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# INDONESIA ENERGY OUTLOOK 2018

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# INTRODUCTION

Indonesia Energy Outlook 2018 is an annual publication of Secretariat General of the National Energy Council to present the energy demand and supply condition and projection in Indonesia until the year 2050 based on 2017 baseline data.

Indonesia Energy Outlook 2018 is written based on the current policies such as KEN, RUEN, NDC, Biofuel Roadmap and RENSTRA of MEMR, Ministry of Transportation, Ministry of Industry, and other government's energy related policies. Long-range Energy Alternatives Planning System (LEAP) is used to calculate energy demand projection while Balmorel is used to calculate electricity supply.

This book is expected to be one of the references for the stakeholders in analyzing and developing Indonesia energy management policy in the future.

Last but not least, we would like to convey our gratitude and appreciation to all related parties for the contribution to this book.

Jakarta, December 2018

Secretary General of National Energy Council

**Saleh Abdurrahman**

# EDITORIAL BOARD



# ACKNOWLEDGEMENTS

We would like to convey our gratitude to all related parties for the inputs and suggestions in formulating Indonesia Energy Outlook:

- 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.

# DISCLOSURE

Indonesia Energy Outlook (IEO) 2018 is an analysis as well as a long term national energy demand and supply projection. The data in this IEO is derived from official publication, temporary data, or updated data by the sources.

The materials in this IEO are data and projection of energy demand and supply with particular assumptions which are developed for the purpose of future energy scenario planning. The assumptions and projections are including energy technology development both fossil energy and renewable energy based on current data and condition. Thus, it is possible for the dynamic change outside the projection in this IEO.

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# EXECUTIVE SUMMARY

Indonesia Energy Outlook (IEO) 2018 presents national energy demand and supply projection in 2017-2050 based on social assumption, economy and technology development in the future by using 2017 as baseline year.

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

Population growth, economic growth and energy price are the basic assumptions of these two scenarios which are developed to obtain an illustration of energy demand up to the year 2050. Beside these basic assumptions, there are also additional assumptions related to a number of energy policies such as RUEN, RUPTL and Biofuel mandatory.

IEO 2018 uses two scenarios for the projection period of 2018-2050 namely Current Policy (KS) and Green scenario. The Current Policy scenario uses Gross Domestic Product's basic assumption of 5.6% in average per year. This scenario also refers to energy mix target and energy intensity decline as in National Energy Policy (KEN) and National Energy General Planning (RUEN). Besides that, related sector policies also become references in calculating energy demand assumption such as National Industry Development Master Plan (RIPIN) 2015-2035, RUPTL (Electricity Supply Business Plan) 2018-2027, and emission reduction target as in National Determined Commitment (NDC). Green scenario refers to emission reduction policy by using the same economic and population growth assumption as in Current Policy scenario. However, due to higher energy conservation in final energy demand in each sector, energy demand is lower than the previous scenario. Besides that, the target of biodiesel and bioethanol utilization is higher than the previous scenario. The target of electric vehicle utilization is higher as well. For calculation, electricity supply is assumed that Biomass electricity plant with higher efficiency level can be achieved in 10 years earlier. To calculate electricity supply, several assumptions are used. They are

assumption that biomass (palm shell) price is lower of about 80% from coal price and assumption that biomass (wood pellet) price refers to national market actual price. However, it will decline and will be the same with coal price starting in 2030.

Based on analysis, primary energy supply (without traditional biomass) will reach 236 MTOE for Current Policy (KS) scenario and 218 MTOE for Green scenario in 2025. In 2050, it becomes 769 MTOE (KS) and 609 MTOE (Green). The share of NRE in KS scenario in 2025 and 2050 is 17% and 30%, while NRE share in Green scenario in the same year is 23% and 41%. Meanwhile, for national final energy demand in 2025 based on KS and Green scenario will reach 164 MTOE and 153 MTOE. Final energy demand in 2050 in the same scenario is 475 MTOE and 395 MTOE.

Electricity plant capacity in 2025 is 83 GW (KS) and 90 GW (Green) which is still dominated by coal and gas. In 2050, total capacity of electricity plant increases into 433 GW (KS) and 311 GW (Green).

**Secretariat General**
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# CHAPTER 1
# INTRODUCTION

Indonesia Energy Outlook 2018 publication is to present the national energy condition especially demand and supply projection up to 2050. For modeling, year 2017 is used as the baseline year. It also uses realistic economic growth assumption of the average of 5.6% as similar to or approaching Bank of Indonesia's projection and population growth assumption based on BPS projection reference. Besides that, calculation assumption also refers to other energy-related policies and has been decided by the government such as KEN, RUEN, RIPIN, NDC, RENSTRA of MEMR, Ministry of Transportation and Ministry of Industry, as well as Roadmap of Biofuel and National Strategic Project.

The main data source in Indonesia Energy Outlook 2018 is Handbook of Energy and Economic Statistic Indonesia (HEESI) 2017, RUPTL 2018-2027, 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).

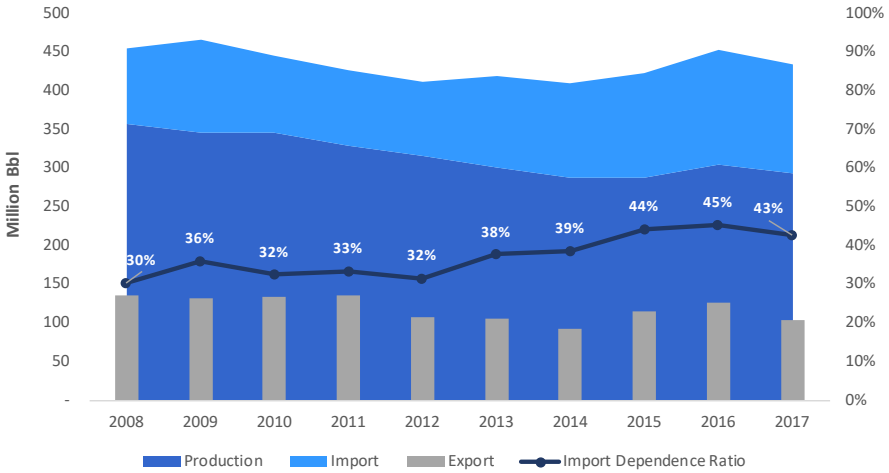
## 1.1 CURRENT ENERGY CONDITION

In 2017, the primary energy production consisting of oil and gas, coal, and renewable energy was 382.9 MTOE. Around 68% or 262.7 MTOE are coal and LNG which are exported abroad. In order to meet the gap of energy supply of 165.3 MTOE, Indonesia is importing oil, fuel, and LPG up to 45.1 MTOE in total.

The total final energy consumption (without traditional biomass) in 2017 was around 110.5 MTOE in which transportation was the biggest consumer followed by industry, household, commercial sector and then other sectors (agriculture, construction, and mining).

### 1.1.1 Crude Oil

Crude Oil production in the last 10 years shows a decline from 357 million barrel (1 million bpd) in 2008 into 292 million barrel (801 thousand bpd) in 2017. The declining production is due to the mature oil production wells, while the new production wells are relatively limited in number. To meet the oil refinery demand, Indonesia is importing crude oil especially from Middle East. Indonesia's oil import dependency is around 43% (Picture 1.1)



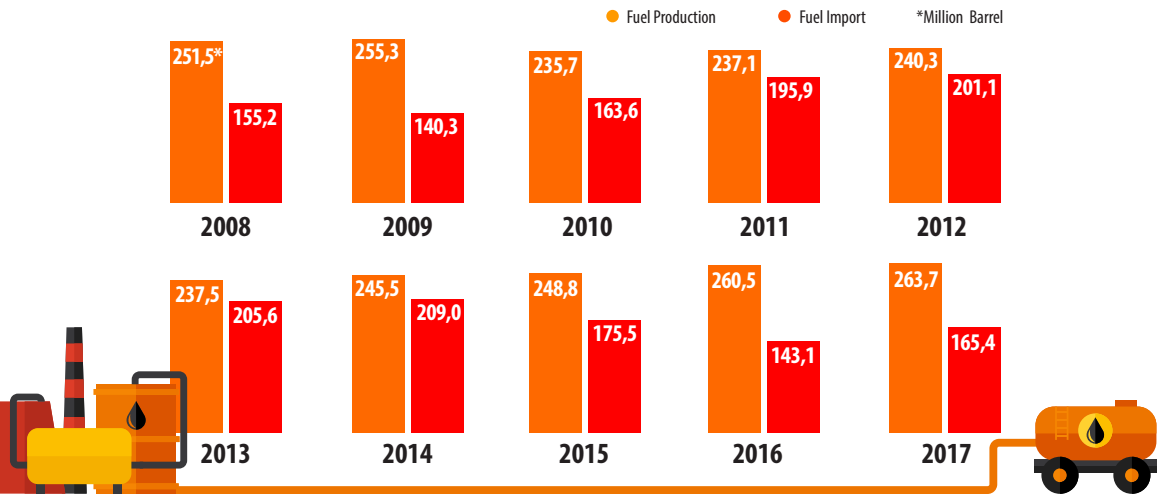

Source: Ministry of EMR, processed by Secretariat General of NEC, 2018
Note: Import Dependency ratio = Import divided by Domestic Supply (Production+Import-Export)

**Picture 1.1 Dependency on Crude Oil Import**

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 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 and declining crude oil price. The revisions are in the form of tax holiday in exploration and exploitation period (import VAT, duty, domestic VAT, land and building tax, and free of income tax on cost sharing).

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 will be entirely borne by contractor. Currently, there have been 30 new contracts with gross split scheme from new working area tender and termination working area in which the contracts will end in 2017-2020. Besides that, gross split policy is also supported by GR No.53 of 2017 on Gross Split PSC Taxation which eliminates taxes from exploration to production phase in the first year.

In demand side, fuel demand in 10 years is approximately 70 million KL fulfilled from the production of domestic refineries and from the import. The production of fuel and non fuel from domestic refinery is around 335 thousand barrel and from import is around 28 thousand barrel. The development of fuel production and import in the last 10 years can be seen in picture 1.2.



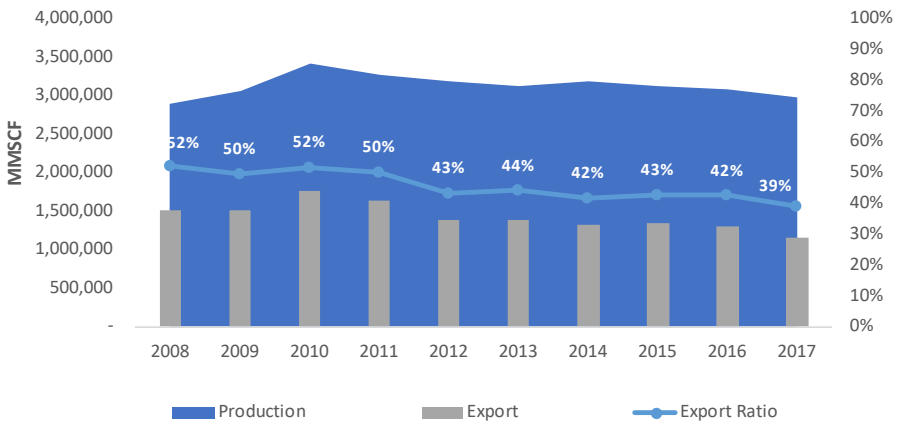

Source: HEESI, 2018

**Picture 1.2 Fuel Production and Import**

In 2017, LPG consumption reached 7.1 million Ton and more than 70% of the LPG is derived from import. The success of kerosene to LPG conversion program has increased LPG consumption while LPG supply from domestic LPG refinery is limited. The increasing LPG consumption especially the subsidized-3 kg LPG needs to be anticipated by the government since the use of 3 kg LPG does not meet the target.

### 1.1.2 Gas

Gas is used to meet the demand from industry, electricity plant, city gas (household and commercial) and gas lift. Furthermore, gas is also used as export commodity in the form of LNG and piped gas. Gas export (through pipeline or LNG) reaches almost half of the total production. However, in the last few years, gas export tends to decline up to 39% in 2017 (Picture 1.3)




Source: HEESI, 2018

**Note: Export ratio = Export divided by Production**

**Picture 1.3 Gas Production and Export**

On the contrary, the domestic gas utilization in the last few years has shown an increase from 43% in 2006 into 61% in 2017.

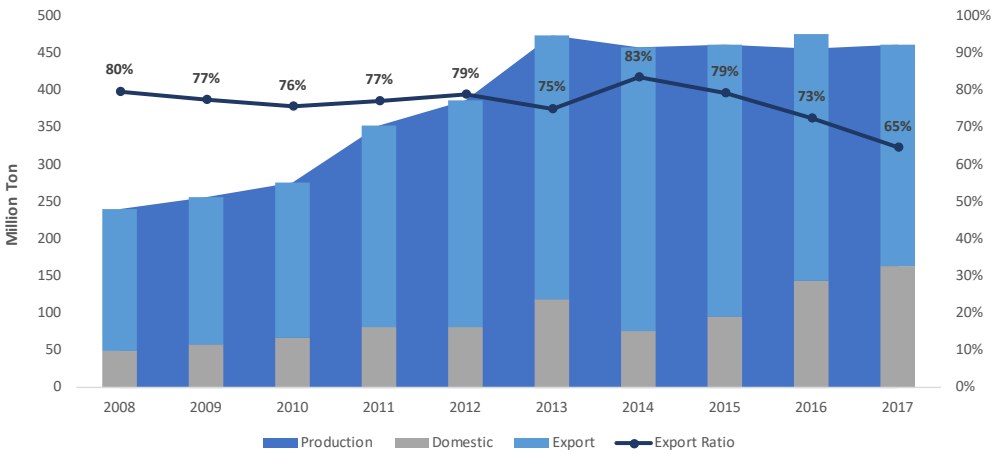
As the effort to promote the acceleration of economic growth and the competitiveness of national industry, the government has issued Presidential Regulation Number 40 of 2016 on gas price stipulation in upstream and gas price in certain industry. Based on this Presidential Regulation, if gas price is higher than US$ 6 dollar per MMBTU, Minister of EMR may decide certain gas price for fertilizer industry, petrochemical industry, oleo chemical industry, steel industry, ceramic industry, glass industry and gloves industry.

### 1.1.3 Coal

Indonesia coal production is predicted to increase especially to meet domestic demand (electricity plant and industry) and export.

The development of coal production in 2008-2017 increased significantly with the production of 461 million ton in 2017. From the total national coal production, the percentage of coal export in 2017 reached 65%. Most of them use 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, China and America.

In 2017, the target of domestic coal consumption was 121 million ton. However, the realization of this mineral consumption was only 97 million ton. There are factors which cause coal consumption in 2017 does not meet the target. One of the factors is the operation delay of several Steam Coal Power Plant in 35,000 MW program and also the declining industry. The picture of coal supply and demand in the last 10 years can be seen in Picture 1.4.




**Source: HEESI, 2018**

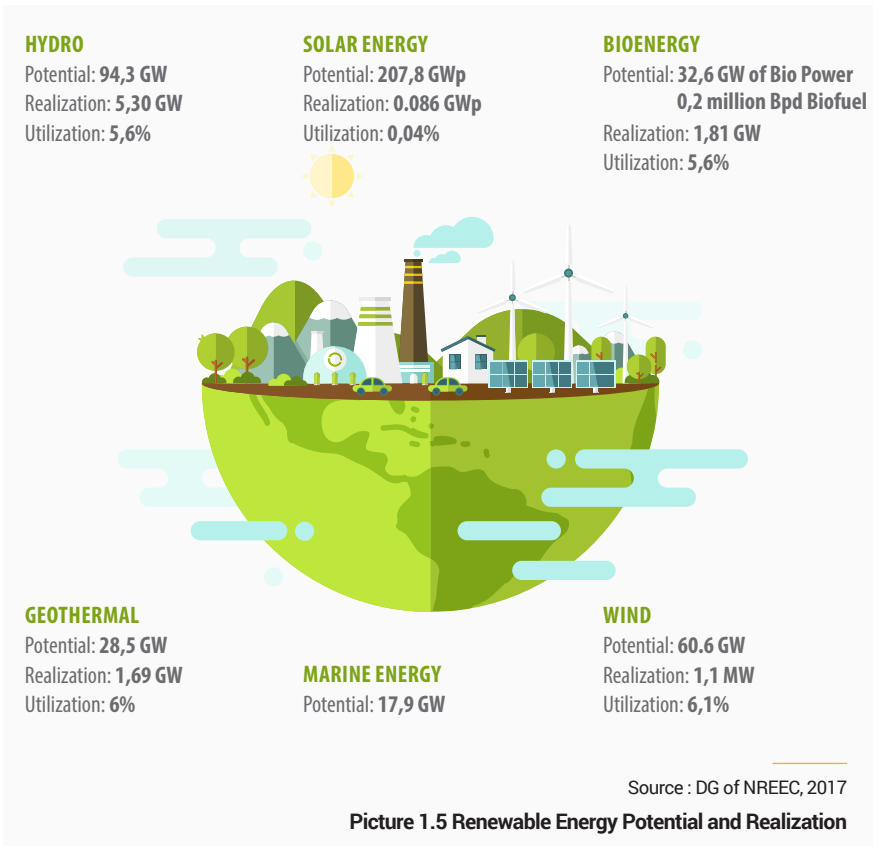
**Picture 1.4 Coal Production and Export**

### 1.1.4 New Energy and Renewable Energy

### a. New Energy and Renewable Energy Potential

The declining fossil energy potential especially oil and gas as well as the international commitment in reducing emission have encouraged the government to put new and renewable energy as the main priority to maintain energy security and independence. As stated in National Energy Policy (Government Regulation No. 79 of 2014), new and renewable energy mix target is in minimum 23% by 2025 and 31% by 2050.

In order to meet the primary energy mix target based on National Energy Policy, Indonesia may develop renewable energy potential maximally as seen in Picture 1.5 below.




Source : DG of NREEC, 2017

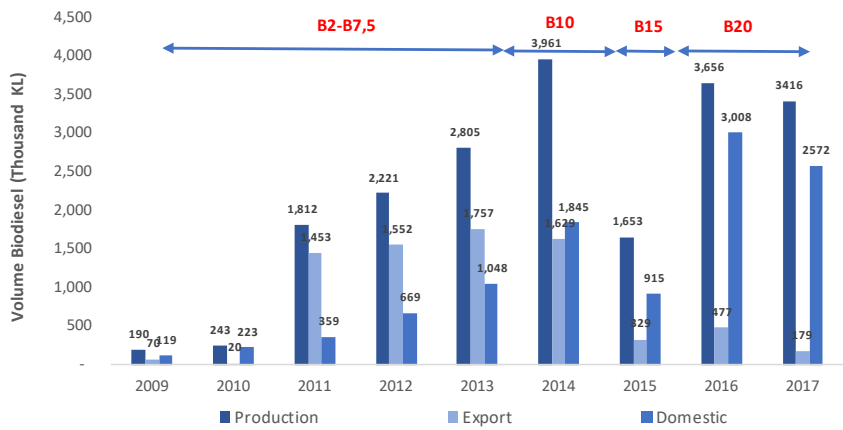
**Picture 1.5 Renewable Energy Potential and Realization**

Beside the energy in the above table, Indonesia also has new energy potential such as shale gas and Coal Bed Methane (CBM) reaching 574 TSCF and 456.7 TSCF which are not yet developed today.

In total, NRE potential in Indonesia is around 441.7 GW, but only 2% or 8.8 GW is utilized. Meanwhile, the total electricity plant capacity (both fossil and non fossil) in 2017 was 60.1 GW. Thus, NRE electricity plant capacity contributes only 15% from the current electricity plant capacity. NRE is mostly utilized for electricity plant, while other NRE resources (biofuel and biogas) are used as fuel in transportation, household, commercial and industry.

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

NRE utilization especially in transportation has been increasingly developing following the biofuel mandatory policy which says that the mix of biofuel in fuel in transportation should reach 20% (B20). Biodiesel production, export and utilization are seen in Picture 1.6.




**Source: DG NREEC**

**Picture 1.4 Biodiesel Utilization**

## b. NRE Supporting Policy

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

Presidential Regulation number 4/2016 on Electricity Infrastructure Acceleration, Article 14 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, the establishment of business entity to supply electricity to PT PLN (Persero), and/or subsidy.

Minister of Finance Regulation on fiscal and non fiscal incentive on NRE development. One of them is Minister of Finance Regulation No.177/PMK.011/2007 on Free Duty on Imported Goods for Upstream Oil and Gas Business and Geothermal.

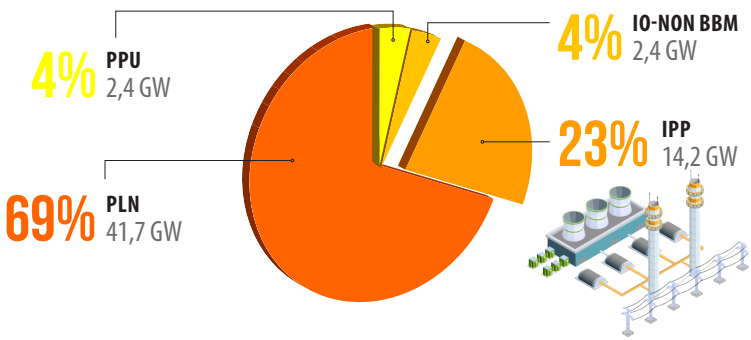
Minister of Energy and Mineral Resources Regulation number 49 of 2017 as the refinement of Minister of Energy and Mineral Resources Regulation number 10 of 2017 on Principles in Electricity Sales and Purchase Agreement.

Minister of Energy and Mineral Resources Regulation number 50 of 2017 as the revision of Minister of Energy and Mineral Resources Regulation number 12 of 2017 on Renewable Energy Utilization for Electricity Supply to create a better investment climate by promoting efficiency and affordable electricity price.

Presidential Regulation Number 66 of 2018 on the Second Amendment of Presidential Regulation Number 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).

### 1.1.5 Electricity

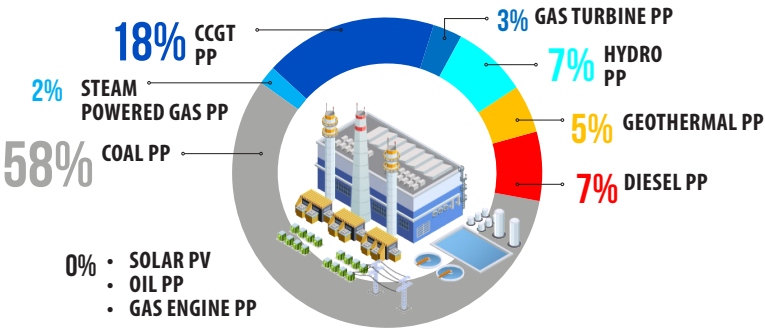
Indonesia power plant capacity in 2017 reached 60.2 GW which was dominated by fossil energy (85%) especially coal. Most of power plants are operated by PLN reaching 41.7 GW, while the rest 14.2 GW is operated by IPP. Meanwhile, Private Production Utility (PPU) produces 2.4 GW and non-fuel Operation Permit (IO) produces 2.4 GW. (Picture 1.7).




Source : Directorate General of Electricity, 2017

**Picture 1.7 Power Plant Capacity in Indonesia Year 2017**

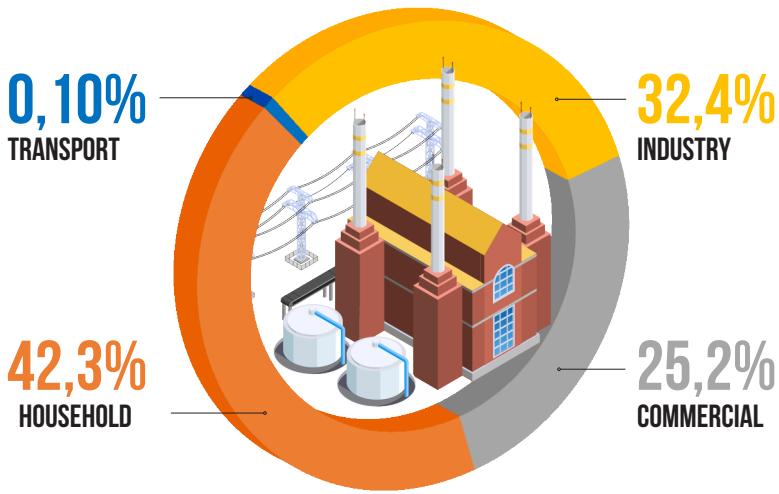
In 2017, power plant production reached 254,619.5 GWh which was derived 58% from coal, 22% from gas, 7% from fuel and 13% from NRE. The detail is shown in Picture 1.8.




Source : HEESI, 2018

**Picture 1.8 Power Production per Energy Type Year 2017**

Electricity from PLN and non PLN which is already connected to PLN network (on grid) is distributed to consumer. The biggest consumer is household of 94.5 thousand GWh, industry of 72.2 thousand GWh, commercial sector of 56.2 thousand GWh and transportation only for commuter train of 236 GWh (Picture 1.9)



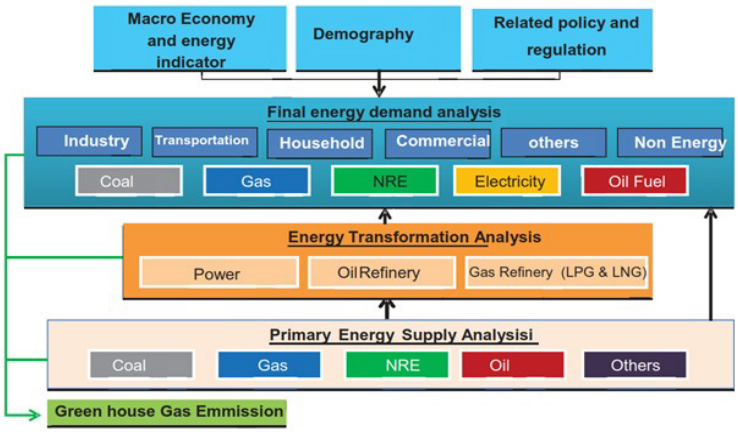

Source : HEESI, 2018

**Picture 1.9 Electricity Sales 2017**

## 1.2 METHODOLOGY

### 1.2.1 Analysis Framework

The analysis modeling is divided into three stages namely analysis on energy demand, energy transformation, and energy supply. Next, as the main energy demand growth driver, GDP and demography are used as the main parameters. Besides that, energy demand analysis also considers policy, strategic plan, and roadmap on energy. The framework analysis is shown in Picture 1.10

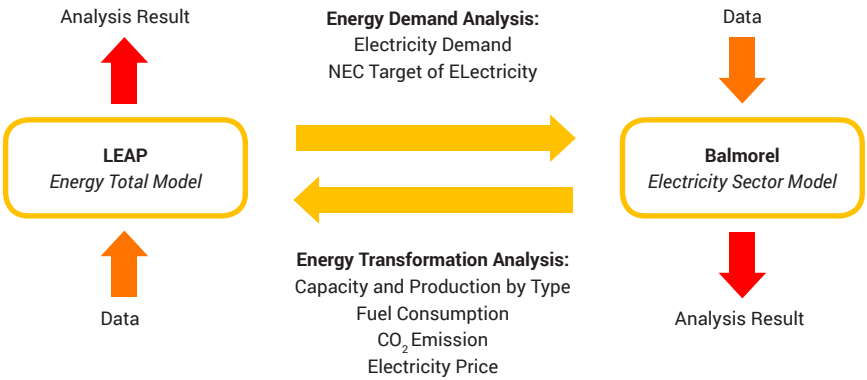



**Picture 1.10 Analysis Framework**

The energy supply and demand analysis is conducted 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 volume 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 Picture 1.10, the parameters in projecting energy demand are social economic data including population and economic growth, historical data in energy consumption (energy intensity and energy consumption pattern) and living standard improvement. The energy data in 2017 is used as the baseline data while data history in the last five years is used to see the trend.

To calculate the projection of power plant supply and types of power plant, Balmorel model is used as the energy planning modeling application especially for electricity supply with optimization approach. Electricity demand per sector from LEAP model will become the input in projecting electricity supply in Balmorel model. The correlation between LEAP and Balmorel in calculating energy demand is shown in Picture 1.11.




**Picture 1.9 LEAP and Balmorel Synergy**

## 1.2.2 Energy Projection Scenario

### 1.2.2.1 Current Policy Scenario

Statistics Indonesia shows that Indonesia economy real growth in 2015, 2016 and 2017 is 4.88%, 5.02% and 5.07%. Based on State Budget 2018, Indonesia economic growth in 2018 is targeted to reach 5.4%. Besides that, the study of International Monetary Fund (IMF) 2018 also predicted that Indonesia economic growth until the year 2022 is around 5.6% annually. 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 energy mix target and energy intensity decline in KEN (National Energy Policy) and RUEN (National Energy General Plan), RIPIN (National Industry Development Master Plan) 2015-2035 and RENSTRA of each ministry which is adjusted to the current realization.

In electricity supply analysis which uses Balmorel, there are additional assumptions such as electricity demand based on RUPTL 2018-2027 (not including planned-power plant), cost assumption in technology development in Wind Electricity Plant and Biomass Electricity Plant referring to moderate scenario in Technology Catalogue (Secretariat General of National Energy Council and DEA's publication) and fossil energy price referring to World Energy Outlook 2016 (IEA).

### 1.2.2.2 Green Scenario

Green scenario uses the same economic growth and population growth assumption as in Current Policy Scenario. However, the energy consumption is lower than the above condition due to energy conservation in final energy demand. Besides that, the target of biodiesel and bioethanol utilization is higher compared to the previous scenario. Furthermore, the target of electric vehicle utilization has higher portion than in green scenario.

Green scenario also considers long term-CO2 emission reduction target in power plant. Besides that, cost assumption in Wind Turbine Power Plant refers to Technology Catalogue and assumption of Biomass Power Plant technology development with higher efficiency level can be achieved 10 years earlier, assumption of biomass (palm shell) price which is 80% lower than coal price, and assumption of biomass (wood pellet) price which refers to national market actual price. However, the price is declining and will be the same with coal price starting in 2030. The assumption in both scenarios can be seen in table 1.1.

| No. | Current Policy Scenario | Green Scenario |
|---|---|---|
| 1 | Economic growth of 5.6 % | |
| 2 | Population Growth based on BPS data | |
| 3 | Biodiesel target of 20 % by 2025 | Biodiesel target of 30 % by 2025 |
| 4 | Bioethanol Target of 2 % by 2025 | Bioethanol Target of 10% by 2025 and 50% by 2050 |
| 5 | Electric vehicle Target by 2025<br>Electric car 0.01%*)<br>Electric motorcycle 0.2% | Electric vehicle Target by 2025<br>Electric car 1.7%<br>Electric motorcycle 1.4%**) |
| 6 | Price of fossil energy refers to data of World Energy Outlook 2016, IEA | |
| 7 | Power plant capacity refers to RUPTL until 2027 (not including projects in planning-status) | |
| 8 | CO2 emission target refers to NDC target | CO2 emission target refers to 2 degree decline scenario |
| 9 | Wind Turbine Power Plant Investment cost refers to data moderate scenario of Technology Data Catalog ***) | Wind Turbine Power Plant Investment cost refers to data optimist scenario of Technology Catalog |

| | | |
|---|---|---|
| 10 | Technology development assumption of Biomass Power Plant refers to Technology Data Catalogue | Technology development assumption of Biomass Power Plant with higher efficiency level can be achieved in 10 years earlier |
| 11 | Assumption of biomass (palm shell) price refers to Perhepi****) (Agriculture Economy Association) actual price of Rp 1000 per Kg | Assumption of biomass (palm shell) price which is cheaper, about 80% from coal price |
| 12 | Assumption of biomass (wood pellet) price refers to national market actual price of USD 131 per ton (Perhepi) | Assumption of biomass (wood pellet) refers to national market actual price which is then declining or similar to coal price starting in 2030 |

***) RUEN Projection**
****) Based om Ministry of Industry's projection, motorcycle production by 2025 is 10 million units, 20% is electric motorcycles or 2 million units or 1.5% from the total motorcycle operating in 2025 of around 146 million units**
*****) Technology Data Catalog is the publication of Secretariat General of National Energy Council in cooperation with Danish Energy Agency (DEA)**
******) Perhepi: Perhimpunan Ekonomi Pertanian (Agriculture Economy Association)**

**Table 1.3 Scenario Assumption**

## 1.2.3 MODELING ASSUMPTION

### 1.2.3.1 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 to 2035 (Statistics Indonesia 2014), Indonesia population growth declined from 1.2% in period 2015-2017 to 1% in period 2020- 2025.

Due to the difference in energy consumption pattern between urban and rural residents, the urbanization rate indicator has been very important in obtaining a more accurate energy projection. The urbanization rate also follows Statistic Indonesia projection in which urban residents reaches 60 % in 2020 and continues to increase up to 66.6 % in 2035.

### Economic Growth

Energy demand is closely related to economic activity. GDP growth assumption will be very sensitive toward energy projection from the two developed scenarios.

Indonesia economic growth in the last five years tends to decline from 6.2 % in year 2012 to 5.1% in year 2017. It is due to the slowing global economic growth, the low commodity price including oil, the slowing global trade, and the reducing capital rate. Besides that, the weakening investment growth and Indonesia's export also contribute to the current economic condition. However, the high resistance domestic expenditure, the government's commitment to conduct economic deregulation and investment licensing simplification are also expected to support future growth.

## 1.2.4 Energy-related Policy Assumption

In order to support energy demand projection, several energy-related policies are being considered, including:

### 1. National Energy Policy

NEC (KEN) mandates renewable energy mix target in primary energy supply to reach 23% by 2025 by optimizing NRE utilization and minimizing the use of oil up to 25% by 2025. Beside that, energy efficiency is also targeted to decline 1% per year in the effort to promote energy saving in all sectors. Several targets in NEC that also become considerations in energy demand projection are 100% of electrification ratio by 2020, optimization of domestic gas use, and fossil energy priority for national industry raw material.

### 2. National Energy General Plan

National Energy General Plan (RUEN) is the derivative of KEN. Thus, energy policy in RUEN also refers to KEN. In conducting a more detail energy demand and supply projection, assumption based on RUEN is used especially related to NRE supply target in electricity plan and its utilization in other sectors (transportation, industry and household).

## 3. Strategic Planning of MEMR

Several programs of MEMR Strategic Planning (RENSTRA) which are considered in calculating energy demand projection are city gas, fuel to gas conversion in transportation, fuel to gas diversification program, and NRE utilization.

## 4. Strategic Planning of the Ministry of Transportation

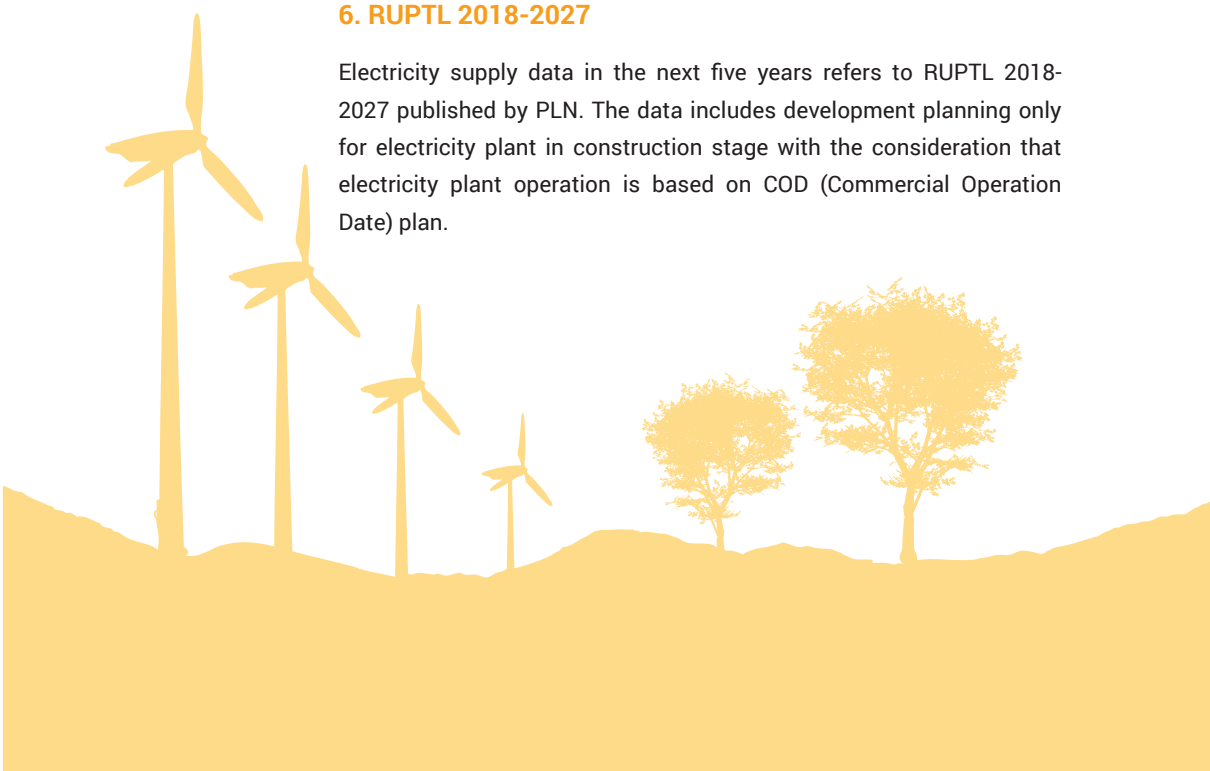
There are a number of programs in the Strategic Planning of the Ministry of Transportation which become considerations in the energy demand projection such as the operation plan of BRT (Bus Rapid Transit), Mass rapid Transit (MRT), and Light Rail Transit (LRT) which are currently being in construction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

## 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 in 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

Electricity supply data in the next five years refers to RUPTL 2018-2027 published by PLN. The data includes development planning only for electricity plant in construction stage with the consideration that electricity plant operation is based on COD (Commercial Operation Date) plan.



## 7. Biofuel Roadmap

Based on Minister Regulation No.12 of 2015 on Biofuel Supply, Utilization and Commercial as Fuel, it is targeted that in 2020 the share of biodiesel as fuel mix is 20% in 2016 and 30% in 2030. Meanwhile, the mandatory of bioethanol minimum utilization as fuel mix is 5% in 2020 and 20% in 2025.

## 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 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). Beside 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.

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# CHAPTER II CURRENT POLICY SCENARIO

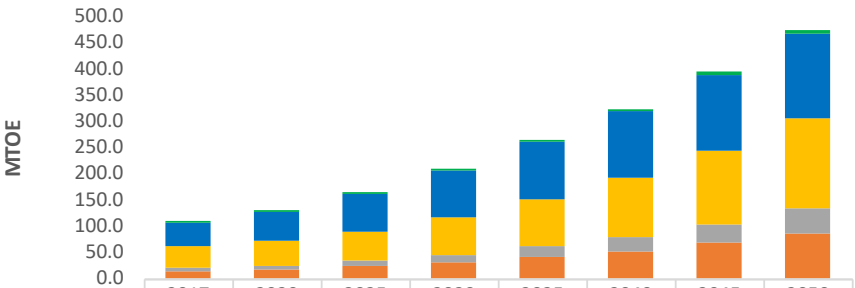
As explained earlier, current policy (KS) scenario is a scenario which uses several government's energy policies including electricity, economy, industry, transportation, household, commercial and environment.

National Energy Policy (KEN) and National Energy General Planning (RUEN) mandate a more aggressive utilization of new and renewable energy (NRE) to reduce high dependency on fossil energy. NRE is utilized especially for NRE electricity plant with the priority to utilize local energy resources and biofuel utilization in transportation. Policy in industry which refers to National Industry Development Master Plan (RIPIN) is prioritized through the development of independent, competitive and green industry. Beside that, policy in industry also includes industry equalization outside Java and industrial development in area with industrial raw material sources. Policy in transportation includes development of public transportation such as mass rapid transit (MRT), light rapid transit (LRT), and bus rapid transit (BRT) to be implemented in 2019 and will be finish at 2019. Besides that, electric vehicle development and gas to fuel substitution are also part of energy policy in transportation. In household, kerosene to LPG conversion program still continues. The government also put a target in developing city gas in several cities in Indonesia with major gas potential such as Jakarta, Bekasi, Surabaya, Balikpapan, Tarakan, Palembang and other cities by optimizing domestic gas utilization and reducing LPG import. In commercial sector, energy conservation and efficiency programs are conducted through green building certification as stipulated in National Energy Conservation Master Plan (RIKEN). In environmental sector, Indonesia has agreed to ratify COP21 Paris Agreement through Nationally Determined Contributions (NDC). Thus, Indonesia has the obligation to reduce GHG of 29% without international help or 41% with international support from GHG emission rate in basic scenario in 2030.

## 2.1 FINAL ENERGY DEMAND

From the analysis, the national final energy demand by KS scenario will reach 163,4 MTOE in 2025. It increases with the average annual growth rate of 5.1% compared to final energy consumption in 2017. In 2050, final energy demand will reach 475.1 MTOE or increases with average annual growth rate of 4.5%.

Based on energy consumer, national final energy demand until 2050 is still dominated by transportation and industry as if in 2017 condition. The increase of industrial activity and vehicle activity give a significant contribution in the increase of energy demand in both sectors despite of the implementation of energy conservation technology. The share of industry is 34% in 2025 and 36% in 2050. Meanwhile, the share of consumption in transportation will decline from 44% in 2025 into 34% in 2050 which is influenced by the substitution of fuel to electricity and the shift from private car into mass transportation (Picture 2.1).

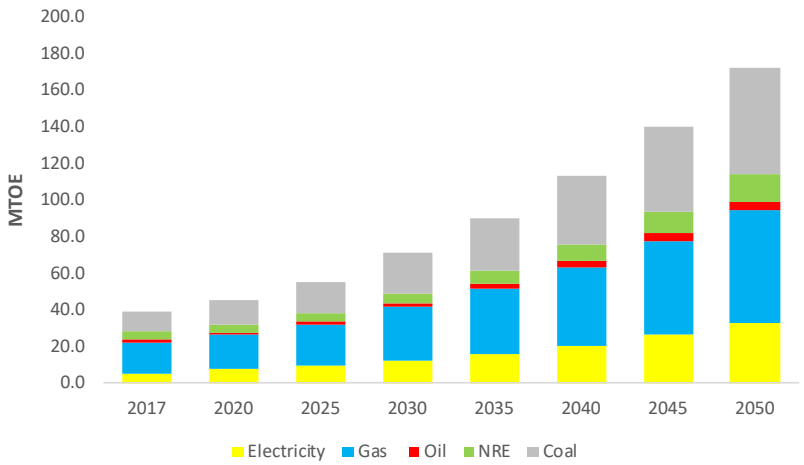



| | 2017 | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| Others | 1.4 | 1.4 | 1.5 | 2.0 | 2.7 | 3.5 | 4.6 | 5.9 |
| Transport | 47.6 | 57.0 | 72.0 | 89.1 | 108.6 | 128.2 | 146.7 | 162.8 |
| Industry | 39.5 | 45.3 | 55.4 | 71.9 | 90.5 | 113.2 | 140.5 | 172.6 |
| Commercial | 6.7 | 8.3 | 10.6 | 14.5 | 19.7 | 26.4 | 35.0 | 45.8 |
| Household | 14.5 | 17.7 | 24.2 | 31.7 | 41.3 | 53.1 | 68.0 | 88.1 |

**Picture 2.1 Final Energy Demand**

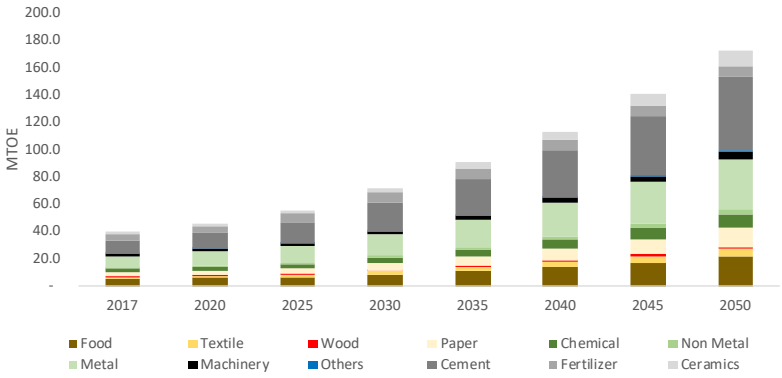
### 2.1.1 Industry

Energy demand trend in industry sector until 2040 is dominated by gas followed by coal, electricity and NRE, while fuel is only used in small number of industry especially for generator and industrial engine. Gas is mostly used to meet the demand of metal, fertilizer (as raw material) and ceramic industry. These three industries consume 84% of gas in industry. Meanwhile, coal (92%) is mostly consumed by cement industry. Energy demand development in industry can be seen in Picture 2.2 below.




**Picture 2.2 Energy Demand of the Industry Sector**

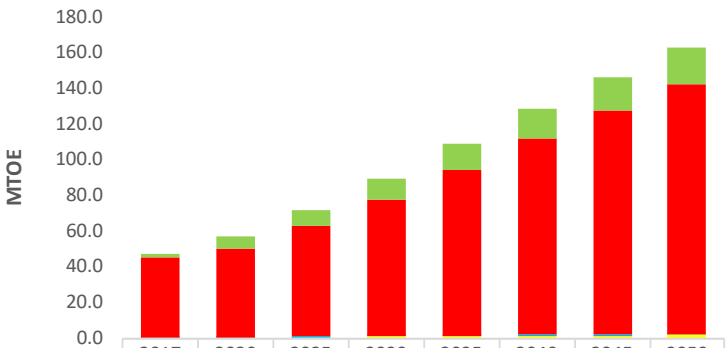
From energy consumption per sub industry, the biggest energy consumption in 2025 is cement industry of 15.7 MTOE (28%), metal industry of 12.2 MTOE (22%), food and beverage industry of 6.5 MTOE (12%) and fertilizer industry of 6.1 MTOE (11%). Energy demand share in 2050 shows the same trend as in 2025 with the consumption of 54.5 MTOE in cement industry, 37.4 MTOE in metal industry and 21.2 MTOE in food industry or 66% from the total energy consumption in industry. Energy demand development in each sub industry can bee seen in Picture 2.3.




**Picture 2.3 Energy Demand by per Type of Industry**

## 2.1.2 Transportation

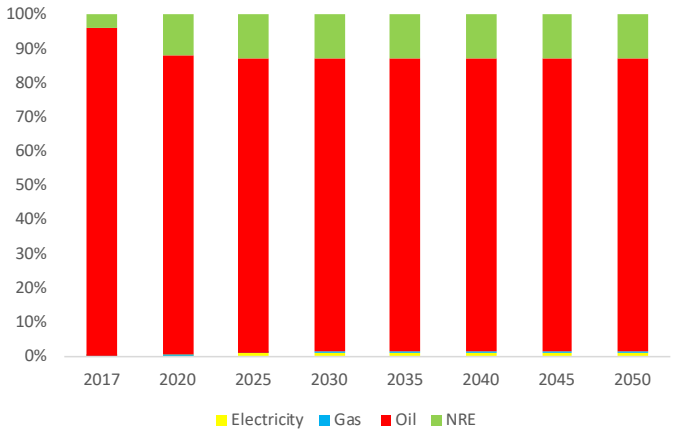
Gasoline, diesel, gas, avtur, avgas, biodiesel, bioethanol, and electricity are energy sources consumed in transportation. In 2025, oil will still dominate energy demand of 86.1% (62 MTOE) followed by biofuel of 12.7% (9.1 MTOE) and the rest 1.2 % are electricity (0.7 MTOE) and gas (0.2 MTOE). The high demand on oil occurs since the users have not completely convert the energy or substitute fuel to biofuel (biodiesel and bioethanol), gas or electricity. The demand of gasoline is declining but it is still needed for biopremium blend, while the demand of diesel is still increasing since biodiesel blend is only limited to 30%. The policy on electric vehicle will increase the population of electric vehicle in the future. Thus, electricity demand will increase from 0.9% in 2025 into 1.1% in 2050. Energy demand development based on its sources is shown in Picture 2.4.




| | 2017 | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| NRE | 1.8 | 6.6 | 9.1 | 11.5 | 14.1 | 16.5 | 18.8 | 20.7 |
| Oil | 45.8 | 50.0 | 62.0 | 76.4 | 93.1 | 109.9 | 125.8 | 139.7 |
| Gas | 0.1 | 0.1 | 0.2 | 0.3 | 0.5 | 0.5 | 0.5 | 0.6 |
| Electricity | 0.0 | 0.2 | 0.7 | 0.8 | 1.0 | 1.4 | 1.6 | 1.8 |

**Picture 2.4 Energy Demand of the Transportation Sector**

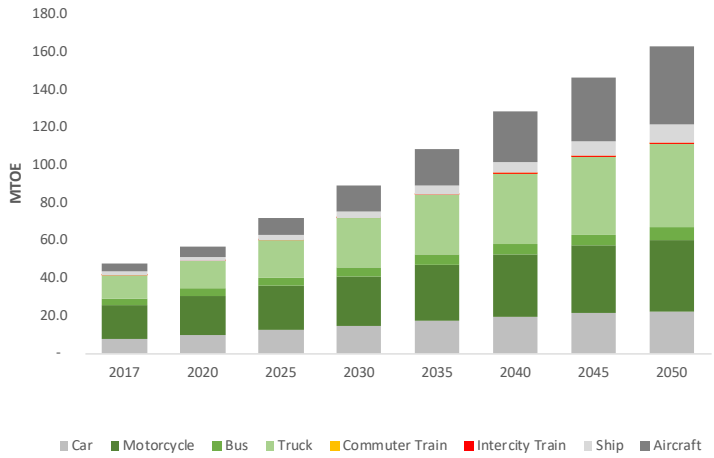
From its trend, oil demand share decreases from 96% in year 2017 into 86% in year 2050. Conversely, NRE share increases from 4 % in year 2017 into 13% in the year 2050 due to the implementation of biofuel mandatory policy (Picture 2.5.)




**Picture 2.5 Energy Demand Share in Transportation Sector**

Energy demand from motor cycle is still dominating in 2025 reaching 23.5 MTOE. In 2017-2025, motor cycle is still the most favorite mode of transportation especially in big cities since it has faster time-travel compared to other vehicles. However, in 2050, with technology innovation from combustion engine to a more efficient electric electricity and the control on motor cycle production as well as the shift from motorcycle to mass transportation, the share of energy demand form motor cycle is declining into 23% (38 MTOE). Energy demand in air transportation reaches its highest demand during the projection period with the average growth of 7.2% in 2017-2050. Thus, the demand of avtur (jet fuel) increases from 8.9 MTOE in 2025 into 41.1 MTOE in 2050. Its energy demand share increases from 12% in 2025 into 25% in 2050. This condition is encouraged by the increasing people's welfare, cheap flights, and the fast growing tourism. Meanwhile, truck (goods carrier mode of transportation) shows an increase of energy demand at the average of 6.4% in 2017-2025. Thus, the volume increases from 20 MTOE in 2025 into 44.1 MTOE in 2050. The trend of digital economy and the increasing online transaction (e-commerce) become a trigger of energy demand increase in this mode of transportation. The distribution of goods usually uses trucks. For passenger vehicles, there is a trend of increasing energy demand. However, its growth can be reduced by the utilization of a more energy saving technology and the shift of passengers to mass transportation (MRT, LRT, commuter train). Thus, the energy demand in 2025 and 2050 only increases into 12.2 MTOE and 22.4 MTOE. The

energy demand of other mode of transportation is relatively stagnant. Energy demand based on mode of transportation can be seen in Picture 2.6.

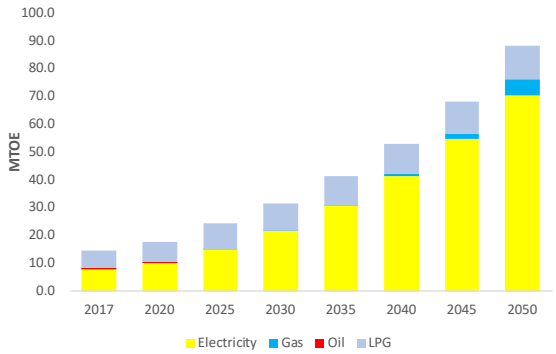



**Picture 2.6 Energy Demand by Mode of Transportation**

### 2.1.3 Household

Energy demand in household is dominated by urban household with the share of 78% (19 MTOE) in 2025 and 88% (77.5 MTOE) in 2050 in line with urbanization. Electricity has the biggest portion in energy demand in household with 14.8 MTOE (61%) in 2025 and 70.6 MTOE (80%) in 2050. The demand on housing in urban area becomes the factor in the increasing electricity demand. Indonesia Investments (2015) recorded that there were 13.5 million backlog houses with the housing growth of 6 – 8%. This growth is conversed by the rate of new electricity installation of 5% per year with the growth of energy sale of 7.5%. Besides that, the use of electronic devices in household especially AC and refrigerator promotes the energy demand. On the other hand, LPG demand is also increasing into 9.3 MTOE in 2025 and 11.7 MTOE in 2050 which is influenced by the success of kerosene to LPG conversion program. Despite of the low gas share, gas growth in 2017-2050 reaches 15.5% with the consumption of 0.1 MTOE in 2025 and 5.8 MTOE in 2050. This condition will become the indicator of the success of the government's program in maximizing the use of gas for domestic need. One of

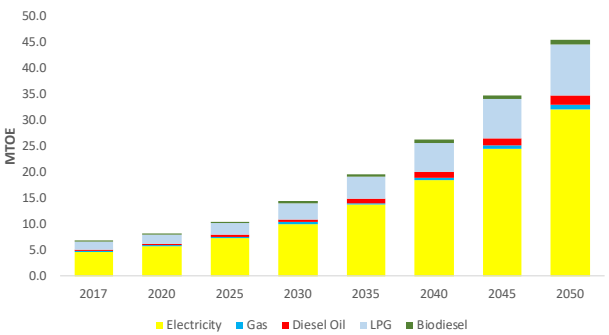
them is through gas pipeline for household program. The trend of energy consumption in household can be seen in Picture 2.7 below.




**Picture 2.7 Energy Demand of the Household Sector**

## 2.1.4 Commercial Sector

Energy demand in commercial sector includes offices, hotels, restaurants, hospitals, and other services. Energy demand in commercial sector is dominated by electricity and LPG. In 2025, the share of electricity energy demand reaches 69% or equals to 7.3 MTOE and the share of LPG energy demand reaches 22% or 2.3 MTOE and the rest 9% is the demand of diesel oil and gas. The biggest electricity consumption in commercial sector is AC, while LPG is used for cooking (hotel and restaurant). Electricity and LPG demand in 2050 increases into 32 MTOE and 9.8 MTOE. The development of energy demand in commercial sector can be seen in Picture 2.8.

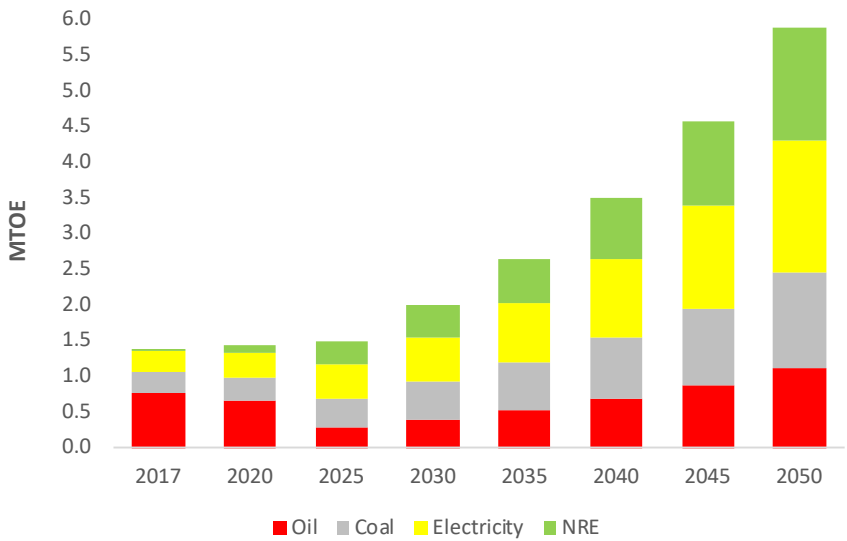



**Picture 2.8. Energy Demand of the Commercial Sector by Energy Source**

Almost 50% of energy demand in commercial sector is consumed by sub sector of trade, hotel and restaurant reaching 3 MTOE and 1.9 MTOE in 2025 and 12 MTOE and 8.2 MTOE in 2050. Meanwhile, the remaining 50% is consumed by the social services, communication services, financial services and office sub-sectors.

### 2.1.5 Other Sectors

Other sectors consist of three sub sectors, namely agriculture, mining and construction. The total energy demand in 2025 and 2050 increases into 1.5 MTOE and 5.9 MTOE. The share of oil demand in 2025 and 2050 will decline into 20% and 19% with the substitution of diesel oil to biodiesel. Conversely, the share of biofuel demand especially biodiesel increases from 2% in 2017 into 21% in 2025 and 27% in 2050. The shift of using generator set to electricity has caused the increase of electricity demand from 21% in 2017 into 32% in 2025. The development of electricity demand in other sectors can be seen in Picture 2.9.

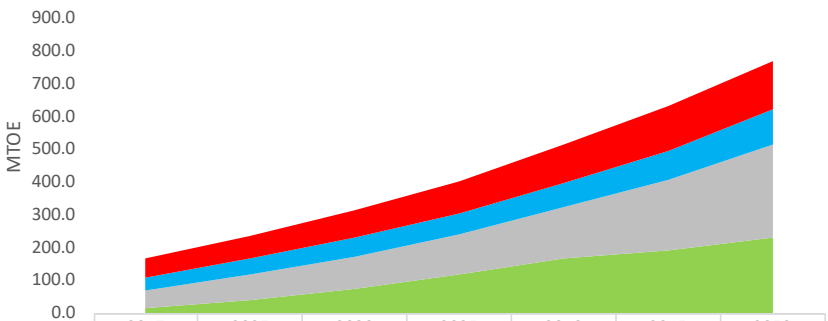



**Picture 2.9 Other Sectors' Energy Demand by Energy Source**

## 2.2 PRIMARY ENERGY SUPPLY

Primary energy supply in KS scenario in 2025 is projected of around 235.7 MTOE and will increase into 769 MTOE in 2050. A number of policies on energy diversification, conservation and efficiency as well as environment give an impact on a more rational primary energy supply growth. The implementation of these policies has retained the growth rate of primary energy supply.

In the last few years, the government has cut energy subsidies such as gasoline RON 88 and electricity for middle and upper class households. The increase of economic activity is predicted not to be influenced by fuel and electricity price increase. Thus, energy demand will keep increasing especially fossil energy demand such as coal, gas, and oil. These three fossil energy sources are still the main options in meeting the national energy demand until 2050. The projection of primary energy supply development per energy source by KS scenario is shown in Picture 2.10.




| | 2017 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|
| Oil | 63.0 | 66.2 | 80.8 | 98.2 | 115.9 | 132.9 | 148.1 |
| Gas | 36.1 | 50.1 | 58.2 | 66.4 | 76.2 | 88.8 | 105.9 |
| Coal | 56.9 | 78.7 | 100.5 | 122.1 | 156.8 | 218.7 | 286.0 |
| NRE | 13.0 | 40.8 | 73.2 | 117.6 | 165.4 | 190.5 | 229.0 |

**Picture 2.10 Primary Energy Supply**

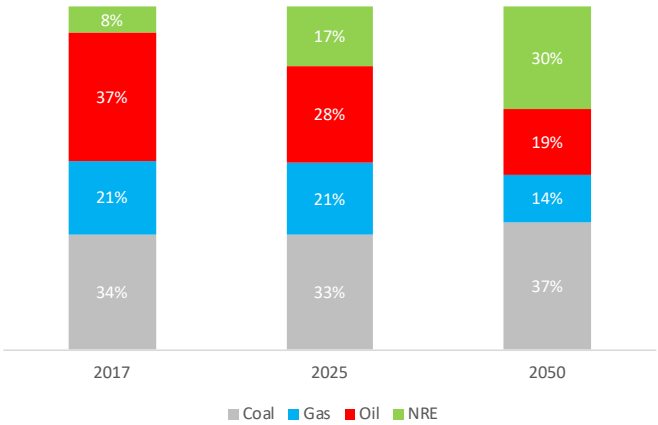
Coal demand including briquettes in 2025 increases into 78.7 MTOE with the share of 33% in 2025 and 286 MTOE or 37% in 2050. The government's policy to optimize domestic coal utilization and export limitation starting in 2046 has shifted the use

of coal for domestic consumption. Besides for industry, coal is also used as raw material in coal gasification and coal liquefaction. Meanwhile, coal for electricity plant will be limited only for mine mouth-steam electricity plant.

Gas demand including gas, LPG and LNG grows into 50.1 MTOE in 2025 and 105.9 MTOE in 2050. It is due to the government's policy in prioritizing domestic demand than gas and LNG export especially after gas export commitment ends in 2035. Besides that, the increase of gas utilization is due to the development of national gas infrastructure such as gas pipeline network based on Gas Transmission and Distribution Network Master Plan, Floating Storage Regasification Unit (FSRU) for LNG which is far from gas source, as well as gas for household in regions which are closer to gas sources.

Oil demand in 2025 and 2050 will increase into 66.2 MTOE and 148.1 MTOE. However, its share in primary energy will decrease into 28% in 2025 and 19% in 2050. The increasing oil demand is influenced by the use of oil especially in transportation both in the form of pure fuel (gasoline, diesel and avtur) or blend of biodiesel, bioethanol and bioavtur.

NRE demand including hydro, geothermal, wind, solar, waste, biomass, biogas and biofuel will increase into 40.8 MTOE in 2025 and 229 MTOE in 2050. The share of NRE also increases into 17% in 2025 and 30% in 2050. The increase of NRE demand is conducted through optimization of utilization on geothermal, water, solar cell, biomass, and wind of which the potential is abundant for electricity plant. Besides that, it is also conducted through substitution of fuel to biofuel in transportation. The optimization on utilization of biofuel is quite influential in increasing primary energy mix since the share of oil in energy demand in transportation is around 95%. The use of electric vehicle is also one of the factors which will indirectly increase NRE share in national energy mix. The development of energy mix in 2017, 2025 and 2050 can be seen in picture 2.11.



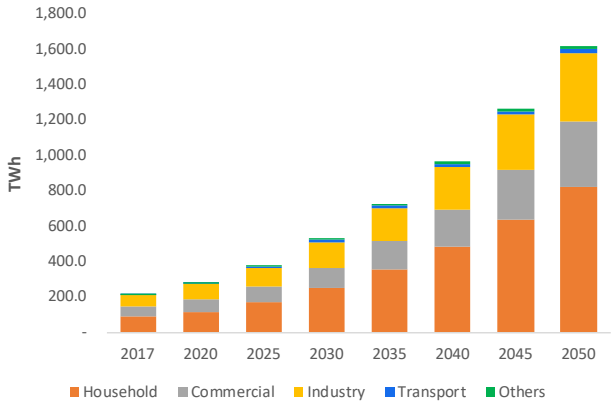

**Picture 2.11 Share of Primary Energy Supply**

## 2.3. ELECTRICITY

### 2.3.1 Electricity Demand

Electricity demand always grows higher than other energy sources. Electricity demand growth is projected to reach 381.7 TWh in 2025 and 1,621.7 TWh in 2050. Electricity demand growth rate is around 6.3% per year during 2017-2050.

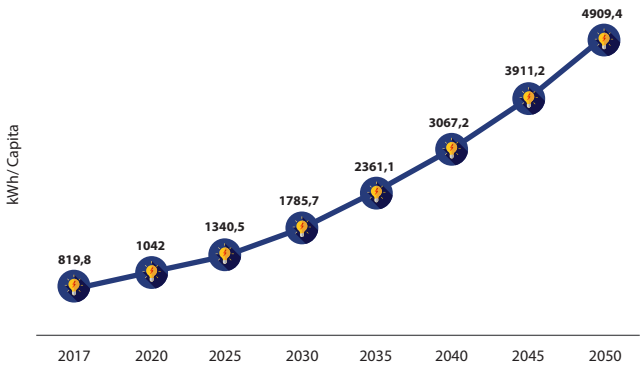
Electricity consumption pattern during projection period is the same with the previous one in which the biggest consumer is household followed by industry, commercial and transportation. In 2025, electricity demand in household is projected to reach 172.7 TWh (45%) from the total national electricity demand. Electricity in industry is 110.5 TWh (29%) and in commercial sector is 85.2 TWh (22%). The rest of demand is from transportation of 7.8 TWh and other sectors of 5.4 TWh. In 2050, electricity demand in household is 820.7 TWh (51%) from the total national electricity demand. Despite of the implementation of energy saving program, the consumption in household is still high since it is influenced by the increasing people's income. Thus, the use of electronic devices also increases such as AC, refrigerator, washing machine, TV, electric stove, and others. Electricity demand per sector is seen in Picture 2.12.




**Picture 2.12 Electricity Demand by Sector**

Electricity demand in transportation will continue to increase especially for electric train in Jabodetabek as well as MRT, LRT, and monorail. Besides that, the trend of using electric vehicle (car and motor cycle) is assumed of about 0.01% (car) and 0.2% (motorcycle) in 2025. Thus, the share of electricity consumption in transportation will grow from 7.8 TWh in 2025 into 21 TWh in 2050.

Basically, the increase of population will also increase energy consumption, especially electricity. Electricity consumption per capita reaches 1,340.5 kWh/capita in 2025 and will increase into 4,909.4 kWh/capita in 2050 (Picture 2.13).

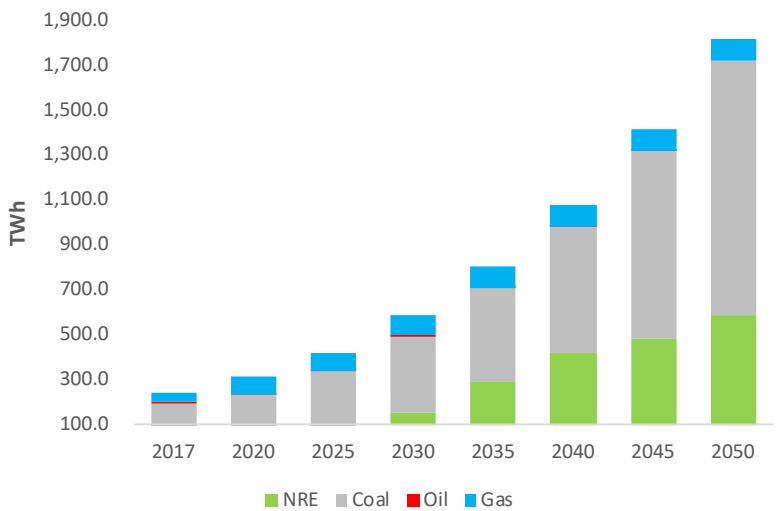



**Picture 2.13 Electricity Consumption per Capita**

## 2.3.2 Electricity Production

Electricity production during projection period is predicted to reach 421.6 TWh in 2025 and 1,815.2 TWh in 2050 with the assumption that the loss in transmission and distribution is around 10%.

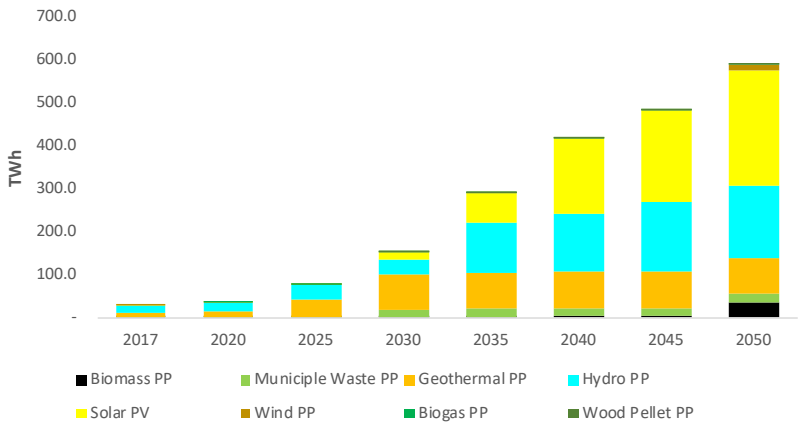
Coal power plant is still dominant in meeting electricity demand in the future, until 2050. On the other hand, the share of electricity production from NRE power plant will increase 18% in 2025 and 32% in 2050. Electricity production from fuel power plant will keep declining from 0.5% in 2025. In 2050, there will be no longer fuel power plant. This is in line with the government's plan to reduce the use of fuel in power plant and substitute diesel to NRE power plant, except in remote areas and frontier islands. Electricity production by energy source can be seen in Picture 2.14




**Picture 2.14 Electricity Production by Energy Source**

In 2025, electricity production from NRE power plant reaches 76.9 TWh derived from geothermal power plant, hydro power plant, waste power plant, solar power plant, wind turbine power plant, biomass power plant, biogas power plant, and wood pellet power

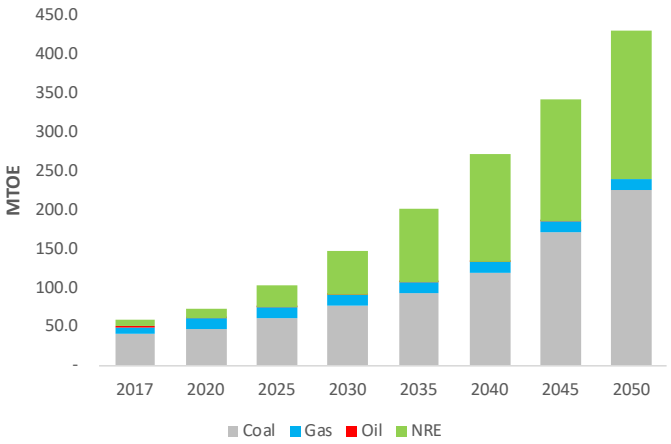
plant. Geothermal power plant produces 40.5 TWh (53%). Electricity production from hydro is 32.4 TWh (42 %) while electricity production from Waste power plant is 1.5 TWh (2%). However, in 2050, the share of electricity production from geothermal power plant decreases into 14%, while from hydro power plant decreases into 29%. It is due to the cheap price of electric components from solar power plant and the programs of solar rooftop and energy saving solar lamp (LTSHE) while the production of geothermal is relatively stable since it has reached its maximum potential in 2025. The trend of electricity production from NRE can be seen in Picture 2.15.




**Picture 2.15 Electricity Production from NRE**

### 2.3.3 Primary Energy Input to Power Plant

Primary energy input to power plant in 2025 is around 102.6 MTOE with coal as the biggest share of 61.0 MTOE (59%) followed by NRE of 27.0 MTOE (26%) and gas of 14.1 MTOE (14%). The high use of coal for power plant in 2025 occurs since the price of coal is cheaper than other energy sources and most power plants are coal-basis. In 2050, primary energy input to power plant is 431.2 MTOE with coal as the biggest share of 226.2 MTOE (52%) followed by NRE of 190.9 MTOE (44%). The increasing share of NRE in power plant is influenced by the competitiveness of NRE power plant price especially solar cell and wind power. Oil used to power plant is still very limited for remote areas and it is not substituted by other energy source (Picture 2.16).



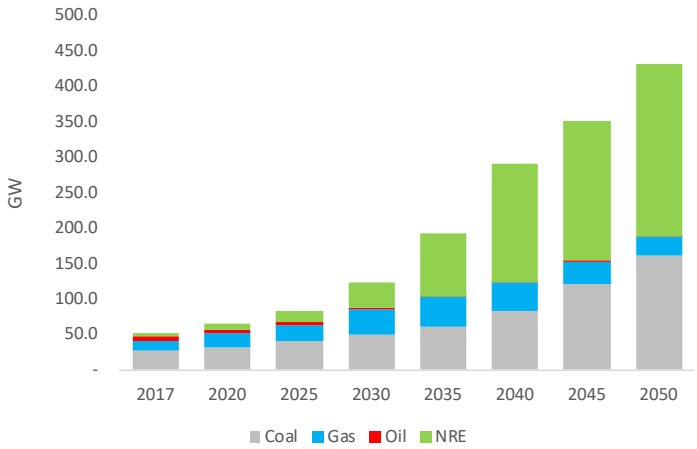

**Picture 2.16 Primary Energy Input to Power Plant**

## 2.3.4 Total Power Plant Capacity

The option to choose power plant types to produce electricity during projection period is based on least cost or cost effective principles with Balmorel model. The least cost is achieved by minimizing net present value of all electricity supply cost consisting of investment, fuel, operation and maintenance cost. The formulation of KS scenario in IEO 2018 also uses Least Cost Principle and accommodates capacity addition as formulated in RUPTL 2018-2027 with the status of projects in construction and feasibility study stage.

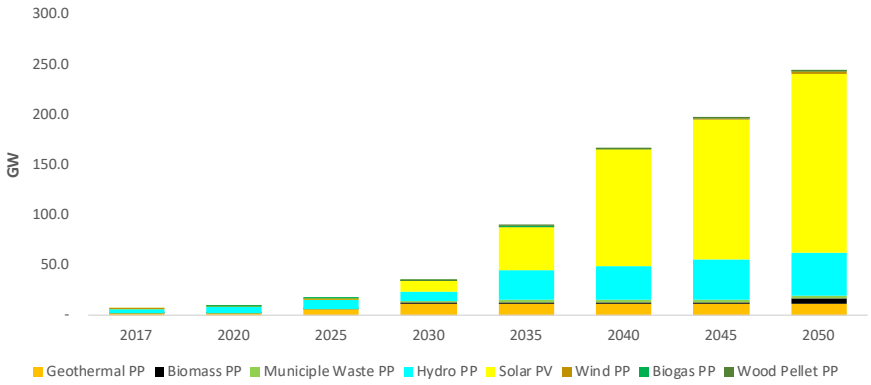
The total power plant capacity in KS scenario will reach 83.3 GW in 2025 consisting of 41 GW of coal power pant, 22.9 GW of gas fueled power plant, 16.3 GW of NRE power plant and 3.1 GW of fuel power plant.

In 2050, total power plant capacity will increase into 432.7 GW in which NRE power plant capacity (244 GW) is still dominant compared to coal power plant (162.2 GW) as seen in Picture 2.17.




**Picture 2.17 Total Power Plant Capacity by Energy Source**

Total capacity of NRE power plant in 2025 reaches 16.3 GW which will be dominated by 9.1 GW of hydro power plant (56%), 5.8 GW of geothermal power plant (36%), and 0.6 GW of solar power plant (4%). The rest are power plant of biomass, waste, wind, biogas and wood pellet power plant. In 2050, the share of solar power plant will increase sharply into 73% or 177.8 GW followed by hydro power plant of 17% (42.1 GW) and geothermal power plant of 5% (12 GW) as seen in Picture 2.17.

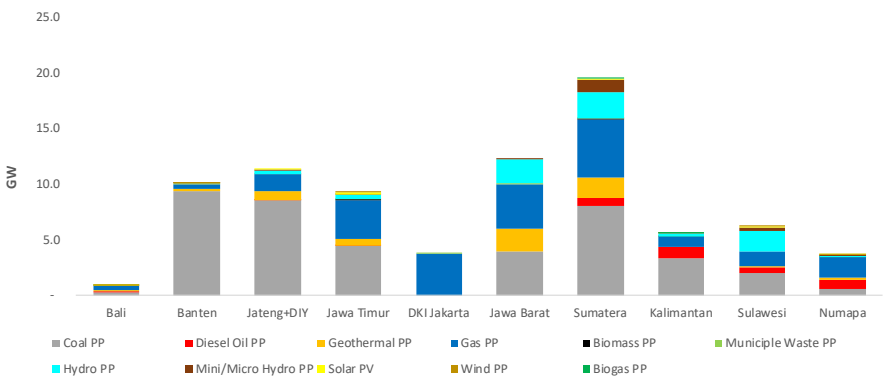



**Picture 2.18 Total Capacity of NRE Power Plant**

## 2.3.5 Power Plant Distribution by Region

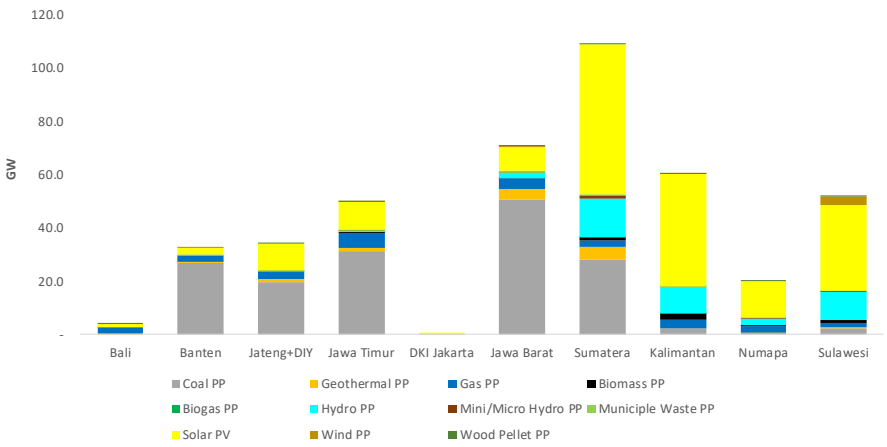
From the power plant distribution per region in 2025, coal steam power plant is mostly located in Java-Bali (26.8 GW) and the rest is located in Sumatera (8.1 GW), Kalimantan (3.4 GW), Sulawesi (2.0 GW) and Numapa (0.6 GW). Gas power plant with the total capacity of 13.6 GW is located in Java-Bali and 5.2 GW is located in Sumatera.

NRE power plant with the total capacity of 16.3 GW is mostly located in Java-Bali (7.4 GW) consisted of geothermal power plant of 3.6 GW and hydro power plant of 3 GW. From the total capacity, NRE power plant is located in Sumatera (5.6 GW), in Sulawesi (2.5 GW), in Numapa (0.4 GW) and in Kalimantan (0.4 GW) as seen in Picture 2.19.




**Picture 2.19 Power Plant Distribution by Region and Energy Source 2025**

In 2050, the total power plant capacity is 432.7 GW which is dominated by solar power plant of 177.8 GW (41%), followed by coal and gas power plant of 162.2 GW (37%) and 40.5 GW (9%). In total, NRE power plant capacity reaches 244 GW which is mostly located in Sumatera with 78.7 GW (32%), and the rest is located in Kalimantan with 54.8 GW (22%), Sulawesi with 47.7 GW (20%), Java-Bali with 45.4 GW (19%) and Numapa with 17.3 GW (7%). The description of power plant per region is seen in Picture 2.20.




**Picture 2.20 Power Plant Distribution by Region and Energy Source 2050**

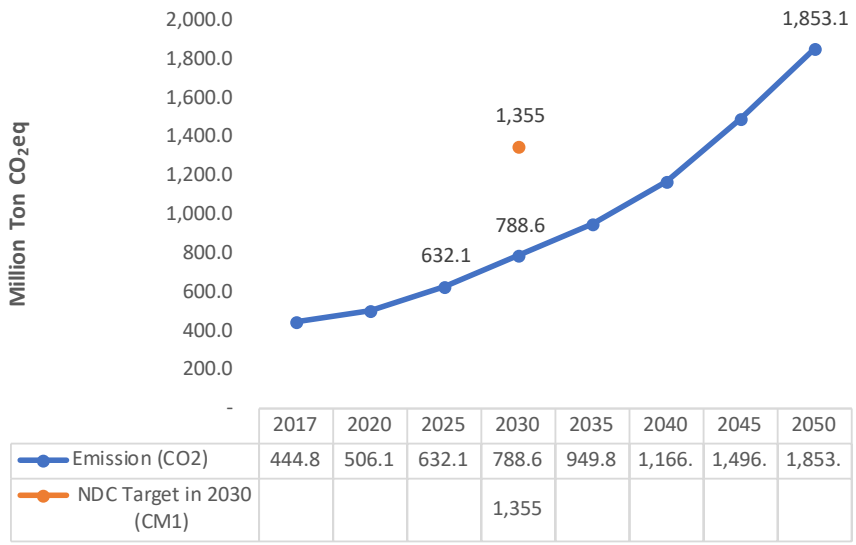
## 2.4 Green House Gas Emission

The population growth and living standard improvement will be followed by the increasing energy demand. If it is not followed by low carbon fuel as well as efficient and environmentally friendly technology, $CO_2$ emission from energy source combustion will be very high. $CO_2$ emission release to atmosphere from energy in commercial sector, household, industry, transportation, electricity plant and other sectors in certain volume will affect global warming. Reducing global warming can be conducted through energy technology efficiency and low carbon energy utilization. $CO_2$ emission is calculated based on IPCC methodology (Intergovernmental Panel on Climate Change), 2006.

Indonesia is committed to reduce Green House Gas emission up to 29% from basic scenario condition which will be reached in 2030 or 41% with international support.

Based on NDC document from Indonesia to United Nations Framework Convention on Climate Change (UNFCCC), the target of emission in energy related sector in 2030 is 1,355 million ton $CO_2$ for CM1 (without international support) or 1,271 million ton $CO_2$ for CM2 scenario (with international support).

The 2018 IEO projection shows that total emission will increase into 632.1 Million Ton $CO_2$eq, in 2025 and 1.8 billion Ton $CO_2$eq, in 2050. Meanwhile, GHG emission rate in 2030 reaches 788.6 million Ton $CO_2$. Thus, this $CO_2$ emission projection is lower than NDC target for energy sector. This IEO projection is also lower than emission target in Attachment of Presidential Regulation on RUEN which says that total emission in 2025 is 893.4 Million Ton $CO_2$eq, and in 2050 is 1.9 Billion Ton $CO_2$eq, since this 2018 IEO uses lower economic growth assumption than assumption in RUEN and NDC (Picture 2.21).

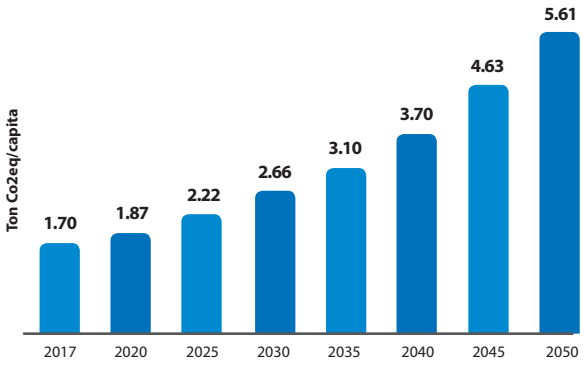



| | 2017 | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| Emission (CO2) | 444.8 | 506.1 | 632.1 | 788.6 | 949.8 | 1,166. | 1,496. | 1,853. |
| NDC Target in 2030 (CM1) | | | | 1,355 | | | | |

**Picture 2.21 GHG Emission 2017-2050**

## 2.4.1 Emission per Capita

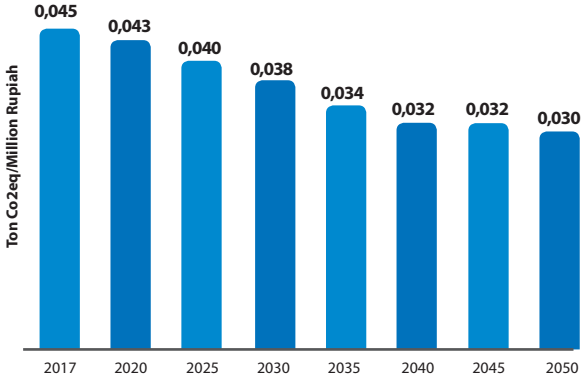
Indicator which describes $CO_2$ emission in a country is to predict the correlation between $CO_2$ emission volume with population and economy. $CO_2$ emission per inhabitant (Ton/Capita) will grow from 1.7 Ton $CO_2$/capita in 2017 into 2.2 Ton $CO_2$/capita in 2025 and 5.6 Ton $CO_2$/capita in 2050. This occurs since emission growth is higher compared to population growth (Picture 2.22)




**Picture 2.22 Emission per Capita**

## 2.4.2 Emission per GDP

In 2017, total emission per GDP is 0.045 Ton $CO_2$ per Million Rupiah and decreases into 0.040 Ton $CO_2$ per Million Rupiah in 2025 and 0.030 Ton $CO_2$ per Million Rupiah in 2050. This indicator trend shows that future energy use is more efficient which causes lower energy consumption growth. This condition creates slower emission growth compared to GDP growth (Picture 2.23).




**Picture 2.23 Emission per GDP**

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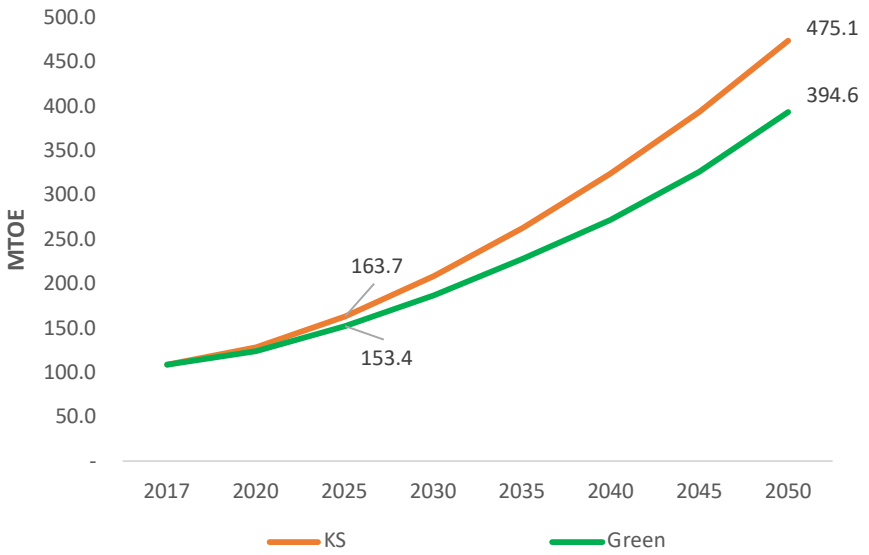
# CHAPTER III
# GREEN SCENARIO

Green scenario uses the same economic growth and GDP growth assumption as in Current Policy (KS) scenario but with lower energy consumption or due to energy conservation in higher final energy use compared to the previous scenario in each sector. Besides that, it has higher target of biodiesel use of 10% in 2025 and 50% in 2050, while biodiesel target will be 30% in 2025. Green scenario also emphasizes on achieving higher emission reduction target and assumption on NRE electricity plant development cost refers to optimism scenario in Technology Catalogue for Indonesian Power Sector.

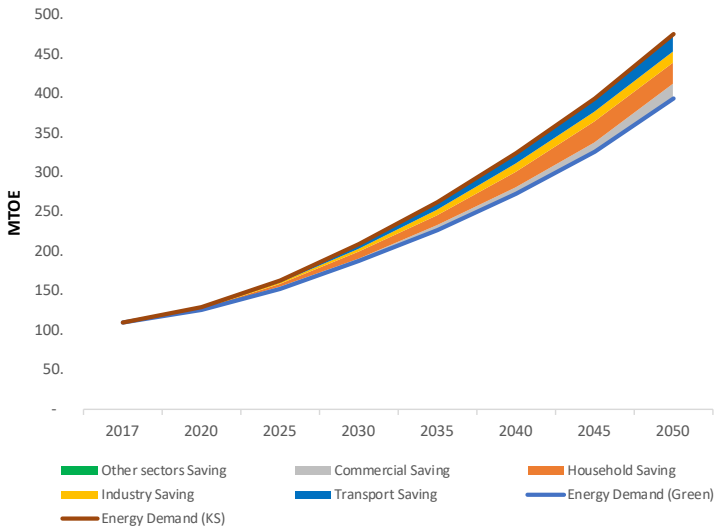
## 3.1 FINAL ENERGY DEMAND

Final energy demand in Green scenario will increase to 153.4 MTOE in year 2025 dan 394.6 MTOE in year 2050. Thus, the saving of final energy consumption is 6% in 2025 and 17% in 2050 as seen in Picture 3.1 below.




**Picture 3.1 Comparison of Final Energy Consumption by KS and Green Scenario**

Compared to KS scenario, the saving in household reaches 26.3 MTOE in 2050, in transportation reaches 20.7 MTOE, and in industry reaches 15.4 MTOE as seen in Picture 3.2 below.




**Picture 3.2 Energy Demand Saving per Sector**

In household, efficiency occurs since electricity consumption is lower compared to in KS scenario with the biggest saving of 2.97 MTOE in 2025 and 42.34 MTOE in 2050. Besides that, efficiency also occurs in LPG consumption in 2025 of 1.58 MTOE and in 2050 in 6.88 MTOE since in Green scenario, DME is used in household of 0.7 MTOE in 2025 and 0.9 MTOE in 2050. It is based on the policy in RUEN.

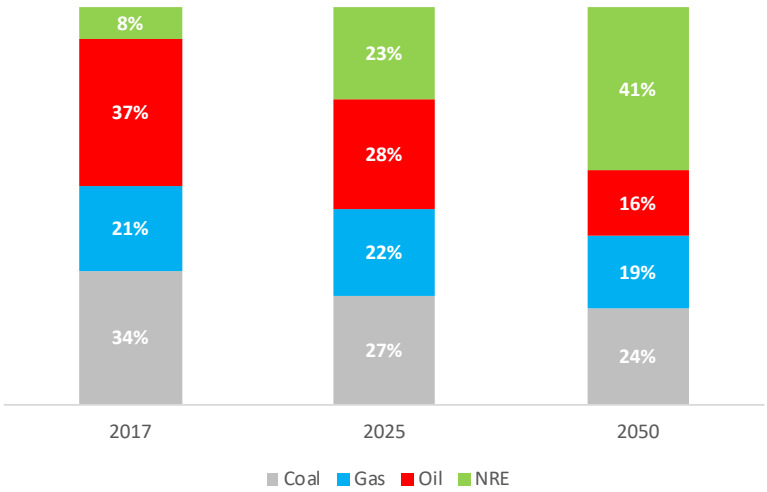
In industry, the biggest efficiency occurs in cement, ceramic and fertilizer industry. Thus, the efficiency in 2050 in industry reaches 19.85 MTOE. The saving in industry is supported by energy consumption efficiency in direct heating through heat loss reduction through regenerative burner reheating furnace. Besides that, efficiency is conducted by implementing waste heat recovery or using boiler for high efficiency, especially in cement industry. The use of motor with the classification of National

Electrical Manufacturers Association (NEMA) for blower, compressor and pump also support a significant energy saving.

The saving in transportation will reach 20.7 MTOE in 2050. One of them is due to the increasing electric car of 7.5% and electric motorcycle of 15% in 2050.

## 3.2 PRIMARY ENERGY SUPPLY

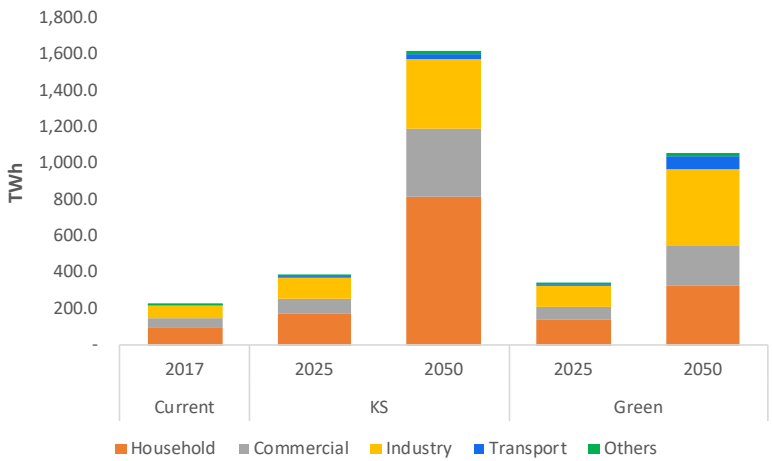
Primary energy supply for green scenario is lower than the previous scenario of 217.8 MTOE in 2025 and 608.6 MTOE in 2050 due to energy conservation policy in various sectors as well as electricity plant efficiency. Higher utilization of NRE in electricity plant and biofuel especially in transportation has increased NRE share in green scenario up to 23% in 2025 and 41% in 2050. After 2025, it is expected that the technology of NRE power plant especially solar power plant will be cheaper. Thus, its utilization will increase significantly compared to the utilization of fossil energy which will also increase the share of NRE in 2050. The comparison of primary energy supply per energy source is shown in Picture 3.3.




**Picture 3.3 Primary Energy Supply by Energy Source**

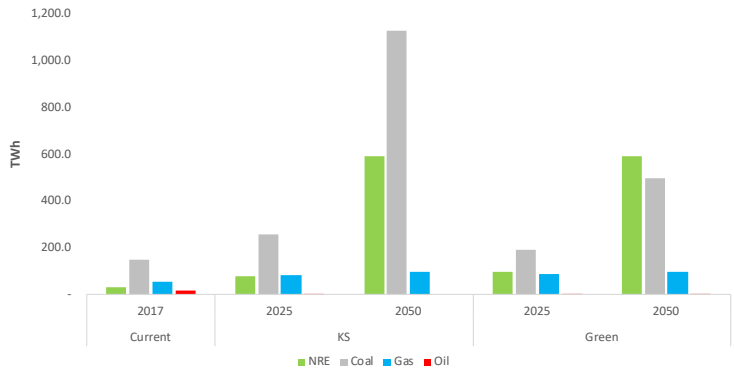
## 3.3 ELECTRICITY

Electricity demand in green scenario is 339.7 TWh in 2025 and 1,060.1 TWh in 2050. The biggest saving is in electricity consumption in household reaching 34.5 TWh in 2025 and 492.4 TWh in 2050 due to energy conservation program in the use of electric devices such as AC which uses inverter technology. Besides that, it is also supported by new energy saving technology in the use of refrigerator, electric stove, water pump, iron, dispenser and LED (Light-Emitting Diode). On the contrary, electricity consumption in transportation is increasing compared to in the previous scenario due to the increasing electric vehicle especially car and motorcycle. The comparison of electricity demand in Current Policy and Green scenario is seen in Picture 3.4



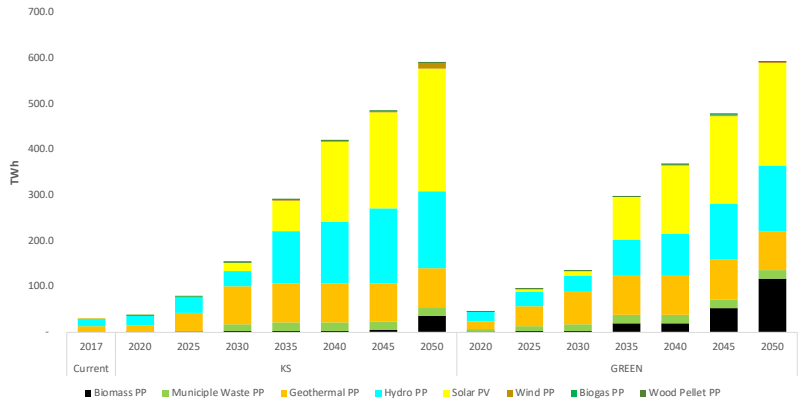

**Picture 3.4 Electricity Demand Comparison**

With electricity demand saving, there is electricity production saving up to 43.2 TWh in 2025 and 629.3 TWh in 2050. In Green scenario, the share of electricity production from coal fueled electricity plant in 2050 is still dominant up to 42% and the share of electricity production from NRE electricity plant is increasing with the share of 27% in 2025 and 50% in 2050. The comparison of electricity production based on energy source is shown in Picture 3.5 below.



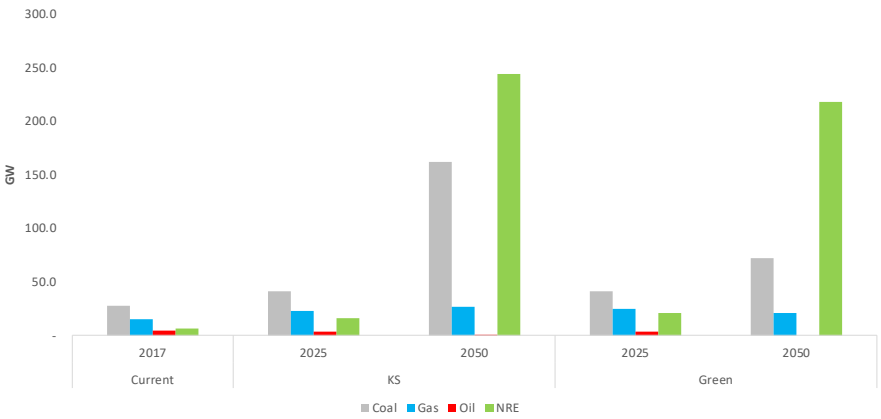

**Picture 3.5 Electricity Production Comparison by Energy Source**

In 2025, the biggest electricity production from NRE power plant in Green scenario is from geothermal power plant of 42.9 TWh (44.3%) and Hydro power plant of 32.4 TWh (33.5%). Meanwhile in 2050, the biggest electricity production is from solar power plant of 225.1 TWh (38%) and Hydro power plant of 142.7 TWh (24.1%). Compared to KS scenario in 2050, the biggest electricity production is from solar power plant and Hydro power plant (267.6 TWh and 169.1 TWh). However, there is a difference in developing biomass power plant in Green scenario in which the electricity production 2.4 TWh in 2025 and 116.2 TWh in 2050. The comparison of electricity production from NRE power plant is as shown in picture below.



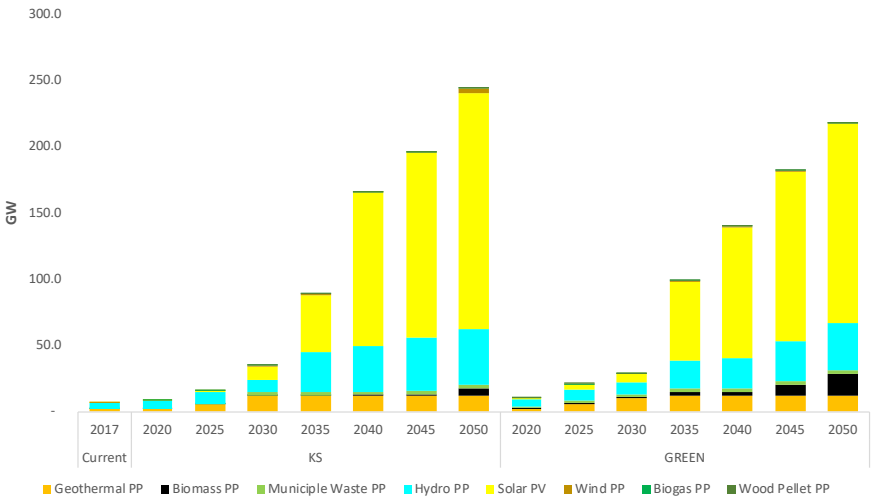

**Picture 3.6 NRE Electricity Production Comparison**

Based on power plant capacity, the need to build electricity plant in 2025 and 2050 is 90.1 GW and 311.3 GW. The capacity of NRE electricity plant in green scenario will increase into 21.1 GW in 2025 and 218.1 GW in 2050. The comparison between total power plant capacity and NRE power plant is seen in table 3.7 below.



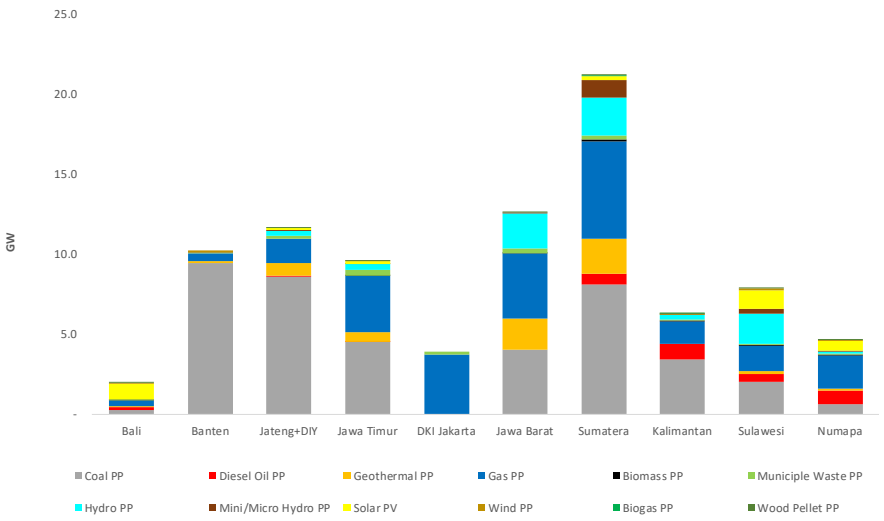

**Picture 3.7 Comparison of Power Plant Capacity by Energy Source**

In 2025, NRE power plant is dominated by Hydro power plant and Geothermal power plant with the share of 43% and 29%. In 2050, NRE power plant's share is 69% solar power plant and 16% Hydro power plant. Besides that, the NRE power plant potentially to be developed is biomass-fueled power plant (biomass, mill waste, waste), biogas power plant, and wind turbine power plant. The comparison of NRE power plant capacity is shown in Picture 3.8.



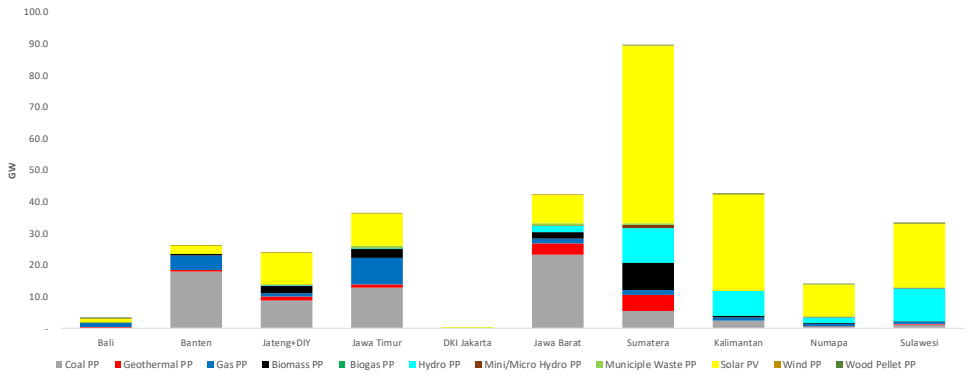

**Picture 3.8 NRE Power Plant Capacity Comparison**

From its power plant distribution by region in 2025, coal power plant is mostly located in Java-Bali (26.8 GW) and the rest is located in other areas especially in Sumatera (8.1 GW). For gas power plant, the total capacity in Java-Bali is 13.6 GW (especially in West Java with 4 GW) and in Sumatera with 6.3 GW. (Picture 3.8) This condition is similar to in Current Policy scenario since the plan to build electricity plant is based on RUPTL 2018-2027. Thus, fossil fueled electricity plant still dominates. Meanwhile, NRE power plant with the total capacity of 21.1 GW is mostly located in Java-Bali (9.3 GW) consisted of geothermal power plant of 3.6 GW and hydro power plant of 3 GW. Around 6.3 GW from the total NRE electricity plant capacity is located in Sumatera and the rest is spread in Kalimantan and other islands. The distribution of electricity plant in several provinces in 2025 is shown in Picture 3.9.




**Picture 3.9 Power Plant Distribution by Region and Energy Source 2025**

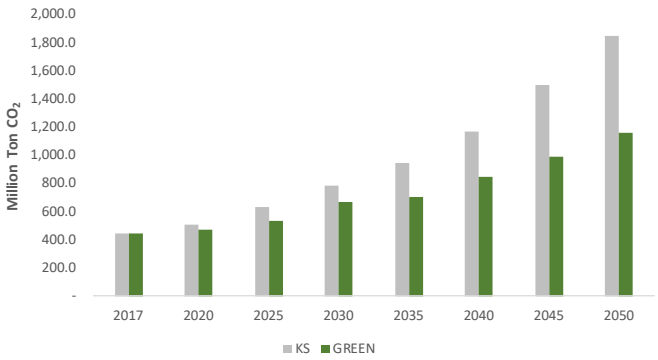
In 2050, most electricity demand is predicted to be fulfilled by NRE power plant especially outside Java-Bali. From the total NRE electricity capacity of 218.2 GW in 2050, around 74% (165.2 GW) is outside Java-Bali such as in Sumatera of 82.7 GW as well as in Kalimantan, Sulawesi and Numapa of 78 GW. Meanwhile, wood pellet, biogas and wind turbine power plant will start to be developed in 2050 in Green scenario. The distribution of electricity plant per region in 2050 in Green scenario is described in Picture 3.10.




**Picture 3.10 Power Plant Distribution by Region and Energy Source 2050**

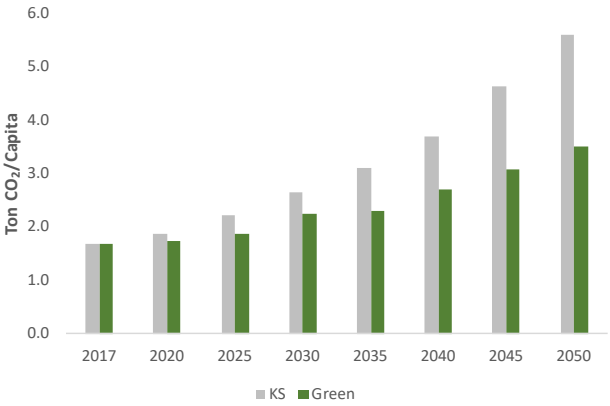
## 3.4 GREEN HOUSE GAS (GHG) EMISSION

With Green scenario, the emission can be reduced up to 96.7 million ton $CO_2$ in 2025 (15 %) and 690.2 million ton $CO_2$ (37%) in 2050 compared to in Current Policy scenario. The comparison of emission in both scenarios can be seen in Picture 3.11.




**Picture 3.11 Comparison of GHS Emission by KS and Green Scenario**

Emission per capita in 2025 in Green scenario is 1.9 ton $CO_2$eq/capita while in Current Policy scenario is 2.2 ton $CO_2$eq/capita (37%). In 2050, emission per capita in Green scenario is 3.5 ton $CO_2$eq/capita and in Current Policy scenario is 5.6 ton $CO_2$eq/capita (Picture 3.12).




**Picture 3.12 Comparison of Emission per Capita by KS and Green Scenario**

In 2030, $CO_2$ emission in both scenarios is below NDC target. However, compared to emission target in Paris Agreement Law No.16 of 2016, the emission in both scenarios has not met the target. The simulation of 2 degree emission reduction target shows that to meet Paris Agreement scenario, the emission in 2050 should be 40-70% lower than emission in 2010. Based on NDC base year data, the 40% decline is around 272 million ton $CO_2$eq in 2050. Thus, emission in Green scenario with 1,217.8 million ton $CO_2$eq in 2050 is still far below the target of Paris Agreement. In general, it can be concluded that it requires a bigger effort to meet the emission target based on Paris Agreement commitment through the efficiency in all sectors and the massive reduction of fossil energy utilization.

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# CHAPTER IV
# CONCLUSION AND RECOMMENDATION

## 4.1 CONCLUSION

Indonesia Energy Outlook (IEO) 2018 presents national energy demand and supply projection in 2017-2050 based on social assumption, economy and technology development in the future by using 2017 as baseline year.

Based on analysis, the primary energy mix for KS scenario in 2025 is 17% NRE, 21% gas, 33% coal and 28% oil, while the primary energy mix in 2050 is 30% NRE, 14% gas, 37% coal and 19%. Thus, with KS scenario, the energy mix target as mandated in National Energy Policy has not been reached.

The primary energy mix for Green scenario in 2025 is 23% NRE, 28% oil, 22% gas and 27% coal. Meanwhile, the primary energy mix for Green scenario in 2050 is 41% NRE, 16% oil, 19% gas and 24% 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 national final energy demand in 2025 based on KS and Green scenario will reach 164 MTOE and 153 MTOE. Final energy demand in 2050 in the same scenario is 475 MTOE and 395 MTOE. The energy demand in both scenarios is still below the energy demand in RUEN of 248.4 in 2025 and 641.5 in 2050.

In conclusion, the share of NRE of 23% in 2025 and 31% in 2050 can be achieved by implementing assumptions in Green scenario such as NRE utilization optimization in power plant development and biofuel mandatory implementation, utilization of electric vehicle and energy efficiency in all energy consuming sectors.

## 4.2 RECOMMENDATION

The efforts to achieve the targets as mandated in National Energy Policy and National Energy General Plan are:

1. Optimizing EOR technology to increase oil and gas production.
2. Prioritizing gas utilization to increase added value.
3. Utilizing electric car and motorcycle followed by the development of domestic electric vehicle industry.
4. Optimizing energy conversion through energy efficiency standardization and labeling on equipments of as well as energy audit mandatory.

5. Expanding the implementation of blended financing scheme from various sources for Renewable Energy development.
6. Gradually LPG subsidies were reduced and converted to the distribution of induction cookers so that it can optimize electricity production especially on when outside the peak load. For the initial stage, PLN can take the initiative to provide induction cooker so that domestic induction cooker production increases and awareness the community to use an induction cooker is increasing.
7. Accelerating LPG to DME conversion by utilizing low rank coal potential or other sources.
8. Requiring firm commitment of land use from regional governments and Ministry of Environment and Forestry to develop non-food bioenergy-producing plants massively in various regions including the use of post-mining land.
9. Reviewing the formation of the board like Board of Oil Palm Plantation Funds/ Badan Pengelola Dana Perkebunan Kelapa Sawit (BPDPKS) for bioethanol with gasoline as the alternative to collect tax from export of sugar cane drops and sugar raw material.
10. Developing second generation of bioethanol by utilizing non food crops.
11. Reviewing the option of bioethanol swap from producing country with Indonesian CPO
12. Accelerating and expanding the incentive of waste PP establishment in all provinces (not limited to 12 provinces).
13. Accelerating the use of Solar PV Rooftop in collaboration with housing developer.
14. Providing smart grid system to support Solar PP and Wind Turbine PP integration.
15. Providing sufficient battery for NRE power plant by optimizing domestic production.
16. Developing power plant components-supporting industry to reduce investment and renewable energy electricity price.
17. Utilizing biomass to replace coal and can be started at the island areas that currently use coal power plants.

# 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/pure)** 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/pure)** 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 into 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.

**Current Scenario (KS),** is a scenario with basic assumption of annual average GDP growth of 5,6%, This assumption is also based on IMF 2018 review, This scenario also refers to energy mix target and energy intensity reduction in KEN and RUEN, RIPIN 2015-2035, RUPTL 2018-2027 and emission reduction target in National Determined Contributions (NDC).

**Green Scenario,** is a scenario which uses the same economic growth and GDP growth assumption as in Current Scenario but uses lower energy consumption compared to above condition due to energy conservation in final energy demand which has different volume in each sector, Besides that, the target of biodiesel and bioethanol use is also higher compared to the previous scenario, Also, the target of electric vehicle use is higher in green scenario.

**TOE (Tonne 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 tons 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

**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

**CO2** : Carbon Dioxide

**COD** : Commercial of Date

**DEN** : National Energy Council

**EBT** : New Renewable Energy

**ESDM** : Energy and Mineral Resources

**FSRU** : Floating Storage Regasification Unit

**GDP** : Gross Domestic Product

**GRK** : 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

**KS** : Current Policy

**kWh** : Kilo Watt hour

**LEAP** : Long-range Energy Alternatives Planning

**LNG** : Liquefied Natural Gas

**LPG** : Liquefied 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 Commitment

**OEI** : Indonesia Energy Outlook

**PDB** : Gross Domestic Product

**Permen** : Ministerial Regulation

**Perpres** : Presidential Regulation

**PLN** : Perusahaan Listrik Negara

**PLTA** : Hydro Electricity Plant

**PLTB** : Wind Turbine Electricity Plant

**PLTBm** : Biomass Electricity Plant

**PLTD** : Diesel Fueled Electricity Plant

**PLTM** : Mini Hydro Electricity Plant

**PLTMH** : Micro Hydro Electricity Plant

**PLTS** : Solar Electricity Plant/Solar PV

**PLTSa** : Waste Electricity Plant

**PLTP** : Geothermal Electricity Plant

**PLTU** : Steam Fueled Electricity 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

**RPJMN** : National Medium Term Development Plan

**RUEN** : National Energy General Plan

**RUPTL** : Electricity Supply Business Plan

**TOE** : Tonnes 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 | KS Scenario | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
| 1 | National final energy demand (Million TOE) | 130 | 164 | 209 | 263 | 324 | 395 | 475 |
| 2 | Oil final energy demand (Million TOE) | 53 | 65 | 80 | 98 | 115 | 132 | 148 |
| 3 | Gas final energy demand (Million TOE) | 28 | 35 | 43 | 51 | 61 | 73 | 90 |
| 4 | Coal final energy demand (Million TOE) | 14 | 18 | 23 | 30 | 38 | 48 | 60 |
| 5 | NRE final energy demand (Million TOE) | 11 | 14 | 18 | 22 | 27 | 32 | 38 |
| 6 | Electricity final energy demand (TWH) | 282 | 382 | 530 | 724 | 968 | 1.265 | 1.622 |
| 7 | Industry final energy demand (Million TOE) | 45 | 55 | 72 | 90 | 113 | 140 | 173 |
| 8 | Transportation final energy demand (Million TOE) | 57 | 72 | 89 | 109 | 128 | 147 | 163 |
| 9 | Household final energy demand (Million TOE) | 18 | 24 | 32 | 41 | 53 | 68 | 88 |
| 10 | Commercial final energy demand(Million TOE) | 8 | 11 | 14 | 20 | 26 | 35 | 46 |
| 11 | Other sector final energy demand (Million TOE) | 1 | 1 | 2 | 3 | 4 | 5 | 6 |
| 12 | Primary energy supply (without biomass) (MTOE) | 180 | 236 | 313 | 404 | 514 | 631 | 769 |
| 13 | Oil primary energy supply (Million TOE) | 54 | 66 | 81 | 98 | 116 | 133 | 148 |
| 14 | Gas primary energy supply (Million TOE) | 43 | 50 | 58 | 66 | 76 | 89 | 106 |
| 15 | Coal primary energy supply (Million TOE) | 61 | 79 | 100 | 122 | 157 | 219 | 286 |
| 16 | NRE primary energy supply (MTOE) | 23 | 41 | 73 | 118 | 165 | 190 | 229 |
| 17 | Primary energy supply per Capita (TOE/Kapita) | 0,7 | 0,8 | 1,1 | 1,3 | 1,6 | 2,0 | 2,3 |
| 18 | Green House Gas Emission (GHG) (Ton $CO_2$/Capita) | 1,9 | 2,2 | 2,7 | 3,1 | 3,7 | 4,6 | 5,6 |
| 19 | Electricity plant capacity (GW) | 65 | 83 | 123 | 193 | 291 | 350 | 433 |
| 20 | Electricity production (TWh) | 312 | 422 | 589 | 806 | 1.079 | 1.412 | 1.815 |

| Num | Result of Analysis | Green Scenario | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
| 1 | National final energy demand (Million TOE) | 126 | 153 | 189 | 228 | 273 | 326 | 395 |
| 2 | Oil final energy demand (Million TOE) | 53 | 60 | 69 | 78 | 86 | 93 | 99 |
| 3 | Gas final energy demand (Million TOE) | 27 | 32 | 38 | 44 | 53 | 68 | 98 |
| 4 | Coal final energy demand (Million TOE) | 13 | 15 | 19 | 24 | 30 | 37 | 45 |
| 5 | NRE final energy demand (Million TOE) | 11 | 17 | 24 | 32 | 42 | 51 | 61 |
| 6 | Electricity final energy demand (TWH) | 258 | 340 | 446 | 571 | 726 | 890 | 1.060 |
| 7 | Industry final energy demand (Million TOE) | 44 | 53 | 67 | 84 | 104 | 128 | 157 |
| 8 | Transportation final energy demand (Million TOE) | 56 | 70 | 84 | 99 | 115 | 129 | 142 |
| 9 | Household final energy demand (Million TOE) | 17 | 20 | 24 | 28 | 33 | 41 | 62 |
| 10 | Commercial final energy demand(Million TOE) | 8 | 9 | 12 | 15 | 19 | 23 | 28 |
| 11 | Other sector final energy demand (Million TOE) | 1 | 1 | 2 | 2 | 3 | 4 | 5 |
| 12 | Primary energy supply (without biomass) (MTOE) | 173 | 218 | 278 | 351 | 426 | 511 | 609 |
| 13 | Oil primary energy supply (Million TOE) | 53 | 61 | 70 | 79 | 86 | 94 | 99 |
| 14 | Gas primary energy supply (Million TOE) | 42 | 47 | 52 | 59 | 68 | 83 | 113 |
| 15 | Coal primary energy supply (Million TOE) | 53 | 60 | 82 | 81 | 106 | 127 | 147 |
| 16 | NRE primary energy supply (MTOE) | 26 | 50 | 73 | 133 | 165 | 207 | 250 |
| 17 | Primary energy supply per Capita (TOE/Kapita) | 0,6 | 0,6 | 0,8 | 0,9 | 1,1 | 1,3 | 1,6 |
| 18 | Green House Gas Emission (GHG) (Ton $CO_2$/ Capita) | 1,7 | 1,9 | 2,2 | 2.3 | 2,7 | 3,1 | 3,5 |
| 19 | Electricity plant capacity (GW) | 67 | 90 | 102 | 176 | 231 | 273 | 311 |
| 20 | Electricity production (TWh) | 287 | 378 | 496 | 635 | 809 | 995 | 1.186 |

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