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Indonesia Energy OUTLOOK 2016

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INTRODUCTION

Let us praise to God the Almighty for His blessing to enable us in presenting Indonesia Energy Outlook 2016 to all stakeholders, energy enthusiasts and society. This book presents energy supply and demand condition and projection in Indonesia in 2016-2050 based on 2015 baseline data.

The focus in Indonesia Energy Outlook 2016 is the optimization of highly potential renewable energy utilization such as hydro and geothermal. In 2016 edition, Indonesia Energy Outlook (IEO) model and LEAP (Long-range Energy Alternatives Planning Modeling) are brought in synergy with Balmorel model especially in discussing electricity.

The energy supply and demand condition and projection as well as infrastructure development and investment in the city of Batam are also specifically presented to give an illustration on the implementation of this model in urban area.

We sincerely hope that IEO 2016 will serve as one of useful references for the government and related stakeholders concerning the future energy supply and demand projection in Indonesia. It is expected as well that the book will enhance and support the policy formulation and implementation as well as energy development in Indonesia.

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

Jakarta, November 2016
Secretary General of National Energy Council

Satry Nugraha

INDONESIA ENERGY OUTLOOK 2016

ACKNOWLEDGMENTS

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 (Soren Mensal Kristensen) and Danish Energy Agency (Ole Emmik Sorensen) for the support in Balmorel modeling, especially to Mr. Bjarne Bach from Ea Energy Analyses which is placed/assigned for 6 months in NEC.

DISCLOSURE

This publication serves as a long term-planning and development analysis of an energy system. This can also serves as an indicator or a pointer of achieving target in National Energy Policy though it should not be viewed as a definite truth. The way to achieve the target is not solely through an analysis, but through an approach in various policies such as tariff, subsidy, tax, and incentive.

This publication is a special assignment from the Ministry of Energy and Mineral Resources to Secretariat General of National Energy Council. Thus, this publication does not necessarily reflect the view of National Energy Council as an institution or the Members of National Energy Council as individuals. The writers of this publication are staffs of Secretariat General of National Energy Council and foreign experts who specially assisting the formulation of this publication including one expert from the Government of Denmark.

LIST OF ABBREVIATION

ALT 1	:	Alternative 1
ALT 2	:	Alternative 2
Balmorel	:	Optimization model to project energy supply and demand especially electricity with least cost approach
Batam	:	Batam City in Riau Islands Province (KEPRI)
BaU	:	Business as Usual
BOPD	:	Barrels of Oil per Day
BOE	:	Barrel Oil Equivalent
BPS	:	Statistic Indonesia
BUMN	:	State Owned Enterprise
CAV	:	Constant Air Volume
CBM	:	Coal Bed Methane
CFL	:	Compact Fluorescent Lamp
CIS	:	Copper Indium Selenide
CO2	:	Carbon Dioxide
CRT	:	Cathode Ray Tube
DAS	:	Watershed
DEN	:	National Energy Council
DMO	:	Domestic Market Obligation
EBT	:	New Renewable Energy
EOR	:	Enhanced Oil Recovery
ESDM	:	Energy and Mineral Resources
ET	:	Renewable Energy
FiT	:	Feed in Tariff
FL	:	Fluorescent Lamp
FSRU	:	Floating Storage Regasification Unit

GW : Giga Watt
GWh : Giga Watt hour
IDD : Indonesian Deep Water Development
ICE : Internal Combustion Engine
IPCC : Intergovernmental Panel on Climate Change
IPP : Independent Power Producer
KBLI : Indonesia Industrial Standard Classification
KEN : National Energy Policy
kl : Kilo liter
kms : Kilo meter sirkuit
KPBU : PPP/Public Private Partnership
KRL : Electric Train
kWh : Kilo Watt hour
LCD : Liquid Crystal Display
LEAP : Long-range Energy Alternatives Planning
LED : Light-Emitting Diode
LNG : Liquified Natural Gas
LPG : Liquified Petroleum Gas
LRT : Light Rail Transit
Migas : Oil and Gas
MMSCF : Million Standard Cubic Feet
MMSCFD : Million Standard Cubic Feet per Day
MRT : Mass Rapid Transit
MTOE : Million Tonnes Oil Equivalent
MTPA : Million Ton per Annum
MW : Mega Watt
MWh : Mega Watt hour
NEP : National Energy Policy
ONWJ : Offshore North West Java
PDB : GDP/Gross Domestic Product
PDRB : GRDP/Gross Regional Domestic Product
PLN : Perusahaan Listrik Negara
PLTA : Hydro Power Generation
PLTBayu : Wind Turbine Power Generation
PLT Biomasa : Biomass Power Generation
PLTD : Diesel Power Generation
PLTG : Gas Turbine Power Generation
PLTGU : Combine Cycle Generation
PLTLaut : Tidal Power Generation
PLTMH : Micro Hydro Power Generation
PLTMG : Gas Machine Power Generation
PLTS : Solar Power Generation
PLTP : Geothermal Power Generation
PLTU : Steam Fueled Power Generation
PP : Power Plant
PS : Pump Storage
PTSP : One Stop Service
RAN-GRK : National Action Plan for Greenhouse Gas Emission Reduction
RDMP : Refinery Development Master Plan
RENSTRA : Strategic Plan

RFCC	:	Residual Fluid Catalytic Cracking
RPJMN	:	National Medium Term Development Plan
RRR	:	Reserve Replacement Ratio
RUPTL	:	Power Supply Business Plan
RUKN	:	National Electricity General Plan
SKK Migas	:	Special Task Force for Upstream Oil and Gas Business Activities
TOE	:	Tonnes Oil Equivalent
TWh	:	Tera Watt hour
TSCF	:	Trillion Standard Cubic Feet
VAV	:	Variable Air Volume
VRF	:	Variable Refrigerant Flow
VFD	:	Variable Frequency Drive

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EXECUTIVE SUMMARY

Indonesia Energy Outlook 2016 presents national energy condition and projection in 2016 to 2050 including realization as well energy demand and supply projection based on social assumption, economy and tecnology development in the future. IEO 2016 utilizes 2015 data 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 power especially in supply side with optimization approach.

IEO 2016 uses 3 scenarios for the projection period of 2016 to 2050 namely Business as Usual (BAU) scenario with basic assumption of moderate GDP growth of 5.6% per year; Alternative 1 scenario (ALT 1) with basic assumption of moderate GDP growth of 5.6% and NRE and energy saving technology implementation; and Alternative 2 scenario (ALT 2) with high GDP growth assumption of 7.1% and NRE and energy saving technology implementation. The result of BaU and ALT 1 Scenario modeling could not be directly compared to ALT 2 Scenario due to the different GDP growth assumption.

Population growth, economic growth, energy price and technology development are the basic assumptions of these three scenarios which are developed to obtain an illustration of energy demand up to the year 2050. Besides these four basic assumptions, additional assumptions related to a number of energy policies are also used.

During the projection period of 2016 to 2050, the price of all energy sources is assumed to increase with different growth depending on the current price development of each energy source. It is assumed that energy price will increase 1.2% per year for coal, 0.9% per year for gas, 2.3% for diesel oil and fuel oil, and 1.2% per year for biomass.

The results of analysis are as follows:

- The national final energy demand in 2025 is 238.8 MTOE (BAU), 201.5 MTOE (ALT 1), and 244 MTOE (ALT 2). The final energy demand in 2050 is 682.3 MTOE (BAU), 430.3 MTOE ALT 1), and 621 MTOE (ALT 2).
- The final energy demand of oil fuel and other refinery products in 2025 is 101 million TOE (BAU), 77 million TOE (ALT 1), and 89 million TOE (ALT 2). In 2050, the number will reach 153 million TOE (BAU), 126 million TOE (ALT 1), and 183 million TOE (ALT 2).
- The final energy demand of gas in 2025 is 43 million TOE (BAU), 43 million TOE (ALT 1), and 47 million TOE (ALT 2). In 2050, it is 96 million TOE (BAU), 80 million TOE (ALT 1), and 111 million TOE (ALT 2).
- The final energy demand of coal is 32 million TOE (BAU), 20 million TOE (ALT 1), and 29 million TOE (ALT 2). In 2050, it is 86 million TOE (BAU), 26 million TOE (ALT 1), and 36 million TOE (ALT 2).
- The final energy demand of NRE in 2015 is 18 million TOE (BAU), 23 million TOE (ALT 1), and 60 million TOE (ALT 2). In 2050, it is 48 million TOE (BAU), 60 million TOE (ALT 1), and 85 million TOE (ALT 2).
- The final energy demand of electricity in 2025 is 45 million TOE (BAU), 38 million TOE (ALT 1), and 60 million TOE (ALT 2). In 2050, it is 193 million TOE (BAU), 138 million TOE (ALT 1), and 200 million TOE (ALT 2).
- The final energy demand of industry in 2025 is 87 million TOE (BAU), 72 million TOE (ALT 1), and 97 million TOE (ALT 2). In 2050, it is 266 million TOE (BaU), 165 million TOE (ALT 1) and 239 million TOE (ALT 2).
- The final energy demand in transportation in 2025 is 83 million TOE (BAU), 69 million TOE (ALT 1), and 75 million TOE (ALT 2). In 2050, it is 228 million TOE (BaU), 131 million TOE (ALT 1) and 180 million TOE (ALT 2).

- The final energy demand in household in 2025 is 38 million TOE (BAU), 35 million TOE (ALT 1), and 38 million TOE (ALT 2). In 2050, it is 97 million TOE (BaU), 71 million TOE (ALT 1) and 97 million TOE (ALT 2).
- The final energy demand in commercial sector in 2025 is 11 million TOE (BAU), 9 million TOE (ALT 1), and 11 million TOE (ALT 2). In 2050, it is 63 million TOE (BaU), 35 million TOE (ALT 1) and 71 million TOE (ALT 2).
- The primary energy supply (without traditional biomass) will increase from 195 million TOE in 2015 into 332 million TOE (BAU), 294 million TOE (ALT 1), and 372 million TOE (ALT 2) in 2025. It will reach 1,041 million TOE (BaU), 708 million TOE (ALT 1), and 1,011 million TOE (ALT 2) in 2050.
- Oil primary energy supply increases from 72 million TOE in 2015 into 110 million TOE (BAU), 86 million TOE (ALT 1), and 97 million TOE (ALT 2) in 2025. It increases into 286 million TOE (BAU), 144 million TOE (ALT 1), and 202 million TOE in 2050.
- Coal primary energy supply increases from 65 million TOE in 2015 into 105 million TOE (BAU), 81 million TOE (ALT 1), and 109 million TOE (ALT 2) in 2025. It increases again into 422 million TOE (BAU), 176 million TOE (ALT 1), and 256 million TOE in 2050.
- Gas primary energy supply increases from 42 million TOE in 2015 into 62 million TOE (BAU), 67 million TOE (ALT 1), and 82 million TOE (ALT 2) in 2025. It increases again into 192 million TOE (BAU), 168 million TOE (ALT 1), and 239 million TOE in 2050.
- NRE primary energy supply increases from 16 million TOE in 2015 into 52 million TOE (BAU), 60 million TOE (ALT 1), and 84 million TOE (ALT 2) in 2025. It increases again into 141 million TOE (BAU), 220 million TOE (ALT 1), and 314 million TOE in 2050.
- The primary energy intensity will decline from 22 TOE/billion rupiah in 2015 into 17 TOE/billion rupiah (BaU) and 12 TOE/billion rupiah (ALT 1), and 10 TOE/billion rupiah (ALT 2) in 2050. Energy elasticity for all scenarios is still above 1 in 2015. Starting in 2025, energy elasticity for ALT 1 and ALT 2 scenario will be under 1.
- The primary energy demand per capita in 2025 is 1.28 TOE/capita (BAU), 1.09 TOE/capita (ALT 1), 1.41 TOE/capita (ALT 2). In 2025 and 2050, it becomes 1.28 and 3.19 TOE/capita (BaU), 1.09 and 2.11 TOE/capita (ALT 1) and 1.41 and 3.01 TOE/capita (ALT 2) or grows 4.2% (BaU), 3.0% (ALT 1) and 4.0% (ALT 2).
- Indonesia targeted to reduce Green House Gas Emission (GHG) of 29% from BaU condition in 2030 or 41% if Indonesia receives financial assistance from developed countries. IEO 2016 shows that emission reduction in 2030 is 402 million Ton CO2 or around 33% (ALT 1) or has reached the target.
- Power generation capacity in 2025 is 125 GW (BAU), 116 GW (ALT 1), and 164 GW (ALT 2). In 2050, it increases into 460 GW (BAU), 381 GW (ALT 1), and 660 GW (ALT 2). Meanwhile, power production in 2025 is 579 TWh (BAU), 495 TWh (ALT 1), and 775 TWh (ALT 2). In 2050, the production is 2,492 TWh (BAU), 1,788 TWh (ALT 1), and 2,585 TWh (ALT 2).

The additional power generation capacity during 2016 to 2025 is around 90 GW (BAU), 81 GW (ALT 1), and 128 GW (ALT 2). Meanwhile for the period of 2016 to 2050, the additional capacity is 455 GW (BaU), 374 GW (ALT 1), and 650 GW (ALT 2).

Energy management in the City of Batam is specially discussed by considering that the city of Batam has a strategic position since it is side by side with Singapore Strait and Malacca Strait. The city of Batam is designed as an industrial zone. Thus, energy supply and demand in the city of Batam should receive an attention.

The total primary energy supply in the City of Batam is projected to increase from 8.3 million BOE in 2015 into 127.6 million BOE in 2050 or about 8.1% per year. In 2015, based on its energy source, oil contributed 4.4 million BOE or 53% while gas and coal contributed 21% and 26%.

The final energy demand in the City of Batam is predicted to increase 6.3% per year in average or from 5,839 thousand BOE (Barrel Oil Equivalent) in 2015 into 50,308 thousand BOE in 2050. The biggest share of final energy demand is industry with 38% in 2015 and 44% in 2050.

In supply side, electricity production increases from 2.4 TWh in 2015 into 26.5 TWh in 2050 or 7.1% per year in average. Gas fueled power generation consisted of Gas fueled Power Generation, Gas Engine Power Generation, and Gas and Steam fueled Power Generation is the power generation which mostly supplies electricity in the City of Batam today of about 52%. However, starting in 2020, Gas fueled power generation will be replaced by Coal-Steam fueled power generation with the contribution of 65% and will increase into 86% from the total electricity supply in 2050. The capacity of installed power generation in the City of Batam will increase from 602 MW in 2015 into 4,995 MW in 2050 or increases with the average growth rate of 6.2% per year. Coal-Steam fueled power generation will have the most significant increase from 165 MW in 2015 into 3,612 MW in 2050 with the average growth rate of 9.2% per year. Meanwhile, gas fueled power generation will increase 4% per year in average or from 367 MW in 2015 into 1,366 MW in 2050.

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CHAPTER 1
INTRODUCTION

CHAPTER 1 / INTRODUCTION

Indonesia Energy Outlook 2016 is an annual publication from the Ministry of Energy and Mineral Resources which is routinely facilitated by Secretariat General of National Energy Council. This book presents the national energy condition in 2016 to 2050 which covers primary energy supply and demand projection and final energy based on Business as Usual (BaU), Alternative 1 (ALT 1) and Alternative 2 (ALT 2) scenario to be developed with Long-range Energy Alternative Planning System (LEAP) and Balmorel System modeling.

The 3rd National Energy Council Plenary Session on 22 June 2016 chaired by President of the Republic of Indonesia has agreed and approved the material of Presidential Regulation-Draft on National Energy General Plan (RUEN) as the reference in energy sector development in Indonesia. RUEN covers energy supply and demand projection until 2050 with the focus to develop NRE. Based on review from International Monetary Fund (IMF) and World Bank in 2015, Indonesia economic growth will not exceed 6% per year up to 2020 or lower than GDP growth assumption according to National Energy Policy.

With this condition, the main focus in Indonesia Energy Outlook 2016 is to conduct projection modeling with GDP assumption based on current condition. The average assumption is 5.6% per year in average or approaches Bank Indonesia projection in 2015 and high GDP assumption based on National Energy Policy of 7.1% per year. It is aimed to find the difference or to compare achievement and projection to meet energy demand up to 2050. This year's edition also present a study of the City of Batam since it is located in the strategic border area and needs to boost its development as energy is one of the indicators in economic development of a region.

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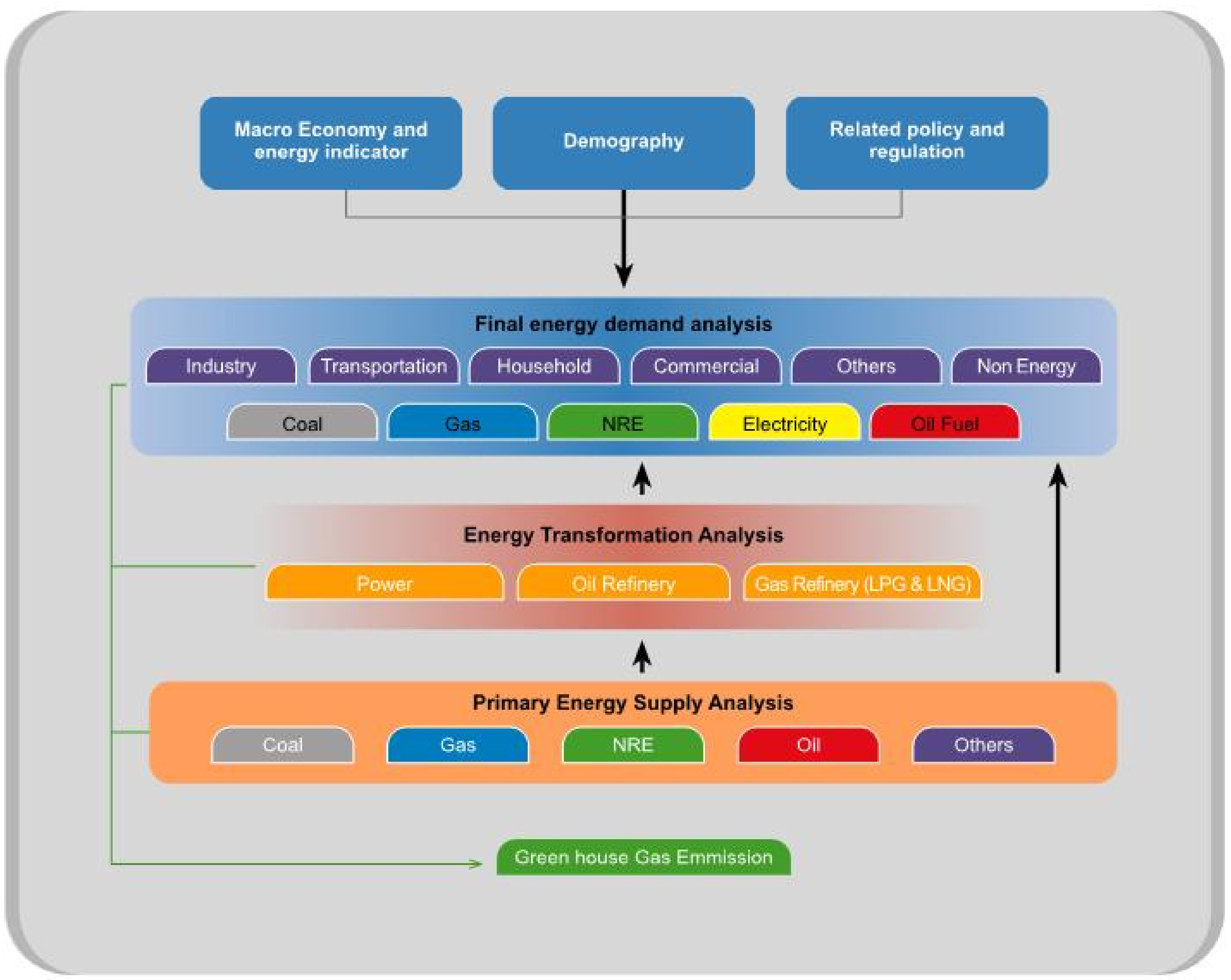
CHAPTER 2
METHODOLOGY

CHAPTER 2 / METHODOLOGY

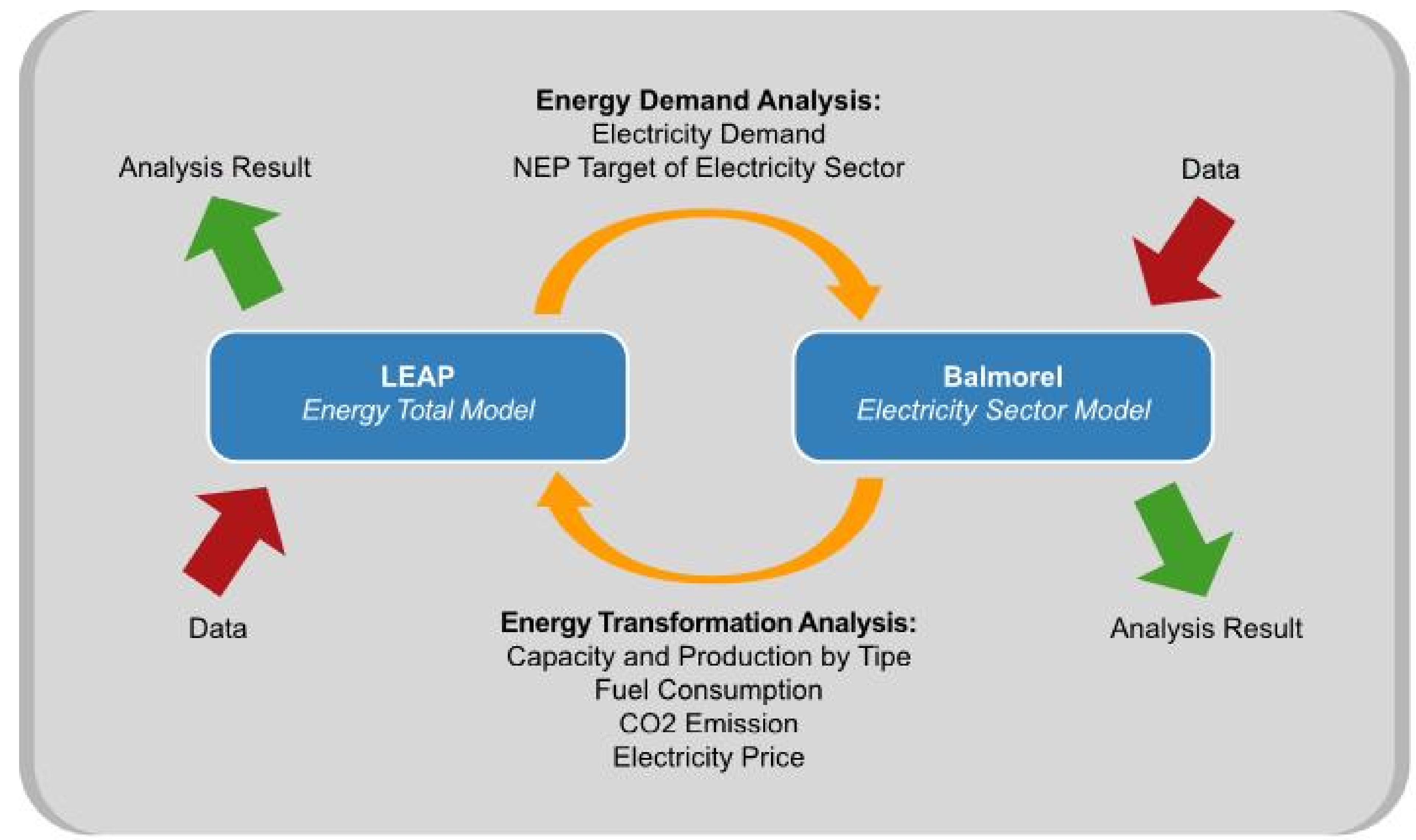
2.1 Framework Analysis

The analysis is divided into three stages namely analysis on energy demand, energy transformation, and energy supply. The analysis is based on energy projection of these three stages. Besides sectoral condition such as activity, technology and intensity, the energy supply and demand projection requires inputs on strategic planning roadmap and existing energy regulation. Assumption on macro economy indicator condition such as GDP, demography, energy price and technology penetration is also needed as the main energy demand driver. The framework analysis of Indonesia Energy Outlook 2016 is shown in Picture 2.1.



Picture 2.1 Framework Analysis of Indonesia Energy Outlook 2016

The energy supply and demand analysis is conducted based on calculation of LEAP and Balmorel. LEAP is a simulation model in energy planning which can conduct an integrated energy supply and demand analysis, while Balmorel is an energy supply planning optimization model for electricity. The correlation between LEAP and Balmorel in calculating energy demand is shown in this picture.



Picture 2.2 Synergy between LEAP and Balmorel

2.2 Energy Projection Scenario

The government has stipulated three main targets in RPJMN (National Medium Term Development Plan) 2015-2019. First, Indonesia is to come out from middle income trap and to be a high income country in 2030. To achieve this, Indonesia's economy should grow about 6% to 8% per year. Besides that, its GDP per capita should be about USD 7000 and poverty rate should be reduced 6% to 8% in 2015 to 2018. The second target is food self-sufficiency. The third target is creating energy security by increasing the role of renewable energy.

Statistics Indonesia shows that Indonesia economy real growth in 2014 and 2015 is 5.02% and 4.79% based on 2010 constant price. Indonesia economic growth prediction in 2016 is about 5.1% or still below 6% as stipulated in National Medium Term Development Plan 2015-2019. 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.

Indonesia Energy Outlook 2016 developed three scenarios based on two different economic growths in projection period of 2016 to 2050. The first scenario or BaU uses basic assumption of moderate GDP growth of around 5.6% per year in the period of 2016 to 2050. This assumption is also based on 2015 IMF and World Bank 2015 review which says that Indonesia economic growth until 2020 will not exceed 6% per year.

The second scenario or Alternative 1 (Alt 1) uses the same basic assumption for GDP growth. Besides this basic assumption, ALT 1 also shows the influence of the optimum NRE technology and energy saving technology implementation toward the future energy demand especially fossil energy.

The third scenario or Alternative 2 (ALT 2) uses high GDP growth assumption of 7.1% per year in average based on National Energy Policy in projection period of 2016 to 2050 as well as optimum NRE technology and energy saving technology implementation assumption. BaU and ALT 1 scenario cannot be compared directly to ALT 2 scenario since they use different GDP growth assumption. A more detail explanation on scenario and assumption is given in the following sub chapter.

The scenario with GDP growth of 6% compared to 5.6% does not give any significant different in its result. For example, based on GDP growth of 5.6%, the total primary energy supply in 2025 is 304.1 MTOE while based on GDP growth of 6% the total energy supply is 341.4 MTOE. Thus the difference is only 0.4%.

2.3 Modeling Assumption

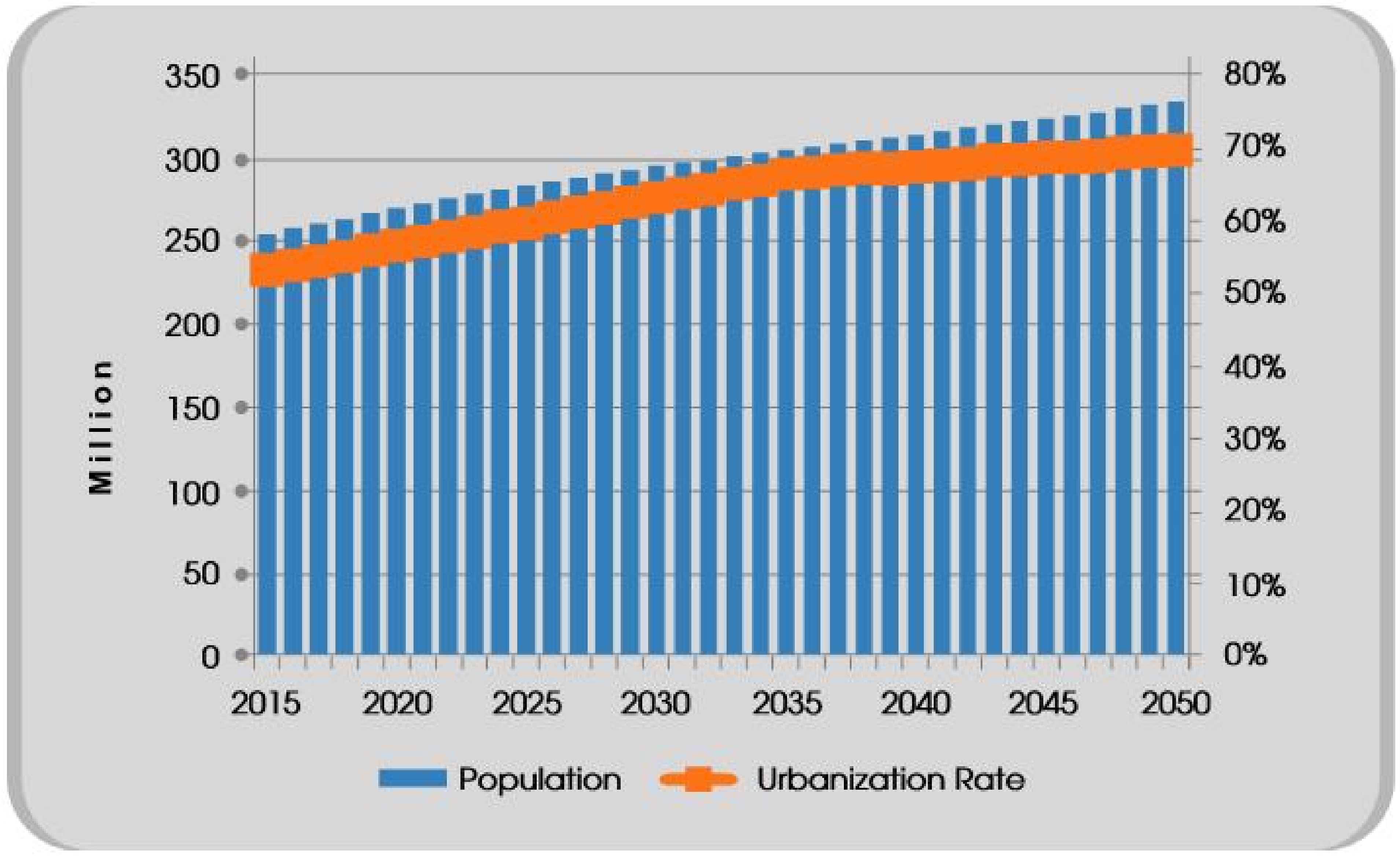
The main driving factor from energy demand increase to be considered in Indonesia Energy Outlook 2016 includes population growth, economic growth, energy price, and technology development. These four factors become the basic assumptions from the three developed scenarios to obtain an overview of energy demand until the year 2050. Besides these four basic assumptions, additional assumptions related to a number of energy policies are also used.

2.3.1 Population Growth

Population growth influences energy demand volume and composition both directly or indirectly from its impact to economic growth.

During the last two decades, Indonesia population growth rate trends to decline along with the increasing public awareness to create prosperous and educated family. Based on Indonesia population projection publication year 2010 to 2035 of Statistics Indonesia 2013, Indonesia population growth is assumed to decrease gradually from 1.38% in 2010 to 1.19% in 2015, 1.00% in 2020, 0.80% in 2025, and 0.62% in 2030. For the following years until 2050, the growth rate is assumed to be constant at 0.62% per year. It means that Indonesia population will increase into 335 million in 2050 from 255 million in 2015.

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 in which rural residents reaches 53% in 2015 and continues to increase up to 70% in 2050. It means that 70% of Indonesian lives in the cities in 2050. Indonesia population per year during 2015 to 2050 and the urbanization rate is shown in Picture 2.3.



Picture 2.3 Population Growth and Urbanization Rate Assumption

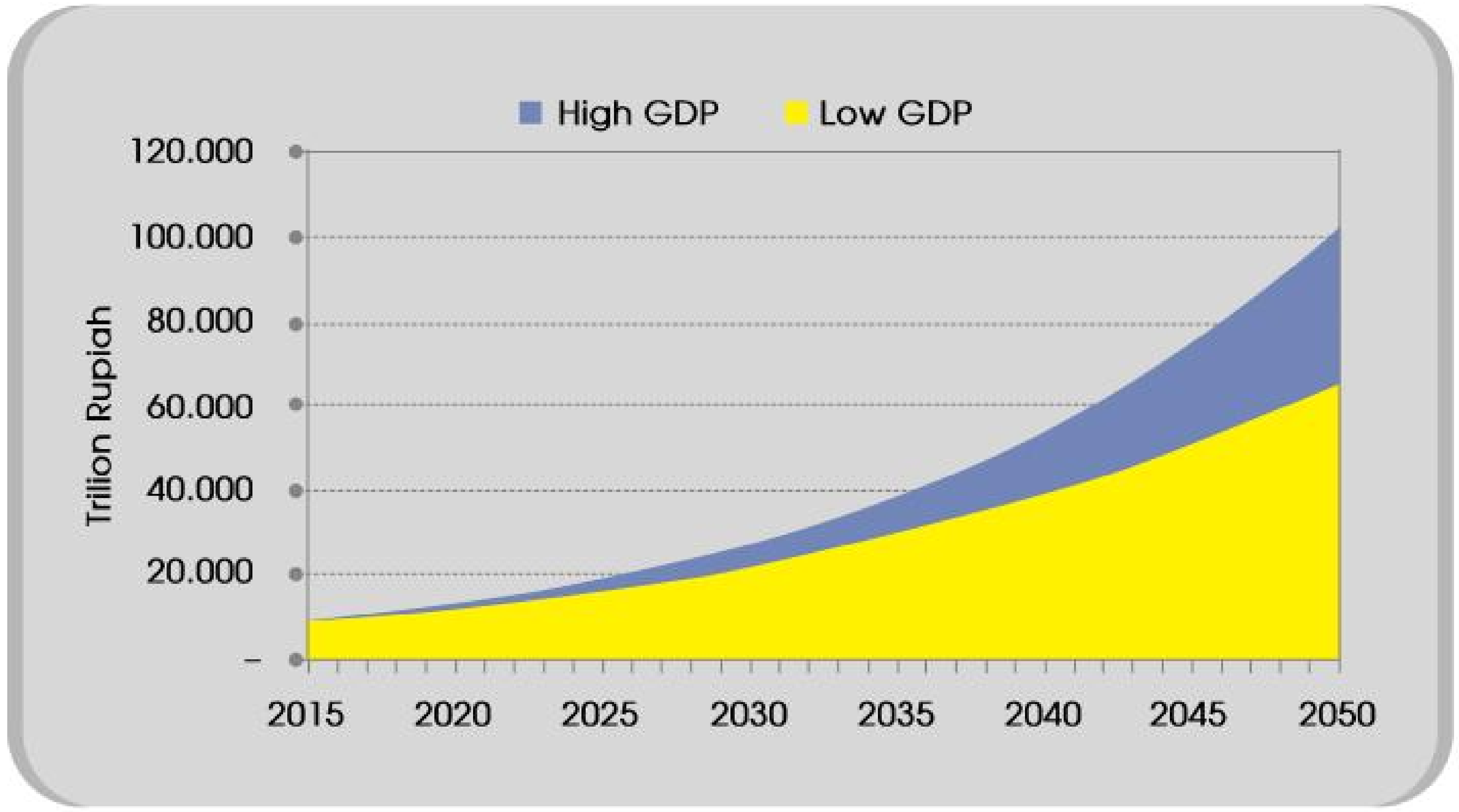
With the assumption that the family members in a household is 3.84 in 2015 and gradually decreases into 3.54 in 2050, then the number of households will grow from 66.5 million to 94.7 million in the same period.

2.3.2 Economic Growth

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

Indonesia economic growth in the last five years tends to decline. It is due to the slowing global economic growth, the low commodity price including price, 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 domestic market in Indonesia has high resistance. The government's committed to conduct economic deregulation and investment licensing simplification is also expected to support future growth.

The unstable Indonesia and global economic condition is the reason for Indonesia Energy Outlook 2016 to use two different GDP growth assumptions namely the moderate and high GDP growth. Seeing the current economic condition, the moderate GDP growth is assumed at the average of 5.6% per year during the projection period. Meanwhile, the high GDP growth is assumed to reach 7.1% per year as the effort to measure whether the economic and energy target in National Medium Term Development Plan 2015-2019 and Government Regulation Number 79 Year 2017 on National Energy Policy can be achieved.



Picture 2.4 High and Low GDP Growth Assumption

With low GDP growth assumption, Indonesia GDP in 2050 will reach IDR 61,360 trillion or USD 6,825 billion. With high GDP, the GDP will reach IDR 102,541 trillion or USD 11,405 billion. Indonesia GDP in basic year 2015 is IDR 8,976 trillion or USD 998 billion with exchange rate of IDR 8,991 per USD. It is based on 2010 constant price.

GDP per capita is one of the indicators to compare the population prosperity in one area and another. With GDP and population growth as explained earlier, Indonesia GDP per capita in 2050 will increase from IDR 183 million or USD 20,351 for low GDP growth. As for the high GDP growth, the GDP will be IDR 306 million or USD 34,009 from the current rate in 2015 of IDR 34 million or USD 3,908.

2.3.3 Technology

The developed and applied energy technology in supply and demand side will influence the investment decision, different supply cost for each energy source, as well as future energy demand rate and composition. Thus, energy projection in this Energy Outlook is sensitive enough toward penetrating rate assumption of an energy technology including NRE and energy efficiency. This assumption is different for each energy source, consumer and scenario. It is also based on proven level and commercialization of the technology as well as the supporting policy.

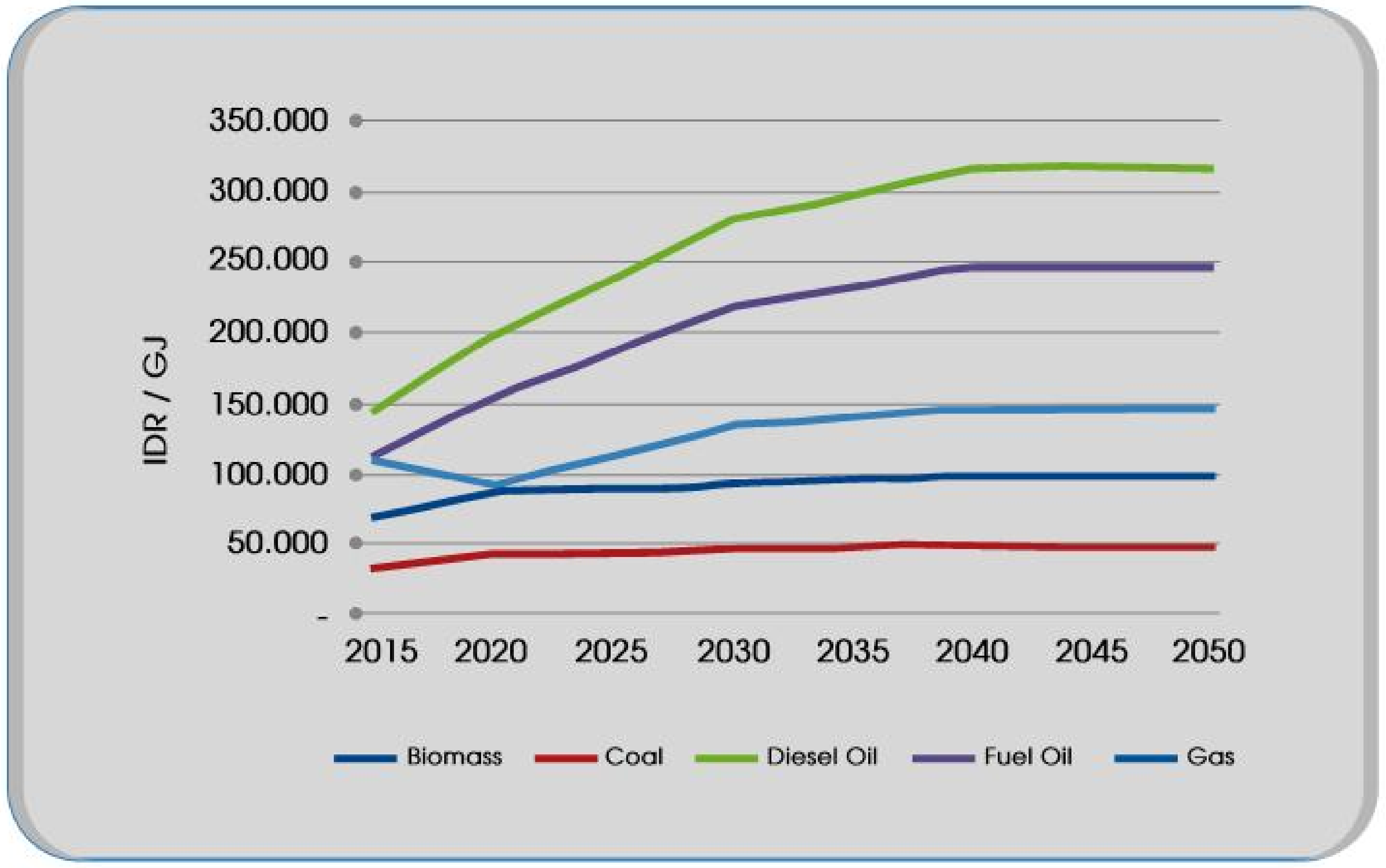
In Indonesia Energy Outlook 2016, the existing technology is predicted to develop in the future with lower cost and higher efficiency rate.

A number of technologies have its role in determining future energy demand rate including power generation technology for solar, wind, biomass, hydro and geothermal. It also includes transportation technology such as hybrid, electric and biofuel car. Energy efficiency technology is applied in all economic sector including industry, household, commercial and transportation. The impact of energy saving technology implementation toward energy demand is quite significant. Those technologies will be further review in the next chapters.

2.3.4 Energy Price

Energy price is a determining factor in energy demand trend. Energy price paid by consumer will influence the choice of technology and devices to meet the energy demand. From supply side, energy price will influence the production and investment decision from the chosen technology.

Since the mid 2014, oil and gas price has been declining sharply of more than 60% due to the increasing production of alternative fuel such as tight oil, shale oil and shale gas. Meanwhile, Organization of Petroleum Exporting Countries decided not to reduce its production. Experts predicted that low oil and gas price would last in short period of time. Energy price trend assumption highly depends on demand side factors. Besides that, the competition between gas and coal price especially for power generation also influences the trend of these two fuels price.



Picture 2.5 Energy Price Assumption

In Indonesia Energy Outlook 2016, energy price is assumed to be the same for all scenarios. With the consideration that energy is still a strategic commodity, the price for all energy sources in projection period is assumed to increase with variety of growth depending on current energy source price development. Based on South East Asia Outlook by International Energy Agency (IEA) in 2015, the price is assumed to increase of 1.2% per year for coal, 0.9% per year for gas, 2.3% per year for diesel oil and fuel oil, and 1.2% per year for biomass during the projection period of 2015 to 2050.

Table 2.1 shows a detailed basic and additional assumption used in Indonesia Energy Outlook 2016 for all scenarios.

Table 2.1: Basic and Additional Assumption

Num	BaU Scenario	Alternative 1 Scenario	Alternative 2 Scenario
	Basic Assumption		
1	Moderate GDP growth of 5.6% per year	Moderate GDP growth of 5.6% per year	High GDP growth of 7.1% per year
2	There is no new technology breakthrough. The energy conservation and efficiency program is conducted based on the existing trend.	The energy saving technology penetration is based on existing and proven technology with penetration rate of 75%.	
3	Energy price increases for each energy source: • 1.2% per year for coal, • 0.9% per year for gas, and • 2.3% per year for diesel oil and fuel oil.		
4	Population growth based on Indonesia projection study from BPS.		
	Additional Assumption		
5	Energy resources and reserve assumption: • Oil and gas, 100% reserve and 50% resources • Coal, 80% reserve and 30% resources • Geothermal, 60% resources, only for moderate and high temperature (> 150oC) • Hydro, 60% resources • Biomass waste, 60% resources • Biofuel, 60% resources • Solar, 10% resources • Wind, 10% resources (speed above 4 m/s) • Sea, 10% resources		
6	Electrification ratio reaches 100% in 2020		
7	Biofuel contents as the mixture of biodiesel and biogasoline RON 88 until 2050 follows Biofuel Development blueprint and roadmap as stipulated by the government such as 30% biodiesel and 20% bioethanol.		
8	The utilization of kerosene in household is only until 2018 and it will be replaced by LPG, gas, electricity, biomass, dimethyl ether and biogas.		
9	There is no significant change of production as well as existing energy production and consumption pattern.	Energy saving reflecting policy or regulation implementation on aggressive energy conservation and efficiency	
10	Electrical Power Supply Business Plan (RUPTL) 2016-2025 is used as a baseline in the calculation of power generation capacity additions for all scenarios starting in 2015 until 2025. In addition, optimization model calculations based on the lowest price (least cost optimization).		
11	NRE power generation development follows the existing trend	NRE power generation development considers all government policy or program and targets as stipulated in Strategic Plan, Roadmap, National Energy Policy, and National Energy General Plan	
12	Biodiesel utilization in industry follows the existing trend	In 2050, biodiesel utilization share in industry reaches 20% in average	
13	Biodiesel and biogasoline RON 88 in transportation follows the existing trend	In 2050, biodiesel and biogasoline RON 88 utilization reaches 80% of the total demand in transportation	
14	Gas utilization in transportation follows the existing trend	In 2050, gas utilization share reaches 20% in average in transportation	
15	Coal gasification utilization for fertilizer industry is not existing yet	Starting in 2018, gas from coal gasification is utilized for fertilizer industry	

No	Skenario BaU	Skenario Alternatif 1	Skenario Alternatif 2
16	There has been no bio aviation fuel utilization	Starting in 2018, bio aviation fuel will be used in aviation	
17	There is no change in the use of transportation mode	There is a movement in transportation mode up to 15% of total vehicle production in 2050 from passenger vehicle and motor cycle to bus and train and from truck to train	
18	Oil refinery capacity in 2025 is adjusted to the government's roadmap (Pertamina) and it is assumed to double in 2050.		
19	Gas production is assumed to decline up to 0.7% per year in average until 2050 from its current production		
20	Oil production is assumed to decline 2.2% per year until 2050		
21	Coal production increases 2.5% per year in average until 2050	Coal production is maintained as constant rate of 400 million Ton but it is assumed to increase when domestic consumption exceeds production	
22	Energy demand without taking into account traditional biomass		

Indonesia Energy
OUTLOOK
2016

CHAPTER 3
CURRENT CONDITION

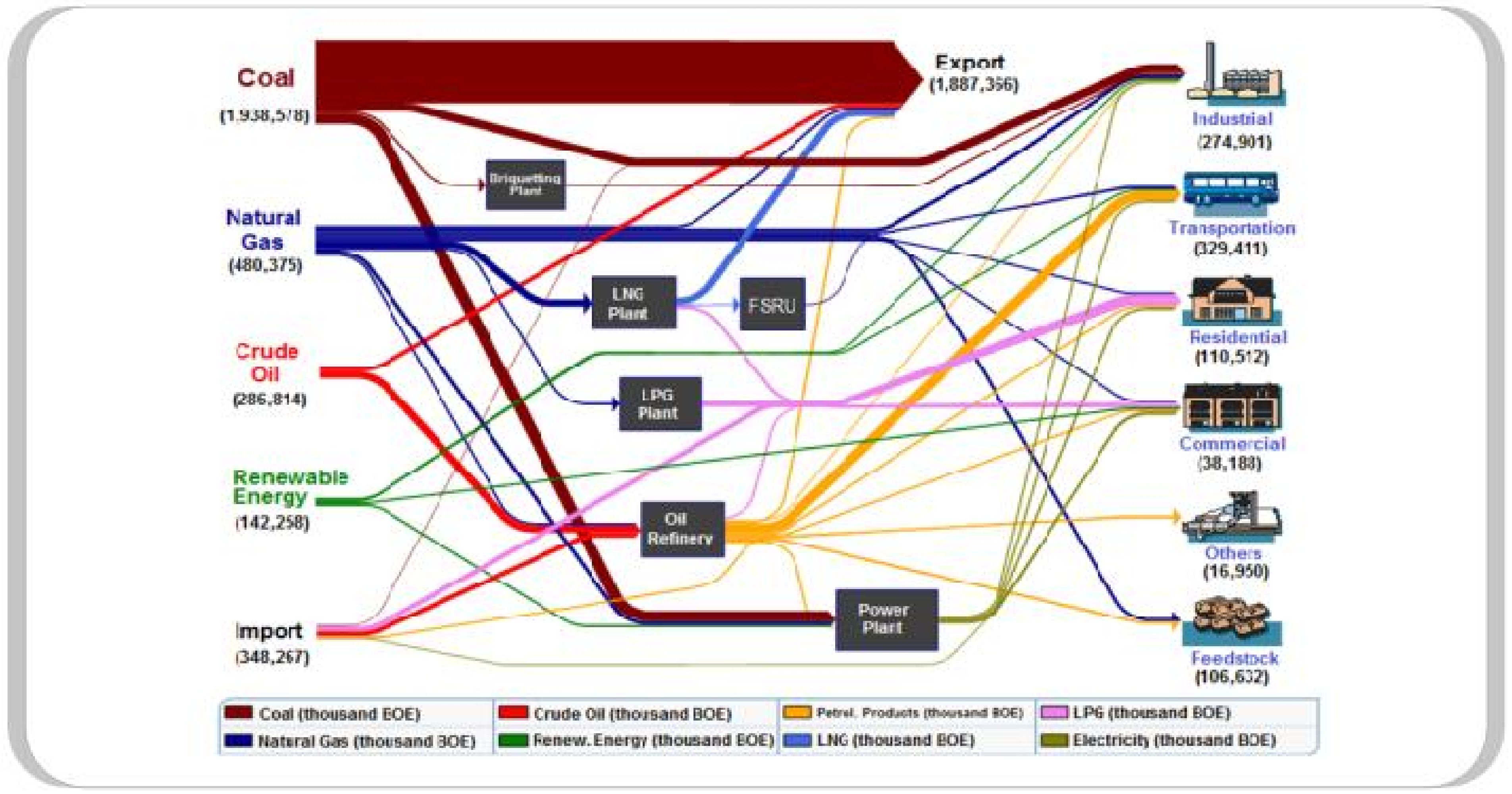
CHAPTER 3 / CURRENT CONDITION

3.1 Energy Balance

Energy balance is an illustration of sectoral energy supply and demand balance. The energy balance is illustrated in an energy system which includes production, conversion, and transportation/distribution to the end user.

Indonesia total primary energy production (coal, gas, oil and NRE) in 2015 was 2,848,025 thousand of BOE in which 1,887,366 thousand BOE was exported abroad. In the same year, Indonesia imported energy of 348,267 thousand BOE. Coal was the most exported commodity, while crude oil, fuel and LPG were the highest imported commodities. From this condition, Indonesia primary energy supply in 2015 was 1,308,926 thousand BOE including stock change (excluding traditional biomass). Indonesia energy export in 2015 reached 66% from total energy production or more than half. Meanwhile, energy import reached 27% from total primary energy supply in the same period or almost one third.

The total sectoral energy demand in 2015 was 876,594 thousand BOE (excluding traditional biomass). Transportation was also the biggest consumer followed by industry, non energy, household, commercial and other sector. Indonesia energy balance in 2015 is shown in Picture 3.1.



Source: Processed from Handbook of Energy and Economic Statistics of Indonesia (HEESI) 2016

Picture 3.1 Energy Balance 2015

3.2 Oil

National oil reserve per 1 January 2015 both proven and potential reserve decreased 1.2% compared to the previous year. Oil potential reserve in 2015 was 3.70 billion barrel, while proven reserve was 3.60 billion barrel. The oil reserve distribution is mostly located in Sumatera reaching 66.15% from total national oil reserve or about 4.83 billion barrel. The oil reserve in Java is 1.78 billion barrel, while Kalimantan has 0.52 billion barrel of oil reserve. The reserve of 0.15 billion barrel is located in Papua, Maluku and Sulawesi (Picture 3.2).

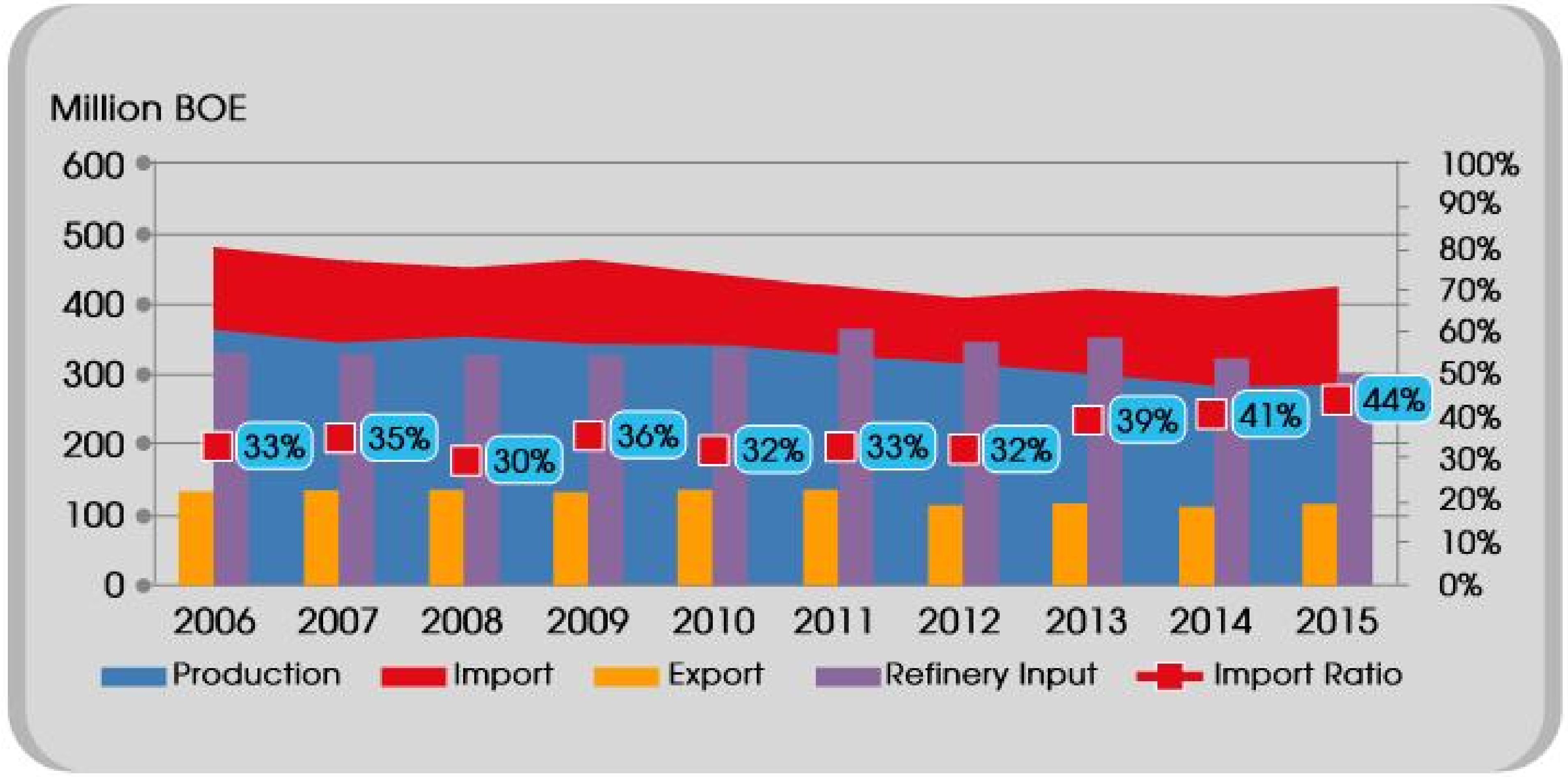
Source: DG of Oil and Gas, 2015

Picture 3.2 Oil Resources 2015

In 2015, the National Energy General Planning draft says that there is 5.2 billion barrel of oil and gas reserve potential from the discovery to be considered as additional in oil and gas reserve in 2016 and oil and gas resources potential of 16.6 billion barrel from early exploration. However, it requires further testing.

Meanwhile, Indonesia oil reserve share is only 0.2% from the total world oil reserve. On the other hand, fuel consumption rate as processing product continues to increase. The development of oil production in the last 10 years has shown a decline from 287.30 million barrel or 800 thousand barrel per day in 2006 into 251.87 million barrel or 690 thousand barrel per day in 2015. The production decline occurred due to the mature oil production wells and the limited new production wells. Since 2010-2014, reserve discovery rate compared to production or Reserve Replacement Ratio (RRR) is 50%. It means that Indonesia is more producing than discovering oil reserve. There has been no major oil reserve discovery after Banyu Urip field in Cepu Block.

The domestic fuel consumption increase and oil production decline have caused the declining oil export. Conversely, crude oil and fuel import keeps increasing. This can be seen in the increase of import dependency ratio with the average ratio of 35% in 2007 into 44% in 2015. It indicates that Indonesia is susceptible to global condition change which can influence the national energy security due to the high dependency on supply from abroad (Picture 3.3)



Source: Ministry of Energy and Mineral Resources processed by Secretariat General of National Energy Council 2016
Note: Import Dependency Ratio = Import divided by domestic supply (Production+Import-Export)

Picture 3.3 Oil Production, Import and Export Development

The increasing fuel consumption is the impact of economic and population growth. Meanwhile, the declining domestic crude oil production and the stagnant refinery capacity increase crude oil and fuel import. Thus, the development of fuel refinery is surely the solution.

In the end of 2015, the government revised Government Regulation number 79 year 2010 on operation cost as cost recovery and taxation in oil and gas upstream business. The revision is conducted since exploration in domestic upstream oil and gas from the perspective of efficiency, the number of wells, and cost is not competitive enough compared to other country. From 2011 to 2014, the number of working areas that attract investors' attention tends to decline despite of the high oil price of above USD 100 /bbl. It was caused by the uncertainty to obtain its spent capital in exploration period.

There are amendment points in Government Regulation revision to create a more interesting oil and gas upstream sector. The first point is taxation facility in exploration period. Import value added tax, import duty, domestic value added tax and property tax will be included in facility borne by the government in exporation period. The second point is the exemption of income tax in cost sharing by contractor in the utilization of state property. There is also non fiscal facilities certainty such as investment credit, accelerated depretiation and DMO holiday. The last point is the split with sliding scale rezime in which the government will acquire higher split when oil price increases significantly.

Besides that, in 2015, 60.2 % of domestic LPG demand was fulfilled from import. The success of kerosene to LPG conversion program has resulted in significant increase of domestic LPG consumption while its supply and refinery is still very limited. It has to be anticipated since 3 kg LPG subsidy is increasing. The current 3 LPG kg selling price is IDR 4,250 per kg and the government has allocated subsidy of IDR 5,750 per kg. The subsidy of 3 kg LPG in 2015 reached IDR 28.27 trillion or declined IDR 50 trillion from the subsidy in 2014.

The national fuel demand is fulfilled from national production and import. Fuel production increased from 235.7 million barrel in 2010 into 248.8 million barrel in 2015, while import was fluctuating from 163.8 million barrel in 2010 into 175.4 million barrel in 2015 (Table 3.1).

3.1 Oil Fuel Production and Import Year 2010 to 2015

Year	Fuel Production (Million Barrel)		Fuel Import (Million Barrel)
	Fuel	Non Fuel	
2010	235.7	85.8	163.6
2011	237.1	104.2	195.9
2012	240.3	111.9	201.1
2013	237.5	85.2	205.6
2014	245.5	97.1	209.0
2015	248.8	80.68	175.4

Source: Ministry of Energy and Mineral Resources. 2016

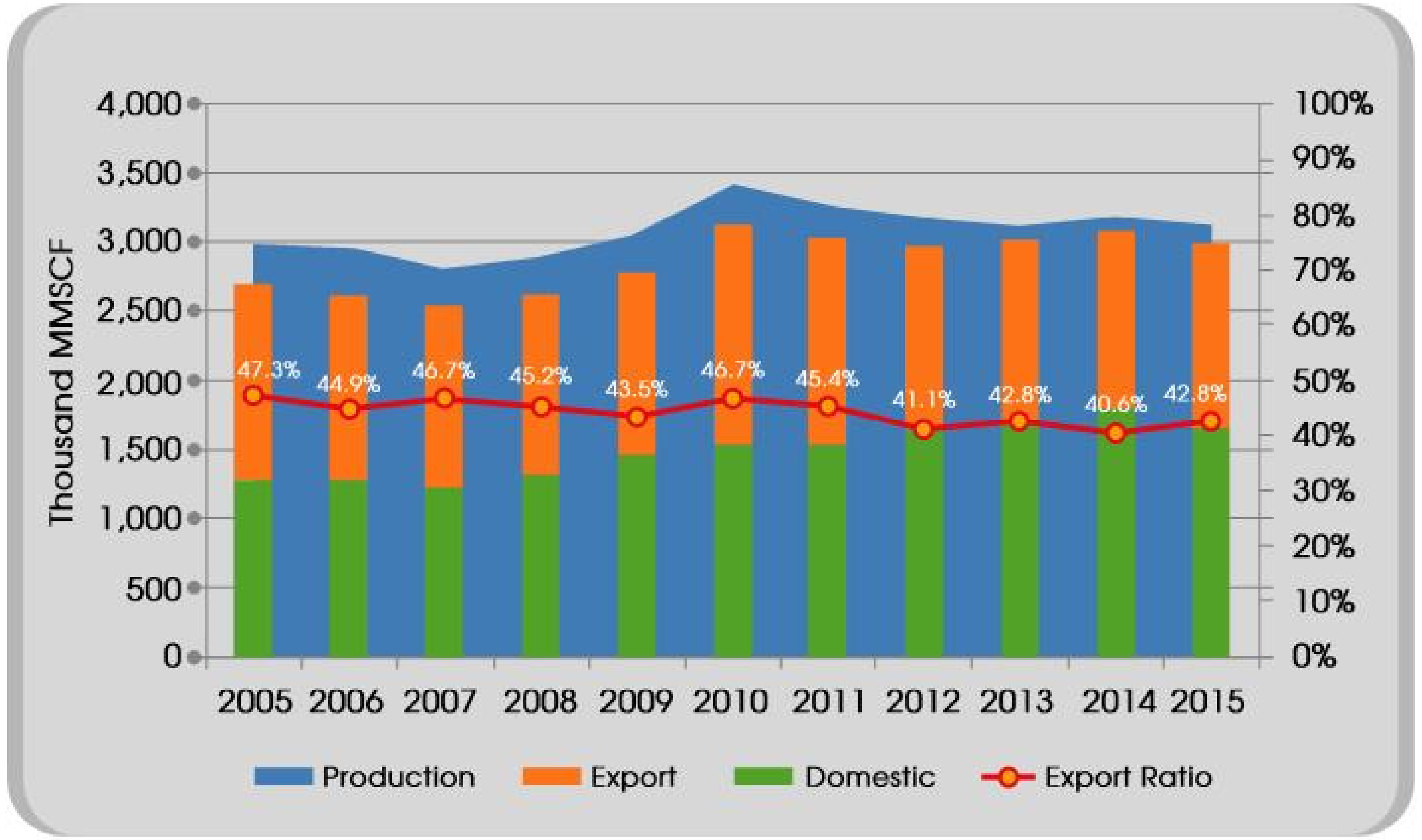
3.3. Gas

The national gas reserve is spread in all areas in Indonesia. The total gas reserve in 2015 was 150.39 TSCF consisting of 101.54 TSCF of proven reserve and 48.85 TSCF of potential reserve (Picture 3.4).

Source: Directorate General of Oil and Gas. 2015

Picture 3.4 Gas Resources 2015

Compared to the previous year, national gas reserve increased 1.36% or 2.03 TSCF in 2014. Gas production in the last ten years is relatively fluctuating with the production rate of about 3.39 million MMSCF per year. Half of gas production is used to meet the demand of industry, power generation, city gas, lift and reinjection gas, and own use gas. Besides supplying domestic demand, gas is also used as export commodity in the form of LNG and piped gas. In the last ten years, gas export through pipeline and LNG reached almost half of total production or almost the same with domestic gas consumption (Picture 3.5).



Source: Ministry of EMR processed by Secretariat General of National Energy Council. 2016
Note: Export Ratio = Export divided by Production

Picture 3.5 Gas Production and Export Development

LPG production in 2015 was 2.27 million ton consisting of 1.6 million ton from gas refinery and 0.6 million ton from oil refinery. Compared to the previous production, the total LPG production declined 4.61% or about 104 thousand ton.

Domestic gas consumption in 2015 declined due to the slowing Indonesia economy. The low gas domestic utilization occurred since domestic purchasing power has not reached economical value. Thus, gas utilization was prioritized to meet the export contract. Besides that, gas resources development is located far from the consumer and the lack of infrastructure development becomes a challenge in gas distribution.

On 7 October 2015, the government issued Economic Policy Package Stage III to reduce the cost in order to increase business climate and simplify business license. One of the policies in this Package is gas price reduction for plant or industry from new gas field to adjust the fertilizer plant purchasing power of USD 7 mmbtu. Meanwhile, gas price for other industries such as petrochemical, ceramic, etc will be reduced based on the industries' purchasing power. Gas price can be reduced by conducting efficiency in eight gas distribution systems and by reducing state revenue or gas as non tax state revenue. The gas price decline will not influence the split for gas company in its cooperation contract.

On 3 May 2016, President Joko Widodo signed a Presdiential Regulation number 40 year 2016 on Gas Price Stipulation which regulates gas price in upstream and certain industry as the effort to boost economic growth and increase national industry competitiveness. Based on this Presidential Regulation, if gas price is higher than USD 6 per mmbtu, Minister of Energy and Mineral Resources may stipulate certain gas price for fertilizer industry, petrochemical industry, oleochemical industry, steel industry, ceramic industry, glass industry and gloves industry.

3.4 Coal

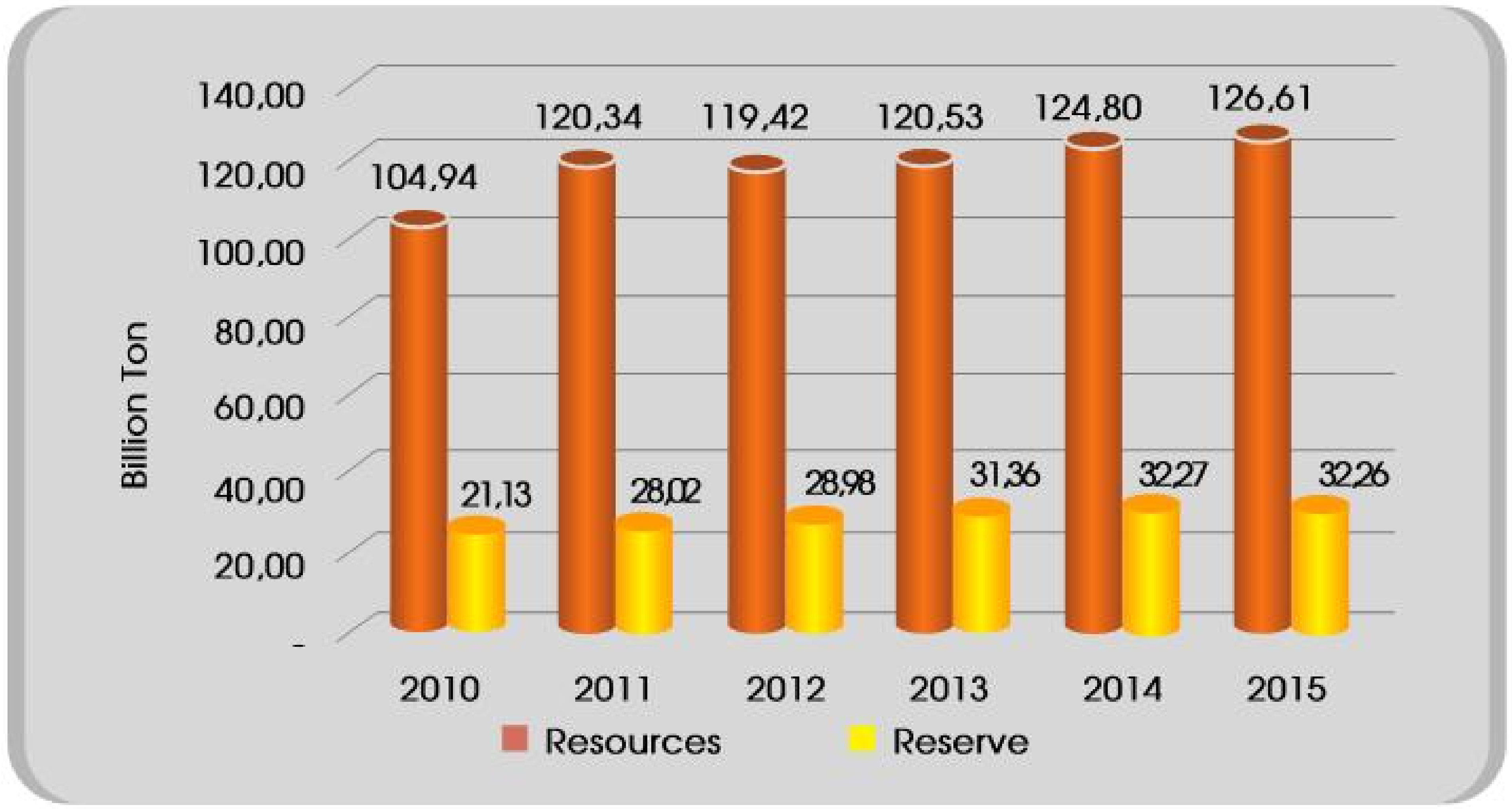
Indonesia coal production is predicted to increase not only to meet domestic demand but also to meet export. Indonesia coal resources until 2015 were 127 billion ton while coal reserves reached 32.3 billion ton. Coal resoures and reserve is dominated by low to medium rank coal while high to very high rank coal is still very limited (Table 3.2)

Table 3.2 Coal Quality, Resources, and Reserve 2015

Quality	Resources (Juta Ton)					Percentage (%)	Reserve (Million Ton)		Total
	Hypothetic	Predicted	Shown	Measured	Total		Predicted	Proven	
Low Rank Coal	1.979	9.650	10.432	12.259	34.320	27.11%	6.204	3.272	9.475
Sub-bituminous	16.882	22.413	17.441	24.286	81.023	63.99%	16.486	3.858	20.344
Bituminous	889	2.804	2.186	3.243	9.123	7.21%	545	974	1.520
anthracite	14	1.276	394	459	2.144	1.69%	762	163	925
Total	19.764	36.144	30.454	40.248	126.609	100%	23.996	8.268	32.264

Source: Ministry of Energy and Mineral Resources. 2015
Note: Quality based on calori class (Presidential Decree number 13 year 2000 amended by Presidential Regulation number 45 year 2003)
a. Low rank coal < 5100 kal/gr
b. sub-bituminous 5100 – 6100 kal/gr
c. bituminous > 6100 – 7100 kal/gr
d. anthracite > 7100 kal/gr

Compared to 2014 balance, coal resources increased 1.8 billion ton. Meanwhile, coal reserve in 2015 declined 5.83 million ton (Pictue 3.6)



Source: HEESI. 2016

Picture 3.6 Coal Resources and Reserve Value Change Year 2010-2015

The declining coal resources and reserve was due to the declining coal exploration and production since coal selling price could not cover production cost and world coal demand especially China has been declining as well. From the total coal resources and reserve, around 50% is located in Sumatera, 49.5% is located in Kalimantan, and the rest is spread in other islands (Picture 3.7).

Sources: Geological Agency MEMR. 2015

Picture 3.7 Indonesia Coal Reserve 2015

Coal production is mostly located in Kalimantan while coal consumer is mostly in Java. Thus, we need infrastructure such as port, coal stockpilling, and land transportation especially with train.

Coal production development 2010-2013 increases significantly of about 20.18% per year. Coal production realization in 2014 declined due to low price with total production of 458 million ton. In 2015, it increased into 461 million ton.

The national coal production is influenced by increasing domestic demand and export. Indonesia is the third major coal producer in the world after China and USA based on BP Statistical Review of World Energy 2015. From Indonesia total coal export, most coal is exported to India and China.

From the total national coal production, more than 75% is exported while the rest is to meet domestic demand. It shows that the produced coal is mostly exported and the domestic use is still low (Picture 3.8).

	2010	2011	2012	2013	2014	2015
Production	275	353	385	474	458	461
Export	208	272	304	356	282	365
Domestic	67	81	81	118	76	96
Export Ratio	75,6%	77,1%	79,0%	75,1%	83,4%	79,2%

Source: Ministry of Energy and Mineral Resourcer, 2015.

Picture 3.8 Coal Production and Export Development Realization 2010-2015

Domestically, coal is used in Steam Power Generation, iron and steel industry, cement industry, pulp and paper industry, and other industries. In 2015, from the total domestic coal consumption, 70 million ton of coal (80.72%) was used by Steam Power Generation. Besides that, the high fuel price and the abundant coal resources force the industry from using oil fuel to coal.

The plan to develop power generation and the development of industry indicates the increasing domestic coal demand as well as coal demand from importing countries. Regarding this, the government has issued energy policy in Presidential Regulation number 79 year 2014 on National Energy Policy especially the strategy to secure sustainable national energy supply and efficient energy utilization as well as to have an optimum energy mix until 2050. In 2025 national energy mix policy, coal utilization is expected to reach 30% by 2025 and 25% by 2050.

Besides that, the government also issued regulation as the base in coal management policy instrument, such as:

1. Law number 4 year 2009 on Mineral and Coal Mining.
2. Government Regulation number 77 year 2014 on the Third Amendment of Government Regulation number 23 year 2010 on Mineral and Coal Mining Industry.
3. Minister of Energy and Mineral Resources Regulation number 34 year 2009 on Coal Domestic Market Obligation.

Law number 4 year 2009 on Mineral and Coal Mining as the derivative of 1945 Constitution is a response toward challenges to complete regulations in mining. This Law regulates a new path in mining management which accomodates national interest, public benefits, business security, and good mining practice for sustainable mining.

Meanwhile, Ministerial Regulation number 34 year 2009 is the policy on Domestic Market Obligation which obligates coal mining company to sell and prioritize the coal to domestic market. Meanwhile, export would be the second priority.

The principles of regulations in coal sector is that Indonesia energy and mineral Resources management should be purposed for energy sovereignity, independence, and security as well as value added increase. Several coal policies are:

1. Prioritizing coal utilization as domestic energy resources.
2. Conservation and mining should be based on good principle by considering the environment.

3. Increasing coal exploration in open mining and underground mount mouth mining.
4. The stipulation of coal benchmark price especially for domestic coal utilization.
5. Coal infrastructure development to support coal supply security and coal buffer reserve.
6. The increase of coal added value.
7. Technology development in coal mining and utilization.

3.5 New and Renewable Energy

a. New and Renewable Energy Potential

The declining fossil energy potential especially oil and gas has encouraged the government to put NRE as the main priority to maintain energy security and independence since NRE potential is huge to be the source in national energy supply in the future. Currently, NRE potential in Indonesia has not been utilized maximally. One of the regulations in the future NRE development is Government Regulation number 79 year 2014 on National Energy Policy. To support NRE development in Indonesia, NRE potential mapping is needed. Until 2015, NRE resources are as shown in Table 3.3.

Table 3.3 New and Renewable Energy Resources

Energy Source	Resources	Installed Capacity	Utilization (%)
Hydro	94.476 MW[1)]	5.024 MW[1)]	5,3%
Geothermal	29.544 MW[1)]	1.403,5 MW[1)]	4,8%
Bioenergy	32.000 MW dan 200.000 bpd BBN[4)]	1.740,4 MW[4)]	5,4%
Solar	4,80 kWh/m^2/day ~207,9 GW[1)]	78,5 MW[1)]	
Wind and Hybrid	3-6 m/s ~60 GW[1)]	3,1 MW[1)]	
Marine energy	61 GW [2)] *Wave: 1.995 MW* [4)] *Ocean thermal (OTEC): 41.001 MW* [4)] *Ocean wave: 17.989 MW* [4)]	0,01 MW[3)]	
Shale Gas	574 TSCF[4)]		
Coal Bed Methane (CBM)	456,7 TSCF[4)]		

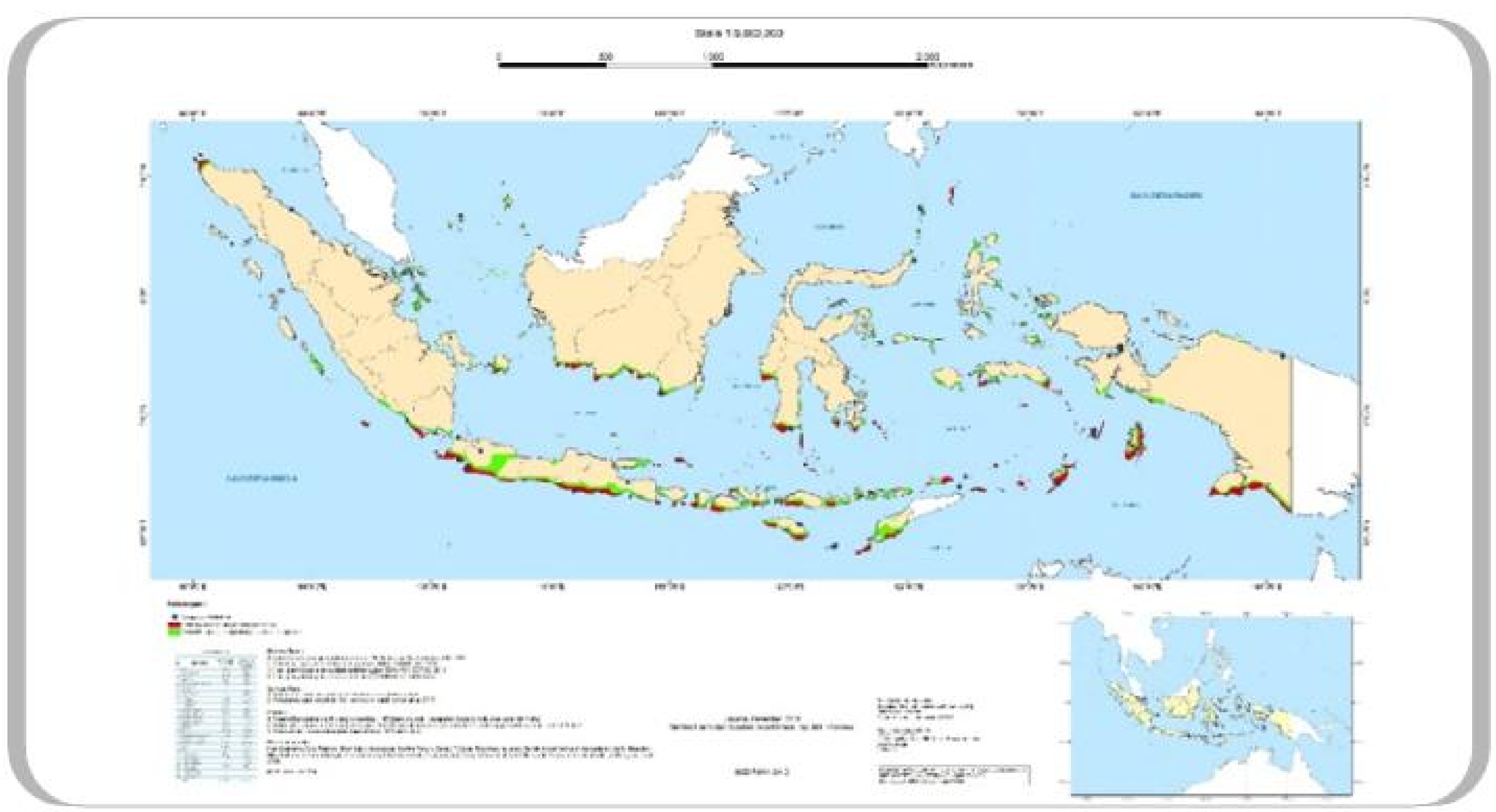
Note:
1) Potential number from RUEN draft. 2016
2) Ratification data between MEMR and ASELI. 2014
3) Prototype of Badan Pengkajian dan Penerapan Teknologi (BPPT). 2010
4) DG NREEC. 2014

Hydro Potential for Hydro Power Generation and Mini/Micro Hydro Power Generation is spread in Indonesia which is predicted of around 75,000 MW. However, its utilization is only about 11% from the total potential (Picture 3.9)

Source: DG NREEC MEMR. 2015

Picture 3.9 Large Scale Hydro Power Potential Map

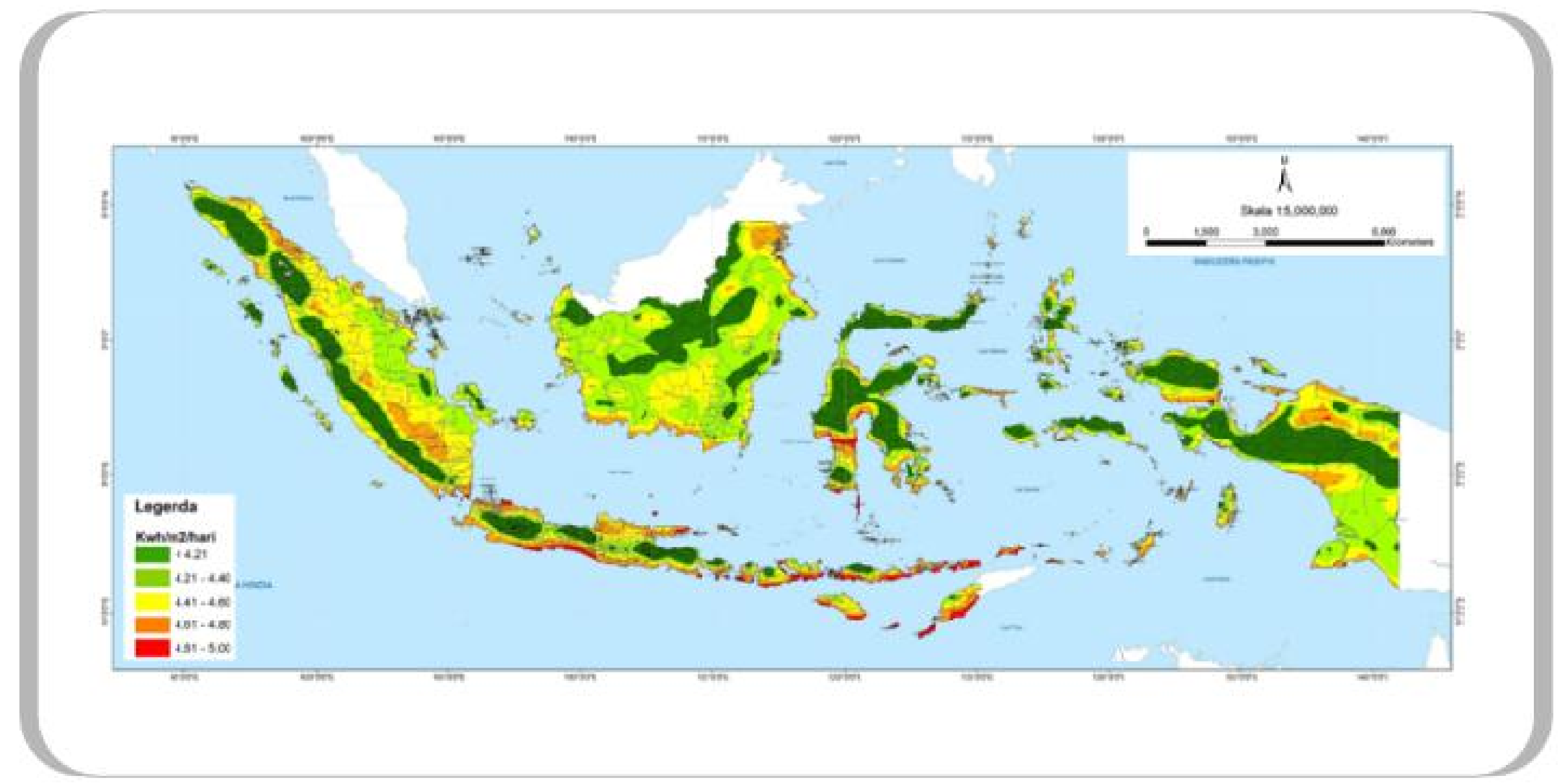
Wind Power Potential. Based on preliminary study, wind power potential is spread in Java and Sulawesi reaching about 950 MW. In 2014, the Research and Development Center for Electricity and NREEC technology has also completed Indonesia wind power potential map (Picture 3.10)



Source: R&D Center for Electricity and NREEC. 2014

Picture 3.10 Wind Power Potential Map

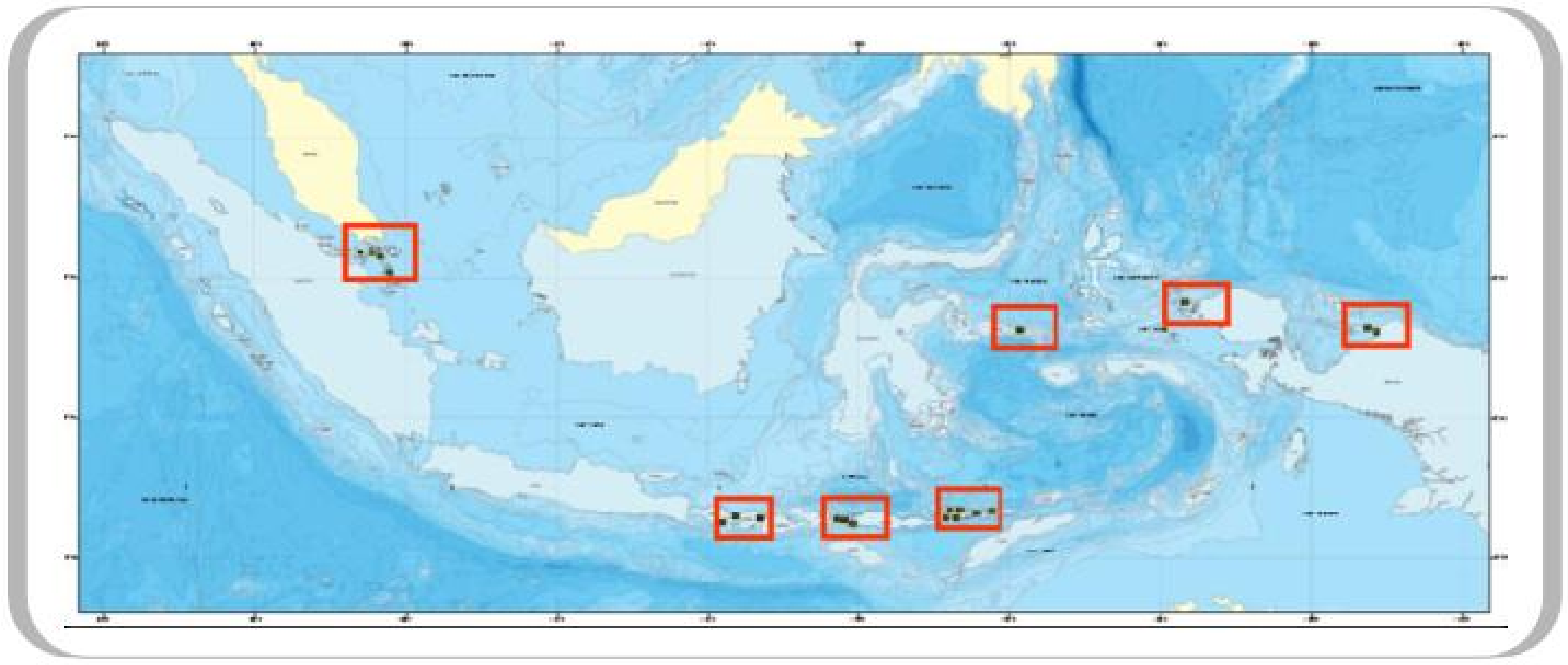
Solar Potential. Indonesia solar energy resources can be grouped based on the location namely western and eastern part of Indonesia. Solar resources in western part of Indonesia is 4.5 kWh/m2.day with monthly variation of about 10%, while solar resources in eastern Indonesia is 5.1 kWh/m2.day with monthly variation of about 9%. The average solar resources in Indonesia are 4.8 kWh/m2.day with monthly variation of about 9%. Solar power potential in Indonesia is around 4.8 kWh/m2.day or equivalent to 112 thousand GWp. Indonesia solar power resources potential is shown in Picture 3.11.



Source: DG NREEC. 2015

Picture 3.11 Solar Power Potential Location Map

Tidal Potential. The research by Reasearch and Development Center for Electricity and NREEC MEMR in 2014 has identified the mapping of tidal power potential in ten potential straits namely in Riau Strait, Sunda Strait, Toyapakeh Strait, Lombok Strait, Alas Strait, Molo Strait, Larantuka Strait, Pantar Strait, Boleng Strait and Mansuar Raja Ampat Strait. Based on the map, the marine energy potential and resources includes 17.9 GW of tidal power potential, 1.9 GW of potential wave energy, and 41 GW of ocean thermal potential. The local potential of Indonesia tidal resources is shown in Picture 3.12.



Source: Indonesia Sea Energy Association (ASELI). 2014

Picture 3.12 Tidal Power Potential Location Map

Bioenergy Potential. Bioenergy potential in Indonesia is huge and varied. Based on DG NREEC MEMR publication in 2015, the bioenergy resources reached 32.6 GW used in power generation and around 200 thousand bpd used in biofuel.

b. New and Renewable Energy Utilization

Energy utilization from NRE is mostly for electricity, while other NRE resources such as biofuel, biogass and biomass are used for household, commercial and industry to reduce fossil energy consumption.

Until 2015, the biggest installed capacity from RE power generation was derived from hydro power of about 8.1 GW including mini and micro power generation. The second biggest capacity is biomass of about 1.7 GW excluding traditional biomass. The development is mostly located in off grid (94%). At present, geothermal development is 1.4 GW or around 15% from total resources.

Based on DG NREEC MEMR data in 2015, bioenergy utilization for power generation was 1.7 GW including 28 MW diesel to biofuel conversion in Diesel Power Generation. Biofuel utilization in non electricity sector is limited to biodesel of about 2.2 million KL with the composition of 90% PSO Fuel and 10% non-PSO fuel. Other RE potential utilization such as solar, wind and ocean is still very low and spread in all over Indonesia. The low RE utilization for power generation is due to the high RE power generation production cost. Thus, it is difficult to compete with fossil fuel power generation especially coal. There are also issues such as land use permit, electricity price negotiation, far located-demand, and lack of support to domestic industry concerning renewable energy power generation and power generation components.

New energy utilization such as Coal Bed Methane (CBM) and Shale Gas is not significant yet. Based on the research by DG of Oil and Gas and Advance Resources International. Inc. in 2003, CBM resources in Indonesia was about 456.7 TSCF. Since the signing of the first CBM cooperation contract in Indonesia on 27 May 2008 until March 2015, there have been 54 contracts. For shale gas, the survey by Geological Agency recorded that shale gas resources in Indonesia main sediment basins was about 574 TSCF located in Sumatera, Kalimantan, Java and Papua.

c. NRE Supporting Policy

In order to support NRE utilization, the government has formulated National Energy General Plan which is to be issued soon to regulate policy harmonization in energy utilization especially industrial zone development, licensing simplification and One Stop Integrated Services, coordination with Ministry of Environment and Ministry of Forestry concerning land use and particular land use license, state and national banking financial support, as well as national industry support with specific mechanism.

DG NREEC MEMR has stipulated main policies to accelerate NRE development such as:

Feed in Tariff (FiT) is the mechanism of electricity purchasing price stipulation from NRE power generation by PT PIN in which the tariff is different in each energy source. The list of FiT is shown in Table 3.4.

Tabel 3.4 NRE Feed in Tariff by Energy Source

NO	TYPE OF POWER PLANT
1	**SOLAR POWER PLANT**
	MoEMR Regulation No. 17/2013 25 sen USD/kWh 30 sen USD/kWh (local Content at least 40 %)
2	**BIOGAS AND BOMASS POWER PLANT**
	MoEMR No. 27/2014 Biomassa : Rp. 1.150/kWh: medium voltage Rp. 1.1500/kWh: low voltage Biogas : Rp. 1.050/kWh: medium voltage Rp. 1.150/kWh: low voltage
3	**MUNICAL WASTE POWER PLANT**
	MoEMR No. 29/2013 Zero Waste : Rp. 1.450/kWh: medium voltage Rp. 1.798/kWh: low voltage Landfill : Rp. 1.250/kWh: medium voltage Rp. 1.598/kWh: low voltage
4	**HYDRO POWER PLANT**
	MoEMR No. 29/2015 Flow/River Waterfall: Medium Voltage: 12 sen USD (year ke 1 up to 8) 7,5 sen USD (year ke 9 up to 20) Low Voltage: 14,4 sen USD (year ke 1 up to 8) 9 sen USD (year ke 9 up to 20) Existing Reservoir: Medium Voltage: 10,8 sen USD (year up to 8) 6,75 sen USD (year up to 20) Low Voltage: 13 sen USD (year up to 8) 8,1 sen USD (year up to 20) HYDRO POWER PLANT (up to 10 MW): price adjustment based on MoEMR No. 22/2014 Medium Voltage: 9,3 sen USD Low Voltage: 11 sen USD
5	**GEOTHERMAL POWER PLANT**
	MoEMR No. 29/2015

COD	Highest Price Benchmark (cent USD/kWh)		
	Wilayah I	Wilayah II	Wilayah III
2015	11.8	17.0	25.4
2016	12.2	17.6	25.8
2017	12.6	18.2	26.2
2018	13.0	18.8	26.6
2019	13.4	19.4	27.0
2020	13.8	20.0	27.4
2021	14.2	20.6	27.8
2022	14.6	21.3	28.3
2023	15.0	21.9	28.7
2024	15.5	22.6	29.2
2025	15.9	23.3	29.6

AREA DISTRIBUTION:

Area I : Sumatera, Java and Bali
Area II : Sulawesi, NTB, NTT, Halmahera, Maluku, Papua and Kalimantan;
Area III : All region in Area 1 or 2 but the transmission system is isolated, the need of electricity fulfillment mostly obtained from fuel oil power plant.

Despite that FiT has been put in place a long time ago, its practice has faced obstacles due to unclear mechanism related to legal security for State Owned Enterprise, in this term PLN, for the issue of purchasing above average price and electricity price load expensiveness. Thus, the government is reviewing the establishment of a business entity with special assignment to purchase RE based on FiT and subsidy mechanism or price gas.

- **Biofuel Share Escalation**. Biofuel mandatory and fund rise from Palm Oil Mill through General Services Institution scheme.
- **Off-grid Electrification Ratio Escalation**. Off-grid electrification ratio escalation through renewable energy power generation development.
- **Price Renegotiation after Exploration and Feasibility Study (FS) for Stalled Projects**. One of the factors which cause the stalled NRE projects is the low or uneconomical electricity price after tender. Thus, the government issued Ministerial Regulation number 17/2014 on Power Purchase from Geothermal Power Generation and Geothermal Steam for Geothermal Power Generation by PT PLN to give the security that after exploration and FS the parties may negotiate to reach the economical value.
- **Shale gas Development**. The government has issued Minister of Energy and Mineral Resources Regulation number 5/2012 on Unconventional Oil and Gas Working Area Stipulation and Offer Procedure.
- **Assigment to State Owned Enterprise (BUMN) or General Services Institution (BLU)**. Remote or uninteresting geothermal working area could be optimized by assigning BUMN or BLU (Law no 21/2014 on Geothermal).

Indonesia Energy OUTLOOK 2016

CHAPTER 4
ENERGY OUTLOOK

CHAPTER 4 / ENERGY OUTLOOK

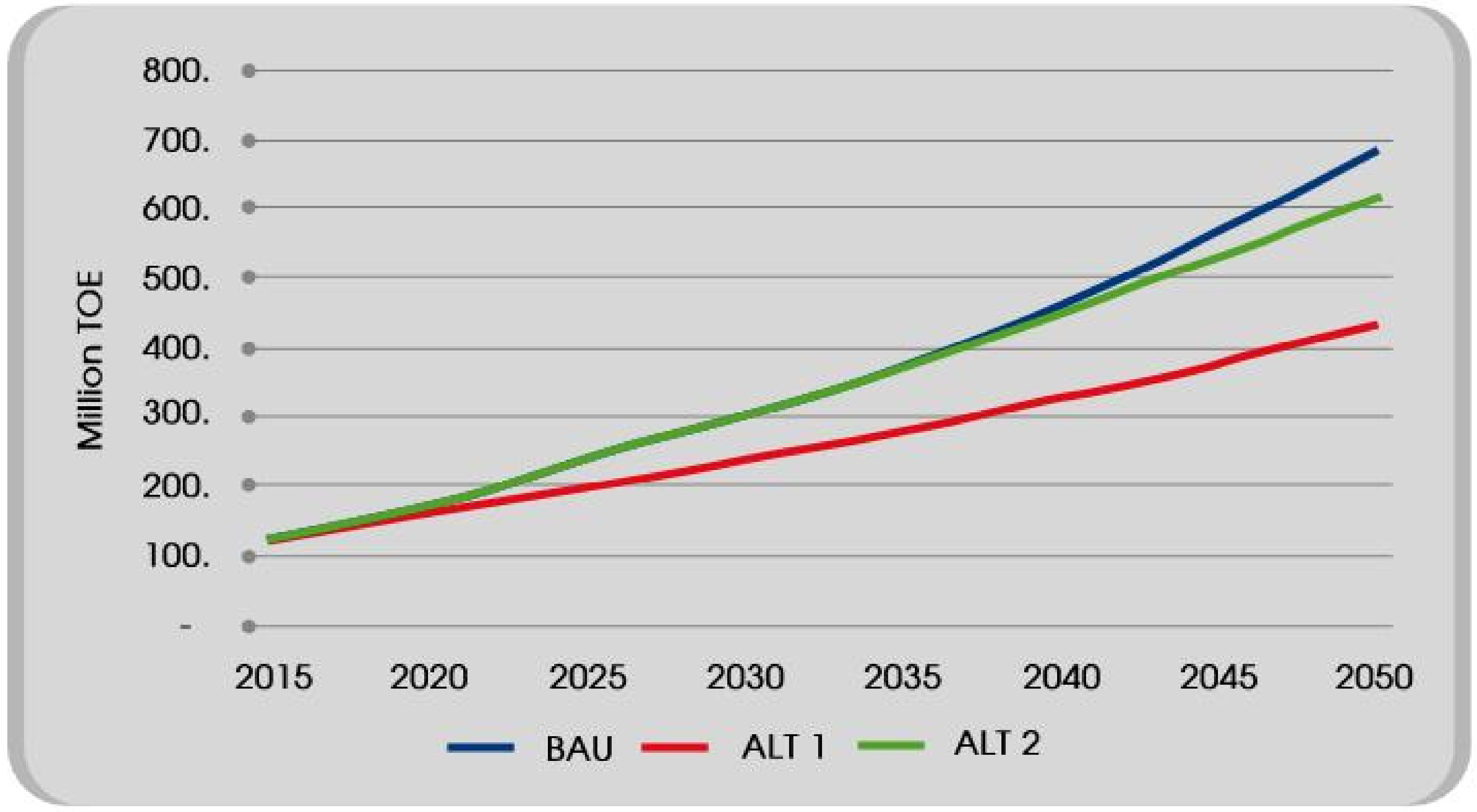
As explained in Chapter 2, Indonesia Energy Outlook does not take traditional biomass (biomass in household) into account. Biomass for industrial sector and power generation is taken into consideration in Indonesia Energy Outlook 2016.

4.1 Final Energy Demand

Based on moderate GDP growth assumption of 5.6% per year in 2015-2050 and average population growth of 0.8% per year, the national fnial energy demand will reach 238.8 MTOE in 2025 for BaU scenario. The demand in 2025 shows 1.8 times increase with the annual growth of 6.4% compared to the final energy consumption in 2015 of 128.8 MTOE. The final energy demand will be increasing up to 682.3 MTOE in 2050. The average energy demand growth in 2015-2050 is around 4.9% per year.

The final energy demand in ALT 1 scenario will increase but with lower growth compared to in BaU scenario. ALT 1 includes energy conservation and other efforts based on National Energy Policy. Thus, the demand of various energy sources will keep increasing but with slower growth rate. The final energy demand in ALT 1 will be 201.5 MTOE in 2025 and 430.3 MTOE in 2050 with averate rate of 3.5% per year in 2015-2050. The energy demand gap between ALT 1 and BaU becomes energy saving potential as the result of energy conservation in end-user which includes industry, transportation, household, commercial and other sectors as well as the utilization of non-energy such as raw material, additive, redactor and lubricants. The energy saving saving potential in national energy demand is 16% in 2025 and 37% in 2050 based on energy demand calculation.

Based on calculation in ALT 2 with 7.1% per year of average GDP growth assumption, the final energy demand will reach 244 MTOE in 2025 and 621 MTOE in 2050 (Picture 4.1). The final energy demand by ALT 2 scenario is similar to final energy demand in BaU scenario. However, in ALT 2, the percentage of NRE utilization is higher. It shows that ALT 2 requires more energy saving to reach ALT 1 condition. The energy demand average growth in ALT 2 is around 4.6% per year.



Picture 4.1 Final Energy Demand by Scenario

The final energy demand of fuel and other refinery products for BaU scenario is 101 million TOE in 2025 and 260 million TOE in 2050 or increases with the average growth of 2.7% per year during the projection period. The final energy demand and other refinery products for ALT 1 scenario is 98 million TOE in 2025 and 126 million TOE in 2050. For ALT 2 , it is 124 million TOE in 2025 and 183 million TOE in 2050.

In ALT 2 condition with high GDP growth, fuel and other refinery products demand will increase with the average growth of 3.8% per year during the projection period. With ALT 2 and high GDP, it takes more energy conservation than in National Energy Policy to reach the same demand level with ALT 1. Then, the demand growth of other energy sources will be higher than in ALT 1 and several times higher than in BaU. The fuel and other refinery products demand growth in ALT 2 is 3.8% per year.

The final energy demand for gas in BaU scenario is 43 million TOE in 2025 and 61 million TOE in 2050. For ALT 1, it is 43 million TOE in 2025 and 80 million TOE in 2050. For ALT 2, it is 47 million TOE in 2025 and 111 million TOE in 2050.

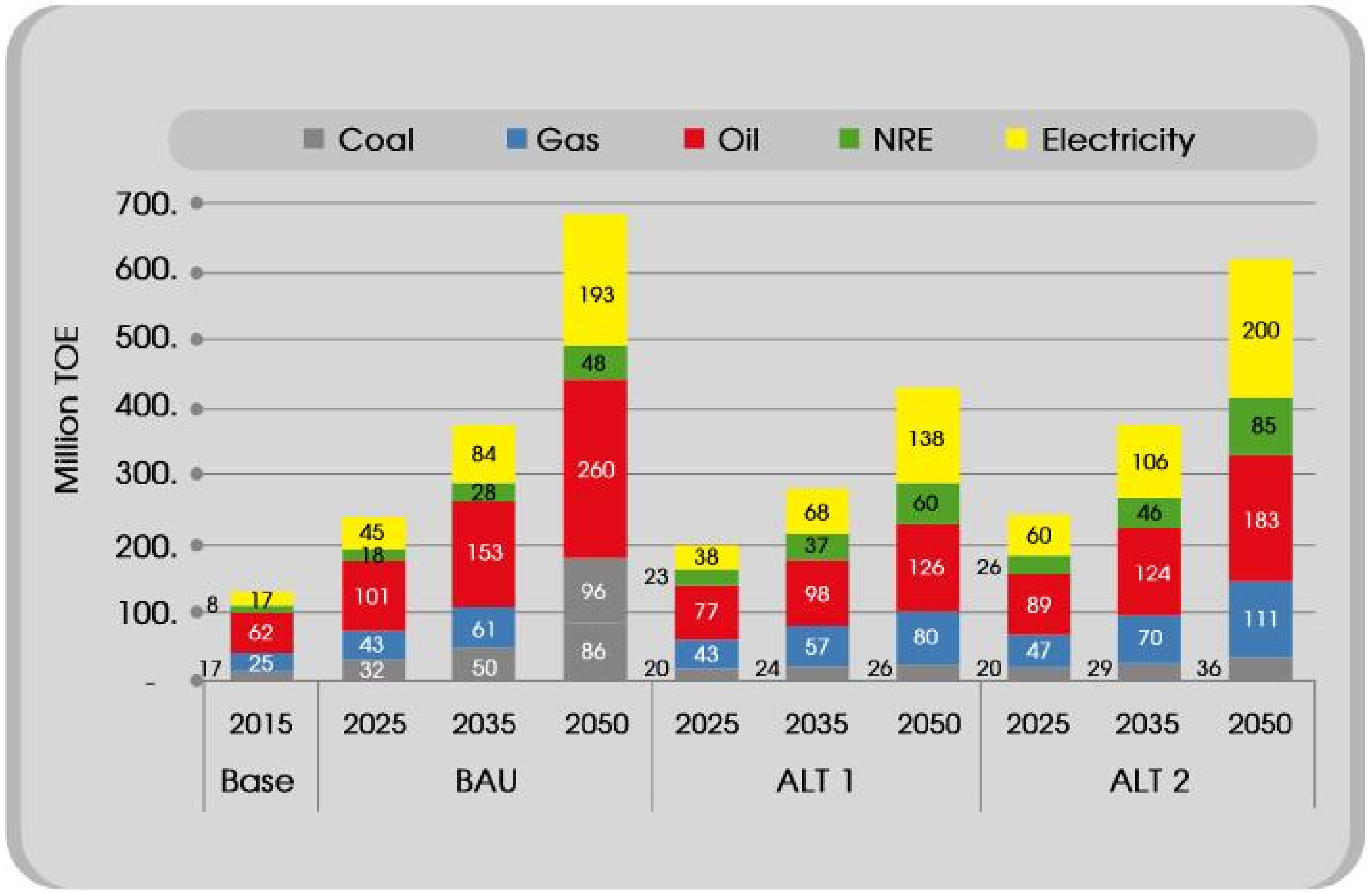
Like oil, gas has major potential to be utilized in industry, household, and commercial sector. Beside relatively cheaper, gas is a clean energy. From the environment side, gas is the main choice after NRE. Gas demand will increase with the average growth of 3.9% per year in BaU, 3.4% per year in ALT 1 and 4.2% per year in ALT 2.

Gas demand in industry is used for energy sources in boiler or stove especially for conventional industry such as ceramic industry, glass industry, and others.

During the projection period, coal demand is predicted to increase the average growth of 4.8% per year in BaU scenario. The demand will reach 32 million TOE in 2025 and 86 million TOE in 2050. For ALT 1 and ALT 2 scenario, coal demand average growth is 1.2 % (ALT 1) and 2.2% (ALT 2) or 20 million TOE (ALT 1 and Alt 2) in 2025 and 26 million TOE (ALT 1) and 36 million TOE (ALT 2) in 2050. Coal demand is closely related to coal utilization in industry especially as energy source for stove in cement industry and other industries.

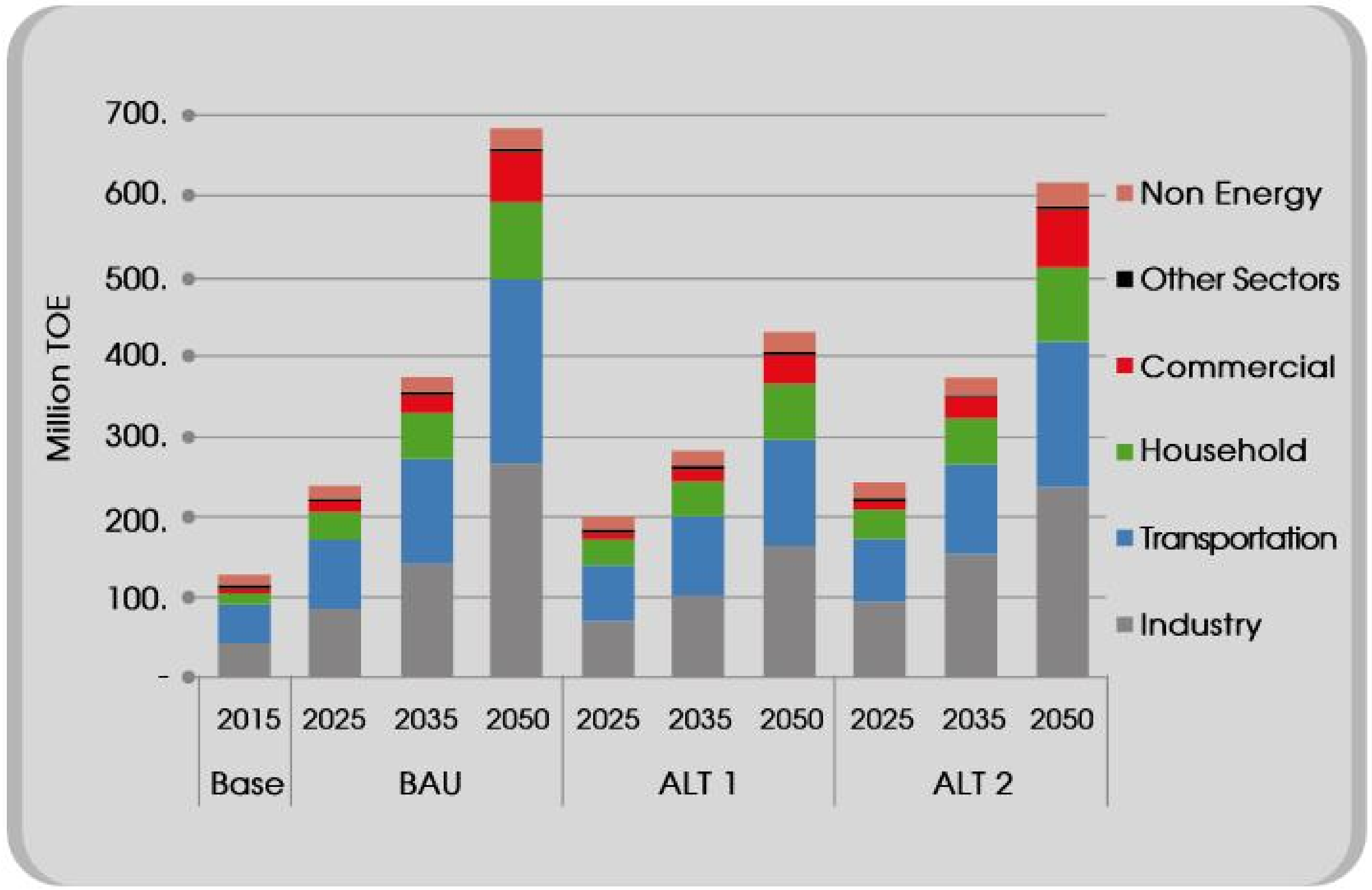
NRE has low consumption level but experiences quite high increase. During the projection period, NRE demand in BaU is projected to increase with growth rate of 5.1% per year. NRE demand will reach 18 million TOE in 2025 and 48 million TOE in 2050. In ALT 1, NRE demand growth is 5.8% per year or 23 million TOE in 2025 and 60 million TOE in 2050. In ALT 2, NRE demand increases sharply into 26 million TOE in 2025 and 85 millin TOE in 2050 with growth rate of 6.9% per year.

Other final energy demand predicted to be high in the future is electricity. In BaU scenario, electricity demand share toward total energy demand reaches 19% or 45 million TOE in 2025 and 28% or 193 million TOE in 2050 or the average growth is 7.1% per year. In ALT 1 and ALT 2, electricity consumption share also increases from 19% or 38 million TOE (ALT 1) and 25% or 60 million TOE (Alt 2) in 2025 into 32% or 138 million TOE (ALT 1) and 33% or 200 million TOE (ALT 2) in 2050 with the average growth of 6.1% (ALT 1) and 7.2% (ALT 2) per year. The high electricity demand is due to the high electrification ration target in 2020 of 100% and the shifting in lifestyle along with the economic improvement and technology development. The final energy demand by source and scenario can be seen in Picture 4.2.



Picture 4.2 Final Energy Demand by Source and Scenario

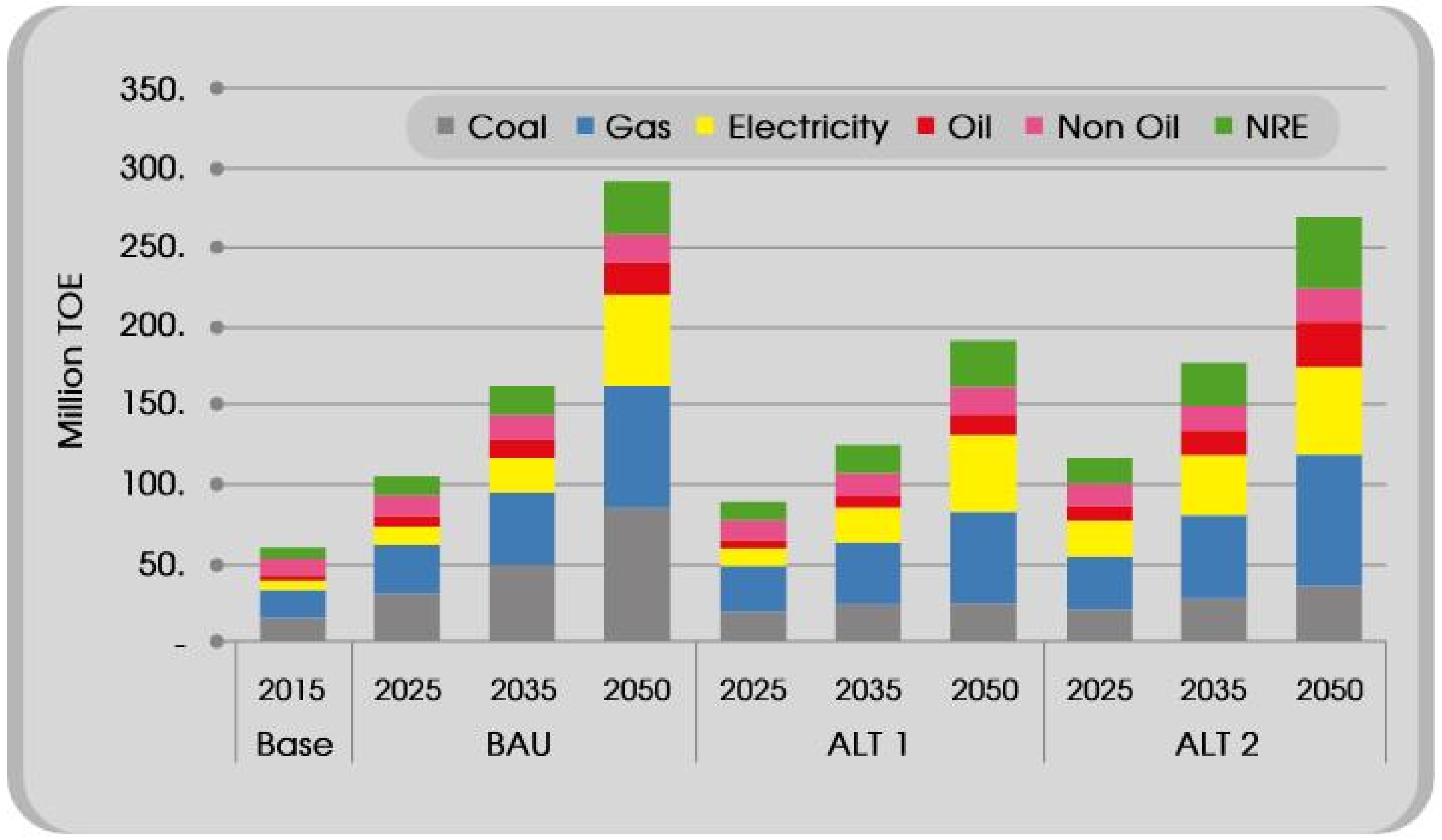
Based on energy consumer, the national final energy demand up to 2025 is still dominated by transportation and industry as in 2015 condition. After 2025, industry will dominate the national final energy demand along with industry activity acceleration and private vehicle deceleration due to the shifting to mass transportation. The share of transportation and industry in national energy demand is about 70% during the projection period. The rest of the share is consumption from household, commercial and other sectors including the utilization as raw material, reducyor, lubricants, additive, and other non-energy use. In BaU, energy demand share from household and commercial increases from 16% in 2015 to 23% to 25% in 2050 (Picture 4.3).



Picture 4.3 Final Energy Demand by Sector

4.1.1 Final Energy Demand in Non Energy Industry

Industry is a major gas consumer. The final energy demand in industry in 2050 is 292 million TOE (BaU), 191 million TOE (ALT 1) and 269 (ALT 2) or grows 5% (BaU), 3% (ALT 1) and 2.4% (ALT 2) from 2015 consumption of about 60 million TOE. The various demands in each scenario are influenced by the different GDP growth and the implementation of energy diversification, conservation and efficiency. Besides gas, industry also uses coal, electricity, oil and NRE as fuel and raw material. In BaU, the share in 2050 shows 29% of coal, 27% of gas, 19% of electricity, 7% of oil fuel, 6% of non-oil fuel, and 11% of NRE. The high NRE share in BaU occurs since biomass mandatory in industry is quite high at present. (Picture 4.4).



Picture 4.4 Final Energy Demand in Industry by Energy Source and Scenario

In ALT 1 scenario, the share in 2050 changes into 13% of coal, 30% of gas, 26% of electricity, 6% of oil fuel, 12% of non oil fuel, and 15% of NRE. In ALT 2, it becomes 13% of coal, 31% of gas, 21% of electricity, 9% of oil fuel, 8% of non oil fuel, and 17% of NRE. In the two scenarios, the role of gas, electricity and NRE is quite dominant.

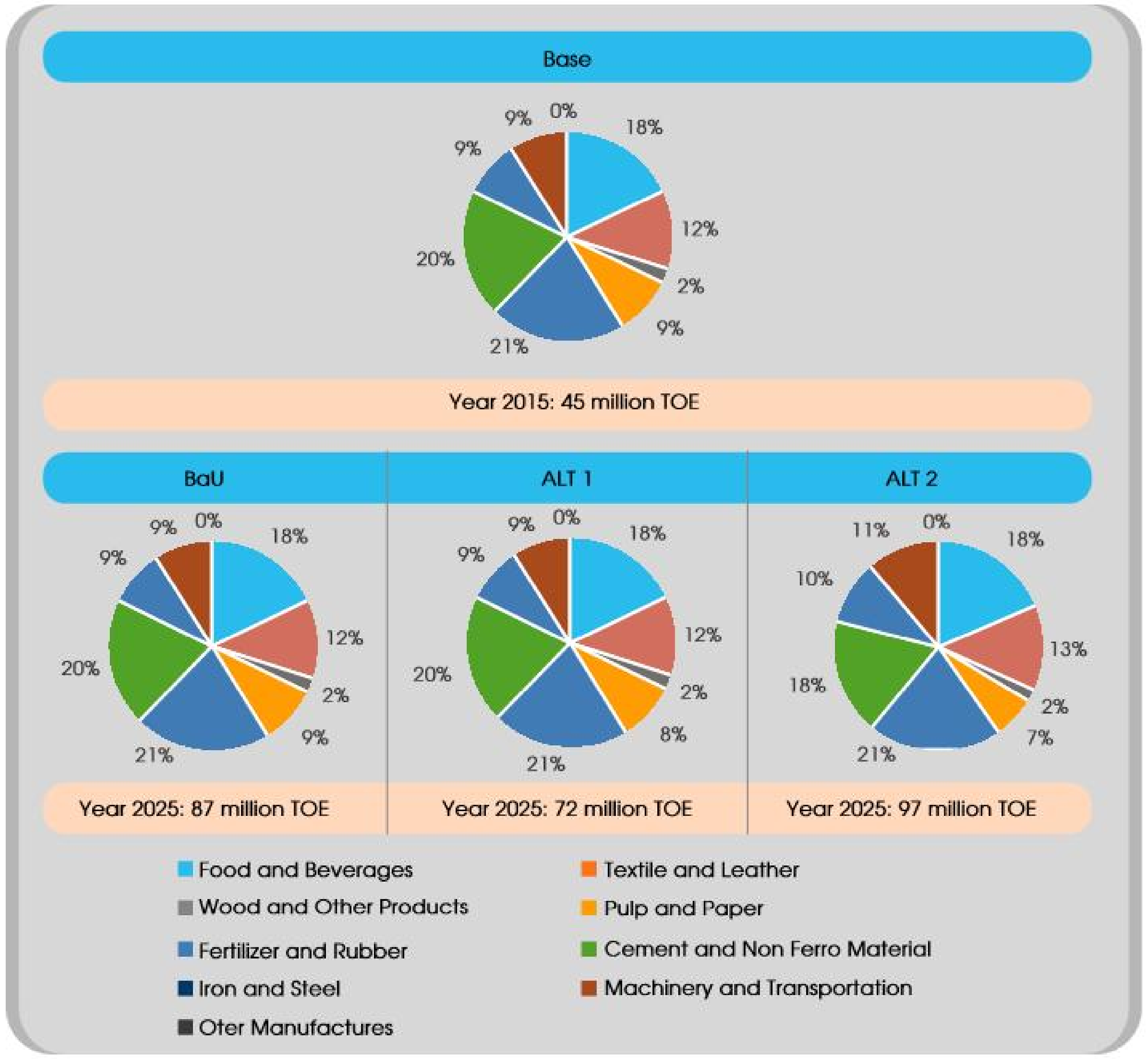
The new policy on gas demand in industry is concerning gas price stipulation. Based on Presidential Regulation number 40/2016 on Gas Price Stipulation, gas price for certain sector can be reduced if the two requirements are fulfilled. They are not meeting the economical value of gas consuming industry and gas price is higher than USD 6 per MMBTU. Presidential Regulation number 40/2016 states that gas price is stipulated by considering field economical value, price in international and domestic market, domestic consumer purchasing power, and added value of gas utilization. Cheap gas is proposed to be allocated from seven sectors to ten industrial sectors. Those ten industries are fertilizer, petrochemical, olechemical, steel/other metals, ceramics, glass, tire, and rubber gloves, pulp and paper, food and beverage, textile, and footware industry.

In ALT 1 and ALT 2, electricity demand experiences the highest increase than the other energy sources with the average growth of 6% and 7% per year. It is then followed by gas with 4% and 5%, coal (including briquettes) with 1% and 2%. Meanwhile, oil fuel decreases from 2 to 6% per year.

NRE utilization in industry is limited to commercial biodiesel and biomass. Biodiesel replaces the high consumption of diesel fuel. In ALT 1 and ALT 2, NRE will increase 4% and 6% per year or 28 and 46 million TOE in 2050.

Energy activity in industry is based on GDP in industry. To simplify the modeling, the number of sub sector is reduced from 24 sub sectors based on Indonesia Industrial Standard Classification (KBLI) issued by Statistic Indonesia in 2009 into 9 sub sectors based on GDP data in processing industry.

From final energy demand 2015, industry can be grouped into three. The first group is high energy consumer such as food and beverage industry, petrochemical fertilizer industry, rubber industry, cement industry and non metals industry with 59%. The second group is moderate energy consumer including textile industry, leather industry, pulp and paper, iron and steel base metal industry, and engine and transportation tools industry with 39%. For low energy consumer such as wood and other processing industries, the share is about 2%. The share for BaU, ALT 1 and ALT 2 in 2025 and 2050 is not much different. The final energy demand projection in industry by industry type is shown in Picture 4.5.



Picture 4.5 Final Energy Demand Share by Industry

From the energy intensive level per unit, industry can be classified into three:

- Energy intensive manufacturing industry: food and beverage, pulp and paper, chemical fertilizer, cement, non metal, iron and steel base metal.
- Non energy intensive manufacturing industry: textile and leather, engine and transportation tool, and other processing industries.
- Non manufacturing industry: wood and other forestry products

are fertilizer, petrochemical, olechemical, steel/other metals, ceramics, glass, tire, and rubber gloves, pulp and paper, food and beverage, textile, and footware industry.

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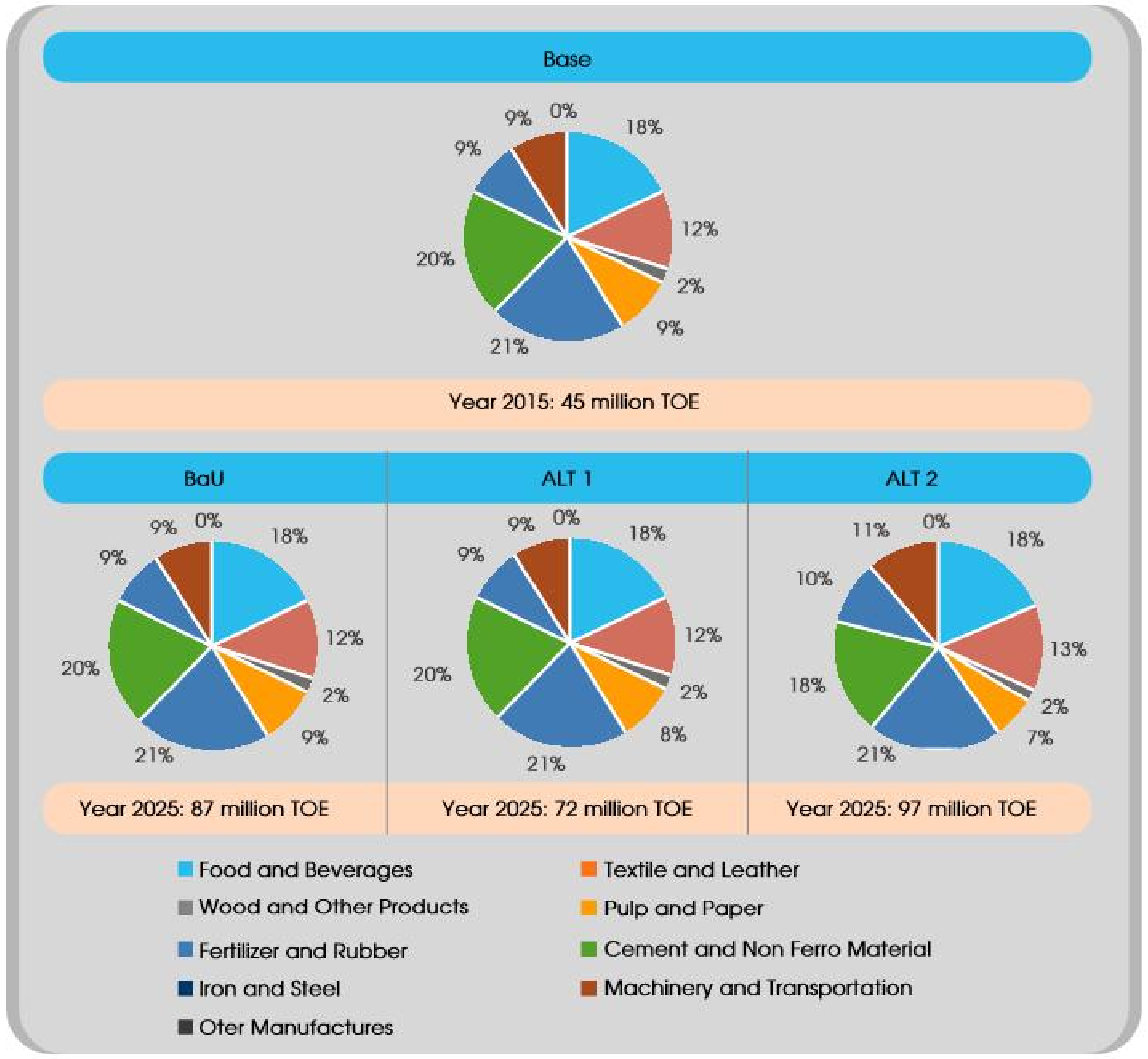

Picture 4.5 Final Energy Demand Share by Industry

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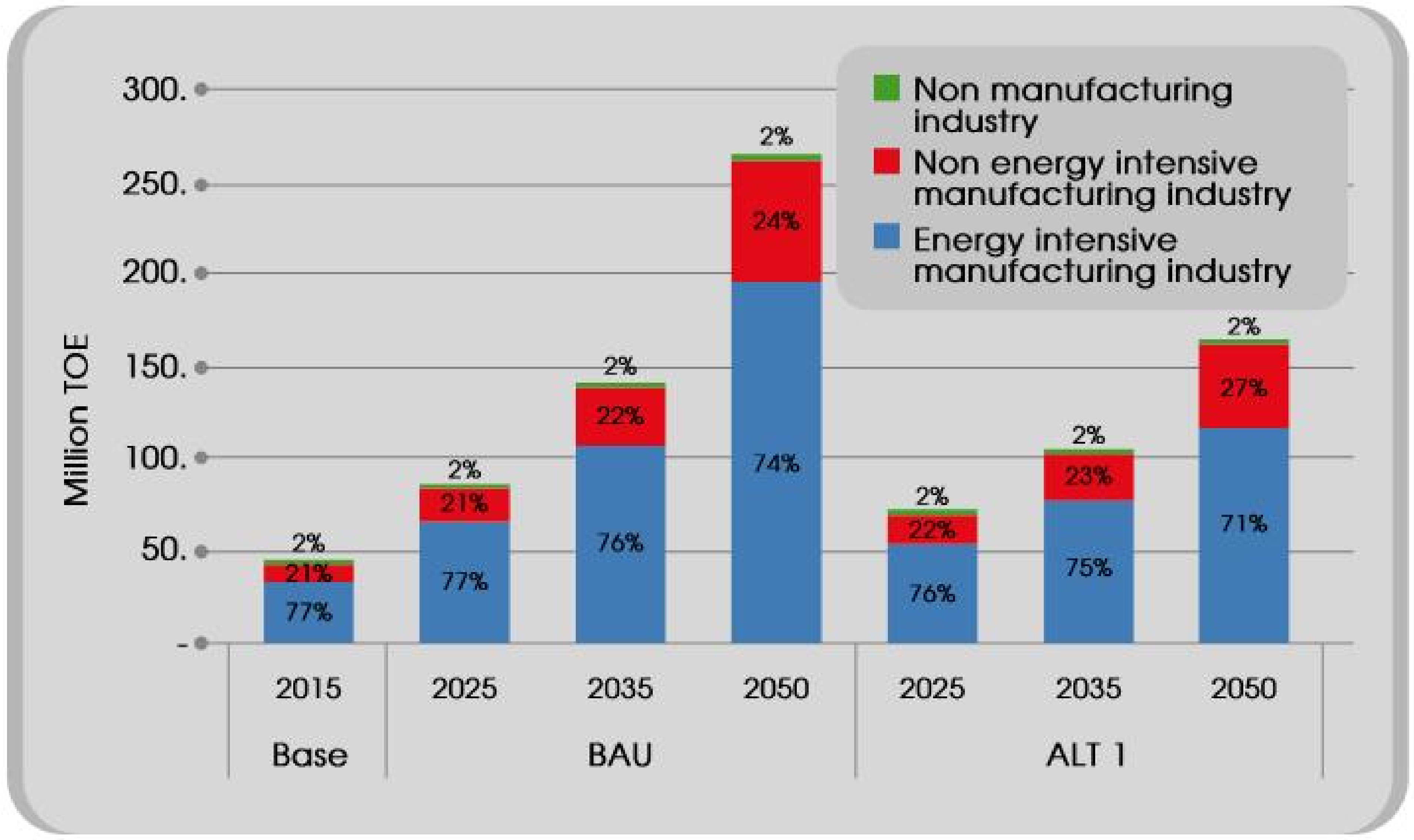
- Non energy intensive manufacturing industry: textile and leather, engine and transportation tool, and other processing industries.
- Non manufacturing industry: wood and other forestry products

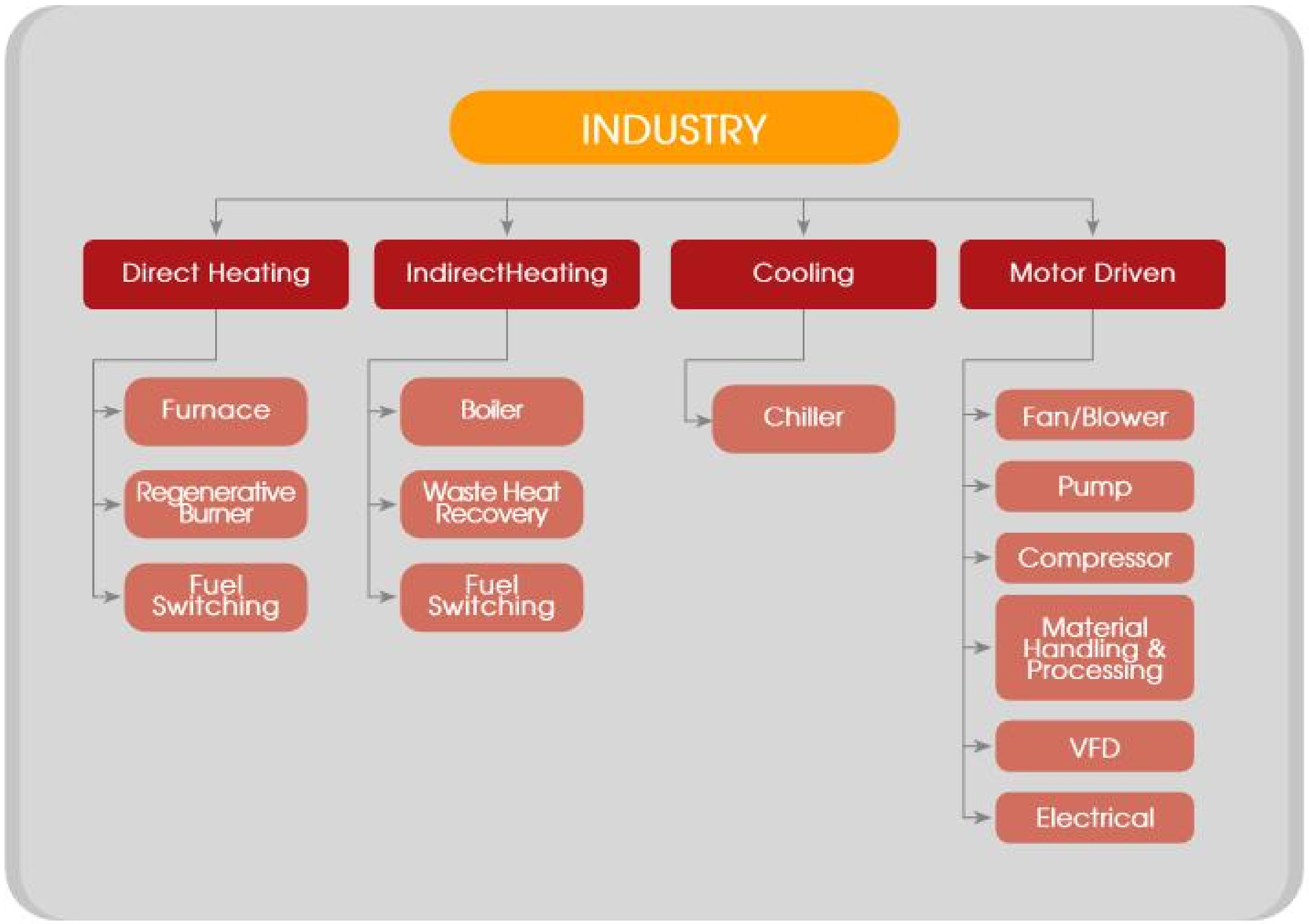
Industrial energy demand is still dominated by energy intensive industry. However, energy intensive manufacturing industry share in ALT 1 is decreasing compared to in BaU due to efficiency effort in energy intensive manufacturing industry. Conversely, non intensive manufacturing industry share is increasing due to expansion from moderate energy consumption of engine and transportation tools industry. The similar condition also happens in ALT 2 (Picture 4.6).



Picture 4.6 Final Energy Demand Share by Subsector and Scenario

Basically, energy consuming technology in industry can be grouped into four processing technologies. They are:

- Indirect process heating;
- Direct process heating;
- Process cooling
- Machine drives/Motor driven



Picture 4.7 Energy Conservation and Efficiency in Industry

Picture 4.7 shows energy conservation and efficiency in industry to conduct energy demand projection for alternative scenario. Fuel switching in industry is directed to optimize the use of coal, gas and biofuel to replace oil fuel.

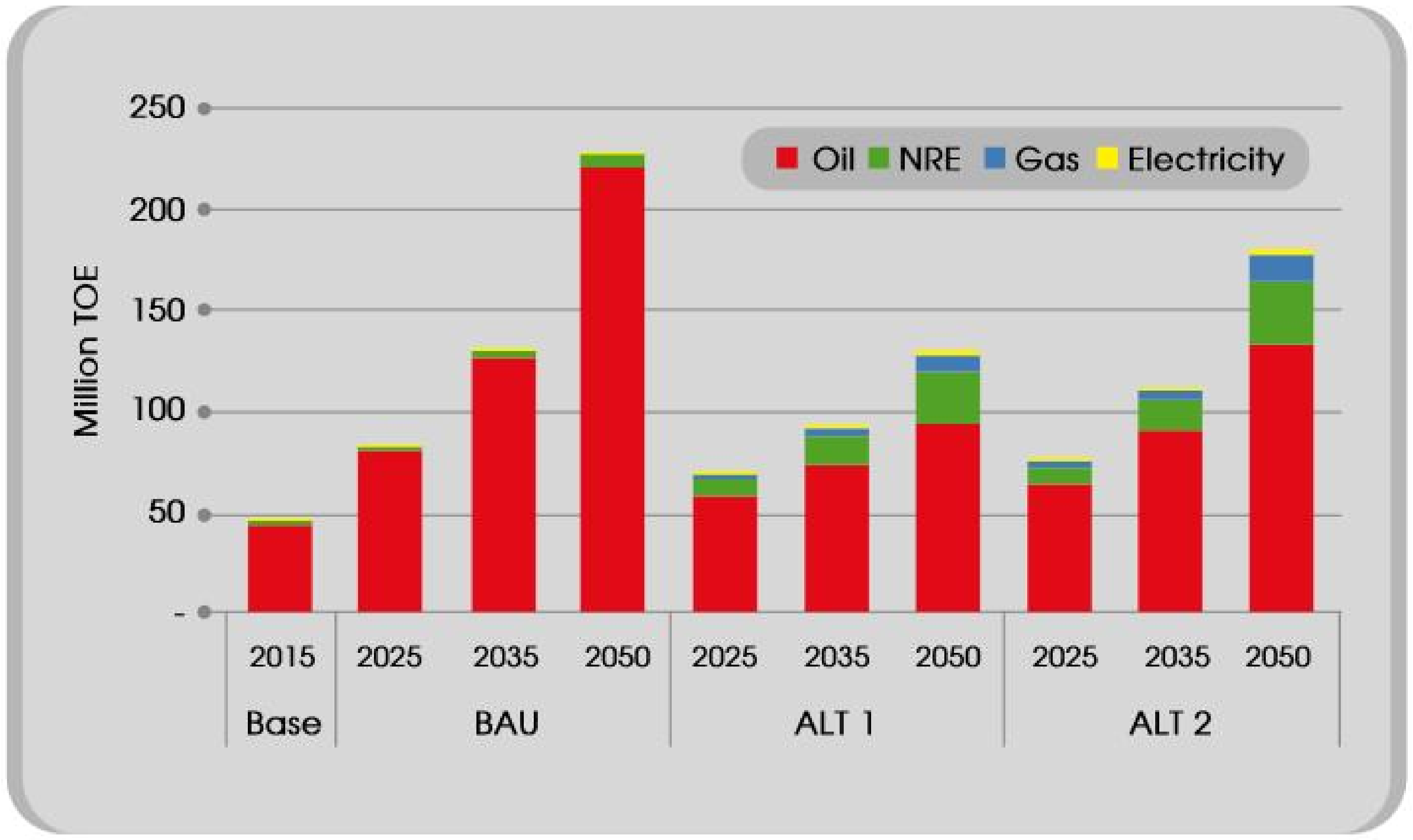
The opportunity of energy saving technology implementation in furnace or stove and boiler such as regenerative burner/reheating furnace and waste heat recovery boiler for all industry is quite high. Variable frequency drive (VFD) technology gives a significant energy saving to driving motors. The use of capacitor bank creates a better power in power generation system and saves more electricity.

4.1.2 Final Energy Demand in Transportation

Final energy demand in transportation is still dominated by oil fuel with 96%, while the rest 4% is NRE (biodiesel). Gas is only in several big cities such as Jakarta, Surabaya, Palembang and Medan with 0.1%. Electricity is used for Electric Train of about 0.04%. To reduce the high dependency on oil fuel, efforts have been conducted to replace oil fuel with biofuel, gas and electricity and to increase efficiency in transportation through energy saving vehicle utilization, mode of transportation shifting, transportation infrastructure improvement and traffic management. Oil fueled vehicle technology is still difficult to be replaced by other alternative fueled technology. Biofuel such as biodiesel and bioethanol has been the fuel mixture in oil fuel along with biofuel mandatory. The government has stipulated the utilization of biofuel in various sectors including transportation in which biodiesel share in diesel fuel is targeted to reach 30% and bioethanol share in gasoline RON 88 to reach 20% in 2025.

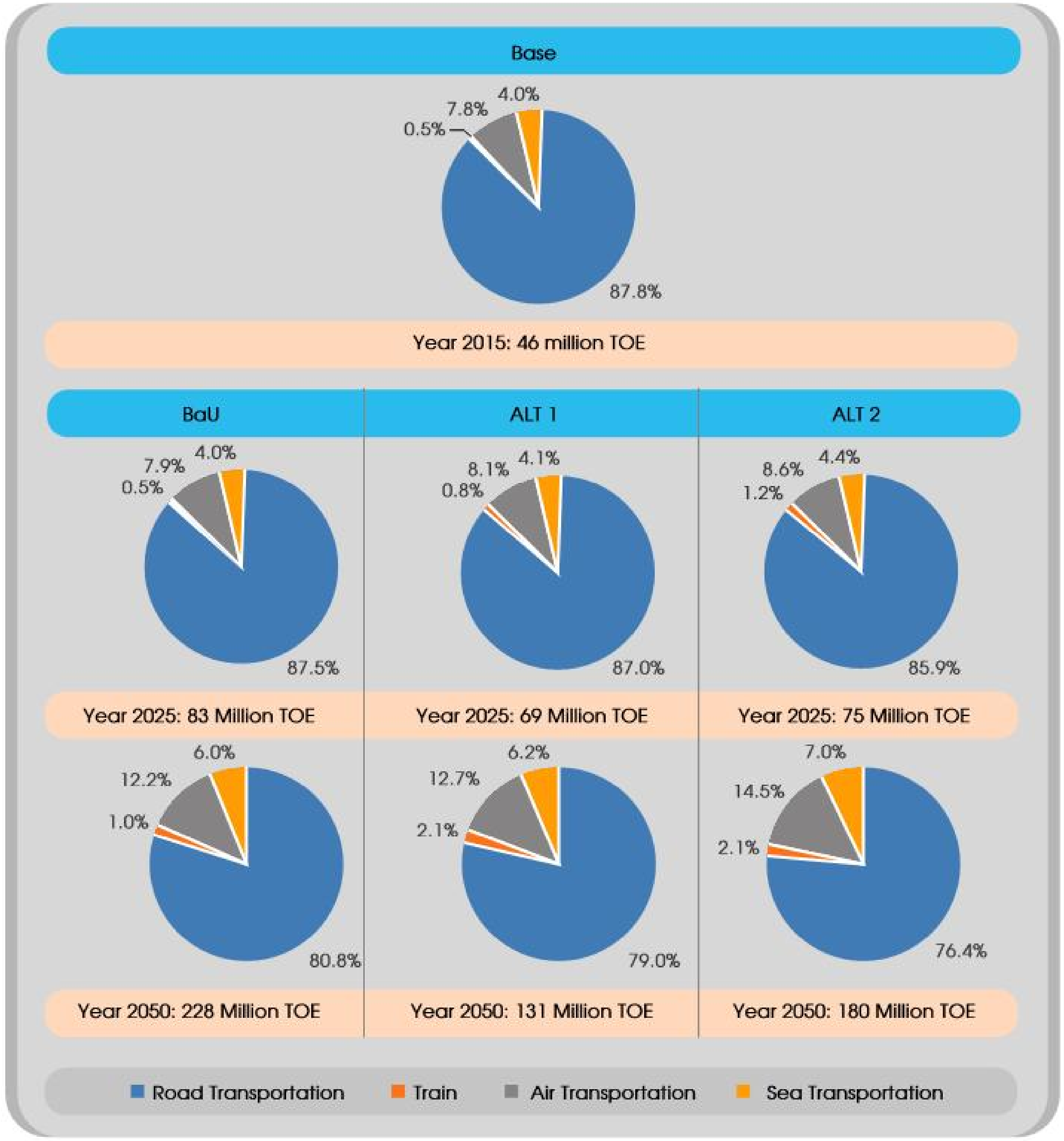
Without aggressive energy diversification and efficiency in BaU, the final energy demand in transportation will grow 5% per year or from 46 million TOE at present into 228 million TOE in 2050. Oil fuel share will also increase into 97%.

According to ALT 1 and ALT 2, the final energy demand in transportation in 2050 reaches 131 million TOE and 180 million TOE or grows 3% and 4% per year. The final energy demand in ALT 1 is lower since GDP growth assumption in ALT 1 scenario is lower. Due to the utilization of energy saving vehicle and mode of transportation shifting, transportation infrastructure improvement and traffic management, the final energy demand of the two scenarios is lower than in BaU. The oil fuel, NRE, gas and electricity demand growth in transportation is shown in Picture 4.8.



Picture 4.8 Final Energy Demand in Transportation by Source and Scenario

Furthermore, oil fuel share in both ALT 1 and ALT 2 will decline significantly into 72% and 74% in 2050 though its demand will increase into 94 million TOE and 133 million TOE from 44 milion TOE at present. NRE share will increase along with the increasing demand of gasoline RON 88 and diesel oil as well as the increasing biofuel mandatory. In 2050, NRE demand including biodiesel and bioethanol for ALT 1 and ALT 2 will reach 26 million TOE and 32 million TOE or increases from 2 million TOE in 2015. Meanwhile, electricity for electric train is predicted to grow from 0.02 million TOE in 2015 to 2 million TOE (ALT 1) and 3 million TOE (ALT 2) in 2050 along with the development of electicity infrastructure. At present, gas demand is only 0.03 million TOE. Gas demand in transportation will increase up to 9 million TOE and 13 million TOE in 2050 for ALT 1 and ALT 2.



PIcture 4.9 Final Energy Share in Transportation by Mode and Scenario

Based on modes of transportation, final energy demand in transportation is mostly consumed by road transportation which includes passenger car, bus, truck and motor cycle. Due to the policy on mode of transportation shifting from car and motor cycle to bus and train including electric train and the shifting of goods transporation from truck to freight train or goods train, the share of road transportation in both alternative scenarios is declining (see Picture 4.9). The government has commited to increase sea transporation and train to reduce the present high goods distribution cost. The shifting of modes of transporation from passenger car and motor cycle to electric train and MRT (Mass Rapid Transport) has significantly increased the train demand especially in the cities.

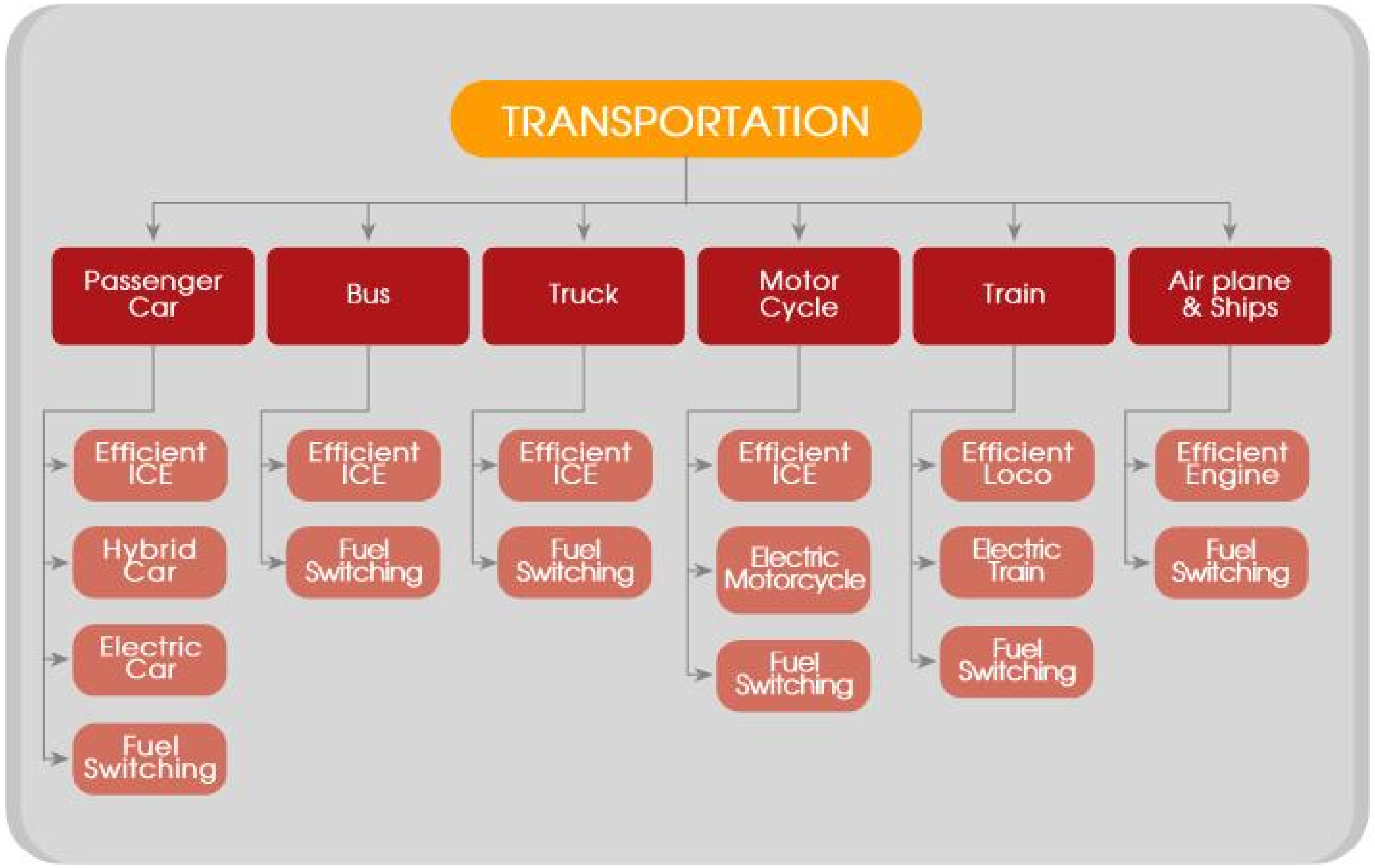
The declining share of road transportation occurs when energy intensity of passenger car and motor cycle is higher than bus or electric train. For goods transportation, energy intensity of truck is higher than freight train. The activity of modes of transportation is differentiated into passenger and goods based on transportation production or useful energy (energy used by passenger and goods). Passenger activity uses passenger-km, while goods activity uses ton-km. it is used to help us in conducting energy conservation and efficiency asuch as modes of transportation shifting in ALT 1 and ALT 2.

Seen from the growth in general, the highest energy demand increase rate in transportation is in train, air plane, and sea plane with average growth rate of 5-9% per year up to 2050. Meanwhile, the average growth of road transportation is only 1-5% per year. Despite of the very high growth of train and sea transportation, the energy demand share is still low. These two modes of transportation only contribute less than 10% in 2050 for all scenarios.

Table 4.1 Final Energy Demand in Transportation by Source and Scenario (Million TOE)

	Base	BaU				ALT 1				ALT 2			
	2015	2025	2035	2050	Growth	2025	2035	2050	Growth	2025	2035	2050	Growth
Passenger car	13.7	25.6	40.8	77.3	5%	20.2	28.2	43.4	3%	23.0	37.1	68.2	5%
Bus	4.0	6.4	9.5	16.3	4%	5.6	7.5	11.0	3%	6.1	9.0	14.8	4%
Truck	10.9	15.8	21.4	32.4	3%	13.3	15.3	17.8	1%	14.2	17.5	22.2	2%
Motor cycle	11.5	25.2	39.8	58.4	5%	21.1	27.8	31.1	3%	21.4	28.6	32.7	3%
Passenger train	0.1	0.3	0.6	1.5	7%	0.1	0.4	1.3	7%	0.4	1.0	1.9	8%
Freight train	0.1	0.2	0.3	0.8	6%	0.4	0.8	1.4	8%	0.4	0.9	1.9	9%
Passenger plane	3.4	6.4	11.7	26.9	6%	5.4	8.6	16.0	4%	6.3	11.4	25.3	6%
Goods plane	0.1	0.2	0.4	0.9	6%	0.2	0.3	0.5	5%	0.2	0.4	0.8	6%
Passenger ship	0.0	0.0	0.1	0.1	7%	0.0	0.0	0.1	5%	0.0	0.1	0.1	7%
Goods ship	1.8	3.3	6.0	13.5	6%	2.8	4.4	8.0	4%	3.3	5.8	12.5	6%
Total	45.7	83.3	130.4	228.1	5%	69.2	93.2	130.7	3%	75.5	111.8	180.5	4%

As explained previously, both ALT 1 and ALT 2 emphasizes on gas and biofuel optimization such as biodiesel, biogasoline RON 88 and bio aviation fuel to replace conventional fuel such as gasoline RON 88, diesel oil, and avtur (fuel switching). Besides fuel switching, there is also a more aggressive penetration of several energy saving car technology due to the supporting policy. In details, energy conservation and efficiency is implemented in both ALT 1 and ALT 2 as shown in Picture 4.10.

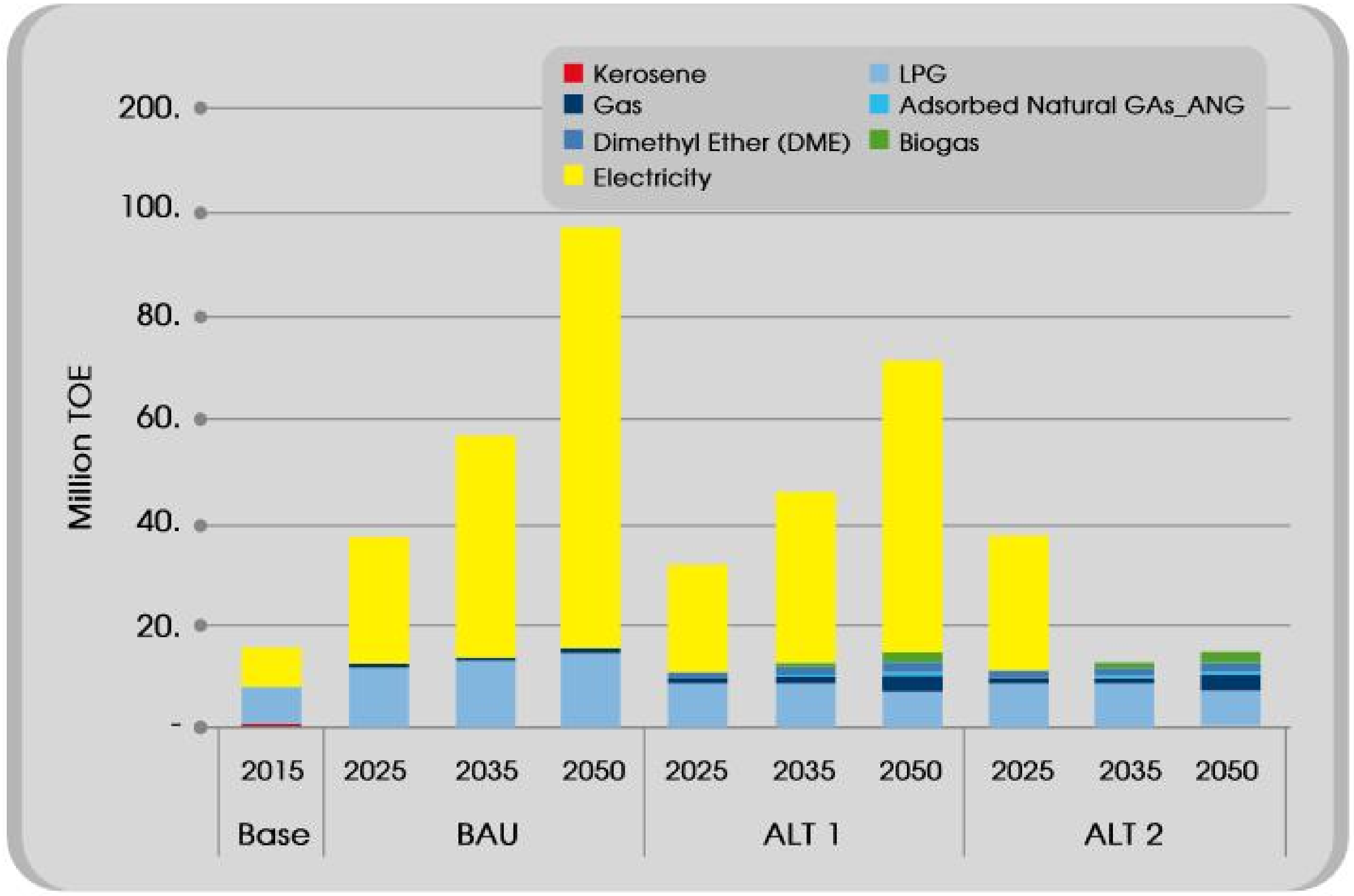


Picture 4.10 Energy Conservation and Efficiency in Transportation

4.1.3 Final Energy Demand in Household

Besides electricity and industry, another major gas consumer is household. Based on energy consumption pattern, energy demand in household is divided into urban dan rural household. Energy in household is used in cooking, lighting, AC, refrigerator, TV and other home appliances such as rice cooker, pump, fan, washing machine and others. Not all household has the same energy demand especially electricity consumption.

Indonesia current electrification ratio is around 87%. Based on the existing policy, the electrification ratio is expected to reach 100% by 2020. The kerosene to LPG conversion program will be 100% completed by 2018.



Picture 4.11 Final Energy Demand in Household by Source and Scenario

BaU, ALT 1 and ALT 2 projected that the final energy demand in household in 2015-2050 would increase at the average growth of 5%, 4% and 5% per year or from 15 million TOE into 97 million TOE, 71 million TOE and 91 million TOE in 2050. During the projection period, energy demand in household will be dominated by electricity with the average growth of 7% (BaU), 6% (ALT 1) and 7% (ALT 2). Electricity share in 2015 was 49%. It will increase into 84% (BaU), 79% (ALT 1) and 84% (ALT 2) by 2050.

LPG for household is predicted to increase despite that it has been started to be replaced by gas, biogas and dimethyl ether. In BaU, LPG demand increases 2% per year while LPG share decreases from 47% in 2015 into 15% in 2050.

In ALT 1 and ALT 2 scenario, LPG demand is relatively constant. In the two alternative scenarios, other energy sources consumed by household such as gas, adsorbed gas, biogas and dimethyl ether strart to replace half of LPG. However, the contribution of this energy is still low of about 10% (ALT 1) and 8% (ALT 2) in 2050 while gas and biogas growth rate reaches 8% and 6%. Dimethyl ether is a new alternative energy for cooking and it is predicted to reach 1 million TOE in 2050. Dimethyl ether to be developed in Indonesia is planned to be derived gas.

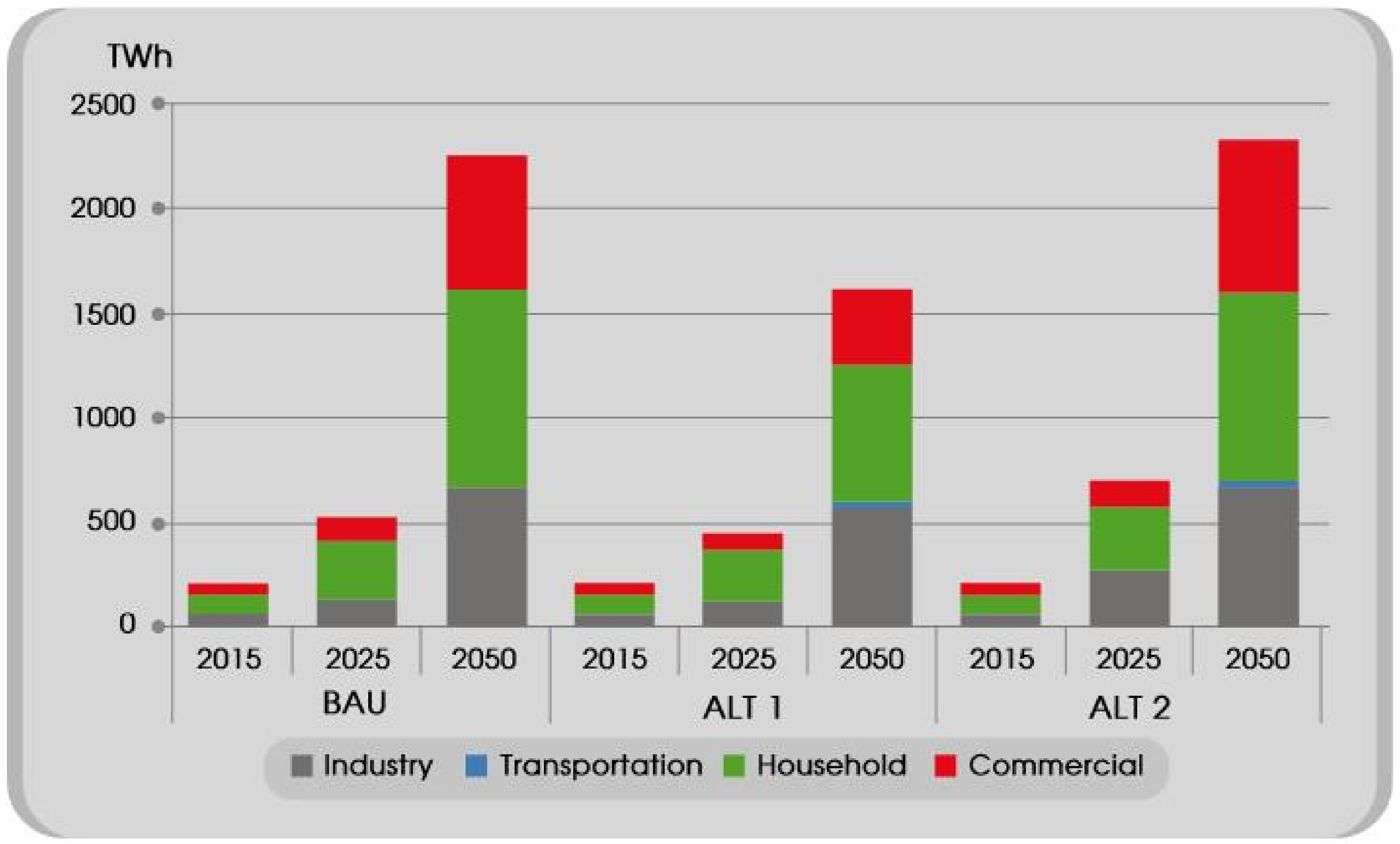
Gas for domestic demand is supplied from domestic gas resources. However, in the future, gas resources are declining and limited. Thus, gas demand should be fulfilled from import in the form of LNG. In this topic, the existing LNG export contract is still continued. However, gas from new gas fields will be prioritizied to meet domestic demand based on Law no 21/2002 on Oil and Gas.

In this Outlook, lighting technology for household that is taken into account is fluorescent lamp (FL) with magnetic and electric ballast, compact fluorescent lamp (CFL) and LED. CFL consumes lower energy of about 25-50% than FL. Meanwhile, LED consumes energy 80% lower than FL. AC in household is limited to middle to upper class household. Most household uses Split Standard AC and gradually uses Split Inverter AC with energy saving technology. TV and refrigerator in household still use older technology namely cathode ray tube (CRT) or liquid crystal display (LCD), while non inverter refrigerator highly consumes energy. It is predicted that the use of energy saving LED TV and inverter refrigerator will increase along with the policy to support this technology.

Every technology has different penetration based on the scenario. Household activity is grouped into urban household, electrified rural household, and unelectrified rural household. In details, energy conservation and efficiency on household is shown in Picture 4.12.

From its demand per capita, projection in BaU shows that power demand is about 1,850 kWh/capita in 2025 and 6,700 kWh/capita in 2050. In ALT 1, power demand is around 1,600 kWh/capita in 2025 and 4,800 kWh per capita in 2050. In ALT 2, power demand per capita is around 2,500 kWh in 2025 and 7,000 kWh in 2050. It shows that power demand per capita with lower growth from the projection in Government Regulation number 79/2014 on National Energy Policy (ALT 1) will be 6% lower than in ALT 2 in 2025 and 77% lower than in 2050.

Based on final consumer sector, household dominates power demand during 2015-2050. However, its share is declining due to the increasing demand from other sectors. Power demand share in household declines from 44% in 2015 to 42% in 2050 in BaU, 41% in ALT 1 and 38% in ALT 2 (Picture 4.42).



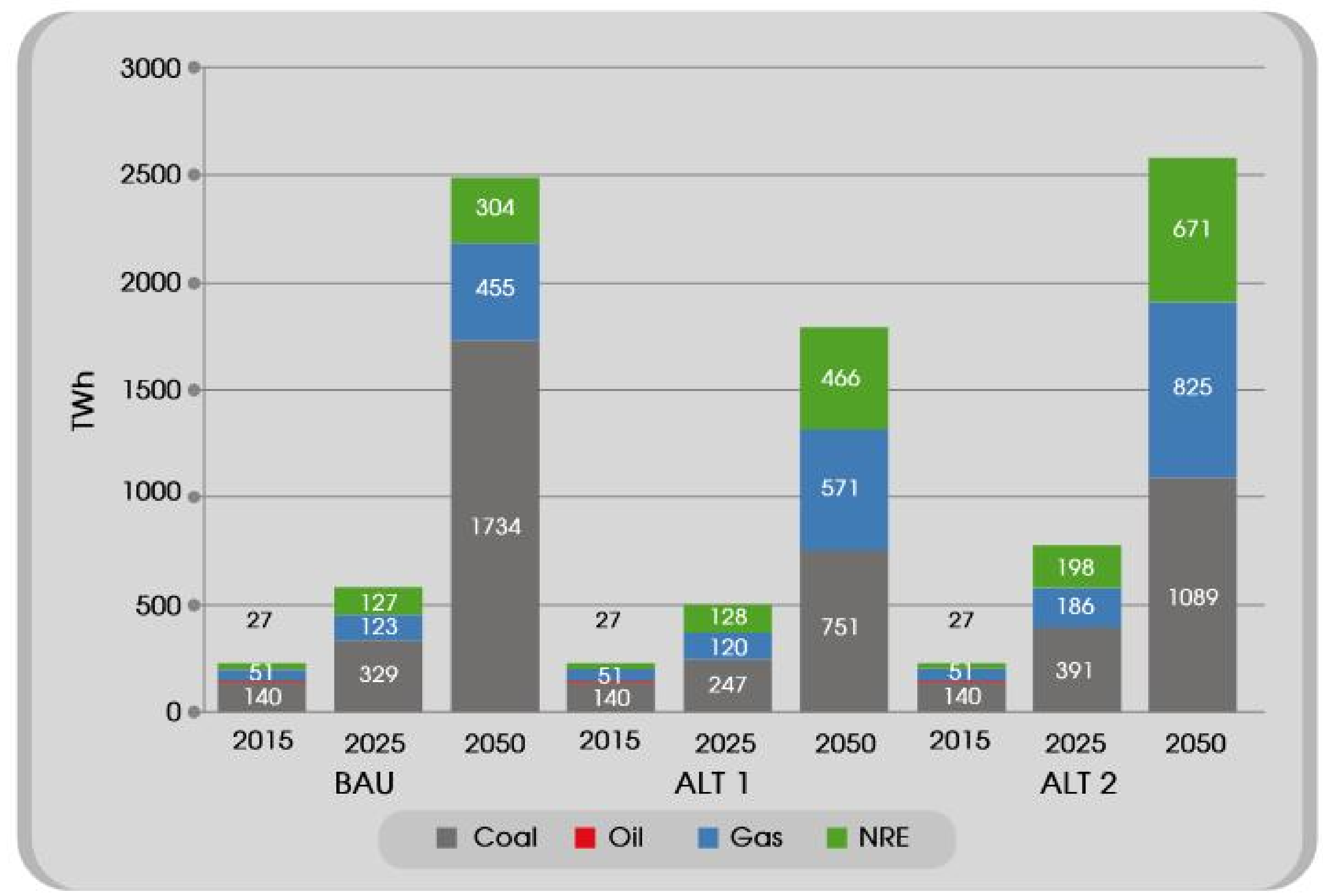
Picture 4.42 Power Demand by Sector

Power demand in industry is the second biggest consumer after household. It is projected that power demand in industry will reach 660 THw in 2050 in BaU and ALT 2 and 570 TWh in ALT 1. Power demand in commercial sector will also increase during projection period with the increasing commercial buildings such as hotels, offices, and malls. Power demand growth in commercial sector us faster that in industry in BaU and ALT 2. In ALT 1 with energy conservation as in ALT 2, power demand is lower since the GDP growth is assumed to be slower. Power demand in transportation is projected based on the electric train transmission development in big cities and intercity express train development.

4.8.2 Power Supply

Power Production

To meet power demand during projection period, it is assumed that the loss in transmission and distribution is 10%. Thus, power production is predicted to increase into 2,500 TWh in 2050 in BaU, 1,800 TWh in ALT 1, and 2,600 TWh in ALT 2 or 10% above power demand. Power production by energy source is shown in Picture 4.43.



Picture 4.43 Power Production by Scenario and Energy Source

Energy source is divided into coal, oil, gas and NRE. Power production from coal fueled power generation is dominant in all scenarios. Coal fueled power generation dominance is the biggest in BaU. In ALT 1 and ALT 2, it is still dominant but with lower share than in BaU since both alternative scenarios has implemented efforts to achieve National Energy Policy mix and NRE utilization.

Power production share from NRE power generation in 20250 reaches 304 TWh (12%) in BaU, 466 TWh (26%) in ALT 1 and 671 TWh (26%) in ALT 2. NRE power generation includes biomass power generation, mill waste power generation, waste power generation, reservoir power generation, ron-off river/mini hydro power generation, solar power generation, wind power generation and geothermal power generation (medium and high temperature). NRE power generation will be discussed in NRE Chapter. Power production from oil fueled power generation is very low. Its share in power production is below 0.1% during projection period. It is based on the plan not to build oil fueled power generation and diesel to NRE power generation substitution especially in remote and frontier areas.

Power production from gas fueled power generation contributes 23% to the energy share in 2015. In BaU, power share from gas fueled power generation will be 21% in 2025 and 18% in 2050. It is due to the slowing power production growth from gas fueled power generation compared to coal fueled power generation. In ALT 1 and ALT 2 with efforts to achieve National Energy Policy mix, power production share from gas fueled power generation increases into 24% in 2025 and 32% in 2050 for ALT 1 and ALT 2.

Power Generation Capacity

The option to choose power generation to produce power during projection period is based on least cost or cost effective principles. The least cost is achieved by minimizing net present value of all power supply cost consisting of investment, fuel, operation and maintenance cost. This principle is also applied by PT PLN in formulating RUPTL (Power Supply Business Plan). This principle is different as in Indonesia Energy Outlook 2016. This principle is applied by accomodating capacity addition as formulated in RUPTL 2016-2025 and in National Energy General Plan.

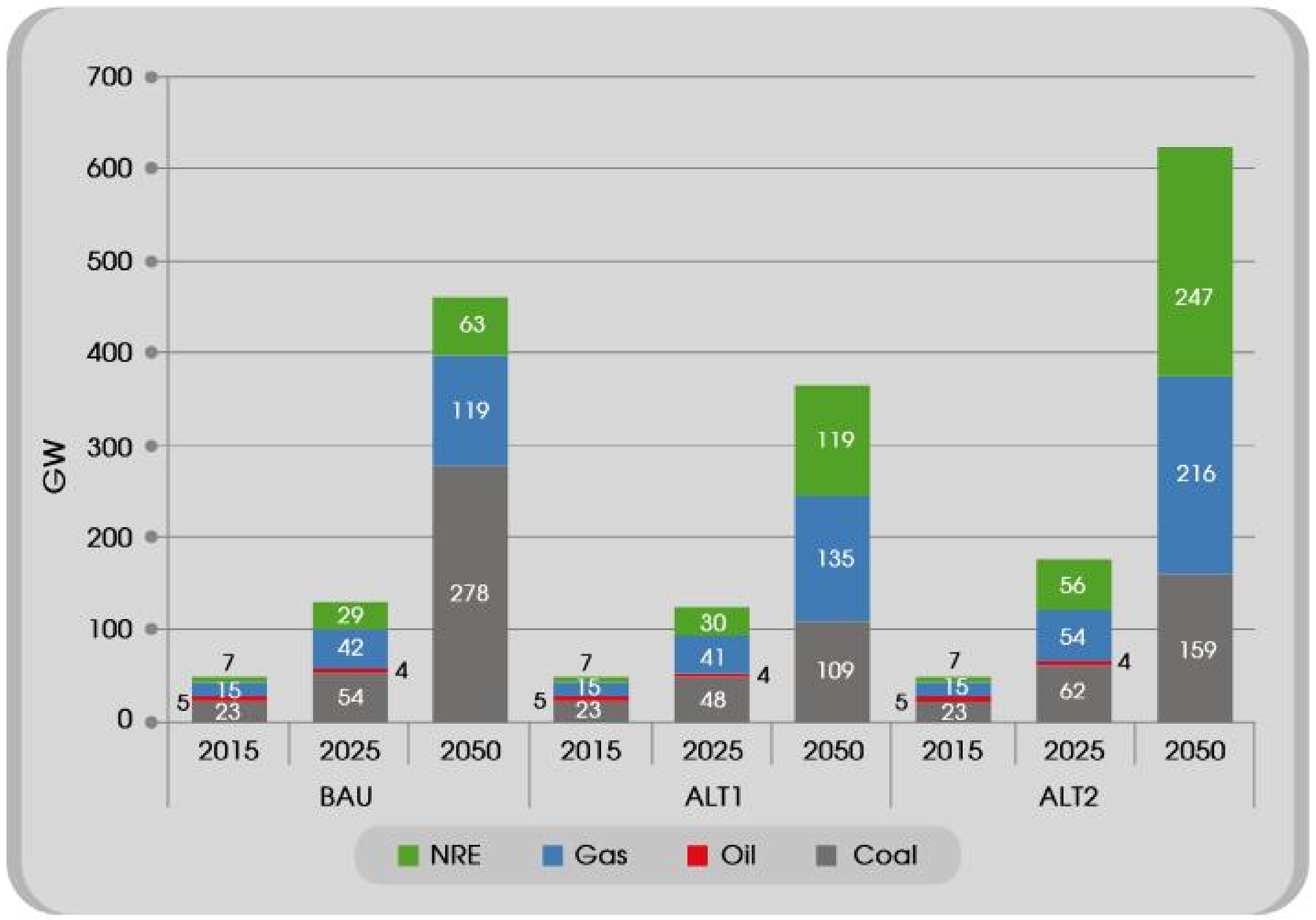
Table 4.8 shows cost and efficiency assumption in Balmorel model. This assumption is the average of technologies in IEA technology database, World Energy Outlook (WEO), 2015.

Table 4.8 Cost and Efficiency Data of Power Generations

Power Plant	Investment cost (thousand USD/MW)	Fixed Cost O&M (thousand USD/MW)	Variable Cost O &M (USD/MWh)	Fuel Efficiency	Availability/ Capacity Factor
Biomass Power Generation	2,300	97	6.5	32%	80%
Coal Steam Power Generation	1,000	35	3.8	34%	72%
SC Coal Steam Power Plan	1,200	48	3.8	38%	80%
USC Coal Steam Power Plan	1,400	56	3.8	42%	80%
Diesel Fueled Power Generation	400	28	3.8	37%	80%
Gas Engine Power Generation	400	28	3.8	42%	80%
Gas Fueled Power Generation	400	20	3.8	34%	80%
Gas and Steam Fueled Power Generation	700	25	3.8	55%	80%
Geothermal Power Generation	2,300	40	0.7	25%	80%
Hydro Power Generation	2,300	54	3.8	25%	41%
Micro Hydro Power Generation	3,100	61	3.8	25%	46%
PS	1,000	54	3.8	95%	80%
Solar Power Generation	1,800	23	0.4	25%	15-19%
Wind Turbine Power Generation	1,400	37	0.8	25%	15-40%

In BaU, power demand is supplied from coal power generation. The total installed capacity in coal fueled power generation will reach 54 GW in 2025 and 278 GW in 2050. Gas fueled power generation and NRE power generation contribues the same amount in total power production in 2025. However, the total installed capacity will be different of about 42 GW for gas power plant and 29 GW for NRE power generation. The oil fueled power generation capacity is about 4 GW.

The total power generation capacity is about 130 GW in 2025. In 2050, it increases into 460 GW in which 60% of it is coal fueled power generation capacity. Gas power generation capacity is 119 GW and NRE power generation capacity is 63 GW. The total oil power generation capacity is only 31 MW with the assumption that there will be no additional oil power generation capacity after 2020 except in remote and frontier areas (Picture 4.44).



Picture 4.44 Power Generation Total Capacity by Scenario and Energy Source

In ALT 1, power demand is lower than in BaU due to energy conservation and other efforts to achieve the target in National Energy Policy mix. Thus, the total power capacity to produce power will be lower too of about 123 GW in 2025 and 364 GW in 2050. From the total capacity in 2015, 48 GW (39%) is coal fueled power generation capacity, 41 GW is from gas fueled power generation capacity, 30 GW is from NRE power generation capacity, and 4 GW is from oil fueled power generation capacity. In 2050, power demand will be supplied from 135 GW of gas fueled power generation, 119 GW of NRE power generation, 109 GW of coal fueled power generation, and only 28 MW of oil fueled power generation.

ALT 2 assumed that National Energy Policy mix achievement is the same as in ALT 1 but with higher GDP growth. As the result, power demand is higher than in ALT 1 but with lower role of coal fueled power generation in order to meet NRE target in National Energy Policy mix. The total capacity of all power generations is around 177 GW in 2025 and the total coal power generation is 62 GW (35%). Other contribution is 54 GW from gas fueled power generation, 56 GW from NRE power generation, and 4 GW from oil fueled power generation. In 2050, the total capacity is 622 GW derived from 278 GW (40%) of NRE power generation, 216 GW (35%) from gas fueled power generation, and 159 GW (25%) from coal fueled power generation.

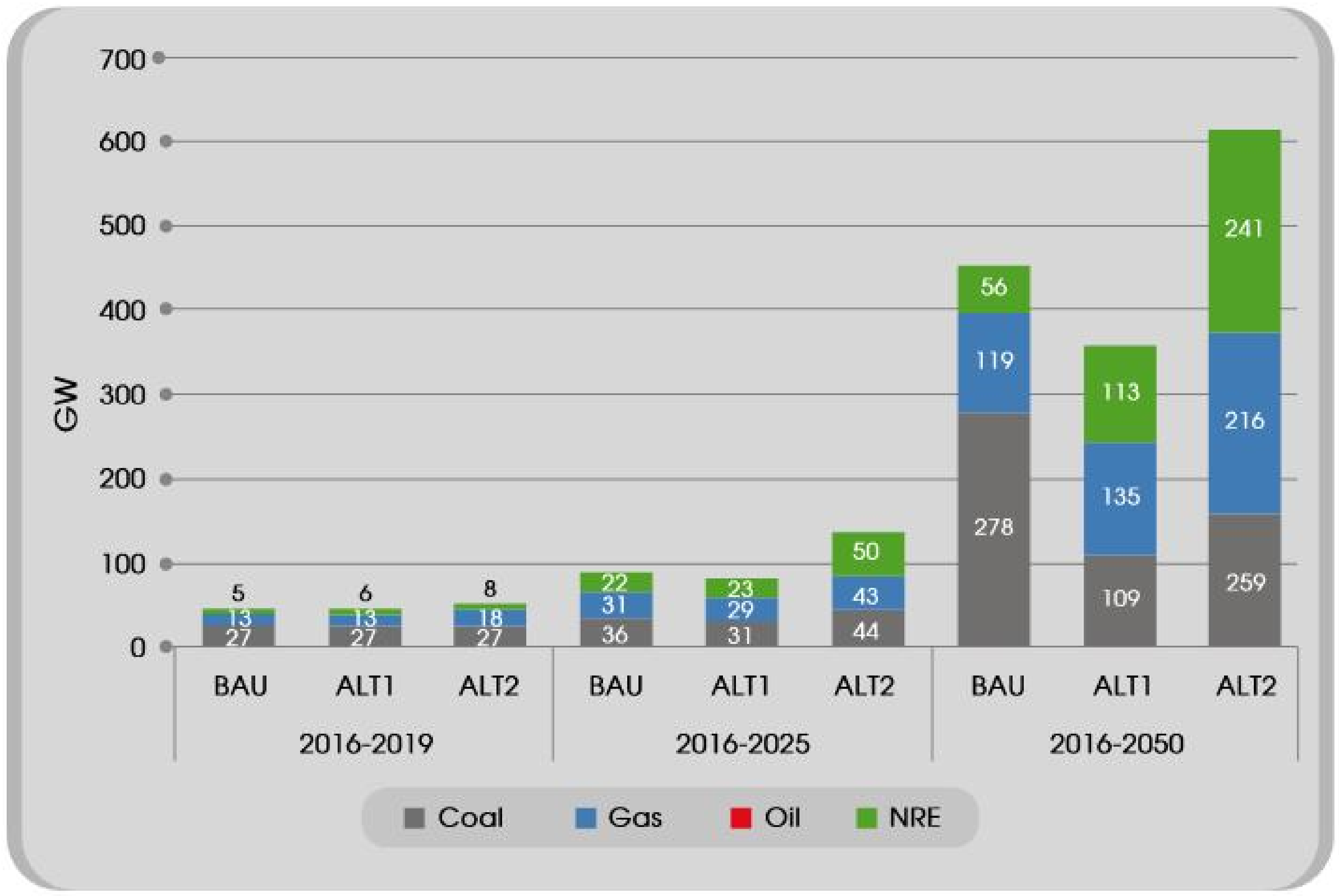
4.8.3 Power Capacity Addition

The development of power generation and its transmission and distribution network require major investment. The previous part shows the total power generation installed capacity during the projection period. Half of it has been operating since 2015 while the rest is the new power generation installed capacity. It should be noted that not all installed capacity which has been operating since 2015 will be available in the end of projection year. Thus, the residual capacity from power generations needs to be calculated during the projection period. Generally, the lifetime of the new power generation is assumed to be around 30 years.

Additional Power Generation during Projection Period

Based on the result in Balmorel model, the total additional power capacity during 2016-2050 is around 454 GW in BaU. Around 61% from the total additional capacity is derived from coal fueled power generation while the share of gas fueled power generation is around 26%. The rest is derived from NRE power generation. Small amount of it is from diesel fueled power generation to meet power demand in frontier and remote areas.

In ALT 1, power demand is lower. Thus, its additional power capacity is omly 358 GW. However, this scenario also covers efforts to achieve target in National Energy Policy mix. It means that additional capacity from coal power generation will be lower than gas or NRE power generation. ALT 2 is similar to in ALT 1 but with higher GDP growth. The total additional capacity is around 616 GW in which around 39% is additional capacity from NRE and 35% is from gas. Coal fueled power generation will add its capacity of 159 GW during the projection period. The additional power generation capacity is shown in Picture 4.48.



Picture 4.45 Power Generation Additional Demand during Projection Period

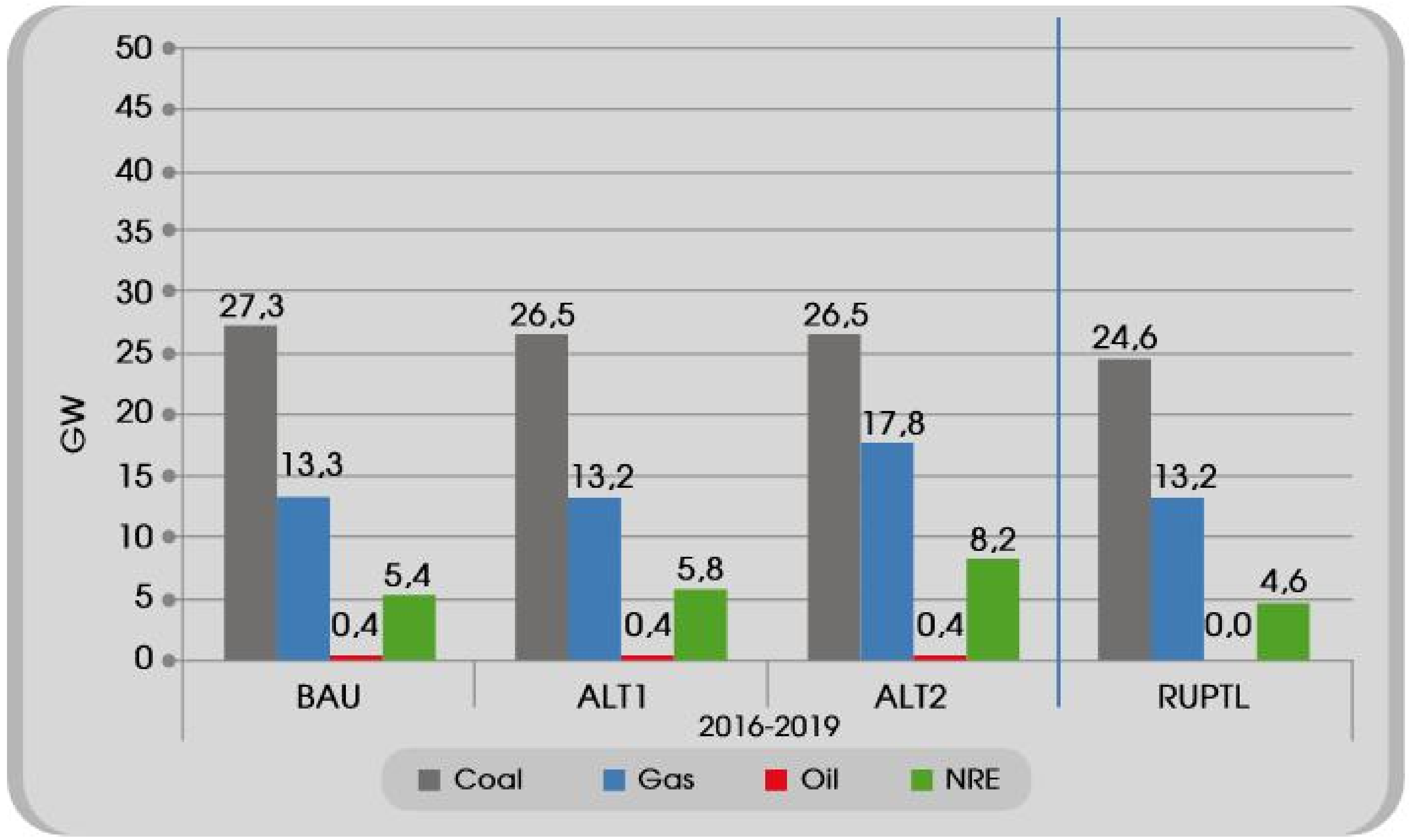
If it only considers 2016-2025 period, then the additional power generation capacity is around 90 GW for BaU, 83 GW for ALT 1, and 137 GW for ALT 2.

Additional Power Generation during 2016-2019

For the period of 2016-2019, additional power generation is around 46.4 GW in BaU, 45.9 GW in ALT 1, and 52.9 GW in ALT 2. It is predicted that the total power generation capacity will reach 96 GW in the end of 2019 from 50 GW in 2015 for BaU and ALT 1. For ALT 2, the total power generation capacity will increase into 103 GW.

In MEMR Strategic Plan 2014-2019, the total power generation capacity in the end of 2019 will be 96.5 GW from 53 GW in 2014. It shows additional capacity of 42.9 GW during 2015-2019 in which 35.5 GW is a new project and 7.4 GW is existing project. In RUPTL 2016-2025, the additional power generation capacity until 2019 is 42.61 GW. With the total power generation capacity in 2015 of 48 GW, then the addition of around 43 GW will increase the national power capacity on 91 GW.

Additional capacity in Indonesia Energy Outlook 2016 for BaU and ALT 1 is similar to MEMR Startegic Plan 2014-2019 and fairly higher than in RUPTL 2016-2019. As explained earlier, the difference in Indonesia Energy Outlook 2016 is that the power demand projection reaches 310 TWh in 2019 in BaU and 294 TWh in ALT 1, while in RUPTL 2016-2025 is 292 TWh. The detail of additional power generation capacity until 2019 by power generation for each scenario and RUPTL 2016-2025 can be seen in Picture 4.46.



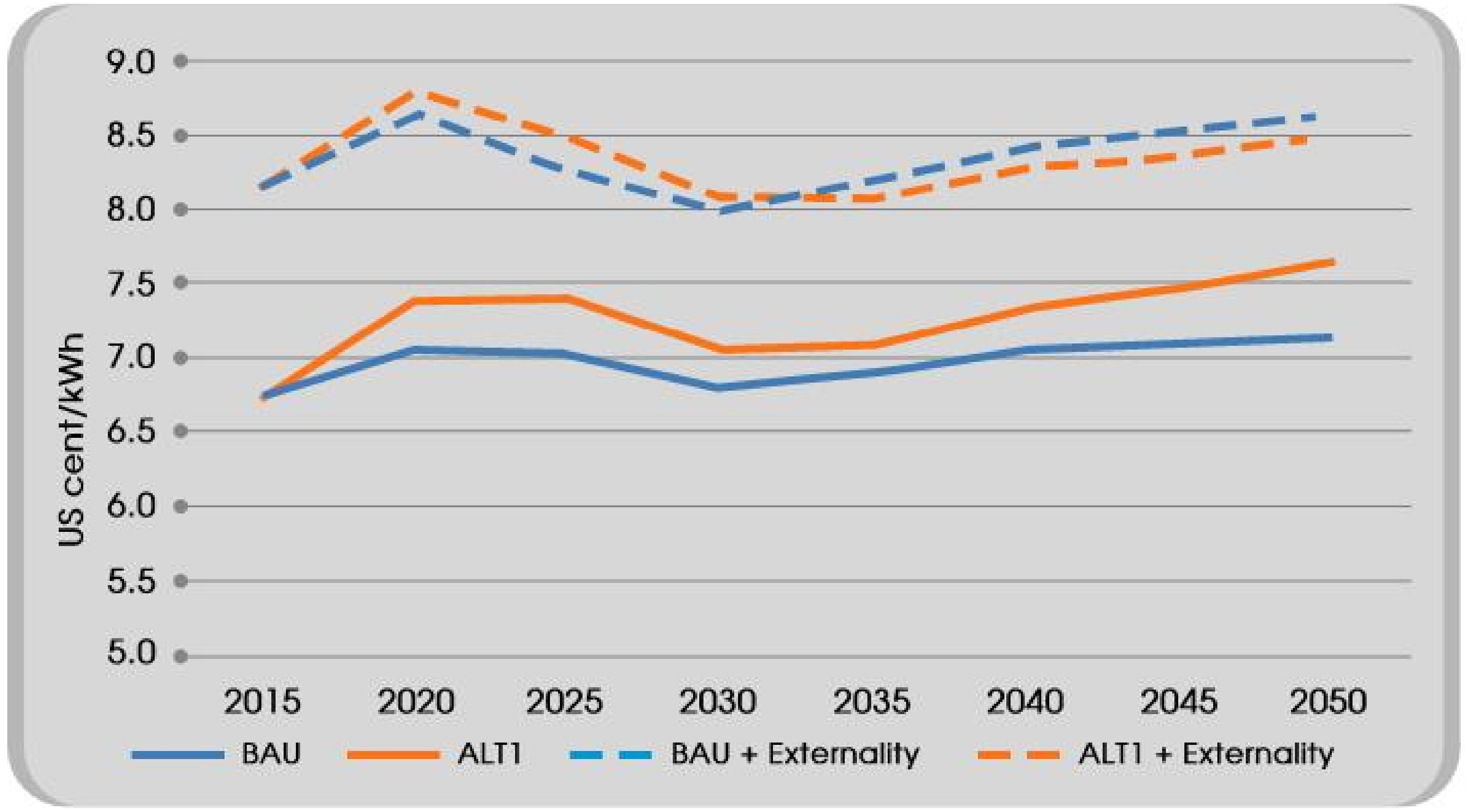
Picture 4.46 Additional Power Generation Demand 2016-2019

As seen above, the biggest additional power generation is coal fueled power generation followed by gas and NRE power generation. Between BaU and ALT 1, additional coal power generation is higher than in BaU, while additional NRE power generation is higher in ALT 1. It is due to the efforts to achieve target in National Energy Policy in ALT 1 compared to in BaU. Additional capacity is higher in ALT 2 since GDP is assumed to be higher than in ALT 1. Thus power demand is higher as well but with the same National Energy Policy target achievement.

4.8.4 Electricity Price

The shown price is the projection of electricity price which is affordable for public. But it can not be the reference for consumer (household, industry and others). The reason is the consideration of tax and electricity subsidy, fuel, emission, and others. Externality includes local pollution cost which affect public's health. It can be assumed that local emission will make people to be vulnerable to illness. It also resulted in hospital cost and production period decline. External costs are cost borned by people. External cost calculation is applied in BaU and ALT 1.

The variables which influence electricity price calculation include fuel cost, capital cost, operation and maintenance cost, and externality cost. Electricity cost in ALT 1 is higher than in BaU since ALT 1 is encouraged to meet NRE utilization taget in power generation. Though electricity price in fossil fuel power generation is relatively lower, it will increase externality cost in the future which affect the increasing electricity price (Picture 4.47).



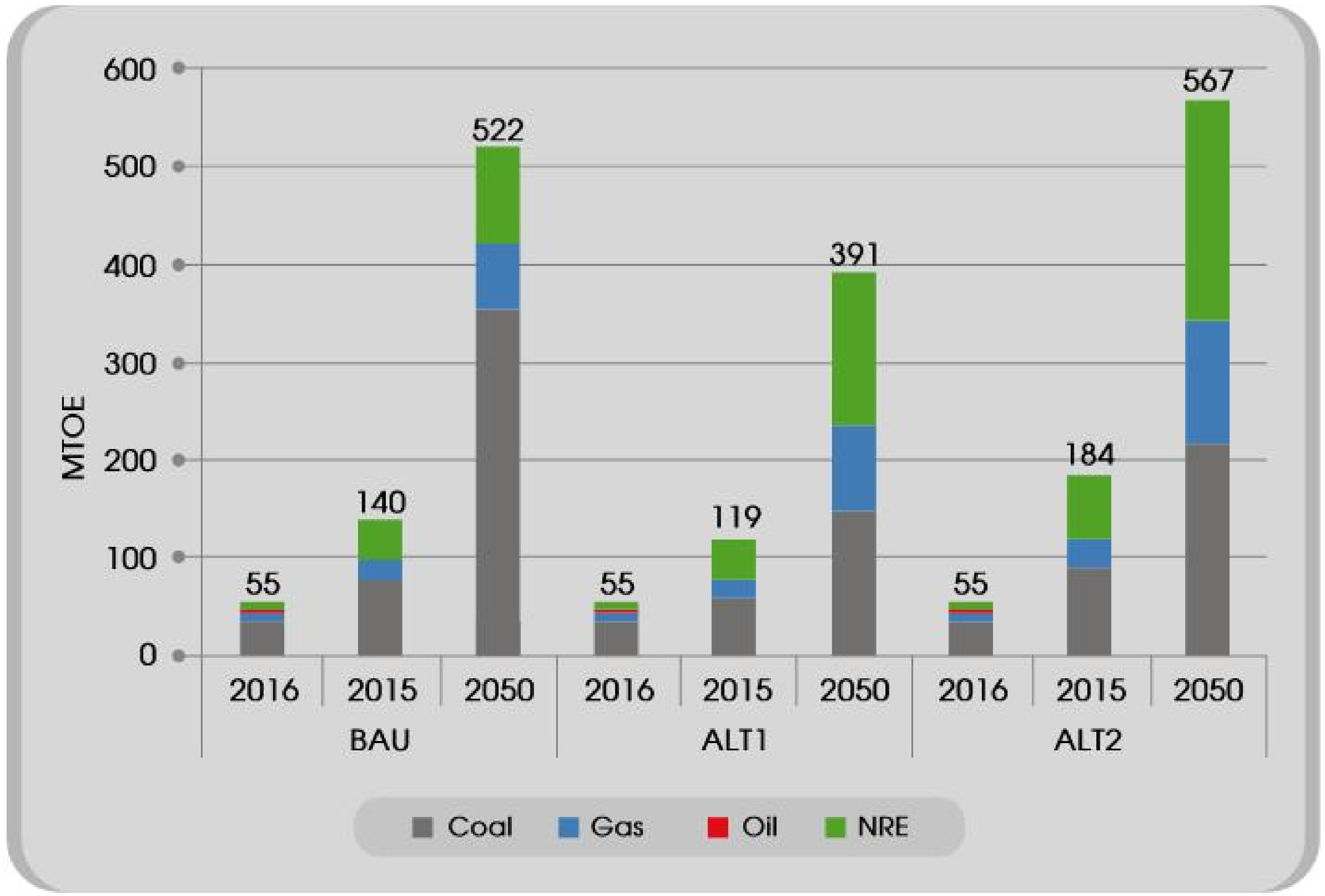
Picture 4.47 Electricity Price 2015-2050

4.8.5 Power Fuel Demand

Fuel demand in power generation will reach 140 MTOE in 2025 in BaU consisting of 78 MTOE of coal, 43 MTOE of NRE, and 19 MTOE of gas. In 2050, the total power generation fuel demand increases into 522 MTOE in which coal dominates 67% from the total demand. Meanwhile, gas contributes 13% and NRE contributes 19%. For oil, its percentage may be ignored but oil is still needed to operate diesel power generation in frontier and remote areas as chosen by Balmorel.

In ALT 1, power generation fuel demand will be lower of about 199 MTOE in 2025 and 391 MTOE in 2050. High GDP growth as in ALT 2 will produce high fuel demand. However, in both scenarios which cover National Energy Policy mix assumption, NRE share increases in a more significant total power generation fuel demand than gas.

In 2025, NRE and gas share in ALT 1 and ALT 2 is relatively the same of 35% and 16%. Based on its fuel demand, NRE reaches 42 MTOE while gas reaches 19 MTOE in ALT 1. In ALT 2, NRE demand reaches 64 MTOE while gas demand reaches 29 MTOE. In 2050, NRE share reaches 40% (157 MTOE), while gas share reaches 22% (86 MTOE) in ALT 1. In ALT 2, NRE and gas share is similar to as in ALT 1. Meanwhile, gas demand share shows 222 MTOE for NRE and 125 MTOE for gas. The increasing NRE and gas share in total power generation fuel demand will decline coal share from 64% in 2015 into 49% in 2025 in 2025 and 38% in 2050. The volume of fuel for power generation during projection period is shown in Picture 4.48.

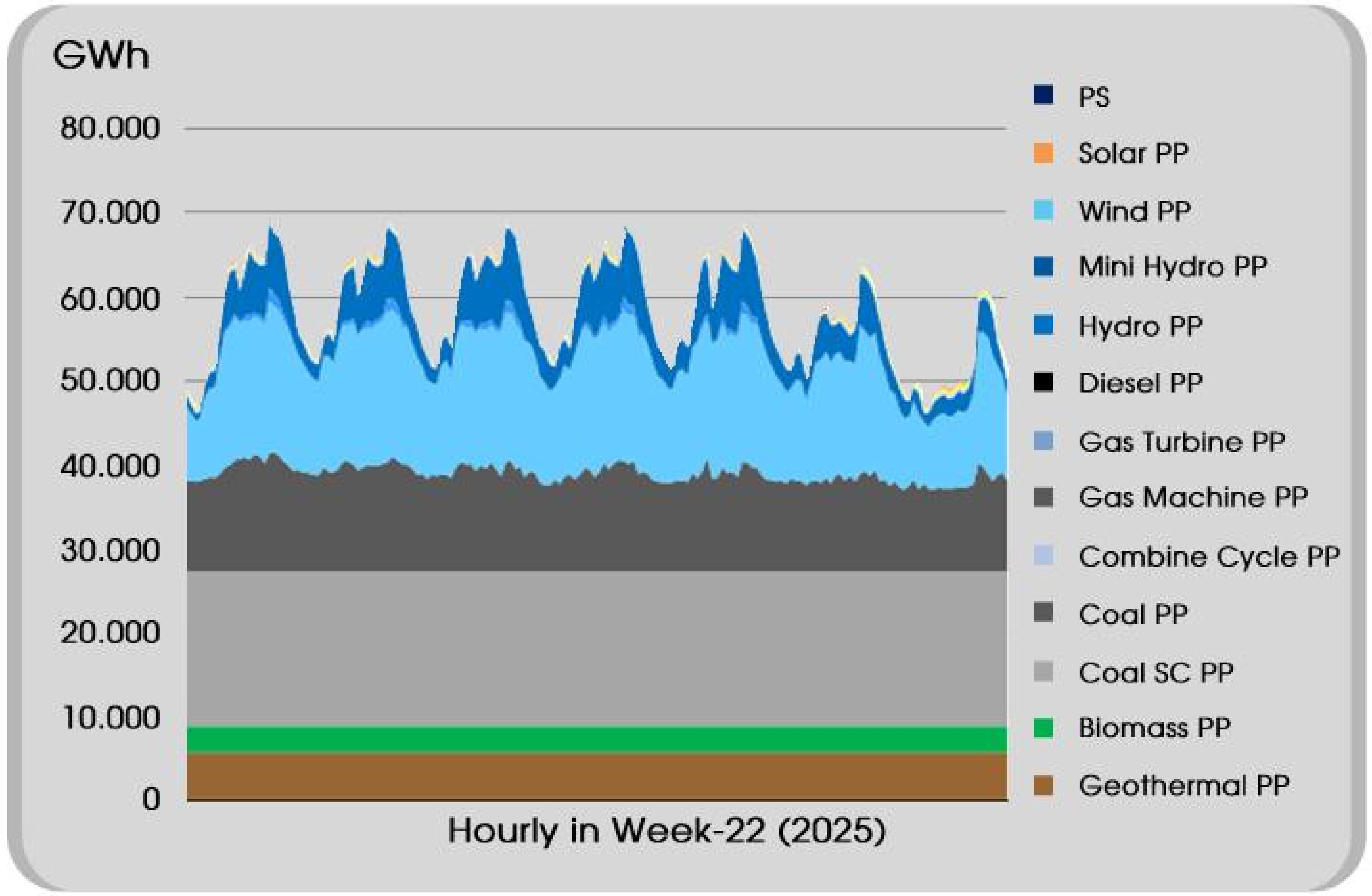


Picture 4.48 Power Generation Fuel Demand

4.8.6 Weekly Power Generation

Balmorel electricity model as any other models differentiates time in year into several time slices which accommodate certain characteristic of an energy system such as electricity load structure, variation in energy demand pattern and electricity production from NRE (hydro, solar, wind and others). In this case, Balmorel differentiates time in year based on week (52 weeks/year) and hour (168 hours/week).

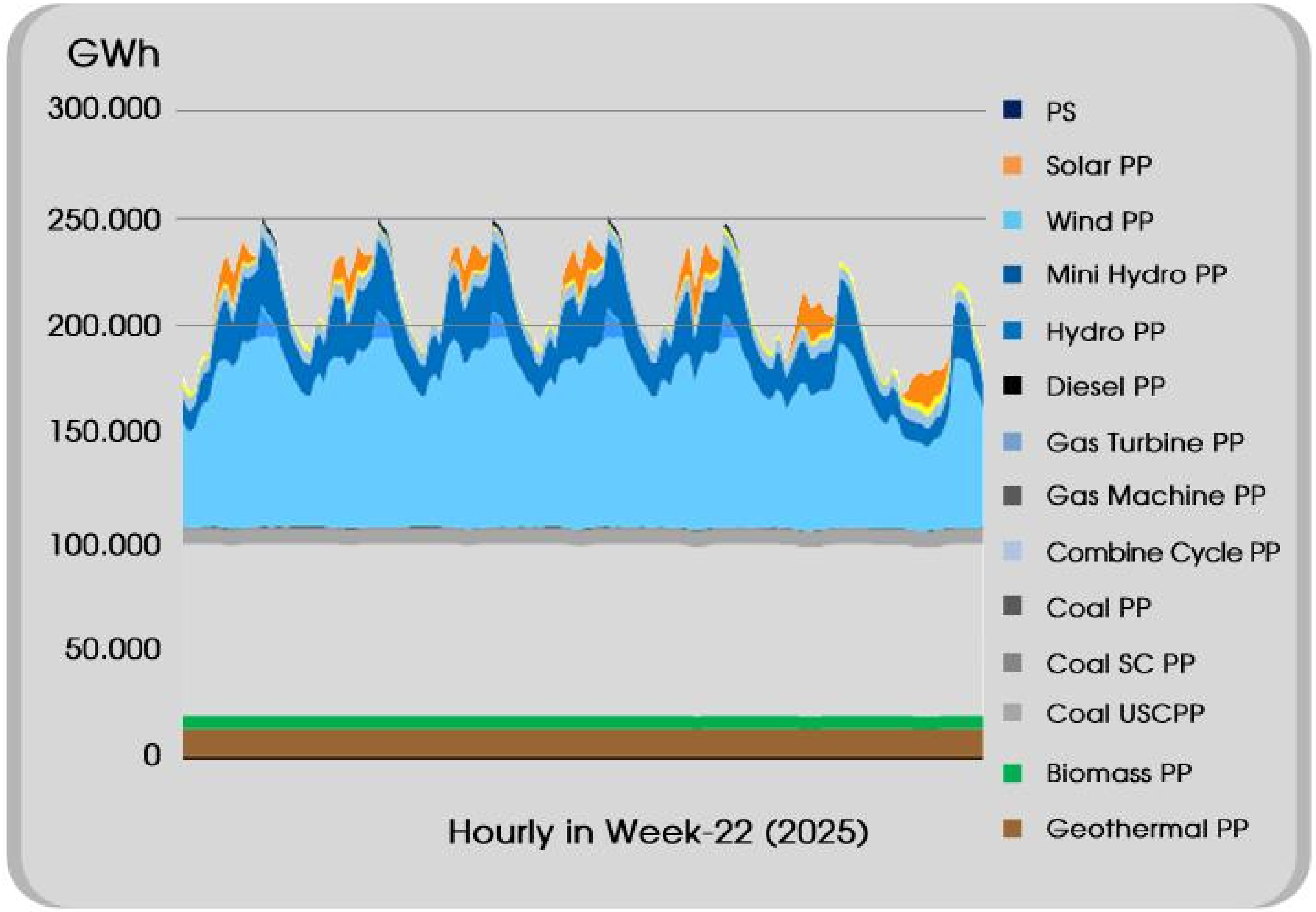
Picture 4.49 shows electricity production from various power generation in supplying electricity demand in the 22nd week (first week of June) in 2025 for ALT 1. The graphic shows that coal power generation (conventional and super critical), biomass power generation and geothermal power generation will always operate in the 22nd week in constant production level. Gas power generation is more flexible in its production. Thus, it can be adjusted with demand level depending on gas price. Hydro power generation is not only flexible in production, but it can also produce fast as long as there is adequate water in reservoir.



Picture 4.49 Power Production Week 22 Year 2025

Wind and solar power generation only produces electricity in certain locations and they depends on weather condition. Their output is also varied. In the week 22 year 2025, wind power generation always produces electricity but the production is very low and fluctuating. The production from solar power generation is lower and it does not always produce electricity in week 22. The pumped storage power generation is only to meet peak load demand.

In week 22 year 2050, power demand is increasing up to 32.4 TWh. With the assumption that this demand can be fulfilled from domestic production, then we need 36 TWh. Picture 4.50 shows the production of various power generations to meet power demand in week 22 year 2050.



Picture 4.50 Power Production Week 22 Year 2050

Similar to in 2025, coal, biomass and geothermal power generation reaches its higher but constant production during week 22. The same pattern also occurs in gas and hydro power generation.

Solar and coal production in week 22 year 2050 increases significantly. With only production in certain hours in a day, solar power generation will contribute to meet midday peak load in week 22. Pumped storage power generation is to meet peak load demand as in 2025 but with bigger quantity.

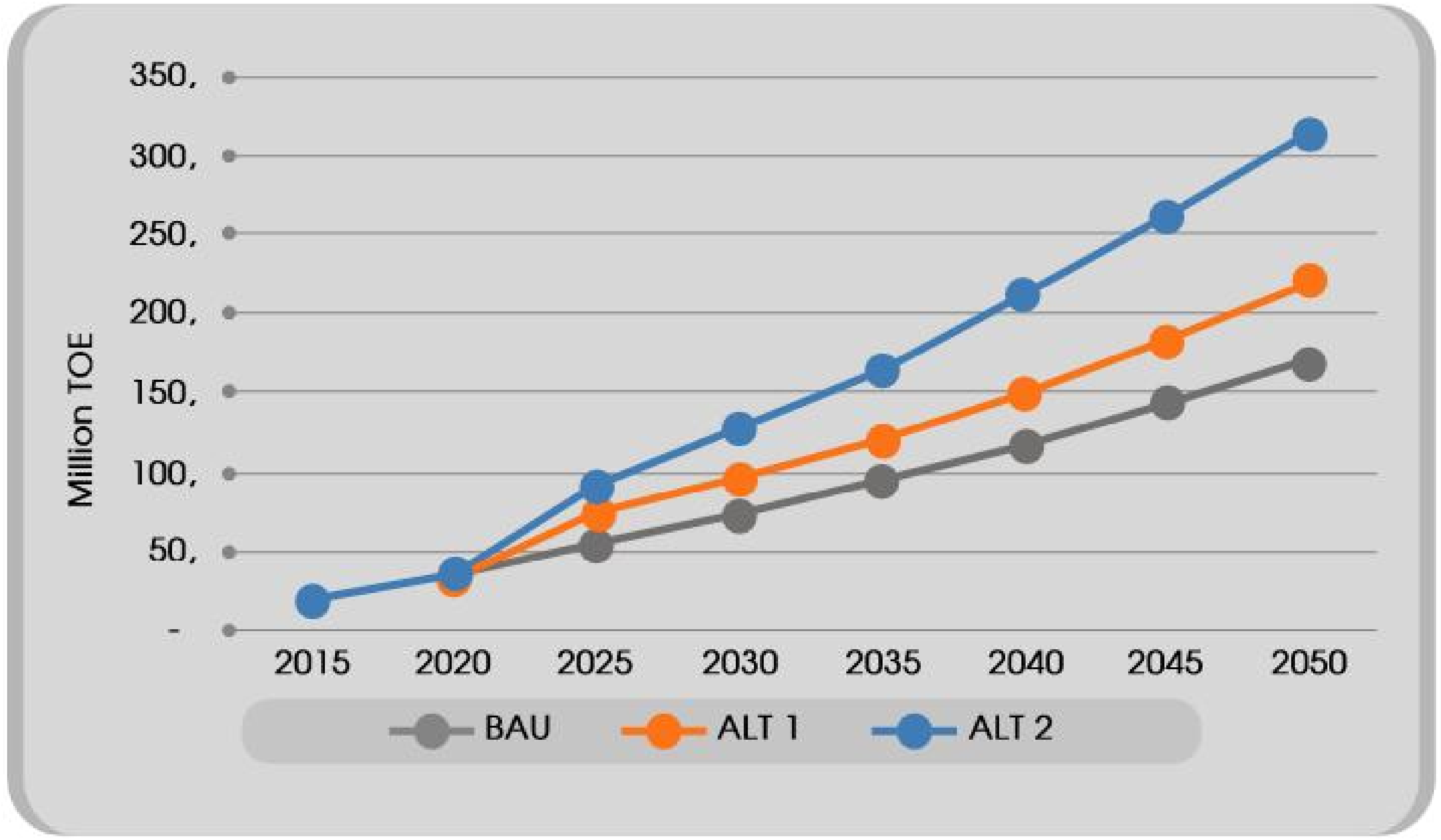
4.9 New Renewable Energy Outlook

4.9.1 NRE Supply

NRE consists of solar, wind, hydro, ocean, geothermal, biodiesel, bioethanol, commercial biomass including agriculture and household waste, but it excludes traditional biomass for household. NRE is categorized into two groups, namely as energy source for power generation and as energy source to replace oil fuel.

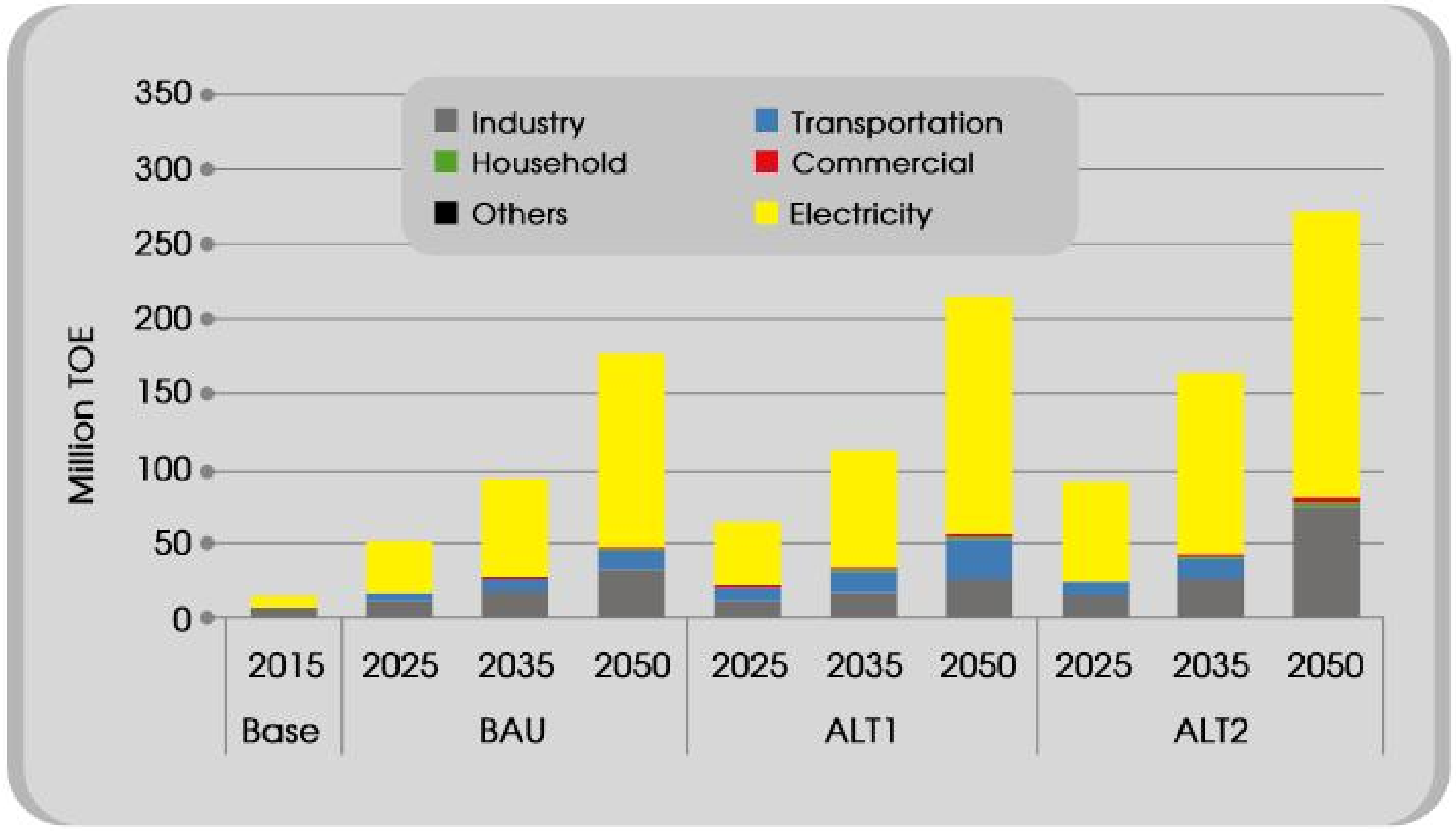
NRE is developed and optimized by changing the mindset that NRE is no longer an alternative energy for fossil fuel but NRE is a national energy supply. Its share is 23% in 2025 and 31% in 2050 based on Government Regulation number 79/2014 on National Energy Policy. Nuclear potential is not included in NRE target achievement projection.

In BaU, NRE supply increases from 16 million TOE in 2015 into 49 million TOE in 2025 and 170 million TOE in 2050 or 7.1% per year. NRE supply for ALT 1 increases into 64 million TOE in 2025 and 215 million TOE in 2050 or grows 7.8% per year. ALT 2 could not be compared to BaU and ALT 1 where NRE supply increases into 93 million TOE in 2025 and 308 million TOE in 2050 (Picture 4.51).



Picture 4.51 NRE Supply

NRE contribution in industry, transportation, household, commercial, electricity and other sectors is shown in Picture 4.52.

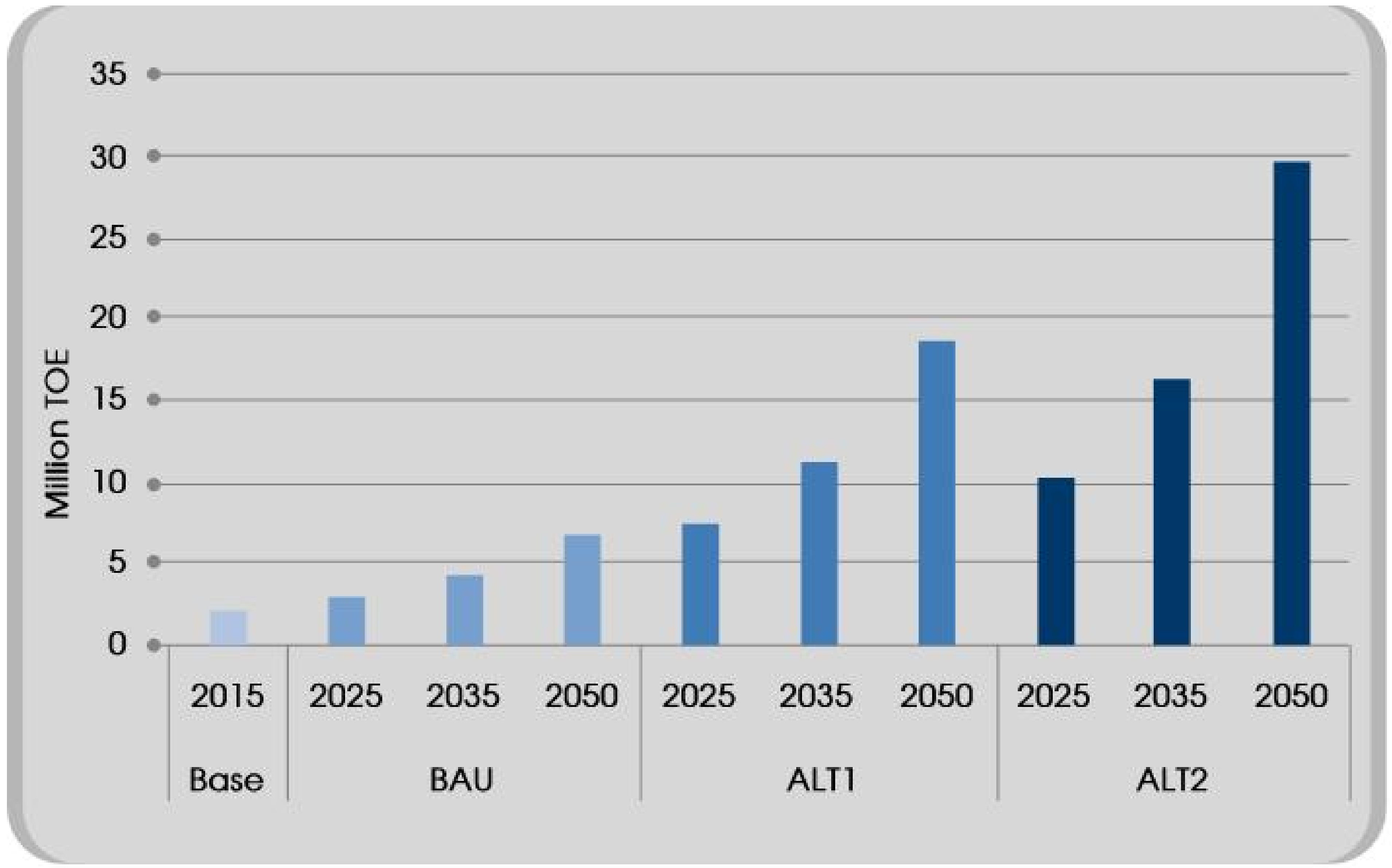


Picture 4.52 NRE Demand by Sector and Scenario

NRE supply in ALT 1 and ALT 2 is higher than in BaU since NRE demand is increasing in industry, transportation, household, commercial, electricity, and other sector. In 2025 based on ALT 1, NRE share is 17% in industry, 13% in transportation, 4% in household, 5% in commercial, and 28% in other sectors. NRE share by sector will increase along with the increasing target of biofuel mandatory.

4.9.2 Biodiesel and Bioethanol Demand

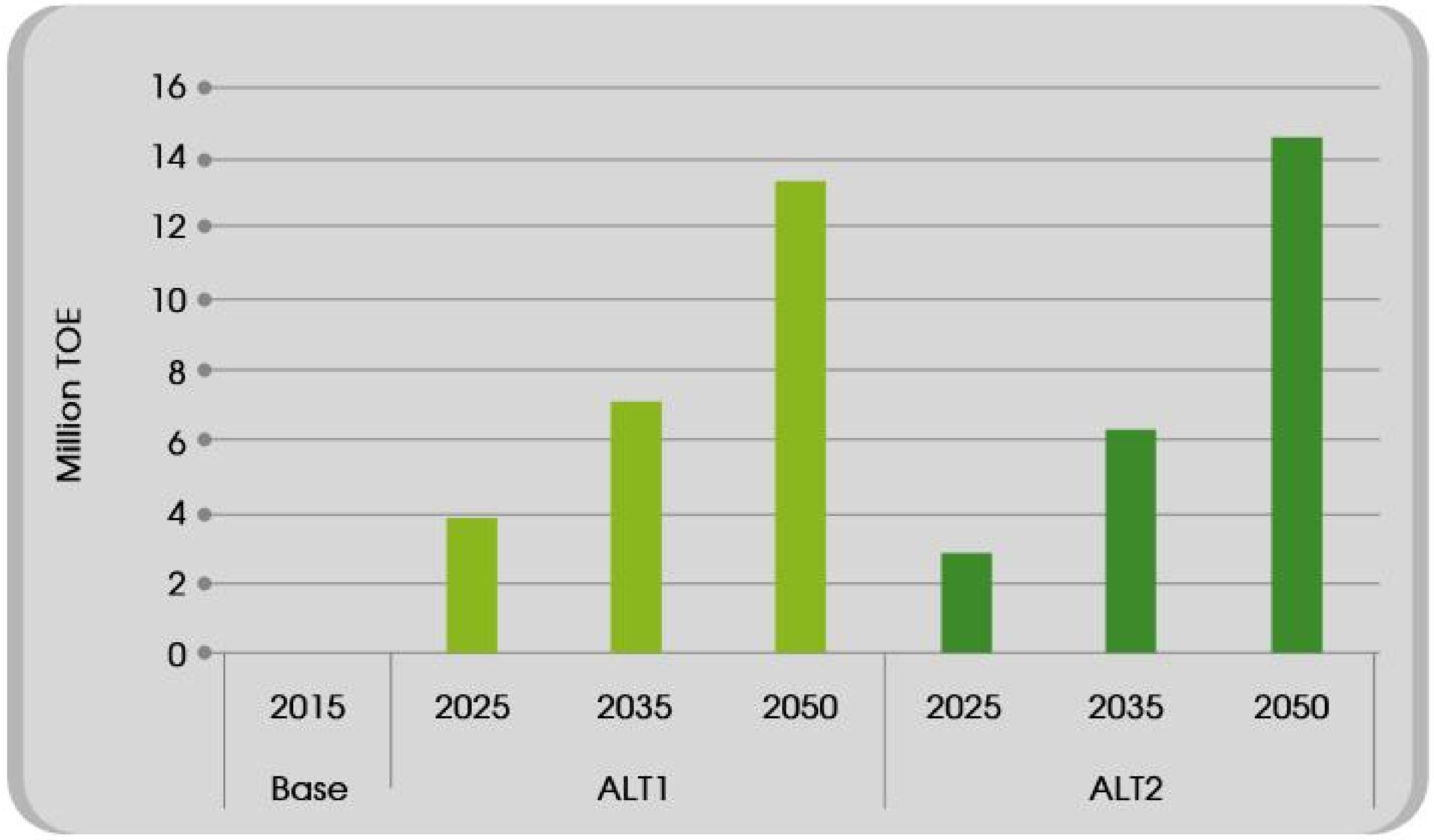
Biodiesel and bioethanol in all sector in all scenarios is shown in Picture 4.53 and 4.54.



PIcture 4.53 Biodiesel Demand Development by Scenario

In BaU, biodiesel demand will grow 5.6% per year from 1.9 million TOE in 2015 into 5.7 million TOE in 2025 and 12.8 million TOE in 2050. Besides that, based on ALT 1, biodiesel demand will grow 6.4% per year from 1.9 million TOE in 2015 into 7 million TOE in 2025 and 16.4 million TOE in 2050.

In ALT 2 with higher assumption, biodiesel will grow 7.8% per year from 8.9 million TOE in 2025 and 25.9 million TOE in 2050. Biodiesel (B100) as the mixture in diesel is applied in all scenarios with 15% mixture in 2015 and 30% mixture in 2020.



Picture 4.54 Bioethanol Demand Development by Scenario

Bioethanol (E100) as the mixture of gasoline (gasoline RON 88 abd pertamax) is projected in all scenarios with the mixture percentage as in MEMR mandatory of 2% in 2016 and 20% in 2025 until the end of projection. Bioethanol growth average for each scenario is 10% in ALT 1 per year and 12% in ALT 1 with higher GDP growth assumption.

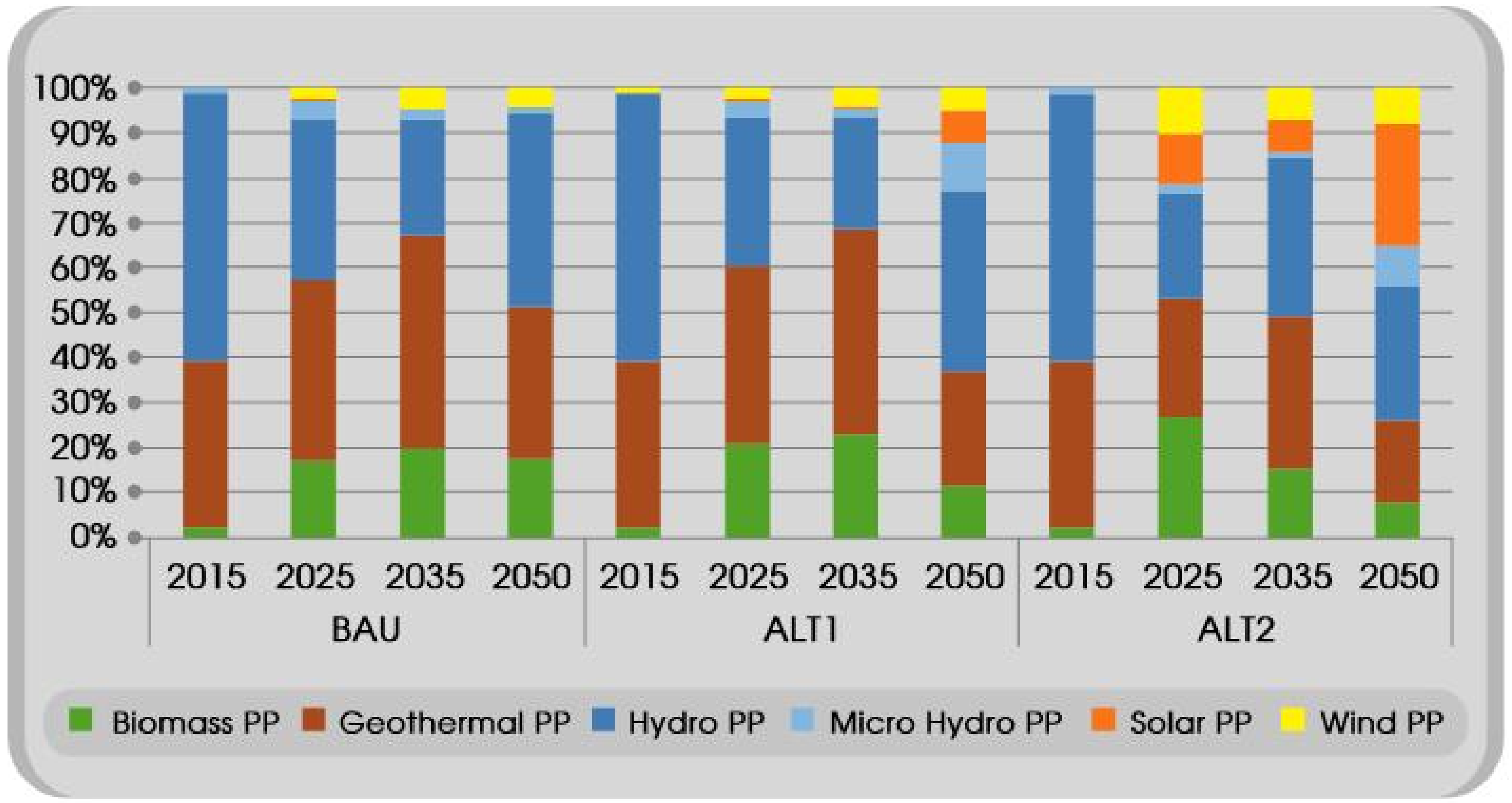
Bioethanol is not yet calculated in BaU. It is different with ALT1. Bioethanol utilization in 2015 is not implemented. Its demand increases 3.8 million TOE in 2025 and 13.4 million TOE in 2050.

In ALT 2, bioethanol is predicted to increase into 2.8 million TOE in 2025 and 14.6 million TOE in 2050.

4.9.3 NRE Demand for Power Generation

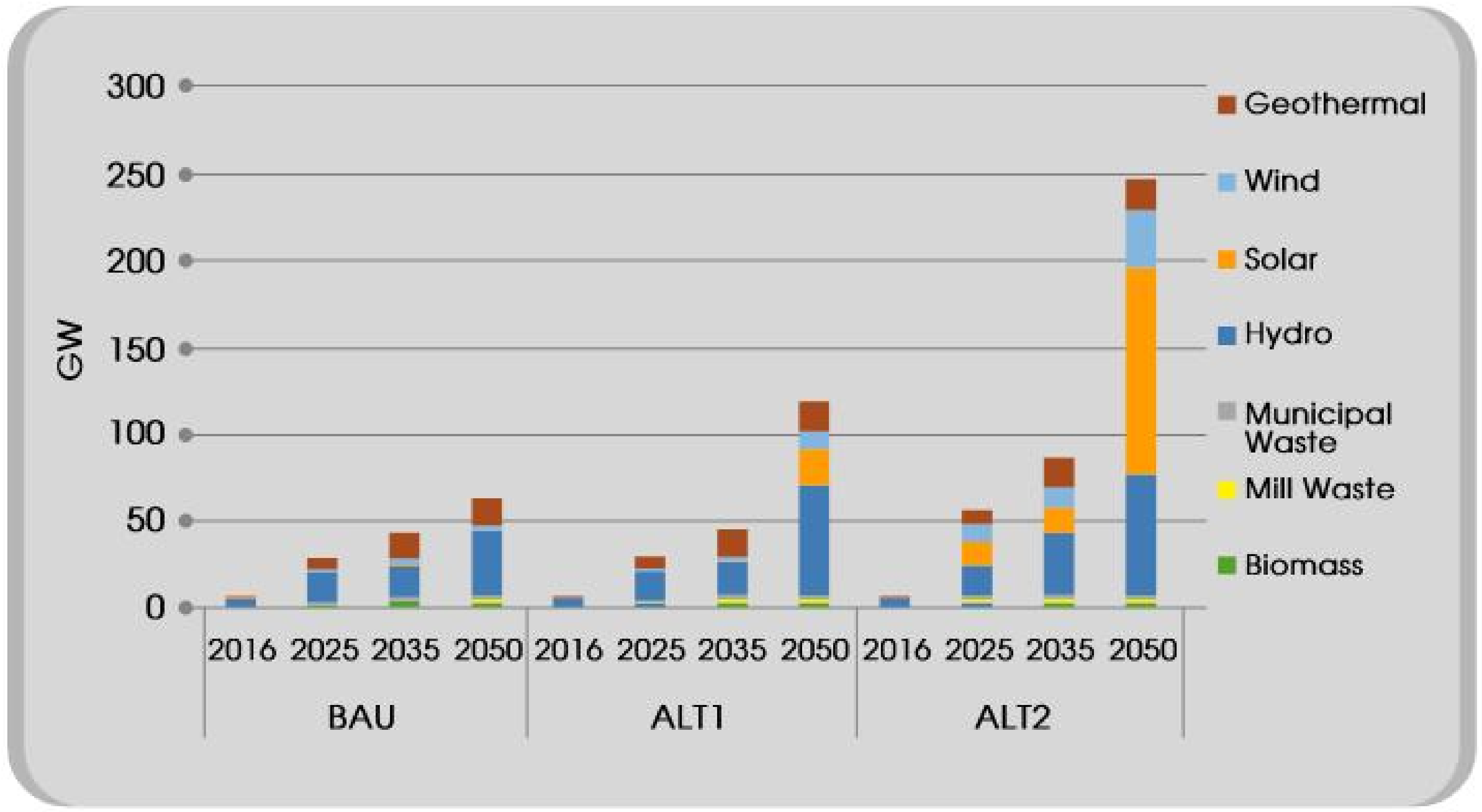
In electricity system, the counted resources are geothermal, solar, wind, hydro (mini hydro and pumped storage) biomass, waste and industrial waste. In geothermal power generation, generally geothermal system in Indonesia is hydrothermal system with high temperature (>225^{O}C) and some with moderate temperature (150-225^{O}C). Geothermal system with low temperature is the system in which its reservoir contains fluid with lower temperature than 125^{O}C and it is usually used in non-electrcity.

In electricity outlook, the highest NRE power generation contribution in total power production during projection period will be around 12% to 27% depends on the scenario. From the total NRE power generation production in 2025, production share of geothermal and hydro power generation will be dominant in all scenarios in which geothermal is higher than hydro. In 2050, the condition changes. Hydro power generation share in total power production will be higher than geothermal power generation. It is possible since geothermal potential in 2050 is located in remote areas. Thus, it development cost is higher than hydro development. Picture 4.55 shows the production composition of various NRE power generations toward total power production from NRE.



PIcture 4.55 NRE Power Generation Production Percentage

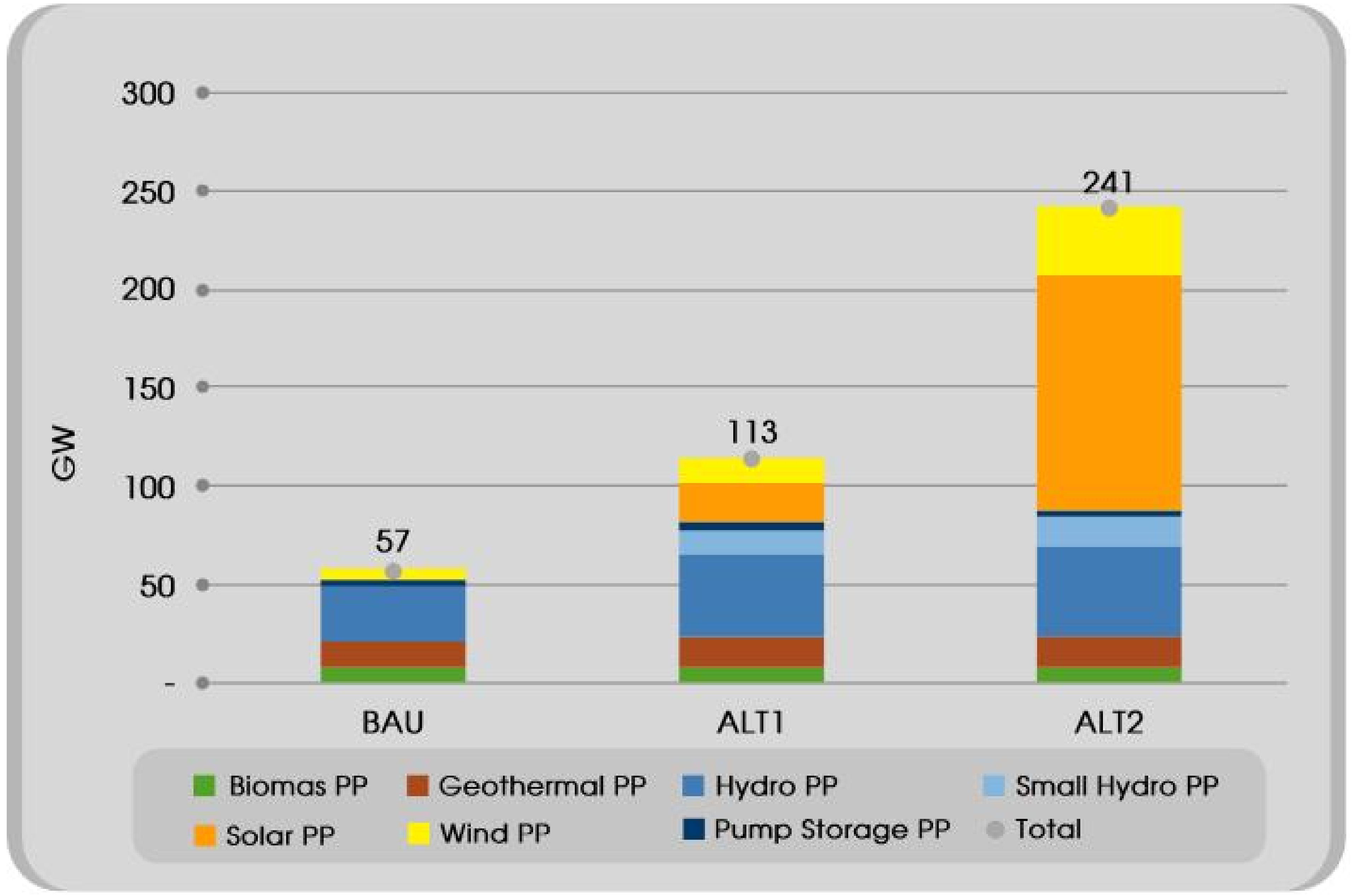
NRE demand in electricity in BaU is 29 GW in 2025 and 63 GW in 2050 as shown in Picture 4.56.



Picture 4.56 Power Generation capacity Supply from NRE

In ALT 1, NRE demand in electricity is 30 GW in 2025 and 119 GW in 2050. In ALT 2, NRE demand in electricity is 56 GW in 2025 and 247 GW in 2050.

In BaU, the total additional NRE power generation capacity will reach 56 GW in 2016-2050. The biggest NRE power generation option is hydro (27 GW), geothermal (13 GW), biomass (8 GW), wind (4 GW) and the rest is additional capacity from solar, mini hydro and pump storage. In ALT 1, additional NRE power generation capacity will be higher than in BaU since it covers achievement of National Energy Policy mix. Thus, the role of NRE in total capacity will be higher despite of the lower power demand (Picture 4.57).



Picture 4.57 NRE Power Generation Additional Demand 2016-2050

According to its NRE, the biggest additional hydro power generation is 42 GW but the additional geothermal capacity (16 GW) is lower than in solar power generation (21 MW). Additional capacity in wind power generation is higher of about 11 GW. The additional capacity in solar power generation and wind power generation compared to the total additional NRE power generation (113 GW) is 18% and 10%. From the total installed capacity in 2050 for ALT 1, the contribution of solar and wind power generation is below 6%. The additional solar and wind power generation capacity is especially in Java with high power demand. Thus, fluctuative NRE power generation such as solar and wind power generation is chosen to supply small amount of this demand.

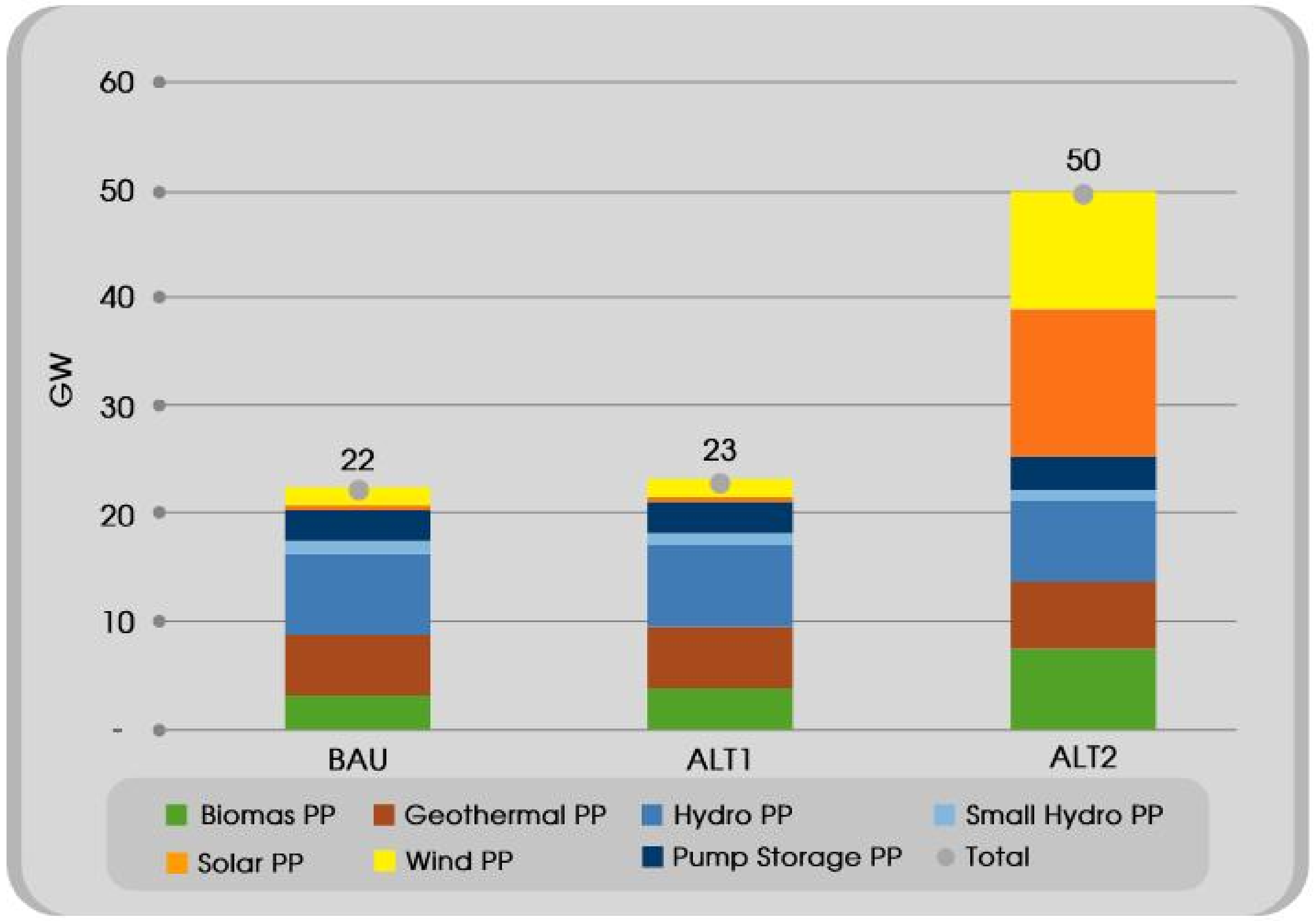
In ALT 2, solar power generation has the biggest additional capacity compared to others reaching 120 GW. The additional capacity in wind power generation is also higher of about 33 GW. The installed capacity in solar power generation then reaches 19% from the total installed capacity in 2050. Meanwhile, the installed capacity in wind power generation reaches 5%.

The increase of installed capacity in solar and wind power generation implicates 50% utilization of its resources physical potential. Compared to other NRE, hydro and geothermal potential utilization is much cheaper but the resources are located in low power demand area such as Papua. The target achievement of National Energy Policy in ALT 2 with higher GDP than ALT 1 has trigerred investment in solar and wind power generation in Java.

The declining solar PV and wind turbine price in the last ten years has enable both resources to compete with new coal power generation in several countries. In EU, almost 26% of the installed capacity in 2015 was sourced from solar and wind which was equivalent to Indonesia installed capacity in 2050 in ALT 2. Therefore, high additional capacity in solar and wind power generation in ALT 2 is possible in the next 35 years.

In hydro power generation, additional capacity reaches 46 GW. In mini hydro, it is 15 GW. Other additional capacities are 16 GW in geothermal, 8 GW in biomass, and the rest in pump storage. The total additional capacity in NRE power generation in ALT 2 is 241 GW.

By only considering power generation development until 2025, additional NRE power generation will be lower of about 22 GW in BaU, 23 GW in ALT 1 and 50 GW in ALT 2. Based on its NRE source, additional capacity in hydro and mini hydro will be the same in all scenarios of 7.5 GW in hydro power generation and 1.2 GW in mini hydro (Picture 4.58).



Picture 4.58 NRE Power Generation Additional Demand 2016-2025

In BaU and ALT 1, additional capacity in hydro power generation is the biggest. In ALT 2, it is in solar power generation with 14 GW. The next biggest additional capacity is wind power generation with 10 GW, hydro power generation with 7.5 GW and biomass power generation with 7.5 GW. In this scenario, additional capacity in biomass power generation is twice higher compared to other scenarios. The additional capacity in solar power generation is also significant of about 6.3 GW compared to other scenarios of about 0.4 GW.

For hydro, geothermal, and mini hydro power generation, the investment demand is similar in each scenario. In solar, wind and biomass power generation, the different is very significant for ALT 2 compared to in ALT 1. In BaU, investment demand for power generations is similar to in ALT 1.

Indonesia Energy

OUTLOOK

2016

CHAPTER 5
THE CITY OF BATAM ENERGY OUTLOOK

CHAPTER 5 / THE CITY OF BATAM ENERGY OUTLOOK

Energy management in the City of Batam is specially discussed by considering that the City of Batam has a strategic position since it is side by side with Singapore Strait and Malacca Strait. Furthermore, the City of Batam is designed as an industrial zone.

5.1 Population Condition

Based on population census in 2010, population in the City of Batam was 944.29 thousand and increased into 1.04 million in 2015. The growth is 1.9% per year. The City of Batam has the biggest population in Riau Island Province of about 56% in 2010 and 53% in 2015. The population growth in the City of Batam is shown in Table 5.1.

Table 5.1. Population Growth in the City of Batam

Year	City of Batam	Riau Island Province
2010	944.285	1.692.816
2011	1.000.661	1.748.810
2012	1.235.651	1.805.089
2013	1.135.412	1.861.373
2014	1.030.528	1.917.415
2015	1.037.187	1.973.043
GR	1,89%	3,11%

Source: BPS. City of Batam in Number, 2016

5.2 Economic Condition

In the last four years, GRDP of the City of Batam has increased from 73.70 trillion rupiah in 2012 into 90.40 trillion rupiah in 2015 (constant price year 2010). It means that the growth is 7.0% per year. From its business sector, industry is the biggest contributor to the economy in the City of Batam of about 55% and 6.9% of growth per year. GRDP growth of other industries is the highest in the City of Batam with 9.3% per year. This is the consequence of major infrastructure development to prepare the industrialization in the City of Batam (Table 5.2).

Table 5.2 GRDP Growth in the City of Batam
(Constant Price Year 2010 in Billion Rupiah)

Sector	2012	2013	2014	2015	2012-2015 Growth
Industry	41.020,46	43.920,06	47.498,01	50.088,89	6,9 %
Commercial	15.839,80	16.785,06	18.068,46	18.552,05	5,4 %
Transportation	2.332,03	2.525,65	2.598,16	2.797,09	6,2 %
Others	14.505,78	15.628,07	16.995,5	18.959,07	9,3 %
Total	73.698,07	78.858,84	85.160,13	90.397,10	7,0 %

Source: BPS. City of Batam in Number 2016

5.3. Energy Sector Development

Final energy demand in the City of Batam in 2015 is predicted of 5.84 million BOE consisting of 75% of fuel, 1% of coal, 23% of electricity, and 1% of others. Meanwhile, the primary energy consumption is around 8.27 million BOE consisting of 53% of oil, 26% of coal, 21% of gas and 0.0% of NRE (too small).

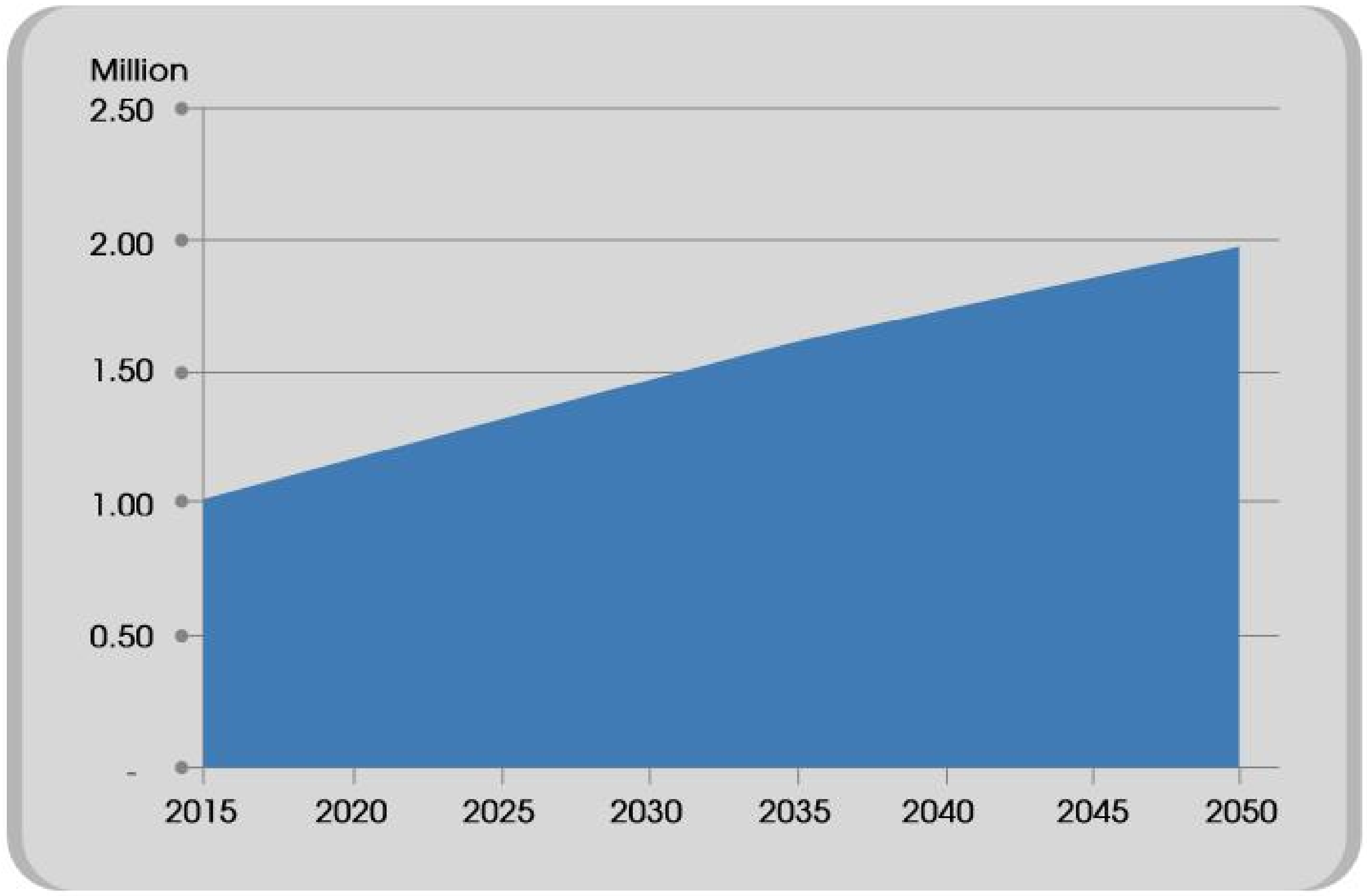
It is predicted that energy distribution by sector is derived from 38% of industry, 33% of transportation, 15% of household, 12% of commercial, 2% of other sector including agriculture, construction and mining.

The final energy demand in the City of Batam is predicted to reach 60% from energy consumption in Riau Island Province. It makes sense since 85.94% of industry in Riau Islands Province is in the City of Batam. Around 60% of vehicles in Riau Islands Province are in the City of Batam. Furthermore, around 56.24% of population in Riau Islands Province is in the City of Batam (census 2010).

5.4. Social Economy Projection

5.4.1 Population

Population in the City of Batam is projected to increase from 1.04 million in 2015 into 1.32 million in 2025 and 1.99 million in 2050 or it grows of 1.87% per year. This population growth projection is 1.45% higher than in the beginning of projection year and 0.38% higher than in the end of projection year compared to Indonesia population growth average. The factor which contribute high population growth in Batam is urbanization outside Batam since the City of Batam is economic development center in Riau Island Province. Population projection in the City of Batam can be seen in Picture 5.1.



Picture 5.1 Population Projection in City of Batam

5.4.2 Gross Regional Domestic Product (GRDP)

Economic growth is reflected in GRDP growth 2015-2050 and it is varied from year to year. GRDP of the City of Batam is projected to increase from 90.40 trillion rupiah in 2015 into 892.02 trillion rupiah in 2050 (Constant Price Year 2010) or it grows of 6.8% per year (Table 5.3).

Table 5.3 GRDP and and its Growth in the City of Batam

	2015	2020	2025	2030	2035	2040	2045	2050
GRDP (Trillion Rupiah)	90,40	125,37	177,32	250,80	348,81	479,69	659,70	892,02
GRDP growth (%)	7,04	7,18	7,18	7,18	6,58	6,58	6,58	5,98

Toward the national condition, GRDP growth in the City of Batam is projected 1.19% higher compared to national GRPD growth. This projection occurs since economic growth in the City of Batam has the elasticity between 0.78 to 1.33 compared to national condition.

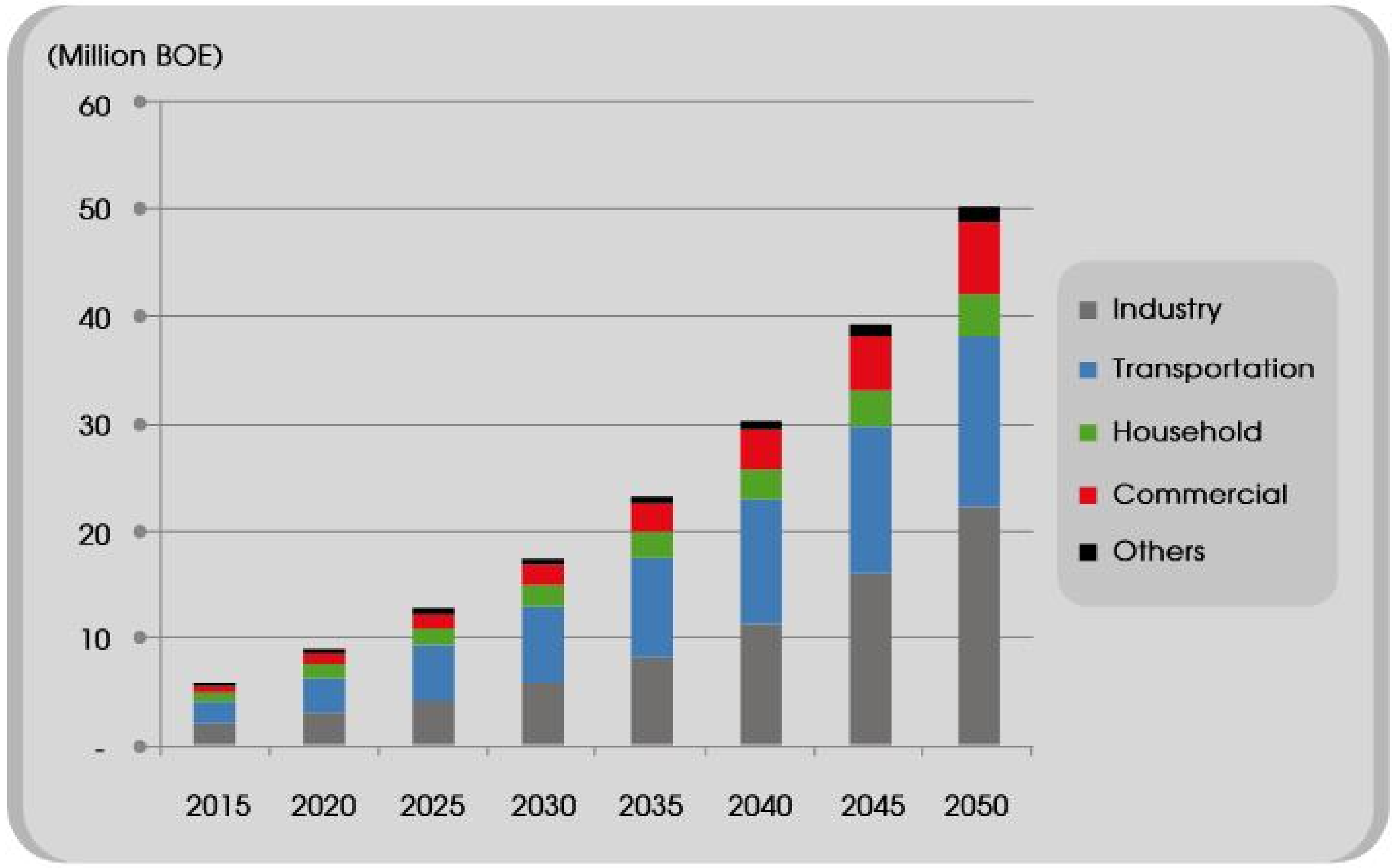
5.5 Final Energy Demand Projection

5.5.1. Energy Demand Projection by Sector

In total, final energy demand in the City of Batam is predicted to increase of 6.3% per year or from 5,839 thousand BOE in 2015 into 50,308 thousand BOE in 2050. The biggest final energy demand share is in industry from 38% in 2015 to 44% in 2050. Besides contributing the biggest final energy demand share, industry in the City of Batam also has the biggest growth. Until 2015, energy demand growth in industry is projected to increase 6.8% per year along with the development of the City of Batam as industrial zone since 1980s.

The development of the City of Batam as industrial zone has encouraged other sectors especially sub contractor in infrastructure service to grow significantly. This sector has grown signicantly of 6.8% per year though its energy demand share is still low of 2 to 3%. Commercial sector also experiences quite signifant growth of 6.7% per year. The high energy demand growth in commercial and other sectors shows the infrastructure development and supporting facility to the economy along with the development of industry.

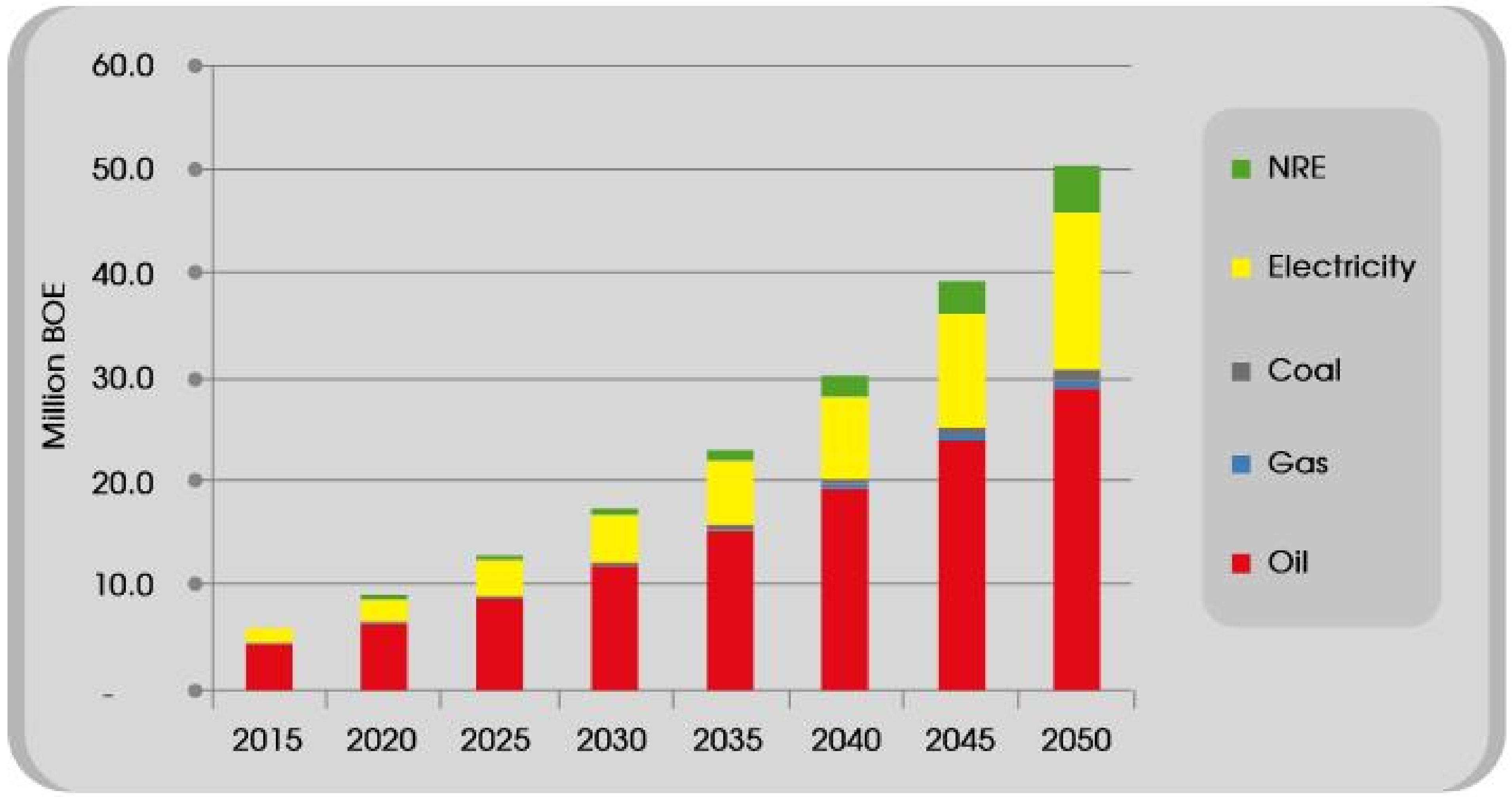
Transportation is the second biggest energy consumer with the average growth of 6.2% per year. The final energy demand share in this sector decreases from 36% in 2015 into 32% in 2050. The declining share is due to lower growth rate than in industry and other sectors. For household, both the share and growth is relatively low (below average growth). The energy demand in household is 14% in 2015 and 8% in 2050 with the average growth of 4.4.% per year. The enegy demand projection by sector is shown in Picture 6.7.



PIcture 5.2 Final Energy Demand Projection in the City of Batam by Consumer

5.5.2. Energy Demand Projection by Energy Source

The final energy with the highest growth is gas with the average growth of 13.8%. However, gas demand has low share of 1 to 2% compared to other energy sources. Thus, it does not influence much in energy supply. Significant energy consumption and demand occurs in electricity. Electricity demand share is 23% in 2015 and increases into 28% in 2050 or the average growth of 7.1% per year. A relatively high population growth and high economic growth with low electrification cuase very high electricity demand. Other energy with high demand is coal of about 7.2% per year. Caol share is very low of only 1 to 2%. Meanwhile, the final energy with the lowest growth is oil fuel of 5.5% per year. Oil fuel has the lowest demand growth, but its share is the highest of 70% in 2015 and 61% in 2050. It shows that oil fuel is difficult to be relaced by other energy especially in vehicle. For NRE, its share is very low but it shows increasing trend. It share is only 2% in 2015 and 9% in 2050. The energy demand development in the City of Batam by energy source in 2015-2050 is shown in Picture 7.6.



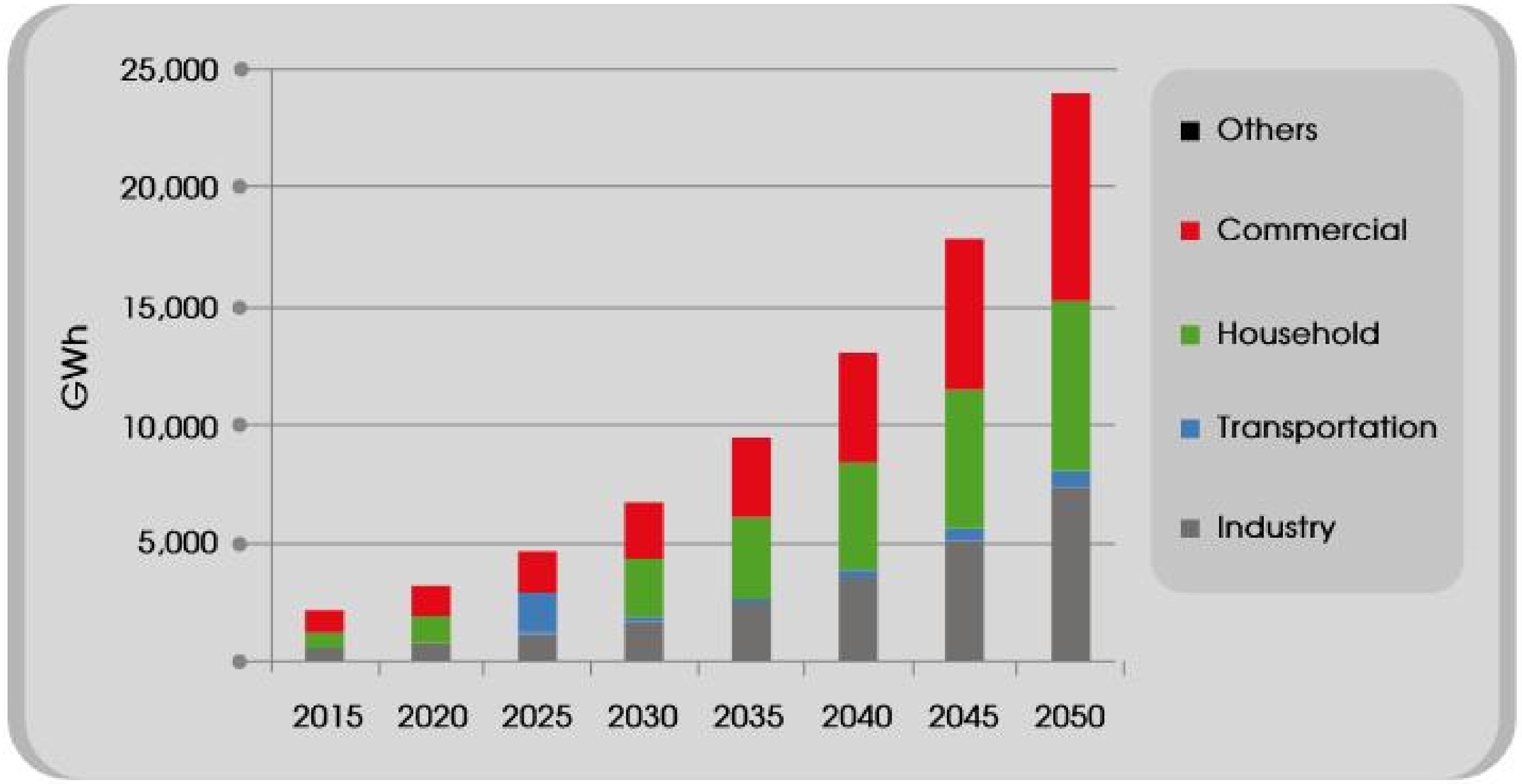
Picture 5.3 Final Energy Demand Projection in the City of Batam By Energy Source

5.5.3 Electricity

5.5.3.1 Demand and Supply

Total electricity demand in the City of Batam is predicted to increase from 2.2 TWh in 2015 into 24.0 TWh in 2050 or at the average growth of 7.1% per year. The biggest electricity consumer is commercial with the share of 41% in 2015 and 36% in 2050.

Looking at its growth, industry and household are sectors with highest electricity demand of 7.2% per year. It occurs since economic development in the City of Batam is encouraged to be developed as industrial zone. The interesting thing is the implementation of electric car after 2020. Until 2050, electricity consumption in transportation is projected to increase with the average growth of 12% per year. The electricity demand projection by sector is shown in Picture 5.4.



PIcture 5.4 Power Demand Projection in the City of Batam

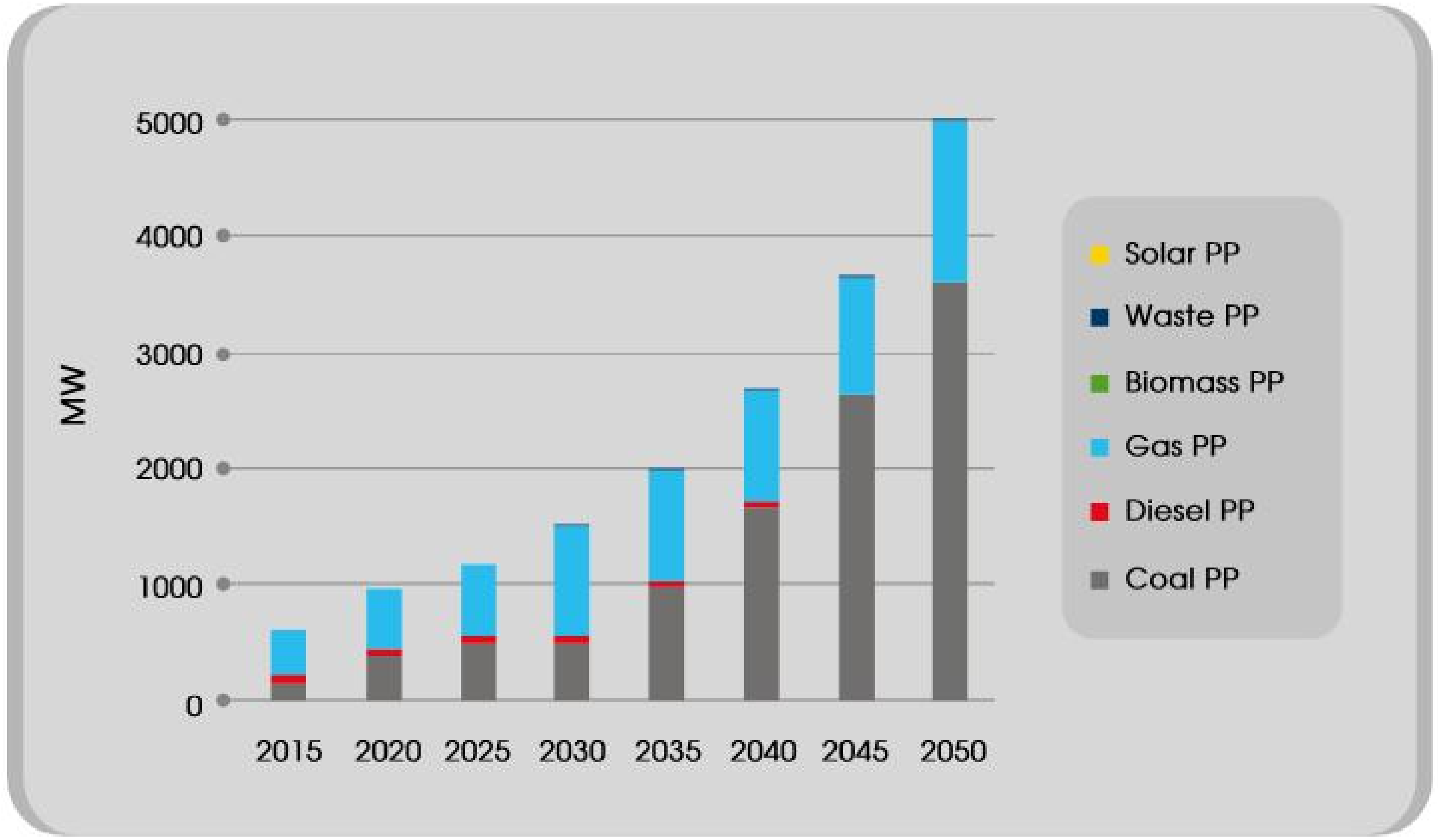
From supply side, electricity production is increasing from 2.4 TWh in 2015 into 26.5 TWh in 2050 with average growth of 7.1% per year. Although gas fueled power generation including gas, mini gas and steam gas power generation has the biggest installed capacity, coal fueled power generation supplies the highest electricity in the City of Batam if seen from supply optimization. It supplies 69% in the beginning of projection year and keeps increasing until the end of projection year of about 86% from the total electricity supply in 2050 or with average growth of 7.7% per year. Meanwhile, electricity production from gas fueled power generation decreases from 31% in 2015 into 14% in 2050. However, there has been significant increase between projection years until 53% in 2030 due to the high capacity.

Based on its capacity, power generation installed capacity in the City of Batam will increase from 719 MW in 2015 into 4,995 MW in 2050 or at the average growth of 5.7% per year. Coal power generation will have the highest increase from 240 MW in 2015 into 3,612 MW in 2050 or at the average growth of 8.1% per year. Gas fueled power generation with the highest capacity (56%) in 2015 will only increase at the average growth of 3.5% per year from 406 MW in 2015 to 1,366 MW in 2050.

Diesel fueled power generation with installed capacity of 72 MW or 10% from the total installed capacity of power generation in the City of Batam will experience the declining role and will be replaced by gas or coal power generation with cheaper price. Diesel fueled power generation will become back up power generation and its capacity will be zero in 2045.

The role of NRE power generation in the City of Batam is predicted not to grow well. Electricity supply optimization in NRE power generation is relatively expensive and could not compete with coal or gas fueled power generation. The high price of NRE based-electricity in the City of Batam is due to the low NRE potential in Batam. There is no major NRE potential in Batam such as hydro, geothermal, wind and solar. NRE power generation share in the City of Batam in 2015 only supplied solar power generation for hinterland with the capacity of 0.6 MW. Other NRE power generation projected to be developed to supply electricity in Batam in 2025 is biomass power generation with 7

MW in capacity. In 2030, waster power generation will be built with the capacity of 10 MW. Biomass power generation will produce 49 GWh, while waste power generation will produce 70 GWh. The power generation capacity projection in the City of Batam is shown in Picture 5.5.



Note: Gas power generation consists of Gas, Gas Engine and Gas Steam Powrer Generation

Picture 5.5 Power Generation Capacity Projection in the City of Batam

5.5.3.2 Capacity and Cost Addition

As explained earlier that the installed capacity of power generation in the City of Batam currently is 719 MW. To meet the increasing electricity demand, the installed capacity should be increased as well. Until 2050, the total installed capacity addition for power generation in the City of Batam is 4,463 MW consisting of 77% from coal power generation, 22% from gas power generation (gas, gas engine, gas steam). From NRE, there will be additional capacity of 7 MW in 2025 from biomass power generation and 10 MW in 2030 from waste power generation. From diesel, there will no additional capacity.

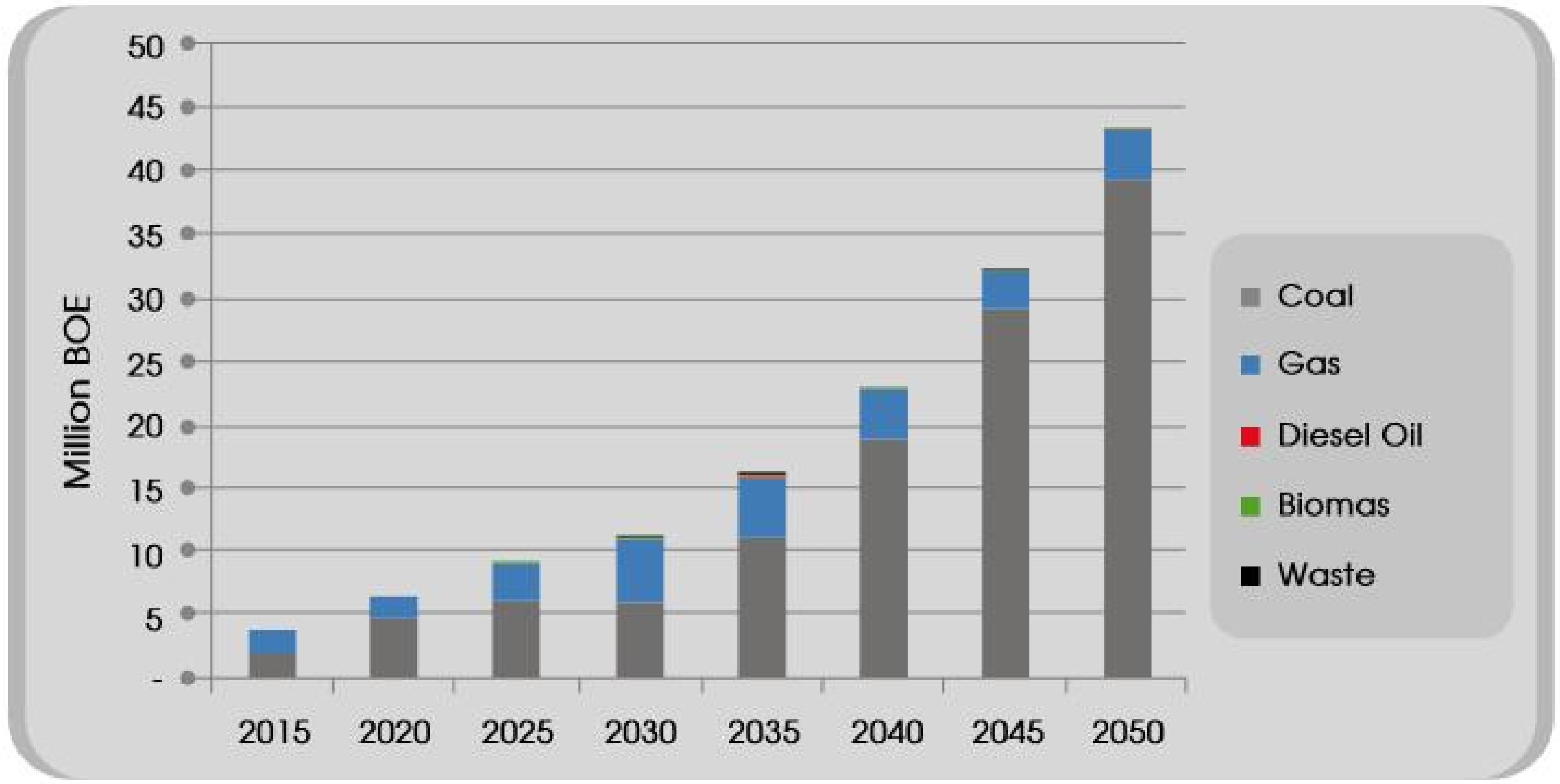
Based on projection, the addition will be conducted gradually. Until 2020, there will 350 MW additional installed capacity consisting of 220 MW of coal fueled power generation and 130 MW of gas fueled power generation. The additional installed capacity is shown in Table 5.4.

Table 5.4 Capacity Addition of Installed Power Generation in the City of Batam (MW)

	Coal	Diesel	Gas	Biomass	Waste	Solar	Total
2015	240	72	406	0	0	0.60	719
2020	165	0	0	0	0	0	165
2025	110	0	55	7	0	0	172
2030	0	0	343	0	10	0	353
2035	530	0	0	0	0	0	530
2040	729	0	0	0	0	0	729
2045	863	0	201	0	0	0	1,063
2050	975	0	362	0	0	0	1,337
Total	3,372	0	960	7	10	0	4,349

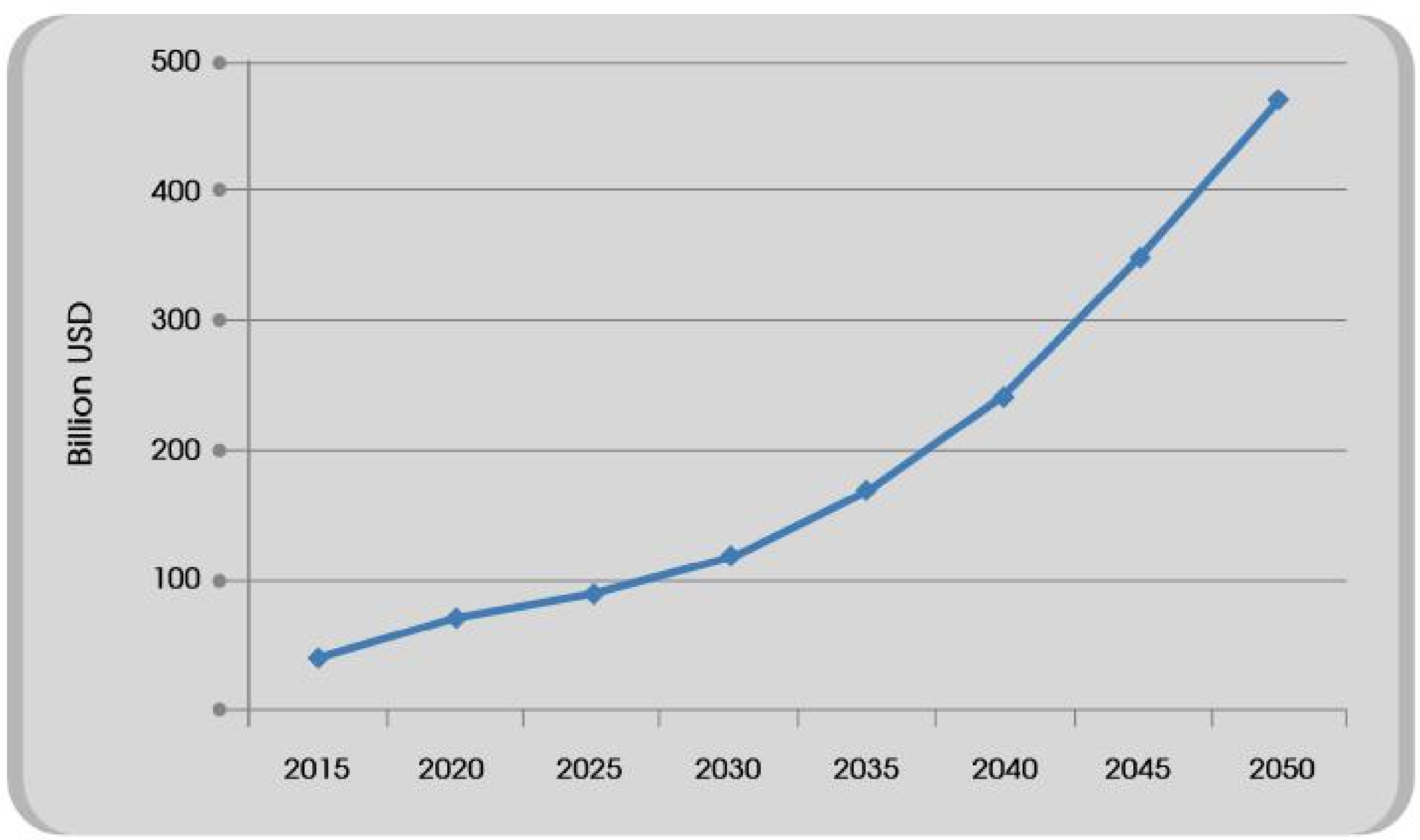
Note: Year 2015 is the current installed capacity

The increasing capacity of the existing power generation will directly increase fuel demand. In this case, fuel demand for power generation will increase from 3.78 million BOE in 2015 into 43.41 million BOE in 2050 or at the average growth of 7.2% per year. Fuel demand is only dominated by coal and gas of 7.7% and 4.5% per year. There is no diesel oil consumption in diesel fueled power generation. In NRE, biomass demand is only 80 thousand BOE while waste demand is 160 thousand BOE. The fuel (primary energy) demand development for power generation is shown in Picture 5.6.



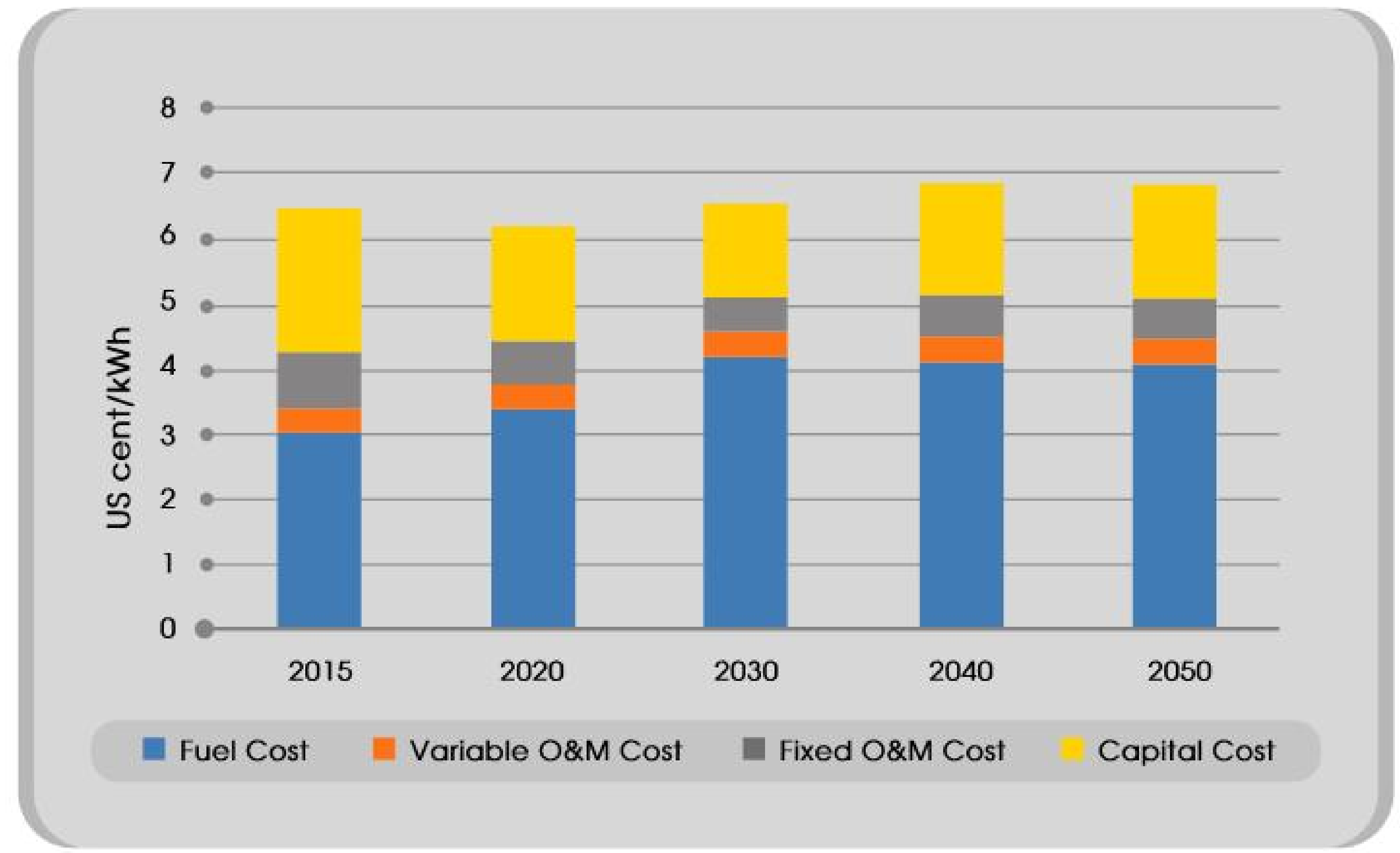
Picture 5.6 Fuel Demand Projection for Power Generation in the City of Batam

The increasing power generation capacity requires investment for its development. As explained above, the required investment is USD 54 million in 2015, USD 89 million in 2025 and USD 471 million in 2050. The capital demand in power generation addition from 2015 to 2050 is shown in Picture 5.7.



Picture 5.7 Capital Cost Projection for Power Generation Construction in the City of Batam

By adding all cost components including capital cost, fuel cost, operation and maintenance cost, the cost of power generation in the City of Batam will be around 6.2 to 6.8 cent USD/kWh or 6.6 cent USD/kWh in average. The biggest cost is fuel cost of around 47% to 64%. Capital cost is in the second place with 23% to 34%. Operation and maintenance cost (fix cost) is 8% to 13% and variable cost is around 6% from power generation cost. The cost fluctuation highly depends on the existing power generation constribution. The fluctuation of power generation cost in the city of Batam is shown in Picture 5.8.

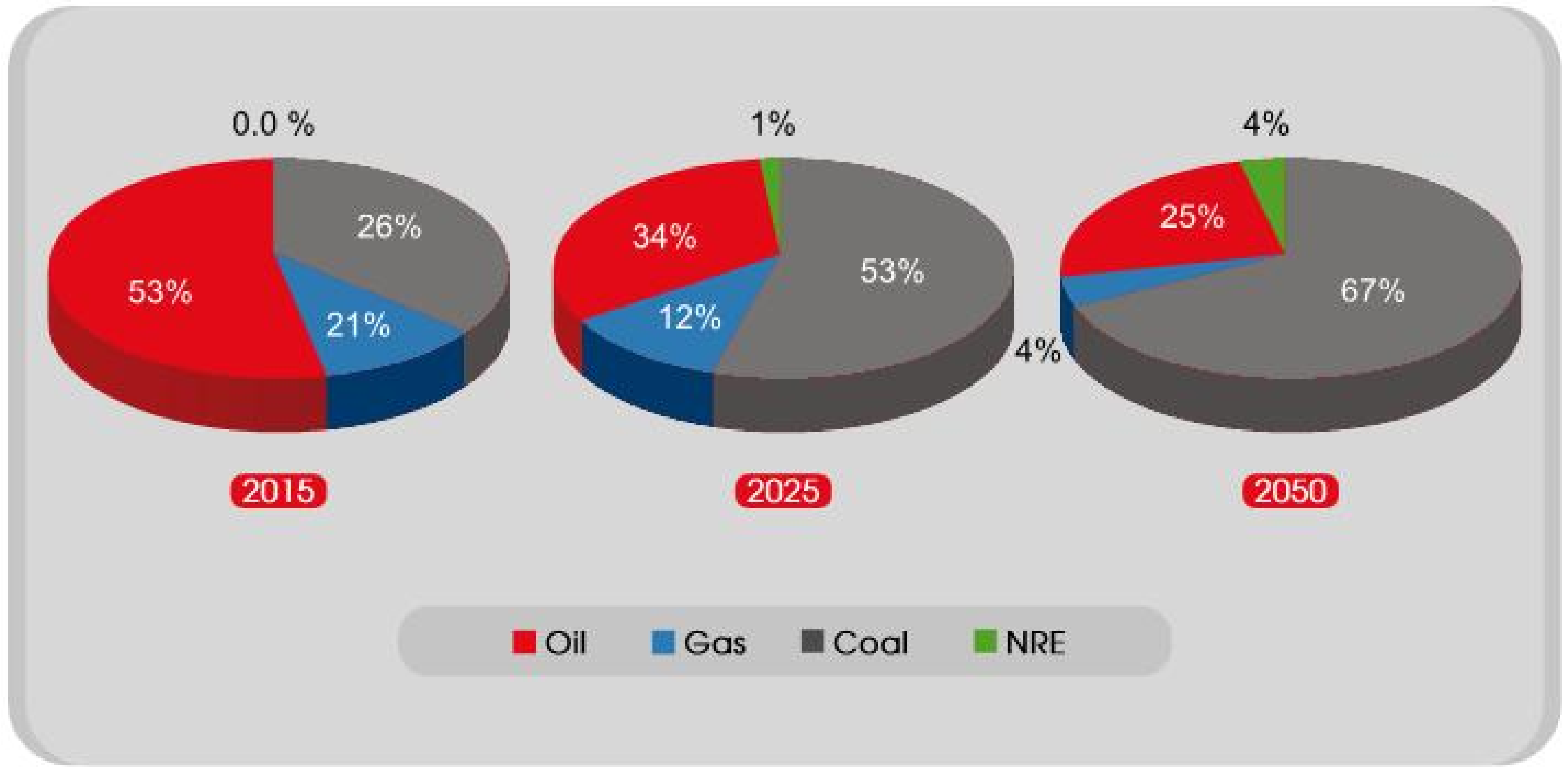


Picture 5.8 Power Generation Cost in the City of Batam based on Cost Component

5.5.4 Primary Energy Supply

The total primary energy supply in the City of Batam is projected to increase from 8.3 million BOE in 2015 into 127.6 million BOE in 2050 or at the average growth of 8.1% per year. Based on energy source in 2015, 4.4 million BOE or 53% is derived from oil. Meanwhile, coal and gas contributed 37% (3.0 million BOE) and 10% (0.8 million BOE).

From the primary energy mix, the future energy demand in the City of Batam will highly depend on coal. Coal contribution will increase with the average growth of 10% per year from 52% in 2025 into 67% in 2050. The high increase is due to the coal demand from coal fueled power generation which will dominate power generation in the City of Batam. Oil and gas demand will increase 5.8% and 5.4% but their contribution will decline and will be replaced by coal. Oil and gas contribution in the end of projection year is 25% and 4%. NRE demand is very low. But it will increase significantly at the average of 25% per year. NRE share in 2015 is only 0.02% and will increase into 1% in 2025 and 4% in 2050. Despite of significant change in primary energy supply contribution and high NRE demand growth, this condition could not meet the contribution as targeted in National Energy Policy. The primary energy mix projection is shown in Picture 5.9.



Picture 5.9 Primary Energy Mix in the city of Batam

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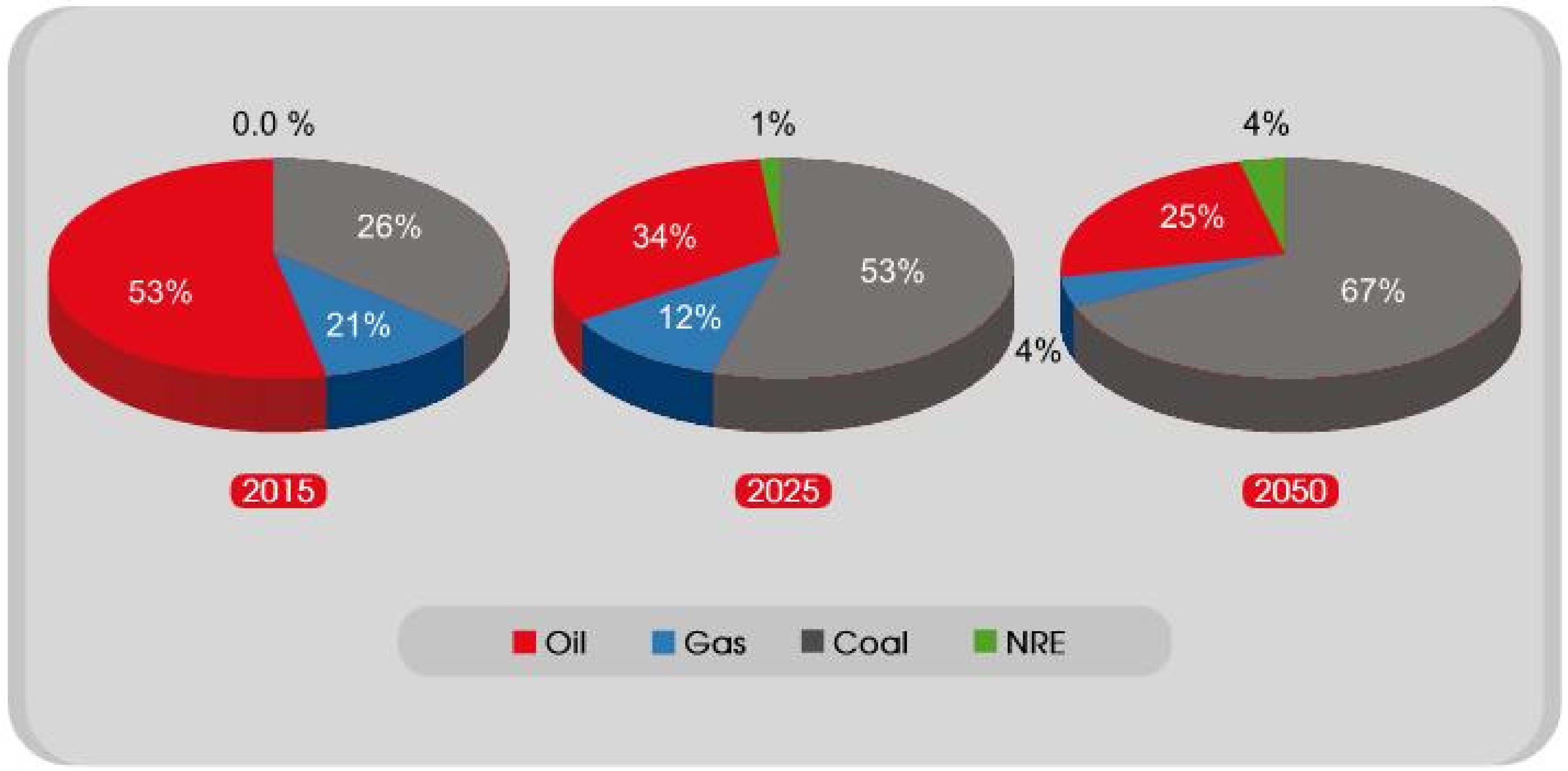

Picture 5.9 Primary Energy Mix in the city of Batam

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DEFINISI

BaU (Bussines as Usual) is basic energy projection scenario as the continuation of historical development or without any intervention from government policy which can change historical behavior

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

Bioetanol (E100/pure) is ethanol product from biological material and other biomasswhich are processed through biotechnology.

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.

Eff (Efficiency) is energy projection scenario with NRE development and energy conservation intervention based on Government Regulation number 79 year 2014 on National Energy Policy.

EFF_HIGH (Efficiency High) is energy projection scenario which considers a more aggressive implementation of energy efficiency and conservation policy compared to EFF scenario such as energy saving technology impelementation with 100% of market penetration.

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