MINDANAO ENERGY PLAN 2018 - 2040

In partnership with
Mindanao Development Authority

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MINDANAO ENERGY PLAN 2018 - 2040

Message

Acclaimed as the "*Land of Promise and Food Basket of the Philippines*", Mindanao has what it takes to be among the most dynamic places in the country. It has vast potential supply of natural resources including energy that could help transform the entire island into a vibrant **economy**. Spurring Mindanao's growth and development are its increasing level of economic competitiveness, improvement in vital infrastructure, enhancement of its connectivity, growing number of economic zones, business centers and industrial hubs. The establishment of Development Corridors in the region is also a critical factor. With all these exciting progress for Mindanao, the expansion of the region's power system is imperative to parallel the demand of economic surge. The Government therefore is called upon to respond through appropriate measures that can complement and sustain development.

Towards this end, the Mindanao Energy Plan (MEP) 2018-2040 was formulated to ensure sustainable, stable and secure energy supply in the Mindanao Region. The MEP aims to address the region's energy supply requirements to meet its higher economic targets as espoused in the Mindanao 2030 and Mindanao Development Corridors. It provides for a long term energy planning that will not only help DOE respond to growing energy needs of Mindanao and to its changing supply-demand dynamics but would also ensure energy security through the optimization of energy resources.

The Plan pushes for energy diversification with the formulation of a well-balanced energy mix to help achieve the ultimate goal of having a secured, stable and sustainable energy supply. It simulates varying energy supply and demand scenarios that will be responsive and dynamic to the needs of the region within the planning period and address the potential supply shortfalls and other future challenges.

In simulating the energy requirements of Mindanao over the next 20 years, the DOE considered several economic parameters and sectoral targets to include energy savings across all economic sectors, targets for alternative fuels and the promotion, development and utilization of indigenous energy resources to include renewable energy sources. To further manage the region's energy demand, the Plan also seeks to scale-up energy efficiency programs to capture more energy saving towards vast economic and environmental gains.

The participation of the private sector and international financial institutions in mobilizing investments plays a vital role in attaining efficient, secure and sustainable energy supply. The Plan makes sure that energy supply is sustained by attracting prospective investments that will help meet the forecasted energy required capacity. Without private investments, the quest for secured energy, globalization and competition would indeed be very challenging.

Through this Plan, the DOE is committed to contribute to a robust and vibrant Mindanao and pull Mindanawons out of poverty and lift them to the levels of prosperity.

Mabuhay Mindanao!

ALFONSO G. CUSI
Secretary
Department of Energy

Message

Assalamo Alaikum wah'Rahmatullahi wah'barakutuh!

My warmest congratulations to the energy family for the publication of the Mindanao Energy Plan (MEP) 2018-2040. The Mindanao Development Authority is honored to have assisted the formulation of the plan in partnership with the Department of Energy.

I wish to also extend my gratitude to all our partners and stakeholders who contributed their insights and expertise during the rounds of consultation conducted in the key cities of Mindanao last year. Your valuable inputs have been instrumental in ensuring that the MEP 2018-2040 is truly responsive to the energy needs of Mindanao.

MEP espouses a balanced energy mix with a 50 percent target for renewable energy by 2030. This is consistent with the targets that are also identified under the Mindanao 2030 Peace and Development Framework. With this, these plans will both serve as our guide in pursuing a dependable power system that optimizes the use of renewable energy, and ensures reliable distribution of affordable electricity up to the most remote barangays.

However, this cannot be done by the government, alone. After all, MEP was formulated with potential energy investors in mind, given the foreseeable power demand clearly laid out in the plan. Blackouts and power deficits should no longer be a reality for Mindanao from 2018 onwards. I am confident that with a well-guided private sector on board, we will soon realize our vision of providing a reliable, sustainable, and affordable power for Mindanao.

Mainstreaming the key findings and reports of MEP, will be crucial in keeping our partners in the business sector attuned with the energy requirements of Mindanao. Rest assured that MinDA, as the co-chair of the Mindanao Power Monitoring Committee (MPMC) will continue to harmonize efforts of all the MPMC-member agencies and external stakeholders to expedite renewable energy development in areas where they are needed the most.

Let us continue the work towards a progressive Mindanao, one that is fueled by clean, renewable, and indigenous power sources.

DATU ABUL KHAYR D. ALONTO
Secretary
Mindanao Development Authority

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ENERGY DEMAND OUTLOOK

POWER SUPPLY OUTLOOK

TRANSMISSION DEVELOPMENT

INVESTMENT PORTFOLIO

Note: The detailed information on the tables/figures are reflected on the annexes.

Abbreviations and Acronyms

AAGR	Annual Average Growth Rate
ADB	Asian Development Bank
AIMS	ASEAN Interconnection Master Plan Study
AOG	Administrative Operational Guidelines
ASEAN	Association of Southeast Asian Nation
ASEP	Access to Sustainable Energy Program
ARMM	Autonomous Region in Muslim Mindanao
BAU	Business As Usual
BBL	Barrels
BCF	Billion Cubic Feet
BIMP-EAGA	Brunei-Indonesia-Malaysia-Philippines-East ASEAN Growth Area
BIR	Bureau of Internal Revenue
BOI	Board of Investment
BPLO	Business Permit and Licensing Office
BPO	Business Process Outsourcing
BTU	British Thermal Unit
CEPALCO	Cagayan Electric Power and Light Company, Inc.
CEPNS	Certificate of Projects of National Significance
CCGP	Coordinating Committee for Geoscience Programmes
CCGT	Combined-Cycle Gas Turbine
CCL	Cumming Cockburn Limited
CGSI	Canadian Gas Services International
CO_2	Carbon Dioxide
COC	Coal Operating Contract
CME	Coco-Methyl Ester
CMU	Central Mindanao University
CNG	Compressed Natural Gas
COLIGHT	Cotabato Light and Power Company, Inc.
COTELCO	Cotabato Electric Cooperative Inc.
CRAPLEGA	Comprehensive Resource Assessment of the Philippine Low Enthalpy Areas in the Philippines
CREC	Centralized Review and Evaluation Committee
CSEE	Contract for the Supply of Electric Energy
CSR	Corporate Social Responsibility
DAP	Development Academy of the Philippines
DASURECO	Davao del Sur Electric Corporation
DBCC	Development Budget Coordination Committee
DC	Department Circular
DLF	Development and Livelihood Fund
DLPC	Davao Light and Power Company, Inc.
DO	Department Order
DOE	Department of Energy
DOD	Deed of Donation
DPNS	Draft Philippine National Standards
DPP	Diesel Power Plant
DUs	Distribution Utilities
DVTE	Diesel Vehicles in Truck Equivalent
EE&C	Energy Efficiency and Conservation
ECs	Electric Cooperatives
EF	Electrification Fund
EICC	Energy Investment Coordinating Council
EMS	Energy Management System
EO	Executive Order
EPIRA	Electric Power Industry Reform Act
EPNS	Energy Project of National Significance
ER	Energy Regulations
ERB	Energy Regulatory Board
ERC	Energy Regulatory Commission
ERIA	Economic Research Institute for ASEAN and East Asia
ESCOs	Energy Services Companies
ETC	Expected Time of Completion
EU-ASEP	European Union – Access to Sustainable Energy Programme
EVs	Electric Vehicle
EVOSS	Energy Virtual One Shared System
FIT	Feed-in-Tariff
FSRU	Floating Storage Regasification Facility
GEMP	Government Energy Management Program
GEOP	Green Energy Option Program
GDP	Gross Domestic Product
GFCE	Government Financial Consumption Expenditures
GHG	Greenhouse Gas
GOCC	Government-Owned and Controlled Corporation
GPDC	Gingoog Power Development Corporation
GRDP	Gross Regional Domestic Product
GSLFAP	Gasoline Station Lending and Financial Assistance Program
GVA	Gross Value Added
GVCE	Gasoline Vehicles in Car Equivalent
GWh	Gigawatt Hour
HAPUA	Heads of ASEAN Power Utilities and Authorities
HECS	Household Energy Consumption Survey
HEP	Household Electrification Program
HFCE	Household Final Consumption Expenditure
HGS	High Growth Scenario
HHI	Herfindahl-Hirschman Index
HUC	Highly Urbanized Cities
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
ICC	Indigenous Cultural Communities
ICG	Internal Cash Generation
IEC	Information, Education and Communication
IEEJ	Institute of Energy Economics, Japan
IGU	International Gas Union
ILPI	Iligan Light and Power, Inc.
IMEM	Interim Mindanao Electricity Market
IP	Indigenous People
IPP	Investment Priority Plan
IEA	International Energy Agency
IMF	International Monetary Fund
ISF	Institute for Sustainable Futures
JAO	Joint Administrative Order
JSK	Jaya Samudra Karunia Gas
KIGAM	Korean Institute of Geoscience and Mineral Resources
KM^2	Square Kilometer
KTOE	Thousand Tons of Oil Equivalent
KTON	Thousand Ton
KV	kilovolt
KWh	Kilowatt Hour
LASURECO	Lanao del Sur Electric Cooperative, Inc.
LBP	Land Bank of the Philippines
LGU	Local Government Unit
LGUOU	Local Government Unit Owned Utilities
LGS	Low Growth Scenario

LNG	Liquefied Natural Gas
LOLP	Loss of Load Probability
LPG	Liquefied Petroleum Gas
LTO	Land Transportation Office
M^3	Cubic Meter
MB	Thousand Barrels
MB/d	Thousand Barrels per day
MICT	Mindanao Integrated Container Terminal
MinDA	Mindanao Development Authority
MinDC	Mindanao Development Corridors
MIR	Minimum Inventory Requirement
MMB	Million Barrels
MMMT	Million Metric Tons
MMHERC	Misamis Mini-Hydro Electric Resources Corp.
MMSCF	Million Standard Cubic Feet
MTPY	Million Ton Per Year
MO	Market Operator
MOA	Memorandum of Agreement
MOGP	Malampaya On-shore Gas Processing Plant
MOPS	Mean of Platts Singapore
MOU	Memorandum of Understanding
MPC	Minergy Power Corporation
MSO	Mindanao System Operator
MVIP	Mindanao-Visayas Interconnection Project
MW	Megawatt
MWh	Megawatt Hour
MWP	Meteorologist Weather Processor
NAC	Nickel Asia Corporation
NBB	National Biofuels Board
NEA	National Electrification Administration
NECM	National Energy Consciousness Month
NEDA	National Economic Development Authority
NEECP	National Energy Efficiency and Conservation Program
NEPIO	Nuclear Energy Program Implementation Organization
NG	National Government
NGAs	National Government Agencies
NGCP	National Grid Corporation of the Philippines
NIHE	Nationwide Intensification of Household Electrification
NPC	National Power Corporation
NPC-SPUG	National Power Corporation-Small Power Utilities Group
NPP	New Private Provider
NPSC	Nuclear Power Steering Committee
NREL	National Renewable Energy Laboratory
NREP	National Renewable Energy Program
ODA	Official Development Assistance
O&M	Operation and Maintenance
OEM	Original Equipment Manufacturer
OPEC	Organization of Petroleum Exporting Countries
ORB	Official Registry Book
PECR	Philippine Energy Contracting Round
PCECP	Philippine Conventional Energy Contracting Program
PDAs	Pre-determined Areas
PDNGR	Philippine Downstream Natural Gas Regulation
PDP	Philippine Development Plan
PIA	Philippine Information Agency
PIEEP	Philippine Industrial Energy Efficiency Project
PIOUs	Private Investor Owned Utilities
PMU	Project Management Unit
PNS	Philippine National Standards
PPP	Purchasing Power Parity
PRV	Pressure Relief valve
PSALM	Power Sector Assets and Liabilities Management
PUC	Project under construction
PUJs	Public Utility Jeepneys
PUVs	Public Utility Vehicle
PSA	Philippine Statistical Authority
PV	Photovoltaic
PVM	Photovoltaic Mainstreaming
PV SHS	Photovoltaic Solar Home System
QS	Quality Standard
QTP	Qualified Third Party
RA	Republic Act
RE	Renewable Energy
RE-REC	Renewable Energy - Review and Evaluation Committee
RES	Retail Electricity Supplier
RESC	Renewable Energy Service Contract
RFID	Radio Frequency Identification
RPS	Renewable Portfolio Standard
RWMHEEF	Reforestation, Watershed Management, Health and/or Environment Enhancement Fund
SEP	Sitio Electrification Program
SEPA	Sustainable Education on Public Awareness
SIIG	Small Islands and Isolated Grids
SO	System Operator
SOCOTECO	South Cotabato Electric Cooperative
SPUG	Small Power Utilities Group
SSCMP	Small-Scale Mining Permit
SU	Station Use
SUC	State Universities and Colleges
SUKELCO	Sultan Kudarat Electric Cooperative, Inc.
SULECO	Sulu Electric Cooperative, Inc.
STRI	Sim Techno Research Institute
TDP	Transmission Development Plan
TEP	Total Electrification Program
TEPP	Total E & P Philippines
TESDA	Technical Education and Skills Development Authority
TFBM	Task Force Bangon Marawi
TFEC	Total Final Energy Consumption
TFEM	Task Force E-Power Mo
TFED	Total Final Energy Demand
TL	Transmission Losses
TMP	Transmission Master Plan
TOE	Tons of Oil Equivalent
TOP	Trial Operations Program
TOR	Terms of Reference
TPES	Total Primary Energy Supply
TRAIN	Tax Reform for Acceleration and Inclusion Law
TRANSCO	National Transmission Corporation
TUP	Technological University of the Philippines
TWG	Technical Working Group
USeP	University of Southeastern Philippines
VMIP	Visayas-Mindanao Interconnection Projects
VRE	Variable Renewables
WB	World Bank
WEI	World Energy Investment
WEO	World Economic Outlook
WESM	Wholesale Electricity Spot Market
WOO	World Oil Outlook
ZAMCELCO	Zamboanga City Electric Cooperative, Inc.
ZAMSURECO	Zamboanga Del Sur Electric Cooperative

OVERVIEW & EXECUTIVE SUMMARY

"Unless there is development in Mindanao, it is hard to see how the Philippines can achieve sustained and inclusive growth."

- 2017 Philippines Mindanao Jobs Report World Bank

Mindanao has been enjoying economic dynamism over the last five (5) years with its gross regional domestic product (GRDP), exports and investments consistently growing at an average of 6.0 to 7.0 percent. The forward drive towards sustaining this economic growth must always be complemented with diversified energy sources leading to a more secured supply to satisfy the foreseen increase in energy demand or consumption.

Aptly noted by the 2017 World Bank Mindanao Jobs Report, the country's bid for a prosperous nation and reduction of its poverty level by 2040 will depend mostly on what becomes of Mindanao's development. And the key challenge for Mindanao is to acquire an inclusive growth that will create more and better jobs, reduce poverty and propel competitiveness of the island. Adeptly supported by the 2016-2022 Philippine Development Plan, which prioritizes countryside development, and with the new Philippine President hailing from Mindanao, the country is on the right track toward achieving its economic targets for the island. To fully realize these targets, energy development will be the driving force for the island's developmental growth. High on the energy agenda is to provide sustainable and resilient energy infrastructure, as well as acquire substantive investments for critical energy projects to address long-term energy supply requirements of the island.

To help steer the way toward the growth scenario of Mindanao, the Mindanao Development Authority (MinDa) has developed the *Mindanao Development Corridors* as a key spatial strategy. Such Development Framework seeks to improve infrastructure, establish connectivity, and spur development of growth clusters within the island, allowing it to achieve balanced and inclusive growth among its regions.

For its part, the DOE, in collaboration with MinDa as its strategic partner, has formulated the 2018-2040 Mindanao Energy Plan (MEP), an update of the MEP 2014-2030, to provide sustainable energy infrastructure support as a key to attaining the development strategies of the island. The MEP integrates the sectoral energy plans and programs, and specific targets covering all phases of energy development and utilization. Unlike in the previous MEP, this Plan update intends to promote a technology-neutral energy mix by providing different supply options for power generation including the corresponding estimated blended rate, energy investments, environmental impact and other energy supply security indicators to aid the Mindanawons make better energy choices. Other proposed energy infrastructures are included in the Plan, such as the possibility of hosting a liquified natural gas (LNG) receiving terminal to introduce natural gas in the island's energy mix, and an oil refinery facility.

An overview of energy developments and future progress in Mindanao is summarized as follows:

Upstream Oil, Gas and Coal

Oil and Gas. A primary undertaking is the assessment of oil and gas reserves particularly in the Cotabato Basin and Agusan-Davao Basins (with a potential of 196 million barrels of oil equivalent (MMB). Investments will be stimulated through the conduct of the Philippine Conventional Energy Contracting Program (PCECP) and intensified Information, Education and Communication (IECs) campaigns. International cooperation initiatives will be strengthened to help the energy sector be at par with global developments in terms of upstream petroleum industry.

Coal. Coal reserves are seen to step up with projected incremental reserves of 142.64 million metric tons (MMMT) in 2018 and further increasing to 213.81 MMMT by 2040, bringing the total mineable reserves to 692.05 MMMT at the end of the planning period. These additional reserves are based on the projected supplemental exploration activities of converted Coal Operating Contracts (COCs) (from exploration to development and production phase) and from the newly issued Small-scale Coal Mining (SSCM) permits and awarded COCs. The largest incremental reserves will come from Soccsksargen region. Meanwhile, production of coal is seen to increase from 0.470 million metric tons (MMMT) in 2018 to about 27.0 MMMT in 2040.

The government will put emphasis on the rapid development of local coal, as well as the use of clean coal technologies to address environmental concerns attached on the fuel. Regulations on health and safety in coal mining will also be formulated and implemented.

Renewable Energy

With the greening of the energy sector, the use of renewable energy (RE) remains to be a global interest. The crucial policy mechanisms are now in place [Feed-in-Tariff (FIT), Renewable Portfolio Standards (RPS), Green Energy Option (GEOP) and Net Metering] bringing in the much needed investments and stirring public interest in RE development.

And to further accelerate the use of renewables, the DOE recently issued the Department Order (DO) 2018-03-003 or the "*Creation of a Centralized Review and Evaluation Committee (CREC) for the Purpose of Integrating the Current Committees Administering the Review and Evaluation of Renewable Energy, Petroleum, Downstream Natural Gas, and Coal Service Contract Applications, the Award, Amendment and Termination of Contracts*". Said Committee is now responsible for the management of energy projects covering exploration, development, utilization, distribution and conservation.

Likewise, the DOE developed the Energy Virtual One Shared System (EVOSS), a web-based monitoring system for energy applications and as a repository of project-related information and permits issued by all permitting agencies involved in the approval process of energy applications. Moreover, the use of Radio Frequency Identification (RFID) Monitoring System to track movements of project applications is now being pilot-tested. These two (2) systems will ultimately interphase to provide the status of actions taken by the DOE and permitting agencies on the project applications.

In the country's pursuit of a low carbon economy, the DOE will continue to take bold targets in harnessing the following renewable sources of energy.

Geothermal. There are seven (7) potential geothermal power projects located in Northern Mindanao, Davao and Soccksargen regions with an estimated aggregate potential capacity of 80 MW. Also, the Mt. Apo Geothermal Production Field has a 30-MW capacity expansion project, which is expected to be completed in December 2021, thus increasing its total installed capacity to 138.48 MW. On the other hand, the 60-MW Parker Geothermal Power Project in South Cotabato is awaiting the awarding of a service contact upon completion of documentary requirements.

The DOE's project on Comprehensive Resource Assessment of Philippine Low Enthalpy Geothermal Areas (CRAPLEGA) will conduct a detailed assessment of potential low enthalpy geothermal areas for possible power generation application.

Hydropower. Mindanao ranks second (next to Luzon) in terms of hydropower potential and installed capacity. For the planning horizon, about 1,012 MW of combined capacity from 81 hydropower potential projects are expected to be in place. In addition, there are 33 pending hydropower energy service contracts/applications with a total estimated potential capacity of 160.36 MW. Majority of these projects are found in Bukidnon, Davao, South Cotabato, and Sultan Kudarat.

Wind. The wind resource assessment conducted by the National Renewable Energy Laboratory (NREL) of the United States-Department of Energy revealed that Northern Mindanao has the largest potential for wind energy development. Wind potential projects are also present in the provinces of Agusan del Sur, Agusan del Norte and Surigao del Norte. And to maximize wind potential for power generation, the DOE will carry out wind resource assessment as a continuing initiative within the planning horizon.

Solar. Over the past few years, the cost of solar technologies continued to drop, consequently increasing its competitiveness vis-a-vis conventional energy sources. And once solar power projects are built, its fuel remains free and inexhaustible. In the country, solar energy projects are investment-favorite and would play a crucial role in the country's total electrification program for the households by 2022.

A total of 20 solar power projects with a combined capacity of 636.11 MW are programmed for implementation within the planning horizon. The largest of which is located in the province of Sarangani with a total capacity of 175 MW.

Moreover, a total of 12 pending solar energy service contract applications are being processed with an estimated potential capacity of 161.50 MW. The provinces of Bukidnon and Misamis Oriental host majority of these projects.

Ocean. Mindanao hosts the 6-MW Gaboc Channel Ocean Energy Project located in Surigao del Norte. Since this technology is currently at an early stage of development in the country, the DOE will continue to monitor developments and international trends to improve expertise in terms of technological development, including establishing benchmarks and best practices to develop our vast ocean energy potential.

Biomass. As Mindanao being considered the country's main source of agricultural products, enhancing its agricultural production would result in increased sources for biomass energy. Aside from committed and indicative biomass power projects, there are pending biomass project applications with an aggregate capacity of 33.19 MW mostly located in South Cotabato, which can boost power supply contribution from renewables within the planning period.

Biofuels. A Roadmap was formulated to support the nationwide implementation of the biofuels blend from 2017 to 2040 in compliance with the Biofuels Act of 2006. Under the said Roadmap, biodiesel blend will be maintained at 2.0 percent for the period 2017 to 2019. For the medium- and long-term periods, the DOE plans to revisit the blending requirements and availability of feedstock. On bioethanol blend, which is currently at 10.0 percent, the government will review the bioethanol mandate and continuously conduct research and development on potential feedstock sources.

Alternative Fuels and Emerging Technologies

Auto-LPG. To further promote the use of auto-LPG in the transport sector, the following initiatives have been outlined in the Alternative Fuels Roadmap:

- Review and update the existing Code of Practice on the Use of LPG in Internal Combustion Engines;
- Formulate the Emergency Response Protocol for auto-LPG fueled vehicles, which will be complemented with the comprehensive health-hazard assessment;
- Continue to undertake research and development on the expanded application of LPG in other sectors; and,
- Advocate for a legislation providing incentives for the importation and/or manufacturing of original manufactured LPG-fueled vehicles.

Electric Vehicles. Emerging technologies on electric vehicles will be closely monitored for appropriate application in the local market. Likewise, the provision of preferential franchises for electric vehicles is on the DOE's agenda in the short-term. The establishment of linkage with financial conduits (e.g. rural banks, transport cooperatives, multi-purpose cooperatives) will enable loan facilities for interested investors to engage in manufacturing of alternative fuel vehicles. Further, a Minimum Energy Performance and Non-discriminatory Regulations for electric vehicles and charging stations will be formulated and implemented in the planning horizon.

In partnership with Technical Education and Skills Development Authority (TESDA), training modules for drivers and operators on the safe use of electric vehicles will be developed. The DOE will persistently advocate for the passage of a law to bring down the cost of electric vehicles (either through importation or local sourcing).

Energy Efficiency and Conservation

Aside from the continuing implementation of the energy efficiency and conservation (EE&C) initiatives, such as the National Energy Efficiency and Conservation Program (NEECP), the DOE highly anticipates the passage of the Energy Efficiency and Conservation Law that will provide the framework to institutionalize the efficient use of energy and other modes of demand-side management. Such will lay down the structure for the implementation of the "National Energy Efficiency and Conservation Roadmap 2017-2040." This policy initiative also includes the granting of incentives to EE&C projects, such as income tax holidays, zero percent value added tax rates on purchases, and tax and duty exemptions on imported capital equipment used for energy efficiency. On 30 January 2019, the Bicameral Conference Committee approved the Bill titled: ***"An Act Institutionalizing Energy Efficiency and Conservation, Enhancing the Efficient Use of Energy, and Granting Incentives to Energy Efficiency and Conservation Projects."***

Downstream Oil and Gas

To address the growing oil demand and ensure that petroleum products inventory levels are met, additional oil depot/storage will be needed with a total capacity of 4,702 thousand barrels (MB) under the high growth scenario (HGS) on top of the existing 3,767 MB on the assumption of 30-day inventory except for LPG with a 15-day level. The additional requirement also considered 80.0 percent capacity utilization rate of the facility. For low growth scenario (LGS), additional storage capacity is only 3,277 MB. The scenarios are based on the growth rate assumptions (high and low) for Mindanao's GRDP. In collaboration with the PNOC, the DOE will study the feasibility of operating a strategic oil stockpile in the country, which will be used for local supply contingency.

As oil demand reaches 100 million barrels per day (MMB/d) in 2027 in HGS, an oil refinery with an initial capacity of 50 MB/d may be proposed to be built (assuming that about 40.0 percent of oil products supply will come from this facility based on 80.0 utilization rate). The capacity can be expanded to 100 MB/d in 2040 as projected oil demand rises to around 200 MB/d. In LGS, refinery may be considered in 2028 with a total capacity reaching 85 MB/d in 2040.

To improve Mindanao's gasoline station density (the number of gasoline station per city/municipality), the DOE together with the local government units (LGUs) must encourage oil companies to put up additional retail stations to cater for the unserved and underserved markets. This is seen to address the issue on "bote-bote" retail practice.

And to mitigate the effects of volatile prices in the world market, the DOE will step up its efforts to raise awareness on the efficient use of gasoline and diesel. In terms of its monitoring, enforcement and consumer protection activities, the DOE will inspect an average of 2,000 establishments (liquid fuels and LPG) nationwide until 2019.

On natural gas, the infrastructure projects needed to introduce the use of natural gas in Mindanao, initially for power generation, are being proposed, such as the Petroleum Brunei and Brunei LNG Onshore Power Plant in Misamis Oriental, the LNG Barge Mounted Power Project, and the Philippine National Oil Company–Exploration Corporation (PNOC-EC) Integrated LNG Receiving Facility in Davao City. In the power supply scenario of this plan, the entry of natural gas in the power generation necessitates the establishment of an LNG terminal with a total capacity of 2.5 million tons per year (Mtpy) by 2040 to fuel the 2,000 MW of natural gas power plants in HGS and 2.0 Mtpy for 1,800 MW in LGS.

In terms of policy development, the DOE is set to formulate an immediate policy agenda on the following:

a) Standards on LNG Terminal;
b) Transmission and Distribution Codes;
c) Safety Codes on Natural Gas Facilities; and,
d) Third Party Access Rules.

Power Development

Historically, Mindanao relied mainly on renewable sources for its power generation with more than half, as high as 65% in 2011, contribution to the total power generation mix of the island. However, the share of renewables decelerated over the years with the entry of additional capacities from coal power plants starting in 2015. In 2017, contribution from renewables stood at almost 40.0 percent of total power generation. With the island's abundant hydro resources, about 80.0 percent of generation from renewables had been sourced from hydro.

Currently, Mindanao is enjoying excess supply of power, more than enough to meet the present and short-term power supply requirements of the grid. However, the island's power demand is expected to significantly increase due to foreseen robust growth of its local economy, coupled with the construction boom from the *Build, Build, Build Program* of the government. As of December 2017, the committed power projects covering the period 2017-2025 in the island have a total capacity of 1,332.43 MW, about half coming from coal, while hydropower accounts for nearly 44.3 percent. On the other hand, indicative power projects stand at 1,980.62 MW, nearly 60.0 percent is coal power projects.

Several programs have been crafted for continuing implementation to ensure supply security and increase access to electricity, as follows:

Wholesale Electricity Spot Market (WESM). WESM Mindanao was formally launched on 28 June 2017 as a medium for efficient scheduling, dispatch and settlement of energy withdrawals and injections in the grid. Full commercial operation of WESM will commence once all criteria for such operation are fulfilled.

Mindanao-Visayas Interconnection Project. The implementation of the Mindanao-Visayas Interconnection Project, certified as an Energy Project of National Significance (CEPNS), is highly anticipated as the project will attain the goal of a one-grid Philippines. Under a unified grid, the country can expect more reliable power transmission services and less power interruptions due to sharing of excess (available) power supply.

Electrification Program. Electrification programs have been carried out in both on-grid and off-grid areas in the country. For on-grid, electrification programs include the barangay line enhancement, sitio electrification, electrification component of the financial benefits under the Energy Regulations (ER) 1-94, and the Nationwide Intensification of Household Electrification (NIHE). On the other hand, off-grid programs cover the Household Electrification Program (HEP) using renewables, solar PV mainstreaming under the Access to Sustainable Energy Program (ASEP) and Qualified Third Party (QTP) Program.

The "Task Force E-Power Mo" (TFEM) has been created to ensure that the remaining unserved and underserved communities within the franchise areas of the distribution utilities (DUs) and ECs are provided with access to electricity. Said Task Force is the overall overseer of the government's Total Electrification Program (TEP). The Total Electrification Master Plan is being finalized, which will serve as the framework for the development of a national unified strategy on total electrification. The government has set a target of 100.0 percent electrification for those households accessible to the grid by 2022.

Financial Benefits under E.R. 1-94. On the administration of funds under E.R. 1-94, the planning horizon will see the transfer of financial benefits directly to the DUs/ECs and to host LGUs and Indigenous Cultural Communities (ICCs)/Indigenous People (IPs) as provided under the Department Circular (DC) No. 2008-08-0021 issued by the DOE on 23 August 2018. The Electrification Fund (EF) component of E.R. 1-94 will be directly remitted to the DUs/ECs, while the Development and Livelihood Fund (DLF) and the Reforestation, Watershed Management, Health and/or Environment Enhancement Fund (RWMHEEF) will be remitted to the host LGUs and ICCs/IPs. An earlier Department Circular (DC 2018-03-005) was issued recognizing the rights of ICCs/IPs to the said financial benefits.

Agus-Pulangi Rehabilitation Project. The Agus-Pulangi Hydropower Complex is planned for rehabilitation to extend the service life and increase the facility's reliability and availability. The PhP50 billion rehabilitation project will take two years to complete, from 2020-2022.

Regional Cooperation. On ASEAN inter-region initiatives, the Brunei Darussalam-Indonesia-Malaysia-Philippines East ASEAN Growth Area (BIMP-EAGA) is looking at interconnecting the power transmissions of Borneo to the Philippines via two viable routes – Sabah-Luzon (via Palawan) and the Sabah-Mindanao (via Zamboanga).

Energy Outlook

With high economic growth prospects in Mindanao, total final energy demand (TFED) rises at 6.2 percent a year, on the average, in HGS within the planning period, a four-fold increase from 2017 level reaching 19,057 ktoe in 2040. Under LGS, TFED only expands at 5.0 percent annually translating to 14,791 ktoe in 2040.

Oil still remains as the dominant fuel with more than 40.0 percent share in TFED and growing at 6.3 percent and 5.6 percent a year in HGS and LGS, respectively. The transport sector demands about 85.0 percent of oil requirement of Mindanao in 2040. On the other hand, electricity shows a significant increase in projected demand at 9.8 percent in HGS and 7.3 percent in LGS annual growth rate. Its share to TFED climbs to 36.1 percent in HGS and 28.2 percent share in LGS at the end of the planning period, from 2017 level of 17.1 percent.

Bulk of the increase in TFED is attributed to the combined energy demand of Northern Mindanao and Davao regions, representing about half of the total demand of the island. In HGS, demand of these regions reaches 10,322 ktoe in 2040 from 2,650 ktoe in 2017. Such huge demand from these regions is due to their population size and contributions to the island's GRDP. Among the regions, Soccsksargen registers the fastest growth rate in demand at 7.1 percent (HGS) and 5.9 percent (LGS). Northern Mindanao has a potential to be a logistics hub being a host to the Laguindingan Airport and the Mindanao Integrated Container Terminal. Davao and Soccsksargen regions dominate in the areas of agro-industry and agricultural processing, and mineral resource development.

Sectoral Final Energy Demand Outlook. Over the planning period, the residential and transport sectors account for a combined average share of more than half of TFED. However, the share of the residential sector to TFED declines from 24.8 percent in 2017 to around 15.3 percent (both HGS and LGS) in 2040. The sector's demand only grows annually at 4.0 percent (HGS) and 3.0 percent (LGS) over the planning period as more households will have greater access to efficient and convenient fuel, such as LPG for cooking instead of biomass. Bulk of the energy consumption is electricity and biomass, comprising 95.0 percent of TFED of the sector. Residential demand for electricity increases a year at 7.9 percent (HGS) and 5.5 percent (LGS) taking into consideration the target of total household electrification by 2022, while biomass demonstrates a nil increase at around 1.0 percent a year. Among the biomass, fuelwood is used mostly by the sector with an average share of 63.5 percent to total biomass demand, followed by charcoal and agricultural waste.

The transport sector exhibits an increasing share to TFED from 33.2 percent in 2017 to 40.9 percent in HGS and 45.8 percent in LGS in 2040. However, the sector's energy demand slows down to 4.6 percent and 4.0 percent annual growth rate during the latter period from a high of 7.6 percent and 6.7 percent in 2025-2030, respectively. With positive outlook for the island's economy supported by improvements on household income and government investments on transport-related infrastructures, the demand for travel and transport of goods is projected to grow. As such, petroleum demand of the transport sector rises by more than four-fold over the planning period. Gasoline and diesel are the dominant petroleum products, accounting for around 90.0 percent of total oil demand of the sector. The sector's demand also includes electricity consumption for the Phase 1 of the Mindanao Rail Project (Tagum-Davao City-Digos), which is a 105-kilometer long and with an estimated demand of 280 gigawatt-hour (GWh) a year.

During the planning period, the gross value added (GVA) of the commercial sector (services) to the Mindanao's GRDP is expected to expand from 5.1 percent historical average annual growth rate to 9.6 percent (HGS) and 6.4 percent (LGS). With the improvement in the sector's GVA, its energy demand increases to 1,591 ktoe (HGS) and 1,163 ktoe (LGS) in 2040 from 460 ktoe in 2017. This translates to annual growth rate of 5.5 percent in HGS and 4.1 in LGS, higher than the 2010-2017 historical average of 3.2 percent.

On the other hand, the growth of energy demand of the industry sector in the past stood at 5.2 percent annually. From 1,461 ktoe TFED in 2017, the sector's demand expands to 6,431 ktoe and 4,329 ktoe at the end of the planning period in HGS and LGS, respectively. Historically, the average share of electricity demand to the sector's total energy demand was recorded at 23.0 percent. In the planning horizon, electricity consumption of the sector constitutes an average share of around 40.0 percent of total in both scenarios. Coal utilization likewise expands annually at 3.0 percent in HGS, while in LGS the growth is pegged at 1.8 percent annual average.

The agriculture sector demonstrates a big leap as energy demand grows at 6.2 percent (HGS) and 4.3 percent (LGS) a year from historical growth rate of 2.2 percent. The increasing energy demand of the sector is manifested in the development agenda of Mindanao with a focus on agro-industry strategy. The sector, the least energy user, shows an upward trend in its energy demand, from 81 ktoe in 2017 to 322 ktoe (HGS) and 216 ktoe (LGS) in 2040. Electricity consumption increases its average share from nearly 60.0 percent (historical) to 80.9 percent (HGS) and 72.8 percent (LGS), with annual growth rates of 8.4 percent (HGS) and 6.0 percent (LGS). Consumption of petroleum registers an

annual growth rate of 1.9 percent (HGS) and 1.6 percent (LGS) within the planning period, contributing an average share of 35.7 percent to total energy requirement of the sector.

Petroleum Products and Biofuels Demand Outlook. The growing oil demand in Mindanao is a manifestation of continued development and urbanization that result in increased economic activities, and thus requiring additional oil supply necessary for the delivery of products and services. The development agenda to transform Mindanao from merely agriculture to agro-industrial and industrialized island drives the demand for oil to rise significantly, a four-fold increase from 2017 level of 17,192 thousand barrels (MB) to 73,882 MB in HGS in 2040, translating to 6.3 percent annual growth rate. In LGS, oil demand rises at 5.6 percent a year reaching 63,598 MB in 2040.

All sectors demonstrate a steady increase in their oil demand over the planning, although both transport and industry show a declining growth post 2030. The share of the transport sector to total oil demand expands to nearly 85.0 percent in 2040 from 72.0 percent in 2017, registering a 7.3 percent growth rate in HGS and 6.6 percent in LGS equivalent to 62,395 MB and 54,109 MB at the end of the planning horizon, respectively.

The commercial sector oil demand displays an upward trend with an annual average rate of 3.8 percent (HGS) and 3.3 percent (LGS). Despite such growth, the sector's share to total oil demand decelerates, from 12.3 percent in 2017 to about 7.0 percent in 2040. The industry sector's demand registers a growth rate of 4.1 percent (HGS) and 3.4 percent (LGS) a year, but its shares slips down to around 6.0 percent of total in 2040 from almost 10.0 percent in 2017.

Diesel and gasoline have been the most consumed petroleum products, with a combined share of 80.0 percent (HGS and LGS) in total oil demand mix by 2040. The increasing number of fleet in the island pushes up the demand for both diesel and gasoline.

With the assumption of an increase in mandated bioethanol and biodiesel blends to 20.0 percent in 2020 and 2025, respectively, the demand for biofuels likewise rises in both scenarios with a share of 7.8 percent in 2040. Biodiesel and bioethanol grow annually at 5.0 percent and 8.4 percent in HGS, and 4.6 percent and 7.7 percent in LGS, respectively.

Coal Demand Outlook. Historically, the average share of Mindanao to the total coal consumption of the country was about 18.0 to 20.0 percent. For the planning period, coal demand of the island slows down from a historical average of 7.3 percent a year to 3.0 percent in HGS and 1.8 percent in LGS, and contributes 6.4 percent to TFED. Coal demand almost doubles from its 2017 level of 1,214 million metric ton (MMT) (@ 10,000 btu/lb) to 2,413.4 MMT (HGS) and 1,812.2 MMT (LGS). The increase in coal demand is due to projected increase in the economic activity of the industry sector, particularly for cement, steel, and food processing. About a quarter of the industry sector's energy demand in the island is coal, on the average, over the planning period.

Biomass Demand Outlook. Traditional biomass mostly consists of wood fuels, agricultural by-products and manure are used for cooking and heating purposes. With a higher economic growth target for Mindanao, the standard of living of the people improves, and thus a reduction in poverty incidence. As such, biomass utilization, as one of the primary fuels specifically for residential sector, weakens due to better economic condition and household income level, and expanding urbanization. Historically, biomass consumption grew annually at 2.4 percent and accounted for a significant share in TFED, around 23.5 percent of total in 2017. During the planning period, biomass displays a modest growth of 1.9 percent in HGS and 2.3 percent in LGS annually. Fuel wood is the most consumed with 80.0 percent average share to total biomass consumption of the island over the planning period.

Electricity Demand Outlook. With an annual average growth rate of 4.3 percent, electricity demand in Mindanao more than tripled from 1990 to 2017. Over the planning period, electricity demand continues to grow at 9.8 percent in HGS and 7.3 percent in LGS. Specifically, the rural-to-urban migration and economic growth are regarded as the major factors that determine the electricity consumption. The Household Final Consumption Expenditure (HFCE) in Mindanao is projected to grow at 8.3 percent (HGS) and 5.6 percent (LGS) a year during the planning horizon. This impacts the lifestyle of the households significantly, which leads to an expanded use of electricity in the residential sector by 7.9 percent a year in HGS and 5.5 percent in LGS. The electricity demand also considers the island's primary infrastructure projects such as the Mindanao Railway Project (MRP) as the first phase is expected to be completed by 2022. With 12-hour operation using a 4-Car Train, the MRP's estimated demand reaches 152 GWh in 2022, and further increases to 280 GWh as the system operates with an 8-Car Train by 2025.

Power Supply Outlook

Mindanao Grid

The significance of looking at various supply options arises from the fact that Mindanao's socio-economic landscape is expected to change within the planning period leading to significant increase in electricity demand. Assessing long-term supply requirements begins with examining demand. Once established, possible supply options may be drawn to augment existing supply and address the growing demand.

Demand Outlook

As discussed above, this plan presents two demand projections – the HGS and LGS. For HGS projection,

Mindanao's on-grid peak demand increases at 9.6 percent annually from 1,760 MW in 2017 to 2,364 MW in 2020, 5,916 MW in 2030 and 14,575 MW in 2040. In the LGS, peak demand rises to 8,632 MW in 2040 translating to an annual growth of 7.14 percent.

Electricity Consumption. In HGS, on-grid electricity consumption expands by eight-fold from 11,602 GWh in 2017 to 96,329 GWh in 2040 with an annual growth rate of 9.6 percent. Industry becomes the largest user of electricity by 2040 accounting for almost half of the total electricity consumption, surpassing residential post 2025. Residential customers comprise 20.1 percent of total at the end of the planning period. For the LGS, total electricity consumption rises about five-fold from its 2017 level reaching 57,016 GWh by 2040. Demand in LGS is around 40.0 percent lower compared with HGS.

Electricity Sales by Region. Aggregate electricity sales is expected to increase from 9,289 GWh in 2017 to 79,801 GWh in 2040, translating to a growth rate of 9.7 percent a year. Among the regions in Mindanao, Northern Mindanao and Davao both posted the highest sales with corresponding growth rates of 10.1 percent and 9.3 percent annually, respectively, during the planning period. The industry sector drives the electricity demand in both regions. On the other hand, electricity sales in LGS only reaches 47,225 GWh in 2040 with an annual growth rate of 7.2 percent.

Supply Outlook

Three scenarios were developed as possible options for power supply mix in Mindanao – *Reference, Alternative* and *Nuclear.*

The ***Reference Scenario*** implies that development strategies in the energy sector will continue. The scenario assumes that:

a) all committed power projects and RE-based indicative power projects (as of April 2018) will be completed; and
b) RE capacities from the awarded and pending RE service contracts (RESCs) will likewise be realized and provide additional power supply to grid.

The ***Alternative Scenario*** adopts the same assumptions from Reference, but takes into account the entry of additional variable renewables (VRE), solar with 1,500 MW capacity addition and wind with 750 MW, and additional hydro potential of 328 MW. This scenario also considers the entry of a 500-MW natural gas infrastructure by 2025, and the capacity increases further to 2,000 MW in HGS and 1,800 MW in LGS by 2040[1].

The ***Nuclear Scenario*** is guided with the premise that should the government decide to have a nuclear energy program for power generation in the country, a nuclear power plant in Mindanao with a capacity of 1,000-MW will be introduced and operational by 2035. Its entry is anchored on the assumption of a 10-year lead time given the process that need to undertake in developing nuclear for power generation. The island was identified as a potential candidate host/site for a nuclear plant back in 1996 by then Nuclear Power Steering Committee (NPSC). The sites identified are Siocon (Piacan and Cauit Point) in Zamboanga del Norte and General Santos in Sarangani as the candidate areas for the possible construction of nuclear power plant[2].

In all the scenarios, retirement of oil power plants is reflected. The retired oil plants can still be maintained and served as the government's security supply asset during the planning period. Some solar and biomass capacities will also be retired based on the assumed economic life of these plants.

Supply Scenario Results

Reference

In HGS, the total required capacity reaches 19,545 MW in 2040, about five times larger from 2017 level of 3,482 MW, equivalent to 16,947 MW of additional capacity. Mindanao's capacity requirement increases by 7.8 percent annually. Over the planning period, renewables account for about a half of total capacity in 2030, but gradually decelerates to 24.6 percent in 2040. Coal significantly expands its contribution to almost 70.0 percent of the capacity mix in 2040 from only around 40.0 percent in 2017.

Considering the Mindanao's committed power plants with a total capacity of 1,300.5 MW, the grid demand can be satisfied until 2023 based on the assumed capacity factor per technology. With the inclusion of indicative projects (829.3 MW), grid's demand can be met up to 2025.

As for LGS, the system's capacity requirement is down by 39.3 percent requiring only 12,370 MW by 2040 (with an annual growth rate of 5.7 percent). In terms of capacity mix, coal comprises 58.0 percent (7,170 MW) of total, equivalent to about half of the capacity from coal in HGS. As capacity addition from renewables is the same in both HGS and LGS, the share from RE climbs to 38.8 percent in 2040 (from 24.6 percent in HGS).

Electricity generation under HGS rises to 96,329 GWh in 2040, an eight-fold increase from 2017 level. For LGS, generation is 40.8 percent lower, reaching only 57,016 GWh in 2040. Coal dominates the power generation mix for both scenarios with a share reaching almost 80.0 percent (HGS) and 67.5 percent (LGS). Highest share from renewables is seen from 2018-2023 and 2026-2027 having an aggregate share of 40.0 – 46.0 percent (HGS)

[1] The assumption on natural gas entry in Mindanao is based on the PEP 2017 – 2040 and the ERIA Study titled "Seeking Optimal Solutions on Delivering LNG to Mid and Large Islands in the Philippines."
[2] Source: BNPP Presentation of NPC.

and from 2025-2030 at around 47.0 percent (LGS). At the end of the planning period, renewables account for 18.6 percent (HGS) and 31.4 percent (LGS) of the total generation.

Alternative

Mindanao's capacity mix becomes more diverse with the introduction of natural gas. Under HGS, renewables constitute 33.8 percent, natural gas accounts for 9.2 percent, and oil only comprises 3.6 percent of the capacity mix in 2040. Capacity from coal declines by almost 23.0 percent from Reference HGS, equivalent to 2,800 MW of displaced coal capacity as a result of natural gas coming into the system coupled with additional renewables. The total capacity addition in this scenario is higher at 19,225 MW compared with Reference HGS as attributed to the capacity additions from solar and wind (on top of the capacity added in Reference Scenario) with lower capacity factor.

Total capacity under LGS is 33.7 percent lower compared with HGS, but higher by 17.0 percent than the Reference LGS. Capacity reaches to 14,473 MW by 2040, growing at 6.4 percent a year. Renewables dominate the capacity mix providing a share of 51.0 percent, while natural gas expands its share to 12.4 percent, from only 9.2 percent in HGS. With higher shares from renewables and natural gas, coal capacity only rises to 5,070 MW. In this scenario, new additional capacity from coal totals 3,000 MW for the planning period. It is also observed that new capacities from oil power plants are seen during the latter part of the planning period (starting 2033) wherein more than half of the existing oil plants are assumed to be retired.

Natural gas accounts for 11.2 percent (10,820 GWh) of total generation under HGS, the same from its initial contribution in 2025. For LGS, it contributes 16.3 percent (9,285 GWh) to the total generation in 2040. With lower capacity from coal, its generation share at the end of the planning period slips down to 63.5 percent (HGS) from 79.7 percent in Reference HGS and 42.6 percent (LGS) from 67.5 percent in Reference LGS. Renewables yield 24.0 percent (HGS) and 40.6 percent (LGS) of total generation in 2040. Oil contribution for both scenario is minimal as natural gas and other renewables can also meet the peaking demand of the grid.

Nuclear

Mindanao's sources for power generation further diversifies with the entry of 1,000 MW nuclear power plant in 2035. Nuclear contributes 4.6 percent to total capacity mix, while natural gas provides 9.2 percent. Similar with Alternative HGS, renewables share stands at 33.8 percent of the capacity mix in 2040. On the other hand, coal still makes up a significant share of 49.3 percent, which is lower by 9.4 percent from Alternative HGS, while oil capacity addition also declines by 10.0 percent. In this scenario, total capacity requirement in 2040 is at 21,848 MW, a little higher compared with 21,823 MW in Alternative HGS.

In LGS, the system's total capacity requirement of 14,498 MW is 33.6 percent lower compared with HGS but 0.2 percent higher compared with Alternative LGS. For the capacity mix, renewables capture the largest chunk at 50.9 percent while natural gas, coal and nuclear energy get a share of 12.4 percent, 28.8 percent and 6.9 percent, respectively.

In terms of generation mix, the share of renewables accounts for 24.0 percent (HGS) and 40.6 percent (LGS), the same with Alternative Scenario. Nuclear produces 8.2 percent (HGS) and 13.8 percent (LGS) of total generation. Similarly, the share of nuclear pushes further down the share of coal to 56.0 percent (HGS) and 30.7 percent (LGS) from almost 63.5 percent (HGS) and 42.6percent (LGS) in Alternative.

Renewable Portfolio Standard Requirement

Given the influx of renewable investments in Mindanao as evident in the awarded RESCs, potential power generation from new RE-based capacity can provide a portion or fully satisfy the RPS requirements of the grid starting 2020 as mandated by law. The projected generation from new RE as exhibited in the three supply scenarios for 2020, 2030 and 2040 could be enough to cover the RPS requirement for the planning period. The generation for 2030 in the three scenarios reaches 7,905 GWh (Reference) and 9,175 GWh (Alternative and Nuclear). In 2040, projected generation stands at 12,400 GWh (Reference) and 17,647 GWh (Alternative and Nuclear).

Impact of Mindanao-Visayas Interconnection

The Mindanao-Visayas Interconnection Project (MVIP) is one of the significant energy projects that will have an immense impact on the Mindanao grid, particularly on its power supply situation.

As stated in the Transmission Development Plan (TDP), the MVIP has both tangible and intangible benefits. Tangible benefits include sharing of system reserves/ excess supply, lesser investment in power generation in either grids to maintain the one-day Loss of Load Probability (LOLP) and reduction in operating cost due to economic dispatch of generators. The intangible benefits meanwhile are:

a) attractiveness of the MVIP to power generation investments due to the bigger market created by an interconnected network;
b) added supply security, improved system reliability and improvement in quality of power supply; and
c) optimized utilization of indigenous resources. The interconnection project is scheduled to commence by 2020.

Scenario Implications

The different power supply scenarios offer power capacity and generation option(s) for Mindanao. Each scenario

has some implications in terms of cost, environmental sustainability, supply diversity and self-sufficiency.

In Reference Scenario, blended rate per kilowatt-hour (KWh) of electricity is at USD 0.102/KWh in 2040, which is at the same level as in Alternative Scenario but lower than in Nuclear Scenario. The Nuclear Scenario has the highest rate at USD 0.106 in HGS. However, in LGS, the Alternative Scenario has the lowest rate at USD 0.098/KWh followed by Nuclear Scenario with USD 0.099/KWh, which could be attributed to greater reduction of capacity requirement from coal. Reference Scenario in LGS has the highest rate at USD 0.100/KWh.

As coal dominates in Reference Scenario, carbon dioxide (CO_2) emission level is at the highest level among the scenarios at 61.52 million ton of CO_2 equivalent ($MTCO_2$) in HGS and 31.08 $MTCO_2$ in LGS. Nuclear Scenario offers the lowest CO_2 emission level at 46.79 $MTCO_2$ (HGS) and 17.18 $MTCO_2$ (LGS).

Nuclear Scenario also presents the highest self-sufficiency level at 32.2 percent (HGS) and 54.4 percent (LGS) and with highly diversified generation mix, thus the scenario poses greater supply security among the other scenarios. Similar to other countries, nuclear is considered indigenous even if uranium is sourced overseas.

Small Island Grids

Consistent with the administration's thrust to expand energy access and achieve full household electrification, off-grid energy development is essential to realize the government's aspiration of promoting inclusive economic growth and developments at the grassroots level.

Under the HGS, electricity consumption is projected to grow from 256 GWh in 2017 to 1,598 GWh in 2040 with an average annual growth rate of 8.5 percent. For the LGS, the demand is expected to be 30.0 percent lower having a total of only 1,139 GWh by 2040. For both scenarios, the share of each sector to the total electricity consumption remains almost the same. Majority of the electricity demand comes from the residential sector representing an average share of about 75.0 percent, followed by commercial and "others" sector with a combined share of around 11.0 percent. The industry sector only requires less than 1.0 percent of total. From an average 19.2 percent in 2017, it is anticipated that system loss declines annually at 0.6 percent, on the average, reaching the 12.0 percent level by 2030, and eventually further reduces to 10.0 percent in 2040.

Under the NPC's Missionary Electrification Plan 2018-2022, several generation capacity additions are programmed to be in operation in response to the increasing electricity demand in some of the missionary areas in Mindanao. Among the regions, ARMM has the largest capacity addition of 48.3 MW out of the total of 67.8 MW. Potential solar PV has also been identified as part of hybridization of existing diesel power plants. To widen energy access and improve electricity services, the plan also targets to increase the operating hours in certain areas to 8 hours, 16 hours, and up to 24 hours depending on the demand requirements in the area. Majority of the areas to receive increase and full service operations between 2018 and 2019 will be in ARMM.

Investment

Mindanao's investment portfolio underscores the required monetary resources in financing key energy infrastructures that are crucial in spurring energy development in the island region. In a liberalized energy industry, private investors are expected to infuse the much needed capital to revitalize the island's entire energy system.

In HGS, the overall investment requirement under Investment Option 1 which considers on-shore LNG facility reaches USD 34.3 billion in the Reference power supply scenario; USD 35.8 billion in the Alternative power supply scenario; and USD 38.6 billion in the Nuclear power supply scenario. These projected costs are lower by 35.0 to 45.0 percent in the low growth assumption, estimated at USD 21.5 billion in the Reference supply scenario; USD 22.8 billion in the Alterative supply scenario; and USD 25.7 billion in the Nuclear supply scenario.

Alternatively, Investment Option 2 which considers floating storage regasification unit (FSRU) facility in lieu of a land-based LNG terminal offers a much lesser capital requirement, given the technology's low upfront cost. Under this option, the total required investment can be trimmed down by USD 575.0 million and USD 460.0 million in the high and low growth scenarios, respectively.

By subsector, bulk of the investment needs (roughly 80.0 percent on the average) are concentrated to the power sector, that is essential in financing capital-intensive transmission and generation facilities to secure a balanced and reliable power system. The remaining portion is allotted to downstream investments, comprising oil and natural gas infrastructure projects.

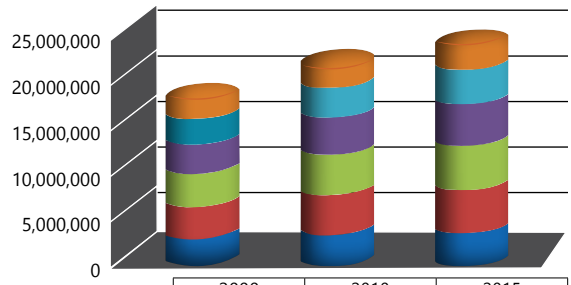
I. SOCIO-ECONOMIC PROFILE

Bounded by the Sulu Sea to the west, the Philippine Sea to the east, and the Celebes Sea to the south, **Mindanao** is largely mountainous but is surrounded by seas. The island has a unique atmosphere with exceptional landmarks and exotic attractions. It has refreshing, cool springs, majestic waterfalls, beautiful lakes and forests, rugged mountains with mysterious caves and mighty rivers. Being the second largest island in the Philippines, Mindanao has a total land area of 102,022 square kilometer (km^2) and composed of six (6) regions and 27 provinces.

POPULATION GROWTH

Based on Philippine Statistical Authority (PSA) data in August 2015, it registered a population of 24,135,775 accounting for 23.9 percent of the country's overall population. The 2015 population is higher by 2.2 million compared with the population of 21,968,174 in 2010, and by 6.1 million compared with the population of 18,133,863 in 2000. It increased by 1.90 percent annually, on average, during the period 2010 to 2015. By comparison, the rate at which the island's population grew during the period 2000 to 2010 was higher at 2.9 percent.

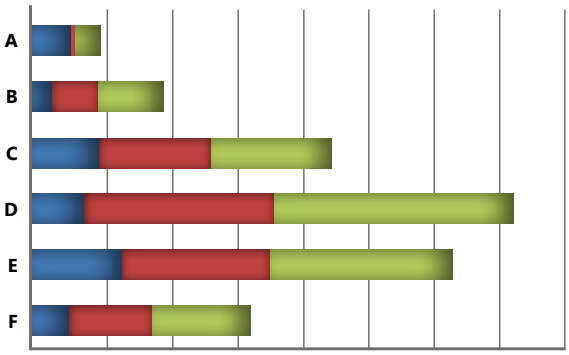
Figure 1. MINDANAO's POPULATION



	2000 CENSUS	2010 CENSUS	2015 CENSUS
Caraga	2,095,367	2,429,224	2,596,709
ARMM	2,803,045	3,256,140	3,781,387
SOCCSKSARGEN	3,222,169	4,109,571	4,545,276
Davao Region	3,676,163	4,468,563	4,893,318
Northern Mindanao	3,505,708	4,297,323	4,689,302
Zamboanga Peninsula	2,831,412	3,407,353	3,629,783

Among its regions, Davao Region (Region XI) and Northern Mindanao (Region X) are the most populated accounting for 20.3 percent (4,893,318) and 19.4 percent (4,689,302), respectively. The Autonomous Region in Muslim Mindanao (ARMM) was the fastest growing region with an average annual population growth rate of 2.9 percent.

Figure 2. MINDANAO's 2017 GRDP



		Agriculture, Hunting, Forestry & Fishing	Industry Sector	Service Sector
A	ARMM	30,771	3,206	20,538
B	CARAGA	16,386	35,262	51,053
C	SOCCSKSARGEN	53,052	84,936	92,610
D	DAVAO REGION	41,388	144,806	183,603
E	NORTHERN MINDANAO	69,888	112,947	140,174
F	ZAMBOANGA PENINSULA	29,373	63,817	75,512

ECONOMIC INDICATORS

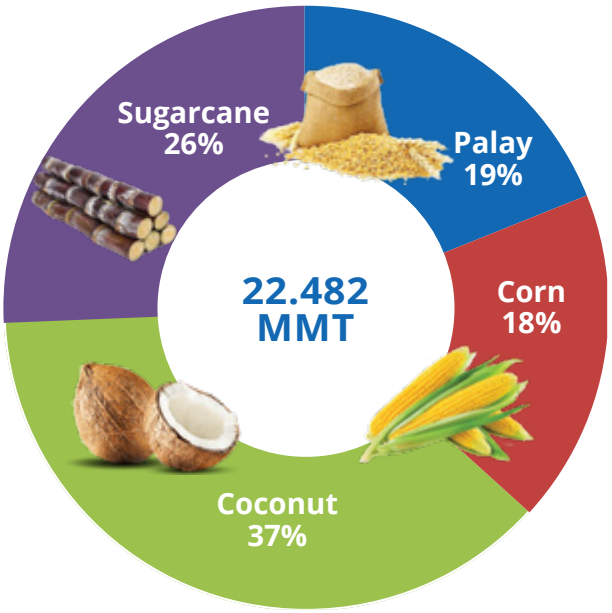
In terms of economic performance in 2017, the Gross Regional Domestic Product or GRDP (at constant 2000 prices) of Mindanao stood at PhP 1,249.3 billion. The island's economy posted a 7.1 percent growth in 2017, from a 6.3 percent growth in 2016 driven by the faster growth of Services and Industry sectors. *Services* sector accounted for 45.1 percent of the island's GRDP, while the *Industry* sector recorded a share of about 35.6 percent. *Agriculture, Hunting, Forestry and Fishing* sector comprised for almost 20.0 percent of the island's economy. These major industries are significant contributors to the economic development and export performance of the country.

Davao continued to have the largest share at 29.6 percent (PhP 369.8 billion), followed by Northern Mindanao with 25.9 percent share (PhP 323.0 billion).

Mindanao continues to improve its **agricultural performance** despite the occurrence of natural calamities (i.e., typhoons), which affect the food and crop production. It provides substantial contribution to the country's food security making the island as the agricultural basin of the Philippines. Based on PSA 2018 report, agricultural output of the region was recorded at 22,482,068 metric tons. Leading agricultural crops include coconut, sugarcane and palay contributing 37.5, 25.7, and 18.9 percent shares, respectively. Banana, pineapple, mango and coffee are the other major crops.

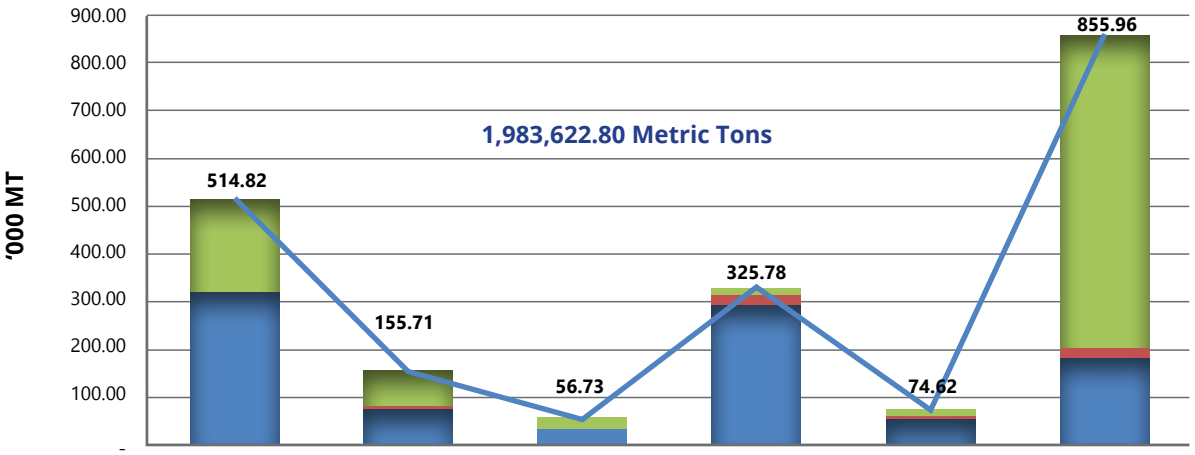
Mindanao is also fortunate to have diverse marine resources with a wide variety of species, fish and seafood supplies. The fisheries industry constitutes *marine fisheries, inland fisheries,* and *aquaculture* coming from brackish water fishpond, freshwater fish cage/fishpond, marine pen and other seawater resources like oyster, mussel and seaweed. In 2017, about 1,983,623 metric tons was produced from the island's aquaculture and marine resources. Majority of the production was sourced mainly from ARMM, Zamboanga Peninsula and Soccsksargen.

Figure 3. 2017 AGRICULTURAL PRODUCTION



Mineral resources like silver, gold, copper, iron, chromium, nickel, cobalt, manganese, limestone, sand and gravel are also abundant in Mindanao. High-interest mining areas are Eastern Mindanao, North- Central Mindanao, Zamboanga Peninsula and Southeastern Mindanao. The Gross Value Added (GVA) of Mining and Quarrying sector at 2000 constant prices in 2017 was at 26.21 billion, about 2.1 percent of the Mindanao's GRDP.

Figure 4. 2017 FISHERIES PRODUCTION



	Zamboanga Peninsula	Northern Mindanao	Davao Region	SOCCSKSARGEN	Caraga	ARMM
Aquaculture	195.14	74.52	24.62	12.76	15.22	653.21
Inland	1.03	3.82	0.21	20.16	4.20	22.21
Marine	318.65	77.37	31.90	292.86	55.21	180.53
Total	514.82	155.71	56.73	325.78	74.62	855.96

II. KEY ASSUMPTIONS, PARAMETERS AND METHODOLOGIES

KEY MACROECONOMIC ASSUMPTIONS, PARAMETERS AND METHODOLOGY

The energy outlook defines the potential long-term energy demand and supply scenario in Mindanao, which covers the period 2018 to 2040. The outlook will aid the region to addressing the energy supply requirements for a higher economic target as espoused in the **Mindanao 2030 and Mindanao Development Corridors**.

In demand projection, the historical period covering 1990 to 2017 served as the foundation for energy demand outlook. Historical data on energy demand (e.g. regional sales) and socio-economic indicators like gross regional domestic products (GRDP) or gross value added (GVA), demographic profile, household income and expenditure, energy prices, and other relevant data formed the working database used to assess the energy situation and the bases for projections on the region's final energy demand by economic sector (i.e., residential, industry, commercial and others) and fuel type.

In the process of doing the outlook, difficulties emerged due to limited data availability and data collection. The accounting of energy consumption at the regional level (i.e. Region IX to ARMM) for the types of fuel consumed by the economic sector is still a field that is relatively undeveloped. To address this concern, disaggregation from national level data using the Energy Balance Table as reference was undertaken to come up with regional energy data based on Mindanao's shares to national including the sectors' profiles (industry, commercial and agriculture). For biomass, the reference for disaggregation from national data is the Household Energy Consumption Survey (HECS) results.

Demand models were provided for each type of fuel or energy consumed in Mindanao using the following parameters:

- ***Estimation of Electricity Consumption.*** Demand for electricity was generated from elasticity of electricity consumption to economic growth. Such estimation means that a percentage change in electricity consumption to realize a one percent change in GRDP was considered and assumed to be **0.80 to 1.00** over the planning period.

  For sectoral electricity consumption, regression analysis was applied using the indicators (explanatory variables) mentioned as above for projection and done on per regional basis. From the results, the shares per region and each economic sector were obtained and used to split the total Mindanao electricity demand (estimated from elasticity) to arrive at the regional and per economic sector demand. As a result of econometric modeling, the share per economic sector changes in the planning period in some regions due to projected significant growth in industry and commercial, and even in agriculture. The projection for household electricity demand considered the government target of 100.0 percent electrification level by 2022 (based on the 2015 census), and full electricity level in 2030 (based on projected number of household in the same year).

- ***Estimation of Petroleum Consumption by Product Type.*** From the National Energy Balance Table, the Mindanao petroleum consumption is prorated from the national data using sales data. Petroleum demand was divided into transport and non-transport. For each segment, the demand is measured on per fuel basis – gasoline, diesel, LPG, Kerosene, fuel oil, Avgas and Jet fuel.

  For transport, petroleum demand was projected for each of the three (3) modes – road, air and water. For future demand levels of land transport, the following indicators were considered: number of vehicles per type of fuel used, fuel efficiency and mileage, fuel conversion, and number of households. As for water and air transport petroleum demand model, variables such as number of passengers, cargo loads, capacity factor/information (i.e. aircraft movements, number of ship calls/vessels), and sectoral value-added were considered. Meanwhile, the non-transport comprises residential, commercial, industry, and agricultural sectors. Demand for petroleum of residential sector was generated from computed intensity – residential petroleum demand over household final consumption expenditure (HFCE) when explanatory variables failed to get acceptable results. In some cases, residential demand per capita was estimated and used for the projection.

  Of the remaining, the other sectors' (industry, commercial and agriculture) petroleum consumptions were estimated based on their shares (proportion) in the total national petroleum demand. In other instances, demand intensity was estimated vis-à-vis GVA of the sectors.

- ***Estimation of Biomass Consumption.*** Mindanao regional data is disaggregated using the profile of distribution from the 2011 HECS data. The total demand for biomass was divided into residential and non-residential (commercial and Industry) uses. For residential, consumption data was obtained by getting its proportion from the total national demand by fuel type (fuelwood, charcoal and agriwaste) based on the profile indicated in HECS data. Similarly, industry and commercial demands were generated from total national (share/ proportion). In general, biomass demand of both industry and commercial sectors exhibits the same consumption pattern with the residential sector because demand is assumed to be dependent on the availability of resources.

  In residential sector, biomass demand per fuel type was simulated on a per capita basis. Further, household income and HFCE were used in modelling residential demand. For commercial and Industry demand model, the GVA was regressed with the consumption pattern.

- ***Estimation of Coal Consumption.*** Consumption of coal is purely for industry use. In forecasting the demand for coal, the growth of demand is based on the elasticity of industry consumption to growth of the sector in terms of its GVA. This means that the percentage change in coal consumption to realize a one (1) percent change in industry GVA is assumed to be **0.70** over the planning period.

Two (2) demand scenarios were formulated for the Mindanao Energy Plan – the **High Growth Scenario (HGS)** and **Low Growth Scenario (LGS)**. In LGS, the region's share to the national economic growth rate (Real GDP) target was adopted, while HGS used the Mindanao 2020 regional growth rate target. Regression analysis was employed to determine the historical relationship between final energy demand by sectors and the explanatory socio-economic variables. The regression analysis produced a set of sectoral energy consumption model equations, relating the energy consumption by sectors with corresponding socio-economic variables.

For power supply planning, three (3) scenarios were formulated – Reference, Alternative and Nuclear. In each scenario, supply is simulated both for HGS and LGS. *Please see more discussion in Power Outlook*.

ECONOMIC GROWTH

"The Philippines by 2040: matatag, maginhawa, at panatag na buhay. The country is a prosperous middle-class society where no one is poor. People live long and healthy lives and are smart and innovative. The Philippines is a high-trust society where families thrive in vibrant, culturally diverse, and resilient communities."

- AmBisyon Natin 2040

The Philippine Development Plan (PDP) 2017-2022 is the first medium-term plan anchored on the 10-point Socio-economic Agenda that is geared towards the Ambisyon Natin 2040. The Ambisyon articulates the Filipino people's collective vision of a "*MATATAG, MAGINHAWA, AT PANATAG NA BUHAY PARA SA LAHAT.*" It also takes into account the country's international commitments such as the 2030 Sustainable Development Goals. The PDP aggressively set the country's annual growth to be 7.0 to 8.0 percent annually. **The Philippine Development Plan (PDP) 2017-2022** has explicitly stated the overall targets in terms of economic growth. Specifically, the plan intends to achieve the following:

- The Philippines will be an upper middle-income country by 2022. In the medium-term, GDP growth is expected to strengthen further to 7.0 – 8.0 percent, in real terms. This means that the economy will expand by about 50.0 percent by 2022 from its base in 2016. Per capita income will increase from USD 3,550 in 2015 to at least USD 5,000 in 2022.

- Growth will be more inclusive as manifested by a lower poverty incidence in the rural areas, from 30.0 percent in 2015 to 20.0 percent in 2022. Overall poverty rate will decline from 21.6 percent to 14.0 percent in 2022 – equivalent to lifting about 6 million Filipinos out of poverty. The proportion of subsistence poor individuals will fall from 8.1 percent to 5.0 percent. Food inflation will also be closely monitored, to serve as an early warning indicator on the welfare of the poor. It should not go beyond the bounds set for overall inflation, which is at 2.0 to 4.0 percent.

With a growing economy, the Philippines requires more and better selected infrastructure investments, given its archipelagic landscape, expanding population and rapid urbanization. To support a higher growth trajectory and improve the quality of life in both urban and rural communities, infrastructure development will remain among the top priorities of the government over the medium-term. Spending on infrastructure has to be intensified while addressing persistent issues and challenges hampering implementation, so that the so-called "Golden Age of Infrastructure" will form part of a solid foundation for reaching the country's long-term vision.

ECONOMIC DEVELOPMENT

The average annual growth rate of the country's real GDP from 2010 to 2017 was at 6.1 percent, an improvement from the 4.8 percent annual growth rate recorded for 2000 to 2010. This growth was fueled by domestic demand in terms of investment and consumption. Over the same period, there was continued robust expansion in investments, which grew by 11.5 percent per annum. Government financial consumption expenditures (GFCE) or public investment in infrastructure remained strong expanding by 6.9 percent, faster than the 3.4 percent growth in the period 2000 to 2010. HFCE accounting for 69.0 percent of the country's total output continued

to grow faster at the annual growth rate of 6.1 percent compared to 4.3 percent registered in 2000 to 2010.

The economic growth of the country is expected to have spill over effects in the countryside. Therefore, the domestic economy of Mindanao will likely to experience an accelerated growth. Mindanao's domestic economy posted growth rates of **6.3 percent** and **7.2 percent in 2016** and **2017**, respectively. The island's average share to total GDP was about 14.3 percent from 2010-2017. Mindanao's economy grew faster at 6.4 percent average annual growth rate than the national average of 6.2 percent from 2010-2017.

The path towards national development entails contributions from the various economic sectors in the country. According to the National Economic and Development Authority (NEDA), this is attributed to high consumer confidence, modest inflation and interest rates, and improving labor market conditions. The Philippines' demand for energy is increasing rapidly because of population and economic growth. This is especially evident in emerging regional economies. As the country aims to reduce regional disparities by supporting (employment and wealth-generating) economic activities, a high level of development requires a sustainable and reliable energy supply.

Energy development is a fundamental part of economic development. The correlation among energy, other inputs, and economic activity noticeably change significantly as an economy transforms through different stages of development.

As the Philippine economy will remain robust in 2018 and beyond particularly that the outlook on the global economy is becoming more optimistic, GDP is expected to grow by around 6.1 percent on average from 2018 to 2040. With the future growth trend of the country's economy, there is a strong focus on Mindanao's progress and transformation. Over the planning period, Mindanao's GRDP is projected to increase by ten-fold, from PhP 1.2 trillion in 2017 to around PhP 10.7 trillion by 2040 under HGS following higher economic target as espoused in the Mindanao 2030 and Mindanao Development Corridors. It is seen to grow at 7.0 percent annually from 2020-2025, 10.0 percent from 2025-2030, and drops to 9.5 percent over the next decade between 2030 and 2040. (Table 1). For LGS, GRDP growth rate decelerates at 6.1 percent a year on the average over the planning period (Table 2).

Table 1. GROSS REGIONAL DOMESTIC PRODUCT LONG-TERM PROJECTION 2018-2040 – High Growth Scenario (Trillion Pesos @ 2000 constant Prices)

Region	Outlook							Growth Rates (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs'17	2018-'40	2020-'25	2030-'35	2030-'35	2035-'40
Philippines	8.7	9.3	10.6	14.9	20.3	27.2	36.4	7.0	6.1	5.0	6.4	6.0	6.0
Mindanao	1.2	1.4	1.7	2.7	4.3	6.8	10.7	10.2	9.3	7.0	10.0	9.5	9.5
Region IX	0.2	0.2	0.2	0.3	0.4	0.5	0.7	7.0	6.1	5.0	6.4	6.0	6.0
Region X	0.3	0.3	0.4	0.6	0.9	1.2	1.7	8.2	7.2	5.8	7.5	7.0	7.0
Region XI	0.4	0.4	0.5	0.8	1.2	1.9	2.8	10.1	8.8	7.1	9.2	8.6	8.6
Region XII	0.2	0.2	0.3	0.4	0.6	0.8	1.1	7.7	6.7	5.4	7.0	6.6	6.6
CARAGA	0.1	0.1	0.1	0.2	0.3	0.4	0.6	8.2	7.2	5.8	7.5	7.1	7.1
ARMM	0.1	0.1	0.1	0.1	0.1	0.1	0.1	4.2	3.7	3.0	3.9	3.6	3.6

Table 2. GROSS REGIONAL DOMESTIC PRODUCT LONG-TERM PROJECTION 2018-2040 – Low Growth Scenario (Trillion Pesos @ 2000 constant Prices)

Region	Outlook							Growth Rates (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs'17	2018-'40	2020-'25	2030-'35	2030-'35	2035-'40
Philippines	8.7	9.3	10.6	14.9	20.3	27.2	36.4	7.0	6.1	5.0	6.4	6.0	6.0
Mindanao	1.2	1.3	1.5	2.1	2.9	3.9	5.2	7.0	6.1	5.0	6.4	6.0	6.0
Region IX	0.2	0.2	0.2	0.3	0.3	0.4	0.5	5.7	4.9	4.0	5.1	4.8	4.8
Region X	0.3	0.3	0.4	0.5	0.7	1.0	1.3	6.7	5.8	4.7	6.1	5.6	5.6
Region XI	0.4	0.4	0.5	0.7	1.0	1.4	2.0	8.3	7.1	5.8	7.5	7.0	6.9
Region XII	0.2	0.2	0.3	0.4	0.5	0.7	0.9	6.9	5.9	4.8	6.2	5.8	5.7
CARAGA	0.1	0.1	0.1	0.2	0.2	0.3	0.5	7.4	6.3	5.2	6.6	6.2	6.2
ARMM	0.1	0.1	0.1	0.1	0.1	0.1	0.1	3.7	3.2	2.6	3.3	3.1	3.0

DEMOGRAPHICS

This analysis draws population assumptions from the Philippine Statistical Authority (PSA). On the average, the country's population is growing at an average annual growth rate of 1.7 percent from 2010 to 2017. About 22.8 percent of the country's population is living in Mindanao and growing at almost at the same rate as the national average. The outlook assumes that population of the island shall increase from 24.7 million in 2017 to 34.7 million persons in 2040, translating to an annual growth rate of 1.4 percent. Regional population growth rate is seen to decelerate in the succeeding five-year interval to 1.5 percent in 2025-2030, 1.3 percent in 2030-2035, and 1.1 percent in 2035-2040 (Table 3). Consequently, the population density in Mindanao of 216 persons per square kilometer in 2017 is projected to reach 330 persons per square kilometer by 2040.

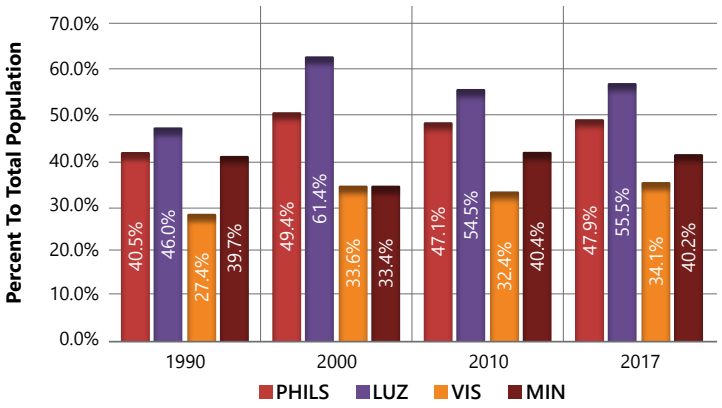
Table 3. POPULATION PROJECTION 2018-2040, By Region (million persons)

Region	Outlook							Growth Rates (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs'17	2018-'40	2020-'25	2030-'35	2030-'35	2035-'40
Philippines	108.2	110.1	113.8	122.8	131.3	139.3	146.4	1.7	1.2	1.1	1.4	1.2	1.0
Mindanao	24.7	25.2	26.1	28.5	30.7	32.8	34.7	1.9	1.4	1.2	1.5	1.3	1.1
Region IX	3.8	3.8	3.9	4.3	4.6	4.9	5.1	1.7	1.3	1.1	1.4	1.2	1.0
Region X	4.8	4.9	5.1	5.4	5.7	6.0	6.2	1.5	1.0	1.0	1.1	0.9	0.6
Region XI	4.7	4.8	5.0	5.4	5.8	6.2	6.5	1.8	1.3	1.2	1.4	1.2	1.0
Region XII	4.7	4.8	5.0	5.4	5.8	6.2	6.6	1.9	1.4	1.2	1.5	1.3	1.1
CARAGA	2.7	2.8	2.9	3.2	3.4	3.7	4.0	2.0	1.6	1.4	1.7	1.6	1.4
ARMM	4.0	4.1	4.3	4.8	5.3	5.9	6.4	2.5	2.0	1.7	2.2	1.9	1.7

Energy demand in the country has been growing through the years with rapid urbanization, increased industrialization and economic growth. Mindanao, as a potential area for growth, is characterized by migration from rural areas to urban centers (Figure 5). This is one of the key fundamentals of energy demand since it reflects the behavioral landscape of energy consumers as any changes in socio-economic conditions will lead to higher demand as energy becomes more accessible. In most regions in Mindanao, rising urbanization drives up energy use. People in urban Mindanao areas, particularly in Highly Urbanized Cities (HUC)[1] of Butuan, Cagayan de Oro, Davao, General Santos, Iligan and Zamboanga - consumed significantly higher levels of energy than those in rural areas because of differences in lifestyles and demand for higher comfort levels. In Mindanao regions, estimated urbanization rates range from as low as 13.0 percent in Autonomous Region for Muslim Mindanao (ARMM) to above 40.0 percent in Zamboanga Peninsula (Region IX), Northern Mindanao (Region X) and Soccsksargen (Region XII) regions, compared with most Philippine regions having urbanization rates well above 40.0 percent.

With significantly higher levels of energy consumption in urban versus rural areas, this trend towards increasing urbanization puts pressure on energy demand in regional development of Mindanao, underscoring the importance of effecting more energy-efficient urban design strategies. Urban planners should foster the growth of more well-organized cities with good public transport networks and highly energy efficient buildings, rather than sprawling urban areas in which congestion tends to be high.

Figure 5. MINDANAO URBANIZATION LEVEL VIS-À-VIS PHILIPPINES, 1990 – 2017



FUEL PRICE

The crude oil price assumption was sourced from the World Bank (WB) projections as a proxy for international oil prices.

Recent Developments. Oil remains as the leading fuel in the Philippines, accounting for 34.2 percent of total primary energy supply (TPES). As a developing and emerging economy, oil continued to dominate the growth in local energy consumption. On the average, the growth in the country's oil demand over the last 27 years (1990-2017) was 5.0 percent. Oil price booms and busts in the past affected the Philippines mainly because it is a net importing country. Given this, the traditional view is that the Philippines enjoys a net economic benefit from gradual decreases in crude oil prices and suffers a net hit when prices increase.

Table 4. WORLD ENERGY PRICES

Energy Fuel Price	Actual				Growth Rates (in %)			
	1990	2000	2010	2017	1990-2017	1990-2000	2000-2017	2010-2017
Dubai Crude ($/barrel)	20.73	26.09	78.06	53.10	3.5	2.3	-2.2	-5.4
Coal, Indonesia ($/tonne)	37.50	24.82	100.24	85.92	3.1	-4.0	-0.9	-2.2
LNG, Asia ($/million Btu)	3.64	5.24	9.38	8.61	3.2	3.7	-0.5	-1.2
GDP, PPP (current international Trillion $)	28.80	48.53	89.00	127.57	5.7	5.4	2.1	5.3

Source : Dubai Crude Oil and LNG - World Bank Commodity Market Prices (Annual 2018 Report)[2]; Indonesia Coal - Indonesia Investments[3]

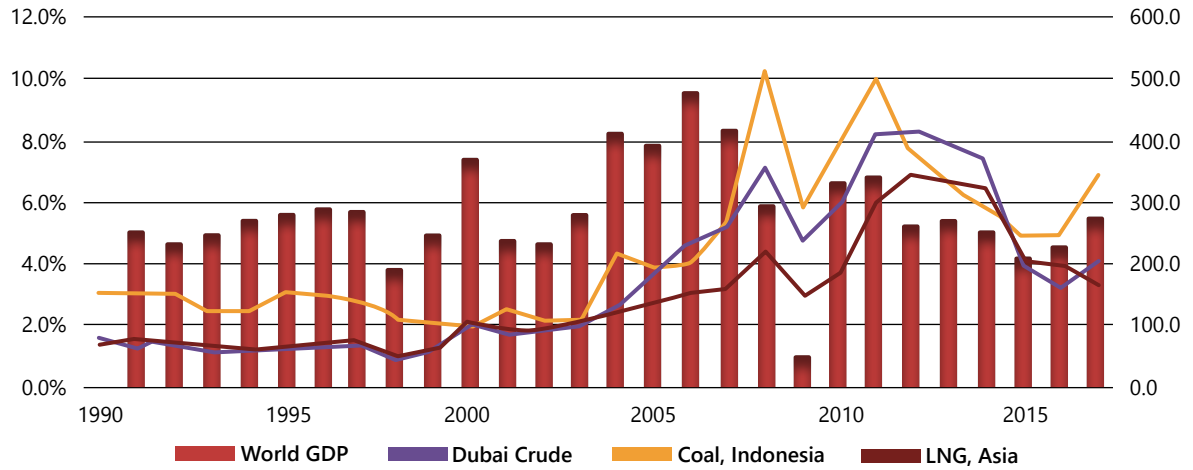
[1] Highly Urbanized Cities are local government units autonomous from provinces that have a minimum population of 200,000 and an annual income of at least ₱ 50 million (in 1991 constant prices)

[2] Updated on January 04, 2019

[3] https://www.indonesia-investments.com/news/todays-headlines/benchmark-coal-price-of-indonesia-near-six-year-high-in-march-2018/item8637?

Over the last 27 years, the price per barrel of Dubai crude oil increased annually at 3.5 percent (Table 4 and Figure 6). During the recent years, it experienced major shocks as it dwindled to approximately 5.4 percent on the average from 2010 to 2017. By the end of 2017, the average oil price per barrel of the Dubai crude had fallen by almost 32.0 percent from a high of $78.06/barrel in 2010. Similarly, prices of natural gas and coal had also declined. Natural gas price fell to $8.61 per million BTU[4] from $9.38 in 2010, a reduction of 8.2 percent. On the other hand, coal price declined by 16.8 percent from $100.24 per tonne in 2010 to $83.44 in 2017.

Figure 6. ENERGY PRICE INDEX AND WORLD GDP GROWTH



Source: Indexed using the World Bank Commodity Market Prices (2018)

Future Expectations. Developing future expectation on fuel prices is very challenging as a number of factors influence international price movement (e.g. future economic growth rates across the world, development of new technologies, global climate change policies, technological developments and strategies of resource holders). In this report, a set of price assumptions were taken based on available descriptive evidences of the trend and development over time which may provide a potential pattern of a plausible price range over the planning period (2018-2040). These assumptions are necessary to anticipate the uncertainties of fuel prices in the long-term scenario.

The World Bank (2018) reported that for crude oil, prices have been supported by a combination of robust demand and supply concerns. Production continues to fall in Venezuela, while the impact of U.S. sanctions on Iranian oil exports is projected to be higher than in 2012. Capacity restrictions among OPEC members and the decline in 2018 stocks hint the oil market, which is rather constricted at present and thus prices are vulnerable to supply shocks. Dubai crude oil prices are projected to increase to $71.1/bbl in 2019 from $69.2/bbl in 2018, before easing to $66.27/bbl in 2020. Coal and natural gas prices have been sustained by robust demand resulting from unusually hot temperatures in Asia and Europe, which heightened demand for electricity, but prices are expected to moderate in 2019.

Table 5. ENERGY PRICE PROJECTIONS

Region	Outlook							Growth Rates (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs'17	2018-'40	2020-'25	2030-'35	2030-'35	2035-'40
Dubai Crude ($/barrel)	53.12	69.15	66.27	66.75	67.23	67.71	68.20	30.2	-0.1	0.1	0.1	0.1	0.1
Coal, Indonesia ($/tonne)	85.92	93.98	90.55	91.13	91.70	92.28	92.87	9.4	-0.1	0.1	0.1	0.1	0.1
LNG, Asia ($/million Btu)	8.61	10.65	9.05	10.43	10.65	10.86	11.08	23.7	0.2	2.1	0.4	0.4	0.4
GDP, PPP (current international Trillion $)	127.57	135.20	151.75	198.20	252.47	317.89	395.62	6.0	4.8	3.9	5.0	4.7	4.5

Source: Dubai, Coal and LNG projections estimated based on growth rates published in a World Bank Report: Commodity Markets Outlook (October 2018)

The long-term price assumptions for oil, natural gas and coal in the outlook are based on the Dubai average crude import price. It is assumed that prices of natural gas and coal have elasticity levels to the behavior of oil over the forecast horizon. By the end of the planning period (2040), the assumed price for Dubai crude reaches US$68.2/barrel, which represents an average of 0.12 percent decline per annum from 2017 to 2040 (Table 5). The projected growth is anchored on the assumption that the global GDP based on purchasing-power-parity (PPP) valuation of the country's GDP expands at 5.0 percent annually over the planning period.

[4] British Terminal Unit

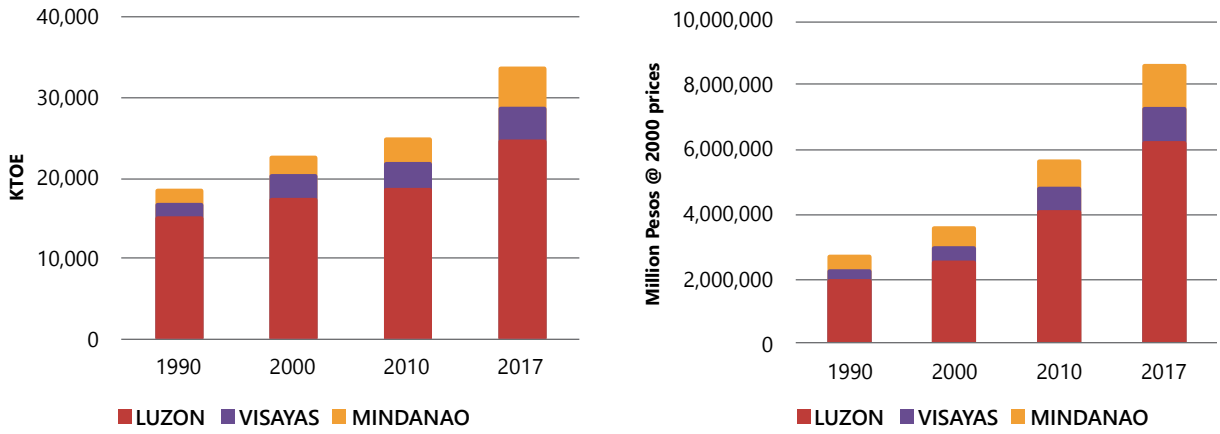
III. ENERGY OUTLOOK

KEY TRENDS AND DEVELOPMENT

TOTAL FINAL ENERGY CONSUMPTION

Mindanao represents nearly 14.1 percent of the Philippines total final energy consumption (TFEC) and about 14.4 percent of real GDP (Figure 7). As Mindanao covers four (4) of the country's fastest growing regional economies (Northern Mindanao, Davao, Soccsksargen and Caraga), and two BIMP-EAGA[5] focused regions (Zamboanga Peninsula and the least developed region of ARMM), the island's energy consumption is vital to the national growth.

Figure 7. Mindanao's share to the Total FInal Energy Consumption (KTOE) and Regional Gross Domestic Product, 1990 - 2017



In 2017, the country's TFEC stood at 33,761 thousand tons of oil equivalent (ktoe). Mindanao's share to TFEC improved from 7.7 percent (1,438 ktoe) in 1990, 9.7 percent (2,208 ktoe) in 2000, 11.2 percent (2,787 ktoe) in 2010, and up 14.1 percent (4,770 ktoe) in 2017. From 1990-2017, TFEC of Mindanao displayed a 4.5 percent annual increase, on the average. The island manifested a higher growth rate of 8.0 percent from 2010-2017. The island's energy demand supported its economic output as evidently showed with its share to the country's GDP of 14.4% (Php 1.25 Trillion) in 2017, which was almost at the same level as its share to the national energy consumption.

Mindanao regions are characterized by different drivers of energy use such as geographical conditions, population densities, and economic structures. Despite these diversities, the regions share common energy goals with a strong focus on having greater access to energy and enhancing energy security while supporting the island's overall economic growth.

Regional Energy Consumption. The significant role of Northern Mindanao (Region X) and Davao Region (Region XI) in shaping the energy outlook of Mindanao is apparent. Since 1990, Northern Mindanao and Davao regions' energy demand more than tripled, and accounted for over half of the total energy consumption of Mindanao. In 2017, Northern Mindanao energy consumption of 1,466 ktoe made up 30.7 percent of Mindanao's TFEC, making the region as the largest energy user among the regions in the island (Table 6). For the period 2010-2017, the region registered higher GRDP average growth rate of 6.3 percent, while energy demand rising almost two-fold. On the other hand, Davao is the fastest growing regional economy with an annual GRDP growth rate of 7.9 percent (2010 to 2017). For the same period, its energy demand grew at an average of 6.7 percent a year. The combined energy consumption of these two regions represent more than half of the Mindanao's energy use, highlighting their critical roles in determining the energy future of the island.

[5] Brunei – Indonesia – Malaysia – Philippines East ASEAN Growth Area (BIMP-EAGA) is a sub-regional economic co-operation initiative in Southeast Asia.

Table 6. TOTAL FINAL ENERGY CONSUMPTION, By Region (KTOE)

Region	Actual				Growth Rate (in %)			
	1990	2000	2010	2017	1990-2017	1990-2017	2000-2017	2010-2017
IX	247	368	427	678	3.8	4.0	2.8	6.8
X	335	524	731	1,466	5.6	4.6	4.2	10.5
XI	354	633	753	1,184	4.6	6.0	2.7	6.7
XII	251	352	466	674	3.7	3.4	2.2	5.4
CARAGA	136	174	247	525	5.1	2.5	4.5	11.4
ARMM	115	158	163	244	2.8	3.2	2.4	5.9
Mindanao	**1,438**	**2,208**	**2,787**	**4,770**	**4.5**	**4.4**	**3.2**	**8.0**

With a GRDP growth of 6.9 percent a year, Caraga displayed the fastest growth rate of 11.4 percent in energy consumption during 2010-2017 with almost 3.0-percentage point higher than the Mindanao average. Meanwhile, the energy consumption of Zamboanga Peninsula (Region IX) grew at 6.8 percent annually with an economic growth rate of 5.4 percent a year. ARMM, with an average economic growth rate of 2.2 percent over the same period, almost doubled its energy consumption of 163 ktoe in 2010 to 244 ktoe in 2017, equivalent to a 5.9 percent growth per annum. Generally, the energy demand of all the regions had been growing at an average higher than the national level of 2.2 percent per annum over the same period.

Sectoral Energy Consumption. The transportation sector, which accounted for one-third (33.2 percent) of total energy consumption, was the biggest contributor to the island's energy demand in 2017. Its aggregate energy demand level reached 1,586 Ktoe from 317 Ktoe in 1990. The annual average growth rate of 6.1 percent between 1990-2017 was attributed to increased utilization of gasoline and diesel for road transport. The sector exhibited higher growth rate of 9.7 percent in its energy demand for the period 2010-2017.

Table 7 shows that the economic expansion in commercial sector between 1990 to 2017 - such as increased number of banks, malls, office buildings and the likes - resulted in an annual average growth of 7.2 percent in its energy consumption, the fastest among the economic sectors. Higher growth rate for the sector's energy consumption was recorded between 2010-2017 at 8.9 percent a year. The sector's share in TFEC in 2017 stood at 9.6 percent.

The expanded production output from the Industry sector, particularly in the food processing and manufacturing industries, resulted in a 5.0 percent annual average surged in the sector's energy requirements for the period 1990 to 2017 (and 10.7 percent increase in 2010-2017). Its share to TFEC in 2017 was 30.6 percent. On the other hand, the residential sector, despite being the third largest user of energy with a share of 24.8 percent of the Mindanao's TFEC, registered a moderate annual average increase of 2.3 percent in its energy consumption (1990-2017), and 3.4 percent (2010-2017).

Table 7. TOTAL FINAL CONSUMPTION, By Sector (KTOE)

Sector	Actual				Growth Rate (in %)			
	1990	2000	2010	2017	1990-2017	1990-2017	2000-2017	2010-2017
Industry	395	474	716	1,461	5.0	1.8	4.3	10.7
Commercial	70	147	254	460	7.2	7.8	3.6	8.9
Transportation	317	634	829	1,586	6.1	7.2	3.9	9.7
Residential	634	890	935	1,182	2.3	3.5	1.4	3.4
Agriculture	24	64	53	81	4.7	10.5	2.5	6.3
Total	**1,438**	**2,208**	**2,787**	**4,770**	**4.5**	**4.4**	**3.2**	**8.0**

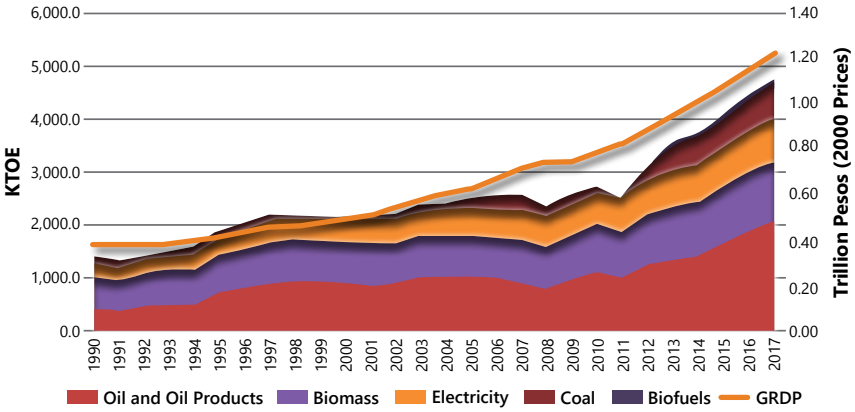
Developments in the Energy Demand by Fuel. Fossil fuels dominate the energy consumption mix of Mindanao with more than half (57.9 percent) of the total final energy consumption in 2017, up from 40.3 percent in 1990 (Table 8). The large increase in oil share from 33.6 percent in 1990 to 44.5 percent in 2017 reflected the significant change in energy consumption mix with a 5.6 percent growth rate a year. A much faster growth rate of 9.3 percent was recorded in 2010-2017, reaching a total oil demand of 2,122 Ktoe. The rapid demand growth for electricity with 4.3 percent annual growth rate in the same period complemented the economic growth of the island over the last two decades. For the period 2010-2017, growth in electricity demand was at 4.8 percent annually. In 2017, electricity share was posted at 17.1 percent of TFEC, equivalent to 817 Ktoe.

Table 8. TOTAL FINAL ENERGY CONSUMPTION, By Product (KTOE)

Sector	Actual				Growth Rate (in %)			
	1990	2000	2010	2017	1990-2017	1990-2017	2000-2017	2010-2017
Coal	97	51	130	641	7.3	-6.1	9.8	25.6
Oil and oil products	483	956	1,142	2,122	5.6	7.1	3.7	9.3
Electricity	261	420	588	817	4.3	4.9	1.9	4.8
Biomass	598	781	904	1,119	2.4	2.7	1.3	3.1
Biofuels	0	0	22	72			7.1	18.2
Total	**1,438**	**2,208**	**2,787**	**4,770**	**4.5**	**4.4**	**3.2**	**8.0**

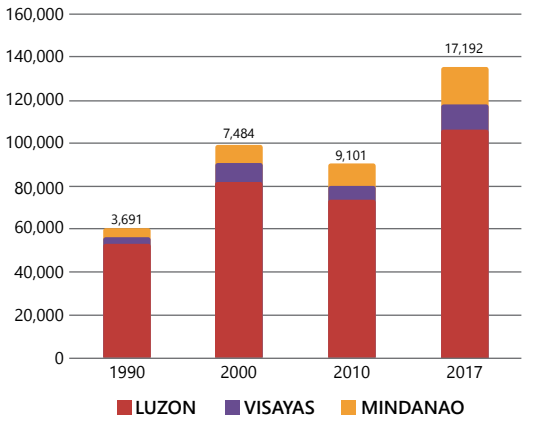
Figure 8 illustrates the relative shares of TFEC by fuels in 1990-2017 timeframe. As discussed above, oil remained as the dominant fuel with a 5.6 percent annual growth rate, increasing from 483 Ktoe in 1990 to 2,122 Ktoe in 2017. The growth was mainly attributable to the expansion in the overall demand of the transport sector. Biomass had the second highest share in 2017 followed by electricity. Electricity consumption experienced a considerable 4.3 percent annual increase for the 1990-2017 period, from 261 Ktoe in 1990 to 817 Ktoe in 2017. This indicates both an upward trend towards greater use of electricity in the industry and commercial sectors, as well as increased electrification efforts in the underserved areas of Mindanao, which also result in an increasing relevance of electricity in the residential sector.

Figure 8. TOTAL FINAL ENERGY CONSUMPTION, By Product (KTOE)



Further, the island's socio-economic landscape can actually be defined by its biomass utilization. Biomass was the second most consumed fuel in 2017 with 23.5 percent share to TFEC. Biomass is highly accessible and affordable source of fuel given its abundant supply. Biomass energy plays a significant role in the island's energy supply as it is mainly used for household cooking by the rural areas. Of the total biomass, 72.5 percent was consumed by the residential sector, while industry and commercial applications accounted for the remaining. Almost 77.0 percent of the biomass consumption of the residential sector was used for cooking. However, biomass consumption grew slowly at an average rate of 1.3 percent from 2000 to 2017, which may be attributed to changes in energy consumption pattern by shifting to a more efficient fuel brought about by improvement in household income and urbanization.

Figure 9. MINDANAO'S SHARE TO THE 2017 TOTAL PETROLEUM CONSUMPTION (MB)



Total Petroleum Consumption

As shown in Figure 9, the Mindanao's share to total petroleum consumption of the country improved from 6.0 percent in 1990 to 12.6 percent in 2017. Demand for oil rose to 17,192 thousand barrels (MB) in 2017 from 3,691 MB in 1990 driven by higher transport energy demand, primarily for road vehicles. Two factors significantly contributed to the growth of oil demand in road transport – higher freight transport demand and number of vehicles. Freight transport oil demand was linked to rapid industrialization with manufacturing and construction growing at 9.6 percent and 12.7 annually from 2010 to 2017, respectively. On the other hand, an average of 9,500[6] of new vehicles were added per year reflecting the effect of rising household income level. Additional vehicle is expected to continue over the coming decades, as vehicle ownership in the island is still below (88 vehicles per 1,000 inhabitants) the national average (106 vehicles per 1,000 inhabitants).

[6] Estimated New Vehicles registered in Land Transportation Office (LTO) per year on the average: Cars 1,000; Utility Vehicles 7,000; Trucks 1,500

Regional Oil Consumption. Northern Mindanao and Davao region's petroleum consumption rose by more than four-fold from 1990 level with both demanding a combined share of 58.9 percent of total petroleum in 2017. Northern Mindanao oil consumption of 4,585 MB in 2017 represent 26.7 percent of total (Table 9). During the period 2010-2017, the region demonstrated higher annual GRDP growth of 6.3 percent, which resulted in an increase in petroleum demand by almost two-fold. Davao region's consumption of 5,549 MB was 32.3 percent of total, and registered a 9.8 percent growth a year for the 2010-2017 period. ARMM, Zamboanga Peninsula and Caraga displayed the fastest growth of 14.0, 11.1 and 10.8 percent, respectively, in petroleum consumption for the same period.

Table 9. TOTAL PETROLEUM CONSUMPTION, By Region (MB)

Region	Actual				Growth Rate (in %)			
	1990	2000	2010	2017	1990-2017	1990-2017	2000-2017	2010-2017
IX	625	1,166	1,366	2,846	5.8	6.4	4.4	11.1
X	998	1,811	2,657	4,585	5.8	6.1	3.3	8.1
XI	1,131	2,624	2,883	5,549	6.1	8.8	3.9	9.8
XII	499	983	1,277	2,241	5.7	7.0	3.4	8.4
CARAGA	295	575	724	1,487	6.2	6.9	4.3	10.8
ARMM	143	325	193	484	4.6	8.6	5.5	14.0
Total	**3,691**	**7,484**	**9,101**	**17,192**	**5.9**	**7.3**	**3.8**	**9.5**

Sectoral Petroleum Consumption. Consumption of petroleum products constituted an average share of around 37.0 percent of TFEC (1990-2017). This was largely because of the petroleum consumption of the transportation sector with an average share of 72.0 percent of the total oil requirements. Oil demand in the transport sector registered an average annual growth of 6.2 percent between 1990 and 2017, as a result of increased use of transport vehicles such as passenger cars, sea vessels and airplanes. The sector's demand reached 12,378 MB in 2017, almost five times increase from 1990 level. Conversely, oil consumption in industry increased from 662 MB to 1,708 MB during the same period, equivalent to a 3.6 percent growth on an annual basis (Table 10 and Figure 10).

Table 10. TOTAL PETROLEUM CONSUMPTION, By Sector (MB)

Region	Actual				Growth Rate (in %)			
	1990	2000	2010	2017	1990-2017	1990-2017	2000-2017	2010-2017
Industry	662	784	1,092	1,708	3.6	1.7	2.7	6.6
Commercial	39	366	756	2,122	15.9	24.9	6.3	15.9
Transportation	2,418	4,838	6,419	12,378	6.2	7.2	3.9	9.8
Residential	546	1,158	666	683	0.8	7.8	0.2	0.4
Agriculture	25	337	167	300	9.7	29.9	3.5	8.7
Total	**3,691**	**7,484**	**9,101**	**17,192**	**5.9**	**7.3**	**3.8**	**9.4**

Table 11 and Figure 11 show the overall increasing trend in oil consumption for the last two decades. All oil products expanded during the historical period. Diesel and gasoline, as the main fuels utilized in road transport, provided a combined share of about 80.0 percent in the overall oil demand mix. During the period 1990 to 2017, gasoline and diesel grew at 6.7 percent and 6.2 percent annually, respectively. In 2017, half of oil consumption of Mindanao was diesel (8,589 MB) and a quarter gasoline (5,158 MB). On the other hand, fuel oil consumption, increased by 3.5 percent in the same period. Corresponding to increased demand of diesel and gasoline, biofuels usage rose as well. Biodiesel went up annually at 10.7 percent, while bioethanol escalated at 23.7 percent a year over 2010 to 2017 period.

Figure 10. TOTAL PETROLEUM CONSUMPTION, By Sector (MB)

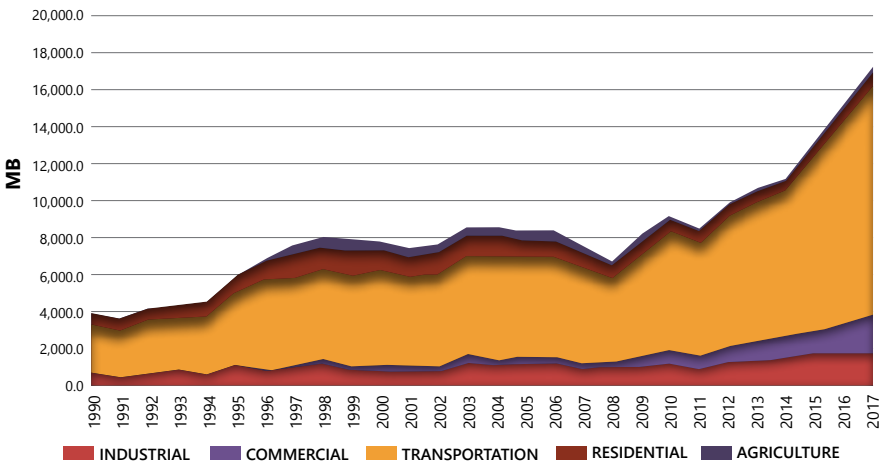
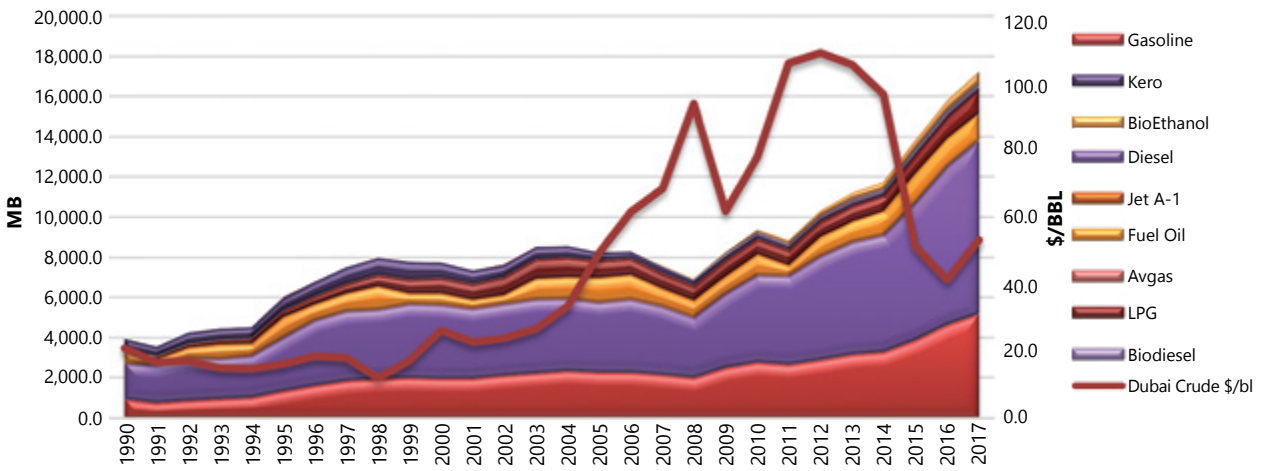


Table 11. TOTAL FINAL ENERGY CONSUMPTION, By Petroleum Products (MB)

Region	Actual				Growth Rate (in %)			
	1990	2000	2010	2017	1990-2017	1990-2017	2000-2017	2010-2017
Gasoline	890	1,874	2,697	5,158	6.7	7.7	3.9	9.7
Diesel	1,674	3,570	4,223	8,589	6.2	7.9	4.3	10.7
Fuel Oil	544	579	995	1,386	3.5	0.6	2.0	4.9
LPG	126	736	777	1,161	8.6	19.3	2.4	5.9
Kerosone	456	718	195	133	-4.5	4.6	-2.2	-5.3
Jet A-1 and Avgas	1	7	4	35	12.7	17.8	14.3	38.5
Biodiesel			86	175			4.3	10.7
Bioethanol			125	554			9.2	23.7
Total	**3,691**	**7,484**	**9,101**	**17,192**	**5.9**	**7.3**	**3.8**	**9.5**

Figure 11. TOTAL FINAL ENERGY CONSUMPTION, By Petroleum Products (MB)



Current Infrastructure. Table 12 presents the current density of gasoline stations in Mindanao. On the average, the density of gasoline station per municipality or city in the island improved from 1.3 gasoline station in 2004 to 3.9 in 2017. This can be translated to an average growth rate of 8.8 percent per year compared with 9.3 percent for national.

Among the regions, Davao obtained the highest density with almost 14 gasoline stations per municipality/city. The region had 682 gasoline stations in 2017 from 135 stations in 2004, exhibiting a growth rate of 13.3 percent a year.

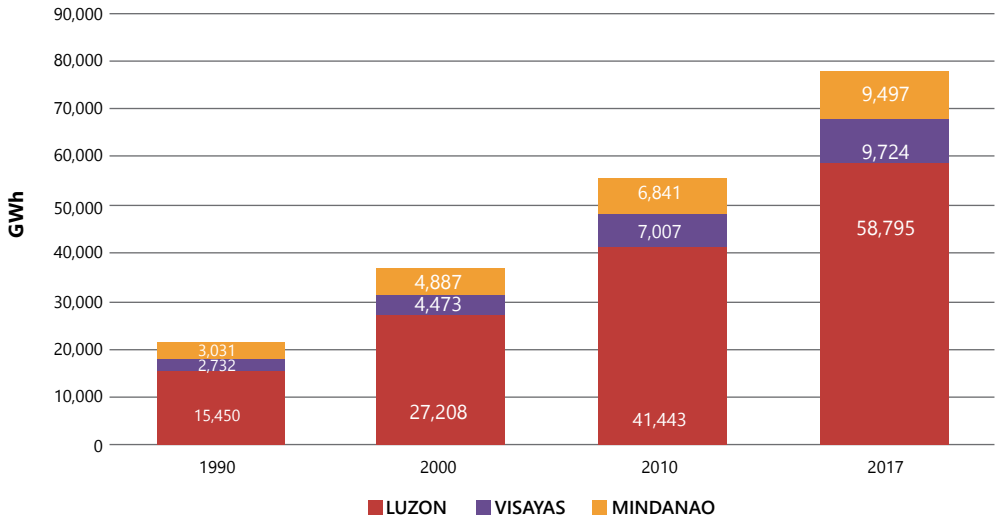
Table 12. DENSITY OF GASOLINE STATIONS IN MINDANAO versus THE PHILIPPINES

Region/ year	Total Cities and Towns	No. of Gasoline Station					Density (No. of Stations per City and Town)				
		2004	2009	2012	2013	2017	2004	2009	2012	2013	2017
PHILIPPINES	1,617	3,459	4,114	4,997	6,083	8,677	2.1	2.5	3.1	3.8	5.4
NCR	17	648	664	743	846	1,144	38.1	39.1	43.7	49.8	67.3
LUZON	754	1,698	1,981	2,437	2,953	4,071	2.3	2.6	3.2	3.9	5.4
VISAYAS	408	520	669	786	1,041	1,694	1.3	1.6	1.9	2.6	4.2
MINDANAO	455	593	800	1,031	1,243	1,768	1.3	1.8	2.3	2.7	3.9
Zamboanga Peninsula	72	102	108	145	180	183	1.4	1.5	2.0	2.5	2.5
Northern Mindanao	93	148	175	215	248	402	1.6	1.9	2.3	2.7	4.3
Davao Region	49	135	273	320	383	682	2.8	4.8	6.5	7.8	13.9
SOCCSKSARGEN	50	110	161	203	264	290	2.2	3.2	4.1	5.3	5.8
CARAGA	73	68	77	106	122	154	0.9	1.1	1.5	1.7	2.1
ARMM	118	30	42	42	46	57	0.3	0.4	0.4	0.4	0.5

Total Electricity Consumption

Mindanao region represents 12.2 percent of the Philippines' total electricity consumption. Electricity demand in the island, covering both on-grid and off-grid areas, more than tripled from 1990 to 2017, and constantly rose to an average annual growth rate of 4.3 percent (Figure 12). Residential and industry sectors were the heavy users accounting for 37.3 percent and 41.6 percent, respectively, of total. The commercial sector only required 16.1 percent of total.

Figure 12. MINDANAO'S SHARE TO THE 2017 TOTAL ELECTRICITY CONSUMPTION (GWh)



Regional Electricity Consumption. Growth in electricity was driven by the demands from Northern Mindanao, Davao and Soccsksargen. Northern Mindanao's electricity demand increased by four-fold equivalent to 5.4 percent growth rate a year with demand reaching 2,412 GWh in 2017. Soccsksargen displayed a 4.4 percent annual growth rate which resulted in three times increase in electricity demand. Meanwhile, Davao region's demand more than doubled with 3.5 percent growth rate per annum. Electricity demand of Davao region was eight times more than ARMM.

Davao remained the largest electricity consumer although its share to total declined from 41.1 percent in 1990 to 33.3 percent in 2017. Northern Mindanao increased its share from 19.5 percent in 1990 to 25.4 percent in 2017. On the other hand, ARMM is the fastest growing regional economy with annual average electricity consumption growth of 6.3 percent from 1990-2017. Both Zamboanga Peninsula and Caraga regions grew at annual average growth rates of 4.4 percent and 4.3 percent, respectively (Table 13).

Table 13. TOTAL ELECTRICITY CONSUMPTION, By Region (GWh)

Region	Actual				Growth Rate (in %)			
	1990	2000	2010	2017	1990-2017	1990-2017	2000-2017	2010-2017
IX	326	549	802	1,042	4.4	5.3	1.6	3.8
X	590	989	1,440	2,412	5.4	5.3	3.1	7.6
XI	1,245	1,910	2,564	3,165	3.5	4.4	1.2	3.1
XII	529	864	1,220	1,673	4.4	5.0	1.9	4.6
CARAGA	274	438	613	851	4.3	4.8	1.9	4.8
ARMM	67	136	203	354	6.3	7.2	3.3	8.3
Total	**3,031**	**4,887**	**6,841**	**9,497**	**4.3**	**4.9**	**1.9**	**4.8**

Note: Including off-grid areas; Excluding Non-Utility, Station use and power losses

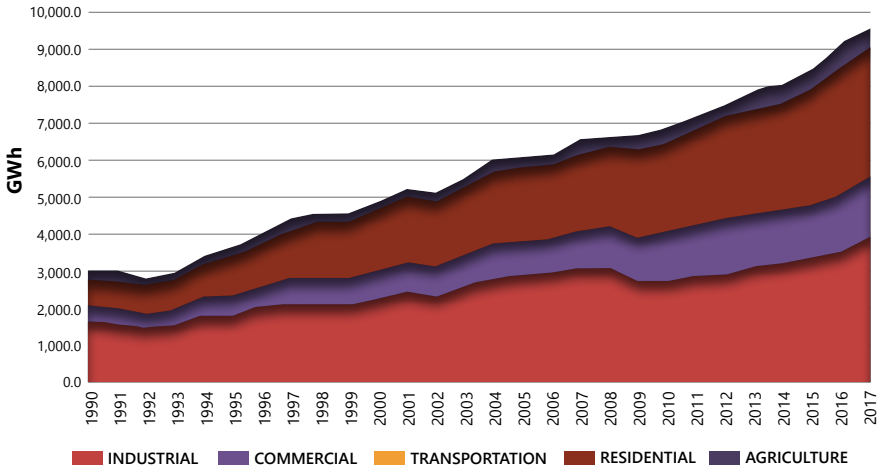
Sectoral Electricity Consumption. The sector that consumed most electricity varies across the regions in Mindanao. Over the 1990-2017 period, the residential sector showed the largest growth at 6.1 percent a year, as increasing urbanization and rising per capita income allowed households and individuals to purchase more electrical appliances. The residential sector's share to total electricity demand jumped from 23.7 percent in 1990 to 37.3 percent in 2017. Surge in electricity consumption by the industry sector was observed during 2010-2017, which posted a 5.2 percent growth rate a year, reflecting the development of industrial facilities to energy intensive industries. Consumption grew in the commercial sector at an average of 2.7 percent annually (1990-2017) (Table 14).

Table 14. TOTAL ELECTRICITY CONSUMPTION, By Sector (GWh)

Sector	Actual				Growth Rate (in %)			
	1990	2000	2010	2017	1990-2017	1990-2017	2000-2017	2010-2017
Industry	1,726	2,290	2,776	3,955	3.1	2.9	2.1	5.2
Commercial	350	709	1,265	1,525	5.6	7.3	1.1	2.7
Transportation								
Residential	720	1,654	2,445	3,541	6.1	8.7	2.2	5.4
Agriculture	235	233	356	476	2.7	-0.1	1.7	4.3
Total	**3,031**	**4,887**	**6,841**	**9,497**	**4.3**	**4.9**	**1.9**	**4.8**

Note: Including off-grid areas; Excluding Non-Utility, Station use and power losses

Figure 13. TOTAL ELECTRICITY CONSUMPTION, By Sector (GWh)



Total Coal Consumption

Mindanao's share to total coal consumption of the country increased from 18.4 percent in 1990 to 21.3 percent in 2017. The growth in coal consumption was driven by the demand from Northern Mindanao, Soccsksargen and CARAGA. Northern Mindanao's coal consumption, about 67.0 percent of total Mindanao, increased annually at 9.7 percent with demand reaching 811 million metric ton (MMT) in 2017. Meanwhile, CARAGA exhibited a 5.9 percent growth a year in its coal consumption, translating to more than four-fold increase (1990 to 2017) and demanding 22.0 percent of total in 2017. Soccsksargen displayed a modest growth of 2.8 percent annually that resulted in two-fold increase in coal consumption over the historical period. However, the region's share to total dropped to 10.6 percent in 2017 from 32.9 percent in 1990.

Coal consumption in Mindanao is primarily used by the industry sector, specifically for direct process of cement, steel, mining and food processing industries, among others. During the period 1990-2017, the coal demand of the cement industry grew at 6.8 percent annually. Forty-six percent of the total coal consumption in Mindanao is heavily used by the cement industry. Over the past years, the local cement industry expanded along with the Philippine economy. The country has been experiencing a continuing increase in cement demand due to heightened investment in infrastructure that fuels demand for cement and other construction materials.

Table 15. TOTAL COAL CONSUMPTION, By Region (MMT @ 10,000 BTU/LB)

Region	Actual				Growth Rate (in %)			
	1990	2000	2010	2017	1990-2017	1990-2017	2000-2017	2010-2017
IX	0	0	11	6			-3.5	-8.3
X	66	59	121	811	9.7	-1.2	11.8	31.2
XI	0	0	1	2			5.2	13.2
XII	60	23	88	128	2.8	-9.2	2.3	5.6
CARAGA	57	16	25	267	5.9	-12.1	14.9	40.0
Total	**183**	**97**	**246**	**1,214**	**7.3%**	**-6.1%**	**9.8%**	**25.6%**

Table 16. TOTAL COAL CONSUMPTION, By Sector (MMT @ 10,000 BTU/LB)

Sector	Actual				Growth Rate (in %)			
	1990	2000	2010	2017	1990-2017	1990-2017	2000-2017	2010-2017
Cement	95	77	165	560	6.8	-2.0	7.4	19.1
Industrial/ direct process	98	20	81	654	7.7	-13.8	13.1	34.8
Total	**183**	**97**	**246**	**1,214**	**7.3**	**-6.1**	**9.8**	**25.6**

Total Biomass Consumption

Mindanao's share to total biomass consumption of the country was recorded at 15.6 percent in 2017. In Mindanao, traditional biomass mostly consists of fuelwood and agricultural by-products which are used mostly for cooking and heating purposes. Traded informally and non-commercially, it is widely harvested and utilized in an unsustainable way. The increasing use of traditional biomass is notable in regions with low access to modern energy services. Regions with lower GRDP and electrification level like ARMM and Caraga tend to use more traditional biomass to satisfy their energy demand. Caraga exhibited annual growth rate of 4.8 percent in biomass consumption, while ARMM posted a 3.3 percent over the historical period. On the other hand, the reduced relevance of traditional biomass in 2000 to 2017 for Northern Mindanao reflected the increasing prosperity and improvement in household income that led to fuel switching or using a more convenient fuel for cooking (such as LPG) (Table 17).

Table 17. TOTAL BIOMASS CONSUMPTION, By Region (in '000 MT)

Region	Actual				Growth Rate (in %)			
	1990	2000	2010	2017	1990-2017	1990-2017	2000-2017	2010-2017
IX	253	343	451	561	3.0	3.1	1.3	3.2
X	403	595	519	479	0.6	4.0	-0.5	-1.2
XI	316	437	517	610	2.5	3.3	1.0	2.4
XII	297	420	415	453	1.6	3.5	0.5	1.3
CARAGA	123	162	313	439	4.8	2.8	2.0	5.0
ARMM	242	327	468	587	3.3	3.1	1.3	3.3
Total	**1,633**	**2,285**	**2,683**	**3,129**	**2.4**	**3.4**	**0.9**	**2.2**

ENERGY-ECONOMY

Energy is one of the development drivers and an essential commodity in the economy. Energy's contribution to economic growth is two-fold:

a) creates jobs and value by extracting, transforming and distributing energy goods and services throughout the economy; and,
b) underpins the rest of the economy by serving as an input to goods and services. With the long-term vision of the *AmBisyon Natin 2040*, energy will play an important role in all the economic sectors in its realization, i.e., in the connectivity, manufacturing, housing and urban development, agriculture, etc.

Energy's role cannot also be discounted as the primacy (or increase in the presence of high order services) of cities and municipalities are set to be intensified primarily due to the government's dream of attaining the golden age of infrastructure. "Build, Build, Build" is the current government's ambitious infrastructure plan that is seen to be the solution to lack of jobs, high prices, transportation and traffic. Eventually, development will trickle down or have spill-over effects because of the stimulated impact of infrastructure on interlinking areas throughout the country.

Mindanao has been enjoying economic dynamism over the last five (5) years with its GRDP, exports and investments consistently growing at an average of 6.0 to 7.0 percent. The forward drive towards sustaining this economic growth must always be complemented with diversified energy sources leading to a more secured supply to satisfy the foreseen increase in energy demand or consumption. In the long-term, the government must explore a stable, sustainable and reliable energy options to augment existing supply and address the increase in demand. It is in this context that ensuring energy security remains at the top of the energy agenda.

Table 18. MINDANAO ENERGY-ECONOMY INDICATORS

Energy Economy Indicators	Actual				Growth Rate (in %)			
	1990	2000	2010	2017	1990-2017	1990-2017	2000-2017	2010-2017
Energy Intensity								
Energy intensity[7] (*TOE/PhpM*)	3.70	4.31	3.44	3.81	0.1	1.5	0.6	1.5
Oil Consumption (*BBL/P100k*)	0.95	1.46	1.13	1.38	1.4	4.4	1.2	2.9
Electricity Gen/GDP (*GWh/Php*)	7.80	9.54	8.46	7.60	-0.1	2.0	-0.6	-1.5
Energy per Capita								
Energy Primary Demand	0.10	0.12	0.13	0.19	2.4	2.0	2.4	6.0
Oil Primary Demand (*BBL/person*)	0.26	0.42	0.42	0.70	3.7	4.9	3.0	7.5
Electricity (*kWh/person*)	212.50	272.19	314.68	384.54	2.2	2.5	1.2	2.9

[7] Total Final Energy Consumption / Gross Regional Domestic Product @ constant 2000 price

Energy Intensity (TOE/PhpM) (TFEC), 1990-2017. Energy intensity represents one of the main indicators for economic development and expressed as the ratio between domestic energy consumption and GDP (energy consumption per unit of GDP). Energy consumption encompasses the consumption of solid fuels, liquid fuels, natural gas, renewables, electricity and other fuels. By quantifying how much energy is used to produce one unit of economic output (in peso terms), energy intensity addresses one aspect of economic efficiency. Energy intensity is strongly linked with the economic cycle. Historically, while energy intensity fell in Luzon and Visayas, trends in energy intensity continued to rise in Mindanao, from 3.44 tonnes of oil equivalent (TOE) in 2010 to 3.81 toe in 2017. Compared with the national level of 4.02 TOE[8] per million pesos in 2017, energy intensity of Mindanao was lower by 0.21 TOE (Table 18 and Figure 14).

Table 19. MINDANAO ENERGY ELASTICITY

Energy Elasticity	1990-2017	1990-2017	2000-2017	2010-2017
Energy Demand Primary-GDP	1.01	1.57	1.22	1.23
Oil Demand Primary-GDP	1.27	2.25	1.43	1.44
Electricity-GDP	0.98	1.75	0.75	0.75

Figure 14. MINDANAO ENERGY INTENSITY (TOE/PhpM) (TFEC) vis-à- vis Philippines, 1990 – 2017

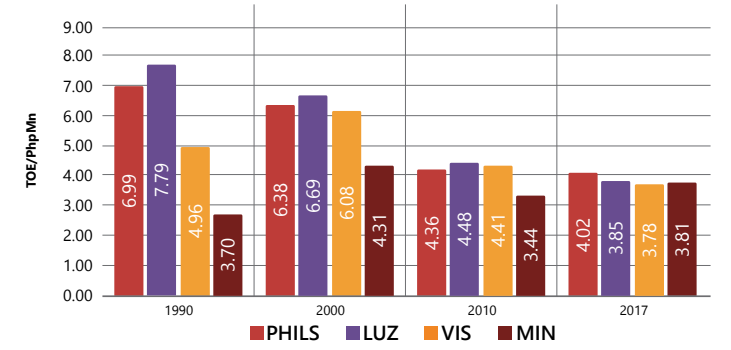


Figure 15. MINDANAO OIL CONSUMPTION (BBL/P100k) INTENSITY

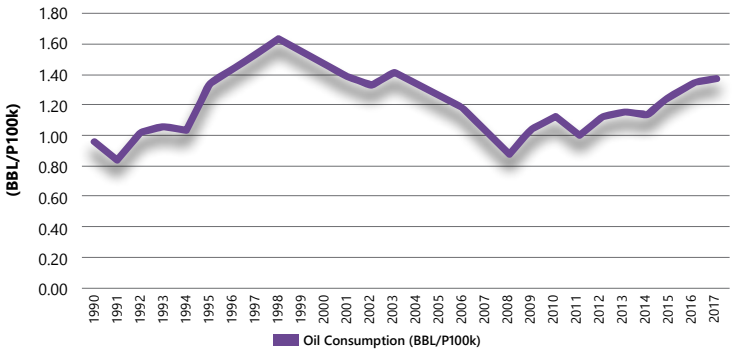
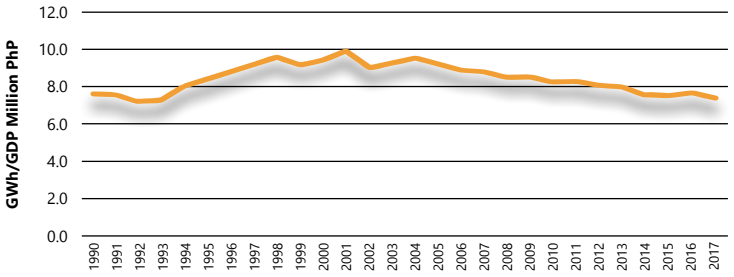


Figure 16. MINDANAO ELECTRICITY CONSUMPTION /GDP (GWh/Php)



In terms of oil intensity (oil consumed per one hundred thousand pesos of GRDP), Mindanao burned 0.95 barrel per PhP100,000 in 1990, and increased to 1.38 barrel in 2017 (Table 18 and Figure 15). This can be translated to an average of 1.4 percent increase per year. Compared with the national intensity level[9], the country consumed 2.28 barrel per PhP100,000 in 1990, and then fell to 1.58 barrel in 2017.

Electricity consumed per million pesos of GRDP in Mindanao was at 7.80 GWh/million PhP in 1990 and slightly decreased to 7.60 GWh/million PhP in 2017 (Table 18 and Figure 16. At the national level, electricity consumption in 2017 stood at 3.04 GWh/million PhP.

Energy per Capita (TOE/person), 1990-2017. Energy per capita grew at an average of 2.4 percent annually from 1990 to 2017. Energy per capita in 1990 was registered at 0.10 TOE per person, and rose to 0.19 TOE per person in 2017 (Table 18 and Figure 17). Compared with the national level[10] of 0.33 TOE per person, Mindanao is lower by 0.14 TOE.

How significantly does the size and growth of the country's population affect the demand for energy? Relative to this, income and energy use are conspicuously correlated. Even at comparable levels of per capita GRDP, the volume of energy use will differ among regions and provinces, depending on structural characteristics of the regional economy, spatial features, climate, fuel and power prices, government conservation policies, and other factors.

The relationship between per capita income and energy indicates that as income per capita rises, so does per capita energy use.

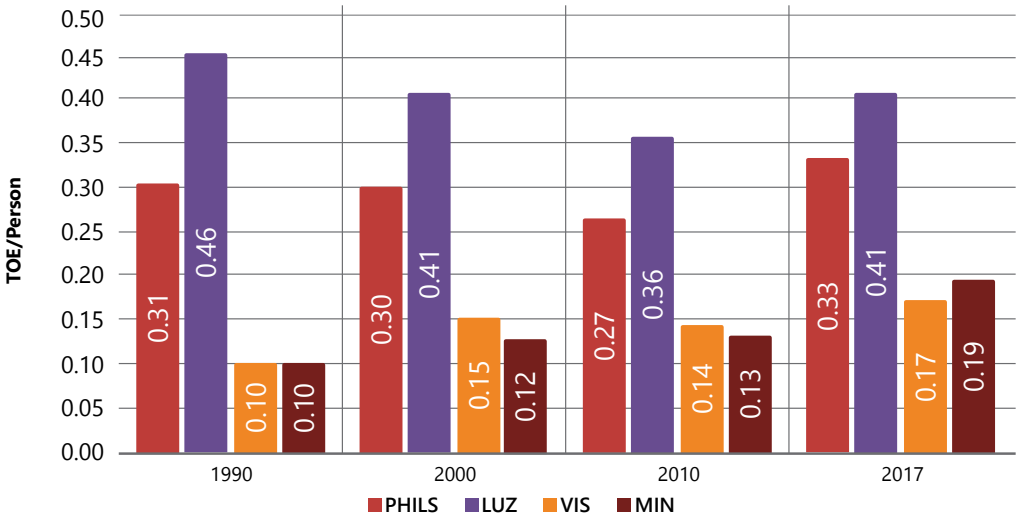
[8] Only accounts for the Total Final Energy Consumption to make the Energy Intensity value for Mindanao Comparable. If Total Final Energy Supply is used, the National Energy intensity level is pegged at 6.66

[9] Only accounts for the Total Oil Consumption (BBL/Php100,000)

[10] Only accounts for the Total Final Energy Consumption to make the Energy per capita value for Mindanao Comparable. If Total Final Energy Supply is used, the National Energy per capita level is pegged at 0.55 TOE/person

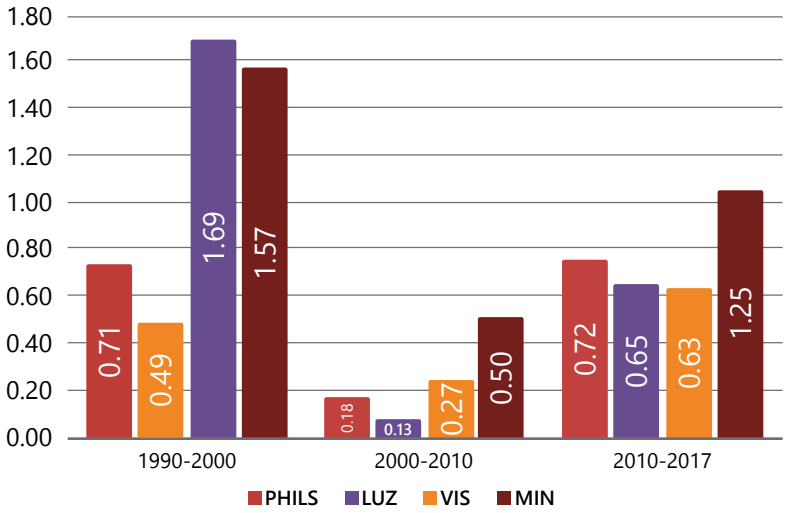
The rate of change over time for both indicators is evident on how the application of energy by all the economic sectors supports a number of economic activities. There is a dynamic complement to investments for improving productivity and fueling economic growth. Consequently, economic growth gives life to the acquisition of household provisions and creates conveniences associated with increased energy usage.

Figure 17. MINDANAO ENERGY PER CAPITA (TOE/person) vis-à-vis Philippines, 1990 – 2017



Energy Elasticity. Energy elasticity is the relationship between the percentage change in energy consumption as a result of the percentage change in GRDP. Over the period 1990-2000, with GRDP growth rate at 2.8 percent annually and total primary energy consumption at 3.8 percent a year, the computed energy elasticity was recorded at 1.57. Elasticity dived down to 0.50 for the period 2000-2010 and climbed to 1.25 in 2010-2017. On the other hand, the 1.01 elasticity for the period 1990-2017 shows that GRDP and energy consumption grew at almost the same level. For the period 2010-2017, GRDP exhibited a 6.4 percent annual growth rate, while energy consumption registered a 6.6 percent growth (Table 19 and Figure 18). The decline in energy elasticity suggested a delinked of energy consumption with economic growth.

Figure 18. MINDANAO ELASTICITY VIS-À-VIS GDP (%Energy/%GDP) vis-à-vis Philippines, 1990 – 2017



During 1998 to 2010, the Philippine economy underwent sustained but moderate expansion of 4.6 percent, on the average. However, structural changes affirmed the relative decline of industry and agriculture, and the increasing domination of the services sector. Over the same period, energy consumption remained flat at an annual average of 0.4 percent.

The period 2010-2017 demonstrated a strong economic growth of 6.2 percent for the Philippines which is attributed to the sound policies and a favorable external environment. During the same period, total final energy consumption of the country experienced a strong growth of 4.5 percent, on the average. The period was marked with low inflation and a stable fiscal position, which significantly supported by the government's adoption of a long-term perspective on policies and reforms. This contributed to strengthening confidence in the economy.

ENERGY DEMAND OUTLOOK

TOTAL FINAL DEMAND OUTLOOK

Mindanao's energy demand shall continually increase to sustain its economic growth momentum with foreseen positive outlook. Under the High Growth Scenario (HGS), the island's total final energy demand (TFED) escalates by 6.2 percent a year within the planning period, a four-fold increase from 2017 level reaching 19,057 ktoe in 2040. Growth in energy demand tapers off from a high of 6.5 percent (2025-2030) down to 5.8 percent in 2040 (Table 20). In Low Growth Scenario (LGS), energy demand decelerates to 5.0 percent compared with HGS (Table 21). Energy demand only increases to 14,791 Ktoe, a cut of around 4,266 ktoe from HGS.

Table 20. TOTAL FINAL ENERGY CONSUMPTION, By Product (KTOE) – HGS

Product	Outlook							Growth Rates (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Coal	641	645	660	751	876	1,047	1,274	0.7	3.0	1.9	3.1	3.6	4.0
Oil and oil products	2,122	2,202	2,584	3,845	5,349	6,974	8,672	3.8	6.3	5.8	6.8	5.4	4.5
Electricity	817	924	1,140	1,788	2,858	4,461	6,986	13.1	9.8	6.6	9.8	9.3	9.4
Biomass	1,119	1,127	1,148	1,226	1,323	1,442	1,584	0.7	1.5	1.0	1.5	1.7	1.9
Biofuels	72	98	125	214	319	429	542	36.4	9.2	7.9	8.3	6.1	4.8
Total	**4,770**	**4,996**	**5,657**	**7,823**	**10,724**	**14,354**	**19,057**	**4.7**	**6.2**	**4.7**	**6.5**	**6.0**	**5.8**

Table 21. TOTAL FINAL ENERGY CONSUMPTION, By Product (KTOE) – LGS

Fuel	Outlook							Growth Rates (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Coal	641	645	649	708	777	859	956	0.7	1.8	1.2	1.9	2.0	2.2
Oil and oil products	2,122	2,202	2,563	3,686	4,926	6,200	7,479	3.8	5.6	5.3	6.0	4.7	3.8
Electricity	817	906	1,069	1,522	2,129	2,970	4,149	11.0	7.3	5.2	6.9	6.9	6.9
Biomass	1,119	1,127	1,174	1,293	1,426	1,573	1,734	0.7	1.9	1.4	2.0	2.0	2.0
Biofuels	72	98	125	206	295	385	473	36.4	8.5	7.4	7.4	5.5	4.2
Total	**4,770**	**4,979**	**5,581**	**7,414**	**9,552**	**11,987**	**14,791**	**4.4**	**5.0**	**4.1**	**5.2**	**4.6**	**4.3**

Oil still remains as the most consumed fuel, with more than 40.0 percent share (8,672 ktoe) in HGS and about half (7,479 Ktoe) in LGS of the TFED in 2040. Oil share is lower in HGS than LGS due to the significant increase in projected electricity demand which grows faster than oil demand. Oil increases annually at 6.3 percent in HGS and 5.6 percent in LGS.

Meanwhile, electricity shows a significant increase in projected demand in HGS from a robust of 6.6 percent annual growth rate for the period 2020-2025, picks up to 9.8 percent in 2025-2030, and 9.4 percent post 2030. This translates to 1,140 ktoe of electricity demand in 2020 to 6,986 ktoe in 2040. With this growth, the share of electricity to TFED jumps to 36.7 percent in 2040 from 2017 level of 17.1 percent. The increasing electricity demand aligns with the government policy to move towards total household electrification by 2022. In LGS, electricity demand expands annually at 7.3 percent, a reduction of about 40.6 percent from HGS demand.

With expected significant contribution from the industry sector to the local economy of Mindanao, coal demand registers an increasing growth trend in both scenarios exhibiting a 3.0 percent (HGS) and 1.8 percent (LGS) rate annually, equivalent to 1,274 ktoe and 956 ktoe in 2040, respectively. The sector displays higher growth rate in the latter part of the planning period.

Regional Final Energy Demand Outlook. Growing economy drives the final energy demand to rise in Mindanao over the planning period. To improve the contribution of Mindanao to the Philippines' GDP, a spatial development strategy is being adopted. The **Mindanao 2030 and Mindanao Development Corridors (MinDC)** reflect a spatial development strategy that aims to increase the competitiveness of Mindanao industries by providing them with common service facilities. The program also aims to achieve physical integration among key economic clusters in Mindanao in its bid to become self-reliant and internally dependable. Notably the identification of development corridors has complementary roles, which anchor their respective development on competitive advantages and strong economic potentials. As such,

all regions in Mindanao are projected to more than triple their energy demand, with some even display a four-fold to five-fold increase.

Bulk of the increase is attributed to the combined energy demand (54.2 percent share) of Northern Mindanao and Davao regions from just 2,650 ktoe in 2017 to 10,322 ktoe in 2040 under HGS due to their population size and continued economic growth. Said regions remain the wealthiest regional economies based on GDP per capita. Soccsksargen registers the fastest growth in energy demand with 7.1 percent (HGS) and 5.9 percent (LGS) a year, reflecting a higher energy requirement to support its economic growth. This region accounts for about 17.0 percent (both scenarios) of the energy demand of the island in 2040 (Tables 22 and 23).

Table 22. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, By Region (KTOE) – HGS

Region	Outlook							Growth Rates (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
IX	678	697	824	1,233	1,722	2,298	2,996	2.8	6.7	5.9	6.9	5.9	5.4
X	1,466	1,529	1,662	2,139	2,817	3,778	5,079	4.3	5.6	3.7	5.7	6.0	6.1
XI	1,184	1,238	1,422	2,010	2,845	3,876	5,243	4.6	6.7	5.1	7.2	6.4	6.2
XII	674	705	826	1,221	1,760	2,414	3,250	4.6	7.1	5.7	7.6	6.5	6.1
CARAGA	525	550	614	813	1,047	1,323	1,662	4.8	5.1	4.1	5.2	4.8	4.7
ARMM	244	276	309	406	532	665	827	13.4	5.5	4.0	5.5	4.6	4.5
Total	**4,770**	**4,996**	**5,657**	**7,823**	**10,724**	**14,354**	**19,057**	**4.7**	**6.2**	**4.7**	**6.5**	**6.0**	**5.8**

Table 23. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, By Region (KTOE) – LGS

Region	Outlook							Growth Rates (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
IX	678	694	794	1,130	1,493	1,885	2,316	2.4	5.5	5.2	5.7	4.8	4.2
X	1,466	1,515	1,638	2,028	2,487	3,057	3,711	3.3	4.1	3.1	4.2	4.2	4.0
XI	1,184	1,247	1,419	1,919	2,540	3,264	4,151	5.4	5.6	4.4	5.8	5.1	4.9
XII	674	701	822	1,174	1,581	2,020	2,505	4.0	5.9	5.2	6.1	5.0	4.4
CARAGA	525	548	602	769	943	1,135	1,347	4.3	4.2	3.5	4.2	3.8	3.5
ARMM	244	274	306	395	508	626	761	12.5	5.1	3.7	5.2	4.3	4.0
Total	**4,770**	**4,979**	**5,581**	**7,414**	**9,552**	**11,987**	**14,791**	**4.4**	**5.0**	**4.1**	**5.2**	**4.6**	**4.3**

According to the Mindanao Development Authority (MinDA), the Northern Mindanao Development Corridor provides the gateway to domestic markets in Visayas and Luzon. Heavy industries are prominently located in this area with PHIVIDEC, other industrial estates and several mineral development companies operating within this cluster. It has a potential to become a logistics hub being a host to the Laguindingan Airport and the Mindanao Integrated Container Terminal (MICT). It is also remarkable to note that the agro-industry and agricultural processing and mineral resource development dominate in Davao and Soccsksargen regions. Davao City and General Santos City serve as the twin main growth centers of this cluster. Davao City optimizes its potentials as the business, tourism and services hub, while General Santos City builds on its trade, finance and transport potentials. Of the total Mindanao gross value added (GVA) in trade, about 54.0 percent is contributed by the Business and Industrial Trade Cluster.

Further, part of the priority projects and developments identified under the MinDC is the development of economic zones. Currently, there are 34 operating economic zones in Mindanao. Thirteen of which are agro-industrial zones, eight (8) as manufacturing zones, eight Information Technology Centers, and four (4) serve as Information Technology Parks with most of the locators engaged in Business Process Outsourcing (BPO), creative services, software development and innovation are situated. One economic zone is dedicated for medical tourism.

SECTORAL FINAL ENERGY DEMAND OUTLOOK

Forecasts of energy demand in buildings and transport sectors are particularly sensitive to assumptions about macroeconomic growth. As average income level increases, demand for energy services also rises as people buy and use more personal vehicles, appliances and electronic gadgets. Per capita GDP over the planning period climbs in all Mindanao regions.

Over the planning period, the residential and transport sectors account for a combined average share of more than half of TFED. However, the share of residential sector to TFED is expected to decline from 24.8 percent in 2017 to about 15.3 percent in 2040. The sector displays a growth rate of 4.0 percent a year in HGS and 3.0 percent in LGS over the planning period as more households will have greater access to efficient fuel/energy (electricity and LPG). Meanwhile, the transport sector exhibits an increasing share to TFED from 33.2 percent in 2017 to 40.9 percent in HGS and 45.8 percent in LGS in 2040. However, the sector's energy demand slows down to 4.6 percent (HGS) and 4.0 percent (LGS) annual growth rate during the latter period from a high of 7.6 percent and 6.7 percent in 2025-2030, respectively (Tables 24 and 25). Meanwhile, the industry sector's 2017 share of 30.6 percent expands to 33.8 percent in 2040 under HGS, but decreases a bit in LGS at 29.3 percent for the same period with annual growth rates of 6.7 percent (HGS) and 4.8 percent (LGS). The lower contribution of the industry sector under LGS can be explained by relatively stronger growth from the transportation sector. The increasing energy demand in the transport and industry sectors signifies urbanization trends, which lead to an increased need for transport services, and the shift from agriculture towards a more industrialized Mindanao.

Energy demand of other sectors – commercial and agriculture – were estimated based on their shares to TFED and the projected GVAs. Commercial sector is expected to decrease its 2017 share of 9.6 percent to around 8.3 (HGS) and 7.8 percent (LGS) in 2040. The sector is seen to grow at an average annual rate of 5.5 percent (HGS) and 4.1 percent (LGS). As for the agriculture, the sector demonstrates a stable average share of 2.0 percent until the end of the planning period. Agriculture registers annual growth rates of about 6.2 percent (HGS) and 4.3 percent (LGS). The demand growth of these sectors will likely be spurred by progressive activities of the services sector due to anticipated increase in tourism and business process outsourcing in key cities in Mindanao and agro-Industry as espoused in the **MinDC**.

Table 24. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, By Sector (KTOE) – HGS

Sector	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Industry	1,461	1,536	1,668	2,129	2,955	4,296	6,431	5.1	6.7	3.5	6.8	7.8	8.4
Commercial	460	479	528	668	879	1,175	1,591	4.1	5.5	3.4	5.6	6.0	6.3
Transportation	1,586	1,670	2,033	3,255	4,696	6,229	7,802	5.3	7.2	7.0	7.6	5.8	4.6
Residential	1,182	1,230	1,340	1,661	2,041	2,434	2,911	4.0	4.0	3.1	4.2	3.6	3.6
Agriculture	81	80	87	110	153	220	322	-1.3	6.2	3.3	6.9	7.5	7.9
Total	**4,770**	**4,996**	**5,657**	**7,823**	**10,724**	**14,354**	**19,057**	**4.7**	**6.2**	**4.7**	**6.5**	**6.0**	**5.8**

Table 25. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, By Sector (KTOE) – LGS

Sector	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Industry	1,461	1,530	1,627	1,962	2,482	3,251	4,329	4.8	4.8	2.7	4.8	5.5	5.9
Commercial	460	477	516	623	762	940	1,163	3.7	4.1	2.7	4.1	4.3	4.4
Transportation	1,586	1,670	2,022	3,130	4,334	5,556	6,768	5.3	6.5	6.4	6.7	5.1	4.0
Residential	1,182	1,222	1,332	1,599	1,848	2,075	2,316	3.4	3.0	2.6	2.9	2.3	2.2
Agriculture	81	79	84	100	127	164	216	-2.6	4.3	2.5	4.8	5.4	5.6
Total	**4,770**	**4,979**	**5,581**	**7,414**	**9,552**	**11,987**	**14,791**	**4.4**	**5.0**	**4.1**	**5.2**	**4.6**	**4.3**

Energy intensity is a measure of the energy efficiency performance of a regional economy. The Energy Efficiency Roadmap of the Department of Energy (DOE) aims to reduce the Intensity (TFEC/GDP) by 40.0 percent in 2040 as compared to 2005 level. Figures 19 and 20 show that Mindanao is well-placed to reach this target of reducing the intensity level. In particular, energy intensity reduction of 53.2 percent from 2017 level is achieved by 2040 in HGS, from 3.81 TFEC/GDP in 2017 to 1.78 TFEC/GDP. On the other hand, energy intensity in LGS declines by 26.2 percent, falling to 2.81 TFEC/GDP in 2040.

Figure 19. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, By Sector (KTOE) – HGS

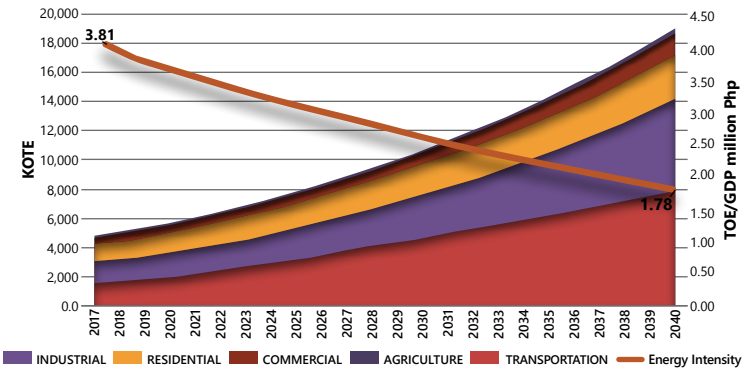
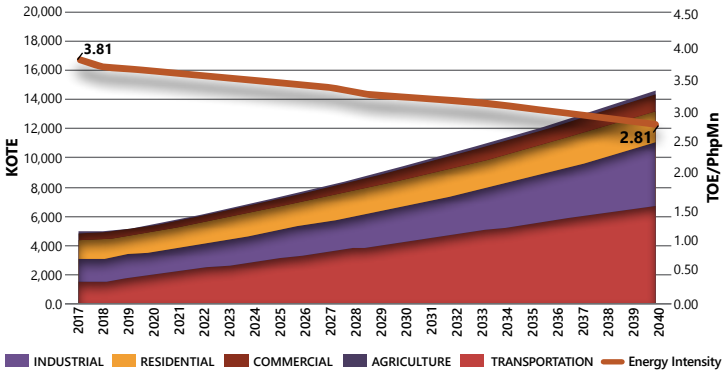


Figure 20. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, By Sector (KTOE) – LGS



Residential Final Energy Demand Outlook. In the planning period, total energy consumption of the residential sector registers a slow growth as discussed above. From 1,182 ktoe energy consumption in 2017, the sector's energy demand reaches 2,911 ktoe in 2040 under HGS and 2,316 ktoe in LGS. Bulk of energy consumption of the sector is electricity and biomass with a combined share of around 95.0 percent over the planning period (Tables 26 and 27). Electricity consumption grows annually at 7.9 percent (HGS) and 5.5 percent (LGS). It may be noted that the share of biomass declines as electricity takes the largest share within the planning period. Biomass demonstrate a nil growth of less than 1.0 percent for HGS as socio-economic structure becomes better in Mindanao. Among the biomass, fuel wood is used mostly by the sector with an average share of 63.5 percent of total biomass demand, followed by charcoal (20.6 percent) and agricultural waste (16.0 percent). The changing consumption pattern is attributed to fuel switching from traditional fuel (biomass) to a more convenient fuel (LPG).

Table 26. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, Residential Sector (KTOE) – HGS

Product	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Kerosene	15	13	11	8	6	4	3	-9.3	-6.4	-5.3	-6.2	-5.4	-5.2
LPG	52	55	60	76	95	119	149	4.6	4.7	3.4	4.6	4.5	4.6
Biomass	811	809	810	837	875	929	998	-0.2	0.9	0.5	0.9	1.2	1.5
Electricity	304	353	459	741	1,065	1,382	1,761	15.9	7.9	7.1	7.5	5.4	5.0
Total	**1,182**	**1,230**	**1,340**	**1,661**	**2,041**	**2,434**	**2,911**	**4.0**	**4.0**	**3.1**	**4.2**	**3.6**	**3.6**

TABLE 27. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, Residential Sector (KTOE) – LGS

Product	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Kerosene	15	13	12	8	6	5	4	-9.3	-5.6	-4.6	-5.4	-4.8	-4.7
LPG	52	55	55	60	66	72	79	4.6	1.8	1.3	1.8	1.7	1.8
Biomass	811	809	837	907	988	1,080	1,185	-0.2	1.7	1.1	1.7	1.8	1.9
Electricity	304	345	428	623	788	918	1,049	13.2	5.5	5.5	4.8	3.1	2.7
Total	**1,182**	**1,222**	**1,332**	**1,599**	**1,848**	**2,075**	**2,316**	**3.3**	**3.0**	**2.6**	**2.9**	**2.3**	**2.2**

It can be observed that under LGS both traditional biomass and kerosene have higher absolute values compared with HGS. Such reflect the higher growth in demand for electricity and petroleum products in HGS as a result of a better household income level that encourages the people to utilize modern and more convenient fuel or energy. This leads to a slower growth in biomass and kerosene demand in HGS than in LGS.

As a substitute to decreasing biomass demand for cooking, LPG consumption of the sector grows annually at an average rate of 4.7 percent (HGS) and 1.8 percent (LGS), from 52 ktoe in 2017 to 149 ktoe and 79 ktoe in 2040, respectively. LPG accounted for 4.4 percent of total residential consumption. On the other hand, the sector's demand for kerosene being used primary for lighting decreases annually at 6.4 percent (HGS) and 5.6 percent (LGS) as more households are given access to electricity during the planning period. From 2017 level of 15 ktoe, kerosene demand falls to 3 ktoe (HGS) and 4 ktoe (LGS). As discussed above, the improvement in the island's economy and the accelerated household electrification program of the government pushes up the demand for electricity.

Transportation Sector Energy Demand Outlook. Over the long-term plan, it is envisioned that these connectivity projects for Mindanao will eventually put in place: (1) Mindanao Railway System; (2) the high standard highway between Davao City and General Santos City; (3) the PhP 959 million General Santos Aerotropolis; (4) the Panguil Bay Bridge and Polloc Port; (5) New Zamboanga Airport; and, (6) the enhancement of operations and maintenance of the Laguindingan Airport. These are the potential public-private partnerships projects that can spur massive development and inclusive growth in Mindanao and thus support a positive outlook for the energy requirements of the transport sector.

During the planning period, transport sector demand for energy grows by 7.2 percent in HGS and 6.5 percent in LGS annually during the planning period. The sector's demand rises to 7,802 ktoe and 6,768 ktoe in 2040 under HGS and LGS, respectively, from 2017 level of 1,586 ktoe. The sector takes up more than one-third of Mindanao's energy requirement. Diesel and gasoline are the dominant petroleum products of the sector, which account for a combined share of 90.6 percent of the oil demand mix by 2040. Gasoline shows a faster growth than diesel at 8.6 percent (HGS) and 7.9 percent (LGS). Diesel increases only at 5.5 percent (HGS) and 4.8 percent (LGS) over the planning period (Tables 28 and 29). The demand of the sector also includes the electricity consumption of the (1) portion of the national target deployment of the e-trikes that will be running in Mindanao including electric vehicle (EVs); and (2) Phase 1 of the Mindanao Rail Project (Tagum-Davao City-Digos) with an estimated demand of 283 GWh a year.

Table 28. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, Transportation Sector (KTOE) – HGS

Product	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Gasoline	634.7	666.5	884.1	1,600.3	2,447.1	3,337.2	4,237.0	5.0	8.6	8.8	8.9	6.4	4.9
Diesel	833.3	857.4	968.7	1,342.4	1,807.1	2,309.0	2,826.8	2.9	5.5	4.8	6.1	5.0	4.1
Fuel Oil	46.8	47.2	52.6	68.7	86.9	107.5	132.2	0.7	4.6	3.9	4.8	4.3	4.2
LPG	0.77	2.7	2.2	2.8	2.7	2.4	1.8	249.5	3.7	0.6	-0.8	-3.0	-5.7
Jet Fuel and Avgas	4.4	5.0	6.5	11.8	19.3	30.6	50.6	14.3	11.2	8.8	10.4	9.7	10.6
Biofuels	65.7	91.6	118.0	205.2	308.8	417.9	528.5	39.3	9.5	8.2	8.5	6.2	4.8
Electricity	0.00	0.00	0.01	24.1	24.1	24.3	24.7			201.1	0.0	0.1	0.3
Total	**1,585.8**	**1,670.37**	**2,032.53**	**3,255.31**	**4,696.1**	**6,228.8**	**7,801.5**	**5.3**	**7.2**	**7.0**	**7.6**	**5.8**	**4.6**

Table 29. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, Transportation Sector (KTOE) – LGS

Product	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Gasoline	634.7	666.5	880.8	1,533.6	2,249.2	2,969.0	3,672.5	5.0	7.9	8.2	8.0	5.7	4.3
Diesel	833.3	857.4	964.2	1,300.4	1,683.1	2,075.0	2,463.4	2.9	4.8	4.4	5.3	4.3	3.5
Fuel Oil	46.8	47.2	50.4	61.6	73.3	85.9	100.3	0.7	3.4	2.9	3.5	3.2	3.1
LPG	0.77	2.7	2.7	2.7	2.5	2.1	1.6	249.5	3.1	0.3	-1.4	-3.5	-6.1
Jet Fuel and Avgas	4.4	5.0	6.2	10.8	17.4	27.9	47.1	14.3	10.9	8.1	10.1	9.8	11.1
Biofuels	65.7	91.6	117.5	196.9	284.3	372.2	458.3	39.3	8.8	7.7	7.6	5.5	4.2
Electricity	0.00	0.00	0.01	24.1	24.1	24.3	24.6			204.9	0.0	0.1	0.3
Total	**1,585.8**	**1,670.4**	**2,021.8**	**3,130.1**	**4,334.0**	**5,556.3**	**6,767.8**	**5.3**	**6.5**	**6.4**	**6.7**	**5.1**	**4.0**

The growth of petroleum consumption of the transport sector in all modes is significantly determined by the volume of vehicles, frequencies of flights and number of vessels moving in and out of Mindanao. These modes of transportation are driven by the demand to transport people and goods flowing in and out of the island, which continuously improve and grow alongside economic development. With positive outlook for the island's economy supported by improvements on household income and government investments on transportation-related infrastructures, the demand for travel and transport of goods is projected to grow. As such, petroleum demand of the transport sector rises by more than four-fold over the planning period.

Land Transportation Energy Demand. Historically, fuel requirement for the land transport exhibited an upward trend with an average growth rate of 5.9 percent (2000-2017). Such trend continues in the planning period, but slows down post 2030. Overall, the sector's demand increases at 7.2 percent a year in HGS and 6.6 percent in LGS during the planning period. Its demand in 2040 stands at 7,619 ktoe (HGS) and 6,620 ktoe (LGS) from 1,535 ktoe in 2017 (Table 30). The fleet of "Diesel Vehicles in Truck Equivalent[11]" grows at an average of 9.4 percent and 8.7 percent in HGS and LGS, respectively. Further, the fleet of "Gasoline Vehicles in Car Equivalent[12]" escalates at 9.5 percent (HGS)

[11] Diesel Vehicles in Truck Equivalent (DVTE) is used in highway capacity analysis to convert a diesel vehicle flow into an equivalent passenger truck flow. Based on the Philippine Energy Plan methodology, the DVTE factors used in traffic analysis relevant to Mindanao are as follows: cars (0.11), utility vehicles (0.12), trucks (1.00), buses (0.97) and motorcycles (0.02).

and 8.8 percent (LGS) a year. The volume of land transport vehicles significantly affects the consumption of diesel and gasoline of the sector.

Table 30. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, Transportation Sector (KTOE) – by Modality

Mode	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
HGS													
Land	1,535	1,618	1,973	3,175	4,590	6,091	7,619	5.5	7.2	7.0	7.7	5.8	4.6
Water	47	47	53	69	87	108	132	0.7	4.6	3.9	4.8	4.3	4.2
Air	4	5	7	12	19	31	51	14.3	11.2	8.8	10.4	9.7	10.6
Total	**1,586**	**1,670**	**2,033**	**3,255**	**4,696**	**6,229**	**7,802**	**5.3**	**7.2**	**7.0**	**7.6**	**5.8**	**4.6**
LGS													
Land	1,535	1,618	1,965	3,058	4,243	5,443	6,620	5.5	6.6	6.5	6.8	5.1	4.0
Water	**47**	**47**	**50**	**62**	**73**	**86**	**100**	**0.7**	**3.4**	**2.9**	**3.5**	**3.2**	**3.1**
Air	**4**	**5**	**6**	**11**	**17**	**28**	**47**	**14.3**	**10.9**	**8.1**	**10.1**	**9.8**	**11.1**
Total	**1,585.8**	**1,670**	**2,022**	**3,130**	**4,334**	**5,556**	**6,768**	**5.3**	**6.5**	**6.4**	**6.7**	**5.1**	**4.0**

Water Transportation Energy Demand. Shipping vessels in Mindanao registered a historical growth rate of 4.8 percent. However, from 2006 to 2011, the consumption of fuel oil by marine transport experienced a decline, which could be attributed to the aggressive marketing of low cost airlines during the period. It pulled back again in 2012-2017 with increasing demand for fuel oil within the period. Demand prospects for marine fuel are dependent on the movements of revenue passenger and cargo loads flowing in and out of Mindanao. Within the planning period, marine transport demand for energy is projected to grow at 4.6 percent (HGS) and 3.4 percent (LGS) (Table 30). For HGS, demand picks up by almost three-fold reaching 132 ktoe in 2040 from only 47 ktoe in 2017. Meanwhile, LGS only requires 100 ktoe in 2040.

Air Transportation Energy Demand. The refueling requirements for all-types of aircraft in Mindanao registered a historical growth rate of 12.4 percent growth, which was influenced when the island's airports – Davao, Cagayan de Oro and Zamboanga cities – have been considered airline hubs in 2012-2013. With additional flights mounted by air carriers to service the growing demand of major cities and the introduction of flights to missionary areas, total available seat capacity in the market expanded historically by more than 10.0 percent a year. Airlines serving the domestic market of the island are operating with an average combined load factor of 80.0 percent. The frequently used aircraft in Mindanao is the single-aisle narrow body aircraft (Airbus-319 and Airbus-320) with a seating capacity ranging from 150 to 180 depending on the seats configuration. Wide body aircraft (Airbus-330 and Boeing-777) are deployed in cities where demand for cargo and passenger traffic is high.

According to industry experts, the demand in the commercial air travel market is forecasted to more than double over the next two decades. To meet this demand, airline services maintain a conservative and flexible fleet expansion plans. Consistent with the air travel demand growth trends, air transport energy demand is expected to increase at an average of more than 10.0 percent over the planning period (both scenarios). The sector's energy demand reaches 51 ktoe (HGS) and 47 ktoe (LGS) in 2040 (Table 30). Jet fuel accounts for about 80.0 percent of air transport fuel requirement, while the remaining is Avgas.

E-Vehicles (EVs). The government has been providing an enabling environment for the use of EVs in the country and promote investment to encourage the private sector in providing the support infrastructure, such as charging stations. Over the planning period, it is projected that the number of EVs in Mindanao under HGS reaches around 3,534 by 2040, which is equivalent to 24.4 percent of the total projected EVs nationwide.

Fuel demand of EVs during the planning period reaches 7.48 GWh (HGS) and 6.73 GWh (LGS), a seven-fold increase from 0.02 GWh in 2018. The expansion on the usage of EVs necessitates additional power supply requirements, but consequently displaces a total of 5.38 million liters of gasoline-fuel requirement in HGS and 4.84 million liters in LGS (Table 31).

[12] Gasoline Vehicles in Car Equivalent (GVCE) is used in highway capacity analysis to convert a gasoline vehicle flow into an equivalent passenger car flow. The GVCE factors considered in traffic analysis relevant to Mindanao are as follows: cars (1.0), utility Vehicles (1.2), trucks (1.8), buses (2.5) and motorcycles (0.18).

Table 31. Mindanao-wide TARGET OF E-VEHICLE

Mode	Outlook					
	2018	2020	2025	2030	2035	2040
High Growth Scenario						
No of E-Vehicles	10	59	165	457	1,272	3,534
% to Total National	0.1	0.6	1.4	3.2	8.8	24.4
Total Demand in GWh	0.02	0.12	0.35	0.97	2.69	7.48
Power Requirement in MW	0.01	0.05	0.14	0.38	1.06	2.95
Fuel Displacement Gasoline (In Million liters)	0.02	0.09	0.25	0.70	1.94	5.38
Low Growth Scenario						
No of E-Vehicles	10	54	149	411	1,144	3,182
% to Total National	0.1	0.6	1.3	2.9	7.9	22.0
Total Demand in GWh	0.02	0.11	0.32	0.87	2.42	6.73
Power Requirement in MW	0.01	0.05	0.12	0.34	0.95	2.65
Fuel Displacement Gasoline (In Million liters)	0.02	0.08	0.23	0.63	1.74	4.84

Note: Gasoline Liter Equivalent is based on 5liters/day at 313 days per annum
Total Power Consumption per day = (Lithium Ion Battery (estimated 1 hr. – 1.5 hrs. charging)) = 7 kWh

Commercial Sector Energy Demand. During the planning period, the GVA of the commercial sector (services) to the Mindanao's GRDP is expected to expand from 5.1 percent historical average annual growth rate to 9.6 percent (HGS) and 6.4 percent (LGS). With the improvement in the sector's GVA, its energy consumption increases to 1,591 ktoe (HGS) and 1,163 ktoe (LGS) in 2040 from 460 ktoe in 2017. This translates to annual growth rate of 5.5 percent in HGS and 4.1 LGS, higher than the 2010 to 2017 timeframe historical average of 3.2 percent (Tables 32 and 33). Historically, the elasticity level of the commercial sector's energy demand is 0.70, on the average. The same elasticity factor is observed over the planning period.

As rising economic growth would indicate higher electricity demand over the planning horizon, more than 50.0 percent of the total energy consumption of the sector will be electricity. From historical average share of 38.0 percent, electricity contribution goes up to about half of total energy demand of the sector in 2040. The sector's electricity demand accelerates at 8.4 percent a year in HGS and 6.0 percent in LGS. The growth of electricity demand of the sector in the past stood at 5.2 percent annually.

Petroleum contributes an average of 50.0 percent to the total energy demand of the sector during the planning horizon. However, its annual growth rate slides down from historical average of 6.1 percent to 3.7 percent (HGS) and 3.1 percent (LGS). On the other hand, biomass consumption of the sector is seen to increase at 2.9 percent (HGS) and 2.3 percent (LGS) annually as a result of shifting the demand to petroleum and electricity.

Table 32. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, Commercial Sector (KTOE) – HGS

Product	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
LPG	47	48	51	62	75	92	116	3.4	4.1	2.6	3.9	4.2	4.8
Diesel	191	198	213	253	300	355	424	3.7	3.5	2.5	3.4	3.4	3.6
Fuel Oil	28	30	33	44	57	72	93	5.8	5.3	3.9	5.2	5.1	5.2
Electricity	131	138	163	233	360	552	835	5.6	8.4	5.2	9.0	8.9	8.6
Biomass	63	64	67	77	89	104	123	2.2	2.9	1.9	2.9	3.2	3.4
Total	**460**	**479**	**528**	**668**	**879**	**1,175**	**1,591**	**4.1**	**5.5**	**3.4**	**5.6**	**6.0**	**6.3**

Table 33. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, Commercial Sector (KTOE) – LGS

Product	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
LPG	47	48	51	60	70	83	100	3.4	3.4	2.3	3.3	3.4	3.7
Diesel	191	198	211	247	286	331	383	3.7	3.1	2.3	3.0	2.9	3.0
Fuel Oil	28	30	33	42	52	64	79	5.8	4.6	3.5	4.5	4.3	4.3
Electricity	131	136	154	200	269	368	496	4.0	6.0	3.8	6.1	6.5	6.2
Biomass	63	64	67	75	84	94	105	2.2	2.3	1.6	2.3	2.3	2.3
Total	**460**	**477**	**516**	**623**	**762**	**940**	**1,163**	**3.7**	**4.1**	**2.7**	**4.1**	**4.3**	**4.4**

Industry Sector Energy Demand. The industry sector's increasing energy consumption is linked with its growing contribution to GRDP as annual GVA rises from historical of 5.2 percent to 6.9 percent in HGS and 5.0 percent in LGS. From 1,461 ktoe total energy consumption in 2017, the sector's demand expands to 6,431 ktoe (HGS) and 4,329 ktoe (LGS) at the end of the planning period (Tables 34 and 35). Electricity consumption of the sector constitutes an average share of around 40.0 percent of total in both scenarios. In the past, the average share of electricity demand to the sector's total energy demand was recorded at 23.0 percent. Electricity consumption grows annually at 11.4 percent (HGS) and 8.9 percent (LGS).

Coal utilization likewise decelerate annually at 3.0 percent (HGS) and 1.8 percent (LGS) from 7.3 historical average growth. Coal share to total energy requirement declines to around 20.4 percent, from historical share of almost 40.0 percent. Meanwhile, petroleum demand escalates annually at 4.1 percent (HGS) and 3.4 percent (LGS) contributing an average share of about 14.0 percent.

Table 34. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, Industry Sector (KTOE) – HGS

Product	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Coal	641	645	660	751	876	1,047	1,274	0.7	3.0	1.9	3.1	3.6	4.0
Oil and oil products	235	245	267	340	413	501	590	4.4	4.1	3.5	4.0	3.9	3.3
Electricity	340	392	471	725	1,306	2,339	4,105	15.4	11.4	6.3	12.5	12.4	11.9
Biomass	245	253	270	313	359	409	463	3.4	2.8	2.1	2.8	2.6	2.5
Total	**1,461**	**1,536**	**1,668**	**2,129**	**2,955**	**4,296**	**6,431**	**5.1**	**6.7**	**3.5**	**6.8**	**7.8**	**8.4**

Table 35. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, Industry Sector (KTOE) – LGS

Product	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Coal	641	645	649	708	777	859	956	0.7	1.8	1.2	1.9	2.0	2.2
Oil and oil products	235	245	264	324	381	444	506	4.4	3.4	2.9	3.3	3.1	2.6
Electricity	340	386	444	619	971	1,549	2,422	13.6	8.9	4.9	9.4	9.8	9.4
Biomass	245	253	269	311	354	399	445	3.4	2.6	2.1	2.6	2.4	2.2
Total	**1,461**	**1,530**	**1,627**	**1,962**	**2,482**	**3,251**	**4,329**	**4.7**	**4.8**	**2.7**	**4.8**	**5.5**	**5.9**

Agriculture Sector Energy Demand. The agriculture sector demonstrates a big leap as energy demand grows at 6.0 percent (HGS) and 4.1 percent (LGS) a year from historical growth rate of 2.2 percent (Tables 36 and 37). The increasing energy demand of agriculture sector is manifested in the development agenda of Mindanao, which will focus on agro-Industry strategy.

Table 36. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, Agriculture Sector (KTOE) – HGS

Product	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Oil and oil products	40	40	41	45	50	56	62	-0.4	1.9	1.4	2.1	2.1	2.0
Electricity	41	40	46	65	103	164	261	-2.2	8.4	5.0	9.8	9.8	9.7
Total	**81**	**80**	**87**	**110**	**153**	**220**	**322**	**-1.3**	**6.2**	**3.3**	**6.9**	**7.5**	**7.9**

The agricultural sector, which is the least energy intensive sector, shows an upward trend in its energy consumption, from 81 ktoe in 2017 to 322 ktoe (HGS) and 216 ktoe (LGS) in 2040. Electricity consumption increases its average share from nearly 60.0 percent (historical) to 64.3 percent, with annual growth rates of 8.4 percent (HGS) and 6.0 percent (LGS). Consumption of petroleum registers an annual growth rate of 1.9 percent (HGS) and 1.6 percent (LGS) within the planning period, contributing an average share of 35.7 percent to total energy requirement of the sector.

Table 37. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, Agriculture Sector (KTOE) – LGS

Product	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Oil and oil products	40	40	41	45	49	54	59	-0.4	1.6	1.2	1.9	1.8	1.7
Electricity	41	39	43	55	77	111	157	-4.7	6.0	3.6	6.9	7.4	7.2
Total	**81**	**79**	**84**	**100**	**127**	**164**	**216**	**-2.6**	**4.3**	**2.5**	**4.8**	**5.4**	**5.6**

ENERGY-ECONOMY OUTLOOK

As shown in Figure 21, energy demand decouples from economic growth, which could be an outcome of efforts to reduce energy intensity (energy consumption per unit of GDP) by underpinning energy efficiency policies and conservation measures. Overall energy intensity in Mindanao considerably slows down during the Planning period, with the annual reduction rate of 3.2 percent, falling to 1.78 Toe per Million GDP in HGS in 2040, nearly half of the 2017 level of 3.81 TOE per one Million GDP. In LGS, energy intensity declines annually at 1.3 percent reaching 2.81 Toe per million GDP.

Figure 21. MINDANAO ENERGY INTENSITY (TOE/PHPM) (TFED), Actual 2000, 2017 and Projection for 2040

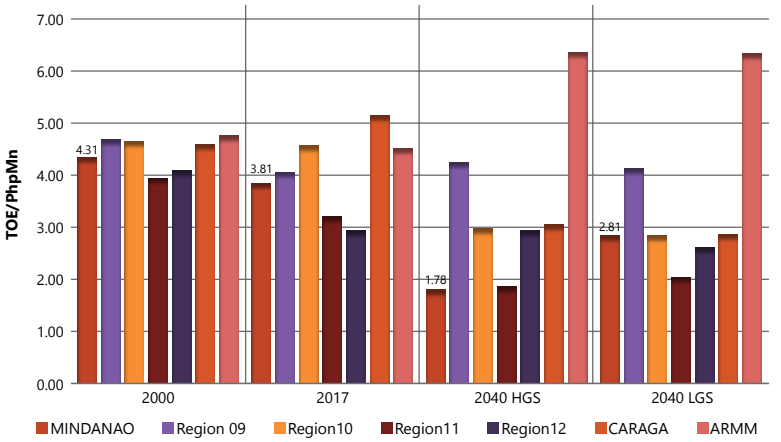
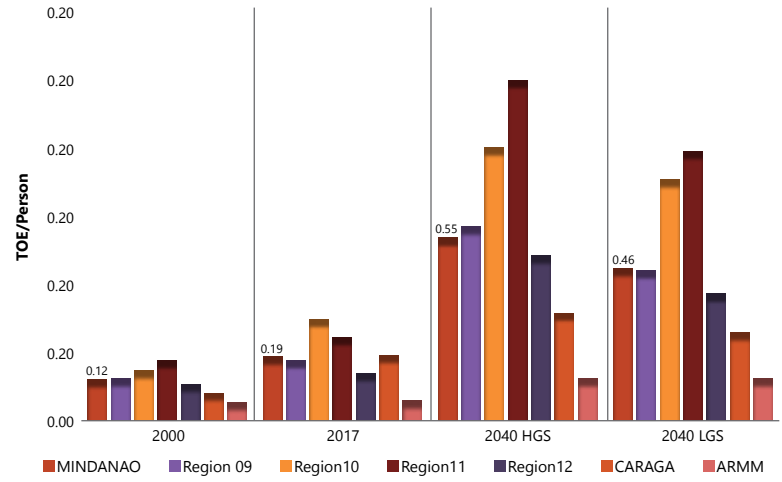


Figure 22. MINDANAO ENERGY PER CAPITA (TOE/person), Actual 2000, 2017 and Projection for 2040



Energy intensity drops in almost all regions in Mindanao (Figure 21) relative to 2017 level, except in Zamboanga Peninsula and ARMM regions. Northern Mindanao, Davao and Caraga regions register an annual reduction rate of around 2.0 percent (both in HGS and LGS) in their energy intensities, while Soccsksargen energy intensity shows a slight decline of less than one percent. Zamboanga's energy intensity increases a bit from 2017 level, while ARMM displays about one percent increase in intensity.

On the other hand, Mindanao's energy per capita shows an upward trend. Average energy demand per capita rises significantly, from 0.19 Toe/person in 2017 to 0.55 Toe/person (HGS) and 0.46 Toe/person (LGS) in 2040, as higher income level boosts energy demand (Figure 22). Generally, energy use per capita triples over the planning period but still below the national average of 4.0 Toe/person. Northern Mindanao and Davao continue to have the highest energy per capita with 0.82 and 1.02 Toe/person in 2040, respectively. Davao region's energy per capita increases by four-fold in HGS and three-fold in LGS, translating to 6.3 percent and 5.3 percent annual growth rates, respectively, the highest among the regions. ARMM has the lowest per capita, around 0.13 Toe/person in 2040, but considerably registers an annual growth of about 3.3 percent a year.

PETROLEUM PRODUCTS AND BIOFUELS DEMAND OUTLOOK

Tables 38 and 39 present the historical and projected demand for oil. Similar to national, oil is still the major fuel consumed in Mindanao with historical average share of almost 44.0 percent to total energy demand. In spite of price volatility, dependence on oil continues over the planning period with demand increasing at 6.3 percent a year in HGS and 5.6 percent in LGS. In HGS, demand for oil and biofuels reaches 21,418 thousand barrels (MB) in 2020 and 73,882 MB in 2040. Meanwhile, demand in LGS only requires 63,598 MB in 2040, a reduction of 13.9 percent from HGS.

Diesel and gasoline have been the most consumed petroleum products. Both products account for a combined share of about 80.0 percent (HGS and LGS) in oil demand mix by 2040. Gasoline exhibits the fastest growth than diesel at 8.6 percent (HGS) and 7.9 percent (LGS), resulting in greater share in total oil demand surpassing diesel starting 2027. Diesel grows only at 4.9 percent (HGS) and 4.3 percent (LGS) over the planning period. The increasing number of vehicles in the island drives the rapid growth in both diesel and gasoline demand.

On the other hand, fuel oil demand is projected to increase at 4.9 percent a year in HGS and 3.9 percent in LGS during the planning period. Meanwhile, annual LPG demand climbs at 4.7 percent (HGS) and 2.9 percent (LGS) demonstrating an increasing growth as more households shift to using a convenient fuel instead of the traditional biomass for cooking. The projected economic growth pushes up electricity demand, which results in a 5.1 percent (HGS) and 4.5 percent (LGS) annual average decline in kerosene demand.

Table 38. TOTAL PETROLEUM DEMAND OUTLOOK 2018-2040, By Product (MB) – HGS

Product	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Gasoline	5,158	5,419	7,183	12,992	19,861	27,083	34,387	5.1	8.6	8.8	8.9	6.4	4.9
Diesel	8,589	8,836	9,819	13,039	16,978	21,262	25,759	2.9	4.9	4.1	5.4	4.6	3.9
Fuel Oil	1,386	1,443	1,605	2,143	2,715	3,398	4,138	4.1	4.9	4.2	4.8	4.6	4.0
LPG	1,161	1,234	1,342	1,673	2,086	2,609	3,318	6.3	4.7	3.2	4.5	4.6	4.9
Kerosene	133	122	105	76	59	48	40	-8.2	-5.1	-4.5	-4.9	-4.1	-3.6
Jet A-1 and Avgas	35	40	52	93	153	243	401	14.3	11.2	8.8	10.4	9.6	10.5
Biodiesel	175	186	207	275	358	449	544	6.3	5.0	4.1	5.4	4.6	3.9
Bioethanol	554	833	1,105	2,000	3,058	4,171	5,296	50.3	8.4	8.8	8.9	6.4	4.9
Total	**17,192**	**18,114**	**21,418**	**32,292**	**45,268**	**59,263**	**73,882**	**5.4**	**6.3**	**6.0**	**7.0**	**5.5**	**4.5**

Table 39. TOTAL PETROLEUM DEMAND OUTLOOK 2018-2040, By Product (MB) – LGS

Product	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Gasoline	5,158	5,419	7,156	12,449	18,252	24,089	29,795	5.1	7.9	8.2	8.0	5.7	4.3
Diesel	8,589	8,836	9,770	12,667	15,932	19,304	22,702	2.9	4.3	3.8	4.7	3.9	3.3
Fuel Oil	1,386	1,443	1,564	1,982	2,398	2,871	3,359	4.1	3.9	3.4	3.9	3.7	3.2
LPG	1,161	1,234	1,283	1,473	1,686	1,932	2,235	6.3	2.9	2.0	2.7	2.8	3.0
Kerosene	133	122	109	83	66	55	46	-8.2	-4.5	-3.9	-4.4	-3.7	-3.5
Jet A-1 and Avgas	35	40	50	86	138	221	372	14.3	10.8	8.1	10.1	9.8	11.0
Biodiesel	175	186	210	273	345	421	498	6.3	4.6	3.8	4.8	4.0	3.4
Bioethanol	554	833	1,101	1,917	2,811	3,711	4,590	50.3	7.7	8.2	8.0	5.7	4.3
Total	**17,192**	**18,114**	**21,243**	**30,928**	**41,629**	**52,603**	**63,598**	**5.4**	**5.6**	**5.5**	**6.1**	**4.8**	**3.9**

Given the growing concern on price volatility of oil, the government will continue to intensify its program on the utilization of alternative fuels. With mandated bioethanol and biodiesel blends assumed to increase by 20.0 percent in 2020 and 2025, respectively, the demand is expected to expand in both scenarios with a share of about 7.8 percent in 2040. Biodiesel and bioethanol grow annually at 5.0 percent and 8.4 percent in HGS, and 4.6 percent and 7.7 percent in LGS, respectively. From 729 MB in 2017, demand for biofuels picks up to 1,312 MB in 2020 and 5,840 MB in 2040 in HGS. Demand in LGS only stands at 5,088 MB in 2040.

Regional Petroleum Demand Outlook. Under HGS, petroleum demand of all regions is projected to more than triple over the planning period. Northern Mindanao and Davao regions account for about half of the oil demand. These regions remain to hold more than half of the gasoline and diesel vehicles in Mindanao. Soccsksargen and ARMM register the fastest growth at around 8.0 percent a year. Other regions – Zamboanga and Caraga – likewise show strong growth in oil demand, increasing annually between 6.0 percent to 7.5 percent (Tables 40 and 41). The growth in the regional oil demand is driven by transport, commercial and industry sectors, which reflects urbanization trends in both scenarios.

Table 40. TOTAL PETROLEUM DEMAND OUTLOOK 2018-2040, By Region (MB) – HGS

Region	Outlook							Growth Rates (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
IX	2,846	2,933	3,678	6,037	8,657	11,532	14,641	3.0	7.4	7.3	7.5	5.9	4.9
X	4,585	4,801	5,411	7,393	9,773	12,338	15,044	4.7	5.3	4.6	5.7	4.8	4.0
XI	5,549	5,834	6,799	10,014	13,935	18,094	22,316	5.1	6.2	5.7	6.8	5.4	4.3
XII	2,241	2,383	3,026	5,152	7,718	10,453	13,253	6.4	8.0	7.9	8.4	6.3	4.9
CARAGA	1,487	1,508	1,749	2,604	3,636	4,721	5,833	1.4	6.1	5.9	6.9	5.4	4.3
ARMM	484	655	755	1,093	1,550	2,127	2,796	35.4	7.9	5.4	7.2	6.5	5.6
Total	**17,192**	**18,114**	**21,418**	**32,292**	**45,268**	**59,263**	**73,882**	**5.4**	**6.5**	**6.0**	**7.0**	**5.5**	**4.5**

Table 41. TOTAL PETROLEUM DEMAND OUTLOOK 2018-2040, By Region (MB) – LGS

Region	Outlook							Growth Rates (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
IX	2,846	2,933	3,611	5,703	7,887	10,154	12,481	3.0	6.6	6.7	6.7	5.2	4.2
X	4,585	4,801	5,364	7,143	9,138	11,191	13,272	4.7	4.7	4.2	5.1	4.1	3.5
XI	5,549	5,834	6,823	9,650	12,786	15,940	19,022	5.1	5.5	5.1	5.8	4.5	3.6
XII	2,241	2,383	2,970	4,881	7,020	9,196	11,341	6.4	7.3	7.4	7.5	5.5	4.3
CARAGA	1,487	1,508	1,731	2,501	3,365	4,231	5,087	1.4	5.5	5.4	6.1	4.7	3.8
ARMM	484	655	744	1,050	1,434	1,891	2,394	35.4	7.2	5.0	6.4	5.7	4.8
Total	**17,192**	**18,114**	**21,243**	**30,928**	**41,629**	**52,603**	**63,598**	**5.4**	**5.9**	**5.5**	**6.1**	**4.8**	**3.9**

Sectoral Petroleum Demand Outlook. All sectors show a steady increase in oil demand during the planning period, albeit industry and transport sectors display a downward trend in growth rates post 2030 (Tables 42 and 43). The transport sector increases its share to total oil demand by almost 85.0 percent in 2040 (both scenarios) compared with its 2017 level of 72.0 percent. This translates to a higher growth rate of 7.3 percent a year in HGS and 6.6 percent in LGS resulting in total oil demand of 62,395 MB and 54,109 MB in 2040, respectively. Oil demand of the commercial sector displays an increasing growth trend with an average rate of 3.8 percent (HGS) and 3.3 percent (LGS). However, its share decelerates to around 7.0 percent in 2040 from 12.3 percent in 2017. The industry sector's demand accelerates annually at 4.1 percent (HGS) and 3.4 percent (LGS), but with a declining share to total from 9.9 percent in 2017 down to about 6.0 percent in 2040.

The rising demand of these sectors manifests the development and urbanization trends in Mindanao leading to increased economic activities requiring additional oil demand for the delivery of products and services. The shift from merely agriculture towards an agro-industrial and more industrialized Mindanao pushes up the demand for oil.

Table 42. TOTAL PETROLEUM DEMAND OUTLOOK 2018-2040, By Sector (MB) – HGS

Sector	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Industry	1,708	1,784	1,946	2,475	3,016	3,660	4,330	4.4	4.1	3.5	4.0	3.9	3.4
Commercial	2,122	2,203	2,369	2,851	3,428	4,134	5,055	3.8	3.8	2.7	3.8	3.8	4.1
Transportation	12,378	13,130	16,058	25,745	37,373	49,731	62,395	6.1	7.3	7.0	7.7	5.9	4.6
Residential	683	699	738	883	1,077	1,322	1,640	2.2	3.9	2.6	4.0	4.2	4.4
Agriculture	300	299	307	338	376	417	462	-0.3	1.9	1.4	2.1	2.1	2.1
Total	**17,192**	**18,114**	**21,418**	**32,292**	**45,268**	**59,263**	**73,882**	**5.4**	**6.5**	**6.0**	**7.0**	**5.5**	**4.5**

Table 43. TOTAL PETROLEUM DEMAND OUTLOOK 2018-2040, By Sector (MB) – LGS

Sector	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Industry	1,708	1,784	1,925	2,358	2,775	3,240	3,695	4.4	3.4	2.9	3.3	3.1	2.7
Commercial	2,122	2,203	2,346	2,771	3,251	3,804	4,474	3.8	3.3	2.4	3.2	3.2	3.3
Transportation	12,378	13,130	15,975	24,744	34,471	44,339	54,109	6.1	6.6	6.5	6.9	5.2	4.1
Residential	683	699	691	722	766	819	882	2.2	1.1	0.6	1.2	1.4	1.5
Agriculture	300	299	307	335	367	402	438	-0.3	1.7	1.3	1.9	1.8	1.7
Total	**17,192**	**18,114**	**21,243**	**30,928**	**41,629**	**52,603**	**63,598**	**5.4**	**5.9**	**5.5**	**6.1**	**4.8**	**3.9**

The residential sector registers a growth rate of only 3.9 percent (HGS) and 1.1 percent (LGS) and accounting for less than 3.0 percent share to total oil demand in 2040, from 4.0 percent in 2017. Although the demand of the sector grows slowly compared with the other sectors, it already considers more households having greater access to efficient fuel (LPG). The agriculture sector posts the lowest yet relatively stable growth rate at 1.9 percent (HGS) and 1.7 percent (LGS) annually. Said sector remains as the least user of oil with less than 1.0 percent share to total.

Oil Facility Requirement. Mindanao has existing 37 oil depot/storage with a total capacity of 3,767 MB used to stock inventory supply for the different petroleum products. It is assumed that the allocation of existing depot/storage for

petroleum products is based on the share of each (product) to total oil demand. About half of the total capacity is located in Northern Mindanao, while Davao region hosts 30.0 percent of the capacity. Caraga only secured 2.0 percent of total. *Please see Figure 46.*

Table 44. STORAGE CAPACITY, TURNOVER RATE AND INVENTORY DAYS, HGS

Year	Total Oil Demand (MMB)	Oil Storage Requirements (MB)	Turnover Rate	Inventory (No. of Days)	Oil Storage Requirements (MB) at 80% Capacity Utilization Rate
2018	18,114	3,767	4.81	76	3,767
2019	19,562	3,767	5.19	70	3,767
2020	21,418	3,767	5.69	64	3,767
2021	23,369	3,767	6.20	59	3,767
2022	25,436	3,767	6.75	54	3,767
2023	27,626	3,767	7.33	50	3,767
2024	29,952	4,017	7.46	49	5,021
2025	32,292	4,017	8.04	45	5,021
2026	34,724	4,020	8.64	42	5,025
2027	37,310	4,020	9.28	39	5,025
2028	39,918	4,120	9.69	38	5,150
2029	42,581	4,820	8.83	41	6,025
2030	45,268	4,820	9.39	39	6,025
2031	47,9991	4,820	9.96	37	6,025
2032	50,759	4,820	10.53	35	6,025
2033	53,563	4,835	11.08	33	6,044
2034	56,410	5,785	9.75	37	7,231
2035	59,263	5,785	10.24	36	7,231
2036	62,119	5,785	10.74	34	7,231
2037	65,018	5,785	11.24	32	7,231
2038	67,960	6,665	10.20	36	8,331
2039	70,914	6,765	10.48	35	8,456
2040	73,882	6,775	10.91	33	8,469

For the planning period, although the DOE requires a minimum of 15-day inventory level for petroleum products, except for LPG with a 7-day inventory, it is assumed that inventory level will be at 30 days for diesel, gasoline, biofuels and others, while LPG is 15 days. Higher inventory level is considered in the planning period for the island to have a buffer capacity to stock additional petroleum supply as a precautionary measure in the event of imminent supply disruption.

The current capacity is still enough to cover the assumed inventory requirement until 2023. With growing oil demand (HGS), total storage capacity requirement of the island in 2040 reaches 6,775 MB with a turnover rate of around 10.9, or a replenishment rate of 11 times in a year. Taken into account the capacity utilization rate, which is assumed to be at 80.0 percent, total storage capacity requirement stands at 8,469 MB in 2040 (Table 44). This means the island needs to put up additional storage with a total capacity of about 4,702 MB until 2040. Of the total storage capacity, gasoline and diesel entail about 40.0 percent each of total, while fuel oil requires almost 7.0 percent. Biofuels need 7.4 percent and LPG 5.2 percent of total (Table 45).

Table 45. TOTAL STORAGE CAPACITY REQUIREMENT BY PETROLEUM PRODUCT (2018-2040), HGS

Petroleum Products	Oil Storage Requirements (MB)	Share (%)
Gasoline	3,500	41.3
Diesel	3,250	38.4
Fuel Oil	563	6.6
LPG	438	5.2
Bioethanol	563	6.6
Biodiesel	69	0.8
Others	87	1.0

In LGS, the island needs a total storage capacity of 7,044 MB (an additional of 3,277 MB), about 16.8 percent lower compared with HGS. On capacity requirement per petroleum product, gasoline needs almost half of total and diesel around 33.0 percent.

If the mandated minimum inventory requirement of the government shall be considered in the planning period, the existing capacity can still maintain such inventory level until 2035 and 2040 in HGS and LGS, respectively.

The island may also consider hosting its own refinery when demand climbs to 100.0 thousand barrels per day (MB/d).

In Figure 23, oil demand reaches 102.2 MB/d in 2027 in HGS, and increases to 202.4 MB/d at the end of the planning period. With growing oil demand level, a refinery facility may be put up with an initial capacity of 50 MB/d to meet a portion of the supply requirement in 2027 with the possibility for capacity expansion to 100 MB/d in 2040. Under LGS, refinery facility may be introduced a year late (102.2 MB/d in 2028) with 50 MB/d initial capacity, which can be increased to 85 MB/d in 2040 (Figure 24). It is assumed that refinery output only provides around 40.0 percent of the island's petroleum supply requirement based on 80.0 percent utilization rate of the facility.

However, the decision to establish a refinery depends on the economic and financial feasibility, and the market share of the prospective oil company that will put up such facility in the island. Initial refinery capacity may also be higher or lower than what is assumed in the planning period, which is determined by economic and financial prospects of the interested oil company.

Figure 23. OIL DEMAND PER DAY, HGS

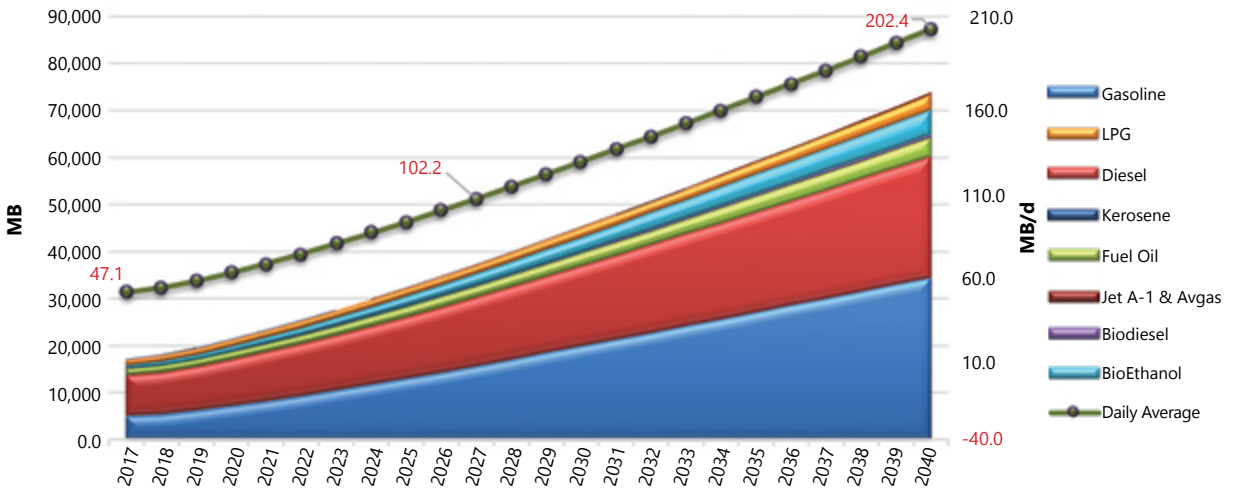
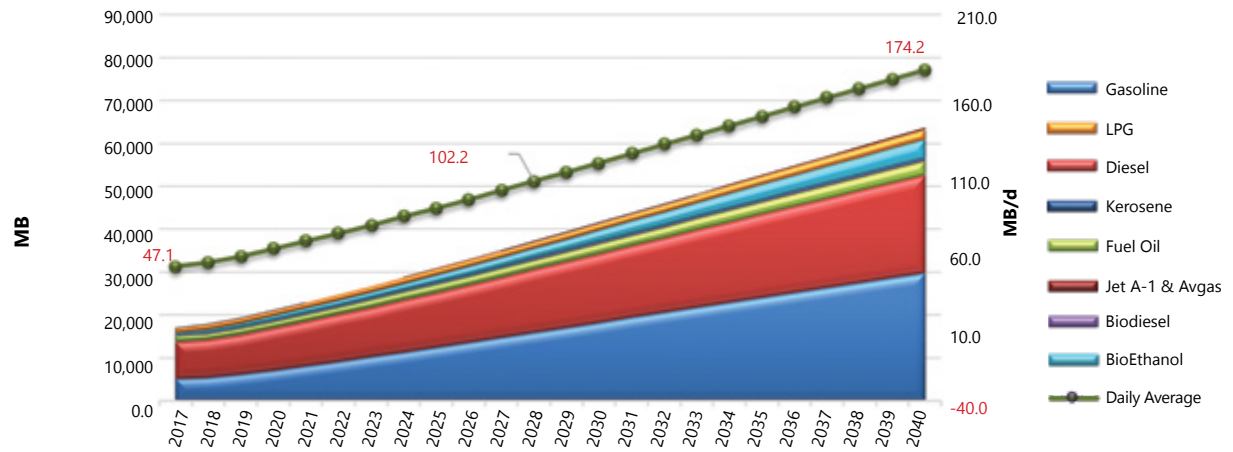


Figure 24. OIL DEMAND PER DAY, LGS



COAL DEMAND OUTLOOK

Demand for coal slowdowns from historical average growth rate of 7.3 percent (1990-2017) to 3.0 percent in HGS and 1.8 percent in LGS taking into account the economic growth assumptions in Mindanao, owning about 6.5 percent share (both HGS and LGS) to final energy demand by 2040 (Tables 46 and 47). Coal demand more than doubles from its 2017 level of 1,214 million metric ton (MMT) (@ 10,000 btu/lb) to 2,413 MMT (HGS) in 2040. In LGS, demand picks up to 1,812 MMT. The rising demand is due to projected increase in the economic activity of the industry sector, particularly for cement, steel, and food processing.

Mindanao's average share to the total national coal consumption during the historical period was about 15.0 to 20.0 percent. On the average, about a quarter of the industry sector's energy demand in the island is coal. Northern Mindanao and Caraga together account for nearly 90.0 percent of coal demand in 2017 and further increases to about 92.0 percent by the end of the planning period under HGS. Northern Mindanao requires about three-fourth of the demand, while Caraga necessitates nearly one-fifth. Combined share of these regions remains the same as in 2017 under LGS.

Table 46. TOTAL COAL DEMAND OUTLOOK 2018-2040, By Region (MMT @ 10,000 BTU/LB) – HGS

Region	Outlook							Growth Rates (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
X	811	802	812	941	1,134	1,413	1,797	-1.2	3.5	2.1	3.8	4.5	4.9
XII	128	134	139	152	165	178	191	4.3	1.7	1.3	1.7	1.5	1.4
CARAGA	267	279	292	324	357	389	421	4.7	2.0	1.5	1.9	1.7	1.6
Others	8	8	6	5	4	4	4	-5.3	-3.2	-4.3	-3.0	-1.3	-0.2
Total	**1,214**	**1,223**	**1,250**	**1,422**	**1,660**	**1,984**	**2,413**	**0.7**	**3.0**	**1.9**	**3.1**	**3.6**	**4.0**

Table 47. TOTAL COAL DEMAND OUTLOOK 2018-2040, By Region (MMT @ 10,000 BTU/LB) – LGS

Region	Outlook							Growth Rates (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
X	811	802	793	859	946	1,057	1,196	-1.2	1.7	1.2	1.9	2.3	2.5
XII	128	134	139	152	165	178	191	4.3	1.7	1.3	1.7	1.5	1.4
CARAGA	267	279	292	324	357	389	421	4.7	2.0	1.5	1.9	1.7	1.6
Others	8	8	6	5	4	4	4	-5.3	-3.3	-4.0	-2.7	-1.1	-0.1
Total	**1,214**	**1,223**	**1,230**	**1,341**	**1,472**	**1,628**	**1,812**	**0.7**	**1.8**	**1.2**	**1.9**	**2.0**	**2.2**

BIOMASS DEMAND OUTLOOK

Traditional biomass mostly consists of wood fuels, agricultural by-products and manure are used for cooking and heating purposes. Traded informally and non-commercially, it is widely harvested and used in an unsustainable way, specifically in rural areas. A higher economic growth target for Mindanao would mean that the standard of living improves as a result of poverty reduction. Consequently, the demand for biomass slows down.

The role of biomass as one of the primary fuels weakens as socio-economic conditions of the household sector is seen to further improve – better income level and expanding urbanization. Historically, biomass accounted for a significant share to TFEC, about 23.5 percent of total in 2017, and grew annually at 2.4 percent (1990-2017). Across the planning horizon, it is projected to have a modest growth of 1.9 percent (HGS) and 2.3 percent (LGS) annually. Such growth corresponds to a share of 8.4 percent and 11.7 percent under HGS and LGS, respectively, in 2040. In HGS, biomass demand moderately rises to 4,864 thousand metric ton (MMT) in 2040, while demand in LGS reaches 5,327 MMT from 2017 level of 3,129 MMT (Tables 48 and 49).

The residential sector, as the major user of biomass, is seen to significantly contribute to the moderate growth in biomass demand. During the planning period, household consumption of biomass exhibits a moderate increase with a 1.3 percent growth in HGS and 2.1 percent a year in LGS. More than 60.0 percent of biomass consumption is for household use (Tables 50 and 51). Northern Mindanao and Davao regions remain as the major contributors to biomass demand with around 15.0-25.0 percent share to total.

Among the biomass, fuelwood is used mostly with an average share of about 50.0 percent of total, followed by animal waste (25.0-28.0 percent) and charcoal (12.0-14.0 percent). Fuel wood is expected to grow at an average annual rate of 2.3 percent and 2.4 percent in HGS and LGS, respectively.

Table 48. TOTAL BIOMASS DEMAND OUTLOOK 2018-2040, By Region ('000 MT) – HGS

Region	Outlook							Growth Rates (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
IX	602	611	638	720	826	959	1,129	1.4	2.8	1.8	2.8	3.0	3.3
X	685	681	679	670	679	700	731	-0.6	0.3	-0.2	0.3	0.6	0.9
XI	568	593	649	784	916	1,052	1,208	4.3	3.3	2.7	3.1	2.8	2.8
II	504	502	503	494	495	499	508	-0.4	0.0	-0.2	0.0	0.2	0.4
CARAGA	342	353	379	435	493	552	617	3.3	2.6	2.0	2.5	2.3	2.3
ARMM	428	439	466	522	571	619	671	2.7	2.0	1.6	1.8	1.6	1.6
Total	**3,129**	**3,178**	**3,313**	**3,626**	**3,980**	**4,382**	**4,864**	**1.6**	**1.9**	**1.3**	**1.9**	**1.9**	**2.1**
Rice hull	26	26	28	33	40	50	62	2.5	3.9	2.4	4.0	4.2	4.5
Charcoal	402	406	417	445	479	523	581	0.9	1.6	0.9	1.5	1.8	2.1
Fuel wood	1,623	1,662	1,759	1,984	2,207	2,449	2,735	2.4	2.3	1.7	2.2	2.1	2.2
Bagasse	107	113	128	162	196	230	264	6.5	4.0	3.4	3.9	3.2	2.8
Animal waste	971	970	980	1,002	1,057	1,130	1,222	-0.1	1.0	0.3	1.1	1.3	1.6

Table 49. TOTAL BIOMASS DEMAND OUTLOOK 2018-2040, By Region ('000 MT) – LGS

Region	Outlook							Growth Rates (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
IX	602	611	607	661	725	798	884	1.4	1.7	1.2	1.9	1.9	2.1
X	685	681	751	845	939	1,032	1,129	-0.6	2.2	1.7	2.1	1.9	1.8
XI	568	593	623	704	787	872	965	4.3	2.3	1.8	2.3	2.1	2.0
II	504	502	552	621	694	769	850	-0.4	2.3	1.7	2.2	2.1	2.0
CARAGA	342	353	376	426	479	533	592	3.3	2.4	1.8	2.4	2.2	2.1
ARMM	428	439	481	567	665	777	907	2.7	3.3	2.4	3.2	3.1	3.2
Total	**3,129**	**3,178**	**3,389**	**3,823**	**4,289**	**4,780**	**5,327**	**1.6**	**2.3**	**1.7**	**2.3**	**2.2**	**2.2**
Rice hull	26	26	28	33	38	44	51	2.5	3.0	2.1	3.1	3.0	3.0
Charcoal	402	406	443	507	577	653	740	0.9	2.7	1.9	2.6	2.5	2.5
Fuel wood	1,623	1,662	1,770	1,991	2,229	2,483	2,774	2.4	2.4	1.7	2.3	2.2	2.2
Bagasse	107	113	128	162	196	230	264	6.5	4.0	3.4	3.9	3.2	2.8
Animal waste	971	970	1,019	1,132	1,250	1,370	1,499	-0.1	1.9	1.5	2.0	1.9	1.8

Table 50. TOTAL BIOMAS DEMAND OUTLOOK 2018-2040, By Sector ('000 MT) – HGS

Sector	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Industry	685	714	778	925	1,080	1,243	1,421	4.3	3.2	2.5	3.2	2.8	2.7
Commercial	176	182	195	227	267	315	376	3.1	3.4	2.2	3.3	3.4	3.6
Residential	2,267	2,282	2,339	2,474	2,632	2,823	3,067	0.7	1.3	0.8	1.2	1.4	1.7
Total	**3,129**	**3,178**	**3,313**	**3,626**	**3,980**	**4,382**	**4,864**	**1.6**	**1.9**	**1.3**	**1.9**	**1.9**	**2.1**

Table 51. TOTAL BIOMAS DEMAND OUTLOOK 2018-2040, By Sector ('000 MT) – LGS

Sector	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Industry	685	714	777	919	1,065	1,212	1,366	4.2	3.0	2.4	3.0	2.6	2.4
Commercial	176	182	194	222	253	286	323	3.1	2.7	1.9	2.6	2.5	2.5
Residential	2,267	2,291	2,417	2,682	2,971	3,282	3,639	1.0	2.1	1.5	2.1	2.0	2.1
Total	**3,129**	**3,186**	**3,389**	**3,823**	**4,289**	**4,780**	**5,327**	**1.9**	**2.3**	**1.7**	**2.3**	**2.2**	**2.2**

ELECTRICITY DEMAND OUTLOOK

With an annual average growth rate of 4.3 percent, electricity demand in Mindanao (covering both on-grid and off-grid areas) more than tripled from 1990 to 2017. Over the planning period, electricity demand continues to grow at 9.8 percent in HGS and 7.3 percent in LGS. Prospective economic growth across regions is the key factor of the rise in electricity demand. In HGS, all Mindanao regions register more than seven-fold increase in their electricity demand, with exception of Northern Mindanao and Soccsksargen with demand rises by nine (9) times. Northern Mindanao, Davao and Soccsksargen regions continue to be the major users of electricity with combined share of around 78.0 percent (both scenarios) of total electricity demand in 2040 (Tables 52 and 53). The surge in demand from these regions has been driven mainly by the presence of heavy industries and reflecting the flow of investment to these regions. Overall, the island's electricity demand climbs up to 81,243 GWh in HGS by 2040 from 9,497 GWh in 2017, an eight-fold growth. On the other hand, most regions display more than four-fold increase in electricity demand in LGS, with total demand reaches 48,252 GWh in 2040.

Table 52. TOTAL ELECTRICITY DEMAND (SALES) OUTLOOK 2018-2040, By Region (GWh) – HGS

Region	Outlook							Growth Rates (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
IX	1,042	1,135	1,454	2,437	3,881	5,846	8,793	9.0	9.7	7.7	9.8	8.5	8.5
X	2,412	2,960	3,652	5,735	9,106	14,906	23,791	22.7	10.5	6.7	9.7	10.4	9.8
XI	3,165	3,351	3,945	5,744	9,408	14,972	24,295	5.9	9.3	5.5	10.4	9.7	10.2
XII	1,673	1,841	2,327	3,815	6,283	9,807	15,335	10.0	10.1	7.3	10.5	9.3	9.4
CARAGA	851	1,016	1,271	2,004	2,885	4,162	6,130	19.5	9.0	6.7	7.6	7.6	8.1
ARMM	354	439	603	1,057	1,672	2,193	2,899	23.9	9.6	8.3	9.6	5.6	5.7
Total	**9,497**	**10,744**	**13,252**	**20,792**	**33,236**	**51,887**	**81,243**	**13.1**	**9.8**	**6.6**	**9.8**	**9.3**	**9.4**

Note: Including off-grid areas; excluding losses and station use

Table 53. TOTAL ELECTRICITY DEMAND (SALES) OUTLOOK 2018-2040, By Region (GWh) – LGS

Region	Outlook							Growth Rates (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
IX	1,042	1,104	1,334	1,984	2,752	3,704	4,987	6.0	7.0	5.8	6.8	6.1	6.1
X	2,412	2,793	3,266	4,590	6,281	9,012	12,503	15.8	7.4	5.0	6.5	7.5	6.8
XI	3,165	3,454	3,982	5,514	7,998	11,615	17,218	9.1	7.6	4.8	7.7	7.7	8.2
XII	1,673	1,792	2,152	3,147	4,428	6,006	8,138	7.1	7.1	5.6	7.1	6.3	6.3
CARAGA	851	986	1,166	1,660	2,107	2,726	3,589	15.9	6.5	5.2	4.9	5.3	5.7
ARMM	354	413	530	803	1,193	1,474	1,817	16.6	7.4	6.1	8.2	4.3	4.3
Total	**9,497**	**10,542**	**12,430**	**17,698**	**24,759**	**34,537**	**48,252**	**11.0**	**7.3**	**5.2**	**6.9**	**6.9**	**6.9**

Note: Including off-grid areas; excluding losses and station use

Industrialization and urbanization are two structures that defined the present socio-economic development of Mindanao. Specifically, the rural-to-urban migration and economic growth are regarded as the major factors that determine the electricity consumption. Further, urban centers have the dominant position in the processes for the island's development. The development spurred by these urban centers have a spill-over effect to rural areas, which stimulates the demand for electricity. Thus, the demand for electricity over the planning period is robust.

The industry sector becomes the major user of electricity with more than 50.0 percent share (both scenarios) to total electricity consumed in 2040, overtaking residential sector post 2030. The sector's electricity demand grows annually at 11.4 percent in HGS and 8.9 percent in LGS. Followed next is residential sector with 26.0 percent share and commercial sector with 12.0 percent in 2040 (Tables 54 and 55).

Table 54. TOTAL ELECTRICITY DEMAND OUTLOOK 2018-2040, By Sector (GWh) – HGS

Sector	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Industry	3,954.75	4,562.43	5,482.70	8,433.46	15,190.84	27,199.54	47,736.67	15.4	11.4	6.3	12.5	12.4	11.9
Commercial	1,524.92	1,610.50	1,900.34	2,713.15	4,181.28	6,417.19	9,713.38	5.6	8.4	5.2	9.0	8.9	8.6
Transportation	0.00	0.02	0.12	279.97	280.59	282.31	287.10			201.1	0.0	0.1	0.3
Residential	3,540.75	4,104.98	5,334.29	8,614.87	12,386.31	16,076.92	20,474.82	15.9	7.9	7.1	7.5	5.4	5.0
Agriculture	476.18	465.70	535.00	750.70	1,196.74	1,910.91	3,030.87	-2.2	8.4	5.0	9.8	9.8	9.7
Total	**9,496.59**	**10,743.63**	**13,252.46**	**20,792.15**	**33,235.74**	**51,886.88**	**81,242.83**	**13.1**	**9.8**	**6.6**	**9.8**	**9.3**	**9.4**

Note: Including off-grid areas; excluding losses and station use

Table 55. TOTAL ELECTRICITY DEMAND OUTLOOK 2018-2040, By Sector (GWh) – LGS

Sector	Outlook							Growth Rate (in %)					
	2017	2018	2020	2025	2030	2035	2040	2018 vs' 17	2017-'40	2020-'25	2025-'30	2030-'35	2035-'40
Industry	3,954.75	4,494.55	5,161.00	7,202.68	11,293.19	18,014.11	28,168.42	15.4	8.9	4.9	9.4	9.8	9.4
Commercial	1,524.92	1,586.66	1,790.09	2,325.05	3,124.14	4,274.26	5,766.95	5.6	6.0	3.8	6.1	6.5	6.2
Transportation	0.00	0.02	0.11	279.93	280.49	282.04	286.35			204.9	0.0	0.1	0.3
Residential	3,540.75	4,007.34	4,976.30	7,245.84	9,161.02	10,679.75	12,204.85	15.9	5.5	5.5	4.8	3.1	2.7
Agriculture	476.18	453.79	502.14	644.70	900.56	1,286.76	1,825.19	-2.2	6.0	3.6	6.9	7.4	7.2
Total	**9,496.59**	**10,542.37**	**12,429.65**	**17,698.20**	**24,759.40**	**34,536.92**	**48,251.77**	**13.1**	**7.3**	**5.2**	**6.9**	**6.9**	**6.9**

The residential sector's use of electricity is broadly affected by the spatial concentration of households in urban areas and the government's program on household electrification. This growth is supported by urban development that is influenced by factors like economic growth, employment generation and consumer spending. The Household Final Consumption Expenditure (HFCE) in Mindanao is projected to grow at 8.3 percent (HGS) and 5.6 percent (LGS) a year over the planning horizon[13]. This impacts the lifestyle of the households significantly, which leads to an expanded use of electricity in the residential sector by 7.9 percent in HGS and 5.5 percent a year in LGS within the planning period. Meanwhile, the commercial sector benefited from the recent developments in the island's retailing market, which includes expansion of modern-day grocery giant retailers, such as SM Group of Companies, Ayala Land, Megaworld and Robinsons Malls.

The electricity demand for the Mindanao Railway Project (MRP) in the planning period is considered to be one of Mindanao's primary infrastructure projects. With 12-hour operation using a 4-Car Train, the MRP will have an estimated demand of 152 GWh in 2022. The demand will further increase to 280 GWh as the system will operate with an 8-Car Train by 2025. The railway system to be built in Mindanao is envisioned to be about 2,000 kilometers (km) of trackage. The first phase which is a 105-km long is expected to be completed by 2022. The initial railway will connect Tagum, Davao City, and Digos in Davao region and is designed to accommodate around 120,000 passengers per day on opening year.

Over the long-term, there is an indicative plan to extend the railway to connect the other major cities in Mindanao, such as General Santos, Cagayan de Oro, Zamboanga, Cotabato and Butuan. The electricity demand for railway operations may further increase once this extension pushes through.

POWER SUPPLY OUTLOOK

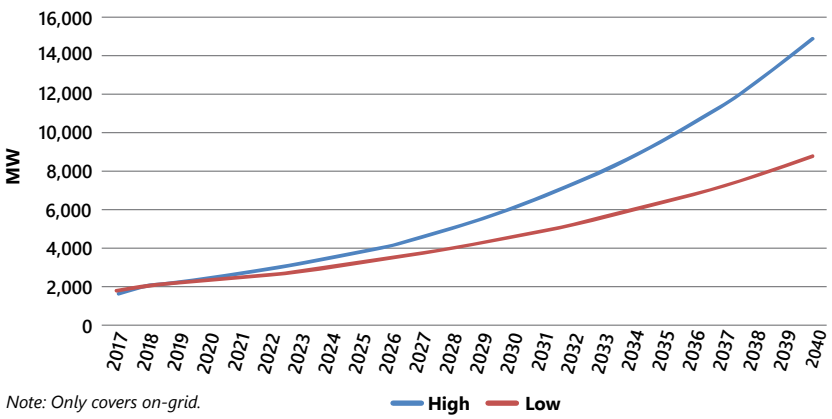
MINDANAO GRID

Mindanao's socio-economic landscape in the long-term looks promising with the government's *Ambisyon Natin 2040* vision with associated development programs, such as the "Build, Build, Build" and the Mindanao Development Corridors (MinDC). Once the vision is realized and the programs become full-blown, these serve as drivers of electricity demand. As the economy is stirred by various energy-intensive activities, the need for having sufficient supply arises.

DEMAND OUTLOOK

For this plan update, two (2) demand projections were prepared – *High Growth Scenario (HGS) and Low Growth Scenario (LGS) covering on-grid*. In coming up with the electricity sales and peak demand forecasts in HGS, a high growth on gross regional domestic product (GRDP) was assumed based on the Mindanao Development Authority (MinDA) target as espoused in the Mindanao 2020: Peace and Development Framework Plan. The Mindanao 2020 envisions greater economic prosperity with the aim of achieving an average annual real GRDP of 8-10 percent. From the target GRDP growth rate, share per region to total GRDP of Mindanao was also estimated to forecast each region's electricity sales[14]. Station use and losses were added to come up with electricity consumption.

Figure 25. MINDANAO PEAK DEMAND, 2018 - 2040 (High and Low)



Note: Only covers on-grid.

In LGS, the projection of the Development and Budget Coordination Committee (DBCC) for the gross domestic product (GDP) of the Philippines in the medium-term was adopted and then extended to cover until 2040. From the projection, the contribution of Mindanao was estimated.

For HGS projection, Mindanao's peak demand is anticipated to increase at 9.6 percent annually from 1,760 MW in 2017 to 2,364 MW in 2020, 5,916 MW in 2030 and further increases to 14,575

[13] Projection done by the Planning Division, Energy Policy and Planning Bureau.
[14] Total electricity sales exclude losses and station use

MW in 2040. In the low demand projection, peak demand rises to 8,632 MW in 2040 translating to an annual growth of 7.1 percent (Figure 25 and Table 56).

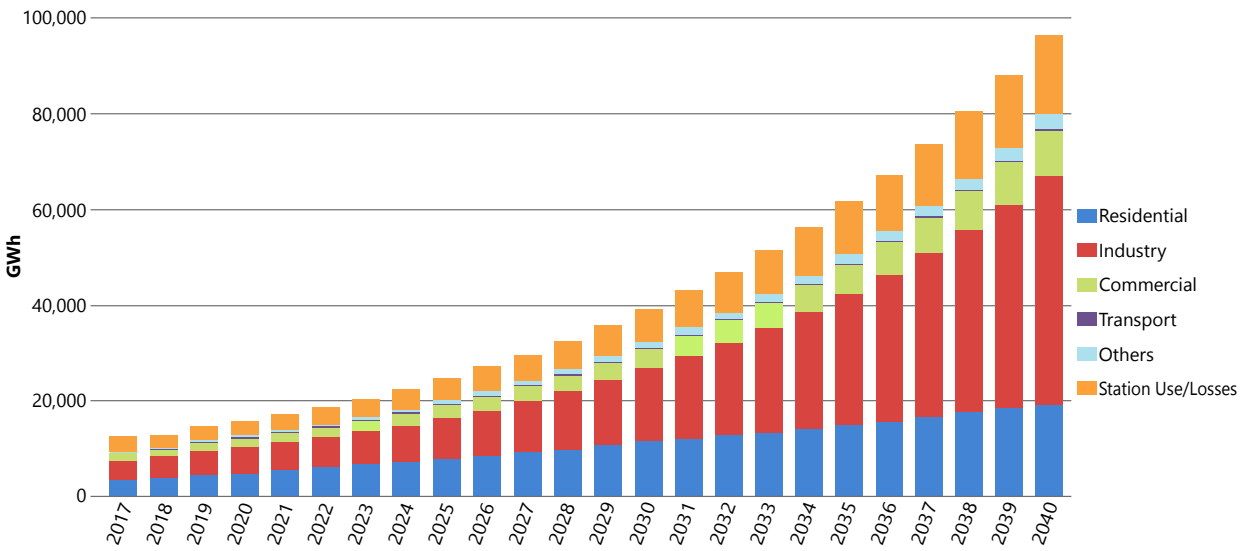
Electricity Consumption. Electricity consumption in HGS escalates by eight-fold from 11,602 GWh in 2017 to 96,329 GWh in 2040, increasing annually at 9.6 percent. Industry becomes the largest user of electricity by 2040 accounting for almost half or 47.4 percent (45,709 GWh) of the total electricity consumption (Figure 26). Residential customer followed next with 20.1 percent of total.

Table 56. SYSTEM PEAK DEMAND, MW

Year	High Growth	Low Growth
2017	1,760	1,760
2018	2,095	2,064
2020	2,364	2,226
2025	3,695	3,165
2030	5,916	4,416
2035	9,280	6,171
2040	14,575	8,632
Average Annual Growth Rate () (2018-2040)	**9.6**	**7.1**

Note: Only covers on-grid.

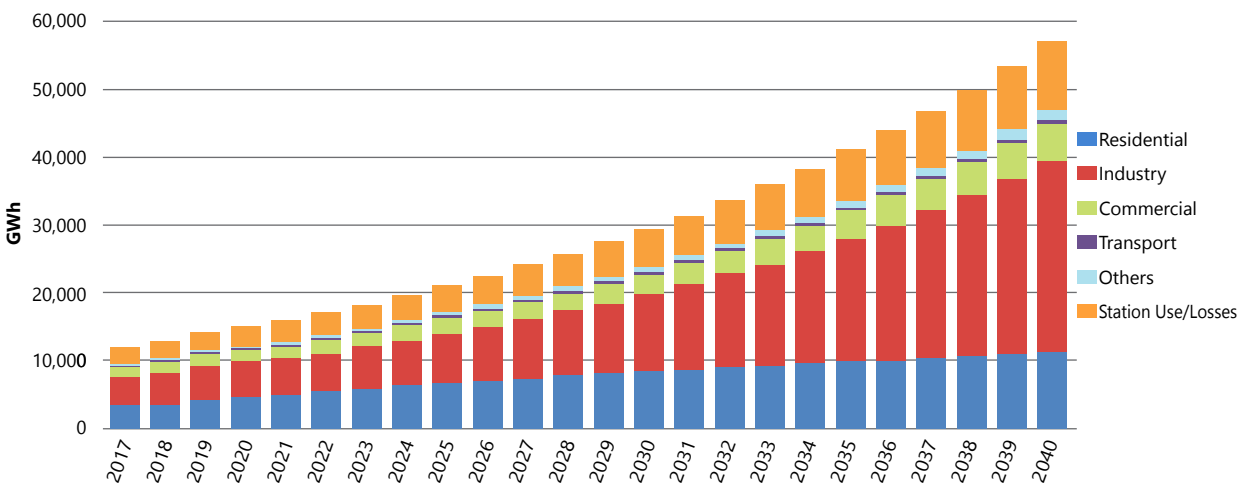
Figure 26. ELECTRICITY CONSUMPTION, GWh (High Growth)



Note: Only covers on-grid. "Others" include public buildings, street lights, irrigation (agriculture), among others.

In the LGS, total electricity consumption grows by five times from its 2017 level reaching 57,016 GWh by 2040 (Figure 27). This is 40.8 percent lower compared with HGS. Similarly, industry and residential sectors are the largest users requiring 27,055 GWh and 11,435 GWh, respectively.

Figure 27. ELECTRICITY CONSUMPTION, GWh (Low Growth)



Note: Only covers on-grid. "Others" include public buildings, street lights, irrigation (agriculture), among others.

Electricity Sales by Region. The projected electricity sales at the regional level (aggregate) in HGS is expected to increase from 9,289 GWh in 2017 to 79,801 GWh by 2040. Northern Mindanao and Davao regions both posted the highest sales in 2040 at 23,791 GWh and 24,295 GWh with corresponding growth rate of 10.1 percent and 9.3 percent a year during the planning period, respectively (Table 57). It was evident that in both regions, industry serves as the main driver in the increase in demand. In Northern Mindanao, the industry sector demand reaches 15,068 GWh in 2040 from only 1,066 GWh in 2017. For Davao Region, the sector's demand increases from 1,582 GWh in 2017 to 18,214 by 2040. On the other hand, electricity sales in LGS climbs up to 47,225 GWh in 2040, about 40.8 percent lower compared with HGS (Table 57). Under this scenario, sales increases annually at 7.2 percent.

Table 57. ELECTRICITY SALES BY REGION, GWh (High Growth)

Region	2017	2018	2020	2030	2040	Average Annual Growth Rate (%) (2017-2040)
IX	1,042	1,135	1,454	3,881	8,793	9.7
X	2,412	2,960	3,652	9,106	23,791	10.1
XI	3,165	3,351	3,945	9,408	24,295	9.3
XII	1,641	1,841	2,327	6,283	15,335	10.1
CARAGA	831	978	1,217	2,775	5,962	8.9
ARMM	186	211	261	777	1,625	9.7
Total	**9,289**	**10,477**	**12,856**	**32,231**	**79,801**	**9.7**

Note: Only covers on-grid. Excluding losses and station use

The industry sector is keen to contribute to increased electricity sales in both HGS and LGS. This can also be correlated on how Northern Mindanao and Davao regions are being positioned in the development corridors with the former regarded as an industrial trade cluster (being a host to heavy and large industries), while the latter belongs to the food basket / food, agri-business and logistics cluster.

Table 58. ELECTRICITY SALES BY REGION, GWh (Low Growth)

Region	2017	2018	2020	2030	2040	Average Annual Growth Rate (%) (2018-2040)
IX	1,042	1,104	1,334	2,752	4,987	7.0
X	2,412	2,793	3,266	6,281	12,503	7.1
XI	3,165	3,454	3,982	7,998	17,218	7.6
XII	1,641	1,792	2,152	4,428	8,138	7.1
CARAGA	831	953	1,122	2,027	3,471	6.4
ARMM	186	203	239	556	908	7.0
Total	**9,289**	**10,299**	**12,095**	**24,043**	**47,225**	**7.2**

Note: Only covers on-grid. Excluding losses and station use

SUPPLY OUTLOOK

Aside from analyzing long-term demand, the outlook also entails the assessment of possible supply options that will augment existing capacity in Mindanao. It is rationale to evaluate plausible supply that addresses and supports the increasing electricity demand from 2018-2040.

Methodology and Assumptions. The supply-side simulation adopts 2017 as the base year. The data and information used as inputs in the simulation were:

a) installed capacity of Mindanao (3,482 MW) in 2017[15];
b) power generation in Mindanao[16];
c) plant retirement based on the economic life (i.e. plants that were retired are oil, solar and biomass);
c) station use/transmission loss (10.14 percent);
d) distribution loss of 9.0 percent and gradually decreasing to around 8.0 percent by 2040;
e) reserve margin of 25.0 percent; and
f) load factor of 67.8 percent.

[15] Based on the December 2017 List of Existing Power Plants in Mindanao
[16] Based on the 2017 DOE Power Statistics

Table 59. COMMITTED AND INDICATIVE POWER PROJECTS in Mindanao (as of April 2018)

	Committed Capacity (MW)	Indicative Capacity (MW)
Coal	700.00	-
Geothermal	-	30.00
Hydro	588.49	249.90
Solar	-	460.00
Biomass	12.00	89.40
Total	**1,300.49**	**829.30**

Capacity Additions. Apart from the identified existing available capacity in Mindanao, committed power projects for both fossil and renewables (RE) and the indicative RE power projects were included as capacity additions (Table 59). The total committed capacity is around 1,300.49 MW, more than half of which will be contributed by coal, while the remaining will come from RE projects (46.0 percent), specifically hydro. For indicative, only RE power projects were considered with a total capacity of 829.30 MW. The combined RE-based capacity (stemming from committed and indicative) totals 1,429.8 MW.

Potential RE capacities were also added from the awarded and pending RE Service Contracts (RESC) issued by the DOE (as of December 2017), including those classified as prospective capacities (with application for RESC). The potential capacity from these RESCs stands at 2,471 MW, consisting of 1,728 MW with awarded RESC, 415 MW with pending RESC, and 328 MW prospective capacity from the RESC application as shown in Table 60.

All new coal capacities (committed and endogenous[17] capacities considered in the supply model) are assumed to be a supercritical technology. Oil capacity additions are only endogenous capacity generated from the supply model.

Table 60. POTENTIAL CAPACITY OF AWARDED AND PENDING RE PROJECTS (as of December 2017)

	Awarded RESC (MW)	Pending RESC (MW)	RE Potential (MW)*	TOTAL RE Potential (MW)
Geothermal	80.00	60.00		140.00
Hydro	1,012.00	160.36	328.33	1,500.00
Solar	636.11	161.50		797.61
Biomass		33.19		33.00
Total	**1,728.11**	**415.05**	**328.33**	**2,470.97**

*Note: *Potential provided by REMB-HOEMD*

To further illustrate the high presence of renewables in the scenarios (particularly in Alternative and Nuclear), additional RE capacity for solar and wind based on the study conducted by the Institute for Sustainable Futures (ISF)[18] was likewise incorporated in the supply mix. Solar and wind were cited to have potentials of 1,100 gigawatt (GW) and 89 GW. However, in the simulation, only 1,500 MW of solar capacity (100 MW added annually starting 2026) and 750 MW of wind (50 MW added annually starting 2026) were considered (Table 61).

Table 61. ADDITIONAL RE CAPACITY BASED ON THE ISF STUDY

	Capacity (MW)
Solar	1,500.00
Wind	750.00
Total	**2,250.00**

Capacity Factor. The technologies considered in the simulation also assumed specific capacity factors. It represents the ratio of actual to theoretically possible electricity generation of a power plant[19]. It varies greatly on the type of fuel being used to generate power, as well as on the power plant design. Compared to fossil fuels, renewables, particularly variable RE (solar and wind), have lower capacity factors due to intermittency of the resource (Table 62).

Table 62. CAPACITY FACTOR ASSUMPTIONS

Technology	Capacity Factor [20]
Coal	85
Oil	25
Geothermal	90
Hydro	50
Solar	16
Biomass	35
Wind	26
Natural Gas	85
Nuclear	90

[17] Capacity calculated internally by LEAP in order to maintain the planning reserve margin. LEAP decides when these plants will be added. It does this by monitoring the module's reserve margin and adds plants as needed.
[18] Enabling Mindanao: Technical and Financial Requirements for RE power generation
[19] Source: IEEE 762-2006
[20] The capacity factor of 85% for coal and gas were adopted based on the assumption used by EIA in the 2015 Projected Costs of Generating Electricity

Capital Costs. The cost of technologies for power generation reflected in the simulation, particularly capital and operations and maintenance (O&M) costs were based on the projections from the International Energy Agency (IEA)[21] and the ISF. Details on the capital cost for each type of plant are shown in Table 63. Among the RE technologies, solar exhibits large reduction in capital cost with 3.6 percent annual decline from 2018 – 2030 and 2.5 percent from 2018 – 2040.

Table 63. CAPITAL COSTS OF POWER PLANTS

	2017 (USD per kW)	2020 (USD per kW)	2030 (USD per kW)	2040 (USD per kW)
Coal	1,500	1,500	1,500	1,500
Coal - Supercritical	1,733	1,733	1,733	1,733
Oil	967	948	910	872
Geothermal	5,000	4,940	4,739	4,544
Hydro	2,338	2,350	2,350	2,363
Solar	1,730	1,295	1,055	940
Biomass	2,225	2,188	2,150	2,113
Wind	1,755	1,690	1,640	1,610
Natural Gas (CCGT)	883	883	883	883
Nuclear	5,200	5,000	4,633	4,333

Sources: International Energy Agency (IEA) and Institute for Sustainable Futures (ISF)

Scenario. Three scenarios were developed as possible options for power supply mix in Mindanao – *Reference, Alternative* and *Nuclear*.

The ***Reference Scenario*** implies that development strategies in the energy sector will continue. The scenario assumes that:

a) all committed power projects and RE-based indicative power projects (as of April 2018) will be completed; and
b) RE capacities from the awarded and pending RE service contracts (RESCs) will likewise be realized and provide additional power supply to grid.

The ***Alternative Scenario*** takes off from the Reference Scenario and adopts the same assumptions. However, this scenario takes into account the entry of additional variable renewables (VRE), solar with additional 1,500 MW and wind with 750 MW, in the planning horizon. Also considered is additional hydro potential with a total capacity of 328 MW. In addition, the scenario considers the entry of a 500-MW natural gas infrastructure by 2025, and the capacity increases further to 2,000 MW in HGS and 1,800 MW in LGS by 2040[22].

The ***Nuclear Scenario*** is guided with the premise that should the government decide to have a nuclear energy program for power generation in the country, a nuclear power plant in Mindanao with a capacity of 1,000-MW will be introduced and operational by 2035. Its entry considers the assumption of a 10-year lead time given the process that need to undertake from the decision and issuance of a national decision up to addressing all the International Atomic Energy Agency (IAEA) infrastructure requirements and issues in developing nuclear for power generation. Mindanao was identified as a potential candidate host/site for a nuclear plant back in 1996 by then Nuclear Power Steering Committee (NPSC). The sites identified are Siocon (Piacan and Cauit Point) in Zamboanga del Norte and General Santos in Sarangani as the candidate areas for the possible construction of nuclear power plant[23].

In all the scenarios, retirement of oil power plants was reflected. However, the retired oil plants can still be maintained as government's security supply assets during the planning period. As oil plants are easy to start up, they can be utilized during emergencies, if the reserve supply is not enough to cover the losses in power supply.

SUPPLY SCENARIO RESULTS

Reference High

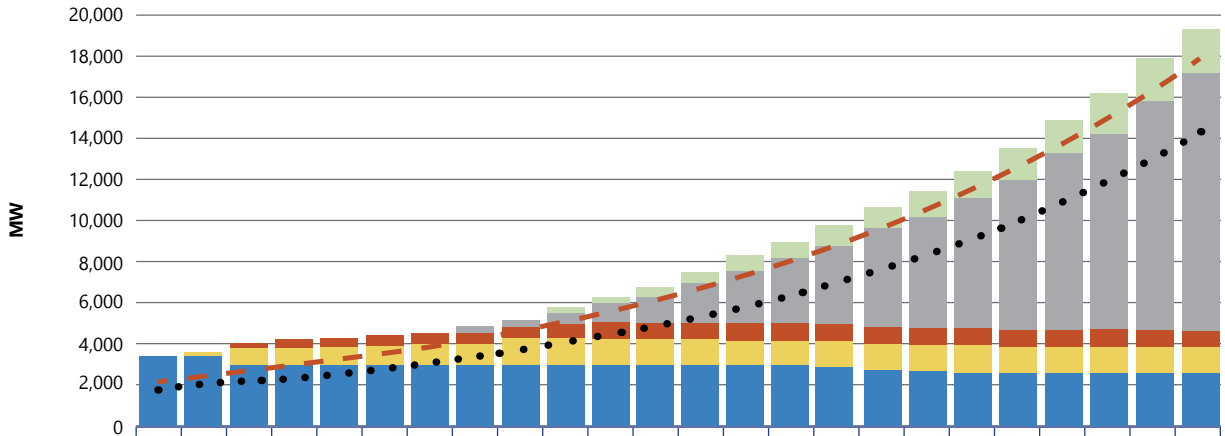
Capacity. Total installed capacity reaches 19,545 MW in 2040 from only 3,482 MW in 2017 with an annual average growth of 7.8 percent (Figure 28). By 2030, coal accounts for 53.2 percent (4,470 MW) of the capacity mix followed by renewables at 40.8 percent (3,429 MW) and oil at 6.0 percent (506 MW).

At the end of the planning period, coal comprises 70.5 percent of the capacity mix, while renewables and oil contribute 24.6 percent and 5.0 percent, respectively. Capacity from renewables increases by almost four-fold from 1,284 MW in 2017 to 4,800 MW in 2040. Bulk of the

[21] Capital and annual O&M costs were lifted from IEA's Power Generation Assumptions in the New Policies and 450 Scenarios in the World Energy Outlook 2016. Cost of oil-based plants were based on the Institute for Sustainable Futures (ISF).
[22] The assumption on entry of natural gas in Mindanao is based on the PEP 2017 – 2040 and the ERIA Study titled "Seeking Optimal Solutions on Delivering LNG to Mid and Large Islands in the Philippines."
[23] Source: BNPP Presentation of NPC.

capacity from renewables comes from hydropower (64.4 percent) and solar (27.0 percent). The share of oil-based capacity dwindles from 24 percent in 2017 to 5.0 percent in 2040 as a result of the assumed retirement of existing capacity (828 MW) within the planning period. Note that the retired oil capacity can still serve as government's security asset whenever supply concerns in the grid arise.

Figure 28. MINDANAO DEMAND-SUPPLY, 2018-2040 (Reference High)

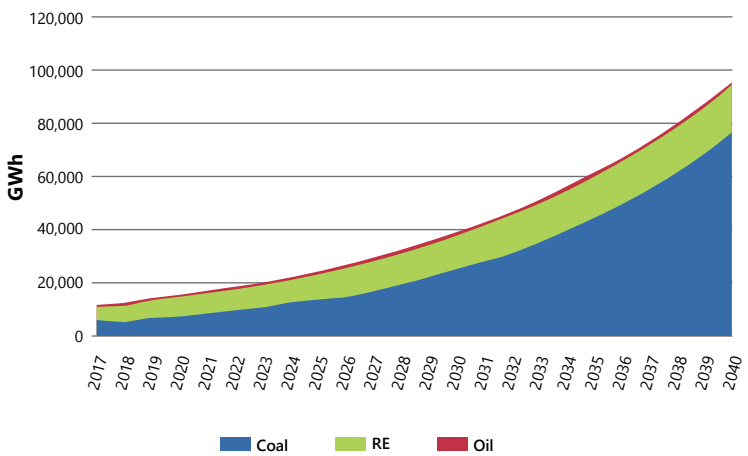


	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
New RE	0	0	0	0	0	0	0	0	0	242	282	472	528	753	793	983	1,023	1,248	1,288	1,518	1,598	1,985	2,065	2,143
New Fossil	0	0	0	0	0	0	0	300	300	625	950	1,275	1,925	2,575	3,225	3,875	4,850	5,500	6,475	7,450	8,750	9,725	11,350	12,675
Indicative RE (cumulative)		0	228	417	447	474	529	579	579	677	829	829	829	829	829	829	829	829	829	829	829	829	829	829
Committed PP (cumulative)		162	814	814	853	962	997	1,013	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Installed Capacity (less retirement)	3,482	3,482	3,022	3,022	3,022	3,022	3,022	3,022	3,022	3,022	3,022	2,985	2,984	2,948	2,948	2,917	2,765	2,711	2,677	2,628	2,617	2,617	2,617	2,598
Peak Demand (High Scen)	1,760	2,092	2,172	2,364	2,575	2,808	3,064	3,364	3,695	4,059	4.459	4,899	5,383	5,916	6,472	7,082	7,749	8,480	9,280	10,156	11,115	12,165	13,316	14,575
Reserve Margin (25%)	2,200	2,619	2,715	2,955	3,219	3,510	3,830	4,206	4,619	5,074	5,574	6,124	6,729	7,395	8,090	8,852	9,686	10,599	11,599	12,695	13,894	15,207	16,644	18,219

The required power generation capacity is needed to meet the projected peak demand of 14,575 MW in 2040 plus the 25.0 percent reserve capacity, equivalent to 3,644 MW. In order to meet the demand, Mindanao's existing supply should be supplemented with additional capacity of 16,947 MW. Of the total additional capacity, coal gets more than 70.0 percent for baseload demand of the grid. Renewables provide 21.1 percent share from the identified committed (600 MW), indicative (829 MW) and potential RE-based plants (2,143 MW) (Figure 28).

It should be noted that committed power plants (1,300.5 MW) in Mindanao can still accommodate the island's grid demand (including reserve capacity) until 2023 based on the assumed capacity factor per technology. On the other hand, with the inclusion of indicative projects (829.3 MW), grid's demand can be satisfied up to 2025 (Figure 28).

Figure 29. POWER GENERATION, GWh (Reference High)



Generation. Electricity generation rises to 96,329 GWh in 2040, an eight-fold increase from 2017 level (Figure 29). Coal dominates the power generation mix with a share reaching as high as almost 80.0 percent (76,814 GWh) in 2040 from only 53.0 percent (6,271 GWh) in 2017.

Renewables substantially contribute to generation mix having a high aggregate share of 40.0 – 46.0 percent from 2018 – 2023 and 2026 - 2027. However, renewable share decelerates to 18.6 percent in 2040. Contribution from variable renewables (only solar) for the planning period exhibits an average share of 2.5 percent. The decreased share of renewables is due to the entry of more coal-based plants in the system starting 2024 compared with the capacity addition from RE.

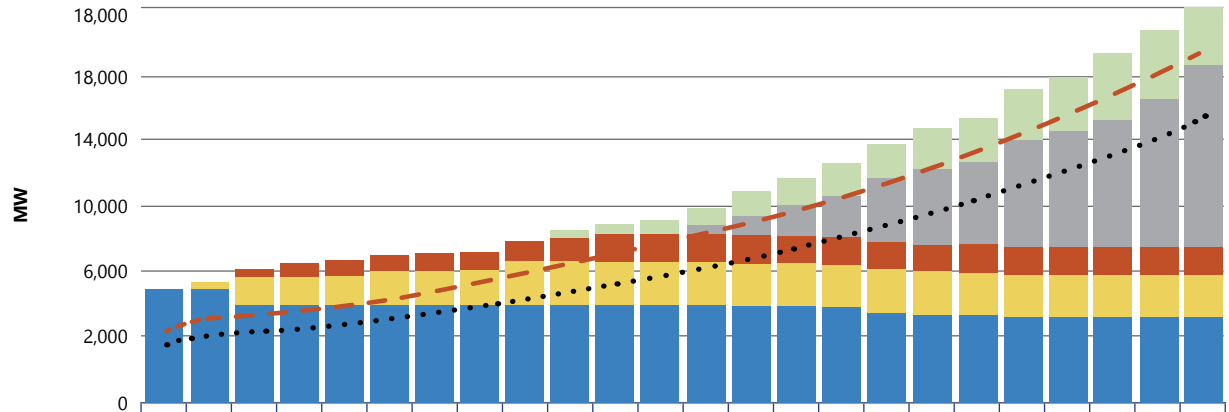
Reference Low

Capacity. With lower demand under this scenario, the system's capacity requirement is only 12,370 MW by 2040 (with an annual growth rate of 5.7 percent), down by 36.7 percent compared with Reference High. In terms of capacity mix, coal comprises 58.0 percent (7,170 MW) of total, equivalent to about half of the capacity of coal in Reference High. As capacity addition from renewables is the same in both HGS and LGS, the share from RE climbs to 38.8 percent in 2040 (from 24.6 percent in Reference High). On the other hand, oil capacity decreases to 400 MW, a two-third decline in capacity from Reference High in 2040 (Figure 30).

In LGS, committed projects can still provide the grid supply requirement until 2027, and with indicative projects up to 2028.

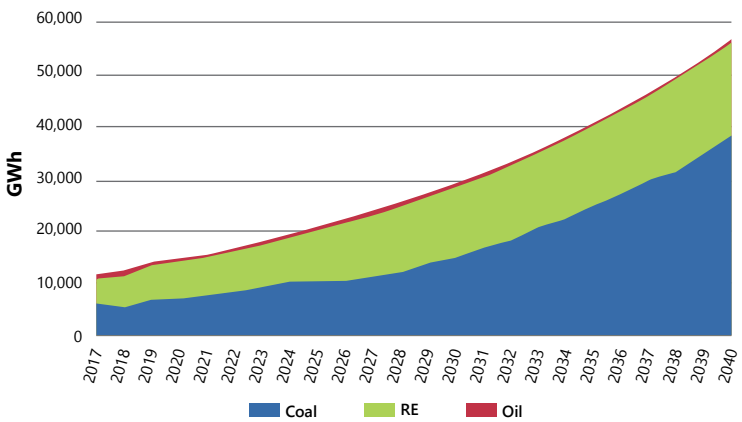
Generation. Generation picks up to 57,016 GWh in 2040, almost five times higher from 2017 level. In this scenario, generation is 40.8 percent lower than Reference High. As shown in Figure 31, the generation mix is largely dominated by coal with 67.5 percent share in 2040 (38,477 GWh). Renewables account for 31.4 percent (17,877 GWh) of total with hydro and solar providing a combined share of 85.9 percent (15,352 GWh) to total RE generation. Highest share from renewables is seen from 2026-2028 with an average of 49.0 percent. Oil comprises 1.2 percent (665 GWh) of total generation.

Figure 30. MINDANAO DEMAND-SUPPLY, 2018-2040 (Reference Low)



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
New RE	0	0	0	0	0	0	0	0	0	242	282	472	529	753	793	983	1,023	1,248	1,288	1,518	1,598	1,985	2,065	2,143
New Fossil	0	0	0	0	0	0	0	0	0	0	0	0	300	625	950	1,275	1,925	2,250	2,575	3,225	3,575	3,875	4,525	5,500
Indicative RE (cumulative)		0	228	417	447	474	529	579	579	677	829	829	829	829	829	829	829	829	829	829	829	829	829	829
Committed PP (cumulative)		162	814	814	853	962	997	1,013	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Installed Capacity (less retirement)	3,482	3,482	3,022	3,022	3,022	3,022	3,022	3,022	3,022	3,022	3,022	2,985	2,984	2,948	2,948	2,917	2,765	2,711	2,677	2,628	2,617	2,617	2,617	2,598
Peak Demand (Low Scen)	1,760	2,064	2,130	2,226	2,359	2,359	2,732	2,941	3,165	3,383	3,616	3,865	4,131	4,416	4,721	5,048	5,397	5,771	6,171	6,599	7,057	7,547	8,071	8,632
Reserve Margin (25%)	2,200	2,580	2,663	2,783	2,949	3,173	3,415	3,676	3,957	4,229	4,520	4,831	5,194	5,520	5,902	6,310	6,747	7,214	7,714	8,249	8,821	9,433	10,088	10,790

Figure 31. POWER GENERATION, GWh (Reference Low)

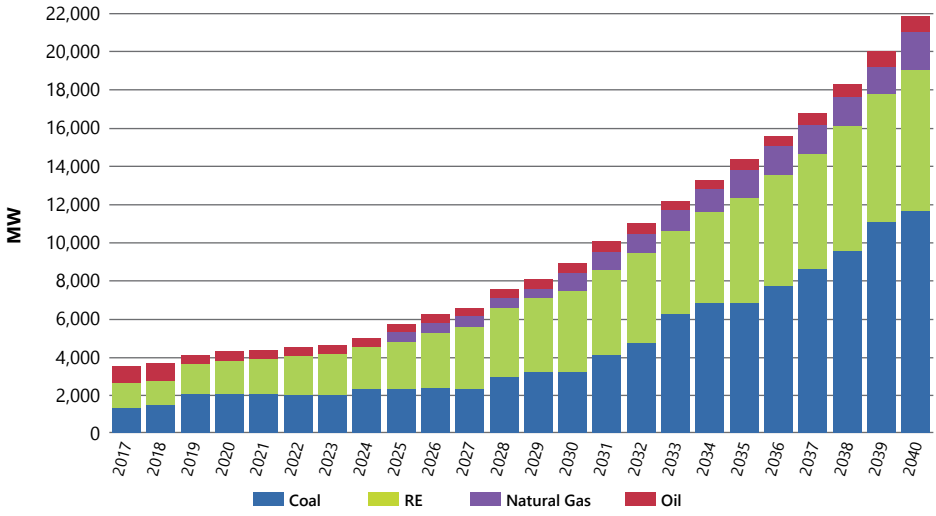


Alternative High

In this scenario, additional capacities of 2,250 MW from variable renewables and 328 MW from hydro potential are included in the system together with the entry of a 500-MW natural gas power plant in 2025. Capacity from natural gas increases to 2,000 MW by 2040.It is assumed that the introduction of natural gas is coupled with the development of gas infrastructures, such as the establishment of a liquefied natural gas (LNG) receiving terminal with a capacity equivalent to the fuel requirements of the power plants. Availability of critical gas infrastructures promotes the use of natural gas and creates a market for its demand.

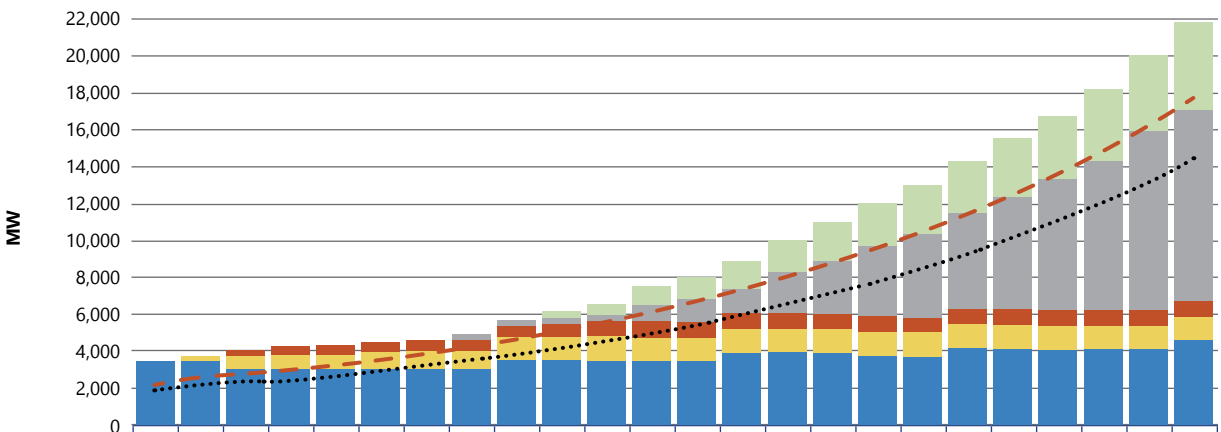
Capacity. Total capacity in Alternative High increases to 21,823 MW in 2040. The introduction of natural gas leads to a more diverse capacity mix for Mindanao as shown in Figure 32. Renewables constitute 33.8 percent, natural gas accounts for 9.2 percent, and oil only provides 3.6 percent of total in 2040. Apart from hydropower, geothermal, biomass and solar, wind is seen to contribute in the renewable-based capacity mix in 2040 as it takes up 10.0 percent (750 MW) of the 7,378 MW total renewables capacity. Additional capacity from renewables within the planning period reaches 6,150 MW. Coal remains as the dominant plant type with 53.5 percent share to total capacity mix. However, capacity from coal declines by almost 23.0 percent from Reference High, equivalent to 2,800 MW of displaced coal capacity as a result of natural gas coming into system, as well as the additional capacity from renewables. Capacity addition from coal drops by 17.0 percent from Reference High requiring only 9,600 MW in the planning period. In similar situation, oil capacity addition falls by about 21.0 percent, from 975 MW in Reference High to 775 MW, contributing only 3.6 percent to total capacity mix.

Figure 32. TOTAL CAPACITY, MW (Alternative High)



For the planning period, a total of 10,375 MW of new fossil-based plants (excluding natural gas) and 4,721 MW of new RE plants are added in the system. Correspondingly, the increase in natural gas capacity from 500 MW in 2025 to 2,000 MW in 2040 further boosts supply. The total capacity addition in this scenario is higher at 19,225 MW compared with Reference High (16,947 MW). Such can be attributed to the capacity additions from solar and wind (on top of the capacity added in Reference Scenario) with lower capacity factor (Figure 33).

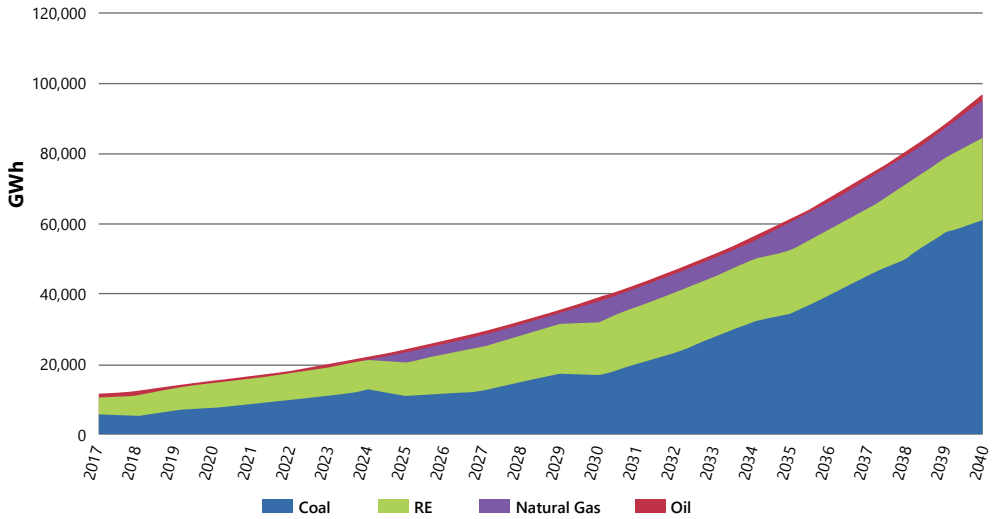
Figure 33. MINDANAO DEMAND-SUPPLY, 2018-2040 (Alternative High)



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
New RE	0	0	0	0	0	0	0	0	0	392	582	922	1,128	1,503	1,693	2,033	2,223	2,598	2,788	3,128	3,318	3,843	4,033	4,721
New Fossil	0	0	0	0	0	0	0	300	300	300	300	950	1,275	1,300	2,250	2,900	3,875	4,525	5,175	6,150	7,150	8,125	9,725	10,375
Indicative RE (cumulative)		0	228	417	447	474	529	579	579	677	829	829	829	829	829	829	829	829	829	829	829	829	829	829
Committed PP (cumulative)		162	814	814	853	962	997	1,013	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Installed Capacity (less retirement + NG)	3,482	3,482	3,022	3,022	3,022	3,022	3,022	3,022	3,522	3,522	3,522	3,485	3,484	3,948	3,948	3,917	3,765	3,711	4,177	4,128	4,117	4,117	4,117	4,598
Peak Demand (Low Scen)	1,760	2,095	2,172	2,364	2,575	2,808	3,064	3,364	3,695	4,059	4,459	4,899	5,383	5,916	6,472	7,082	7,749	8,480	9,280	10,156	11,115	12,165	13,316	14,575
Reserve Margin (25%)	2,200	2,619	2,715	2,955	3,219	3,510	3,830	4,206	4,619	5,074	5,574	6,124	6,729	7,395	8,090	8,852	9,686	10,599	11,599	12,695	13,894	15,207	16,644	18,219

Generation. As a result of additional sources for power generation coming from natural gas and renewables, generation from coal slips down to 61,157 GWh, or 63.5 percent of total in 2040 from 79.7 percent in Reference High (Figure 34). Renewables add 23,124 GWh to total generation in 2040, up by 29.3 percent from Reference High, thus improving RE share to 24.0 percent (from 18.6 percent in Reference High). With additional capacity, generation from solar more than double in 2040 at 3,920 GWh, around 17.0 percent of RE generation, compared with 1,818 GWh in Reference High. Meanwhile, wind produces 7.4 percent of RE generation. Average share of variable RE increases within the planning period at 4.6 percent of total generation, an improvement from 2.5 percent average share in Reference High.

Figure 34. POWER GENERATION, GWh (Alternative High)

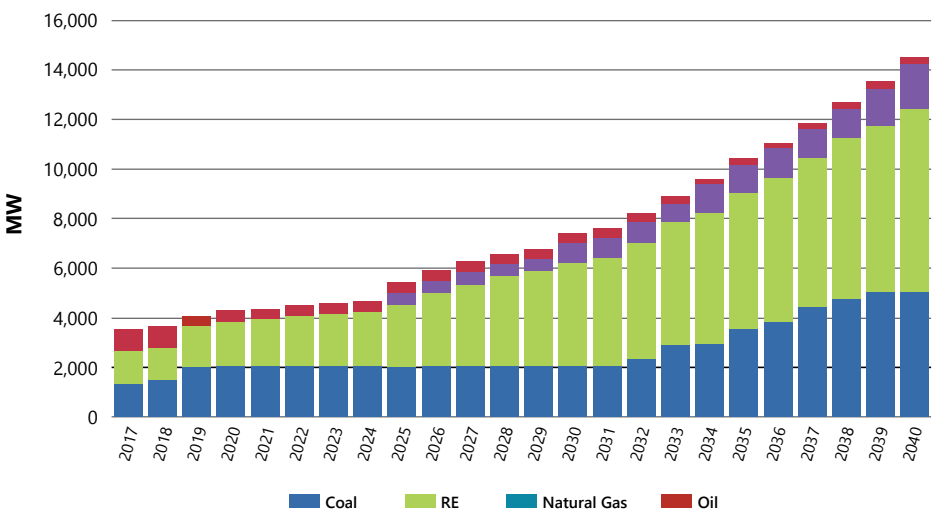


Natural gas accounts for 11.2 percent (10,820 GWh) of total generation, the same contribution in its initial year in 2025. The entry of natural gas together with additional capacity from renewables limits the generation from coal. Oil contribution is minimal as natural gas and other renewables can also meet the peaking demand of the grid.

Alternative Low

Capacity. Total capacity grows at 6.4 percent a year reaching 14,473 MW (an addition of 11,875 MW) by 2040 (Figure 35), this is 33.7 percent lower compared with Alternative High, but higher by 17.0 percent than the Reference Low. Under a low demand scenario, renewables dominate, given the same amount of capacity considered in the system (same capacity in Alternative High), providing a share of 51.0 percent to total capacity.

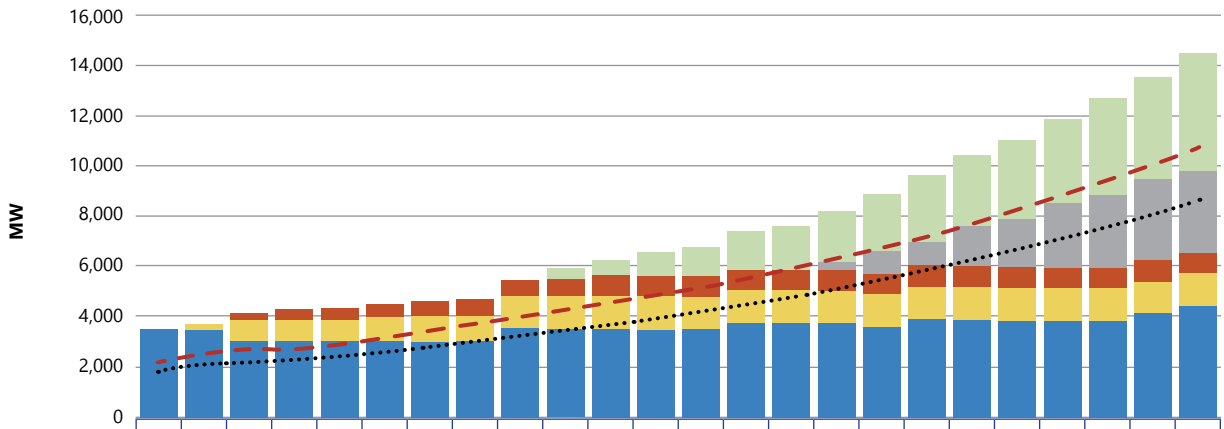
Figure 35. TOTAL CAPACITY, MW (Alternative Low)



Similarly, natural gas expands its share to 12.4 percent, from only 9.2 percent in Alternative High. With higher shares from renewables and natural gas, coal capacity only rises to 5,070 MW. In this scenario, new additional capacity from coal totals 3,000 MW for the planning period. It is also observed that new capacities from oil power plants are seen during the latter part of the planning period (starting 2033) wherein more than half of the existing oil plants are assumed to be retired.

The 1,800 MW of natural gas power plants including the additional coal is deemed enough to cover the baseload, mid-merit and peaking demand requirements of the grid. Likewise, the capacity requirement of the system is supported by the 6,150 MW of additional renewables capacity. On top of the 2,129 MW of committed and indicative projects, additional supply of 4,721 MW will be provided by new RE-based plants and 3,225 MW from the new fossil-based plants (coal and oil) (Figure 36).

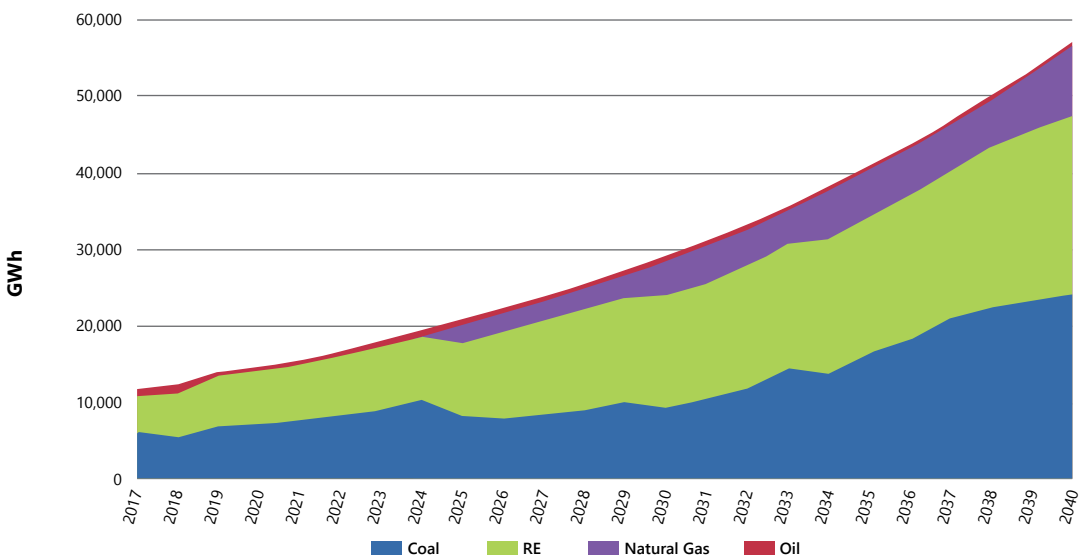
Figure 36. MINDANAO DEMAND-SUPPLY, 2018-2040 (Alternative Low)



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
New RE	0	0	0	0	0	0	0	0	0	392	582	922	1,128	1,503	1,693	2,033	2,223	2,598	2,788	3,128	3,318	3,843	4,033	4,721
New Fossil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	300	950	950	1,600	1,925	2,575	2,900	3,225	3,225
Indicative RE (cumulative)		0	228	417	447	474	529	579	579	677	829	829	829	829	829	829	829	829	829	829	829	829	829	829
Committed PP (cumulative)		162	814	814	853	962	997	1,013	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Installed Capacity (less retirement + NG)	3,482	3,482	3,022	3,022	3,022	3,022	3,022	3,022	3,522	3,522	3,522	3,485	3,484	3,748	3,748	3,717	3,565	3,911	3,877	3,828	3,817	3,817	4,177	4,398
Peak Demand (Low Scen)	1,760	2,064	2,130	2,226	2,359	2,359	2,732	2,941	3,165	3,383	3,616	3,865	4,131	4,416	4,721	5,048	5,397	5,771	6,171	6,599	7,057	7,547	8,071	8,632
Reserve Margin (25%)	2,200	2,580	2,663	2,783	2,949	3,173	3,415	3,676	3,957	4,229	4,520	4,831	5,164	5,520	5,902	6,310	6,747	7,214	7,714	8,249	8,821	9,433	10,088	10,790

Generation. Natural gas power plants deliver 16.3 percent (9,285 GWh) of total power generation in 2040 (Figure 37). The grid sees the introduction of natural gas in 2025 and its entry to the system resulted in a share of 11.8 percent or 2,461 GWh in generation. Renewables yield 40.6 percent (23,124 GWh) of total generation with variable RE contributing 24.3 percent or 5,628 GWh of the total renewable-based generation. In this scenario, oil generates minimally starting 2033 as natural gas and other renewables could also provide for the peaking requirement of the system.

Figure 37. POWER GENERATION, GWh (Alternative Low)



Nuclear High

Apart from adopting similar assumptions with Alternative High, this scenario considers the entry of a 1,000-MW nuclear power plant by 2035. This is on the standpoint that the government has decided to pursue a nuclear energy program for the country, the 19 infrastructure issues specified by IAEA have already been addressed, and Mindanao is willing to host a nuclear plant.

Capacity. With the entry of nuclear power plant, Mindanao further diversifies its sources for power generation. Nuclear contributes 4.6 percent to total capacity mix, while natural gas provides 9.2 percent (Figure 38). The same with Alternative High, renewables constitute 33.8 percent of the capacity mix. Coal still makes up a significant share of 49.3 percent with a total capacity addition of 8,700 MW, which is lower by 9.4 percent from Alternative High. Oil capacity addition also declines by 10.0 percent with only 700 MW.

Total capacity requirement in 2040 stands at 21,848 MW, a bit higher than in Alternative High. To meet the grid and the reserve capacity, the existing supply will be complemented by total capacity addition of 19,250 MW coming from new RE (4,721 MW), new fossil-based plants (9,400 MW), committed and indicative projects (2,129 MW), the 2,000 MW from natural gas and the 1,000 MW from nuclear (Figure 39).

Figure 38. TOTAL CAPACITY, MW (Nuclear High)

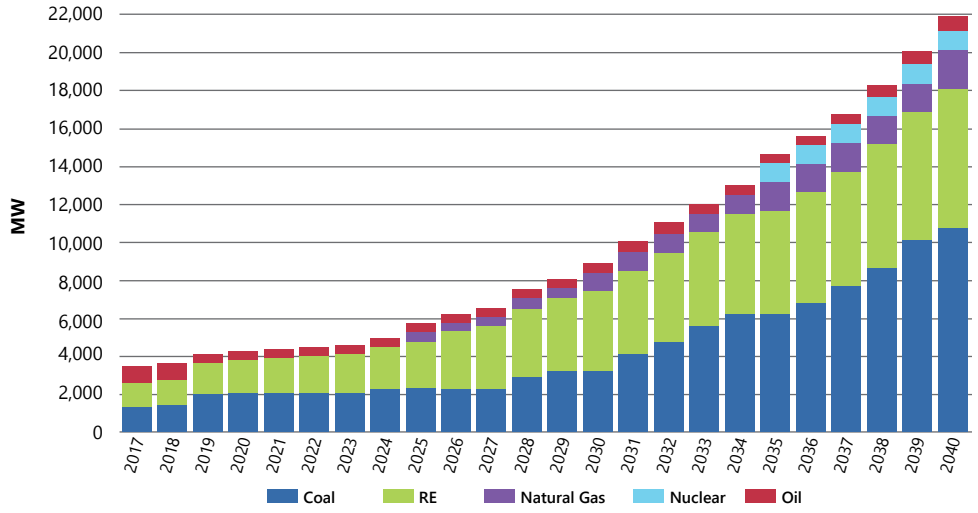
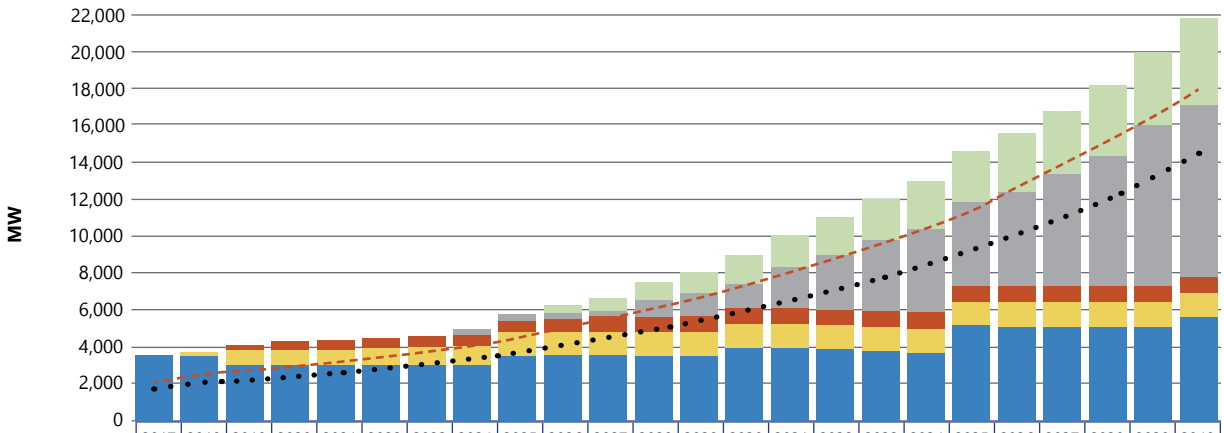


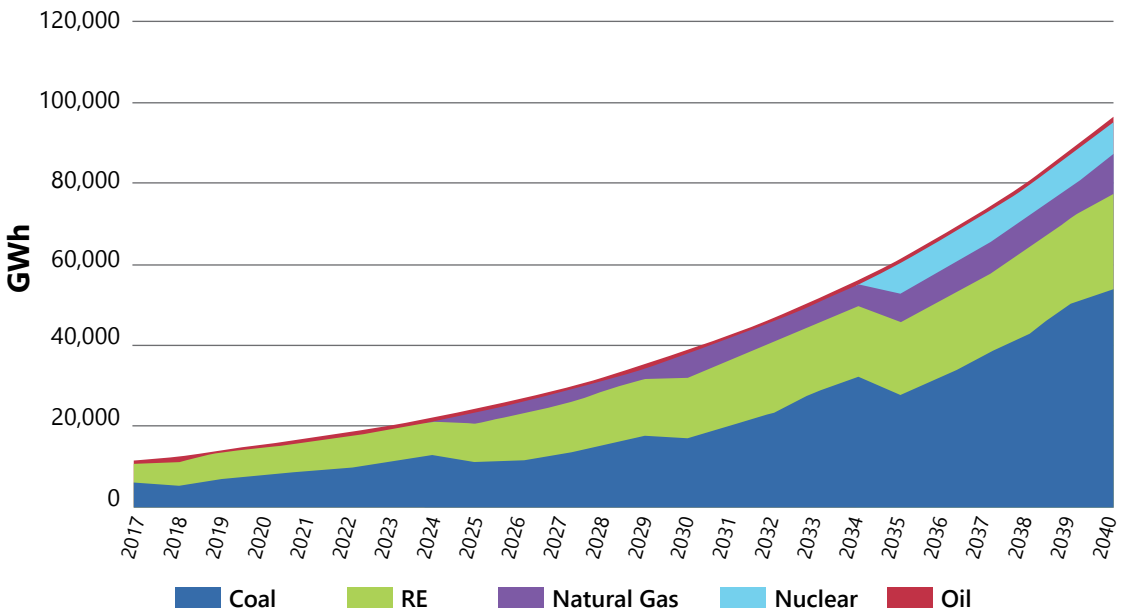
Figure 39. MINDANAO DEMAND-SUPPLY, 2018-2040 (Nuclear High)



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
New RE	0	0	0	0	0	0	0	0	0	392	582	922	1,128	1,503	1,693	2,033	2,223	2,598	2,788	3,128	3,318	3,843	4,033	4,721
New Fossil	0	0	0	0	0	0	0	300	300	300	300	950	1,275	1,300	2,250	2,900	3,875	4,525	4,525	5,175	6,150	7,125	8,750	9,400
Indicative RE (cumulative)		0	228	417	447	474	529	579	579	677	829	829	829	829	829	829	829	829	829	829	829	829	829	829
Committed PP (cumulative)		162	814	814	853	962	997	1,013	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Installed Capacity (less retirement)	3,482	3,482	3,022	3,022	3,022	3,022	3,022	3,022	3,522	3,522	3,522	3,485	3,484	3,948	3,948	3,917	3,765	3,711	5,177	5,128	5,117	5,117	5,117	5,598
Peak Demand (Low Scen)	1,760	2,095	2,172	2,364	2,575	2,808	3,064	3,364	3,695	4,059	4,459	4,899	5,383	5,916	6,472	7,082	7,749	8,480	9,280	10,156	11,115	12,165	13,316	14,575
Reserve Margin (25%)	2,200	2,619	2,715	2,955	3,219	3,510	3,830	4,206	4,619	5,074	5,574	6,124	6,729	7,395	8,090	8,852	9,686	10,599	11,599	12,695	13,894	15,207	16,644	18,219

Generation. Generation from nuclear energy pushes further down the share of coal to 56.0 percent from almost 64 percent in Alternative High. Coal generation declines by 11.9 percent at 53,899 GWh in 2040 compared to 61,157 GWh in Alternative High. On the other hand, nuclear energy produces 8.2 percent (7,884 GWh) of total generation. Natural gas and renewables contribute 10.8 percent and 24.0 percent, respectively. Oil generation is only 1.1percent of total in 2040 (Figure 40).

Figure 40. POWER GENERATION, GWh (Nuclear High)



Nuclear Low

Capacity. The system's capacity requirement drops by 33.6 percent with total requirement of 14,498 MW from 21,848 MW in Nuclear High. However, the capacity is higher by 0.2 percent compared with Alternative Low. With the same amount of capacity addition, renewables grab the largest chunk at 50.9 percent. Natural gas gets a share of 12.4 percent, and nuclear energy comprises 6.9 percent of total capacity requirement. Coal settles with 28.8 percent of total. Similar to Alternative Low, oil capacity addition is seen on the later part of the planning period (2033 onwards). It can be inferred that the system capacity sourced from renewables, natural gas and nuclear energy, given the low demand, can sustain the supply requirements.

The same with the other low scenarios, the projected peak demand in the planning period particularly in 2040 at 8,632 MW and with the inclusion of the 25.0 percent reserve requirement, total demand reaches 10,790 MW. In this scenario, total supply increases to 14,498 MW by 2040. Supply in the grid will be augmented by the total capacity addition of 11,900 MW coming from new RE (4,721 MW), committed and indicative projects (2,129 MW) and the remaining 2,800 MW from natural gas (1,800 MW) and nuclear (1,000 MW) (Figures 41 and 42).

Figure 41. TOTAL CAPACITY, MW (Nuclear Low)

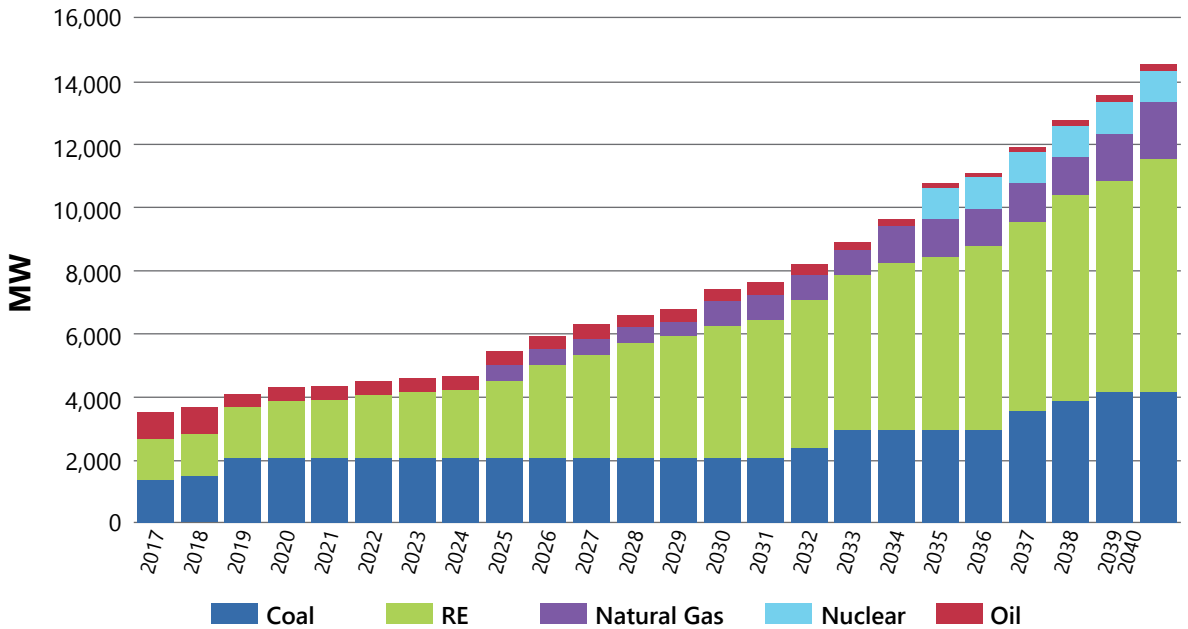
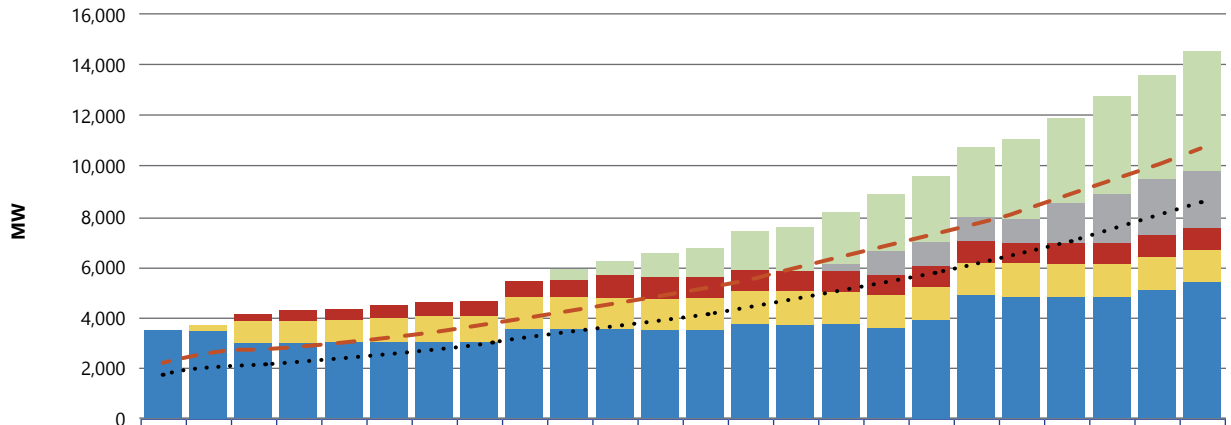


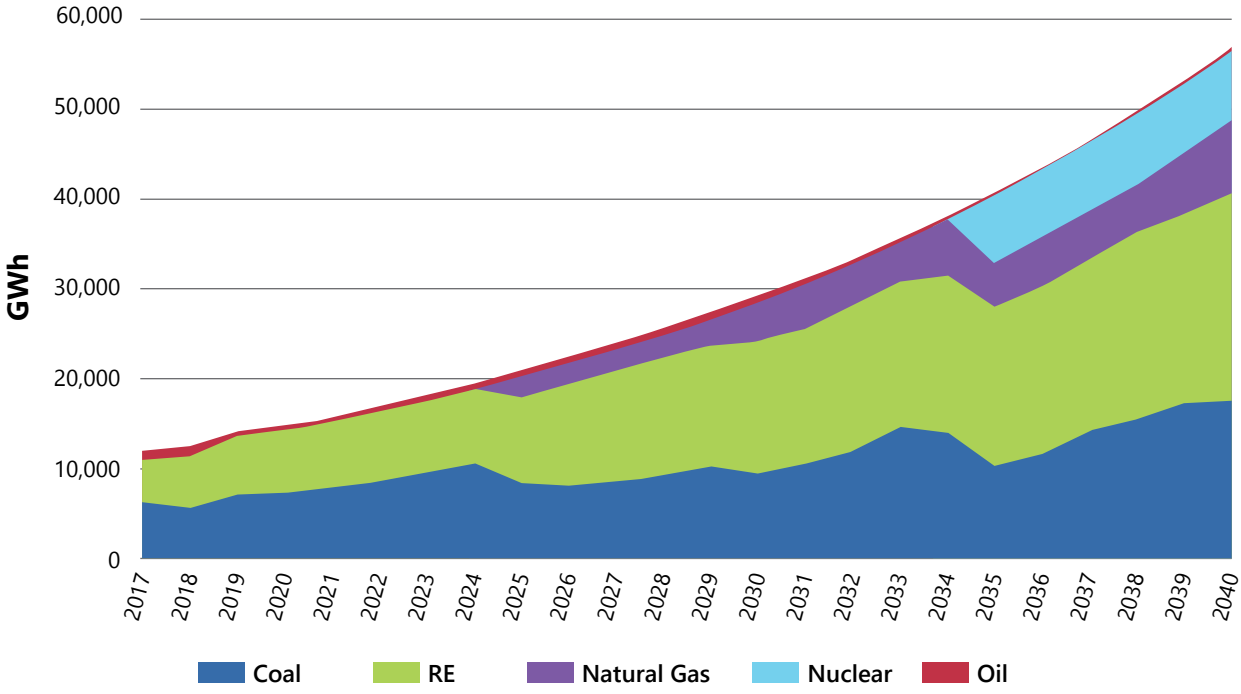
Figure 42. MINDANAO DEMAND-SUPPLY, 2018-2040 (Nuclear Low)



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
New RE	0	0	0	0	0	0	0	0	0	392	582	922	1,128	1,503	1,693	2,033	2,223	2,598	2,788	3,128	3,318	3,843	4,033	4,721
New Fossil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	300	950	950	950	950	1,600	1,925	2,250	2,250
Indicative RE (cumulative)		0	228	417	447	474	529	579	579	677	829	829	829	829	829	829	829	829	829	829	829	829	829	829
Committed PP (cumulative)		162	814	814	853	962	997	1,013	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Installed Capacity (less retirement + NG + Nuc)	3,482	3,482	3,022	3,022	3,022	3,022	3,022	3,022	3,522	3,522	3,522	3,485	3,484	3,748	3,748	3,717	3,565	3,911	4,877	4,828	4,817	4,817	5,117	5,398
Peak Demand (Low Scen)	1,760	2,064	2,130	2,226	2,359	2,539	2,732	2,941	3,165	3,383	3,616	3,865	4,131	4,416	4,721	5,048	5,397	5,771	6,171	6,599	7,057	7,547	8,071	8,632
Reserve Margin (25%)	2,200	2,580	2,663	2,783	2,949	3,173	3,415	3,676	3,957	4,229	4,520	4,831	5,164	5,520	5,902	6,310	6,747	7,214	7,714	8,249	8,821	9,433	10,088	10,790

Generation. Renewables comprise 40.6 percent of the generation mix, same level in Alternative Low. Gas accounts for 14.5 percent of the mix with 8,293 GWh in 2040, a decrease of about 10.7 percent from Alternative Low of 9,285 GWh. This is a result of nuclear displacing some amount of natural gas for baseload requirement in this scenario. With the same observation in Alternative Low, natural gas is introduced and starts to generate electricity in 2025 with a share of 11.8 percent. Nuclear seizes 13.8 percent of total generation having the same capacity as in Nuclear High. Coal share is 30.7 percent of the total, while oil generates electricity of a meager 0.3 percent starting 2035 (Figure 43).

Figure 43. POWER GENERATION, GWh (Nuclear Low)



Renewable Portfolio Standard (RPS) Requirement

The RPS is a market-based policy stipulated under Republic Act No. 9513 or the *Renewable Energy Act of 2008* that requires power distribution utilities (DUs), electric cooperatives (ECs) and retail electricity suppliers (RES) to source an agreed portion of their energy supply from eligible renewable facilities.

Given the influx of renewable investments in Mindanao as evident in the awarded RESCs, potential power generation from new RE-based capacity can provide a portion or fully satisfy the RPS requirements of the grid starting 2020 as mandated by law. The projected generation from new RE as exhibited in the three supply scenarios for 2020, 2030 and 2040 could be enough to cover the RPS requirement for the planning period. The generation for 2030 in the three scenarios reaches 7,905 GWh (Reference) and 9,175 GWh (Alternative and Nuclear). In 2040, projected generation stands at 12,400 GWh (Reference) and 17,647 GWh (Alternative and Nuclear).

It is deemed critical for these RESCs to progress from pre-development to commercial operation. The government and RE developers have pivotal roles in order for renewables to contribute to Mindanao's supply security and suffice the RPS requirements.

IMPACT OF MINDANAO-VISAYAS INTERCONNECTION

The Mindanao-Visayas Interconnection Project (MVIP) is one of the significant energy projects that will have an immense impact on the Mindanao grid, particularly on its power supply situation. One of the viewed impacts is the sharing of excess supply/capacity between Mindanao and Visayas-Luzon grids in instances where there is supply shortage or lack in available capacity to meet varying demand.

As stated in the TDP, the MVIP has both tangible and intangible benefits. The tangible benefits include sharing of system reserves/excess supply, lesser investment in power generation in either grids to maintain the one-day Loss of Load Probability (LOLP) and reduction in operating cost due to economic dispatch of generators. Meanwhile, intangible benefits are the following:

a) attractiveness of the MVIP to power generation investments due to the bigger market created by an interconnected network;
b) added supply security, improved system reliability and improvement in quality of power supply; and
c) optimized utilization of indigenous resources. The interconnection project is scheduled to commence by 2020.

SUPPLY SCENARIO IMPLICATIONS

Sustainable energy supply is essential for actualizing the Philippines' vision to be an upper middle-income country by 2022. Under this vision, growth will be more inclusive as manifested by lowering poverty incidence in the rural areas, from 30.0 percent in 2015 to 20.0 percent in 2022. As the country aims to reduce regional disparities by supporting (employment and wealth-generating) economic activities, there is a strong focus on Mindanao's progress and transformation.

With significant growth in electricity demand as a result of foreseen expansion of Mindanao's local economy, additional power generation capacities should be in place at the time when needed by the grid including the reserve capacity to ensure continuous and sustainable supply of electricity. The government's power generation capacity expansion plan underscores a technology-neutral policy – the inclusion of renewables and other potential sources for power.

As presented above, the different supply scenarios provide the power capacity and generation mix option(s) for the island. Each supply scenario is coupled with some implications on cost, environmental sustainability, supply diversity and self-sufficiency as described below.

Cost Effectiveness (Blended Rate). The policy options that could address concerns on energy security and high power rates include adoption of more efficient technologies and consideration of lower capital and fuel costs for power generation technologies. With technological improvements and economies of scale, capital costs for renewables, specifically solar and wind, are seen to decline further within the planning period. The consideration of VRE technologies as supply options in the long-term must also be cognizant of its lower capacity factor.

Environmental Sustainability (CO_2 Emission). This component focuses on the environmental dimension of energy security. Energy utilization and global environmental sustainability are inextricably linked. While development necessitates the increasing need for energy, sustainability must not be compromised and overlooked. An important factor in evaluating environment sustainability is CO_2 emission level given that it is one of the greenhouse gases emitted from electricity production. Among the scenarios, Alternative and Nuclear were observed to yield the lowest CO_2 emissions level in 2030 and 2040 in both HGS and LGS. This can be associated with the technology supply options considered in the scenarios with high presence of renewables, and the entry of natural gas and nuclear to the grid.

Energy Self-sufficiency Level. It measures the degree of dependency to imported energy resources. This indicator is based on the premise that the more the country relies on external energy resources, the more it becomes highly vulnerable to the geopolitics of energy and exposure to supply disruptions. Similar to other countries, nuclear is considered indigenous even if uranium is sourced overseas.

Supply Diversity. The diversification of supply is considered as another measure of energy security for a country. The **Herfindahl-Hirschman Index (HHI)**[24] is used as an indicator to measure the supply diversity index for power generation. HHI is an economic concept applied to assess market share or market concentration. A well-diversified power generation mix means that the country will be more resilient to changes in terms of supply interruption or price escalation as the impact of such would be lessen given the share of each technology or fuel to the mix. The HHI ranges from 0.0 to 1.0 with higher index means high concentration (or highly not diversified), while low index translates to low concentration (highly diversified).

Energy economics researchers and experts like Kanchana and Unesaki (2014)[25] used the HHI to describe and measure the degree of diversity of primary energy supply in the study on "ASEAN Energy Security: An Indicator-based Assessment. The study assessed the energy supply security of the ASEAN member states and examined how it evolved over the past decade. Likewise, Tufail, Ibrahim and Melan (2018)[26] affirmed that a commonly used method of measuring the degree of diversification is HHI. On the other hand, the Asia Pacific Energy Research Center (APERC, 2017) also used the HHI as one of the sub-indicators for the development of an overall Energy Security Index. HHI has been widely applied in the electric power industry through the quantification of diversification. The diversity score is defined as a measure of the degree of diversification for a given portfolio.

Table 64 highlights the implications from the different supply scenarios considered in this plan based on the four indicators presented. Analysis were drawn per supply scenario as follows:

Table 64. SUPPLY SCENARIO IMPLICATIONS

Indicators	Reference Scenario			Alternative Scenario			Nuclear Scenario		
	2020	2030	2040	2020	2030	2040	2020	2030	2040
High Growth Scenario (HGS)									
Blend Rate, USD/KWh[27] (with reserves)	0.108	0.097	0.102	0.108	0.096	0.102	0.107	0.104	0.106
Blend Rate, USD/KWh (without reserves)	0.091	0.090	0.092	0.090	0.089	0.092	0.090	0.100	0.098
CO_2 Emission, $MTCO_2$*	7.31	20.71	61.52	7.31	16.78	52.72	7.31	16.78	46.79
Self-Sufficiency Level[28] (%)	44.7	34.2	18.6	44.7	38.6	24.0	44.7	38.6	32.2
Supply Diversity Index (HHI)	0.39	0.48	0.66	0.39	0.30	0.44	0.39	0.30	0.36
Low Growth Scenario (LGS)									
Blend Rate, USD/KWh (with reserves)	0.110	0.095	0.100	0.110	0.097	0.098	0.110	0.097	0.099
Blend Rate, USD/KWh (without reserves)	0.091	0.090	0.090	0.090	0.089	0.090	0.090	0.089	0.088
CO_2 Emission, $MTCO_2$*	6.53	13.09	31.08	6.53	10.04	22.92	6.53	10.04	17.18
Self-Sufficiency Level (%)	47.5	45.9	31.3	47.5	50.2	40.5	47.5	50.2	54.4
Supply Diversity Index (HHI)	0.37	0.40	0.51	0.37	0.26	0.28	0.37	0.26	0.21

**Million Tons of CO_2 equivalent*

Reference Scenario. Coal dominates the generation mix, albeit a significant amount of renewables is included in the system. As such, the estimated blend rate in HGS, using the Levelized Cost of Electricity (LCOE) of technologies/fuels and their shares in the total generation, is about USD 0.102/KWh in 2040 (PhP5.31/KWh using PhP 52.0/USD conversion rate). The blend rate is lower than the Nuclear Scenario, but at the same level with Alternative Scenario. The blend rate considers the assumed required reserve supply/capacity of the grid at 25.0 percent of peak demand, which is equivalent to an average of USD 0.009/KWh (PhP 0.48/KWh) in HGS. The reserve supply is contributed by coal and oil in this scenario.

[24] Herfindahl-Hirschman Index is calculated by squaring the share of each technology/fuel to total power generation, and then add each share to get the total. For energy security indicator purposes, the HHI is modified such that the range of high concentration (highly not diversified) was adjusted from its original of >0.25 to 1.00. A higher HHI means a high concentration in one or few sources. HHI of below 0.10 is considered low concentration (highly diversified), 0.10-0.19 is moderately diversified, 0.20-0.49 is somewhat diversified, 0.50-0.99 is highly not diversified (dominant fuel in the mix), and 1.0 is not diversified.

[25] Kanchana, Kamonphorn & Unesaki, Hironobu. (2014). ASEAN Energy Security: An Indicator-based Assessment. Energy Procedia. 56. 163–171. 10.1016/j.egypro.2014.07.145.

[26] Akademia Baru, Penerbit. (2019). Conceptualizing Energy Security and the Role of Diversification as the Key Indicator Against Energy Supply Disruption.

[27] Based on levelized cost of the different technologies/fuels. Likewise, the levelized cost is computed based on capacity factor per technology/fuel.

[28] Self-sufficiency ratio = Indigenous Source / Total Power Generation * 100

The blended rate falls by 5.5 percent from 2020 level as more renewables are considered in the system with declining cost (specifically for solar). In LGS, the blended rate in 2040 stands at 0.100 USD/KWh (PhP 5.2/KWh).

The CO_2 emission level is the highest among the scenarios reaching 61.52 MT CO_2 equivalent (HGS) in 2040. As coal increases its share (80.0 percent in 2040), CO_2 level significantly rises by ten-fold from around 6.0 MT CO_2 in 2017 (eight-fold increase from 2020 level). In LGS, emission level goes down by about half from HGS due to lower grid demand and contribution from coal.

On the self-sufficiency ratio, this scenario has the lowest level at 18.6 percent (HGS) and 31.3 percent (LGS) in 2040, about 80.0 percent and 70.0 percent import dependent, particularly coal, respectively. In terms of supply diversity index using HHI, the generation mix obtains 0.66 (HGS) and 0.51 (LGS) from 0.35 in 2017, highest among the scenarios, which can be translated to highly not diversified with dominant fuel in the mix, which is coal.

Alternative Scenario. The projected blend rate in HGS at the end of the planning period reaches 0.102 USD/KWh (PhP 5.30 KWh) and 0.098 USD/KWh (PhP 5.093 KWh) in LGS, the lowest among scenarios. The entry of natural gas with a much higher efficiency rating and additional renewables (from solar and wind) lead to around 2.0 percent cheaper in blend rate compared with Reference Scenario (LGS). However, the LCOE of natural gas does not include the support infrastructure such as LNG receiving terminal. If considered, the blend rate may be higher, although this scenario results in lowest total investment in the power sector, including the LNG receiving terminal *(please see discussion in Chapter 10: Investment)*. The reserve supply/capacity requires an average of USD 0.010/KWh (PhP 0.53/KWh) in HGS, as coal, oil and natural gas provide the reserve supply.

This scenario results in second lowest emission level – lower compared with Reference Scenario but higher than Nuclear Scenario. The CO_2 emission level declines by 14.3 percent in HGS and 26.2 percent in LGS in 2040 compared with Reference Scenario, translated to 52.72 MT CO_2 and 22.92 MT CO_2, respectively, at the end of the planning period.

Self-sufficiency ratio level both in HGS and LGS is higher than Reference Scenario with the additional entry of solar and wind into the system. By 2040, self-sufficiency level is at 24.0 percent in HGS and 40.5 percent in LGS. Supply diversity index likewise improves in this scenario at 0.40 HHI in HGS and 0.26 HHI, which fall under somewhat diversified fuel mix for power generation.

Nuclear Scenario. The entry of nuclear in the grid pushes the blend rate higher than the Alternative Scenario at USD 0.106 KWh (PhP 5.51/KWh) in HGS and USD 0.099 KWh (PhP 5.13/KWh) in LGS, but lower than Reference Scenario (LGS). The relatively high blended rate in HGS is due to little lower capacity factor from natural gas and coal as it takes a portion of the baseload requirement of the grid. On the other hand, the lower blend rate compared with Reference Scenario in LGS is a result of a reduction in additional capacity from coal. The blend rate may reduce beyond 2040 in this scenario as the capacity factor of natural gas (and even coal) increases with rising demand. The average cost for reserve supply/capacity is at USD 0.009/KWh (PhP0.45/KWh) as more natural gas is considered than coal.

The lowest CO_2 emission level and supply diversity index is observed in this scenario. Emission level is 46.79 MT CO_2 in HGS and 17.18 MT CO_2 in LGS by the end of the planning period. On the other hand, supply diversity index is 0.36 HHI (HGS) and 0.21 HHI (LGS). Likewise, this scenario offers the highest self-sufficiency level at 32.2 percent (HGS) and 54.4 percent (LGS) among the scenarios.

According to the World Nuclear Association (WNA), nuclear power on a levelised (i.e. lifetime) basis denotes an economic source of electricity generation, combining the advantages of security, reliability and very low GHG emissions. The WNA also adds that the economics of new nuclear plants are heavily influenced by their capital cost, which accounts for 60 percent of their LCOE[29].

Based on the supply scenario implications, Mindanao has the option on which supply mix to adopt in its grid system, taking into account the four indicators related to energy security and sustainability. Mindanao may consider other indicators (not included in the analysis) in making a decision on the appropriate supply mix for the island. The entry of more solar and wind with a combined capacity of almost 4,800 MW in both Alternative and Nuclear Scenarios denotes the need to look at the absorptive capacity of the transmission network. If transmission reinforcement is required in some portion of the network, the corresponding cost must be accounted and incorporated in the blended rate. On the aspect of introducing nuclear energy in Mindanao, the decision will depend on how the identified 19 nuclear infrastructures as required by IAEA have been addressed. A decision brings with it considerable weight given that national position, legal and regulatory framework, safety, human resource, environmental protection and public

[29] World Nuclear Association (2018 December). Economics of Nuclear Power. Retrieved from http://www.world-nuclear.org/information-library/economic-aspects/economics-of-nuclear-power.aspx

acceptance are some of the infrastructure issues that must be dealt with in considering nuclear as a long-term option for power generation.

SMALL ISLAND GRIDS

Electricity Sales and Consumption

The electricity consumption in small island grids is also projected to grow significantly within the planning period. In HGS, electricity consumption increases by six-fold from only 256 GWh in 2017 to 1,598 GWh in 2040, translating to an average annual growth rate of 8.5 percent (Table 65).

Each sector's share to total electricity consumption is seen to follow the historical pattern throughout the outlook period. Residential sector still remains as the largest user of electricity with an average share of about 76.0 percent. Commercial and "others" sectors are expected to have a combined average share of around 10.0 percent. Meanwhile, the industry sector demands the least electricity use requiring less than 1.0 percent of total consumption.

Despite having minimal share to total electricity consumption, the "others" sector exhibits the highest annual growth rate at 10.3 percent, even higher than the 9.0 percent of the residential sector. The government's commitment to provide off-grid areas with equal access and opportunities in terms of basic goods and services is anticipated to significantly contribute to the growth of electricity sales for "others". On the other hand, electricity demand of commercial and industry sectors is expected to remain on a steady growth path of 7.7 percent and 7.6 percent, respectively.

Table 65. ELECTRICITY SALES AND CONSUMPTION, GWh (HGS)

Consumer Type	2017	2018	2020	2025	2030	2035	2040	2018-2040	
								Average Share	AAGR
Residential	174	229	352	640	896	1037	1195	75.7	9.0
Industrial	1	1	1	1	2	3	4	0.2	7.6
Commercial	18	19	22	32	46	67	99	4.8	7.7
Others	15	17	21	37	61	95	144	5.8	10.3
Total Sales	**208**	**266**	**396**	**710**	**1005**	**1202**	**1442**	**86.5**	9.0
System Loss	49	60	83	122	135	146	156	13.5	-0.4
Total Consumption	**256**	**326**	**480**	**832**	**1140**	**1348**	**1598**	**100**	8.5

Note: Others includes public buildings, street lights, irrigation and utility's station use, among others.
Based on 2018 DDP of electric cooperatives servicing off-grid areas only.

Table 66 displays the trend of electricity consumption for LGS. Electricity consumption stretches up to 1,139 GWh in 2040, translating to more than four-fold increase with 7.1 percent annual growth rate. Compared with HGS, total electricity consumption drops by 28.8 percent, equivalent to 460 GWh reduction. The share of each sector to the total electricity consumption remains relatively almost the same trend as in HGS.

Table 66. ELECTRICITY SALES AND CONSUMPTION, GWh (LGS)

Consumer Type	2017	2018	2020	2025	2030	2035	2040	2018-2040	
								Average Share	AAGR
Residential	174	206	291	441	618	715	824	73.5	7.1
Industrial	1	1	1	1	2	2	3	0.2	5.9
Commercial	18	19	22	31	43	59	82	5.8	6.8
Others	15	16	20	34	54	82	119	7.0	9.3
Total Sales	**208**	**243**	**334**	**508**	**717**	**858**	**1027**	**86.5**	7.3
System Loss	49	55	70	87	96	104	112	13.5	-0.4
Total Consumption	**256**	**298**	**405**	**595**	**813**	**962**	**1139**	**100**	6.8

Note: Others includes public buildings, street lights, irrigation and utility's station use, among others.
Based on 2018 DDP of electric cooperatives servicing off-grid areas only.

Transmission/distribution losses in small island grids stood at 19.0 percent in 2017. For both scenarios, system loss is anticipated to reduce annually at 0.6 percent, on the average, until it reaches the 12.0 percent level by 2030. Through the implementation of various initiatives in improving efficiency of power supply system, system loss continues to improve in the longer term with only 10.0 percent by 2040.

Capacity Additions

The National Power Corporation-Small Power Utilities Group (NPC-SPUG) remains resolute in improving its capacity addition program as a response to increasing electricity demand, as well as achieving total household electrification in missionary areas. Table 67 summarizes the programmed generation capacity additions from 2018-2022 in existing NPC-SPUG areas in Mindanao.

Table 67. CAPACITY ADDITION OF NPC-SPUG, MW

Region	Power Plant	Cooperative	2018	2019	2020	2021	2022	Total
IX	Sacol	ZAMCELCO	0.2					**0.2**
XI	Talicud	DANECO	0.3		0.3			**0.6**
	Balut	DASURECO	0.4					**0.4**
XII	Kalamansig	SUKELCO	4.5	4.0			1.0	**9.5**
	Ninoy Aquino	SUKELCO	0.5	1.0				**1.5**
	Palimbang	SUKELCO	0.3					**0.3**
CARAGA	Dinagat	DIELCO	3.0		3.0		1.0	**7.0**
ARMM	Hikdop	SURNECO	0.2		0.2			**0.4**
	Basilan	BASELCO	5.0		10.0	6.0		**21.0**
	Jolo	SULECO		15.0		5.0		**20.0**
	Siasi	SIASELCO					0.1	**0.1**
	Pandami	SIASELCO	0.4					**0.4**
	Tawi-Tawi	TAWELCO	4.2	1.7			0.5	**6.4**
Total			**19.0**	**21.7**	**13.5**	**11.0**	**2.6**	**67.8**

Source: 2018-2022 NPC Missionary Electrification Plan

For the five-year planning period, a total of 67.8 MW of additional capacities are expected to be in place by 2022. Among the regions, ARMM has the largest capacity addition of 48.3 MW, bulk of the requirements are allocated for Basilan and Jolo with 21 MW and 20 MW, respectively. Apart from the capacity expansion plan, NPC-SPUG is currently working on the adoption and promotion of hybridization of the system with renewables, specifically solar as a potential capacity addition in off-grid areas. The integration of renewables in the system is also an option to reduce electricity rate and consequently the subsidy level, as well as increasing the operating hours to 24 in certain areas. Table 68 summarizes the list of solar PV capacities to be installed to hybridize existing diesel power plants.

Table 68. NPC RENEWABLE ENERGY PROJECTS

Area	Solar PV Capacity Addition, KW		
	2018	2019	2020
Dinagat			
Gibusong Island, Loreto	150		
Sibanag Island, Basilisa	100		
Davao Occidental			
Sarangani Island	300		
Basilan			
Tausan, Pilas Is.,Haji Muhtamad	200		
Bubuan Island, Tabuan Lasa		50	
Lanawan Island, Tabuan Lasa		50	
Linungan Island, Akbar			38
Total	**750**	**100**	**38**

Operating Hours

To widen energy access and improve electricity services, utmost priority should be given to areas without access to electricity and limited service hours. The DOE, through the NPC-SPUG, continuously supports the initiatives to extend the operating hours of power supply in areas where electricity service is less than 24 hours. Although 24-hour service is already available in large off-grid areas, there are still remaining areas having 6 to 8 hours of service.

Table 69. OPERATING HOURS

Region	Area	Operating Hours (as of September 2017)	2018	2019	2020	2021	2022
XI	Talicud , Davao del Norte	16	24				
	Balut, Davao Occidental	16		24			
XII	Lebak/Kalamansig	24					
	Sen. Ninoy Aquino	16	24				
	Palimbang	16	24				
IX	Sacol, Zamboanga	16	24				
CARAGA	Loreto,Dinagat	24					
ARMM	Hikdop, Sultan Kudarat	16		24			
	Basilan Grid	24					
	Tausan, Pilas Isl., Haji Muhtamad		8		16		24
	Linungan Isl., Akbar				8		16
	Bubuan Isl., Tabuan Lasa			8		16	
	Lanawan Isl., Tabuan Lasa			8		16	
	Saluping Isl., Tabuan Lasa			8		16	
	Tapiana Isl., Tabuan Lasa			8		16	
	Mapun, Tawi-tawi	16	24				
	Siasi, Sulu	24					
	Jolo, Sulu	24					
	Pangutaran, Sulu	6	16	24			
	Tawi-tawi Grid	24					
	Balimbing, Tawi-Tawi	16	24				
	Tandubas, Tawi-Tawi	8	16	24			
	Sibutu, Tawi-Tawi	16	24				
	Sitangkai, Tawi-Tawi	16		24			
	Manuk-Mangkaw, Tawi-Tawi	8	16	24			
	West Simunul, Tawi-Tawi	14		24			
	Tandubanak, Tawi-Tawi	12		24			

Listed in Table 69 is the scheduled increase in operating hours in various off-grid areas in Mindanao from 2018 to 2022. The corresponding operating hours will be increased to 8 hours, 16 hours, and up to 24 hours with due consideration on the historical load growth, high potential for tourism and degree of commercialization of such area. It can be seen that ARMM will benefit the most as majority of the areas to receive increase and full service operations between 2018 and 2019 will come from this region.

The provision of a 24-hour power service is expected to support and stir the growth of local economies through technology, business, and tourism leading to the improvement of people's quality of life in the countryside.

POLICY IMPLICATIONS / RECOMMENDATIONS

The results of the outlook point to some policy implications and recommendations.

1. Supply diversification for greater energy security.

It is ideal to be in milieu where a range of supply options are available to be tapped when needed. Diversity of supply may bring several outcomes, such as lower dependence on one or few energy sources thus improving energy supply security, or a reduction in greenhouse gas (GHG) emissions. Energy security in the strictest sense as defined by the International Energy Agency (IEA) is uninterrupted availability of energy resources at an affordable price.

The Reference Scenario shows heavy reliance on coal for electricity generation. Since the Philippines uses more imported coal for power generation, supply may be susceptible to potential disruptions from exporting countries due to changing domestic policies toward coal. A system cannot solely rely on a fuel that is sourced overseas. The same holds true for natural gas when it is imported (in LNG form). In the Alternative Scenario, natural gas is introduced in the system, which accounts for a significant share in generation mix. In this case, supply diversity limits the share of particular fuels in the system, thereby minimizes the risks of any supply disruptions.

Supply diversity also balances the impacts on power rates and greenhouse gas (GHG) emission level. Coal with natural gas and renewables may lead to a higher electricity rates, but can limit and displace some amount of carbon dioxide (CO_2) from burning more coal. Although we see, based on the projection of IEA, that the capital costs for renewables, particularly solar and wind, are expected to further reduce in the future. On the other hand, the entry of nuclear energy offers a cheaper and cleaner source of electricity. The government has established the Nuclear Energy Program Implementing Organization (NEPIO) in October 2016 to study all aspects (19 infrastructure requirements of IAEA) of a nuclear energy program and whether the country is ready to have a national position on nuclear energy.

Exploration and development of fossil fuels (oil, gas and coal) are pivotal in the country's energy supply security when utilized domestically. Using more our indigenous energy resources increases our energy self-sufficiency level, which in turn leads to improvement in our energy supply security.

The Scenarios presented in this plan provides option(s) for power generation capacity and supply mix in Mindanao. If natural gas is considered in the generation mix, Mindanao should promote and facilitate the development of infrastructure requirements for such fuel like the establishment of an LNG receiving terminal and the associated pipeline networks to expand its use to non-power application. Creating a market for natural gas is critical to realize this supply option for Mindanao.

2. Pursue greater contribution from renewables

It has been a policy of the government to accelerate renewable energy development in the country. The various renewable resources in Mindanao are options for greater supply diversification. From the study conducted by the ISF, the region has technical potentials of 1,100 GW of solar and 89 GW of wind. The implementation of the RPS in 2020 will likewise ensure significant contribution of renewables in power generation mix in the country. Greater share of renewables in the supply mix for power calls for greater private sector participation and commitments from both the national government agencies (NGAs) and local government units (LGUs) to fast track the issuance of permits and clearances for renewable power projects to ensure timely completion and operation. The Mindanao's vision of having a **50 – 50 Balanced Mix** of fossil-based and renewable energy by 2030 serves as a guidepost to underscore the increase in the contribution of renewables.

The supply scenarios indicated the high presence of renewable capacity with the integration of more RE capacity from committed and indicative projects, RESCs (both awarded and pending) and additional VRE (solar and wind) in the ISF study. In the context of this vision, all of the low growth scenarios resulted in almost 50.0 percent generation from renewables in 2030 – Reference (45.9 percent), Alternative (50.2 percent) and Nuclear (50.2 percent). While this may be a significant outcome and denotes Mindanao's vision, RE share gradually declines towards 2040 as the scenarios showed 31.4 percent (Reference) and 40.6 percent (Alternative and Nuclear) generation share of RE at the end of the planning period.

It is also deemed necessary to conduct more resource assessments to further quantify the potential capacity of renewables in Mindanao. The information on the renewable potential can be used extensively for progressing the efforts on RE development.

3. Energy investments are critical

The role of government is to provide an enabling environment for energy investors. The government designs and implements policies intended to encourage investments in highly capital intensive energy sector. It is also essential to identify the energy investment spaces in order to provide a window of opportunity to interested parties that will improve energy infrastructures in the country. In the case of Mindanao, natural gas and its related infrastructures have gained interest from the private sector. However, such interest must be translated into real investment leading to project realization. MinDA plays an important role in facilitating and pursuing investment interest in the energy sector.

4. Power sector developments such as the electricity market and interconnection will aid Mindanao.

The influx of capacities in the grid is seen to be addressed by WESM which is a central dispatch system that will optimize available capacities. On the other hand, the Mindanao-Visayas Interconnection Project (MVIP) will link Mindanao grid with the Visayas-Luzon grid. Interconnection benefits Mindanao because excess supply/reserves can be shared, and thus added supply security, improved system reliability and improved quality of power supply.

IV. ENERGY RESOURCE DEVELOPMENT

To heed the call of Secretary A. G. Cusi on fueling the Mindanao economy, the energy sector will pursue its ***technology and fuel-neutral policy*** *with due consideration to environmental concerns to bring about sustainable growth and promote competitiveness of the island. In view of this, the exploration and development of conventional fuels such as oil, gas and coal will continue to form part of the Department's Strategic Agenda.*

OIL AND GAS

With the region's rich resource base, exploring the full potential of indigenous resources in Mindanao remains an unceasing undertaking of the government to boost the region's energy supply security. The government, together with the private sector, has exerted greater effort in expanding the exploration and development of oil and gas resources. A key national strategy is the continued conduct of the Philippine Conventional Energy Contracting Program (PCECP)[30] (formerly known as the Philippine Energy Contracting Round (PECR) offering prospective sites for oil and gas resources exploration and development, which may lead to new discoveries. During the conduct of PECR 4 in 2011, promising leads and prospects were identified and delineated in Area 15 over the Sulu Sea Basin. Several applications for the exploration of this area were received during the opening of bids. However, after thorough evaluation of bid documents, said applicants did not qualify under the criteria set by the DOE.

Meanwhile, work commitments of existing oil and gas contract holders in Mindanao are continuously being supervised and monitored by the DOE to ensure timely completion of their contract obligations. Service Contract No. 56, covering exploration of 622,000 hectares in Sulu Sea and being operated by Total E & P Philippines (TEPP) B. V., has been extended twice since it commenced operation in 2005. Apart from on-going Metocean[31] survey and acquisition of 1,000 kilometers of 2D seismic data, other activities that will form part of the five (5)-year extension period from 2015 to 2020 include the following:

- Acquisition of 2,000 square kilometers of high-resolution seabed scan data;
- Drilling of offshore exploration well to at least 4,000 meters subsea;

[30] The PCECP is the DOE's revised and transparent petroleum service contract awarding mechanism replacing the PECR that allows the government to develop and utilize indigenous petroleum resources under a service contract with qualified local and international exploration companies through a competitive selection process or via nomination.

[31] Meteorological and oceanographic (metocean) survey involves statistical analyses in the field of data validation, determination of normal and extreme metocean conditions and data transformation.

- Completion of geotechnical pre-development studies; and,
- Completion of commercial evaluation studies.

PLANS AND PROGRAMS

With the objective of increasing production from oil and gas resources throughout the planning period, the DOE has devised an Oil and Gas Roadmap which sets out specific timelines and activities in order to achieve this aspirational goal. One primary undertaking is the continuing assessment of oil and gas reserves to improve the prospective of under-explored sedimentary basins in Mindanao, such as the **Cotabato Basin** and **Agusan-Davao Basins**. The resource assessment of the Agusan-Davao Basin has shown a total of 196 million barrels (MMB) of oil equivalent consisting of 59 MMB of oil (21 MMB mapped[32] and 38 MMB unmapped[33]) and 768 billion cubic feet (BCF) of gas (238 BCF mapped and 530 BCF unmapped). Discovery of new fields in the region will be pursued within the planning period.

Another key approach is to stimulate investments in petroleum exploration, development and production. This can be done through regular conduct of energy contracting rounds and strengthened Information, Education and Communication (IEC) Campaigns for both foreign and local stakeholders, and Local Government Units (LGUs) and local communities. The IECs also promote awareness on the benefits of petroleum exploration and encourage acceptability of project development.

In 2018, the DOE conducted a series of roadshows in Palawan, Davao and Zamboanga to boost the exploration of oil and gas resources in the country under the new PCECP. These areas are strategically located near the 14 pre-determined areas (PDAs) of the DOE for potential petroleum exploration and development activities. The PDAs include one (1) each in the Cagayan Basin and Cotabato, two (2) in Agusan-Davao, three (3) in Sulu, three (3) in Eastern Palawan and four (4) in Western Luzon. Apart from these areas, the PCECP now has an added option of allowing prospective investors to nominate areas outside of the identified PDAs. During the roadshows, local communities were oriented on the benefits of hosting exploration and development projects and its greater contribution to nation building.

Aside from ensuring compliance with work commitments of existing service contractors, the DOE will harmonize government projects to have a unified and coordinated approach in pursuit of energy security. As complementing initiative, the Department will also formulate and implement policies to streamline petroleum-related activities of service contract operators/holders.

The government will likewise strengthen international cooperation initiatives to keep abreast with global developments in the upstream petroleum industry. Establishment of partnerships among international organizations (such as the Coordinating Committee for Geoscience Programmes in East and Southeast Asia (CCGP) and Korea Institute of Geoscience and Mineral Resources (KIGAM)) promotes capacity building, technology transfer, exchange of information and institutional linkages for sustainable resource development, management of geo-information, geo-hazard mitigation and protection of the environment.

COAL

Coal is another significant source of energy in Mindanao. As a major fuel in the country's energy supply mix, the continued exploration of the potential coal areas in the country is one of the strategies identified in the energy security agenda of the government. As such, Mindanao is exhausting its full coal potential, which currently stands at 2,266.70 million metric tons (MMMT).

Based on reserves assessment as of December 2017, about 300 MMMT of coal potential have been recorded in Sultan Kudarat, 230 MMMT in South Cotabato and 209 MMMT in Surigao. Significant amount of reserves was also found in Davao, Zamboanga, Maguindanao and Sarangani (Table 70). Apart from these exploration activities, the DOE has been conducting reconnaissance to semi-detailed mapping of under-explored coal areas.

Table 70. COAL RESERVES in Mindanao (as of December 2017), Metric Ton (MT)

Coal Region	Resource Potential	Positive Reserves	Probable Reserves	In-Situ Reserves	Mineable Reserves
Davao	100,000,000	1,393,007	1,467,359	2,371,246	1,422,748
Surigao	209,000,000	29,444,073	61,509,284	70,450,262	48,099,332
Zamboanga	45,000,000	34,147,739	6,497,305	38,479,276	23,087,566
Maguindanao	108,000,000	-	-	-	-
Sarangani	120,000,000	-	-	-	-
South Cotabato	230,400,000	35,093,186	68,959,017	81,065,864	68,905,984
Sultan Kudarat	300,300,000	-	-	-	-
Total	**2,366,700,000**	**463,478,670**	**199,474,753**	**596,461,839**	**478,242,038**

[32] Potential accumulation is sufficiently well-defined to represent a viable drilling target
[33] Recognized prospective trend of potential prospects

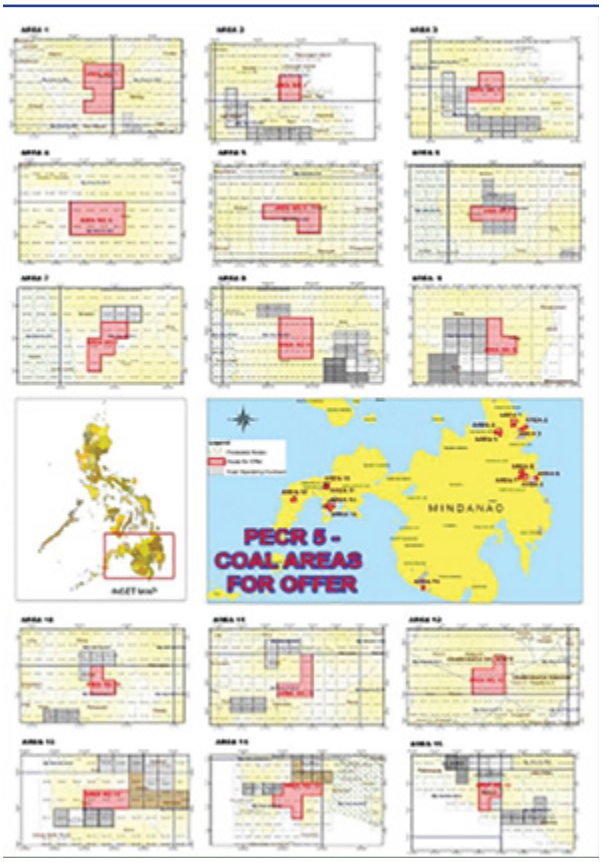
Philippine Conventional Energy Contracting Program (PCECP)

The PCECP for coal was issued through Department Circular (DC) No. 2017-09-0010 on 13 September 2017. The PCECP offers a simpler and faster public contracting program by nomination through publication to facilitate the acceptance of applications for Coal Operating Contract (COC) from interested applicants. The DOE deems such approach to be more responsive in intensifying the development of the country's coal resources. The processing time from the opening of bids to awarding of the service/operating contract now takes only 30 calendar days to complete.

The launch of the then-PECR 5 in May 2014 showcased 15 coal areas in Mindanao for exploration and possible development and production. As shown in Figure 44, the areas offered for possible investments include the following:

Area 1: Carmen, Lanuza & Tandag, Surigao del Sur
Area 2: Tandag & Tago, Surigao del Sur
Area 3: Tandag, Tago & San Miguel, Surigao del Sur
Area 4: Sibagat, Agusan Sur & Butuan City, Agusan del Norte
Area 5: Sibagat, Agusan del Sur & Butuan City, Agusan del Norte
Area 6: Bunawan, Agusan del Sur
Area 7: Bunawan & Trento, Agusan del Sur
Area 8: Bunawan &Trento, Agusan del Sur; & Bislig City, Surigao del Sur
Area 9: Lingig & Bislig City, Surigao del Sur
Area 10: Godod, Zamboanga del Norte & Kabasalan, Zamboangay Sibugay
Area 11: Godod, Zamboanga del Norte & Kabasalan, Zamboanga Sibugay
Area 12: Baliguian & Siocon, Zamboanga del Norte
Area 13: Alicia, Imelda & Payao, Zamboanga Sibugay
Area 14: Imelda, Malangas, Alicia & Payao, Zamboanga Sibugay
Area 15: Maitum, Sarangani

Figure 44. COAL AREAS FOR OFFER DURING PECR 5



Successful bid proposals, which satisfactorily complied with the technical, legal and financial requirements, have warranted seven (7) contracts for the exploration of several coal exploratory areas in Mindanao. The COC No. 193 has been awarded to Coal Block Mining Corp. for the exploration of coal areas in Surigao del Sur, while the COC Nos. 194, 195, 198 and 199 were awarded to Sahi Mining Corp. for the exploration of coal areas in Agusan del Sur and Norte and some areas in Zamboanga del Norte/ Sibugay. Similarly, the COC Nos. 196 and 197 were granted to Philsaga Mining Corp. for exploration of coal areas in Agusan del Sur. To date, there are 39 COC holders in Mindanao, 30 of these are in the exploration phase and nine (9) are in development and production phase.

Coal Production

Existing coal producers, including small scale miners in Surigao del Sur and Zamboanga del Sur, have been actively exploiting the full potential of coal resources. In 2017, about 75.1 thousand metric tons (MMT) of coal have been produced in these areas.

Table 71. COAL PRODUCTION in MINDANAO (Run-of-Mine), MT

Coal Areas	2017
Surigao del Sur	26,727.92
Small Scale Mines	
Surigao del Sur	17,750.80
Zamboanga del Sur	30,673.73
Total	**75,152.45**

Monitoring Activities/IEC Campaigns

To ensure compliance to work program commitments and prevent the conduct of illegal mining and trading activities, the DOE regularly monitors the activities of valid and existing COCs and Small-scale Coal Mining Permit (SSCMP) holders including those accredited coal traders and registered coal end-users Applications for SSCM permits in Zamboanga Sibugay, Bislig and Surigao del Sur were also processed and evaluated.

Public hearings on coal projects of Daguma Agro Minerals, Inc. (COC No 126), Sultan Energy Philippine Corp. (COC No. 134) and Bonanza Energy Resources, Inc. (COC No. 138) organized by the Sangguniang Panlalawigan of South

Cotabato were also conducted on 10-13 April 2018 in consultation with the DOE to facilitate the granting of endorsement. Likewise, consultative meetings on the formulation of "*Guidelines on Coal Handling, Transport, Storage and Distribution*" were undertaken during the breakout sessions of E-Power Mo in Baguio City on 24 April 2018. This was followed with a public consultation on 18 June 2018 at the DOE Audio Visual Room for the final draft of the said guidelines.

Coal stakeholders participated during the Public Consultation on the final draft of the Guidelines on Coal Handling, Transport, Storage and Distribution held on 18 June 2018 at the DOE-Audio Visual Room.

PLANS AND PROGRAMS

With the overall goal of increased indigenous coal reserves and production by 2040, the DOE formulated a roadmap to effectively achieve the target. Additional reserves and production outputs are targeted for the three (3) milestone periods: short-term (2018), medium-term (2019-2022) and long-term (2023-2040).

Coal Reserves

Mindanao's coal reserves are expected to increase during the 2018-2040 planning period. From 142.64 MMMT of incremental coal reserves in 2018, it is expected that such additions increase up to 213.81 MMMT by 2040. These reserves are calculated based on the projected additional delineated[34] reserves from supplemental exploration activities of converted COCs – from exploration to development and production phase. Apart from the SSCM permits that were issued, newly awarded COCs will also contribute to the additional reserves (Table 72). Once these additions are realized, total mineable reserves reach 692.05 MMMT in 2040.

Table 72. COAL RESERVES TARGET (Incremental Reserve), MT

Region	Short-Term (2018)	Medium- Term (2019-2022)	Long- Term (2023-2040)
IX	23,270,912	23,499,748	26,096,252
XI	1,422,748	1,972,748	3,582,748
XII	68,977,803	69,379,803	124,493,803
CARAGA	48,967,688	49,245,524	59,638,028
Total	**142,639,151**	**144,097,823**	**213,810,642**

Among the regions in Mindanao, the biggest additional reserves will come from Soccsksargen from 69.0 MMMT in 2018 to about 124.5 MMMT in 2040. Additional reserves are anticipated mainly from newly awarded exploration contracts resulting from the conduct of PECRs. Holders of SSCMP will also be sharing a substantial amount of reserves as 55 permits are expected to be issued within the planning period.

Production

Based on the work program of existing COC holders in Mindanao, a total of 470 MMMT of coal is expected to be produced during the short-term period, increasing to about 27,000 MMMT by 2040. Coal producers in Soccsksargen will provide much of the increase, from 1.0 MMMT in the medium-term, production is seen to significantly rise to 18.3 MMMT by 2040. Likewise, converted exploration contracts into the development and production stage is expected to provide the foreseen increase. (Table 73).

Table 73. COAL PRODUCTION TARGET, MT

Region	Short-Term (2018)	Medium-Term (2019-2022)	Long-Term (2023-2040)
IX	151,300	436,500	2,220,300
XII	17,200	85,800	678,100
XII	-	1,000,000	18,334,000
CARAGA	301,500	786,900	5,721,100
Total	**470,000**	**2,309,200**	**26,953,500**

[34] The amount of reserves agreed both by the DOE and the contractor.

In an effort to reduce its dependency on imported coal, government is putting emphasis on the rapid development of domestic coal resources, as well as the use of clean coal technologies so as to use coal in the cleanest possible way. Thus, the government in partnership with the private sector has been resolute in finding ways to gradually achieve the sector's goal of increased reserves and production by 2040.

For the aspirational target on coal to materialize, continued assessment of prospective coal resources in Mindanao will be a top undertaking of the DOE. Complementary efforts include the conduct of IEC campaigns among relevant stakeholders to strategize harmonization of coal projects with initiatives of other government agencies. This will not only help in fast tracking of coal projects but would also raise responsiveness on environmental and mitigation measures being adopted by the government on coal development.

Further, the DOE will continuously monitor timely completion of work commitments of existing COC/SSCMP holders relating to exploration, development and production activities. Pertinent regulations on health and safety in coal mines will also be formulated and implemented. Apart from this, administration of coal importation, exportation, registration of coal end-use and implementation of *DC No. 2012-05-0006*[35] will also be carried out to ensure that unauthorized and informal coal resource development, production and trading activities will be addressed.

To kindle economic activities in the coal industry sector, formulation of new policies and updating of existing guidelines will be prioritized. Fostering stronger cooperation and partnerships with both local and international stakeholders on coal operation and developments will also be pursued. Providing technical assistance to academe, LGUs, and COCs and SSCMP holders is another strategy that the DOE will be extending to strengthen further its relationship among the industry stakeholders.

RENEWABLE ENERGY

The passage of **Republic Act No. 9513 or the Renewable Energy (RE) Act in 2008** established the framework for the accelerated development and advancement of renewables, and the development of a strategic program to increase its utilization in the country.

Mindanao's economic landscape is ever evolving. To keep up with Mindanao's growth and increasing demand for energy, the acceleration, development, and utilization of renewable energy is essential to the region's agenda for clean, efficient and sustainable energy.

In accordance with the law, the Department of Energy (DOE) spearheaded the formulation of the National Renewable Energy Program (NREP), in consultation with its stakeholders. The NREP aims to triple the country's renewable energy capacity from 5,438 MW in 2010 to 15,304 MW by 2030. The program is aligned with the government's thrust to increase the country's energy self-sufficiency, ensure energy security, and promote sustainable development.

The NREP lays down the foundation for development of renewable energy in the country, stimulating investments in the RE sector, developing technologies, and providing the impetus for national and local renewable energy planning that will help identify the most feasible and least-cost renewable energy development options.

Given the dynamic nature of the country's energy sector, the NREP is a living document. Forecasts and targets will be updated periodically as key developments in the energy sector continuously emerge. Likewise, programs will be reviewed while deployment of RE projects will be monitored to ensure that stakeholders make good on their promise to deliver. Above all, partnerships will be enhanced to ensure a country-wide approach in developing the country's renewable energy resources.

[35] DC No. 2012-05-0006 Guidelines on the Accreditation of Coal Traders and Registration of Coal End-Users.

RE POLICY MECHANISMS

In order to spur the growth and expand the shares of renewable energy in the power generation mix, the following policy mechanisms were stipulated under the RE Act:

1. **Renewable Portfolio Standards (RPS).** Refers to a market-based policy that requires power distribution utilities (DUs), electric cooperatives (ECs), and retail electricity suppliers to source an agreed portion of their energy supply from eligible RE facilities.

   On 22 December 2017, the DOE promulgated the Philippine *On-Grid RPS Rules* which was published through Department Circular (DC) No. 2017-12-0015. Said rules, target to restore RE share in the power generation mix to 35% in MWh by 2030 up to 2040. During the first semester of 2018, series of IECs were conducted to facilitate the RPS compliance to the mandated sectors in preparation for its full implementation come 2020.

   On the other hand, to continue with the efforts of bringing clean and sustainable energy to far-flung areas, the proposed *RPS Rules for Off-grid* Areas will contribute to the growth of the renewable energy industry through increased development and utilization of RE resources in the countryside where a significant percentage is using expensive fuels. On 06 November 2017, the Mindanao leg of the RPS for Off Grid Areas public consultation was conducted. Among the issues discussed during the consultation include roles and responsibilities, pricing, competitive selection process and public bidding, monitoring and transparency, academic participation, long-term plans and programs, technology, transmission, permitting, relevant RE policies and even international commitments on greenhouse gas emission (GHG) reduction. Subsequently, the RPS rules for off-grid was promulgated on 24 August 2018.

2. **Feed-in-Tariff (FIT).** Under the FIT System, qualified project of emerging RE sources are offered at a fixed rate per kilowatt-hour (kWh) of their exported electricity to the distribution or transmission network. This scheme excludes the energy utilized from RE plants eligible for own use. ERC may review the FIT after three (3) years or if the installation targets have been met, whichever comes first.

Table 74. ERC APPROVED FIT RATES

Technology	Installation Target (MW)	First Tranche	Second Tranche
Run-of-River Hydro	250	Php 5.90/kWh	PhP 5.87/kWh**
Wind	200/200*	Php 8.53/kWh	PhP 7.40/kWh
Solar	50/450*	Php 9.68/kWh	PhP 8.69/kWh
Biomass	250	Php 6.63/kWh	PhP 6.60/kWh**

**Additional installation targets*
*** Degressed FIT rates (H&B-ERC Res1,2017)*

The installation targets of 400 MW for wind was fully subscribed last June 2015, while the 500 MW for solar was fully subscribed last March 2016. (Table 74). Meanwhile, the 250 MW installation targets for biomass and hydropower are still under-subscribed. In consideration for both under-subscribed technologies, the National Renewable Energy Board (NREB) and Renewable Energy Management Bureau (REMB) of the DOE recommended the completion of the said targets for two (2) years, from December 2017 to December 2019 or until fully subscribed, whichever comes first. Said recommendation was signed by the Energy Secretary and subsequently endorsed to the ERC for the determination of new FIT rates.

3. **Green Energy Option.** The GEOP is a mechanism which provides end-users with the option to choose RE resources in meeting their energy requirements through respective distribution utilities. The Mindanao leg in the series of public consultations on GEOP was conducted in Davao City on 12 September 2017. Some of the comments and suggestions raised during the consultation include:
   a) implementation details, including contracting timeline under the GEOP;
   b) sourcing of RE suppliers; and,
   c) incentives for RE developers under the RE law and cost component transparency towards consumers.

   On 18 July 2018, the DOE promulgated DC No. 2018-07-0019 titled, "*Promulgating the Rules and Guidelines Governing the Establishment of the Green Energy Option Program Pursuant to the Renewable Energy Act of 2008.*"

4. **Net Metering.** Allows customers of DUs to install an on-site renewable energy facility not exceeding 100 kilowatts (kW) in capacity so they can generate electricity for their own use. Any electricity generated that is not consumed by the customer is automatically exported to the DU's distribution system. The DU then gives a peso credit for the excess electricity received equivalent to the DU's blended generation cost, excluding other generation adjustments, and deducts the credits earned to the customer's electric bill.

As of 13 November 2018, a total of 2,186 end-users with a combined capacity of 17,183.17 kWp have availed of the Net Metering Scheme from various DUs in the country. In Mindanao, Zamboanga City Electric Cooperative, Inc. (ZAMCELCO), Misamis Oriental II Electric Cooperative, Inc. (MORESCO), Iligan Light and Power, Inc. (ILPI), Davao del Sur Electric Cooperative (DASURECO), Davao Light and Power Company, Inc. (DLPC) and Agusan del Norte Electric Cooperative, Inc. (ANECO) are already serving 36 net metering customers with a total combined capacity of 580.22 kWp (Table 75). With the promulgation of this scheme, there is a potential market to be developed for residential and commercial customers in Mindanao to encourage other electricity end-users to participate in the Net-Metering program of the government.

Table 75. STATUS OF NET-METERING (As of 31 May 2018)

Distribution Utilities	No. of Customers	Capacity (kWp)
ZAMCELCO	1	94.86
MORESCO	1	5.28
ILPI	5	37.63
DASURECO	2	35.00
DLPC	25	345.85
ANECO	2	61.60
Total	**36**	**580.22**

POLICY INITIATIVES

To enhance the promotion and development of RE sources, the DOE issued Department Order (DO) 2017-04-005 on 07 April 2017 titled *"Prescribing the New Guidelines in the Processing of Applications for Renewable Energy Service/ Operating Contracts."* The new DO supersedes DO 2016-06-0010 which further shortens the evaluation process and issuance of RESC from 45 working days to 25 working days. The RE-Review and Evaluation Committee (RE-REC) Secretariat allots one copy each of RE contract application to the Department's Legal Services, Financial Services, and Renewable Energy Management Bureau for the simultaneous one- day (upon receipt) legal, financial and technical evaluations.

To further implement the coordination of all bureaus and services concerned, the Department issued DO 2018-03-0003 titled, "*Creation of a Centralized Review and Evaluation Committee for the Purpose of Integrating the Current Committees Administering the Review and Evaluation of Renewable Energy, Petroleum, Downstream Natural Gas, and Coal Service Contract Applications, the Award, Amendment and Termination of Contracts,*" which was signed on 16 March 2018. The said DO creates a Centralized Review and Evaluation Committee (C-REC) for the management of energy projects on energy exploration, development, utilization, distribution and conservation.

BANGON MARAWI

Under President Duterte's directive to "Build Back Better" Marawi City, Secretary Alfonso Cusi created an inter-agency group to ensure the rehabilitation of energy facilities to fast-track the city's rebuilding process. The DOE turned over 400 solar-powered lamps to Task Force Bangon Marawi, while 131 solar-powered streetlights were turned over to Lanao del Sur Electric Cooperative, Inc. (LASURECO).

RENEWABLE ENERGY TECHNOLOGIES

Geothermal

As of December 2017, Mindanao has seven (7) potential geothermal power projects with an aggregate capacity of 80 MW, which could augment the supply for the grid, while at the same time promote clean energy for the island. These projects are located in Northern Mindanao, Davao and Soccsksargen regions with potential capacity of 20 MW, 40 MW and 20 MW, respectively, and are expected to be operational within the planning period (Table 76). The 30-MW expansion project in Mt. Apo Geothermal Production Field, an addition to the existing 108.48 MW installed capacity, is expected to be completed in December 2021. Likewise, one pending project in South Cotabato, the 60-MW Mt. Parker Geothermal Power project is awaiting completion of documentary requirements to be awarded a service contract.

On the other hand, the implementation of the locally-funded project titled, "*Comprehensive Resource Assessment of the Philippine Low Enthalpy Geothermal Areas,*" (CRAPLEGA) is a continuation of the "*Detailed Resource Assessment of Selected Low Enthalpy Areas in the Philippines,*" which started in 2011 and was completed in June 2015. The follow-

up project aims to conduct a detailed assessment of three (3) potential low enthalpy geothermal areas identified in previous field appraisals particularly for power generation application in the remote areas hosting the resource. This includes the Camiguin Province in Northern Mindanao. These resources may be developed for power generation, and for other applications in tourism and agricultural sectors.

Table 76. POTENTIAL GEOTHERMAL POWER PROJECTS in Mindanao

Region	Province	Project Name	Potential Capacity (MW)
X	Misamis Oriental / Bukidnon	Balatukan-Balingasag Geothermal Prospect	20.00
	North Cotabato / Davao del Sur*	Mt. Apo Geothermal Production Field	-
XI	Davao del Sur	Mt. Sibulan-Kapatagan Geothermal Power Project	-
	Compostella Valley	Amacan Geothermal Power Project	40.00
XI and XII	North Cotabato / Davao del Sur	Mt. Zion Geothermal Power Project	20.00
		Mt. Zion 2 Geothermal Power Project	-
	North Cotabato/Davao del Sur	Mt. Talomo-Tico Geothermal Power Project	-
Total			**80.00**

*Indicative Project

Development Challenges

There are challenges concerning geothermal energy development, which include:

a) environmental and socio-cultural concerns in protected areas and ancestral lands which affect investment decisions;
b) technical constraints with regard to acidic reservoir; and,
c) level of public awareness on the non-power applications of geothermal energy.

Hydropower

As the country is endowed with abundant hydropower resources, the government has intensified its efforts to cultivate and harness the untapped hydro power potentials. Among the major islands, Mindanao ranks second in hydropower potential and installed capacity. As of December 2017, a total of 15 awarded hydropower projects with total combined capacity of 78.39 MW are already operational and connected to the Mindanao grid.

Apart from these projects, 81 potential hydropower projects with estimated combined capacity of 1,012 MW are set to be in place within the planning period (Table 77). Bulk of these projects are situated in Northern Mindanao covering 12 sites with a total capacity of 353.58 MW.

Likewise, 21 mini-hydropower projects were also identified by the National Electrification Administration (NEA), National Power Corporation (NPC), Cumming Cockburn Limited (CCL), Gingoog Power Development Corporation (GPDC) and Misamis Mini-Hydro Electric Resources Corp. (MMHERC) with an aggregate potential capacity of 328.33 MW (Table 78).

Meanwhile, there are still 33 pending hydropower energy service contracts/applications in Mindanao with a total estimated potential capacity of 160.36 MW. Majority of these projects are found in Bukidnon, while others are in the provinces of Davao, South Cotabato, and Sultan Kudarat.

Table 77. POTENTIAL HYDROPOWER PROJECTS in Mindanao

Region	Province	No. of Sites	Potential Capacity (MW)
IX	Zamboanga del Sur	4	15.70
	Zamboanga del Norte	3	10.4
	Zamboanga City	6	4.25
X	Bukidnon	6	32.13
	Misamis Occidental	2	7.20
	Misamis Oriental	1	0.25
	Lanao del Norte	3	314.00
XI	Davao del Sur	4	11.70
	Compostela Valley	5	27.40
	Davao Oriental	15	179.70

Table 77. POTENTIAL HYDROPOWER PROJECTS in Mindanao

Region	Province	No. of Sites	Potential Capacity (MW)
	Compostela Valley/Davao Oriental	1	16.00
XII	North Cotabato	3	13.10
	Sultan Kudarat	1	110.00
	Sarangani	6	24.18
	South Cotabato	2	19.85
XII/CARAGA	Sultan Kudarat	2	15.00
CARAGA	Agusan del Norte	3	9.00
	Surigao del Sur	5	30.84
	Agusan del Sur	6	44.30
ARMM	Lanao del Sur	3	127.00
Total		**81**	**1,012.00**

Table 78. POTENTIAL MINI-HYDROPOWER PROJECTS

Region	Province	Potential Capacity (MW)
IX	Zamboanga del Norte	10.36
	Zamboanga del Sur	10.16
X	Misamis Oriental	51.04
	Bukidnon	26.34
	Camiguin	3.21
	Misamis Occidental	4.43
XI	Davao del Norte	11.76
	Davao Oriental	4.58
	Davao del Sur	12.72
	South Cotabato	43.49
XII	North Cotabato	31.63
	Lanao del Norte	3.80
	Sultan Kudarat	2.53
ARMM	Maguindanao	3.58
	Lanao del Sur	4.69
	Basilan	1.00
	Sulu	0.13
CARAGA	Agusan del Sur	20.92
	Agusan del Norte	27.14
	Surigao del Norte	14.56
	Surigao del Sur	40.26
Total		**328.33**

Note: Potential projects are identified by NEA/NPC/CCL/GPDC and MMHERC

Development Challenges

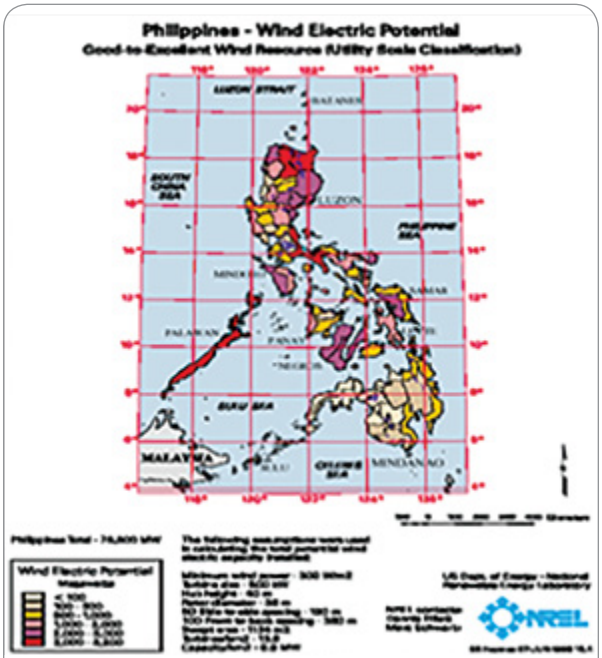
Major challenges encountered in harnessing hydro power resources are:

a) the resource is location specific and limited only to certain areas;
b) season-dependent which must take into account the design to avoid shutting down the plant due to insufficient water supply in the dry season; and,
c) high upfront investment for the development and operation of large hydropower plants.

Wind

The country's wind energy sector has significant potential and could augment the country's power capacity especially in Mindanao. In 2014, the National Renewable Energy Laboratory (NREL) of the United States–Department of Energy presented a wind resource assessment and geospatial tool kit to help investors identify windy land areas

in the country which could theoretically give excellent wind resource potential for the country. Under a subcontract AGG-3-23372-01 titled "Mapping the Philippines," the NREL produced a large wind resource dataset, which includes gridded raw Meteorologist Weather Processor (MWP), gridded wind resource data, time series at select locations for validation purposes, and 15 years of gridded monthly wind speed anomalies to facilitate analysis and planning for wind energy development in the Philippines. Based on the assessment, Northern Mindanao holds the most potential to develop wind power projects in the island. Consequently, the DOE continues to conduct wind resource assessments for possible sites in Mindanao. However, Mindanao has low potential on wind development based on the existing technology, while electricity tariffs are considered low brought about by the Agus-Pulangui, which was found part of PSALM's portfolio of generation facilities. Taking advantage of wind resources will eventually lead to better means of energy and also a great way to mitigate climate change. There are also potential wind projects in the provinces of Agusan del Sur, Agusan del Norte and Surigao del Norte.



www.google.com.ph/renewable Energy Resources-Library-index-GlobalEnergy

Table 79. POTENTIAL SOLAR PROJECTS in Mindanao

Region	Location	Plant	Potential Capacity (MW)
X	Misamis Oriental	Tagoloan Solar Power Project	13.14
		Bulua Solar Power Project	0.50
		Iponan Solar Power Project	0.50
		Gingoog City Solar Power Project	10.00
		Laguindingan Solar Power Project	40.00
		Laguindingan Solar Power Project	20.00
		Claveria Solar Power Project	61.10
	Bukidnon	Manolo Fortich Solar Power Project	60.00
	Lanao del Norte	Iligan Solar Power Project	0.03
XI	Davao del Sur	Darong Solar Power Project	35.00
	Davao Oriental	Davao Oriental Solar Power Project	60.00
	Davao del Norte	Tagum Solar Power Project	0.84
XII	South Cotabato	South Cotabato Solar Power Project	20.00
		Mabuhay Solar Power Project (Phase I)	44.00
		Conel Solar Power Project (Phase II)	16.00
	Sarangani	Alabel Solar Power Project	15.00
		Alabel Solar Power Project	160.00
CARAGA	Agusan del Norte	Butuan City 1 Solar Power Project	10.00
ARMM	Lanao del Sur	ICOM Solar Power Project	50.00
	Maguindanao	Maguindanao Solar Power Project	20.00
Total			**636.11**

Solar

Solar energy can be used almost anywhere in the country. As an alternative to fossil fuels, solar energy helps reduce the country's carbon footprint. In the past years, the price of solar panels and improvements of the technology have allowed solar energy to be more competitive against conventional energy. As of December 2017, about 20 solar power projects with a total capacity of 636.11 MW are available to be tapped within the planning period. The biggest solar power projects are located in Northern Mindanao and Soccsksargen within the provinces of Misamis Oriental and Sarangani, respectively.

On the other hand, 12 pending solar energy service contracts applications in Mindanao are awaiting completion of documentary requirements, with estimated potential capacity of 161.50 MW. Most of these projects are located in Northern Mindanao in the provinces of Bukidnon and Misamis Oriental.

Development Challenges

One major factor affecting large-scale solar power plants is the land requirement. Estimated pit land area requirement at approximately one square kilometer for every 20-60 MW solar capacity. Other challenges include:

a) intermittency of the resource;
b) high initial cost;

c) research and development; and
d) capacity building on the latest technological developments.

Ocean

The Philippines being an archipelago is blessed with vast ocean resource potential. In Mindanao, one potential ocean energy project is seen in Surigao del Norte, with a potential capacity of 6.0 MW[36]. As of December 2017, Gaboc Channel Ocean Energy Project is still undergoing the permitting process and studies.

The DOE shall intensify efforts to assist potential investors in the exploration and development of the untapped ocean energy resource potential. To further harness this resource, a comprehensive program for research and development needs to be formulated together with capacity building activities, and close coordination and cooperation with local and international institutions for technology development. The DOE would also monitor developments and international trends, domestic and abroad, to identify opportunities for technology development, as well as the establishment of standards and best practices to further develop the ocean energy potential.

Biomass

Biomass energy is derived from organic matter of plants and animals. Biomass in the form of dead plants, trees, grass, leaves, crops, and animal waste can be a great source of alternative fuels that can be used to replace fossil fuels. As a renewable source of energy, five (5) biomass energy projects in Mindanao (as of December 2017) have come online, four (4) of which are grid-connected and one is for own-use. These projects have a combined installed capacity of 81.80 MW located in the provinces of Bukidnon and Maguindanao. Further, there are pending biomass projects with an aggregate capacity of 33.19 MW. Majority of these projects are located in South Cotabato.

Despite such potential, several challenges that biomass energy developers face include:

a) high feedstock cost;
b) competing land uses;
c) alignment of DOE's position with policies related to forestry and forestry-based activities;
d) standards and best practices for sustainable feedstock supply; and
e) environmental compliance for waste to energy.

Biofuels

The passage of Republic Act (R.A.) 9367 or the *"Biofuels Act of 2006"* mandates the use of biofuels and establishes the **National Biofuels Program** to ensure a sustained investment climate for production, distribution, and utilization of biodiesel and bioethanol.

With the current 2.0 percent level of blending requirement for biodiesel and 10.0 percent for bioethanol, the DOE conducts vehicle performance evaluation using higher blend of biofuels. This is in anticipation of an increase in blend requirement for both biofuels in the future. As a start-up activity, an actual on-road and performance testing using B2 for baseline data (2,000km) and B5 (initial – 2,000 kms of 30,000 kms) were conducted for brand new vehicles on 11-15 April and 18-22 July 2016.

In September 2017, the DOE, together with the National Biofuels Board (NBB)-TWG conducted the second-run of the actual on-road and performance testing using B5 for the remaining targeted 28,000 kms. Implementation of Memorandum of Agreement (MOA) between the DOE and Technological University of the Philippines (TUP) on the testing of 5.0 percent and 20.0 percent biofuels blend for in-use vehicles as well as road testing validation will be a major activity during the planning period.

Production and Sales. About 20.2 percent of the country's total production of biodiesel (registered at 219.6 million liters in 2017) came from the Mindanao region. Such production level increased by 138.5 percent from 2014 level production of 18.56 million liters (Table 78).

Table 80. BIODIESEL PRODUCTION in Mindanao (Million Liters)

Year	Production	Sales
2014	18.56	17.78
2015	33.26	35.33
2016	36.33	39.89
2017*	44.26	47.22

** Full year 2017*

Fuel sales likewise shown positive improvement over the last four (4) years. From 17.9 million liters biodiesel sales in 2014, it rose by 165.6 percent registering total sales of about 47.2 million liters in 2017. (Table 80).

Although there are no bioethanol plants in Mindanao, the implementation of the National Biofuels Program has been cascaded down to the island as postulated in the Biofuels Act. Hence, the 10.0 percent bioethanol blend requirement based on volume of gasoline will always be available in the petroleum retail market.

Capacity. From the total registered capacity of 584.9 million liters of biodiesel produced in the country, Mindanao provides 17.0 percent share from the four accredited biodiesel producers in Mindanao region namely;

(1) Bioenergy 8 Corp.,
(2) Freyvonne Milling Services,
(3) Phoenix Petroleum Philippines, Inc., and
(4) Econergy Corp.

[36] Not considered in the supply mix scenario

Table 81 shows the accredited producers with their respective annual production capacity totaling to 99.60 million liters.

Table 81. LIST OF AWARDED BIODIESEL PRODUCERS, (Million Liters)

Biodiesel (CME) Producers	Location	Registered Capacity	Feedstock
Bioenergy8 Corp.	Sasa, Davao City	30.00	Coconut Oil
Freyvonne Milling Services	Torii, Davao City	15.60	Coconut Oil
Phoenix Petroleum Philippines, Inc.	Villanueva, Misamis Oriental	24.00	CNO
Econergy Corp.	General Santos City	30.00	Cochin Coconut Oil
Total		**99.60**	

To further increase production capacity, the DOE issued a Certificate of Registration with Notice to Proceed to two new biodiesel producers in Misamis Oriental, Northern Mindanao. The *Bio-Renewable Energy Ventures* has a registered production capacity of 75 million liters and the *Archemicals Corporation* with a capacity of 15 million liters (Table 82). Both will be producing coco-methyl ester (CME) derived from coconut oil. When these plants commence their production, total biodiesel production capacity in Mindanao increases to 189.6 million liters from the existing 99.60 million liters.

Table 82. NEW BIODIESEL PRODUCER ISSUED A CERTIFICATE OF REGISTRATION WITH NOTICE TO PROCEED, (Million Liters)

Biodiesel (CME) Producers	Location	Registered Capacity	Feedstock
Bio-Renewable Energy Ventures, Inc. (Under the name and Style of Biorev)	Jasaan, Misamis Oriental	75.00	Coconut Oil
Archemicals Corporation	Tagoloan, Misamis Oriental	15.00	Coconut Oil
Total		**90.00**	

The DOE has come up with a roadmap that will facilitate the nationwide implementation of the scheduled blending requirement of biofuels from 2017 to 2040 in compliance with the Biofuels Act as shown (Table 83)

Table 83. BIOFUELS TARGET

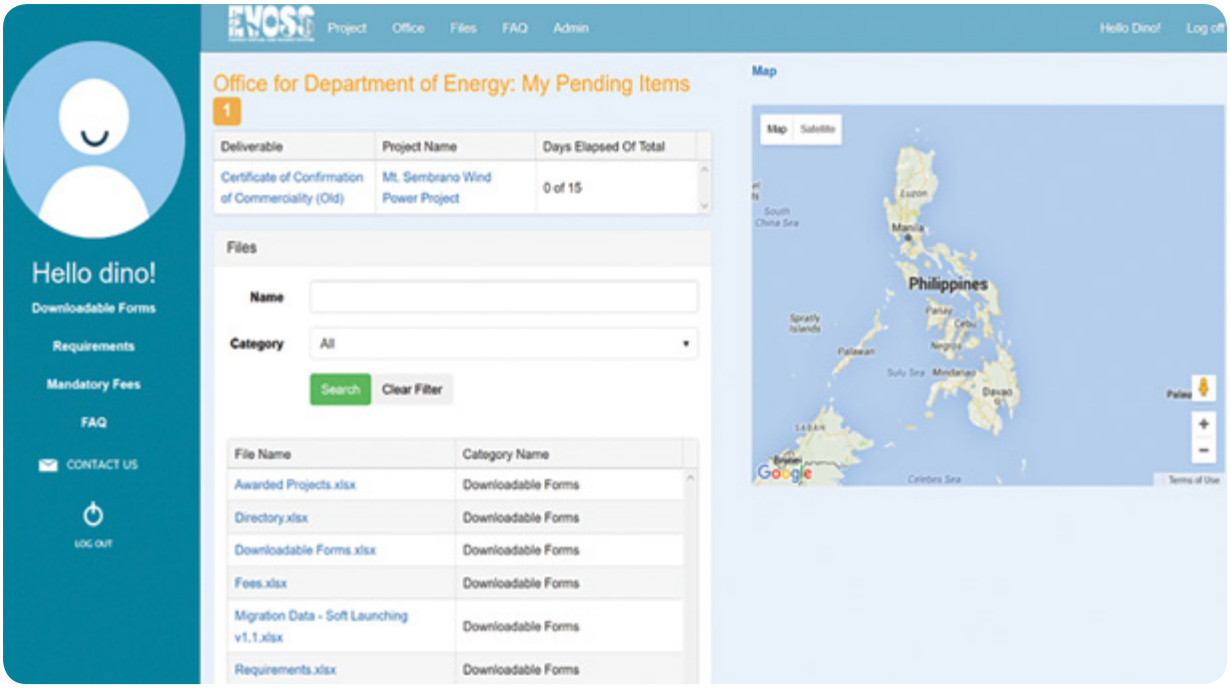
Alternate Fuel	Short-Term (2017-2019)	Medium-to-Long Term (2020-2040)
Biodiesel (B2)	Maintain 2% Biodiesel blending on diesel	• Revisit blending requirement and available feedstock • Continuous conduct of research and development on feedstock sources
Bioethanol (E10)	Review the bioethanol mandate	

Biodiesel is seen to maintain its current 2.0 percent blend level, while bioethanol at 10.0 percent blend during the short-term period (2017-2019). In the medium- to long-term (2020-2040) period, the DOE together with the NBB will be revisiting/re-evaluating the blending requirement with due consideration on the availability of feedstock. Continuous conduct of research and development of biofuels feedstock sources will also be undertaken to take full advantage of its fuel potential.

Energy Virtual One Shared System (EVOSS)

In line with the government's intent to improve its world ranking in terms of doing business, the DOE developed the EVOSS. EVOSS is a web-based monitoring system for energy applications and a repository of project-related information and permits issued which shall be shared by all agencies involved in the approval process of energy applications. More specifically, EVOSS aims to facilitate and streamline business processes, create an environment of transparency and accountability, and cut down transaction costs through harmonization of forms and process to increase efficiency in the bureaucracy. As of December 2017, there are 800 uploaded renewable energy awarded projects and 292 registered users in EVOSS.

On the other hand, with the aim to further improve the internal monitoring of applications, the DOE is now pilot-testing the use of the Radio Frequency Identification (RFID) Monitoring System to track the movement of applications (initially for renewable energy projects) within the Department. Currently, there are 150 applications from proponents



in the RFID system. This will later on interphase with EVOSS to provide the status of the actions taken by the DOE on the expected deliverables.

With the continuous cooperation and valuable contribution of the concerned government agencies and energy project developers, EVOSS (www.evoss.ph) is now up and running being of service to its stakeholders and the public.

V.

ALTERNATIVE FUELS AND EMERGING TECHNOLOGIES

With rising cost of conventional fuels and the corresponding drawbacks in terms of effects to the environment, the use of ***alternative fuels and technologies*** *is now shaping the future of energy development. The Department's focus is fuel diversification and transformation of mass transportation to green and efficient vehicles to further enhance the country's energy supply security.*

Implementation of programs that promote the use of alternative fuels as well as new and advanced energy technologies is currently a major thrust of the DOE to effectively manage the country's utilization of energy resources, especially in the transport sector.

Putting this thrust on board, the DOE has enabled the implementation of a locally funded project – the *"Alternative Fuels for Transportation and Other Purposes"* to introduce alternative fuel vehicles and promote emerging and advanced energy technologies. The project encourages cooperation and private sector investments to maximize the benefits of alternative fuels on the country's transportation system. It also supports the government's environment sustainability strategic goal while aiming for the efficient deployment of alternative fuels.

The Project's core activities include the following:

(1) conduct of Information, Education and Communication (IEC) campaign activities to increase public acceptance of locally available alternative fuels and energy technologies;
(2) identification, validation and assessment of new and advanced alternative fuels;
(3) adoption, review and update of necessary policies and enabling mechanisms; and,
(4) Strengthen partnership and collaboration with academic/research institution, national government agencies and sectoral stakeholders.

Ensuring that this national initiative is cascaded down to the regional level, seven (7) IECs were scheduled in Mindanao for 2018. To date, IECs were done in *Bislig, Surigao* on 16 January, Malaybalay, Bukidnon on 01 February, and Kidapawan, North Cotabato on 27 February, which was in partnership with the Philippine Information Agency (PIA). For the remaining quarters of the year, IECs will also held in Prosperidad, Agusan Del Sur and in Dipolog and Ozamis Cities in Zamboanga del Norte.

A total of 151 Participants from Academe, LGUs, Barangay Officials and Transport Group attended the IEC campaign on Alternative Fuels Program in Kidapawan City, North Cotabato held on 27 February 2018

AUTO-LPG

Determined to mainstream auto-LPG as a cleaner alternative fuel for public transport to replace gasoline or diesel, an interim inter-agency Auto-LPG Technical Working Group (TWG) was officially institutionalized in June 2016 through the adoption of the Joint Administrative Order (JAO) No.1 Series of 2016 titled *"Creating the Inter-Agency Technical Working Group on the Use of Auto-LPG as Fuel for Public Transport and for Other Related Purposes."* The TWGs will be established in key areas of Luzon, Visayas and Mindanao with the objective of harmonizing all auto-LPG related policies, rules and guidelines, and develop a mechanism for collaboration, cooperation and coordination among member government agencies for the effective implementation of the Auto-LPG Program. An exploratory meeting is scheduled in October 2018 with the regional offices of member agencies for the establishment of a TWG.

Further, the DOE has partnered with State Universities and Colleges (SUCs), such as the *University of Southeastern Philippines (USeP)* in Davao City to integrate the Auto-LPG Technician Curriculum in its technical and vocational course offerings for the purpose of providing a steady pool of experts and capable technicians to serve the repair and maintenance needs of the auto-LPG vehicles. Likewise, the DOE has collaborated with the *Central Mindanao University (CMU)* in Bukidnon on the characterization of local Napier Grass to replace wood-based fuel for domestic cooking. On top of these, DOE conducts nationwide stakeholders-focused IEC campaign and scientific studies on performance test, and health and hazard assessment with the goal of formulating and espousing safety related rules, regulations and standards to address the negative public perception issue on the use of Auto-LPG.

PLANS AND PROGRAMS

Moving forward the widespread utilization of auto-LPG in the transport sector, various undertakings have been identified to take off during the planning period. For the near term, harmonization of policies among national government agencies on auto-LPG will be strengthened with the establishment of TWGs. The existing Philippine National Standard 05 s.1983, otherwise known as the Code of Practice on the Use of LPG in Internal Combustion Engines, will also be reviewed and updated. The DOE will encourage international manufacturers to make available in the local market the original equipment manufacturer (OEM) LPG-vehicles and develop high-performance LPG prototype for jeepneys.

And to properly safeguard auto-LPG consumers, the Emergency Response Protocol for auto-LPG fueled vehicles will be formulated and complemented with the comprehensive health-hazard assessment/studies on the use of LPG in vehicles.

Forming part of the DOE's long term-plan is the conduct of research and development on the expanded applications of LPG in other sectors including agriculture (farming and fishing sub-sectors). A legislation providing incentives for the importation and/or manufacturing of original manufactured LPG-fueled vehicles will also be advocated within the planning horizon. This will be supported with the development of rules and guidelines to encourage the establishment of support infrastructure, such as auto-LPG refilling stations, after-sales services and manufacture of parts.

E-VEHICLE (EVs)

In support of President Duterte's directive of *Rebuild Back Better* in Marawi City (Lanao del Sur), the DOE and the T*ask Force Bangon Marawi* (TFBM) signed a Memorandum of Understanding (MOU) for the donation and deployment by the DOE of 200 e-trike units to Marawi City. Said MOU was signed in January 2018 to establish cooperation and facilitate the delivery and implementation of the project. This served as the DOE's contribution to the on-going efforts of government to rehabilitate and recover the war-stricken city which was devastated causing the subsequent crippling of its public transportation service.

Marawi City Mayor Majul Gandamra, TFBM Chairman Eduardo del Rosario and DOE Secretary Alfonso G. Cusi signed the MOU for the donation of 200 e-trikes to Marawi City on 12 January 2018 at the DOE-Audio Visual Room in Taguig City.

Subsequently in March 2018, the DOE and the LGU of Marawi City, headed by Mayor Majul Gandamra signed the Deed of Donation (DOD) for the donation of the 200 e-trikes to Marawi City. Initially, 10 e-trike units were delivered to Marawi City in June 2018 and were utilized during the conduct of the drivers and technicians' training in partnership with the Development Academy of the Philippines (DAP), LGUs, TESDA-Lanao del Sur and Uzuzhio/ BEMAC Electric Transportation Philippines Incorporated. The project is being funded under the loan agreement with Asian Development Bank (ADB) entailing PhP 91.2 billion of investment. It is expected that by May 2019, the project will be completed.

Exemption from Excise tax

The government has provided financial incentives to plug-in electric vehicles (EVs) to consumers through the newly enacted Tax Reform for Acceleration and Inclusion Law or TRAIN Law. Section 9e of the law provides that purely electric vehicles shall be exempted from the excise tax on automobiles, while hybrid vehicles will be subjected to 50.0 percent of the applicable excise tax rates on automobiles. Prior to the removal of the automobiles from the manufacturing plant or customs custody, the DOE will determine whether the automobiles are pure electric vehicles or hybrid vehicles and furnish the Bureau of Internal Revenue (BIR) the certified copies of the results of such examination or endorsement to that effect. The exemption is expected to pave the way for more affordable EV models and increased investment in support infrastructure that will help sustain the drive for electric mobility.

PLANS AND PROGRAMS

The DOE will continuously monitor emerging energy technologies, such as EVs for domestic application/adoption. These energy technologies, considered mature in developed countries and proven to be efficient, may be considered for evaluation and adoption for domestic application in other sectors of the economy.

Providing the enabling environment like preferential franchises for EVs will also be part of DOE's short-term plan. To provide loan facilities to consumers who would like to manufacture alternative fuel vehicles, linkages with the Land Bank of the Philippines (LBP) and other financial conduits, such as rural banks, transport cooperatives, multi-purpose cooperatives will be established.

The DOE will also facilitate the establishment of minimum performance and non-discriminatory regulations for EVs and charging stations, as well as improve the value chain through the development of training modules for drivers and operators on the safe use in partnership with TESDA. In addition, the Department will advocate the passage of legislations that will bring down the cost of electric vehicles acquisition, either through importation for the initial market penetration and sourcing out locally in the medium-term.

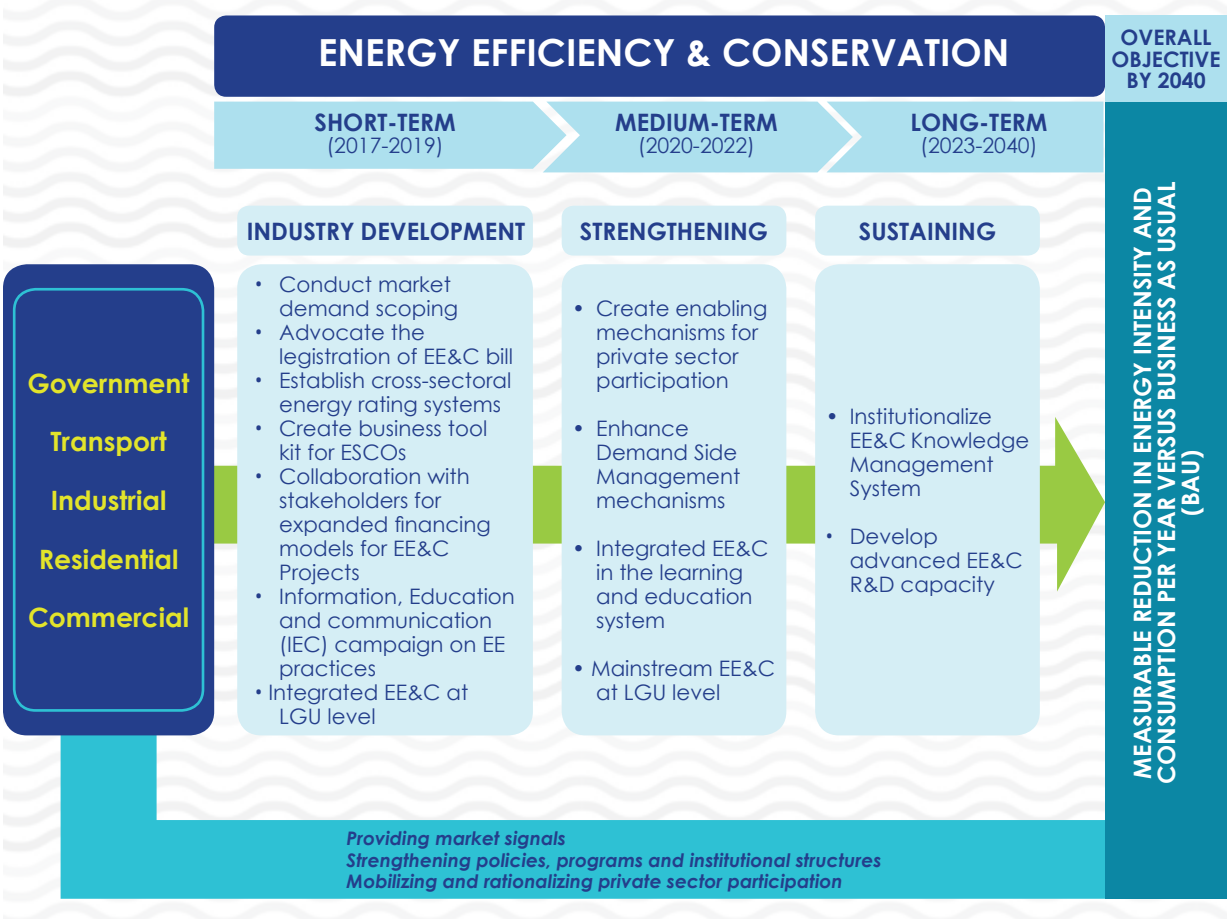
To continuously support the rehabilitation of the war-stricken Marawi City, the DOE, in coordination with the TFBM, BEMAC, LGUs of Marawi City and the Philippine Navy will facilitate the delivery and other logistical requirements of the remaining 190 e-trike Units to Marawi City.

VI. ENERGY EFFICIENCY AND CONSERVATION

With the growing use of energy in every sector of the economy, the use of energy efficient technologies is becoming more important than ever. From energy efficiency and conservation (EE&C) initiatives, the country can earn the triple benefits of using clean energy sources, promoting environmental sustainability and supporting economic growth. However, the challenge of every economy lies in maximizing energy efficiency as a hidden energy resource that can even form part of the energy supply mix.

To put energy efficiency at the forefront of priorities, the DOE has initiated the development of an Energy Efficiency and Conservation Roadmap, in fact the first sector roadmap that was developed by the DOE. The Roadmap, considered as the blueprint for the implementation of EE&C initiatives in the country, phased its action plans based on short-, medium-and long-term goals. It outlines the DOE's objectives for EE&C in the country, namely: industry development, strengthening and sustaining across the government, transport, industrial, residential and commercial sectors.

Figure 45. ENERGY EFFICIENCY AND CONSERVATION ROADMAP



Source: DOE, PEP 2017-2040

Central to this Roadmap is the anticipated approval of the Energy Efficiency and Conservation Law that would serve as the framework to boost the use of energy efficient technologies in the country. Said measure seeks to encourage the efficient use of energy and other modes of demand-side management. It also seeks to ensure that energy is produced and utilized in a manner that will promote sustainable development and support the government's goal of fueling economic activity and growth in pursuit of "*Ambisyon 2040*." On 30 January 2019, the Bicameral Conference

Committee approved the Bill titled: ***"An Act Institutionalizing Energy Efficiency and Conservation, Enhancing the Efficient Use of Energy, and Granting Incentives to Energy Efficiency and Conservation Projects."***

The EE&C Roadmap also looks into the following measures:

(a) conduct market scoping;
(b) advocate legislation for the Energy Efficiency and Conservation Bill;
(c) Establish cross-sectoral energy performance and rating systems;
(d) facilitate promotion of Energy Service Companies (ESCOs) activities;
(e) collaborate with stakeholders for expanded financing models for EE&C projects;
(f) conduct information, education and communication (IEC) campaign on energy efficiency practices; and,
(g) integrate EE&C at the local government units (LGUs) level.

The overall objective of attaining reduction in the country's energy intensity and consumption by 2040 will be realized through a change in the individual habits of Filipinos in terms of using energy, as well as the application of the latest technologies. The Roadmap is designed to provide clear direction for the energy sector towards cost effective opportunities for energy savings and emission reduction. And it is within the vision of the DOE that all of these initiatives will be implemented on a nationwide scale to ensure the country's full uptake of EE&C opportunities

Although conservative in terms of energy consumption (with only a 14% share in the country's total energy consumption in 2017), Mindanao's energy demand is expected to grow annually at 6.3 percent in high growth scenario (HGS) and 5.0 percent in low growth scenario (LGS) during the planning period (2017-2040). Under the "Build, Build, Build" Program of the government, the island will be a beneficiary of around PhP100 billion worth of infrastructure projects which include a railway project, bridges, airports and irrigation projects. These are expected to stimulate the island's growth in the short-term and support the development of a competitive economy in the long-term. The implementation of the EE&C Roadmap in Mindanao will help ensure that the island's economic targets are realized on time.

National Energy Efficiency and Conservation Program (NEECP)

As part of the effective implementation of the EE&C Roadmap, the National Energy Efficiency and Conservation Program (NEECP) which intends to make energy efficiency and conservation a way of life for every Filipino is continuously being implemented. The NEECP is a two-pronged program consisting of power conservation and demand management and fuel efficiency and conservation programs, which are intended to be implemented nationwide. In support of NEECP, the DOE conducted an energy audit of energy facilities. Several NPC-Small Power Utilities Group (SPUG) diesel-power plants (DPP) and private–owned DPP all throughout the country were visited to improve efficiency. In Mindanao, one DPP in Davao del Norte (Talicud DPP) was audited for performance assessment of its generation system facility. This initiative was conducted, in partnership with the European Union – Access to Sustainable Energy Programme (EU-ASEP).

To promote sustainable energy management system and achieve energy efficiency best practices within the Philippine industrial setting, the DOE and the Department of Trade and Industry (DTI), with technical assistance from the United Nations Industrial Development Organization (UNIDO) and in collaboration with the Department of Science and Technology (DOST), jointly undertook the implementation of the Philippine Industrial Energy Efficiency Project (PIEEP). The PIEEP under the Project Management Unit (PMU) conducts energy management activities for industries based on ISO 5001 Energy Management System (EMS) Standard Framework for Philippine industries along with system optimization approach specifically on steam, compressed air, and pumping systems. This is to improve industrial companies' energy efficiency levels through the provision of awareness workshops and capacity building activities for the manufacturing companies. To date, there are different levels of project implementations covering several areas nationwide under component 1 (EMS). For Mindanao, the EMS was introduced in November 2018 in Cagayan de Oro during the training course for trainers on energy auditing for energy efficiency and conservation for state universities. Around 23 attendees coming from the different regional government institutions and universities participated in the activity.

For the continued and effective implementation of EE&C programs, the DOE conducted IECs nationwide primarily aimed at mainstreaming the EE&C at the local government level. In Mindanao, a mainstreaming activity was conducted in Davao City through a workshop designed for the LGUs to recognize the value of integrating and mainstreaming EE&C in all energy-demand sectors. The activity likewise included identification of programs, projects, and activities for the efficient use and conservation of energy, and preparation of EE&C action plans and proposals focusing on the formulation of policies and/or ordinances for EE&C mainstreaming.

VII. DOWNSTREAM DEVELOPMENT

OIL INDUSTRY

The deregulation of the Downstream Oil industry through Republic Act No. 8479 or the Downstream Oil Industry Deregulation Law in 1998 provides a truly competitive market through fair prices, adequate supply of environmentally clean and high quality of petroleum products. It created a free market atmosphere encouraging other players and investors to join the downstream oil sector which include among others, oil refineries, petrochemical plants, petroleum products distributors, and retail outlets. It also encompasses processing, product distribution and marketing of petroleum products, such as gasoline, diesel, jet fuel, heating oil, asphalt, lubricants, synthetic rubber, plastics, fertilizers, antifreeze, pesticides, pharmaceuticals, natural gas and propane.

Under RA 8479, the Department of Energy (DOE) monitors and publishes the daily international crude oil prices and the movement of domestic oil prices for the information of the public. The DOE likewise monitors the quality of petroleum products in compliance with the Philippine National Standards (PNS), and refining and manufacturing processes of local petroleum products to ensure clean and safe technologies are applied, and maintain a periodic schedule of present and future total industry inventory of petroleum products to determine level of supply. In times of national emergency, when the public interest so requires, the DOE may, under reasonable terms prescribed by it, temporarily take over or direct the operation of any person or entity engaged in the Industry. The DOE, in collaboration with other government agencies and private stakeholders, has established several programs to boost additional investments in the bulk and retail market.

OIL SUPPLY

The global oil market remains vulnerable to a wide range of risk factors, including natural disasters, major technical accidents, and geo-political tensions. As a net importer of oil, it is vital to ensure a sustainable supply of high quality and right quantity petroleum products in the country. As oil is expected to remain a major component of global energy demand for the coming decades, particularly for the transportation sector, maintaining the strategic oil stockpiling continues to remain an essential part of oil supply security.

Since the country's oil requirement is practically sourced from other countries, local supply is basically vulnerable as we have no control over the factors that may affect it. This makes the oil contingency plan a necessity. The existing plan should be periodically updated to reflect the changes in supply/demand parameters and applicable scenarios and schemes to mitigate a reduction in supply, such as in emergency situations brought about by natural and man-made disasters.

In the 2017 Oil-Supply Demand full-year report, the December 2017 actual crudes and petroleum products inventory closed at 20,363 thousand barrels (MB) or 46-day supply equivalent, composed of 37 days for crude oil and products in country stocks and nine (9) days in-transit. This was lower by 1.8 percent from December 2016's 20,742 MB.

The government continues to enforce the Minimum Inventory Requirement (MIR) given the continuing risks faced by the downstream oil industry sector, such as geopolitical instability and supply delivery problems to areas affected by calamities (e.g. typhoon, flood, earthquake). Current MIR for refiners in-country stocks is equivalent to 30 days while 15 days stock is required for the bulk marketers and seven (7) days for the LPG players.

Further, in response to the emergency situation brought about by extremism and terrorism in Marawi City, the DOE intensified its monitoring of the bulk oil supply status in Mindanao to ensure continuous and adequate supply of petroleum products in the area.

CONSUMER PROTECTION

Due to rising concerns over methanol blends, the DOE conducted various inspections and sampling of liquid petroleum products in various gasoline stations and retail outlets nationwide. Said activities are part of the DOE's measures to ensure the compliance of energy players with existing national standards.

Vigilant Watch on Tax Reform for Acceleration and Inclusion (TRAIN) Oil Excise Taxes

The DOE's efforts to ensure that the imposition of the new excise tax rates on petroleum products under the TRAIN Law in the industry would be fairly and responsibly implemented by all the participants.

Even before the passage of the TRAIN Law, the DOE continues to safeguard consumers' welfare by meeting the industry stakeholders for guidelines, providing advisories to the public, conducting random inspections, data gathering and reviewing the inventory, examining the paper trail, as well as issuing show-cause orders to retail outlets that raised prices before January 15, the projected average period for exhaustion of old inventory.

Also, the DOE directed oil companies to:

(1) duly submit notarized inventory report as of 31 December 2017, on per depot and per product basis for effective monitoring;
(2) impose the excise tax under TRAIN Law only after the 31 December 2017 stocks of finished products are fully exhausted;
(3) submit the daily summary of withdrawal starting 1 January 2018 until the depletion of the declared inventory as of 31 December 2017, supported by the Official Registry Book (ORB); and
(4) advise their retailers to post in a conspicuous area, for transparency, notice of new excise tax implementation under the TRAIN in a signage measuring one (1) meter by 1 meter in size.

TRAIN Law Mitigation

To help mitigate the impact of the imposition of the new excise tax rates on the commuting public, the DOE also held talks with several oil companies to provide, renew, and/or to expand their discount mechanisms to public utility vehicle (PUV) drivers.

As a result of these talks, the DOE in partnership with several oil companies signed a Memorandum of Agreement (MOA) to provide fuel discounts to public utility vehicles (PUVs) as part of their Corporate Social Responsibility (CSR). The CSR programs will expand oil companies' existing discount programs for Public Utility Jeepneys (PUJs), which include the increase in the number of participating retail stations, higher discounts and inclusion of other PUVs. In addition, oil companies will provide a designated lane for PUVs and additional privileges and other promotional offers to the drivers of PUVs.

NEW STANDARDS FORMULATION

The DOE drafted and endorsed to the Department of Trade and Industries-Bureau of Product Standards the new Philippine National Standard (PNS) for automotive and industrial diesel products automotive and industrial diesel oil in compliance with the standard specification under the Philippine Clean Air Act. Said standards aim to improve diesel quality for cleaner and efficient fuels sold in the market.

PNS/DOE Quality Standard: 004:2017

The improved PNS/DOE Quality Standard (QS): 004:2017 on coco-methyl ester (CME)-blended Automotive Diesel Oil Specification contains revised technical provisions to upgrade the fuel quality requirement (such as reduced sulfur content limit in compliance with Euro-4 emission standard) and test methods for more accurate evaluation of fuel quality.

PNS/DOE Quality Standard 08:2017

The proposed standard is an update/ review of PNS/DOE QS 008:2012 mainly in line with the January 2016 implementation of the Euro 4-PH specification for the sulfur requirement of 50 ppm, maximum in gasoline fuel as well as updating the test methods.

Signing of the Final Draft of E-Gasoline PNS (PNS/DOE Quality Standard 008:2017)

PNS/DOE Quality Standard 013:2017

The upgraded PNS/DOE QS 013:2017: CME-Blended Industrial Diesel Oil Specifications include introduction of cetane number or derived cetane number as new property, removal of distillation property, reduction in the limit of carbon residue, increase the limits of density, flash point and kinematic viscosity and updating of test method.

NEW POLICY INITIATIVES

Addressing the Filipino's sachet culture and adulterated fuels or "Bote-bote"

The sale of gasoline and diesel using inappropriate containers to motorboats, tricycles and jeepneys by illegal peddlers or the so-called "*bote-bote*" system, specifically in rural areas may be suppressed or even eliminated with the crafting of new policies to further strengthen the country's downstream oil industry.

To help fill the gap and to serve the unserved market, the DOE has promulgated Department Circular (DC) 2017-11-0011 otherwise known as the "Revised Retail Rules" which intends to safeguard the welfare of the consumers against unsafe and substandard method of retailing liquid petroleum products. It promotes Technology-solution Retail Outlet, which is a result of emerging technologies that will address the fuel requirements of those catered by the "*bote-bote*" in a safe manner. The DOE is enforcing this rule in coordination with the Bureau of Fire Protection, Philippine National Police and Business Permit and Licensing Office (BPLO) of the Local Government Units. The Circular is being implemented to protect the buying public/consumers from the hazardous effect (i.e. fire) it may cause and to ensure that only best quality liquid fuels will be sold.

Code of Safety Practices for LPG Refilling Plant

As part of the celebration of the National Energy Consciousness Month (NECM) in December 2017, the DOE promulgated the Code of Safety Practices for LPG Refilling Plant. This policy aims to safeguard the welfare of the consumers against the unscrupulous trading of petroleum products by establishing regulations on emerging and expanding technologies in the retail of liquid fuels and more stringent measures for safe LPG manufacturing and use. It likewise seeks to encourage industry players to improve their services and products. Further, it outlines the safety standard operating procedures of the following:

a) Tank Truck & Lorry Entry Procedure;
b) Cylinder Refilling Procedure;
c) LPG Cylinders Housekeeping and Preventive Maintenance;
d) Fire Drill and Fire Marshall; and,
e) Personnel Training Requirements.

Small-sized 2.7 kilogram LPG cylinders: For Outdoor Use Only

The DOE required manufacturers and retailers to comply with the additional marking of 'For Outdoor Use Only' on the body of every small-sized 2.7 kilogram LPG cylinders sold in the market. This new rule is defined in DC 2018-03-0004 which prohibits the sale and distribution of 2.7 kg LPG Cylinders and below, without the required "For Outdoor Use Only" marking in addition to the usual mandatory marking for LPG Cylinders. The policy is in line with the revised PNS 03-1:2014 issued by the Bureau of Product Standards specifying the additional mandatory marking to be indicated in the body to serve as a warning to consumers that the product should not be used indoors.

The DOE advises the public that 2.7 kg cylinder lacks the following safety features:

a) Pressure Relief Valve (PRV); and
b) Regulator. Without these two components, the possibility of having LPG leaks is much higher as compared with bigger LPG cylinders which have the said features.

The Circular also outlined the penalties for any violation committed by LPG refiller/marketer, dealer and LPG retail outlet.

GASOLINE STATION LENDING AND FINANCIAL ASSISTANCE PROGRAM (GSLFAP)

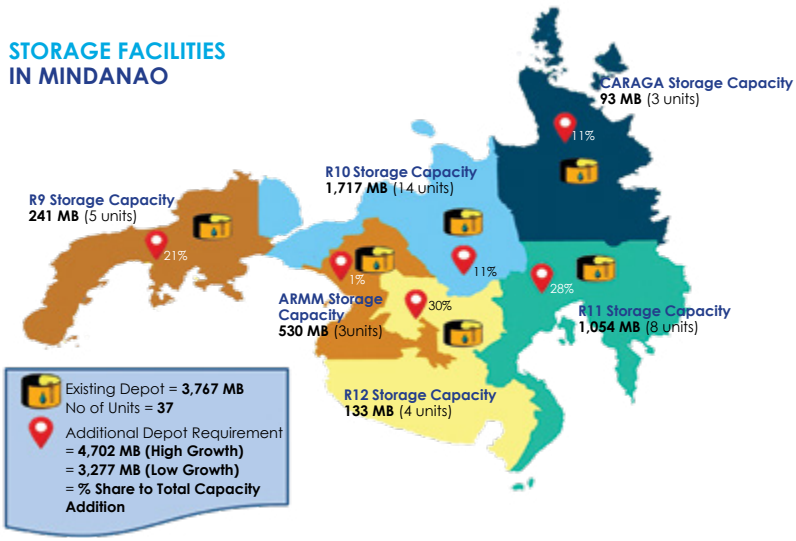
The existence of a gas station could be critical to the development of a town in rural areas. Availability and accessibility of fuel could spur business and progress. This is one of the main reasons why the oil deregulation law provided funds for the promotion of Gasoline Station Lending and Financial Assistance Program. Department Circular No. 2011-03-0005 or the amended GSLFAP is designed to provide credit assistance to New Industry Participants (private sectors and cooperatives i.e. Transport Groups). Those who would like to avail of it must first undergo and successfully complete a series of management and skills training in the retailing of petroleum products for the establishment, operation, improvement, management and maintenance of the gasoline stations. Said program provides prospective owners option to avail of training and loan for putting up their own gas station. However, promotion of this program needs to be intensified through information campaigns. Moreover, coordination with participating lending institutions on easy access and terms of loans should be conducted especially for station to put up in areas where supply accessibility is limited.

PLANS AND PROGRAMS

New Oil Facilities

With the Build, Build, Build Program of the government aimed at bringing down the costs of production, improving rural incomes, encouraging countryside investments, make the movement of goods and people more efficient, and create more jobs, Mindanao is set to realize its economic potential. The gradual shift to industrialization fuels up the region's growth rate, requiring additional oil facilities in the region. During the planning period, it is projected that demand for oil under high growth scenario (HGS) increases from 17.2 million barrels (MMB) in 2017, about 12.0 percent of the total national demand, to 45.3 MMB by 2030 and further accelerates to 73.9 MMB in 2040. Under the low growth scenario (LGS), oil demand reaches 63.6 MMB in 2040.

Figure 46. EXISTING AND ADDITIONAL OIL STORAGE



Mindanao needs additional storage capacity to meet the region's growing oil demand and inventory level requirement (Figure 46). The additional storage capacity is estimated based on the assumption that the region can manage to have up to 30-day inventory level (equivalent to oil demand) except LPG with only 15-day inventory. From this assumption, the region requires 4,702 **thousand barrels (MB)** or **12.9 MB per day** of storage capacity addition in HGS until 2040. The capacity addition brings the total storage capacity to almost 8,500 MB, from the current capacity of 3,767 MB. Meanwhile, 3,277 MB of additional capacity is needed for the LGS.

The distribution of additional oil storage within Mindanao depends on oil demand and existing capacity hosted by each region. Using these parameters, Soccsksargen and Davao regions require 30.0 percent and 28.0 percent, respectively, of the total capacity addition, while Zamboanga region needs 21.0 percent, and Northern Mindanao and Caraga each needs 11.0 percent of total. With lowest oil demand among the regions, ARMM takes only less than 1.0 percent of total. However, the distribution may also be affected by the utilization of existing storage in a region - whether a number of storage capacities are dedicated to store gasoline, diesel or other oil products. In such a case, some regions may have or may require more storage capacities allocated for a specific oil product and distribute it to other regions through oil tanker/trucks.

Mindanao could also host its first refinery facility when oil demand per day reaches 100 MB/day. By 2027, the region's oil demand rises to 102.2 MB/day and 202.4 MB/day in 2040 in HGS. In LGS, demand increases to 102.4 MB/day in 2028 and 173.1 MB/day in 2040. Taking into account the per day oil requirement of the region, an oil refinery plant with an initial capacity of 50 MB/day may be built before 2027 on the assumption that 40.0 percent of oil products supply will come from this facility based on 80.0 percent utilization rate. Additional capacity of 50 MB/day in HGS and 35 MB/day in LGS may be considered in 2040. The decision to build a refinery plant is vested on the oil companies operating in the region, if it is financially and economically viable to put up this facility. Higher market share of oil companies in the region could be one of the factors to have a business decision in establishing a refinery plant.

Improvement of gasoline station density (average number of gasoline stations per municipality/city) is also a concern in some regions in Mindanao, specifically ARMM, Caraga and even Zamboanga Peninsula with 0.5, 2.1 and 2.5 computed density in 2017. In the same year, the overall density for Mindanao was 3.9, lower than Luzon with 5.4 and Visayas with 4.2. Efforts to encourage oil companies to expand their retail business (putting up additional gasoline stations) must be intensified by the DOE, the Mindanao Development Authority (MinDa) and the local government units (LGUs) to cater the unserved and underserved markets, which could reduce the "*bote-bote*" retail practice.

Oil Supply Security

In line with the Department's No. 1 strategic direction to ensure energy security, the DOE, in collaboration with PNOC will formulate and operate a strategic oil stockpile in the country. This is in addition to the commercial stockpile that the existing oil players are required to maintain. Said strategic oil stockpile is for local supply contingency purposes. In

the international scene, the government will continue to pursue collaboration with ASEAN member states for the establishment of regional petroleum stockpiles to form part of the measures to ensure the country's oil security.

Oil Pricing

To strengthen consumer welfare and protection, the DOE maintains a daily oil price monitor and a weekly oil price situationer report. In addition, the DOE also monitors international prices with Mean of Platts Singapore (MOPS) as the benchmark for prices of local oil products. The DOE has been using the Energy Regulatory Board (ERB) formula since 1998 as a barometer to determine propriety of weekly oil price increases in the country. The constituent element of the ERB formula is the average weekly MOPS price for unleaded gasoline and automotive diesel oil as the benchmark for finished petroleum products in Asia. Further, there are only two refiners in the country, and they are importing not just crude oil but finished products as well to meet their own demand. All the other players in the downstream oil industry that import finished products also use MOPS as benchmark for their pricing.

In an effort to cushion the impact of international oil prices to local consumers and the effect of the TRAIN Law, the DOE is ramping up its efforts in raising public awareness toward efficient use of gasoline and diesel.

Oil and Facilities Standards

Envisioning a low carbon future, the DOE continuously formulates standards on fuel and its related products along with oil facilities to ensure a more stringent quality of fuels and other related products in the country. In the first quarter of 2018 alone, the DOE conducted three (3) denaturing activities and five (5) depot products sampling in Davao Region.

The following are on-going standards development which will be implemented during the planning period:

Fuel Quality Standards

1) E-Gasoline Specification (E10) – DPNS/DOE QS 008:2017
2) PNS for Marine Fuels
3) PNS for Emulsified Fuel / Bunker Oil
4) PNS for Kerosene

Facilities Standards

1. PNS/DOE FS 10:2017: Code of Safety Practices for LPP in Retail Outlet (new). Endorsed to BPS and awaiting for adoption and promulgation as PNS)
2. Code of Safety Practices for an LPG Refilling Plant (new):
    - Part 1 – Tank Truck & Lorry Entry Procedure
    - Part 2 – Cylinder Refilling Procedure
    - Part 3 – LPG Cylinders Housekeeping and Preventive Maintenance
    - Part 4 – Fire Drill & Marshalls
    - Part 5 – Personnel Training

    (Parts 1 to 3 were already endorsed to the Office of the Secretary, while Parts 4 and 5 are still on deliberation)
3. DPNS/FS 2:2017: LPG Refilling Plant (review/ update of 2006)

Monitoring, Enforcement and Consumer protection

Continuous and vigorous inspection of retail outlets should be conducted consistently. This is to ensure that the consumers' purchases of petroleum product are of standard quality and of right quantity. During the short-term planning period until 2019, the DOE targets to inspect an average of 2,000 establishments (liquid fuels and LPG) all over the country. On the other hand, Information, Education and Communication Campaigns (IECs) are also conducted nationwide such as the DOE's E-Power MO! campaign to help empower consumers with information about the downstream oil industry and other sectors in energy industry.

NATURAL GAS INDUSTRY

The country's downstream natural gas industry is young and emerging, essentially a "single-project" stage that kicked-off during the successful launching of the Malampaya Deep Water Gas-to-Power Project in 2001. As the sole producer and supplier of natural gas, the Malampaya gas field has commenced delivery of gas in October 2001 to its three (3) anchor market. It is transported to areas close to the Malampaya On-shore Gas Processing Plant (MOGP) supplying the 3,291 MW natural gas-fired power plants in Luzon including the newly commissioned 511 MW in 2016.

At the moment, the Malampaya Gas Field has an average gas production of 450 million standard cubic feet (MMSCF) per day. However, it is estimated to be depleted between 2024-2025 consonant with its concession period until 2024. While the field can still operate beyond the expiry period, it does not have enough gas to provide the future demand considering that the government is keen on expanding its utilization to the non-power sectors, such as the industrial, commercial, transport and residential.

Mindful of these developments, the DOE seek to build the necessary infrastructure to support the advancement in the natural gas industry. The government deems that the establishment of gas transmission and distribution pipeline networks, including related facilities, such as the liquefied natural gas (LNG) terminals, compressed natural gas (CNG) refilling stations, and other respective ancillary facilities, are keys to successfully expand the utilization of natural gas in the country, and thus the development of the downstream natural gas industry.

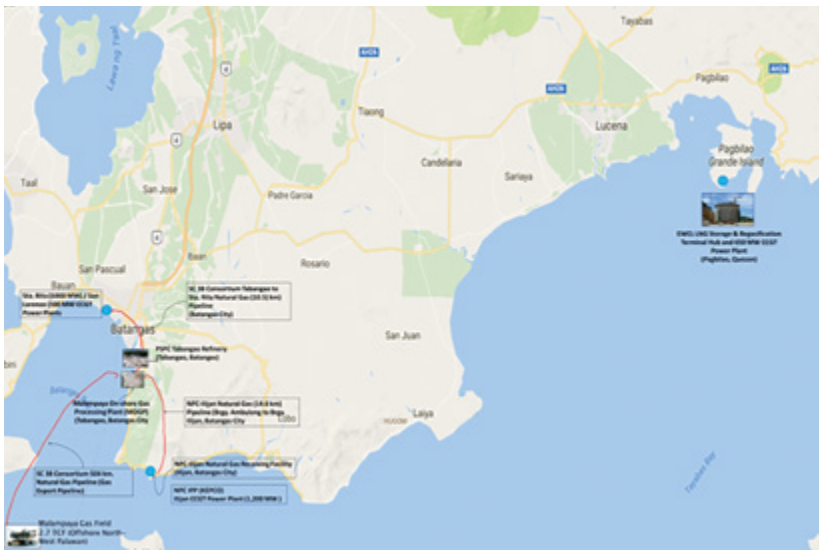
The archipelagic nature of the Philippines requires the need for a mixed of modes in transporting natural gas to

all demand sectors in the country. Without this mix of infrastructure network, natural gas will not be accessible to all identified users in the power, transport, industrial and commercial sectors. Critical gas infrastructure projects have been identified primarily in Luzon where demand concentration for natural gas is projected to be the highest in the next ten years and subsequently seen to expand to the Visayas and Mindanao regions and even to the off-grid islands located within the respective regions.

The government is also considering importing gas (LNG form) as one of the solutions for the medium-term. It recognizes the urgency to put in place an LNG import receiving facility so that the country can import and access LNG to ensure security of natural gas supply. As construction of an LNG facility is capital intensive, it requires a sure anchor market to capitalize this kind of investment.

Putting up an LNG facility in the country opens up investment opportunities in the following areas:

1. Provide the natural gas requirement of the existing 3,200 MW gas fired plants when Malampaya runs down;
2. As RE capacity is poised to increase and due to its intermittent nature, natural gas fired power plants can complement when these plants are not running;
3. Additional potential demand of LNG will come from the off-grid or missionary islands by replacing the existing diesel-fired power plants with natural gas; and,
4. LNG will primarily be consumed in the power sector, but will soon cover non-power applications such as in the industrial processes, transportation, commercial and residential sectors.



Proposed LNG Terminal

Policy Issuances

The DOE's issuance of the Philippine Downstream Natural Gas Regulation (PDNGR) on 28 November 2017 has provided the regulatory framework for the downstream natural gas industry in the country. It applies to compliance to policies, rules, standards and best practices on areas of siting, design, construction, expansion, modification, operation and maintenance of any project necessary to the development of the Philippine Downstream Natural Gas Industry value chain. The regulatory framework also covers industry compliance to policies, rules and best practices on the importation of LNG, indigenous natural gas after the point of sale up to the customer and on the supply and transport activities of natural gas to the customers. Given the newly formulated regulatory framework, the DOE can effectively perform its regulatory function that will lead to the construction of the required natural gas infrastructure facilities and/or projects in meeting the challenges the country is facing today.

Infrastructure Development

The promotion of new technology in the transportation and distribution of natural gas has stirred interest for potential investors to consider their investment in Mindanao. Mindanao has promising demand for natural gas applications as suggested in the study conducted by the World Bank-East Asia in 2012 through the Canadian Gas Services International (CGSI) wherein a Floating Storage Regasification Facility (FSRU) will be put up in Macajalar Bay in Tagaloan, Misamis Oriental.

A two-phased approached was recommended for the introduction of natural gas in the region. Phase 1 will be the construction of FSRU in the vicinity of PHIVIDEC Industrial Authority and a transmission and distribution pipelines will be put up to serve the requirements in the cities of Cagayan de Oro and Iligan. Phase 2 could be an expansion to cities of Davao and General Santos and/or parallel development to Phase 1. Ensuing the said study, a potential investor conducted feasibility study for an FSRU Facility in Tagaloan, Misamis Oriental.

PLANS AND PROGRAMS

The DOE will continuously support and strengthen activities on the following key components which are vital in pushing further the development of natural gas industry in Mindanao Region:

Expand Supply Source

The DOE will intensify efforts to encourage and promote investments in the development and exploration of domestic natural gas supply and put up the necessary infrastructure so that the country will be ready to bring in imported LNG in Luzon and harmoniously expand the market and distribute natural gas to Mindanao region within the planning period as part of its strategy of expanding fuel supply source.

Economic Research Institute for ASEAN and East Asia (ERIA) Study on LNG

ERIA in cooperation with the DOE, the Institute of Energy Economics, Japan (IEEJ) and Sim Techno Research Institute (STRI) conducted a study on "*Seeking Optimal Solutions on Delivering LNG to Medium and Large Islands in the Philippines,*" which is aimed at analyzing possible configuration of small scale LNG supply chain for power generation in the Philippines. The study used Static Simulation Model and Dynamic Simulation Model to analyze the optimal LNG transport solutions.

Based on the study, Cebu, Tacloban, Tagbilaran, Zamboanga, Iligan, Bislig, Surigao and General Santos were identified as possible location for bulk LNG receiving terminals. Both Cebu and Zamboanga are suggested as the primary LNG receiving terminals with the capacity to redistribute the LNG to other demand centers in southern districts using FSRU solutions. Application of two primary ports indicates lower cost solution compared with one primary port. Cebu delivers LNG to subordinate (secondary and tertiary) terminals in Tacloban and Tagbilaran in the Visayas, and Bislig and Surigao in Mindanao. On the other hand, Zamboanga transports LNG to Bislig and General Santos. Primary terminal as presented in the study must have a capacity of 6 million ton per year (Mtpy), secondary terminal with 1 Mtpy and tertiary with 0.6 Mtpy.

Results of the study also show six (6) transportation models to deliver LNG from primary to subordinate terminals at the minimum total system cost. The study suggests using 3 large LNG barges with each having a capacity of 30,000 cubic meter (m3), or equivalent to 13.5 thousand ton (Kton).

Infrastructure Development

The availability of required infrastructure to receive, store and deliver natural gas to the potential customers should be developed within the planning horizon. Implementation of the identified infrastructure projects in Mindanao is most of the time private and/or government led-investments intended to cater the domestic demand growth of the region. Table 84 shows the proposed natural gas infrastructure projects that the private and even government-owned and controlled corporation (GOCC) entities signified interest to be constructed in Mindanao region.

Table 84. PROPOSED NATURAL GAS INFRASTRUCTURE DEVELOPMENT

Project	Proponent	Location	Capacity	Status
Petroleum Brunei & Brunei LNG	Petroleum Brunei and Brunei and LNG	Tagoloan, Misamis Oriental in Mindanao.	163 cu m/hr of LNG 500 MW CCGT anchor market	Completed FS study for the location of the onshore power plant
LNG Barge Project	PT Jaya Samudra Karunia Gas (JSK)	Panay, Mindanao, Cebu, Negros Province, Palawan	Barge Mounted Power Plant	New Planned Project
Integrated LNG Receiving Facility	Philippine National Oil Company Exploration Corporation	Davao City	Includes pipeline and 1200 MW anchor PP	New Planned project

In the supply planning for power generation, a 500-MW combined-cycle gas turbine (CCGT) power plant will be introduced in 2025, and increases the capacity to 2,000 MW until 2040 in HGS. In LGS, the total capacity from natural gas only reaches to 1,800 MW in 2040. Fuel requirement for natural gas is estimated at 23.9 billion cubic feet (Bcf) in 2025, 47.9 Bcf in 2030, and 95.8 Bcf in 2040[37] under the HGS. The fuel requirement is estimated based on the projected generation of natural gas power plants.

Market Development

With projected growth in gross regional domestic product (GRDP), the Mindanao region needs around 19,000 MW of power generation capacity addition by 2040 in HGS and about 12,000 MW[38] in LGS. The capacity requirements include the reserve capacity/supply of the Mindanao grid. In pursuit of a technology-neutral policy on energy sources

[37] This is on the assumption of 85.0 percent maximum capacity factor for natural gas. Capacity factor of CCGT varies year-by-year depending on the requirement of the Mindanao grid. Fuel requirement in low growth scenario is 85.6 Bcf in 2040 (1,800 MW in 2040).

[38] The capacity addition is the requirement for Alternative Scenario in the Power Supply Outlook. Under this Scenario, natural gas power plant is introduced in the capacity mix for the Mindanao grid. The same capacity addition from natural gas is likewise considered in the Nuclear Scenario.

in meeting the ideal proportion of baseload, mid-merit and peaking requirements for power generation, natural gas is considered as a flexible fuel to meet all the demand requirements.

Access to gas supply and the distribution networks within the planning period are critical for the development of natural gas in the region. Constructing an LNG receiving terminal to accommodate the delivery of gas in liquefied form requires huge capital investments, thus an anchor load power plant must be built to make it more financially viable business venture. The natural gas supply requirement for the CCGTs considered in the power supply outlook necessitates the establishment of an LNG receiving terminal with an initially capacity of 1.0 million tonne per year (Mtpy) in 2025 and reaches to 2.5 Mtpy in 2040 in HGS, while for LGS the initial capacity is 0.50 Mtpy in 2025 and increases to 2.0 Mtpy at the end of the planning period.

Conversion of diesel-fired power plants to natural gas in off-grid areas in Mindanao is also a potential demand, although at present very marginal. However, such demand is expected to grow once access to gas supply and transport of fuel is realized in the planning period. The government is determined to expand the application of natural gas to the non-power sector, such as in transport, industry, commercial and residential uses.

Manpower Capacity/Skills Development

Manpower capacity building is essential for the effective implementation and sustainability of plans and programs under the gas industry. Hence, for this planning period, a set of program from short- to long-term period will be facilitated to develop skills required for the natural gas industry and the regulators.

As a continuing effort of the government of promoting and creating awareness on natural gas on the industry's development plans and program, the conduct of a sustainable education on public awareness (SEPA) is being conducted in Mindanao region. Said activity covers various sectors such as industry, academe, government and private organizations and financial institutions.

Policy Development

Policy and legislative framework support is vital in order to accelerate the development of the downstream natural gas industry in the country. The formulation of gas related policy as well as legislative framework for short- to long-term period will be carried out to enable the emerging downstream natural gas industry to graduate to a matured market.

In the absence of a law that provides guidance to investors in the natural gas industry, the DC2017-11-0012 or PDNGR was issued to serve as the regulatory framework and policy direction in the promotion of investment and attainment of efficient natural gas facility operations, quality service, fair, transparent, and competitive industry.

Alongside these critical components, the DOE continues to embark on the following undertakings as part of its long-term agenda:

- Formulation of an immediate Policy Agenda on:

    i) Standards on LNG Terminal;
    ii) Transmission and Distribution Codes;
    iii) Safety Code on Natural Gas Facilities; and
    iv) Third Party Access Rules.

- Advocates the Technical Working Group of the House of Representatives in the amendment of the draft Natural Gas Bill to be responsive with the current economic and political conditions and on its passage.

- Promote investment on natural gas infrastructure projects so that the country can readily start importing LNG to safeguard the anticipated drop in the supply of the Malampaya natural gas between 2024-2025 coupled with the forthcoming termination of its concession by 2024.

- Intensify SEPA activities in Mindanao region to promote natural gas application and infrastructure development as well as create a well-informed group to advocate future development plans and programs for natural gas in Mindanao.

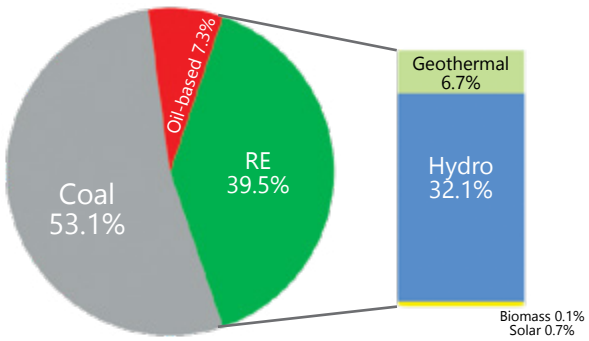
- Establish close coordination with Board of Investments (BOI) for the continued inclusion of the natural gas projects and activities in the Investment Priority Plan (IPP).

VIII. POWER DEVELOPMENT

Mindanao Grid

Mindanao's gross power generation in 2017 was recorded at 11,804 GWh, a 4.0 percent growth from the 11,345 GWh generation in 2016. More than half of electricity was primarily sourced from coal followed by renewables (RE) with 39.5 percent share to total power generation. Hydro contributed about 80.0 percent of power generation from renewable, or 32.1 percent of total generation, while geothermal provided 17.0 percent (6.8 percent of total generation). Combined share of solar and biomass stood at less than 1.0 percent. Generation from oil-based plants was at 7.3 percent of total (Figure 47).

Figure 47. 2017 MINDANAO GENERATION MIX



Total installed generating capacity of Mindanao in December 2017 was recorded at 3,480.9 MW, while dependable capacity stood at 3,022.9 MW. Installed capacity from the grid-connected and embedded generation were at 2,730.1 MW and 750.8 MW, and with dependable capacity of 2,378.7 MW and 644.2 MW, respectively (Tables 85 and 86).

The increase in Mindanao's grid capacity is attributed to the influx of private sector investments in power generation projects. In 2017, 337.4 MW of new capacity was added to the grid. The 135-MW FDC Misamis Unit 3 was the grid-connected plant commissioned in that year. Embedded plants were likewise up in the region, namely: the *165-MW coal power plant from Minergy Power Corporation (MPC) Balingasag (the plant has 3 units at 55 MW)*; the *10.9-MW diesel power plant (DPP) from Nickel Asia Corporation (NAC)*; the *10.5-MW DPP from PACERM-1; and, the 16-MW DPP from Zamboanga City Electric Cooperative, Inc. (ZAMCELCO)*.

Table 85. EXISTING POWER PLANTS IN MINDANAO, As of December 2017 (Grid Connected)

Plant	Capacity (in MW)		Location
	Installed	Dependable	
Coal	**1,087.0**	**965.0**	
Mindanao Coal U1	116.0	105.0	PHIVIDEC, Villanueva, Misamis Oriental
Mindanao Coal U2	116.0	105.0	
Therma South U1	150.0	130.0	Davao City / Sta. Cruz, Davao del Sur
Therma South U2	150.0	130.0	
FDC Misamis U1	135.0	120.0	PHIVIDEC, Villanueva, Misamis Oriental
FDC Misamis U2	135.0	120.0	
FDC Misamis U3	135.0	120.0	
SMC Malita U1	150.0	135.0	Malita, Davao Occidential
Diesel	**486.0**	**450.0**	
SPPC	59.0	55.0	Alabel, Sarangani
TMI 1	100.0	96.0	Maco, Davao del Norte
TMI 2	100.0	96.0	Nasipit, Agusan del Norte
WMPC	113.0	100.0	Sangali, Zamboanga City, Zamboanga del Sur
MPC - IDPP	114.0	103.0	Dalipuga, Iligan City, Lanao del Norte
Geothermal	**108.5**	**100.0**	
Mt. Apo	108.5	100.0	Kidapawan, North Cotabato
Hydro (large)	**1,001.1**	**828.0**	

Table 85. EXISTING POWER PLANTS IN MINDANAO, As of December 2017 (Grid Connected)

Plant	Capacity (in MW)		Location
	Installed	Dependable	
Agus 1	80.0	60.0	Marawi City, Lanao del Sur
Agus 2	180.0	120.0	Saguiaran, Lanao del Sur
Agus 4	158.1	150.0	Baloi, Lanao del Norte
Agus 5	55.0	52.0	Buru-un, Iligan City, Lanao del Norte
Agus 6	219.0	171.0	Buru-un, Iligan City, Lanao del Norte
Agus 7	54.0	50.0	Buru-un, Iligan City, Lanao del Norte
Pulangi 4	255	225	Maramag, Bukidnon
Hydro (small)	**8.4**	**8.4**	
Tudaya 2	8.4	8.4	Sta. Cruz, Davao del Sur
Solar	**39.1**	**27.3**	
Kibawe Solar	10.5	7.3	Brgy. Labuagon, Kibawe, Bukidnon
Digos Solar	28.6	20	Brgy. San Roque, Digos City, Davao del Sur
Total	**2,730.1**	**2,378.7**	

Table 86. EXISTING POWER PLANTS IN MINDANAO, As of December 2017 (Embedded)

Plant	Capacity (in MW)		Location
	Installed	Dependable	
Coal	**283.0**	**255.0**	
MPC Balingasag U1	55.0	50.0	Brgy. Mandangoa, Balingasag, Misamis Oriental
MPC Balingasag U2	55.0	50.0	Brgy. Mandangoa, Balingasag, Misamis Oriental
MPC Balingasag U3	55.0	50.0	Brgy. Mandangoa, Balingasag, Misamis Oriental
SEC	118.0	105.0	Maasim, Sarangani
Diesel	**342.0**	**301.7**	
Bajada DPP	58.7	48.0	Davao City, Davao del Sur
BPC DPP	7.3	6.4	Pangantucan, Bukidnon
Cotabato Light	10.0	9.9	Cotabato
EEI Power	15.0	13.5	Davao del Norte
KEGI - Bukidnon	3.2	3.0	Valencia City, Bukidnon
KEGI - Camiguin	4.1	4.0	Mambajao, Camiguin
KEGI - Maramag	7.8	7.5	Maramag, Bukidnon
KEGI - Misamis Oriental	10.6	10.0	Gingoong, Misamis Oriental
KEGI - Panaon	15.6	15.0	Panaon, Ozamis City, Misamis Occidental
KEGI - Tandag	7.8	7.5	Tandag, Surigao del Norte
MEGC	15.0	14.3	Iligan City, Lanao del Norte
Mindanao Energy System 1	18.9	18.0	Cagayan de Oro, Misamis Oriental
Mindanao Energy System 2	27.5	27.0	Cagayan de Oro, Misamis Oriental
MPC - Koronadal	13.0	13.0	Koronadal City, South Cotabato
MPC - Digos	15.0	15.0	Digos, Davao del Sur
NAC DPP	10.9	8.2	Surigao City, Surigao del Norte
PACERM- 1	10.5	10.5	El Salvador City, Misamis Oriental
PSC	37.1	18.4	PHIVIDEC, Villanueva, Misamis Oriental
PSFI	5.2	5.0	San Francisco, Agusan del Sur
PSI	20.9	19.6	General Santos City, South Cotabato

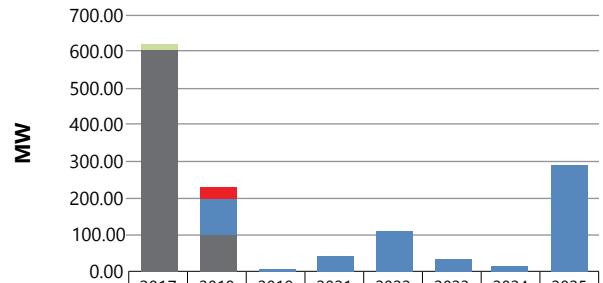
Table 86. EXISTING POWER PLANTS IN MINDANAO, As of December 2017 (Embedded)

Plant	Capacity (in MW)		Location
	Installed	Dependable	
SPC - Koronadal	11.9	11.9	Koronadal, South Cotabato
ZAMCELCO DPP	16.0	16.0	Zamboanga City
Hydro (large)	**42.5**	**42.5**	
Sibulan	42.5	42.5	Sta. Cruz, Davao del Sur
Hydro (small)	**21.6**	**15.3**	
Bubunawan	7.0	2.7	Baungon, Bukidnon
Cabulig	8.0	6.0	Claveria, Misamis Oriental
Tudaya 1	6.6	6.6	Sta. Cruz, Davao del Sur
Hydro (mini-hydro)	**6.1**	**4.4**	
Agusan	1.6	1.6	M. Fortich, Bukidnon
Talomo	4.5	2.8	Mintal, Davao City, Davao del Sur
Biomass	**35.9**	**10.0**	
Crystal Sugar	35.9	10.0	Maramag, Bukidnon
Solar	**19.7**	**15.3**	
Centralla	6.2	5.0	Brgy. Centralla, Surallah, South Cotabato
CEPALCO	1.0	0.3	Sitio Lomboy, Cagayan de Oro, Misamis Oriental
Kirahon	12.5	10.0	Villanueva, Misamis Oriental
Total	**750.8**	**644.2**	

Committed and Indicative Power Projects

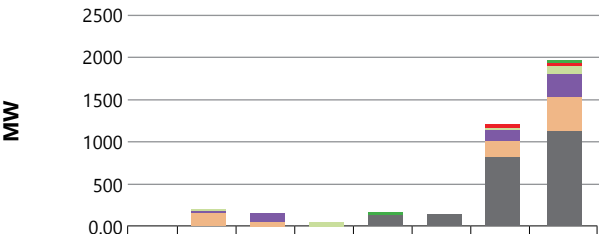
The private sector led power projects can be classified as committed and indicative. Committed power projects refers to power projects which have complied with the necessary permits and clearances from the various government agencies and concerned local government units (LGU) and in the process of financial closing. Mindanao's committed power projects covering the period 2017 – 2025 have an aggregate capacity of 1,332.43 MW. Coal accounts for 52.5 percent (700 MW) of total, followed by hydropower at 44.3 percent (590.89 MW). Figure 48 shows the grid committed projects based on the plant type.

Figure 48. COMMITTED POWER PROJECTS IN MINDANAO (as of Dec 2017)



	2017	2018	2019	2021	2022	2023	2024	2025
Biomass	12.00							
Oil		29.54						
Hydropower		96.20	8.00	39.20	108.70	34.80	16.85	287.14
Coal	600.00	100.00						

Figure 49. INDICATIVE POWER PROJECTS IN MINDANAO (as of Dec 2017)



	2017	2018	2019	2021	2022	2023	2024	2025
Geothermal					30.00			30.00
Oil							45.22	45.22
Biomass		12.00		62.50			14.90	89.40
Hydropower		28.00	100.00				140.00	268.00
Solar		168.00	60.00				182.00	410.00
Coal					150.00	150.00	838.00	1,138.00

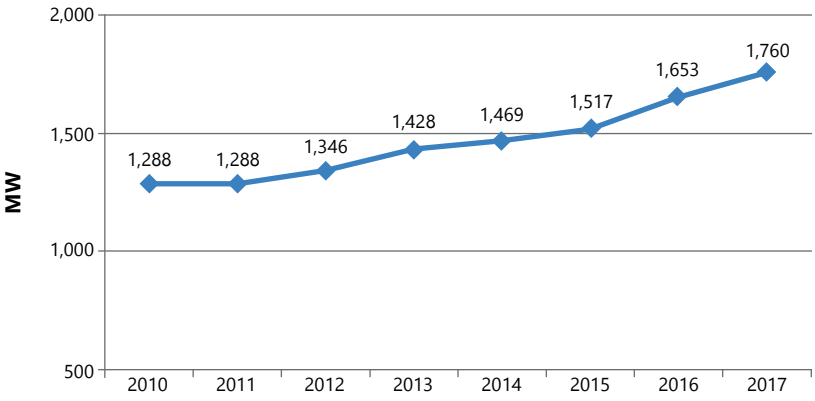
Meanwhile, indicative power projects stand at 1,980.62 MW. About 58.0 percent (1,138 MW) of total comes from coal power projects. Renewable-based projects comprise 40.3 percent of total, which are mostly solar (21.0 percent or 410 MW) and hydropower (14.0 percent or 268 MW) (Figure 49).

Peak Demand

Mindanao's peak demand grew by 6.5 percent from 1,653 MW in 2016 to 1,760 MW in 2017 (Figure 50). The highest recorded increase in peak demand was in 2016 with 1,653 MW from 2015 level of 1,517 MW, equivalent to a 9.0 percent growth.

The increase in electricity consumption was triggered by new power generation capacities that came in to provide additional supply to the grid. Likewise, the increased consumption may also be correlated to the performance of the industry given that Mindanao is known for its manufacturing industry. For one, the region is being positioned to be the hub for rubber manufacturing given that it supplies 99.0 percent of the country's natural rubber production[39].

Figure 50. MINDANAO PEAK DEMAND



In the long-term, demand is seen to further increase as development corridors (Mindanao Development Corridors or MinDC)[40] have been identified by the Mindanao Development Authority (MinDA). The development clusters – *industrial trade, mariculture and trade, biodiversity and ecotourism, food basket and food, agribusiness and logistics* – are perceived to increase the region's competitiveness and provide physical integration between economic clusters.

SMALL ISLAND GRIDS

Missionary areas in Mindanao are provided with electricity by 26 power plants (24 land-based and 2 power barges) operated and maintained by the National Power Corporation's (NPC) – Small Power Utilities Group (SPUG). Total installed (rated) capacity of these plants is at 79.789 MW with dependable capacity of 59.131 MW. The 24 land-based plants have an aggregate installed and dependable capacity of 74.389 MW and 55.331 MW, respectively, while the two (2) power barges have a combined installed capacity of 5.4 MW and a dependable capacity of 3.8 MW (Table 87).

Table 87. SPUG PLANTS IN MINDANAO, as of 25 December 2017

Region	SPUG Plant	Province	Installed Capacity (MW)	Dependable Capacity (MW)	Maximum Demand (MW)	Operation Time (Hours)	Status
IX	Sacol DPP	Zamboanga	0.360	0.220	0.092	16	Operational
X	Balut DPP	Davao Occidental	0.787	0.670	0.176	16	Operational
XI	Talicud DPP	Davao del Norte	0.884	0.690	0.278	16	Operational
XII	Kalamansig DPP	Sultan Kudarat	9.019	6.900	4.228	24	Operational
	Ninoy Aquino DPP	Sultan Kudarat	1.518	1.250	0.859	16	Operational
	Palimbang DPP	Sultan Kudarat	0.996	0.690	0.330	16	Operational
CARAGA	Dinagat DPP	Dinagat	10.424	8.390	3.801	24	Operational
	Loreto DPP	Dinagat	0.500	0.380	0.000		Operational; Back-up/On-standby
	Hikdop DPP	Surigao del Norte	0.581	0.491	0.130	16	Operational
ARMM	Basilan DPP	Basilan	14.909	10.180	9.320	24	Operational
	PB 119	Basilan	5.400	3.800	0.000	24	Operational
	Jolo DPP	Sulu	14.665	11.300	8.600	24	Operational
	Luuk DPP	Sulu	0.000	0.000	0.000	8	Unoperational
	Pangutaran	Sulu	0.493	0.370	0.090	8	Operational; commissioned on March 2017

[39] Source: http://www.mindanews.com/top-stories/2015/11/mindanao-eyed-as-manufacturing-hub-of-rubber-products/

[40] A spatial development strategy with the aim of increasing the competitiveness of Mindanao industries by provision of common service facilities. Source: http://www.minda.gov.ph/project-management-and-coordination/mindanao-development-corridors-mindc

Table 87. SPUG PLANTS IN MINDANAO, as of 25 December 2017

Region	SPUG Plant	Province	Installed Capacity (MW)	Dependable Capacity (MW)	Maximum Demand (MW)	Operation Time (Hours)	Status
	Siasi DPP	Sulu	2.535	1.620	0.790	24	Operational
	Bongao DPP	Tawi-Tawi	9.034	6.350	4.020	24	Operational
	PB 108	Tawi-Tawi	0.000	0.000	0.000		Deactivated
	Balimbing DPP	Tawi-Tawi	1.062	0.730	0.235	16	Operational
	Tandubas DPP	Tawi-Tawi	0.450	0.340	0.209	8	Operational
	Sibutu DPP	Tawi-Tawi	0.819	0.490	0.225	16	Operational
	Sitangkai DPP	Tawi-Tawi	1.332	1.070	0.354	16	Operational
	Manuk-Mangkaw DPP	Tawi-Tawi	0.163	0.150	0.100	8	Operational
	West Simunul DPP	Tawi-Tawi	0.973	0.710	0.450	14	Operational
	Languyan DPP	Tawi-Tawi	0.210	0.160	0.076	8	Operational; commissioned on Sept 2017
	Mapun DPP	Tawi-Tawi	1.747	1.530	0.400	16	Operational
	Tandubanak DPP	Tawi-Tawi	0.928	0.650	0.235	12	Operational
Total			**79.789**	**59.131**	**34.998**		

Source: http://www.spug.ph/gridstat/Gridstat_122017_existing.pdf

About two-third of SPUG plants are located in ARMM with 17 missionary areas (11 in Tawi-Tawi, 4 in Sulu and 2 in Basilan) with a total installed capacity of 54.720 MW and a dependable capacity of 39.450 MW. SOCCSKSARGEN (Region XII) and CARAGA regions (Region XIII) both host three (3) SPUG plants each. The total capacity of the plants in SOCCSKSARGEN stands at 11.533 MW (dependable at 8.840 MW), while CARAGA has an aggregate capacity of 11.505 MW (dependable of 9.261 MW). On the other hand, Davao region XI) has 2 plants with total installed capacity of 1.671 MW (dependable of 1.360 MW). The single plant in Zamboanga Peninsula (Region IX) has an installed and dependable capacity of 0.360 MW and 0.220 MW, respectively.

Operation time varies among the SPUG plants and usually ranges from eight (8) to 24 hours. Seven (7) plants or 29.0 percent operate for 24 hours. Ten plants (42.0 percent) have been operating at 16 hours per day, and five (5) plants (21.0 percent) provide eight (8) hours a day operation.

DISTRIBUTION

Electricity distribution in the grid is administered by 37 distribution utilities (DU's) – 33 Electric Cooperatives (ECs) and four (4) Private Investor Owned Utilities (PIOUs)/Local Government Unit Owned Utilities (LGUOU). CARAGA and ARMM both have seven EC's operating in their respective regions. The four PIOUs in Mindanao are Cagayan Electric Power and Light Company, Inc. or CEPALCO (Region X), Iligan Light and Power, Inc. or ILPI (Region X), Davao Light and Power Company, Inc. or DLPC (Region XI) and Cotabato Light and Power Company, Inc. or COLIGHT (Region XII).

Table 88 details the profile of DUs in Mindanao in terms of electricity purchased, total electricity sales, systems loss and own-use.

Table 88. REGIONAL ELECTRICITY PROFILE OF MINDANAO DUs (as of December 2017)

DU	Electricity Purchased (MWh)	Electricity Sales (MWh)				Total Sales (MWh)	System Loss (MWh)
		Residential	Commercial	Industrial	Others		
EC	**6,209,994**	**2,410,073**	**921,305**	**1,717,272**	**370,808**	**5,419,457**	**790,537**
Region IX	1,265,419	479,928	249,603	218,711	93,097	1,041,339	224,080
Region 10	1,181,665	394,963	153,362	451,159	70,348	1,069,832	111,833
Region 11	941,311	386,590	92,644	277,279	48,688	805,201	136,111

Table 88. REGIONAL ELECTRICITY PROFILE OF MINDANAO DUS (as of December 2017)

DU	Electricity Purchased (MWh)	Electricity Sales (MWh)				Total Sales (MWh)	System Loss (MWh)
		Residential	Commercial	Industrial	Others		
Region 12	1,685,408	649,672	262,250	526,150	71,100	1,509,172	176,236
CARAGA	928,992	388,087	145,662	234,174	70,569	838,492	90,500
ARMM*	207,198	110,833	17,783	9,800	17,005	155,421	51,777
PIOU	**4,043,230**	**1,138,698**	**574,249**	**1,977,134**	**57,907**	**3,747,987**	**295,243**
Region 10	1,393,892	356,723	308,010	615,329	15,181	1,295,244	98,648
Region 11	2,479,985	704,925	247,784	1,305,213	40,440	2,298,361	181,624
Region 12	169,353	77,049	18,454	56,591	2,287	154,382	14,971
Total	**10,253,224**	**3,548,770**	**1,495,553**	**3,694,406**	**428,715**	**9,167,444**	**1,085,780**

*Note: *Excluding LASURECO*
Data based on 2018 Distribution Development Plan (DDP) of DUs
Others include public buildings, street lights, irrigation and utility's station use.
Excluding directly connected customers.

Industry and residential sectors were the largest users of electricity in 2017 with recorded sales of 3,694,406 MWh and 3,548,770 MWh, respectively. These sectors demanded almost 80.0 percent of the total electricity sales. For the EC's electricity sales, 44.5 percent (2,410,073 MWh) went to residential customers, while industry customers accounted for 31.7 percent (1,717,272 MWh). On the part of PIOUs, 52.7 percent (1,977,134 MWh) of electricity sales was required by the industry customers, and residential customers comprised 30.4 percent (1,138,698 MWh).

Zamboanga and ARMM registered the highest aggregate system loss under EC's franchise in terms of percentage to total electricity purchased at 17.7 percent (224,080 MWh) and 25.0 percent (51,777 MWh), respectively. In the case of PIOUs, SOCCSKSARGEN region had 8.8 percent (14,971 MWh) of recorded aggregate system loss, compared with 7.0 percent in other regions covered by their franchise.

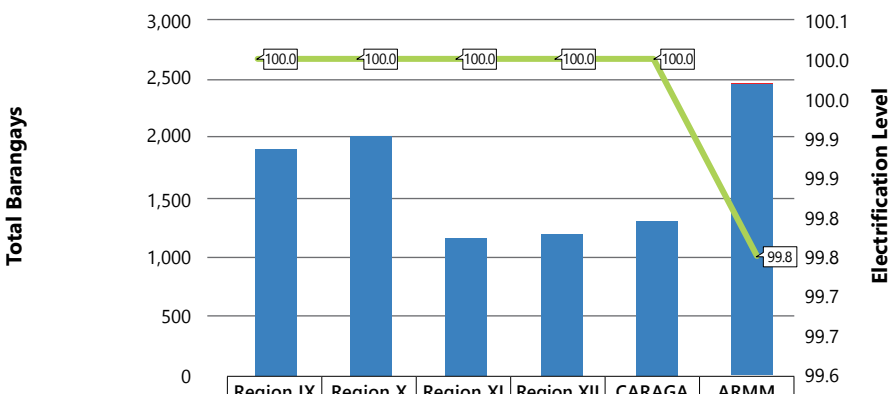
ELECTRIFICATION

In the medium- to long-term, one of the energy sector's direction is to expand energy access to ensure affordable, reliable, sustainable and modern energy for all. Serving as the policy guidepost of the government is the provision of electricity services to 90.0 percent of the total households in 2017[41]. Correspondingly, one (1) of the nine-point programs of the current Administration is the goal of 100.0 percent electrification by providing access to electricity for the targeted and identified households in all three major islands. This goal is translated in the electrification roadmap with the aim to attain 100.0 percent household electrification (accessible to the grid) by 2022.

Barangay

To date, Mindanao's barangay electrification level still stands at 99.9 percent as 10,041 out of the 10,047 barangays are with access to electricity. Only ARMM has not reached 100.0 percent barangay electrification as it is still left with six (6) unenergized barangays which are mostly located in Maguindanao (Figure 51).

Figure 51. BARANGAY ELECTRIFICATION, December 2017



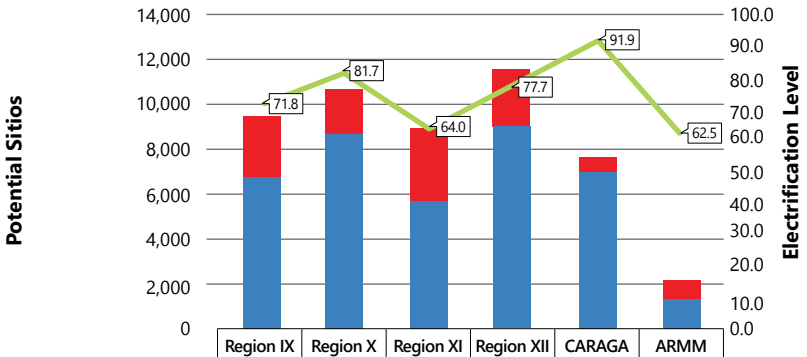
	Region IX	Region X	Region XI	Region XII	CARAGA	ARMM
Unenergized Barangays	0	0	0	0	0	6
Unenergized Barangays	1,904	2,020	1,160	1,194	1,310	2,453
Electrification Level (%)	100.0	100.0	100.0	100.0	100.0	99.8

[41] In 2016, the country was able to achieve 90.65% household electrification level. As of December 2017, the country posted an 88.3% household electrification level. The lower level can be attributed to the reference year used as basis (from 2010 to 2015 Census) for the number of households.

Sitio

Apart from targeting barangays, the government is also bent on providing electricity to sitios throughout the country. As of January 2018, 76.5 percent of sitios in Mindanao are already with electricity services translating to 38,590 sitios energized out of the potential 50,440. As shown in Figure 52, CARAGA recorded the highest electrification level at 91.9 percent (7,004 out of 7,623 sitios), followed by Northern Mindanao (Region X) with 81.7 percent (8,719 out of the 10,674 sitios). The lowest sitio electrification was registered in ARMM with 62.5 percent electrification level (1,362 out of the 2,180 sitios).

Figure 52. MINDANAO SITIO ELECTRIFICATION LEVEL (Jan 2018)

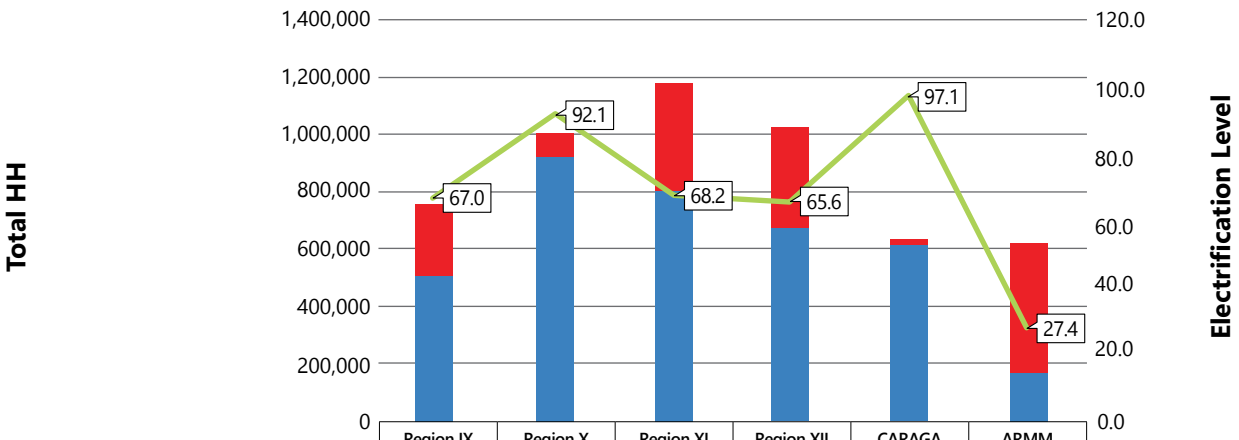


	Region IX	Region X	Region XI	Region XII	CARAGA	ARMM
Unenergized Sitios	2,660	1,955	3,207	2,591	619	818
Energized Sitios	6,786	8,719	5,705	9,014	7,004	1,362
Electrification Level (%)	71.8	81.7	64.0	77.7	91.9	62.5

Household

As of December 2017, Mindanao household level was recorded at 70.8 percent, which means that 3,691,614 out of the potential 5,214,937 households are reaping the benefits of electricity services. On a per region basis, CARAGA recorded the highest electrification level at 97.1 percent (615,515 out of 633,700 households), followed by Northern Mindanao at 92.1 percent (924,878 out of 1,004,722 households). ARMM has the lowest household electrification level at 27.4 percent where 169,190 out of the 618,600 potential households are with electricity (Figure 53).

Figure 53. MINDANAO HH ELECTRIFICATION LEVEL (Dec 2017)



	Region IX	Region X	Region XI	Region XII	CARAGA	ARMM
Unenergized HH	248,856	79,844	374,008	353,020	18,185	449,410
Unenergized HH	505,444	942,878	803.588	672,999	615,515	169,190
Electrification Level (%)	67.0	92.1	68.2	65.6	97.1	27.4

PLANS AND PROGRAMS

The Government will also continue its plans and programs for Mindanao as these specifically point to supply security and increase in electricity access which primarily supports the Administration's thrust of total electrification for all Filipinos. These plans and programs are detailed below.

Mindanao Modular Generator Set Program[42]

The program had the intent of providing additional power supply to end-users in Mindanao. Through a loan facility, participating ECs were able to acquire modular generator sets to serve as an urgent supply for their franchise areas. ECs where also given the option of retaining the generators or returning it to government once the supply situation stabilized in Mindanao. Table 89 details the ECs that availed of the program.

[42] The modular generator sets acquired by ECs can be used as backup capacity or for augmenting supply during peaking requirements of the system.

Table 89. STATUS OF MINDANAO MODULAR GENSET PROGRAM (as of October 2018)

EC	No. of Units	Capacity (MW)	Status
ZAMCELCO	8	2	Construction completed; with pending application for certificates and other regulatory requirements
DANECO	3	1	Gensets to be transferred to Samal Island from original location in Montevista
SURNECO	5	2	Gensets transferred to Leyte; with existing issues and concerns on re-installation and loan repayment
MORESCO I	1	2	In commercial operation
	3	2	On-going civil works. Modular Gensets factory tests already done and waiting for the shipment arrival
MORESCO II	5	2	Construction completed; on-going application for certificates and other regulatory requirements
ANECO	5	2	Construction completed; on-going application for certificates and other regulatory requirements
SUKELCO	2	2	Civil works not yet started. Modular Gensets factory tests already done and waiting for the shipment arrival.
	2	0.5	

Wholesale Electricity Spot Market (WESM) in Mindanao

Establishing the WESM is one of the power industry reforms espoused in Electric Power Industry Reform Act (EPIRA) and this has already been carried out in Luzon and Visayas. This leaves Mindanao as the grid that has yet to have its own electricity market.

On 4 May 2017, Department Circular (DC) No. 2017-05-0009 titled "Declaring the Launch of Wholesale Electricity Spot Market (WESM) in Mindanao and Providing for Transition Guidelines" was signed by Secretary Alfonso G. Cusi. The DC became effective on 7 June 2017, which provides for the following:

a) commencement of registration of WESM participants;
b) application of the Interim Mindanao Dispatch Protocol until commercial operations is declared by the DOE; and,
c) termination of the Interim Mindanao Electricity Market (IMEM).

WESM was formally launched on 28 June 2017 and is seen as a medium for providing an efficient scheduling, dispatch and settlement of energy withdrawal and injections in the grid. The market is an embodiment of competition and transparency that is aimed at Mindanao electricity consumers. The launching of the WESM signaled the commencement of the trial operations program (TOP) that was participated in by the Market Operator (MO), System Operator (SO) and trading participants. WESM's commercial operation will be declared once the criteria for commencement of full commercial operations is complied with.

Mindanao – Visayas Interconnection Project (MVIP)

The Transmission Development Plan or TD[43] formulated by NGCP classifies the MVIP as a strategic connection since it is a major island connection and will require a decision from both oversight and regulatory agencies.

Its tangible benefits as specified in the TDP are: a) sharing of system reserves; b) lesser investment in power generation in either Visayas or Mindanao to maintain the one day Loss of Load Probability (LOLP); and, c) reduction in operating cost due to economic dispatch of generators. On the other hand, the intangible benefits are: a) attractiveness of MVIP to power generation investments due to the bigger market through an interconnected power network; b) on a technical standpoint, the interconnection benefits the system in terms of added supply security, improved system reliability and improvement in the quality of power supply; and c) optimized utilization of indigenous energy resources such as natural gas in Luzon, geothermal in Visayas and hydro in Mindanao. The interconnection is also seen to complement the electricity market to be established in Mindanao.

[43] National Grid Corporation of the Philippines. Transmission Development Plan 2016-2040 Vol. 1 (Consultation Draft). Available at http://www.ngcp.ph/downloads.asp

Privatization of Agus-Pulangui Hydro Power Plants

The combined rated capacity of these hydropower plants is at 1,001.1 MW. As of this time, no indicative bid date has been set. The complex is up for rehabilitation. The complex's privatization is still subject for consultation with Congress (particularly the Mindanao legislators) and PSALM Board's policy direction on privatization[44].

Electrification

As access to electricity is a conduit for development, the government is currently guided with the objective of attaining 100.0 percent electrification of targeted and identified households (accessible to the grid) by 2022.

To further strengthen the government's efforts on electrification, Department Order (DO) No. 2018-05-0010 was issued by the DOE on 24 May 2018 creating the "Task Force E-Power Mo (TFEM)" to ensure electricity access is provided in communities that remain unserved and underserved by DUs/ECs. The Task Force is primarily the overseer of the government's Total Electrification Program (TEP).

Once the Total Electrification Masterplan is evaluated and finalized, the DOE through the Task Force shall develop the national unified strategy for total electrification that will achieve the objective of total electrification in the country.

Electrification programs have been carried out in both grid and off-grid areas in the country. The grid electrification programs that have been implemented include barangay line enhancement, sitio electrification, electrification component of the financial benefits under the Energy Regulations (ER) 1-94, and the Nationwide Intensification of Household Electrification (NIHE). Meanwhile, off-grid programs include Household Electrification Program (HEP) using renewables, solar PV mainstreaming under the Access to Sustainable Energy Program (ASEP) and Qualified Third Party (QTP) Program.

Sitio Electrification Program (SEP)[45]

The National Electrification Administration (NEA) is the lead agency in the implementation of sitio electrification. The program primarily aims to energize sitios situated within barangays.

In 2017, 342 sitios were provided with electricity in Mindanao. For 2018 (as of October 31), 716 sitios benefitted from the program.

Phase 2 of SEP entails the provision of electricity to a total of 2,573 sitios (705 in 2018 and 1,868 in 2019) (Table 90). Davao and Soccsksargen regions have the most number of sitios targeted to be energized from 2018-2019 with 702 and 615, respectively.

Table 90. SITIO ELECTRIFICATION PROGRAM (SEP) PHASE 2 IN MINDANAO

Region	Electric Cooperative	Targets	
		2018	2019
IX	ZANECO	65	135
	ZAMSURECO I		221
	ZAMSURECO II	45	25
	ZAMELCO	10	8
	Sub-Total	**120**	**389**
X	BUSECO		
	FIBECO		229
	CAMELCO		
	MORESCO I	16	
	MORESCO II		40
	MOELCI I	12	
	MOELCI II	7	

[44] Source: https://psalm.gov.ph/rpa/rop
[45] Source: NEA submission on the list of programs and projects under SEP for inclusion in the MEP dated 26 February 2018

Table 90. SITIO ELECTRIFICATION PROGRAM (SEP) PHASE 2 IN MINDANAO

Region	Electric Cooperative	Targets	
		2018	2019
	LANECO	28	
	Sub-Total	**63**	**269**
XI	DANECO	45	133
	DORECO		61
	DASURECO		463
	Sub-Total	45	657
XII	COTELCO	80	46
	COTELCO-PPALMA	59	33
	SOCOTECO I		144
	SOCOTECO II	65	20
	SUKELCO		168
	Sub-Total	**204**	**411**
CARAGA	ANECO	38	15
	ASELCO	83	21
	SURNECO	56	
	SIARELCO		
	DIELCO	8	8
	SURSECO I	24	
	SURSECO II	34	10
	Sub-Total	**243**	**54**
ARMM	MAGELCO	26	21
	LASURECO		
	CASELCO		
	BASELCO	4	
	SULECO		
	SIASELCO		
	TAWELCO		67
	Sub-Total	**30**	**88**
Total		**705**	**1,868**

Energy Regulations (ER) 1-94

As stipulated in EPIRA, the DOE serves as the fund administrator of ER 1-94, particularly the electrification fund component or (EF). This fund is primarily utilized to bring electricity access to all households with priority given to host municipalities/cities. This is implemented with electrification projects for both grid and off-grid.

In 2018, the DOE issued two (2) critical Department Circulars (DCs) concerning ER 1-94. On 20 March 2018, *DC No. 2018-03-0005* was promulgated which recognized the rights of indigenous cultural communities (ICCs) / indigenous peoples (IPs) in their ancestral domains for their equitable share from the financial benefits under ER 1-94. Correspondingly, *DC No. 2008-08-0021* was promulgated on 23 August 2018 to effect the transfer of financial benefits under ER 1-94 to the DUs/ECs and to host LGUs and ICCs/IPs. The EF component will be remitted directly to the DUs/ECs, while the Development and Livelihood Fund (DLF) and the Reforestation, Watershed Management, Health and/or Environment Enhancement Fund (RWMHEEF) will be remitted to the host LGUs and ICCs/IPs.

Nationwide Intensification of Household Electrification[46]

NIHE aims to implement measures and grant assistance to intensify household electrification. It also intends to develop and implement specific policy measures and financial incentives to mobilize DUs in fast-tracking the connections of

[46] Program rationalized for 2019. This will be implemented under the umbrella program of the DOE, which is the Total Electrification Program (TEP)

the remaining households without electricity in both energized (load centers and urban/slum areas) and unenergized areas within their franchise.

Through NIHE, household beneficiaries situated in areas/sitios where the DU's distribution line is physically available get a house-wiring subsidy amounting to PhP 3,750. For 2017, the program approved 55,074 households with an estimated project cost of PhP 206.5 million and implementation is on-going for these. For 2018, the program was able to approve 58,062 households with an estimated cost of PhP 217.7 million.

Household Electrification Program using Renewables[47]

HEP is carried out by utilizing mature RE technologies such as photovoltaic solar home system (PV SHS), PV streetlights and micro-hydro systems (if a hydropower resource is available within a reasonable distance from the clustered household beneficiaries.

Program implementation resulted in benefitting 6,738 households in Mindanao for 2018. Additionally, 55 communal SHS and 44 solar streetlights were also installed.

Photovoltaic (PV) Mainstreaming under Access to Sustainable Energy Program

ASEP's primary objective is to assist the Philippines in expanding sustainable energy generation to meet the growing economic needs and provide energy access to the poor and marginalized sector in accordance with the Philippine Development Plan (PDP). One component of the program is to implement SHS mainstreaming/fee-for-service approach for dispersed households and highly remote areas within the franchise of concerned DUs and ECs.

Participating ECs in Mindanao include COTELCO-PPALMA, SOCOTECO II, COTELCO, SUKELCO, DASURECO and ZAMSURECO. The Photovoltaic Mainstreaming (PVM) target is around 40,500 households.

For 2018, 3,704 households in Mindanao are targeted (funded under the government counterpart of PVM to be provided with electricity access. These households are under the franchise areas of ZAMSURECO I (1,129 households) and SULECO (2,575 households) and are currently undergoing the procurement process.

As a way forward on electrification for 2019, the DOE intends to carry out the following:

a) implement the total electrification master plan; and
b) issue a Department Order that will specify the administrative operational guidelines (AOG) of the financial benefits under ER 1-94 from DOE to host beneficiaries.

Agus-Pulangi Rehabilitation Project[48]

The Power Sector Assets and Liabilities Management Corporation (PSALM) and NPC lead the implementation of the Agus-Pulangi Rehabilitation Project. The project intends to extend the life of the plant's equipment and increase capacity if feasible. The project's scope entails rehabilitating the electrical and mechanical components of 18 units of the Agus-Pulangi complex with a 932.1 MW rated capacity. The estimated investment requirement/project cost is PhP 50 Billion and the funding scheme being considered is through the Official Development Assistance (ODA).

Ongoing preparation of bid documents is being undertaken for the project. For 2018 – 2019, the concerned agencies will undertake project approval, preparation of the terms of reference (TOR), procurement activities, and negotiation for funding source. The project implementation is scheduled from 2020-2022.

Acquisition of Dredging Machine and Accessories for Pulangi IV HEP[49]

The dredging machine to be acquired will be used in removing sediments that accumulated in the Pulangi Lake (reservoir), which has resulted in poor water quality affecting plant operations. The budget for the program will be proposed for 2020 and if approved, implementation will also be on the same year.

[47] Ibid
[48] Source: PSALM submission to DOE on Programs and Projects to be included in MEP dated 7 February 2018
[49] Ibid

IX. TRANSMISSION DEVELOPMENT

*Efficient transmission planning is imperative in identifying and analyzing appropriate transmission investments and grid development strategies that will help address future transmission issues. From this perspective, the **Transmission Development Plan (TDP) 2016-2040** of NGCP, approved by the DOE, serves as the planning and programming framework to continually improve the reliability, adequacy, security and stability of the grid in the three major island groups of the Philippines.*

Consistent with the DOE's Power Development Plan 2016-2040, the TDP 2016-2040 provides the long-term view of the country's transmission network encompassing all approved projects for the 4th Regulatory Period (2016-2020), crucial projects for implementation in the 5th Regulatory Period (2021-2025) and the indicative transmission projects for the succeeding five-year intervals until 2040.

In Mindanao, the National Grid Corporation of the Philippines (NGCP) is spurring significant investments on generation entry-driven transmission projects triggered by the influx of bulk generation capacity additions from a number of new coal-fired power plants and in consideration of aggressive plans for future plant expansions. The transmission requirements generally consist of reinforcements and extensions of the existing transmission lines, development of various transmission backbones and island interconnections, and transformer capacity additions in the substations for continuous adequate supply for the load customers. Realization of these future grid developments will support the system to be consistent with the basic requirements and standards of the Philippine Grid Code and will enable the region to reliably meet its existing and forecasted power demand.

ERC APPROVED TRANSMISSION PROJECTS

The transmission projects included in the TDP 2016-2040 as approved by ERC are in various stages of implementation. For Mindanao, the list of completed and energized transmission projects within 2014 to 2016 period is summarized in Table 91.

Table 91. LIST OF COMPLETED PROJECTS, 2014-2016

Project Name/Component		Purpose	Date of Energization
Mindanao S/S Reliability Project 1 • Aurora S/S • Jasaan S/S	3rd REG	To provide N-1 contingency transformers at various substations	 Feb 2014 Dec 2015
Villanueva-Maramag 230KV T/L	PUC*	To complete the transmission corridor from northern to southern Mindanao	Aug 2014
Balo-I -Villanueva 230 kV T/L • Baloi -Villanueva T/L • Baloi S/S • Villanueva S/S	PUC*	To provide new transmission corridor to Agus hydro for higher reliability	 Jan 2015 Jan 2015 Jan 2015
Malita-Matanao 230kV T/L	ERC-Approved (Nov 2014)	To accommodate the grid connection of SMCPC's CFPP	Mar 2016
Maramag-Kibawe 138kV T/L	3rd REG	To strengthen the existing 138kV double circuit Maramag Kibawe Transmission Line and to relieve Maramag-Kibawe transmission line from overloading due to the frequent outage of the Agus 2- Kibawe 138kV line.	Apr 2016
Matanao-Gen. Santos 138kV	3rd REG	To provide N-1 contingency transformers at various substations	Jun 2016

Table 91. LIST OF COMPLETED PROJECTS, 2014-2016

Project Name/Component		Purpose	Date of Energization
Opol 138 kV S/S Project & Associated T/L	ERC-Approved (Jul 2013)	To address the increase in demand and improve power quality in the area	Aug 2016
Mindanao S/S Expansion Project 2 • Gen. Santos S/S • Kidapawan S/S	3rd REG	To add substation capacity to meet load growth	Aug 2016 Nov 2016

Source: NGCP's Transmission Project Status Report as of 31 May 2017
PUC – Project under Construction

The updates on several transmission projects that are currently in progress are summarized in Table 92 with the indicated expected time of completion (ETC).

Table 92. LIST OF ONGOING PROJECTS, 2018-2022

Name Of Project		Purpose	Expected Time of Completion	Cost Estimate (Million Pesos)
Manolo Fortich (Lingion) 138 kV Switching Station		To accommodate the grid connection of Hedcor's 68.8 MW HEPP	February 2018	358
Aurora-Polanco 138-kV T/L	PUC	To boost the power delivery service to the increasing power demand in northern part of Zamboanga Peninsula	June 2018	1,889
Sultan Kudarat (Nuling) Capacitor Project	PUC	To mitigate the projected low voltage problems in Maguindanao area	June 2018	64
Agus 6 Switchyard Upgrading/ Rehabilitation	ERC -Approved (Sep 2013)	To upgrade the existing obsolete and aging primary and secondary equipment and devices in Agus 6 Switchyard	June 2018	721
Agus 2 Switchyard Upgrading/ Rehabilitation	ERC -Approved (Sep 2013)	To upgrade the existing antiquated and aging primary and secondary equipment and devices in Agus 2 Switchyard	January 2018	569
Mindanao 230 kV Transmission Backbone Project	ERC -Approved (Aug 2016)	To increase transfer capacity of the existing corridor and maintain the N-1 contingency provision.	March 2019	6,858
Balo-i-Kauswagan 230 kV Transmission Line (Formerly Balo-i-Kauswagan-Aurora 230 kV Transmission Line (Phase 1))	ERC-Approved (08-Jun-2015)	To accommodate the proposed 600 MW coal-fired power plant of GNPower in Kauswagan	April 2018	2,222
Kauswagan–Lala 230 kV Transmission Line(Formerly Balo-i–Kauswagan–Aurora 230 kV Transmission Line (Phase 2)	ERC-Approved (08-Jun-2015)	To enhance reliability of power delivery towards Zamboanga Peninsula. This will also complement the transmission of excess power from Mindanao Grid towards the Visayas Grid and vice versa.	December 2020	5,347
Toril 138 kV S/S, Phase 2	ERC-Approved (Nov 2013)	To add substation capacity to provide N-1 contingency	February 2019	956
Butuan-Placer 138kV T/L Project	3rd REG	To provide N-1 contingency	October 2018	924
Tacurong-Kalamansig 69 kV T/L Project	ERC-Approved (Nov 2013)	To provide grid connection to the off-grid municipalities in Sultan Kudarat province	September 2021	1,257
Mindanao Substation Upgrading		To add substation capacity to provide N-1 contingency	December 2022	5,065
Mindanao Substation Rehabilitation		To upgrade the existing obsolete and aging primary and secondary equipment and devices in various Mindanao Substations	December 2022	3,451

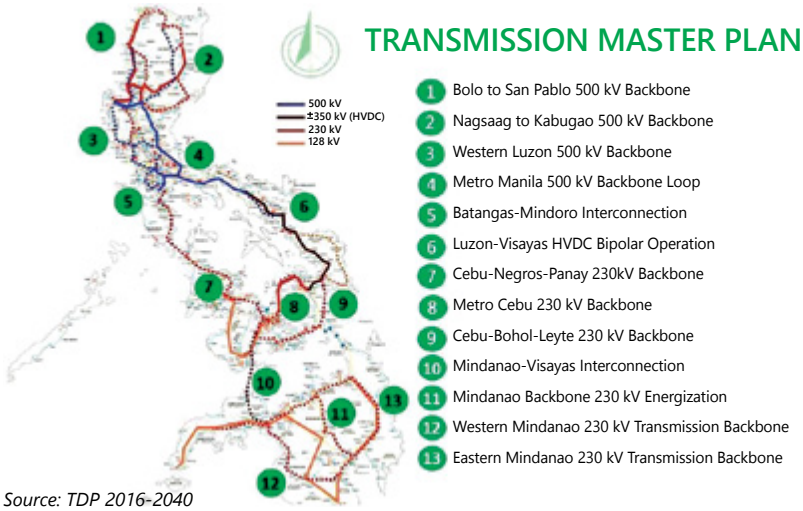
MAJOR ISLAND/GRID INTERCONNECTION

Transmission Master Plan

Responding to the need to upgrade and expand the existing transmission system, the development of transmission backbones and island interconnections are among the consideration in terms of grid reinforcement especially these days that the region is experiencing electricity oversupply. With increased interconnection, the sharing of larger volume of power throughout the grid will enhance the network security of supply.

The Transmission Master Plan (TMP) of NGCP is in line with its thrust of building the strongest power grid in Southeast Asia contributing to the social and economic development of the country and satisfying its stakeholders' needs. In reference to the TMP, four major projects have been proposed for implementation in Mindanao as summarized in Table 93. These large-scale transmission projects are significant bridge for moving the nation's objective of having a unified grid and modernized transmission network. With the efforts to establish a reliable and cost-effective transmission facility, the regional energy needs will be met in a more efficient manner.

Figure 54. TRANSMISSION BACKBONES AND ISLAND INTERCONNECTIONS



Source: TDP 2016-2040

Table 93. TMP PROPOSED PROJECTS FOR MINDANAO, 2016-2040

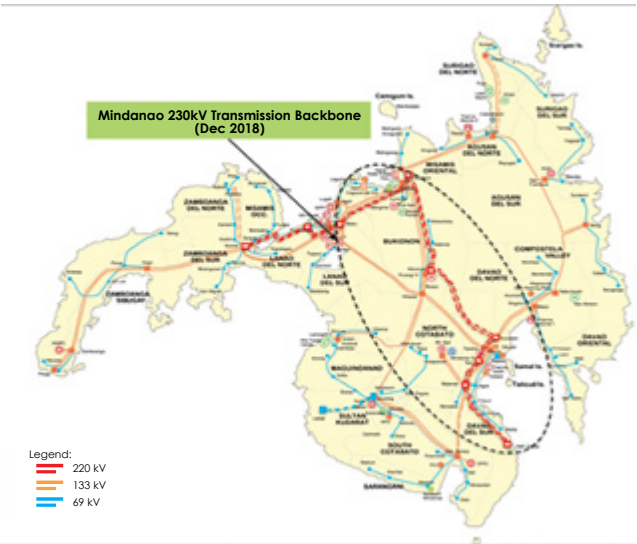
Project Name	Provinces	Expected Time of Completion
Mindanao 230 KV Backbone	Mindanao Island	Mar 2019
Mindanao-Visayas Interconnection Project	Cebu, Lanao del Norte, Zamboanga del Norte	Dec 2020
Eastern Mindanao 230 kV Transmission Backbone	Agusan del Norte, Agusan del Sur, Compostella Valley	Dec 2025
Western Mindanao 230 kV Transmission Backbone	Zamboanga del Sur, Sultan Kudarat, Maguindanao, South Cotabato	Dec 2040

Among these transmission projects, the Mindanao 230 kV Transmission Backbone and Mindanao-Visayas Interconnection Project are already programmed for implementation within the Fourth Regulatory Period (2016-2020).

- **Mindanao 230 kV Transmission Backbone Project**

The energization of Mindanao backbone from 138 kV to 230 kV voltage level will support the impending entry of huge capacity power plants in Mindanao and serve as major transmission highway delivering both renewable and conventional energy throughout the island. The project has two major components: the *Matanao-Toril-Bunawan 230 kV Transmission Line* and the energization of the existing *Mindanao Transmission Backbone (Balo-I-Villanueva-Maramag-Bunawan)* to 230 kV voltage level. This project is similarly considered to play a vital role in the exchange of power between Mindanao and Visayas in consideration of the proposed Mindanao-Visayas Interconnection Project. Expected completion of the project is on March 2019.

Figure 55. MINDANAO 230 kV TRANSMISSION BACKBONE



- **Mindanao-Visayas Interconnection Project**

The implementation of the Mindanao-Visayas Interconnection Project (MVIP) is in support of the government's vision to finally interconnect the three major grids into a single national grid. Formerly known as Visayas-Mindanao Interconnection Project (VMIP), the project was changed to MVIP to indicate the importance and priority given to Mindanao which has long been isolated. The proposed interconnection is expected to improve the overall power supply security of the country by allowing power reserves sharing among the grids in times of supply shortfall.

Based on the results of the hydrographic survey conducted in 2016, the MVIP will traverse the country's western seaboard in the area between the islands of Cebu and Zamboanga.

Complementing the operationalization of the Wholesale Electricity Spot Market (WESM) in Mindanao, the project will promote an open, liberalized and competitive electricity market nationwide since it will maximize the use of available energy resources and additional generation capacities that include renewable energy resources.

Figure 56. CONNECTION CONFIGURATION OF MVIP

On July 2017, NGCP was granted by Energy Regulatory Commission (ERC) the provisional authority to implement the project. On May 2018, the project qualified as an Energy Project of National Significance (EPNS) and was issued a Certificate (CEPNS) by the Energy Investment Coordinating Council (EICC) created under Executive Order No. 30 (EO 30) issued by the President in June 2017. This PhP52-billion interconnection project is estimated to be completed in 40 months or by December 2020.

SMALL ISLAND INTERCONNECTION PROJECTS

The power system in the small islands and isolated grids (SIIG) or missionary areas in the region is being operated and managed by the Small Power Utilities Group (SPUG) of the National Power Corporation (NPC) or the private sector through New Private Provider (NPP) and the Qualified Third Party (QTP).

Considering the manifold social and economic benefits of interconnecting the SIIGs with the main grid, the current Administration puts equal emphasis and importance to grid and off-grid areas in terms of development planning. To further cope with this commitment, expanding energy access and the total electrification of the SIIGs is a top priority of the department. Summarized in Table 94 are the potential small island interconnections in Mindanao indicating the length of the required facilities and the peak load in the island for 2015 and the projection in 2040.

Table 94. POTENTIAL SMALL ISLAND INTERCONNECTIONS IN MINDANAO

Island	Interconnection Point	Length (kms)		2015 Peak Demand (MW)	2040 Peak Demand (MW)
	(Town)	Submarine	Overhead		
Tawi-Tawi	Pagatpat	84	60	5.66	31.93
Basilan	Pitogo	27	12	8.67	29.04
Sulu	Taberlongan	100	34	8.34	20.11
Samal	Lasang	9	21	5.99	14.81
Dinagat	Canlanipa	30	15	3.16	13.22
Siargao	Cagdiano	13	7	5.13	11.28
Camiguin	Esperanza	30	37	4.33	8.95
Siasi	Parang	43	32	0.7	1.84

Note: Further project assessments are required for the small island interconnections listed above

Linking these small island provinces to the grid is important to utilize most of the region's excess reserves. However, detailed studies are still necessary to support and determine the substantial benefits of interconnection to the receiving island.

PROPOSED TRANSMISSION PROJECTS

In addition to the already approved projects by ERC, several transmission projects have been proposed to address the foreseen transmission needs in the region. Shown in Table 95 is the list of transmission projects planned for Mindanao within the planning horizon.

Table 95. PROPOSED TRANSMISSION PROJECTS IN MINDANAO

Project Name	Driver	Province(s)	ETC
Kabacan 138 kV Substation	System Reliability	North Cotabato	Dec 2021
Nasipit Substation Bus-In (formerly Villanueva-Jasaan-Butuan 138 kV Transmission Line)	System Reliability	Agusan del Norte	Dec 2021
Villanueva–Butuan 230 kV Transmission Line	Load Growth	Misamis Oriental, Agusan del Norte	Dec 2022
Mindanao Substation Expansion 3 Project	Load Growth	Mindanao Island	Dec 2023
San Francisco– Tandag 138 kV Transmission Line	System Reliability	Agusan Del Sur, Surigao Del Sur	Dec 2023
Maco–Mati 138 kV Transmission Line	System Reliability	Compostela Valley, Davao Oriental	Dec 2023
Opol Substation Bus-in (formerly Balo-i-Tagoloan-Opol 138 kV Transmission Line)	System Reliability	Lanao del Norte and Misamis Oriental	Dec 2025
Sultan Kudarat–Tacurong 230 kV Transmission Line	System Reliability	Maguindanao, Sultan Kudarat	Dec 2025
Eastern Mindanao 230 kV Transmission Line Project	System Reliability	Agusan del Norte, Agusan del Sur, Compostela Valley	Dec 2025
Matanao 230/138 kV Transformer	Load Growth	Davao del Sur	Dec 2030
Lala–Malabang–Sultan Kudarat 230 kV Transmission Line	System Reliability	Lanao del Norte, Lanao del Sur, Maguindanao	Dec 2030
Siom–Sindangan– Salug 69 kV Transmission Line	System Reliability	Zamboanga Del Norte	Dec 2030
Davao–Samal 69 kV Interconnection	Interconnection	Davao del Norte	Dec 2030
Zamboanga–Basilan 69 kV Interconnection	Interconnection	Zamboanga del Sur, Basilan	Dec 2030
Bislig-Baganga 138 kV Transmission Line	System Reliability	Davao Oriental, Surigao del Sur	Dec 2035
San Francisco-Tandag 138 kV Transmission Line 2	System Reliability	Surigao del Sur, Agusan del Sur	Dec 2035
Naga-Salug 138 kV Transmission Line	System Reliability	Zamboanga del Sur, Zamboanga del Norte	Dec 2035
Sultan Kudarat-Tacurong 230 kV Transmission Line 2	System Reliability	Maguindanao, Sultan Kudarat	Dec 2035
Maco-Mati 138 kV Transmission Line 2	System Reliability	Davao Oriental, Compostela Valley	Dec 2035
Lala–Naga 230 kV Transmission Line	System Reliability	Zamboanga del Sur, Lanao del Norte	Dec 2040
Baganga–Mati 138 kV Transmission Line	System Reliability	Davao Oriental	Dec 2040
Lala–San Miguel 138 kV Transmission Line	System Reliability	Zamboanga del Sur, Lanao del Norte	Dec 2040
Nabunturan– Bunawan 230 kV Transmission Line	System Reliability	Davao del Norte	Dec 2040
Matanao–Tacurong 230 kV Transmission Line	System Reliability	Davao del Sur & Sultan Kudarat	Dec 2040

IDEAL LOCATIONS OF POWER PLANTS

The implementation and operationalization of massive infrastructure projects in Mindanao under the current Administration's "Build, Build, Build" program is envisioned to have a major impact on the region's economic development. In effect, transmission system reinforcements will eventually be required to serve new generation developments that will be needed to sustain its economic growth.

The proposed locations for new power plants take a strong role in optimizing the construction of transmission infrastructures to connect new power sources to the grid. At present, the entry of generation facilities depends on the existing capacity of the grid since some of existing transmission facilities in generation potential areas are unable to accommodate bulk generation addition. In an effort to maximize the capability of the existing network, it is helpful for generation investors to have a guide on where new power projects should be put up to ensure the availability of connection points that will accommodate power plants in the area.

Shown in Figure 57 are the recommended power plant connection points in Mindanao grid where new power plants may connect without the need for any significant transmission reinforcement. For the period 2016-2025, the ideal locations of power plants for the 138kV system are: (1) Pitogo, Zamboanga del Sur; (2) Aurora, Zamboanga del Sur; (3) Villanueva, Misamis Oriental; (4) Bislig, Agusan del Sur; (5) Maramag, Bukidnon; (6) San Francisco, Agusan del Sur; (7) General Santos and, (8) Tacurong, Sultan Kudarat. Each of the substations can accommodate 100 MW of power capacity. In addition, both the 230kV Culaman Substation and 230kV Toril Substation in Davao can accommodate 300MW of power capacity. Siting new generation capacities adjacent to these substations will in turn reduce the needed investment costs for new transmission facilities.

IDENTIFIED SITES FOR BULK LOAD GROWTH

The expected boost in investments in Mindanao will definitely entail significant load requirements. One of the associated key challenges is how will the transmission

Figure 57. RECOMMENDED POWER PLANTS CONNECTION POINTS

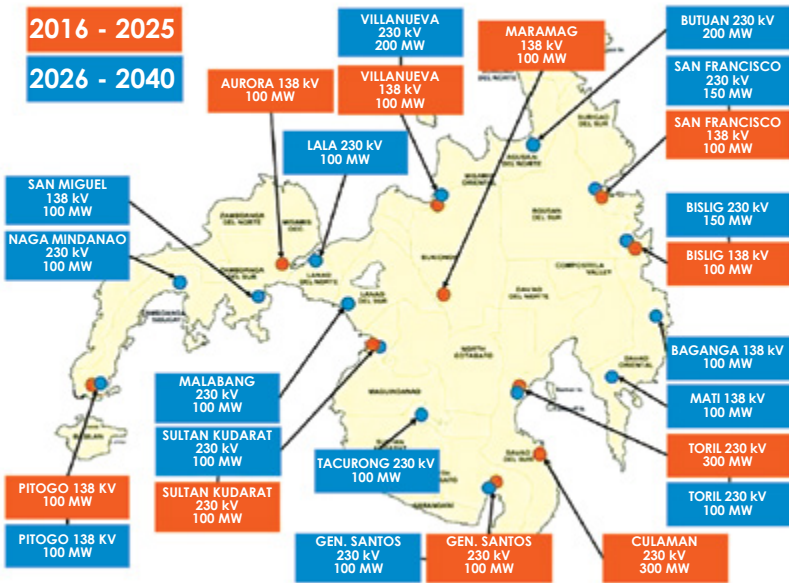


Table 96. IDENTIFIED AREAS IN MINDANAO FOR BULK LOAD GROWTH

Areas Where Bulk Load Growth is Recommended to Absorb Excess Generation	
Zamboanga del Sur (170 MW)	Agusan del Sur (30 MW)
Zamboanga del Norte (25 MW)	Agusan del Norte (55 MW)
Lanao del Norte (8 MW)	Davao del Sur (20 MW)
Misamis Oriental (60 MW)	Compostela Valley (50 MW)
Bukidnon (8 MW)	Cotabato (40 MW)
Surigao del Norte (60MW)	South Cotabato (65 MW)
Surigao del Sur (2 MW)	Sultan Kudarat (75 MW)

network be able to meet the growing load demand without heavily investing on new transmission facilities. One possible solution is for bulk load growth to take place in areas with huge excess generation capacity so that grid reinforcements can be avoided or delayed. This will result to significant increase in the local load absorption which can help stabilize the grid as it reduces the loading in the existing transmission line due to excess power that needs to be exported to the other parts of the grid. As balancing the grid is becoming more complex along with the increased amount of intermittent power generation, the bulk load growth can also help maintain the supply-demand balance. Table 96 shows the identified areas in Mindanao where bulk load growth is recommended to absorb excess generation.

INTERSTATE INTERCONNECTION

The successful implementation of cross-border interconnection projects among Association of Southeast Asian Nation (ASEAN) member countries opens opportunities in terms of investment and technology transfer towards the envisioned regional transmission interconnection projects in Brunei Darussalam-Indonesia-Malaysia-Philippines (BIMP) region. The Heads of ASEAN Power Utilities & Authorities (HAPUA), an association promoting regional power interconnection, has identified Borneo (Kalimantan, Sarawak, Sabah, and Brunei Darussalam) as the main energy resource center to enhance power security and enable interisland power trade across the BIMP region.

Through Brunei Darussalam-Indonesia-Malaysia-Philippines East ASEAN Growth Area (BIMP-EAGA), the discussions on interconnecting the power transmission of Borneo to Philippines are being undertaken with two suggested routes such as the Sabah-Luzon via Palawan and the Sabah-Mindanao via Zamboanga. The former was identified under the ASEAN Interconnection Master Plan Study (AIMS II) while the latter continued to be one of the future transmission options for inter-ASEAN interconnections.

In a pre-feasibility assessment entitled *"An Evaluation of the Prospects for Interconnections among the Borneo and Mindanao Power Systems"* which was conducted by Asian Development Bank in 2014 (ADB TA-8040 REG: Master plan on ASEAN Connectivity Implementation), the Sabah–Mindanao power interconnection is being planned as part of the inter-Borneo interconnection projects. The proposed project is a 400-km HVDC line directly link to Zamboanga in Mindanao with an export power capacity up to 600MW. However, this would require Sabah to be interconnected first to Sarawak since the main supply will likely be supported by hydropower from Sarawak to be wheeled through the Sabah 275kV systems. With the result of this preliminary study, further detailed studies are required to support and determine all the possible options that will make the proposed interconnection viable. It is also important that the MVIP is already in place to first unify the Philippine Grid and to strengthen the Mindanao power system.

It should be noted that the proposed interconnection via Mindanao must continuously be explored and assessed while being considered as an option in securing the adequate power in the region. However, the realization of this project will much depend on the requirements of the power systems as well as the governing laws and regulations given the differences in the electric power industry structure of the trading sub-regions.

X. INVESTMENT PORTFOLIO

Energy is unquestionably a fundamental element in fuelling economic growth and development. The Mindanao region, in its quest for equitable progress and economic competitiveness vis-à-vis Luzon and Visayas islands, necessitates adequate energy infrastructures to ensure the delivery of sufficient, reliable and reasonably-priced energy supply to meet the growing energy demand.

Taking into consideration the technical structure, such as complex engineering designs, advanced technological configurations and significant fixed costs, investments in the energy sector is by nature heavily capital intensive.

This chapter briefly enumerates Mindanao's energy investment portfolio, underscoring capital cost estimates of energy infrastructures covering the downstream oil and gas and power sectors. It depicts the estimated amount of monetary resources needed in constructing energy facilities, such as oil storage and refinery, liquefied natural gas (LNG) receiving terminal, floating storage regasification unit (FSRU), power transmission system upgrades, and power plant capacity additions.

Mindanao's investment portfolio entails different capital requirements, depending on several assumptions such as economic growth scenarios (i.e. high and low), available infrastructure technologies (e.g. on-shore LNG facility vs. FSRU, etc.), and the different energy supply options (i.e. reference, alternative and nuclear), among others.

For each of these assumptions, cost estimates are calculated in a per unit price of an energy facility or infrastructure capacity. These cost estimates are benchmarked from prevailing international prices, expressed in million U.S. dollars (USD) at 2017 prices.

OVERALL INVESTMENT REQUIREMENT

The overall energy investment requirement in Mindanao only covers the aggregate capital cost expenditure for each energy sub-sector, essential in financing energy infrastructure projects.

For the downstream sector, the investment requirement considers on-shore LNG receiving terminal (with regasification facility), while the FSRU serves as an alternative option in lieu of a land-based LNG facility, which offers a much lower investment cost. The sector's investment also includes the additional capacity for oil depot/storage to address the growing oil demand of the island, as well as the possible hosting of refinery facilities.

Investment in the power sector comprises both the power generation and transmission network. The National Grid Corporation of the Philippines (NGCP), being the franchise holder through a concession agreement with the government, upholds the responsibility of infusing capital investments in maintaining and upgrading the national transmission grid. On the other hand, investments in the power generation remains to the private sector and considers different power supply scenarios – *Reference, Alternative* and *Nuclear.*

For the upstream sector, the successful launching of the 5th Philippine Energy Contracting Round (PECR 5) in 2014 led to the awarding of seven (7) coal operating contracts (COCs) in Mindanao region. Currently in the exploration phase, these COCs have previously contributed a significant amount of investments to the island region, and in the coal industry. As a key priority strategy of the government towards conventional energy resource exploration and development, the DOE is constantly identifying new prospective areas covering potential indigenous oil, gas and coal resources that will be offered to the private investors through the Philippine Conventional Energy Contracting Program (PCECP). In anticipation of the next PCECP round, upstream investments are not accounted in Mindanao's investment portfolio.

The overall investment requirement can be classified into two (2) options – *Investment Option 1 and Investment Option 2*. In *Investment Option 1*, downstream investment considers the default on-shore LNG terminal, and the total investment for the power sector across three supply options. On the other hand, *Investment Option 2* encapsulates downstream investment covering FSRU instead of the LNG terminal.

Energy Investments, High Growth Scenario (HGS)

In *Investment Option 1* under HGS, the Nuclear power supply scenario as shown in Table 97 requires the highest cumulative investment at USD 38.6 billion. Alternative power supply scenario with a capital requirement of USD 35.8 billion follows next while the Reference power supply scenario garnered the lowest investment requirement at USD 34.3 billion. On the average, investment in power sector accounts for more than 80.0 percent of total, while the remaining is allocated for downstream sector. On the other hand, *Investment Option 2* is USD 575 million less than *Investment Scenario 1* due to lower capital cost of FSRU.

Table 97. TOTAL ENERGY INVESTMENT REQUIREMENTS BY SCENARIO, 2018 -2040 (USD Million 2017 Prices)

	HGS	LGS
DOWNSTREAM SECTOR		
Oil Facilities and On-shore LNG Terminal	5,182.1	4,316.6
Oil Facilities and FSRU	4,607.1	3,856.6
POWER SECTOR		
Transmission and Generation *(Reference Supply)*	29,087.8	17,156.0
Transmission and Generation *(Alternative Supply)*	30,580.6	18,495.1
Transmission and Generation *(Nuclear Supply)*	33,439.7	21,354.4
TOTAL : INVESTMENT OPTION 1		
Downstream *(On-shore LNG)* + Power *(Reference)* Supply	34,269.9	21,472.6
Downstream *(On-shore LNG)* + Power *(Alternative)* Supply	35,762.7	22,811.7
Downstream *(On-shore LNG)* + Power *(Nuclear)* Supply	38,621.8	25,671.0
TOTAL : INVESTMENT OPTION 2		
Downstream *(FSRU)* + Power *(Reference)* Supply	33,694.9	21,012.6
Downstream *(FSRU)* + Power *(Alternative)* Supply	35,187.7	22,351.7
Downstream *(FSRU)* + Power *(Nuclear)* Supply	38,046.8	25,211.0

Energy Investments, Low Growth Scenario (LGS)

For *Investment Option 1* under LGS, energy infrastructures in Mindanao require a total investment allotment of USD 21.5 billion in the Reference supply scenario; USD 22.8 billion in the Alterative supply scenario; and USD 25.7 billion in the Nuclear supply scenario (Table 97). Investments in LGS decline by 35.0 to 45.0 percent from HGS. Similarly, the power sector gets the bulk of the total investment at 86.1 percent, on the average. As described above, the amount of investment in Investment Option 2 is USD 460.0 million lower.

DOWNSTREAM OIL AND GAS INVESTMENTS

Capital infusion in the downstream oil and natural gas sectors cover new facilities that should be in place to ensure security of supply in Mindanao. Energy infrastructures needed are additional storage facilities, oil refining or processing, and LNG facilities (or FSRU) to receive natural gas to fuel the gas-fired power plants considered in the capacity and generation mix for Alternative and Nuclear power supply scenarios.

Based on the capital cost[50] per facility as presented in Table 98, the required total downstream investment with an on-shore LNG receiving terminal is estimated at USD 5.2 billion for HGS and 4.3 billion in LGS. Alternatively, the investment costs can be trimmed down to USD 4.6 billion (HGS) and USD 3.9 billion (LGS), if FSRUs will be deployed instead of land-based LNG terminals. An itemized cost estimate of downstream investments is shown in Table 99 below.

Table 98. DOWNSTREAM INVESTMENT REQUIREMENT, 2018-2040 (USD Million, 2017 Price)

DOWNSTREAM FACILITY	HGS	LGS
Oil Storage	282.1	196.6
Oil Refinery	4,000.0	3,400.0
On-Shore LNG Terminal	900.0	720.0
FSRU (Replacement of LNG Terminal)	325.0	260.0
TOTAL INVESTMENT, ON-SHORE LNG TERMINAL	**5,182.1**	**4,316.6**
TOTAL INVESTMENT, FSRU	**4,607.1**	**3,856.6**

Table 99. CAPITAL COST FOR DOWNSTREAM FACILITIES (USD 2017 Price)

DOWNSTREAM FACILITY	COST
Oil Storage (USD/Barrel)	USD 60.0 / barrel
Oil Refinery (USD/Barrel per Day)	USD 40,000.0 / barrel per day
On-Shore LNG Terminal (USD/Tonne per Day)	USD 360.0 / tonne per day
FSRU (replacement of LNG Terminal)	USD 130.0 / tonne per day

Regardless of growth trend scenarios, the biggest chunk of downstream investments is allocated for oil storage and refining facilities to accommodate the rising demand for petroleum products in Mindanao. Meanwhile, allotment for natural gas associated infrastructures gets a fair share of the total downstream capital requirement, which will support the government's plan of developing the

[50] Obtained from different international sources, such as the International Energy Agency (IEA), the International Gas Union (IGU), and Oil and Gas Journal.

Philippines as an LNG hub. The cumulative downstream investment requirements for the period 2018 to 2040 by growth scenario is included in Annex 63.

Oil Storage

Over the next two decades, oil continuously dominates other fuels and remains as the primary fuel to sustain the Mindanao's growing economy. With the projected increase in oil demand, the existing oil storage capacity of 3,767 thousand barrels (MB) should be augmented to be able to meet a 30-day inventory level or stockpile (as assumed in this plan). The investment cost in putting up an oil storage facility is estimated at USD 60 per barrel. This figure is based on the 2016 World Energy Investment (WEI) report of the International Energy Agency (IEA), with cost adjustments due to inflation to reflect the 2017 level.

Table 100. OIL STORAGE INVESTMENT REQUIREMENTS, 2018-2040

	HGS	LGS
Final Oil Demand, (in MB)	73,882	63,598
Total Storage Requirement @80% Capacity Utilization Factor, (MB)	8,469	7,044
Existing Storage Capacity, (MB)	3,767	3,767
Additional Storage Capacity, (MB)	4,702	3,277
CUMULATIVE INVESTMENT COST, (USD million)	**282.1**	**196.6**

On top of the existing oil storage capacity, Mindanao needs an additional 4,702 MB (HGS) and 3,277 MB (LGS) of oil storage at 80.0 percent capacity utilization factor. The cumulative capital investment for these new facilities will cost around USD 282.1 and USD 196.6 million for HGS and LGS, respectively (Table 100).

Oil Refinery

The continued dependence on petroleum fuels by the transport sector in Mindanao opens the opportunity for possible oil refinery operation in the island to supplement supply and delivery of oil products. As projected demand reaches 202.4 thousand barrels per day (MB/d) in HGS and 174.2 MB/d in LGS in 2040, oil refinery may be put up with a total capacity of 100.0 MB/d (HGS) and 85.0 MB/d (LGS) within the planning period on the assumption of providing half of total oil demand in the island. The investment costs for oil refinery plants are estimated at USD 4.0 billion in HGS and USD 3.4 billion in LGS, calculated based on the 2017 adjusted price for oil refinery at USD 40,000/barrel per day capacity (Table 101).

Table 101. OIL REFINERY INVESTMENT REQUIREMENT, 2018-2040

	HGS	LGS
Average Daily Oil Consumption in 2040, (MB/d)	202.4	174.2
Refinery Capacity, (MB/d)	100.0	85.0
CUMULATIVE INVESTMENT COST, (USD million)	**4,000.0**	**3,400.0**

Natural Gas Infrastructures

Funding requirement for natural gas related facility accounts for the smallest portion of the total downstream sector's investment. With the anticipated depletion of indigenous natural gas resources from the Malampaya gas field by 2024 to 2025, the government is now preparing for the eventual importation of LNG, and thus investment in LNG receiving terminal has become a priority. The construction and operation of an LNG terminal in Mindanao by 2025 coincides with the foreseen importation of natural gas to provide the fuel supply for the gas power plants in Luzon. The entry of natural gas power plants in the Alternative and Nuclear scenarios by 2025 reflects the government's initiative to expand the contribution of natural gas in power generation mix and for non-power applications.

There are several considerations in determining the type of LNG infrastructure or facility that should be constructed. These include certain market conditions, demand level, economies of scale, geographical location, public safety, political decision, and environmental constraints, among others.

Typically, land-based LNG terminal is more multifunctional compared with other types of LNG facilities. These functionalities include reloading of LNG feeders, bunkering of vessels and LNG tanker truck loading systems. Because of these multifunction features, capital expenditure requirement for this type of LNG facility is technically higher, and thus more capital intensive.

On the other hand, FSRU is easier to finance as it requires less investment compared with land-based LNG terminal. In general, FSRU involves lesser infrastructure, such as a mooring facility and an onshore receiving terminal. As such, it enables a shorter timetable in the construction phase making it convenient to deploy and commence operations.

While FSRU has an advantage in terms of investment cost, among the drawbacks for this type of facility include limited storage capacity and shorter life span than on-shore facility.

With reference to the World LNG 2018 Report published by the International Gas Union (IGU), constructing an on-shore LNG terminal would entail a capital cost of USD 360/tonne per day, while about USD 130/tonne per day for FSRU capacity.

Table 102 shows the Mindanao's LNG capacity requirement, expressed in million tonne per year (MTPY), as well as the comparative investment costs in developing an on-shore LNG terminal and FSRU.

Table 102. NATURAL GAS INFRASTRUCTURE INVESTMENT REQUIREMENT, 2018-2040

DOWNSTREAM FACILITY	HGS	LGS
On-Shore LNG Terminal		
Capacity Requirement, (MTPY)	2.5	2.0
Cumulative Investment Cost, (USD million)	900.0	720.0
FSRU (Replacement for LNG Terminal)		
Capacity Requirement, (MTPY)	2.5	2.0
Cumulative Investment Cost, (USD million)	325.0	260.0

For the planning period, the projected capacity requirement for LNG terminal in Mindanao is 2.5 MTPY in HGS and 2.0 MTPY in LGS. This entails a cumulative investment requirement amounting to USD 900.0 million (HGS) and USD 700 million (LGS) for on-shore LNG terminals. Alternatively, a much lower capital for FSRU is required at USD 325 million (HGS) and USD 260.0 million (LGS).

POWER SECTOR INVESTMENTS

Because of its integral role in nation building, electricity is considered as an indispensable commodity in all economic sectors. For the planning period, a large portion of Mindanao's total investment requirement is allocated to the power sector. This covers the capital expenditure for extensive infrastructures, such as the transmission network enhancement and new power generating plants that are vital in meeting the surging electricity demand while ensuring the stability and reliability of the island's power system.

Transmission System Projects

The NGCP, under the supervision of the National Transmission Corporation (TransCo) and with policy guidance from the DOE, is currently implementing priority transmission system projects in Mindanao. Primarily, these projects intend to enhance the current state of Mindanao's electricity grid and ensure the delivery of stable and reliable power to the end-users. With a total capital expenditure amounting to PHP 81.4 billion or USD 1.6 billion, these projects consist of extensive upgrades, rehabilitation and extension of existing transmission lines, construction of transmission backbones, and uprating of substations to accommodate load growth.

Among the big ticket projects that have been approved by the Energy Regulatory Commission (ERC) for implementation include the *Mindanao-Visayas Interconnection Project (MVIP)* with a total investment cost of PHP 51.7 billion (USD 994.2 million); the Mindanao 230 kV Transmission Backbone Project with a capital cost amounting to PHP 6.9 billion (USD 131.9 million); and the *Kauswagan-Lala 230 kV Transmission Line Phase 2* with an approved budget of PHP 5.3 billion (USD 102.8 million). These transmission projects are aligned with the government's goal of attaining a *"One Grid Philippines"* and are envisioned to further reinforce the stability of the Mindanao grid. Several other transmission projects are currently on the pipeline and are expected to be completed within the next five years.

As part of its function as the national power transmission grid's System Operator (SO), the NGCP is still eyeing for various transmission projects within the planning horizon. Among others, the main drivers of these proposed projects are compliant with the standards and basic grid requirements, such as enhancing system reliability, ensuring contingency reserves and accommodating bulk capacity additions.

Table 103. ESTIMATED CUMULATIVE INVESTMENT FOR NGCP's PROPOSED TRANSMISSION PROJECTS, 2018-2040

PROJECT CLASSIFICATION / MAIN DRIVER	NUMBER OF PROPOSED PROJECTS	COST ESTIMATES		% SHARE
		PHP MILLION	USD MILLION	
System Reliability	19	88,569	1,703.3	80.1
Small Island Interconnection	2	15,761	303.1	14.3
Load Growth	3	6,243	120.1	5.6
TOTAL	**24**	**110,573**	**2,126.4**	**100.0**

Source: National Grid Corporation of the Philippines (NGCP)
Foreign Exchange Rate: 1 USD = PHP 52

As shown in Table 103, NGCP needs to pour in around USD 2.1 billion for its proposed transmission projects within the planning period. Out of this total, the 19 projects for system reliability improvements get about 80.1 percent of the investment, amounting to USD 1.7 billion. The remaining portion is allotted for small island interconnection projects and grid reinforcement driven by load growth, with corresponding funding requirement amounting to USD 303.1 million and USD 120.1 million or 14.3 percent and 5.6 percent shares, respectively. Detail of NGCP's proposed transmission projects with respective investment costs is listed in Annex 62.

Power Plant Capacity Additions

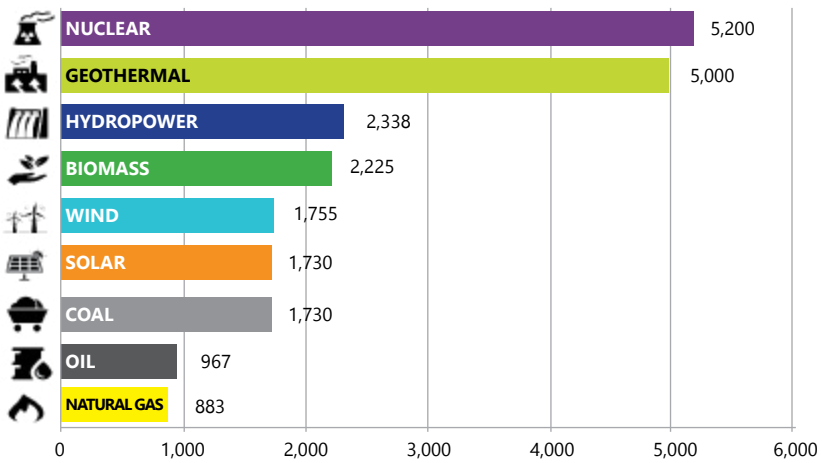
The largest share of Mindanao's investment portfolio is allocated for power generation capacity additions to have a balanced demand and supply power system. Depending on the power supply scenario, the financial resource allotment for future power generating plants varies accordingly.

The estimated capital requirements were based on the outcome of the power demand and supply simulations, utilizing the 2017 estimated costs in constructing power plants as benchmark prices, as well as the projected costs throughout 2040. Essentially, the additional power plant capacities ensure security of power supply to meet the island's projected peak demand including contingency reserve margin.

- **Power Plant Cost**

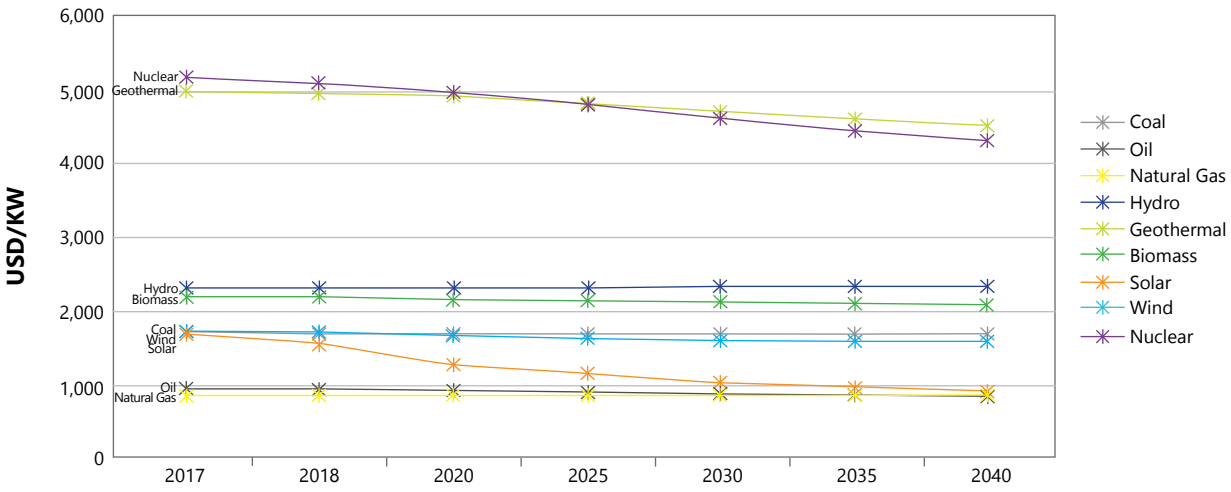
Figure 58 illustrates the 2017 capital cost of power plants per technology (USD/KW), excluding annual fixed and variable costs. The following references were used in investment estimation: World Economic Outlook 2016 by the IEA for coal (supercritical), nuclear, natural gas (combined-cycle gas turbine), biomass, hydropower, solar PV, and wind technologies; the Institute for Sustainable Futures (ISF) for oil-based power plant; and, the Kalinga Geothermal Power Project for geothermal resource based on local setting.

Figure 58. POWER PLANT COST PER TECHNOLOGY, 2017 PRICE (USD/KW)



At USD 5,200/KW, nuclear power remains as the most expensive technology in terms of capital cost while natural gas at USD 883/KW was the least expensive. Next to nuclear, renewables with cost estimates of USD 5,000/KW for geothermal; USD 2,338/KW for hydro; USD 2,225/KW for biomass; USD 1,755/KW for wind; and USD 1,730/KW for solar photovoltaic (PV) system. On the other hand, the investment costs for conventional type of power plants are appraised at USD 1,730/KW for coal-fired power plant and USD 967/KW for oil-based power plant.

Figure 59. POWER PLANT COST PER TECHNOLOGY, 2018-2040 (USD/KW)



Source: IEA, ISF and Kalinga Geothermal Power Project (adjusted)

The projected power plant cost per technology for the period 2018 to 2040 is presented in Figure 59. Due to the extensive mainstreaming of renewables in the capacity mix, investment costs of solar, wind, geothermal and biomass technologies are expected to decline as they become more competitive, except for hydro which is seen to slightly increase towards 2040. Similarly, oil-based and nuclear plant costs are also seen to go down towards the end of the planning period. Meanwhile, the capital costs for coal and natural gas power plants remain from the current levels based on IEA's forecast.

With the assumption that committed power projects have already obtained a financial closing from funding institutions, the total investment requirement only reflects indicative, potential, and new power plant capacity additions needed by the grid.

- Investments for Capacity Additions

In HGS, the Nuclear supply scenario accounts for the highest investment requirement equivalent to USD 31.3 billion, followed by the Alternative supply scenario with USD 28.5 billion. Meanwhile, the Reference supply scenario has the lowest investment needs at USD 27.0 billion (Table 104).

Table 104. POWER GENERATION CUMULATIVE INVESTMENT BY SUPPLY SCENARIO, 2018 TO 2040 (USD Million)

SUPPLY SCENARIO	HGS	LGS
Reference	26,961.4	15,029.6
Alternative	28,454.2	16,368.7
Nuclear	31,313.3	19,228.0

Compared with LGS, the investment for power plant capacity additions is lower by USD 12.1 billion, a cost reduction of 38.6 percent for Nuclear supply scenario; USD 12.1 billion or 42.5 percent reduction for the Alternative supply scenario; and USD 11.9 billion or 44.3 percent reduction for the Reference supply scenario.

Investment in High Growth Scenario

Reference Supply

Mindanao needs a cumulative investment of around USD 27.0 billion for new power generating capacities until 2040 (Table 105).

Table 105. CAPACITY ADDITION CUMULATIVE INVESTMENT, 2018 TO 2040 – REFERENCE, HGS (USD Million)

PLANT TYPE	2020	2025	2030	2035	2040
Coal	0.0	519.0	4,152.0	10,380.0	20,241.0
Oil	0.0	0.0	160.3	429.7	869.0
Natural Gas	0.0	0.0	0.0	0.0	0.0
Hydro	0.0	0.0	1,648.2	2,355.7	3,352.2
Geothermal	0.0	146.4	480.9	644.1	804.5
Biomass	195.6	195.6	266.9	266.9	266.9
Solar	457.5	619.9	840.5	1,044.6	1,427.9
Wind	0.0	0.0	0.0	0.0	0.0
TOTAL	**653.1**	**1,480.8**	**7,548.7**	**15,120.9**	**26,961.4**

Among power plant types or technologies, coal-fired power plants get the largest share at around 75.1 percent of the total investment, equivalent to USD 20.2 billion, while renewables account for 21.7 percent share or USD 5.9 billion. Oil-based receives the remaining 3.2 percent share or USD 869.0 million.

The annual cumulative investment for power plant capacity addition per technology in Reference supply scenario is included in Annex 64.

Alternative Supply

Compared with the Reference supply scenario, the total investment requirement for capacity addition increases to USD 28.5 billion in the Alternative supply scenario, considering the introduction of natural gas with a total capacity of 2,000 MW in the capacity mix, coupled with a much higher penetration rate of mature and variable renewable energy technologies.

For this supply option, investments for new coal-fired power plants accounts for more than half or 58.4 percent share of the total capital requirement, estimated at USD 16.6 billion. Renewables require 33.0 percent share with estimated aggregate capital costs of USD 9.4 billion. Roughly one-third of the investment for renewables is devoted for solar as the Alternative supply scenario considered more capacities from this technology. Wind also contributes to the total renewable share in this scenario with 750 MW capacity, equivalent to USD 1.2 billion investment. Similarly, investment for hydropower technology increases due to additional potential capacity of 328 MW (Table 106).

On the other hand, capacity addition investments for natural gas and oil-based power facilities obtain a 6.2 percent and 2.4 percent shares, with corresponding capital investment equivalent to USD 1.8 billion and USD 690.6 million, respectively.

Annex 66 provides the annual cumulative cost for power plant capacity additions in Alternative supply scenario.

Table 106. CAPACITY ADDITION CUMULATIVE INVESTMENT, 2018 TO 2040 – ALTERNATIVE, HGS (in USD Million)

PLANT TYPE	2020	2025	2030	2035	2040
Coal	0.0	519.0	2,076.0	8,304.0	16,608.0
Oil	0.0	0.0	91.5	338.6	690.6
Natural Gas	0.0	441.5	883.0	1,324.5	1,766.0
Hydro	0.0	0.0	1,648.2	2,355.7	4,127.2
Geothermal	0.0	146.4	480.9	644.1	804.5
Biomass	195.6	195.6	266.9	266.9	266.9
Solar	457.8	620.1	1,392.2	2,106.6	2,966.8
Wind	0.0	0.0	412.5	820.3	1,224.3
TOTAL	**653.4**	**1,922.6**	**7,251.2**	**16,160.6**	**28,454.2**

Nuclear Supply

Investment in the generation sector under the Nuclear supply scenario is higher by 9.1 percent compared with Alternative supply scenario. The entry of nuclear in the capacity mix displaces some capacities from coal resulting in a 9.4 percent decrease in coal investment in this scenario. Coal has relatively cheaper capital cost than nuclear with a USD 4.5 billion investment for a 1,000 MW capacity (Table 107). Since capacities from natural gas and renewables remain the same as in Alternative scenario, no changes in investments for these technologies. For oil-based, investment posted a 9.7 percent increase (up by USD 66.9 million) as additional 700 MW of oil-based capacity is seen necessary to accommodate peaking and reserve margin requirements.

The annual cumulative cost for power plant capacity additions in Nuclear supply scenario is listed in Annex 68.

Table107. CAPACITY ADDITION CUMULATIVE INVESTMENT, 2018 TO 2040 – NUCLEAR, HGS (in USD Million)

Technology	2020	2025	2030	2035	2040
Coal	0.0	519.0	2,076.0	7,266.0	15,051.0
Oil	0.0	0.0	91.5	294.0	623.7
Natural Gas	0.0	441.5	883.0	1,324.5	1,766.0
Hydro	0.0	0.0	1,648.2	2,355.7	4,127.2
Geothermal	0.0	146.4	480.9	644.1	804.5
Biomass	195.6	195.6	266.9	266.9	266.9
Solar	457.8	620.1	1,392.2	2,106.6	2,966.8
Wind	0.0	0.0	412.5	820.3	1,224.3
Nuclear	0.0	0.0	0.0	4,483.0	4,483.0
Total	**653.4**	**1,922.6**	**7,251.2**	**19,561.0**	**31,313.3**

Investment in Low Growth Scenario

Reference Supply

In Reference supply scenario, the estimated cumulative investment is at USD 15.0 billion for additional power generating capacities over the planning period, 44.3 percent lower compared with Reference supply in HGS (Table 108). With lower demand, capacities from coal decrease, thus investment for this technology is down to USD 8.8 billion in LGS from USD 20.2 billion in HGS (Reference). Similarly, oil capacity reduces in LGS with an investment of USD 355.3 million, from USD 869.0 million in HGS. On the other hand, cumulative investment for renewables accounts roughly 38.9 percent of total.

Alternative Supply

The cumulative investment for this scenario in LGS estimated at USD 16.4 billion is 42.5 percent lower in HGS (Alternative). Compared with Reference Scenario in LGS, this supply option entails a much lower capital investment for coal at USD 5.9 billion and oil-based capacity additions at USD 199.7 million (Table 109). In the same situation, the entry of natural gas and higher contribution from renewables with additional capacities from hydropower, solar and wind to satisfy a portion of the baseload and peaking requirements of the grid resulted in 8.2 percent increase in total investments. The share of renewable to total investment in power generation capacity reaches more than half or 57.4 percent in 2040, while natural gas share is almost 10.0 percent of total.

Table 108. CAPACITY ADDITION CUMULATIVE INVESTMENT, 2018 TO 2040 – REFERENCE, LGS (in USD Million)

PLANT TYPE	2020	2025	2030	2035	2040
Coal	0.0	0.0	1,038.0	4,152.0	8,823.0
Oil	0.0	0.0	22.8	157.5	355.3
Natural Gas	0.0	0.0	0.0	0.0	0.0
Hydro	0.0	0.0	1,648.2	2,355.7	3,352.2
Geothermal	0.0	146.4	480.9	644.1	804.5
Biomass	195.6	195.6	266.9	266.9	266.9
Solar	457.5	619.9	840.5	1,044.6	1,427.9
Wind	0.0	0.0	0.0	0.0	0.0
TOTAL	**653.1**	**961.8**	**4,297.2**	**8,620.7**	**15,029.6**

Annex 65 shows the annual investment cost on capacity additions under this supply scenario in LGS.

Table 109. CAPACITY ADDITION CUMULATIVE INVESTMENT, 2018 TO 2040 – ALTERNATIVE, LGS (in USD Million)

PLANT TYPE	2020	2025	2030	2035	2040
Coal	0.0	0.0	0.0	2,595.0	5,190.0
Oil	0.0	0.0	0.0	89.5	199.7
Natural Gas	0.0	441.5	706.4	1,059.6	1,589.4
Hydro	0.0	0.0	1,648.2	2,355.7	4,127.2
Geothermal	0.0	146.4	480.9	644.1	804.5
Biomass	195.6	195.6	266.9	266.9	266.9
Solar	457.8	620.1	1,392.2	2,106.6	2,966.8
Wind	0.0	0.0	412.5	820.3	1,224.3
Nuclear	0.0	0.0	0.0	0.0	0.0
TOTAL	**653.4**	**1,403.6**	**4,907.1**	**9,937.6**	**16,368.7**

Refer to Annex 67 for the annual cumulative cost for power plant capacity additions under the Alternative supply scenario for LGS.

Nuclear Supply

In Nuclear supply scenario for LGS, the cumulative investment stands at USD 19.2 billion, nearly 40.0 percent less as compared with HGS (Nuclear). Under this supply option, the entry of nuclear technology starting 2035 covers a portion of the Mindanao grid's baseload requirement, significantly reducing and displacing coal capacity additions (Table 110). However, with high capital cost of nuclear, total investment remains as the highest among the supply options in LGS (similar in HGS). Renewables share constitute closely half or 48.8 percent of total investment in 2040.

Table 110. CAPACITY ADDITION CUMULATIVE INVESTMENT, 2018 TO 2040 – NUCLEAR, LGS (in USD Million)

PLANT TYPE	2020	2025	2030	2035	2040
Coal	0.0	0.0	0.0	1,557.0	3,633.0
Oil	0.0	0.0	0.0	44.9	133.0
Natural Gas	0.0	441.5	706.4	1,059.6	1,589.4
Hydro	0.0	0.0	1,648.2	2,355.7	4,127.2
Geothermal	0.0	146.4	480.9	644.1	804.5
Biomass	195.6	195.6	266.9	266.9	266.9
Solar	457.8	620.1	1,392.2	2,106.6	2,966.8
Wind	0.0	0.0	412.5	820.3	1,224.3
Nuclear	0.0	0.0	0.0	4,483.0	4,483.0
TOTAL	**653.4**	**1,403.6**	**4,907.1**	**13,338.0**	**19,228.0**

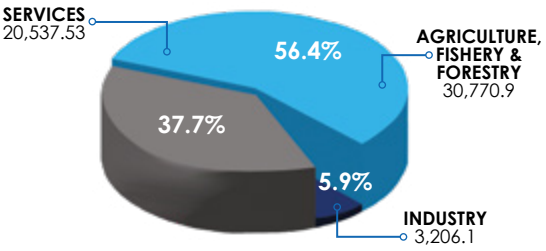
The cumulative annual investment requirements per technology under the Nuclear supply scenario in LGS appears as Annex 69.

ARMM

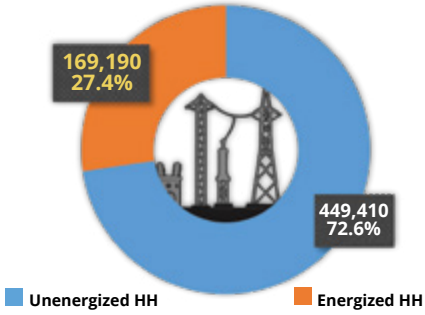
Autonomous Region in Muslim Mindanao

PROVINCES	Basilan, Lanao del Sur, Maguindanao, Sulu and Tawi-Tawi
LAND AREA	12, 535.79 km^2
POPULATION	4.0 Million
DENSITY	316.2/km^2
GDP/CAPITA	13,752.3

2017 GDP



Household Electrification Level
(As of Dec. 2017)



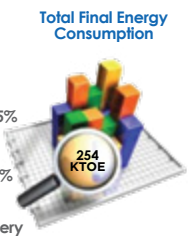
2017 FINAL ENERGY CONSUMPTION

By Fuel

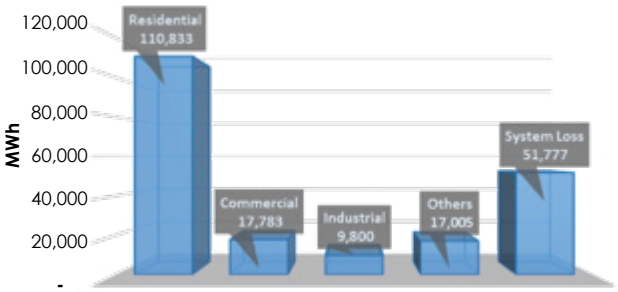
- Electricity - 15.9% — 40.2 KTOE
- Coal - 0% — 0.0 KTOE
- Oil - 23.1% — 58.6 KTOE
- Natural Gas - 0% — 0.0 KTOE
- Biofuels - 0.6% — 1.6 KTOE
- Biomass - 60.4% — 153.2 KTOE

By Sector

- Industry - 8.0% — 20.2 KTOE
- Transport - 14.4% — 36.5 KTOE
- Commercial - 8.5% — 21.5 KTOE
- Residential - 67.8% — 172.0 KTOE
- Agriculture, Fishery and Forestry - 1.3% — 3.4 KTOE



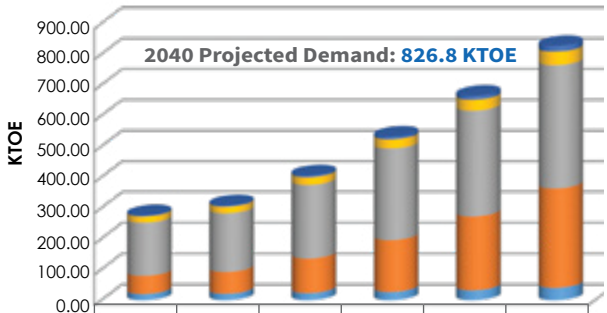
2017 Electricity Sales and Consumption
207,198 MWh



Note: Data based on 2018 Distribution Development Plan of DUs excluding LASURECO
Other: Include public buildings, street lights, irrigation and utility's station use

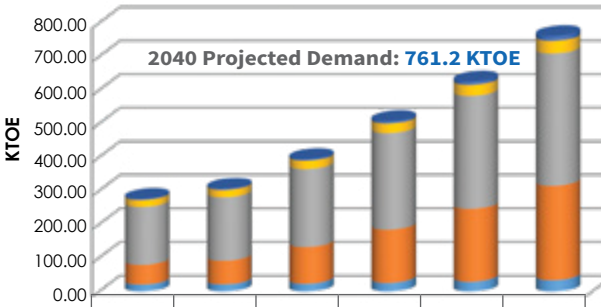
ENERGY OUTLOOK (2018 - 2040)

Total Final Energy Demand
(High Scenario)



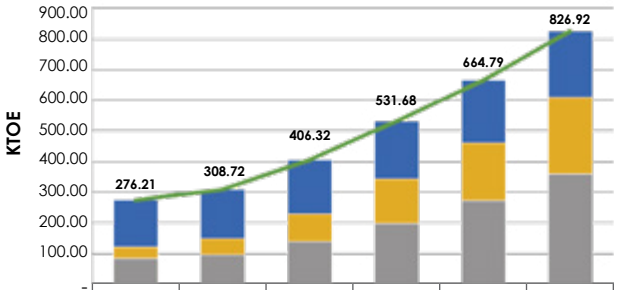
	2018	2020	2025	2030	2035	2040
AFF	3.10	3.62	5.37	8.18	12.29	18.37
Commercial	21.47	22.65	25.93	30.20	35.97	44.23
Residential	172.46	190.34	239.22	297.49	343.90	400.27
Transport	58.66	70.88	112.10	168.65	240.35	323.62
Industry	20.49	21.29	23.67	27.10	32.21	40.35

Total Final Energy Demand
(Low Scenario)



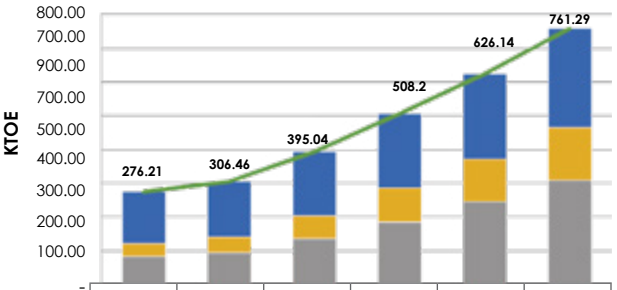
	2018	2020	2025	2030	2035	2040
AFF	3.10	3.46	4.94	7.12	10.11	14.18
Commercial	21.47	22.58	25.56	28.96	33.00	37.95
Residential	172.46	188.96	231.98	287.76	336.91	394.20
Transport	58.66	70.26	109.27	158.33	216.97	281.49
Industry	20.49	21.15	23.23	25.81	29.08	33.40

Total Final Energy Demand by Fuel
(High Scenario)



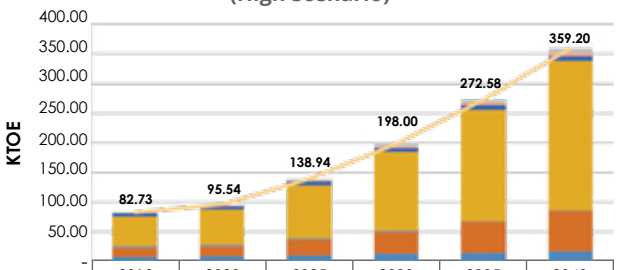
	2018	2020	2025	2030	2035	2040
Biomass	155.73	161.32	176.50	189.88	203.63	218.45
Electricity	37.75	51.87	90.88	143.81	188.58	249.26
Oil and Oil Products	82.73	95.54	138.94	198.00	272.58	359.20
Natural Gas	-	-	-	-	-	-
Coal	-	-	-	-	-	-
Total	276.21	308.72	406.32	531.68	664.79	826.92

Total Final Energy Demand by Fuel
(Low Scenario)



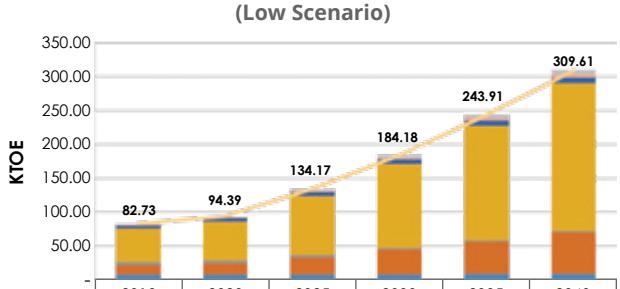
	2018	2020	2025	2030	2035	2040
Biomass	155.73	166.53	191.84	221.25	255.50	295.44
Electricity	37.75	45.54	69.04	102.59	126.73	156.24
Oil and Oil Products	82.73	94.39	134.17	184.18	243.91	309.61
Natural Gas	-	-	-	-	-	-
Coal	-	-	-	-	-	-
Total	276.21	306.46	395.04	508.02	626.14	761.29

Total Final Petroleum Demand Product
(High Scenario)



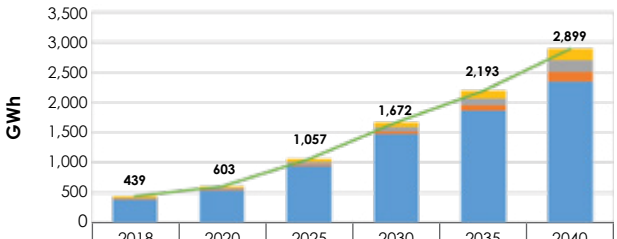
	2018	2020	2025	2030	2035	2040
BioEthanol	1.52	1.85	2.86	4.16	5.74	7.53
Biodiesel	1.01	1.20	1.83	2.71	3.83	5.15
JetFuels	0.03	0.03	0.04	0.04	0.05	0.06
AvGas	0.01	0.01	0.01	0.01	0.02	0.02
Fuel Oil	4.97	5.14	5.95	6.77	7.59	8.41
Diesel	49.63	58.59	89.57	132.61	187.76	252.19
Kerosene	4.24	3.84	3.01	2.40	1.95	1.58
Gasoline	13.73	16.70	25.77	37.48	51.70	67.79
LPG	7.58	8.18	9.90	11.81	13.94	16.46
Total	82.73	95.54	138.94	198.00	272.58	359.20

Total Final Petroleum Demand Product
(Low Scenario)



	2018	2020	2025	2030	2035	2040
BioEthanol	1.52	1.85	2.82	3.99	5.33	6.78
Biodiesel	1.01	1.19	1.78	2.54	3.45	4.46
JetFuels	0.03	0.03	0.04	0.04	0.05	0.06
AvGas	0.01	0.01	0.01	0.01	0.02	0.02
Fuel Oil	4.97	5.14	5.95	6.57	7.39	8.21
Diesel	49.63	58.12	87.24	124.41	169.04	218.46
Kerosene	4.24	3.89	3.12	2.54	2.10	1.74
Gasoline	13.73	16.66	25.37	35.90	48.02	61.04
LPG	7.58	7.50	7.85	8.18	8.51	8.84
Total	82.73	94.39	134.17	184.18	243.91	309.61

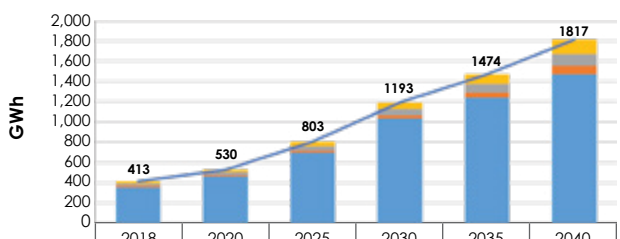
Electricity Sales
(High Scenario)



	2018	2020	2025	2030	2035	2040
Others	24	30	49	81	128	197
Commercial	27	32	46	73	116	189
Industry	10	12	23	45	87	165
Residential	378	529	939	1,474	1,862	2,348
Total	439	603	1,057	1,672	2,193	2,899

Note: Electricity sales cover on-grid and Off-grid areas and non-utility, but excluding losses, station use, and transmission losses. "Others" Include transport, public buildings, Irrigations , and street lights, among others.

Electricity Sales
(Low Scenario)



	2018	2020	2025	2030	2035	2040
Others	23	28	44	69	102	149
Commercial	27	31	42	58	82	115
Industry	9	11	18	30	51	84
Residential	354	460	699	1036	1239	1469
Total	413	530	803	1193	1474	1817

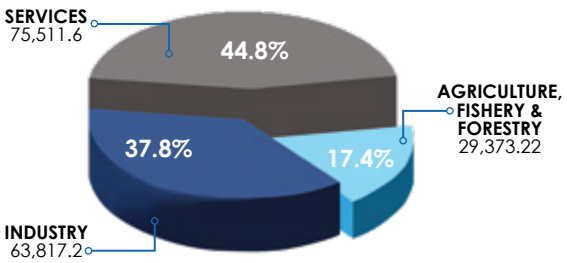
Note: Electricity sales cover on-grid and Off-grid areas and non-utility, but excluding losses, station use, and transmission losses. "Others" Include transport, public buildings, Irrigations , and street lights, among others.

REGION IX

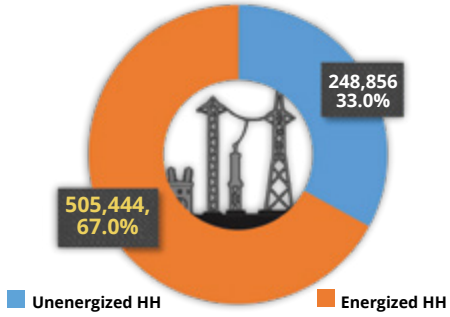
Zamboanga Peninsula

PROVINCES	Isabela City, Zamboanga Del Norte, Zamboanga del Sur, Zamboanga Sibugay
LAND AREA	17,056.73 km^2
POPULATION	3.8 Million
DENSITY	219.9/km^2
GDP/CAPITA	44,973.2

2017 GDP



Household Electrification Level
(As of Dec. 2017)



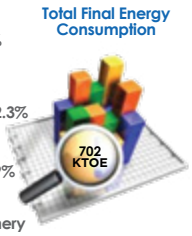
2017 FINAL ENERGY CONSUMPTION

By Fuel

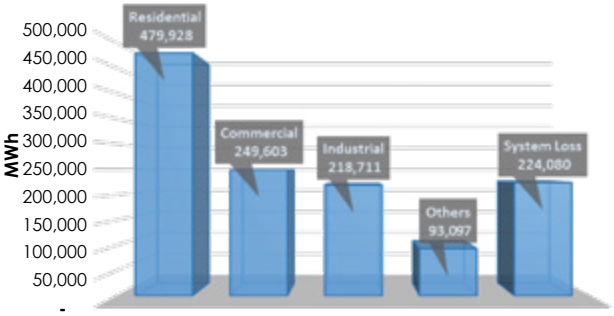
- Electricity - 16.2% — 113.3 KTOE
- Coal - 0.5% — 3.2 KTOE
- Oil - 51.3% — 359.6 KTOE
- Natural Gas - 0% — 0.0 KTOE
- Biofuels - 1.5% — 10.4 KTOE
- Biomass - 30.7% — 215.6 KTOE

By Sector

- Industry - 18.8% — 13.2 KTOE
- Transport - 34.7% — 243.5 KTOE
- Commercial - 12.3% — 86.0 KTOE
- Residential - 31.9% — 223.8 KTOE
- Agriculture, Fishery and Forestry - 2.4% — 16.6 KTOE



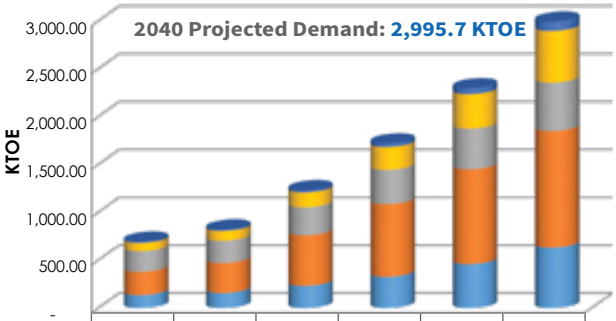
2017 Electricity Sales and Consumption
1,265,419 MWh



Note: Data based on 2018 Distribution Plan of DUs
Others include public buildings, street lights, irrigation an utility's station use.

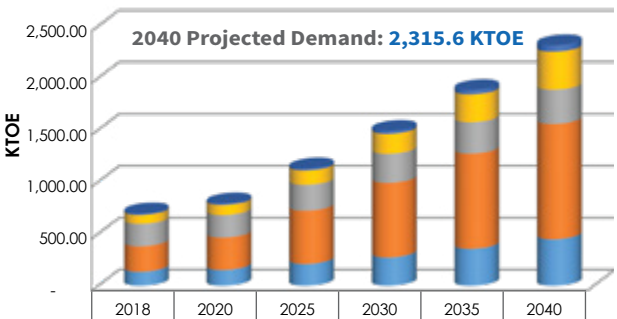
ENERGY OUTLOOK (2018 - 2040)

Total Final Energy Demand
(High Scenario)



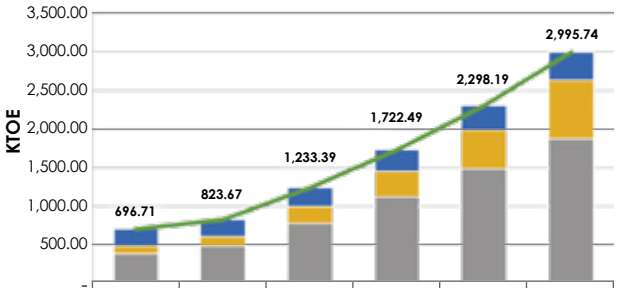
	2018	2020	2025	2030	2035	2040
AFF	14.25	15.97	22.96	37.44	61.08	98.34
Commercial	86.79	102.75	157.18	239.83	361.03	541.09
Residential	216.22	233.35	291.26	357.55	425.05	505.80
Transport	243.64	314.98	529.20	759.54	990.52	1,218.28
Industry	135.81	156.61	232.79	328.18	460.52	632.22

Total Final Energy Demand
(Low Scenario)



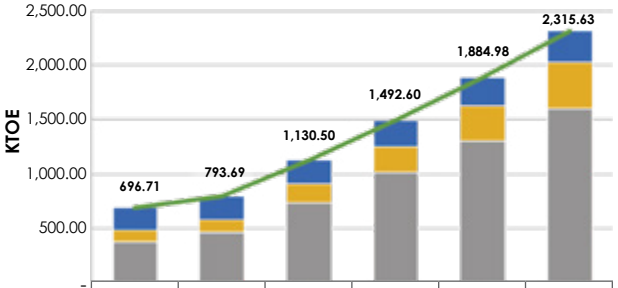
	2018	2020	2025	2030	2035	2040
AFF	14.25	15.18	19.89	28.56	41.94	61.38
Commercial	86.79	97.84	139.04	193.40	266.96	366.88
Residential	216.22	216.50	249.29	278.98	303.51	328.89
Transport	243.64	312.11	512.62	717.64	917.06	1,109.58
Industry	135.81	152.06	209.67	274.03	355.51	448.90

Total Final Energy Demand by Fuel
(High Scenario)



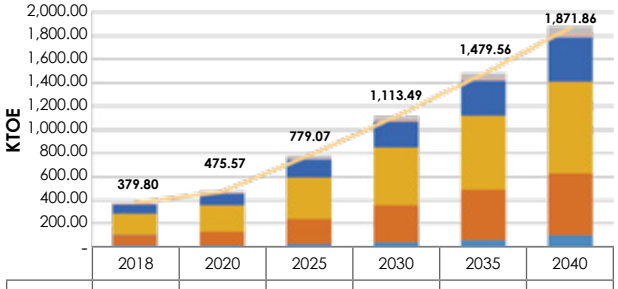
	2018	2020	2025	2030	2035	2040
Biomass	216.47	220.90	243.66	274.65	315.60	367.57
Electricity	97.63	125.06	209.55	333.73	502.67	756.09
Oil and Oil Products	379.80	475.57	779.07	1,113.49	1,479.56	1,871.86
Coal	2.80	2.13	1.11	0.63	0.36	0.21
Total	696.71	823.67	1,233.39	1,722.49	2,298.19	2,995.74

Total Final Energy Demand by Fuel
(Low Scenario)



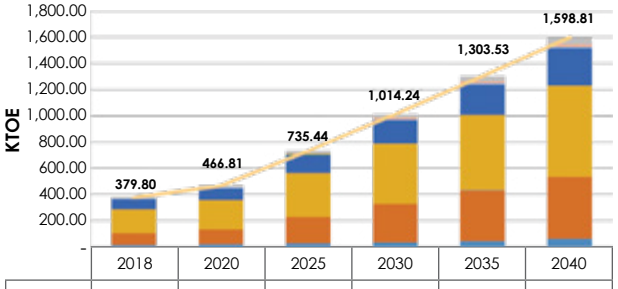
	2018	2020	2025	2030	2035	2040
Biomass	216.47	210.30	223.42	241.17	262.66	287.82
Electricity	97.63	114.66	170.63	236.63	318.47	428.81
Oil and Oil Products	379.80	466.81	735.44	1,014.24	1,303.53	1,598.81
Coal	2.80	1.92	1.00	0.56	0.33	0.19
Total	696.71	793.69	1,130.50	1,492.60	1,884.98	2,315.63

Total Final Petroleum Demand Product
(High Scenario)



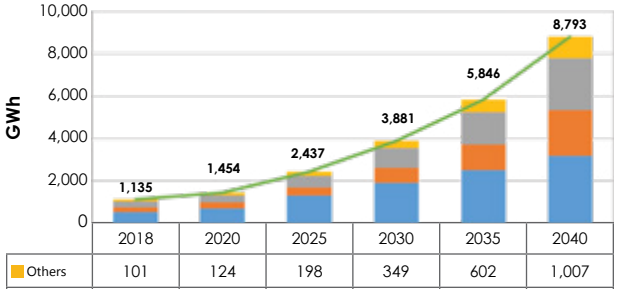
	2018	2020	2025	2030	2035	2040
BioEthanol	9.56	12.83	23.07	34.60	46.35	57.90
Biodiesel	3.66	4.55	7.20	10.01	12.93	16.00
JetFuels	0.81	1.07	2.16	4.15	7.79	15.00
AvGas	0.24	0.27	0.37	0.50	0.67	0.90
Fuel Oil	80.78	97.06	155.02	216.25	291.69	372.10
Diesel	179.22	222.75	352.76	490.36	633.69	784.00
Kerosene	2.51	1.75	0.88	0.54	0.40	0.32
Gasoline	86.79	116.44	209.32	314.07	421.07	526.76
LPG	16.23	18.85	28.28	43.00	64.97	98.87
Total	379.80	475.57	779.07	1,113.49	1,479.56	1,871.86

Total Final Petroleum Demand Product
(Low Scenario)



	2018	2020	2025	2030	2035	2040
BioEthanol	9.56	12.71	22.26	32.41	42.42	52.04
Biodiesel	3.66	5.04	7.68	10.51	13.44	16.50
JetFuels	0.81	1.07	2.16	4.15	7.79	15.00
AvGas	0.24	0.27	0.37	0.50	0.67	0.90
Fuel Oil	80.78	92.40	136.00	178.97	229.25	280.40
Diesel	179.22	219.85	339.10	458.98	578.27	697.61
Kerosene	2.51	2.03	1.21	0.83	0.63	0.49
Gasoline	86.79	115.30	201.71	293.62	384.38	471.74
LPG	16.23	18.13	24.65	34.25	46.69	64.14
Total	379.80	466.81	735.44	1,014.24	1,303.53	1,598.81

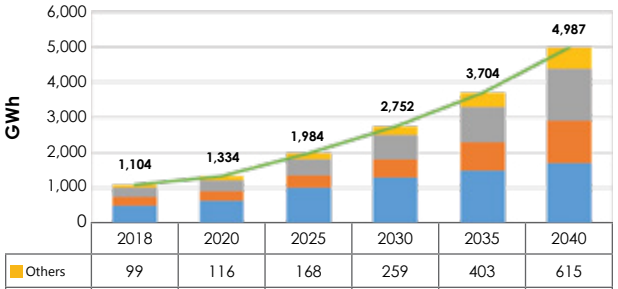
Electricity Sales
(High Scenario)



	2018	2020	2025	2030	2035	2040
Others	101	124	198	349	602	1,007
Commercial	270	331	540	913	1,515	2,456
Industry	229	263	393	692	1,221	2,138
Residential	535	736	1,305	1,927	2,509	3,192
Total	1,135	1,454	2,437	3,881	5,846	8,793

Note: Electricity sales cover on-grid and Off-grid areas and non-utility, but excluding losses, station use, and transmission losses. "Others" Include transport, public buildings, Irrigations , and street lights, among others.

Electricity Sales
(Low Scenario)



	2018	2020	2025	2030	2035	2040
Others	99	116	168	259	403	615
Commercial	266	312	467	684	1,011	1,465
Industry	230	252	337	507	782	1,200
Residential	508	654	1,012	1,302	1,508	1,706
Total	1,104	1,334	1,984	2,752	3,704	4,987

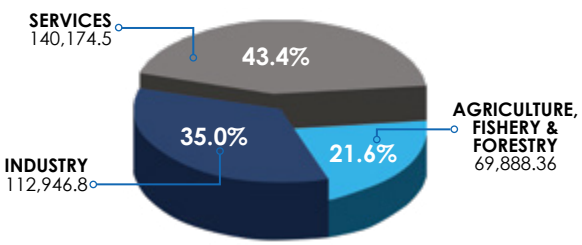
Note: Electricity sales cover on-grid and Off-grid areas and non-utility, but excluding losses, station use, and transmission losses. "Others" Include transport, public buildings, Irrigations , and street lights, among others.

REGION X

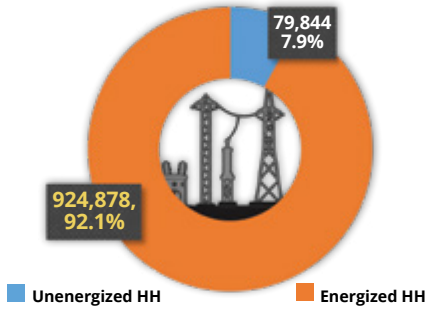
Northern Mindanao

PROVINCES	Camiguin, Misamis Oriental, Lanao del Norte, Bukidnon and Misamis Occidental
LAND AREA	20,496.02 km^2
POPULATION	4.8 Million
DENSITY	235.6 /km^2
GDP/CAPITA	66,891.0

2017 GDP



Household Electrification Level
(As of Dec. 2017)



2017 FINAL ENERGY CONSUMPTION

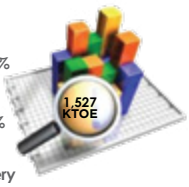
By Fuel

- Electricity - 16.9% — 257.2 KTOE
- Coal - 28.7% — 437.9 KTOE
- Oil - 37.2% — 567.8 KTOE
- Natural Gas - 0% — 0.0 KTOE
- Biofuels - 1.2% — 18.6 KTOE
- Biomass - 16.1% — 245.0 KTOE

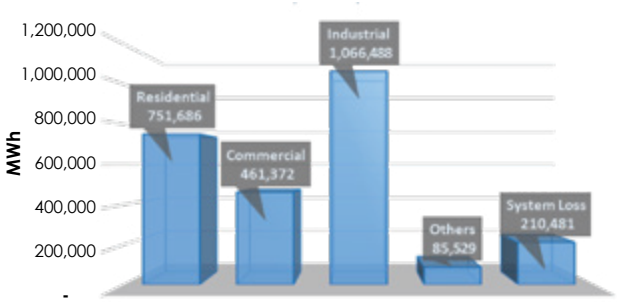
By Sector

- Industry - 47.1% — 718.4 KTOE
- Transport - 27.4% — 418.8 KTOE
- Commercial - 8.6% — 131.3 KTOE
- Residential - 15.6% — 237.7 KTOE
- Agriculture, Fishery and Forestry - 1.3% — 20.4 KTOE

Total Final Energy Consumption



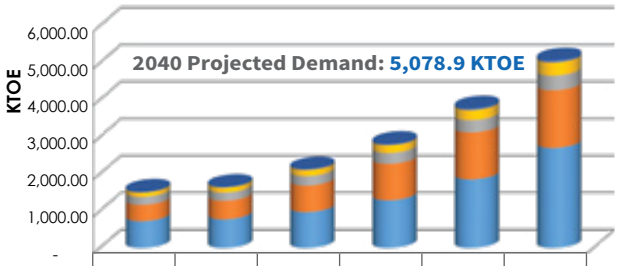
2017 Electricity Sales and Consumption
2,575,557 MWh



Note: Data based on 2018 Distribution Development Plan of DUs
Others include public buildings, street lights, irrigation and utility's station use

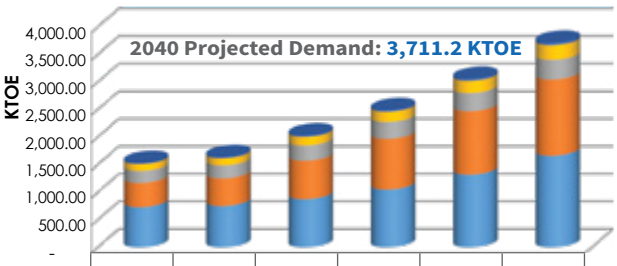
ENERGY OUTLOOK (2018 - 2040)

Total Final Energy Demand
(High Scenario)



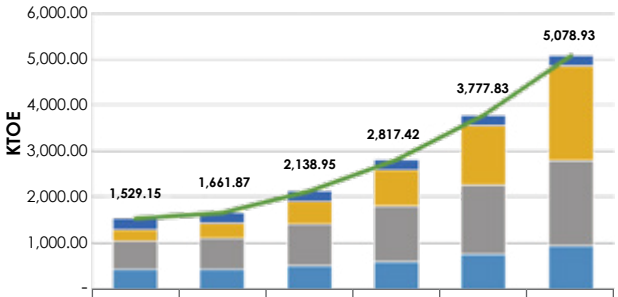
	2018	2020	2025	2030	2035	2040
AFF	19.18	20.90	25.41	33.18	44.55	60.95
Commercial	125.72	137.37	168.42	214.41	276.92	359.93
Residential	216.96	222.86	256.88	293.33	337.52	393.54
Transport	438.25	503.13	718.88	981.51	1,264.39	1,561.31
Industry	729.04	777.61	969.37	1,294.99	1,854.45	2,703.21

Total Final Energy Demand
(Low Scenario)



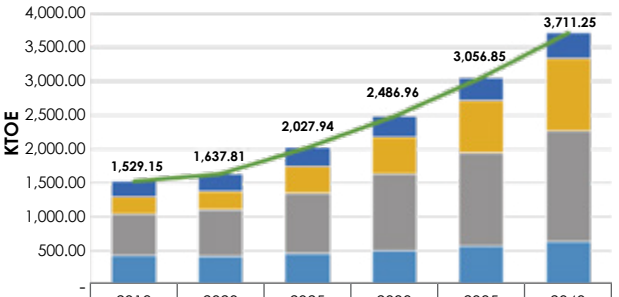
	2018	2020	2025	2030	2035	2040
AFF	19.18	20.36	23.82	28.84	35.71	44.66
Commercial	125.72	134.37	157.26	186.29	223.17	266.94
Residential	216.96	235.19	278.06	305.84	331.16	355.61
Transport	438.25	499.70	696.24	919.07	1,148.92	1,382.48
Industry	729.04	748.19	872.57	1,046.93	1,317.89	1,661.56

Total Final Energy Demand by Fuel
(High Scenario)



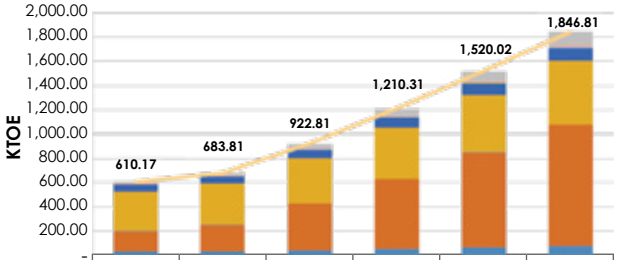
	2018	2020	2025	2030	2035	2040
Biomass	241.34	235.36	226.53	225.70	230.32	238.04
Electricity	254.53	313.99	493.12	782.98	1,281.71	2,045.66
Oil and Oil Products	610.17	683.81	922.81	1,210.31	1,520.02	1,846.81
Coal	423.11	428.71	496.50	598.44	745.79	948.43
Total	1,529.15	1,661.87	2,138.95	2,817.42	3,777.83	5,078.93

Total Final Energy Demand by Fuel
(Low Scenario)



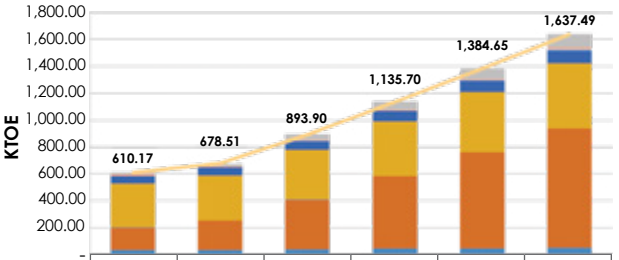
	2018	2020	2025	2030	2035	2040
Biomass	241.34	260.02	285.70	312.13	339.39	367.57
Electricity	254.53	280.81	394.71	540.08	774.91	1,075.08
Oil and Oil Products	610.17	678.51	893.90	1,135.70	1,384.65	1,637.49
Natural Gas	-	-	-	-	-	-
Coal	423.11	418.47	453.63	499.05	557.90	631.11
Total	1,529.15	1,637.81	2,027.94	2,486.96	3,056.85	3,711.25

Total Final Petroleum Demand Product
(High Scenario)



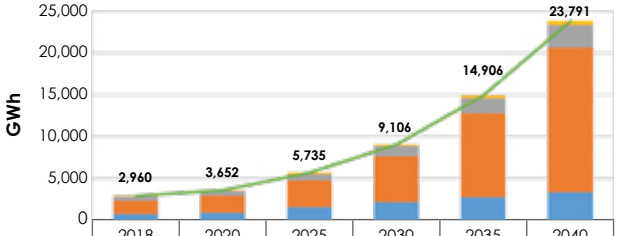
	2018	2020	2025	2030	2035	2040
BioEthanol	18.64	24.20	42.48	64.25	87.25	110.66
Biodiesel	6.60	6.84	7.60	8.56	9.61	10.71
JetFuels	0.31	0.44	1.11	2.63	6.10	14.63
AvGas	0.09	0.10	0.16	0.23	0.33	0.49
Fuel Oil	57.83	61.10	70.36	80.88	92.95	107.48
Diesel	323.49	335.22	372.48	419.55	471.06	524.91
Kerosene	2.54	2.33	1.89	1.57	1.33	1.13
Gasoline	168.19	218.14	382.65	578.53	785.42	996.03
LPG	32.48	35.44	44.07	54.11	65.96	80.76
Total	610.17	683.81	922.81	1,210.31	1,520.02	1,846.81

Total Final Petroleum Demand Product
(Low Scenario)



	2018	2020	2025	2030	2035	2040
BioEthanol	18.64	24.01	41.01	60.05	79.42	98.56
Biodiesel	6.60	6.68	7.55	8.37	9.22	10.10
JetFuels	0.31	0.44	1.11	2.63	6.10	14.63
AvGas	0.09	0.10	0.16	0.23	0.33	0.49
Fuel Oil	57.83	60.19	67.21	74.61	82.47	91.12
Diesel	323.49	334.61	367.80	405.78	445.00	484.33
Kerosene	2.54	2.38	2.00	1.71	1.48	1.29
Gasoline	168.19	216.44	369.45	540.65	714.92	887.12
LPG	32.48	33.50	37.63	41.68	45.71	49.85
Total	610.17	678.51	893.90	1,135.70	1,384.55	1,637.49

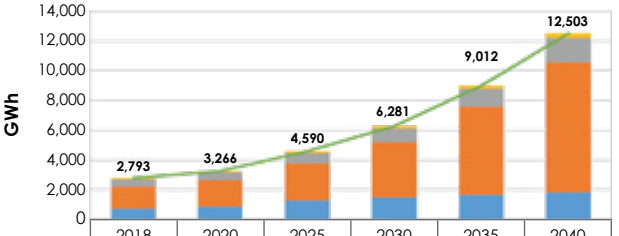
Electricity Sales
(High Scenario)



	2018	2020	2025	2030	2035	2040
Others	91	106	144	221	339	517
Commercial	495	583	826	1,242	1,851	2,698
Industry	1,587	1,971	3,122	5,433	9,936	17,160
Residential	787	992	1,643	2,210	2,780	3,417
Total	2,960	3,652	5,735	9,106	14,906	23,791

Note: Electricity sales cover on-grid and Off-grid areas and non-utility, but excluding losses, station use, and transmission losses. "Others" Include transport, public buildings, Irrigations , and street lights, among others.

Electricity Sales
(Low Scenario)



	2018	2020	2025	2030	2035	2040
Others	89	100	125	169	235	325
Commercial	487	548	696	915	1,225	1,616
Industry	1,476	1,747	2,495	3,704	5,881	8,736
Residential	741	871	1,274	1,493	1,671	1,827
Total	2,793	3,266	4,590	6,281	9,012	12,503

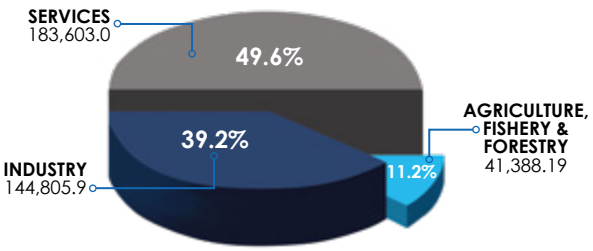
Note: Electricity sales cover on-grid and Off-grid areas and non-utility, but excluding losses, station use, and transmission losses. "Others" Include transport, public buildings, Irrigations , and street lights, among others.

Region XI

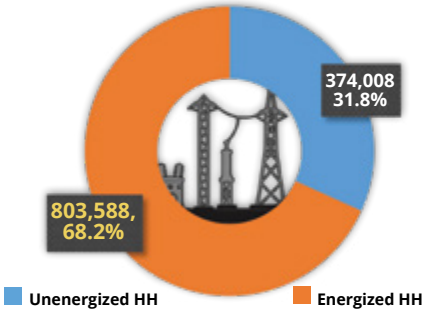
Davao Region

PROVINCES	Compostela Valley, Davao del Norte, Davao del Sur, Davao Oriental and Davao Occidental
LAND AREA	20,357.42 km^2
POPULATION	4.7 Million
DENSITY	232.8 /km^2
GDP/CAPITA	78,019.2

2017 GDP



Household Electrification Level
(As of Dec. 2017)



2017 FINAL ENERGY CONSUMPTION

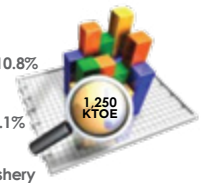
By Fuel

- Electricity - 27.1% — 337.5 KTOE
- Coal - 0.1% — 1.2 KTOE
- Oil - 54.9% — 683.4 KTOE
- Natural Gas - 0% — 0.0 KTOE
- Biofuels - 1.9% — 24.4 KTOE
- Biomass - 16.3% — 203.4 KTOE

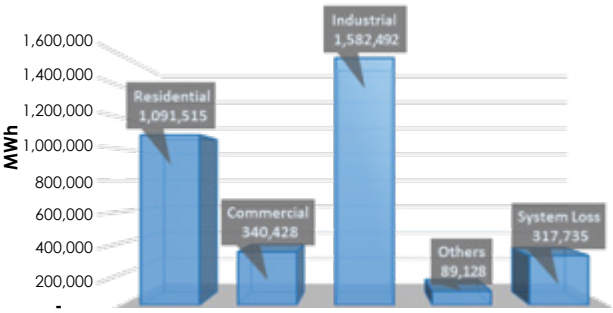
By Sector

- Industry - 21.6% — 269.9 KTOE
- Transport - 42.6% — 532.8 KTOE
- Commercial - 10.8% — 134.7 KTOE
- Residential - 23.1% — 289.2 KTOE
- Agriculture, Fishery and Forestry - 1.9% — 23.3 KTOE

Total Final Energy Consumption



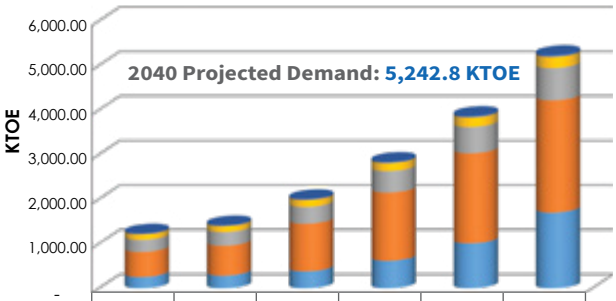
2017 Electricity Sales and Consumption
3,421,298 MWh



Note: Data based on 2018 Distribution Development Plan of DUs
Other include public buildings, street lights, irrigation and utility's station use

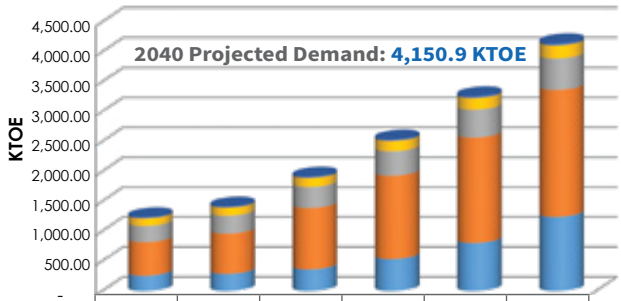
ENERGY OUTLOOK (2018 - 2040)

Total Final Energy Demand
(High Scenario)



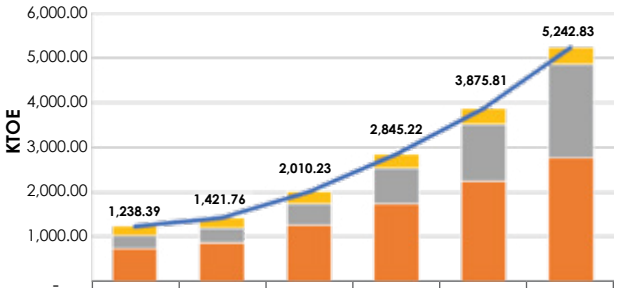
	2018	2020	2025	2030	2035	2040
AFF	21.84	22.66	25.09	30.23	36.95	45.09
Commercial	130.68	139.44	158.90	186.57	218.66	254.15
Residential	269.74	303.33	376.95	479.51	590.42	723.83
Transport	560.22	670.65	1,068.86	1,530.25	2,020.74	2,518.65
Industry	255.91	285.68	380.43	618.66	1,009.04	1,701.11

Total Final Energy Demand
(Low Scenario)



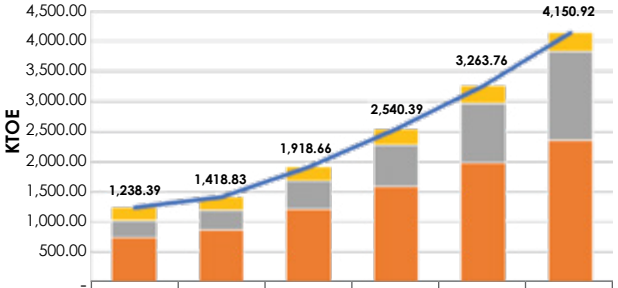
	2018	2020	2025	2030	2035	2040
AFF	21.84	22.44	24.65	28.74	34.17	40.60
Commercial	130.68	137.52	153.76	174.43	197.73	221.79
Residential	269.74	299.65	352.83	410.51	466.56	526.10
Transport	560.22	674.03	1,026.45	1,393.06	1,762.12	2,122.35
Industry	255.91	285.19	360.97	533.65	803.18	1,240.08

Total Final Energy Demand by Fuel
(High Scenario)



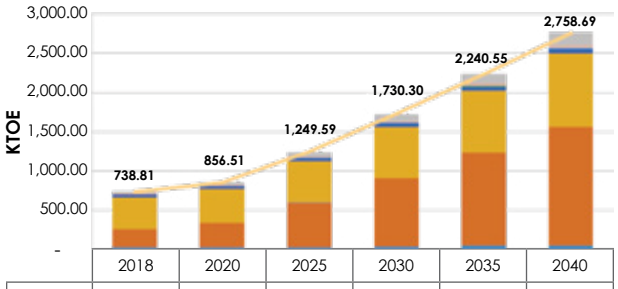
	2018	2020	2025	2030	2035	2040
Biomass	210.19	224.75	265.59	304.42	346.26	393.37
Electricity	288.15	339.21	493.93	808.97	1,287.34	2,088.99
Oil and Oil Products	738.81	856.51	1,249.59	1,730.30	2,240.55	2,758.69
Coal	1.24	1.29	1.41	1.54	1.66	1.79
Total	1,238.39	1,421.76	2,010.23	2,845.22	3,875.81	5,242.83

Total Final Energy Demand by Fuel
(Low Scenario)



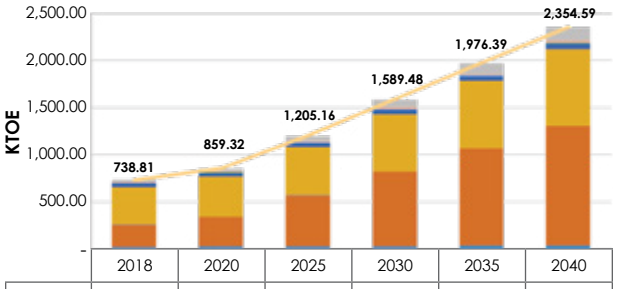
	2018	2020	2025	2030	2035	2040
Biomass	210.19	215.85	238.00	216.66	286.97	314.08
Electricity	288.15	342.37	474.09	687.70	998.73	1,480.46
Oil and Oil Products	738.81	859.32	1,205.16	1,589.48	1,976.39	2,354.59
Coal	1.24	1.29	1.41	1.54	1.66	1.79
Total	1,238.39	1,418.83	1,918.66	2,540.39	3,263.76	4,150.92

Total Final Petroleum Demand Product
(High Scenario)



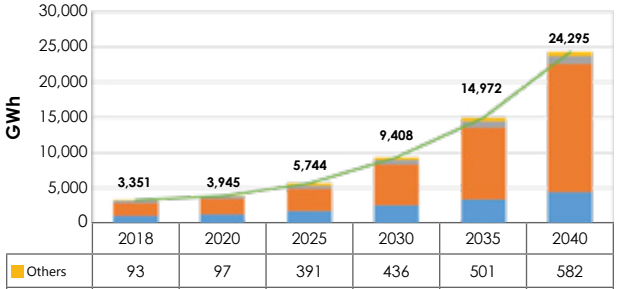
	2018	2020	2025	2030	2035	2040
BioEthanol	25.51	34.13	62.21	95.86	131.29	167.10
Biodiesel	8.13	8.66	10.62	13.21	16.02	18.90
JetFuels	2.68	3.46	5.93	8.74	11.62	14.44
AvGas	0.85	1.12	1.97	2.97	4.00	5.03
Fuel Oil	37.36	39.26	44.27	49.33	54.43	59.73
Diesel	399.13	425.76	523.43	651.39	790.45	932.97
Kerosene	3.34	2.91	2.13	1.68	1.39	1.19
Gasoline	230.20	307.72	560.47	863.33	1,182.19	1,504.44
LPG	31.60	33.48	38.64	43.80	49.16	54.89
Total	738.81	856.51	1,249.59	1,730.30	2,240.55	2,758.69

Total Final Petroleum Demand Product
(Low Scenario)



	2018	2020	2025	2030	2035	2040
BioEthanol	25.51	34.59	59.59	86.84	114.05	140.47
Biodiesel	8.13	8.65	10.34	12.34	14.40	16.43
JetFuels	2.68	3.26	5.20	7.36	9.59	11.85
AvGas	0.85	1.05	1.71	2.47	3.27	4.09
Fuel Oil	37.36	38.99	43.46	47.91	52.38	56.98
Diesel	399.13	425.04	509.29	608.68	710.83	811.86
Kerosene	3.34	3.01	2.31	1.86	1.56	1.34
Gasoline	230.20	311.92	536.87	782.13	1,027.00	1,264.76
LPG	31.60	32.81	36.40	39.89	43.33	46.81
Total	738.81	859.32	1,205.16	1,589.48	1,976.39	2,354.59

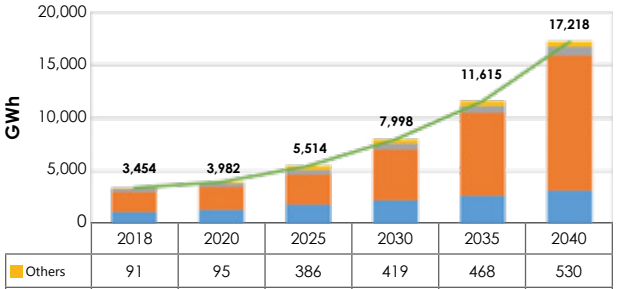
Electricity Sales
(High Scenario)



	2018	2020	2025	2030	2035	2040
Others	93	97	391	436	501	582
Commercial	355	400	485	665	896	1,167
Industry	1,816	2,116	3,100	5,755	10,179	18,113
Residential	1,087	1,332	1,769	2,552	3,395	4,432
Total	3,351	3,945	5,744	9,408	14,972	24,295

Note: Electricity sales cover on-grid and Off-grid areas and non-utility, but excluding losses, station use, and transmission losses. "Others" Include transport, public buildings, Irrigations , and street lights, among others.

Electricity Sales
(Low Scenario)



	2018	2020	2025	2030	2035	2040
Others	91	95	386	419	468	530
Commercial	351	378	425	524	653	791
Industry	1,876	2,109	2,874	4,765	7,782	12,747
Residential	1,137	1,400	1,829	2,290	2,712	3,150
Total	3,454	3,982	5,514	7,998	11,615	17,218

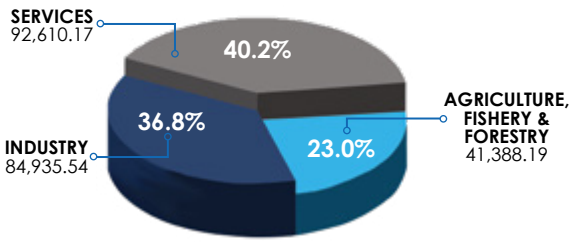
Note: Electricity sales cover on-grid and Off-grid areas and non-utility, but excluding losses, station use, and transmission losses. "Others" Include transport, public buildings, Irrigations , and street lights, among others.

REGION XII

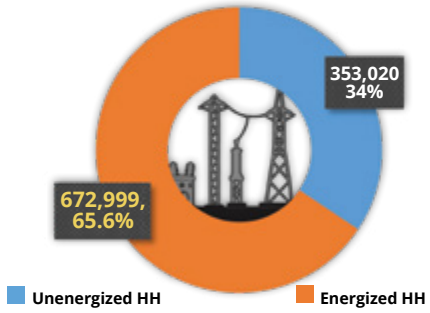
SOCCSKSARGEN

PROVINCES	South Cotabato, Cotabato Province, Sultan Kudarat and Saranggani
LAND AREA	22, 513.3 km^2
POPULATION	4.7 Million
DENSITY	209.32 /km^2
GDP/CAPITA	48,934.1

2017 GDP



Household Electrification Level
(As of Dec. 2017)



2017 FINAL ENERGY CONSUMPTION

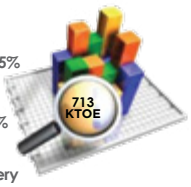
By Fuel

- Electricity - 25.4% — 180.9 KTOE
- Coal - 9.7% — 69.4 KTOE
- Oil - 38.1% — 271.3 KTOE
- Natural Gas - 0% — 0.0 KTOE
- Biofuels - 1.5% — 11.0 KTOE
- Biomass - 25.3% — 180.4 KTOE

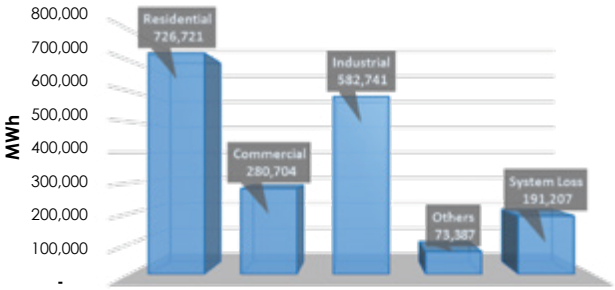
By Sector

- Industry - 26.0% — 185.2 KTOE
- Transport - 31.2% — 222.5 KTOE
- Commercial - 10.5% — 74.6 KTOE
- Residential - 30.5% — 217.5 KTOE
- Agriculture, Fishery and Forestry - 1.8% — 13.1 KTOE

Total Final Energy Consumption



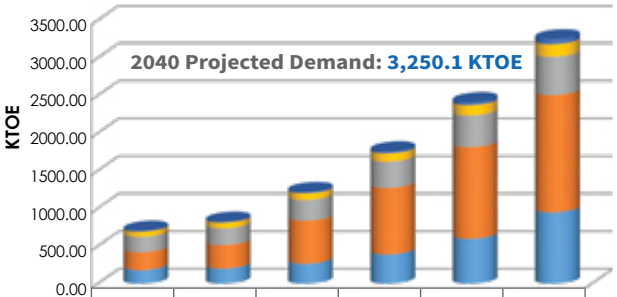
2017 Electricity Sales and Consumption
1,854,76 MWh



Note: Data based on 2018 Distribution Development Plan of DUs
Other include public buildings, street lights, irrigation and utility's station use

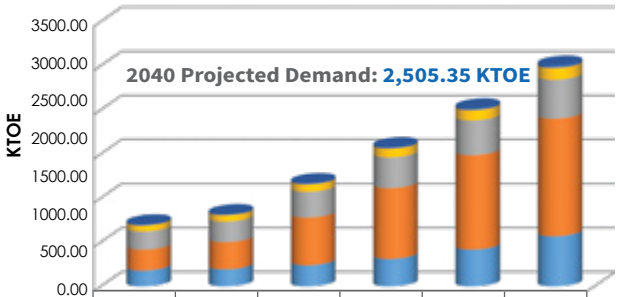
ENERGY OUTLOOK (2018 - 2040)

Total Final Energy Demand
(High Scenario)



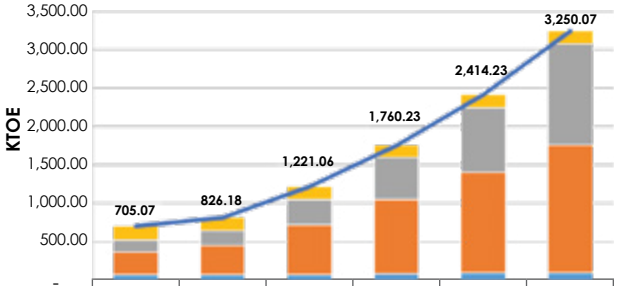
	2018	2020	2025	2030	2035	2040
AFF	12.09	13.63	18.01	26.45	40.86	66.28
Commercial	70.80	76.85	91.65	112.26	137.81	167.42
Residential	205.71	221.85	275.61	349.94	422.28	511.28
Transport	236.42	313.37	570.58	883.03	1216.17	1556.44
Industry	180.05	200.48	265.21	388.55	597.12	948.65

Total Final Energy Demand
(Low Scenario)



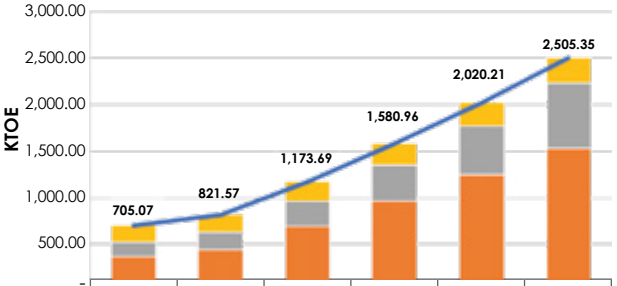
	2018	2020	2025	2030	2035	2040
AFF	12.09	12.67	14.56	17.53	21.82	27.82
Commercial	70.80	75.19	87.01	100.82	117.40	134.94
Residential	205.71	233.01	292.12	348.61	394.54	441.61
Transport	236.42	307.65	540.66	802.55	1069.25	1332.32
Industry	180.05	193.05	239.34	311.45	417.19	569.66

Total Final Energy Demand by Fuel
(High Scenario)



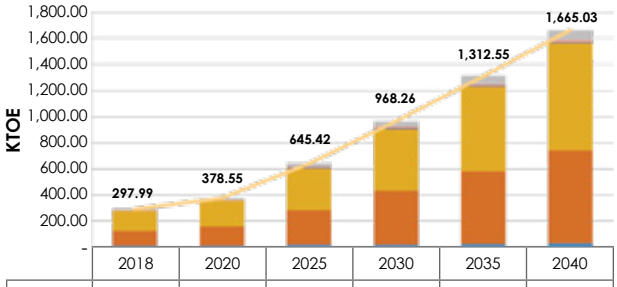
	2018	2020	2025	2030	2035	2040
Biomass	178.00	174.08	167.21	164.46	164.24	165.44
Electricity	158.34	200.06	328.05	540.24	843.28	1,318.54
Oil and Oil Products	297.99	378.55	645.42	968.26	1,312.55	1,655.03
Coal	70.74	73.50	80.39	87.28	94.16	101.05
Total	705.07	826.18	1,221.06	1,760.23	2,414.23	3,250.07

Total Final Energy Demand by Fuel
(Low Scenario)



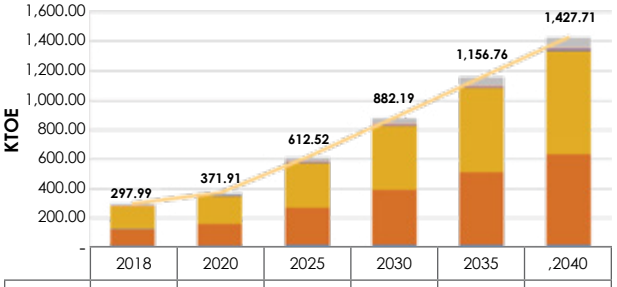
	2018	2020	2025	2030	2035	2040
Biomass	178.00	191.09	210.18	230.72	252.88	276.86
Electricity	158.34	185.07	270.60	380.77	516.40	699.72
Oil and Oil Products	297.99	371.91	612.52	882.19	1,156.76	1,427.71
Coal	70.44	73.50	80.39	87.28	94.16	101.05
Total	705.07	821.57	1,173.69	1,580.96	2,020.21	2,505.35

Total Final Petroleum Demand Product
(High Scenario)



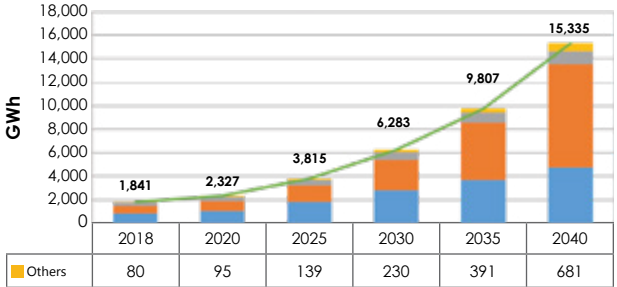
	2018	2020	2025	2030	2035	2040
BioEthanol	12.22	16.35	29.72	45.43	61.89	78.49
Biodiesel	3.15	3.91	6.51	9.75	13.26	16.89
JetFuels	0.01	0.01	0.02	0.02	0.03	0.03
AvGas	0.00	0.00	0.00	0.01	0.01	0.01
Fuel Oil	1.90	2.40	3.67	4.94	6.20	7.47
Diesel	154.31	191.43	317.94	475.74	646.47	822.73
Kerosene	1.91	1.62	1.09	0.78	0.57	0.43
Gasoline	110.25	147.42	267.75	409.07	557.15	706.54
LPG	14.25	15.40	18.71	22.53	26.98	32.45
Total	297.99	378.55	645.42	968.26	1,312.55	1,665.03

Total Final Petroleum Demand Product
(Low Scenario)



	2018	2020	2025	2030	2035	,2040
BioEthanol	12.22	15.96	28.17	41.52	54.91	67.99
Biodiesel	3.15	3.87	6.22	8.92	11.70	14.49
JetFuels	0.01	0.01	0.01	0.02	0.02	0.03
AvGas	0.00	0.00	0.00	0.01	0.01	0.01
Fuel Oil	1.90	2.39	3.65	4.91	6.16	7.41
Diesel	154.31	189.69	303.96	435.39	571.00	706.10
Kerosene	1.91	1.66	1.16	0.84	0.64	0.49
Gasoline	110.25	143.94	253.73	373.78	494.33	612.04
LPG	14.25	14.39	15.62	16.82	17.99	19.15
Total	297.99	371.91	612.52	882.19	1,159.76	1,427.71

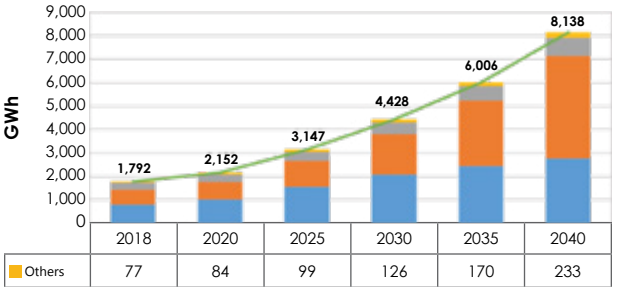
Electricity Sales
(High Scenario)



	2018	2020	2025	2030	2035	2040
Others	80	95	139	230	391	681
Commercial	298	344	453	630	864	1,145
Industry	640	805	1,376	2,629	4,873	8,780
Residential	823	1,083	1,847	2,794	3,680	4,730
Total	1,841	2,327	3,815	6,283	9,807	15,335

Note: Electricity sales cover on-grid and Off-grid areas and non-utility, but excluding losses, station use, and transmission losses. "Others" Include transport, public buildings, Irrigations , and street lights, among others.

Electricity Sales
(Low Scenario)



	2018	2020	2025	2030	2035	2040
Others	77	84	99	126	170	233
Commercial	295	324	399	497	626	767
Industry	607	719	1,076	1,732	2,780	4,360
Residential	813	1,026	1,574	2,073	2,429	2,777
Total	1,792	2,152	3,147	4,428	6,006	8,138

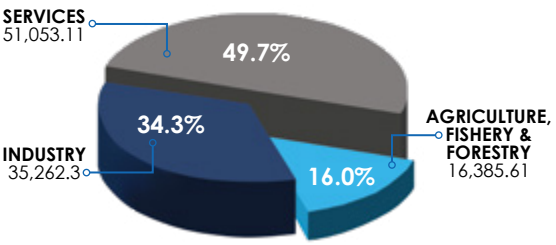
Note: Electricity sales cover on-grid and Off-grid areas and non-utility, but excluding losses, station use, and transmission losses. "Others" Include transport, public buildings, Irrigations , and street lights, among others.

REGION XIII

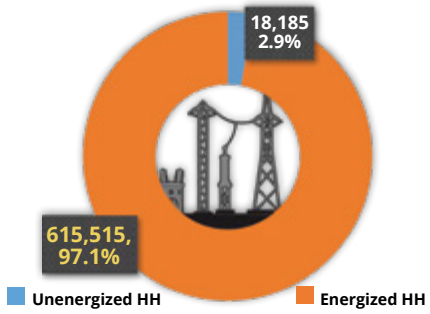
CARAGA

PROVINCES	Agusan del Norte, Agusan del Sur, Surigao del Norte, Surigao del Sur and Dinagat Islands
LAND AREA	21,478.35 km^2
POPULATION	2.7 Million
DENSITY	124.3 /km^2
GDP/CAPITA	38,039.7

2017 GDP



Household Electrification Level
(As of Dec. 2017)



2017 FINAL ENERGY CONSUMPTION

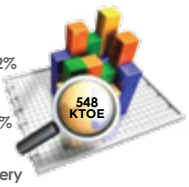
By Fuel

- Electricity - 16.9% — 92.3 KTOE
- Coal - 26.3% — 144.0 KTOE
- Oil - 33.4% — 182.8 KTOE
- Natural Gas - 0% — 0.0 KTOE
- Biofuels - 1.1% — 6.3 KTOE
- Biomass - 22.3% — 122.3 KTOE

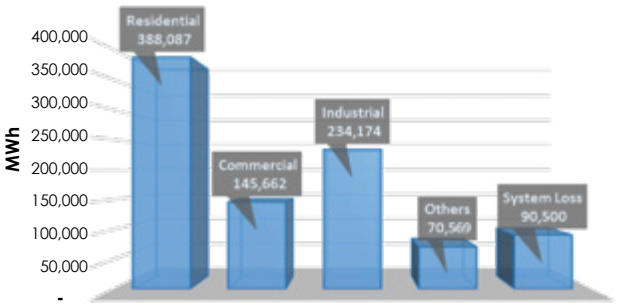
By Sector

- Industry - 38.6% — 211.6 KTOE
- Transport - 24.3% — 133.0 KTOE
- Commercial - 8.2% — 44.7 KTOE
- Residential - 27.0% — 148.0 KTOE
- Agriculture, Fishery and Forestry - 1.9% — 10.5 KTOE

Total Final Energy Consumption



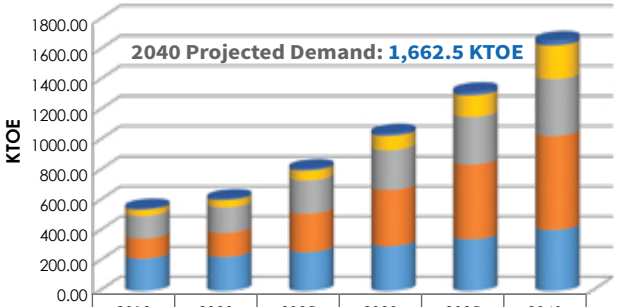
2017 Electricity Sales and Consumption
928,992 MWh



Note: Data based on 2018 Distribution Development Plan of DUs
Other include public buildings, street lights, irrigation and utility's station use

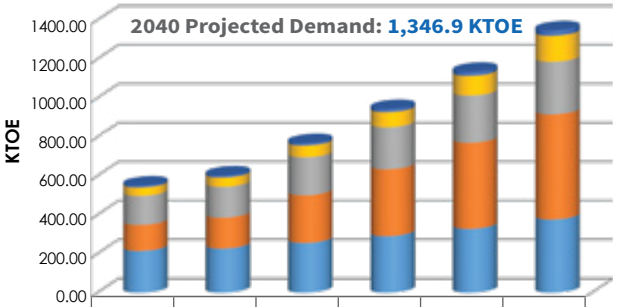
ENERGY OUTLOOK (2018 - 2040)

Total Final Energy Demand
(High Scenario)



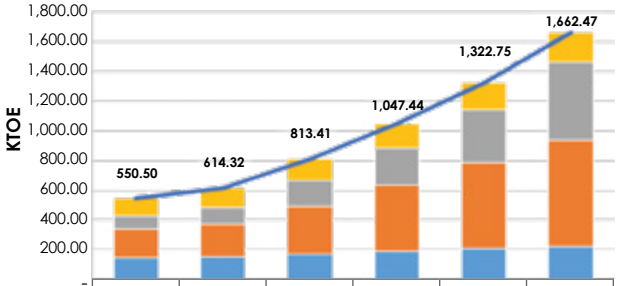
	2018	2020	2025	2030	2035	2040
AFF	9.69	10.45	13.04	17.71	24.33	33.25
Commercial	43.89	49.38	66.41	95.91	144.35	224.39
Residential	149.20	168.51	221.23	263.18	315.05	376.33
Transport	133.14	159.59	255.65	373.04	496.60	623.16
Industry	214.58	226.38	257.08	297.61	342.42	405.33

Total Final Energy Demand
(Low Scenario)



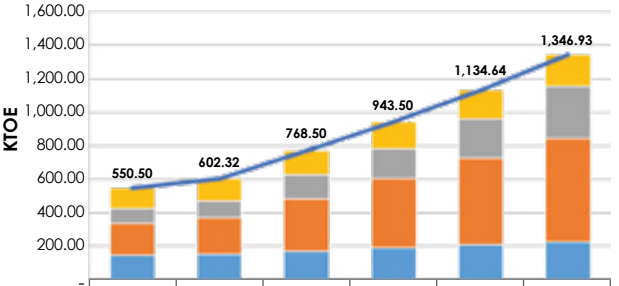
	2018	2020	2025	2030	2035	2040
AFF	9.69	10.23	12.47	15.88	20.72	26.94
Commercial	43.89	48.28	60.74	77.69	101.54	134.37
Residential	149.20	158.82	194.71	216.08	242.33	270.02
Transport	133.14	158.00	244.80	343.26	441.91	539.45
Industry	214.58	226.99	255.79	290.57	328.13	376.14

Total Final Energy Demand by Fuel
(High Scenario)



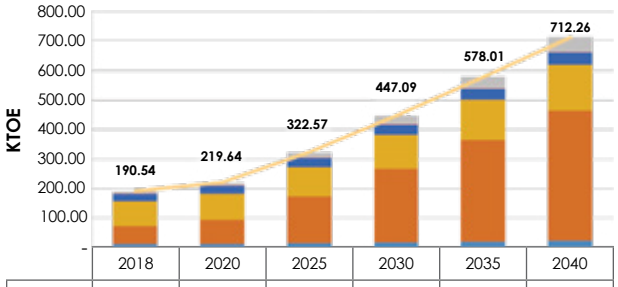
	2018	2020	2025	2030	2035	2040
Biomass	125.13	131.13	147.29	164.02	181.53	200.78
Electricity	87.39	109.31	172.27	248.04	357.90	527.09
Oil and Oil Products	190.54	219.64	322.57	447.09	578.01	712.26
Coal	147.44	154.24	171.27	188.29	205.31	222.33
Total	550.50	614.32	813.41	1,047.44	1,322.75	1,662.47

Total Final Energy Demand by Fuel
(Low Scenario)



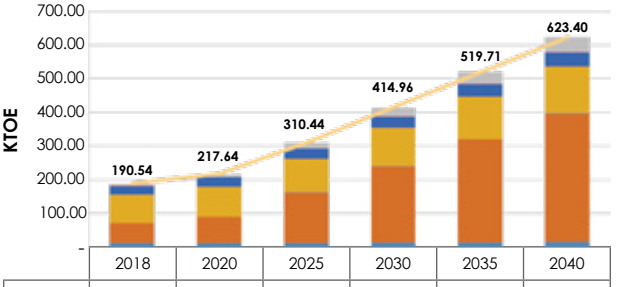
	2018	2020	2025	2030	2035	2040
Biomass	125.13	130.14	144.10	159.09	175.22	192.61
Electricity	87.39	100.30	142.70	181.15	234.39	308.59
Oil and Oil Products	190.54	217.64	310.44	414.96	519.71	623.40
Coal	147.44	154.24	171.27	188.29	205.31	222.33
Total	550.50	602.32	768.50	943.50	1,134.64	1,346.93

Total Final Petroleum Demand Product
(High Scenario)



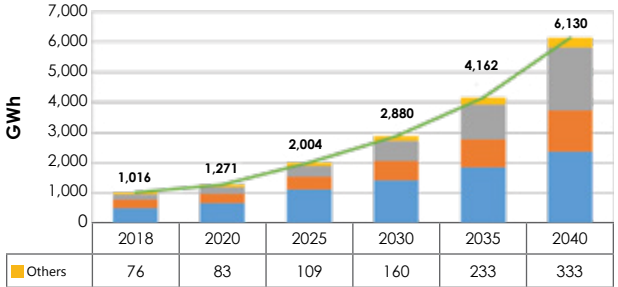
	2018	2020	2025	2030	2035	2040
BioEthanol	6.60	8.87	17.45	27.59	38.27	49.09
Biodiesel	1.72	1.81	2.05	2.40	2.75	3.13
JetFuels	-	-	-	-	-	-
AvGas	-	-	-	-	-	-
Fuel Oil	25.55	26.81	30.22	33.89	37.87	42.39
Diesel	84.49	88.83	100.30	117.24	134.54	152.91
Kerosene	1.00	0.89	0.69	0.57	0.49	0.44
Gasoline	59.58	80.01	157.20	248.37	344.50	441.83
LPG	11.60	12.42	14.66	17.05	19.59	22.47
Total	190.54	219.64	322.57	447.09	578.01	712.26

Total Final Petroleum Demand Product
(Low Scenario)



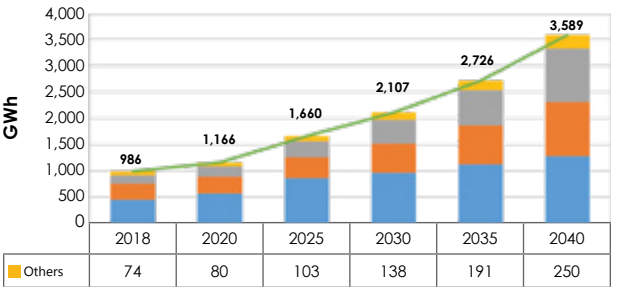
	2018	2020	2025	2030	2035	2040
BioEthanol	6.60	8.74	16.55	25.12	33.76	42.22
Biodiesel	1.72	1.81	2.02	2.30	2.57	2.85
JetFuels	-	-	-	-	-	-
AvGas	-	-	-	-	-	-
Fuel Oil	25.55	26.71	29.92	33.31	36.93	40.96
Diesel	84.49	88.65	98.84	112.81	126.07	139.63
Kerosene	1.00	0.92	0.74	0.62	0.55	0.49
Gasoline	59.58	78.83	149.05	226.15	303.90	380.00
LPG	11.60	11.98	13.33	14.65	15.93	17.26
Total	190.54	217.64	310.44	414.96	519.71	623.40

Electricity Sales
(High Scenario)



	2018	2020	2025	2030	2035	2040
Others	76	83	109	160	233	333
Commercial	165	211	362	659	1,175	2,059
Industry	280	316	419	636	903	1,381
Residential	465	662	1,113	1,430	1,851	2,356
Total	1,016	1,271	2,004	2,885	4,162	6,130

Electricity Sales
(Low Scenario)



	2018	2020	2025	2030	2035	2040
Others	74	80	103	138	191	250
Commercial	161	198	296	447	677	1,012
Industry	295	323	404	554	737	1,042
Residential	455	565	857	967	1,121	1,275
Total	986	1,166	1,660	2,107	2,726	3,589

Note: Electricity sales cover on-grid and Off-grid areas and non-utility, but excluding losses, station use, and transmission losses. "Others" Include transport, public buildings, Irrigations , and street lights, among others.

Note: Electricity sales cover on-grid and Off-grid areas and non-utility, but excluding losses, station use, and transmission losses. "Others" Include transport, public buildings, Irrigations , and street lights, among others.

ANNEXES

ANNEX 1. GROSS REGIONAL DOMESTIC PRODUCT LONG-TERM PROJECTION 2018-2040 – HIGH GROWTH SCENARIO (TRILLION PESOS @ 2000 CONSTANT PRICES)

REGION	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Philippines	8.67	9.27	9.92	10.62	11.36	12.15	13.00	13.92	14.89	15.86	16.89	17.99	19.15	20.30	21.52	22.81	24.18	25.63	27.17	28.80	30.53	32.36	34.30	36.36
Mindanao	1.25	1.38	1.51	1.66	1.82	2.01	2.21	2.43	2.67	2.94	3.23	3.55	3.91	4.30	4.71	5.15	5.64	6.18	6.77	7.41	8.11	8.88	9.73	10.65
Region IX	0.17	0.18	0.19	0.21	0.22	0.24	0.25	0.27	0.29	0.31	0.33	0.35	0.37	0.40	0.42	0.45	0.47	0.50	0.53	0.56	0.60	0.63	0.67	0.71
Region X	0.32	0.35	0.38	0.41	0.44	0.48	0.52	0.56	0.61	0.65	0.70	0.76	0.82	0.87	0.93	1.00	1.07	1.15	1.23	1.31	1.41	1.51	1.61	1.73
Region XI	0.37	0.41	0.45	0.49	0.54	0.60	0.66	0.72	0.80	0.87	0.95	1.04	1.14	1.24	1.35	1.46	1.59	1.73	1.88	2.04	2.21	2.40	2.61	2.84
Region XII	0.23	0.25	0.27	0.29	0.31	0.33	0.36	0.39	0.42	0.45	0.48	0.51	0.55	0.59	0.63	0.67	0.71	0.76	0.81	0.86	0.92	0.98	1.04	1.11
CARAGA	0.10	0.11	0.12	0.13	0.14	0.15	0.17	0.18	0.19	0.21	0.22	0.24	0.26	0.28	0.30	0.32	0.34	0.37	0.39	0.42	0.45	0.48	0.51	0.55
ARMM	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.10	0.11	0.11	0.11	0.12	0.12	0.13	0.13

ANNEX 2. GROSS REGIONAL DOMESTIC PRODUCT LONG-TERM PROJECTION 2018-2040 – LOW GROWTH SCENARIO (TRILLION PESOS @ 2000 CONSTANT PRICES)

REGION	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Philippines	8.67	9.27	9.92	10.62	11.36	12.15	13.00	13.92	14.89	15.86	16.89	17.99	19.15	20.30	21.52	22.81	24.18	25.63	27.17	28.80	30.53	32.36	34.30	36.36
Mindanao	1.25	1.34	1.43	1.53	1.64	1.75	1.87	2.01	2.15	2.29	2.43	2.59	2.76	2.93	3.10	3.29	3.49	3.70	3.92	4.15	4.40	4.67	4.95	5.24
Region IX	0.17	0.18	0.19	0.20	0.21	0.22	0.24	0.25	0.26	0.28	0.29	0.31	0.32	0.34	0.35	0.37	0.39	0.41	0.43	0.45	0.47	0.49	0.51	0.54
Region X	0.32	0.34	0.37	0.39	0.42	0.45	0.48	0.51	0.54	0.58	0.61	0.65	0.69	0.73	0.77	0.81	0.86	0.91	0.96	1.01	1.07	1.13	1.19	1.26
Region XI	0.37	0.40	0.43	0.47	0.51	0.55	0.59	0.64	0.70	0.75	0.81	0.87	0.93	1.00	1.07	1.14	1.22	1.31	1.40	1.49	1.60	1.71	1.83	1.95
Region XII	0.23	0.25	0.26	0.28	0.30	0.32	0.34	0.37	0.39	0.42	0.44	0.47	0.50	0.53	0.56	0.59	0.63	0.66	0.70	0.74	0.78	0.83	0.87	0.92
CARAGA	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.21	0.22	0.23	0.25	0.26	0.28	0.30	0.32	0.34	0.36	0.38	0.40	0.43	0.45
ARMM	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.11	0.11	0.11	0.12

ANNEX 3. POPULATION PROJECTION 2018-2040, BY REGION (MILLION PERSONS)

REGION	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Philippines	108.25	110.08	111.94	113.84	115.57	117.33	119.13	120.95	122.81	124.46	126.14	127.85	129.58	131.34	132.88	134.44	136.02	137.63	139.26	140.65	142.07	143.50	144.96	146.43
Mindanao	24.70	25.17	25.65	26.13	26.59	27.05	27.52	27.99	28.48	28.92	29.36	29.81	30.27	30.73	31.14	31.55	31.97	32.39	32.82	33.19	33.56	33.94	34.32	34.71
Region IX	3.75	3.82	3.88	3.95	4.01	4.07	4.14	4.21	4.27	4.33	4.40	4.46	4.52	4.59	4.64	4.70	4.76	4.82	4.88	4.93	4.98	5.03	5.08	5.13
Region X	4.83	4.90	4.98	5.06	5.13	5.19	5.27	5.34	5.41	5.47	5.53	5.59	5.66	5.72	5.77	5.82	5.87	5.92	5.97	6.01	6.05	6.09	6.12	6.16
Region XI	4.74	4.83	4.92	5.01	5.09	5.17	5.25	5.34	5.42	5.50	5.58	5.65	5.73	5.81	5.88	5.95	6.02	6.10	6.17	6.23	6.29	6.36	6.42	6.48
Region XII	4.71	4.80	4.89	4.99	5.07	5.16	5.24	5.33	5.42	5.50	5.58	5.67	5.75	5.84	5.91	5.98	6.06	6.14	6.21	6.28	6.35	6.41	6.48	6.55
CARAGA	2.70	2.75	2.81	2.87	2.92	2.98	3.03	3.09	3.15	3.20	3.26	3.32	3.37	3.43	3.49	3.54	3.60	3.65	3.71	3.76	3.82	3.87	3.93	3.98
ARMM	3.96	4.06	4.17	4.27	4.37	4.47	4.58	4.69	4.80	4.90	5.01	5.12	5.23	5.34	5.44	5.55	5.65	5.76	5.87	5.98	6.08	6.18	6.29	6.40

ANNEX 4. ENERGY PRICE PROJECTION 2018-2040

PRODUCT	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Dubai Crude ($/bbl)	53.10	69.15	71.07	66.27	66.37	66.46	66.56	66.65	66.75	66.85	66.94	67.04	67.13	67.23	67.33	67.42	67.52	67.62	67.71	67.81	67.91	68.01	68.10	68.20
Coal, Indonesia ($/tonne)	85.92	93.98	96.27	90.55	90.67	90.78	90.90	91.01	91.13	91.24	91.36	91.47	91.59	91.70	91.82	91.94	92.05	92.17	92.28	92.40	92.52	92.63	92.75	92.87
LNG, Asia ($/ mn Btu)	8.61	10.65	10.33	9.05	10.33	10.35	10.38	10.41	10.43	10.47	10.52	10.56	10.60	10.65	10.69	10.73	10.78	10.82	10.86	10.91	10.95	11.00	11.04	11.08
GDP, PPP (current international Trillion $)	127.57	135.20	143.31	151.75	160.83	170.48	179.34	188.58	198.20	208.22	218.65	229.49	240.76	252.47	264.62	277.22	290.30	303.85	317.89	332.41	347.44	362.98	379.04	395.62

ANNEX 5. TOTAL FINAL ENERGY CONSUMPTION 2017-2040, BY PRODUCT (IN KTOE) – HIGH GROWTH SCENARIO

PRODUCT	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	641.0	645.3	648.7	659.9	674.4	691.2	709.7	729.5	750.7	773.0	796.6	821.5	847.8	876.2	906.5	938.7	972.9	1,009.0	1,047.3	1,087.8	1,130.5	1,175.7	1,223.4	1,273.8
Oil & Oil Products	2,121.9	2,201.7	2,369.5	2,584.4	2,810.1	3,049.5	3,303.3	3,573.0	3,844.8	4,126.3	4,426.2	4,728.2	5,037.1	5,348.9	5,664.9	5,986.3	6,312.1	6,643.1	6,974.1	7,305.6	7,642.2	7,983.9	8,327.2	8,672.3
Electricity	923.8	1,044.4	1,139.5	1,244.5	1,355.3	1,479.2	1,626.2	1,787.8	1,963.3	2,156.2	2,368.3	2,601.4	2,857.8	3,123.1	3,413.7	3,731.8	4,080.1	4,461.5	4,879.0	5,336.3	5,837.0	6,385.2	6,985.6	6,814.9
Biomass	1,118.9	1,126.9	1,136.4	1,147.5	1,160.3	1,174.7	1,190.5	1,207.8	1,226.5	1,243.7	1,262.1	1,281.6	1,302.2	1,323.1	1,345.0	1,367.7	1,391.4	1,416.0	1,441.6	1,468.1	1,495.5	1,523.9	1,553.3	1,583.7
Biofuels	72.1	98.3	110.0	125.2	141.2	158.1	175.9	194.8	213.6	233.4	254.4	275.6	297.0	318.5	340.3	362.3	384.4	406.7	429.2	451.5	474.0	496.6	519.1	541.6
TOTAL	**4,770.4**	**4,996.0**	**5,309.0**	**5,656.5**	**6,030.5**	**6,428.7**	**6,858.6**	**7,331.3**	**7,823.4**	**8,339.8**	**8,895.5**	**9,475.2**	**10,085.4**	**10,724.5**	**11,379.8**	**12,068.7**	**12,792.6**	**13,554.9**	**14,353.6**	**15,192.0**	**16,078.5**	**17,017.1**	**18,008.3**	**19,057.0**

ANNEX 6. TOTAL FINAL ENERGY CONSUMPTION 2017-2040, BY PRODUCT (IN KTOE) – LOW GROWTH SCENARIO

PRODUCT	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	641.0	645.3	642.6	649.4	658.8	669.7	681.7	694.4	707.7	721.0	734.5	748.3	762.3	776.7	792.0	807.9	824.5	841.7	859.4	877.6	896.4	915.9	935.9	956.5
Oil & Oil Products	2,121.9	2,202.3	2,359.7	2,563.3	2,773.3	2,990.5	3,216.0	3,450.3	3,685.7	3,924.5	4,173.6	4,422.2	4,673.6	4,925.9	5,178.7	5,433.0	5,688.2	5,945.3	6,200.3	6,454.5	6,709.7	6,966.5	7,223.0	7,478.7
Electricity	816.6	906.5	1,019.6	1,068.8	1,135.1	1,219.0	1,311.7	1,412.8	1,521.8	1,627.4	1,740.3	1,861.2	1,990.5	2,128.9	2,275.1	2,431.6	2,598.9	2,778.0	2,969.6	3,174.7	3,394.1	3,628.8	3,880.1	4,148.9
Biomass	1,118.9	1,126.9	1,151.6	1,173.9	1,196.8	1,220.1	1,243.9	1,268.3	1,293.2	1,318.7	1,344.7	1,371.3	1,398.4	1,426.0	1,454.2	1,483.0	1,512.3	1,542.1	1,572.6	1,603.7	1,635.4	1,667.7	1,700.7	1,734.4
Biofuels	72.1	98.3	110.5	125.3	140.5	156.2	172.4	189.3	206.0	223.2	241.1	259.0	276.9	294.9	312.8	330.8	348.8	366.7	384.7	402.4	420.2	437.9	455.5	472.9
TOTAL	**4,770.4**	**4,979.3**	**5,284.0**	**5,580.7**	**5,904.4**	**6,255.5**	**6,625.7**	**7,015.1**	**7,414.3**	**7,814.8**	**8,234.3**	**8,662.0**	**9,101.7**	**9,552.4**	**10,012.9**	**10,486.3**	**10,972.6**	**11,473.9**	**11,986.6**	**12,512.9**	**13,055.8**	**13,616.9**	**14,195.1**	**14,791.4**

ANNEX 7. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, BY REGION (IN KTOE) - HIGH GROWTH SCENARIO

REGION	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
IX	677.8	696.7	756.2	823.7	896.4	974.3	1,055.0	1,142.2	1,233.4	1,322.4	1,416.5	1,514.8	1,617.4	1,722.5	1,828.7	1,939.6	2,055.3	2,176.4	2,298.2	2,424.9	2,557.6	2,696.9	2,842.7	2,995.7
X	1,466.2	1,529.1	1,591.8	1,661.9	1,739.0	1,822.9	1,921.9	2,027.7	2,138.9	2,257.6	2,385.6	2,521.1	2,664.5	2,817.4	3,008.0	3,182.6	3,368.1	3,566.2	3,777.8	4,003.3	4,245.0	4,504.1	4,781.5	5,078.9
XI	1,183.8	1,238.4	1,328.1	1,421.8	1,523.0	1,632.7	1,745.0	1,875.2	2,010.2	2,158.5	2,318.4	2,485.9	2,661.7	2,845.2	3,013.7	3,213.3	3,423.1	3,643.7	3,875.8	4,120.0	4,378.0	4,651.0	4,938.7	5,242.8
XII	674.0	705.1	763.1	826.2	894.3	967.7	1,046.5	1,132.2	1,221.1	1,316.9	1,420.2	1,528.3	1,641.6	1,760.2	1,878.8	2,003.1	2,133.4	2,270.3	2,414.2	2,563.9	2,721.9	2,888.9	3,064.6	3,250.1
CARAGA	525.1	550.5	578.8	614.3	649.7	686.5	728.4	770.4	813.4	856.0	902.8	947.9	996.2	1,047.4	1,094.7	1,148.5	1,204.3	1,262.4	1,322.8	1,385.1	1,450.1	1,518.1	1,588.8	1,662.5
ARMM	243.6	276.2	291.1	308.7	328.0	344.6	361.8	383.5	406.3	428.4	452.0	477.3	504.0	531.7	555.9	581.7	608.3	636.0	664.8	694.6	725.9	758.2	791.9	826.9
TOTAL	**4,770.4**	**4,996.0**	**5,309.0**	**5,656.5**	**6,030.5**	**6,428.7**	**6,858.6**	**7,331.3**	**7,823.4**	**8,339.8**	**8,895.5**	**9,475.2**	**10,085.4**	**10,724.5**	**11,379.8**	**12,068.7**	**12,792.6**	**13,554.9**	**14,353.6**	**15,192.0**	**16,078.5**	**17,017.1**	**18,008.3**	**19,057.0**

ANNEX 8. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, BY REGION (IN KTOE) - LOW GROWTH SCENARIO

REGION	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
IX	677.8	694.1	736.4	793.7	855.3	921.5	988.8	1,058.7	1,130.5	1,199.4	1,270.6	1,343.3	1,417.8	1,492.6	1,568.0	1,645.0	1,724.0	1,805.0	1,885.0	1,966.5	2,050.4	2,136.4	2,224.8	2,315.6
X	1,466.2	1,515.0	1,580.7	1,637.8	1,702.1	1,774.3	1,857.3	1,941.6	2,027.9	2,114.2	2,204.0	2,296.1	2,390.3	2,487.0	2,609.7	2,716.0	2,825.7	2,939.3	3,056.9	3,178.2	3,304.1	3,435.0	3,570.5	3,711.2
XI	1,183.8	1,247.4	1,340.5	1,418.8	1,506.0	1,603.1	1,700.0	1,807.8	1,918.7	2,033.7	2,154.6	2,279.4	2,408.0	2,540.4	2,662.3	2,805.1	2,952.6	3,105.4	3,263.8	3,427.9	3,598.3	3,775.7	3,959.8	4,150.9
XII	674.0	700.9	763.7	821.6	884.3	952.9	1,024.6	1,098.6	1,173.7	1,250.5	1,330.7	1,412.5	1,495.9	1,581.0	1,665.1	1,751.0	1,838.8	1,928.5	2,020.2	2,112.8	2,207.6	2,304.9	2,404.1	2,505.3
CARAGA	525.1	547.9	572.8	602.3	632.1	663.7	699.0	733.6	768.5	801.6	837.5	870.7	906.1	943.5	977.6	1,015.8	1,054.7	1,094.3	1,134.6	1,175.5	1,217.1	1,259.7	1,302.9	1,346.9
ARMM	243.6	274.0	289.9	306.5	324.5	340.0	356.0	374.8	395.0	415.5	437.0	460.0	483.6	508.0	530.3	553.3	576.7	601.3	626.1	652.0	678.2	705.2	733.0	761.3
TOTAL	**4,770.4**	**4,979.3**	**5,284.0**	**5,580.7**	**5,904.4**	**6,255.5**	**6,625.7**	**7,015.1**	**7,414.3**	**7,814.8**	**8,234.3**	**8,662.0**	**9,101.7**	**9,552.4**	**10,012.9**	**10,486.3**	**10,972.6**	**11,473.9**	**11,986.6**	**12,512.9**	**13,055.8**	**13,616.9**	**14,195.1**	**14,791.4**

ANNEX 9. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, BY SECTOR (IN KTOE) - HIGH GROWTH SCENARIO

SECTOR	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Industry	1,460.8	1,535.9	1,603.9	1,668.0	1,739.2	1,810.7	1,895.9	2,009.7	2,128.5	2,264.2	2,413.2	2,577.1	2,757.1	2,955.0	3,176.1	3,419.0	3,685.5	3,978.6	4,295.8	4,646.1	5,031.3	5,454.5	5,919.7	6,430.9
Commercial	460.3	479.4	506.0	528.5	552.2	576.1	602.7	635.1	668.5	705.3	744.7	786.7	831.7	879.2	930.6	985.6	1,044.4	1,107.3	1,174.7	1,246.9	1,324.1	1,407.0	1,495.8	1,591.2
Transportation	1,585.8	1,670.4	1,826.9	2,032.5	2,248.1	2,489.5	2,731.2	2,987.9	3,255.3	3,526.1	3,814.6	4,103.9	4,398.4	4,696.1	4,996.3	5,300.3	5,606.9	5,916.5	6,228.8	6,539.6	6,853.5	7,170.3	7,486.3	7,801.5
Residential	1,182.4	1,230.3	1,288.1	1,340.2	1,400.3	1,458.4	1,531.0	1,594.9	1,661.1	1,727.1	1,798.0	1,873.9	1,955.2	2,041.0	2,112.2	2,187.2	2,265.9	2,348.2	2,434.2	2,522.2	2,613.8	2,709.1	2,808.1	2,911.1
AFF	81.2	80.2	84.0	87.2	90.6	94.0	97.8	103.7	109.9	117.1	125.0	133.6	143.0	153.2	164.5	176.7	190.0	204.4	220.1	237.2	255.9	276.2	298.2	322.3
TOTAL	**4,770.4**	**4,996.0**	**5,309.0**	**5,656.5**	**6,030.5**	**6,428.7**	**6,858.6**	**7,331.3**	**7,823.4**	**8,339.8**	**8,895.5**	**9,475.2**	**10,085.4**	**10,724.5**	**11,379.8**	**12,068.7**	**12,792.6**	**13,554.9**	**14,353.6**	**15,192.0**	**16,078.5**	**17,017.1**	**18,008.3**	**19,057.0**

ANNEX 10. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, BY SECTOR (IN KTOE) - LOW GROWTH SCENARIO

SECTOR	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Industry	1,460.8	1,530.3	1,587.5	1,626.6	1,675.4	1,728.8	1,793.0	1,877.0	1,961.6	2,052.6	2,149.7	2,253.6	2,364.4	2,482.4	2,616.2	2,759.6	2,913.1	3,077.7	3,251.0	3,437.8	3,638.0	3,852.6	4,082.5	4,328.7
Commercial	460.3	477.4	500.9	515.8	533.2	552.5	573.8	598.5	623.4	648.9	675.4	703.1	732.0	761.6	794.2	828.2	863.8	900.9	939.8	980.4	1,022.9	1,067.4	1,114.0	1,162.9
Transportation	1,585.8	1,670.4	1,823.8	2,021.8	2,225.6	2,449.0	2,667.1	2,893.3	3,130.1	3,362.7	3,605.4	3,846.7	4,089.7	4,334.0	4,577.9	4,822.2	5,066.4	5,311.5	5,556.3	5,799.3	6,042.3	6,285.9	6,527.8	6,767.8
Residential	1,182.4	1,222.1	1,289.2	1,332.1	1,383.6	1,436.3	1,500.1	1,550.2	1,599.0	1,645.6	1,693.8	1,743.4	1,794.8	1,847.8	1,891.3	1,935.8	1,981.4	2,027.8	2,075.0	2,121.9	2,169.5	2,217.7	2,266.7	2,316.4
AFF	81.2	79.1	82.6	84.3	86.5	88.9	91.8	96.0	100.3	105.0	110.0	115.2	120.8	126.7	133.4	140.5	148.0	156.0	164.5	173.5	183.1	193.3	204.1	215.6
TOTAL	**4,770.4**	**4,979.3**	**5,284.0**	**5,580.7**	**5,904.4**	**6,255.5**	**6,625.7**	**7,015.1**	**7,414.3**	**7,814.8**	**8,234.3**	**8,662.0**	**9,101.7**	**9,552.4**	**10,012.9**	**10,486.3**	**10,972.6**	**11,473.9**	**11,986.6**	**12,512.9**	**13,055.8**	**13,616.9**	**14,195.1**	**14,791.4**

ANNEX 11. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, RESIDENTIAL SECTOR (IN KTOE), BY PRODUCT - HIGH GROWTH SCENARIO

PRODUCT	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Kerosene	14.8	13.4	12.3	11.2	10.4	9.6	8.9	8.2	7.7	7.2	6.7	6.3	5.9	5.6	5.3	5.0	4.7	4.4	4.2	4.0	3.8	3.6	3.4	3.2
LPG	52.3	54.7	57.2	59.9	62.8	65.8	69.0	72.3	75.9	79.4	83.1	87.1	91.2	95.2	99.5	104.0	108.7	113.6	118.8	124.2	130.0	136.0	142.3	148.9
Biomass	810.9	809.2	809.1	810.4	813.1	817.2	822.5	829.1	836.8	842.9	849.9	857.8	866.4	875.2	884.6	894.7	905.4	916.8	928.8	941.5	954.8	968.7	983.3	998.4
Electricity	304.4	353.0	409.5	458.7	514.1	565.9	630.6	685.3	740.7	797.6	858.2	922.8	991.7	1,065.0	1,122.9	1,183.5	1,247.1	1,313.3	1,382.4	1,452.5	1,525.3	1,600.8	1,679.2	1,760.5
TOTAL	**1,182.4**	**1,230.3**	**1,288.1**	**1,340.2**	**1,400.3**	**1,458.4**	**1,531.0**	**1,594.9**	**1,661.1**	**1,727.1**	**1,798.0**	**1,873.9**	**1,955.2**	**2,041.0**	**2,112.2**	**2,187.2**	**2,265.9**	**2,348.2**	**2,434.2**	**2,522.2**	**2,613.8**	**2,709.1**	**2,808.1**	**2,911.1**

ANNEX 12. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, RESIDENTIAL SECTOR (IN KTOE), BY PRODUCT - LOW GROWTH SCENARIO

PRODUCT	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Kerosene	14.8	13.4	12.7	11.8	11.0	10.3	9.6	9.0	8.5	8.0	7.6	7.1	6.8	6.4	6.1	5.8	5.5	5.3	5.0	4.8	4.5	4.3	4.1	3.9
LPG	52.3	54.7	54.2	55.1	56.1	57.1	58.2	59.3	60.4	61.5	62.6	63.7	64.8	65.9	67.1	68.2	69.4	70.6	71.9	73.1	74.4	75.8	77.1	78.5
Biomass	810.9	809.2	824.6	837.3	850.5	864.0	878.0	892.3	907.1	922.4	938.0	954.1	970.7	987.7	1,005.2	1,023.1	1,041.6	1,060.5	1,079.8	1,099.7	1,120.1	1,141.1	1,162.5	1,184.6
Electricity	304.4	344.6	397.8	427.9	466.0	504.8	554.3	589.6	623.0	653.8	685.6	718.5	752.6	787.7	812.9	838.6	864.9	891.4	918.3	944.2	970.4	996.6	1,022.9	1,049.4
TOTAL	**1,182.4**	**1,221.9**	**1,289.2**	**1,332.1**	**1,383.6**	**1,436.3**	**1,500.1**	**1,550.2**	**1,599.0**	**1,645.6**	**1,693.8**	**1,743.4**	**1,794.8**	**1,847.8**	**1,891.3**	**1,935.8**	**1,981.4**	**2,027.8**	**2,075.0**	**2,121.9**	**2,169.5**	**2,217.7**	**2,266.7**	**2,316.4**

ANNEX 13. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, TRANSPORTATION SECTOR (IN KTOE), BY PRODUCT - HIGH GROWTH SCENARIO

PRODUCT	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Gasoline	634.7	666.5	761.0	884.1	1,013.9	1,150.9	1,295.4	1,448.0	1,600.3	1,760.6	1,929.8	2,100.9	2,273.5	2,447.1	2,622.4	2,799.3	2,977.3	3,156.6	3,337.1	3,516.0	3,696.2	3,877.7	4,057.9	4,237.0
Diesel	833.3	857.4	904.7	968.7	1,034.6	1,105.3	1,180.7	1,261.5	1,342.4	1,428.7	1,522.2	1,614.4	1,709.5	1,807.1	1,905.0	2,004.4	2,104.8	2,206.4	2,309.0	2,411.3	2,514.6	2,618.9	2,722.9	2,826.8
Fuel Oil	46.8	47.2	49.8	52.6	55.6	58.7	61.8	65.3	68.7	72.1	75.7	79.4	83.3	86.9	90.7	94.8	98.8	103.2	107.5	112.0	116.9	121.8	127.0	132.2
LPG	0.8	2.7	2.7	2.7	2.8	2.8	2.8	2.9	2.8	2.8	2.8	2.8	2.8	2.7	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8
Jet Fuel & Avgas	4.4	5.0	5.7	6.5	7.4	8.3	9.4	10.5	11.8	13.0	14.4	16.0	17.6	19.3	21.2	23.2	25.4	27.9	30.6	33.7	37.2	41.2	45.6	50.6
Biofuels	65.7	91.6	103.0	118.0	133.8	150.4	168.0	186.6	205.2	224.8	245.5	266.4	287.5	308.8	330.3	351.9	373.8	395.8	417.9	439.9	462.0	484.3	506.4	528.5
Electricity	0.0	0.0	0.0	0.0	0.0	13.1	13.1	13.1	24.1	24.1	24.1	24.1	24.1	24.1	24.1	24.2	24.2	24.2	24.3	24.3	24.4	24.5	24.6	24.7
TOTAL	**1,585.8**	**1,670.4**	**1,826.9**	**2,032.5**	**2,248.1**	**2,489.5**	**2,731.2**	**2,987.9**	**3,255.3**	**3,526.1**	**3,814.6**	**4,103.9**	**4,398.4**	**4,696.1**	**4,996.3**	**5,300.3**	**5,606.9**	**5,916.5**	**6,228.8**	**6,539.6**	**6,853.5**	**7,170.3**	**7,486.3**	**7,801.5**

ANNEX 14. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, TRANSPORTATION SECTOR (IN KTOE), BY PRODUCT - LOW GROWTH SCENARIO

PRODUCT	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Gasoline	634.7	666.5	761.5	880.8	1,004.0	1,131.3	1,262.7	1,398.6	1,533.6	1,672.8	1,816.8	1,961.0	2,105.2	2,249.2	2,393.3	2,537.5	2,681.5	2,825.3	2,969.0	3,110.9	3,252.5	3,394.1	3,534.0	3,672.5
Diesel	833.3	857.4	902.7	964.2	1,026.7	1,091.4	1,159.0	1,229.6	1,300.4	1,373.6	1,451.2	1,526.9	1,604.2	1,683.1	1,761.2	1,839.5	1,917.6	1,996.4	2,074.9	2,153.0	2,231.0	2,309.2	2,386.7	2,463.4
Fuel Oil	46.8	47.2	48.4	50.4	52.6	54.7	56.9	59.1	61.6	63.8	66.1	68.6	71.0	73.2	75.8	78.2	80.6	83.3	85.9	88.8	91.5	94.3	97.3	100.2
LPG	0.8	2.7	2.6	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.5	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.5
Jet Fuel & Avgas	4.4	5.0	5.6	6.2	7.0	7.8	8.7	9.7	10.8	11.9	13.1	14.5	15.9	17.4	19.1	21.0	23.0	25.3	27.9	30.8	34.1	37.9	42.2	47.1
Biofuels	65.7	91.6	103.0	117.5	132.5	148.0	164.0	180.5	196.9	213.9	231.5	249.0	266.7	284.3	301.9	319.5	337.1	354.7	372.2	389.6	406.9	424.2	441.4	458.3
Electricity	0.0	0.0	0.0	0.0	0.0	13.1	13.1	13.1	24.1	24.1	24.1	24.1	24.1	24.1	24.1	24.2	24.2	24.2	24.3	24.3	24.4	24.4	24.5	24.6
TOTAL	**1,585.8**	**1,670.4**	**1,823.8**	**2,021.8**	**2,225.6**	**2,449.0**	**2,667.1**	**2,893.3**	**3,130.1**	**3,362.7**	**3,605.4**	**3,846.7**	**4,089.7**	**4,334.0**	**4,577.9**	**4,822.2**	**5,066.4**	**5,311.5**	**5,556.3**	**5,799.3**	**6,042.3**	**6,285.9**	**6,527.8**	**6,767.8**

ANNEX 15. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, TRANSPORTATION SECTOR (IN KTOE), BY MODALITY - HIGH GROWTH SCENARIO

MODE	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Land	1,534.5	1,618.2	1,771.4	1,973.5	2,185.1	2,422.5	2,660.0	2,912.1	3,174.8	3,441.0	3,724.4	4,008.6	4,297.4	4,589.8	4,884.5	5,182.4	5,482.6	5,785.4	6,090.7	6,393.8	6,699.3	7,007.4	7,313.7	7,618.7
Water	46.8	47.2	49.8	52.6	55.6	58.7	61.8	65.3	68.7	72.1	75.7	79.4	83.3	86.9	90.7	94.8	98.8	103.2	107.5	112.0	116.9	121.8	127.0	132.2
Air	4.4	5.0	5.7	6.5	7.4	8.3	9.4	10.5	11.8	13.0	14.4	16.0	17.6	19.3	21.2	23.2	25.4	27.9	30.6	33.7	37.2	41.2	45.6	50.6
TOTAL	**1,585.8**	**1,670.4**	**1,826.9**	**2,032.5**	**2,248.1**	**2,489.5**	**2,731.2**	**2,987.9**	**3,255.3**	**3,526.1**	**3,814.6**	**4,103.9**	**4,398.4**	**4,696.1**	**4,996.3**	**5,300.3**	**5,606.9**	**5,916.5**	**6,228.8**	**6,539.6**	**6,853.5**	**7,170.3**	**7,486.3**	**7,801.5**

ANNEX 16. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, TRANSPORTATION SECTOR (IN KTOE), BY MODALITY - LOW GROWTH SCENARIO

MODE	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Land	1,534.5	1,618.2	1,769.8	1,965.2	2,166.0	2,386.5	2,601.5	2,824.5	3,057.7	3,287.1	3,526.3	3,763.6	4,002.8	4,243.3	4,483.0	4,723.0	4,962.7	5,202.8	5,442.5	5,679.7	5,916.7	6,153.7	6,388.3	6,620.4
Water	46.8	47.2	48.4	50.4	52.6	54.7	56.9	59.1	61.6	63.8	66.1	68.6	71.0	73.2	75.8	78.2	80.6	83.3	85.9	88.8	91.5	94.3	97.3	100.2
Air	4.4	5.0	5.6	6.2	7.0	7.8	8.7	9.7	10.8	11.9	13.1	14.5	15.9	17.4	19.1	21.0	23.0	25.3	27.9	30.8	34.1	37.9	42.2	47.1
TOTAL	**1,585.8**	**1,670.4**	**1,823.8**	**2,021.8**	**2,225.6**	**2,449.0**	**2,667.1**	**2,893.3**	**3,130.1**	**3,362.7**	**3,605.4**	**3,846.7**	**4,089.7**	**4,334.0**	**4,577.9**	**4,822.2**	**5,066.4**	**5,311.5**	**5,556.3**	**5,799.3**	**6,042.3**	**6,285.9**	**6,527.8**	**6,767.8**

ANNEX 17. MINDANAO-WIDE TARGET OF E-VEHICLE - HIGH GROWTH SCENARIO

MODE	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
No. of E-Vehicles		10.0	50.0	59.0	67.0	89.0	106.0	138.0	165.0	203.0	251.0	305.0	373.0	457.0	557.0	688.0	842.0	1,035.0	1,272.0	1,563.0	1,919.0	2,350.0	2,881.0	3,534.0
% to Total National		0.1%	0.5%	0.6%	0.7%	0.8%	1.0%	1.2%	1.4%	1.6%	2.0%	2.3%	2.7%	3.2%	3.9%	4.8%	5.8%	7.2%	8.8%	10.8%	13.3%	16.3%	19.9%	24.4%
Total Demand in GWh		0.02	0.11	0.12	0.14	0.19	0.22	0.29	0.35	0.43	0.53	0.65	0.79	0.97	1.18	1.46	1.78	2.19	2.69	3.31	4.06	4.97	6.09	7.48
Power Requirement in MW		0.01	0.04	0.05	0.06	0.07	0.09	0.12	0.14	0.17	0.21	0.25	0.31	0.38	0.46	0.57	0.70	0.86	1.06	1.30	1.60	1.96	2.40	2.95
Fuel Displacement Gasoline (in million liters)		0.02	0.08	0.09	0.10	0.14	0.16	0.21	0.25	0.31	0.38	0.46	0.57	0.70	0.85	1.05	1.28	1.57	1.94	2.38	2.92	3.58	4.38	5.38

ANNEX 18. MINDANAO-WIDE TARGET OF E-VEHICLE - LOW GROWTH SCENARIO

MODE	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
No. of E-Vehicles		10.0	45.0	54.0	60.0	80.0	96.0	125.0	149.0	183.0	226.0	274.0	336.0	411.0	502.0	619.0	759.0	932.0	1,144.0	1,407.0	1,727.0	2,116.0	2,594.0	3,182.0
% to Total National		0.1%	0.5%	0.6%	0.6%	0.8%	0.9%	1.1%	1.3%	1.5%	1.8%	2.1%	2.4%	2.9%	3.5%	4.3%	5.3%	6.5%	7.9%	9.7%	11.9%	14.6%	17.9%	22.0%
Total Demand in GWh		0.02	0.10	0.11	0.13	0.17	0.20	0.26	0.32	0.39	0.48	0.58	0.71	0.87	1.06	1.31	1.61	1.97	2.42	2.98	3.65	4.48	5.49	6.73
Power Requirement in MW		0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.8	1.0	1.2	1.4	1.8	2.2	2.7
Fuel Displacement Gasoline (in million liters)		0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.8	0.9	1.2	1.4	1.7	2.1	2.6	3.2	3.9	4.8

ANNEX 19. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, COMMERCIAL SECTOR (IN KTOE), BY PRODUCT - HIGH GROWTH SCENARIO

PRODUCT	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
LPG	46.5	48.1	49.7	51.4	53.2	55.1	57.2	59.3	61.6	63.9	66.3	69.0	71.7	74.6	77.6	80.8	84.2	87.8	91.7	95.9	100.4	105.2	110.4	116.0
Diesel	191.3	198.4	205.5	212.7	220.2	228.0	236.1	244.4	253.1	261.8	270.9	280.3	290.1	299.8	310.0	320.6	331.6	343.1	355.1	367.6	380.7	394.5	408.9	424.1
Fuel Oil	28.3	29.9	31.6	33.4	35.3	37.2	39.3	41.5	43.8	46.1	48.5	51.1	53.8	56.5	59.4	62.4	65.5	68.9	72.4	76.1	80.1	84.2	88.7	93.4
Electricity	131.1	138.5	153.3	163.4	174.3	184.8	197.4	215.2	233.3	254.6	277.7	302.8	330.0	359.5	392.2	427.5	465.7	507.1	551.8	600.0	652.1	708.5	769.4	835.2
Biomass	63.0	64.5	65.9	67.5	69.2	70.9	72.8	74.7	76.8	78.9	81.2	83.6	86.1	88.7	91.5	94.4	97.4	100.5	103.8	107.2	110.8	114.5	118.4	122.5
TOTAL	**460.3**	**479.4**	**506.0**	**528.5**	**552.2**	**576.1**	**602.7**	**635.1**	**668.5**	**705.3**	**744.7**	**786.7**	**831.7**	**879.2**	**930.6**	**985.6**	**1,044.4**	**1,107.3**	**1,174.7**	**1,246.9**	**1,324.1**	**1,407.0**	**1,495.8**	**1,591.2**

ANNEX 20. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, COMMERCIAL SECTOR (IN KTOE), BY PRODUCT - LOW GROWTH SCENARIO

PRODUCT	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
LPG	46.5	48.1	49.5	51.0	52.6	54.3	56.1	57.9	59.8	61.8	63.8	65.9	68.1	70.3	72.6	75.1	77.6	80.3	83.1	86.1	89.2	92.5	96.0	99.7
Diesel	191.3	198.4	204.0	210.7	217.5	224.5	231.7	239.1	246.7	254.3	262.0	270.0	278.3	286.4	294.8	303.5	312.3	321.5	330.9	340.7	350.7	361.1	371.9	383.0
Fuel Oil	28.3	29.9	31.3	32.9	34.5	36.2	38.0	39.8	41.7	43.7	45.7	47.7	49.9	52.0	54.3	56.6	59.0	61.5	64.1	66.8	69.7	72.7	75.8	79.1
Electricity	131.1	136.4	150.3	153.9	159.8	167.2	176.1	188.2	199.9	212.3	225.3	239.0	253.4	268.6	286.4	305.1	324.8	345.6	367.5	390.6	414.8	440.4	467.4	495.9
Biomass	63.0	64.5	65.8	67.3	68.7	70.3	71.9	73.5	75.2	76.9	78.6	80.4	82.3	84.2	86.1	88.0	90.0	92.1	94.1	96.2	98.4	100.6	102.9	105.2
TOTAL	**460.3**	**477.3**	**500.9**	**515.8**	**533.2**	**552.5**	**573.8**	**598.5**	**623.4**	**648.9**	**675.4**	**703.1**	**732.0**	**761.6**	**794.2**	**828.2**	**863.8**	**900.9**	**939.8**	**980.4**	**1,022.9**	**1,067.4**	**1,114.0**	**1,162.9**

ANNEX 21. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, INDUSTRY SECTOR (IN KTOE), BY PRODUCT - HIGH GROWTH SCENARIO

PRODUCT	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	641.0	645.3	648.7	659.9	674.4	691.2	709.7	729.5	750.7	773.0	796.6	821.5	847.8	876.2	906.5	938.7	972.9	1,009.0	1,047.3	1,087.8	1,130.5	1,175.7	1,223.4	1,273.8
Oil & Oil Products	234.8	245.1	255.7	267.1	279.4	292.8	307.2	322.8	339.9	353.2	367.2	382.1	397.8	413.5	430.0	447.4	465.7	485.1	500.8	517.1	534.1	551.9	570.4	589.8
Electricity	340.0	392.3	438.2	471.4	507.4	540.2	583.8	653.4	725.1	816.1	918.3	1,033.2	1,161.9	1,306.2	1,470.8	1,654.2	1,858.3	2,085.7	2,338.7	2,621.9	2,936.7	3,286.3	3,674.3	4,104.6
Biomass	244.9	253.2	261.4	269.6	278.0	286.6	295.2	304.0	312.9	321.9	331.0	340.3	349.7	359.2	368.9	378.7	388.6	398.7	409.0	419.4	429.9	440.7	451.6	462.7
TOTAL	**1,460.8**	**1,535.9**	**1,603.9**	**1,668.0**	**1,739.2**	**1,810.7**	**1,895.9**	**2,009.7**	**2,128.5**	**2,264.2**	**2,413.2**	**2,577.1**	**2,757.1**	**2,955.0**	**3,176.1**	**3,419.0**	**3,685.5**	**3,978.6**	**4,295.8**	**4,646.1**	**5,031.3**	**5,454.5**	**5,919.7**	**6,430.9**

ANNEX 22. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, INDUSTRY SECTOR (IN KTOE), BY PRODUCT - LOW GROWTH SCENARIO

PRODUCT	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	641.0	645.3	642.6	649.4	658.8	669.7	681.7	694.4	707.7	721.0	734.5	748.3	762.3	776.7	792.0	807.9	824.5	841.7	859.4	877.6	896.4	915.9	935.9	956.5
Oil & Oil Products	234.8	245.1	254.2	264.1	274.6	285.7	297.5	310.1	323.6	334.2	345.2	356.7	368.7	380.5	392.8	405.6	418.9	432.8	444.0	455.7	467.6	479.9	492.6	505.6
Electricity	340.0	386.5	429.5	443.8	464.6	487.6	519.7	570.0	619.3	677.9	741.9	811.9	888.0	971.0	1,068.4	1,174.2	1,289.0	1,413.7	1,548.9	1,696.8	1,857.1	2,030.8	2,218.8	2,422.0
Biomass	244.9	253.2	261.2	269.3	277.5	285.8	294.1	302.5	311.0	319.5	328.1	336.7	345.4	354.1	362.9	371.8	380.7	389.6	398.6	407.7	416.8	426.0	435.3	444.6
TOTAL	**1,460.8**	**1,530.0**	**1,587.5**	**1,626.6**	**1,675.4**	**1,728.8**	**1,793.0**	**1,877.0**	**1,961.6**	**2,052.6**	**2,149.7**	**2,253.6**	**2,364.4**	**2,482.4**	**2,616.2**	**2,759.6**	**2,913.1**	**3,077.7**	**3,251.0**	**3,437.8**	**3,638.0**	**3,852.6**	**4,082.5**	**4,328.7**

ANNEX 23. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, AGRICULTURE SECTOR (IN KTOE), BY PRODUCT - HIGH GROWTH SCENARIO

PRODUCT	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Oil & Oil Products	40.29	40.11	40.62	41.24	41.95	42.72	43.54	44.41	45.32	46.26	47.23	48.22	49.24	50.29	51.35	52.42	53.51	54.63	55.76	56.90	58.07	59.25	60.45	61.67
Electricity	40.94	40.04	43.43	46.00	48.70	51.25	54.26	59.26	64.55	70.87	77.80	85.40	93.75	102.90	113.12	124.27	136.46	149.77	164.31	180.31	197.80	216.91	237.79	260.61
TOTAL	**81.23**	**80.15**	**84.05**	**87.25**	**90.65**	**93.97**	**97.80**	**103.67**	**109.87**	**117.12**	**125.03**	**133.63**	**143.00**	**153.19**	**164.46**	**176.69**	**189.97**	**204.40**	**220.06**	**237.22**	**255.87**	**276.17**	**298.25**	**322.28**

ANNEX 24. TOTAL FINAL ENERGY DEMAND OUTLOOK 2018-2040, AGRICULTURE SECTOR (IN KTOE), BY PRODUCT - LOW GROWTH SCENARIO

PRODUCT	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Oil & Oil Products	40.29	40.11	40.58	41.17	41.82	42.53	43.28	44.07	44.89	45.73	46.58	47.46	48.34	49.23	50.13	51.04	51.96	52.89	53.83	54.78	55.73	56.70	57.67	58.65
Electricity	40.94	39.02	41.99	43.18	44.72	46.41	48.47	51.92	55.43	59.27	63.37	67.75	72.44	77.43	83.25	89.45	96.07	103.12	110.64	118.74	127.38	136.60	146.44	156.94
TOTAL	**81.23**	**79.13**	**82.58**	**84.34**	**86.54**	**88.94**	**91.75**	**96.00**	**100.33**	**105.00**	**109.96**	**115.21**	**120.78**	**126.67**	**133.39**	**140.50**	**148.03**	**156.02**	**164.47**	**173.52**	**183.11**	**193.30**	**204.11**	**215.59**

ANNEX 25. TOTAL PETROLEUM DEMAND OUTLOOK 2018-2040, BY PRODUCT (IN MB) - HIGH GROWTH SCENARIO

PRODUCT	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Gasoline	5,157.7	5,419.2	6,185.3	7,183.4	8,236.2	9,347.3	10,519.2	11,757.0	12,991.6	14,291.9	15,664.8	17,052.5	18,452.7	19,860.9	21,283.1	22,718.3	24,162.9	25,617.8	27,082.9	28,534.9	29,997.2	31,470.4	32,933.6	34,387.3
Diesel	8,589.4	8,836.5	9,264.2	9,818.7	10,391.0	11,001.3	11,650.1	12,342.2	13,039.3	13,771.5	14,560.8	15,343.7	16,151.8	16,977.6	17,809.1	18,655.2	19,513.3	20,383.7	21,261.8	22,141.8	23,034.0	23,938.8	24,846.2	25,758.8
Fuel Oil	1,385.6	1,443.1	1,521.0	1,605.0	1,697.3	1,795.5	1,901.8	2,018.3	2,143.4	2,246.2	2,356.4	2,471.5	2,594.9	2,715.0	2,841.9	2,977.2	3,118.6	3,269.3	3,398.3	3,533.1	3,675.3	3,822.5	3,977.6	4,138.4
LPG	1,161.0	1,233.7	1,286.3	1,342.4	1,401.4	1,463.7	1,529.6	1,599.5	1,673.3	1,747.4	1,825.8	1,908.9	1,997.1	2,085.7	2,178.7	2,277.3	2,381.6	2,492.4	2,609.5	2,734.0	2,866.4	3,007.4	3,157.6	3,317.8
Kerosene	133.2	122.3	113.2	105.1	98.1	91.8	86.1	81.0	76.4	72.3	68.7	65.3	62.1	59.4	56.9	54.5	52.3	50.2	48.3	46.5	44.7	43.1	41.6	40.1
Jet A-1 & Avgas	35.0	40.0	45.5	51.7	58.5	66.1	74.3	83.4	93.4	103.5	114.6	126.7	139.9	153.1	167.8	183.9	201.6	221.1	242.6	267.2	294.8	325.8	360.9	400.5
Biodiesel	175.3	186.4	195.4	207.1	219.2	232.0	245.7	260.3	275.0	290.5	307.1	323.7	340.7	358.1	375.7	393.6	411.7	430.1	448.6	467.2	486.0	505.2	524.3	543.6
Bioethanol	554.4	833.0	951.1	1,104.9	1,267.2	1,438.5	1,619.1	1,809.8	2,000.1	2,200.5	2,412.0	2,625.8	2,841.5	3,058.5	3,277.6	3,498.7	3,721.2	3,945.3	4,170.9	4,394.5	4,619.7	4,846.5	5,071.8	5,295.5
TOTAL	**17,191.6**	**18,114.3**	**19,562.2**	**21,418.4**	**23,369.0**	**25,436.3**	**27,626.0**	**29,951.6**	**32,292.3**	**34,723.9**	**37,310.3**	**39,918.2**	**42,580.8**	**45,268.4**	**47,990.8**	**50,758.6**	**53,563.1**	**56,409.8**	**59,262.9**	**62,119.1**	**65,018.2**	**67,959.8**	**70,913.6**	**73,882.1**

ANNEX 26. TOTAL PETROLEUM DEMAND OUTLOOK 2018-2040, BY PRODUCT (IN MB) - LOW GROWTH SCENARIO

PRODUCT	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Gasoline	5,157.7	5,419.2	6,188.9	7,156.3	8,155.3	9,187.2	10,252.8	11,354.6	12,448.7	13,577.6	14,745.0	15,914.3	17,083.9	18,251.5	19,420.0	20,589.4	21,756.9	22,923.4	24,088.6	25,239.1	26,388.2	27,536.4	28,671.8	29,795.0
Diesel	8,589.4	8,836.5	9,239.5	9,769.6	10,309.8	10,867.9	11,449.9	12,056.0	12,666.8	13,291.3	13,951.0	14,597.8	15,259.6	15,932.1	16,600.2	17,272.3	17,945.7	18,625.9	19,303.8	19,980.5	20,659.5	21,342.8	22,023.9	22,702.2
Fuel Oil	1,385.6	1,443.1	1,495.6	1,563.9	1,638.1	1,715.5	1,798.2	1,886.3	1,981.9	2,058.7	2,139.0	2,224.4	2,312.2	2,398.1	2,489.0	2,582.5	2,680.1	2,783.4	2,871.0	2,963.0	3,056.7	3,153.7	3,255.4	3,359.3
LPG	1,161.0	1,233.7	1,248.7	1,283.2	1,318.7	1,355.3	1,393.1	1,432.1	1,472.6	1,512.7	1,554.3	1,597.4	1,642.0	1,686.2	1,731.7	1,779.0	1,828.2	1,879.1	1,932.2	1,987.5	2,045.3	2,105.6	2,168.7	2,234.8
Kerosene	133.2	122.3	116.5	109.4	103.2	97.5	92.2	87.4	82.9	79.1	75.5	72.1	69.0	66.3	63.7	61.3	59.0	56.8	54.8	52.8	50.9	49.2	47.5	45.9
Jet A-1 & Avgas	35.0	40.0	44.2	49.6	55.5	62.0	69.1	76.9	85.5	94.4	104.0	114.7	126.4	138.2	151.5	166.1	182.4	200.4	220.6	243.9	270.2	300.0	333.8	372.4
Biodiesel	175.3	186.4	199.0	210.4	222.1	234.2	246.8	260.0	273.3	287.0	301.6	315.8	330.5	345.4	360.3	375.3	390.3	405.5	420.8	436.1	451.4	466.9	482.4	497.9
Bioethanol	554.4	833.0	951.7	1,100.9	1,254.9	1,414.0	1,578.2	1,748.1	1,916.7	2,090.7	2,270.7	2,450.9	2,631.2	2,811.2	2,991.3	3,171.5	3,351.5	3,531.2	3,710.8	3,888.1	4,065.1	4,242.1	4,417.0	4,590.0
TOTAL	**17,191.6**	**18,114.3**	**19,484.0**	**21,243.2**	**23,057.5**	**24,933.4**	**26,880.3**	**28,901.4**	**30,928.4**	**32,991.4**	**35,141.1**	**37,287.4**	**39,454.8**	**41,628.9**	**43,807.7**	**45,997.5**	**48,194.1**	**50,405.7**	**52,602.5**	**54,790.8**	**56,987.4**	**59,196.6**	**61,400.7**	**63,597.5**

ANNEX 27. TOTAL PETROLEUM DEMAND OUTLOOK 2018-2040, BY REGION (IN MB) - HIGH GROWTH SCENARIO

REGION	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
IX	2,846.4	2,933.0	3,268.3	3,677.5	4,107.4	4,557.9	5,031.0	5,527.9	6,037.3	6,531.5	7,047.5	7,576.3	8,117.0	8,656.6	9,209.5	9,776.2	10,356.7	10,953.0	11,532.0	12,122.0	12,727.3	13,349.9	13,986.8	14,640.6
X	4,584.8	4,800.8	5,073.6	5,411.3	5,767.9	6,145.1	6,544.6	6,967.6	7,392.6	7,839.6	8,313.5	8,794.0	9,282.0	9,773.4	10,272.4	10,778.1	11,290.3	11,810.2	12,337.5	12,865.1	13,401.4	13,946.2	14,493.5	15,043.9
XI	5,549.4	5,833.9	6,265.1	6,799.3	7,369.1	7,979.4	8,627.7	9,320.4	10,013.8	10,749.9	11,532.5	12,325.2	13,127.7	13,934.7	14,751.7	15,576.7	16,409.6	17,249.0	18,093.5	18,932.9	19,778.5	20,629.9	21,475.4	22,315.8
XII	2,240.6	2,383.4	2,667.5	3,026.3	3,407.2	3,811.2	4,240.3	4,696.1	5,151.6	5,633.5	6,145.2	6,663.8	7,188.6	7,717.6	8,253.1	8,795.1	9,342.0	9,894.5	10,452.6	11,006.6	11,566.0	12,131.1	12,693.4	13,253.4
CARAGA	1,486.7	1,508.2	1,589.4	1,748.9	1,903.0	2,066.3	2,239.1	2,422.3	2,604.3	2,796.3	3,011.5	3,205.7	3,414.3	3,635.8	3,848.2	4,063.1	4,280.1	4,499.3	4,720.7	4,940.4	5,162.4	5,386.6	5,610.1	5,832.6
ARMM	483.7	655.0	698.3	755.2	814.3	876.3	943.5	1,017.3	1,092.7	1,173.2	1,260.1	1,353.1	1,451.1	1,550.2	1,655.9	1,769.5	1,884.4	2,003.9	2,126.5	2,252.1	2,382.7	2,516.0	2,654.4	2,795.8
TOTAL	**17,191.6**	**18,114.3**	**19,562.2**	**21,418.4**	**23,369.0**	**25,436.3**	**27,626.0**	**29,951.6**	**32,292.3**	**34,723.9**	**37,310.3**	**39,918.2**	**42,580.8**	**45,268.4**	**47,990.8**	**50,758.6**	**53,563.1**	**56,409.8**	**59,262.9**	**62,119.1**	**65,018.2**	**67,959.8**	**70,913.6**	**73,882.1**

ANNEX 28. TOTAL PETROLEUM DEMAND OUTLOOK 2018-2040, BY REGION (IN MB) - LOW GROWTH SCENARIO

REGION	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
IX	2,846.4	2,933.0	3,229.2	3,611.4	4,006.2	4,412.8	4,831.9	5,264.3	5,703.5	6,126.8	6,561.1	7,000.7	7,446.5	7,886.5	8,332.7	8,784.0	9,241.4	9,705.2	10,154.0	10,606.3	11,065.6	11,531.3	12,002.6	12,480.7
X	4,584.8	4,800.8	5,043.7	5,363.8	5,696.4	6,040.9	6,399.1	6,771.6	7,143.0	7,527.3	7,927.5	8,330.1	8,734.2	9,138.3	9,545.3	9,953.2	10,363.7	10,776.3	11,190.6	11,603.1	12,017.9	12,436.5	12,854.2	13,271.9
XI	5,549.4	5,833.9	6,313.9	6,822.5	7,352.2	7,900.2	8,469.6	9,061.1	9,650.1	10,259.0	10,889.1	11,521.8	12,154.6	12,785.8	13,417.9	14,050.3	14,680.5	15,310.8	15,940.2	16,562.5	17,183.1	17,803.5	18,416.7	19,022.3
XII	2,240.6	2,383.4	2,626.0	2,969.8	3,326.9	3,697.5	4,082.5	4,482.7	4,881.3	5,294.2	5,723.8	6,155.2	6,587.3	7,020.0	7,453.7	7,888.5	8,323.7	8,759.3	9,195.5	9,626.5	10,058.0	10,490.0	10,917.7	11,341.1
CARAGA	1,486.7	1,508.2	1,578.3	1,731.3	1,875.6	2,025.2	2,180.3	2,341.4	2,500.8	2,665.7	2,848.8	3,008.8	3,181.0	3,364.9	3,537.3	3,710.5	3,883.7	4,057.2	4,231.0	4,402.7	4,574.8	4,747.2	4,918.0	5,087.4
ARMM	483.7	655.0	692.9	744.3	800.2	856.9	916.8	980.2	1,049.8	1,118.5	1,191.0	1,270.9	1,351.2	1,433.5	1,520.8	1,610.9	1,701.0	1,796.9	1,891.1	1,989.7	2,088.0	2,188.1	2,291.5	2,394.1
TOTAL	**17,191.6**	**18,114.3**	**19,484.0**	**21,243.2**	**23,057.5**	**24,933.4**	**26,880.3**	**28,901.4**	**30,928.4**	**32,991.4**	**35,141.1**	**37,287.4**	**39,454.8**	**41,628.9**	**43,807.7**	**45,997.5**	**48,194.1**	**50,405.7**	**52,602.5**	**54,790.8**	**56,987.4**	**59,196.6**	**61,400.7**	**63,597.5**

ANNEX 29. TOTAL PETROLEUM DEMAND OUTLOOK 2018-2040, BY SECTOR (IN MB) - HIGH GROWTH SCENARIO

SECTOR	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Industry	1,708.5	1,784.4	1,862.1	1,945.5	2,035.4	2,132.5	2,237.5	2,351.3	2,474.9	2,572.5	2,675.7	2,784.7	2,900.2	3,015.6	3,136.8	3,264.7	3,399.8	3,542.6	3,659.9	3,782.3	3,910.1	4,043.7	4,183.4	4,329.6
Commercial	2,121.7	2,202.7	2,284.6	2,369.5	2,457.7	2,549.7	2,645.6	2,746.0	2,851.1	2,956.9	3,067.7	3,183.7	3,305.6	3,427.5	3,555.2	3,689.2	3,830.0	3,978.0	4,133.9	4,298.4	4,471.9	4,655.4	4,849.6	5,055.4
Transportation	12,378.3	13,129.8	14,395.6	16,057.5	17,800.7	19,646.8	21,600.4	23,673.7	25,744.9	27,931.5	30,260.1	32,596.1	34,972.0	37,373.0	39,794.7	42,246.2	44,717.8	47,213.6	49,730.7	52,234.1	54,762.5	57,314.4	59,858.3	62,395.1
Residential	683.3	698.6	717.3	738.5	762.4	788.9	817.9	849.4	883.5	917.8	954.5	993.7	1,035.4	1,076.8	1,120.6	1,166.9	1,215.7	1,267.2	1,321.5	1,378.8	1,439.1	1,502.7	1,569.6	1,640.1
Agriculture	299.7	298.8	302.7	307.4	312.7	318.5	324.7	331.2	338.0	345.1	352.4	359.9	367.6	375.5	383.5	391.6	399.9	408.3	416.9	425.6	434.5	443.5	452.6	461.9
TOTAL	**17,191.6**	**18,114.3**	**19,562.2**	**21,418.4**	**23,369.0**	**25,436.3**	**27,626.0**	**29,951.6**	**32,292.3**	**34,723.9**	**37,310.3**	**39,918.2**	**42,580.8**	**45,268.4**	**47,990.8**	**50,758.6**	**53,563.1**	**56,409.8**	**59,262.9**	**62,119.1**	**65,018.2**	**67,959.8**	**70,913.6**	**73,882.1**

ANNEX 30. TOTAL PETROLEUM DEMAND OUTLOOK 2018-2040, BY SECTOR (IN MB) - LOW GROWTH SCENARIO

SECTOR	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Industry	1,708.5	1,784.4	1,852.3	1,924.5	2,000.9	2,082.0	2,168.2	2,259.8	2,357.6	2,435.2	2,516.1	2,600.3	2,688.1	2,774.7	2,864.5	2,958.0	3,055.2	3,156.4	3,239.7	3,325.4	3,413.7	3,504.6	3,598.2	3,694.7
Commercial	2,121.7	2,202.7	2,268.9	2,346.2	2,425.9	2,507.9	2,592.6	2,680.0	2,770.5	2,860.9	2,954.4	3,051.1	3,151.2	3,250.7	3,353.6	3,460.0	3,570.4	3,684.8	3,803.5	3,927.0	4,055.4	4,189.0	4,328.3	4,473.6
Transportation	12,378.3	13,129.8	14,373.3	15,974.9	17,623.7	19,325.7	21,089.8	22,918.9	24,744.0	26,624.7	28,585.3	30,535.2	32,498.6	34,470.6	36,440.0	38,412.8	40,384.4	42,362.4	44,338.6	46,298.8	48,259.2	50,223.9	52,174.6	54,108.7
Residential	683.3	698.6	687.1	690.7	695.3	700.8	707.1	714.0	721.7	729.6	738.0	746.9	756.4	765.8	775.6	785.8	796.5	807.5	818.9	830.8	843.1	855.8	868.9	882.4
Agriculture	299.7	298.8	302.4	306.8	311.7	317.0	322.6	328.5	334.7	340.9	347.3	353.9	360.5	367.2	374.0	380.8	387.7	394.7	401.7	408.8	416.0	423.3	430.6	438.0
TOTAL	**17,191.6**	**18,114.3**	**19,484.0**	**21,243.2**	**23,057.5**	**24,933.4**	**26,880.3**	**28,901.4**	**30,928.4**	**32,991.4**	**35,141.1**	**37,287.4**	**39,454.8**	**41,628.9**	**43,807.7**	**45,997.5**	**48,194.1**	**50,405.7**	**52,602.5**	**54,790.8**	**56,987.4**	**59,196.6**	**61,400.7**	**63,597.5**

ANNEX 31. TOTAL COAL DEMAND OUTLOOK 2018-2040, BY REGION (MT @ 10 THOUSAND BTU/LB) - HIGH GROWTH SCENARIO

REGION	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
X	811.1	801.7	799.6	812.3	831.2	854.4	880.7	909.5	940.7	974.2	1,009.9	1,048.1	1,089.0	1,133.8	1,182.3	1,234.3	1,290.0	1,349.5	1,413.0	1,480.6	1,552.6	1,629.2	1,710.6	1,796.9
XII	128.5	134.0	136.6	139.3	141.9	144.5	147.1	149.7	152.3	154.9	157.5	160.1	162.7	165.4	168.0	170.6	173.2	175.8	178.4	181.0	183.6	186.2	188.9	191.5
CARAGA	266.8	279.3	285.8	292.2	298.7	305.1	311.6	318.0	324.5	330.9	337.4	343.8	350.3	356.7	363.2	369.6	376.1	382.5	389.0	395.4	401.9	408.3	414.8	421.2
Others	8.1	7.7	7.0	6.5	6.0	5.6	5.3	5.0	4.8	4.6	4.4	4.3	4.2	4.1	4.0	4.0	3.9	3.9	3.8	3.8	3.8	3.8	3.8	3.8
TOTAL	**1,214.4**	**1,222.7**	**1,229.1**	**1,250.2**	**1,277.8**	**1,309.6**	**1,344.6**	**1,382.2**	**1,422.3**	**1,464.6**	**1,509.3**	**1,556.4**	**1,606.2**	**1,660.0**	**1,717.5**	**1,778.5**	**1,843.2**	**1,911.7**	**1,984.2**	**2,060.9**	**2,142.0**	**2,227.6**	**2,318.0**	**2,413.4**

ANNEX 32. TOTAL COAL DEMAND OUTLOOK 2018-2040, BY REGION (MT @ 10 THOUSAND BTU/LB) - LOW GROWTH SCENARIO

REGION	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
X	829.7	796.9	788.5	792.9	801.9	813.9	827.9	843.1	859.5	875.8	892.5	909.6	927.2	945.5	965.5	986.7	1,009.1	1,032.5	1,057.0	1,082.6	1,109.2	1,136.9	1,165.7	1,195.7
XII	131.4	134.0	136.6	139.3	141.9	144.5	147.1	149.7	152.3	154.9	157.5	160.1	162.7	165.4	168.0	170.6	173.2	175.8	178.4	181.0	183.6	186.2	188.9	191.5
CARAGA	272.9	279.3	285.8	292.2	298.7	305.1	311.6	318.0	324.5	330.9	337.4	343.8	350.3	356.7	363.2	369.6	376.1	382.5	389.0	395.4	401.9	408.3	414.8	421.2
Others	8.3	7.1	6.6	6.1	5.7	5.3	5.0	4.8	4.6	4.4	4.3	4.1	4.1	4.0	3.9	3.9	3.8	3.8	3.8	3.8	3.7	3.7	3.7	3.8
TOTAL	**1,242.2**	**1,217.4**	**1,217.5**	**1,230.4**	**1,248.1**	**1,268.9**	**1,291.5**	**1,315.6**	**1,340.8**	**1,366.1**	**1,391.7**	**1,417.7**	**1,444.3**	**1,471.6**	**1,500.5**	**1,530.8**	**1,562.2**	**1,594.7**	**1,628.2**	**1,662.8**	**1,698.5**	**1,735.2**	**1,773.1**	**1,812.2**

ANNEX 33. TOTAL BIOMASS DEMAND OUTLOOK 2018-2040, BY REGION (IN '000 MT) – HIGH GROWTH SCENARIO

REGION	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
IX	602.2	610.5	620.7	637.7	644.6	656.9	669.9	683.6	720.4	733.4	747.0	761.2	776.0	826.1	841.9	858.3	875.1	892.6	959.2	980.0	1,000.3	1,021.2	1,042.7	1,129.1
X	684.6	680.7	692.0	679.4	686.8	699.9	713.7	728.3	669.7	681.9	694.5	707.7	721.5	678.9	691.9	705.3	719.2	733.5	700.0	715.2	730.0	745.2	761.0	731.2
XI	568.2	592.8	602.7	648.8	655.8	668.3	681.6	695.5	784.3	798.5	813.4	828.8	844.9	915.6	933.1	951.3	970.0	989.3	1,052.4	1,075.2	1,097.4	1,120.4	1,144.0	1,208.3
XII	503.9	502.0	510.4	502.5	507.9	517.6	527.9	538.7	494.3	503.3	512.7	522.4	532.5	494.7	504.1	513.9	524.0	534.5	499.2	510.0	520.5	531.4	542.6	508.2
CARAGA	341.7	352.9	358.8	378.5	382.6	389.9	397.7	405.8	435.5	443.4	451.6	460.2	469.1	493.3	502.8	512.5	522.6	533.1	551.8	563.7	575.4	587.4	599.8	616.7
ARMM	427.9	439.2	446.6	465.7	470.7	479.7	489.2	499.2	521.8	531.3	541.1	551.4	562.1	571.1	582.0	593.3	605.0	617.1	618.9	632.3	645.4	658.9	672.8	671.0
TOTAL	**3,128.5**	**3,178.2**	**3,231.3**	**3,312.7**	**3,348.4**	**3,412.4**	**3,480.0**	**3,551.2**	**3,626.0**	**3,691.7**	**3,760.3**	**3,831.8**	**3,906.2**	**3,979.7**	**4,055.9**	**4,134.6**	**4,216.0**	**4,300.0**	**4,381.6**	**4,476.5**	**4,569.0**	**4,664.4**	**4,762.9**	**4,864.5**

ANNEX 34. TOTAL BIOMASS DEMAND OUTLOOK 2018-2040, BY REGION (IN '000 MT) – LOW GROWTH SCENARIO

REGION	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
IX	602.2	610.5	625.5	607.1	607.5	620.0	632.7	645.8	660.5	648.7	662.1	675.8	689.8	725.4	703.5	718.1	733.0	748.2	798.3	770.0	786.1	802.5	819.3	884.1
X	684.6	680.7	697.3	750.6	751.1	766.5	782.3	798.4	844.6	829.6	846.7	864.2	882.1	938.8	910.6	929.4	948.7	968.4	1,031.5	995.0	1,015.7	1,036.9	1,058.6	1,129.0
XI	568.2	592.8	607.4	623.1	623.5	636.3	649.4	662.8	703.6	691.0	705.3	719.9	734.8	787.0	763.3	779.1	795.3	811.8	872.2	841.3	858.9	876.8	895.1	964.8
XII	503.9	502.0	514.3	551.6	552.0	563.3	574.9	586.8	621.4	610.3	622.9	635.8	648.9	694.0	673.1	687.0	701.3	715.8	768.6	741.4	756.8	772.6	788.8	850.4
CARAGA	341.7	352.9	361.6	375.7	375.9	383.7	391.5	399.6	426.0	418.4	427.0	435.9	444.9	478.5	464.1	473.7	483.6	493.6	532.6	513.7	524.4	535.4	546.6	591.6
ARMM	427.9	439.2	450.0	480.7	481.0	490.9	501.0	511.3	567.1	557.0	568.5	580.3	592.3	665.5	645.4	658.8	672.5	686.4	776.6	749.0	764.7	780.6	797.0	907.5
TOTAL	**3,128.5**	**3,178.2**	**3,256.1**	**3,388.9**	**3,391.0**	**3,460.7**	**3,531.9**	**3,604.7**	**3,823.3**	**3,755.0**	**3,832.6**	**3,911.9**	**3,992.8**	**4,289.2**	**4,160.0**	**4,246.2**	**4,334.3**	**4,424.4**	**4,779.8**	**4,610.4**	**4,706.5**	**4,804.8**	**4,905.3**	**5,327.4**

ANNEX 35. TOTAL BIOMASS DEMAND OUTLOOK 2018-2040, BY FEEDSTOCK (IN '000 MT) – HIGH GROWTH SCENARIO

FEEDSTOCK	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Rice Hull	25.7	26.3	26.8	28.2	28.5	29.0	29.6	30.2	33.3	33.9	34.5	35.2	35.9	40.4	41.2	42.0	42.8	43.7	49.7	50.8	51.8	52.9	54.0	62.0
Charcoal	402.1	405.6	412.4	417.3	421.7	429.8	438.3	447.3	444.8	452.9	461.3	470.1	479.2	479.3	488.4	497.9	507.7	517.9	523.1	534.4	545.5	556.9	568.6	581.0
Fuel Wood	1,622.9	1,662.5	1,690.2	1,759.2	1,778.1	1,812.1	1,848.0	1,885.8	1,983.5	2,019.5	2,057.0	2,096.1	2,136.8	2,206.6	2,248.8	2,292.5	2,337.6	2,384.2	2,448.7	2,501.7	2,553.4	2,606.8	2,661.8	2,735.5
Bagasse	106.5	113.4	115.3	128.1	129.5	131.9	134.5	137.3	161.9	164.8	167.9	171.1	174.4	195.9	199.7	203.6	207.6	211.7	229.6	234.6	239.4	244.4	249.6	263.9
Animal Waste	971.4	970.4	986.6	980.0	990.6	1,009.5	1,029.5	1,050.5	1,002.5	1,020.6	1,039.6	1,059.4	1,079.9	1,057.5	1,077.7	1,098.6	1,120.2	1,142.6	1,130.5	1,155.0	1,178.8	1,203.5	1,228.9	1,222.1
TOTAL	**3,128.5**	**3,178.2**	**3,231.3**	**3,312.7**	**3,348.4**	**3,412.4**	**3,480.0**	**3,551.2**	**3,626.0**	**3,691.7**	**3,760.3**	**3,831.8**	**3,906.2**	**3,979.7**	**4,055.9**	**4,134.6**	**4,216.0**	**4,300.0**	**4,381.6**	**4,476.5**	**4,569.0**	**4,664.4**	**4,762.9**	**4,864.5**

ANNEX 36. TOTAL BIOMASS DEMAND OUTLOOK 2018-2040, BY FEEDSTOCK (IN '000 MT) – LOW GROWTH SCENARIO

FEEDSTOCK	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Rice Hull	25.7	26.3	27.0	28.1	28.2	28.7	29.3	29.9	32.6	32.0	32.7	33.3	34.0	38.0	36.8	37.6	38.4	39.2	44.0	42.5	43.4	44.3	45.2	51.1
Charcoal	402.1	405.6	415.5	443.1	443.4	452.5	461.8	471.3	506.6	497.6	507.9	518.4	529.1	576.6	559.2	570.8	582.6	594.8	652.6	629.5	642.6	656.0	669.8	739.8
Fuel Wood	1,622.9	1,662.5	1,703.2	1,770.3	1,771.4	1,807.8	1,845.0	1,883.0	1,990.6	1,955.1	1,995.5	2,036.7	2,078.9	2,228.7	2,161.6	2,206.4	2,252.2	2,299.0	2,483.5	2,395.4	2,445.4	2,496.5	2,548.7	2,773.6
Bagasse	106.5	113.4	116.2	128.1	128.2	130.8	133.5	136.2	161.9	159.0	162.3	165.6	169.1	195.9	190.0	194.0	198.0	202.1	229.6	221.4	226.1	230.8	235.6	263.9
Animal Waste	971.4	970.4	994.2	1,019.3	1,019.9	1,040.9	1,062.3	1,084.2	1,131.6	1,111.4	1,134.4	1,157.8	1,181.8	1,250.0	1,212.3	1,237.5	1,263.1	1,289.4	1,370.1	1,321.6	1,349.1	1,377.3	1,406.1	1,499.0
TOTAL	**3,128.5**	**3,178.2**	**3,256.1**	**3,388.9**	**3,391.0**	**3,460.7**	**3,531.9**	**3,604.7**	**3,823.3**	**3,755.0**	**3,832.6**	**3,911.9**	**3,992.8**	**4,289.2**	**4,160.0**	**4,246.2**	**4,334.3**	**4,424.4**	**4,779.8**	**4,610.4**	**4,706.5**	**4,804.8**	**4,905.3**	**5,327.4**

ANNEX 37. TOTAL BIOMASS DEMAND OUTLOOK 2018-2040, BY SECTOR (IN '000 MT) – HIGH GROWTH SCENARIO

SECTOR	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Industry	684.9	713.9	724.0	777.5	768.2	782.9	798.4	814.7	919.3	887.7	904.2	921.4	939.3	1,065.2	1,007.2	1,026.8	1,047.0	1,067.9	1,211.6	1,134.7	1,158.2	1,182.4	1,207.3	1,365.6
Commercial	176.3	181.7	184.2	194.2	191.8	195.5	199.4	203.4	222.2	214.6	218.6	222.7	227.0	253.2	239.4	244.1	248.9	253.8	286.1	267.9	273.5	279.2	285.1	323.2
Residential	2,267.4	2,290.8	2,323.1	2,417.3	2,388.4	2,434.0	2,482.2	2,533.0	2,681.8	2,589.4	2,637.6	2,687.7	2,739.9	2,970.9	2,809.2	2,863.7	2,920.1	2,978.3	3,282.1	3,073.8	3,137.3	3,202.9	3,270.5	3,638.6
TOTAL	**3,128.5**	**3,186.4**	**3,231.3**	**3,388.9**	**3,348.4**	**3,412.4**	**3,480.0**	**3,551.2**	**3,823.3**	**3,691.7**	**3,760.3**	**3,831.8**	**3,906.2**	**4,289.2**	**4,055.9**	**4,134.6**	**4,216.0**	**4,300.0**	**4,779.8**	**4,476.5**	**4,569.0**	**4,664.4**	**4,762.9**	**5,327.4**

ANNEX 38. TOTAL BIOMASS DEMAND OUTLOOK 2018-2040, BY SECTOR (IN '000 MT) – LOW GROWTH SCENARIO

SECTOR	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Industry	684.9	713.9	729.6	777.5	778.0	794.0	810.3	827.0	919.3	902.9	921.6	940.6	960.1	1,065.2	1,033.1	1,054.5	1,076.4	1,098.8	1,211.6	1,168.7	1,193.1	1,218.0	1,243.4	1,365.6
Commercial	176.3	181.7	185.6	194.2	194.3	198.3	202.3	206.5	222.2	218.3	222.8	227.4	232.1	253.2	245.6	250.6	255.8	261.2	286.1	276.0	281.7	287.6	293.6	323.2
Residential	2,267.4	2,290.8	2,340.9	2,417.3	2,418.8	2,468.5	2,519.3	2,571.2	2,681.8	2,633.8	2,688.3	2,743.9	2,800.7	2,970.9	2,881.3	2,941.1	3,002.1	3,064.5	3,282.1	3,165.8	3,231.8	3,299.3	3,368.3	3,638.6
TOTAL	**3,128.5**	**3,186.4**	**3,256.1**	**3,388.9**	**3,391.0**	**3,460.7**	**3,531.9**	**3,604.7**	**3,823.3**	**3,755.0**	**3,832.6**	**3,911.9**	**3,992.8**	**4,289.2**	**4,160.0**	**4,246.2**	**4,334.3**	**4,424.4**	**4,779.8**	**4,610.4**	**4,706.5**	**4,804.8**	**4,905.3**	**5,327.4**

ANNEX 39. TOTAL ELECTRICITY DEMAND OUTLOOK 2018-2040, BY REGION (IN GWH) - HIGH GROWTH SCENARIO

REGION	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
IX	1,042	1,135	1,307	1,454	1,622	1,811	1,992	2,205	2,437	2,678	2,940	3,226	3,540	3,881	4,212	4,571	4,962	5,386	5,846	6,343	6,882	7,467	8,103	8,793
X	2,412	2,960	3,356	3,652	3,961	4,290	4,739	5,216	5,735	6,290	6,898	7,566	8,299	9,106	10,316	11,308	12,394	13,590	14,906	16,357	17,956	19,716	21,655	23,791
XI	3,165	3,351	3,700	3,945	4,225	4,542	4,831	5,261	5,744	6,332	6,985	7,711	8,516	9,408	10,109	11,158	12,312	13,580	14,972	16,509	18,196	20,045	22,073	24,295
XII	1,673	1,841	2,110	2,327	2,567	2,833	3,122	3,451	3,815	4,218	4,663	5,151	5,690	6,283	6,864	7,501	8,201	8,967	9,807	10,720	11,720	12,816	14,017	15,335
CARAGA	851	1,016	1,158	1,271	1,392	1,514	1,683	1,837	2,004	2,153	2,314	2,490	2,679	2,885	3,057	3,302	3,567	3,853	4,162	4,496	4,858	5,249	5,672	6,130
ARMM	354	439	515	603	706	771	836	941	1,057	1,162	1,276	1,398	1,530	1,672	1,765	1,862	1,966	2,076	2,193	2,318	2,450	2,591	2,740	2,899
TOTAL	**9,497**	**10,744**	**12,147**	**13,252**	**14,473**	**15,762**	**17,203**	**18,912**	**20,792**	**22,833**	**25,077**	**27,543**	**30,255**	**33,236**	**36,322**	**39,701**	**43,401**	**47,451**	**51,887**	**56,743**	**62,061**	**67,884**	**74,260**	**81,243**

Note: Including off-grid areas; excluding losses and station use

ANNEX 40. TOTAL ELECTRICITY DEMAND OUTLOOK 2018-2040, BY REGION (IN GWH) - LOW GROWTH SCENARIO

REGION	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
IX	1,042	1,104	1,258	1,334	1,437	1,575	1,703	1,839	1,984	2,121	2,265	2,418	2,580	2,752	2,920	3,098	3,288	3,490	3,704	3,930	4,170	4,426	4,698	4,987
X	2,412	2,793	3,138	3,266	3,430	3,653	3,968	4,270	4,590	4,891	5,208	5,545	5,902	6,281	6,949	7,417	7,914	8,445	9,012	9,620	10,270	10,965	11,708	12,503
XI	3,165	3,454	3,843	3,982	4,193	4,492	4,757	5,117	5,514	5,930	6,384	6,878	7,415	7,998	8,457	9,157	9,915	10,732	11,615	12,575	13,609	14,723	15,924	17,218
XII	1,673	1,792	2,040	2,152	2,301	2,496	2,706	2,919	3,147	3,373	3,613	3,868	4,139	4,428	4,704	4,999	5,314	5,649	6,006	6,380	6,778	7,203	7,656	8,138
CARAGA	851	986	1,110	1,166	1,240	1,325	1,447	1,550	1,660	1,740	1,824	1,913	2,007	2,107	2,184	2,309	2,441	2,580	2,726	2,880	3,043	3,215	3,397	3,589
ARMM	354	413	469	530	600	637	673	736	803	873	946	1,024	1,106	1,193	1,245	1,299	1,355	1,413	1,474	1,537	1,603	1,672	1,743	1,817
TOTAL	**9,497**	**10,542**	**11,858**	**12,430**	**13,201**	**14,177**	**15,255**	**16,431**	**17,698**	**18,926**	**20,240**	**21,646**	**23,150**	**24,759**	**26,460**	**28,279**	**30,225**	**32,308**	**34,537**	**36,922**	**39,473**	**42,204**	**45,125**	**48,252**

Note: Including off-grid areas; excluding losses and station use

ANNEX 41. TOTAL ELECTRICITY DEMAND OUTLOOK 2018-2040, BY SECTOR (IN GWH) - HIGH GROWTH SCENARIO

SECTOR	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Industry	3,955	4,562	5,096	5,483	5,901	6,283	6,790	7,598	8,433	9,491	10,680	12,016	13,512	15,191	17,105	19,239	21,613	24,257	27,200	30,493	34,153	38,219	42,732	47,737
Commercial	1,525	1,610	1,783	1,900	2,027	2,149	2,296	2,503	2,713	2,961	3,230	3,521	3,838	4,181	4,562	4,972	5,417	5,897	6,417	6,978	7,584	8,240	8,948	9,713
Transportation	0	0	0	0	0	152	152	152	280	280	280	280	280	281	281	281	281	282	282	283	284	285	286	287
Residential	3,541	4,105	4,763	5,334	5,979	6,582	7,334	7,970	8,615	9,276	9,981	10,732	11,534	12,386	13,059	13,764	14,503	15,274	16,077	16,892	17,739	18,618	19,529	20,475
Agriculture	476	466	505	535	566	596	631	689	751	824	905	993	1,090	1,197	1,316	1,445	1,587	1,742	1,911	2,097	2,300	2,523	2,766	3,031
TOTAL	**9,497**	**10,744**	**12,147**	**13,252**	**14,473**	**15,762**	**17,203**	**18,912**	**20,792**	**22,833**	**25,077**	**27,543**	**30,255**	**33,236**	**36,322**	**39,701**	**43,401**	**47,451**	**51,887**	**56,743**	**62,061**	**67,884**	**74,260**	**81,243**

Note: Including off-grid areas; excluding losses and station use

ANNEX 42. TOTAL ELECTRICITY DEMAND OUTLOOK 2018-2040, BY SECTOR (IN GWH) - LOW GROWTH SCENARIO

SECTOR	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Industry	3,955	4,495	4,995	5,161	5,403	5,671	6,044	6,629	7,203	7,884	8,629	9,442	10,328	11,293	12,426	13,656	14,991	16,441	18,014	19,734	21,599	23,618	25,804	28,168
Commercial	1,525	1,587	1,748	1,790	1,858	1,944	2,048	2,189	2,325	2,469	2,620	2,779	2,947	3,124	3,331	3,548	3,778	4,019	4,274	4,542	4,825	5,122	5,436	5,767
Transportation	0	0	0	0	0	152	152	152	280	280	280	280	280	280	281	281	281	282	282	283	283	284	285	286
Residential	3,541	4,007	4,627	4,976	5,420	5,871	6,446	6,857	7,246	7,604	7,974	8,356	8,752	9,161	9,454	9,753	10,059	10,367	10,680	10,982	11,285	11,590	11,897	12,205
Agriculture	476	454	488	502	520	540	564	604	645	689	737	788	842	901	968	1,040	1,117	1,199	1,287	1,381	1,481	1,589	1,703	1,825
TOTAL	**9,497**	**10,542**	**11,858**	**12,430**	**13,201**	**14,177**	**15,255**	**16,431**	**17,698**	**18,926**	**20,240**	**21,646**	**23,150**	**24,759**	**26,460**	**28,279**	**30,225**	**32,308**	**34,537**	**36,922**	**39,473**	**42,204**	**45,125**	**48,252**

Note: Including off-grid areas; excluding losses and station use

ANNEX 43. SYSTEM PEAK DEMAND 2017-2040, BY GROWTH SCENARIO (IN MW)

SCENARIO	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
High Growth	1,760.0	2,095.1	2,172.2	2,363.7	2,574.8	2,807.9	3,063.9	3,364.5	3,695.2	4,058.9	4,459.0	4,899.1	5,383.2	5,915.8	6,472.3	7,081.6	7,748.9	8,479.5	9,279.6	10,155.7	11,114.9	12,165.4	13,315.6	14,575.1
Low Growth	1,760.0	2,064.0	2,130.2	2,226.3	2,359.0	2,538.5	2,732.0	2,940.6	3,165.4	3,383.0	3,615.7	3,864.8	4,131.2	4,416.4	4,721.5	5,047.9	5,397.2	5,771.0	6,170.9	6,598.8	7,056.7	7,546.6	8,070.8	8,631.7

Note: Only covers on-grid

ANNEX 44. ELECTRICITY SALES 2017-2040, BY REGION (IN GWH) - HIGH GROWTH SCENARIO

REGION	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
IX	1,042	1,135	1,307	1,454	1,622	1,811	1,992	2,205	2,437	2,678	2,940	3,226	3,540	3,881	4,212	4,571	4,962	5,386	5,846	6,343	6,882	7,467	8,103	8,793
X	2,412	2,960	3,356	3,652	3,961	4,290	4,739	5,216	5,735	6,290	6,898	7,566	8,299	9,106	10,316	11,308	12,394	13,590	14,906	16,357	17,956	19,716	21,655	23,791
XI	3,165	3,351	3,700	3,945	4,225	4,542	4,831	5,261	5,744	6,332	6,985	7,711	8,516	9,408	10,109	11,158	12,312	13,580	14,972	16,509	18,196	20,045	22,073	24,295
XII	1,652	1,841	2,110	2,327	2,567	2,833	3,122	3,451	3,815	4,218	4,663	5,151	5,690	6,283	6,864	7,501	8,201	8,967	9,807	10,720	11,720	12,816	14,017	15,335
CARAGA	831	978	1,113	1,217	1,328	1,448	1,606	1,753	1,911	2,057	2,216	2,388	2,574	2,775	2,943	3,183	3,443	3,724	4,028	4,356	4,711	5,095	5,511	5,962
ARMM	186	211	236	261	287	313	343	389	440	495	556	623	696	777	837	901	971	1,045	1,125	1,212	1,305	1,404	1,511	1,625
TOTAL	**9,289**	**10,477**	**11,822**	**12,856**	**13,990**	**15,236**	**16,634**	**18,276**	**20,082**	**22,070**	**24,258**	**26,666**	**29,315**	**32,231**	**35,281**	**38,622**	**42,282**	**46,292**	**50,685**	**55,497**	**60,768**	**66,544**	**72,870**	**79,801**

Note: Only covers on-grid. Excluding losses and station use

ANNEX 45. ELECTRICITY SALES 2017-2040, BY REGION (IN GWH) - LOW GROWTH SCENARIO

REGION	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
IX	1,042	1,104	1,258	1,334	1,437	1,575	1,703	1,839	1,984	2,121	2,265	2,418	2,580	2,752	2,920	3,098	3,288	3,490	3,704	3,930	4,170	4,426	4,698	4,987
X	2,412	2,793	3,138	3,266	3,430	3,653	3,968	4,270	4,590	4,891	5,208	5,545	5,902	6,281	6,949	7,417	7,914	8,445	9,012	9,620	10,270	10,965	11,708	12,503
XI	3,165	3,454	3,843	3,982	4,193	4,492	4,757	5,117	5,514	5,930	6,384	6,878	7,415	7,998	8,457	9,157	9,915	10,732	11,615	12,575	13,609	14,723	15,924	17,218
XII	1,652	1,792	2,040	2,152	2,301	2,496	2,706	2,919	3,147	3,373	3,613	3,868	4,139	4,428	4,704	4,999	5,314	5,649	6,006	6,380	6,778	7,203	7,656	8,138
CARAGA	831	953	1,072	1,122	1,189	1,274	1,390	1,488	1,592	1,670	1,752	1,839	1,931	2,027	2,102	2,223	2,351	2,487	2,629	2,780	2,938	3,106	3,283	3,471
ARMM	186	203	222	239	257	276	298	329	363	397	433	472	513	556	585	614	646	678	713	749	786	825	866	908
TOTAL	**9,289**	**10,299**	**11,573**	**12,095**	**12,808**	**13,765**	**14,822**	**15,961**	**17,190**	**18,381**	**19,655**	**21,020**	**22,480**	**24,043**	**25,717**	**27,509**	**29,427**	**31,481**	**33,679**	**36,032**	**38,551**	**41,248**	**44,135**	**47,225**

Note: Only covers on-grid. Excluding losses and station use

ANNEX 46. TOTAL ELECTRICITY SALES AND CONSUMPTION 2017-2040, BY SECTOR (IN GWH) - HIGH GROWTH SCENARIO (ON-GRID)

SECTOR	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Residential	3,439	3,876	4,478	4,982	5,544	6,101	6,814	7,386	7,953	8,568	9,225	9,924	10,672	11,468	12,117	12,795	13,506	14,247	15,021	15,807	16,623	17,471	18,351	19,264
Industry	3,935	4,561	5,096	5,482	5,900	6,299	6,808	7,617	8,471	9,530	10,719	12,056	13,553	15,232	17,144	19,278	21,652	24,297	27,239	30,532	34,193	38,258	42,771	47,775
Commercial	1,487	1,591	1,762	1,878	2,003	2,117	2,261	2,466	2,668	2,914	3,179	3,467	3,780	4,119	4,496	4,902	5,342	5,817	6,332	6,887	7,487	8,135	8,836	9,594
Transport	0	0	0	0	0	152	152	152	280	280	280	280	280	281	281	281	281	282	282	283	284	285	286	287
Others	427	449	486	514	543	567	599	654	710	779	855	938	1,030	1,131	1,244	1,367	1,502	1,649	1,810	1,988	2,182	2,394	2,626	2,880
Total Sales	**9,289**	**10,477**	**11,822**	**12,856**	**13,990**	**15,236**	**16,634**	**18,276**	**20,082**	**22,070**	**24,258**	**26,666**	**29,315**	**32,231**	**35,281**	**38,622**	**42,282**	**46,292**	**50,685**	**55,497**	**60,768**	**66,544**	**72,870**	**79,801**
Station Use/ Losses	2,313	2,296	2,588	2,810	3,053	3,322	3,615	3,961	4,340	4,756	5,212	5,713	6,263	6,867	7,495	8,181	8,931	9,750	10,645	11,623	12,692	13,859	15,134	16,528
Total Consumption	**11,602**	**12,773**	**14,410**	**15,666**	**17,043**	**18,558**	**20,250**	**22,236**	**24,422**	**26,826**	**29,470**	**32,379**	**35,578**	**39,098**	**42,776**	**46,803**	**51,213**	**56,042**	**61,330**	**67,120**	**73,460**	**80,403**	**88,004**	**96,329**

ANNEX 47. TOTAL ELECTRICITY SALES AND CONSUMPTION 2017-2040, BY SECTOR (IN GWH) - LOW GROWTH SCENARIO (ON-GRID)

SECTOR	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Residential	3,439	3,801	4,381	4,685	5,074	5,505	6,063	6,442	6,790	7,115	7,451	7,798	8,157	8,526	8,802	9,082	9,368	9,656	9,948	10,229	10,512	10,795	11,080	11,365
Industry	3,935	4,493	4,994	5,160	5,402	5,686	6,060	6,646	7,235	7,918	8,663	9,478	10,364	11,331	12,462	13,693	15,028	16,479	18,053	19,773	21,638	23,658	25,843	28,208
Commercial	1,487	1,567	1,727	1,768	1,834	1,911	2,013	2,152	2,279	2,421	2,569	2,726	2,891	3,064	3,268	3,482	3,708	3,945	4,196	4,460	4,738	5,031	5,339	5,665
Transport	0	0	0	0	0	152	152	152	280	280	280	280	280	280	281	281	281	282	282	283	283	284	285	286
Others	427	437	470	482	497	512	533	571	606	647	691	738	788	841	904	971	1,042	1,119	1,200	1,287	1,381	1,481	1,587	1,701
Total Sales	**9,289**	**10,299**	**11,573**	**12,095**	**12,808**	**13,765**	**14,822**	**15,961**	**17,190**	**18,381**	**19,655**	**21,020**	**22,480**	**24,043**	**25,717**	**27,509**	**29,427**	**31,481**	**33,679**	**36,032**	**38,551**	**41,248**	**44,135**	**47,225**
Station Use/ Losses	2,313	2,262	2,537	2,646	2,797	3,003	3,224	3,462	3,719	3,965	4,228	4,509	4,809	5,129	5,471	5,835	6,224	6,639	7,082	7,556	8,061	8,601	9,176	9,791
Total Consumption	**11,602**	**12,561**	**14,110**	**14,741**	**15,606**	**16,768**	**18,046**	**19,424**	**20,909**	**22,346**	**23,883**	**25,528**	**27,289**	**29,172**	**31,187**	**33,344**	**35,651**	**38,120**	**40,761**	**43,588**	**46,612**	**49,848**	**53,311**	**57,016**

ANNEX 48. TOTAL CAPACITY 2017-2040, BY SOURCE (IN MW) REFERENCE SUPPLY - HIGH GROWTH SCENARIO

SOURCE	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	1,370	1,520	2,070	2,070	2,070	2,070	2,070	2,370	2,370	2,670	2,970	3,270	3,870	4,470	5,070	5,670	6,570	7,170	8,070	8,970	10,170	11,070	12,570	13,770
Oil	828	828	368	368	368	368	368	368	368	393	418	406	456	506	556	576	498	495	536	561	650	725	850	975
RE	1,284	1,296	1,625	1,814	1,884	2,019	2,109	2,176	2,463	2,803	2,994	3,184	3,240	3,429	3,469	3,659	3,699	3,924	3,964	4,194	4,274	4,661	4,741	4,800
Natural Gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nuclear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**3,482**	**3,644**	**4,063**	**4,253**	**4,322**	**4,458**	**4,548**	**4,914**	**5,201**	**5,866**	**6,383**	**6,861**	**7,566**	**8,405**	**9,095**	**9,905**	**10,767**	**11,589**	**12,570**	**13,725**	**15,094**	**16,456**	**18,161**	**19,545**

ANNEX 49. POWER GENERATION 2017-2040, BY SOURCE (IN GWH) REFERENCE SUPPLY - HIGH GROWTH SCENARIO

SOURCE	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	6,271	5,795	7,343	8,122	9,233	10,198	11,403	13,254	14,134	15,087	16,966	19,174	22,203	24,819	28,355	31,646	36,156	40,010	45,174	50,157	56,250	61,500	68,806	76,814
Oil	867	1,127	467	516	587	648	725	716	764	757	802	789	850	900	986	1,010	854	855	924	962	1,097	1,225	1,409	1,643
RE	4,664	5,784	6,547	6,985	7,199	7,713	8,123	8,267	9,525	10,983	11,704	12,417	12,527	13,381	13,437	14,150	14,206	15,180	15,236	16,005	16,117	17,681	17,793	17,877
Natural Gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nuclear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**11,802**	**12,706**	**14,357**	**15,623**	**17,019**	**18,559**	**20,251**	**22,238**	**24,423**	**26,827**	**29,472**	**32,381**	**35,580**	**39,100**	**42,778**	**46,806**	**51,216**	**56,045**	**61,333**	**67,124**	**73,464**	**80,407**	**88,009**	**96,334**

ANNEX 50. TOTAL CAPACITY 2017-2040, BY SOURCE (IN MW) REFERENCE SUPPLY - LOW GROWTH SCENARIO

SOURCE	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	1,370	1,520	2,070	2,070	2,070	2,070	2,070	2,070	2,070	2,070	2,070	2,070	2,370	2,670	2,970	3,270	3,870	4,170	4,470	5,070	5,370	5,670	6,270	7,170
Oil	828	828	368	368	368	368	368	368	368	368	368	331	331	356	381	376	273	245	236	236	275	275	325	400
RE	1,284	1,296	1,625	1,814	1,884	2,019	2,109	2,176	2,463	2,803	2,994	3,184	3,240	3,429	3,469	3,659	3,699	3,924	3,964	4,194	4,274	4,661	4,741	4,800
Natural Gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nuclear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**3,482**	**3,644**	**4,063**	**4,253**	**4,322**	**4,458**	**4,548**	**4,614**	**4,901**	**5,241**	**5,433**	**5,586**	**5,941**	**6,455**	**6,820**	**7,305**	**7,842**	**8,339**	**8,670**	**9,500**	**9,919**	**10,606**	**11,336**	**12,370**

ANNEX 51. POWER GENERATION 2017-2040, BY SOURCE (IN GWH) REFERENCE SUPPLY - LOW GROWTH SCENARIO

SOURCE	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	6,271	5,636	7,075	7,260	7,884	8,515	9,331	10,491	10,705	10,685	11,453	12,404	14,079	15,106	17,019	18,492	20,966	22,516	25,104	27,184	30,013	31,687	34,955	38,477
Oil	867	1,096	450	461	501	541	593	667	680	679	728	709	684	687	733	703	480	426	424	401	485	483	566	665
RE	4,664	5,784	6,547	6,985	7,199	7,713	8,123	8,267	9,525	10,983	11,704	12,417	12,527	13,381	13,437	14,150	14,206	15,180	15,236	16,005	16,117	17,681	17,793	17,877
Natural Gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nuclear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**11,802**	**12,517**	**14,072**	**14,706**	**15,583**	**16,769**	**18,047**	**19,425**	**20,910**	**22,347**	**23,885**	**25,530**	**27,290**	**29,174**	**31,189**	**33,346**	**35,653**	**38,122**	**40,764**	**43,590**	**46,615**	**49,851**	**53,314**	**57,019**

ANNEX 52. TOTAL CAPACITY 2017-2040, BY SOURCE (IN MW) ALTERNATIVE SUPPLY - HIGH GROWTH SCENARIO

SOURCE	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	1,370	1,520	2,070	2,070	2,070	2,070	2,070	2,370	2,370	2,370	2,370	2,970	3,270	3,270	4,170	4,770	5,670	6,270	6,870	7,770	8,670	9,570	11,070	11,670
Oil	828	828	368	368	368	368	368	368	368	368	368	381	406	431	481	501	423	420	436	461	550	625	725	775
RE	1,284	1,296	1,625	1,814	1,884	2,019	2,109	2,176	2,463	2,953	3,294	3,634	3,840	4,179	4,369	4,709	4,899	5,274	5,464	5,804	5,994	6,519	6,709	7,378
Natural Gas	0	0	0	0	0	0	0	0	500	500	500	500	500	1,000	1,000	1,000	1,000	1,000	1,500	1,500	1,500	1,500	1,500	2,000
Nuclear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**3,482**	**3,644**	**4,063**	**4,253**	**4,322**	**4,458**	**4,548**	**4,914**	**5,701**	**6,191**	**6,533**	**7,486**	**8,016**	**8,880**	**10,020**	**10,980**	**11,992**	**12,964**	**14,270**	**15,535**	**16,714**	**18,214**	**20,004**	**21,823**

ANNEX 53. POWER GENERATION 2017-2040, BY SOURCE (IN GWH) ALTERNATIVE SUPPLY - HIGH GROWTH SCENARIO

SOURCE	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	6,271	5,795	7,343	8,122	9,233	10,198	11,403	13,254	11,430	11,961	13,241	15,547	17,797	17,295	20,622	23,697	28,468	32,412	34,837	39,627	45,338	50,272	57,550	61,157
Oil	867	1,127	467	516	587	648	725	716	618	646	716	669	732	755	767	792	668	677	686	725	883	1,004	1,146	1,233
RE	4,664	5,784	6,547	6,985	7,199	7,713	8,123	8,267	9,525	11,237	12,212	13,179	13,987	15,095	15,969	16,936	16,714	17,466	17,776	18,743	19,054	20,938	21,248	23,124
Natural Gas	0	0	0	0	0	0	0	0	2,851	2,983	3,303	2,984	3,064	5,954	5,420	5,380	5,367	5,489	8,034	8,027	8,189	8,192	8,064	10,820
Nuclear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**11,802**	**12,706**	**14,357**	**15,623**	**17,019**	**18,559**	**20,251**	**22,238**	**24,423**	**26,827**	**29,472**	**32,381**	**35,580**	**39,100**	**42,778**	**46,806**	**51,216**	**56,045**	**61,333**	**67,124**	**73,464**	**80,407**	**88,009**	**96,334**

ANNEX 54. TOTAL CAPACITY 2017-2040, BY SOURCE (IN MW) ALTERNATIVE SUPPLY - LOW GROWTH SCENARIO

SOURCE	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	1,370	1,520	2,070	2,070	2,070	2,070	2,070	2,070	2,070	2,070	2,070	2,070	2,070	2,070	2,070	2,370	2,970	2,970	3,570	3,870	4,470	4,770	5,070	5,070
Oil	828	828	368	368	368	368	368	368	368	368	368	331	331	331	331	301	198	145	161	136	175	200	225	225
RE	1,284	1,296	1,625	1,814	1,884	2,019	2,109	2,176	2,463	2,953	3,294	3,634	3,840	4,179	4,369	4,709	4,899	5,274	5,464	5,804	5,994	6,519	6,709	7,378
Natural Gas	0	0	0	0	0	0	0	0	500	500	500	500	500	800	800	800	800	1,200	1,200	1,200	1,200	1,200	1,500	1,800
Nuclear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**3,482**	**3,644**	**4,063**	**4,253**	**4,322**	**4,458**	**4,548**	**4,614**	**5,401**	**5,891**	**6,233**	**6,536**	**6,741**	**7,380**	**7,570**	**8,180**	**8,867**	**9,589**	**10,395**	**11,010**	**11,839**	**12,689**	**13,504**	**14,473**

ANNEX 55. POWER GENERATION 2017-2040, BY SOURCE (IN GWH) ALTERNATIVE SUPPLY - LOW GROWTH SCENARIO

SOURCE	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	6,271	5,636	7,075	7,260	7,884	8,515	9,331	10,491	8,391	8,188	8,602	9,145	10,180	9,514	10,631	12,069	14,603	13,985	16,547	18,353	21,122	22,486	23,301	24,269
Oil	867	1,097	450	461	501	541	593	667	533	520	547	523	582	544	608	532	326	228	244	209	265	300	328	341
RE	4,664	5,784	6,547	6,985	7,199	7,713	8,123	8,267	9,525	11,237	12,212	13,179	13,543	14,651	14,961	15,928	16,239	17,466	17,776	18,743	19,054	20,938	22,256	23,124
Natural Gas	0	0	0	0	0	0	0	0	2,461	2,402	2,523	2,682	2,986	4,465	4,989	4,816	4,485	6,443	6,196	6,284	6,175	6,126	7,429	9,285
Nuclear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**11,802**	**12,517**	**14,072**	**14,706**	**15,583**	**16,769**	**18,047**	**19,425**	**20,910**	**22,347**	**23,885**	**25,530**	**27,290**	**29,174**	**31,189**	**33,346**	**35,653**	**38,122**	**40,764**	**43,590**	**46,615**	**49,851**	**53,314**	**57,019**

ANNEX 56. TOTAL CAPACITY 2017-2040, BY SOURCE (IN MW) NUCLEAR SUPPLY - HIGH GROWTH SCENARIO

SOURCE	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	1,370	1,520	2,070	2,070	2,070	2,070	2,070	2,370	2,370	2,370	2,370	2,970	3,270	3,270	4,170	4,770	5,670	6,270	6,270	6,870	7,770	8,670	10,170	10,770
Oil	828	828	368	368	368	368	368	368	368	368	368	381	406	431	481	501	423	420	386	386	450	525	650	700
RE	1,284	1,296	1,625	1,814	1,884	2,019	2,109	2,176	2,463	2,953	3,294	3,634	3,840	4,179	4,369	4,709	4,899	5,274	5,464	5,804	5,994	6,519	6,709	7,378
Natural Gas	0	0	0	0	0	0	0	0	500	500	500	500	500	1,000	1,000	1,000	1,000	1,000	1,500	1,500	1,500	1,500	1,500	2,000
Nuclear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,000	1,000	1,000	1,000	1,000	1,000
TOTAL	**3,482**	**3,644**	**4,063**	**4,253**	**4,322**	**4,458**	**4,548**	**4,914**	**5,701**	**6,191**	**6,533**	**7,486**	**8,016**	**8,880**	**10,020**	**10,980**	**11,992**	**12,964**	**14,620**	**15,560**	**16,714**	**18,214**	**20,029**	**21,848**

ANNEX 57. POWER GENERATION 2017-2040, BY SOURCE (IN GWH) NUCLEAR SUPPLY - HIGH GROWTH SCENARIO

SOURCE	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	6,271	5,795	7,343	8,122	9,233	10,198	11,403	13,254	11,430	11,961	13,241	15,547	17,797	17,295	20,622	23,697	28,468	32,412	28,017	32,448	38,122	43,015	50,215	53,899
Oil	867	1,127	467	516	587	648	725	716	618	646	716	669	732	755	767	792	668	677	538	566	681	800	979	1,067
RE	4,664	5,784	6,547	6,985	7,199	7,713	8,123	8,267	9,525	11,237	12,212	13,179	13,987	15,095	15,969	16,936	16,714	17,466	17,776	18,743	19,054	20,938	21,248	23,124
Natural Gas	0	0	0	0	0	0	0	0	2,851	2,983	3,303	2,984	3,064	5,954	5,420	5,380	5,367	5,489	7,117	7,482	7,723	7,769	7,682	10,360
Nuclear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7,884	7,884	7,884	7,884	7,884	7,884
TOTAL	**11,802**	**12,706**	**14,357**	**15,623**	**17,019**	**18,559**	**20,251**	**22,238**	**24,423**	**26,827**	**29,472**	**32,381**	**35,580**	**39,100**	**42,778**	**46,806**	**51,216**	**56,045**	**61,333**	**67,124**	**73,464**	**80,407**	**88,009**	**96,334**

ANNEX 58. TOTAL CAPACITY 2017-2040, BY SOURCE (IN MW) NUCLEAR SUPPLY - LOW GROWTH SCENARIO

SOURCE	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	1,370	1,520	2,070	2,070	2,070	2,070	2,070	2,070	2,070	2,070	2,070	2,070	2,070	2,070	2,070	2,370	2,970	2,970	2,970	2,970	3,570	3,870	4,170	4,170
Oil	828	828	368	368	368	368	368	368	368	368	368	331	331	331	331	301	198	145	111	61	100	125	150	150
RE	1,284	1,296	1,625	1,814	1,884	2,019	2,109	2,176	2,463	2,953	3,294	3,634	3,840	4,179	4,369	4,709	4,899	5,274	5,464	5,804	5,994	6,519	6,709	7,378
Natural Gas	0	0	0	0	0	0	0	0	500	500	500	500	500	800	800	800	800	1,200	1,200	1,200	1,200	1,200	1,500	1,800
Nuclear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,000	1,000	1,000	1,000	1,000	1,000
TOTAL	**3,482**	**3,644**	**4,063**	**4,253**	**4,322**	**4,458**	**4,548**	**4,614**	**5,401**	**5,891**	**6,233**	**6,536**	**6,741**	**7,380**	**7,570**	**8,180**	**8,867**	**9,589**	**10,745**	**11,035**	**11,864**	**12,714**	**13,529**	**14,498**

ANNEX 59. POWER GENERATION 2017-2040, BY SOURCE (IN GWH) NUCLEAR SUPPLY - LOW GROWTH SCENARIO

SOURCE	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	6,271	5,636	7,075	7,260	7,884	8,515	9,331	10,491	8,391	8,188	8,602	9,145	10,180	9,514	10,631	12,069	14,607	13,988	10,255	11,562	14,228	15,552	17,211	17,529
Oil	867	1,097	450	461	501	541	593	667	533	520	547	523	582	544	608	532	321	223	124	75	121	151	185	189
RE	4,664	5,784	6,547	6,985	7,199	7,713	8,123	8,267	9,525	11,237	12,212	13,179	13,543	14,651	14,961	15,928	16,239	17,466	17,776	18,743	19,054	20,938	21,248	23,124
Natural Gas	0	0	0	0	0	0	0	0	2,461	2,402	2,523	2,682	2,986	4,465	4,989	4,816	4,486	6,445	4,724	5,326	5,328	5,325	6,785	8,293
Nuclear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7,884	7,884	7,884	7,884	7,884	7,884
TOTAL	**11,802**	**12,517**	**14,072**	**14,706**	**15,583**	**16,769**	**18,047**	**19,425**	**20,910**	**22,347**	**23,885**	**25,530**	**27,290**	**29,174**	**31,189**	**33,346**	**35,653**	**38,122**	**40,764**	**43,590**	**46,615**	**49,851**	**53,314**	**57,019**

ANNEX 60. ELECTRICITY SALES AND CONSUMPTION 2017-2040, BY CUSTOMER TYPE (IN GWH) HIGH GROWTH SCENARIO

CUSTOMER TYPE	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Residential	174	229	284	352	434	472	510	572	640	686	735	786	839	896	923	950	978	1,007	1,037	1,067	1,098	1,130	1,162	1,195
Commercial	18	19	21	22	24	26	28	30	32	34	37	40	43	46	50	54	58	62	67	73	79	85	92	99
Industrial	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	4	4	4
Others	15	17	19	21	24	26	30	33	37	41	45	50	55	61	67	73	80	87	95	103	112	122	133	144
TOTAL SALES	**208**	**266**	**325**	**396**	**483**	**526**	**569**	**637**	**710**	**763**	**819**	**877**	**940**	**1,005**	**1,041**	**1,079**	**1,119**	**1,160**	**1,202**	**1,246**	**1,292**	**1,340**	**1,390**	**1,442**
System Loss	49	60	71	83	98	113	106	114	122	125	128	131	133	135	137	140	142	144	146	148	150	152	154	156
TOTAL CONSUMPTION	**256**	**326**	**396**	**480**	**581**	**638**	**675**	**751**	**832**	**888**	**947**	**1,008**	**1,073**	**1,140**	**1,179**	**1,219**	**1,260**	**1,303**	**1,348**	**1,395**	**1,443**	**1,492**	**1,544**	**1,598**

Note: Others includes public buildings, street lights, irrigations and utility's station use. Based on 2018 DDP of electric cooperatives servicing off-grid areas only.

ANNEX 61. ELECTRICITY SALES AND CONSUMPTION 2017-2040, BY CUSTOMER TYPE (IN GWH) LOW GROWTH SCENARIO

CUSTOMER TYPE	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Residential	174	206	245	291	345	361	376	408	441	473	507	542	579	618	636	655	675	695	715	736	757	779	801	824
Commercial	18	19	21	22	24	26	27	29	31	33	35	38	40	43	46	49	52	55	59	63	67	72	76	82
Industrial	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3
Others	15	16	18	20	23	25	28	31	34	38	41	46	50	54	59	64	70	76	82	88	95	102	110	119
TOTAL SALES	**208**	**243**	**285**	**334**	**393**	**413**	**433**	**469**	**508**	**545**	**585**	**626**	**670**	**717**	**743**	**770**	**798**	**827**	**858**	**889**	**922**	**956**	**991**	**1,027**
System Loss	49	55	62	70	79	88	81	84	87	89	91	93	95	96	98	99	101	103	104	106	107	109	110	112
TOTAL CONSUMPTION	**256**	**298**	**347**	**405**	**472**	**501**	**513**	**553**	**595**	**634**	**676**	**720**	**765**	**813**	**841**	**869**	**899**	**930**	**962**	**995**	**1,029**	**1,064**	**1,101**	**1,139**

Note: Others includes public buildings, street lights, irrigations and utility's station use. Based on 2018 DDP of electric cooperatives servicing off-grid areas only.

ANNEX 62. INVESTMENT REQUIREMENTS FOR NGCP'S PROPOSED TRANSMISSION PROJECTS 2018-2040

PROJECT NAME / DRIVER	LOCATION	TARGET YEAR OF COMPLETION	COST ESTIMATE	
			(MILLION PHP)	(MILLION USD)
System Reliability			**88,569.00**	**1,703.25**
Kabacan 138 kV Substation	North Cotabato	2021	4,168.00	80.15
Nasipit Substation Bus-In (formerly Villanueva-Jasaan-Butuan 138 kV T/L)	Agusan del Norte	2021	1,172.00	22.54
San Francisco-Tandag 138 kV Transmission Line	Agusan Del Sur, Surigao Del Sur	2023	3,864.00	74.31
Maco-Mati 138 kV Transmission Line	Compostela Valley, Davao Oriental	2023	2,075.00	39.90
Opol Substation Bus-in (formerly Balo-i-Tagoloan-Opol 138 kV T/L)	Lanao del Norte and Misamis Oriental	2025	559.00	10.75
Sultan Kudarat-Tacurong 230 kV Transmission Line	Maguindanao, Sultan Kudarat	2025	1,872.00	36.00
Eastern Mindanao 230 kV Transmission Line Project	Agusan del Norte, Agusan del Sur, Compostela Valley	2025	4,563.00	87.75
Lala-Malabang-Sultan Kudarat 230 kV Transmission Line	Lanao del Norte, Lanao del Sur, Maguindanao	2030	14,313.00	275.25
Siom-Sindangan-Salug 69 kV Transmission Line	Zamboanga Del Norte	2035	6,565.00	126.25
Bislig-Baganga 138 kV Transmission Line	Davao Oriental, Surigao del Sur	2035	3,356.00	64.54
San Francisco-Tandag 138 kV Transmission Line 2	Surigao del Sur, Agusan del Sur	2035	4,744.00	91.23
Naga-Salug 138 kV Transmission Line	Zamboanga del Sur, Zamboanga del Norte	2035	1,680.00	32.31
Sultan Kudarat-Tacurong 230 kV Transmission Line 2	Maguindanao, Sultan Kudarat	2035	4,169.00	80.17
Maco-Mati 138 kV Transmission Line 2	Davao Oriental, Compostela Valley	2035	4,003.00	76.98
Lala-Naga 230 kV Transmission Line	Zamboanga del Sur, Lanao del Norte	2040	1,659.00	31.90
Baganga-Mati 138 kV Transmission Line	Davao Oriental	2040	4,684.00	90.08
Lala-San Miguel 138 kV Transmission Line	Zamboanga del Sur, Lanao del Norte	2040	4,244.00	81.62
Nabunturan-Bunawan 230 kV Transmission Line	Davao del Norte	2040	9,523.00	183.13
Matanao-Tacurong 230 kV Transmission Line	Davao del Sur and Sultan Kudarat	2040	11,356.00	218.38
Load Growth			**6,243.00**	**120.06**
Villanueva-Butuan 230 kV Transmission Line Mindanao S/S Upgrading	Misamis Oriental, Agusan del Norte, Mindanao Island	2022	4,193.00	80.63
Mindanao Substation Expansion 3 Project	Mindanao Island	2023	1,420.00	27.31
Matanao 230/138 kV Transformer	Davao del Sur	2030	630.00	12.12
Interconnection			**15,761.00**	**303.10**
Davao-Samal 69 kV Interconnection	Davao del Norte	2030	13,335.00	256.44
Zamboanga-Basilan 69 kV Interconnection	Zamboanga del Sur, Basilan	2030	2,426.00	46.65
TOTAL			**110,573.00**	**2,126.40**

ANNEX 63. DOWNSTREAM INVESTMENT REQUIREMENTS 2018-2040, BY GROWTH SCENARIO (CUMULATIVE, IN MILLION USD)

DOWNSTREAM FACILITY / SCENARIO	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Oil Storage																							
High Growth	0.00	0.00	0.00	0.00	0.00	0.00	75.24	75.24	75.47	75.47	82.97	135.47	135.47	135.47	135.47	136.59	207.84	207.84	207.84	207.84	273.84	281.34	282.09
Low Growth	0.00	0.00	0.00	0.00	0.00	0.00	75.24	75.24	75.24	75.47	75.47	127.97	127.97	127.97	127.97	127.97	129.09	129.09	196.59	196.59	196.59	196.59	196.59
Oil Refinery																							
High Growth	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2,000.00**	**2,000.00**	**2,000.00**	**2,000.00**	**2,000.00**	**2,000.00**	**2,000.00**	**2,000.00**	**2,000.00**	**2,000.00**	**2,000.00**	**2,000.00**	**4,000.00**
Low Growth	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,000.00	2,000.00	2,000.00	2,000.00	2,000.00	2,000.00	2,000.00	2,000.00	2,000.00	2,000.00	2,000.00	2,000.00	3,400.00
On-Shore LNG Terminal																							
High Growth	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**360.00**	**360.00**	**360.00**	**360.00**	**360.00**	**540.00**	**540.00**	**540.00**	**540.00**	**540.00**	**720.00**	**720.00**	**720.00**	**720.00**	**720.00**	**900.00**
Low Growth	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**180.00**	**180.00**	**180.00**	**180.00**	**180.00**	**360.00**	**360.00**	**360.00**	**360.00**	**540.00**	**540.00**	**540.00**	**540.00**	**540.00**	**720.00**	**720.00**
FSRU (Replacement of On-Shore LNG)																							
High Growth	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**130.00**	**130.00**	**130.00**	**130.00**	**130.00**	**195.00**	**195.00**	**195.00**	**195.00**	**195.00**	**260.00**	**260.00**	**260.00**	**260.00**	**260.00**	**325.00**
Low Growth	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**65.00**	**65.00**	**65.00**	**65.00**	**65.00**	**130.00**	**130.00**	**130.00**	**130.00**	**195.00**	**195.00**	**195.00**	**195.00**	**195.00**	**260.00**	**260.00**
TOTAL: DOWNSTREAM (ON-SHORE LNG)																							
HIGH GROWTH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**75.24**	**435.24**	**435.47**	**435.47**	**2,442.97**	**2,495.47**	**2,675.47**	**2,675.47**	**2,675.47**	**2,676.59**	**2,747.84**	**2,927.84**	**2,927.84**	**2,927.84**	**2,993.84**	**3,001.34**	**5,182.09**
LOW GROWTH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**75.24**	**255.24**	**255.24**	**255.47**	**2,255.47**	**2,307.97**	**2,487.97**	**2,487.97**	**2,487.97**	**2,487.97**	**2,669.09**	**2,669.09**	**2,736.59**	**2,736.59**	**2,736.59**	**2,916.59**	**4,316.59**
TOTAL: DOWNSTREAM (FSRU)																							
HIGH GROWTH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**75.24**	**205.24**	**205.47**	**205.47**	**2,212.97**	**2,265.47**	**2,330.47**	**2,330.47**	**2,330.47**	**2,331.59**	**2,402.84**	**2,467.84**	**2,467.84**	**2,467.84**	**2,533.84**	**2,541.34**	**4,607.09**
LOW GROWTH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**75.24**	**140.24**	**140.24**	**140.47**	**2,140.47**	**2,192.97**	**2,257.97**	**2,257.97**	**2,257.97**	**2,257.97**	**2,324.09**	**2,324.09**	**2,391.59**	**2,391.59**	**2,391.59**	**2,456.59**	**3,856.59**

ANNEX 64. POWER CAPACITY ADDITION INVESTMENT REQUIREMENTS 2018-2040, (CUMULATIVE, IN MILLION USD) REFERENCE SUPPLY - HIGH GROWTH SCENARIO

PLANT TYPE	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	0.00	0.00	0.00	0.00	0.00	0.00	519.00	519.00	1,038.00	1,557.00	2,076.00	3,114.00	4,152.00	5,190.00	6,228.00	7,785.00	8,823.00	10,380.00	11,937.00	14,013.00	15,570.00	18,165.00	20,241.00
Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.13	46.17	69.11	114.80	160.30	205.61	250.73	318.12	362.86	429.69	496.23	584.57	650.54	760.01	869.01
Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydro	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	583.77	941.42	1,294.70	1,294.70	1,648.18	1,648.18	2,001.85	2,001.85	2,355.71	2,355.71	2,709.77	2,709.77	3,352.16	3,352.16	3,352.16
Geothermal	0.00	0.00	0.00	0.00	0.00	146.39	146.39	146.39	315.06	315.06	315.06	315.06	480.93	480.93	480.93	480.93	644.06	644.06	644.06	644.06	804.47	804.47	804.47
Biomass	0.00	0.00	195.61	195.61	195.61	195.61	195.61	195.61	231.33	231.33	231.33	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87
Solar	0.00	328.03	457.53	495.66	529.33	559.91	619.86	619.86	665.90	710.98	755.10	798.26	840.46	882.20	923.48	964.30	1,004.66	1,044.56	1,123.44	1,201.40	1,278.44	1,354.56	1,427.88
Wind	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nuclear	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	**0.00**	**328.03**	**653.14**	**691.27**	**724.94**	**901.90**	**1,480.85**	**1,480.85**	**2,857.19**	**3,801.96**	**4,741.30**	**5,903.69**	**7,548.73**	**8,673.78**	**10,151.85**	**11,817.06**	**13,457.16**	**15,120.89**	**17,177.37**	**19,419.67**	**21,922.46**	**24,703.06**	**26,961.38**

ANNEX 65. POWER CAPACITY ADDITION INVESTMENT REQUIREMENTS 2018-2040, (CUMULATIVE, IN MILLION USD) REFERENCE SUPPLY - LOW GROWTH SCENARIO

PLANT TYPE	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	519.00	1,038.00	1,557.00	2,076.00	3,114.00	3,633.00	4,152.00	5,190.00	5,709.00	6,228.00	7,266.00	8,823.00
Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.75	45.41	67.97	112.90	135.27	157.54	201.90	246.07	246.07	289.86	355.26
Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydro	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	583.77	941.42	1,294.70	1,294.70	1,648.18	1,648.18	2,001.85	2,001.85	2,355.71	2,355.71	2,709.77	2,709.77	3,352.16	3,352.16	3,352.16
Geothermal	0.00	0.00	0.00	0.00	0.00	146.39	146.39	146.39	315.06	315.06	315.06	315.06	480.93	480.93	480.93	480.93	644.06	644.06	644.06	644.06	804.47	804.47	804.47
Biomass	0.00	0.00	195.61	195.61	195.61	195.61	195.61	195.61	231.33	231.33	231.33	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87
Solar	0.00	328.03	457.53	495.66	529.33	559.91	619.86	619.86	665.90	710.98	755.10	798.26	840.46	882.20	923.48	964.30	1,004.66	1,044.56	1,123.44	1,201.40	1,278.44	1,354.56	1,427.88
Wind	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nuclear	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	**0.00**	**328.03**	**653.14**	**691.27**	**724.94**	**901.90**	**961.85**	**961.85**	**1,796.06**	**2,198.79**	**2,596.19**	**3,193.89**	**4,297.18**	**4,880.58**	**5,817.09**	**6,940.84**	**8,039.57**	**8,620.74**	**10,136.04**	**10,777.17**	**12,176.00**	**13,333.91**	**15,029.63**

ANNEX 66. POWER CAPACITY ADDITION INVESTMENT REQUIREMENTS 2018-2040, (CUMULATIVE, IN MILLION USD) ALTERNATIVE SUPPLY - HIGH GROWTH SCENARIO

PLANT TYPE	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	0.00	0.00	0.00	0.00	0.00	0.00	519.00	519.00	519.00	519.00	1,557.00	2,076.00	2,076.00	3,633.00	4,671.00	6,228.00	7,266.00	8,304.00	9,861.00	11,418.00	12,975.00	15,570.00	16,608.00
Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.88	68.73	91.48	136.79	181.91	249.30	294.04	338.59	405.13	493.47	559.44	647.02	690.62
Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	441.50	441.50	441.50	441.50	441.50	883.00	883.00	883.00	883.00	883.00	1,324.50	1,324.50	1,324.50	1,324.50	1,324.50	1,766.00
Hydro	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	583.77	941.42	1,294.70	1,294.70	1,648.18	1,648.18	2,001.85	2,001.85	2,355.71	2,355.71	2,709.77	2,709.77	3,418.28	3,418.28	4,127.18
Geothermal	0.00	0.00	0.00	0.00	0.00	146.39	146.39	146.39	315.06	315.06	315.06	315.06	480.93	480.93	480.93	480.93	644.06	644.06	644.06	644.06	804.47	804.47	804.47
Biomass	0.00	0.00	195.61	195.61	195.61	195.61	195.61	195.61	231.33	231.33	231.33	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87
Solar	0.00	328.32	457.82	495.95	529.62	560.19	620.14	620.14	781.28	939.06	1,093.48	1,244.54	1,392.24	1,538.33	1,682.81	1,825.68	1,966.94	2,106.59	2,244.63	2,381.06	2,515.88	2,649.09	2,966.81
Wind	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	83.00	165.75	248.25	330.50	412.50	494.35	576.05	657.60	739.00	820.25	901.35	982.30	1,063.10	1,143.75	1,224.25
Nuclear	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	**0.00**	**328.32**	**653.43**	**691.56**	**725.23**	**902.19**	**1,481.14**	**1,922.64**	**2,954.95**	**3,553.13**	**5,227.21**	**6,037.90**	**7,251.19**	**9,081.44**	**10,744.41**	**12,593.23**	**14,415.63**	**16,160.58**	**18,357.32**	**20,220.04**	**22,927.54**	**25,823.98**	**28,454.20**

ANNEX 67. POWER CAPACITY ADDITION INVESTMENT REQUIREMENTS 2018-2040, (CUMULATIVE, IN MILLION USD) ALTERNATIVE SUPPLY - LOW GROWTH SCENARIO

PLANT TYPE	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	519.00	1,557.00	1,557.00	2,595.00	3,114.00	4,152.00	4,671.00	5,190.00	5,190.00
Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44.93	44.93	89.48	111.66	155.83	177.82	199.72	199.72
Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	441.50	441.50	441.50	441.50	441.50	706.40	706.40	706.40	706.40	1,059.60	1,059.60	1,059.60	1,059.60	1,059.60	1,324.50	1,589.40
Hydro	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	583.77	941.42	1,294.70	1,294.70	1,648.18	1,648.18	2,001.85	2,001.85	2,355.71	2,355.71	2,709.77	2,709.77	3,418.28	3,418.28	4,127.18
Geothermal	0.00	0.00	0.00	0.00	0.00	146.39	146.39	146.39	315.06	315.06	315.06	315.06	480.93	480.93	480.93	480.93	644.06	644.06	644.06	644.06	804.47	804.47	804.47
Biomass	0.00	0.00	195.61	195.61	195.61	195.61	195.61	195.61	231.33	231.33	231.33	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87
Solar	0.00	328.32	457.82	495.95	529.62	560.19	620.14	620.14	781.28	939.06	1,093.48	1,244.54	1,392.24	1,538.33	1,682.81	1,825.68	1,966.94	2,106.59	2,244.63	2,381.06	2,515.88	2,649.09	2,966.81
Wind	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	83.00	165.75	248.25	330.50	412.50	494.35	576.05	657.60	739.00	820.25	901.35	982.30	1,063.10	1,143.75	1,224.25
Nuclear	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	**0.00**	**328.32**	**653.43**	**691.56**	**725.23**	**902.19**	**962.14**	**1,403.64**	**2,435.95**	**3,034.13**	**3,624.33**	**3,893.18**	**4,907.12**	**5,135.06**	**6,233.91**	**7,541.26**	**8,634.12**	**9,937.57**	**11,051.95**	**12,351.50**	**13,977.02**	**14,996.68**	**16,368.70**

ANNEX 68. POWER CAPACITY ADDITION INVESTMENT REQUIREMENTS 2018-2040, (CUMULATIVE, IN MILLION USD) NUCLEAR SUPPLY - HIGH GROWTH SCENARIO

PLANT TYPE	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	0.00	0.00	0.00	0.00	0.00	0.00	519.00	519.00	519.00	519.00	1,557.00	2,076.00	2,076.00	3,633.00	4,671.00	6,228.00	7,266.00	7,266.00	8,304.00	9,861.00	11,418.00	14,013.00	15,051.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.88	68.73	91.48	136.79	181.91	249.30	294.04	294.04	338.40	404.66	470.63	580.10	623.70
Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	441.50	441.50	441.50	441.50	441.50	883.00	883.00	883.00	883.00	883.00	1,324.50	1,324.50	1,324.50	1,324.50	1,324.50	1,766.00
Hydro	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	583.77	941.42	1,294.70	1,294.70	1,648.18	1,648.18	2,001.85	2,001.85	2,355.71	2,355.71	2,709.77	2,709.77	3,418.28	3,418.28	4,127.18
Geothermal	0.00	0.00	0.00	0.00	0.00	146.39	146.39	146.39	315.06	315.06	315.06	315.06	480.93	480.93	480.93	480.93	644.06	644.06	644.06	644.06	804.47	804.47	804.47
Biomass	0.00	0.00	195.61	195.61	195.61	195.61	195.61	195.61	231.33	231.33	231.33	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87
Solar	0.00	328.32	457.82	495.95	529.62	560.19	620.14	620.14	781.28	939.06	1,093.48	1,244.54	1,392.24	1,538.33	1,682.81	1,825.68	1,966.94	2,106.59	2,244.63	2,381.06	2,515.88	2,649.09	2,966.81
Wind	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	83.00	165.75	248.25	330.50	412.50	494.35	576.05	657.60	739.00	820.25	901.35	982.30	1,063.10	1,143.75	1,224.25
Nuclear	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4,483.00	4,483.00	4,483.00	4,483.00	4,483.00	4,483.00
TOTAL	**0.00**	**328.32**	**653.43**	**691.56**	**725.23**	**902.19**	**1,481.14**	**1,922.64**	**2,954.95**	**3,553.13**	**5,227.21**	**6,037.90**	**7,251.19**	**9,081.44**	**10,744.41**	**12,593.23**	**14,415.63**	**19,561.03**	**21,216.59**	**23,057.22**	**25,764.73**	**28,683.06**	**31,313.28**

ANNEX 69. POWER CAPACITY ADDITION INVESTMENT REQUIREMENTS 2018-2040, (CUMULATIVE, IN MILLION USD) NUCLEAR SUPPLY - LOW GROWTH SCENARIO

PLANT TYPE	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	519.00	1,557.00	1,557.00	1,557.00	1,557.00	2,595.00	3,114.00	3,633.00	3,633.00
Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44.93	44.93	44.93	44.93	89.10	111.09	132.99	132.99
Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	441.50	441.50	441.50	441.50	441.50	706.40	706.40	706.40	706.40	1,059.60	1,059.60	1,059.60	1,059.60	1,059.60	1,324.50	1,589.40
Hydro	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	583.77	941.42	1,294.70	1,294.70	1,648.18	1,648.18	2,001.85	2,001.85	2,355.71	2,355.71	2,709.77	2,709.77	3,418.28	3,418.28	4,127.18
Geothermal	0.00	0.00	0.00	0.00	0.00	146.39	146.39	146.39	315.06	315.06	315.06	315.06	480.93	480.93	480.93	480.93	644.06	644.06	644.06	644.06	804.47	804.47	804.47
Biomass	0.00	0.00	195.61	195.61	195.61	195.61	195.61	195.61	231.33	231.33	231.33	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87	266.87
Solar	0.00	328.32	457.82	495.95	529.62	560.19	620.14	620.14	781.28	939.06	1,093.48	1,244.54	1,392.24	1,538.33	1,682.81	1,825.68	1,966.94	2,106.59	2,244.63	2,381.06	2,515.88	2,649.09	2,966.81
Wind	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	83.00	165.75	248.25	330.50	412.50	494.35	576.05	657.60	739.00	820.25	901.35	982.30	1,063.10	1,143.75	1,224.25
Nuclear	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4,483.00	4,483.00	4,483.00	4,483.00	4,483.00	4,483.00
TOTAL	**0.00**	**328.32**	**653.43**	**691.56**	**725.23**	**902.19**	**962.14**	**1,403.64**	**2,435.95**	**3,034.13**	**3,624.33**	**3,893.18**	**4,907.12**	**5,135.06**	**6,233.91**	**7,541.26**	**8,634.12**	**13,338.02**	**13,911.22**	**15,210.77**	**16,836.29**	**17,855.95**	**19,227.97**

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