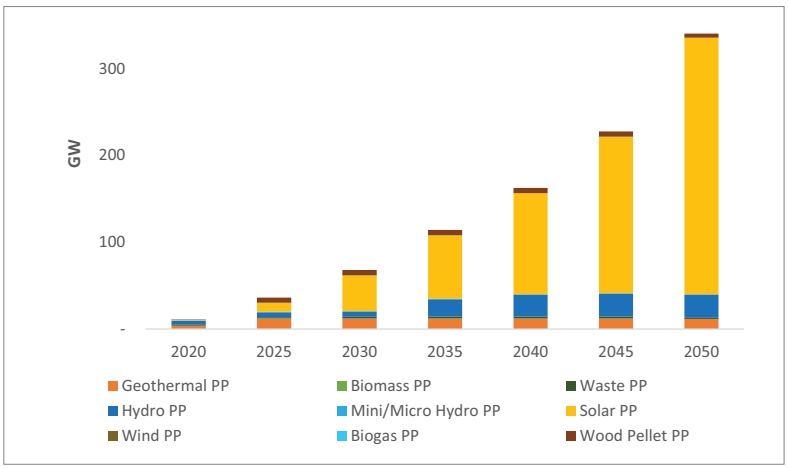


Figure 4.9 NRE Power Plant Installed Capacity by PB Scenario

The power plant installed capacity in RK scenario differs from the power plant installed capacity in BaU and PB scenario. In 2050, the total installed capacity in RK scenario will reach 584 GW consisting of 466 GW NRE power plant capacity, 96 GW coal power plant capacity, and 23 GW gas power plant. The rest installed capacity is from oil power plant. The share of power plant capacity in RK scenario can be seen in Figure 4.10.

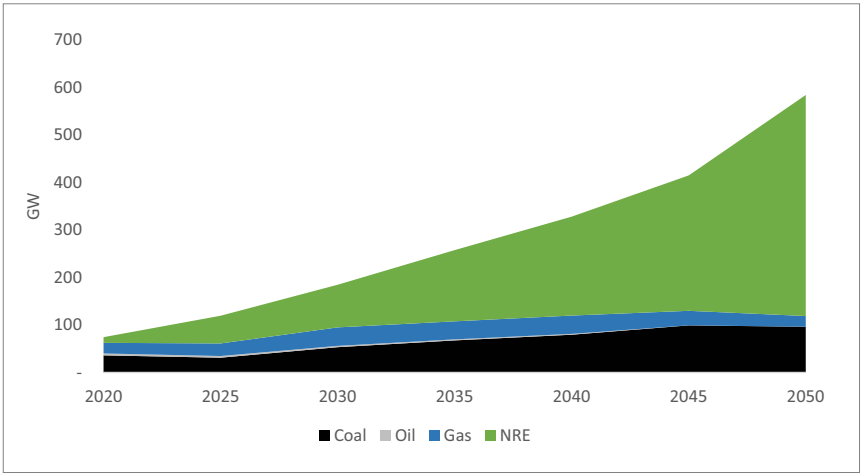


Figure 4.10 Power Plant Capacity Share by RK Scenario

In 2025, the total power plant installed capacity will reach 119 GW. From the total capacity, the capacity of NRE power plant will reach 58 GW which is mainly derived from biomass and geothermal. In 2050, the total NRE power plant installed capacity will reach 578 GW consisting of 355 GW (61%) from solar power plant, 42 GW (7%) from hydro power plant, 24 GW (4%) from biomass power plant, and 45 GW from other NRE power plants. To support solar power plant, 112 GW (18%) of battery is needed. The NRE power plant installed capacity in RK scenario can be seen in Figure 4.11.

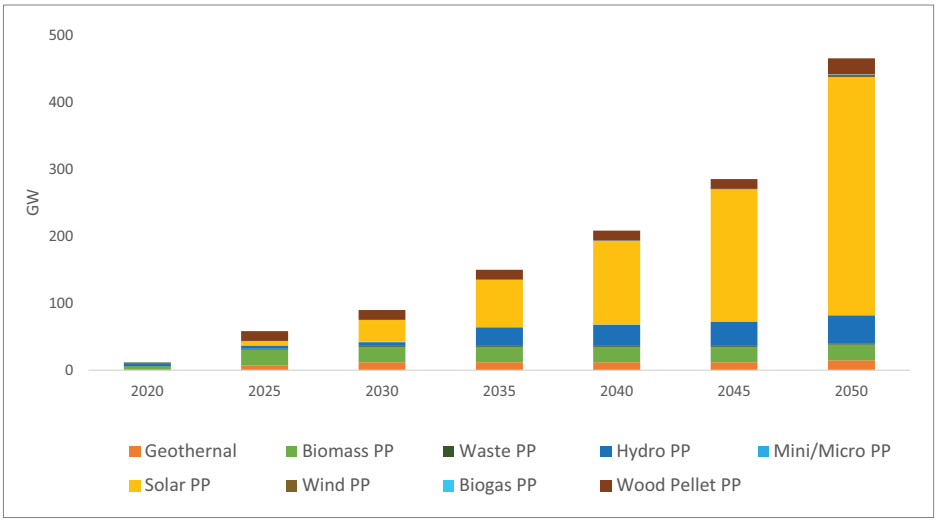
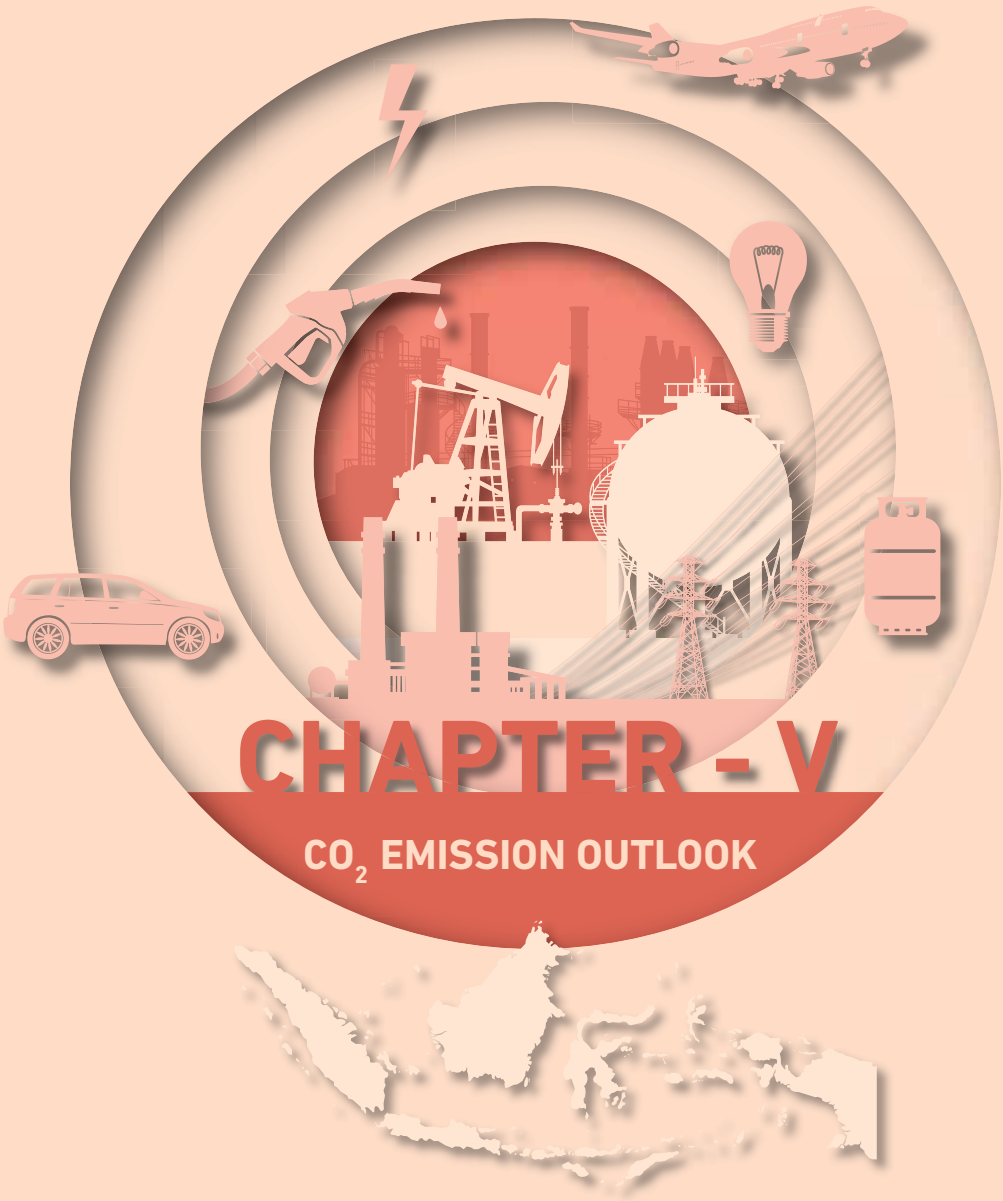


Figure 4.11 NRE Power Plant Installed Capacity by RK Scenario



CHAPTER - V

CO_2 EMISSION OUTLOOK

5 CO_2 EMISSION OUTLOOK

The population growth and living standard improvement will be followed by the increasing energy demand which will impact the increasing CO_2 emission growth if it does not followed by low carbon fuel as well as environmentally friendly and efficient technology. The release of CO_2 emission to atmosphere from energy source combustion in power plant, transportation, industry, commercial sector, household and other sectors in certain volume will affect the global warming. Reducing global warming can be carried out through energy technology efficiency and low carbon energy utilization.

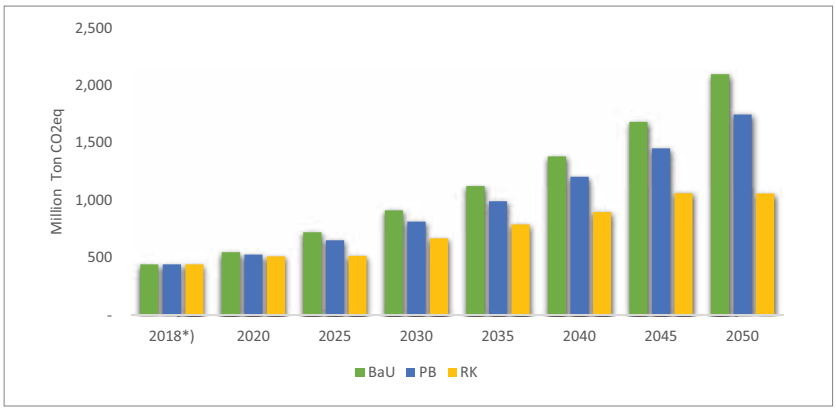
Based on NDC document to United Nations Framework Convention on Climate Change (UNFCCC), the emission target in energy sector in 2030 is 1,355 million Ton CO_2 for CM1 scenario (without international aid) with 29% of emission reduction target from the 2010 base year scenario condition of 453.2 million Ton CO_2eq. Meanwhile, the emission target for CM2 scenario (with international aid) is 1,271 million Ton CO_2eq with 41% of emission reduction target from base scenario condition. The CO_2 emission reduction target can be seen in Table 5.1.

Table 5.1 CO_2 Emission Reduction Traget by Sector

No	Sector	2010 GHG Emission Rate	2030 GHG Emission Rate (Mton CO_2 eq)			GHG Emission Reduction				BaU Annual Average Growth (2010-2030)	2000-2012 Average Growth*
						(Mton CO_2eq)		% of Total BaU			
		(Mton CO2eq)	BaU	CM1	CM2	CM1	CM2	CM1	CM2		
1	Energy*	453.2	1,669	1.355	1.271	314	398	11%	14%	6.7%	4.50%
2	Waste	88	296	285	270	11	26	0.38%	1%	6.3%	4.00%
3	IPPU	36	69.6	66.85	66.35	2.75	3.25	0.10%	0.11%	3.4%	0.10%
4	Agriculture	110.5	119.66	110.39	115.86	9	4	0.32%	0.13%	0.4%	1.30%
5	Forestry**	647	714	217	64	497	650	17.20%	23%	0.5%	2.70%
	Total	**1,334**	**2.869**	**2.034**	**1.787**	**834**	**1.081**	**29%**	**38%**	**3.9%**	**3.20%**

* Including fugitive ** Including peat fire
Notes: CM1 = Counter Measure 1 (Condition without mitigation requirement-unconditional)
CM2 = Counter Measure 2 (Condition with mitigation requirement-unconditional)

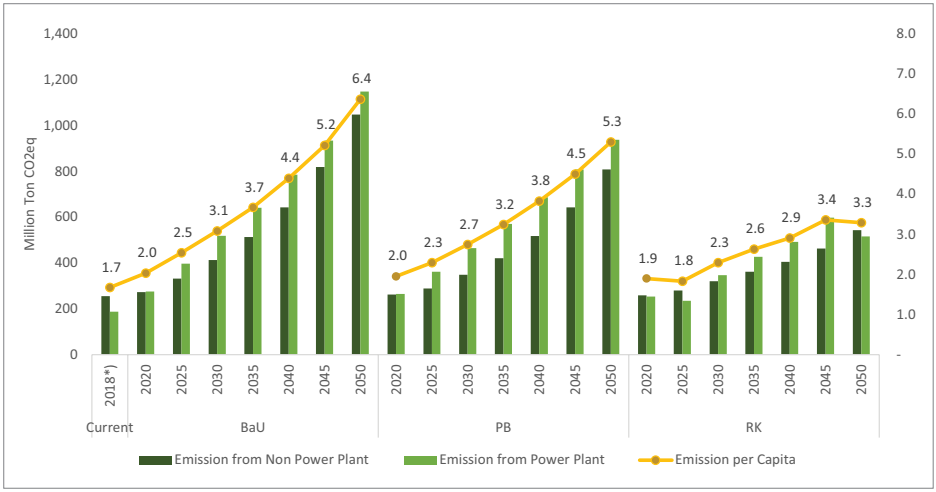
From the calculation of CO_2 emission based on IPCC (Intergovernmental Panel on Climate Change), 2006, the total projection of emission in 2030 will increase to 912 million ton CO_2eq (BaU), 813 million ton CO_2eq (PB), and 667 million ton CO_2eq (RK). Thus, CO_2 emission projection in three scenarios is lower than the emission target in NDC for energy sector. The GHG emission growth in three scenarios can be seen in Figure 5.1.



Note: *) Temporary Data

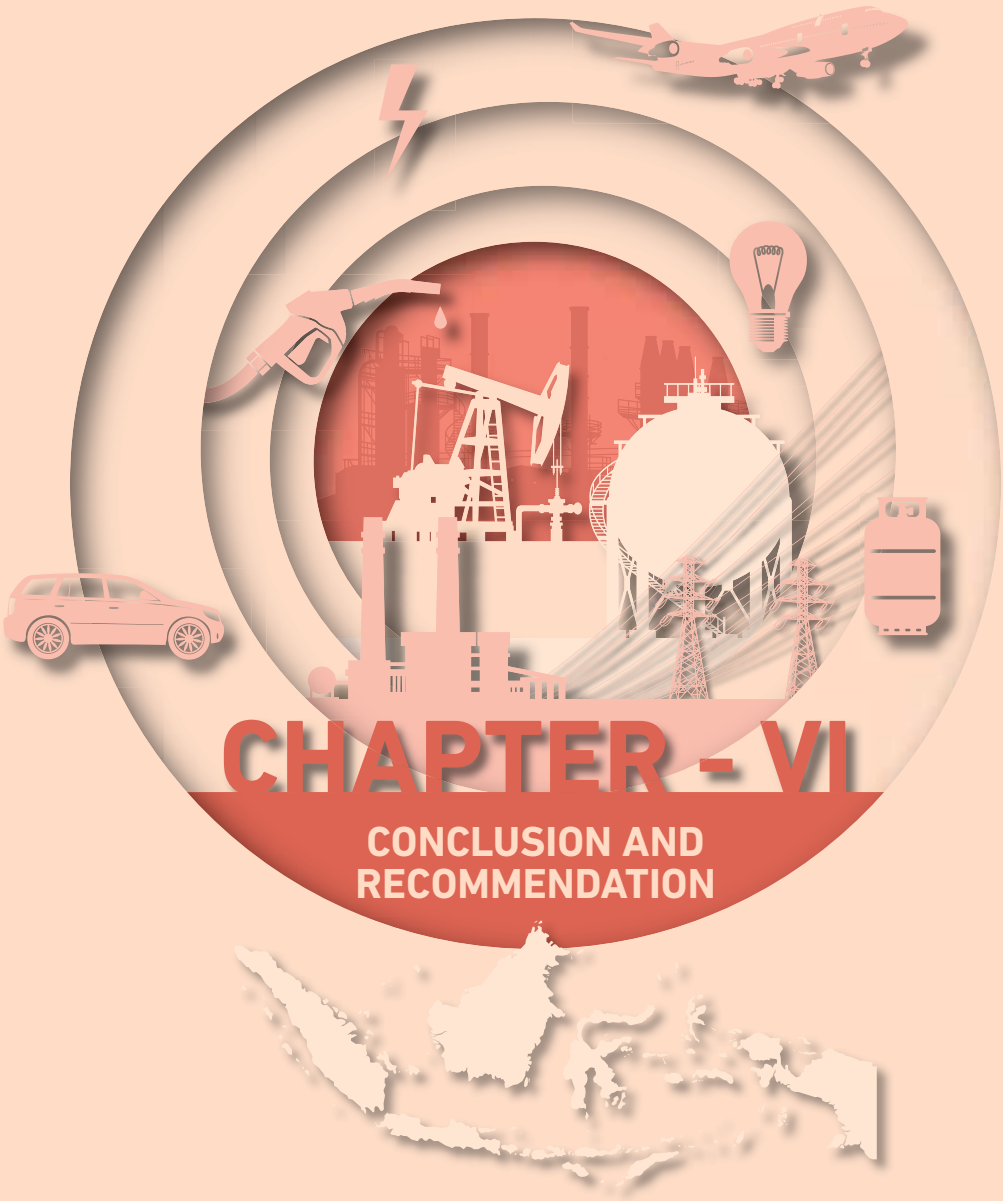
Figure 5.1 GHG Emission Growth

Furthermore, the indicator of emission per capita shows an increase from 1.7 Ton CO_2/capita in 2018 to 6.4 ton CO_2/capita (BaU), 5.3 ton CO_2/capita (PB), 3.3 Ton CO_2/capita (RK) in 2050, in line with the increasing emission and population growth. GHG emission per capita in three scenarios can be seen in Figure 5.2.



Note: *) Temporary Data

Figure 5.2 GHG Emission per Capita



CHAPTER - VI

CONCLUSION AND RECOMMENDATION

6 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The Outlook is always updated with the latest policy information and the methodology. Based on the analysis, there is an increase of accuracy in the final energy demand projection in 2016, 2017 and 2018 from IEO 2016 to IEO 2017. From the comparison, the final energy demand projection in IEO 2017 shows smaller disparity than the final energy demand projection in 2016 (decreases 0.1% on average). This result shows an increasing accuracy since IEO 2016 and IEO 2017 use the 5.6% GDP average growth data in which GDP growth realization in 2016 and 2017 is around 5% (5.03% in 2016 and 5.07% in 2017).

IEO 2019 presents national energy demand and supply projection in 2019-2050 based on social, economy and technology development assumption in the future by using 2018 as baseline year.

Based on the projection, the primary energy mix for BaU scenario in 2025 is 21% NRE, 24% gas, 34% coal and 21% oil, while the primary energy mix in 2050 is 29% NRE, 23% gas, 32% coal and 16% oil. The energy mix target as mandated in National Energy Policy has not been reached.

The primary energy mix in PB scenario in 2025 is 23% NRE, 21% oil, 24% gas and 32% coal. In 2050, it becomes 32% NRE, 15% oil, 24% gas and 29% coal. Compared to the target in National Energy Policy, the NRE target in 2025 can be reached and the NRE target in 2050 is higher than the National Energy Policy's target.

The primary energy mix in RK scenario in 2025 is 36% NRE, 19% oil, 21% gas and 24% coal. In 2050, it becomes 58% NRE, 8% oil, 12% gas, and 22% coal. Compared to the target in National Energy Policy, the NRE share in 2025 and 2050 is very optimistic and higher than the target in National Energy Policy.

The national final energy demand in 2025 based on BaU, PB and RK scenario will reach 548.8 MTOE, 481.1 MTOE and 424.2 MTOE. Final energy demand in three scenarios is still below the energy demand in RUEN of 641.5 MTOE in 2050.

Based on the final energy demand projection, CO_2 emission in three scenarios in 2030 will reach 912 million ton CO_2eq (BaU), 813 million ton CO_2eq (PB), and 667 million ton CO_2eq (RK) or lower than the emission target in NDC in energy sector.

In conclusion, the NRE share target of 23% by 2025 and 31% by 2050 can be achieved by at least implementing assumptions in PB scenario through NRE utilization optimization in power plant and non-power plant (biofuel mandatory implementation), electric vehicle usage and energy efficiency in all energy consuming sectors.

6.2 Recommendation

The breakthrough to achieve the primary energy mix target as mandated in National Energy Policy are as follows:

1. Promoting the use of electric car which is followed by vehicle age restriction for maximum 25 years old cars (BaU), 15 years old cars (PB) and 10 years old cars (RK);
2. Starting from 2025, the government needs to substitute LPG to DME (20%), city gas (4.7 million household connection), and induction stove (0.5% from the LPG demand in household) in order to reduce import dependency at least 5% by 2025 and 45% by 2050 (BaU scenario);
3. The policy to substitute LPG to induction stove especially in household sector and electricity utilization in transportation should be followed by NRE-based power plant to support RK scenario;
4. The acceleration of solar power plant development should be supported by domestic battery industry which meets 40% minimum local content requirement;
5. The utilization of bioenergy, biodiesel (B30), and green diesel (D100) in transportation and power plant will reduce greenhouse gas emission and increase local economic growth;

6. The utilization of bioethanol (E5 to E100) becomes the main alternative of fuel diversification for vehicle. It also reduces greenhouse gas emission and increase local economy growth.
7. To meet Indonesia's commitment in Paris Agreement, RK scenario should be considered by implementing energy efficiency through the massive use of energy saving technology and NRE.

ATTACHMENT I DEFINITION

Baseline Data is basic information gathered before the program begins. This data is used as the comparison to project the impact of the program.

Biodiesel (B100/Murni) is Fatty Acid Methyl Ester (FAME) or Mono Alkyl Ester produced from biological raw material and other biomass which is processed through esterification.

Bioetanol (E100/Murni) is ethanol product from biological material and other biomass which are processed through biotechnology.

Blended Finance is the financing scheme from philanthropy fund collected from the society to mobilize private sector capital in a long-term investment.

BOE (Barrel Oil Equivalent) is energy units with a calorific value equivalent to one barrel of oil, based on IEA conversion standard, 1 BOE is equivalent to 0,14 TOE (see definition of TOE).

BOPD (Barrel Oil per Day) is oil refinery capacity unit which describes refinery production per day.

Btu (British Thermal Unit) is amount unit of heat required to raise the temperature of 1 lb (one pound) of water to 1oF (Fahrenheit) at a pressure of 14,7 psi (pounds per square inch), (Conversion to MMscf and TOE, see each definition).

Energy Reserve is energy resources known for its location, volume and quality.

Proven Reserve is oil, gas and coal which are predicted to be produced from a reservoir with stipulated and measured size.

Potential Reserve is oil and gas in a reservoir.

Energy Elasticity is the comparison between energy demand growth and economic growth.

Energy is the ability to do work in the form of heat, light, mechanical, chemical, and electromagnetic.

New Energy is energy from new energy resources.

Renewable Energy is energy from renewable energy resources.

Final Energy is the energy which can be directly consumed by end consumer.

Primary Energy is energy from nature and is not further processed.

Gas is energy type which covers gas, gas refinery products (LPG, LNG) and unconventional gas (CBM).

Natural Gas is all types of gaseous hydrocarbons produced from the well including wet mining gas, dry gas, sheathing pipeline gas, residual gas after the extraction of liquid hydrocarbons and wet gas, and non-hydrocarbon gas mixed in it naturally.

Energy intensity is the total energy consumption per unit of GDP.

Oil is class of energy that covers oil, condensate, natural gas liquid (NGL), and energy derived from petroleum (refinery gas, Ethane, LPG, aviation gasoline, motor gasoline, jet fuels, Kerosene, diesel oil, fuel oil, naphtha, lubricants and other refinery products).

Crude Oil is a mixture of various hydrocarbons contained in the liquid phase in the reservoir below ground level and which remain liquid at atmospheric pressure after passing the separator facility on the surface.

MMSFC is the amount of gas needed to fill the room of 1 (one) million cubic feet, with a pressure of 14.73 psi at 60°F (Fahrenheit) in dry condition, 1 MMscf is equivalent to 1,000 Mmbtu.

Electrification Ratio is the comparison between electrified household and the total household.

RON (Research Octane Number) is the number determined by CFR F1 tester engine at a speed of 600 rotations per minute; quality guidelines of anti-petrol tap on low speed or light load condition.

Business as Usual (BaU) Scenario, is a scenario with basic assumption of annual average GDP growth of 5.6%, This assumption is also refers to targets in KEN and RUEN, RIPIN 2015-2035, as well as Renstra in each ministry based on the current realization.

Sustainable Development (PB) Scenario, is a scenario which uses RUEN assumptions with the same economic and population growth assumption in BaU scenario. Furthermore, it takes account also the target of 30% biodiesel and 20% bioethanol utilization by 2025 based on the Minister of Energy and Mineral Resources Regulation No.12 of 2015. In 2050, the target of biodiesel and bioethanol utilization is assumed to be 30% and 50% respectively. The use of electric vehicle and induction stove is assumed to be bigger than in BaU scenario. The city gas development is assumed to reach 1 million household connections per annum starting from 2020.

Low Carbon (RK) Scenario, is a scenario which uses the assumption of higher greenhouse gas emission reduction than the government's target. This scenario gives the description of higher contribution by Indonesia in supporting the global effort (based on Paris Agreement) to prevent earth temperature increase above 2 degree Celsius. In RK scenario, the target of biodiesel and bioethanol utilization in 2025 is the same with the target in BaU and PB scenario. The target increases to 100% (B100) biodiesel and 85% (B85) bioethanol by 2050. The city gas development will be also optimized to become more than 1 million household connections starting from 2020. The use of electric vehicle and induction stove is also assumed to be higher than in BaU and PB scenario.

TOE (Ton Oil Equivalent) is energy unit with a calorific value equivalent to one Ton of petroleum, based on IEA conversion standard, 1 TOE is equivalent to 11.63 MWh of electricity, 1.43 Ton of coal, 39.68 MBtu or 10,000 MCal of natural gas.

Transformation is the process of energy conversion from one form of primary energy into final energy form. The transformation process can occur through the process of refinery, electricity plants, gasification and liquefaction.

ATTACHMENT II
LIST OF ABBREVIATION

BaU : Business as Usual
BBG : Gas fuel
BBM : Oil fuel
BBN : Biofuel
BOE : Barrel Oil Equivalent
BOPD : Barrel Oil per Day
bph : Barrel per Hour
BPS : Statistic Indonesia
CBM : Coal Bed Methane
CO_2 : Carbon Dioxide
COD : Commercial of Date
DEN : National Energy Council
DME : Dimethyl Ether
EBT : New Renewable Energy
ESDM : Energy and Mineral Resources
FSRU : Floating Storage Regasification Unit
GDP : Gross Domestic Product
GR : Government Regulation
GHG : Green House Gas
GW : Giga Watt
GWh : Giga Watt hour
HEESI : Handbook of Economy and Energy Statistic Indonesia
IEA : International Energy Agency
IMF : International Monetary Fund
IO : Operation License
IPCC : Intergovernmental Panel on Climate Change
IPP : Independent Electricity Producer
KEN : National Energy Policy
kWh : Kilo Watt hour
LEAP : Long-range Energy Alternatives Planning
LNG : Liquified Natural Gas
LPG : Liquified Petroleum Gas
LRT : Light Rail Transit

Migas : Oil and Gas
MMBTU : Million Metric British Thermal Unit
MMSCF : Million Standard Cubic Feet
MRT : Mass Rapid Transit
MW : Mega Watt
NDC : National Determined Contributions
OEI : Indonesia Energy Outlook
PB : Sustainable Development
PDB : Gross Domestic Product
Permen : Ministerial Regulation
Perpres : Presidential Regulation
PLN : Perusahaan Listrik Negara
PLTA : Hydro Power Plant
PLTB : Wind Power Plant
PLTBm : Biomass Power Plant
PLTD : Diesel Power Plant
PLTM : Mini Hydro Power Plant
PLTMH : Micro Hydro Power Plant
PLTS : Solar Power Plant/Solar PV
PLTSa : Waste Power Plant
PLTP : Geothermal Power Plant
PLTU : Steam Power Plant
PMK : Minister of Finance Regulation
PP : Government Regulation
PPU : Private Productions Utility
PV : Photovoltaic
RDMP : Refinery Development Master Plan
RENSTRA : Strategic Plan
RIKEN : National Energy Conservation Master Plan
RIPIN : National Industry Development Master Plan
RK : Low Carbon
RPJMN : National Medium Term Development Plan
RUEN : National Energy General Plan
RUPTL : Electricity Supply Business Plan
TOE : Ton Oil Equivalent
TWh : Tera Watt hour
TSCF : Trillion Standard Cubic Feet
UNFCCC : United Nations Framework Convention on Climate Change

ATTACHMENT III TABLE OF OUTLOOK SUMMARY

No	Result of Analysis	BaU Scenario						
		2020	2025	2030	2035	2040	2045	2050
1	National final energy demand (Million TOE)	128.7	170.8	219.7	277.5	348.6	436.8	548.8
2	Oil final energy demand (Million TOE)	59.9	67.8	77.5	89.6	105.0	124.3	149.1
3	Gas final energy demand (Million TOE)	17.3	22.6	29.7	37.4	47.9	61.9	80.9
4	Coal final energy demand (Million TOE)	13.3	17.2	23.1	31.1	41.9	56.4	76.1
5	NRE final energy demand (Million TOE)	9.0	13.7	17.7	23.2	30.3	39.7	52.4
6	Electricity final energy demand (TWH)	339.2	576.2	833.4	1,119.3	1,437.2	1,796.9	2,214.0
7	Industry final energy demand (Million TOE)	45.0	58.2	76.5	99.6	131.2	173.5	230.9
8	Transportation final energy demand (Million TOE)	50.2	60.2	70.3	83.2	99.4	119.9	146.4
9	Household final energy demand (Million TOE)	24.0	39.8	56.2	72.8	88.9	104.7	119.9
10	Commercial final energy demand (Million TOE)	8.0	10.7	14.4	19.4	26.3	35.4	47.7
11	Other sector final energy demand (Million TOE)	1.4	1.8	2.2	2.6	2.9	3.4	3.9
12	Primary energy supply (without biomass) (MTOE)	223.5	313.5	400.8	505.2	628.9	773.6	942.5
13	Oil primary energy supply (Million TOE)	61.1	66.8	76.2	88.1	103.3	122.5	147.1
14	Gas primary energy supply (Million TOE)	63.9	73.9	92.0	116.0	144.6	179.2	221.7
15	Coal primary energy supply (Million TOE)	76.5	106.4	134.0	164.0	200.3	239.4	298.4
16	NRE primary energy supply (MTOE)	22.0	66.4	98.5	137.1	180.7	232.6	275.3
17	Primary energy supply per Capita (TOE/capita)	0.8	1.1	1.4	1.7	2.0	2.4	2.9
18	Green House Gas Emission (GHG) (Ton CO_2/Capita)	2.0	2.5	3.1	3.7	4.4	5.2	6.4
19	Power plant capacity (GW)	77.2	138.5	207.1	296.5	388.7	481.5	552.5
20	Electricity production (TWh)	379.1	647.7	938.7	1,264.9	1,634.3	2,058.8	2,562.0

No	Result of Analysis	PB Scenario						
		2020	2025	2030	2035	2040	2045	2050
1	National final energy demand (Million TOE)	124.0	154.7	197.8	248.3	309.7	385.6	481.1
2	Oil final energy demand (Million TOE)	57.0	58.7	66.9	77.2	90.3	106.8	128.1
3	Gas final energy demand (Million TOE)	16.5	19.7	25.8	32.4	41.3	53.2	69.1
4	Coal final energy demand (Million TOE)	13.3	16.8	21.6	28	36.8	48.3	63.9
5	NRE final energy demand (Million TOE)	8.9	13.4	17.6	23.3	30.9	41.2	55.0
6	Electricity final energy demand (TWH)	330.3	537.0	766.7	1,015.4	1,284.8	1,581.9	1,917.9
7	Industry final energy demand (Million TOE)	42.7	50.0	65.4	84.8	111.3	146.6	194.3
8	Transportation final energy demand (Million TOE)	48.3	54.3	63.2	74.7	89.4	108.3	132.9
9	Household final energy demand (Million TOE)	23.9	38.9	54.0	68.9	83.0	96.5	109.0
10	Commercial final energy demand (Million TOE)	7.7	9.7	12.8	17.1	22.8	30.4	40.5
11	Other sector final energy demand (Million TOE)	1.4	1.9	2.3	2.8	3.2	3.7	4.3
12	Primary energy supply (without biomass) (MTOE)	218.9	290.7	362.1	452.3	555.7	678.1	827.7
13	Oil primary energy supply (Million TOE)	56.2	57.7	65.7	75.7	88.7	105.0	126.1
14	Gas primary energy supply (Million TOE)	60.3	69.4	84.3	105.1	129.0	157.9	194.7
15	Coal primary energy supply (Million TOE)	75.4	97.9	121.4	146.8	175.7	207.1	242.9
16	NRE primary energy supply (MTOE)	27.0	65.7	90.8	124.7	162.4	208.1	264.1
17	Primary energy supply per Capita (TOE/capita)	0.8	1.0	1.2	1.5	1.8	2.1	2.5
18	Green House Gas Emission (GHG) (Ton CO_2/Capita)	2.0	2.3	2.7	3.2	3.8	4.5	5.3
19	Power plant capacity (GW)	75.0	125.7	202.9	279.5	349.1	443.1	580.1
20	Electricity production (TWh)	368.4	600.4	857.5	1,136.6	1,441.1	1,778.6	2,167.3

No	Result of Analysis	RK Scenario						
		2020	2025	2030	2035	2040	2045	2050
1	National final energy demand (Million TOE)	122.8	150.1	188.1	231.7	284.8	347.7	424.2
2	Oil final energy demand (Million TOE)	56.3	56.5	60.4	62.9	63.1	64.2	67.4
3	Gas final energy demand (Million TOE)	16.4	19.4	24.7	30.1	37.1	45.9	57.3
4	Coal final energy demand (Million TOE)	13.1	16.2	20.2	25.4	32.2	40.7	51.7
5	NRE final energy demand (Million TOE)	8.9	13.3	20.6	32.9	53.4	78.2	108.1
6	Electricity final energy demand (TWH)	327.7	520.7	724.1	934.7	1,152.6	1,380.9	1,625.2
7	Industry final energy demand (Million TOE)	42.2	48.3	61.3	77.0	97.6	123.9	157.7
8	Transportation final energy demand (Million TOE)	47.7	52.7	60.8	71.7	87.2	106.5	131
9	Household final energy demand (Million TOE)	23.7	37.8	51.3	63.9	75.4	85.7	94.7
10	Commercial final energy demand (Million TOE)	7.6	9.5	12.3	16.2	21.2	27.7	36.2
11	Other sector final energy demand (Million TOE)	1.5	2.0	2.5	2.9	3.4	3.9	4.6
12	Primary energy supply (without biomass) (MTOE)	216.4	291.8	364.7	451.4	550.2	660.1	812.1
13	Oil primary energy supply (Million TOE)	55.4	55.5	59.1	61.4	61.4	62.3	65.4
14	Gas primary energy supply (Million TOE)	60.0	60.6	62.9	69.8	76.8	84.8	95.4
15	Coal primary energy supply (Million TOE)	73.0	70.7	102.5	127.9	150.9	186.2	176.8
16	NRE primary energy supply (MTOE)	28.1	105.0	140.2	192.4	261.1	326.8	474.6
17	Primary energy supply per Capita (TOE/capita)	0.8	1.0	1.2	1.5	1.7	2.0	2.5
18	Green House Gas Emission (GHG) (Ton CO_2/Capita)	1.9	1.8	2.3	2.6	2.9	3.4	3.3
19	Power plant capacity (GW)	74.1	119.2	184.5	257.5	327.9	414.8	584.2
20	Electricity production (TWh)	365.4	582.2	810.3	1,046.6	1,294.1	1,555.5	1,838.5

NATIONAL ENERGY COUNCIL
Secretariat General
Jl. Jenderal Gatot Subroto Kav. 49, Lt. 4
Jakarta Selatan 12950, Indonesia
Ph : +62 21 5292 1621
Fax : +62 21 5292 0190
sekretariat@den.go.id
www.den.go.id

ISSN 2527-3000