IEMOP
INDEPENDENT ELECTRICITY MARKET OPERATOR
PHILIPPINES

AN IEMOP SPECIAL REPORT

Philippine Electric Power Industry Assessment

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FOREWORD

For four years now, IEMOP has very satisfactorily performed its mandate as the Independent Market Operator (IMO) of the Philippine wholesale electricity spot market, known as the WESM, fulfilling the vision of the Electric Power Industry Reform Act of 2001 (EPIRA) that an entity independent from the power industry participants shall operate the WESM. In 2018, the joint endorsement of the Department of Energy (DOE) and electric power industry participants sanctioned the formation of an IMO, leading to IEMOP's assumption of the daily operations of the WESM on 26 September 2018.

The COVID-19 pandemic and lockdowns imposed in 2020 and 2021 have tremendously impacted the trading participants. The reduction of electricity consumption as well as the limitations on the capability of the generators to maintain their plants because of the lockdowns impaired the level of supply as agreed in the power supply agreements (PSA) of Distribution Utilities (DUs) and Generation Companies (GenCos). Likewise, the volatility of electricity spot market prices heightened. These circumstances eventually manifested in an increase in the price of electricity charged to consumers.

Furthermore, the increasing frequency of imposition of "yellow alert" and "red alert" causes concern on the energy supply reliability and security in the country, especially in the Luzon grid. When a yellow or red alert is declared by the System Operator, it indicates the risk that the supply may not be enough to meet the demand in case an emergency in the grid occurs. Several factors, such as transmission congestion and fuel scarcity, contribute to this situation.

In view of these issues, IEMOP conducted a study intended to assess the country's energy industry. It likewise endeavors to provide insights into the interaction of supply and demand of electricity in the Luzon and Visayas grids for the past seven years based on WESM trading results along with the factors affecting the capacity and supply gap. The study culminated in the preparation of this report which contains an evaluation of the Philippine energy industry's performance by providing data-driven analysis and recommendations with the end goal of ensuring the security, reliability, and affordability of electricity. Additionally, this report shall serve as a briefer on the status of the electric power industry during the covered period.

CONTENTS

ABBREVIATIONS

ACRONYM	DEFINITION
IMO	Independent Market Operator
IEMOP	Independent Electricity Market Operator of the Philippines
WESM	Wholesale Electricity Spot Market
EPIRA	Electric Power Industry Reform Act
ASEAN	Association of Southeast Asian Nation
NGCP	National Grid Corporation of the Philippines
DOE	Department of Energy
ERC	Energy Regulatory Commission
IPPs	Independent Power Producers
PSALM	Power Sector Assets and Liabilities Management Corporation
NPC	National Power Corporation
RCOA	Retail Competition and Open Access
RES	Retail Electricity Supplier
VRE	Variable Renewable Energy
MW	Mega Watt
COC	Certificate of Compliance
MOT	Merit Order Table
FIT	Feed-in Tariff
PDP	Power Development Plan
LDC	Load Duration Curve
BESS	Battery Energy Storage System
REC	Renewable Energy Certificate
REM	Renewable Energy Market
GEAP	Green Energy Auction Program
GEOP	Green Energy Option Program
RPS	Renewable Portfolio Standards

EXECUTIVE SUMMARY

The Independent Electricity Market Operator of the Philippines Inc. (IEMOP) conducted a study on the pertinent power sector concerns relating to electricity supply reliability, security, and affordability. Through analysis of available power systems and electricity market data, the study looked into the historical and present situation of generator performance, trading behavior, market prices vis-à-vis fuel prices, and renewable energy utilization. A comparative assessment of the Philippines' performance in terms of the energy mix, economic metrics, and retail electricity prices against other countries was also conducted. Finally, the study included a forward perspective on the supply security of the Philippines through an evaluation of the Department of Energy's power outlook.

Across the covered period from January 2015 to July 2022, the actual MW capacity supplied in the Luzon and Visayas grids is consistently lower by a wide margin compared to the total capacity of generating plants registered in the WESM. This gap is attributable to varying factors which include seasonal availability, planned maintenance outage, technology and operations-related restrictions, and fuel constraints. However, this gap increases significantly especially when unplanned outages of generating plants occur. For instance, coal plants' increased outages are usually related to efficiency issues and ageing given their base-load nature whereas variable renewable energy generators such as wind and solar farms are largely dependent on the availability of their intermittent sources.

Transmission limitations, which translate to congestions in the grid, also affect generator availability and dispatchability. In July 2022, the Hermosa Transmission Corridor (Luzon) was congested 8.3% of the time and curtailed around 260 MW of capacity. In Visayas, the transmission interconnection capacity to export power from Negros and Panay to Cebu is affected by the outage of one of the submarine cables interconnecting Negros and Panay islands to Cebu. Pertinent data indicates that the Negros and Panay generating plants were not able to maximize delivery of their capacities due to this transmission limitation. Delay in the completion of transmission reinforcements discourages the entry of new power plants in view of instances where generating plants are already installed but the necessary transmission infrastructure or reinforcements have yet to be completed.

In the oil economics facet, the geopolitical conflict between Russia and Ukraine has raised fuel prices in the global market. Fossil fuel prices dipped in 2015 but drastically increased from 2020 up to the present. This increase in fuel cost is manifested in the noticeable increase in WESM offer prices of coal, natural gas, and oil plants. Considering that nearly three-fourths of the generation mix in the WESM comes from plants using imported fossil fuel, the high-priced generation offers resulted in an increase in the spot market prices and contributed to volatility of the said price.

This report also tackles the impact of renewable energy (RE) integration in the electricity market. Currently, the injection of Variable Renewable Energy (VRE) generators is comparatively low relative to the entire generation mix, with only around 2104 MW additional capacity registered in the WESM from 2014. However, there is an overall effort to fast-track RE development in view of the various programs which strongly promote RE, such as the Feed-in Tariff, Renewable Energy Market, Green Energy Option Program, and Green Energy Auction Program. With around 2,000MW expected additional RE capacity by 2023-2025, RE plants are expected to have a greater impact on the electricity price and generation mix.

Gauging the local energy industry situation necessitates understanding the country's position relative to its ASEAN and global counterparts. To examine how the country performs among its peers, the energy mix and prices, including the rate regulation mechanism of the Philippines, were also compared with other ASEAN countries and global powerhouses. For 2014-2021, the Philippines has consistently recorded a high cost of electricity relative to its ASEAN neighbors. In 2021, the retail electricity rate of the Philippines ranked 2nd highest in Southeast Asia next only to Singapore but, globally, is lower than that of Germany, Japan, and the UK. Unlike the Philippines which has removed almost all of the government subsidies to electricity charges in accordance with the Electric Power Industry Reform Act of 2001 (EPIRA), most ASEAN countries still employ government subsidies for electricity, thus resulting to comparatively lower electricity prices for these countries. It should be noted, however, that various development agencies such as the World Bank, the Asian Development Bank (ADB), and the International Institute for Sustainable Development (IISD) have recommended the rationalization and minimization of subsidies to reflect the true cost of electricity.

Equally significant is the segment of this report which provides for demand growth projections in view of the Philippines' commitment to the international community to reduce its dependence on fossil fuels. This is in line with the Department of Energy's Power Development Plan for 2020-2040. Given these long-term targets and scenarios, the projected capacities and demand were evaluated using Load Duration Curve (LDC) analysis which provides visualization of how consistently the grid consumes electricity at a specific MW level and insights on how much capacities are needed to serve as baseload, intermediate or mid-merit, and peak demand. The projections show that Luzon has adequate base load capacities until 2030 but will become insufficient towards 2040. Visayas' projected capacity, on the other hand, has ample base load capacity until 2025 but additional capacities will be needed starting 2030. For Mindanao, the total projected capacity is sufficient until 2030 but additional capacities will be needed beyond 2030.

Improving the country's current energy situation calls for measures to simultaneously address electricity supply reliability and security as well as affordability. To help achieve these noble objectives, this study offers recommendations for the consideration of our policy and regulatory oversight bodies. For supply reliability and security, the recommendations include the conduct of holistic generation planning, regulatory review of generator performance and standards (short term), determination of appropriate generation technology for use as baseload, mid-merit, and peaking plants, implementation of the capacity market to incentivize new generation (medium term), integration of nuclear power plants to the grid and the government's active participation in the energy sector, such as revisiting the EPIRA, and introducing amendments, if necessary (long term). While, the thorough review of subsidies, universal charges and tariffs, and regulatory assessment of electricity prices are recommendations that could potentially positively impact electricity affordability in the short-term.

INTRODUCTION

I. THE PHILIPPINE ELECTRIC POWER INDUSTRY STRUCTURE

The current structure of the Philippine electric power industry was pursuant to Republic Act 9136 or the Electric Power Industry Reform Act of 2001 (EPIRA). The EPIRA restructured the industry from a vertically integrated regime, largely monopolized by the National Power Corporation (NPC), to a scheme where generation, transmission operations, and distribution are privatized to institutionalize competition in the industry.

To initialize privatization in the generation sector, the EPIRA created the Power Sector Assets and Liabilities Management (PSALM) Corporation which is the entity mandated to privatize the generation assets of the NPC.[1] Through the EPIRA, independent power producers (IPPs) now compete to provide electricity to the end-users.

To facilitate the competition among the generators, the law also provided for the establishment of the Wholesale Electricity Spot Market (WESM)[2] as the central platform where electricity is traded among large-scale generators and customers. In order to be dispatched, generators in the grid must offer their maximum capacity, with accompanying offer price, to the WESM.[3] Currently, WESM operates only in the Luzon and Visayas grids.

For the transmission sector, the franchise to operate, manage, and maintain the same was awarded to the National Grid Corporation of the Philippines (NGCP).[4] Likewise, grid operations and metering services to grid-connected end-users were also awarded to the NGCP.

Lastly, distribution of electricity is facilitated by private distribution utilities and electric cooperatives. Among the largest private distribution utilities are Manila Electric Company (MERALCO), Visayan Electric Company (VECO), and Davao Light and Power Company (DLPC). While for electric cooperatives, the Batangas II Electric Cooperative Inc. (BATELEC II) is among the largest electric cooperatives in terms of franchise area.

The law also created a scheme to give end-users the power to choose their electricity supplier through the Retail Competition and Open Access (RCOA).[5] The current threshold to qualify for the contestable market is at least 500kW.[6] Hence, customers with a monthly average peak demand of at least 500kW may select which among the licensed Retail Electricity Suppliers (RES) will provide the best option for their electricity supply.

While the EPIRA provided for the restructuring of the energy industry, it is Republic Act 9513 or the Renewable Energy Act of 2008 (RE Act) which prioritizes new and developing renewable energy in the grid. Under the RE Act, the development and use of renewable energy were given fiscal and non-fiscal incentives, including the prioritization of Variable Renewable Energy (VRE) resources in the WESM scheduling and dispatching processes.

In addition, the policies, rules and regulations promulgated by the DOE and the Energy Regulatory Commission (ERC) provide further details on the relationship of the electric power industry participants among themselves.

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1 Electric Power Industry Reform Act of 2001, R.A. 9136, §6, (2001).
2 Id. at §30
3 The Wholesale Electricity Spot Market Rules, WESM Rules, §3.5.5.2, (2022).
4 An Act Granting the NGCP a Franchise to Engage in the Business of Transmission of Electric Power, R.A. 9511, §1
5 Electric Power Industry Reform Act of 2001, R.A. 9136, §31 (2001).
6 A Resolution Prescribing the Timeline for the Implementation of RCOA, ERC Reso. No. 12 s. 2020, (2020).

The above described framework facilitates the orderly delivery of electric power from the generators to the customers, and provides for the mechanism on how the cost of electricity charged to the end-user is computed. It also aims to provide options to empower end-users to choose their suppliers, negotiate terms thereof as applicable, and monitor their consumption vis-à-vis the electricity rates imposed. This structure is in pursuit of the objective of EPIRA to ensure the quality, reliability, security, and affordability of the supply of electric power.[7]

II. CURRENT INDUSTRY CHALLENGES

The Philippine electric power industry is not without challenges. One of the primary concerns in the industry is the state of electricity supply reliability and security in the country. This is evidenced by the frequent declaration of red and yellow alerts in the Luzon and Visayas grids indicating that there is supply insufficiency in the event that an emergency or a contingency occurs.

YEAR	LUZON		VISAYAS	
	YELLOW	RED	YELLOW	RED
2017	40.97	12.95	315.23	127.68
2018	27.68	-	420.12	37.47
2019	405.92	102.00	530.77	18.30
2020	8.52	0.00	17.17	1.97
2021	28.85	21.90	1.97	1.97
2022 *(as of June 2022)*	24.58	-	1.70	1.17

***Table 1.** Imposition of Yellow and Red Alert in Luzon and Visayas grids (hours)*

Data gathered by IEMOP from the advisories sent by the NGCP-System Operator shows that as of June 2022, yellow alert was raised in the Luzon grid for a total of 24.58 hours. For the same period, yellow alert was raised in the Visayas grid for 1.7 hours and a red alert for 1.17 hours.

The impending depletion of the Malampaya gas field on the coast of Palawan also poses a significant risk to the country's supply security and reliability. The Malampaya gas field supplies natural gas to several generators with combined capacities of 3,285MW. However, some of these power plants may still operate using other fuel sources, which may be more expensive than natural gas.

[7] Electric Power Industry Reform Act of 2001, R.A. 9136, §2(b) (2001).

Generator Facility Name	Capacity (MW)
San Gabriel Avion Power Plant Unit 1	47.2
San Gabriel Avion Power Plant Unit 2	45.8
Ilijan Natural Gas Power Plant	600
Ilijan Natural Gas Power Plant	600
San Gabriel Power Plant	420
Sta. Rita Natural Gas Power Plant	257.3
Sta. Rita Natural Gas Power Plant	255.7
Sta. Rita Natural Gas Power Plant	265.5
Sta. Rita Natural Gas Power Plant	264
San Lorenzo Natural Gas Power Plant	265
San Lorenzo Natural Gas Power Plant	265
TOTAL	**3285.5**

Table 2. *Natural Gas Power Plants*

Meanwhile, the power outage of the Cebu-Negros cable due to the underwater dredging by the Department of Public Works and Highways (DPWH) on 15 June 2021,[8] also caused stranded capacities in Negros. Negros has a WESM registered capacity of 789.7MW as of June 2022 while the highest demand recorded in the island is only 389MW. Excess power from Negros is usually exported to Cebu, which has the highest demand in the Visayas grid. However, the outage of one of the transmission lines connecting these two islands halted this transmission of power.

The country's aging power plants coupled with its natural wear and tear also cause an increase in the frequency of duration and maintenance schedules. Data from the DOE shows that 55.6% of the installed capacity in the Philippines was built in 2003 or earlier. For the Luzon grid, the increase in installed capacity falls behind the steady growth in demand.

GRID	Installed Capacity (MW)[9]				Peak Demand (MW)[10]	
	2003	2021	% Increase	2003	2021	% Increase
LUZON	11,812	18,857	37.36%	8,221	11,599	41.09%
VISAYAS	1,647	3,814	56.82%	1,567	2,252	43.71%
MINDANAO	1,665	4,511	63.09%	1,420	2,100	47.89%
PHILIPPINES	**15,124**	**27,182**	**44.36%**			

Table 3. *Comparison of Installed Capacity and Peak Demand (2003 vs. 2021)*

[8] Angelica Y. Yang, Business World Online, "Undersea cable damage disrupts power link between Negros, Cebu", *https://www.bworldonline.com/economy/2021/07/07/380982/undersea-cable-damage-disrupts-power-link-between-negros-cebu/*
[9] DOE 2021 Annual Power Statistics, *https://www.doe.gov.ph/energy-statistics/philippine-power-statistics?q=energy-statistics/philippine-power- statistics*
[10] Processed from Hourly Demand (NGCP Operations), *https://www.ngcp.ph/operations#operations*

In terms of cost of electricity, the retail electricity rate in the Philippines, as of 2021, is the second highest in the ASEAN region. A more comprehensive evaluation of the energy situation of the ASEAN countries will be discussed in the succeeding chapters.

Moreover, the rising cost of coal and oil[11], combined with the impending depletion of Malampaya natural gas field, further threatens steeper prices of electricity.

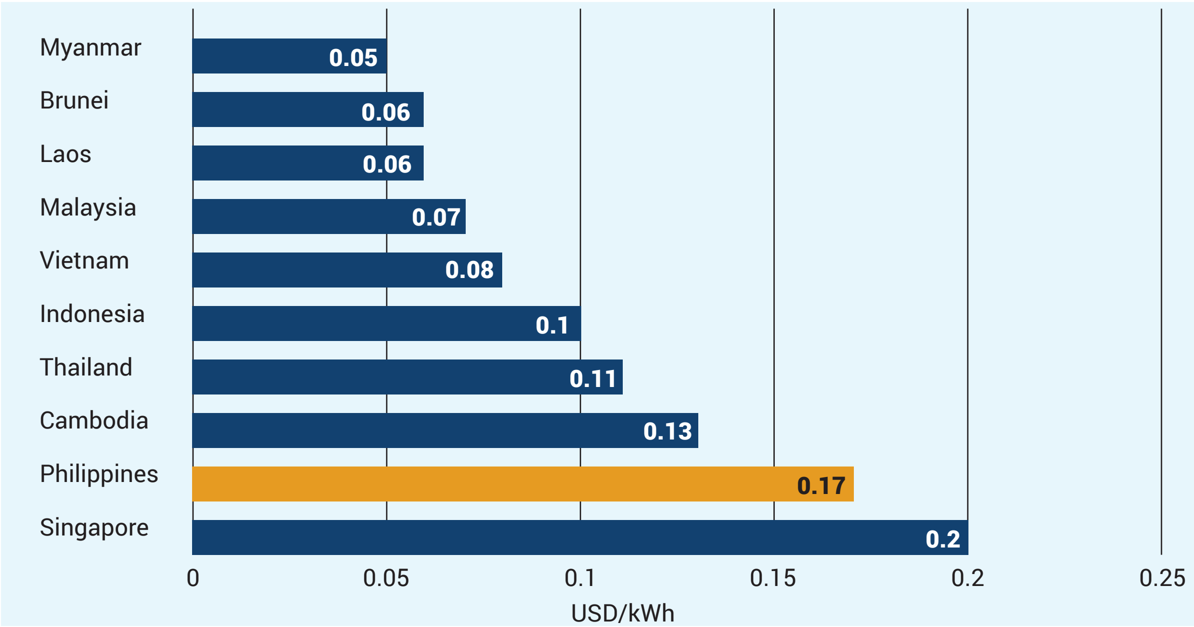

Figure 1. *Retail Electricity Rates of ASEAN Countries (2021)*[12]

Given these growing concerns in energy security, reliability, and affordability, a data-driven assessment of the possible causes is necessary in order to formulate effective and feasible solutions and recommendations to mitigate and resolve these identified issues.

III. OBJECTIVES

The primary purpose of this study is to provide data-driven analysis and recommendations to aid in ensuring the security, reliability, and affordability of electricity. It encompasses the following specific objectives:

1. Evaluate the current energy industry status, in terms of the following:
    a. State of supply and demand
    b. Generator performance
    c. Market Price vis-à-vis Fuel Price
    d. Offer Price Distribution
    e. Merit Order Table
    f. Renewable Energy
    g. ASEAN and Global Comparison on Energy Mix, Industry Structure, and Prices
2. Provide a long-term power outlook in view of the Philippine's targets and commitments.
3. Enumerate recommendations to ensure energy security, reliability, and affordability.

[11] Marielle Lucenio, "Power rates headed upward due to more expensive coal", Business World Online, *https://www.bworldonline.com/economy/2022/03/06/434154/power-rates-headed-upward-due-to-more-expensive-coal/*
[12] The Price of Electricity per KWh in 230 countries, Cable.co.uk, *https://www.cable.co.uk/energy/worldwide-pricing/*

Re-energizing Our Identity as San Miguel Global Power

Our reinvigorated brand—San Miguel Global Power—emphasizes the strength of our roots as we navigate toward a sustainable future. It represents who we are and what we value as a company. The new corporate logo, with its smooth arcs and vibrant colors, expresses our diversifying portfolio and our focus on making sustainable energy solutions available for every Filipino.

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BESS Facility in Jasaan, Misamis Oriental

METHODOLOGY

A. EVALUATION OF INDUSTRY PERFORMANCE

The metrics used in this study for the evaluation of the electric power industry performance are: (1) supply reliability and security; and (2) affordability. The factors considered to assess these metrics include generator performance, fuel cost, generator offers, merit order in the Wholesale Electricity Spot Market (WESM), and renewable energy performance. In addition, the Philippines' performance, with respect to retail prices and energy mix, is contrasted with the rest of the ASEAN countries.

The data used for the evaluation of energy industry performance is mainly sourced from IEMOP. Other data and information were obtained from publicly available data of relevant private and public institutions.

1. State of supply and demand

Trends of grid capacity, supply, and demand in WESM grids (Luzon and Visayas) shall be determined to provide a holistic overview of the energy industry in recent years.

Data on capacity is sourced from WESM Registered Generation Capacity. All generators connected to the grid are required to register with the WESM. The maximum registered capacity corresponds to the Megawatt (MW) value as stated in the generator's Certificate of Compliance (COC) issued by the ERC. On the other hand, peak demand data is based on the highest demand recorded in the grid for the relevant month. Lastly, supply data is the total available MW value that may be dispatched at the time coincident with the recorded peak demand.

2. Generator performance

To reconcile the registered capacity and supply data, historical generator performance shall be measured by fuel type. This measurement provides meaningful insights into what generator technologies are most efficient for baseload, mid-merit, and peaking plants.

Generator performances are measured using the following metrics:

(a) Availability Factor

$$\text{Availability Factor} = \frac{\text{Available Capacity}}{\text{Registered Capacity}}$$

This factor measures how much generator capacity is available with reference to its registered capacity. High availability factor suggests less deration and higher generator efficiency.

(b) Capacity Factor

$$\text{Capacity Factor} = \frac{\text{MW Output Dispatch}}{\text{Registered Capacity}}$$

This factor measures the ratio of the generator's MW value that is actually dispatched versus its registered capacity. This factor is affected by the generator's offer, its schedule, the Merit Order Table for the dispatch interval, and actual grid conditions, among others.

It is important to note that conventional or thermal plants are more efficient when they are running near 100% of their capacity (fully loaded).

3. Market Price vis-à-vis Fuel Price

The conflict between Russia and Ukraine has raised energy prices in global markets.[13] This study determines the effect, if any, of the rising fuel (coal, crude oil, and natural gas) prices in the resulting WESM prices.

In the WESM, all conventional generators are required to offer their maximum available capacity, including corresponding prices, to the market for every trading interval. In view of the rising fuel prices globally, it is expected that the offers of generators using coal, crude oil, and natural gas—, will be higher, which will translate to higher market prices. This study aims to validate this hypothesis.

Historical global fuel price data were gathered and converted to Php/kWh. These crude oil prices were sourced from Brent, Dubai, and West Texas Intermediate, coal prices from African and Australian prices, and natural gas prices from Europe Gas, US Gas, and LNG Japan markets.

To measure correlation between fuel prices and market prices, Pearson's Correlation (formula shown below) is computed, as follows:

$$r = \frac{n\ (\sum xy)\ -\ (\sum x)\ (\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2\ [n\sum y^2 - (\sum y)^2]}}$$

Where r = Pearson coefficient
n = number of data pairs (market price vs. fuel price)
$\sum xy$ = sum products of data pairs
$\sum x$ = sum of market price points
$\sum y$ = sum of fuel price points

Pearson coefficient indicates whether the relationship between two variables is positive or negative as well as the strength of the relationship.

4. Offer Price Distribution

Given the recent significant events that affected the Philippine energy industry and pose a substantial risk to the country's energy security and reliability, it is likely that generators are offering higher prices for their capacity in the WESM because of such factors. To test this theory, the offer price ranges of conventional generators were plotted, per fuel type, for the periods of January-June 2021, July-December 2021, and January-May 2022.

The generator offer price distribution will provide an assessment of the change, if any, in the generator's market behavior.

5. Merit Order Table (MOT)

The scheduling process of the WESM takes into account grid security and economic value of capacity offered in the WESM. Thus, to ensure that the generators scheduled to be dispatched for a specific trading interval is the most economical option, generators are arranged or "stacked" from the cheapest to most expensive, based on their offers. This stacking of generators according to their offer price results to the "WESM Merit Order Table."

[13] Firdevs Yuksel and Zeynep Beyza Kilic, "Energy prices in global markets continue to rise over Russia-Ukraine war", *https://www.aa.com.tr/en/energy/coal/energy-prices-in-global-markets-continue-to-rise-over-russia-ukraine-war/34794*

The Merit Order Table (MOT) also indicates how generators' behavior interacts with others in the market. An MOT which is heavily dominated by high prices, is expected to result to higher market clearing prices with little sensitivity to the demand for that specific trading interval. On the other hand, a well-distributed MOT will result to a market clearing price with higher sensitivity to the demand.

For the purpose of assessing whether there is a change in the WESM MOT, the merit order for two specific intervals (1400H of 16 April 2021 and 1400H of 15 April 2022) were compared.

6. **Renewable Energy**

With the enactment and implementation of the RE Act, new and developing renewable energy are given priority in the WESM. The law introduced a feed-in tariff (FIT) system for electricity produced from wind, solar, ocean, run-of-river hydropower, and biomass. The FIT system includes priority connections to the grid for electricity generated from these sources as well as a fixed tariff to be paid for the electricity produced for a mandated number of years, which shall not be less than twelve (12) years.[14]

One of the objectives of this study is to evaluate the impact of renewable energy plants, if any, on the capacity mix, generation mix, and WESM market clearing price. Rates of the FIT-Allowance, or the cost recovered from all end-users to pay the guaranteed FIT rates, were considered in this study to determine the overall effect of the integration and prioritization of variable renewable energy in the energy industry.

7. **ASEAN and Global Comparison on Energy Mix, Industry Structure, and Prices**

To have a picture of where the Philippines stands among its peers, its energy mix, industry structure, and retail electricity prices were compared with those of other ASEAN countries. Metrics also include per capita electricity generation, GDP, and energy intensity.

Related literature, country reports, laws, issuances, and current news articles were also reviewed to provide underlying context to each country's situation and give insight into what is similar and what is unique to the Philippine setting.

B. POWER OUTLOOK

The DOE, in its Power Development Plan (PDP) 2040, targets 35% Renewable Energy in the country's energy mix by 2030, and 50% by 2040.[15] Given these targets, the DOE formulated four scenarios based on a high and low forecasted demand.

Scenario	RE Target	Demand
1	35% by 2030	Low Demand
2	35% by 2030	High Demand
3	50% by 2040	Low Demand
4	50% by 2040	High Demand

***Table 4.** List of Scenarios in PDP 2020-2040*

[14] Renewable Energy Act of 2008, R.A. 9513, §7(c) (2008).
[15] Department of Energy, Power Development Plan 2020-2040, pp.46-47

The study evaluated the projected capacities and demand in view of these long-term targets and scenarios using Load Duration Curve (LDC) analysis. LDC provides an effective visualization of how consistently the grid consumes electricity at a specific MW level. This analysis provides insights on how much capacity is needed to serve baseload, intermediate or mid-merit, and peak demand.

To develop the LDC, DOE's latest committed and indicative power projects were used. The total projected capacity for each load level was also estimated using the plant's availability factor for the year 2022.

The following classification of generators, according to the demand that they serve, was adopted:

Generator Classification	Demand Served
Base Load	Coal and Geothermal
Intermediate	Natural Gas
Peak	Oil-based, Hydro, Battery Energy Storage System

Table 5. *Generator Classification for LDC Development*

Due to the innate intermittency of Variable Renewable Energy (VRE) resources, coupled with their prioritization in the WESM scheduling process, VREs are excluded from this generator classification. VREs include Solar, Wind, Run-of-River, and Biomass.

RESULTS AND ANALYSIS

I. STATE OF SUPPLY AND DEMAND

The WESM Registered Capacity, demand, and supply from year 2015 to 2022 are illustrated in the following figure where the demand data shown are peak demands during the month and supply is based on total supply coincident to the peak demand during the month. Moreover, the supply margin is the difference between available capacity and demand excluding reserve requirement.

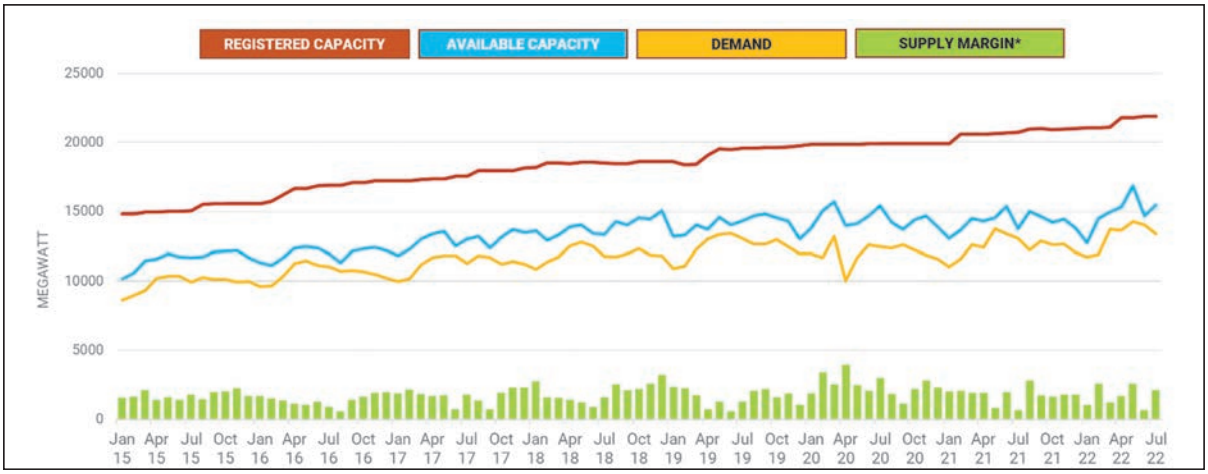


Figure 2. *Capacity, Supply, and Demand (2015-2022) (Luzon and Visayas)*

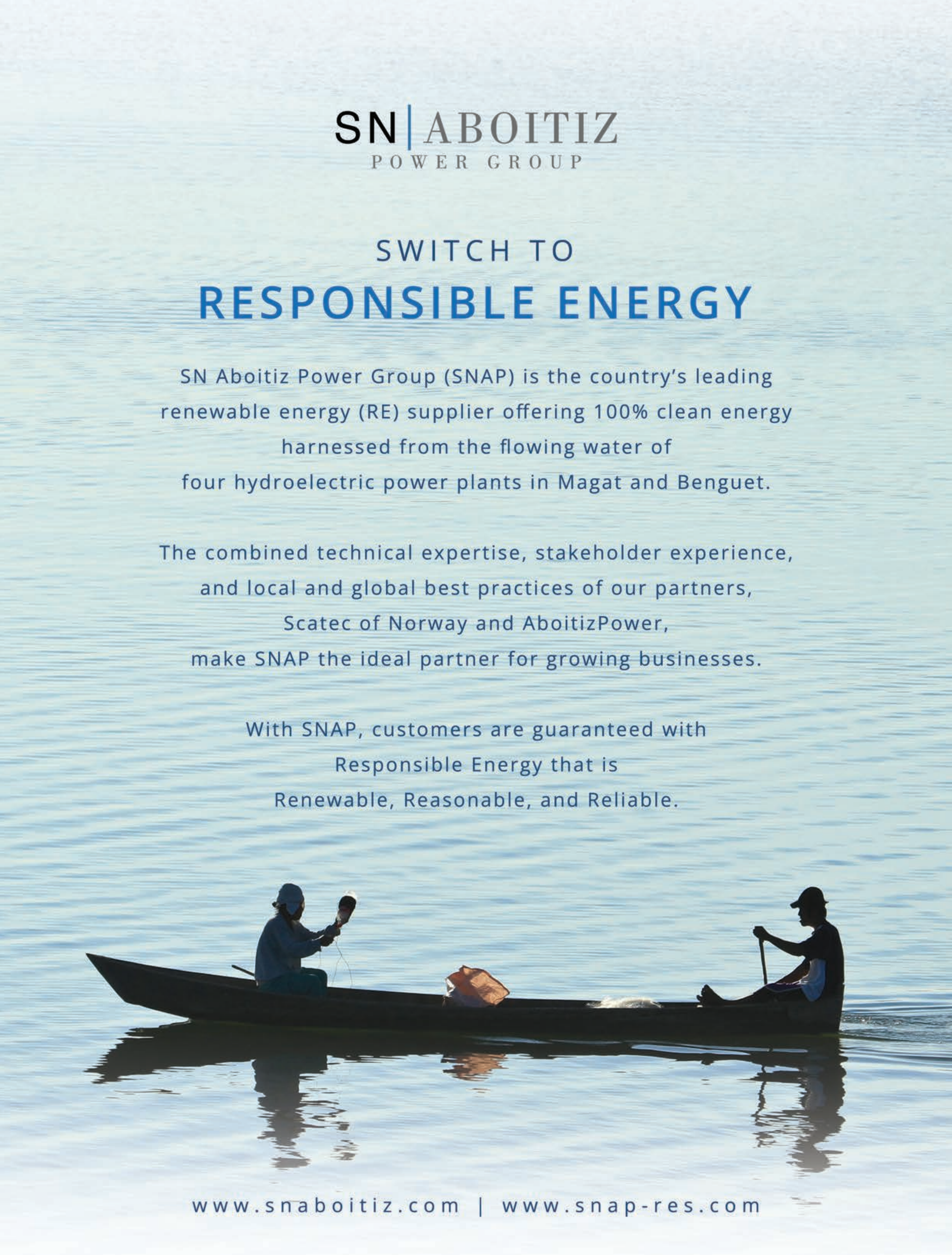
The graph shows that the registered capacity is consistently higher than supply by a wide margin. On the other hand, the margin between supply and demand varies per month. Generally, with the exception of 2020, the supply-demand margin is narrower during summer months than that for colder months.

The substantial gap between the registered capacity and supply may be explained by analyzing each specific generator technology and determining what factors are contributing to the gap.

For context, the registered capacity in WESM as of 27 June 2022 is as follows:

LUZON-VISAYAS GRIDS		
FUEL TYPE	**REGISTERED CAPACITY (MW)**	**ENERGY MIX (%)**
Coal	9,720	44.36%
Natural Gas	3,286	14.99%
Hydro	2,554	11.66%
Oil-Based	2,337	10.67%
Geothermal	1,754	8.00%
Solar	1,213	5.53%
Wind	428	1.95%
Biomass	**392**	**1.79%**
Battery	**230**	**1.05%**
TOTAL	**21,913**	**100%**

Table 6. *WESM Registered Capacity (27 June 2022)*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MINDANAO GRID		
FUEL TYPE	**REGISTERED CAPACITY (MW)**	**ENERGY MIX (%)**
Coal	2,266	56.74%
Hydro	986	24.68%
Oil-Based	514	12.87%
Geothermal	104	2.60%
Solar	63	1.58%
Battery	40	1.00%
Biomass	21	0.53%
TOTAL	**3,993**	**100%**

Table 7. *WESM Registered Capacity for Mindanao Grid (27 June 2022)*

II. GENERATOR PERFORMANCE

CONVENTIONAL PLANTS

A. COAL-FIRED PLANTS

I. LUZON

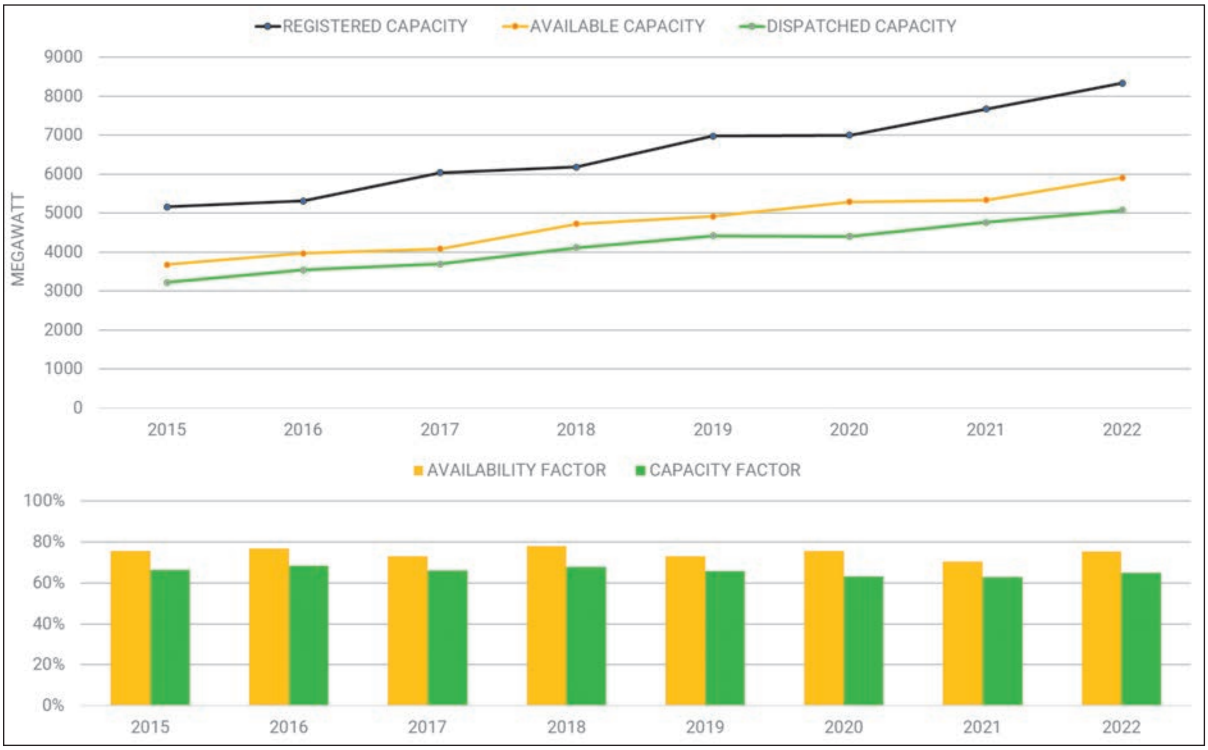

Figure 3. *Performance of Coal-Fired Power Plants (Luzon)*

YEAR	REGISTERED (MW)	AVAILABLE (MW)	DISPATCHED (MW)
2015	4,872	3,681	3,225
2016	5,179	3,971	3,545
2017	5,590	4,086	3,693
2018	6,069	4,727	4,112
2019	6,730	4,915	4,420
2020	6,982	5,291	4,406
2021	7,568	5,334	4,764
2022	7,833	5,907	5,074

Table 8. *Registered vs. Available vs. Dispatched Capacities of Coal-Fired Power Plants (Luzon)*

Coal plants in Luzon have an average availability factor of 75% for 2015-2022 which is largely affected by forced outages and de-ratings. On the other hand, their capacity factor for the same period is 65%, which means 10% of their capacity is not dispatched as they cycle through changing demand levels.

Typically, coal power plants are utilized as baseload plants for their low-cost fuel and stable output. However, the capacity factor of 65% indicates that coal plants are also acting as intermediate or mid-merit plants.

II. VISAYAS

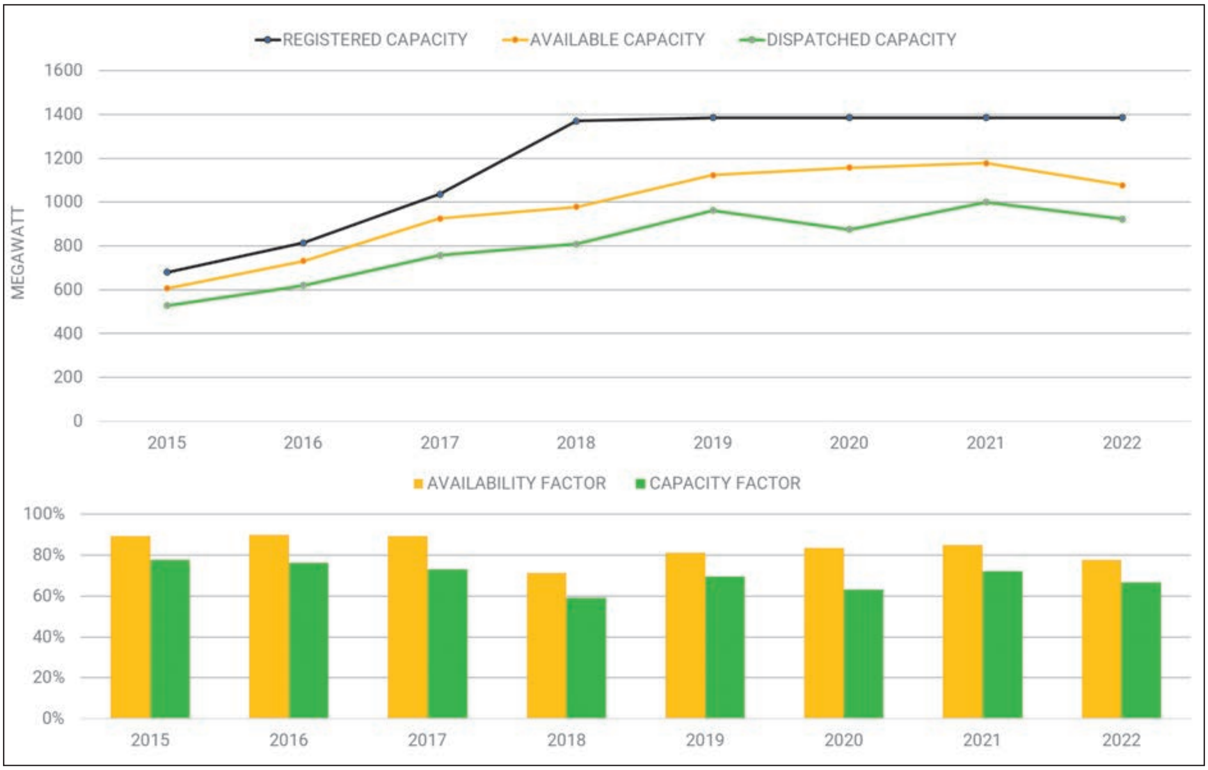

Figure 4. *Performance of Coal-Fired Power Plants (Visayas)*

YEAR	REGISTERED (MW)	AVAILABLE (MW)	DISPATCHED (MW)
2015	679	607	528
2016	814	732	621
2017	1,037	925	758
2018	1,371	978	809
2019	1,385	1,124	962
2020	1,385	1,157	876
2021	1,385	1,178	1,000
2022	1,385	1,077	923

Table 9. *Registered vs. Available vs. Dispatched Capacities of Coal-Fired Power Plants (Visayas)*

Coal power plants in Visayas have an average availability factor of 83%, which is higher than Luzon coal plants. They have a capacity factor of 69%, which means 14% of their capacity is typically not dispatched as they also cycle through the changing demand levels.

B. NATURAL GAS PLANTS

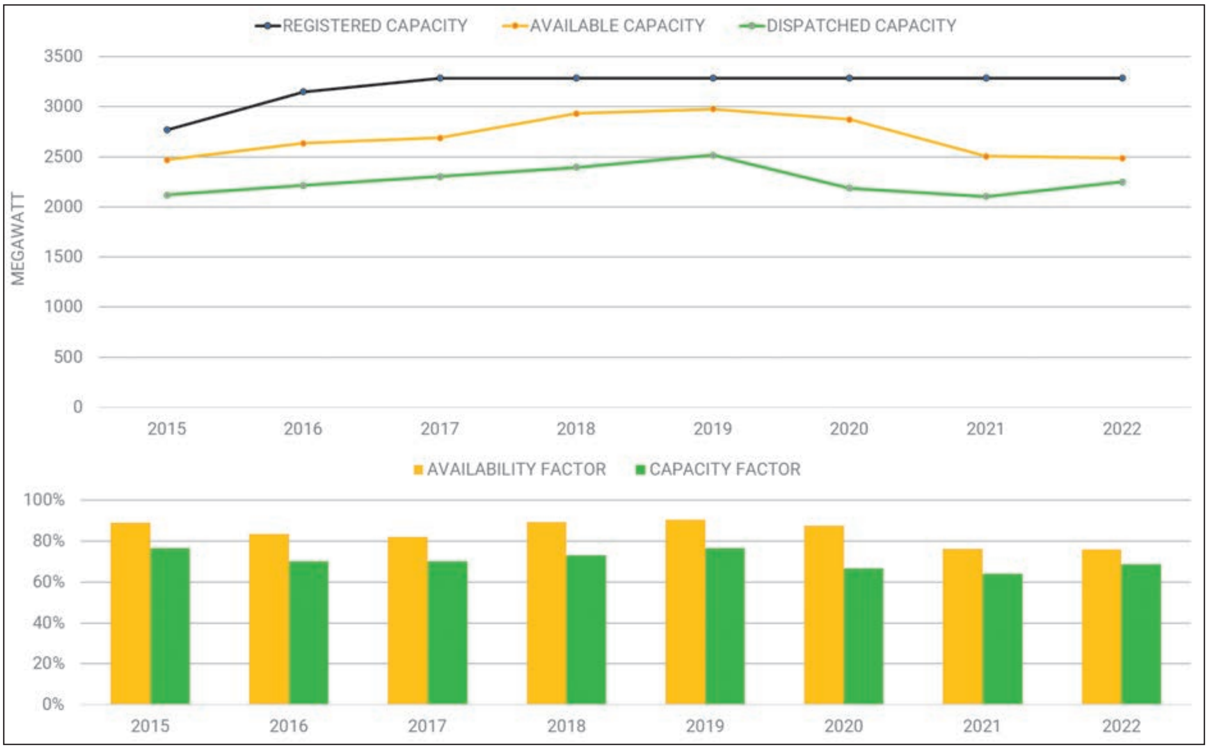

Figure 5. *Performance of Natural Gas Plants (Luzon)*

YEAR	REGISTERED (MW)	AVAILABLE (MW)	DISPATCHED (MW)
2015	2,770	2,471	2,119
2016	3,150	2,637	2,214
2017	3,284	2,690	2,302
2018	3,286	2,933	2,397
2019	3,286	2,978	2,518
2020	3,286	2,874	2,186
2021	3,285	2,507	2,104
2022	3,286	2,487	2,251

Table 10. *Registered vs. Available vs. Dispatched Capacities of Natural Gas Plants (Luzon)*

For 2015-2019, natural gas plants have a higher availability factor, at 90%, than coal power plants. It had a capacity factor of 73% and the remaining un-dispatched capacity came from plants that are not fully contracted (merchant plants).

However, for 2020-2022, its availability and capacity factors dropped to 81% and 66%, respectively, due to natural gas restrictions.

C. GEOTHERMAL PLANTS

I. LUZON

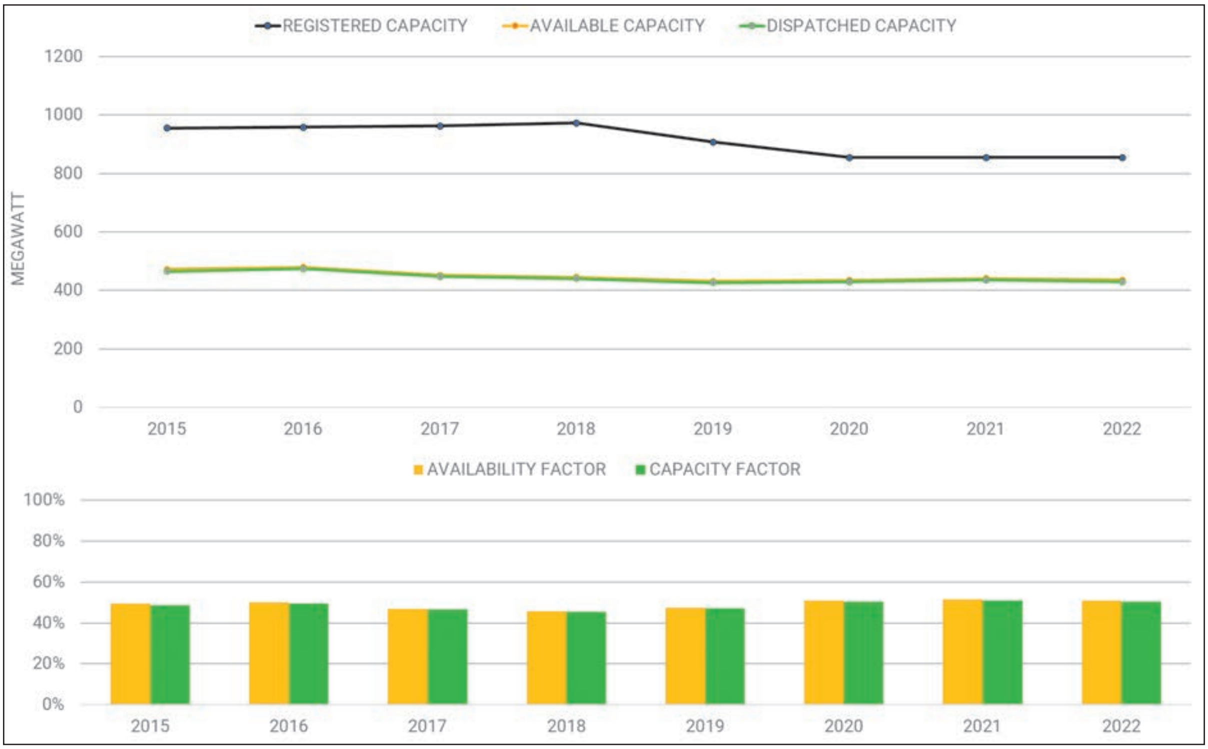

Figure 6. *Performance of Geothermal Plants (Luzon)*

YEAR	REGISTERED (MW)	AVAILABLE (MW)	DISPATCHED (MW)
2015	956	473	465
2016	959	480	475
2017	962	452	448
2018	973	445	441
2019	908	431	427
2020	855	435	430
2021	855	441	436
2022	855	436	430

Table 11. *Registered vs. Available vs. Dispatched Capacities of Geothermal Plants (Luzon)*

Geothermal plants in Luzon have a low availability factor of 49% due to limited steam supply. Its capacity factor of 48%, which is almost equal to its availability factor, shows that Luzon geothermal plants dispatch whatever capacity is readily available. Geothermal plants, due to the nature of their operations, must use their steam supply immediately.

II. VISAYAS

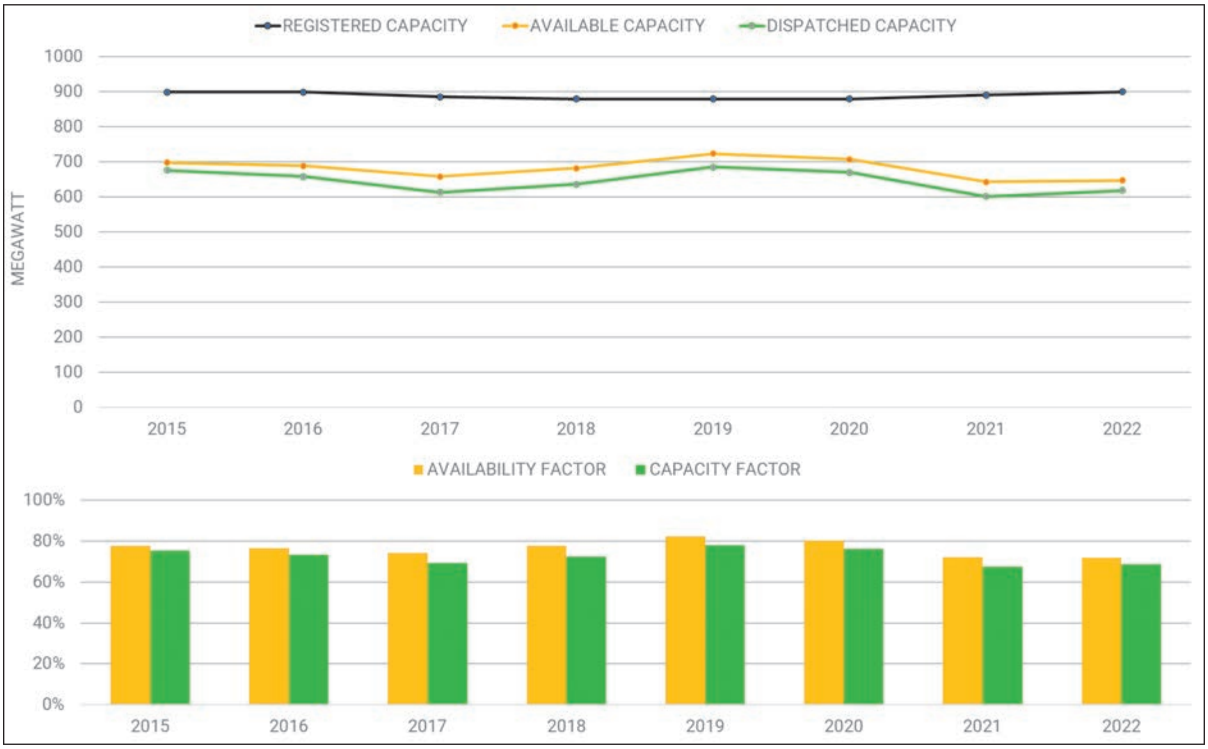

Figure 7. *Performance of Geothermal Plants (Visayas)*

YEAR	REGISTERED (MW)	AVAILABLE (MW)	DISPATCHED (MW)
2015	898	698	676
2016	899	689	658
2017	886	658	613
2018	879	682	636
2019	879	724	685
2020	879	707	670
2021	890	642	601
2022	899	647	618

Table 12. *Registered vs. Available vs. Dispatched Capacities of Geothermal Plants (Visayas)*

Geothermal plants in Visayas, largely located in Leyte/Samar, have a higher availability factor of 77% than Luzon geothermal plants. Similar to geothermal plants in Luzon, its capacity factor of 73% is very near its availability factor.

D. HYROELECTRIC PLANTS

Figure 8. *Performance of Hydroelectric Plants (Luzon)*

YEAR	REGISTERED (MW)	AVAILABLE (MW)	DISPATCHED (MW)
2015	2,424	651	494
2016	2,424	1,266	534
2017	2,425	1,472	614
2018	2,426	1,435	634
2019	2,426	1,253	533
2020	2,426	1,192	466
2021	2,426	1,303	583
2022	2,426	961	442

Table 13. *Registered vs. Available vs. Dispatched Capacities of Hydroelectric Plants (Luzon)*

Hydroelectric power plants in Luzon have a low availability factor of 50% owing to their seasonal availability. Their capacity factor of 22% is much lower than its availability factor since most are providing ancillary services (standby capacity to support the reliable operations of the grid) while some are built based on multiple purposes such as irrigation and water supply.

E. OIL-BASED PLANTS

I. LUZON

Figure 9. *Performance of Oil-Based Plants (Luzon)*

YEAR	REGISTERED (MW)	AVAILABLE (MW)	DISPATCHED (MW)
2015	2,424	651	494
2016	2,424	1,266	534
2017	2,425	1,472	614
2018	2,426	1,435	634
2019	2,426	1,253	533
2020	2,426	1,192	466
2021	2,426	1,303	583
2022	2,426	961	442

Table 14. *Registered vs. Available vs. Dispatched Capacities of Oil-based Plants (Luzon)*

Oil-based plants in Luzon have a low availability factor of 59%. Its low capacity factor of 8% can be attributed to the higher cost of fuel. Hence, they are typically used as a “peaking plant” (i.e., only running at high demand levels, or when supply margins are thin), or when needed as ancillary services.

In addition, Malaya Thermal Plant (650 MW) has mostly been unavailable throughout the years since it is only used during cases where supply margin levels are already posing a risk of load dropping.

II. VISAYAS

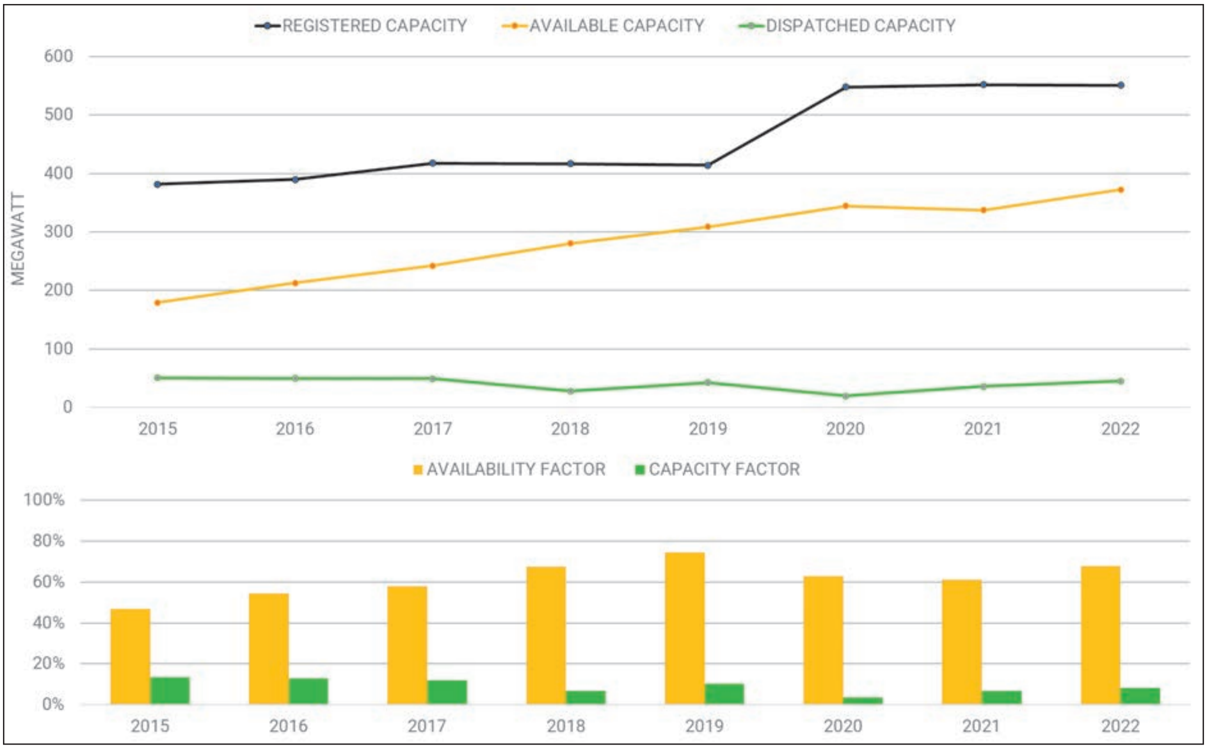

Figure 10. *Performance of Oil-Based Plants (Visayas)*

YEAR	REGISTERED (MW)	AVAILABLE (MW)	DISPATCHED (MW)
2015	382	179	51
2016	390	213	50
2017	418	242	49
2018	417	281	28
2019	414	309	42
2020	548	345	20
2021	552	337	36
2022	551	372	45

Table 15. *Registered vs. Available vs. Dispatched Capacities of Oil-based Plants (Visayas)*

Oil-based plants in Visayas also reflect a low availability factor of only 62%. Similar to Luzon oil-based plants, it also has a low capacity factor (9%) since it is only used as a "peaking plant" or for ancillary services.

RENEWABLE ENERGY SOURCES

F. SOLAR FARMS

I. LUZON

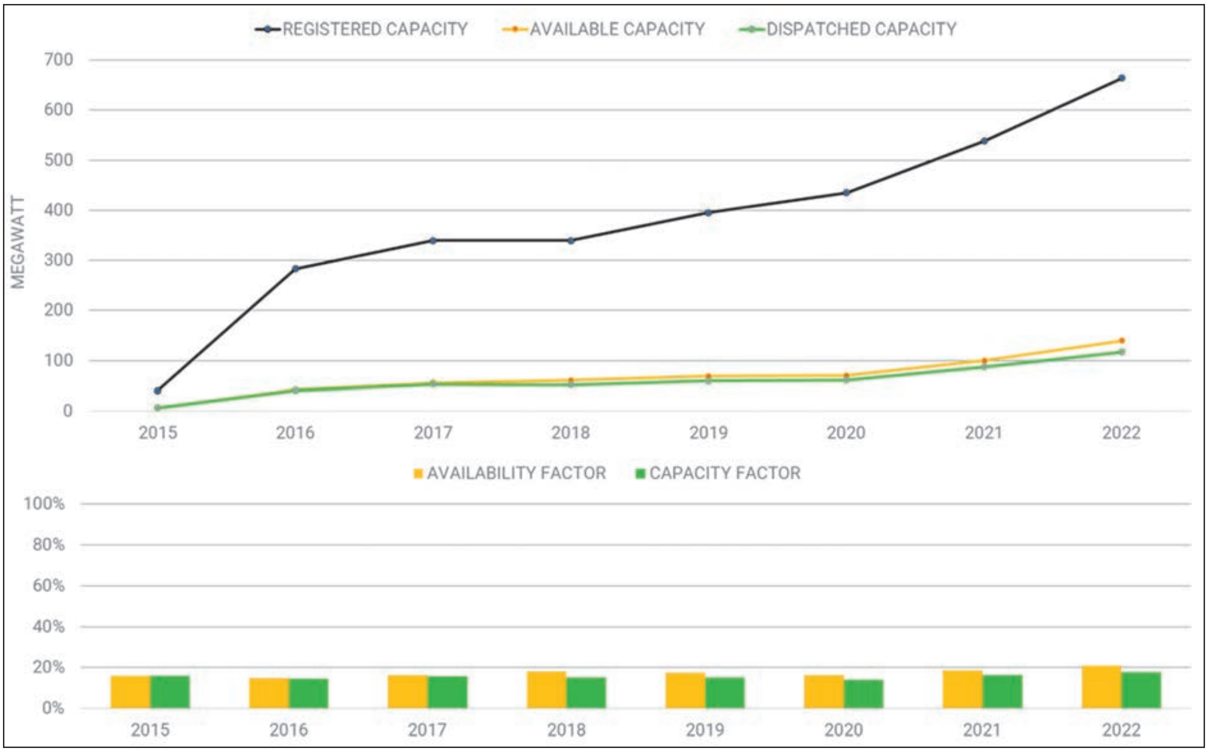

Figure 11. *Performance of Solar Farms (Luzon)*

YEAR	REGISTERED (MW)	AVAILABLE (MW)	DISPATCHED (MW)
2015	41	7	7
2016	283	7	41
2017	339	56	53
2018	340	61	52
2019	396	69	60
2020	435	70	61
2021	435	100	87
2022	664	140	117

***Table 16**. Registered vs. Available vs. Dispatched Capacities of Solar Farms (Luzon)*

A significant increase in the capacity of Luzon solar plants was observed from 2015 to 2016 due to the implementation of incentives for Renewable Energy under the RE Act, including the Feed-in-Tariff. No significant additional capacity was observed in 2017 and 2018 but an increase was observed in the past 4 years. The capacity factor was only at 15% because its output is largely dependent on solar irradiance.

If only daytime is considered, from 6am-6pm, Luzon solar plants exhibit an efficiency capacity factor of 31%, as follows:

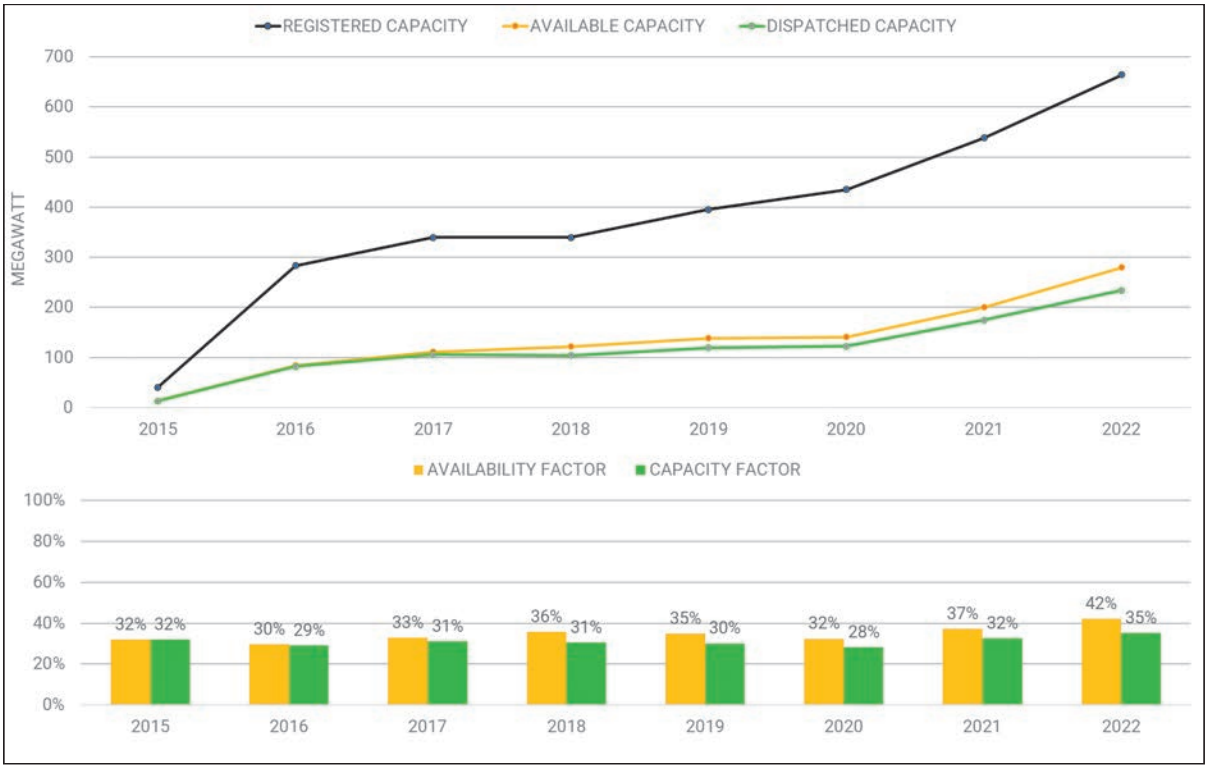

***Figure 12.** Performance of Solar Farms during Day Time (Luzon)*

II. VISAYAS

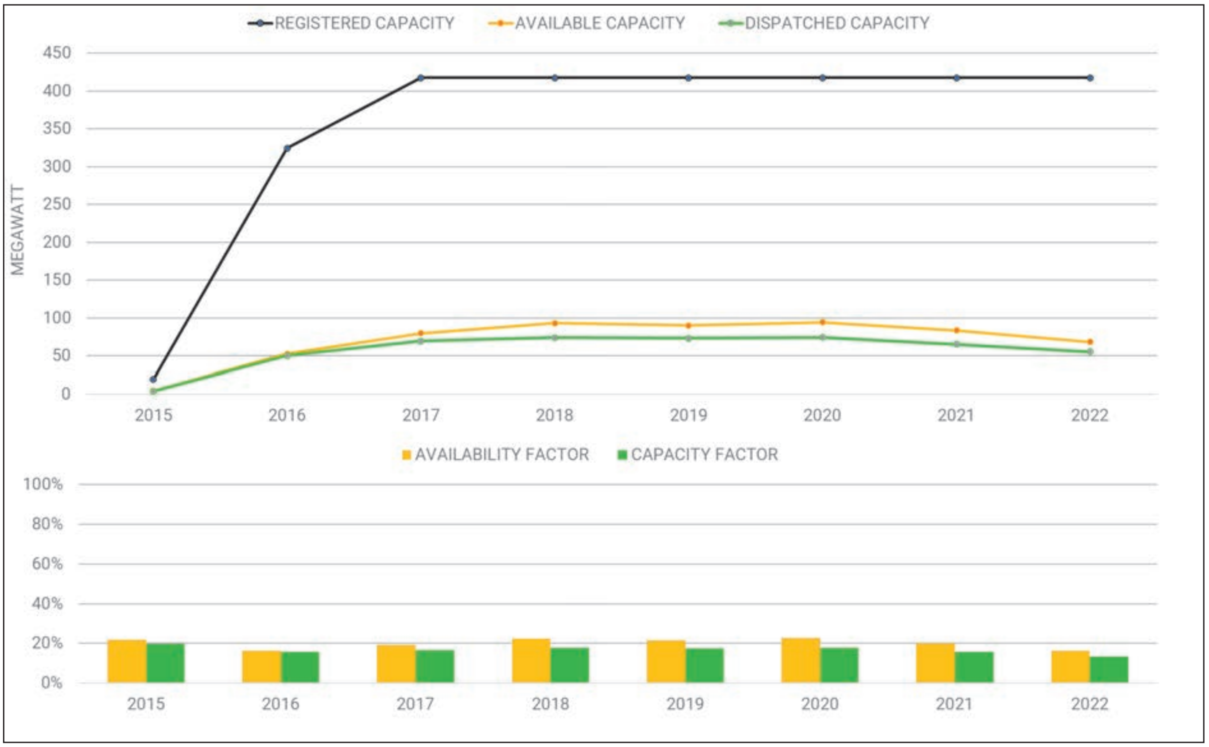

Figure 13. *Performance of Solar Farms (Visayas)*

YEAR	REGISTERED (MW)	AVAILABLE (MW)	DISPATCHED (MW)
2015	20	4	4
2016	324	53	51
2017	417	80	69
2018	417	93	74
2019	417	90	73
2020	417	95	75
2021	417	84	65
2022	417	68	55

Table 17. *Registered vs. Available vs. Dispatched Capacities of Solar Farms (Visayas)*

Similar to Luzon solar plants, a significant increase in capacity from Visayas solar plants was observed from 2015 to 2016 due to the implementation of the RE Act. There has been no significant solar facility added in Visayas after 2016 due to the transmission capacity limitations in the said grid.

Most solar plants in Visayas are in Negros, where the transmission capacities for exporting power are highly limited. Thus, the capacity factor is only 17%.

Considering only daytime hours, the availability and capacity factors are observed to be much higher.

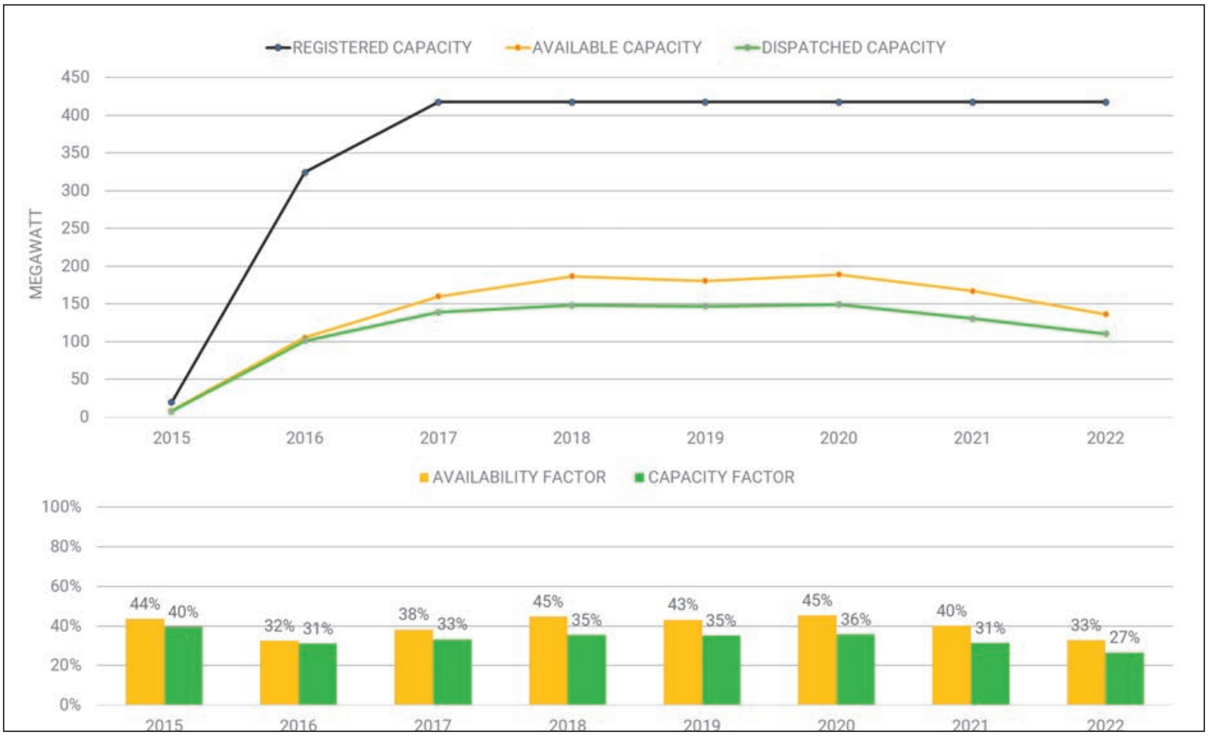

Figure 14. *Performance of Solar Farms during Day Time (Visayas)*

G. WIND FARMS

I. LUZON

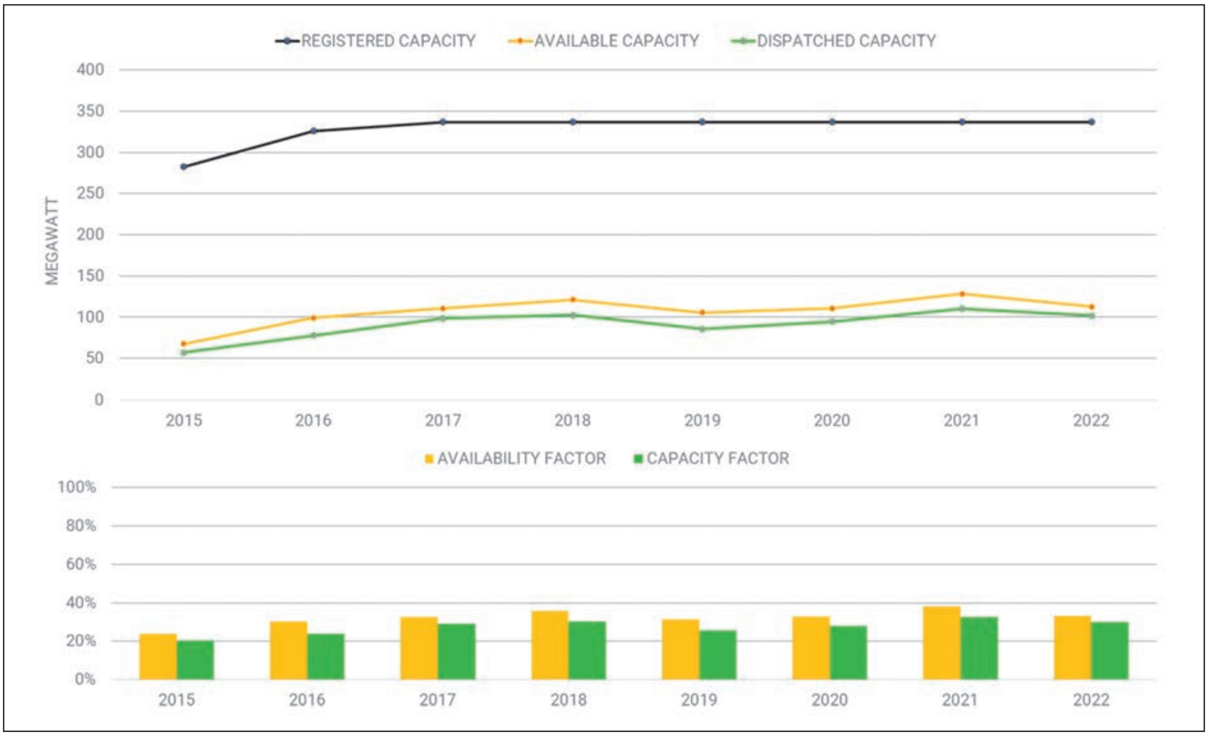

Figure 15. *Performance of Wind Farms (Luzon)*

YEAR	REGISTERED (MW)	AVAILABLE (MW)	DISPATCHED (MW)
2015	283	67	57
2016	326	99	78
2017	337	111	98
2018	337	121	102
2019	337	105	85
2020	337	111	95
2021	337	128	110
2022	337	113	102

Table 18. *Registered vs. Available vs. Dispatched Capacities of Wind Farms (Luzon)*

Additional capacity from Luzon Wind farms only increased from 2015 to 2016. After 2016, wind farm capacity remained stagnant. Its availability factor in Luzon is at 32% whereas its capacity factor is at 27%. Similar to solar farms, wind farms generate power instantaneously based on the wind's driving force. It has also been observed that the availability of wind farms has dropped in the past 2 years.

II. VISAYAS

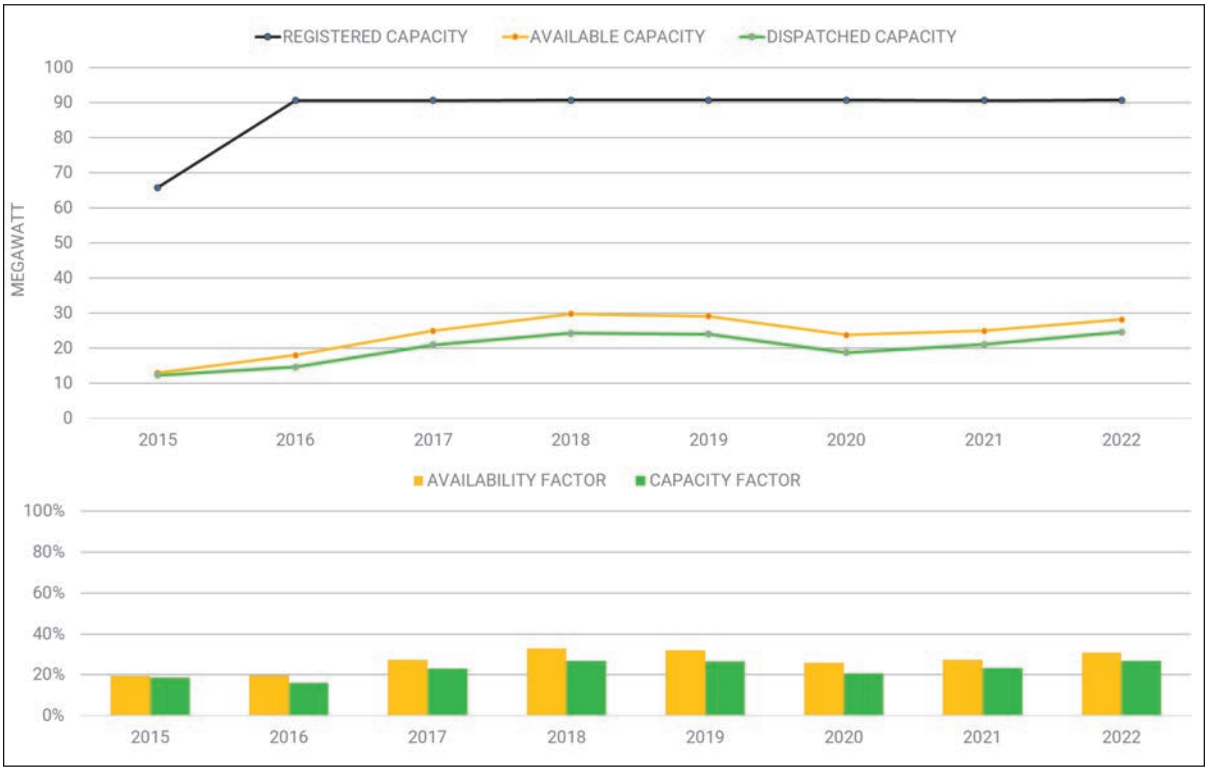

Figure 16. *Performance of Wind Farms (Visayas)*

YEAR	REGISTERED (MW)	AVAILABLE (MW)	DISPATCHED (MW)
2015	66	13	12
2016	91	18	15
2017	91	25	21
2018	91	30	24
2019	91	29	24
2020	91	24	19
2021	91	25	21
2022	91	28	25

Table 19*. Registered vs. Available vs. Dispatched Capacities of Wind Farms (Visayas)*

There has been no additional capacity from Visayas Wind farms in the past 7 years. Availability factor is at 27%, while capacity factor is only at 23%. Availability has also dropped gradually since 2018.

H. BIOMASS PLANTS

I. LUZON

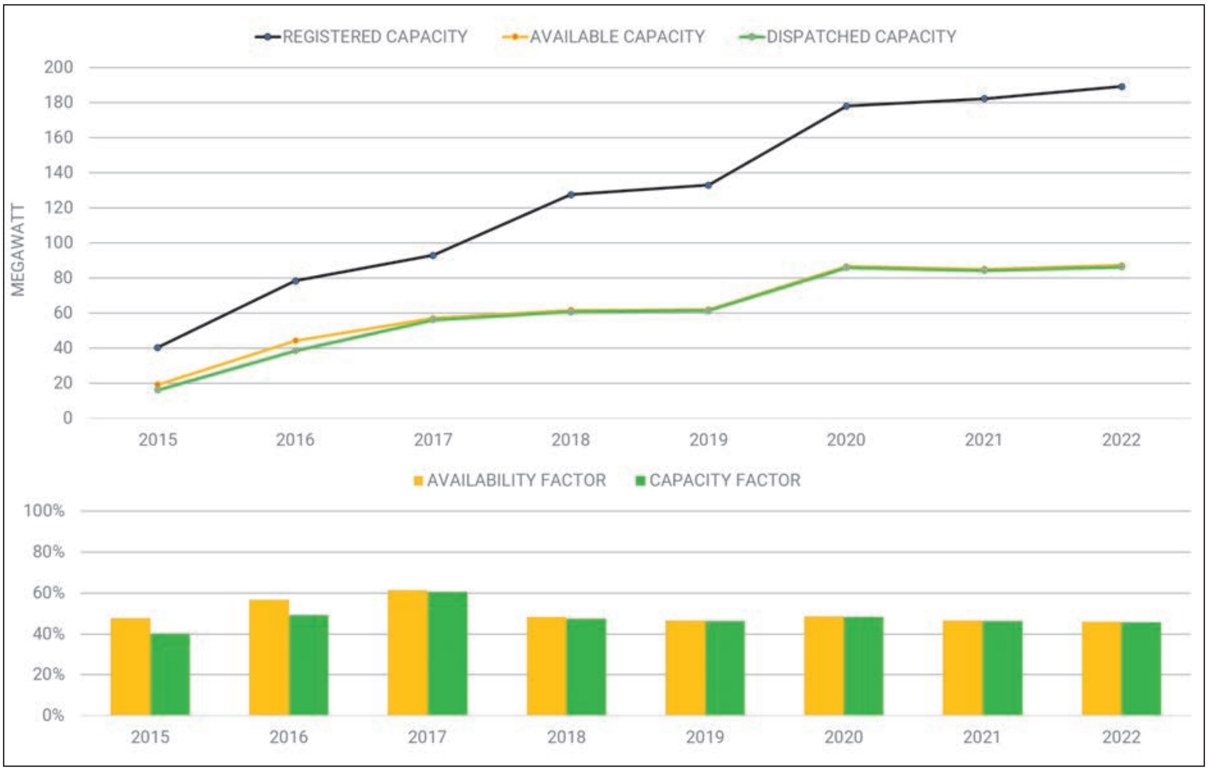

Figure 17. *Performance of Biomass Plants (Luzon)*

YEAR	REGISTERED (MW)	AVAILABLE (MW)	DISPATCHED (MW)
2015	40	19	16
2016	78	44	38
2017	93	57	56
2018	128	62	61
2019	133	62	61
2020	178	87	86
2021	182	85	84
2022	189	87	86

Table 20. *Registered vs. Available vs. Dispatched Capacities of Biomass Plants (Luzon)*

There has been a steady increase in capacity from Luzon Biomass farms with an annual average increase of 18% since 2015. However, its availability factor is only at 50% due to its seasonal availability. A capacity factor of 48%, near its 50% availability factor reflects that biomass plants intend to generate all its available capacity.

II. VISAYAS

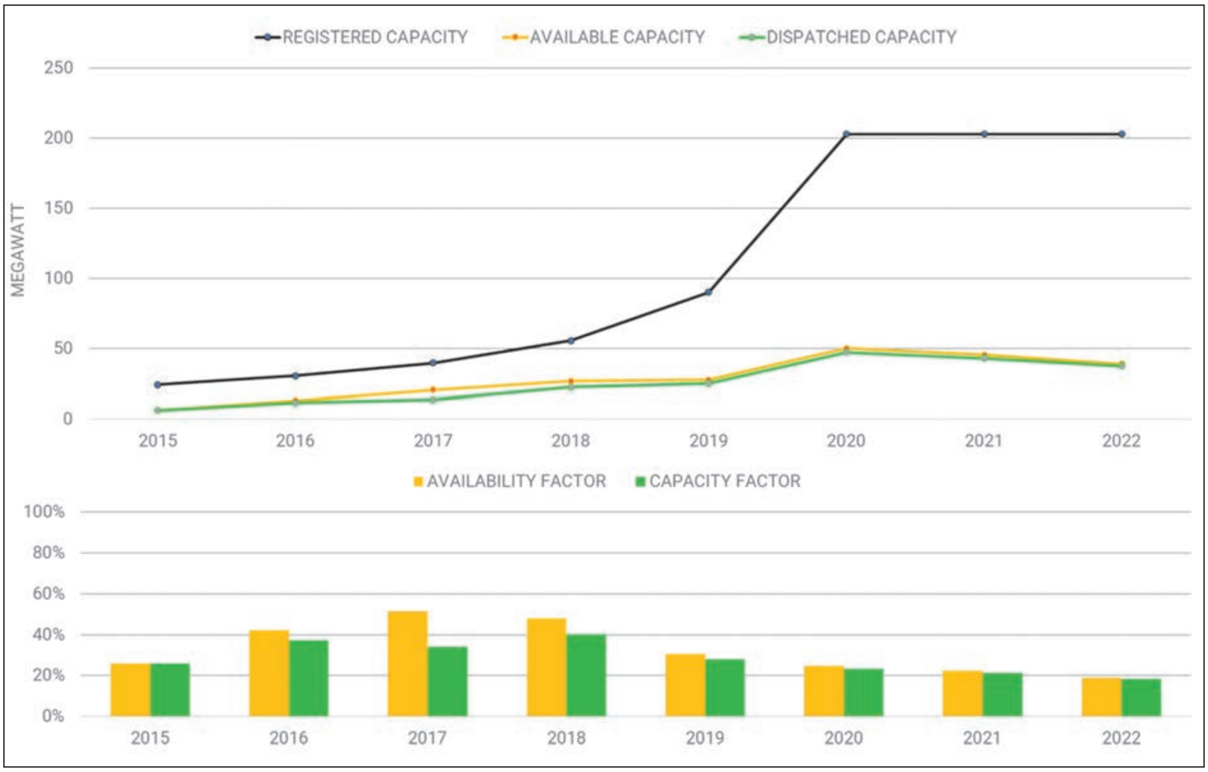

Figure 18. *Performance of Biomass Plants (Visayas)*

YEAR	REGISTERED (MW)	AVAILABLE (MW)	DISPATCHED (MW)
2015	24	6	6
2016	31	13	11
2017	40	21	14
2018	56	27	22
2019	90	28	25
2020	203	50	47
2021	203	46	43
2022	203	39	38

Table 21. *Registered vs. Available vs. Dispatched Capacities of Biomass Plants (Visayas)*

A significant jump in capacity from Visayas biomass farms was observed in 2019. Its availability factor is much lower at 28% due to its seasonal availability and transmission capacity limitations in the said grid. Moreover, various biomass plants are located in Negros and Panay, and the transmission capacities that can export power from these areas are highly limited.

I. RUN-OF-RIVER HYDRO PLANTS

I. LUZON

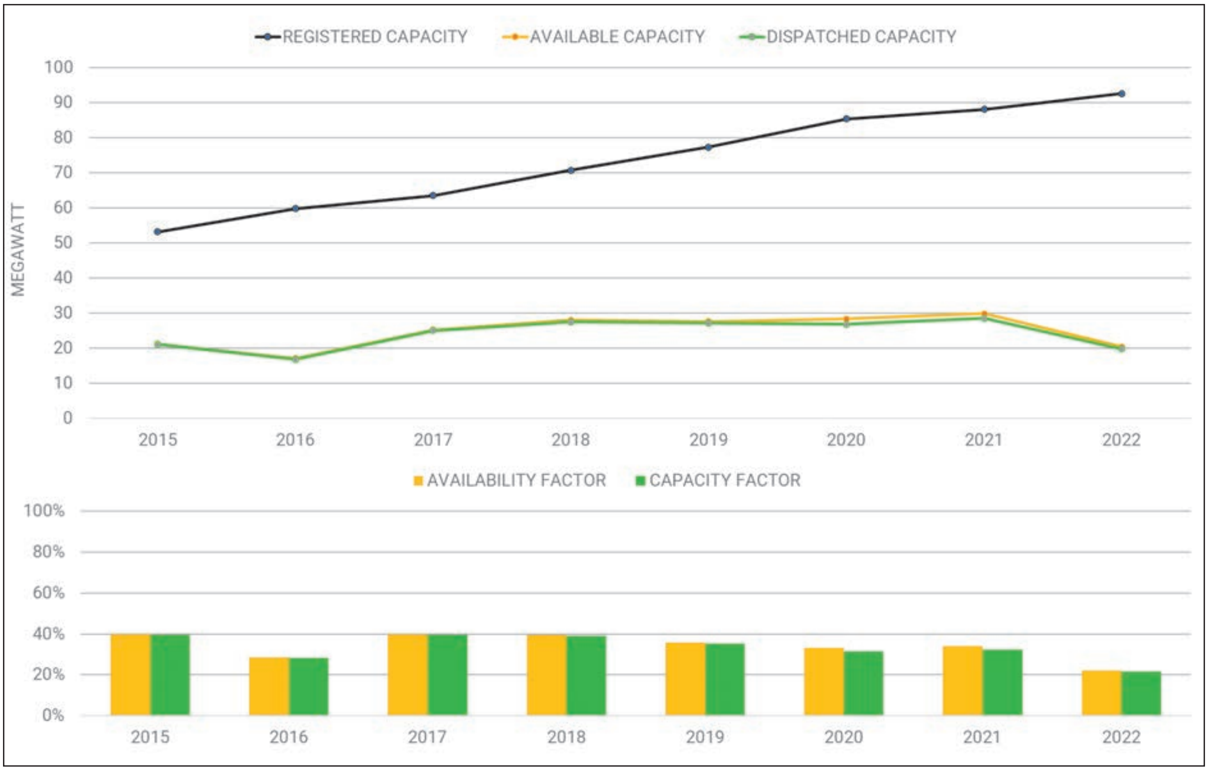

Figure 19. *Performance of Run-of-River Hydro (Luzon)*

YEAR	REGISTERED (MW)	AVAILABLE (MW)	DISPATCHED (MW)
2015	53	21	21
2016	60	17	17
2017	64	25	25
2018	71	28	27
2019	77	28	27
2020	85	28	27
2021	88	30	28
2022	93	20	20

Table 22. *Registered vs. Available vs. Dispatched Capacities of Run-of-River Hydro (Luzon)*

There has been a gradual increase in capacity from Luzon run-of-river (ROR) hydro plants for the past seven (7) years. The availability factor for the period is 35% with the capacity factor at 34%. Since ROR plants are must-dispatch plants, they generate power immediately based on the availability and inflow of water.

II. VISAYAS

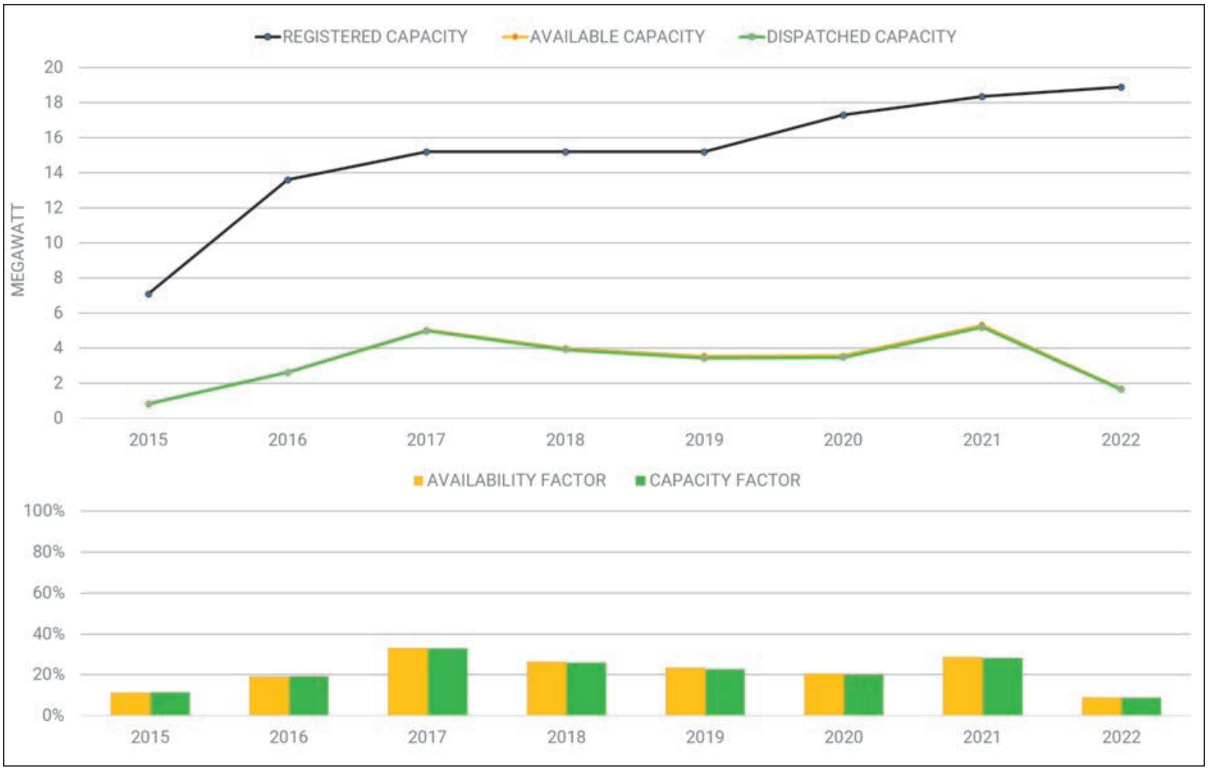

Figure 20. *Performance of Run-of-River Hydro (Visayas)*

YEAR	REGISTERED (MW)	AVAILABLE (MW)	DISPATCHED (MW)
2015	7	1	1
2016	14	3	3
2017	15	5	5
2018	15	4	4
2019	15	4	3
2020	17	4	3
2021	18	5	5
2022	19	2	2

Table 23. Registered vs. Available vs. Dispatched Capacities of Run-of-River Hydro (Visayas)

Capacity of ROR Hydro in Visayas has been steadily increasing since 2019. As of date, the total registered capacity is at 19MW. The availability and capacity factor for these plants is both at 23%. Noticeably, the availability factor of some ROR Hydro dropped in 2022 coincident with Typhoon Odette.

SUMMARY

The large gap between the installed and available capacity of generators depends on its fuel type and nature of operations. For coal plants, the gap is attributable to frequent outages due to generator efficiency issues and natural wear and tear as they age. In the case of natural gas plants, the gap is due to the depletion of natural gas supply. Fuel for oil-based plants is expensive, hence, they are mostly used as peaking plants resulting to low availability and capacity factor.

On the other hand, renewable energy generators are largely dependent on the availability of their natural fuel. For solar and wind plants, their availability and capacity factors depend on solar irradiance and wind force, respectively. For geothermal plants, the gap between installed and available capacity depends on its steam supply. For ROR and biomass plants, their availability and capacity factors are largely seasonal.

Additionally, the Battery Energy Storage System (BESS) facilities in Luzon have significantly increased in the past 2 years. The availability factor for the entire period is at 35%. The net generation dispatch is zero for 2016-2021. This means that the MW discharge of BESS (power generator) is almost equal to its MW charge (power consumption) over the study period. In Visayas, BESS facilities have significantly increased in the past 3 years. For the entire period, the availability factor is 11% but the capacity factor is only at 1%. Due to the nature of their operations, they cannot be used continuously and reliably as “base-load” plants. The main purpose of BESS is to provide ancillary services to support reliable operations in the grid.

III. MARKET PRICE vs. FUEL PRICE COMPARISON

A. FUEL PRICES

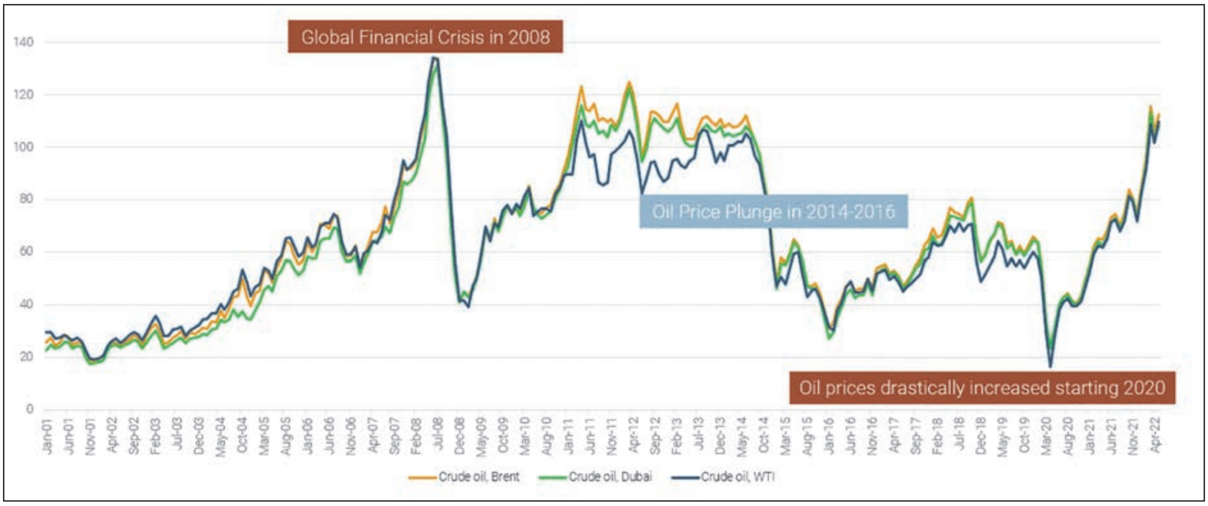

Figure 21. *Historical Crude Oil Prices*[16]

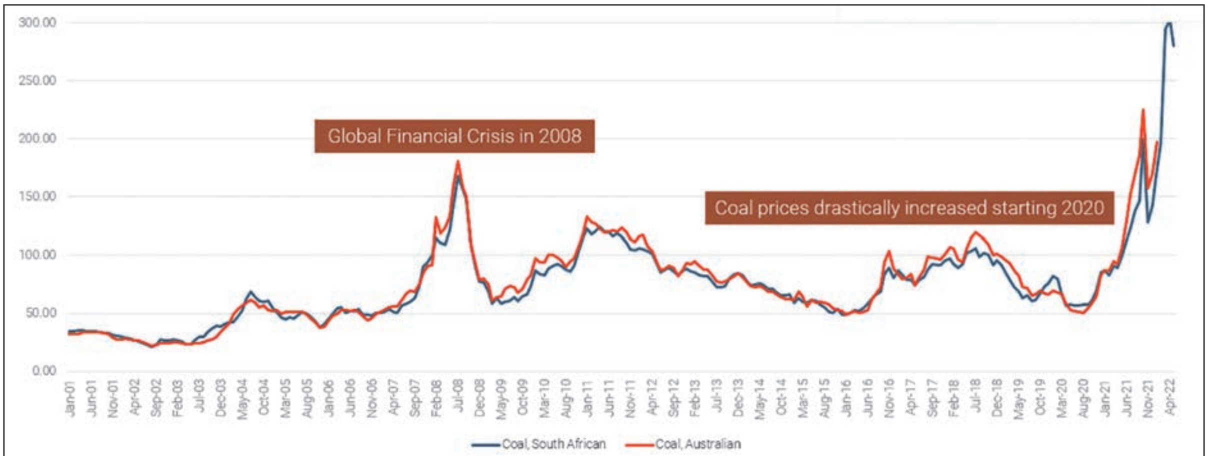

Figure 22. *Historical Coal Prices*[17]

[16] World Bank Commodity Price Data
[17] *Id.*

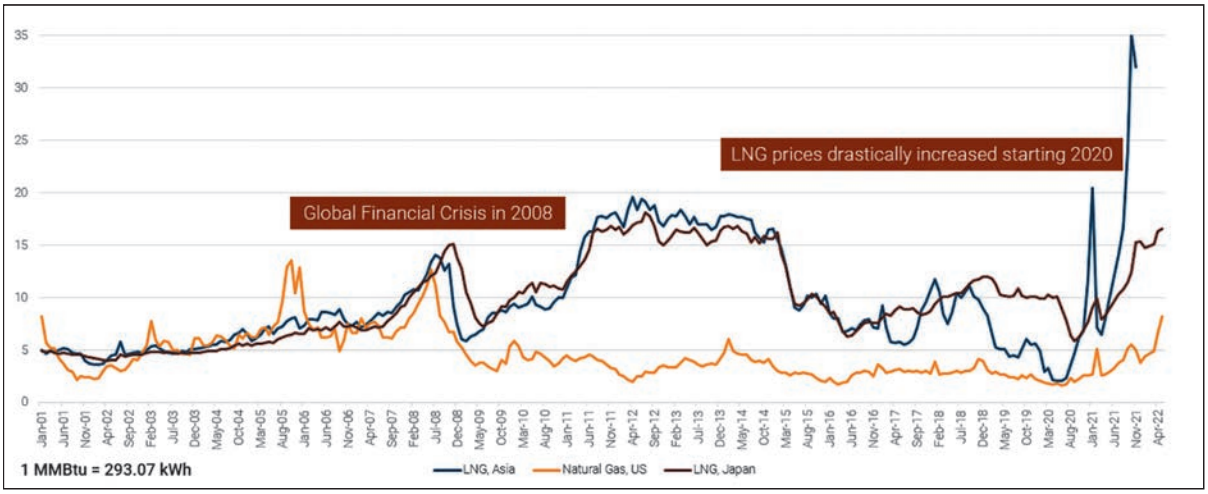

Figure 23. *Historical Natural Gas Prices*[18]

The behavior of crude oil, coal, and natural gas prices generally follow a similar trend. Their prices increased in 2008 due to the global financial crisis. Crude oil prices dropped in 2014-2016 due to large production by the United States and stable international relations.

In 2020, however, the price of fuel dropped substantially due to the effect of the COVID-19 pandemic. Price notably increased starting late 2021 mainly because of the conflict involving Russia and Ukraine.

B. MARKET PRICE vs. FUEL PRICE

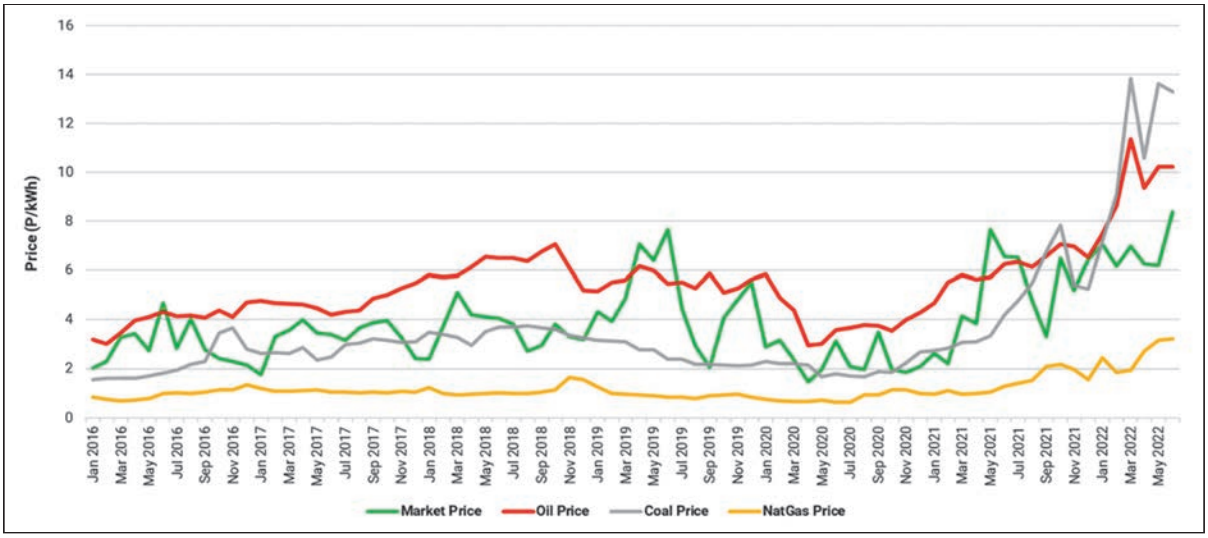

Figure 24. *Market Price vs. Fuel Prices*

[18] *Id.*

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EDC's geothermal power plant in Negros Oriental

rates with IEMOP for providing competitive, reliable, and city for business and communities in the country.

Annual Average Price (P/kWh)	Market Price	Oil Price	Coal Price	Natural Gas Price
2016	2.92	3.98	2.19	0.95
2017	3.33	4.72	2.85	1.08
2018	3.62	6.21	3.48	1.13
2019	4.85	5.55	2.54	0.93
2020	2.37	3.98	2.02	0.82
2021	4.98	6.11	4.57	1.43
2022	6.84	9.55	11.27	2.56

Table 24. *Average Annual WESM Prices and Fuel Prices*

Fuel	Energy Mix Share (%)	Correlation with Market Price
Oil	1.7 - 2.8	Positive
Coal	57.6 - 60.1	Positive
Natural Gas	19.3 - 21.7	Positive

Table 25. *Energy Mix Share and Correlation of Fuel vs. Market Price*

Market prices shown in the tables above are based on WESM monthly average prices while fuel prices are based on the end-of-month value. The energy mix share in Table 27 is based on energy generation mix in Luzon-Visayas from April to June 2022.

Based on this data, market prices and fuel prices show an upward movement starting the 2nd half of 2021. Moreover, considering the historical annual average prices, prices recorded in 2022 are higher than in the last six (6) years.

The positive correlation of fuel prices and market prices, using Pearson's Correlation Coefficient, suggests that the price trend in WESM is affected, to some extent, by the trend of fuel prices. The combined energy share of these oil-based plants, coal plants, and natural gas plants is roughly at 80%, which may explain this positive correlation.

ACEN targets 20 GW renewables by 2030

ACEN, Ayala group's listed energy platform, recently unveiled its new corporate vision and strategy targeting **20 GW of attributable renewables capacity by 2030**, a bold aspiration set amidst the global energy crisis and the imperative to accelerate the energy transition.

This represents **6x growth from 3.4 GW of renewables capacity today**, or a 25% compounded annual growth rate up to the end of the decade. ACEN currently has **18 GW of pipeline** across the region, which will help with the achievement of the company's 2030 goals.

The Philippines will remain as the core market, which currently accounts for 40% of total capacity, and is expected to remain at this level. The company also plans to aggressively grow its investments in Australia which is expected to be its second largest market within the decade. ACEN will also continue to grow its presence in Vietnam, Indonesia and India, and expand its geographic footprint through strategic partnerships.

Solar and wind will remain as core energy technologies, complemented by investments in new technologies such as **battery energy storage, floating solar, and offshore wind.**

With the global energy crisis, and the elevated fuel prices compounding the tight power supply situation in the country, ACEN aims to accelerate the energy transition, and urgently add new capacity. ACEN believes it is an opportune time to set bold renewable targets for 2030, and help address the challenges that the world is confronted with.

Eric Francia, ACEN president and CEO, said: "The entire organization is committed to **ACEN 2030**, which is our vision to reach 20GW of renewables by 2030. It is an aggressive goal, though we believe that we have the right elements to succeed. We have a strong balance sheet, robust pipeline, strong partnerships, and a highly energized organization."

We have added ~3,400 MW in new renewables capacity since our strategic pivot to renewables in 2016, augmenting our generating capacity with the construction and acquisition of new solar, wind and battery storage projects despite the pandemic. We will continue to expand our renewables footprint across the region as we target to reach 20 GW of renewables capacity by 2030.

ACEN's 120 MW Alaminos Solar and 40 MW Energy Storage is the country's first hybrid utility scale solar and storage project

ACEN's 81 MW North Luzon Renewables wind farm in Ilocos Norte, Philippines

IV. OFFER PRICE DISTRIBUTION

A. COAL PLANTS

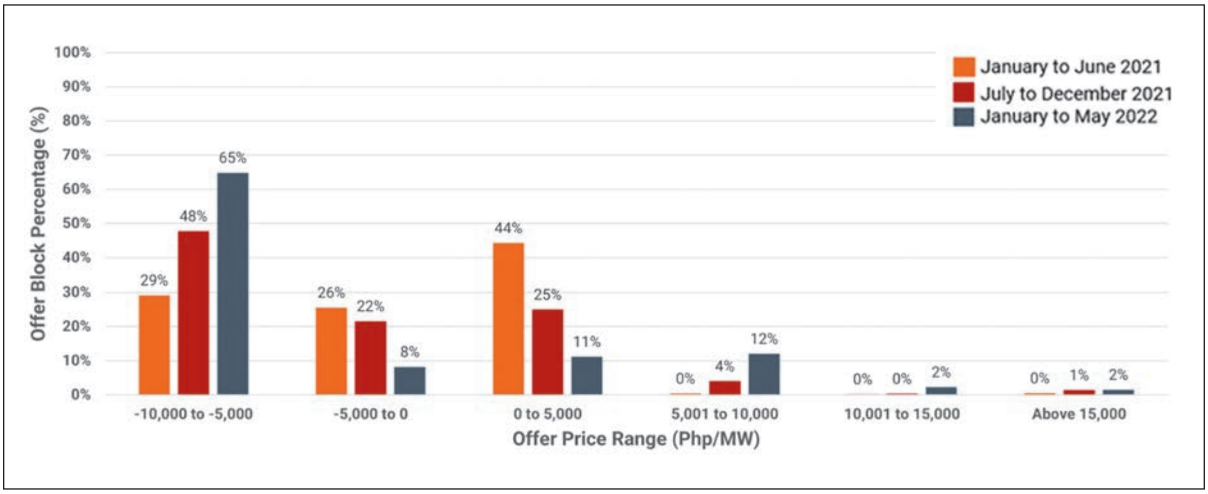


Figure 25. *Offer price distribution of Coal Plants (2021-2022)*

For the 1st half of 2021, there were no offers submitted by coal-fired power plants above 5,000Php/MWh. While for the 2nd half of 2021 and for the 1st half of 2022, there is a noticeable increase in the offer prices above 5,000Php/MWh submitted by coal-fired power plants, especially in the 5,000-10,000 PhP/MWh offer price range.

B. NATURAL GAS

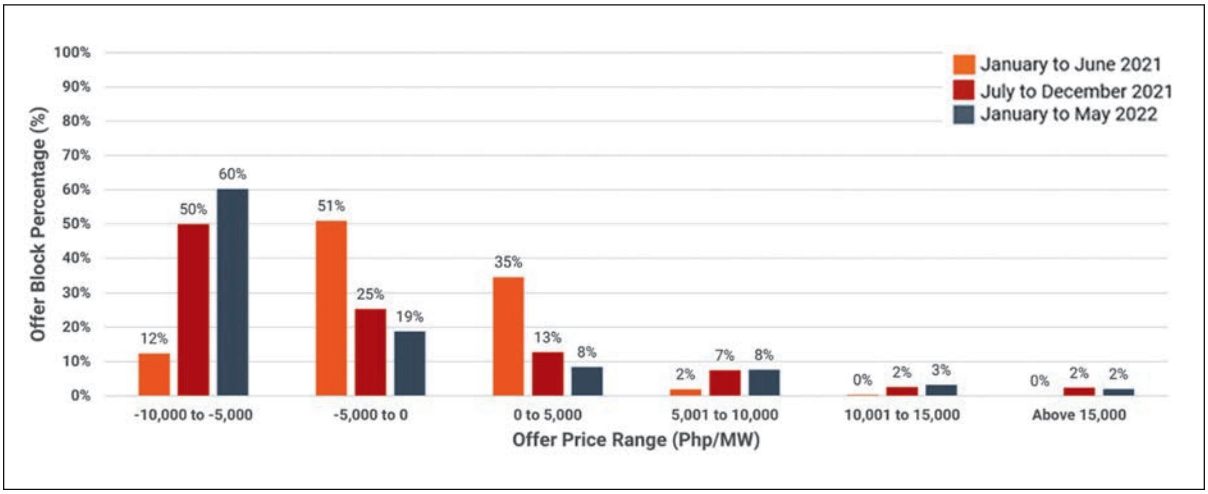


Figure 26. *Offer Price Distribution for Natural Gas Plants (2021-2022)*

Natural gas plants submitted a few offers in the range of 5,000-10,000 Php/MWh for the first half of 2021. For the 2nd half of 2021 to 1st half of 2022, however, there is a relative increase in offer prices being submitted beyond the 5,000Php/MWh mark.

C. OIL-BASED PLANTS

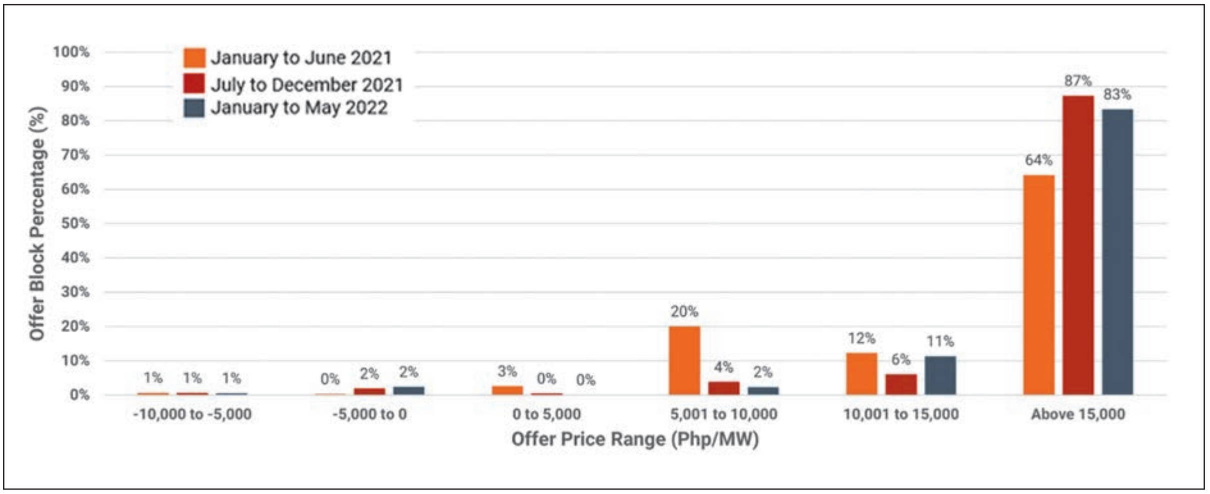


Figure 27. *Offer Price Distribution of Oil-based Plants (2021-2022)*

For oil-based plants, offer prices are distributed among 5,000-10,000 Php/MWh, 10,000-15,000 Php/MWh, and above 15,000 Php/MWh offer price ranges in the 1st half of 2021. From the 2nd half of 2021 to the 1st half of 2022, majority of the offer prices shifted above the 15,000 Php/MWh price range.

D. HIGHEST OFFER TREND

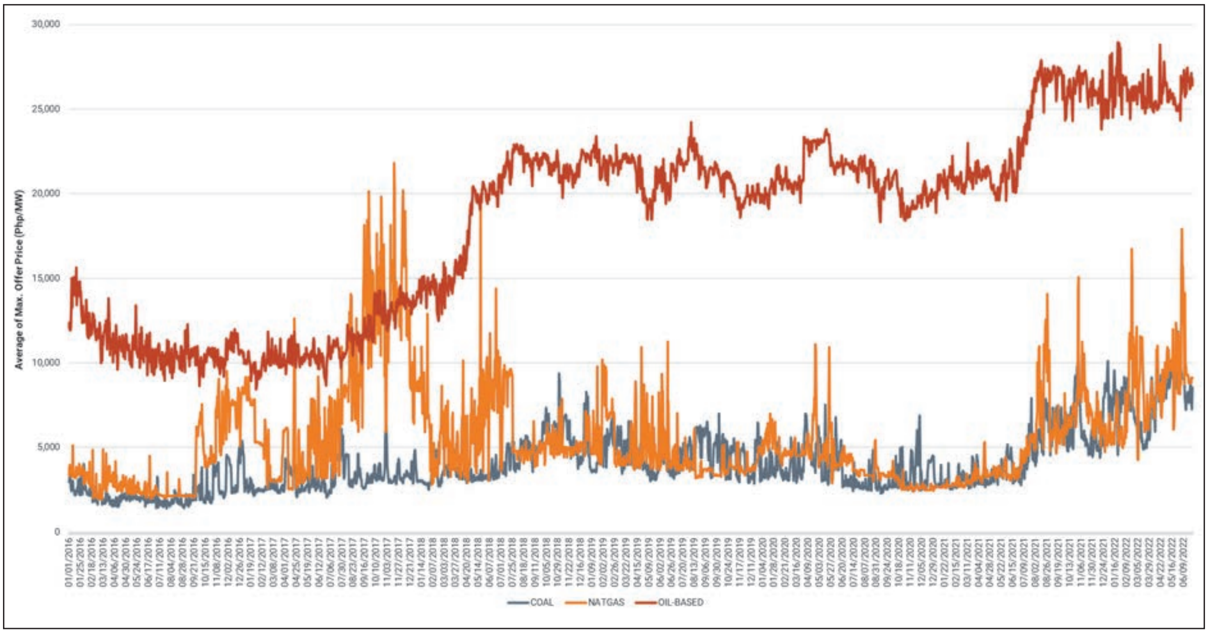


Figure 28. *Highest Offer Trends of Coal, Natural Gas, and Oil-based Plants*

Considering the trends of the highest offers of generators in WESM, it can be observed that the offer price of coal and natural gas plants generally follow the same market behavior in terms of price submission. Natural gas plants are also observed to have spikes in their offer prices in 2017 due to restrictions and outages of Malampaya gas field forcing these plants to use more expensive fuel. On the other hand, the offers of oil-based plants are relatively higher than the offers of natural gas and coal power plants. Noticeably, the offers of generators using coal, natural gas, and oil increased in the later months of 2021.

E. MERIT ORDER TABLE (2021 vs. 2022)

MW Level	Market Clearing Price (P/MWh)	
	1400H of Apr 16, 2021	1400H of Apr 15, 2022
8,000MW	2,300	7,100
9,000MW	7,300	26,000

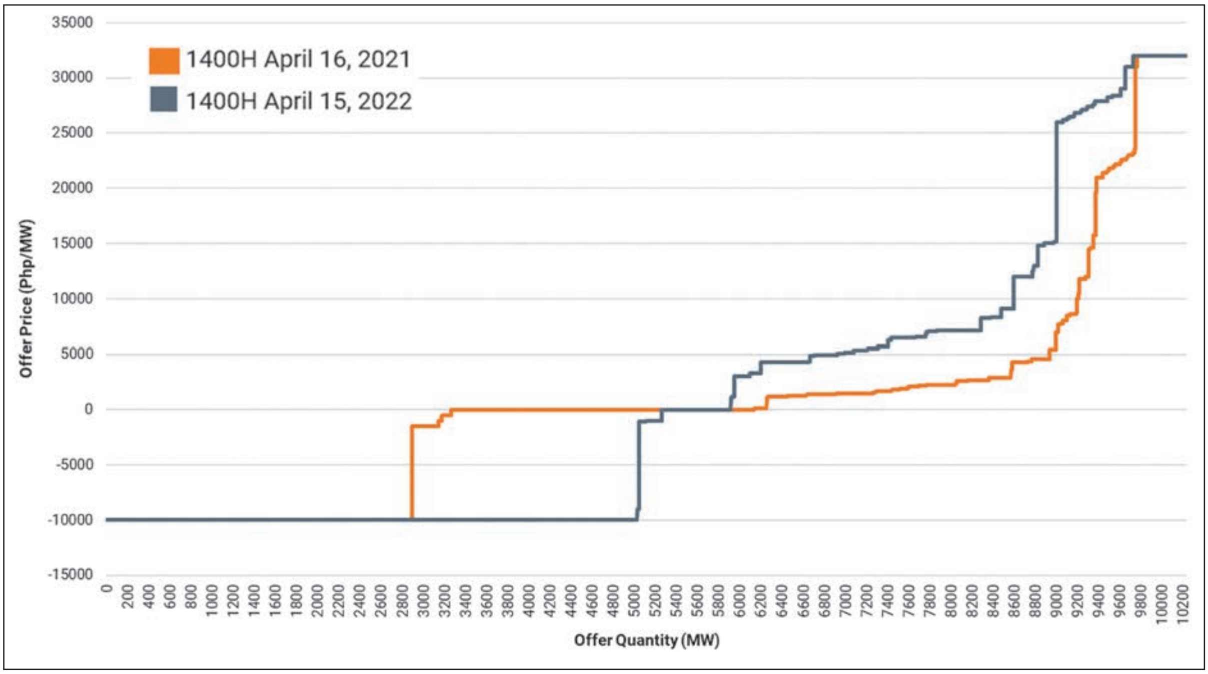


Figure 29. Merit Order Table Comparison (2021, 2022)

Offer Price Range (Php/MW)	1400H of April 16, 2021	1400H of April 15, 2022
Below 0	3,805	5,462
0 to 2,500	4,241	469
2,501 to 5,000	786	883
5,001 to 10,000	365	1,783
Above 10,000	915	1,638

***Table 26.** Offer Price Range Distribution Comparison (2021, 2022)*

Sample merit order tables for 2021 and 2022 indicate that the distribution of generators' offers mostly shifted to either below 0 Php/MWh or higher than 5,001 Php/MWh. Higher offer prices were also observed for higher offer quantities. For instance, the market clearing price for 8,000MW on 16 April 2021 is only 2,300 Php/MWh while for the same day in 2022, the market clearing price is already at 7,100 Php/MWh. Likewise, the market clearing price for 9,000MW demand increased from 7,300 Php/MWh in 2021 to 26,000 Php/MWh in 2022.

V. RENEWABLE ENERGY EVALUATION

The enactment of the RE Act institutionalized programs to encourage and incentivize the development and utilization of new and developing renewable energy technology. Among these programs are the Renewable Portfolio Standards (RPS) and Feed-in-Tariff. RPS refers to a market-based policy that requires electricity suppliers to source an agreed portion of their energy supply from eligible RE resources.[19]

To evidence compliance with RPS, the mandated market participants are required to acquire Renewable Energy Certifications (RECs) in accordance with the prevailing minimum RE supply percentage. The available mechanisms to comply with RECs include execution of a contract with a new RE generator, Green Energy Auction Program, Feed-in-Tariff, Renewable Energy Market, and Green Energy Option Program.

On the other hand, Feed-in-Tariff (FIT) provides guaranteed rates for electricity produced from wind, solar, ocean, run-of-river hydropower, and biomass. The law further mandates that these renewable energy sources shall have priority purchase and transmission of, and payment for, such electricity by the grid system operators.[20]

In the WESM, generators under the FIT system are dispatched first in the MOT. FIT generators are "price-takers". They only nominate their MW capacity in the market without corresponding offer prices. In summary, they are under priority dispatch and take whatever price is dictated in the market. Through this mechanism, FIT generators are expected to lower WESM prices by "bumping off" conventional generators in the merit order.

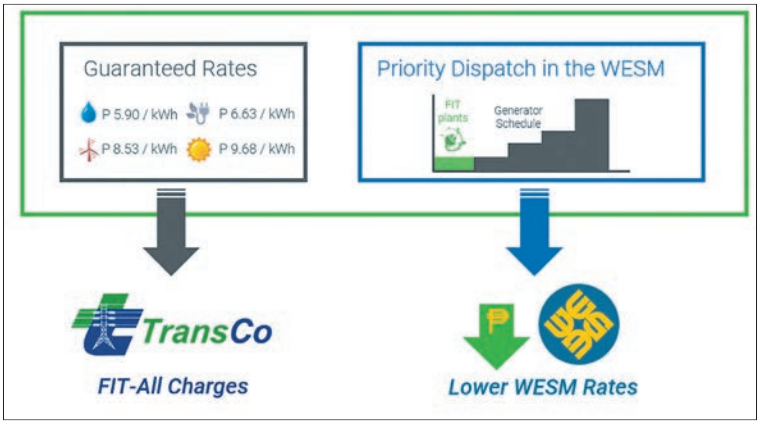


Figure 30. *Current Feed-in-Tariff Mechanism*

19 Renewable Energy Act of 2008, R.A. 9513, §4(ss) (2008).
20 Id. at §7(b)

As of July 2022, the total registered Variable RE (VRE) plants in WESM is 2,104 MW consisting of 427 MW from wind plants, 1,202 MW from solar power, 161 MW from run-of-river hydro, and 313 MW from biomass plants. Out of the 2,104 MW of total VRE, 1,302 MW is under the FIT program, broken down to 427 MW from wind plants, 430 MW from solar power, 137 MW from run-of-river hydro, and 307 MW from biomass plants.

The total installed capacity of FIT plants has also increased since its implementation. The following figure shows the growth of installed capacity in the WESM from 2014 to 2022. In comparison to the growth of installed capacity from wind and solar plants, the growth of installed capacity from biomass and run-of-river hydro are observed to be much slower.

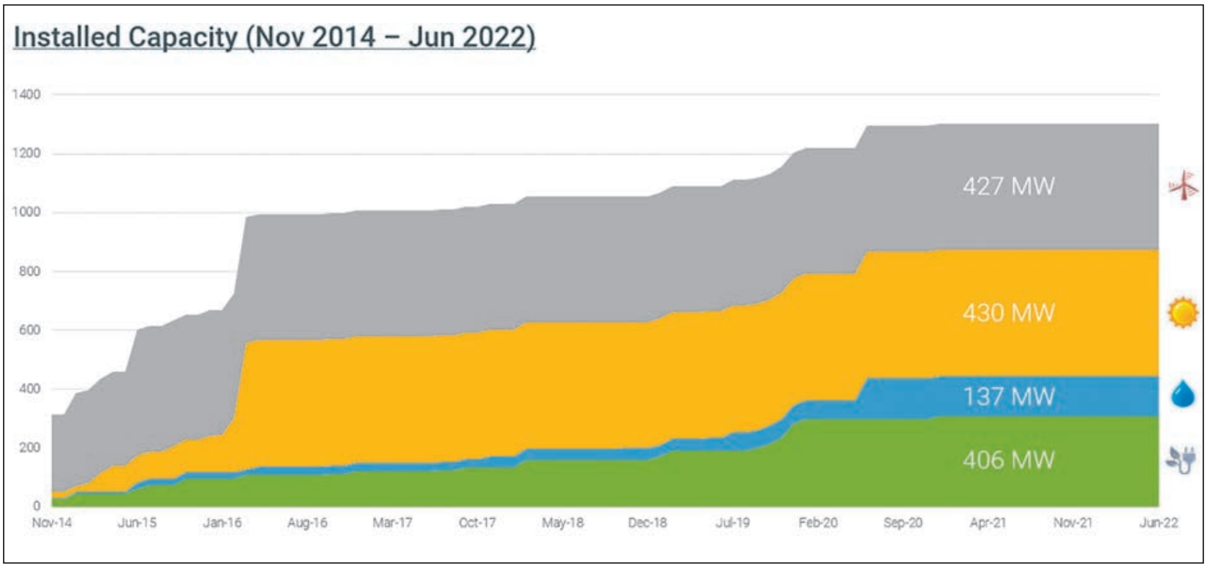


Figure 31. *Installed Capacity of FIT plants*

The VREs may also offset the offers of scheduled plants resulting to a lower market clearing price. Using the offered quantities in the WESM from July 2021 to February 2022, the merit order effect of VREs was studied. On average, the quantity of VRE nominated to the WESM is only at 800MW despite its total installed capacity of 2,104MW due to its low capacity factor. Even with low availability factor, the VREs still lower the market clearing price, especially during periods of low demand.

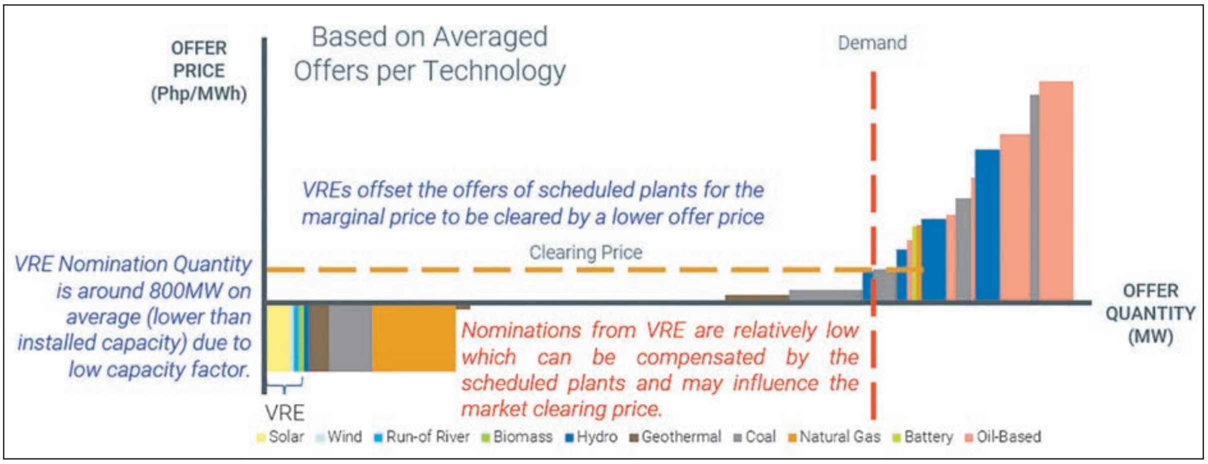


Figure 32. *Merit Order Effect of RE Plants*

With the implementation of other RE incentive mechanisms, such as Green Energy Option Program (GEOP) and Green Energy Auction (GEAC), it is expected that there will be around 2,000MW additional RE capacity by 2023-2025. Should this happen, RE plants will have a more significant effect on the electricity price, generation mix, and grid operations.

VI. ASEAN COMPARATIVE STUDY

From an international and global perspective, the Philippines' energy industry metrics, such as energy mix, capacity mix, and per capita electricity generation, among others, were compared to its ASEAN and global counterparts.

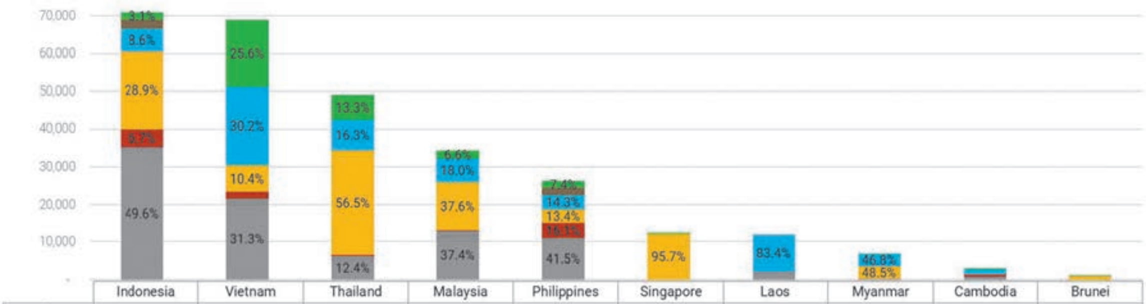
COUNTRY	INSTALLED CAPACITY (MW)	ELECTRICITY GENERATION (GWh)	POPULATION
Indonesia[22]	71,002	291,830	273,523,615
Vietnam[23]	68,789	213,274	97,338,579
Thailand[24]	49,008	180,943	69,799,978
Malaysia[25]	34,379	151,960	32,365,999
Philippines[26]	26,376	101,756	109,581,078
Singapore[27]	12,58	53,071	5,850,342
Laos[28]	11,950	29,974	7,275,560
Myanmar[29]	6,891	23,572	54,409,800
Cambodia[30]	2,917	8,582	16,718,965
Brunei[31]	894	4,642	437,479

***Table 27.** Installed Capacity, Electricity Generation, and Population of ASEAN Countries (2021)*

While the Philippines is the 2nd most populous country in the ASEAN region following Indonesia, it ranks 5th in terms of installed capacity and electricity generation.

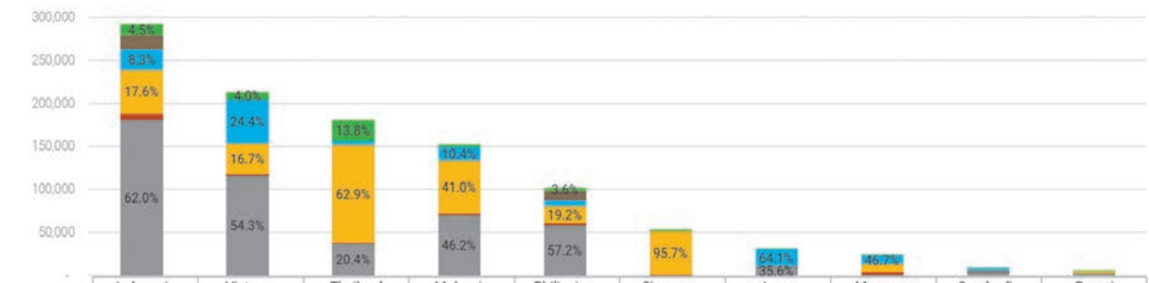
In terms of capacity mix,[32] the Philippines has one of the most diverse energy sources in the region. Fossil fuel-powered plants still dominate the capacity mix of ASEAN countries taking up at least 50% of the capacity mix for every country, except Vietnam, Laos, and Myanmar. Meanwhile, natural gas also has a substantial percentage in almost all ASEAN countries except Laos and Cambodia.

21 WorldoMeter, *https://www.worldometers.info/world-population/south-eastern-asia-population/*
22 Ministry of Energy and Mineral Resources Indonesia, *https://www.esdm.go.id/assets/media/content/content-handbook-of-energy-and-economic-statistics-of-indonesia-2021.pdf*
23 Energy Planning and Policy Office, Ministry of Energy Thailand, *http://www.eppo.go.th/index.php/en/en-energystatistics/electricity-statistic*
24 Energy Planning and Policy Office, Ministry of Energy Thailand - *http://www.eppo.go.th/index.php/en/en-energystatistics/electricity-statistic*
25 Our World in Data, *https://ourworldindata.org/energy/country/malaysia*
26 Department of Energy Philippines, *https://www.doe.gov.ph/sites/default/files/pdf/energy_statistics/2021_power_statistics_01_summary.pdf*
27 Electricity Market Authority Singapore - *https://www.ema.gov.sg/Statistics.aspx*
28 Our World in Data, *https://ourworldindata.org/energy/country/laos*
29 Our World in Data, *https://ourworldindata.org/energy/country/myanmar*
30 Electricity Authority of Cambodia - *https://eac.gov.kh/uploads/salient_feature/english/salient_feature_2021_en.pdf*
31 Our World in Data, *https://ourworldindata.org/energy/country/brunei*
32 ASEAN Power Updates 2021, ASEAN Center for Energy, *https://aseanenergy.org/asean-power-updates-2021/*



	Indonesia	Vietnam	Thailand	Malaysia	Philippines	Singapore	Laos	Myanmar	Cambodia	Brunei
Coal	35,220	21,554	6,114	12,846	10,944		1,978	120	675	
Oil	4,781	1,706	369	148	4,237			25	644	15
Natural Gas	20,537	7,152	27,920	12,919	3,543	12,035		3,341		877
Hydro	6,121	20,774	8,050	6,200	3,779		9,972	3,225	1,330	
Geothermal	2,131				1,928					
VRE	2,212	17,603	6,555	2,266	1,945	547	-	180	268	2
TOTAL	**71,002**	**68,789**	**49,008**	**34,379**	**26,376**	**12,582**	**11,950**	**6,891**	**2,917**	**894**

Figure 33. *Capacity Mix (MW) of ASEAN Countries (2020)*



	Indonesia	Vietnam	Thailand	Malaysia	Philippines	Singapore	Laos	Myanmar	Cambodia	Brunei
Coal	180,869	115,740	36,823	70,140	58,176		10,674	890	3,919	2,300
Oil	6,775	1,510	721	980	2,474	212		3,280	447	130
Natural Gas	51,276	35,580	113,859	62,260	19,497	50,811		8,380		2,210
Hydro	24,325	51,980	4,540	15,800	7,192		19,200	11,000	3,860	
Geothermal	15,563		2		10,757					
VRE	13,022	8,464	24,998	2,780	3,660	2,048	100	22	356	2
TOTAL	**291,830**	**213,274**	**180,943**	**151,960**	**101,756**	**53,071**	**29,974**	**23,572**	**8,582**	**4,642**

Figure 34. *Energy Mix (GWh) of ASEAN Countries (2020)*

The energy mix of ASEAN countries closely follows the respective country's capacity mix. The volume of electrical energy generation of the Philippines (101,756 GWh) is the 5th largest in the region. It can also be observed that the Philippines has a significant dependence on coal at 57.2%, second only to Indonesia at 62%. In addition, Indonesia is a net coal exporter while the Philippines is a net coal importer.[33]

[33] WorldoMeter, https://www.worldometers.info/coal/

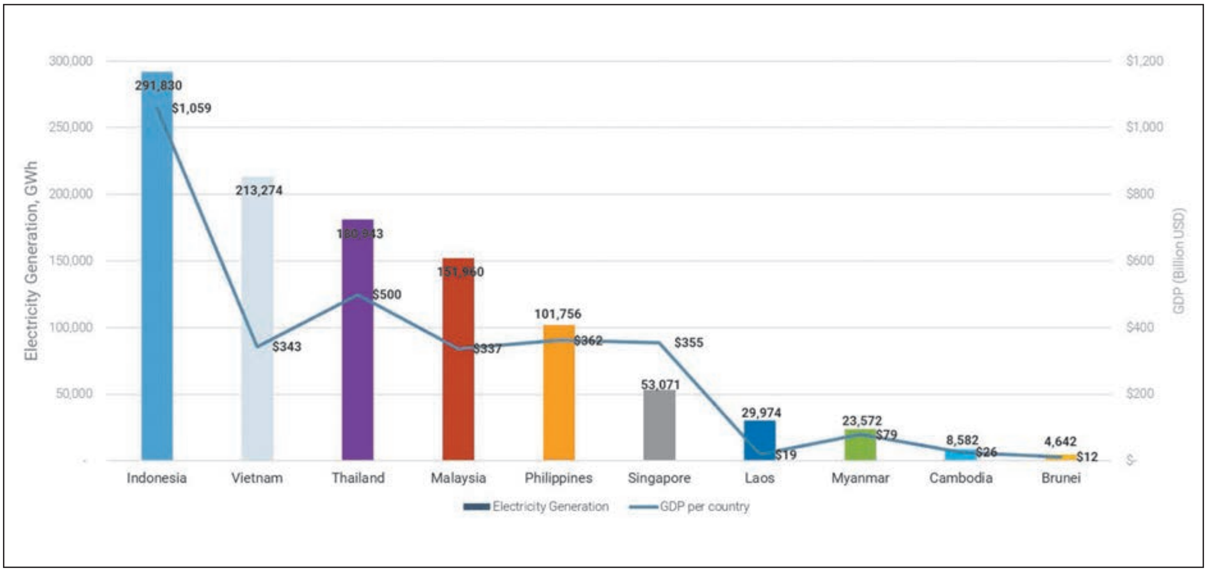


Figure 35. *Electricity Generation vis-a-vis GDP of ASEAN Countries (2020)*

In terms of electricity generation vis-à-vis Gross Domestic Product (GDP), the Philippines has a comparable GDP to Malaysia, Singapore, and Vietnam. Historically, the demand of electricity generation and economic growth has a direct correlation. However, this is no longer accurate due to the collective movement towards energy efficiency as well as the shift of some nations from industrial to service economy.

When it comes to energy efficiency, the Philippines ranked 3rd among ASEAN countries. Energy efficiency may be best measured through its opposite metric, energy intensity. Energy intensity is a measure of how much energy is consumed per unit of GDP. Thus, a country with lower energy intensity signifies a higher efficiency in using energy to produce a unit of GDP.

While the Philippines' GDP standing is roughly the same as Singapore, Malaysia and Vietnam, data shows that the Philippines is more efficient in using electricity to drive the economy compared to Malaysia and Vietnam but less efficient relative to Singapore. The recent enactment and implementation of Republic Act 11285 or the Energy Efficiency and Conservation Law may have contributed to reduction in energy intensity. Moreover, reduction in energy intensity is one of the targets in Sustainable Development Goal 7 (affordable, reliable, sustainable, and modern energy for all).

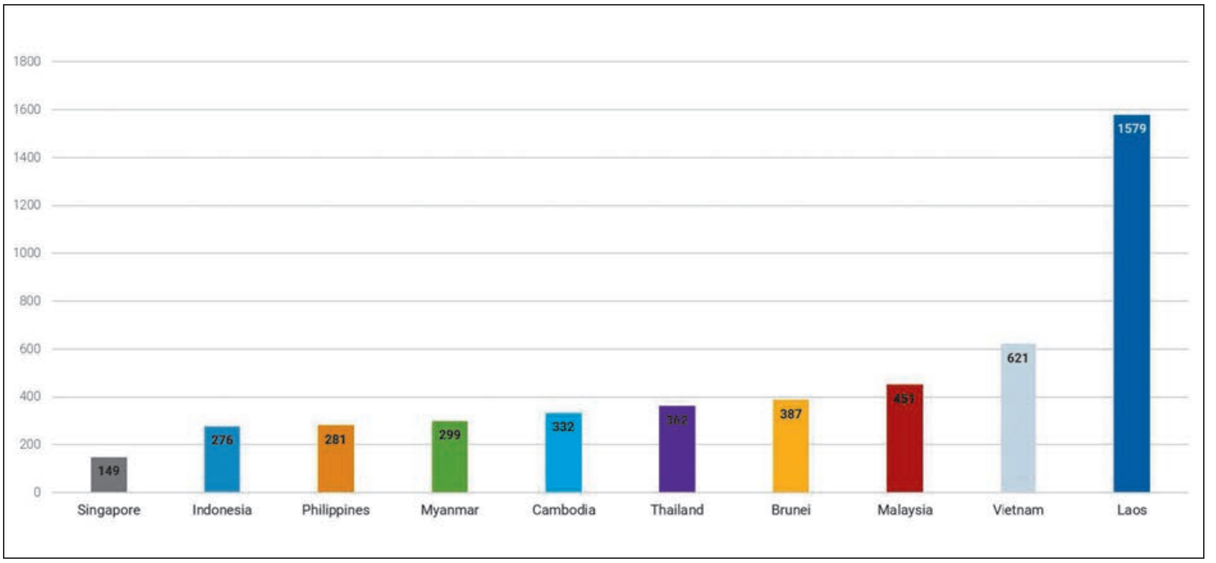


Figure 36. *Energy Intensity of ASEAN Countries (2020)*

With reference to per capita generation, the Philippines ranked 9th among the ASEAN countries. Generation per capita measures how much electricity a country produces for one person. High measures of per capita generation suggest that there are high levels of electrification in the country but may also indicate lower electricity usage efficiency. Moreover, while the electrification rate of the Philippines is relatively high at 94.5%[34], low GDP per capita and low generation per capita could be attributed to high electricity prices and low-income levels experienced by Filipinos.

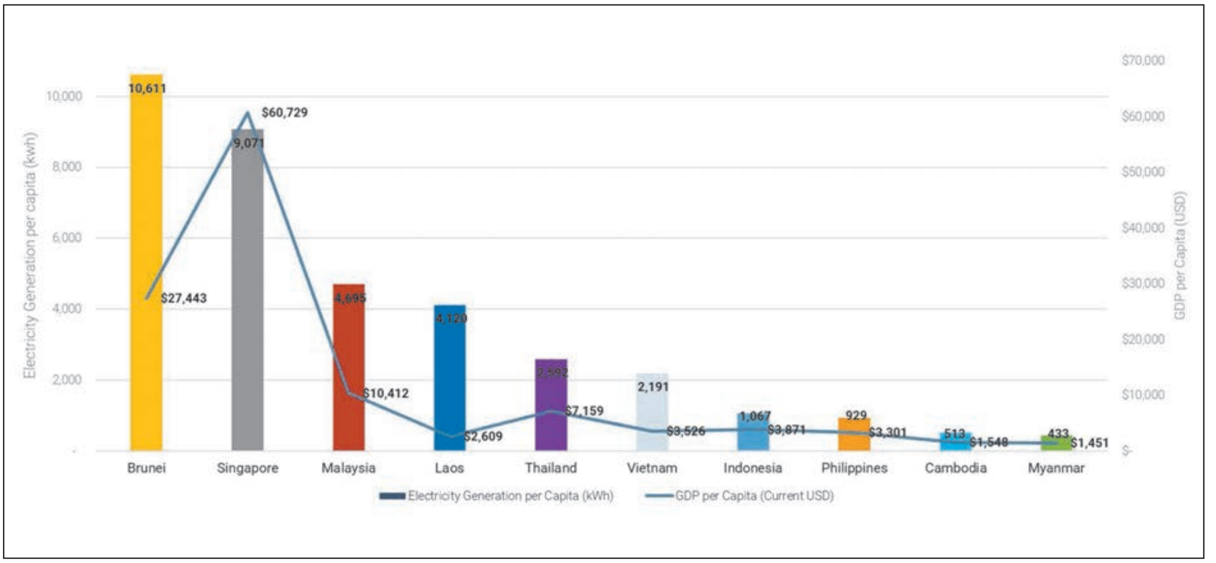
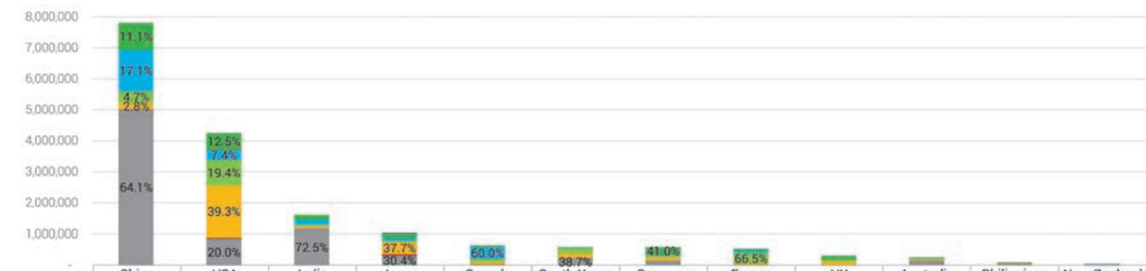


Figure 37. *Per Capita Generation vis-a-vis GDP of ASEAN Countries (2020)*

[34] STATISTA, Household electrification rate Philippines 2016-2020, *www.Statista.com*

Outside Southeast Asia, the Philippines' electricity generation (101,756 GWh) is relatively small, at only 1% of China's, 2% of the USA's, 6% of India's, 10% of Japan's, 16% of Canada's, 17% of South Korea's, 18% of Germany's, 19% of France's, 33% of the UK's, and 38% of Australia's.[35]



	China	USA	India	Japan	Canada	South Korea	Germany	France	UK	Australia	Philippines	New Zealand
Coal	5,001,122	851,863	1,167,298	313,325	31,213	226,646	148,164	5,067	6,201	145,522	58,176	2,360
Oil	10,799	36,212	4,922	48,366	5,136	6,337	4,907	5,266	887	4,509	2,474	61
Natural Gas	218,242	1,669,868	68,288	389,055	70,884	151,393	99,564	35,203	114,128	55,216	19,497	625
Nuclear	366,247	823,191	43,029	38,752	98,211	160,184	64,382	353,833	50,278			
Hydro	1,334,859	314,316	167,029	88,245	384,745	7,148	24,877	66,708	7,894	15,150	7,192	24,231
Geothermal	125	19,292		2,854			217	128			10,757	8,143
VRE	866,472	532,926	160,402	131,783	50,563	30,528	238,710	65,240	133,360	44,781	3,660	4,054
Others	12	4,716		18,659	123	4,094	1,174	990	11			62
TOTAL	7,797,878	4,252,384	1,610,968	1,031,039	640,875	586,330	581,995	532,435	312,759	265,178	101,756	39,356

Figure 38. *Energy Mix, Global (2020)*

In terms of electricity prices, for 2014-2021, the Philippines has a consistently high cost of electricity relative to its ASEAN neighbors. In 2021, the retail electricity rate of the Philippines ranked 2nd highest in Southeast Asia next only to Singapore.

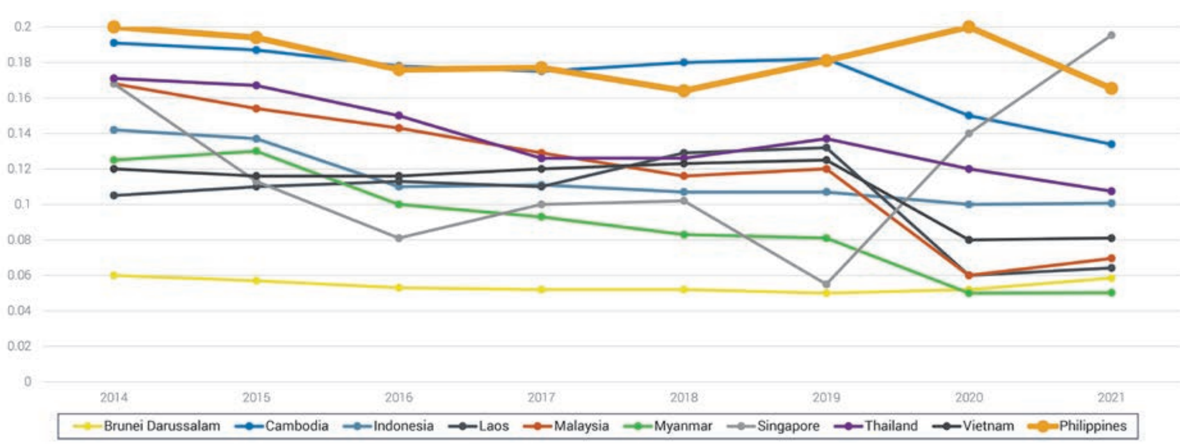


Figure 39. *Retail Electricity Prices in ASEAN countries (2014-2021)*

[35] International Energy Agency, *https://www.iea.org/*

As regards the energy industry structure, the Philippines is the only ASEAN country that implements a decentralized buyer model for the captive market. A different utility procures and distributes power to captive consumers in a specific franchise area. At present, there are 152 distribution utilities in the Philippines.

In most countries, state-owned utilities are designated as the buyer of wholesale power, allowing them to resell power to consumers at rates below market prices. Moreover, only 2 countries alongside Philippines have a wholesale electricity market – Singapore and Vietnam. However, Vietnam has yet to implement a fully liberalized wholesale electricity market. Lastly, only the Philippines and Singapore have launched retail competition in the ASEAN region. Unlike Singapore where retail competition has already reached the household level, only End-users with average peak demand greater than or equal to 500kW in the Philippines currently have the option to switch to non-captive supply.

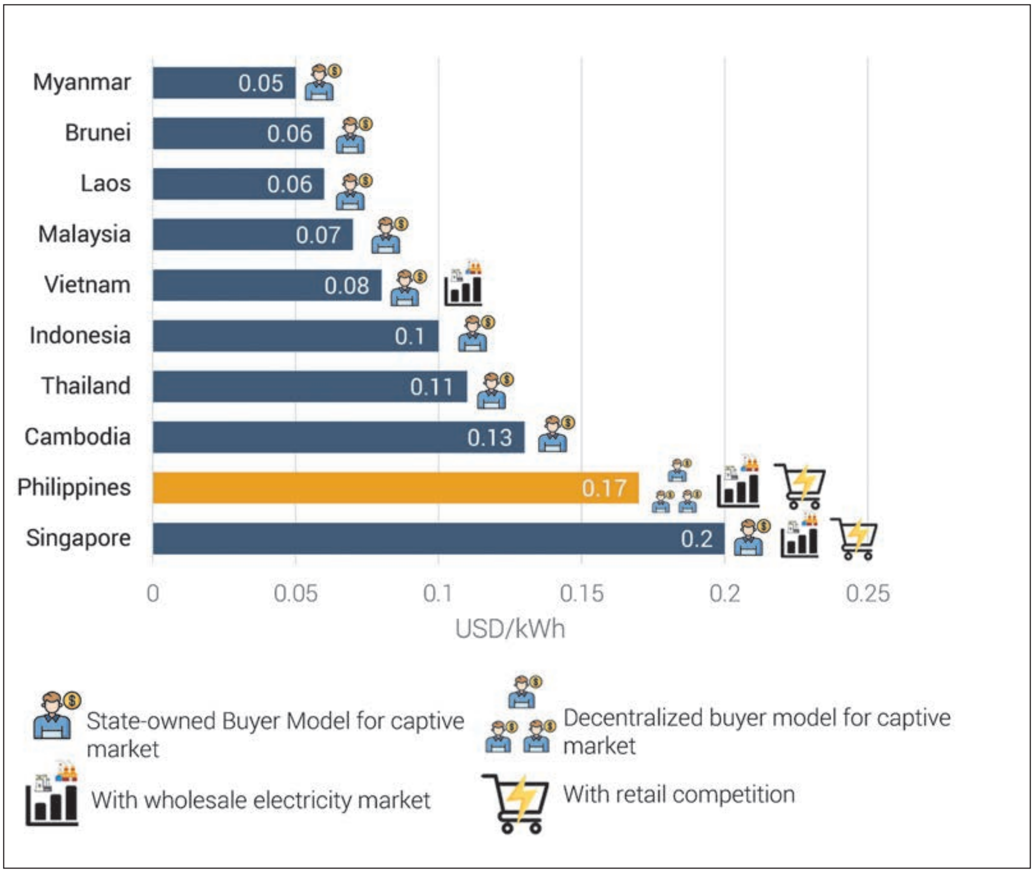


***Figure 40.** Energy industry structure of ASEAN countries (2021)*

With the restructuring of the energy industry, retail rates in the Philippines are more volatile compared to its ASEAN counterparts as generation rates are pass-through charges which fluctuate every month (evaluated for over or under recovery every 3 years) while transmission and distribution rates are adjusted every 4 years per utility.

Since electricity bills are unbundled to reflect charge for each service, adjustment of rate components is more transparent in the Philippines. The same was not observed in other countries, except Singapore.

On the other hand, Singapore, Thailand, and Indonesia adjust rates on a quarterly basis, Vietnam on a biannual basis, Cambodia and Lao PDR on an annual basis. Malaysia changes rates every 3 years while there is no definite rate adjustment schedule indicated for Myanmar, where the last electricity tariff hike was implemented in 2019.

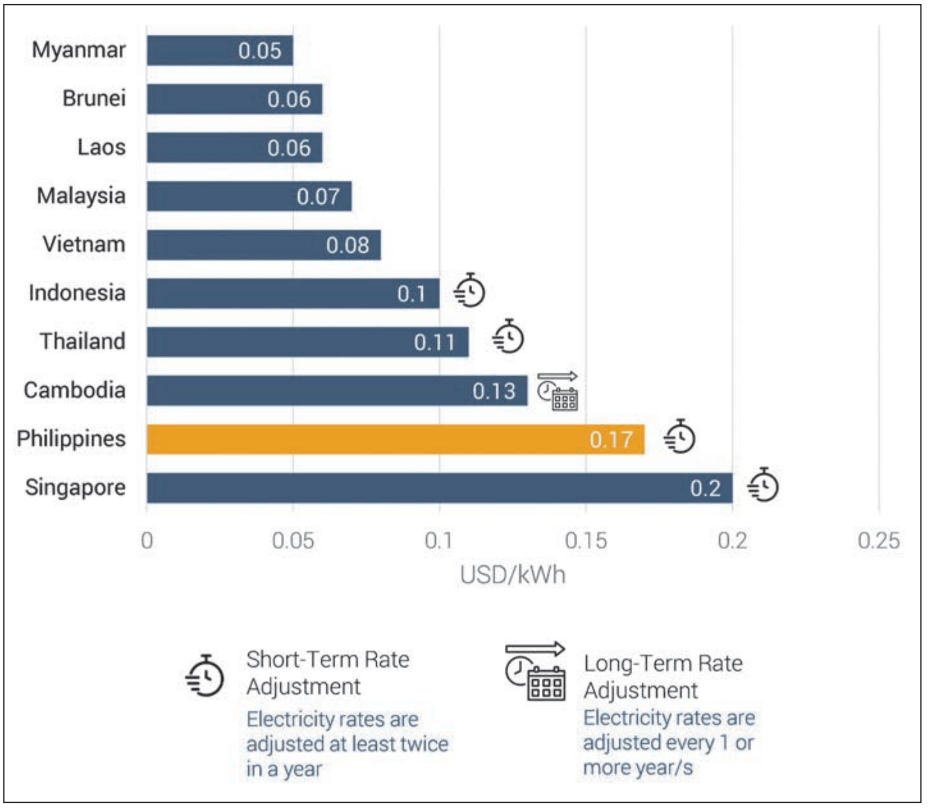


***Figure 41.** Electricity Prices and Rate Regulation*

As regards electricity subsidies, only the Philippines, Singapore, and Thailand have no direct government subsidies allocated to reduce electricity prices charged to consumers. Both the Philippines and Thailand implement an inter-class subsidy mechanism that allows low-income households to enjoy outright discounts in their electricity bills, but the burden is recovered from other end-users. Meanwhile, Singapore disburses quarterly rebates to eligible citizens which they can use to reduce electricity, water, gas, and refuse collection bills.

The estimated government subsidies per capita in different ASEAN countries are as follows – Indonesia at 55 USD, Cambodia at 6 USD, Malaysia at 6 USD, and Myanmar at 5 USD. Subsidies directly affect the affordability of electricity prices in most ASEAN nations. However, various development agencies such as the World Bank[36] and ADB[37] have recommended energy subsidy reforms noting that while subsidies improve energy affordability, it also tends to benefit the rich disproportionally, drain fiscal resources, and lead to wasteful consumption.[38]

[36] The Energy Subsidy Reform Assessment Framework, Good Practice Notes towards Evidence-Based Energy Subsidy Reforms
[37] Energy Assessment Strategy and Roadmap for various countries, ADB
[38] World Bank, Energy Subsidy Reform, https://www.worldbank.org/en/results/2020/11/12/energy-subsidy-reform-facility-generatesknowledge-to-support-governments-to-design-and-implement-sustainable-energy-subsidy-reforms-while-safeguarding-the-welfare-of-the-poor

Globally, the electricity rates of the Philippines are at mid-level. In 2021, Germany and United Kingdom have the highest retail electricity rates.

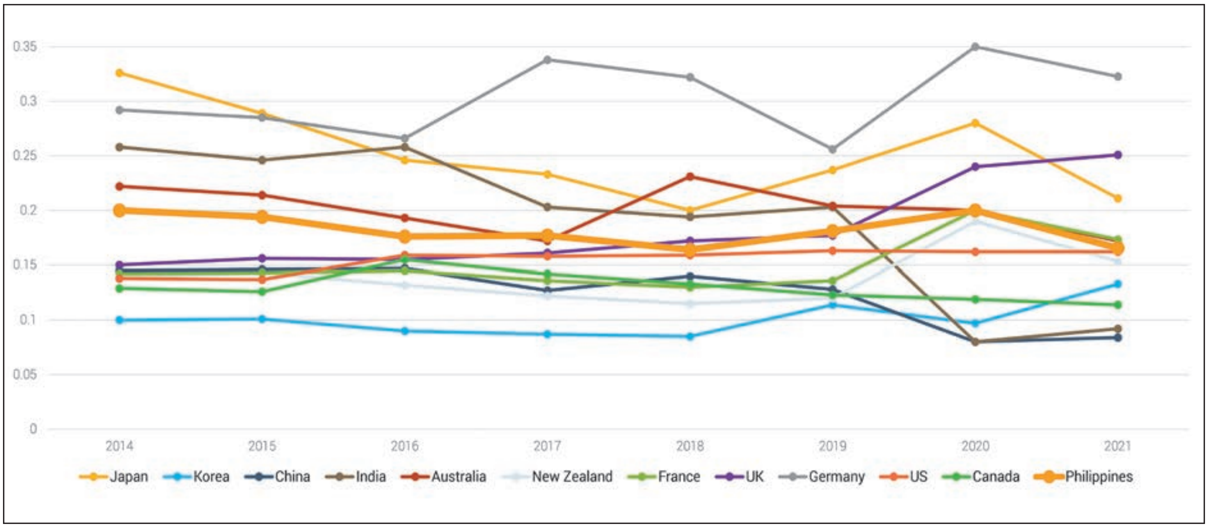


Figure 42. *Global electricity rates (2021)*

VII. POWER OUTLOOK BASED ON DOE's POWER DEVELOPMENT PLAN

As captured from the DOE's Power Development Plan, the Power Outlook is generated using the following inputs and assumptions:

INPUT	DESCRIPTION
Electricity Demand	• Low and high Gross Domestic Product (GDP) growth annual peak demand forecast. Mindanao is projected to have the highest annual growth at 8%, followed by the Visayas grid at 7% and Luzon at 6%.
Generator Parameters	• Existing power plants as of 31 December 2019, with no derating and retirement considered Committed power plants as of 30 September 2020 • Operating technical parameters of existing power plants • Forced and maintenance outage rates • Reserve provision classified as regulating, contingency, and dispatchable reserves
New Build Options	• Existing power plant technologies in the Philippines (i.e., coal, oil, gas turbines, geothermal, hydro, biomass, solar, wind), excluding Battery Energy Storage System (BESS), Nuclear, Hydrogen, Fuel Cell, and Ocean technology • Cost parameters developed by DOE with inputs from the National Renewable Energy Board • Competitive Renewable Energy Zone technical parameters • New power plants can provide ancillary services • Minimum 25% reserve margin per grid

Table 28. *DOE's Power Outlook Inputs and Assumptions*

Using the inputs to electricity demand, the annual peak demand forecast is shown below. Using the high demand forecast, Luzon and Visayas peak demands are projected to reach as high as 13,310MW and 2,733MW, respectively by 2023. Meanwhile, Mindanao is forecasted to attain a peak demand of 2,474MW in the same year.

YEAR	LUZON		VISAYAS		MINDANAO		PHILIPPINES	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
2022	12,387	12,561	2,528	2,567	2,223	2,296	17,138	17,424
2023	13,125	13,310	2,691	2,733	2,395	2,474	18,211	18,517
2024	13,917	14,114	2,891	2,936	2,584	2,669	19,392	19,719
2025	14,769	14,978	3,111	3,160	2,789	2,881	20,669	21,019
2026	15,683	15,906	3,340	3,392	3,013	3,113	22,036	22,411
2027	16,665	16,902	3,585	3,642	3,259	3,366	23,509	23,910
2028	17,719	17,972	3,840	3,902	3,526	3,643	25,085	25,517
2029	18,852	19,122	4,118	4,185	3,819	3,945	26,789	27,252
2030	20,070	20,358	4,423	4,495	4,138	4,275	28,631	29,128
2031	21,349	21,657	4,748	4,827	4,480	4,628	30,577	31,112
2032	22,693	23,020	5,096	5,181	4,844	5,005	32,633	33,206
2033	24,103	24,452	5,466	5,558	5,232	5,406	34,801	35,416
2034	25,584	25,955	5,860	5,959	5,646	5,834	37,090	37,748
2035	27,138	27,532	6,280	6,387	6,088	6,290	39,506	40,209
2036	28,768	29,187	6,730	6,845	6,557	6,775	42,055	42,807
2037	30,478	30,923	7,208	7,332	7,057	7,292	44,743	45,547
2038	32,268	32,740	7,716	7,850	7,588	7,841	47,572	48,431
2039	34,141	34,641	8,255	8,399	8,152	8,423	50,548	51,463
2040	36,101	36,631	8,827	8,982	8,751	9,042	53,679	54,655

***Table 29**. DOE's Annual Peak Demand Forecast*

The DOE Power Outlook highlighted four (4) scenarios consistent with the RE energy generation mix target of [1] 35% by 2030 and [2] 50% by 2040, with both scenarios containing high and low peak demand forecast. IEMOP adopted Scenarios 2 and 4 for illustration to this study.

Scenario	RE Target	Demand
1	35% by 2030	Low Demand
2	35% by 2030	High Demand
3	50% by 2040	Low Demand
4	50% by 2040	High Demand

***Table 30.** DOE's Power Outlook Scenarios*

COMMITTED POWER PROJECTS

Based on the DOE's committed power projects updated as of March 2022, the bulk of capacities will come from coal at 4,488MW, followed by natural gas at 2,401MW and BESS at 2,050MW. Committed power projects signify that these have secured financial closure to build the generating plant, which shows a total of 9,954MW additional capacities until 2027.

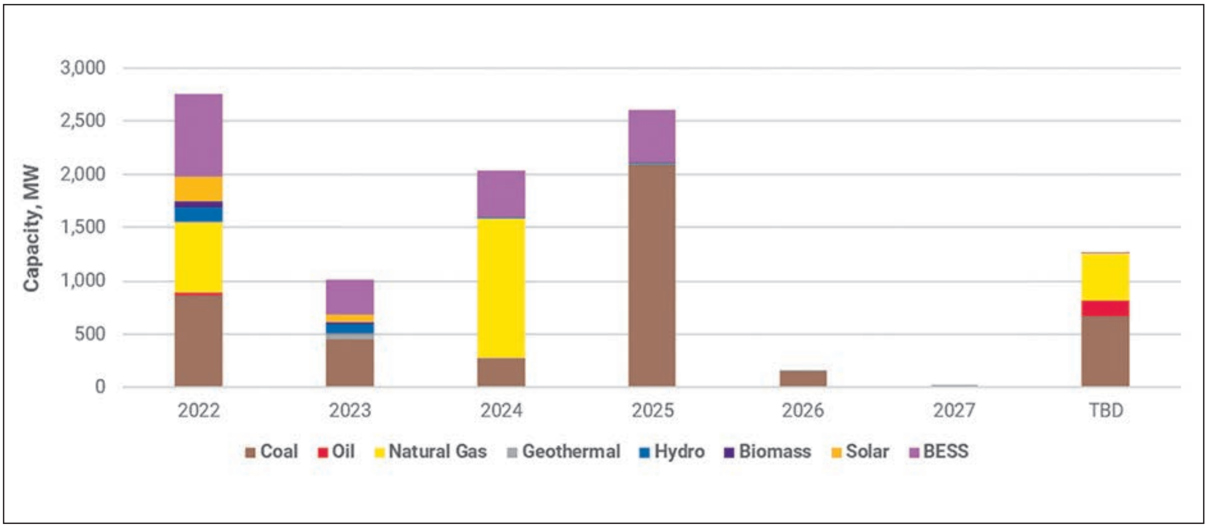


Figure 43. *DOE's Committed Power Projects (as of March 2022)*

Gen Type	2022	2023	2024	2025	2026	2027	TBD	Total
Coal	862	450	270	2,088	150	0	668	4,488
Oil	33	0	0	0	0	0	150	183
Natural Gas	650	0	1,313	0	0	0	438	2,401
Geothermal	10	59	5	10	10	22	0	116
Hydro	137	84	4	8	0	0	0	233
Biomass	52	21	0	0	0	0	0	73
Solar	234	76	0	0	0	0	0	310
BESS	780	320	440	500	0	0	10	2,050
Total	**2,759**	**1,010**	**2,031**	**2,606**	**160**	**22**	**1,266**	**9,854**

Table 31. *DOE's Committed Power Projects (as of March 2022)*

INDICATIVE POWER PROJECTS

Indicative power projects are projects with a plan to construct generating plants but have yet to secure approval of funds. The total 37,260MW capacities are mostly comprised of renewable energy plants such as solar at 12,321 MW, wind at 10,295 MW, and hydro at 7,782 MW. Most of these plants are projected to become operational by 2030. Meanwhile, fossil fuel plants such as coal, natural gas, and oil-based have only a combined total indicative capacity of 5,215MW.

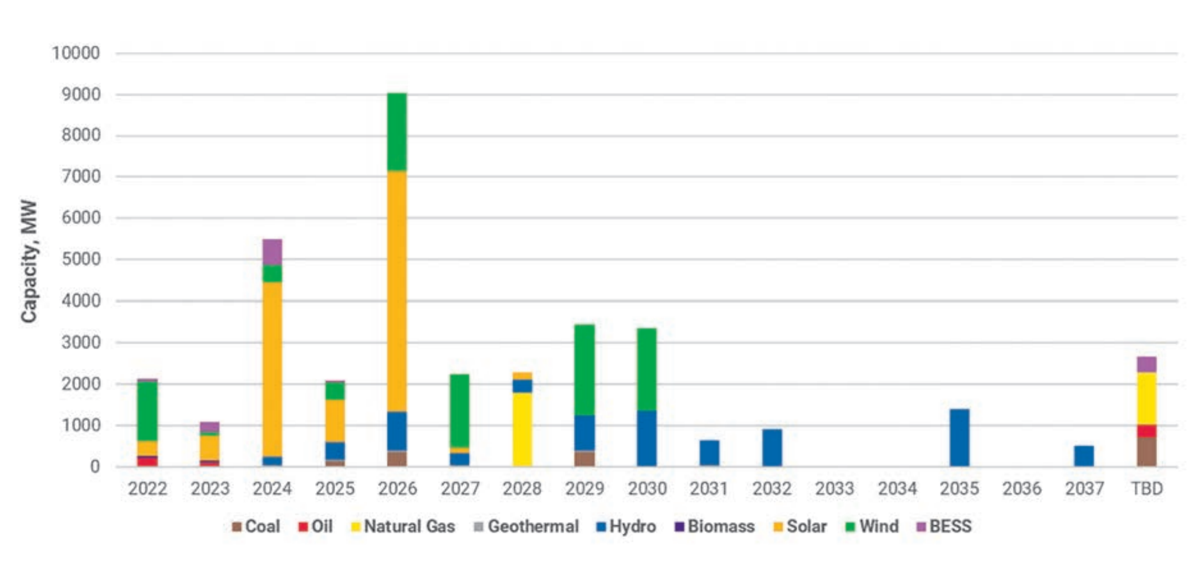


Figure 44. *DOE's Indicative Power Projects (as of March 2022)*

Gen Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	TBD	Total
Coal	0	0	0	120	350	0	0	350	0	0	0	0	0	0	0	0	700	1,520
Oil	210	95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	330	635
Natural Gas	0	0	0	0	0	0	1,800	0	0	0	0	0	0	0	0	0	1,260	3,060
Geothermal	0	0	44	60	50	40	0	40	0	40	0	0	0	0	0	0	0	274
Hydro	17	32	202	408	922	294	300	847	1,360	600	900	0	0	1,400	0	500	0	7,782
Biomass	24	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38
Solar	374	603	4,196	1,030	5,816	121	181	0	0	0	0	0	0	0	0	0	0	12,321
Wind	1,452	100	434	421	1,905	1,781	0	2,202	2,000	0	0	0	0	0	0	0	0	10,295
BESS	49	251	622	40	0	0	0	0	0	0	0	0	0	0	0	0	375	1,337
Total	**2,126**	**1,095**	**5,498**	**2,078**	**9,042**	**2,236**	**2,281**	**3,439**	**3,360**	**640**	**900**	**0**	**0**	**1,400**	**0**	**500**	**2,665**	**37,260**

Table 32. *DOE's Indicative Power Projects (as of March 2022)*

PHILIPPINES' POWER OUTLOOK (35% RE TARGET BY 2030 – HIGH DEMAND)

Using Scenario 2 - RE target of 35% by 2030 and high demand forecast, the total capacity by 2040 for the entire country will be 91,701 MW with a corresponding annual peak demand of 54,655 MW. RE energy production from 2030 to 2040 will be steady at 35%. Energy share from natural gas will increase to 40% while coal generation will be reduced to 25% by 2040.

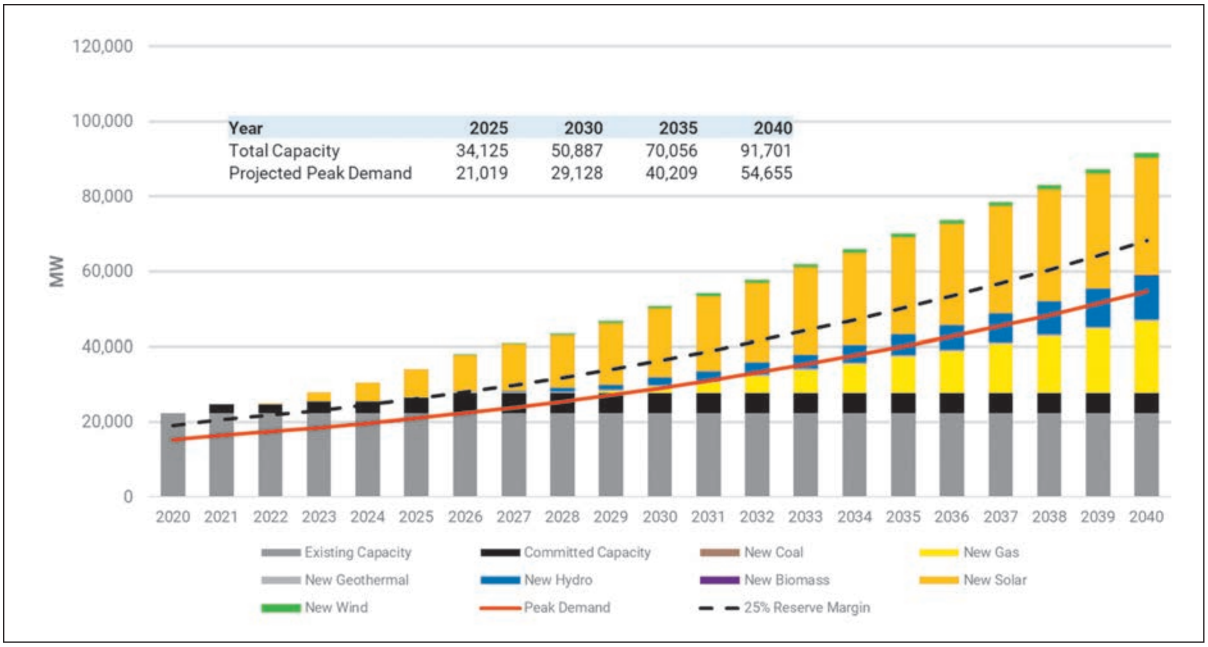


Figure 45. *Philippines Power Outlook (RE 35% by 2030)*

Plant Type	2020	2025	2030	2035	2040
Power Generation in GWh					
Coal	57,040	87,183	87,754	89,096	89,717
Oil-based	69	77	1,047	363	281
Natural Gas	20,291	13,725	37,513	84,853	146,858
Renewable Energy	24,569	39,273	68,016	93,862	127,539
Geothermal	12,821	13,879	15,633	15,633	16,184
Hydro	8,623	8,865	15,873	28,970	51,550
Solar	988	13,614	32,062	44,252	53,062
Wind	1,360	1,775	3,307	3,944	5,121
Biomass	778	1,140	1,141	1,063	1,623
Total	**101,969**	**140,258**	**194,330**	**268,175**	**364,396**
Power Generation in Percent Share					
Coal	56	62	45	33	25
Oil-based	0	0	1	0	0
Natural Gas	20	10	19	32	40
Renewable Energy	24	28	35	35	35
Geothermal	13	10	8	6	4
Hydro	8	6	8	11	14
Solar	1	10	16	17	15
Wind	1	1	2	1	1
Biomass	1	1	1	0	0
Total	**100**	**100**	**100**	**100**	**100**

Table 33. *Philippines Power Generation (RE 35% by 2030)*

The following figures illustrate the regional Power Outlook under Scenario 2:

LUZON

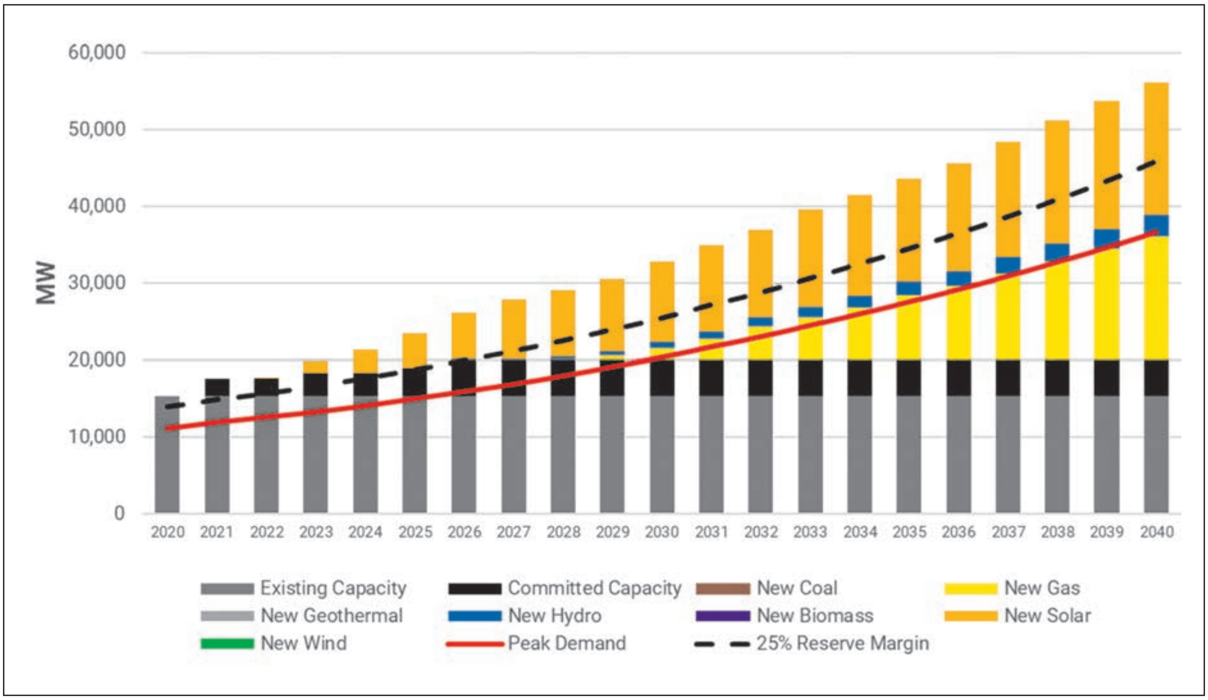


Figure 46. *Luzon Power Outlook (RE 35% by 2030)*

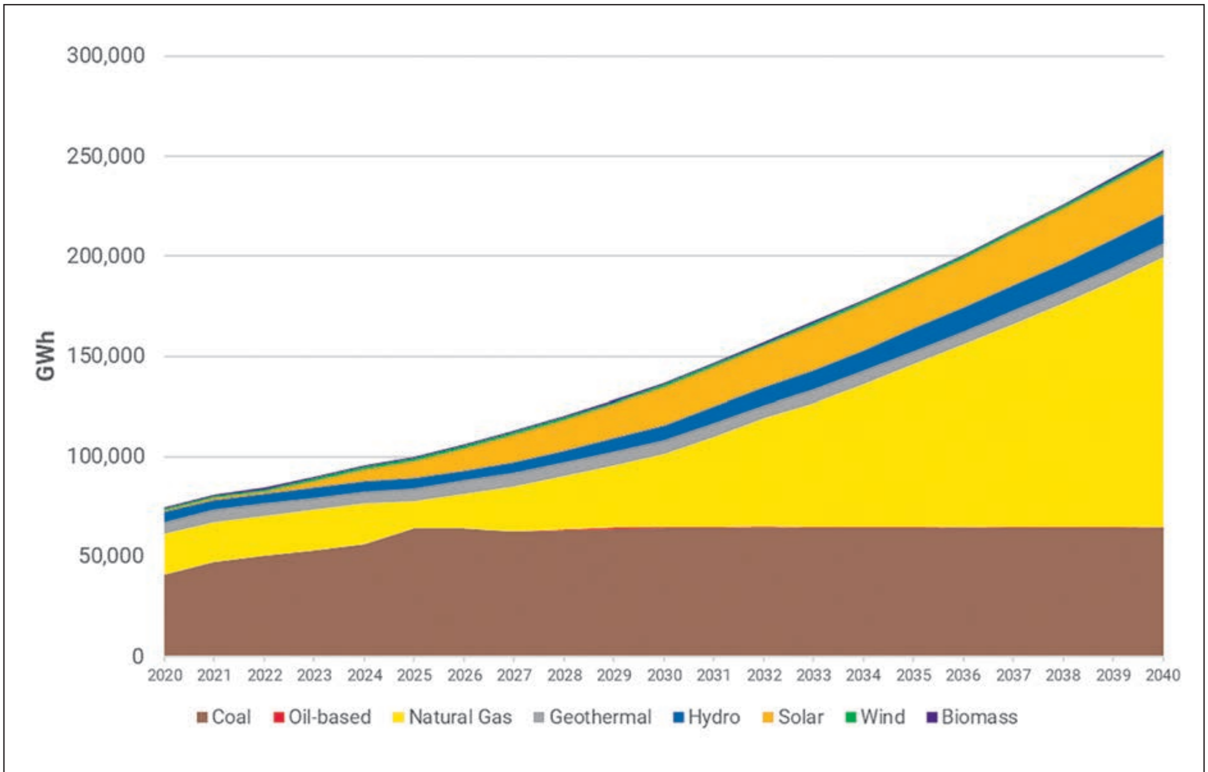


Figure 47. *Luzon Power Generation (RE 35% by 2030)*

VISAYAS

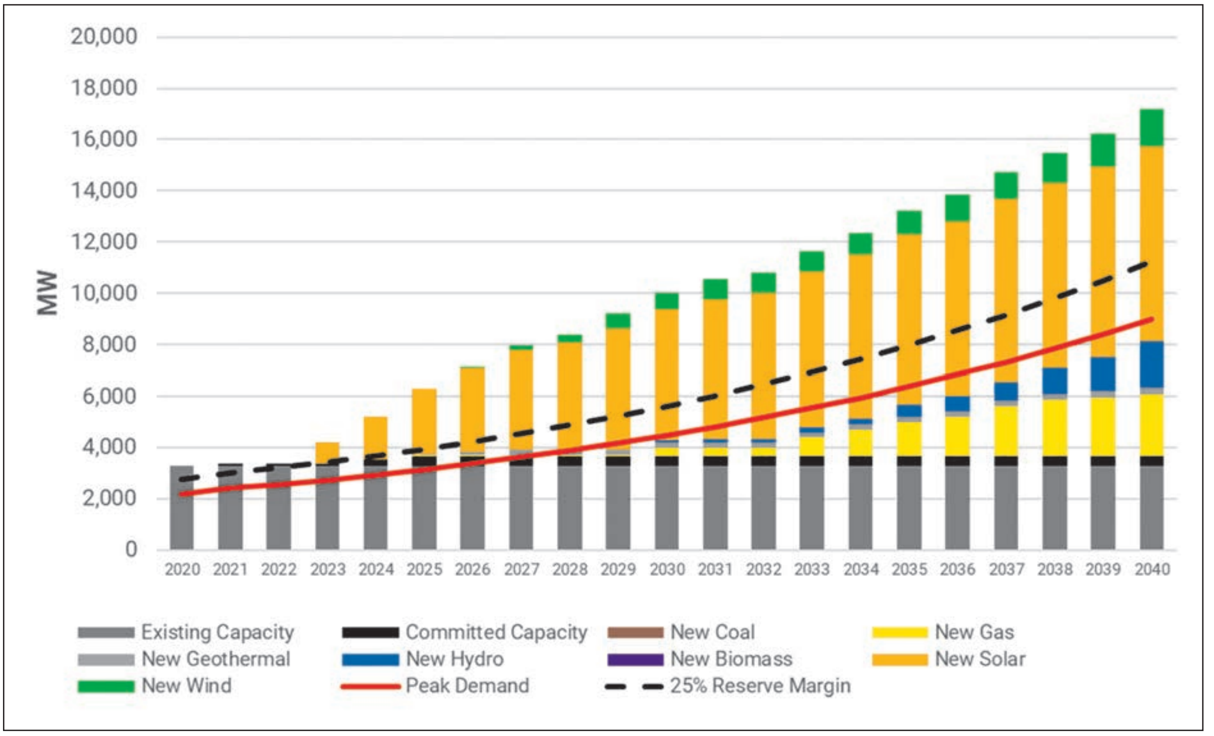


***Figure 48.** Visayas Power Outlook (RE 35% by 2030)*

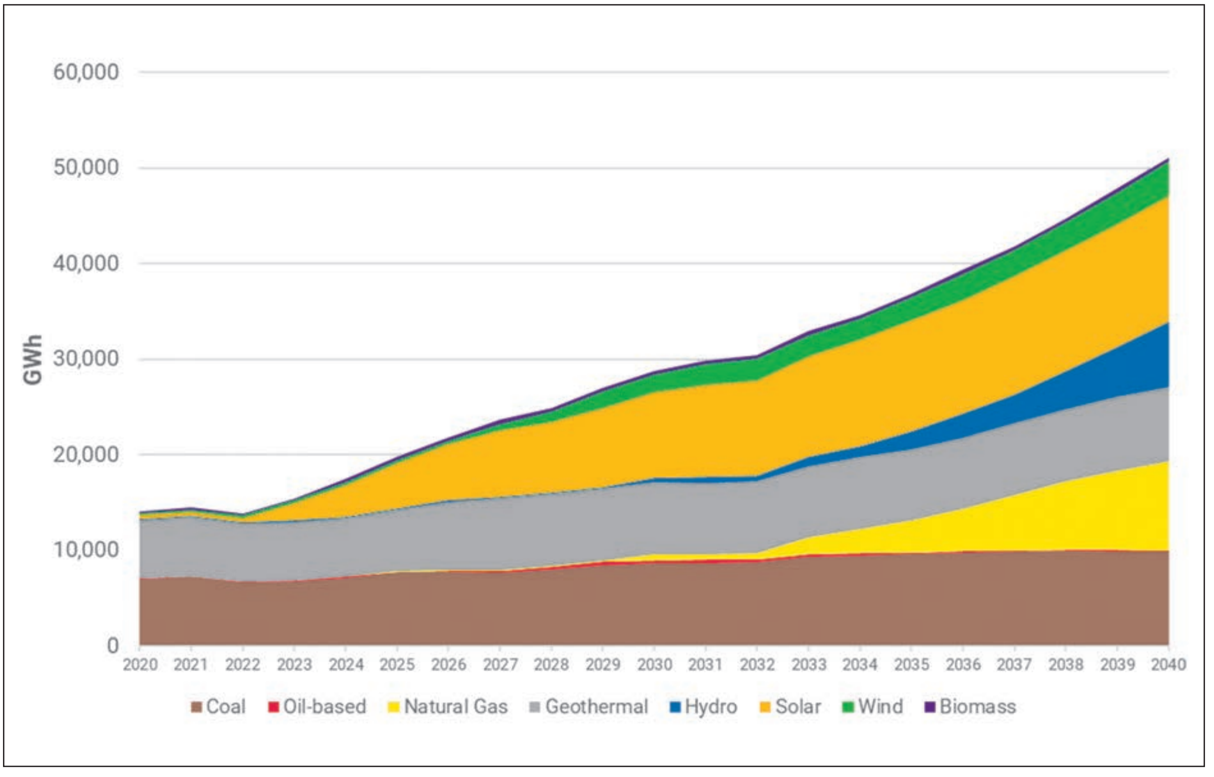


***Figure 49.** Visayas Power Generation (RE 35% by 2030)*

MINDANAO

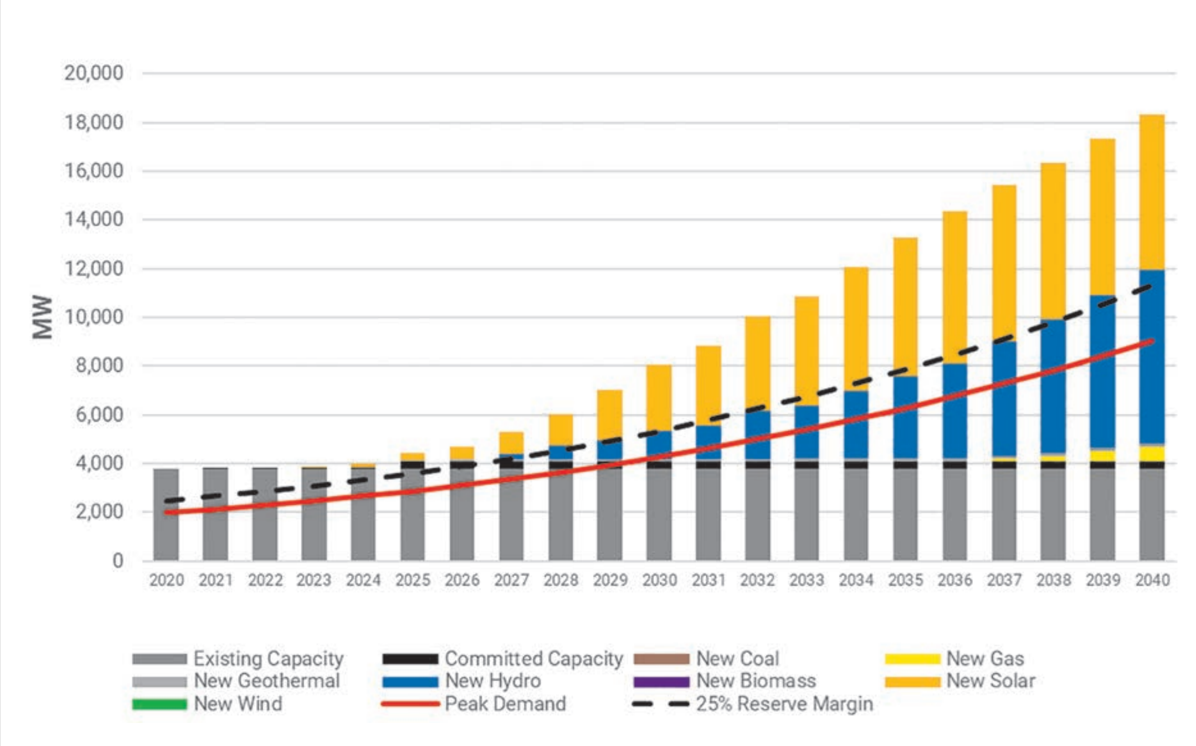


***Figure 50**. Mindanao Power Outlook (RE 35% by 2030)*

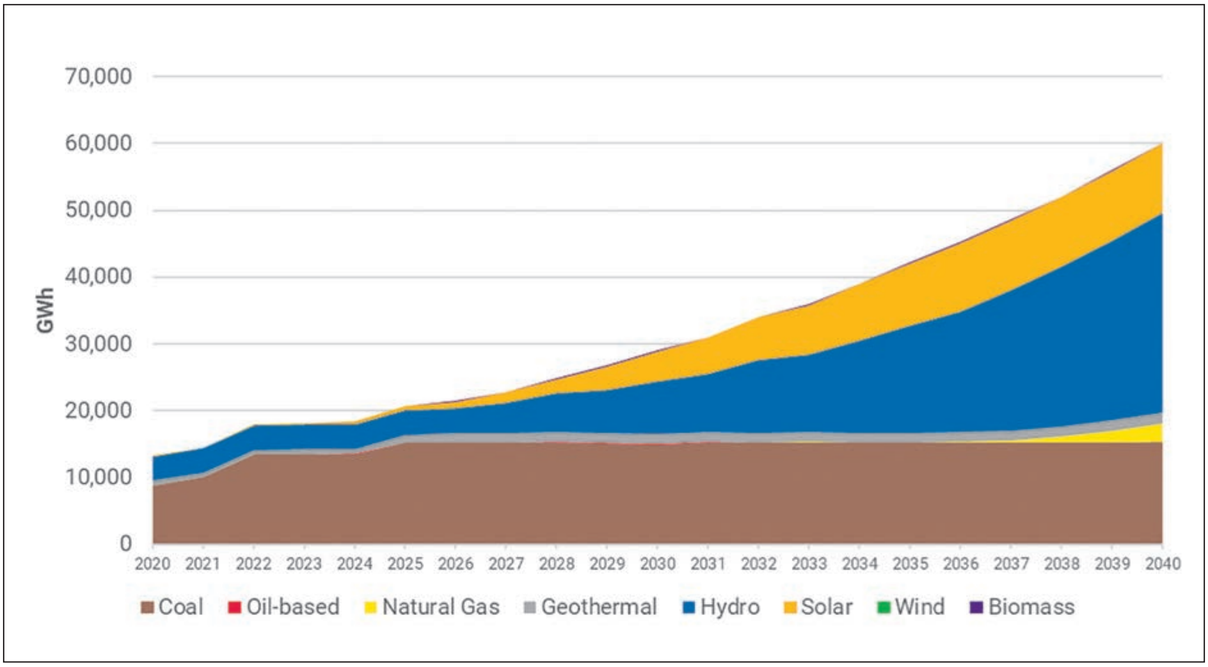


***Figure 51.** Mindanao Power Generation (RE 35% by 2030)*

PHILIPPINES' POWER OUTLOOK (50% RE TARGET BY 2040 – HIGH DEMAND)

Using Scenario 4 - RE target of 50% by 2030 and high demand forecast, the total capacity by 2040 for the entire country will be at 114,601 MW with a corresponding annual peak demand of 54,655 MW. RE energy production from 2030 to 2040 linearly increases from 35% to 50%. Energy share from natural gas will increase to 27% while coal generation will be reduced to 23% by 2040.

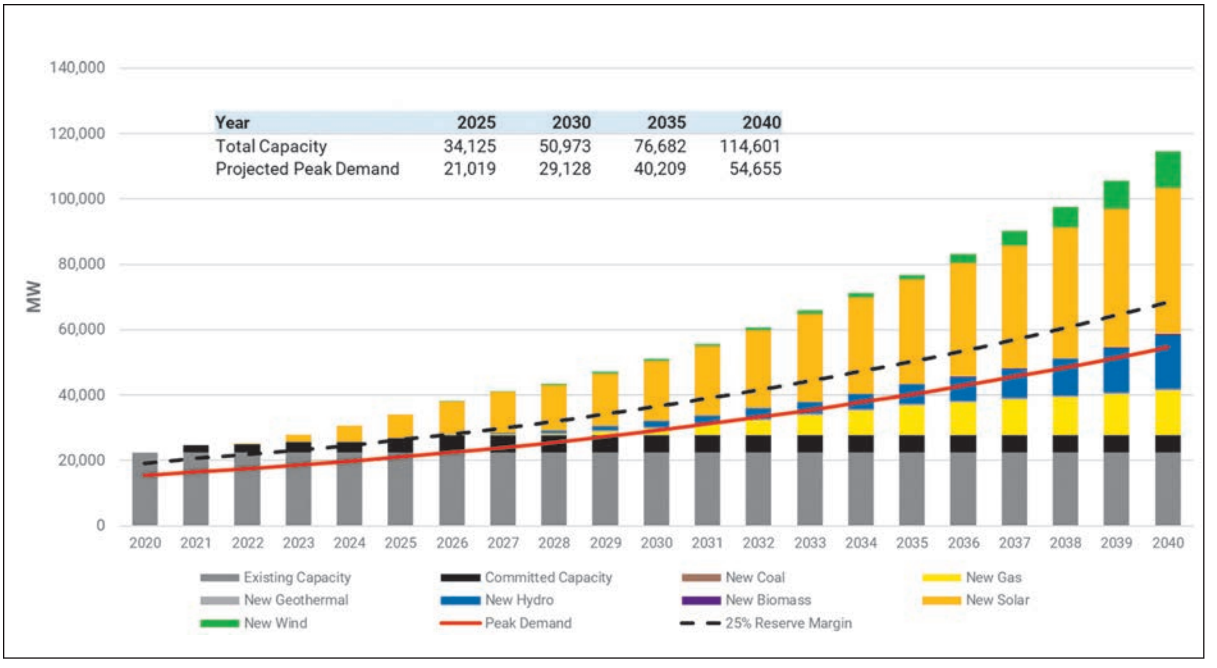


Figure 52. *Philippines Power Outlook (RE 50% by 2040)*

Plant Type	2020	2025	2030	2035	2040
Power Generation in GWh					
Coal	57,040	87,183	87,784	87,717	84,348
Oil-based	69	77	954	332	549
Natural Gas	20,291	13,725	37,575	72,855	97,301
Renewable Energy	24,569	39,273	68,016	107,270	182,198
Geothermal	12,821	13,879	15,633	15,628	15,962
Hydro	8,623	8,865	15,889	30,554	65,885
Solar	988	13,614	32,062	54,512	75,148
Wind	1,360	1,775	3,291	5,231	22,723
Biomass	778	1,140	1,141	1,345	2,480
Total	**101,969**	**140,258**	**194,330**	**268,175**	**364,396**

Plant Type	2020	2025	2030	2035	2040
Power Generation in Percent Share					
Coal	56	62	45	33	23
Oil-based	0	0	0	0	0
Natural Gas	20	10	19	27	27
Renewable Energy	24	28	35	40	50
Geothermal	13	10	8	6	4
Hydro	8	6	8	11	18
Solar	1	10	16	20	21
Wind	1	1	2	2	6
Biomass	1	1	1	1	1
Total	**100**	**100**	**100**	**100**	**100**

Table 34. *Philippines Power Generation (RE 50% by 2040)*

The following figures show the regional Power Outlook under Scenario 4:

LUZON

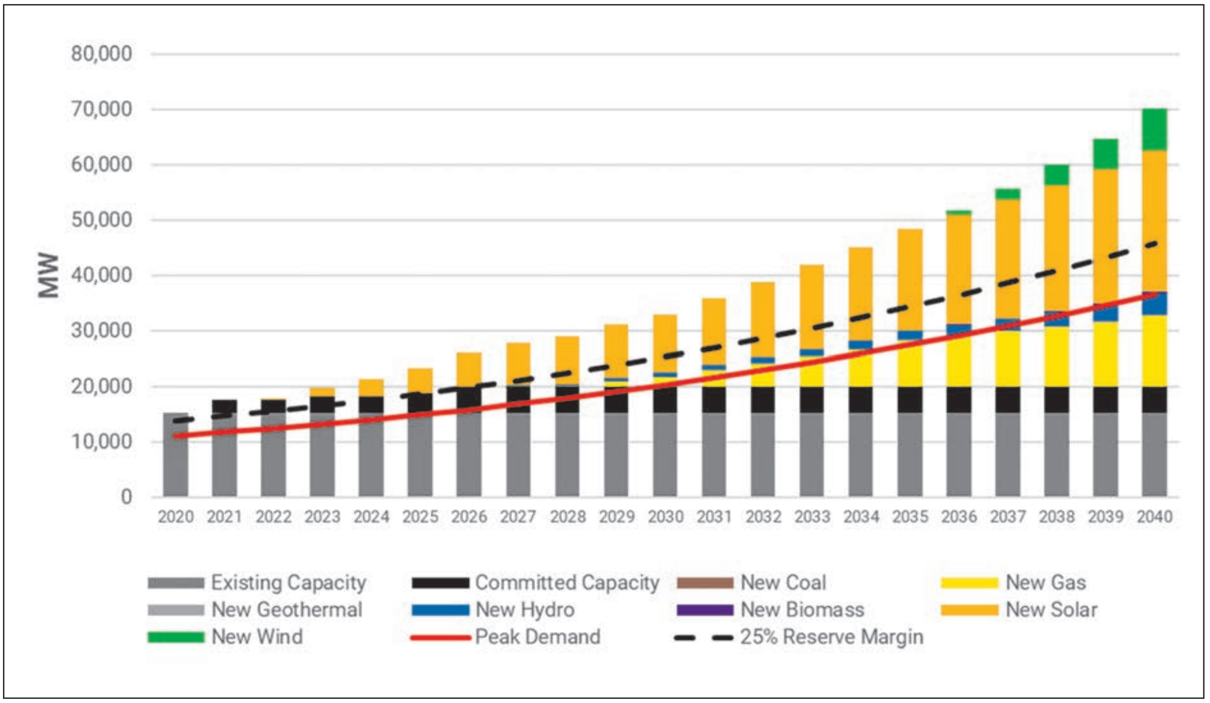


Figure 53. *Luzon Power Outlook (RE 50% by 2040)*

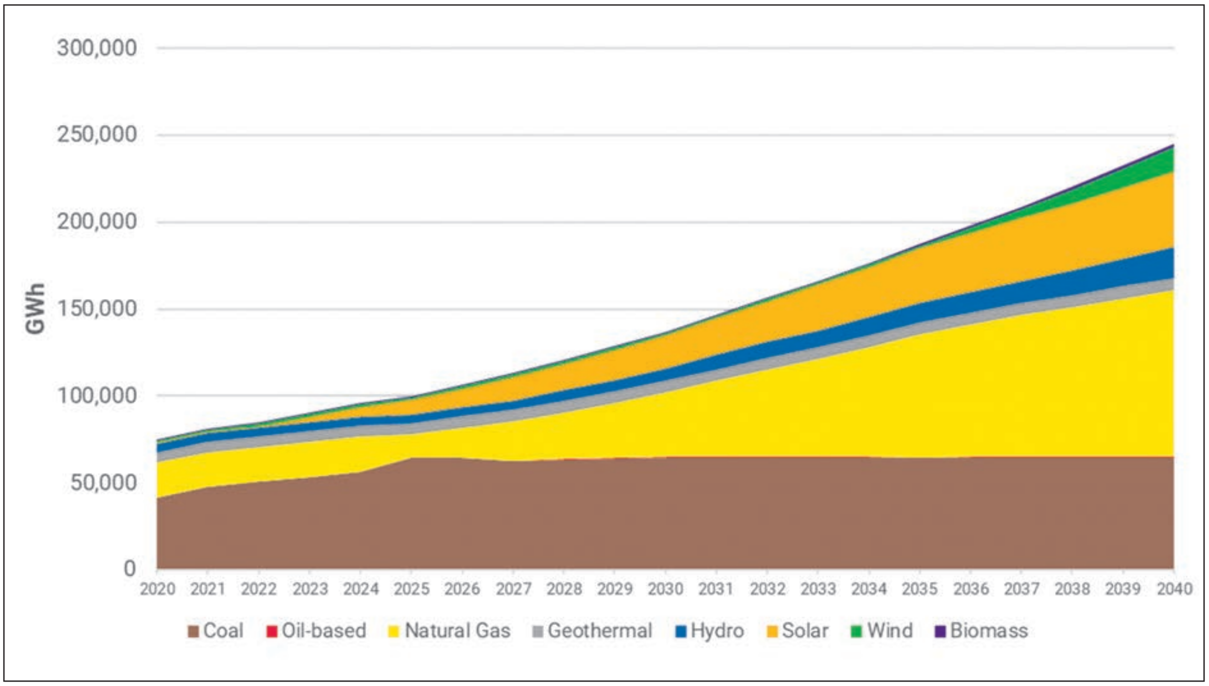


***Figure 54**. Luzon Power Generation (RE 50% by 2040)*

VISAYAS

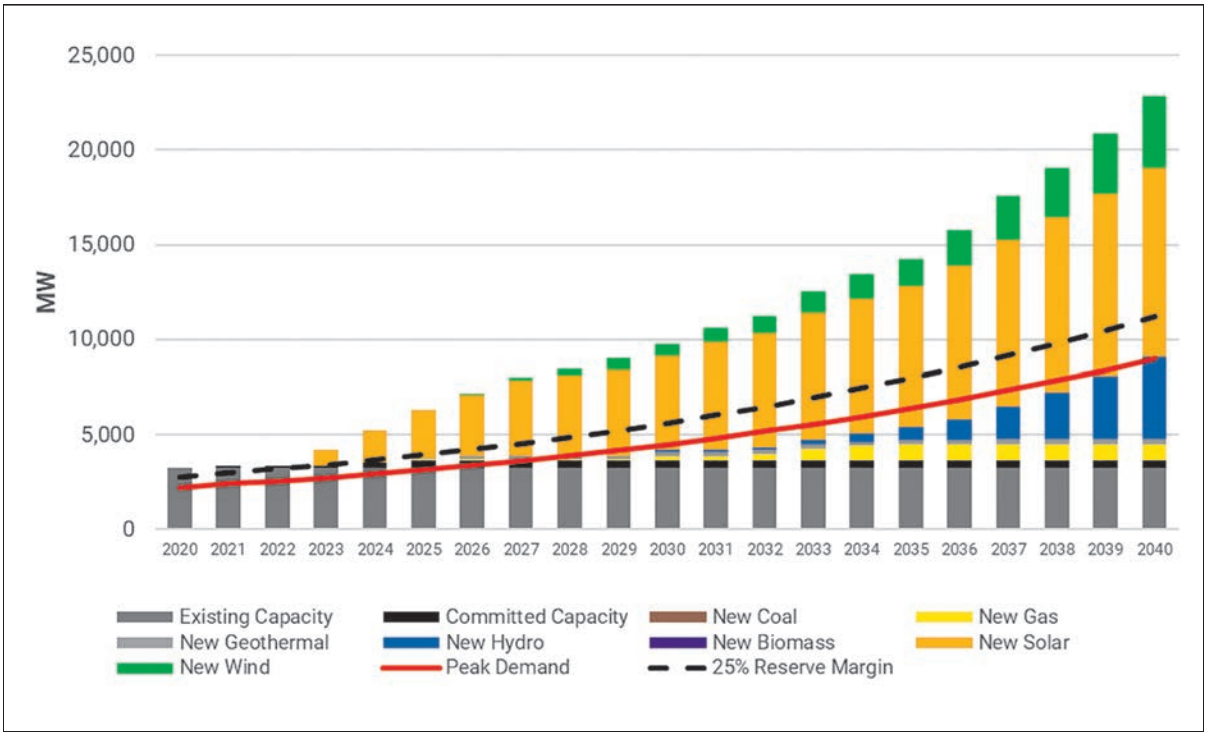


***Figure 55.** Visayas Power Outlook (RE 50% by 2040)*

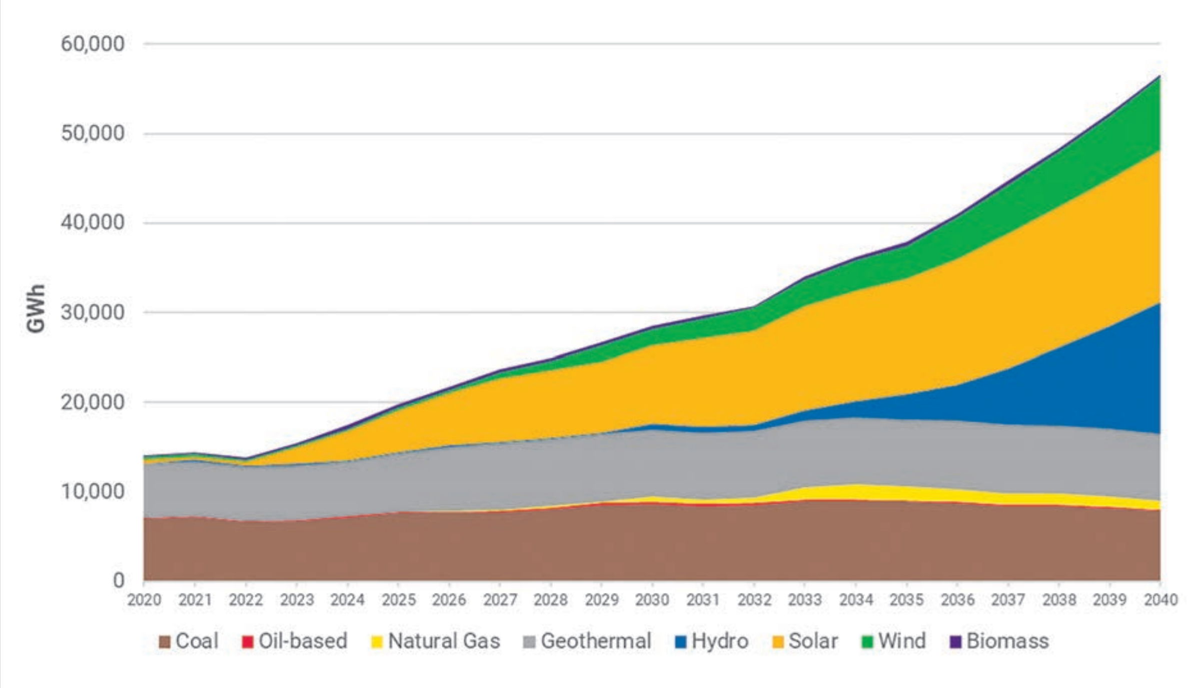


Figure 56. *Visayas Power Generation (RE 50% by 2040)*

MINDANAO

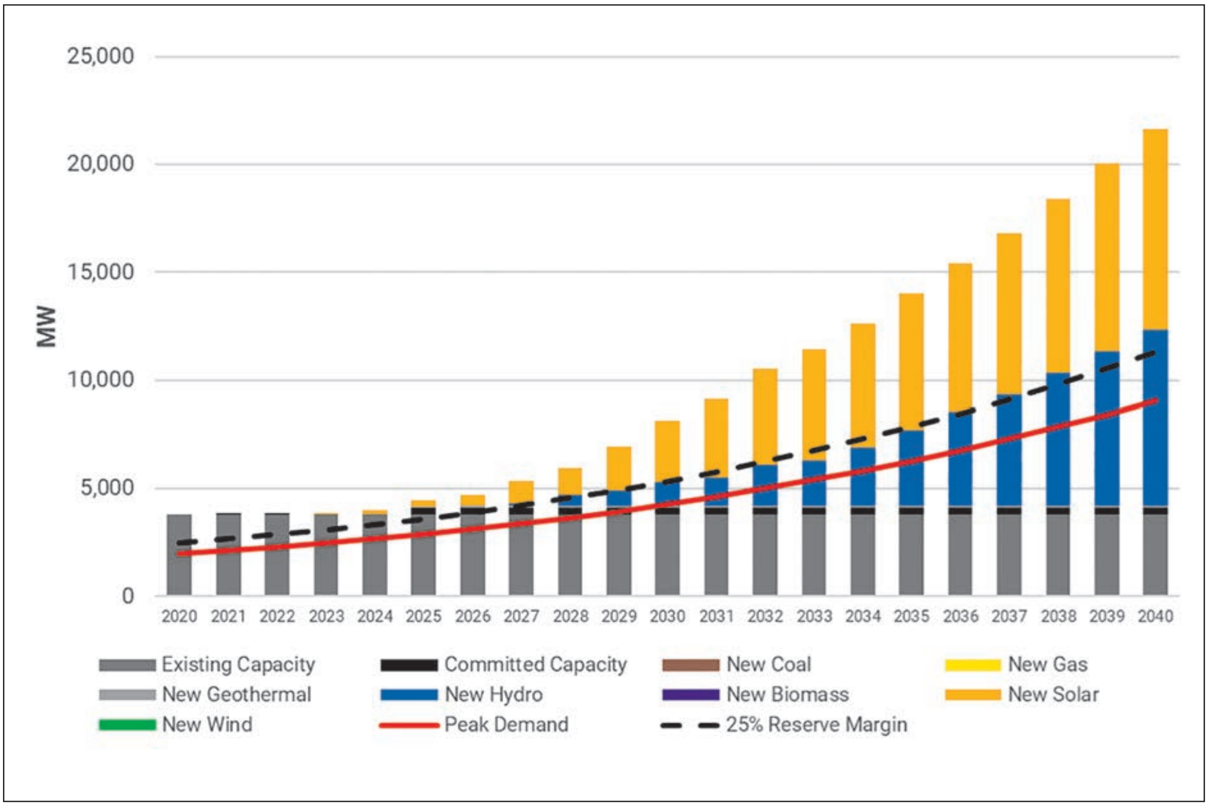


Figure 57. *Mindanao Power Outlook (RE 50% by 2040)*

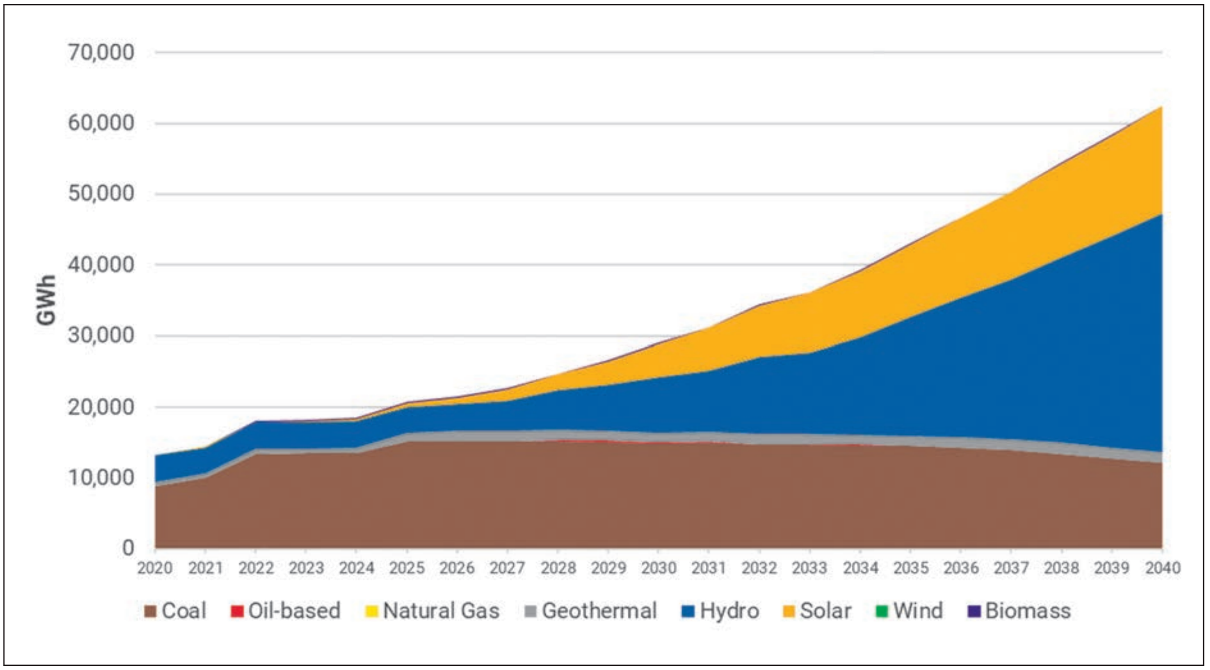


Figure 58. *Mindanao Power Generation (RE 50% by 2040)*

VIII. POWER OUTLOOK ASSESSMENT USING LOAD DURATION CURVE ANALYSIS

This section aims to evaluate the projected capacities and demand as indicated in the DOE's Philippine Development Plan (PDP) 2020-2040 Power Outlook using the Load Duration Curve analysis. This is in consideration of DOE's target of 35% renewable energy mix in 2030 and 50% in 2040.

To carry out the projections, the Annual Peak Demand Forecast using the DOE's PDP 2020-2040 and DOE's Committed and Indicative Power Projects updated as of March 2022 were considered and assessed.

The MW requirements per region were calculated using the following formula:

- Base Load = minimum demand level over the entire year
- Intermediate = demand level that is higher than the base load but lower than the peak demand. It is estimated to be equivalent to the annual peak less the sum of the base load and peak demand
- Peak = highest demand level and is estimated to be equivalent to 15% of the annual peak demand

Furthermore, using the existing WESM registered capacity and additional capacities based on DOE, the projected capacity is compared with the MW requirement per load level (base load, intermediate, or peak). The total projected capacity for each load level is also estimated using its plant's availability factor for the year 2022.

In the following figures and tables, the plants are classified in accordance with these categories:

- Base Load – Coal and Geothermal
- Intermediate – Natural Gas
- Peak – Oil-Based, Hydro and BESS
- Renewable Energy – Solar, Wind, Biomass and Run-of-river

Note that Solar and Wind power plants are also used for intermediate loading.

The figure below is a sample illustration of Load Duration Curve on obtaining base, intermediate and peak MW requirements:

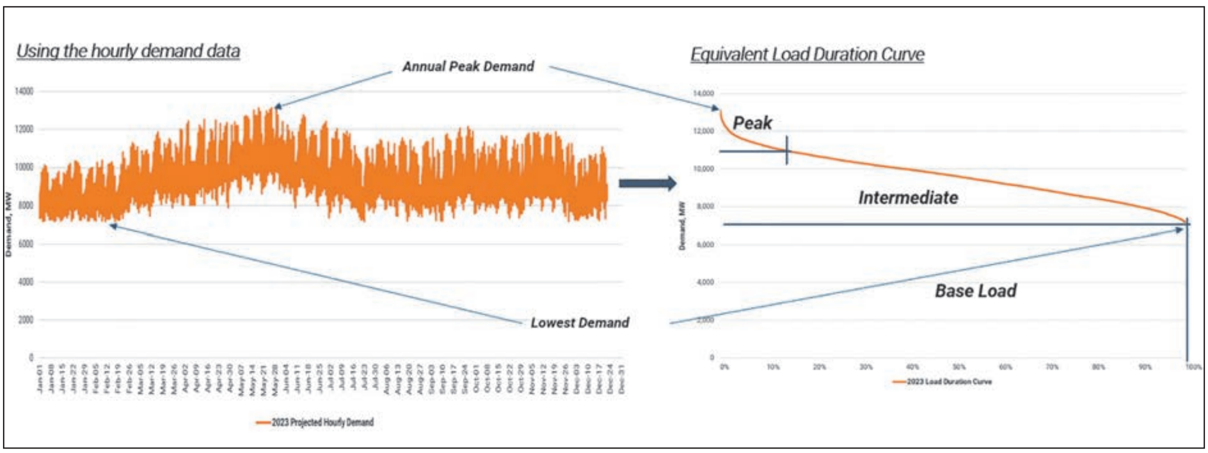


Figure 59. *Illustration of Load Duration Curve*

LUZON

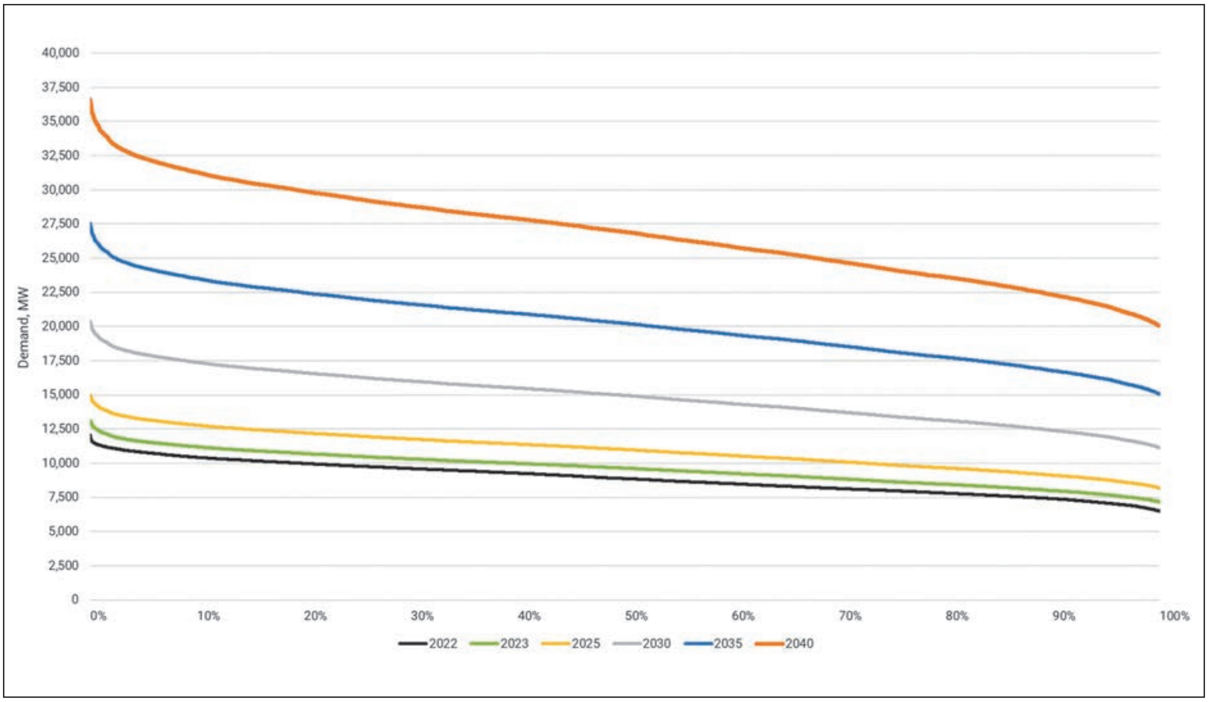


Figure 60. *Luzon Load Duration Curve*

	2022	2023	2025	2030	2035	2040
ANNUAL PEAK DEMAND	12,041	13,125	14,978	20,358	27,532	36,631
PEAK MW REQUIREMENT [A]	1,806	1,969	2,247	3,054	4,130	5,495
INTERMEDIATE MW REQUIREMENT [B]	3,734	3,975	4,536	6,165	8,338	11,093
BASE LOAD MW REQUIREMENT [C]	6,501	7,181	8,195	11,139	15,064	20,043
TOTAL MW REQUIREMENT [D=A+B+C]	12,041	13,125	14,978	20,358	27,532	36,631
PEAK MW CAPACITY [E]	4,320	4,809	6,395	9,379	12,029	12,529
INTERMEDIATE MW CAPACITY [F]	3,286	3,936	5,248	6,448	6,448	6,448
BASE LOAD MW CAPACITY [G]	9,190	9,699	11,537	12,517	12,557	12,557
RENEWABLE ENERGY CAPACITY [H]	1,460	2,202	7,784	18,949	18,949	18,949
TOTAL MW CAPACITY [I=E+F+G+H][1]	18,255	20,645	30,964	47,293	49,983	50,483
PEAK MW CAPACITY x AVAILABILITY FACTOR [J]	2,939	3,081	3,642	5,731	7,586	7,936
INTERMEDIATE MW CAPACITY x AVAILABILITY FACTOR [K]	2,793	3,345	4,461	5,481	5,481	5,481
BASE LOAD MW CAPACITY x AVAILABILITY FACTOR [L]	8,559	9,031	10,773	11,678	11,708	11,708
RENEWABLE ENERGY CAPACITY with AVAILABILITY FACTOR [M]	431	595	1,847	5,300	5,300	5,300
TOTAL MW CAPACITY with AVAILABILITY FACTOR [N=J+K+L+M]	14,723	16,052	20,723	28,190	30,075	30,425

Table 35. *Luzon Grid Capacity Assessment*

Overall, the total projected capacity is sufficient to support the peak demand requirement every year. Luzon has adequate base load capacities until 2030 but will become insufficient towards 2040. The projected intermediate MW capacity with availability consideration is lower than the intermediate MW requirement of the grid since the total new natural gas capacity is only 3,163 MW. Meanwhile, more peaking plants will augment the supply in Luzon with a projected capacity higher than its peaking requirement.

VISAYAS

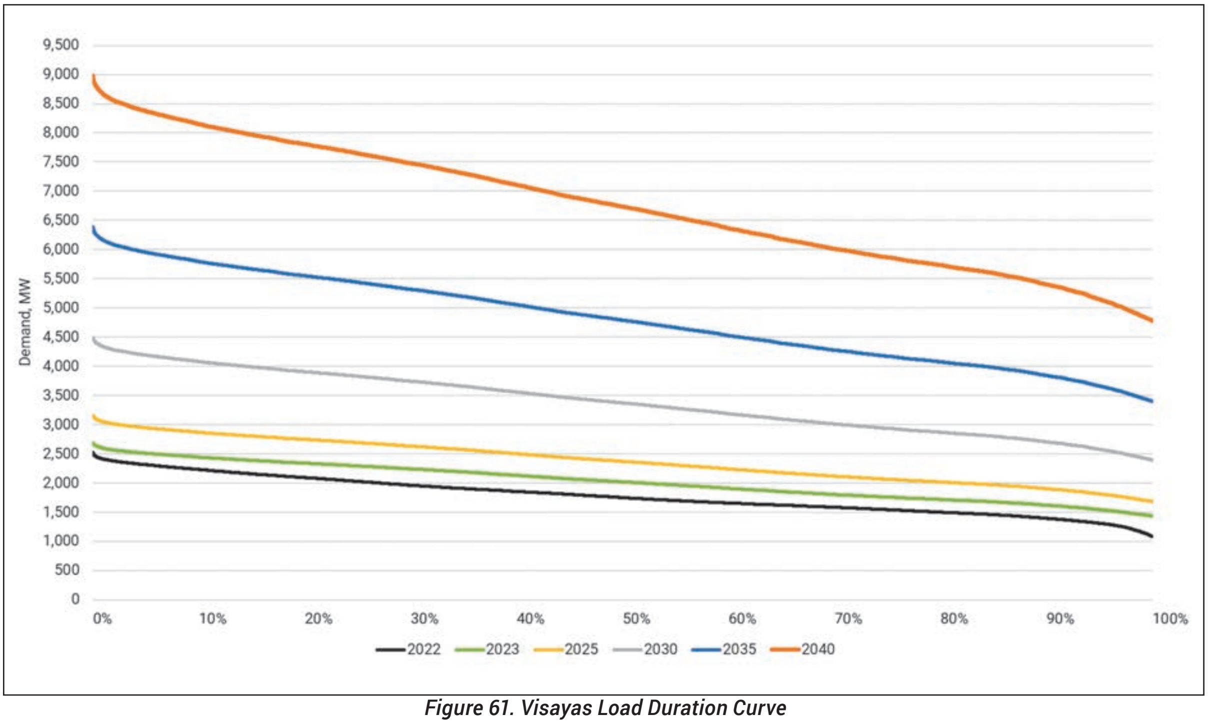


Figure 61. Visayas Load Duration Curve

	2022	2023	2025	2030	2035	2040
ANNUAL PEAK DEMAND	2,528	2,691	3,160	4,495	6,387	8,982
PEAK MW REQUIREMENT [A]	379	404	474	674	958	1,347
INTERMEDIATE MW REQUIREMENT [B]	1,069	855	1,004	1,429	2,030	2,855
BASE LOAD MW REQUIREMENT [C]	1,080	1,432	1,682	2,392	3,399	4,780
TOTAL MW REQUIREMENT [D=A+B+C]	2,528	2,691	3,160	4,495	6,387	8,982
PEAK MW CAPACITY [E]	624	871	1,284	1,619	1,619	1,619
INTERMEDIATE MW CAPACITY [F]	0	0	0	0	0	0
BASE LOAD MW CAPACITY [G]	2,284	2,284	2,653	2,685	2,685	2,685
RENEWABLE ENERGY CAPACITY [H]	735	786	1,257	3,967	3,967	3,967
TOTAL MW CAPACITY [I=E+F+G+H][1]	3,643	3,942	5,194	8,272	8,272	8,272
PEAK MW CAPACITY x AVAILABILITY FACTOR [J]	407	504	617	852	852	852
INTERMEDIATE MW CAPACITY x AVAILABILITY FACTOR [K]	0	0	0	0	0	0
BASE LOAD MW CAPACITY x AVAILABILITY FACTOR [L]	1,990	1,990	2,321	2,345	2,345	2,345
RENEWABLE ENERGY CAPACITY with AVAILABILITY FACTOR [M]	228	249	378	1,270	1,270	1,270
TOTAL MW CAPACITY with AVAILABILITY FACTOR [N=J+K+L+M]	2,626	2,743	3,315	4,466	4,466	4,466

Table 36. *Visayas Grid Capacity Assessment*

In Visayas, the total projected capacity is sufficient until 2025 and additional capacities will be needed starting 2030. There is an ample base load capacity until 2025 but this will become insufficient thereafter. There is no allotted capacity for intermediate loading in Visayas. Moreover, the peaking plants' capacity is higher than its requirement until 2030 but this will become lesser after that period.

MINDANAO

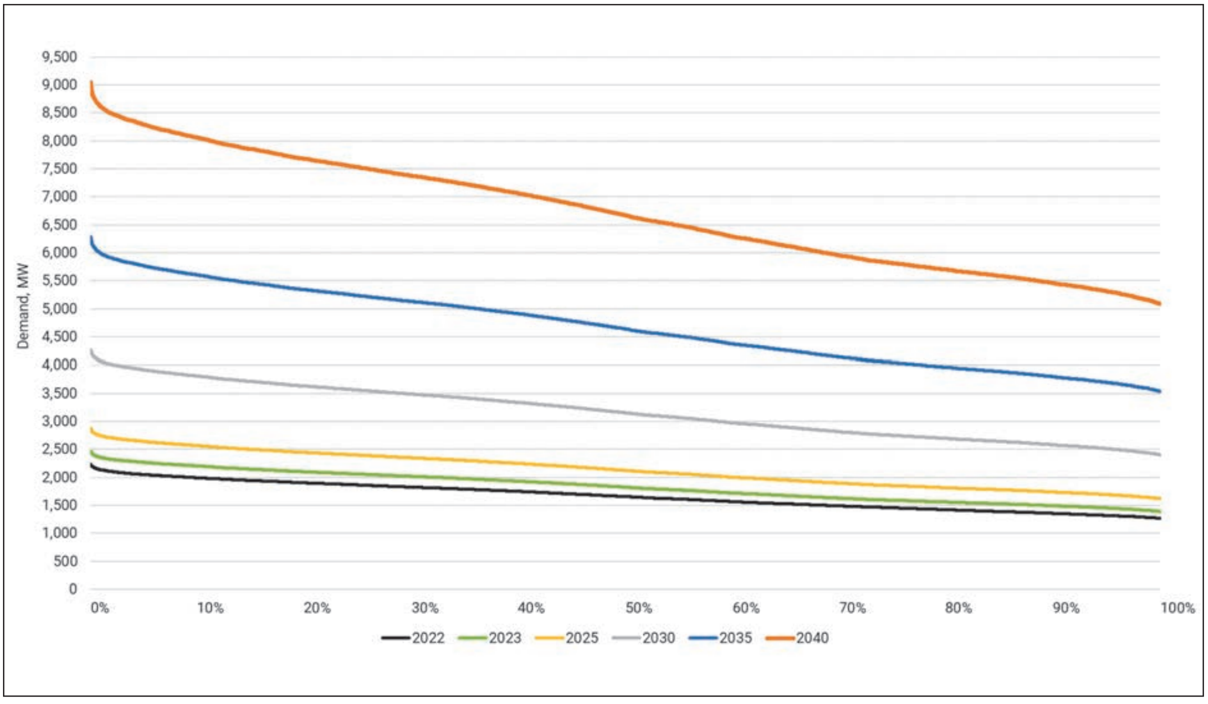


Figure 62. *Mindanao Load Duration Curve*

	2022	2023	2025	2030	2035	2040
ANNUAL PEAK DEMAND	2,243	2,474	2,881	4,275	6,290	9,042
PEAK MW REQUIREMENT [A]	336	371	432	641	944	1,356
INTERMEDIATE MW REQUIREMENT [B]	634	710	827	1,228	1,806	2,596
BASE LOAD MW REQUIREMENT [C]	1,272	1,393	1,622	2,406	3,540	5,089
TOTAL MW REQUIREMENT [D=A+B+C]	2,243	2,474	2,881	4,275	6,290	9,042
PEAK MW CAPACITY [E]	1,590	1,637	1,862	2,264	2,514	2,514
INTERMEDIATE MW CAPACITY [F]	0	0	0	600	600	600
BASE LOAD MW CAPACITY [G]	2,370	2,370	2,760	2,760	2,760	2,760
RENEWABLE ENERGY CAPACITY [H]	273	292	319	451	451	451
TOTAL MW CAPACITY [I=E+F+G+H][1]	4,232	4,299	4,941	6,075	6,325	6,325
PEAK MW CAPACITY x AVAILABILITY FACTOR [J]	1,093	1,116	1,198	1,480	1,655	1,655
INTERMEDIATE MW CAPACITY x AVAILABILITY FACTOR [K]	0	0	0	510	510	510
BASE LOAD MW CAPACITY x AVAILABILITY FACTOR [L]	2,230	2,230	2,601	2,601	2,601	2,601
RENEWABLE ENERGY CAPACITY with AVAILABILITY FACTOR [M]	83	92	98	131	131	131
TOTAL MW CAPACITY with AVAILABILITY FACTOR [N=J+K+L+M]	3,406	3,439	3,897	4,722	4,897	4,897

Table 37. *Mindanao Grid Capacity Assessment*

The total projected capacity in Mindanao is sufficient until 2030 but additional capacities will be needed after 2030. Base load capacity is adequate until 2030 but will become insufficient thereafter. Like in Visayas, there is no intermediate capacity for Mindanao until 2025. Meanwhile, more peaking plants will support the supply in Mindanao with a projected capacity higher than its peaking requirement.

CONCLUSIONS AND RECOMMENDATIONS

I. SUPPLY RELIABILITY AND SECURITY

A. SHORT TERM

1. Review Regulation of Generator Performance

The study shows a significant gap between the registered capacity of generators vis-à-vis their availability and dispatchability. To address this, it is recommended for the ERC to ensure strict compliance by generators with relevant policies, rules, and regulations. Moreover, the review of existing policies, rules, and regulations governing generator performance is crucial to ensure that it is relevant, updated, and appropriate for each specific technology.

It is also imperative that an enforcement criteria, appropriate for each generator technology, be established to help ensure the reliability of all generators.

2. Conduct Holistic Generation Planning

In determining the optimal generation mix and transmission developments, it is recommended for the government to conduct holistic generation planning in harmony with the country's renewable energy targets.

This includes integrating generation planning into the power development plan to optimize the country's generation mix to promote energy affordability and reliability. It is also important for the transmission development plan to be harmonized with medium to long-term generation planning.

In view of the country's aging plants, generation planning should also include solutions to retire old power plants and replace them with more efficient technologies. Moreover, the country's unique archipelagic geography should also be considered such that the optimal size and locations of plants will be achieved while taking into account power system reliability and transmission constraints.

Exist Software Labs, Inc.: A world-class system for a stable, more secure electricity market

IEMOP officially launched the Central Registration Settlement System (CRSS) developed by Exist Software Labs, Inc.

Photo shows Willex Perez, vice-president of sales and marketing at Exist Software Labs, Inc., during the Future Energy Show, the largest energy event in the country.

A popular quote in business attributed to author Michael Gerber goes, "Systems run the business and people run the systems." Indeed, this holds true not only in business, but in government and society as a whole. Every country that has public services, healthcare, tourism, and more depends on systems and the people running those systems to keep things going.

In the Philippines, for example, the Wholesale Electricity Spot Market (WESM), as a centralized venue for buyers and sellers to trade electricity as a commodity where prices are determined based on actual use (demand) and availability (supply), is an integral part of the energy sector. Given its significance and its demands, the WESM needs a robust, efficient systems platform in which it can run its day-to-day operations.

This is where Exist Software Labs, Inc. came in. The Independent Electricity Market Operator of the Philippines (IEMOP), the operator of WESM, required a technology platform to put its goal of reforming the electricity sector through market liberalization and retail competition into action.

Exist mobilized all of its top resources to ensure the delivery of an innovative platform that helped IEMOP energize its vision of achieving full automation for all of its processes, developing and implementing the Central Registration and Settlement System (CRSS), an enterprise system that improves market WESM processes such as registration, metering, billing, and settlement.

The CRSS was engineered to facilitate timely and updated participants' registration and trading information for the WESM, and to ensure their transactions are processed quickly and accurately through a user-friendly interface. It also comes with security features that safeguard their data against fraud or theft.

"We create ground-up development, making it adaptable to any requirements they may have. A highly scalable system allows them to add features and users easily as their company grows. Companies can achieve high resiliency with our system, allowing them to focus on running their business," Exist said.

"Our software is designed to help them streamline processes and increase efficiency. Automating their system will help them achieve easy billing and trading monitoring, forecasting accuracy, payment and collection management, and much more."

This is an expertise borne of experience. Since 2001, Exist Software Labs has helped top global enterprises with their operations by providing the latest cutting-edge technologies solutions and services through consulting and software development services, and assisting in their digitalization and cloud transformation journey. Exist so far has provided breakthrough solutions to vertical and domain in Banking and Finance, Healthcare, Retail, and Power.

With a diverse portfolio and experience in multiple successful large-scale projects, Exist now empowers enterprises from Philippines, Asia Pacific, Australia, Japan, and the United States to transform and build a sustainable advantage through software innovations.

"With over 20 years of experience, we custom-build and develop end-to-end enterprise systems for both major energy utility organizations such as Philippine Electricity Market Corporation (PEMC) and Independent Electricity Market Operator of the Philippines (IEMOP) as well as other power generation and distribution companies. We stand ready and prepared to help more energy companies of the future in transforming their business to achieve higher efficiencies, super agility and harness the maximum potential of an integrated market system," Exist said.

Exist has fully committed to the development of the country's energy future, from its monitoring of developments in renewable energy implementation abroad to participating in the Philippines' development of its own renewable energy industry.

In fact, Exist has also created the Philippine Renewable Energy Market System (PREMS), an enterprise platform that manages all market processes for the Philippine renewable energy market and the Billing and Settlement System for Power Generators, a billing and settlement system for power generators that simplify management of energy contracts to process billing and documentation of energy information.

"These innovative platforms and systems are developed and designed to promote transparent transactions and drive efficiency in the power sector," Exist said.

"As new energy sources, market dynamics, regulatory factors, and the rapid technological advancement are disrupting the energy landscape, Exist Software labs can help bring agility and innovations into Energy Utility Enterprises to succeed in digital power era."

This hands-on approach keeps Exist's power system solutions always up to date and ensures that they can easily adapt to the changing needs of the market.

"We monitor general vertical developments in the country and abroad, technology trends, government policy for the industry, and market player advancements. Our software services are constantly updated to reflect the most recent industry trends, so our clients can be assured that their company is always ahead of the curve," the company said.

"WESM will continue to connect the entire Philippine Grid as the grid connection to Mindanao progresses, and renewable energy producers will grow as part of the government initiative. As these changes take place, Exist Software Labs, Inc., with its forefront system and advanced Information Technology experience, will put forth every effort to help Energy Companies with these developments and achieve digitalization by empowering their systems and processes."

B. MEDIUM TERM

1. Determine appropriate generation technology as baseload plants

The moratorium on coal-fired power plants, combined with the Philippines' commitment to achieving its 30% and 50% Renewable Energy targets by 2030 and 2040, respectively, requires the designation of appropriate generation technologies as baseload plants.

Like in Renewable Energy, Congress may also consider using fiscal and non-fiscal incentive mechanisms to accelerate the use and development of generation technologies. Currently, liquified natural gas (LNG) has the capability to act as both baseload and mid-merit plants. Therefore, exploration and further studies on the utilization and development of LNG may be beneficial to the country.

2. Implement Capacity Market

Building a new power plant is a highly capital-intensive business. Thus, the integration of capacity market in the WESM is expected to accelerate the development of new generation facilities in the grid by minimizing risks to the investors. Moreover, the proposed generation planning, current market rules and price signals will help ensure that the capacities to be added in the grid are optimal for supply security and reliability.

C. LONG TERM

1. Integration of Nuclear Power Plants to the Grid

Integrating Nuclear Power Plants (NPPs) to act as baseload plants will significantly improve grid supply reliability. However, adequate, reliable, and secured transmission backbone must be developed to support NPPs. In addition, proper sizing and identification of the ideal location of an NPP require intensive feasibility studies to ensure its safe operation and economic viability. Moreover, building NPPs is a highly capital-intensive business; thus, government participation is needed to accelerate its capital funding.

2. Government Participation in the Energy Sector

Given the importance of electricity as a commodity for economic development, the participation of the government in the energy industry is indispensable to achieve stability in the industry, expedite innovations, and promote competition. To achieve this, it is recommended that a review of the EPIRA be conducted so that amendments, if necessary, can be introduced to ensure the orderly and efficient participation of the government in the generation sector. Such participation may take the form of directly appropriating funds for building new generation facilities and guaranteeing loans for investors, among others.

II. ENERGY AFFORDABILITY

SHORT TERM

1. Review Subsidies

It is recommended that a thorough review of the current subsidies being implemented by the government be performed. If necessary for a short-term energy affordability solution, the government may consider providing further subsidies or expanding current ones, similar to the subsidies implemented by other jurisdictions, but subject to careful evaluation of the impact to consumption behavior and overall fiscal resources of the country.

2. Review Universal Charges

It is recommended that a review of the universal charges imposed to consumers be undertaken as well as to explore ways to pay these charges through other means. The universal charges in electricity include electrification charges, environmental charges, and stranded debts.

3. Review Regulation of Electricity Prices

Evaluating the current components of electricity prices, including incentives being paid by consumers, is likewise recommended. This is to ensure that charges are reasonable and just in accordance with the current factual circumstances and market conditions. The review must include: a) the costs contained in Power Supply Agreements, b)the Ancillary Services Procurement Agreement, c)incentive schemes for new and renewable energy technologies, d) transmission charges, and e) distribution charges.

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