



Consultation Draft

TRANSMISSION DEVELOPMENT PLAN 2014-2015

Volume I

MAJOR NETWORK DEVELOPMENT

DECEMBER 2015



NGCP

TRANSMISSION DEVELOPMENT PLAN

2014-2015

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FOREWORD

The National Grid Corporation of the Philippines (NGCP) is pleased to present its 2014-2015 Transmission Development Plan (TDP) which strategically lays out, over a 10-year period, the expansion of the Philippine power grid. This is part of its continuous efforts to provide reliable, adequate, secure, and stable power transmission to its customers and stakeholders.

Other than the status of the approved projects for the 3rd Regulatory Period, the 2014-2015 TDP contains the list of proposed transmission projects for the next ten years. The list includes the crucial projects scheduled for implementation in the 4th Regulatory Period.

In Luzon, the additional major projects already approved by the ERC, some already ongoing implementation, are the new Calaca-Dasmariñas Transmission Line Project which aims to accommodate the generation capacity additions in Batangas; the Las Piñas Substation Expansion Project which involves the installation of an additional transformer to support load growth in Metro Manila; and the Tuguegarao-Lal-lo 230 kV Transmission Line Project which will extend the 230 kV transmission backbone to the north-eastern part of Luzon. Positively, the San Esteban-Laoag 230 kV T/L project was already energized which allows full dispatch of the wind farms in northernmost part of Luzon.

NGCP is also giving special attention to increase the capacity and improve system reliability of the transmission facilities in the country's load center in Metro Manila. New substations in Navotas/Manila, Pasay, and Taguig and associated transmission lines have been proposed to support the load growth and to strengthen the Metro Manila grid by forming loop configurations.

In the Visayas, where the Cebu-Negros-Panay 230 kV Backbone Project is already being implemented, more projects that will support the entry of generators are also in the pipeline. These projects will ensure the long-term security of power transmission in the Visayas and strengthen NGCP's transmission facilities to accommodate incoming generating plants that will cater to the region's growing power demand.

In Mindanao, NGCP focuses on generation entry-driven transmission projects in consideration of the region's power situation. These projects will ensure that Mindanao's transmission system is stable, efficient and reliable to support new generation facilities that will augment Mindanao's power supply.

Major projects include the Malita-Matanao 230 kV Transmission Line Project and the Balo-i-Kauswagan 230 kV Transmission Line Project which will support the entry of the new coal-fired power plants in Mindanao. Another noteworthy undertaking is the Mindanao 230 kV Transmission Backbone Project which will enable higher transfer capability of the existing transmission lines and support the impending entry of huge capacity power plants. More importantly, this project is expected to play a vital role in the exchange of power between Visayas and Mindanao in consideration of the proposed Visayas-Mindanao Interconnection Project.

The TDP also includes the transmission planning approach for renewable energy (RE) particularly, wind and solar. The challenges for integration are discussed in this TDP as well as corresponding action plan of NGCP to fully support the development of RE.

The TDP is a valuable document for industry stakeholders. As the country's sole power grid operator and transmission service provider, it continues to improve the quality of its transmission planning process through constant collaboration with the Department of Energy, generation facilities, power customers, distribution utilities, local government units, and the general public. Their inputs are carefully considered in each year's comprehensive and responsive TDP.

The long-term projects contained in the TDP are expected to improve NGCP's transmission services. With the support and engagement of stakeholders in the development of this document, NGCP is ensured of the smooth implementation of its plan towards a "Stronger Transmission for a Stronger Nation."

HENRY T. SY, JR.
President & CEO

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1.1 Introduction

NGCP's transmission system network consists of 500 kV, 350 kV HVDC, 230 kV, 138 kV, 115 kV and 69 kV high voltage lines and cables. As sole transmission service provider, NGCP plays a vital role in the safe and reliable transmission of electricity in response to system requirements and market demands. It continues to improve the reliability, adequacy, security and stability of the grid in the three major regions of the Philippines, namely: Luzon, the Visayas and Mindanao.

As system operator of the Philippine power grid, NGCP balances the supply and demand of electricity to efficiently serve all of its customers – power generators, private distribution utilities, electric cooperatives, government-owned utilities, eco-zones, industries, as well as directly connected companies. It is responsible in dispatching the power plants and transmitting the generated power to the various distribution utilities which, in turn, deliver the electricity at a lower voltage rating to households and other end-users. NGCP also operates and maintains metering facilities and provides technical services, particularly system studies, and operation and maintenance of customer facilities.

This Transmission Development Plan (TDP) outlines the planned projects which are required to address the system needs for the period 2016 to 2025.

1.2 NGCP as a Regulated Entity

With the enactment of the EPIRA into a law in June 2001, the Philippine Electricity Industry was subdivided into four sectors: generation, transmission, distribution and supply. Each sector is distinguished as different business activity. The transmission and distribution sectors exhibit natural monopoly characteristics, hence these are regulated. Generation and supply or the aggregators for the sale of electricity, on the other hand, operates under a competitive environment.

As the transmission service provider, NGCP is regulated under the performance-based regulation (PBR). The PBR is a form of utility regulation that strengthens the financial incentives to provide efficient service. The PBR methodology is outlined in the Rules for Setting Transmission Wheeling Rates or RTWR.

In its continuing effort to provide quality and efficient service, NGCP received its Integrated Management System (IMS) recertification on May 11, 2015 from TUV Rheinland Philippines, a third-party auditing firm specializing in international standards accreditation. The country's sole transmission service provider and power system operator was certified in three management systems: Quality Management System – ISO 9001:2008, Occupational Health and Safety Management System – OHSAS 18001:2007 and Environmental Management System – ISO 14001:2004 + Cor.1:2009.

The 2014-2015 TDP consists of three volumes. Volume I contains the proposed grid expansion and upgrades, which generally, are based on the results of system studies. The other volumes outline the capital expenditure programs of Operations and Maintenance (Volume II–Part 1) and

System Operations (Volume III). Those for metering services have been integrated into Volume II but in a separate report (Volume II-Part 2).

Volume I consists of ten chapters.

- Chapter 1** provides an overview of NGCP organization and operation as transmission service provider and a regulated entity;
- Chapter 2** discusses the steps in the TDP Volume 1 Preparation Process;
- Chapter 3** discusses the profile of each grid and the features of the existing transmission facilities;
- Chapter 4** presents the latest demand projections and generation capacity addition used by NGCP as inputs to the simulation studies to identify future transmission constraints and transmission expansions in each grid;
- Chapter 5** enumerates the ERC-approved projects in Luzon, the Visayas and Mindanao Grids that are in various stages of implementation;
- Chapter 6-9** discusses transmission outlook for 2016-2025 including discussion on project components and drivers for the proposed transmission projects for Luzon, the Visayas and Mindanao Grids including Major Island/Grid Interconnection projects; and
- Chapter 10** contains different appendices that include discussions on relevant topics such as the Prospective Plants, Variable Renewable Energy, Ideal Locations of Power Plants, and Grid Development Map.

2.1 TDP Process Flowchart

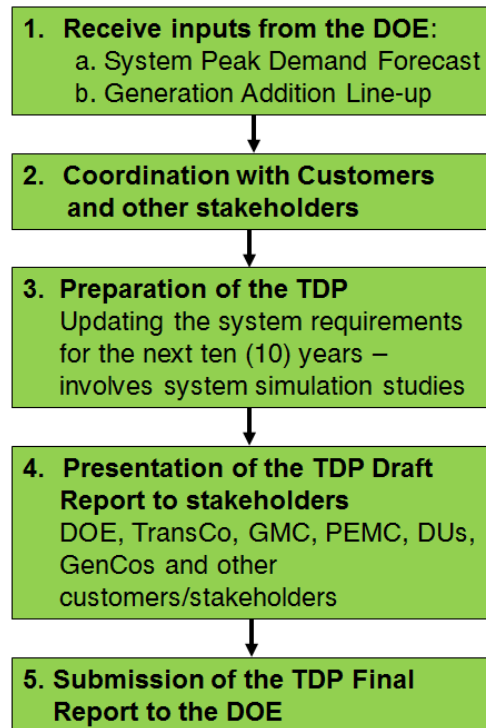


Figure 2.1 - TDP Preparation Process

2.2 Description of Each Steps

Step 1: Receive inputs from the DOE

The System Peak Demand Forecast and the Generation Capacity Addition Line-up are the two major inputs in the TDP which come from the DOE. These inputs are being updated annually by the DOE. For use in the transmission network analysis, the system peak demand forecast shall be broken down and forecasted into individual transformer loads. For determination of load-end substation expansion requirements, on the other hand, NGCP's own non-coincident substation peak loading forecast is being used.

Step 2: Coordination with Customers and other Stakeholders

One of the requirements of EPIRA as regards the preparation of the TDP is the conduct of consultation with the electric power industry participants. NGCP regularly conducts Customers Interface Meetings to gather inputs from the Distribution Development Plans of the Distribution Utilities, expansion programs of Generator Companies and other directly

connected customers. In addition, coordination meetings with other stakeholders are also being conducted.

Step 3: Preparation of the draft TDP

The identification of system requirements for the next ten years involves the conduct of load flow, short-circuit, and transient stability studies using special software in power system simulation. These assessments are made in reference to the planning criteria and limits prescribed in the Philippine Grid Code (PGC).

The system assessment takes off from the model of the existing transmission network. Then using the updated system peak load forecast, which is disaggregated into per substation transformer level and the recent list of generation capacity additions, the network model for the next ten-year period as covered by the TDP will be developed.

In conducting the simulation studies, different dispatch scenarios are considered. For Luzon Grid, the bulk generations are located in the northern and southern part of the island. Thus, the Maximum North, Maximum South, Typical Generation and Other Generation scenarios are considered. Maximum Leyte and Maximum Panay scenarios for the Visayas, and Maximum North and Dry Season scenarios for Mindanao.

Resulting transmission line loading, grid transformer loading, fault level at the substations, voltage profile and system response to disturbance can be evaluated. The next step would be the assessment of the various solutions to the identified network problem which may be in the form of a new transmission line, transmission line upgrading, new substation or substation expansion, PCB replacement, installation of reactive power compensation equipment, and/or transmission network reconfiguration project. One important consideration in the identification of projects is the overall long-term transmission backbone development for each grid. Some projects may have to be implemented by stages or may be initially energized at lower voltage level but will remain consistent with the target end-state of the grid. The selected solution from the network analysis will form part of the documentation of the TDP.

In the case of expansion plans for load-end substations, a direct comparison of the existing substation capacity and the load forecast would already result in the determination of capacity addition projects to meet load growth both during normal and single-outage contingency conditions of the transformers. The transformer addition projects, however, would also take into account the sizing and age of the existing units, optimization and the space limitation issues in a substation. Moreover, development of a separate new substation is also an option in lieu of further expanding the transformer capacity at the existing locations. Under this case, system simulation studies will be required to fully assess the need and impact of new substation nodes in the grid.

Step 4: Presentation of the TDP Draft Report to Stakeholders

This step is still part of the consultation process with the stakeholders as required by the EPIRA. Stakeholders are given the opportunity to raise comments and suggestions on the proposed transmission network developments as contained in the TDP.

Step 5: Submission of the TDP Final Report to the DOE

As provided in the EPIRA, the TDP shall be submitted to the DOE for approval and for integration in the Power Development Program (PDP) and the Philippine Energy Plan (PEP).

2.3 Use of the 2014-2015 TDP in the Regulatory Reset Application

The 2014-2015 TDP will serve as the reference plan in the Fourth Regulatory Period (2016-2020) reset application of NGCP. While the TDP already provides the long list of projects needed by the network, project prioritization and project ranking would be another important process and a separate exercise during the capital expenditure (CAPEX) application. This will involve further assessment on the probability of contingency events, assessment of the impact if a project is not implemented yet and economic analyses.

The proposed major transmission projects for the period 2016-2025 under the 2014-2015 TDP Volume 1, with components shown in Chapters 6, 7, 8 and 9, were based on the selected implementation scheme after considering all the technically feasible alternatives. The identification of project components would involve line routes, substation sites evaluation and selection, and other initial field investigations. A least-cost development approach was also applied consistent with various NGCP Planning and Design Standards utilizing the cost estimate database derived from recently completed projects and/or prices of materials and equipment obtained through canvass from suppliers.

Similar to the 2005 and 2009 TDPs which were used as references in the rate applications for 2nd and 3rd Regulatory Periods, respectively, the capital expenditures of NGCP for Major Network Development were included in the documentation of the 2014-2015 TDP Volume 1. However, a more detailed five-year CAPEX Program will be included in the 4th regulatory reset application together with other relevant information necessary for a more extensive review and evaluation by the ERC following the transparency provision for a prudent CAPEX in the RTWR.

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Chapter 3: Assessment of Transmission System

3.1 Grid Profile

As of August 2015, a total of 31,038 MVA substation capacities and 20,073 circuit-km are accounted in NGCP's asset. Table 3.1 shows the summary of existing facilities.

Table 3.1: Summary of Existing Facilities

SUBSTATION CAPACITY (IN MVA)					
	2011	2012	2013	2014	2015
PHILIPPINES	26,796	27,726	27,931	30,607	31,038
Luzon	20,589	21,170	21,110	23,395	23,785
Visayas	3,414	3,414	3,504	3,734	3,926
Mindanao	2,793	3,142	3,318	3,478	3,327
TRANSMISSION LINE LENGTH (IN CKT-KM)					
	2011	2012*	2013*	2014*	2015
PHILIPPINES	19,704	19,490	19,425	19,463	20,073
Luzon	9,529	9,374	9,439	9,370	9,428
Visayas	4,918	4,971	4,840	4,821	4,813
Mindanao	5,257	5,145	5,146	5,272	5,832

*There was a decrease in total transmission line length in circuit-km due to modification and divestment of various sub-transmission assets.

To ensure that voltages across the network are within the levels prescribed in the Grid Code, capacitor banks and shunt reactors have been installed in appropriate locations in different parts of the grid. The summary is shown below:

Table 3.2: Summary of Installed Capacitor Banks and Shunt Reactors

	CAPACITOR BANK (in MVAR)*	SHUNT REACTOR (in MVAR)
PHILIPPINES	3,324.6	1,472.5
Luzon	2,766	875
Visayas	281.10	575
Mindanao	277.50	22.50

*These exclude the capacitor banks at the Naga and Ormoc Converter Stations

3.2 Dependable Capacity Mix

The dependable capacity indicated in the following sections is based from the DOE List of Existing Plants as of June 30, 2015.

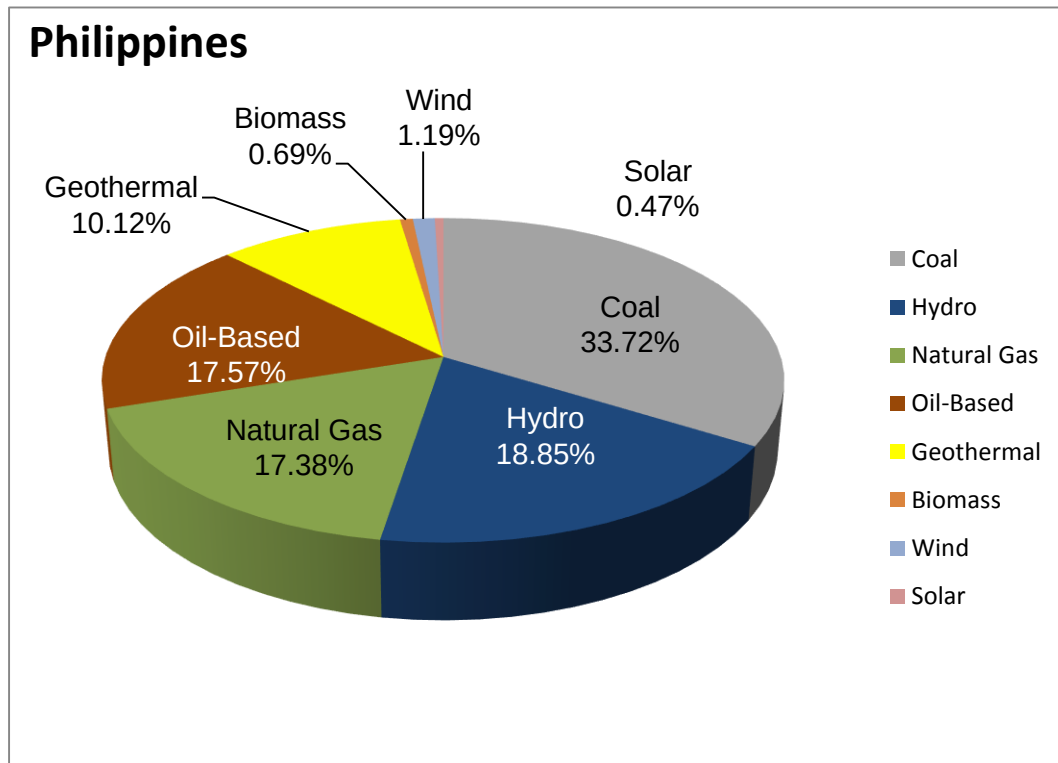


Figure 3.1 – Dependable Capacity Mix

The Philippines has a total dependable capacity of 15,878 MW including embedded generation. 5,354 MW of the capacity comes from coal-fired power plants (CFPP) and 2,993 MW comes from the hydroelectric power plants (HEPP). Natural gas, oil based and geothermal power plants accounts for 2,760 MW, 2,790 MW and 1,607 MW, respectively. The share from all other RE-based plants, on the other hand, is still relatively small with a total dependable capacity of 374 MW only.

Figure 3.2 and Table 3.3 shows the distribution of dependable capacity for Luzon, Visayas and Mindanao.

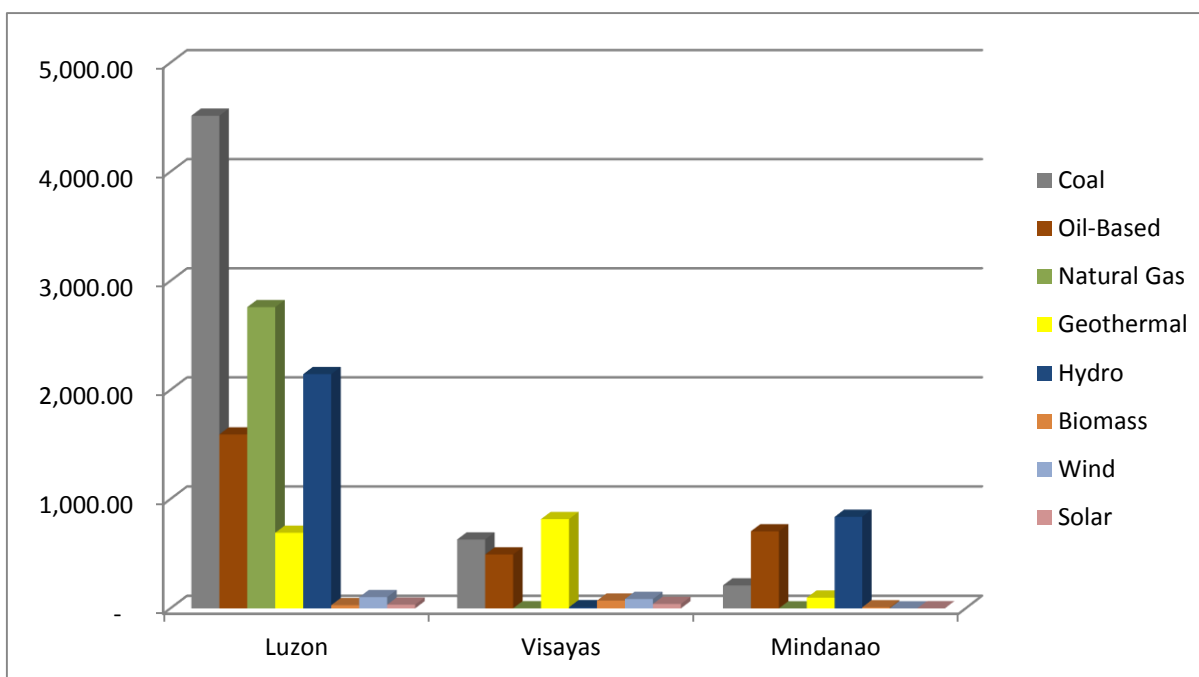


Figure 3.2: Dependable Capacity Mix for Luzon, the Visayas and Mindanao

Table 3.3: Existing Dependable Capacity

Power Plant Type / Fuel Source / RE Source	LUZON		VISAYAS		MINDANAO	
	MW	%	MW	%	MW	%
Conventional Power Plants	8,865		1,124		915	
▪ Coal	4,514	38.03%	630	29.31%	210	11.29%
▪ Oil-based	1,592	13.41%	493	22.93%	705	37.88%
▪ Natural Gas	2,759	23.25%	1	0.05%	-	-
RE-Based Power Plants	3,003		1,026		945	
▪ Wind	103	0.87%	86	4%	-	-
▪ Solar PV	34	0.29%	41	1.88%	0.3	0.02%
▪ Biomass	29	0.24%	71	3.32%	10	0.54%
▪ Geothermal	692	5.83%	817	38.01%	98	5.27%
▪ Hydro	2,145	18.08%	11	0.5%	837	45.01%
TOTAL	11,868		2,150		1,860	

3.3 Luzon Transmission Network

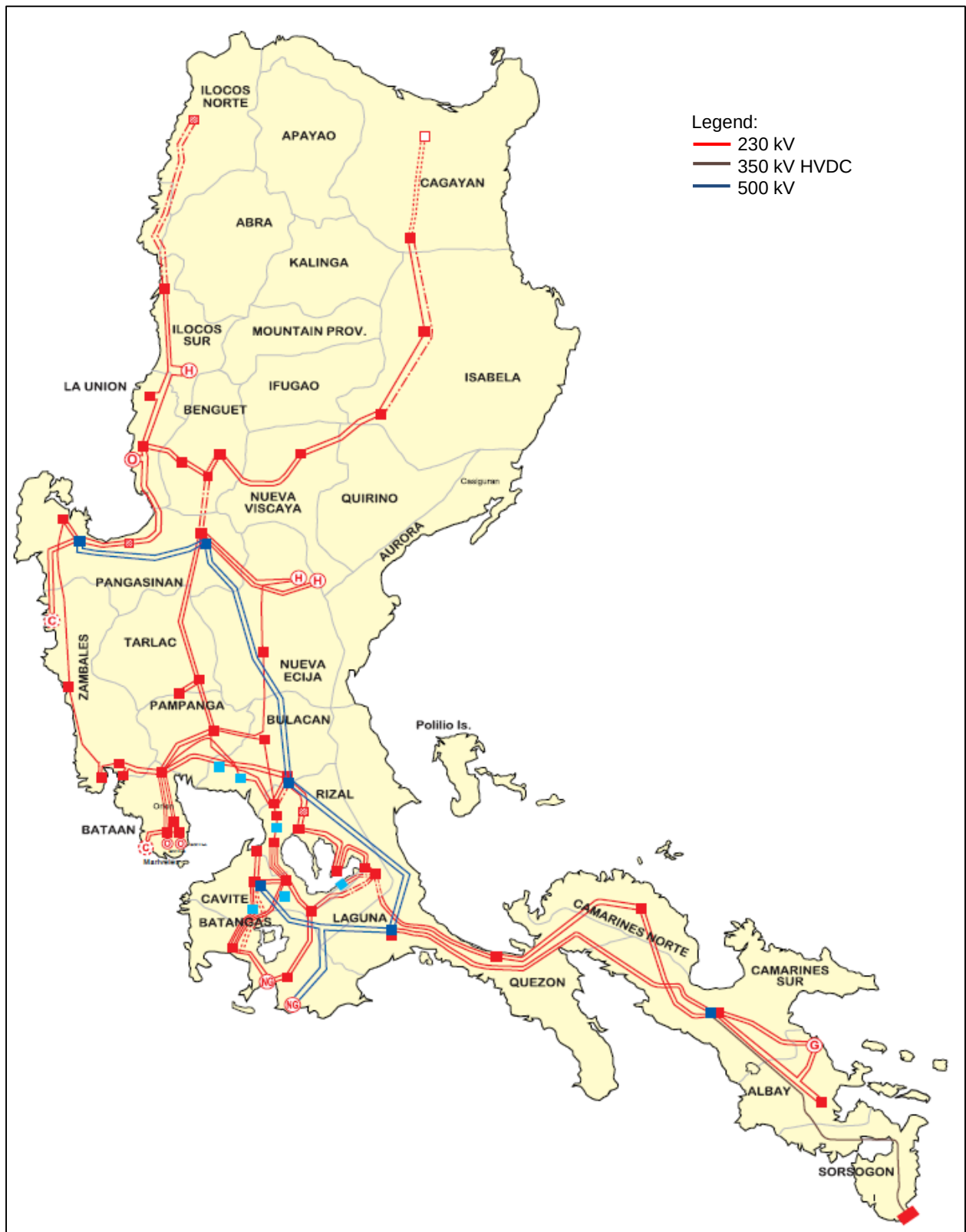


Figure 3.3: Luzon Transmission Network

The bulk generation sources in the Luzon Grid are located in the northern and southern parts of the Luzon Island while the load center is in Metro Manila area. About 53% of the total demand in Luzon is accounted in Metro Manila. Because of this system configuration, NGCP's transmission backbone must have the capability to transfer bulk power from both northern and southern parts of Luzon to the Metro Manila area.

Northern Transmission Corridor

The transmission corridor consists of several flow paths for transferring power from the generation sources located in Northern Luzon to Metro Manila. The 500 kV double-circuit Bolo-Nagsaag-San Jose is rated at 2,850 MVA per circuit and is capable of transferring the more than 1,800 MW generation from Masinloc and Sual CFPP to Metro Manila. The Bolo and Nagsaag 500 kV Substations are the receiving ends of generation from the north. The power is then delivered to Metro Manila mainly via Mexico and San Jose Substations.

Other underlying paths are the 230 kV transmission lines:

- a. Labrador to Hermosa single circuit line;
- b. San Manuel – Concepcion - Mexico double-circuit line; and
- c. San Manuel – Pantabangan – Cabanatuan – Mexico single-circuit line.

The San Manuel-Concepcion-Mexico 230 kV line is an alternate corridor which also caters the generation capacity of the HEPP delivering power to San Manuel 230 kV Substation.

Metro Manila



Figure 3.4 – Metro Manila Transmission Network

As the center of commerce and trade, it is inevitable that the demand within Metro Manila will continue to grow, thus requiring the expansion of existing substations and building of new ones.

The National Capital Region (NCR) accounts to more than half of the total load in Luzon but only relies on the import of power coming from the north and south Luzon.

One unique geographical feature of Metro Manila is its narrow land area between Manila Bay and Laguna Lake, which is only about 10 km wide.

The Antipolo 230 kV Substation, which is among the new facilities to be developed, will cater to the demand increase in Metro Manila and reduce the loads at Doña Imelda and Taytay Substations, which have expansion constraints.

Presently, there are three main load sectors within Metro Manila:

- a. Sector 1 is served through Quezon, Paco and Marilao (Duhai) Substations. Both Paco and Marilao (Duhai) Substations are MERALCO-owned;
- b. Sector 2 is served through Taytay and Doña Imelda 230 kV Substations; and
- c. Sector 3 is served through Muntinlupa and Las Piñas 230 kV Substations.

The major supply lines for both Quezon and Taytay are the double-circuit 230 kV line from San Jose as these substations rely heavily on the supply from San Jose 500 kV Substation.

In the south, the power requirements are being drawn from Dasmariñas 500 kV Substation and from power plants directly connected to the 230 kV system. Las Piñas is connected through a double circuit 230 kV radial line from Dasmariñas, while Muntinlupa has four-circuit supply line from Biñan.

Southern Transmission Corridor

The southern portion of the 500 kV transmission backbone stretches from Naga Substation in Bicol Region to Tayabas, Quezon. Tayabas is also connected to San Jose thereby completing the link between the north and south 500 kV transmission corridors.

The 500 kV backbone segment from Tayabas to Naga Substation is currently energized at 230 kV. The Naga Substation is also the termination point for the HVDC Interconnection System that could allow the exchange of power for up to 440 MW between Luzon and the Visayas Grids.

The 500 kV backbone in the south facilitates the transfer of about 2,400 MW from Ilijan Natural Gas, Pagbilao and QPPL CFPP. The 230 kV transmission system in Batangas and Laguna area caters more than 2,500 MW total generation capacity of Calaca CFPP, new coal-fired power plants and the other Natural Gas Plants (San Lorenzo and Sta. Rita).

From Tayabas Substation, the 500 kV backbone also stretches to Dasmariñas Substation which serves as a drawdown substation for the loads in the south of Metro Manila.

3.4 Visayas Transmission Network

The Visayas transmission system is divided into five different sub-system or sub-grids: Panay, Negros, Cebu, Bohol and Leyte-Samar. The sub-grids are interconnected by AC submarine cables as follows with indicated capacity: Leyte-Cebu (2x185 MW), Cebu-Negros (2x90 MW), Negros-Panay (1x85 MW) and Leyte-Bohol (1x90 MW). These submarine cables provide the capability of sharing excess generation between islands to accommodate the Visayas' growing demand.

The transmission backbone of the Visayas Grid extends from Allen Cable Terminal Station in Samar, all the way to Nabas Substation in Panay. This power delivery system comprises approximately 895 kilometers of transmission lines.

Eastern Visayas (District 1) is composed of Leyte and Samar Islands. Leyte remains the power supplier to Samar and Bohol Islands through the single-circuit Ormoc-Babatngon and Ormoc-Maasin 138 kV lines, respectively. Outage of the said lines will result in power interruption in the affected island. Thus, projects intended to provide single outage contingency or N-1 for the said lines are currently ongoing. Also, it has a 230 kV interconnection to Cebu enabling the other islands to source power from cheaper geothermal resources. Leyte is the site of 547 MW geothermal resources that comprise about 30% of the total dependable capacity in the Visayas.

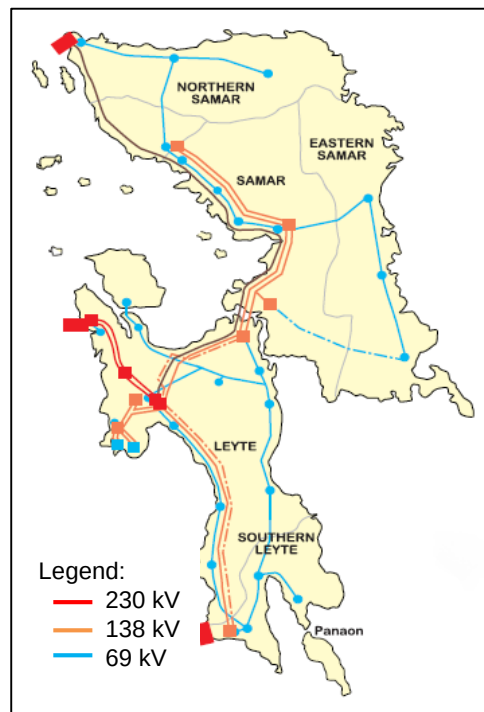


Fig 3.5: Eastern Visayas Transmission Network

Central Visayas (District 2) is composed of Cebu and Bohol. Cebu can be well considered as the major load center of the Visayas Grid. In 2014, it has a coincident peak load of 862 MW which accounted for 53% of the grid's total demand. Bohol has the lowest peak load among sub-grids with 62 MW (3.77%) in 2014.

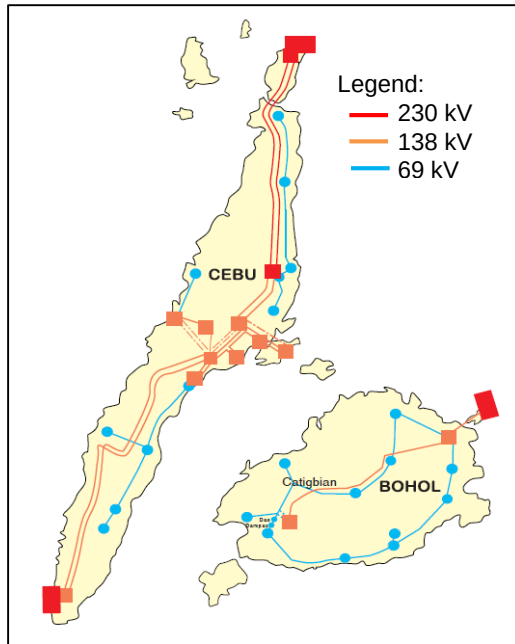


Fig 3.6: Central Visayas Transmission Network

In the Island of Negros (District 3), the load center is located in Bacolod City in the northern part, while the bulk of generation is in the southern part. A total of 95.5 MW was added in the Negros Island due to the entry of San Carlos Solar, Nasulo Geothermal, URC Bagasse Cogeneration and HPCo Bagasse Congeneration Plant from January 2014 to August 2015.

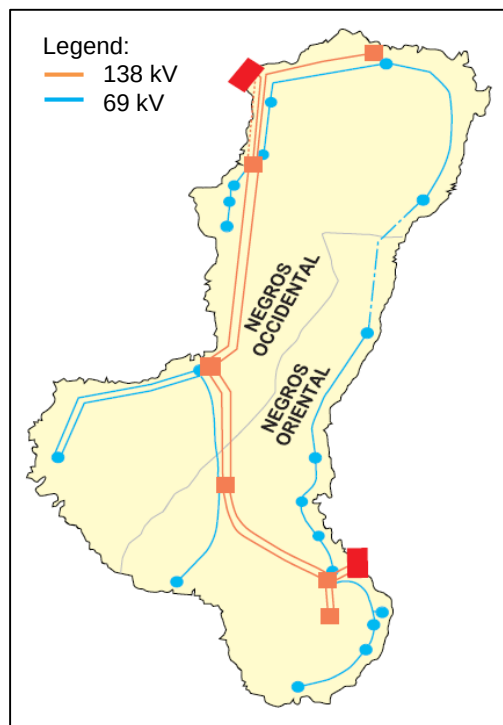


Fig 3.7: Negros Island Transmission Network

Panay Island (District 4) had been reliant to oil-based plants until the entry of Panay Energy Development Corporation (PEDC) 164 MW CFPP. Panay became less reliant on power import from other islands via the 138 kV Negros-Panay Interconnection System and, at certain times, also exports power to Negros. A total of 82.4 MW generation capacity was added in the Panay Island due to the entry of San Lorenzo Wind and the PetroWind Nabas last December 2014 and June 2015, respectively.

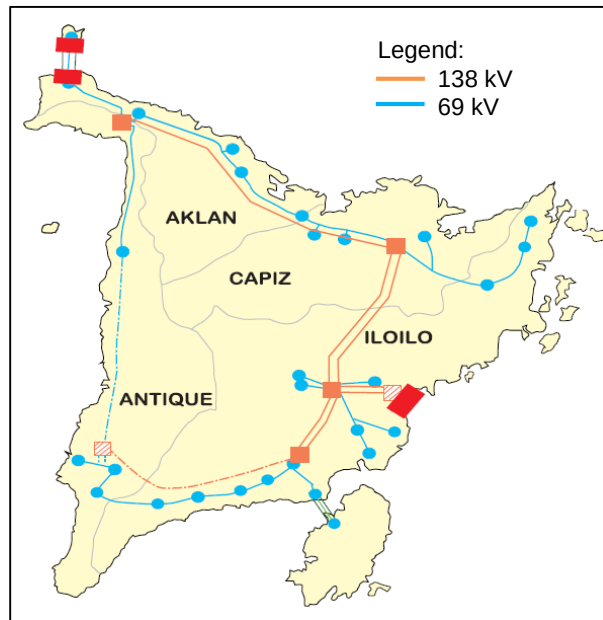


Figure 3.8: Panay Island Transmission Network

3.5 Mindanao Transmission Network

The Mindanao transmission system is composed of six Districts: North Western Mindanao Area (District 1 – NWMA) covers Zamboanga area and Misamis Occidental, Lanao Area (District 2 - LA), North Central Mindanao Area (District 3 - NCMA) includes the provinces of Bukidnon and Misamis Oriental, North Eastern Mindanao Area (District 4 - NEMA) comprised of Agusan and Surigao provinces, South Eastern Mindanao Area (District 5 - SEMA) is the Davao Region, and South Western Mindanao Area (District 6 - SWMA) consists of South Cotabato, Cotabato, Sultan Kudarat, Sarangani and Gen. Santos (SOCCSKSARGEN) and Maguindanao. While the bulk of power generation is situated in the northern part of the island, the load centers are located in southeast (Davao provinces) and southwest (SOCCSKSARGEN) regions. Power demand from these areas accounts to approximately half of Mindanao's total demand of the island.

Given this power supply-demand characteristics, much of the power flows from north to south through the Balo-i-Tagoloan-Maramag-Kibawe 138 kV transmission corridor and the Balo-i-Villanueva-Maramag-Bunawan backbone which is designed at 230 kV but initially energized at 138 kV.

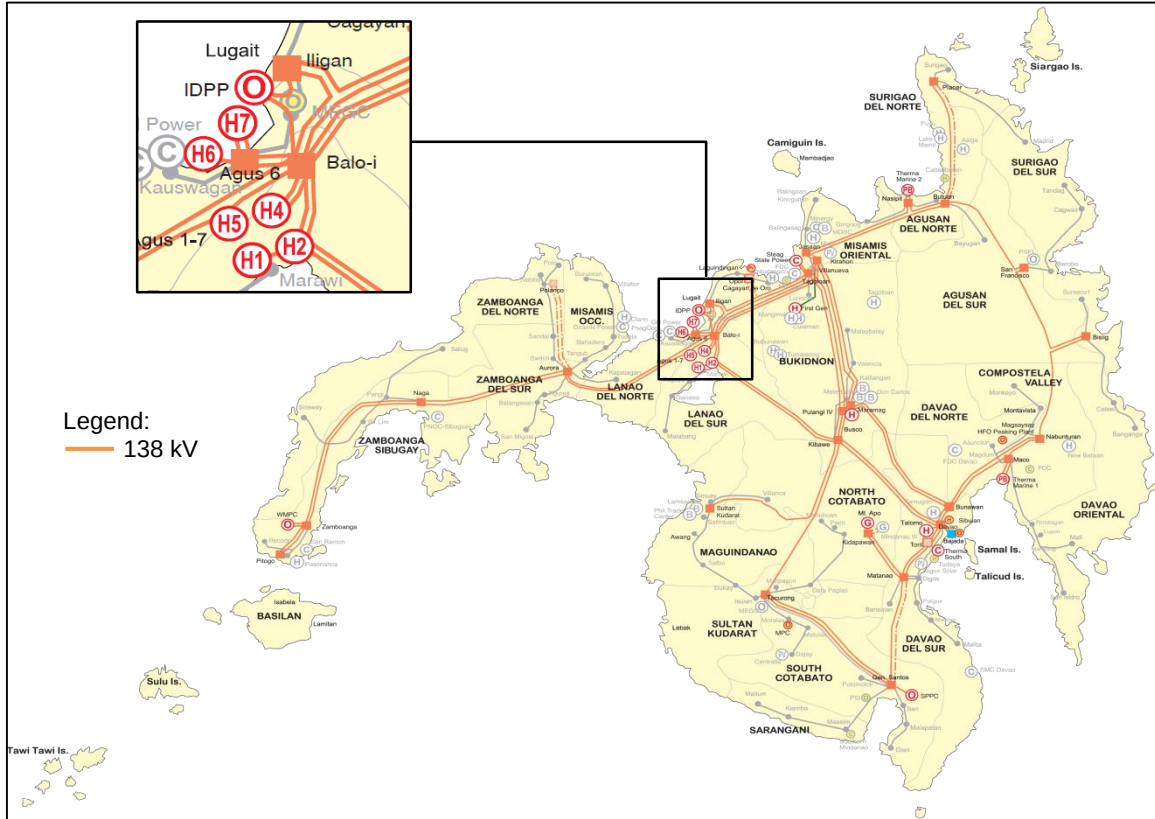


Figure 3.9 – Mindanao Transmission Network

Aside from the new 230 kV-designed transmission backbone, Mindanao Grid comprises mostly of 138 kV transmission corridors, with 69 kV radial lines that traverse from the main substations to load-end substations. Three 138 kV transmission corridors emanate from the Lanao Area, where the biggest chunk of power supply for Mindanao is generated.

Chapter 4: Demand Projections and Capacity Additions

The two important input parameters in the preparation of the TDP are the updated annual peak demand forecast and generation capacity addition listed in the DOE List of Private Sector Initiated Power Project (PSIPP).

4.1 TDP Power Demand Projection

4.1.1 Basis of the Transmission-level Forecast

The demand forecast for the 2014-2015 TDP used the electricity sales and peak demand projections of the Department of Energy (DOE) based on the aggregated forecasts of the Distribution Utilities from the Distribution Development Plans.

4.1.2 Historical and Projected Demand for Electricity

Total peak demand (in MW, non-coincident sum) of the Philippines shows consistent upward trend from 2005 to 2014 with an Average Annual Compounded Growth Rate (AACGR) of 3.41%. Total demand growth was at its highest in 2010 (at 9.53%) while it was at its most sluggish in 2011 (at 0.04%).

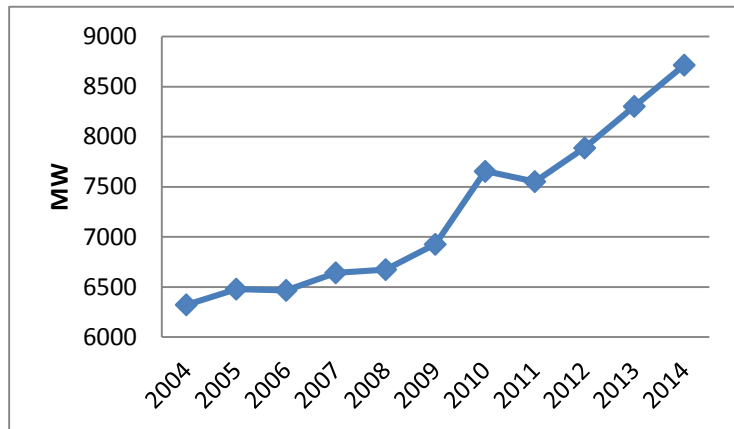
Table 4.1: Summary of Historical Demand per Grid (2004-2014), in MW

Actual	Luzon	Visayas	Mindanao	Philippines
2004	6,323	955	1,177	8,455
2005	6,479	967	1,149	8,595
2006	6,466	997	1,228	8,691
2007	6,643	1,102	1,241	8,987
2008	6,674	1,176	1,204	9,054
2009	6,928	1,241	1,303	9,472
2010	7,656	1,431	1,288	10,375
2011	7,552	1,481	1,346	10,379
2012	7,889	1,551	1,321	10,761
2013	8,305	1,572	1,428	11,305
2014	8,717	1,636	1,469	11,822
%AACGR (2005-2014)	3.26%	5.53%	2.24%	3.41%

*Includes only the demand of generators monitored by NGCP

4.1.2.1 Luzon

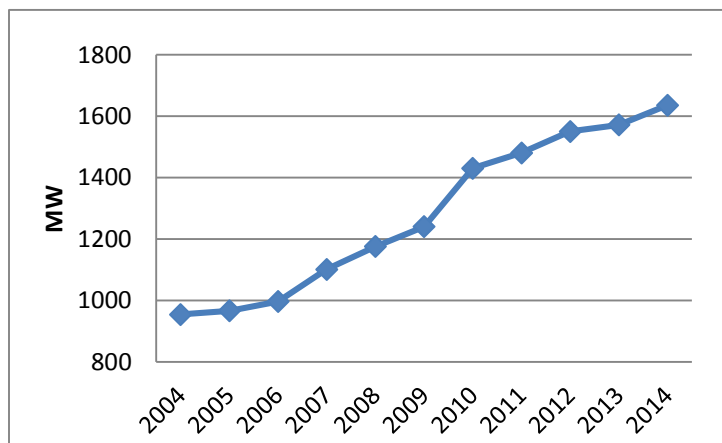
The Luzon Grid has posted an AACGR of 3.26% for the period 2005-2014. Consistent steady growth has been recorded for the Luzon Grid except for the decrease in demand observed in 2006 and 2011. This was due to the reduction in the power consumption of MERALCO for the two periods brought about by the effect of the global financial crisis in 2006 and the effect of La Niña phenomenon experienced in



2011. MERALCO's demand accounts for at least 70% of the total system peak demand (SPD) in Luzon. Further, demand growth in 2010 has been unprecedented (10.51%) – similar double-digit growth was also observed in MERALCO's franchise area. This was attributed to increased economic activity brought about by election spending and the higher-than-average growth in GDP for the year. Also, the prolonged hot temperature experienced during the summer months have contributed to the unusual upsurge in the Luzon SPD. Note however that this demand growth has not been sustained in 2011. In fact, SPD has fallen by 1.36%. Demand was quick to recover though, registering a 4.46% growth in 2012, 5.27% in 2013 and 4.96% in 2014.

4.1.2.2 Visayas

The Visayas Grid has posted an AACGR of 5.53% for 2005-2014. The year 2010 brought significant increase in the demand for electricity in Visayas. Compared with the SPD recorded in 2009, Visayas Grid grew by a record high of 15.31%. This was due to the improved economic activities and increased reliance on power supply from the Grid of existing large customers with self-generation. In addition, the realization of 346 MW increase in capacity coming from

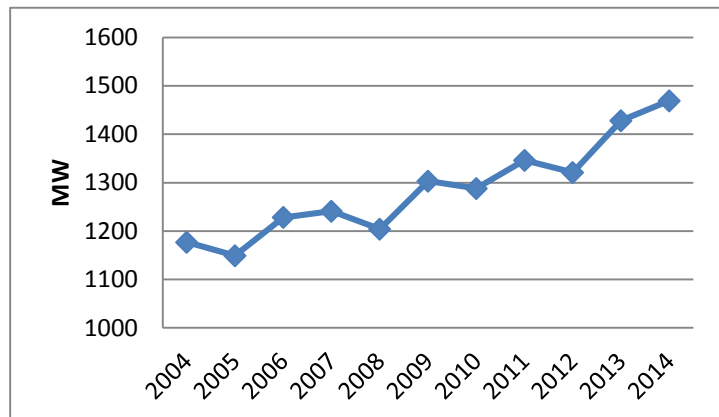


CEDC, KEPCO and PEDC helped boost the supply-demand situation in 2010. However, this growth was not sustained as the system grew only at an average rate of 4.11% for the next 2 years (2011-2012). In 2013, the total demand in Visayas posted a meager increase of only 1.38%. This is due to the effect of Typhoon Yolanda that hit the region in November and caused significant decrease in power consumption. In 2014, the recorded SPD for Visayas stood at 1,636 MW which occurred in May. This is unusual because the peak demand in

Visayas normally occurs during the last quarter of the year specifically between November and December. However, due to the onslaught of typhoons during the second half of the year, majority of the electrical systems was destroyed resulting in reduction in power demand. Typhoons Glenda, Mario, Ruby and Seniang hit Visayas in July, September and December, respectively.

4.1.2.3 Mindanao

The Mindanao Grid has posted an AACGR of 2.24% for the period 2005-2014. After recording high annual growth rates from 2002 to 2004 (an average of 7.36%), demand growth has been sluggish from 2005 to 2010 due to the overall reduced power requirement from large non-utility customers. From 2005 onwards, the historical growth in the Mindanao Grid has been volatile with alternating periods of rise and decline.



Drop in demand occurred in 2005, 2008, 2010 and 2012. 2005 was characterized by reduced demand from distribution utilities while 2008 was characterized by the large decrease in the demand of non-utility customers, possibly a direct effect of the global financial crisis which adversely affected exporting industries. On the other hand, suppressed generation impeded demand growth in 2010 and 2012. This is due to the El Niño phenomenon that hampered hydropower generation, which comprises about half of the Grid's installed capacity. Mindanao power demand recovered in the recent years and grew by 7.1% in 2013 and 3.8% in 2014.

4.2 Forecast for 2014-2015 TDP

Power demand for the country is expected to grow at an AACGR of 4.35% for the period 2016-2020 and 4.10% for 2021-2026. It is projected that Mindanao will have the highest AACGR compared with the other Grids. Mindanao is forecasted to reach an AACGR of 5.89% for 2016-2026 while the Luzon and Visayas Grids at 3.99% and 3.68%, respectively. The peak demand used for Luzon in 2015 is the actual year-to-date peak demand of 8,928 MW which occurred in May. The table below shows the projected demand disaggregated per district based on the transformer peak demand coincident with the System Peak. It was derived from the DOE Forecast as of 11 September 2015 based on the generation level.

Table 4.2: Summary of Projected Demand per District³ (MW)

District	Area	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Luzon		9,127	9,474	9,934	10,368	10,821	11,249	11,694	12,164	12,657	13,161
MERALCO		6,764	7,047	7,294	7,561	7,822	8,107	8,404	8,716	9,029	9,356
1	NCR	4,951	5,161	5,342	5,540	5,486	5,686	5,894	6,114	6,333	6,563
2	North	220	229	238	247	340	352	365	378	392	406
3	South	1,593	1,657	1,714	1,773	1,995	2,068	2,144	2,224	2,304	2,387
North Luzon		1,824	1,876	2,063	2,204	2,361	2,474	2,588	2,710	2,850	2,987
1	Ilocos	160	162	173	181	191	199	208	217	228	238
2	Mt. Province	151	155	165	172	183	191	200	209	220	231
3	North Central	197	200	237	249	264	276	290	303	319	334
4	Cagayan Valley	206	214	229	240	255	267	281	295	311	327
5	West Central	322	332	359	381	409	431	455	488	524	560
6	South Central	716	739	821	897	971	1,018	1,056	1,094	1,138	1,181
7	North Tagalog	72	74	79	83	88	93	98	103	110	116
South Luzon		539	552	577	603	638	667	702	737	778	818
1	Batangas/Cavite	250	254	264	274	288	298	311	325	340	355
2	Laguna /Quezon	86	88	92	96	102	106	112	118	124	131
3	Bicol	204	210	222	234	249	263	279	295	314	332
Visayas		1,699	1,762	1,823	1,885	1,945	2,011	2,079	2,150	2,223	2,320
1	Panay	279	290	300	310	320	330	341	353	365	380
2a	Cebu	879	912	943	975	1006	1040	1075	1112	1150	1200
2b	Bohol	68	71	73	76	78	81	83	86	89	93
3	Leyte-Samar	196	203	211	218	225	232	240	249	257	269
4	Negros	276	287	297	307	316	327	338	350	362	378
Mindanao		1,671	1,804	1,929	2,045	2,142	2,230	2,321	2,415	2,513	2,659
1	North Western	211	217	235	255	270	282	295	308	324	343
2	Lanao Area	162	176	192	203	212	223	231	239	249	264
3	North Central	278	364	379	394	407	418	430	441	454	473
4	North Eastern	156	161	183	198	209	224	243	262	274	292
5	South Eastern	592	607	645	683	718	745	772	801	834	886
6	South Western	272	278	296	313	326	338	350	363	378	400
Philippines		12,496	13,041	13,687	14,298	14,908	15,489	16,094	16,729	17,394	18,139

³Based on the transformer peak demand coincident with the System Peak.

Based on NGCP System Peak Forecast as derived from DOE Forecast Levels, excluding applicable losses

4.2.1 Demand Projections for Substation Capacity Addition

The demand projections for substation expansion take off from the per meter forecast undertaken by NGCP. Forecast energy deliveries per metering point are derived from historical trends and/or information as to the potential expansion or contraction of demand of Grid-connected customers. Inputs are sought from customers in this bottom-up process to incorporate their expansion plans.

Projected monthly energy deliveries (in MWh) to metering points connected to a given transformer are then summed up. Accounting adjustments for technical losses and substation use to this sum, the monthly per transformer energy delivery forecast (in MWh) is derived. The forecast transformer peak (in MW) is then calculated by applying the appropriate load factor to these energy delivery projections. This transformer peak becomes the basis for adding transformer capacities at the substations.

4.2.2 Demand Projections for Transmission Expansions

The SPD projections for each Grid are used in determining the necessary transmission expansion projects. However, for these figures to be usable in the power system analysis software, it has to be broken down into individual transformer loads. First, the embedded generation during system peak is subtracted from the SPD to come up with the non-embedded peak. Then the individual transformer maximum demand projections during the month when the system peak usually occurs (as determined in the previous section) are used to establish the percent share to arrive at the non-embedded peak that will be assumed for a specific transformer.

4.3 Generation Capacity Addition

This section shows the additional capacities and proposed generating plants in Luzon, the Visayas and Mindanao Grids based on DOE Power Outlook 2015-2020 as of August 2015.

The DOE has also provided the list of generating plants that already have clearance to undertake System Impact Study (SIS) but are not included yet in the said DOE Power Outlook since the reports on the status of their development are not yet submitted. This list will fall under the new classification named as the Prospective Projects. Thus, there will be three generation project classifications, as follows:

- a. Committed – These are projects that have service contracts in place, are in the development/commercial stage and have reached financial closure already and have been declared as “committed” by the DOE.
- b. Indicative – Projects with service contracts, in the development/ commercial stage but with no financing yet.
- c. Prospective – Projects with DOE clearance to undertake SIS and service contracts and on the predevelopment stage. These projects are not included in the official list of DOE’s Private Sector Initiated Power Projects. (Refer to Appendix 1 for the generation list).

It is worth noting that the proponents should regularly update the DOE on their plans and updates regarding the status of their projects for monitoring and inclusion in the official list of DOE’s PDP Generation List. Proponents are advised to regularly coordinate with the DOE’s Electric Power Industry Management Bureau (EPIMB).

Table 4.5 shows the additional capacities from 01 January 2014 to 15 August 2015.

Table 4.5: List of Additional Capacities from 01 Jan 2014 to 15 Aug 2015

Power Plant	Location	Installed Capacity (MW)	Dependable Capacity (MW)	Commercial Operation
LUZON				
Maibarara Geothermal Power	Sto. Tomas, Batangas	20	18.6	Feb 2014
Lafarge DPP	Taysan, Batangas	12.7	12	July 2014
Bangui Bay Wind Phase 3	Bangui, Ilocos Norte	18.9	12.6	Oct 2014
Burgos Wind	Burgos, Ilocos Norte	150	45	Nov 2014
SJCI Power Biomass	San Jose, Nueva Ecija	12	10	Oct 2014
Caparispisan Wind	Pagudpud, Ilocos Norte	81	28	Nov 2014
Raslag Solar^	Pampanga	10	8.5	Feb 2015
Majestic CEZ Solar	Cavite	41.3	20	Mar 2015
Burgos Solar^	Burgos, Ilocos Norte	4.1	4	Mar 2015
SLTEC Putting Bato Coal Unit 1	Calaca, Batangas	135	123	Apr 2015
Sinoma Waste Heat Recovery Facility*	San Jose, Antipolo	6	5.7	Apr 2015
SPCRPI SM North*	Quezon City	1.5	1.5	Apr 2015
Millennium Gas**	Navotas, Metro Manila	100	80	May 2015
Sabangan HEPP	Sabangan, Mt. Province	14	4	Jun 2015
Pililia Wind^	Pililia, Rizal	54	48.6	Jul 2015
Sub-total (Luzon)		660.5	421.5	
VISAYAS				
San Carlos Solar Phase 1	San Carlos City, Negros Occidental	13	9	May 2014
San Carlos Solar Phase 2	San Carlos City, Negros Occidental	9	7.5	Aug 2014
Nasulo Geothermal	Valencia, Negros Oriental	49.37	40	Sep 2014
San Lorenzo Wind	San Lorenzo, Guimaras	54	50	Dec 2014
URC Bagasse Cogeneration Facility Phase 1	Kabankalan, Negros Occidental	40	36	Jan 2015
HPCo Bagasse Cogeneration	Silay City, Negros Occidental	12	3	Feb 2015
PSFLI (SOLEQ) Solar	Ormoc, Leyte	30	24	Apr 2015
PetroWind Nabas Wind	Nabas, Aklan	36	32.4	Jun 2015
TPC – 1A Coal	Toledo City, Cebu	82	75.9	
Sub-total (Visayas)		325.37	277.8	
MINDANAO				
SoEnergy DPP^	Brgy. Apopong, Gen. Santos City, South Cotabato	19	18.05	Mar 2014
MPC-Digos DPP^	Digos, Davao del Sur	15	14.25	Mar 2014
KEGI-Panaon DPP^	Panaon, Ozamis City, Misamis Occ.	15	13.6	May 2014
Tudaya 1 Hydro^	Sta. Cruz, Davao del Sur	6.6	6.53	May 2014
Tudaya 2 Hydro^	Sta. Cruz, Davao del Sur	7	6.93	May 2014
KEGI Tandag^	Tandag, Surigao	7.5	6	Oct 2014
Mapalad Energy DPP^	Iligan City	15	14.25	Dec 2014
Peak Power (PSI) DPP^	Brgy. Apopong, Gen. Santos City	20.9	19.6	Jan 2015
Peak Power (PSFI) DPP^	San Francisco, Agusan del Sur	5.9	5	Feb 2015
Sub-Total (Mindanao)		111.9	104.21	
TOTAL		1,097.77	803.51	

Based on the DOE Power Outlook 2015-2020 as of August 2015

^Embedded

*Own-use

**Recommissioned

The following tables shows the DOE List of Private Sector Initiated Power Projects as of August 15, 2015 for Luzon, Visayas and Mindanao.

Table 4.6: Summary of Generation Capacity Addition

	Total Committed Capacity (MW)	Total Indicative Capacity (MW)
Luzon	2,422.1	9,282.95
Visayas	528.3	720.47
Mindanao	2,070.3	1,920.81
PHILIPPINES	5,020.7	11,924.23

It can be noted that the list includes small capacity plants which may not actually connect directly to the grid. For relatively small capacity power plants connecting to the distribution system, the main impact is a slight reduction in the power being drawn by the Distribution Utility from NGCP substations and would not generally require reinforcement in the transmission network.

Also, there are power plant projects in the DOE list with no connection application yet to NGCP or with no System Impact Study (SIS) yet.

Table 4.7(a): List of Luzon Generation Capacity Addition

Proposed Generation Facility / Name of the Project	Capacity (MW)	Location	Comm. Year
COMMITTED POWER PLANTS			
COAL			
SLPGC Coal Phase 1 Unit 1 and 2*	300	Brgy. San Rafael, Calaca, Batangas	2015
Anda Power Coal*	82	Brgy. Bundagul, Mabalacat, Pampanga	2015
Puting Bato Coal Phase 2*	135	Brgy. Puting Bato West, Calaca, Batangas	2015
Limay Coal Phase 1 Unit 1*	150	Brgy. Lamao, Limay, Bataan	2016
Limay Coal Phase 1 Unit 2*	150	Brgy. Lamao, Limay, Bataan	2017
Pagbilao 3 Coal*	420	Pagbilao Power Station, Brgy. Ibabang Polo, Pagbilao, Quezon	2017
San Buenaventura (SBPL) Coal*	460	Mauban, Quezon	2019
Sub-Total Coal	1,697		
BIOMASS			
Bataan 2020 Rice hull-fired Cogen Plant*	7.5	Samal, Bataan	2015
IBEC Biomass*	18	Alicia, Isabela	2015
ACNPC WTE Biomass Phase 1	0.75	Tarlac City, Tarlac	2015
GIFTC Rice Husk-Fired Biomass*	10.8	Muñoz, Nueva Ecija	2015
Bicol Biomass Energy Corp*	4.5	Pili, Camarines Sur	2015
ACNPC WTE Biomass Phase 1	0.75	Tarlac City, Tarlac	2016
Biogas Power Plant	6.1	Batangas	2016
SJCIpower Rice Husk-Fired Phase 2	10.8	Brgy. Tulat, San Jose, Nueva Ecija	2017
Sub-Total Biomass	59.2		
NATURAL GAS			
San Gabriel Avion Project*	100	Brgy. Bolbok, Batangas	2015
San Gabriel Project*	450	San Gabriel, Batangas	2016
Sub-Total Natural Gas	550		
HYDRO			
Kapangan HEPP*	60	Kapangan and Kibungan, Benguet	2019
Bulanao HEPP	1	Tabuk, Kalinga	2019
Prismc HEPP	1	Rizal, Nueva Ecija	2019
Magat A	1.4	Ramon, Isabela	2020
Magat B	1	Ramon, Isabela	2020

Proposed Generation Facility / Name of the Project	Capacity (MW)	Location	Comm. Year
Tubao Mini Hydro	1.5	Tubao, La Union	2020
Sub-Total Hydro	65.9		
SOLAR			
Currimao Solar Power Project*	20	Currimao, Ilocos Norte	2015
Macabud Solar Power Project*	30	Brgy. Macabud, Rodriguez, Rizal	2016
Sub-Total Solar	50		
TOTAL COMMITTED	2,422.1		
INDICATIVE POWER PLANTS			
COAL			
SMC Limay Coal Phase 2 Unit 1*	150	Brgy. Lamao, Limay, Bataan	2016
SMC Limay Coal Phase 3 Unit 1*	150	Brgy. Lamao, Limay, Bataan	2016
SMC Limay Coal Phase 2 Unit 2	150	Brgy. Lamao, Limay, Bataan	2017
SMC Limay Coal Phase 3 Unit 2	150	Brgy. Lamao, Limay, Bataan	2017
Lucidum Energy Coal	300	Silanguin Bay, Zambales	2017
SLPGC Coal Phase 2*	300	Brgy. San Rafael, Calaca, Batangas	2017
SMC Limay Coal Phase 3 Unit 2	300	Brgy. Lamao, Limay, Bataan	2017
JGS Coal Unit 1 and 2*	300	Brgy. Pinamukan Ibaba, Batangas City	2018
Redondo Peninsula Coal*	600	Sitio Naglatore, Cawag, Subic Bay Freeport Zone	2018
GN Power Mariveles Expansion	1,200	Mariveles, Bataan	2019
JGS Coal Unit 3 and 4*	300	Brgy. Pinamukan Ibaba, Batangas City	2019
AES Masinloc Expansion*	600	Zambales	2019
AOE Coal*	1,200	Atimonan, Quezon	2020
PTE Sub-Critical Coal	350	Camarines Norte	2020
PTE Sub-Critical Coal	350	Camarines Norte	2025
Sub-Total Coal	6,400		
OIL-BASED			
Aero Derivative Combined Cycle	150	Calamba, Laguna	TBD
Sub-Total Oil-Based	150		
NATURAL GAS			
Pagbilao Combined Cycle Unit 1*	200	Isla Grande, Pagbilao, Quezon Province	2015
Pagbilao Combined Cycle Unit 2 and 3*	400	Isla Grande, Pagbilao, Quezon Province	2016
Mobile Gas Turbine	250	Ilijan, Batangas	2016
Sta. Maria Project (San Gabriel Phase 2) Unit 1	900	Sta. Maria, Batangas	2017
Sub-Total Natural Gas	1,750		
GEOTHERMAL			
Bacman 3 Geothermal	31	Guinlajon, Sorsogon	2017
Rangas Geothermal*	40	Bacon District, Sorsogon	2018
Kayabon Geothermal*	40	Manito, Albay	2019
Sub-Total Geothermal	111		
SOLAR			
Clark Freeport Zone Solar	12	Clark Freeport Zone, Pampanga	2015
Concepcion Solar*	50.55	Brgy. Sta. Rosa, Concepcion, Tarlac	2015
Cavite Solar	3	Cavite Economic Zone, Rosario Cavite	2016
Sub-Total Solar	65.55		
HYDRO			
Ibulao Hydro*	4.5	Lagawe, Ifugao	2018
Dupinga Hydro	3	Gabaldon, Nueva Ecija	2018
Pinacanauan	6	Peñablanca, Cagayan	2018
Tinoc 2*	11	Tinoc, Ifugao	2019
Tinoc 3*	5	Tinoc, Ifugao	2019
Colasi	0.96	Mercedes, Camarines Norte	2019

Proposed Generation Facility / Name of the Project	Capacity (MW)	Location	Comm. Year
Majayjay	2.2	Majayjay, Laguna	2019
Ranggas	1.5	Goa & Tigaon, Camarines Sur	2019
Biyao	0.8	Balbalan, Kalinga	2019
Tinoc 1*	4.1	Tinoc, Ifugao	2019
Tinoc 4*	5	Tinoc, Ifugao	2019
Abdao HEP	2	Tabaan Sur, Tuba, Benguet	2019
Barit Hydro	0.4	Buhi, Camarines Sur	2019
Tumauni (Lower Cascade)	7.8	Tumauni, Isabela	2019
Tumauni (Upper Cascade)	14	Tumauni, Isabela	2019
Tinoc 5	6.9	Tinoc, Ifugao	2019
Tinoc 6	8	Tinoc, Ifugao	2019
Alilem	16.2	Alilem, Ilocos Sur	2019
Kapipian	2.4	San Miguel, Catanduanes	2020
Ilaguen*	19	San Mariano & San Guillermo, Isabela	2020
Cawayan 2	0.99	Sorsogon, Sorsogon	2020
Ilaguen 2*	14	Dinapigue, Isabela	2020
Danac	13.2	Sugpon, Ilocos Sur	2020
Matuno	8	Bambang, Nueva Vizcaya	2020
Dibuluan	5	San Agustin, Isabela	2020
100 MW Alimit*	100	Lagawe, Ifugao	2021
240 MW Alimit*	240	Ifugao	2021
Olilicon HEPP*	10	Ifugao	2021
Maris Main Canal 1 HEP*	6	Ramon, Isabela	2021
Maapon River Mini-Hydro	2.6	Brgy. Piis, Lucban, Quezon	TBD
Maris Main Canal 2 HEP*	1.75	Alfonso Lista, Ifugao	TBD
Sub-Total Hydro	517.8		
WIND			
Pasuguin East Wind*	48	Pasuguin, Ilocos Norte	2016
Sembrano Wind*	72	Mt. Sembrano, Mabitac, Laguna	2017
Balaoi Wind	45	Brgy. Balaoi, Pagudpud, Ilocos Norte	2017
Pagudpud Wind	84	Brgy. Balaoi and Caunayan, Pagudpud, Ilocos Norte	2018
Sub-Total Wind	249		
BIOMASS			
CJGGEPC Waste-to-Energy	18	Camarines Sur	2015
GGREC Rice Husk-Fired Biomass	10.8	Nueva Ecija	2018
Napier Grass-Fired Biomass	10.8	Bataan	2018
Sub-Total Biomass	39.6		
TOTAL INDICATIVE	9,282.95		

*with SIS

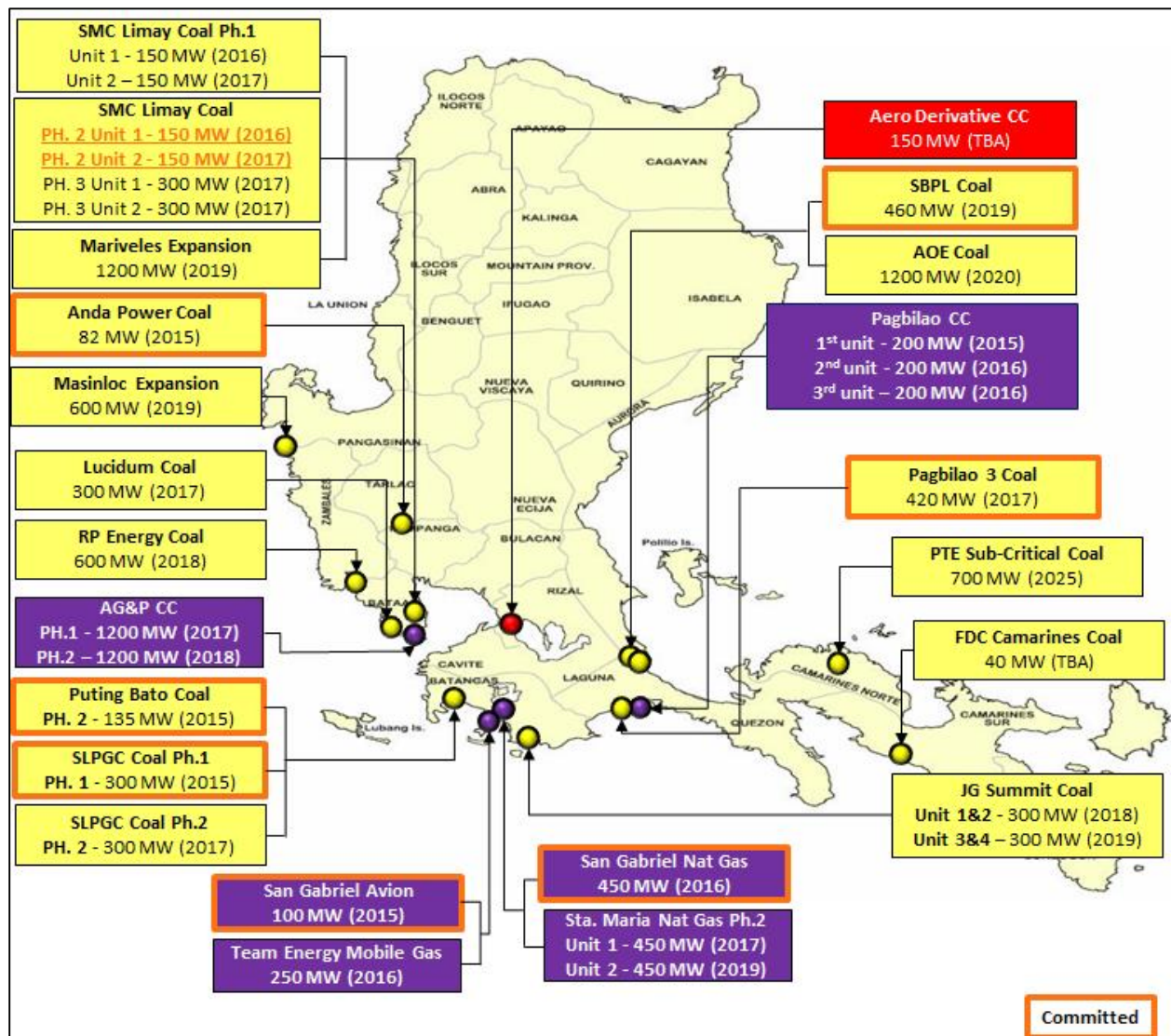


Figure 4.1(a): Luzon Generation Capacity Addition (Conventional Power Plants)

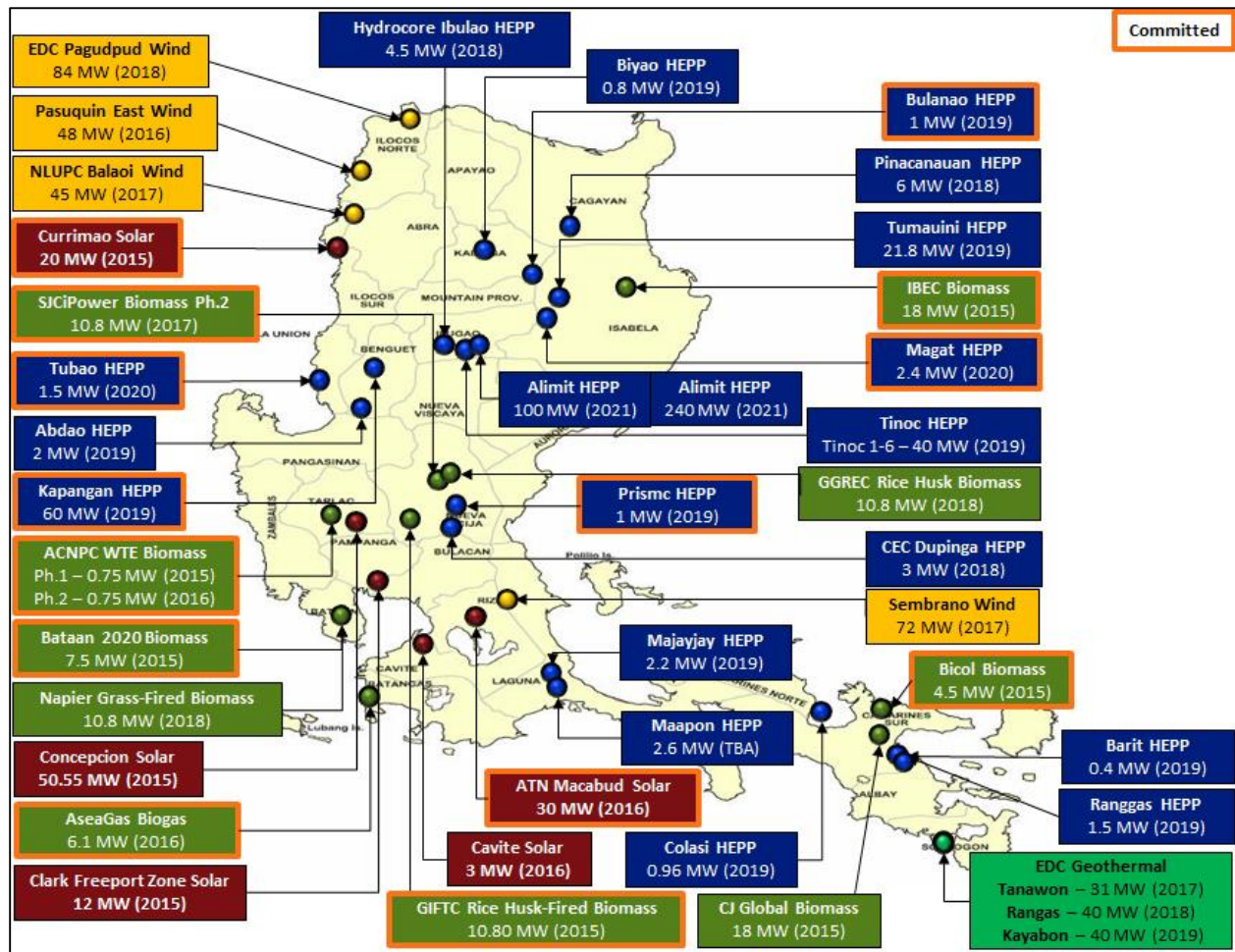


Figure 4.1(b): Luzon Generation Capacity Addition (Renewable Energy Plants)

Table 4.7(b): List of Visayas Generation Capacity Addition

Proposed Generation Facility / Name of the Project	Capacity (MW)	Location	Comm. Year
COMMITTED POWER PLANTS			
COAL			
Concepcion Coal Unit 1 and 2*	270	Brgy. Nipa, Concepcion, Iloilo	2016
Sub-Total Coal	270		
OIL-BASED			
Calumangan Diesel*	18.9	Brgy. Calumangan, Bago City, Negros Occidental	2015
Sub-Total Oil-Based	18.9		
BIOMASS			
Universal Robina Corporation Bagasse Cogeneration Phase 2*	17	Kabankalan, Negros Occidental	2015
VMCI Bagasse-Fired Cogeneration Plant*	3	Negros Occidental	2015
Sub-Total Biomass	20		
HYDRO			
Villasiga HEPP*	8	Brgy. Igsoro, Bugasong, Antique	2015
Igbulo (Bais) Hydro*	5.1	Igbaras, Iloilo	2018
Cantakoy HEP*	8	Danao, Bohol	2018
Proposed Generation Facility / Name of the Project	Capacity (MW)	Location	Comm. Year
Amlan	0.8	Amlan, Negros Oriental	2019
Sub-Total Hydro	21.9		
WIND			
Nabas Wind*	14	Brgy. Pawa, Nabas Aklan	2015
Sub-Total Wind	14		
GEOTHERMAL			
Biliran Geothermal*	10	Biliran, Biliran	2016
Sub-Total Geothermal	10		
SOLAR			
San Carlos Solar* Phase C-10 Phase D-13	23	San Carlos City, Negros Occidental	2015
La Carlota Solar Phase A* (SACASOL II-A)	18	La Carlota City, Negros Occidental	2015
Cadiz Solar*	132.5	Brgy. Tinampa-an, Cadiz City, Negros Occidental	2016
Sub-Total Solar	173.5		
TOTAL COMMITTED	528.3		
INDICATIVE POWER PLANTS			
COAL			
PEDC Expansion	150	Brgy. Ingore, La Paz, Iloilo	2016
Therma Visayas Energy Unit 1*	150	Brgy. Bato, Toledo City, Cebu	2017
Therma Visayas Energy Unit 2*	150	Brgy. Bato, Toledo City, Cebu	2018
Sub-Total Coal	450		
GEOTHERMAL			
Dauin Geothermal	40	Dauin, Negros Oriental	2021
Sub-Total Geothermal	40		
SOLAR			
Miag-ao Solar*	5.67	Miag-ao, Iloilo	TBD
Sub-Total Solar	5.67		

Proposed Generation Facility / Name of the Project	Capacity (MW)	Location	Comm. Year
WIND			
Pulupandan Wind	50	Pulupandan, Negros Occidental	2016
Sub-Total Wind	50		
HYDRO			
Timbaban Hydro*	18	Madalag, Aklan	2018
Loboc Hydro	1.2	Loboc, Bohol	2018
Hilabangan (Upper Cascade)	4.8	Kabankalan, Negros Occidental	2018
Hilabangan (Lower Cascade)	3	Kabankalan, Negros Occidental	2018
Main Aklan River Hydro	15	Libacao, Aklan	2018
Maninila (Lower Cascade)	4.5	San Remigio, Antique	2018
Maninila (Upper Cascade)	3.1	San Remigio, Antique	2018
Sibalom (Upper Cascade)	4.2	San Remigio, Antique	2018
Sibalom (Middle Cascade)	4	San Remigio, Antique	2018
Sibalom (Lower Cascade)	4	San Remigio, Antique	2018
Basak II	0.5	Badian, Cebu	2019
Amlan(Plant A and B)*	4.7	Amlan, Negros Oriental	2019
Malugo	6	Silay City, Negros	2019
Sub-Total Hydro	73		
BIOMASS			
SCBiopower Bagasse-Fired*	18	Negros Occidental	2015
Mina Multi-Fuel Biomass Phase 1*	16.5	Iloilo	2017
Mina Multi-Fuel Biomass Phase 2*	16.5	Iloilo	2018
MCEI Multi-Feedstock Biomass	10.8	Negros Occidental	2018
Sub-total Biomass	61.8		
BATTERY			
AES Battery Storage*	40	Kabankalan, Negros Occidental	2016
Sub-Total Battery	40		
TOTAL INDICATIVE	720.47		

*with SIS

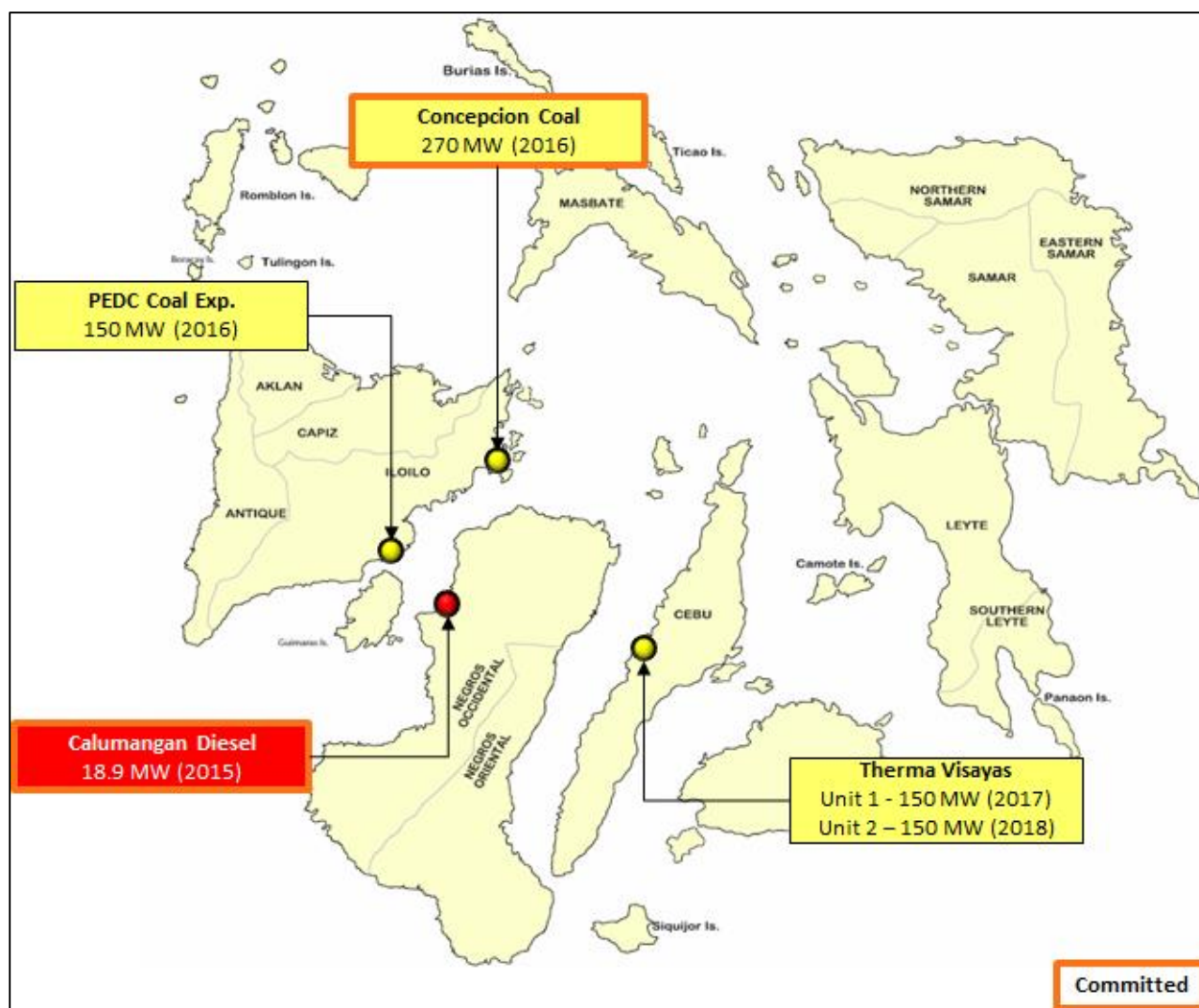


Figure 4.2(a): Visayas Generation Capacity Addition (Conventional Power Plants)

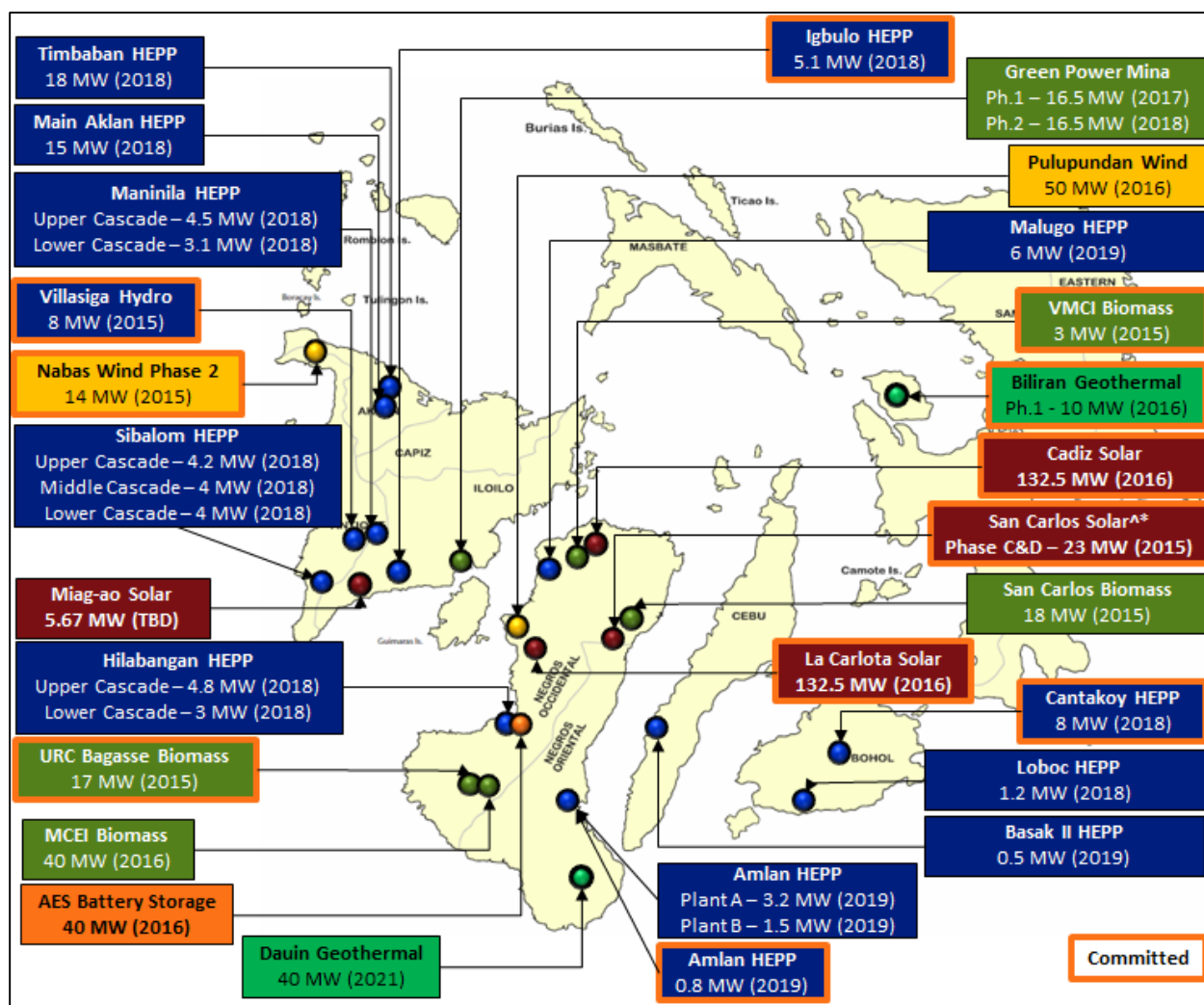


Figure 4.2(b): Visayas Generation Capacity Addition (Renewable Energy Plants)

Table 4.7(c): List of Mindanao Generation Capacity Addition

Proposed Generation Facility / Name of the Project	Capacity (MW)	Location	Comm. Year
COMMITTED POWER PLANTS			
COAL			
Therma South Inc. Unit 1*	150	Brgy. Binugao, Toril, Davao City and Brgy. Inawayan, Sta. Cruz, Davao del Sur	2015
Southern Mindanao Unit 1*	100	Brgy. Kamanga, Maasim, Sarangani	2015
Therma South Inc. Unit 2*	150	Brgy. Binugao, Toril, Davao City and Brgy. Inawayan, Sta. Cruz, Davao del Sur	2016
SMC Davao Phase 1*	300	Brgy. Culaman, Malita, Davao del Sur	2016
FDC-Misamis Coal*	405	Phividec Industrial Estate, Villanueva, Misamis Oriental	2016
Southern Mindanao Unit 2*	100	Brgy. Kamanga, Maasim, Sarangani	2016
Balingasag Thermal Power Plant*	165	Brgy. Mandangao, Balingasag, Misamis Oriental	2017
GNPower Kauswagan Ltd.*	540	Kauswagan, Lanao del Norte	2018
Sub-Total Coal	1,910		
DIESEL			
SPC Koronadal Diesel*	11.9	Purok Garfin, Brgy. Paraiso, Koronadal, South Cotabato	2015
Sub-Total Diesel	11.9		
BIOMASS			
PTCI Rice Husk-Fired Biomass	1.6	Maguindanao	2015
GEEC Biomass Cogeneration System	2.6	Maguindanao	2015
LPC Rice Husk-Fired Biomass*	10	Maguindanao	2016
Sub-Total Biomass	14.2		
HYDRO			
Lake Mainit*	25	Jabonga, Agusan del Norte	2016
New Bataan	2.4	New Bataan, Compostela Valley	2017
Puyo Hydro	30	Jabonga, Agusan del Norte	2018
Asiga HEPP	8	Santiago, Agusan del Norte	2019
Manolo Fortich 1*	43.4	Santiago, Bukidnon	2019
Manolo Fortich 2*	25.4	Santiago, Bukidnon	2019
Sub-Total Hydro	134.2		
TOTAL COMMITTED	2,070.3		
INDICATIVE POWER PLANTS			
COAL			
SMC Davao Phase 3	600	Brgy. Culaman, Malita, Davao del Sur	2016
Sibuguey Power	100	Subugay, Zamboanga	2016
Ozamiz Power*	300	Brgy. Pulot, Ozamiz City, Misamis Occidental	2018
SMC Davao Phase 2*	300	Brgy. Culaman, Malita, Davao del Sur	2018
SRPI Circulating Fluidized Bed Coal*	100	Sitio, San Ramon, Brgy. Talisayan, Zamboanga City	TBD
Sub-Total Coal	1,400		
GEOHERMAL			
Mindanao 3 Geothermal*	40	Kidapawan, North Cotabato	2018
Sub-Total Geothermal	40		
SOLAR			
Digos Solar*	10	Digos City, Davao del Sur	2015
Digos Solar 2*	19.58	Digos City, Davao del Sur	2015
Kibawe Solar	10.49	Brgy. Labuagon, Kibawe, Bukidnon	2016
Kirahon Solar Phase 1	12.5	Brgy. Kirahon, Villanueva, Misamis Oriental	2016
Centralla Solar	6.25	Brgy. Centralla, Surallah, South Cotabato	TBD
Sub-Total Solar	58.82		

Proposed Generation Facility / Name of the Project	Capacity (MW)	Location	Comm. Year
HYDRO			
Limbatangon Hydro	9	Cagayan de Oro, Misamis Oriental	2018
Tagoloan	39	Impasugong & Sumilao, Bukidnon	2018
Culaman Hydro*	10	Manolo Fortich, Bukidnon	2018
Cabadbaran Hydro*	9.75	Cabadbaran, Agusan del Norte	2018
Tumalaong Hydro	9	Baungon, Bukidnon	2018
Pasonanca	0.5	Zamboanga City	2019
Clarin*	5	Clarin, Misamis Occidental	2019
Mat-i-1*	2	Claveria, Cagayan de Oro	2019
Mat-i-2*	1.6	Cagayan de Oro, Misamis Oriental	2019
Mat-i-3*	3.25	Cagayan de Oro, Misamis Oriental	2019
Mangima Hydro	10	Manolo Fortich, Bukidnon	2019
Maladugao River (Upper Cascade)	5.5	Wao, Bukidnon	2020
Maladugao River (Lower Cascade)	10	Kalilangan & Wao, Bukidnon	2020
Lanon (Lam-alu)	9.5	Lake Sebu, South Cotabato	2020
Silo-o*	3.29	Malitbog, Bukidnon	2020
Agus III	225	Pantar & Balo-I, Lanao del Sur & Lanao del Norte	2020
Sub-Total Hydro	352.39		
BIOMASS			
EPC Woody Biomass*	21	Agusan del Norte	2015
Kalilangan Bio-Energy	9	Bukidnon	2016
Don Carlos Bio-Energy	9	Bukidnon	2016
Malay-balay Bio-Energy	9	Bukidnon	2016
Biomass Power Plant	10.8	Misamis Oriental	2017
Napier Grass-Fired Biomass	10.8	Bukidnon	2018
Sub-total Biomass	69.6		
TOTAL INDICATIVE	1,920.81		

*with SIS

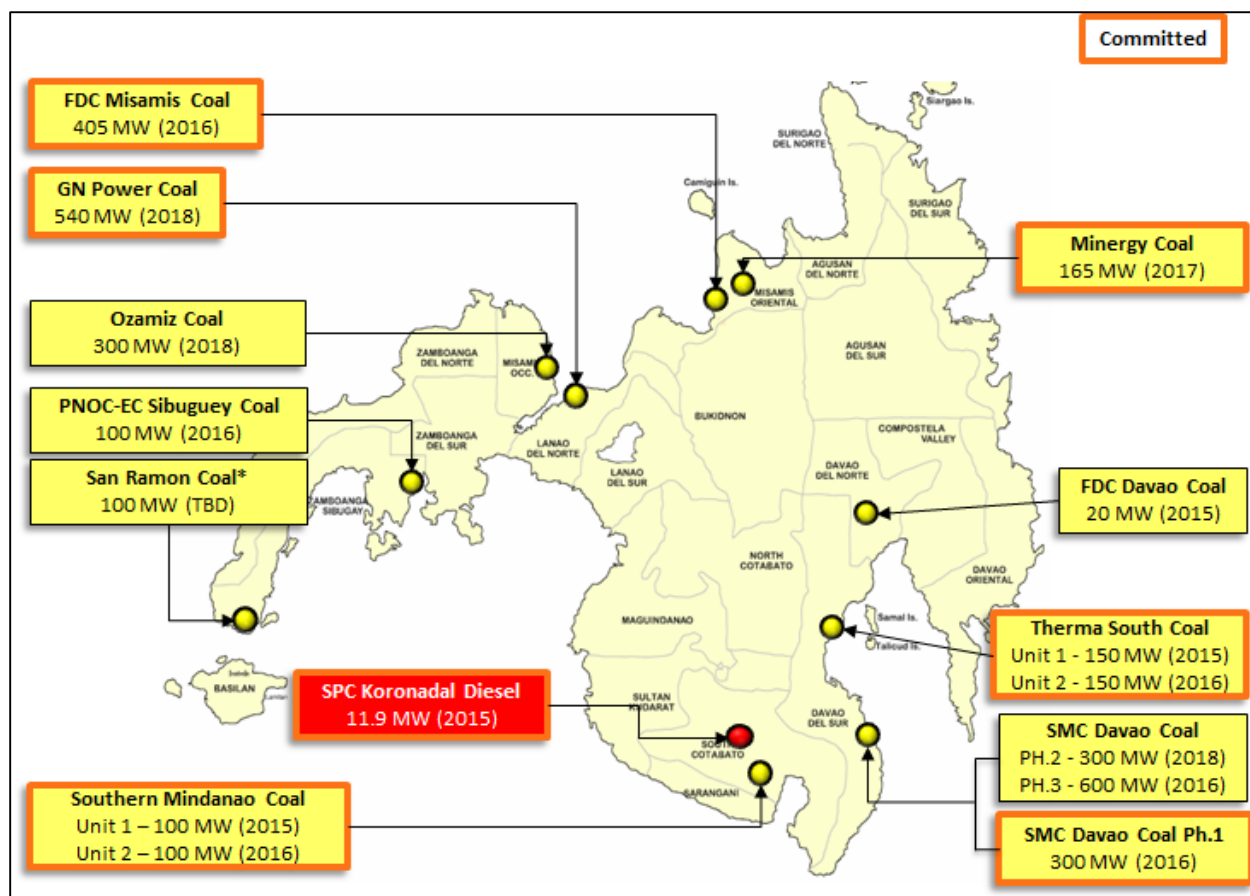


Figure 4.3(a): Mindanao Generation Capacity Addition (Conventional Power Plants)

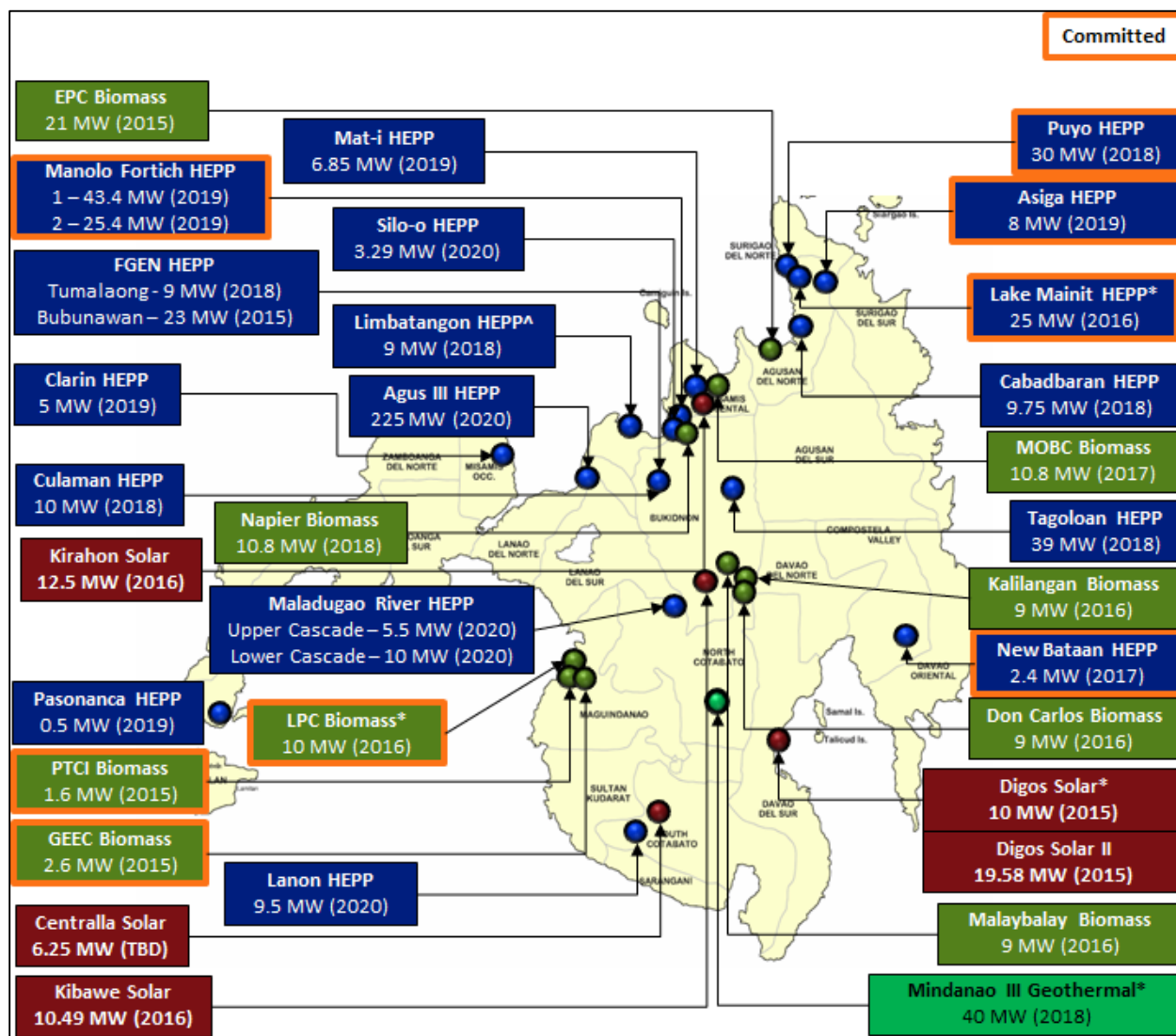


Figure 4.3(b): Mindanao Generation Capacity Addition (Renewable Energy Plants)

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Chapter 5 – ERC Approved Projects

The projects already approved by the ERC are in various stages of implementation. The approval, as contained in the Final Determination (FD), was obtained in 2010 during the regulatory reset process for the Third Regulatory Period. In addition, there are other projects provisionally approved by the ERC as of December 31, 2015 which will form part of the application for the Fourth Regulatory Period to obtain the final approval.

5.1 Projects Completed in 2014 and 2015

Summarized below are the projects completed or energized from 01 January 2014 to 31 December 2015. In this period, NGCP completed a total of 647 circuit-km of overhead transmission lines and installed 1,350 MVA additional substation capacities and 600 MVAR of reactive power support. The list below also indicated the new names of substations based on the Standard Equipment Identification and Labeling or SEIL.

Table 5.1: Completed Projects in 2014-2015

Project Name / Original Name	Purpose	MVA	MVAR	CKT-KM	Date of Completion / Energization
LUZON					
Dasmariñas EHV S/S Expansion Project	To maintain the provision for N-1 contingency for the transformers at Dasmariñas drawdown substation.	900			Oct 2014
Mariveles Coal Transmission Reinforcement Project -BCCPP S/S Expansion	To maintain the N-1 contingency provision of the line during maximum dispatch of both Mariveles CFPP and Limay B-CCPP units.				Dec 2014
Lumban-Bay 230 kV T/L Project -Lumban-Kalayaan Line 1 -Lumban-Bay Line 2 -Lumban-Calauan Line 2 -Lumban-Bay Line 1 -Lumban-Malaya Line 1	To increase the capacity of this corridor in order to accommodate any generation dispatch scenarios			40	Jan 2015 Mar 2015 Mar 2015 Mar 2015 May 2015
Luzon Voltage Improvement Project 2 -Biñan S/S -Dasmariñas S/S -Mexico S/S	To improve voltage regulation and keep the voltages in the area within the Grid Code prescribed limits both during normal and N-1 contingency conditions.		200 200 200		Apr 2015 Mar 2015 Apr 2015
Luzon S/S Expansion Project 2 -Ambuklao S/S -Concepcion S/S -La Trinidad S/S -Mexico S/S -Santiago S/S	To meet load growth and to provide N-1 contingency to various substations in North Luzon.	50 100 600 400			Dec 2014 Aug 2014 Oct 2014 Jun 2015 Jul 2014
Luzon S/S Expansion Project 3 -Batangas S/S	To maintain the provision for N-1 contingency due to increasing load.	300			Nov 2014

Project Name / Original Name	Purpose	MVA	MVAR	CKT-KM	Date of Completion / Energization
Luzon S/S Expansion Project 4 -Bayombong S/S -Limay S/S -Muntinlupa S/S	To add substation capacity to accommodate load growth.	75 100 300			Aug 2015 Dec 2014 Mar 2015
San Esteban-Laoag 230 kV T/L Project Stage 2 -Line 2	To strengthen the existing corridor to provide N-1 contingency and to support the wind farm connections.			120	Sep 2015
VISAYAS					
Bohol Backbone 138 kV T/L	The Ubay-Corella 138 kV line is necessary to prevent the overloading of Ubay-Trinidad 69 kV line during outage of Ubay-Alicia 69 kV line segment, and vice versa. The new substation in Corella will provide a new bulk power delivery point in Bohol and help reduce the load of Ubay S/S.	100		191	June 2014
Visayas S/S Expansion Project 1 -Calong calong S/S -Kabankalan S/S	To accommodate the projected load growth in the area.	50 50			Sep 2014 Mar 2014
MINDANAO					
Maramag-Kibawe 138 kV T/L Project	To maintain reliability in the southern Mindanao area in case of outage of Agus 2-Kibawe.			21	July 2014
Mindanao S/S Reliability Project 1 -Aurora S/S	To provide N-1 contingency transformers at various substations	100			Feb 2014
Villanueva-Maramag 230 kV T/L Project	To complete the transmission corridor from northern to southern Mindanao.			216	Aug 2014
Balo-i-Villanueva 230 kV T/L Project	To provide new transmission corridor to Agus Hydro for higher reliability.			240	Jan 2015
TOTAL					
		1,350	600	647	

In addition to the above list, there are transmission projects that are not part of the Final Determination for the Third Regulatory Period but have been reclassified from connection asset to transmission asset. It also includes ERC approved projects implemented in advance by the concerned power plant proponents. The facilities in this table are either for acquisition or for reimbursement to the power plant proponent.

Project Name / Original Name	Purpose	MVA	MVAR	CKT-KM	Date of Completion / Energization
LUZON					
Hanjin 230 kV Substation	This is an existing substation constructed to accommodate the connection of Hanjin Heavy Industries and Construction Philippines, Inc. (HHIC-PHIL Inc.) in Subic. Because of its cut-in configuration to the Botolan-Olongapo 230 kV Line, the Hanjin Substation itself is part of the transmission corridor, thus, reclassified by the ERC to transmission asset. The main components reclassified are the cut-in lines and the 230 kV switchyard excluding the existing 2x83 MVA transformers which are dedicated facilities to HHIC-PHIL Inc.			34	2007 (Reclassified in October 2011)
Mariveles 230 kV Substation	This substation is presently serving the Mariveles Coal-Fired Power Plant and load customers namely PENELCO and AFAB through a 100 MVA 230/69 kV transformer and new 69 kV lines. The ERC has reclassified the substation including the Mariveles-BCCPP A 230 kV Transmission Line from connection asset to transmission asset.	100		36	2013 (Reclassified in June 2014)
MINDANAO					
Toril 138 kV Substation (Stage 1)	This project was implemented in advance by Therma South Inc. (TSI) to accommodate the connection of the 2x150 MW TSI CFPP. It involves a new substation connected as bus-in to the Matanao-Davao 138 kV Transmission Line. Due to limited line capacity, the implemented project also included the reconductoring of the Toril-Davao Line segment.				2015
TOTAL		100		70	

5.2 Projects for Completion in 2016

The list below summarized the updates on other ERC approved projects and with the indicated expected time of completion or ETC. This includes the previously completed projects but still with some remaining components yet for completion.

Table 5.1: Projects for Completion in 2016

Project Name	Driver	Purpose & Remaining Major Components	ETC
LUZON			
Luzon Substation Expansion III	LG	To add substation capacity to accommodate load growth. Batangas: 1-300 MVA 230/69 kV transformer Bay: 1-100 MVA 230/69 kV transformer	Mar 2016
Luzon Substation Reliability I	SR	To add substation capacity to provide N-1 contingency Botolan: 1-50 MVA 230/69 kV transformer Labo: 1-50 MVA 230/69 kV transformer San Esteban: 1-50 MVA 115/69 kV transformer	Mar 2016
Luzon PCB Replacement	SR	To replace old PCBs to improve substation reliability at San Jose, Labo, Malaya and Gumaca.	Mar 2016
Luzon Substation Expansion IV	LG	To add substation capacity to accommodate load growth. Daraga: 1-100 MVA 230/69 kV transformer Gumaca: 1-50 MVA 230/69 kV transformer Santiago: 2-100 MVA 230/69 kV transformer Tuguegarao: 1-100 MVA 230/69 kV transformer Nagsaag EHV: 1-100 MVA 230/69 kV transformer	Sep 2016
Luzon Voltage Improvement I	PQ	To maintain the voltage profile at various substations within the prescribed limits Doña Imelda: 2-50 MVAR 115 kV capacitor	Jun 2016
Santiago-Tuguegarao 230 kV Line 2	SR	To provide N-1 contingency for the existing transmission corridor serving Isabela and Cagayan Santiago-Tuguegarao: 1-795 MCM ACSR, 118 km	Sep 2016
Dasmariñas EHV Substation	SR	The installation of new 1-600 MVA 500/230 kV transformer has been completed already. The remaining project component is the replacement of some 230 kV PCBs to increase the fault interrupting capability of the substation.	Mar 2016
Bacnotan Tap-Bacnotan 230 kV T/L	SR	To improve the reliability of the Bauang-Bacnotan-San Esteban Line by replacing the wood pole structures with steel tower structures in the segment immediate to Bacnotan Substation. This is an ERC approved project originally under O&M capex.	Apr 2016
Balingueo (Sta. Barbara) 230 kV S/S	LG	To provide a new substation to adequately and reliably serve the load centers in the province of Pangasinan Balingueo: 1-100 MVA 230/69 kV transformer	Jun 2016
Eastern Albay 69 kV T/L Stage 1	LG,SR	To provide reliable power service delivery in eastern Albay by developing new 69 kV supply line and a new 69 kV substation in Sto. Domingo. Daraga-Sto. Domingo: 1-336.4 MCM ACSR, SP-SC, 20 km	Aug 2016
Las Piñas (Zapote) S/S Expansion	LG,SR	Installation of the 4 th transformer unit for N-1 contingency for the 230/115 kV transformers Las Piñas: 1-300 MVA 230/115 kV transformer	Sep 2016

Project Name	Driver	Purpose & Remaining Major Components	ETC
VISAYAS			
Negros V T/L	LG	To accommodate load growth in Northeastern Negros and to provide operational flexibility San Carlos-Guihulngan: 69 kV 1-336.4 MCM ACSR, ST-SC, 58 km	Sep 2016
Southern Panay Backbone	LG	To accommodate load growth in Southern Panay by extending the 138 kV backbone. San Jose: 1-50 MVA 138/69 kV transformer	Apr 2016
Ormoc-Maasin 138kV T/L	SR	To provide N-1 contingency for the existing corridor Ormoc-Maasin: 138 kV 1-795 MCM ACSR, ST-DC2, 113.97 km	Jun 2016
Colon-Cebu T/L	CA	To provide additional capacity to meet load growth and to accommodate the full dispatch of coal plants Colon-Cebu: 138 kV 1-795 MCM ACSR, ST-DC, 25 km	Apr 2016
Calong-Calong-Toledo-Colon 138 kV T/L	GE	To accommodate the full generation capacity of the 246 MW CEDC Coal and the 82 MW TPC Coal Calong-calong-Colon: 1-795 MCM ACSR, ST-DC, 28 km	Apr 2016
Ormoc-Babatngon 138 kV T/L	SR	To provide N-1 contingency for the existing corridor by installing the second circuit Ormoc-Babatngon: 1-795 MCM ACSR, ST-DC1, 78.54 km	Sep 2016
Visayas Substation Reliability I	SR	To add substation capacity to provide N-1 contingency Ormoc: 1-150 MVA 230/138 kV transformer Amlan: 1-50 MVA 138/69 kV transformer Bacolod: 1-100 MVA 138/69 kV transformer Cadiz: 1-50 MVA 138/69 kV transformer Maasin: 1-50 MVA 138/69 kV transformer Samboan: 1-50 MVA 138/69 kV transformer	Sep 2016
Culasi-San Jose 69 kV T/L	SR	To provide N-1 contingency for the existing corridor Culasi-San Jose: 1-336.4 MCM ACSR, ST-SC, 86 km	Apr 2016
Eastern Panay Transmission Project	GE	To accommodate the grid connection of PCPC's 300 MW CFPP implemented by the power plant proponent	Jun 2016
MINDANAO			
Mindanao Substation Reliability I	SR	To provide N-1 contingency transformers at various substations Jasaan: 1-100MVA 138/69 kV transformer Lugait: 1-75MVA 138/69 kV transformer intended for this substation was installed in Opol Substation instead.	Mar 2016
Agus 6 Switchyard Upgrading / Rehabilitation	SR	To ensure the operational reliability of the plant's switchyard	Oct 2016
Malita-Matanao 230 kV T/L	GE	To accommodate the grid connection of SMCP's CFPP Malita-Matanao: 230 kV 2-410mm ² TACSR, ST-DC, 67 km transmission line Malita (New): 1-50 MVA 138/69 kV transformer	Mar 2016
Matanao-Gen. Santos 138 kV T/L	SR	To provide N-1 contingency capability to the transmission corridor Matanao-Gen.Santos: 138 kV 1-795 MCM ACSR, ST-SC, 72.60 km transmission line	Mar 2016

Project Name	Driver	Purpose & Remaining Major Components	ETC
Opol 138 kV S/S	LG, SR, PQ	To address the increase in demand and improve power quality in the area Opol: 1-75 MVA 138/69 kV transformer. This transformer was originally planned for Lugait Substation.	Mar 2016
Butuan-Placer 138 kV T/L	SR	To provide N-1 contingency to the existing line Butuan-Placer: 138 kV 1-795MCM ACSR, ST-SC, 96 km transmission line	Jul 2016
Sultan Kudarat (Nuling) Capacitor Project	SR, PQ	To improve the voltage profile in the area Sultan Kudarat SS: 2-7.5 MVAR 69 kV capacitor	Mar 2016
Mindanao Substation Expansion Project 2	LG	To add substation capacity to meet load growth Gen. Santos SS: 1-100 MVA 138/69 kV transformer Kidapawan SS: Transfer of 1-50 MVA 138/69 kV transformer from General Santos Substation.	Jun 2016

GE – Generation Entry; SR – System Reliability; LG – Load Growth; PQ – Power Quality;

5.3 Projects for Completion in 2017 onwards

The list below summarized the updates on the remaining ERC approved projects with ETC by 2017 onwards.

Table 5.1: Projects for Completion in 2017 onwards

Project Name	Driver	Purpose	ETC
LUZON			
Ambuklao-Binga 230kV T/L	SR	To address the old age condition of the line and accommodate the generation capacity addition in Cagayan Valley area.	Dec 2018
Binga-San Manuel 230 kV T/L Stage 1 & 2	SR	To address the old age condition of the line and provide N-1 contingency during maximum dispatch of the generating power plants in North Luzon.	Dec 2018
New Antipolo 230 kV Substation	LG	To accommodate the demand increase in Metro Manila and maintain the N-1 contingency provision for Taytay Substation.	Dec 2018
San Jose-Angat 115 kV Line Upgrading	SR	To address the old age condition and reliability issues in the existing line serving the Angat Hydroelectric Power Plant.	Jun 2017
San Jose-Quezon 230 kV Line 3	SR	To increase transfer capacity of the existing corridor and maintain the N-1 contingency provision.	Dec 2017
Tuguegarao-Lal-lo (Magapit) 230 kV T/L	PQ, LG	To improve the power quality and reliability of supply in the province of Cagayan and this will form part of the development of the Northern Luzon 230 kV Loop that will cater the wind power generation potential in the region.	Oct 2018
Calaca-Dasmariñas T/L (to be designed at 500 kV)	GE, SR	To reinforce the outgoing 230 kV line from Calaca Substation and accommodate the full dispatch of the incoming power plants in Batangas area.	Jun 2019
Eastern Albay 69 kV Line Stage 2	SR	To provide the looping configuration for the 69 kV line in eastern Albay.	Jun 2019
Hermosa-Floridablanca 69 kV T/L	LG	To relieve the overloading of the existing Hermosa-Guagua line and address the low voltage issues in the area.	Mar 2018

Project Name	Driver	Purpose	ETC
Western 500 kV Backbone (Stage 1)	GE	To develop a 500 kV western corridor that will accommodate the bulk generation in Zambales area and to improve the overall reliability, security and stability of the 500 kV system.	Mar 2019
Bataan-Cavite FS	GE	To conduct hydrographic survey and other survey works for the submarine cable project that will support the delivery of bulk generation from Bataan area to the load center in an alternate route.	Dec 2017
VISAYAS			
Cebu-Lapu-lapu T/L	SR	To increase transfer capacity of the existing corridor and maintain the N-1 contingency provision.	Sep 2017
Cebu-Negros-Panay 230 kV Backbone, Stage 1	GE,SR	To increase transfer capacity of the existing corridor and maintain the N-1 contingency provision. The Negros-Panay submarine cable component of this project will already be completed by Aug 2016.	Mar 2017
Visayas Substation Reliability II	SR	To add substation capacity to provide N-1 contingency	Jan 2017
MINDANAO			
Aurora-Polanco 138 kV T/L	LG	To serve the growing power demand in Zamboanga del Norte area	Dec 2018
Balo-i-Kauswagan-Aurora 230 kV T/L (Phase 1)	GE	To accommodate the proposed 4x600MW coal-fired power plant of GNPowder in Kauswagan.	Aug 2017
Toril 138 kV S/S, Stage 2	GE	To provide 138/69 kV transformer in order to serve load customers such as DASURECO and DLPC	Dec 2017
Tacurong-Kalamansig 69 kV Line	SR	To provide a grid connection to the off-grid municipalities in Sultan Kudarat province	Oct 2019
Agus 2 Switchyard Upgrading Project	SR	To address the deteriorating physical and operational condition of the switchyard	Feb 2018

GE – Generation Entry; SR – System Reliability; LG – Load Growth; PQ – Power Quality;

5.3.1 Luzon Grid

5.3.1.1 Ambuklao-Binga 230 kV Transmission Line Upgrading

Major Project Components

- **Ambuklao-Binga 230 kV T/L**, ST-DC, 2-410mm² TACSR, 11 km;
- **Ambuklao 230 kV S/S**, 6-230 kV PCB and associated equipment.

This project aims to upgrade the existing line in order to address its old age condition and also to maintain the N-1 contingency provision taking

into consideration the repowering of Ambuklao HEPP to a new capacity of 105 MW and generation capacity additions from Alimit 2 X 60 MW Hydroelectric Power Plant, Olilicon 1 X 20 MW Hydroelectric Power Plant, and Alimit 2 X 125 Pumped Storage. Thus, during maximum generation of the power plants, this project will prevent the overloading under N-1 contingency condition, i.e, outage of one 230 kV circuit.

5.3.1.2 Binga-San Manuel 230 kV Transmission Line

Major Project Components

- **Binga – San Manuel 230 kV T/L**, ST-DC, 2-410 mm² TACSR, 40 km;
- **Binga S/S Expansion**, 1-50 MVA 230/69-13.8 kV Transformer, 10-230 kV PCB and associated equipment; 2-69 kV PCB and associated equipment;
- **San Manuel S/S Expansion**, 2-230 kV PCB and associated equipment.

This project involves the construction of a new 40 km double circuit Binga-San Manuel 230 kV transmission line using new right-of-way,

including the installation of switching facilities at Binga and San Manuel Substations. The project aims to provide N-1 contingency during maximum dispatch of the generating plants, particularly HEPPs, in north Luzon. The existing line, as well as the power circuit breakers at Binga Substation, which were constructed/installed in 1956 have already surpassed the economic life. Moreover, there are developments in the power plants affecting the power flow at Binga-San Manuel 230 kV line. These include the repowering of Ambuklao HEPP to a new capacity of 105 MW (previously at 75 MW capacity) and the completion of Binga HEPP expansion to an additional capacity of 25 MW, and the other generation developments in Cagayan Valley area.

5.3.1.3 New Antipolo 230 kV Substation

Major Project Components

- **Bus-in point along San Jose-Taytay 230 kV T/L**, ST-DC 4-795 MCM ACSR, 2 km;
- **Antipolo 230 kV S/S**, 12-230 kV PCB and associated equipment; 2-100 MVAR 230 kV Capacitor.

This involves the new 230 kV substation that will bus-in along the existing ST-DC San Jose-Taytay 230 kV line with 4-794

MCM ACSR conductor. The demand increase in Metro Manila and the expansion constraints at Doña Imelda and Taytay Substations require the development of a new 230 kV delivery substation. Initially, Antipolo 230 kV Substation will have 2-300 MVA capacity with capacitor banks to be installed for voltage support. To draw supply from Antipolo, MERALCO will put up line connections to their existing 115 kV network in the area. In the 3rd Regulatory Period FD, the 2-300 MVA transformers and the 115 kV switchyard components were reclassified as subtransmission assets, thus, only the 230 kV switchyard, 230 kV capacitors, and the 230 kV line extension will be covered by NGCP's project.

5.3.1.4 San Jose-Angat 115 kV Line Upgrading

Major Project Components

- **San Jose-Angat 115 kV T/L**, ST-DC 2-795 MCM ACSR, 18 km;
- **San Jose 115 kV S/S**, 2-115 kV PCB and associated equipment.

This project aims to ensure the reliability of the existing 115 kV transmission lines connecting

Angat HEPP to the Luzon Grid. San Jose-Angat Lines 1 and 2 were built in 1967 while Line 3 (woodpole) was built in 1960. The project involves the construction of a new 115 kV double-circuit line using the existing right-of-way of San Jose-Angat Line 3. The capacity already anticipates the future retirement of Lines 1 and 2, which will be 50 years old already by 2017. Since there are customers connected to the existing lines through tap connection, they will be served by the existing Lines 1 and 2 (radially from San Jose Substation) upon completion of the upgrading project. A 115 kV switching station along the upgraded line will be necessary later to provide a connection point for the customers. With the completion of this project, the San Jose-Angat 115 kV line will become a more reliable transmission corridor. The 300 MVA capacity per circuit of the project would be sufficient to provide N-1 contingency during maximum dispatch of the 246 MW

Angat HEPP. If not implemented, transmission constraints could be experienced when there is an outage in Line 3.

5.3.1.5 San Jose-Quezon 230 kV Line 3

Major Project Components

- **San Jose-Quezon 230 kV T/L**, ST/SP-SC 2-610 mm² TACSR, 19 km;
- **San Jose 230 kV S/S**, 5-230 kV PCB and associated equipment;
- **Quezon 230 kV S/S**, Line Protection and Communication System.

This project involves the construction of the third circuit in the San Jose-Quezon 230 kV

transmission corridor. This will increase the transfer capacity of the line to address the projected overloading problem during an outage of one of the San Jose-Quezon circuits at peak load condition. Without this project, the dispatch of the power plants delivering power to the 500 kV system will have to be limited to maintain the N-1 contingency for the line this may result in supply adequacy issue and load dropping.

5.3.1.6 Tuguegarao-Lal-lo (Magapit) 230 kV Transmission Line

Major Project Components

- **Tuguegarao-Lal-lo 230 kV T/L**, ST-DC, 1-795 MCM ACSR, 64 km;
- **Lal-lo 230 kV S/S**, 2-100 MVA 230/69-13.8 kV Transformer, 6-230 kV PCB and associated equipment, 8-69 kV PCB and associated equipment;
- **Tuguegarao 230 kV S/S**, 3-230 kV PCB and associated equipment.

This project aims to improve the power quality and reliability of supply in the northern part of Cagayan Province which is presently being served by a

very long 69 kV line. The project involves the construction of a double-circuit 230 kV transmission line from Tuguegarao to Lal-lo and the development of a 230/69 kV Lal-lo drawdown substation. This will improve the power quality and reliability of supply to the growing loads in the area which include the Cagayan Ecozone. Moreover, this project will also become an integral part of the development of the Northern Luzon 230 kV loop which will link the north-western and north-eastern 230 kV backbone.

5.3.1.7 Calaca-Dasmariñas 230 kV Transmission Line

Major Project Components

- **Calaca-Dasmariñas 230 kV T/L (to be designed at 500 kV)**, ST-DC, 4-410 mm² TACSR, 57 km;
- **Dasmariñas S/S Expansion**, 2-230 kV PCB and associated equipment;
- **Sta. Rita Switchyard Expansion**, Line Protection and Communication System.

With the projected increase in demand in Luzon Grid, bulk generation capacity expansions are programmed in Batangas. The generation capacity

additions will turn Calaca Substation into a merging point of more than 2,000 MW of power generation. Based on the results of system study conducted, the existing outgoing 230 kV lines going to Dasmariñas and Biñan would not be enough to accommodate the full dispatch of the plants considering the single outage contingency criterion. Thus, the need to develop a new transmission line corridor from Calaca to Dasmariñas Substation. The resulting configuration would involve the direct delivery of power generation from Sta. Rita to Dasmariñas. In view of the recent developments in the capacity of the proposed power plant projects in the area, 500 kV design for the new line is now being considered but the line will be initially energized at 230 kV voltage level.

5.3.1.8 Eastern Albay 69 kV Transmission Line Stage 2

Major Project Components

- **Sto. Domingo-Tabaco 69 kV T/L**, ST/ SP - SC, 1-336.4 MCM ACSR, 18 km.

This project will complete the looping configuration of the 69 kV transmission facility in

eastern Albay. This will provide flexibility in operation and would allow continuous supply to the loads even during line maintenance activities. This will be complemented by another project, Luzon Substation Rehabilitation, which involves the installation of a 230/69 kV transformer at Tiwi Substation in order to provide adequate and reliable alternate source of power in addition to Daraga Substation.

5.3.1.9 Hermosa-Floridablanca 69 kV Transmission Line

Major Project Components

- **Hermosa-Floridablanca 69 kV T/L**, 1-795 MCM ACSR, SP-SC, 16.86 km;
- **Basa Air Base-100D 69 kV T/L**, 1-795 MCM ACSR, SP-SC, 2.86 km.

The existing Hermosa-Guagua 69 kV line is a 53 year old asset and is among the subtransmission lines already

reverted by the ERC to NGCP's Regulatory Asset Base (RAB). The said line has insufficient transfer capacity to accommodate load growth and the heavy loading condition has been resulting in low voltage issues. The Hermosa-Floridablanca 69 kV will ensure the adequacy, reliability and power quality of supply for the connected customers in the area.

5.3.1.10 Western 500 kV Backbone (Stage 1)

Major Project Components

- **Castillejos-Hermosa 500 kV T/L**, ST-DC, 4-410mm² TACSR, 32 km;
- **Hermosa 230 kV S/S**, 4-230 kV PCB and associated equipment.

The Castillejos-Hermosa 500 kV Transmission Line is the first

stage of the Western Luzon 500 kV Backbone that aims to accommodate the connection of RP Energy Coal-Fired Power Plant. The development of the western 500 kV backbone has been part of the master plan in order to improve the system security and reliability in accommodating bulk generation capacity additions.

5.3.1.11 Bataan-Cavite Transmission Line (Phase 1-Feasibility Study)

Major Project Components

- **Power System Study**
- **Feasibility Study**

Several power plant projects have been proposed on the

Luzon Grid and based on the data from the Department of Energy (DOE), the province of Bataan is one of the areas with expected bulk generation capacity additions. To transmit this bulk generation to Luzon load center in Metro Manila, transmission line projects will be required going up to Hermosa then to Metro Manila and submarine cable link from Bataan to Cavite area. For higher level of grid reliability and to support the bulk generation development, the establishment of a looped EHV backbone system including the Bataan – Cavite Transmission Line Project is envisioned for the Luzon Grid. Phase 1 of the project is the conduct of feasibility study to establish the appropriate project scheme and the receiving point in Cavite or Metro Manila side.

5.3.2 Visayas Grid

5.3.2.1 Cebu-Lapu-lapu Transmission Line

Major Project Components

- **Cebu-Umapad 230 kV T/L**, ST/SP-DC, 2-795 MCM ACSR, 9 km;
- **Umapad-Mandaue CJ 138 kV T/L**, SC, 3-1C 1,000mm² XLPE underground cable, 0.3 km;
- **Mandaue-Lapu-lapu CJ 138 kV T/L**, SC, 2-3C 500mm² XLPE Submarine Cable, 0.5km;
- **Lapu-lapu CJ-Lapu-lapu 138 kV T/L**, SC, 3-1C 1,000mm² XLPE underground cable, 0.1km;
- **Lapu-lapu 138 kV S/S**, 1-138 kV GIS Switchbay;
- **Umapad CTS**, Cable Sealing End Structures, 3-138 kV Disconnect Switches.

The project originally involves the construction of the third circuit from Cebu to Mandaue and from Mandaue to Lapulapu utilizing the same conductor and configuration as the existing circuits, i.e., underground cable from Banilad to Mandaue and under

the bridge cable from Mandaue to Mactan. Due implementation issues and also due to new developments in the area, reconsideration on the project scheme was conducted.

The new project configuration now involves 230 kV-designed overhead line will be used from Cebu to Mandaue and submarine cable from Mandaue to Lapulapu. The overhead line will tap along the existing Colon-Cebu 138kV line and will bypass Cebu and Mandaue Substations to minimize unbalanced loading due to difference in impedance between the proposed overhead line and the existing underground cable. Effectively, the project will connect Lapulapu Substation directly to Colon Substation.

Moreover, the overhead line will already be designed at 230 kV but initially energized at 138 kV taking into consideration the demand growth in Metro Cebu and the difficulty of acquiring available space for future transmission facilities as the area is highly urbanized.

5.3.2.2 Cebu-Negros-Panay 230 kV Backbone (Stage 1)

Major Project Components

- **Bacolod S/S - E. B. Magalona CTS, 230 kV (initially energized at 138 kV) T/L**, ST-DC, 2-795 MCM ACSR, 42 km;
- **Barotac Viejo S/S - E. B. Magalona CTS, 230 kV (but will be initially energized at 138 kV) T/L**, Single Circuit, 3-1,600 mm² XLPE submarine cable, 22.75 km;
- **Bacolod S/S Expansion**, 2-138 kV PCB and associated equipment;
- **E. B. Magalona CTS Expansion**, associated submarine cable termination equipment;
- **Barotac Viejo S/S Expansion**, 6-138 kV PCB and associated equipment, 1-40 MVAR, 138 kV shunt reactor, associated submarine cable termination equipment.

This is part of the major transmission backbone development in the Visayas Grid in order to support the generation developments and also to avert the criticality of island grid separations. The priority segment or the Stage 1 is the additional transmission capacity between Panay and

Negros in order to immediately address the congestion and market issues being encountered due to limited capacity of the existing submarine cable. This project involves initial energization to 138 kV voltage level only.

5.3.2.3 Visayas Substation Reliability Project II

Major Project Components
▪ Ormoc 138 kV S/S Expansion, 1-100 MVA 138/69-13.8 kV Transformer, 1-69 kV PCB and associated equipment; ▪ Babatngon 138 kV S/S Expansion, 1-50 MVA 138/69-13.8 kV Transformer, 1-138 kV PCB and associated equipment, 1-69 kV PCB and associated equipment; ▪ Sta. Barbara 138 kV S/S Expansion, 2-50 MVA 138/69-13.8 kV Transformer, 3-138 kV PCB and associated equipment, 3-69 kV PCB and associated equipment; ▪ Mandaue 138 kV S/S Expansion, 1-100 MVA 138/69-13.8 kV Transformer, 1-138 kV GIS Switch Bay, 1-69 kV GIS Switch Bay; ▪ Lapu-lapu 138 kV S/S Expansion, 1-100 MVA 138/69-13.8 kV Transformer, 1-138 kV GIS Switch Bay, 1-69 kV GIS Switch Bay.

The project is intended to improve the system reliability and maintain continuous supply of power to customers even during N-1 contingency condition at various substations in Visayas. It involves the installation of 450 MVA total substation capacity addition.

5.3.3 Mindanao Grid

5.3.3.1 Aurora-Polanco 138 kV Transmission Line

Major Project Components
▪ Aurora-Polanco 138 kV T/L, ST-DC, 1-795 MCM, 79 km; ▪ Polanco-Polanco (LES) 69 kV T/L, SP/CP-DC, 1-336.4 MCM ACSR, 11 km; ▪ Cut-in 69 kV T/L, SC-SP/CP 1-336.4 MCM, 4 km; ▪ Polanco 138 kV S/S (new), 1x75MVA 138/69/13.8 kV Transformer, 5-138 kV PCB and associated equipment, 4-69 kV PCB and associated equipment; ▪ Aurora 138 kV S/S (Expansion), 3-138 kV PCB and associated equipment; ▪ Polanco LES, 3-69 kV Air Break Switch.

The Aurora-Polanco 138 kV line and the Polanco Substation are intended to serve the growing power demand of Dipolog and neighboring load centers, such as Dapitan City. These new facilities will ensure a continuous and reliable power supply in the Zamboanga del

Norte area. At present, Dipolog City including its neighboring cities and towns, draw their power requirements from Aurora Substation in Zamboanga del Sur through a very long 69 kV single circuit wood pole transmission line with a capacity of 47 MW.

5.3.3.2 Balo-i-Kauswagan-Aurora 230 kV Transmission Line (Phase 1)

Major Project Components
Phase 1 ▪ Balo-I – Kauswagan 230 kV T/L, ST-DC, 2-410mm² TACSR, 11 km; ▪ Kauswagan 230 kV S/S, 10-230 kV PCB and associated equipment; ▪ Balo-I S/S Expansion, 4-230 kV PCB and associated equipment .

There is a need to implement a new double circuit 230 kV line from Kauswagan Substation to Balo-i Substation to

accommodate the proposed 4x600 MW Coal Plant of GN Power. Moreover, considering the growing demand and reliability of the existing transmission line connecting the Zamboanga Peninsula to the Mindanao Grid, it is necessary to construct an additional double circuit 230 kV line from Kauswagan Substation to Aurora Substation. This is in lieu of the deferred Agus 6 – Aurora 138 kV Transmission Line Project.

5.3.3.3 Toril 138 kV Substation (Stage 2)

Major Project Components

- **Toril 138 kV S/S**, 3-69 kV PCB and associated equipment and 50 MVA 138/69-13.8 kV Power Transformer including Protection, Control, Metering and Communication Systems;

This is the second stage of the project associated with the entry of TSI plant in Mindanao.

The remaining project scope, however, is focused on the installation of a 138/69 kV transformer that will allow the connection of load customers in the area namely: DLPC and DASURECO, thereby optimizing the utilization of the newly developed Toril 138 kV Substation.

5.3.3.4 Tacurong-Kalamansig 69kV TL

Major Project Components

- **Tacurong-Kalamansig 69kV T/L**, ST-SC, 1-336.4MCM ACSR, 80 km transmission line including Communication System System;
- **Tacurong 69kV SS**, 1-69kV PCB and associated equipment;
- **Kalamansig 69kV SS**, 1-7.5MVAR 69kV capacitor.

With the limited source of power in the area and to support the increasing load in the long term, there is a need to provide grid

connection to the off-grid municipalities of Bagumbayan, Ninoy Aquino, Lebak and Kalamansig. This will allow these towns in Sultan Kudarat to have access to a secured, reliable and efficient power delivery services. Thus, it will serve as a catalyst for economic development and likewise accelerates the total electrification of the province.

5.3.3.5 Agus 2 Switchyard Upgrading Project

Major Project Components

- **Agus 2 Switchyard**, 10-138kV PCB and other old/aged and/or defective equipment and expansion of the existing Control Building Flood Control System.

In addition to addressing the deteriorating physical and operational condition of the

high voltage equipment in the switchyard due to old age, this project also aims to provide clear demarcation of asset boundaries between NGCP and the power plant. It will involve the installation of a separate control building and the installation of new monitoring, switching, metering, annunciation and control equipment in order to have full control of the switchyard.

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Chapter 6 – Luzon Transmission Outlook

The DOE list shows that there are many committed and indicative power plant projects in Luzon Grid which can well support the increasing demand for the next 10 years. The incoming large capacity coal-fired power plants as well as natural gas-fired power plants are mainly concentrated in four (4) provinces namely: Batangas, Quezon, Bataan and Zambales, which would result in huge excess power in these areas. Since the remaining transmission capacity of the existing facilities is also very limited for the grid integration of new bulk generation additions, the development of the Luzon grid is geared towards implementation of new 500 kV transmission facilities that would allow power export from bulk generation sites going to the load center.

With the increasing delivery of bulk power to the 500 kV system, however, the two (2) existing 500 kV substations located in San Jose, Bulacan and Dasmariñas, Cavite which serve as the only EHV drawdown facilities supporting Metro Manila loads would become critical nodes in the grid. The capacity and expansion limitations in these substations could result in grid congestion unless new 500 kV drawdown substations are developed. In the TDP, new 500 kV substations are being proposed with Taguig as the priority site. Being close to the load center, Taguig is a very strategic location but has the major challenge also in the establishment of its associated 500 kV transmission line traversing portion of the Laguna Lake.

Along with the support given to grid integration of new power plants, NGCP is paying special attention in strengthening the transmission facilities in Metro Manila which is the country's load center. The existing 230 kV transmission line traversing from Quezon City to Muntinlupa City is a very critical line given its heavy loading condition and single-circuit configuration. Such conditions also pose great risk both on power quality and supply reliability in the area. In addition, the existing 230/115 kV substations in Metro Manila are heavily loaded already and mostly with capacity expansion limitations, thus, the development of new substations is very important in supporting load growth in the long term.

Being the center of nation's economy, the grid reinforcement projects to ensure the long term adequacy, reliability and security of power supply in Metro Manila can be regarded as "projects of national significance". As can already be expected in a highly urbanized area, securing right-of-way for new transmission facilities is increasingly becoming difficult. It is therefore important to immediately start the implementation to realize the transmission development plans and it should be coupled with support from the local and national government. Aside from Taguig EHV, the proposed new facilities include Pasay and Manila/Navotas Substations which would also involve the implementation of associated 230 kV transmission lines.

After Metro Manila and the already industrialized areas in Cavite and Laguna, the province of Pampanga is expected as the next major load growth area. In the long-term, new 230 kV backbone and new 230/69 kV substations would be needed for Porac and Clark in order support the load increase in the coming years. For other provinces, on the other hand, supporting load growth generally involves installation of additional transformers at existing substations or development of new substations and some reinforcements on the 69 kV transmission lines.

To help improve system reliability and to maintain the power quality within the grid code-prescribed standards, included in the development plans are the implementation of transmission looping configurations even for the 500 kV system, upgrading of old transmission lines and substations as well as installation of reactive power compensation equipment at various substations.

For renewable energy developments particularly in north Luzon, the implementation of the Northern Luzon 230 kV Loop could provide the needed transmission capacity augmentation. In the long-term, however, considering the full wind power generation potential in North Luzon as well as the hydro power generation potential in Cagayan Valley, Abra and Benguet, a new backbone from San Manuel, Pangasinan going up north would also be needed. Solar and other new RE-based plants, on the other hand, are well dispersed in the grid and generally not requiring major grid reinforcements.

6.1 Proposed Transmission Projects for 2016-2025

Shown in Table 6.1 is the list of transmission projects proposed in the period 2016-2025 in addition to the ERC approved projects for Luzon Grid as discussed in Chapter 5.

Table 6.1: Proposed Transmission Projects for Luzon

Project Name/Driver(s)	Province(s)	ETC
Generation Entry		
Pagbilao EHV Substation	Quezon	Nov 2017
Hermosa-San Jose 500 kV Line	Bataan, Bulacan	Dec 2018
Bataan 230 kV Grid Reinforcement	Bataan, Pampanga	Jan 2019
Mariveles-Hermosa 500 kV T/L	Bataan	Jun 2019
Bolo 5 th Bank	Pangasinan	Dec 2019
New Calaca 500/230 kV Substation	Batangas	Dec 2019
Pagbilao-Tayabas 500 kV T/L	Quezon	Dec 2020
Northern Luzon 230 kV Loop	Ilocos Norte, Cagayan	Dec 2020
Sta Maria/ Ibaan 500 kV Substation	Batangas	Dec 2020
Liberty-Nagsaag 230 kV T/L	Nueva Ecija, Pangasinan	Dec 2022
La Trinidad-Sagada 230 kV T/L	Benguet	Dec 2022
Santiago-Nagsaag 500 kV T/L	Isabela, Pangasinan	Dec 2024
Load Growth		
Calamba 230 kV Substation	Laguna	Mar 2018
Taguig EHV Substation	Metro Manila	Dec 2019
Manila (Navotas) 230 kV Substation	Metro Manila	Nov 2019
Pasay 230 kV Substation	Metro Manila	Jun 2019
Clark-Mabiga 69 kV Line	Pampanga	Jul 2019
North Luzon SS Upgrading Project – Stage 1 / Stage 2	Ilocos Norte, Ilocos Sur, Isabela, Nueva Vizcaya, Pangasinan, Bulacan	Dec 2019/ Jun 2022
Daraga-Ligao 69 kV Upgrading	Albay	Dec 2020
Naga-Pili 69 kV T/L Upgrading	Camarines Sur	Dec 2020
Mexico-San Simon 69 kV Line	Pampanga	Dec 2020
Tanauan 230 kV Substation	Batangas	Dec 2020
South Luzon SS Upgrading Project – Stage 1 / Stage 2	Cavite, Metro Manila, Laguna, Quezon, Camarines Sur, Albay	Dec 2020/ Jun 2022
Abuyog 230 kV Substation	Sorsogon	Dec 2021
Malvar 230 kV Substation	Batangas	Dec 2021
Porac 230 kV Substation	Pampanga	Dec 2021

Project Name/Driver(s)	Province(s)	ETC
Abuyog 230 kV Substation	Sorsogon	Dec 2022
Marilao EHV Substation	Bulacan	Jun 2023
San Simon 230 kV Substation	Pampanga	Dec 2023
Liberty-Baler 230 kV T/L	Nueva Ecija, Aurora	Jun 2022
Magalang 230 kV Substation	Pampanga	Dec 2024
System Reliability		
Manila(Navotas)-Dona Imelda 230 kV Line	Metro Manila	Oct 2018
La Trinidad-Calot 69 kV Line	Benguet	Jun 2019
Navotas-Pasay 230 kV T/L	Metro Manila	Jun 2019
Luzon Substation Rehabilitation (Tiwi, Pnt, Cal)	Nueva Ecija, Batangas, Albay	Dec 2019
Taguig-Taytay 230 kV T/L	Metro Manila	Dec 2019
Pinili 115 kV S/S	Ilocos Norte	Dec 2019
Balayan 69 kV Switching Station	Batangas	Dec 2020
San Manuel-Nagsaag 230 kV Line	Pangasinan	Dec 2020
Alaminos 500 kV Switching Station	Laguna	Dec 2021
Mexico-Clark 69 kV T/L Upgrading	Pampanga	Dec 2021
Silang-Taguig 500 kV T/L	Cavite, Metro Manila	Dec 2021
Dasmariñas-Las Piñas 230 kV Line	Metro Manila	Dec 2022
Minuyan 115 kV Switching Station	Bulacan	Dec 2023
Santiago-Dinadiawan-Baler 230 kV T/L	Isabela, Aurora	Dec 2023
Western 500 kV Backbone – Stage 2	Pangasinan, Zambales	Jun 2024
Liberty-Cabanatuan-San Rafael-Mexico 230 kV T/L Upgrading	Nueva Ecija, Pampanga	Dec 2024
Baras 500 kV Switching Station	Rizal	Dec 2025
Power Quality		
Luzon Voltage Improvement Project 3 – Stage 1 / Stage 2	Ilocos Norte, Ilocos Sur, Cagayan, Zambales, Pampanga, Bulacan, Nueva Ecija, Pangasinan	Jan 2018 / Jun 2022
Luzon Voltage Improvement Project 4 – Stage 1 / Stage 2	Albay, Sorsogon, Rizal, Laguna, Cavite, Camarines Sur	Dec 2019/ Jun 2022

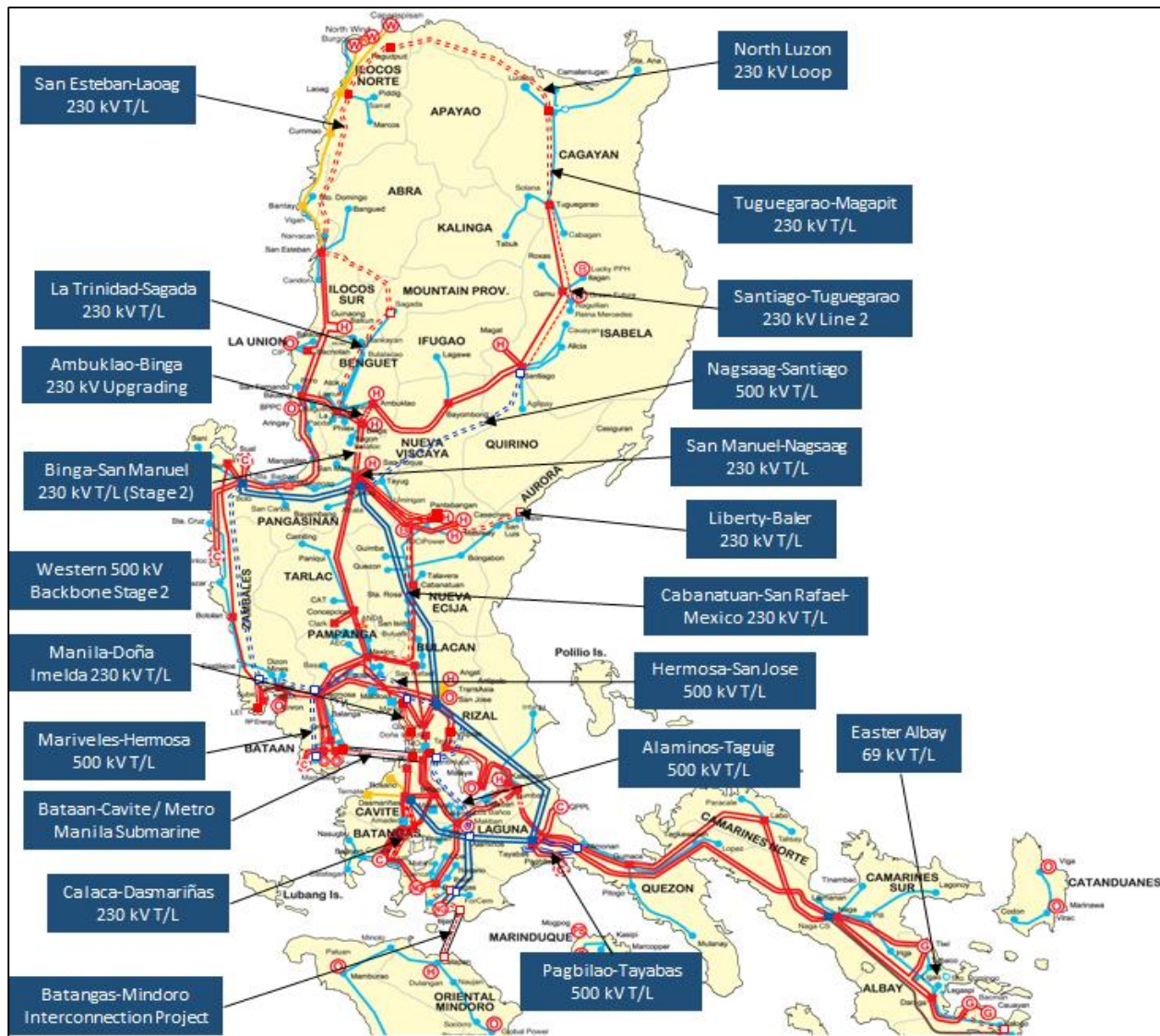


Figure 6.1: Proposed Projects for Luzon

6.1.1 Pagbilao 500 kV Substation

Major Project Components

- **Pagbilao 500 kV S/S**, 3-1000 MVA, 500/230 kV Power Transformers and Accessories, 8-500 kV PCBs and 11-230 kV PCBs and Associated Equipment;
- **Tayabas 500 kV S/S Expansion**, 3-500 kV PCBs and 1-230 kV PCBs and Associated Equipment;
- **Swinging of Naga-Tayabas EHV Line at Tayabas SS**, 500 kV, ST-DC, 4-795 MCM ACSR, 0.5 km;
- **Naga-Tayabas Line Extension to Pagbilao EHV SS**, 500 kV, ST-DC, 4-795 MCM ACSR, 0.5 km;
- **Pagbilao-Tayabas Line Extension to Pagbilao EHV SS**, 230 kV, ST-DC, 4-795 MCM ACSR, 2.75 km; and
- **Pagbilao-Tayabas connection to Naga-Tayabas**, 230 kV, ST-DC, 4-795 MCM ACSR, 2.75 km

The project aims to accommodate the generation capacity additions for the Luzon Grid which will be located in Quezon Province. These include 600 MW Energy World Plant, 420 MW Pagbilao Expansion, 500 MW San Buenaventura Coal-Fired Power Plant. The development of a new 500 kV substation in Pagbilao is in lieu of further expanding the existing Tayabas 500/230 kV Substation which has transformer capacity limitations

and with high fault level issue in the 230 kV side of the substation. The project scheme involves the energization to 500 kV of a segment of the Naga-Tayabas Transmission Line.

6.1.2 Hermosa-San Jose 500 kV Transmission Line

Major Project Components
▪ Hermosa-San Jose 500 kV T/L, ST-DC, 4-410 mm² TACSR/AS, 82.41 km; ▪ New Hermosa-Old Hermosa Tie Line, SP-DC, 4-795 MCM ACSR, 0.5 km; ▪ New Hermosa 500 kV S/S, 2-1000 MVA, 500/230-13.8 kV Power Transformer and Accessories, 10-500 kV PCBs and 12-230 kV PCBs and Associated Equipment; ▪ New Hermosa 500 kV S/S, 2-60 MVAR 500 kV Shunt Reactors and Accessories, 1-90 MVAR 500 kV Line Reactor and Accessories; and 2-100 MVAR, 230 kV Capacitor Banks and Accessories; ▪ Old Hermosa 230 kV S/S, 2-230 kV PCBs and Associated Equipment and 9-69 kV PCBs and Associated Equipment.

This project is very important in accommodating the generation capacity additions in Bataan and Zambales area. Hermosa Substation serves as a merging point of bulk power generation coming from the existing Limay CCPP, Petron RSFF, Subic Enron DPP, Mariveles CFPP and the programmed generation capacity additions which include RP Energy CFPP, SMC CFPP and others. With an aggregate dependable

capacity reaching about 4,000 MW from the existing and incoming power plants, the system study has determined the need to develop a 500 kV transmission backbone which will serve as the additional outgoing circuits from Hermosa to San Jose Substation in order to allow simultaneous maximum dispatch of associated power plants. Because of the expansion limitation of San Jose 500 kV Substation which is a GIS, the scheme would have one 500 kV line that will need to initially by-pass San Jose Substation. This will be permanently addressed by the Marilao 500 kV Substation Project.

6.1.3 Bataan 230 kV Grid Reinforcement Project

Major Project Components
▪ Limay-Hermosa Reconductoring (single circuit termination), 230 kV, 1-795 MCM ACSR/AS to 1-410 mm² TACSR/AS, 38.01 km; ▪ Limay-BCCPP Line Extension, 230 kV, SP-SC, 2-410 mm² TACSR/AS, 1.0 km; ▪ Hermosa-Mexico Reconductoring, 230 kV, 1-795 MCM ACSR/AS to 1-410 mm² TACSR/AS, 35.0 km; ▪ Lamiao (Limay) "bus-in" to the existing Mariveles – BCCPP B 230 kV lines, 230 kV, ST – DC, 4-795 MCM ACSR/AS, 2-1.0 km; ▪ Mexico-Cabanatuan 230 kV Line 'bus-in' to San Rafael S/S, SP-DC, 1-795 MCM ACSR, 1.0 km; ▪ Limay Substation (Replacement), 10-230 kV PCBs and Associated Equipment; ▪ BCCPP A and B Switchyard (Replacement/Expansion), 9-230 kV PCBs and Associated Equipment; ▪ Lamiao Switchyard (New), 12-230 kV PCBs and Associated Equipment; ▪ San Rafael Substation (Expansion), 4-230 kV PCBs and Associated Equipment.

This project aims to accommodate the connection of the 600 MW SMC Consolidated Power Corporation Coal-Fired Power Plant (SMC CPC CFPP) Project to the Luzon Grid through 'bus-in' connection to the existing Mariveles – BCCPP-B 230 kV transmission line. The project involves construction of the Lamiao 230 kV substation, reconductoring of Limay – Hermosa and Hermosa – Mexico 230 kV lines, replacement of underrated Power Circuit Breakers (PCBs) at Limay Substation and BCCPP Block A & B Switchyard as well as the reconfiguration of the Mexico – Cabanatuan 230 kV corridor

to fully dispatch the generation capacity of the existing and the proposed power plant, which is already classified by the Department of Energy (DOE) as a "committed" power plant. While a new

500 kV backbone will also be developed from Mariveles to Hermosa, the Bataan 230 kV Grid Reinforcement has been considered to optimize the existing transmission lines by increasing the capacity without acquiring new right-of-way.

6.1.4 Mariveles-Hermosa 500 kV Transmission Line

Major Project Components

- **Mariveles-Hermosa 500 kV T/L**, ST-DC, 4-410 mm² TACSR/AS, 40 km;
- **New Mariveles Substation**, 9-500 kV PCB and associated equipment;

This involves the establishment of the 500 kV backbone at Bataan peninsula in order to support the entry of large capacity plants in the area namely:

1,336 MW GNPowr Dinginin CFPP and 1,200 MW SMC CFPP. While the Bataan 230 kV Grid Reinforcement Project can increase the capacity of the existing 230 kV corridor in the area, the huge generation capacity addition of 2,536 MW cannot be accommodated unless a new transmission highway is developed. This new backbone will form part of the loop from Hermosa to Mariveles then to Cavite/Metro Manila upon completion of the future submarine cable. This project was previously named Cabcaban-Hermosa 500 kV Transmission Line.

6.1.5 Bolo 500 kV Substation Expansion

Major Project Components

- **Bolo Substation (expansion)**, 1-600 MVA 500/230 kV Transformer, 3-500 kV PCB and associated equipment;

Bolo 500 kV Substation collects the generation from the major coal-fired power plants in the area namely: Sual

and Masinloc. The power flow in the transformers at this substation is also being influenced by the dispatch of the hydro power plants and other generators in north Luzon. With the proposed 600 MW expansion of Masinloc CFPP and the generation developments in North Luzon, the substation capacity would no longer be adequate to maintain the N-1 contingency provision, thus, a 5th transformer bank is being proposed. This will provide the required grid augmentation while the Western 500 kV Backbone is not yet in place.

6.1.6 New Calaca 500/230 kV Substation

Major Project Components

- **New Calaca Substation**, 2-1000 MVA 500/230 kV Transformer, 6-500 kV PCB, 10-230 kV PCB and associated equipment;

This project, which is still associated with the bulk generation capacity expansions in Batangas, aims to

provide a connection point for the entry of large capacity plants at Calaca side. This will be linked to the Calaca-Dasmariñas Transmission Line Project (500 kV-designed). It can be noted, however, that the new transmission line will be initially energized at 230 kV only, thus, the implementation of the new substation will not immediately require the 500 kV switchyard in the initial stage.

6.1.7 Pagbilao-Tayabas 500 kV Transmission Line

Major Project Components

- **Pagbilao-Tayabas 500 kV T/L**, ST-DC, 4-795 MCM ACSR/AS, 17 km;
- **Pagbilao Substation**, 4-500 kV PCB and associated equipment;

This is the second stage of the system development in Quezon province associated with the

expected further generation capacity additions. In particular, with the entry of the proposed 1,200 MW Atimonan CFPP, the existing Tayabas Substation will become a more critical node being the merging point of more than 3,500 MW generation capacity in the area. The new transmission line is needed to establish a by-pass line to Tayabas 500 kV Substation.

6.1.8 Northern Luzon 230 kV Loop

Major Project Components

- **Laoag-Bangui**, 230 kV, ST-DC, 1-795 MCM ACSR/AS, 50 km;
- **Bangui – Pamplona – Lal-lo (Magapit)**, 230 kV, ST-DC, 1-795 MCM, ACSR, 130 km
- **Laoag Substation (Expansion)**, 4-230 kV PCBs and Associated Equipment;
- **Bangui Substation (New)**, 2-300 MVA, 230/115-13.8 kV Power Transformer and Accessories, 10-230 kV PCBs, 11-115 kV PCBs and Associated Equipment;
- **Pamplona Substation (New)**, 2-300 MVA, 230/115-13.8 kV Power Transformers and Accessories, 10-230 kV PCBs and Associated Equipment, 6-115 kV PCBs and Associated Equipment; and
- **Lal-lo (Magapit) Substation (Expansion)**; 4-230 kV PCBs and Associated Equipment.

The Ilocos Region has been identified as among the areas with huge wind power generation potential. In addition to the existing 282 MW of total wind power plant capacity, at least 500 MW additional wind power generation is already being proposed. Even with the completion of the San Esteban-Laoag 230 kV Transmission Line Project, the Ilocos Region will still need additional power outlet to

accommodate not only the renewable energy-based plants but also other power plants that may be located in the area. The looping to Cagayan Valley area will provide the required additional transmission line capacity. In terms of system reliability and operational flexibility, both the Ilocos Region and Cagayan Valley area will benefit from the looping of the 230 kV backbone. Even when there are toppled tower structures in a segment of the transmission lines during typhoons or other calamity, the loads can continuously be served due to the supply line redundancy brought about by the looping configuration. Also, the looping will ensure that any available generation capacity in the area can be delivered to the rest of the grid. Moreover, as regards substation siting where Bangui and Pamplona are the initially identified locations of collector substations, further optimization and evaluation of alternative sites can still be considered in coordination with the wind power plant proponents. Similarly, there are possible reconsiderations also for the scheme for the Laoag-Bangui Line segment given the existing facilities in the area.

6.1.9 Sta. Maria / Ibaan 500 kV Substation

Major Project Components

- **Sta. Maria/Ibaan 500 kV S/S**, 10-500 kV PCB and associated equipment;
- **Sta. Maria 500 kV Cut-in Lines**, ST/SP-DC, 4-795 MCM ACSR, 9 km.

Batangas has been an existing bulk generation site with the presence of the huge LNG-fired power plants namely: Ilijan, Sta. Rita, San Lorenzo

and including the San Gabriel Plant which is already committed. In addition, further generation installations near this site are still being proposed. The 230 kV system has a very limited capacity already while the 500 kV lines connected to Ilijan Substation still have some room. To be able to utilize the remaining capacity of the available 500 kV backbone, a new 500 kV substation either in Sta. Rita or Ibaan will be required. This is an alternative in directing the plant connection down south at the Ilijan 500 kV Switchyard which still owned by the power plant. The site of the new 500 kV Substation would still be subject to further optimization and coordination with the power plant proponents in the area.

6.1.10 Liberty-Nagsaag 230 kV Transmission Line

Major Project Components

- **Liberty-Nagsaag 230 kV T/L**, 4-795 MCM ACSR/AS, ST-DC, 68.0 kms;
- **Liberty 230 kV S/S**, 1-50 MVA 230/69 kV Power Transformer, Control Room, 11-230 kV PCB and associated equipment;
- **Nagsaag 230 kV S/S Expansion**, 3-230 kV PCBs and associated equipment.

The Liberty-Nagsaag 230 kV line project aims to accommodate the entry of potential regulating plant for the Luzon Grid which is the proposed 600 MW Pump-Storage Hydroelectric Power Plant Project of

First Gen Prime Energy Corporation. Because of the limited capacity of the transmission corridor going down to Mexico, this new transmission line will establish the delivery of power going up to Nagsaag where the link to the 500 kV backbone and to the high capacity San Manuel-Concepcion-Mexico 230 kV Transmission Line is located. It can be noted that the Liberty-Nagsaag 230 kV Transmission Line, will already form part of the upgrading project of the old single circuit Nagsaag-Pantabangan-Cabanatuan-Mexico 230 kV line. The Liberty 230 kV Substation, on the other hand, will also be utilized to serve the existing loads connected at the Cabanatuan-Pantabangan 69 kV line. This new substation will allow the shifting of loads connected at the far-end of the Cabanatuan-Pantabangan 69 kV Line thereby improving operational flexibility, supply reliability as well as provision to accommodate future loads in the area.

6.1.11 La Trinidad-Sagada 230 kV Transmission Line

Major Project Components

- **La Trinidad-Sagada 230 kV T/L** (to be initially energized at 69 kV), ST/SP-DC, 1-795 MCM ACSR, 93.25 km transmission line;
- **La Trinidad S/S Expansion**, 2-69 kV PCB and associated equipment;
- **Sagada Switching Station**, 6-69 kV PCB and associated equipment.

In order to cater the proposed generation capacity additions in the area which are mostly hydro power plants, the La Trinidad-Sagada 230 kV T/L is proposed. The project will also help improve the supply

reliability in the area which is presently relying on the old La Trinidad-Bulalacao 69 kV Line.

6.1.12 Santiago-Nagsaag 500 kV Transmission Line

Major Project Components

- **Santiago-Nagsaag 500 kV T/L**, ST-DC, 4-795 MCM ACSR/AS, 140.0 km;
- **Old and new Santiago S/S 230 kV tie-line**, ST-DC, 4-795 MCM ACSR/AS, 1.0 km;
- **New Santiago 500 kV S/S**, 2-750 MVA 500/230-13.8 kV Power Transformer and Accessories, 6-500 kV PCBs and 6-230 kV PCBs and Associated Equipment;
- **Santiago 230 kV S/S**, 4-230 kV PCBs and Associated Equipment;
- **Nagsaag 500 kV S/S**, 4-500 kV PCBs and Accessories, 2-60 MVAR 500 kV Line Reactor and Accessories.

This project will serve as a new transmission backbone to support the generation developments in Cagayan Valley area including hydro power plants, wind farms and other conventional power plants. Without this project, the double-circuit Santiago-Bayombong-Ambuklao 230 kV Line, which is at 300 MVA

capacity only per circuit, will become congested. This project will be implemented by stages and it includes the strategy of initially energizing the line at 230 kV only and also with initial termination at Bayombong Substation only due to the required long transmission line development. It will also complement the Northern Luzon 230 kV Loop Project.

6.1.13 Calamba 230 kV Substation

Major Project Components

- **Calamba 230 kV S/S**, 2-300 MVA, 230/115-13.8 kV Power Transformers to be implemented by MERALCO, 10-230 kV PCB and Associated Equipment;
- **Bus-in Lines**, 230 kV T/L, SP-DC, 2-610 mm² TACSR/AS, 1.5km.

There is a need to develop a new drawdown substation strategically located near the industrial parks in Laguna and Batangas and midway of Sta. Rosa and Calauan Substations

to provide the long-term power requirement of the loads, provide higher level of transmission reliability and flexibility of operation. Thus, Calamba Substation is proposed via “bus-in” connection along the new Biñan-Bay (Makban) 230 kV line. This will also unload and address the single-outage contingency overloading in other adjacent 230 kV drawdown substations namely Sta. Rosa and Calauan Substations, and at the same time, it has the benefit of addressing also the load growth and expected overloading in Caluan-Los Baños 115 kV distribution line during contingency events.

6.1.14 Taguig 500 kV Substation

Major Project Components

- **Taguig 500 kV S/S**, 2-1000 MVA, 500/230-13.8 kV Power Transformers and Accessories, 1-90 MVAR 500 kV Shunt Reactor and Accessories, 3-100 MVAR 230 kV Capacitor Banks and Accessories, 8-500 kV PCBs (GIS), 10-230 kV PCBs (GIS), and Associated Equipment;
- **Taguig ‘cut-in’ to San Jose-Tayabas 500 kV Line**, 500 kV, ST-DC, 4-795 MCM ACSR, 37 km;
- **Taguig ‘bus-in’ to Muntinlupa-Paco 230 kV Line**, 230 kV, SP-SC, 2-410 mm² TACSR, 2-2.4 km.

The Taguig 500 kV Substation will decongest the San Jose and Dasmariñas 500 kV Substations. This is one of NGCP’s transmission network development plans for Metro Manila to ensure that the power requirements of the country’s load center will be adequately and reliably

served in the long term. The Taguig 500 kV Substation Project will be addressing the following issues: need for a new 500 kV drawdown substation to address the increase in bulk power injection to the 500 kV system and need to reinforce the single-circuit 230 kV transmission line traversing within Metro Manila. The implementation of the Taguig 500 kV Substation will improve the reliability of the transmission network by providing direct power injection within Metro Manila through the Muntinlupa-Paco 230 kV Transmission Line segment and at the same time, this will also address the power quality issues. It should be noted that Taguig EHV has been prioritized over the previous Baras (Antipolo) 500 kV Substation Project but this could still be implemented in the far future as part of the 500 kV system development.

6.1.15 Manila/Navotas 230 kV Substation

Major Project Components

- **Manila 230 kV S/S**, 2-300 MVA, 230/115-13.8 kV Power Transformers and Accessories, 2-50 MVAR, 115 kV Capacitor Banks and Accessories, 6-230 kV PCBs (GIS) and 16-115 kV PCBs (GIS) and Associated Equipment;
- **From Marilao-Quezon cut-in point to Manila S/S**, 230 kV ST-DC, 4-795 MCM ACSR/AS, 21 km.

With the further increase in load, the existing 230/115 kV substations in Metro Manila become heavily loaded and have been losing already the provision for N-1 contingency. This will expose the Metro Manila loads to

supply reliability risk as well as power quality concerns during system peak load condition. Manila/Navotas has been identified as a strategic site to augment the supply for MERALCO’s load

sector 1 which is presently relying on Quezon, Duhat, and Paco Substations. The proposed Manila/Navotas 230 kV Substation will be temporarily linked to the grid through “cut-in” connection along the existing Marilao-Quezon 230 kV line and ultimately terminated to the new 500/230 kV substation in Marilao in the future. Furthermore, due to the space constraints for a conventional substation, a Gas Insulated Switchgear (GIS) substation has been considered.

6.1.16 Pasay 230 kV Substation

Major Project Components
▪ Pasay 230 kV S/S, 5-230 kV PCBs (GIS) and associated equipment; ▪ Las Piñas-Pasay 230 kV T/L, 230 kV, 2-795 MCM ACSR/AS, SP-DC, 4.2 km; 230 kV 2-1C-2,000 mm² XLPE, UG-DC, 3.9 km.

The Pasay Substation project will augment the supply for MERALCO's load sector 3 presently being served by Las Piñas and Muntinlupa Substations., These substations

have recent projects for the installation of the 4th transformer unit, but these would serve as medium-term solution only to address the increasing load and to provide single outage (N-1) contingency. Ultimately, new drawdown substation will have to be developed and Pasay was also identified as a strategic site being close to the load growth area in the Entertainment City in Pasay and can also help support the loads in Makati City. As its supply line, a new 230 kV transmission highway from Las Piñas is required where right-of-way is expected as a major challenge.

6.1.17 Clark-Mabiga 69 kV Transmission Line

Major Project Components
▪ Clark-Mabiga 69 kV T/L, 1-410mm² TACSR/AS, SP-DC, 6 km; ▪ Clark Substation (Expansion), 1-300 MVA 230/69-13.8 kV Power Transformer and Accessories, 1-230 kV PCB and Associated Equipment and 3-69 kV PCB and Associated Equipment.

The load growth in the area of Angeles and Mabalacat together with the new industries in Clark Freeport Zone will result in overloading of the existing Mexico-Clark 69 kV Line.

Given the limitation in developing new 69 kV lines coming from Mexico Substation, the development of new 69 kV lines from Clark Substation is proposed to provide an alternate source of power. The recent installation of a new 100 MVA transformer at Clark Substation by CEDC has initially provided the needed relief for the existing Mexico-Clark 69 kV Lines whose heavy loading condition has been resulting in low voltage issues already. The Clark-Mabiga 69 kV Line Project will provide operational flexibility as it will form a loop configuration in the 69 kV system from Mexico Substation. This will optimize first the utilization of the existing Clark 230 kV Substation which may already be subject for reclassification as transmission asset in the future.

6.1.18 North Luzon 230 kV Substation Upgrading Project

Major Project Components
STAGE 1 ▪ Bauang Substation (Replacement), 1-100 MVA 230/115/69-13.8 kV Power Transformer and Accessories, 7-230 kV PCB and associated equipment; ▪ Gamu Substation (Expansion), 1-100 MVA 230/69-13.8 kV Power Transformer and accessories, 10-230 kV PCB and associated equipment, 2-69 kV PCB and associated equipment; ▪ Bayombong Substation (Replacement), 1-100 MVA 230/69-13.8 kV Power Transformer and Accessories, 5-230 kV PCB

This project package contains the transformer capacity installation components at various substations in North Luzon which aim to ensure the continuous adequacy of substation capacity in serving the increasing loads both during normal and N-1

and associated equipment, 3-69 kV PCB and associated equipment;

- **Hermosa Substation**, 13-69 kV PCB and associated equipment;
- **Malaya Substation (Expansion)**, 1-300 MVA, 230/115-13.8 kV Power Transformer and Accessories, 9-230 kV PCB and associated equipment, 1-115 kV PCB and associated equipment; and
- **San Jose Substation (Expansion)**, 1-300 MVA, 230/115-13.8 kV Power Transformers and Accessories, 1-230 kV PCB and associated equipment, 4-115 kV PCB and associated equipment.

STAGE 2

- **Balingueo Substation (Expansion)**, 1-100 MVA 230/69-13.8 kV Power Transformer and Accessories, 5-230 kV PCB and associated equipment, 4-69 kV PCB and associated equipment;
- **Bacnotan Substation (Expansion)**, 1-50 MVA 230/69-13.8 kV Power Transformer and Accessories, 1-230 kV PCB and associated equipment, 6-69 kV PCB and associated equipment;
- **Labrador Substation (Replacement)**, 1-100 MVA 230/69-13.8 kV Power Transformer and Accessories, 5-230 kV PCB and associated equipment, 2-69 kV PCB and associated equipment; and
- **San Rafael Substation (Expansion)**, 1-300 MVA 230/69-13.8 kV Power Transformer and Accessories, 2-230 kV PCB and associated equipment.

contingency conditions. Such developments would allow NGCP to meet the grid code standard and would also allow to have operational flexibility especially during the maintenance activities for power transformers at the substations, thereby, avoiding supply interruption to the loads.

6.1.19 Daraga-Ligao 69 kV Transmission Line Upgrading

Major Project Components

- **Daraga-Ligao 69 kV T/L**, 1-795 MCM ACSR/AS, ST-SC, 22 km;
- **Daraga S/S Expansion**, 1-69 kV PCB and associated equipment;
- **Ligao Switching Station**, 1-69 kV PCB and associated equipment.

The total projected loading of the directly-connected customers and distribution utility in Albay is projected to exceed the capacity of the existing Daraga-Ligao 69 kV Line, thus the

need to reinforce the existing line to accommodate load growth and at the same time ensure the reliability of supply to the customers. It can be noted that the decision on September 22, 2009 for ERC Case No. 2008-105 MC cited that the Tabaco-Ligao-Daraga 69 kV Line will be reclassified as Network/Transmission Assets upon the closing of the Daraga-Tabaco-Ligao 69 kV loop due to the implementation of Eastern Albay 69 kV Line Project.

6.1.20 Naga-Pili 69 kV Transmission Line Upgrading

Major Project Components

- **Naga-Pili 69 kV T/L**, 1-795 MCM ACSR/AS, SP-DC, 10.5 km.

The existing Naga-Pili 69 kV Line is a double circuit facility serving as a

main trunk of the supply for the northeastern part of Camarines Sur. The other circuit of this line is also extended to the city of Ligao in Albay and also linked to Daraga Substation in Albay. With the further increase of the loads being served and considering also the age of the existing 69 kV line, the upgrading project will be able to ensure continuous adequate and reliable operation including the benefit of providing operational flexibility during contingency or maintenance in the 69 kV facility.

6.1.21 Mexico-San Simon 69 kV Transmission Line

Major Project Components

- **Mexico-San Simon 69 kV T/L**, ST/SP-DC, 1-410 mm² TACSR, 6.9 km;
- **Mexico S/S Expansion**, 6-69 kV PCB and associated equipment.

The Mexico-San Simon 69 kV Line is the first stage of the development to accommodate the incoming steel plants and load growth in San Simon, Pampanga. To serve the immediate needs of the new steel plants, additional 69 kV lines should be put-up. If more steel plants or other industrial facilities will be built in San Simon in the future, a new 230 kV drawdown substation, which is a separate project, will serve as the long term solution.

6.1.22 Tanauan 230 kV Substation

Major Project Components

- **Tanauan Substation**, 1-100 MVA, 230/69 kV Power Transformer, 7-230 kV PCBs and associated equipment; 3-69 PCBs and associated equipment; and
- **230 kV Bus-in Lines**, 230 kV, ST/SP-DC, 1-795 MCM ACSR/AS, 12 km.

This project is another proposed 230 kV substation geared towards supporting the development of industrial loads in Batangas. The area which is presently relying on the old single circuit 69 kV line coming from Bay Substation will not be adequately served due to load growth. In lieu of 69 kV line development coming from Bay, which has implementation challenges due to right-of-way concerns, this new 230 kV substation to be supplied from Calamba 230 kV Substation is an alternative.

6.1.23 South Luzon 230 kV Substation Upgrading Project

Major Project Components

STAGE 1

- **Dasmariñas Substation (Expansion)**, 1-300 MVA 230/115-13.8 kV Power Transformer and Accessories;
- **Las Piñas Substation (Expansion)**, 1-300 MVA 230/115-13.8 kV Power Transformer and Accessories;
- **Lumban Substation (Expansion)**, 1-100 MVA 230/69-13.8 kV Power Transformer and Accessories; and
- **Naga Substation (Replacement)**, 1-300 MVA 230/69-13.8 kV Power Transformer and Accessories.

STAGE 2

- **Gumaca Substation (Replacement)**, 1-100 MVA 230/69-13.8 kV Power Transformer and Accessories;
- **Daraga Substation (Replacement)**, 1-100 MVA 230/69-13.8 kV Power Transformer and Accessories;

This project package contains the transformer capacity installation components at various substations in South Luzon which aim to ensure the continuous adequacy of substation capacity in serving the increasing loads both during normal and N-1 contingency conditions. Such developments would allow NGCP to meet the grid code standard and would also allow to have operational flexibility especially during the maintenance activities for power transformers at the substations, thereby, avoiding supply interruption to the loads. For the case of Las Piñas Substation, the proposed installation of additional transformer under this project package, which will already serve as the 5th transformer unit for the substation, is considered only as an interim measure should the development of the new Pasay 230 kV Substation experience a considerable delay particularly in establishing its 230 kV supply line from Las Piñas which is the more challenging part.

6.1.24 Malvar 230 kV Substation

Major Project Components

- **Extension from the bus-in point (Batangas side) to Malvar S/S**, 230 kV, ST-DC, 4-795 MCM ACSR/AS, 5.0 km;
- **Extension from the bus-in point (Bay side) to Malvar S/S**, 230 kV, ST-DC, 4-795 MCM ACSR/AS, 5.0 km;
- **Malvar S/S (New)**, 1-100 MVA, 230/69-13.8 kV Power Transformer, 9-230 kV PCB and 9-69 kV PCB and associated equipment.

The Malvar 230 kV Substation will serve the incoming new industrial loads in Malvar and Lipa City as well as the load growth of the existing customers in the area. This will relieve the loading of both Batangas and Bay Substations and will provide

operational flexibility. The Malvar 230 kV Substation is also in lieu of constructing more 69 kV lines from Batangas Substation or upgrading of existing 69 kV lines.

6.1.25 Porac 230 kV Substation

Major Project Components

- **Porac Substation**, 1-300 MVA 230/69 kV transformer, 5-230 kV PCB, 9-69 kV PCB and associated equipment;
- **Hermosa-Porac-Clark**, 4-795 MCM ACSR, ST-DC, 54-km.
- **Hermosa Substation (expansion)**, 4-230 kV PCB and associated equipment
- **Clark Substation (expansion)**, 4-230 kV PCB and associated equipment.

This project, which will be implemented by stages, has the primary goal of supporting load growth in Pampanga and establishing the 230 kV backbone loop from Hermosa to Clark thereby providing a more direct access to the

generation hub in Bataan. Among the expected major load developments include Alviera and Clark Green City.

6.1.26 Abuyog 230 kV Substation

Major Project Components

- **Abuyog (Sorsogon) 230 kV S/S**, 2-50 MVA 230/69-13.8 kV Power Transformer, 6-230 kV PCB, 5-69 kV PCB and associated equipment;
- **Bacman S/S Expansion**, 4-230 kV PCB and associated equipment;
- **Bacman-Abuyog 230 kV T/L**, 1-795 MCM ACSR/AS, ST-DC, 25 km.

There is a need to establish a 230 kV drawdown substation closer to the loads in Sorsogon to address the supply reliability issues, meet the projected demand in the long term and address the power quality issues at the load-end substations. It can be

noted that the whole province of Sorsogon is solely relying on a single-circuit 69 kV line being supplied from Daraga Substation which is located in Albay. The 230 kV backbone is already extended up to Bacman Plant in Sorsogon and may already be used as part of the supply facilities for the proposed Abuyog Substation.

6.1.27 Marilao 500 kV Substation

Major Project Components

- **Marilao 500 kV S/S**, 2-1000 MVA, 500/230-13.8 kV Power Transformers and Accessories, 14-500 kV PCBs, 14-230 kV PCBs, and Associated Equipment;
- **Nagsaag -San Jose 500 kV Line Extension to Marilao EHV SS**, 500 kV, ST-DC, 4-795 MCM ACSR, 8.7 km
- **Marilao 'bus-in' to Hermosa-San Jose EHV Line**, 500 kV, ST-DC, 4-795 MCM ACSR, 1.5 km;
- **Marilao- Duhat**; 230 kV, SP-DC, 2-795 mm² TACSR/AS, 3.2 km;
- **Marilao-Manila**; 230 kV, SP-DC, 2-795 MCM ACSR, 3.6 km; and
- **Marilao 'bus-in' to Hermosa-Quezon**; SP-DC, 2-410 mm² TACSR/AS, 3.2 km.

This new 500 kV substation, which is also part of the master plan, will provide another drawdown substation to support the increasing demand in the load center and will also address the further increase in bulk power injection to the 500 kV system coming from the new power plants in the grid. This project will also address the initial line by-pass

scheme at San Jose Substation under the project Hermosa-San Jose 500 kV Transmission Line which is brought about by the GIS expansion limitation at San Jose EHV. With the new scheme, the criticality of San Jose EHV, presently at ring-bus configuration, will already be reduced as new Marilao Substation will now serve as the main node in the grid.

6.1.28 San Simon 230 kV Substation

Major Project Components

- **San Simon Substation**, 1-300 MVA 230/69 kV transformer, 5-230 kV PCB, 9-69 kV PCB and associated equipment;
- **230 kV T/L Extension**, 2-795 MCM ACSR, ST-DC, 4-km. from the bus-in point along Mexico-Duhat Line.

This project will alleviate the Mexico Substation in the long term by providing an alternate source substation for the loads in the

southeastern part of the province of Pampanga. The new substation in San Simon will accommodate the further load growth of the steel plants in the area and will also support the entry of other new industrial loads.

6.1.29 Liberty-Baler 230 kV Transmission Line

Major Project Components

- **Liberty-Baler 230 kV T/L**, 1-795 MCM ST-DC, 56.5 km;
- **Liberty 69 kV S/S**, 4-69 kV PCB and associated equipment;
- **Baler 69 kV S/S**, Control Room, 4-69 kV PCB and associated equipment.

The Liberty-Baler 230 kV line project (initially energized at 69 kV) will provide improvement in the reliability of supply as well as voltage quality in

Baler, Aurora, which is presently being served by a long 69 kV line from Cabanatuan Substation. This line will also support the development of line extension going to Casiguran and will serve as a link to connect other loads in Aurora Province which are not Grid connected yet.

6.1.30 Magalang 230 kV Substation

Major Project Components

- **Magalang Substation**, 1-300 MVA, 230/69 kV Power Transformer, 8-230 kV PCB, and associated equipment;
- **230 kV Bus-in Lines**, 230 kV, ST-DC, 2-410 mm² TACSR, 5 km

This new substation project was originally conceptualized as an alternative in addressing the heavy

loading condition of the existing Mexico-Clark 69 kV Lines. Without any augmentation for this 69 kV facility, the loads will not be adequately served even the expected load growth and that low voltage problems will continue as a major issue in the area. With the installation of additional

transformer at Clark Substation and the implementation of the Clark-Mabiga 69 kV Line, present issues will already be addressed. In the long-term, however, this new substation project would still serve as future augmentation in adequately and reliably serving the loads in the area.

6.1.31 Manila (Navotas)-Dona Imelda 230 kV Line

Major Project Components

- **Manila/Navotas-Dona Imelda Line**, 2-410 mm² TACSR, SP-DC, 10 km;

This project aims to provide additional transmission corridor that will complement the existing single

circuit Quezon-Doña-Paco-Muntinlupa 230 kV line and will help address its criticality. Effectively, the Marilao-Manila/Navotas 230 kV Line and the Manila/Navotas-Doña Imelda 230 kV Line together with the existing Marilao-Quezon-Doña Imelda 230 kV Line will form a loop configuration thus creating a more resilient transmission corridor to serve the Metro Manila loads. As can be expected, securing right-of-way for this new transmission line would be a major concern.

6.1.32 La Trinidad-Calot 69 kV Transmission Line

Major Project Components

- **La Trinidad-Calot**, 69 kV, SP/ST-DC, 1-795 MCM ACSR/AS, 21 km.;
- **La Trinidad Substation Expansion**, 1-69 kV PCB and Associated Equipment.

This will improve the reliability of the transmission facilities serving Baguio City and the other loads in Benguet including the hydro power plants in

the area. The existing 69 kV line in the area is more than 50 years old already and it needs the provision for N-1 contingency.

6.1.33 Navotas-Pasay 230 kV Line

Major Project Components

- **Navotas-Pasay Line**, 4-795 MCM ACSR, SP-DC, 13 km;

This proposed line will effectively form a new highway within Metro

Manila by forming a new 230 kV loop. Such scheme will result in more robust transmission network for the area. While the scheme has been conceptualized already, further assessment of the option to use underground power cable will still be considered especially that the new line will traverse along the Roxas Boulevard.

6.1.34 Luzon Substation Rehabilitation

Major Project Components

- **Pantabangan Substation**, 4-230 kV PCBs and Associated equipment;
- **Calaca Substation**, 6-230 kV PCBs and Associated Equipment, 10-69 kV PCBs and Associated Equipment, 1-100 MVA 230/69-13.8 kV Transformer and Accessories;
- **Tiwi A Substation**, 4-230 kV PCBs and Associated Equipment;
- **Tiwi C Substation**, 1-50 MVA, 230/69-13.8 kV Power Transformer and Accessories, 15-230 kV PCBs and Associated Equipment and 3-69 kV PCBs and Associated Equipment.

This project package consists of three power plant switchyards classified as transmission assets but with common concerns on demarcation of asset boundaries particularly on the control building/equipment shared by the substation and by the already privatized power plants and the need

for replacement of aging equipment. For the case of Tiwi Substation, the scheme also involves reconfiguration to simplify the Tiwi A, B and C switchyards. Also, it has a transformer component that will allow the substation to serve load customers presently relying on the plant-owned transformer and from a very long 69 kV line from Daraga Substation. For Calaca Substation, on the other hand, the project includes the installation of the transformer intended to provide N-1 contingency which can only be implemented along with substation layout re-arrangement.

6.1.35 Taguig-Taytay 230 kV Line

Major Project Components

- **Taguig-Taytay 230 kV Line**, 2- TACSR, SP-DC, 10 km;

This project will provide additional outgoing circuits from the new Taguig

500/230 kV Substation. With the link from Taguig to Taytay, the decongestion of San Jose EHV Substation will become more effective, the utilization of the new substation in Taguig will be optimized, and it will further improve the reliability of supply for Taytay and also for the new Antipolo 230 kV Substations. It can be observed also that this project will form part of the 230 kV transmission loop surrounding the Laguna Lake.

6.1.36 Pinili 115 kV Substation

Major Project Components

- **Pinili 115 kV Substation (New)**, 1-100 MVA 115/69-13.8 kV Power Transformer and Accessories, 6-115 kV PCB and associated equipment, 5-69 kV PCB and associated equipment.

This new substation will replace the Currimao 115 kV Substation to accommodate the load growth and

provide N-1 contingency for the loads of Ilocos Norte Electric Cooperative (INEC), Ilocos Sur Electric Cooperative (ISECO) and Abra Electric Cooperative (ABRECO). It will also serve as a connection point to the new renewable energy power plants in the area.

6.1.37 Balayan 69 kV Switching Station

Major Project Components

- **Balayan-Calatagan Line extension**, 69 kV 1-336.4 MCM ACSR SP/CP-SC, 0.7 km;
- **Balayan Switching Station**, 6-69 kV PCBs and Associated Equipment

The Calaca– Balayan – Nasugbu/Calatagan 69 kV line is currently serving load and generator customers. The Balayan to Nasugbu

69 kV line segment serves the BATELEC I Nasugbu and Natipuan loads together with the newly commissioned Aseagas Biomass Plant while the Balayan to Calatagan 69 kV line segment serves the BATELEC I Calatagan and the incoming Calatagan Solar Plant of Solar Philippines. The Balayan Switching Station aims to provide a more reliable supply of power through continuous transmission service even in case of fault in either one of the line segments.

6.1.38 San Manuel-Nagsaag 230 kV Line

Major Project Components

- **San Manuel-Nagsaag Tie-Line Upgrading**, 230 kV, SP-DC, 2-410 mm² TACSR, 0.6 km;
- **Binga Line Extension**, 230 kV, SP-DC, 2-795 MCM ACSR, 0.6 km

The existing 230 kV tie-line connecting Nagsaag and San Manuel 230 kV Substations is a single-circuit facility only. During

- **Nagsaag Substation (Expansion)**, 3-200 MVA, 500/230-13.8 kV Power Transformers and Accessories, 2-500 kV PCB and Associated Equipment and 8-230 kV PCB and Associated Equipment;
- **San Manuel Substation (Expansion)**, 3-230 kV PCB and Associated Equipment;

dispatch of the hydro plants in North Luzon. This project will help improve system security by ensuring continuous connectivity between the concerned substations and will allow optimal utilization of the high capacity San Manuel-Concepcion-Mexico transmission corridor.

outage of the existing tie-line, the identified problems include low voltage issues and overloading of the Pantabangan-Cabanatuan 230 kV Line particularly during maximum

6.1.39 Alaminos 500 kV Switching Station

Major Project Components

- **Alaminos Substation**, 12-500 kV PCB, 2-30 MVAR 500 kV Shunt Reactor and associated equipment

lines connected to the Ilijan 500 kV Substation in Batangas. In the present scheme, the worst contingency event is tripping of the Dasmariñas-Ilijan 500 kV Line which would result in bulk power swing towards Tayabas then back to Dasmariñas. With the increasing bulk power injection to the 500 kV system, the development of this new 500 kV substation in Alaminos will become more important.

This aims to address the reliability and stability concerns brought about by the cut-in scheme of the 500 kV

6.1.40 Mexico-Clark 69 kV Line

Major Project Components

- **Mexico-Clark Line 69 kV**, ST-DC 2-795 MCM ACSR, 18 km

the existing 69 kV transmission line. The existing facility, having been built in 1958, is already due for upgrading. To implement this and to be able to use the existing ROW, Clark-Mabiga 69 kV Line project should be completed first to afford segment by segment upgrading. It can be noted that the line is serving both load and generator customers in the area.

This project aims to increase the capacity and improve the reliability of

6.1.41 Silang-Taguig 500 kV Transmission Line

Major Project Components

- **Silang Substation**, 11-500 kV PCB, 2-30 MVAR 500 kV Shunt Reactor and associated equipment
- **Silang-Taguig Line**, 500 kV 4-795 MCM ACSR ST-DC, 50 km
- **Taguig Substation (expansion)**, 4-500 kV PCB and associated equipment

new substation in Silang has been considered which will bus-in to the existing 500 kV line and will serve as the termination point of the 500 kV-energized line from Calaca. Moreover, the substation also intends to receive the looping line coming from Bataan which involves submarine cable. The new substation site may still involve further reconsideration to take into account the feasibility of the routes of the new 500 kV lines to be connected to this substation. As conceptualized, the Silang-Taguig Line will be traversing the Laguna Lake near the shoreline as the solution to right-of-way problems in establishing a 500 kV backbone within Metro Manila.

This project consists the major segment of the looping configuration of the 500 kV backbone system of the Luzon Grid. Due to space constraints at Dasmariñas 500 kV Substation, a

6.1.42 Dasmariñas-Las Piñas 230 kV Line

Major Project Components

- **Dasmariñas-Las Piñas Line**, 4-795 MCM ACSR SP-DC, 32 km;
- **Las Piñas Substation (expansion)**, 4-230 kV PCB GIS and associated equipment.

Navotas or any augmentation, the substation capacity for Las Piñas and Pasay as well the allowable loads that can be served by these two substations will just be constrained by the capacity of the existing radial Dasmariñas-Las Piñas 230 kV Line. In this regard and in view of the challenges in the right-of-way for a new transmission line from Pasay to Navotas, the development of another circuits from Dasmariñas to Las Piñas has been considered. This new line, which may be able to align with the route of the Cavite-Laguna Expressway or CALAX, will further improve system reliability by providing a separate corridor. Moreover, substation expansion in Las Piñas will also be required.

This line is interrelated with the Navotas-Pasay 230 kV Transmission Line Project. Without the looping to

6.1.43 Minuyan 115 kV Switching Station

Major Project Components

- **Minuyan Switching Station**, 8-115 kV PCBs and Associated Equipment

industrial loads (cement plants) in the area will still continue to use the old San Jose-Angat Lines 1&2. However, as Lines 1&2 are also for later retirement, a new connection point for the load customers is required to provide continuous reliable supply. This will be addressed by this new 115 kV switching station which will bus-in along the new double-circuit line.

Upon completion of the new double-circuit San Jose-Angat 115 kV Line using the right-of-way of Line 3, the

6.1.44 Santiago-Dinadiawan-Baler 230 kV Transmission Line

Major Project Components

- **Santiago-Dinadiawan 230 kV T/L**, ST-DC, 1-795 MCM ACSR/AS, 100.0 km;
- **Dinadiawan-Baler 230 kV T/L**, ST-DC, 1-795 MCM ACSR/AS, 52.6 km;
- **New Santiago 230 kV S/S**, 4-230 kV PCBs and Associated Equipment;
- **Dinadiawan 230 kV S/S**, 1-50 MVA 230/69-13.8 kV Power Transformer and Accessories, 8-230 kV PCBs and Associated Equipment;
- **Baler 230 kV S/S**, 6-230 kV PCBs and Associated Equipment.

Economic Zone and Freeport. The project involves the development of a new substation at Dinadiawan to serve as the connection point for the Ecozone and other loads. This project is expected to be implemented by stages.

The Santiago-Dinadiawan-Baler 230 kV Line project will be developed as another outgoing circuits from Santiago Substation and at the same time, it will form part of the transmission backbone for the province of Aurora. Among the expected load developments in the province is the Aurora Pacific

6.1.45 Western 500 kV Backbone – Stage 2

Major Project Components

- **Castillejos-Bolo**, 500 kV 4-410 mm² TACSR, ST-DC, Castillejos-Masinloc: 84 km, Masinloc-Bolo: 90 km;
- **Castillejos 500 kV Substation**, 2-1000 MVA, 500/230-13.8 kV Power Transformer, 1-90 MVAR 500 kV Shunt Reactor, 11-500 kV PCB, 6-230 kV PCB, and associated equipment.

This project will complete the reinforcement of the capacity of the western corridor presently consisting of a single-circuit line from Labrador down to Botolan to Hanjin then to

Olongapo. The long-term development plan considers providing higher level of reliability up to N-2 contingency for the 500 kV backbone system of the Luzon grid. It should be noted that the existing double-circuit 500 kV transmission line from Bolo to Nagsaag to San Jose is on common tower structures and that toppling of a tower (e.g. due to typhoon) would result in simultaneous outage of two circuits which will completely disrupt the power flow in the EHV corridor. Such scenario can be expected to result in grid congestion due to the required curtailment to the base load coal-fired power plants in the north. The capacity expansion of Masinloc Plant and entry of other new plants in the area would further highlight the critical role of the existing 500 kV backbone in ensuring security of supply, thus, the need to reinforce the transmission network by developing the Western 500 kV backbone corridor. For the case of Castillejos 500 kV Substation, it will serve as the new connection point for RP Energy CFPP and can also help support any future bulk generation development in the area. This Stage 2 project involving very long transmission lines may still be divided into further staging during implementation.

6.1.46 Liberty-Cabanatuan-San Rafael-Mexico 230 kV Line

Major Project Components

- **Liberty-Cabanatuan-San Rafael-Mexico Line**, 230 kV, ST-DC 4-795 MCM ACSR, 140 km.

This project aims to increase the capacity and improve the reliability of the existing single-circuit 230 kV

transmission line. At the same this project will help support the entry of the Pantabangan Pumped-Storage Hydro Plant and other new plants in the future by providing a stronger transmission corridor. Having been built in the 1960s, the old age condition is also a major project driver. As it consists several line segments, the project implementation will be divided into various stages.

6.1.47 Baras Switching Station

Major Project Components

- **Baras Substation**, 10-500 kV PCBs and Associated Equipment

This project aims to address the reliability and stability concerns

brought about by the initial cut-in scheme of Taguig 500 kV Substation. With the increasing bulk power injection to the 500 kV system in the southern part of Luzon grid particularly in Quezon Province area, the worst contingency event will be the tripping of the San Jose-Tayabas 500 kV Line which would result in bulk power swing towards Taguig and Hermosa then back to San Jose.

6.1.48 Luzon Voltage Improvement Project 3

Major Project Components

STAGE 1

- **Laoag 230 kV S/S**, 2-35 MVAR, 230 kV Shunt Reactors and Accessories; 2-25 MVAR, 230 kV Capacitor Banks and Accessories
- **Cabanatuan 230 kV S/S**, 2-50 MVAR, 230 kV Capacitor Banks and Accessories;
- **Nagsaag 500 kV S/S**, 1-90 MVAR, 500 kV Shunt Reactor and Accessories;
- **Tuguegarao 230 kV S/S**, 1-25 MVAR Capacitor Bank and Accessories and 1-25 MVAR, 230 kV Shunt Reactor and Accessories;

The network analyses conducted have identified power quality issues at various 230 kV, 115 kV substations, 69 kV load-end substations as well as 500 kV substation in north Luzon. In order to maintain the system voltages within the PGC-prescribed limits both during normal and N-1 contingency

- **Baler Load-End 69 kV S/S**, 3-2.5 MVAR, 69 kV Capacitor Bank and Accessories;
- **Pantabangan Load-end 69 kV S/S**, 1-5 MVAR, 69 kV Capacitor Bank and Accessories ;
- **Umingan Load-end 69 kV S/S**, 3-5 MVAR 69 kV Capacitor Bank and Accessories;
- **Bantay 115 kV S/S**, 1-7.5 MVAR, 115 kV Capacitor Bank and Accessories ;

STAGE 2

- **San Esteban 230 kV S/S**, 2-25 MVAR, 230 kV Capacitor Banks and Accessories;
- **Botolan 230 kV S/S**, 1-25 MVAR 230 kV Shunt Reactor and Accessories;
- **Mexico 230 kV S/S**, 1-100 MVAR 230 kV Capacitor Bank and Accessories ;
- **San Jose 230 kV S/S**, 1-100 MVAR 230 kV Capacitor Bank and Accessories;
- **Itogon Load-end 69 kV S/S**, 1-7.5 MVAR, 69 kV Capacitor Bank and Accessories;
- **Antipolo 230 kV S/S**, 2-100 MVAR, 230 kV Capacitor Banks and Accessories; and
- **Bayambang Load-end 69 kV S/S**, 3-5 MVAR 69 kV Capacitor Bank and Accessories.

conditions, installation of capacitor banks and shunt reactors will be required.

6.1.49 Luzon Voltage Improvement Project 4

Major Project Components

STAGE 1

- **Ligao Switching Station**, 3-5 MVAR, 69 kV Capacitor Banks and Accessories;
- **Iriga Load-end 69 kV Substation**, 2-5 MVAR, 69 kV Capacitor Banks and Accessories;

STAGE 2

- **Biñan 230 kV S/S**, 2-100 MVAR, 230 kV Capacitor Banks and Accessories;
- **Dasmariñas 230 kV S/S**, 2-100 MVAR, 230kV Capacitor Banks and Accessories;
- **Mabini Load-end 69 kV S/S**, 3-7.5 MVAR, 69 kV Capacitor Banks and Accessories;
- **Cuenca Load-end 69 kV S/S**, 3-7.5 MVAR, 69 kV Capacitor Banks and Accessories;
- **Taysan Load-end 69 kV S/S**, 3-7.5 MVAR, 69 kV Capacitor Banks and Accessories;
- **San Juan Load-end 69 kV S/S**, 3-5 MVAR, 69 kV Capacitor Banks and Accessories;
- **Lagonoy Load-end 69 kV S/S**, 3-5 MVAR, 69 kV Capacitor Banks and Accessories.

The conduct of system study has identified these 230 kV substations and 69 kV load-end substations that will experience power quality issues. In order to maintain the 230 kV and 69 kV system voltages within the PGC-prescribed limits both during normal and N-1 contingency conditions, installation of capacitor banks at various substations is required.

Chapter 7 - Visayas Transmission Outlook

In addition to the projects presented in Chapter 5 which are on various stages of implementation, this section will provide the other identified system requirements in the Visayas Grid but are still subject to regulatory approval prior to implementation. ERC applications for some of the new projects have been made already.

In reference to the DOE list, Cebu and Panay are the main sites for large generation capacity additions specifically for coal-fired power plants. For RE-based plants, on the other hand, it can be observed that the concentration is in Negros and Panay Islands. Such direction of generation development would further emphasize the need to reinforce the 138 kV submarine cable interconnections between Cebu, Negros and Panay.

Presently, the 230 kV facilities are in Leyte and Cebu only but the development of a 230 kV transmission backbone to reach up to Panay Island has been part of the master plan in order to support the generation developments and also to avert the criticality of island grid separations due to the present long radial line configuration of the Visayas Grid. The implementation of this project, which is called Cebu-Negros-Panay 230 kV Backbone, is divided into three (3) stages. The first stage is the additional submarine cable between Negros and Panay. As presented in Chapter 5, this project is already in the construction stage to immediately address the congestion and market issues being encountered due to the limited capacity of the existing single-circuit 138 kV link. Also, the existing Negros-Cebu 138 kV can only export a maximum of 180 MW of excess generation capacity. This will be insufficient even if we consider the entry of committed power plants only. Thus, the second and third stages of the new 230 kV backbone, which will be discussed in this chapter, are the next major requirements in the Visayas Grid.

The upgrading of the Panitan-Nabas and Ormoc-Tongonan-Isabel 138 kV Lines is also a priority project of NGCP. While these lines have been restored already after the onslaught of typhoon Yolanda in 2013, the implemented emergency restoration systems (ERS) or temporary structures would remain susceptible to line interruption concerns especially during times of another calamities. The temporary facilities will be replaced with permanent tower structures which will already adopt new wind design standards to further improve grid security.

Within Cebu Island where the load center is located, the development of new 230 kV load substations and implementation of new 230 kV transmission line extensions are required to ensure adequate supply facilities in the long term. Although not yet included in the DOE list as of August 15, 2015, there are other bulk generation additions such as the proposed coal-fired power plant of Salcon Power Corporation and Ludo Power Corporation which will also require grid reinforcements. As in the case in other urbanized area, securing right-of-way in Cebu is also a major challenge in transmission project implementation.

In Panay, the new developments in the tourism industry in Boracay Island would result in an increase in power supply requirements. It is projected that the existing 69 kV submarine cable serving the island would not be adequate in supporting load growth in the coming years. Thus, this is also one of the areas requiring grid reinforcements through the installation of additional submarine cable under the Nabas-Caticlan-Boracay 138 kV Transmission Project.

Another major submarine cable project to be implemented within the next 10 years is the Cebu-Bohol 138 kV Interconnection Project. Presently, Bohol Island has power deficiency issue due to limited power sources in the island. In 2014, the maximum demand in Bohol reached 71MW. Almost 90% of the island's demand comes from Leyte via the Leyte-Bohol submarine cable which is already equivalent to 70% of the submarine cable's capacity. By 2020, it is expected that the Leyte-Bohol interconnection will be overloaded. The implementation of this Cebu-Bohol Interconnection Project would significantly boost the supply reliability to support the load growth in the island as will be brought about by its direct access to the bulk generations located in Cebu. It can be noted also that during the Typhoon Yolanda incident affecting the transmission facilities in Ormoc, Leyte area, the supply for Bohol Island was also interrupted because there is no alternate source for the island. Such concern will also be addressed by the Cebu-Bohol Interconnection Project.

7.1 Proposed Transmission Projects for 2016-2025

Shown in Table 7.1 is the list of transmission projects planned for Visayas in the period 2016-2025 in addition to the projects already approved by the ERC.

Table 7.1: Proposed Transmission Projects for Visayas

Project Name/Driver(s)	Province(s)	ETC
Generation Entry		
CNP 230 kV Backbone Project - Stage 2 (Cebu Substation 230 kV Upgrading)	Cebu	Dec 2018
Magdugo 230 kV Substation Project	Cebu	Dec 2019
Panay-Guimaras 138 kV Interconnection Project	Panay	Dec 2019
CNP 230 kV Backbone Project - Stage 3 (Negros-Cebu Interconnection)	Negros Occidental, Cebu, Panay	Dec 2020
Sta. Barbara-Dingle 138 kV Line 3 Project	Iloilo	Dec 2023
Load Growth		
Colon Substation Expansion Project	Cebu	Jun 2017
Nabas-Caticlan-Boracay Transmission Project (Stage 1)	Aklan	Aug 2019
Laray 230 kV Substation Project	Cebu	Mar 2020
Amlan-Dumaguete 138 kV T/L Project	Negros Oriental	Jun 2020
Babatngon-Palo 138 kV T/L Project	Leyte	Dec 2020
Nabas-Caticlan-Boracay Transmission Project (Stage 2)	Aklan	Mar 2022
Umapad 230 kV Substation Project	Cebu	Jun 2023
System Reliability		
Upgrading of Ormoc/Tongonan-Isabel 138 kV T/L	Leyte	Nov 2016
Upgrading of Panitan-Nabas 138 kV T/L	Aklan, Capiz	Nov 2016
Panitan-Nabas 138 kV Transmission Line 2 Project	Aklan, Capiz	Jun 2017
Naga S/S Upgrading Project	Cebu	Dec 2018
Cebu-Bohol Interconnection Project	Cebu, Bohol	Dec 2019
Calbayog-Allen 69 kV T/L Project	Samar, Northern Samar	Dec 2020
Tagbilaran 69 kV S/S Project	Bohol	Dec 2020
Visayas S/S Upgrading Project	Cebu, Leyte, Samar, Negros, Panay	Dec 2020
Kabankalan S/S Reliability Improvement Project	Negros Occidental	Jun 2024
Babatngon-Sta. Rita 138 kV T/L Upgrading Project	Leyte, Samar	Dec 2024

Project Name/Driver(s)	Province(s)	ETC
Palo-Javier 138 kV T/L Project	Leyte	Jun 2025
Power Quality		
Visayas Voltage Improvement Project – Stage 1 / Stage 2	Northern Samar, Leyte, Southern Leyte	Dec 2019/ Jun 2022
Maasin-Javier 138 kV T/L Project	Leyte, Southern Leyte	Jun 2025

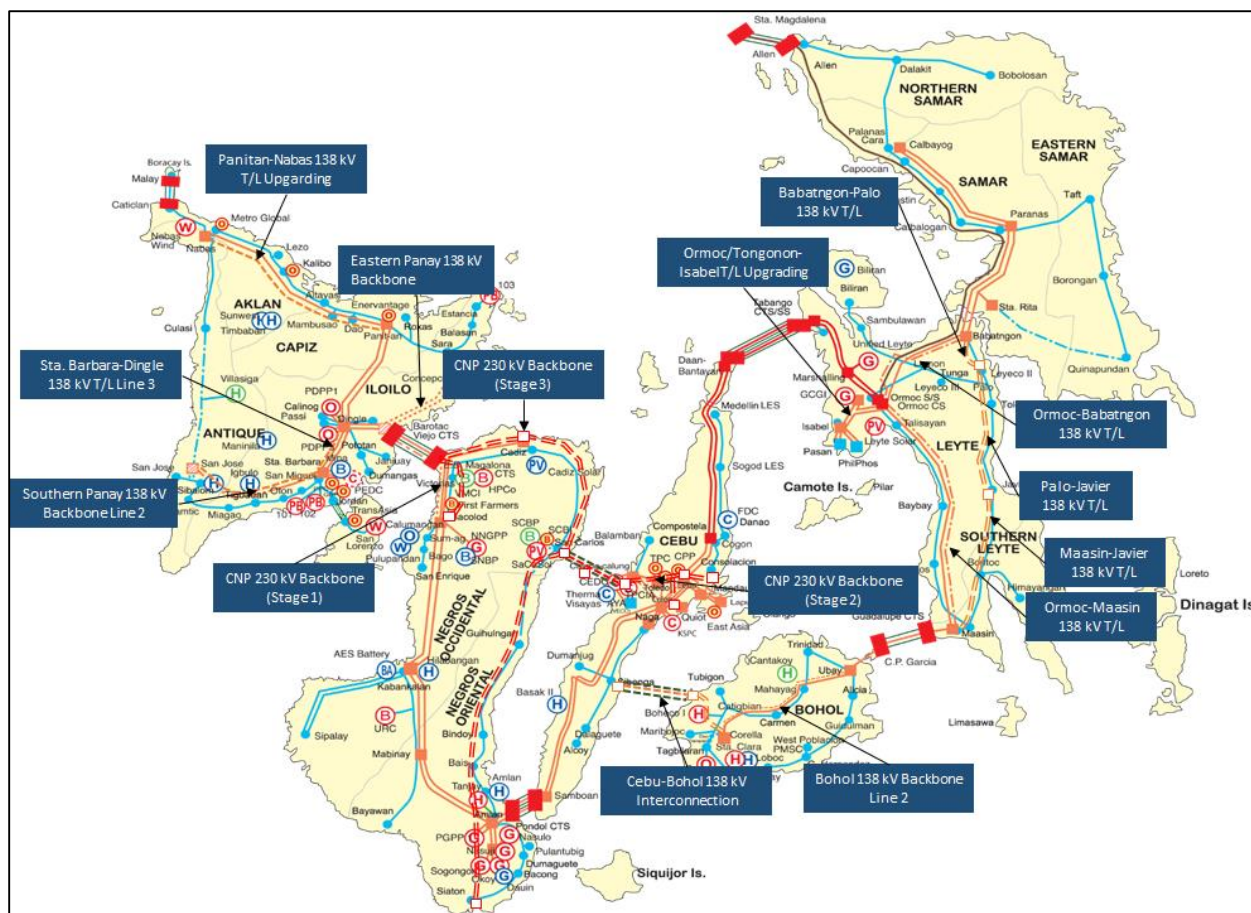


Figure 7.1: Proposed Projects for Visayas

7.1.1 Cebu-Negros-Panay 230 kV Backbone Project –Stage 2 (Cebu Substation)

Major Project Components

- **Cebu S/S**, 3-300 MVA 230/138 kV Power Transformers, 8-230 kV PCB (GIS) and 3-138 kV PCB and associated equipment.

Therma Visayas, Inc. is developing a 300 MW coal-fired power plant in Toledo City. It is targeted for

commissioning in 2017 and requires a high-capacity transmission system to ensure full generation dispatch towards the load centers in Metro Cebu and the rest of the Visayas Grid. However, due to the limited available transmission capacity of the 138 kV system in Central Cebu Grid, the proposed power plant is proposed to be directly connected to Cebu Substation via 230 kV transmission line, which will be constructed by the proponent as part of its connection assets. Relative thereto, a new 230 kV facility will be constructed in Cebu Substation to facilitate the termination of the proposed overhead transmission line from the power plant. The project is also

consistent with the planned 230 kV transmission backbone in Visayas which will extend from Cebu to Panay.

7.1.2 Magdugo 230 kV Substation Project

Major Project Components
<i>Reclassification and Acquisition</i>
▪ Magdugo-Cebu 230 kV T/L, ST-DC, 4-795 MCM ACSR, 35 km ▪ Magdugo S/S, 1-300 MVA 230/138 kV Power Transformer, 5-230 kV PCB, 5-138 kV PCB and associated equipment
<i>Expansion</i>
▪ Magdugo S/S, 1-300 MVA 230/138 kV Power Transformer, 1-150 MVA 230/138 kV Power Transformer, 6-230 kV PCB, 10-138 kV PCB.
<i>Associated Grid Reinforcements</i>
▪ Naga-Colon 138 kV T/L, Re-conductoring to 1-795 MCM STACIR; ▪ Colon-Quiot-Cebu 138 kV T/L, Re-conductoring of Quiot-tapping point segment into higher thermal capacity conductors (preferably with double the capacity of 1-795 MCM ACSR) and bundling of Colon-Quiot and Quiot-Cebu lines. ▪ Colon S/S (termination of VECO and CEDC), 2-138 kV PCB and associated equipment

The project is intended to improve the power transmission capability of the Central Cebu Grid in line with the entry of Salcon Power Corporation's 2-150 MW Coal-Fired Power Plant in Naga City.

The project will be implemented in two stages. First stage involves the upgrading of Naga-Colon 138 kV Lines and the Quiot S/S Cut-in Lines to Colon-Cebu 138 kV Lines. The Colon-Quiot and Quiot-Cebu lines will be reconfigured which will permit additional transfer capacity of the

said 138 kV transmission lines. Furthermore, additional PCBs will be installed at Colon to accommodate the termination of the 138 kV lines from VECO and CEDC.

The second stage of the project involves the acquisition and expansion of Therma Visayas Inc.'s substation in Magdugo, Toledo City to facilitate the reconfiguration of the power transmission network in Central Cebu.

7.1.3 Panay-Guimaras 138 kV Interconnection Project

Major Project Components
<i>Reclassification and Acquisition</i>
▪ Guimaras-Panay, 138 kV XLPE Submarine Cable, 100 MW, 3km. ▪ Zaldivar CTS, Cable Sealing End Equipment.
<i>Expansion</i>
▪ Panay CTS – PEDC Switching Station, ST-DC, 1-795 MCM ACSR, 2km; ▪ PEDC Switching Station, 4-138 kV PCB and associated equipment; ▪ Zaldivar S/S, 2-100 MVA, 138/69 kV Power Transformer, 3-138 kV PCB, 4-69 kV PCB and associated equipment. ▪ Panay CTS, Cable Sealing End Equipment;

The project is intended to ensure the full dispatch of the San Lorenzo Wind Plant and other prospective generators in the area.

The project involves the energization of the Panay-Guimaras Interconnection at 138kV by expanding Zaldivar CTS into a substation and construction of a 2km

overhead line terminating to PEDC substation.

7.1.4 Cebu-Negros-Panay 230 kV Backbone Project - Stage 3

Major Project Components

- **Magdugo S/S**, 4-230 kV PCB and associated equipment.
- **Toledo CTS-Magdugo 230 kV T/L**, ST-DC, 4-795 MCM ACSR, 6 km
- **Toledo CTS**, 3-230 kV PCB, 2-50 MVAR 230 kV Reactor
- **San Carlos-Toledo CTS 230 kV Submarine Cable**, Single Circuit, 4-1,600 mm² XLPE subcable, 22 km
- **San Carlos S/S**, 2-100 MVA 230/69 kV Power Transformer, 8-230 kV PCB, 12 -69 kV PCB, 2-50 MVAR 230 kV Reactor
- **Cadiz-San Carlos 230 kV T/L**, ST-DC, 4-795 MCM ACSR, 80 km
- **Cadiz S/S**, 2-150 MVA 230/138 kV Power Transformers, 10-230 kV PCB, 8-138 kV PCB
- **Cadiz- E. B. Magalona 230 kV T/L**, ST-DC, 4-795 MCM ACSR, 45 km
- **E. B. Magalona Switching Station**, 8-230 kV PCB, 1-70 MVAR 230 kV Reactor
- **Barotac Viejo S/S**, 3-300 MVA 230/138 kV Power Transformers, 7-230 kV PCB, 2-138 kV PCB, 1-70 MVAR 230 kV Reactor
- **Bacolod S/S**, 2-300 MVA 230/138 kV Power Transformer, 6-230 kV PCB, 1-138 kV PCB

In line with the projected increase in the generation capacity addition in Visayas, high-capacity transmission facilities are proposed between Cebu, Negros and Panay. The project aims to facilitate the realization of the transmission master plan of having a 230 kV transmission backbone in the Visayas by establishing a 230 kV interconnection from Panay to Cebu.

The project aims to accommodate the excess generation from baseload plants in Cebu and Panay and the RE based generation in Negros and Panay.

The project includes the construction of new substations that will facilitate the termination and energization of 230 kV transmission lines that will extend from Barotac Viejo Substation in Panay to Magdugo Substation in Cebu. The project will also facilitate the 230 kV energization of the initial stage of the CNP 230 kV Backbone Project (Barotac Viejo S/S - Bacolod S/S) which is proposed to be initially energized at 138 kV.

7.1.5 Sta. Barbara-Dingle 138 kV Line 3 Project

Major Project Components

- **Sta. Barbara-Dingle 138 kV T/L**, ST-DC, 1-795 MCM ACSR, 24 km;
- **Sta. Barbara S/S**, 2-138kV PCB and associated equipment;
- **Dingle S/S**, 2-138 kV PCB and associated equipment.

To provide a reliable transmission corridor for the generation located in southern and western part of Panay, the Sta. Barbara-Dingle 138kV Line 3

is required to ensure that all generators can be fully dispatched even during N-1 contingency condition.

7.1.6 Colon Substation Expansion Project

Major Project Components

- **Colon S/S (New)**, 1-100 MVA 138/69-13.8 kV Power Transformers, 2-138 kV PCB, 2-69 kV PCB and associated equipment
- **Transfer of Naga-Sibonga-Dumanjug 69 kV Feeder from Naga S/S to Colon S/S**, SP-SC, 1-336.4 MCM ACSR, 1.5 km.

The project is intended to improve the delivery of power to the loads connected to the Naga-Sibonga-Dumanjug 69 kV line. It involves the transfer of the Naga-Sibonga-

Dumanjug 69 kV Feeder from Naga S/S to Colon S/S. It also involves the installation of new 100 MVA transformer at Colon S/S. This project is formerly known as New Naga (Cebu) Substation Project.

7.1.7 Nabas-Caticlan-Boracay Transmission Project

Major Project Components
STAGE 1 ▪ Boracay S/S (New), 1-100 MVA 138/69/13.2 kV Power Transformer, 1-138 kV PCB, 1-69 kV PCB and associated equipment; ▪ Caticlan-Boracay Power Cable, XLPE Submarine Cable System of 100 MW capacity at 138 kV, 2 km ▪ Caticlan CTS (New), Cable Sealing End
STAGE 2 ▪ Nabas-Caticlan 138 kV T/L, Combination of ST/SP-DC, ST/SP-DC, 1x795 MCM ACSR, 19 km. and Underground Cable System of 100 MW capacity at 138 kV, 6 km ▪ Nabas S/S, 4-138 kV PCB and associated equipment ▪ Unidos CTS (New), Cable Sealing End

In line with the developments in the tourism industry in Boracay Island, the power requirement is expected to increase. To meet the projected demand, additional substation and submarine cable needs to be implemented.

The project aims to provide additional transmission and substation capacity to cater the growing demand of Caticlan and Boracay Island. The power quality in the area will also improve upon completion of the

project.

7.1.8 Laray 230 kV Substation Project

Major Project Components
▪ Laray S/S (New), 2-150 MVA 230/69-13.8 kV Power Transformers, 5-230 kV PCB (GIS), 4-69 kV PCB (GIS) and associated equipment ▪ Magdugo-Laray 230 kV T/L, ST/SP-DC, 2-610 mm² TACSR/ 4-795 MCM ACSR, 22 km.

In line with the continuing economic and infrastructure development within Metro Cebu, the power requirement in the area is projected to increase. In order to accommodate

the projected increase in the power demand, a new drawdown substation is proposed. The new substation is also intended to provide alternative connection point to power consumers. This project was previously named as SRP Substation.

7.1.9 Amlan-Dumaguete 138 kV Transmission Line Project

Major Project Components
▪ Amlan-Dumaguete 138 kV T/L, ST-DC, 1-795 MCM ACSR, 22 km ▪ Dumaguete S/S (New), 1-50 MVA, 138/69-13.8 kV Power Transformers 5-138 kV PCB and 3-69 kV PCB and associated equipment ▪ Amlan S/S, 4-138 kV PCB and associated equipment.

To address the projected load growth and improve the system reliability in Dumaguete City and vicinity, there is a need to implement another transmission line with bigger capacity and at higher voltage. The proposed

new line will also allow Negros Oriental Electric Cooperative II (NORECO II) to source its power from the proposed Dumaguete Substation, thereby unloading Amlan Substation and the Amlan-Siaton 69 kV line. The proposed implementation scheme will also minimize transmission loss and improve the power quality to the customers served by the 69 kV line.

7.1.10 Babatngon-Palo 138 kV Transmission Line Project

Major Project Components

- **Babatngon-Palo 138 kV T/L**, ST-DC, 1-795 MCM ACSR, 20 km
- **Palo S/S (New)**, 2-50 MVA 138/69-13.8 kV Power Transformer and 5-138 kV PCB, 8-69 kV PCB and associated equipment

capacity and at higher voltage is required. There is also a need to establish a 138 kV drawdown substation in the vicinity of Palo to serve Don Orestes Romualdez Electric Cooperative, Inc. (DORELCO) and LEYECO II and provide alternate power supply source (during N-1 contingency event) for the load customers in the area.

To meet the projected demand and provide an alternate source of power, a new line with higher transfer

7.1.11 Umapad 230 kV Substation Project

Major Project Components

- **Umapad S/S (New)**, 2-150 MVA 230/69-13.8 kV Power Transformer, 7-230 kV PCB (GIS), 5-69 kV PCB (GIS) and associated equipment.

power requirement in the area is projected to increase. In order to accommodate load growth, a new drawdown substation is proposed. To achieve this, the double circuit overhead component of the Cebu Lapulapu transmission project will be energized to 230 kV from 138 kV. This line will connect Umapad 230 kV Substation to the Cebu 230 kV substation via 2-795 MCM ACSR. This will then be stepped down to 69 kV via 2-150 MVA transformer. This is intended to relieve the Cebu – Mandaue 138 kV line and Mandaue 138 kV substation by providing an alternative 230 kV drawdown substation for VECO.

In line with the continuing economic and infrastructure development in the northern part of Metro Cebu, the

7.1.12 Upgrading of Ormoc/Tongonan-Isabel 138 kV Transmission Line

Major Project Components

- **Ormoc/Tongonan-Isabel 138 kV T/L**, 72 tower structures and associated overhead line component to be replaced

Ormoc/Tongonan-Isabel 138 kV T/L. The restoration of the transmission line was undertaken through the use of emergency restoration system (ERS) and steel pole structures, which offer limited capability in terms of reliably transmitting power.

In 2013, the super typhoon Yolanda has caused the toppling of 72 steel tower structures of the

The project is intended to address the system limitation and improve the reliability of the Ormoc/Tongonan-Isabel 138 kV Transmission Line. It involves the construction of new steel tower structures and installation of associated overhead line component. It also aims to provide N-1 contingency for the transmission corridor between the Isabel, Tongonan and Ormoc Substations.

7.1.13 Upgrading of Panitan-Nabas 138 kV Transmission Line

Major Project Components

- **Panitan-Nabas 138 kV T/L**, 128 tower structures and associated overhead line component to be replaced

Nabas 138 kV T/L. The restoration of the transmission line was undertaken through the use of emergency restoration system (ERS) and steel pole structures, which offer limited capability in terms of reliably transmitting power.

In 2013, the super typhoon Yolanda has caused the toppling of 128 steel tower structures of the Panitan-

The project is intended to address the system limitation and improve the reliability of the Panitan-Nabas 138 kV Transmission Line. It involves the construction of new steel tower structures and installation of associated overhead line component.

7.1.14 Panitan-Nabas 138 kV Transmission Line 2 Project

Major Project Components

- **Panitan-Nabas 138 kV T/L**, ST-DC2 (2nd circuit stringing), 1-795 MCM ACSR, 95 km
- **Panitan S/S**, 1-138 kV PCB and associated equipment
- **Nabas S/S**, 3-138 kV PCB and associated equipment

The northeastern part of Panay, which includes the Boracay Island, draws power from the grid through the existing Panitan-Nabas

Transmission Corridor which is composed of a single circuit 138 kV line and a single circuit 69 kV line. However, during the outage of the 138 kV line, the 69 kV line will have limited transmission capacity to cater the entire load of the area, hence, will result in power curtailment.

The project is intended to improve the reliability of the power transmission system towards the northwestern part of Panay by providing N-1 contingency to the existing single circuit Panitan-Nabas 138 kV Transmission Line.

7.1.15 Naga Substation Upgrading Project

Major Project Components

- **Naga S/S**, 6-138 kV PCB and associated equipment

The project is being proposed to improve the operational reliability of

Naga Substation in Cebu by minimizing outages due to equipment failure, maintenance and repair works which are expected to occur more frequently and at longer duration. The Naga Substation was commissioned in 1977, hence, most of the equipment are already antiquated and are difficult to maintain. This project is formerly Naga Substation Rehabilitation Project.

7.1.16 Cebu-Bohol 138 kV Interconnection Project

Major Project Components

- **Sibonga S/S (New)**, 1-50MVA, 138/69kV Transformer, 12-138kV PCB and associated equipment, 3-40MVAR Reactor, 3-69kV PCB and associated equipment
- **Corella S/S**, 3-138kV PCB & Associated Equipment
- **Sibonga CTS-Corella CTS**, Single circuit submarine cable system of 200 MW capacity at 138 kV, 30km
- **Loon CTS-Corella S/S**, ST-DC, 1 x 795 MCM, 17 km

Currently, Cebu, Leyte and Bohol are connected radially which makes it more prone to outages. By year 2020, the Leyte-Bohol submarine cable will be overloaded which could result in load curtailment in Bohol. Outage of the 138kV overhead lines such as Ubay-Corella, Tugas-Ubay,

Maasin-Guadalupe and Ormoc-Maasin will result in system collapse. During the outage of the Leyte-Bohol 138 kV Interconnection, power delivery towards the entire Bohol Island will be interrupted. Since the existing power plants in Bohol do not have sufficient generation capacity to cater the power demand in the island during N-1 contingency condition, there is a need to establish an alternative transmission corridor towards Bohol. The project will address the increasing demand and improve the reliability of power supply in Bohol Island. It will also serve as an alternative transmission corridor between Cebu and Leyte/Samar Islands.

7.1.17 Calbayog-Allen 69 kV Transmission Line Project

Major Project Components

- **Calbayog-Allen 69 kV T/L**, SP-SC 1-336.4 MCM ACSR, 78 km
- **Calbayog S/S**, 1-69 kV PCB and associated equipment.

In line with the frequent and extended outage of the 69 kV lines, construction of a 69 kV line from

Calbayog to Allen is needed to form a loop and provide single outage contingency (N-1) capability to the transmission lines serving Northern Samar.

7.1.18 Tagbilaran 69 kV Substation Project

Major Project Components

- **Tagbilaran S/S (New)**, 10 MVA 69/13.8 kV Power Transformer and 3-69 kV PCB and associated equipment.

This project involves the installation of a 10 MVA transformer for Tagbilaran Substation that will allow

continuous reliable supply of power for Bohol Electric Incorporated (BEI) and for the Loboc Hydroelectric Power Plant (LHEP). Presently, these customers are just relying on the 2x10 MVA transformers at Bohol Diesel Power Plant (BDPP) Switchyard, thus, any outage or maintenance works in the BDPP-owned transformers, the grid connection of BEI and LHEP is being disrupted. With the project, BEI and LHEP will have dedicated connection to Tagbilaran substation.

7.1.19 Visayas Substation Upgrading Project

Major Project Components

LEYTE

- **Tabango S/S**, 1-50 MVA 230/69-13.8kV Power Transformer, 1-138kV PCB, 2-69kV PCB and associated equipment.
- **Maasin S/S**, 1-50 MVA 138/69-13.8 kV Power Transformer, 2-138 kV PCB, 1-69 kV PCB and associated equipment;

SAMAR

- **Calbayog S/S**, 1-50MVA 138/69-13.8kV Power Transformer, 1-138kV PCB, 2-69kV and associated component;

CEBU

- **Daanbantayan S/S**, 1-100MVA 230/69-13.8kV Power Transformer, 1-138kV PCB, 1-69kV PCB and associated equipment.
- **Colon S/S**, 1-100 MVA 138/69-13.8 kV Power Transformer, 1-138 kV PCB, 1-69 kV PCB and associated equipment;
- **Calong-calong S/S**, 1-50 MVA 138/69-13.8 kV Power Transformer, 2-138 kV PCB, 2-69 kV PCB and associated equipment
- **Compostela S/S**, 1-50 MVA 138/69-13.8 kV Power Transformer, 2-138 kV PCB, 1-69 kV PCB and associated equipment

NEGROS

- **Kabankalan S/S**, 1-50 MVA 138/69-13.8 kV Power Transformer, 2-138 kV PCB, 1-69 kV PCB and associated equipment;
- **Mabinay S/S**, 1-50 MVA 138/69-13.8 kV Power Transformer, 2-138 kV PCB, 1-69 kV PCB and associated equipment;

To accommodate the projected demand and avoid overloading of the transformer, there is a need to upgrade the substation capacity of Tabango Substation.

To accommodate the proposed 100MW CEKO Solar Power Plant, there is a need to upgrade the substation capacity in Daanbantayan Substation.

To comply with N-1 contingency criterion of the PGC, an additional 50 MVA transformer needs to be installed at Dingle, San Jose, Maasin and Calbayog Substations. Considering the 10-year projected demand of the distribution utilities and electric cooperatives being served by Panit-an Substation, the existing 2-30 MVA, 138/69-13.8 kV transformer needs to be upgraded to 2-50 MVA to increase the substation capacity and improve the reliability up

- **E.B. Magalona S/S**, 2-30 MVA, 138/69-13.8 kV Power Transformer (transferred from Panitan S/S), 4-138 kV PCB, 2-69 kV PCB and associated equipment.

PANAY

- **Dingle S/S**, 1-50 MVA 138/69-13.8 kV Power Transformer, 2-138 kV PCB, 1-69 kV PCB and associated equipment;
- **San Jose S/S**, 1-50 MVA 138/69-13.8 kV Power Transformer, 2-138 kV PCB, 1-69 kV PCB and associated equipment;
- **Panit-an S/S**, 2-50 MVA 138/69-13.8 kV Power Transformer, 4-138 kV PCB, 2-69 kV PCB and associated equipment.

to the substation level. Kabankalan, Mabinay, and E.B. Magalona Substations need upgrading to provide N-1 contingency capability and increase reliability at the substation level.

7.1.20 Kabankalan Substation Reliability Improvement Project

Major Project Components

- Substation Reconfiguration (no additional major equipment)

To improve the system reliability of the 138 kV lines to Bacolod and

Mabinay Substations and prevent partial blackout during double-bus outage in Kabankalan Substation, the Kabankalan-Bacolod and Kabankalan-Mabinay 138 kV lines should be connected in the same switchbay. The proposed connection scheme will ensure continuity of supply in Northern Negros and Panay during the simultaneous outage of the two 138 kV buses at Kabankalan Substation.

7.1.21 Babatngon-Sta. Rita 138 kV Transmission Line Upgrading Project

Major Project Components

- **Babatngon-Paranas 138 kV T/L (portion along San Juanico Strait)**, ST-DC, 2-795 MCM ACSR, 1.8 km;
- **Babatngon-Sta. Rita 69 kV T/L**, 1-336.4 MCM ACSR, 11.6 km, 1-69 kV PCB and associated equipment (installation and hauling from Sta. Rita).

The project aims to address the need to increase the transmission capacity of the Babatngon-Paranas 138 kV line, which, due to portion of the line that utilizes smaller conductor size,

has a limited capacity of 100 MW or equivalent only to half of the capacity designed for the entire line. It will facilitate the transfer of load connection point from Sta. Rita to Babatngon, hence, will eliminate the 138 kV tap connection of the Sta. Rita Substation and correspondingly improve the system reliability.

7.1.22 Palo-Javier 138 kV Transmission Line Project

Major Project Components

- **Palo-Javier 138 kV T/L**, ST-DC, 1-795 MCM ACSR, 45 km;
- **Palo S/S**, 4-138 kV PCB and associated equipment;
- **Javier S/S**, 4-138 kV PCB and associated equipment;

The project aims to improve the reliability of the transmission backbone in Leyte by establishing a

138 kV transmission loop. The project will link the Babatngon-Palo 138 kV Line in the north and the Maasin-Javier 138 kV Line in the south, therefore, will provide N-1 contingency to the loads connected to the 138 kV transmission corridor.

7.1.23 Visayas Voltage Improvement Project

Major Project Components

- **Corella S/S**, 3-5 MVAR, 138 kV Capacitor Banks;
- **Catarman LES**, 1-7.5 MVAR, 69 kV Capacitor Bank;
- **Bobolosan LES**, 1-5 MVAR, 69 kV Capacitor Bank;
- **Tolosa LES**, 1-5 MVAR, 69 kV Capacitor Bank;
- **Caticlan LES**, 4-5 MVAR, 69 kV Capacitor Banks;
- **Himayangan LES**, 1-5 MVAR, 69 kV Capacitor Bank;

Maintaining the system voltages within the PGC-prescribed limits both during normal and N-1 contingency condition requires the installation of capacitor banks at the identified substations in Visayas.

7.1.24 Maasin-Javier 138 kV Transmission Line Project

Major Project Components

- **Maasin-Javier 138 kV T/L**, ST-DC, 1-795 MCM ACSR, 105 km;
- **Maasin S/S**, 3-138 kV PCB and associated equipment.
- **Javier S/S (New)**, 2-50 MVA 138/69-13.8 kV Power Transformer, 6-138 kV PCB, 5-69kV PCB and associated equipment.

To address the low voltage and improve reliability, the system needs another transmission line with bigger transfer capacity, at higher voltage

and a new drawdown substation in the vicinity of Javier. This proposed Javier Substation could serve the entire SOLECO customers. DORELCO and LEYECO II Load-end Substations may also be shifted to this proposed substation during N-1 contingency event.

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Chapter 8 – Mindanao Transmission Outlook

The recent major transmission development in Mindanao is the completion of a 230 kV-designed transmission backbone system from Balo-I, Lanao del Sur to Villanueva, Misamis Oriental then down to the Bunawan in Davao del Sur. This facility, which is initially energized at 138 kV, facilitates the transfer of bulk power from the hydro power plant complex in the north going to the load centers in the south of Mindanao.

In its generation capacity mix in the past years, Mindanao is known as a hydro generation dependent grid, thus, the adequacy of supply has always been a major concern during dry seasons. However, the power supply deficiency being experienced in Mindanao Grid is slowly being averted by the entry of bulk generation capacity additions from a number of coal-fired power plant projects which are already committed. To facilitate its integration to the grid, further extensions of the 230 kV system have been required to reach the bulk generation sites as in the case for GNPowder Kauswagan, TSI, and SMC Malita. It can be noted also that the new power plants have plans for generation capacity expansions in the future which would reach a total of 600 MW to 1,200 MW capacity in each site. Such developments would already necessitate the energization of the Mindanao backbone to 230 kV voltage level to increase its transmission capacity.

Furthermore, because of the aggressive plans for future plant expansion which could be more than enough for the Mindanao loads particularly during wet seasons, there is an increasing clamour to pursue already the Visayas-Mindanao Interconnection Project in order to allow export of power to the other grids. This major interconnection project, which is the final link to unify the Philippine Grid, is further discussed in Chapter 9.

In other parts of Mindanao, the requirements generally include reinforcements of the existing 138 kV transmission lines and extension also of some 69 kV facilities for system reliability improvement, and the usual transformer capacity additions in the substations for continuous adequate supply for the load customers.

In terms of backbone system configuration, Mindanao is a relatively robust grid. However, because of the security concerns for some of the transmission lines in Mindanao, NGCP is facing major challenges.

8.1 Proposed Transmission Projects for 2016-2025

Shown in Table 1.1 is the list of transmission projects planned for Mindanao Grid in the period 2016-2025 in addition to the projects already approved by the ERC.

Table 8.1: Proposed Transmission Projects for Mindanao

Project Name/Driver(s)	Province(s)	ETC
Generation Entry		
Mindanao 230 kV Transmission Backbone	Mindanao Island	Dec 2018
Balo-i-Kauswagan-Aurora 230 kV T/L (Phase 2)	Lanao del Norte, Misamis Occidental, Zamboanga del Sur	Dec 2021
Load Growth		
Mindanao Substation Upgrading	Mindanao Island	Dec 2022
System Reliability		
Kabacan 138 kV S/S	Cotabato	Dec 2021
Villanueva-Jasaan-Butuan 138 kV T/L	Misamis Oriental, Agusan del Norte	Dec 2021
Mindanao Substation Rehabilitation	Mindanao Island	Dec 2022
Balo-i-Tagoloan-Opol 138 kV T/L	Lanao del Sur and Misamis Oriental	Dec 2025
Tacurong-Sultan Kudarat 138 kV T/L	Maguindanao, Sultan Kudarat	Dec 2025

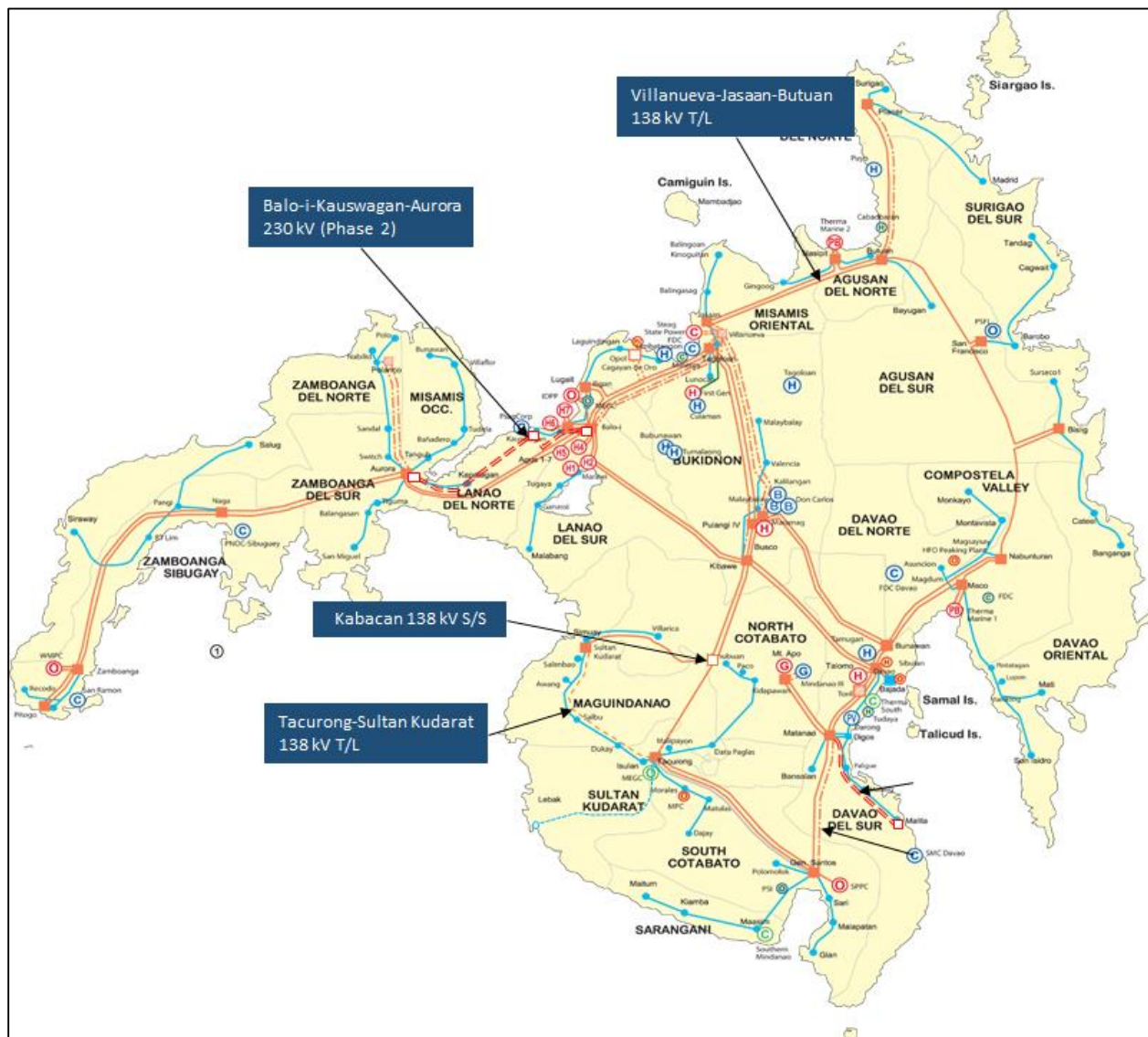


Figure 8.1: Proposed Projects for Mindanao

8.1.1 Mindanao 230 kV Transmission Backbone

Major Project Components

- **Matanao-Toril 230 kV T/L**, ST-DC, 4-795 MCM ACSR, 34 km;
- **Toril-Bunawan 230 kV T/L**, ST-DC, 4-795 MCM ACSR, 40.2 km;
- **Malita 230 kV S/S**, 1-50 MVA 230/69 kV Power Transformer;
- **Matanao 230 kV S/S**, 2-230 kV PCB and associated equipment;
- **Toril 230 kV S/S**, 2-300 MVA 230/138 kV Power Transformer; 10-230 kV PCB, 6-138 kV PCB and associated equipment;
- **Bunawan 230 kV S/S**, 2-300 MVA 230/138 kV Power Transformer; 10-230 kV PCB, 1-69 kV PCB and associated equipment;
- **Balo-I 230 kV S/S**, 10-230 kV PCB and associated equipment;
- **Villanueva 230 kV S/S**, 2-300 MVA 230/138 kV Power Transformer; 2-35MVAR Reactor, 12-230 kV PCB, 1-69 kV PCB and associated equipment;
- **Maramag 230 kV S/S**, 4-230 kV PCB and associated equipment.

capacity of the backbone and eliminate the vulnerability of power supply in the island to hydropower. It has two major components: the Matanao-Toril-Bunawan 230 kV Transmission Line and the energization of the existing Mindanao Transmission Backbone (Balo-I-Villanueva-Maramag-Bunawan) to 230 kV voltage level. Transmission line component of the project will be in place starting year 2017 while others will be completed until year 2020.

The project will provide additional high voltage corridor for the upcoming power plants in the northern and southern parts of the island. It will strengthen the existing transmission backbone of Mindanao serving as major transmission highway delivering both renewable and conventional energy throughout the island. The project will allow full dispatch of the new large power plants increasing the transmission

8.1.2 Balo-i-Kauswagan-Aurora 230 kV Transmission Line (Phase 2)

Major Project Components

Phase 2

- **Aurora-Kauswagan 230 kV T/L**: ST-DC, 2-795 MCM ACSR, 73 km;
- **Aurora S/S Expansion**: 2-300 MVA 230/69-13.8 kV Power Transformer, 6-230 kV PCB, 4-138 kV PCB and associated equipment;;
- **Kauswagan S/S Expansion**: 2-230 kV PCB and associated equipment.

loaded during N-1 contingency condition. Considering the growing demand and reliability of these existing transmission lines connecting the Zamboanga Peninsula to the Mindanao Grid, it is necessary to construct the additional double-circuit 230kV line from Kauswagan Substation to Aurora Substation.

The Project will ensure the reliability of power supply to the entire Zamboanga Peninsula given that majority of power is being supplied through the existing Balo-I – Aurora and Balo-I – Agus 5 – Aurora 138kV transmission lines, which are critically

8.1.3 Mindanao Substation Upgrading

Major Project Components

- **Polanco S/S**, 1-75 MVA 138/69 kV Power Transformer, 3-138 kV PCB, 1-69 kV PCB and associated equipment;
- **Naga S/S**, 1-100MVA 138/69 kV Power Transformer, 2-69kV PCB and associated equipment;
- **Pitogo S/S**, 1-100MVA 138/69 kV Power Transformer, 1-138 kV PCB, 1-69kVPCB and associated equipment;
- **Agus 6**, 1-100MVA 138/69 kV Power Transformer, 2-138 kV PCB and associated equipment;
- **Maramag S/S**, 1-75MVA 138/69 kV Power Transformer, 1-138 kV PCB, 1-69 kV PCB and associated equipment;
- **Tagoloan S/S**, 1-100MVA 138/69 kV Power Transformer, 3-138 kV PCB, 2-69 kV PCB and associated equipment;

This project involves the installation of a total of 975 MVA power transformers, 52.5 MVAR capacitor banks, 19 – 138 kV power circuit breakers (PCB) and 22 – 69 kV PCB. Also included in the project are the replacement of 14 – 138 kV and 28 – 69 kV PCB.

It will enable various substations in Mindanao Grid to accommodate projected load growth and to comply

- **Opol S/S**, 1-75MVA 138/69 kV Power Transformer, 4-138 kV PCB, 5-69 kV PCB and associated equipment;
- **Butuan S/S**, 1-100MVA 138/69 kV Power Transformer, 2-7.5 MVAR Shunt Capacitor, 5-138 kV PCB, 5-69 kV PCB and associated equipment;
- **Placer S/S**, 1-100MVA 138/69 kV Power Transformer, 1-7.5 MVAR Shunt Capacitor, 3-138 kV PCB, 6-69 kV PCB and associated equipment;
- **Bislig S/S**, 1-50MVA 138/69 kV Power Transformer, 4-138 kV PCB, 5-69 kV PCB and associated equipment;
- **San Francisco S/S**, 1-50MVA 138/69 kV Power Transformer, 2-7.5 MVAR Shunt Capacitor, 4-138 kV PCB, 3-69 kV PCB and associated equipment;
- **Kidapawan S/S**, 1-50MVA 138/69 kV Power Transformer, 1-138 kV PCB, 2-69 kV PCB and associated equipment;
- **Gen. Santos S/S**, 1-7.5MVAR Shunt Capacitor, 1-138 kV PCB, 8-69 kV PCB and associated equipment;
- **Tacurong S/S**, 1-7.5MVAR Shunt Capacitor, 1-138 kV PCB, 10-69 kV PCB and associated equipment;

with the single-outage (N-1) contingency provision prescribed under the Philippine Grid Code (PGC). The project also includes the installation of capacitor banks that can improve the voltage regulation of the network and reduce transmission system losses. Lastly, to replace old, obsolete and underrated PCB to avoid frequent breaker failures and rampant power interruptions. The additional power transformers, installation of capacitor banks and replacement of old, obsolete and underrated PCB, are part of the plan of NGCP to ensure adequate, reliable and quality power transmission

system.

8.1.4 Kabacan 138 kV Substation

Major Project Components

- **Kabacan 138 kV S/S**, 50MVA 138/69-13.8kV Power Transformer; 8-138kV PCB, 3-69kV PCB and associated equipment;
- **Kabacan-Villarica 69 kV T/L**, SC-SP/CP, 1-336.4 MCM, 2km;
- **Kabacan-Manauban 69 kV T/L**, SC-SP/CP, 1-336.4 MCM, 10km.

The new Kabacan Substation will function as a common bus for the double circuit Kibawe – Kabacan 138 kV double circuit lines, Kabacan –

Sultan Kudarat 138 kV and Kabacan – Tacurong 138kV single circuit lines. It will also serve as connection point for load end substations connected at the far end of the 69kV transmission lines emanating from the substations of Sultan Kudarat and Kidapawan. This project will ensure the reliability and security of power supply in the area during contingencies.

The new Kabacan Substation is proposed to be situated in Cotabato which will serve as the terminal point for the Kibawe – Kabacan double-circuit line and new connection point for Sultan Kudarat – Kabacan and Tacurong – Kabacan 138 kV lines. The new substation will also cater load end substations connected at Sultan Kudarat – Midsayap 69kV line and Kidapawan – Matalam (Manauban) 69kV line, further connecting the Kidapawan substation to the proposed substation. The Project, likewise, will serve as a loop connection scheme for the 69kV lines in the vicinity giving flexibility in transmitting power to Sultan Kudarat substation during critical incidents. Sultan Kudarat can then draw its power requirement from adjacent substations through Kabacan – Sultan Kudarat 138 kV line which offers more secured power transmission than the existing Tacurong – Cotabato – Sultan Kudarat 69 kV line.

8.1.5 Villanueva-Jasaan-Butuan 138 kV Transmission Line

Major Project Components

- **Villanueva-Jasaan 138 kV T/L:** ST-SC, 1-795 MCM ACSR, 12km;
- **Nasipit-Tower 179 138 kV T/L:**
 - Line 1: ST-SC, 1-795 MCM ACSR, 4km;
 - Line 2: ST-SC, 1-795 MCM ACSR, 4km;
- **Nasipit S/S Expansion:** 1-50MVA, 138/69-13.8 kV Power Transformer, 9-138 kVPCB and associated equipment;
- **Jasaan S/S Expansion:** 2-138kV PCB and associated equipment;
- **Villanueva S/S Expansion:** 2-138 kV PCB and associated equipment.

The total power demand in NEMA has reached more than 130 MW and is expected to increase at a significant rate in the next 10 years. This projected increase in power demand in NEMA requires the implementation of 3rd circuit of Villanueva-Jasaan 138kV Line to prevent overloading should there be

an outage in one of the circuits. In addition, there is also a need to “bus-in” or divert the existing Jasaan-Butuan 138kV transmission line to Nasipit Substation and install additional 50MVA transformer thereat to improve system reliability as well as improve power quality in Butuan, Placer and San Francisco Substations during N-1 contingency event.

8.1.6 Mindanao Substation Rehabilitation

Major Project Components

- **Aurora S/S,** 1-138 kV PCB, 3-69 kV PCB and associated equipment;
- **Zamboanga S/S,** 3-138 kV PCB, 2-69 kV PCB and associated equipment;
- **Balo-i S/S,** 13-138 kV PCB and associated equipment;
- **Agus 5 S/S,** 4-138 kV PCB and associated equipment;
- **Lugait S/S,** 5-138 kV PCB and associated equipment;
- **Pulangi 4 S/S,** 10-138 kV PCB, 3-69 kV PCB and associated equipment;
- **Nasipit S/S,** 4-138 kV PCB and associated equipment;
- **Davao S/S,** 4-138 kV PCB, 6-69 kV PCB and associated equipment;
- **Maco S/S,** 2-69 kV PCB and associated equipment;
- **Nabunturan S/S,** 3-138 kV PCB, 5-69 kV and associated equipment;
- **Sultan Kudarat kV S/S,** 4-69 kV PCB and associated equipment.

Mindanao Substation Rehabilitation Project aims to replace defective, old, obsolete and low fault level capacity PCBs in the Mindanao Grid. This involves the replacement of 47 – 138 kV and 25 – 69 kV Power Circuit Breakers (PCB) in eleven (11) NGCP substations. Implementation of project will increase the reliability of the network, reduce/prevent unserved energy, and reduce costly maintenance expenses. Lastly, the implementation of the project can improve personnel safety and

decrease incidents of breaker failures.

8.1.7 Balo-i-Tagoloan-Opol 138 kV Transmission Line

Major Project Components

- **Opol S/S Bus-in to Balo-i-Tagoloan 138 kV Line:**
 - Line 1: 138 kV, ST-DC1, 1-795 MCM ACSR, 7 km
 - Line 2: 138 kV, ST-DC1, 1-795 MCM ACSR, 7 km; and
- **Opol 138 kV S/S:** 1-75 MVA, 138/69-13.8 kV Power Transformer, 3-138 kV PCB and associated equipment, 3-69 kV PCB and associated equipment.

With the projected completion of the proposed Opol Substation by the first quarter of 2015, the existing Lugait – Tagoloan 138 kV line needs to be diverted through “cut-in” connection via the construction of two circuits,

employing steel tower double circuit design, constructed initially with single circuit strung utilizing 1-795 MCM ACSR conductor. Tagoloan Substation is also presently connected to Balo-i Substation through the existing 138 kV ST-SC, 1-795 MCM ACSR conductor. Given the rapid growth in demand, the existing transmission system, particularly the capacity of Opol Substation,

may not be able to comply with the power quality standards prescribed under the PGC during single outage (N-1) contingency condition. The Project requires the Balo-i-Tagoloan 138 kV Line “bus-in” to Opol Substation which will address the possible low voltage that may be experienced by customers served by Opol Substation during the outage of the Opol – Tagoloan 138 kV ST-SC line. Another component is the additional 1-75 MVA transformer at Opol Substation which will comply with the N-1 contingency criterion to ensure the security and reliability of the grid during such condition.

8.1.8 Tacurong-Sultan Kudarat 138 kV Transmission Line

Major Project Components

- **Tacurong-Sultan Kudarat 138 kV T/L**, ST-DC1, 1-795 MCM ACSR, 101 km;
- **Tacurong 138 kV S/S**, 2-138 kV PCB and associated equipment;
- **Sultan Kudarat 138 kV S/S Expansion**, 2-138 kV PCB and associated equipment.

The projected increase in demand in the area for the next ten years would require a more reliable power delivery system. Based on the DOE list of PSIPP (Private Sector Initiated

Power Project), several generation developments in Davao and South Cotabato have intentions to connect to the grid in the next five years. Thus, the need to establish a new 138 kV line with higher transfer capacity linking Tacurong and Sultan Kudarat Substations to provide an alternative power transmission corridor for Cotabato City and adjacent municipalities.

9.1 Island Interconnection

With the archipelagic nature of the Philippines, one of the challenges in improving the system reliability and reducing the reserve requirements without adding new generation is the interconnection of two or more islands by the use of an undersea cable. Major considerations in the implementation of such kind of project are the required investment and the potential generation resources in the concerned island. The power cable systems have exhibited high reliability and long life of more than 20-30 years with limited maintenance.

9.1.1 Existing Island Interconnections

As of December 2015, the Philippines has seven major undersea island interconnection systems: six High Voltage Alternating Current (HVAC) and one High Voltage Direct Current (HVDC). These are the Leyte-Luzon $\pm$ 350 kV HVDC, Leyte-Cebu 230 kV, Negros-Panay 138 kV, Cebu-Negros 138 kV, Cebu-Lapu-lapu 138 kV HVAC and the Panay-Boracay 69 kV AC Interconnection facilities. The 432-km Leyte-Luzon $\pm$ 350 kV HVDC, with a 23-km connecting Leyte Island (via Samar Island) to the Luzon Grid has been in operation since 1998. Its maximum transmission capacity is 440 MW with provision for upgrade to 880 MW.

The Leyte-Cebu interconnection is a 33-km double circuit 230 kV submarine cable, with a transfer capacity of nearly 400 MW. The first and second circuits were energized in 1997 and 2005, respectively. The double circuit Cebu-Negros Interconnection enables power sharing of maximum of 180 MW between Cebu and Negros Islands. Its first circuit of 18-km, 138 kV submarine cable was energized in 1993 while its second circuit was energized in 2007. From Negros Island, connected is the 18-km 138 kV Negros-Panay Interconnection, energized in 1990 with a rated capacity of 85 MW.

Connecting the island of Mactan to mainland Cebu is the 8.5-km 200 MW capacity submarine cable that was energized in 2005. It is laid underneath the Cebu-Mactan Bridge. Another island interconnection is the Leyte-Bohol Interconnection, a submarine cable that allows a maximum power flow of 90 MW to the island of Bohol since 2004.

9.1.2 Benefits of Island Interconnection

The following are some of the salient benefits of island interconnections:

- a) Generally, island interconnections can provide additional power supply similar to a generator having the ability to import power when required;
- b) With island interconnections, the most efficient generator across both power systems is brought on to meet demand resulting in a more efficient dispatch;
- c) Island interconnections also reduces power curtailment as it provides a means of exporting power when there is surplus from other island; and

- d) Renewable energy sources, such as wind, hydro and geothermal potential sites suitable for energy generation may also be taken into consideration. These are clean and sustainable sources of energy that may become attractive for development by generation proponents as a result of a wider market due to island interconnection.

Considering these salient and other intangible benefits, island interconnections become more economically attractive in the long run. However, detailed studies should be undertaken to quantify the overall benefits to the receiving island.

9.1.3 Major Project Development Considerations for Island Interconnections

The following major considerations shall be taken into account in the project development of island interconnections:

- a) The depth of the seabed between two islands is always an issue in interconnecting islands. This is due to mechanical stress that the cable must be designed to withstand cable weight, sea current, bottom drag, etc. during installation and repairs;
- b) The use of HVAC or HVDC transmission systems, the size and length of the cable, the existing situation of the grid, estimated load growth, environmental impact and public acceptance and the possibilities for the development of energy resources; and
- c) On the operational side, single outage contingency or N-1 reliability criterion needs to be clarified further if it will be economically beneficial to the power consumers.

9.2 Transmission Backbone and Island Interconnection Projects for 2016-2025

Figure 9.1 shows the development of transmission backbones and island interconnections. While some segments of the transmission backbones are already programmed for implementation within the Fourth Regulatory Period (2016-2020), as discussed in Chapters 6, 7 and 8, however, other segments will still be subjected to a more thorough system analyses or even Feasibility Study for some big and more complicated backbone projects.

For Major Island Interconnections, however, no dominant projects driver is deemed appropriate to trigger its implementation. In this sense, both the Batangas-Mindoro and Leyte-Mindanao Interconnection Projects would seem to require a strategic decision, which will deeply involve both the oversight and regulatory agencies of the government, hence these island interconnection projects fall under “**Strategic Interconnection**”. NGCP is conducting related studies, e.g., economic, system and other studies to support its application to secure approval of the ERC.

Figure 9.2 shows the Existing and Future Philippine Network Topology of a unified grid.

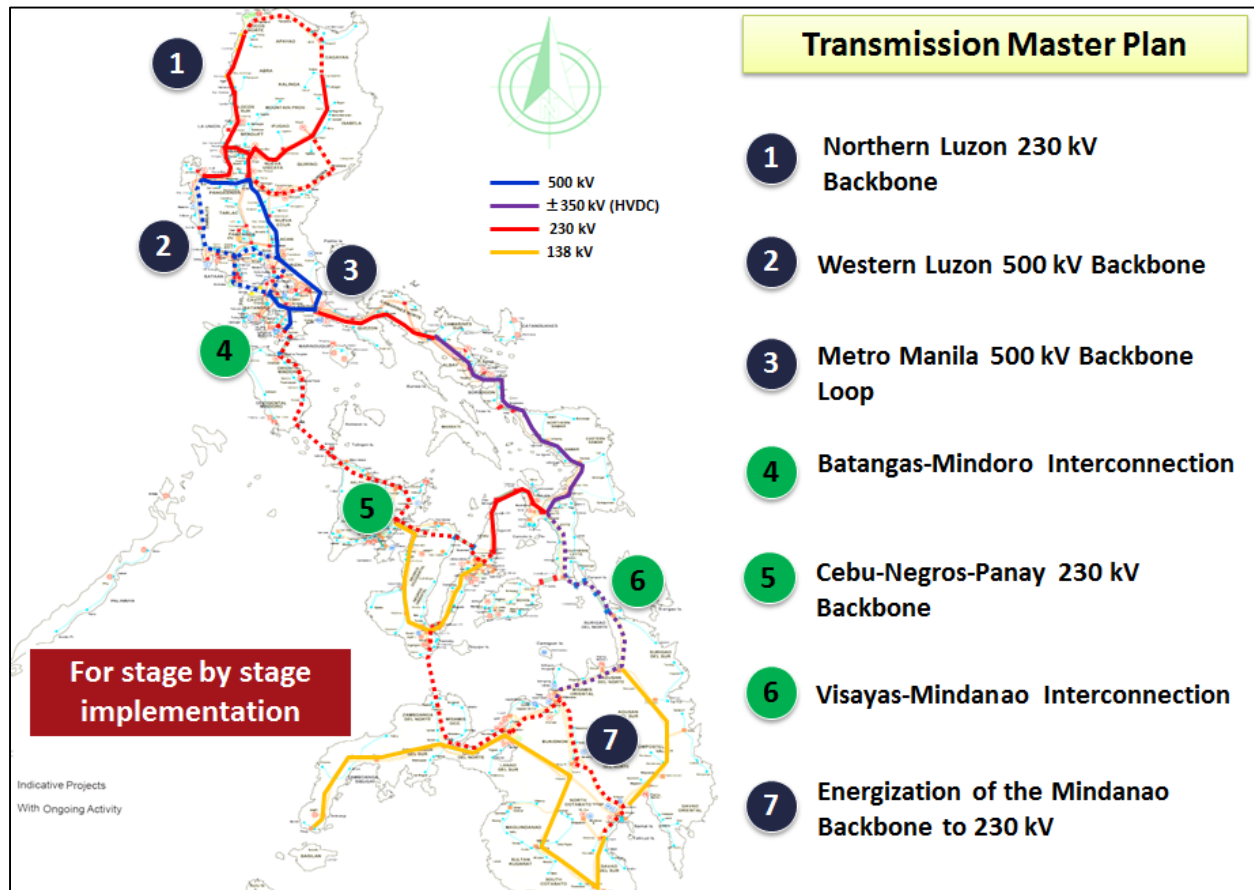


Figure 9.1 - Transmission Backbones and Island Interconnections

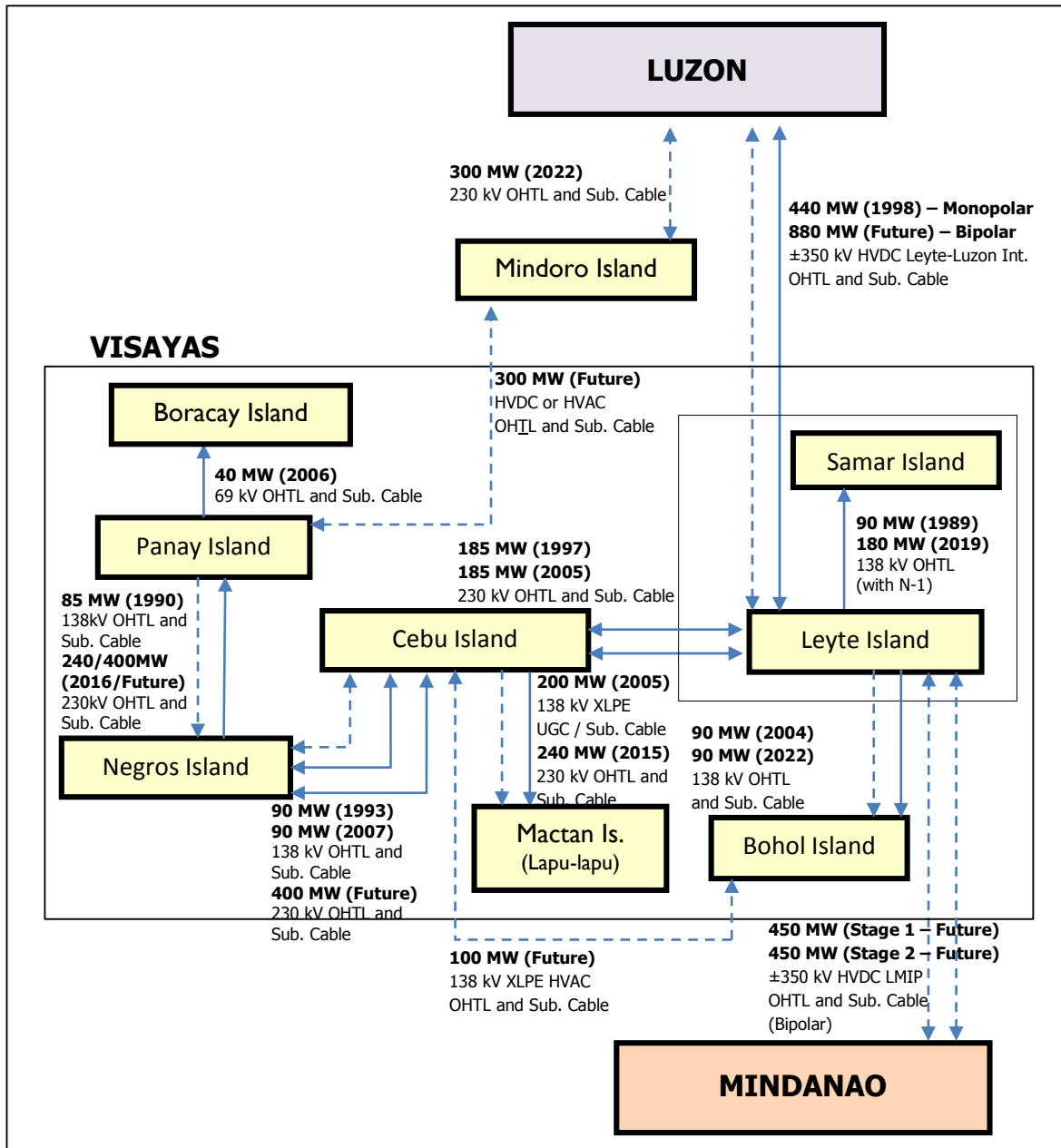


Figure 9.2 - Existing and Future Philippine Network Topology

OHTL – Overhead Transmission Line, Sub. Cable – Submarine Cable, UGC – Underground Cable and N-1 – Single Outage Contingency.

9.2.1 Batangas-Mindoro Interconnection Project (BMIP)

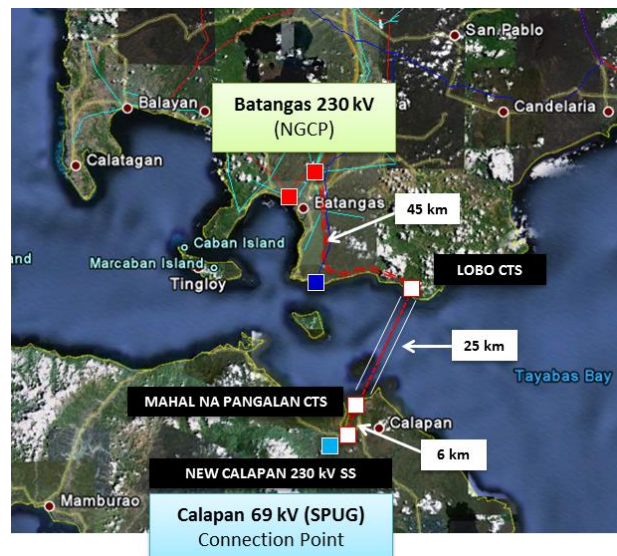
The power system of Mindoro Island, which is composed of 69 kV lines connected to several power plants and various load-end substations, is presently being operated by Small Power Utilities Group (SPUG) of the National Power Corporation (NPC). Power distribution to the consumers is handled by Oriental Mindoro Electric Cooperative (ORMECO) and Occidental Mindoro Electric Cooperative (OMECO). The major load center is in Calapan City in Oriental Mindoro and the total peak demand of the island in 2015 was more than 60 MW already, based on the combined total load of ORMECO and OMECO.

As the implementation of an interconnection project may take some time, further generation capacity additions within Mindoro Island would still be required to be able to sustain the short-term and medium term power supply requirements of its increasing load. The interconnection of the island with the main Luzon Grid was envisioned to provide the island the access to bulk generation sources in the main grid while at the same time providing the means to export excess power once the generation potentials, including RE-based plants, within the island have been developed. The improvement in reliability of supply is expected to result in better economic growth as the island could attract more investors for industrial, commercial loads and for the tourism industry.

The interconnection of Mindoro would only serve as the initial stage in the development of the power system in the island. Calapan would serve as the interconnection point but given the configuration of the island involving long 69 kV lines, in-land generators will still have to operate to provide voltage regulation support. In the long term, a 230 kV backbone system within the island could be developed as well as the future establishment of a loop to Panay Island thereby providing another corridor for the Luzon and Visayas link.

Major Project Components:

- Batangas–Lobo CTS 230 kV T/L, ST-DC 1-795 MCM ACSR, 45 km;
- Lobo CTS-Mahal na Pangalan CTS 230 kV Submarine Cable, 4-1000 mm² XLPE, 25 km;
- Mahal na Pangalan CTS-Calapan 230 kV T/L, ST-DC 1-795 MCM ACSR, 6 km;
- Batangas S/S Expansion: 1-138 kV PCB and associated equipment;
- Lobo CTS: 3-230 kV PCB, 2-30 MVAR 230 kV Shunt Reactors and associated protection equipment;
- Mahal na Pangalan CTS: 3-230 kV PCB, 2-30 MVAR 230 kV Shunt Reactors and associated protection equipment; and
- Calapan 230 kV S/S: 2-100 MVA, 230/69-13.8 kV Power Transformers, 7-230 kV PCB and 4-69 kV PCB and associated equipment and a 25 MVAR 230 kV Shunt Reactor.



9.2.2 Visayas-Mindanao Interconnection Project (VMIP)

The tangible benefits in terms of reduced investments in power generation due to the implementation of VMIP are due to the following:

- a) The sharing of system reserve;
- b) The lesser investment in power generation in either the Visayas or Mindanao to maintain the one day Loss of Load Probability (LOLP); and
- c) The reduction of operating cost due to economic dispatch of generators.

The intangible benefits in the implementation of VMIP:

- a) The benefit that is difficult to be quantified in monetary terms includes the attractiveness of VMIP to power generation investments due to the bigger market through an interconnected power network;
- b) From a technical standpoint, VMIP will provide benefit to the system in terms of added supply security, improved system reliability and improvement in the quality of power supply; and
- c) The optimized utilization of indigenous energy sources, such as natural gas in Luzon, geothermal in the Visayas and hydro in Mindanao. VMIP will reduce the overall generation of pollution as well as the dependency on the importation of fossils fuel, where its availability and price are sensitive to the price in the world market.

The implementation of VMIP will also complement the ultimate operation of the Wholesale Electricity Spot Market (WESM) in Mindanao. As a transition mechanism to the operation of the WESM, the Interim Mindanao Electricity Market (IMEM) commercial operations was launched in Davao City on September 20, 2013. The IMEM, which was developed by the government, is an interim solution to the region's power supply deficiency by ensuring the transparent and efficient utilization of all available power capacities in Mindanao Grid.

The following are the feasibility/planning and conceptual design-related activities and other information:

- Except for Converter Stations, which are already based on December 2013 conceptual design prepared by HVDC Experts from State Grid Corporation of China (SGCC), all other major project components were based on System Study completed in January 2013 by China Electric Power Research Institute (CEPRI);
- Stage 1 of the project has a capacity of 1-225 MW per pole, hence the total capacity of the conventional bipolar Converter Stations is 450 MW. While Stage 2 of the project requires an additional 1-225 MW per pole, hence the ultimate capacity of the Converter Stations is 900 MW;
- Both ± 350 kV HVDC overhead lines and submarine cables will already be designed with an ultimate or maximum power transfer capacity of 900 MW;
- In a Conventional Bipolar Scheme, outage in one pole reduces the transfer capacity by half (or 50%). Unlike in an HVAC system, single outage (N-1) contingency is not considered due to sizeable amount involved (or it will not be economically viable);

- The hydrographic/marine survey for the Eastern Option involving Surigao Strait was undertaken in December 2013 to April 2014 by EGS (Asia) Inc., a Cebu-based Earth Sciences and Surveying Company with regional hub in Hong Kong for its business operations in South East Asia. EGS (Asia) Inc. has initially recommended an alternative with lower environmental impact; and
- The result of marine/hydrographic survey in the Surigao Strait for the Eastern Option revealed the following major challenges:
 - a) There are geophysical hazards consisting of an underwater volcano, fault lines and unstable rock slabs that poses seismic hazards, i.e., fluidization of sediments, bulk ground displacement, strain on cable passage of seismic wave, landslips and turbidity currents and tsunami;
 - b) Strong seabed currents ranging from 0.58 meter per second (m/s) to 2.00 m/s. These would certainly be sufficient to move either a bare cable or cable in shells, thus surface laying is not recommended. Generally, 0.50 m/s and below can be deemed safe for surface laying. On the other hand, the existence of hard rocks with Ultimate Tensile Strength (UTS) of over 60 Mega Pascals is beyond the rock cutting capability of available cable trenching machines; and
 - c) Significant quantity of unexploded ordnance or UXO from the Battle of Surigao Strait in 1944, which consist mainly of torpedoes and high-explosives shells likely to remain in the seabed.
- With the above findings on the Eastern Option for VMIP, NGCP decided that it will be prudent to consider exploring the Western Option, which includes the area between Negros to Cebu Islands facing Mindanao (Zamboanga Del Norte and Misamis Occidental), as shown in Figure 9.3. The corresponding implementation scheme is shown in Figure 9.4.

Major Project Components:

Pending the completion of both Grid Impact Study (GIS) as well as the hydrographic/marine survey for the Western Option, listed below are the initial project components, which exclude length of submarine cables, overhead lines (consist of DC, AC and electrode lines) and specific locations of Converter Stations (CS), Cable Terminal Stations (CTS) and Electrode Stations (ES):

I Land Portion

a) Overhead DC Transmission Lines:

- Visayas CS-CTS (Visayas Side) ± 350 kV HVDC OHTL, Bipolar, 3-795 MCM ACSR; and
- CTS (Mindanao Side)-Mindanao CS ± 350 kV HVDC OHTL, Bipolar, 3-795 MCM ACSR Condor.

b) Electrode Lines/Stations:

- Mindanao CS–Mindanao ES 20 kV OHTL (2 Lines), 2-795 MCM ACSR Condor;
- Mindanao ES; and
- Visayas CS-Visayas ES, 20 kV OHTL (2 lines), 2-795 MCM ACSR Condor.

c) Converter Stations (Conventional Bipolar):

Visayas Converter Station:

- Thyristor Valves: 2-227.5 MW, 350 kV, 750 A, water cooled, air insulated, suspended, indoor 12-pulse single phase quadruple;
- Converter Transformers: 2-225 MW, 230 kV AC/350 kV DC, single phase and three - winding;
- Oil immersed DC Smoothing Reactor; 2 groups of double-tuning passive DC filters and 2 large groups with 4 small groups AC filters;
- DC Field Equipment including DC High-Speed Switches, Metallic Return Transfer Breaker, Ground Return Transfer Switch, various DC Switches, DC Measuring equipment and wall bushings; and
- Secondary System including Operator Control, AC/DC Station Control, Pole Control, DC Protection, Station Master Clock, Fault Recording, DC Line Fault Location, AC Protection, Revenue Metering, Auxiliary System, Management Subsystems of Relay Protection and Fault Information and Telecontrol and Telecommunication Equipment.

Mindanao Converter Station:

- Thyristor Valves: 2-227.5 MW, 350 kV, 750 A, water cooled, air insulated, suspended, indoor 12-pulse single phase quadruple;
- Converter Transformers: 2-225 MW, 230 kV AC/350 kV DC, single phase and three-winding;
- Oil immersed DC Smoothing Reactor; 2 groups of double-tuning passive DC filters and 2 large groups with 4 small groups AC filters;
- DC Field Equipment including DC High-Speed Switches, Metallic Return Transfer Breaker, Ground Return Transfer Switch, various DC Switches, DC Measuring equipment and wall bushings; and
- Secondary System including Operator Control, AC/DC Station Control, Pole Control, DC Protection, Station Master Clock, Fault Recording, DC Line Fault Location, AC Protection, Revenue Metering, Auxiliary System, Management Subsystems of Relay Protection and Fault Information and Telecontrol and Telecommunication Equipment.

d) Substations:

- Ormoc S/S Expansion: 6-230 kV PCB and associated equipment;
- Villanueva S/S Expansion: 2-300 MVA, 230/138-13.8 kV Power Transformers and accessories; and

- Other Equipment/Facilities identified based on the result of GIS, e.g., power compensating equipment, etc.

II Marine Portion

- a) Visayas CTS-Mindanao CTS, ± 350 kV HVDC, Bipolar, $1,500 \text{ mm}^2$ mass impregnated submarine cable.

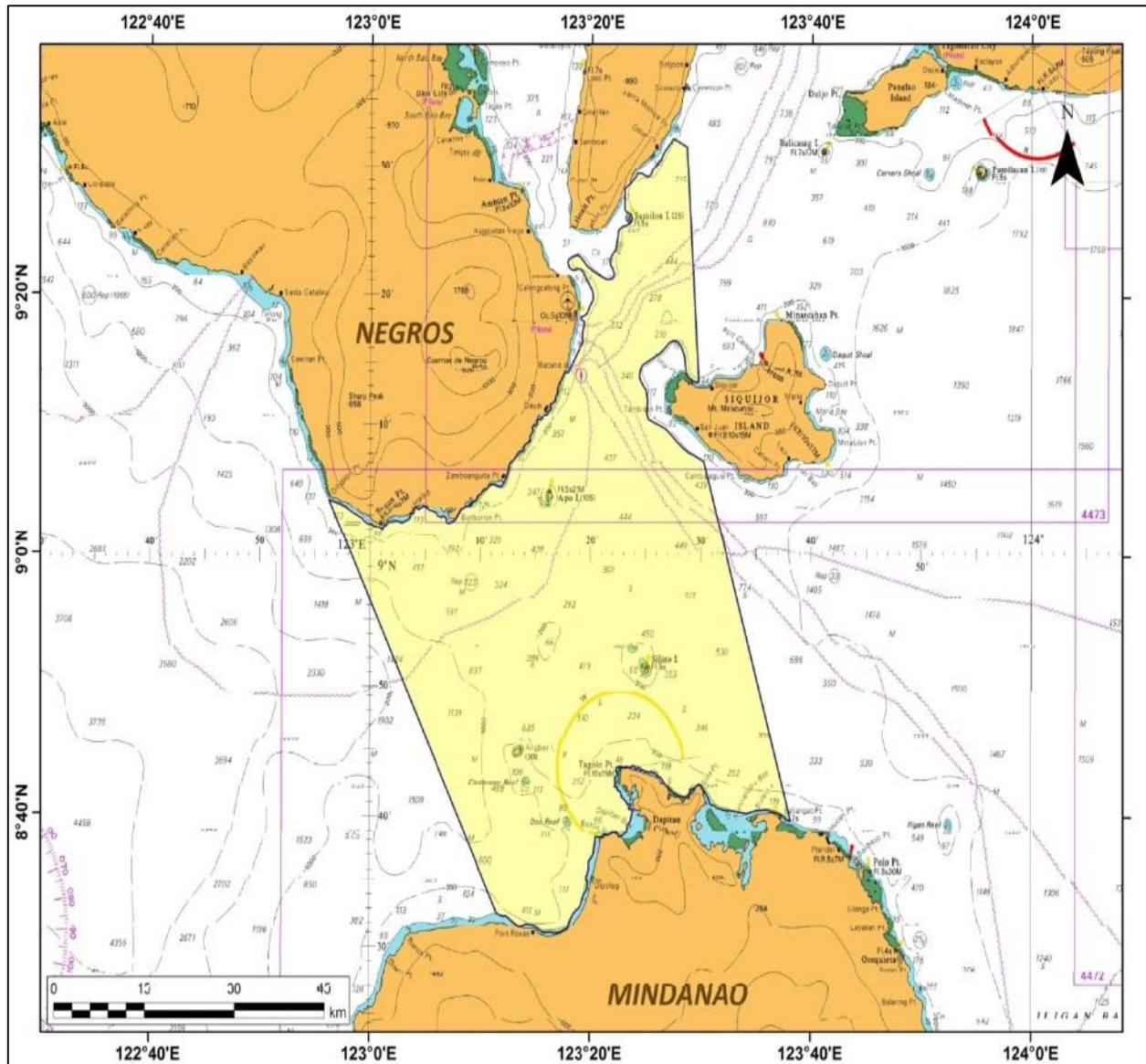


Figure 9.3 – Area for Possible Submarine Cable Route

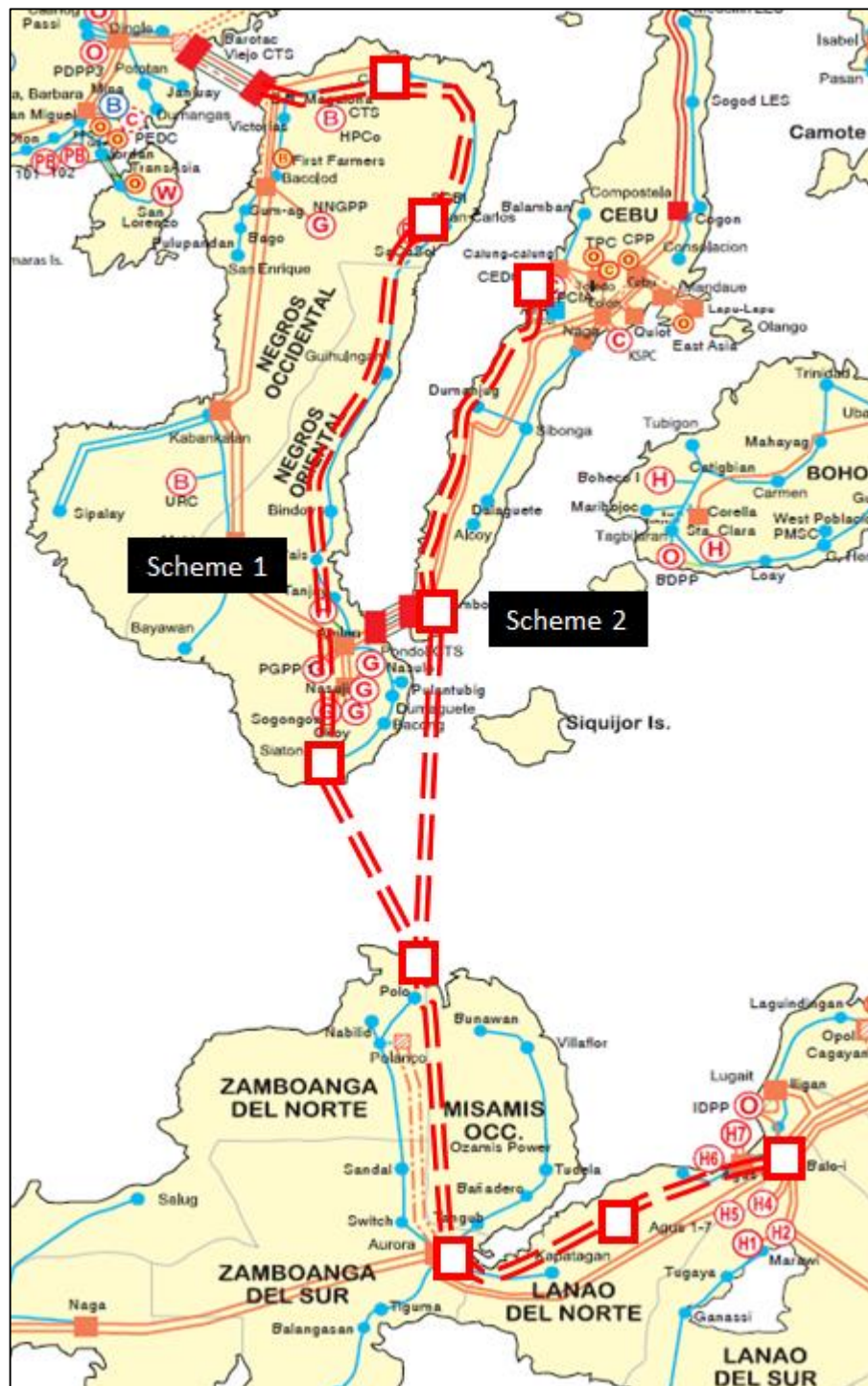


Figure 9.4 – Connection Schemes for VMIP

Appendix 1 – Prospective Power Plants

Table 10.1 – List of Prospective Power Plants

Proposed Generation Facility	Capacity (MW)
LUZON	
Man-Asok Agno Mini-hydropower Project	3
EWCL Interim Connection	400
Maris Hydro Power Project	10
Jobin Solar Plant	20
Jobin Wind Farm	50
Pantabangan PSPP	600
Wawa Pumped Storage Hydropower Project	500
Bataan Coal Fired Kepco-Hanjin	300
Calatagan Solar Plant	50
NLREC Wind Farm Expansion	69
EDC Burgos Solar Plant	30
Tarlac Solar Plant	50
Shell Gas Turbine Power Plant Project	20
UPPC Cogeneration Power Plant	30
NGPT Mariveles Solar Plant	20
Pasuquin Solar Power Project	100
VISAYAS	
Silay Solar Power Project	20
Negros PH Felisa Solar	50
Montesol Solar Power Plant	15.3
First Toledo Solar Power Plant	60
San Carlos Sun Solar Power Plant	48.6
SACASOL Solar Power Plant	27.2
PASAR Diesel Power Plant	42
Manapla Solar Power Plant	40.5
Biliran Solar Farm	25
Solexar Solar Power Plant Project	28.26
Constellation Wind Power Project	45
Cosmo Solar Power Plant	5.6
SPC Coal Power Plant	300
PDC 1 & 2 Diesel Power Plant	92
MINDANAO	
Eastern Petroleum Corporation Biomass Power Plant	23.5
Astroenergy Solar Power Project	20
ARR Green Dynamic Resources Solar Power Plant	60
KEGI Diesel Power Plant	7.8
Tagoloan Solar Power Plant	40

Appendix 2 – Renewable Energy

NGCP allocates this section for the development and plans associated with the entry of Renewable Energy (RE). Discussed here are the transmission planning approach with RE and the activities of NGCP in support to RE.

A2.1 Transmission Planning for RE: Philippine Scenario

In developing transmission expansion plans for the grid, every project included in the TDP is evaluated to meet the following objectives:

- a. Ensure the reliability and stability of the grid
- b. Grid demand requirements are met by available supply
- c. Minimize the cost of transmission investments passed-through to end-consumers
- d. Minimize the cost of energy by providing more opportunities for competition and mitigating market congestions

The same objectives are given with the addition of RE. The RE Act of 2008 mandates NGCP to include the required connection facilities for RE-based power facilities in the TDP. The Feed-in Tariff (FIT) rules strengthens this mandate by giving eligible RE plants priority connection to the transmission or distribution system, subject to their compliance to the pertinent standards and ERC rules governing such connection. This, however, provides further challenges in transmission planning faced by NGCP.

First challenge is the proximity of transmission facilities and its available evacuation capacity to Variable Renewable Energy (VRE) potential areas. These are applicable to VREs located far from load centers. Though there are some areas that are near transmission facilities, these are not designed to accommodate the potential capacity of VRE. As a result, long transmission lines are still needed to be built which are quite expensive.

Second is the shorter timeline of implementation of VRE projects compared to transmission expansion projects. Actual construction timeline of VRE projects has proven that it can be completed faster compared to transmission projects. Aggravated by the “first come first serve” policy of the FIT scheme, VRE proponents are somewhat in a race to secure an allocation to the installation targets. Consequently, the transmission expansion projects need to catch-up with the VRE projects.

Though recognized, NGCP cannot simply advance the transmission facilities without the confirmation of VRE proponent. Transmission investments shall still conform to the Rules for Setting Transmission Wheeling Rates and the principles contained therein, the optimization principle among one of them. At this regulation, NGCP can be exposed to the risk of being optimized if the VRE proponent decided not to pursue with their project. As a result in some cases, the VRE proponent had to advance the transmission investment and later to be transferred to NGCP.

In addition, heavy concentration of VRE in one area only could pose operational concerns as in the case of the many solar power plants in Negros Island. Ideally, VRE should be well-dispersed geographically in a grid in order to avert the impact of its variability.

Third challenge is the grid connection and operational requirements for VRE. The latest Grid Code after the approval of the RE Act of 2008 only covers the rules and requirements for conventional generators. With the limited experience on VRE, creating and setting the proper requirements for VRE was a challenge. The goal was to set the necessary requirements to make VRE behave like a conventional power plant. Positively, the addendum to the Grid Code was approved in 2013, containing the requirements for VRE, particularly wind and solar.

The availability of data for grid integration studies also provided some challenge. In the RE Act of 2008, NGCP is required to determine a maximum penetration limit to the grid of intermittent or variable RE. NGCP and PEMC are also tasked to implement technical mitigation and improvements in the system in order to ensure safety and reliability of electricity transmission.

Starting with the limited knowledge on grid integration of VRE, NGCP was in an interesting position. With continuous research and capacity building, NGCP has determined how to analyze the effect of VRE to the grid in its study called the Renewable Energy Integration Study. Here, the variability of the net load or residual load (load minus VRE) was analyzed and compared to the availability of regulating reserves.

However, the availability of accurate data to come up with a credible study gave further challenge to NGCP. NGCP initially requested the resource assessment data of VRE proponents and used it as substitute to actual data. NGCP had reservations on whether the results of the study would actually provide the safe level of VRE penetration. With the given uncertainty, NGCP will update the results of the study using actual VRE data.

A2.2 Action Plan by NGCP

Based on other jurisdictions, there are no studies involving the determination of such penetration limit but rather on the optimistic side; what are the needed changes to the grid to integrate a certain target of VRE. With this, NGCP will conduct a new integration study based on the experience and challenges. NGCP has conceptualized an approach that will not only analyze the variability of VRE but also geographic grid adequacy involving these potential areas of VRE and the system inertia and frequency response. NGCP expects that these three areas will provide a clearer integration study to the grid.

The geographic grid adequacy study intends to determine the maximum amount of VRE in potential areas that can be connected without violating static thermal, voltage limits and stability limits. The study will also include the required transmission expansion projects to increase the capacity. The results of this study are intended to be part of the TDP. Furthermore, the results of this study will provide a guide to the most plausible areas to connect to the grid.

The inertia and frequency response study intends to determine a limit on the penetration of “inertia-less” generation in each of the regional grid systems. This study is to assess the frequency response of the grid on a certain amount of VRE penetration. The result of the study will provide a basis on when to require operating restrictions on VRE, particularly on the amount and delivery of power sourced from VREs during contingencies.

Lastly, the reserve adequacy study that is previously known as the Renewable Energy Integration Study intends to analyze of VRE variability and review the existing reserve requirements under the ASPP. It is needed to revisit ASPP given that the conventional generator would not follow only the load but rather the residual or net load (load minus VRE). As previously mentioned on the

availability of accurate data, NGCP is closely monitoring and recording all the data from the recently installed VRE generators for this study. The result of the study would provide how much VRE capacity can be accommodated using the existing requirements for reserves and how much additional reserves should be scheduled for more VREs.

Coincidentally, a new project called “Greening the Grid Project” by the United States Agency for International Development (USAID) and National Renewable Energy Laboratory (NREL) will conduct an RE Integration Study for the DOE. The project will involve the concerned agencies, among others, DOE, NGCP, GMC and PEMC to work together and have a collaborative study. The study will develop a production cost model which is needed to conduct economic analysis. The investments needed for flexible generation and transmission infrastructures are among the benefits/actions from the study. It is aimed to complete this study in 2016.

NGCP sees that this study will complement its proposed studies, particularly the geographic grid adequacy and reserve study with the help of the experts from NREL. Definitely, NGCP will participate in this initiative and will provide its outmost support.

Appendix 3 – Climate Change Adaptation Measures

NGCP supports the seven Strategic Action Plans under the National Climate Change Action Plan (NCCAP) formulated by the Climate Change Commission (CCC). Specifically, NCCAP “Strategic Actions on Sustainable Energy for 2011 to 2028”, highlights the following facts:

- a) The Philippines is facing formidable challenge of developing sustainable clean energy options to support the requirements of economic and social development with minimal adverse effects on the environment;
- b) The country continues to rely on importation to meet energy demand. Based on the 2010 DOE data, the country imports an average of 300,000 barrels per day of crude oil and petroleum products and more than three quarters of its coal consumption;
- c) The country’s total energy sufficiency, however, has been increasing from 48 % in 2001 to 59% in 2009 due to the increase in renewable energy production; and
- d) Environmental sustainability and energy security are the twin energy challenges caused by the country’s economic growth and rapid urbanization. The energy sector is a major source of greenhouse gas emissions, whereas the transport and electricity generation are the biggest Green House Gas (GHG) emitters.

The NCCAP further emphasized that “the energy sector has to respond to significant changes in demand due to fluctuation in temperature and weather condition to ensure that energy systems are able to adapt to the impacts of climate change”. **Climate-proofing and rehabilitation of energy systems infrastructures** is one of the four priorities identified to address the climate change issues of the energy sector.

In the Transmission Sector, considering the economic lives¹ of transmission infrastructures being implemented by NGCP, the following are the details of climate change adaptation initiatives in support to the NCCAP:

- a) The maximum wind velocity design of overhead transmission lines’ (OHTL) support structures is based on three wind zones: Zone 1 (270 kph), Zone 2 (240 kph) and Zone 3 (160 kph). The areas under a particular wind zone are shown in Table A1 of Appendix A, 2008 Philippine Electrical Code (PEC) Part 2. In view of the increasing frequency of super typhoons that hit various areas in the country in the past decade, NGCP will be increasing the maximum velocity design of support structures for all OHTL including substation take-off towers and other support structures;
- b) In the transmission line route selection process, careful evaluation are undertaken to avoid areas prone to flood, with steep slopes prone to soil erosions, and with sufficient distance from fishponds, rivers, lakes, swamps and seashores; and

¹ Under the Performance-Based Regulation (PBR), the economic lives of transmission assets ranges from 15 to 50 years (depending on the type of assets, e.g., transmission lines, substations, protection and communication facilities, etc.)

- c) For substation sites, the risk of flood or flash flood are carefully assessed, while avoiding areas that are considered possible sources of pollutions, e.g., industrial plant/buildings that generate polluted gases, storage areas for explosive or inflammable materials, bulk oil storage tanks and oil/gas pipelines. If necessary, close proximity to seashores are also avoided to prevent or minimize corrossions and depletion or failure of insulations of substation equipment.

Furthermore, NGCP selects overhead transmission line route and substation site that has minimal effect on human settlement or as much as possible, minimize the removal of vegetation or cutting of trees.

Appendix 4 – Ideal Locations of Power Plants

To serve as a guide for generation investors, this section identifies the substations where new power plants may connect without the need for any significant transmission reinforcement. These recommended connection points, however, should be viewed from a transmission planning perspective and are based on the capability of the existing grid and already considering the completion of ERC-approved projects for the 3rd Regulatory Period and without consideration on the following other requirements in generation location siting, particularly for the non-site specific plants: (a) fuel supply/transport; (b) topology/geology of site; (c) accessibility; (d) availability of area; (e) availability of cooling water; (f) fresh water supply; (g) security; and (h) environmental/social concerns.

It can be noted, however, that the existing transmission facilities in some generation potential areas have no much room particularly in accommodating bulk generation addition. Thus, new transmission backbone developments are usually required first for the entry of new large capacity plants.

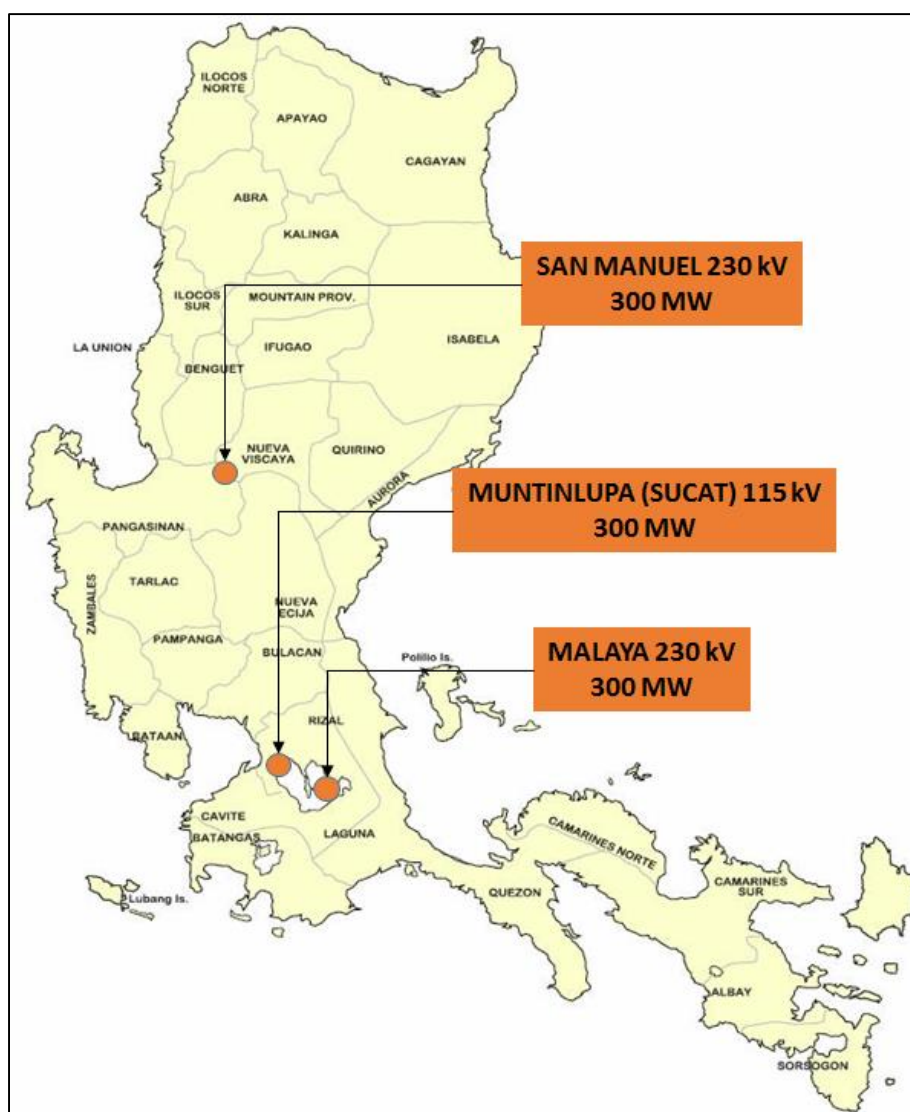


Figure A-1: Ideal Location of Power Plants (Luzon)

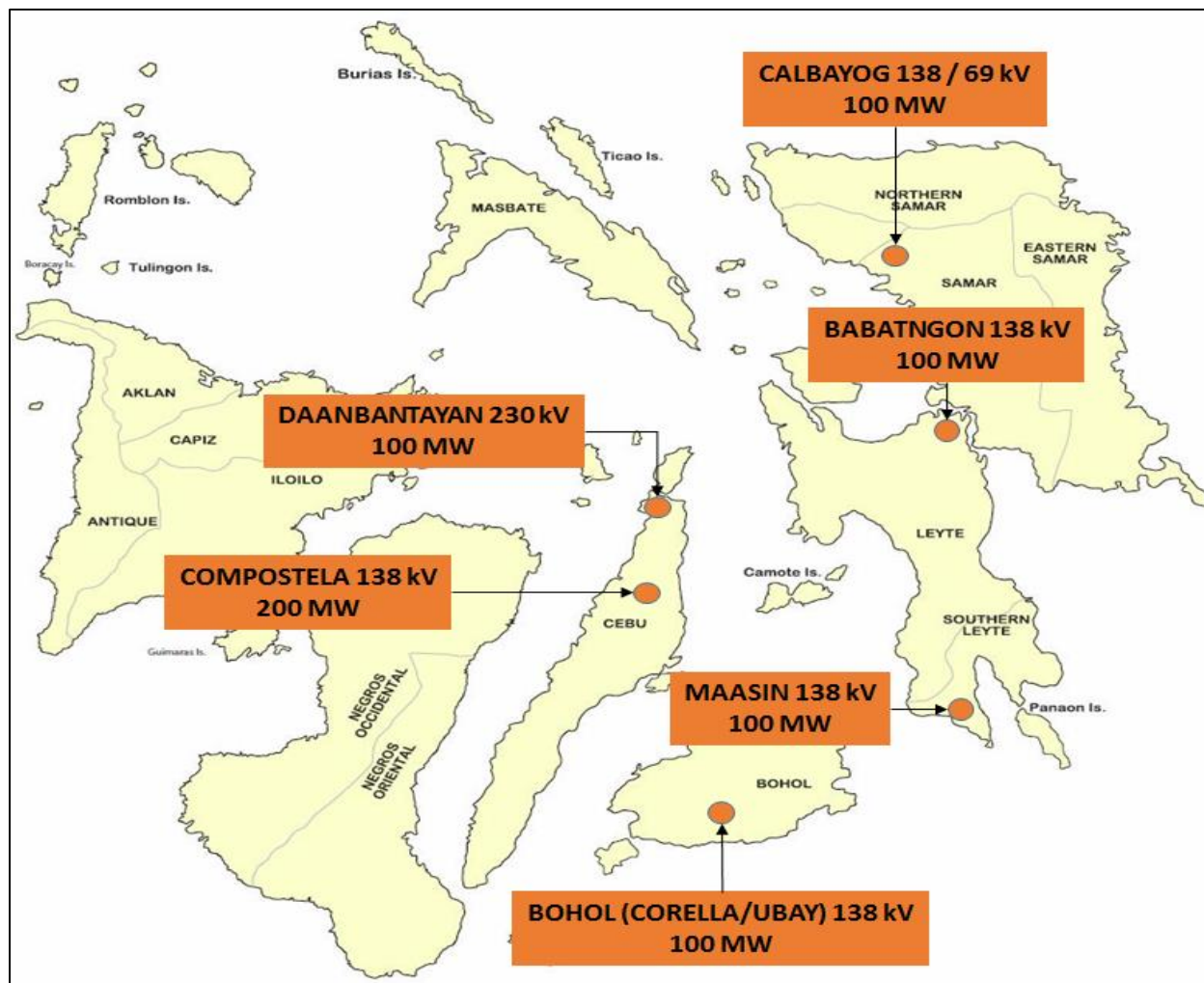


Figure A-2: Ideal Location of Power Plants (Visayas)

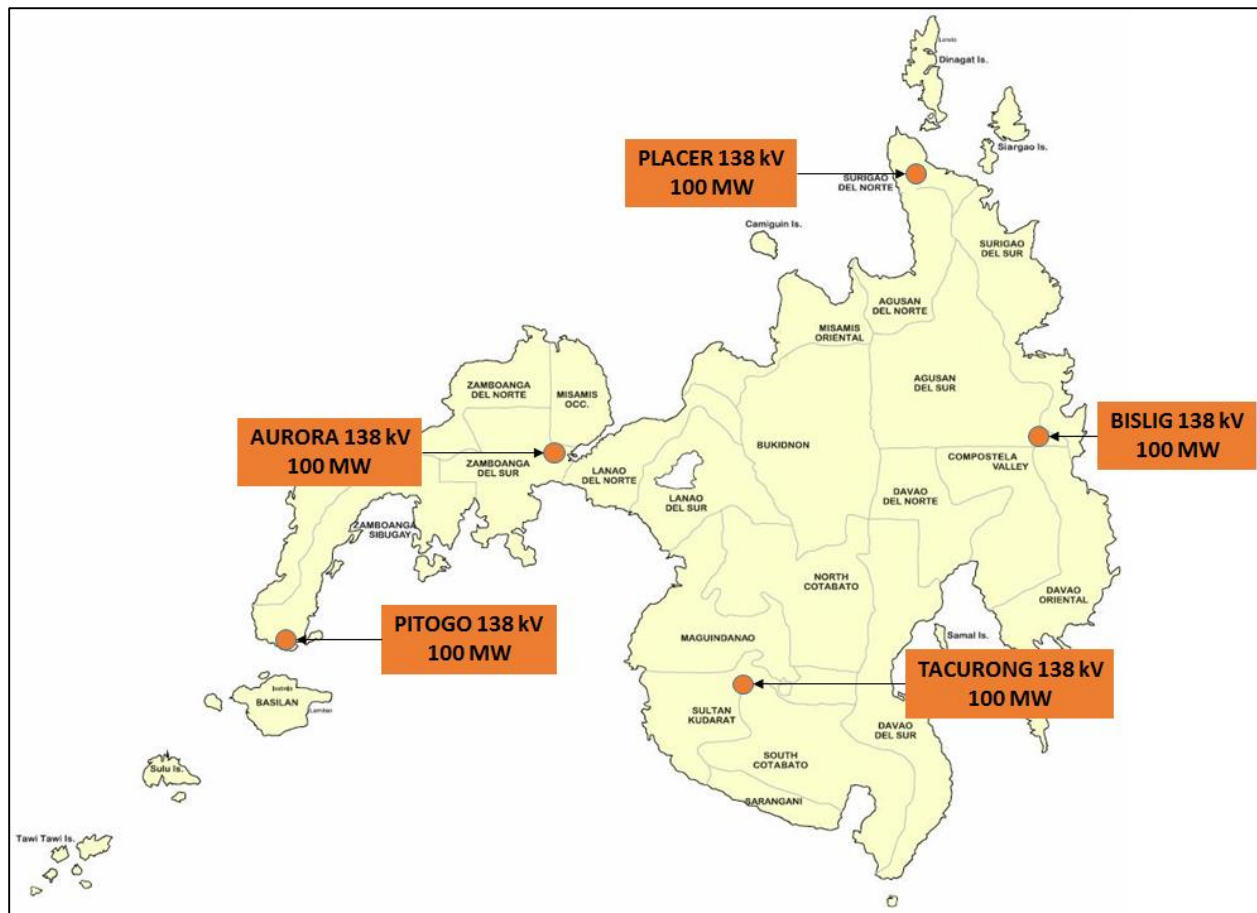


Figure A-3: Ideal Location of Power Plants (Mindanao)

Appendix 5 – Contact Details

For all inquiries regarding the TDP, you may contact any of the following:

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