Bohol Island Power Development Plan

Technical Working Group (TWG) of the
Bohol Energy Development Advisory Group (BEDAG)

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With technical assistance from:

USAID
FROM THE AMERICAN PEOPLE

Advancing Philippine Competitiveness (COMPETE) Project

Bohol Island Power Supply Plan 2016-2045

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COMPETE	Advancing Philippine Competitiveness Project
USAID	United States Agency for International Development
BDPP	Bohol Diesel Power Plant
BEDAG	Bohol Energy Development Advisory Group
BEDAG-TWG	Bohol Energy Development Advisory Group – Technical Working Group
BIPDP	Bohol Island Power Development Plan
BIPSP	Bohol Island Power Supply Plan
BLCI	Bohol Light Company, Inc.
BOHECO I	Bohol I Electric Cooperative
BOHECO II	Bohol II Electric Cooperative
BPO	Business Process Outsourcing
BSMHC	BOHECO-I-Sevilla Mini-Hydro Corp
CAIDI	Customer Average Interruption Duration Index
CF	Capacity Factor
CSP	Competitive Selection Process
CY	Contract Year
DOE	Department of Energy
DU	Distribution Utility
EC	Electric Cooperative
FOREX	Foreign Exchange
GDP	Gross Domestic Product
GenCo	Generating Company
GWh	Gigawatts per hour
ICT	Information, Communication & Technology
JHEP	Janopol Hydroelectric Plant
JVA	Joint Venture Agreement
km	kilometer
KPO	Knowledge Process Outsourcing
kV	Kilovolt
kW	kilowatt
kWh	kilowatt hour
MAIFI	Momentary Average Interruption Frequency Index
MAPE	Mean Absolute Percentage
MSMEs	Micro, Small & Medium Economic Enterprises
MVA	Megavolt Ampere
NGCP	National Grid Corporation of the Philippines
NGCP-SPUG	Small Power Utility Groups of the National Power Corporation
O&M	Operation and Maintenance
PGBh	Provincial Government of Bohol
PES	Provincial Electric System
PhP	Philippine Peso
PSA	Power Supply Agreements
PSC	Power Supply Contracts
ROOMM	Rehabilitate-Own-Operate-Maintain and Manage
SAIFI	System Average Interruption Frequency Index
SAIDI	System Average Interruption Duration Index
SII	Salcon International, Inc.
SPC	Salcon Power Corporation
TDP	Transmission Development Plan
V	Volt
WESM	Wholesale Electricity Spot Market

Section 1: Introduction

1.1 Background

Bohol is a progressive island-province blessed with rich natural resources and biodiversity that supports its two main economic drivers – agriculture and tourism. However, in 2013, Bohol's economic rise, especially in tourism, commerce, and related industries was hampered by two naturally-occurring events: The 7.2 magnitude earthquake that shook the island on October 13, and Supertyphoon Yolanda (International Name: Haiyan) that, about one month later on November 8, devastated Eastern Visayas (primarily Tacloban City and Ormoc City, the rest of Northern Leyte, and Eastern Samar) and Central Visayas (parts of Cebu and Panay islands), destroying so many homes and infrastructure, and claiming thousands of lives in the process.

The October 13 earthquake destroyed many structures and infrastructure in Bohol and caused power outages in Tagbilaran City for several hours, and for several days in other municipalities. Surprisingly, Supertyphoon Yolanda which did not affect the island of Bohol, was the one that caused widespread blackouts in the island province for a month. This is due to the fact that the Leyte-Bohol transmission line linking Bohol to its main power sources in Leyte, Cebu, the rest of the Visayas Grid and Luzon Grid, was heavily damaged by Yolanda. Furthermore, the total aggregated capacity of power plants inside Bohol at that time (20.4 MW) was not enough to supply the total power demand of the island amounting to about 62 MW. These two successive events in 2013 made the Provincial Government of Bohol and the various local power industry players/stakeholders recognize the extreme vulnerability of their power supply and its effect on economic activities in various industries.

To ensure immediate resolution to the power supply problems brought about by these events in 2013, Governor Edgardo Chatto called on the DOE, NGCP, the electric distribution utilities (BLCI, BOHECO I and BOHECO II), tourism stakeholders, the chamber of commerce, and the academe to come together and help come up with immediate as well as long-term solutions that will mitigate the vulnerability of Bohol's power supply.

1.2 Executive Order No. 13, Series of 2014 Creating the BEDAG

In early 2014, the Governor issued Executive Order No. 13, Series of 2014, creating the Bohol Energy Development Advisory Group (BEDAG), an advisory council composed of various stakeholders in the power sector including the NGCP, the 3 Bohol DUs, tourism sector, business sector, and the academe. Chaired by the Governor of Bohol and co-chaired by the Secretary of the DOE, the BEDAG was created to serve as the principal mechanism through which the Provincial Government shall obtain multi-sector inputs, advice, and assistance on matters related to energy and power development in the island.

This executive order also created the BEDAG-Technical Working Group (BEDAG-TWG) that is tasked to do technical studies and analysis, and formulate the Bohol Island Power Development Plan (BIPDP), in consultation with the key stakeholders. The BIPDP sis to be formulated and updated yearly, and implemented to ensure that Bohol has adequate, reliable, affordable (least-cost), environment-friendly, secure and resilient power supply. The BEDAG-TWG is also tasked to recommend to the Governor (through the BEDAG) policies, strategies and actions that are necessary for the effective and efficient implementation or further improvement of the Bohol Island Power Development Plan.

Governor Chatto sought the help of the USAID Advancing Philippine Competitiveness (COMPETE) Project to provide technical assistance to the Provincial Government of Bohol through the conduct of capacity-building activities and mentorship to the BEDAG-TWG for the technical studies and analysis required in the formulation of the BIPDP.

1.3 Objectives of Power Development Planning

In Power Development Planning, we aim to achieve an orderly and economic expansion of the power system by determining the optimal plan (least cost) in terms of capacity, timing, type and location. The objectives of this Plan are to ensure adequacy, affordability, and reliability of power supply. In the case of Bohol, the requirement for resiliency is added due to the vulnerability of Bohol's power system to the effects of natural disasters. This Power Development Planning process and its implementation should result in the same quality, reliability and cost of service from each of the three DUs in Bohol that will encourage economic growth not only in established commercial and tourism centers such as Tagbilaran and Panglao, but also in all other municipalities.

To ensure adequacy, the question on "what capacity and when" has to be answered. For affordability (least-cost), the optimal supply mix (baseload and peaking supply) should be determined. The quality, reliability, safety, efficiency, and resiliency of electric power service may be achieved by ensuring that the (a) power supply/generation is adequate, and (b) performance standards set by the Philippine Grid Code, the Philippine Distribution Code, and the Philippine Electrical Code are met in the planning and development of the transmission and distribution systems.

1.4 Power Development Planning Process

Economic development and planning of any local government must be accompanied and supported by energy supply and delivery system plans. Local energy plans not only address local energy problems but also sustain local economic development. The BEDAG created by the Bohol local government unit adopts a bottom-up approach to power development planning, a subset of energy planning, which includes power supply/generation, transmission, distribution and electrification plans.

Figure 1.1 shows the framework we adopted for government-enabled local energy planning and development which involves bottom-up participatory planning process and integration to the top-down national energy planning. It consists of four (4) phases, namely: (i) organization phase, (ii) resource assessment phase, (iii) planning phase, and (iv) implementation and monitoring phase.

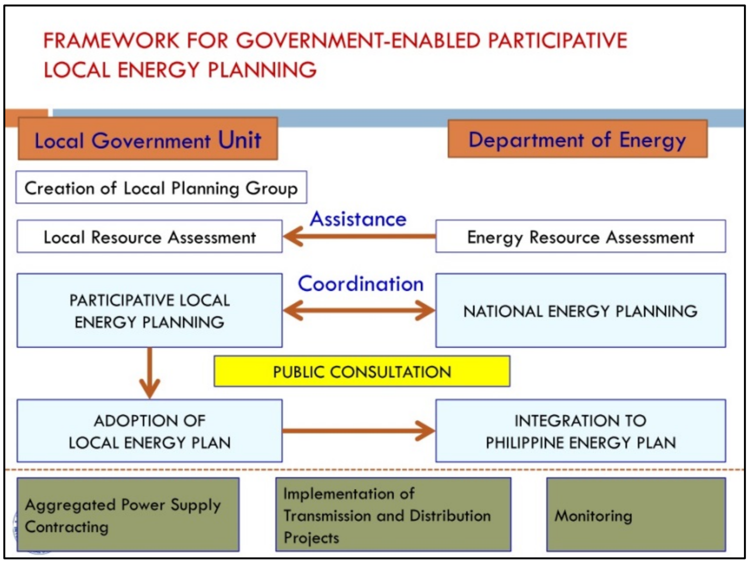


Figure 1-1 Bohol Local Energy Planning Framework

During this process, the various power sector stakeholders were invited to participate in the formulation of the plans, presentation and the eventual adoption of the plans by the BEDAG and the Sangguniang Panlalawigan of the Province of Bohol.

The three DUs (BOHECO I, BOHECO II & BLCI), which will be implementing the power supply plan, will be working together for the aggregation of their power supply requirements to achieve economies of scale in order to get the best possible and least cost power supply subject to a competitive selection process. The BEDAG-TWG also worked and coordinated with the National Grid Corporation of the Philippines (NGCP), which is also represented in the TWG, in the inclusion of NGCP's Transmission Development Plan. The

TWG of the three DUs prepared their respective Distribution Development Plan which aims to ensure that all customers in Bohol enjoy the same level of quality, reliability, efficiency, and affordability of electricity service.

The process in the preparation of the Power Development Plan follows the same general process for energy development planning shown in Figure 1.2 below. It starts with forecasting of energy and demand, followed by an assessment of the performance of the existing system, the formulation of candidate solutions that will solve the problems, and then the optimization of solutions. The end-result is the Bohol Island Power Development Plan consisting of the Power Supply Plan, The Transmission Development Plan of the NGCP, and the Distribution Development Plans of the 3 DUs.

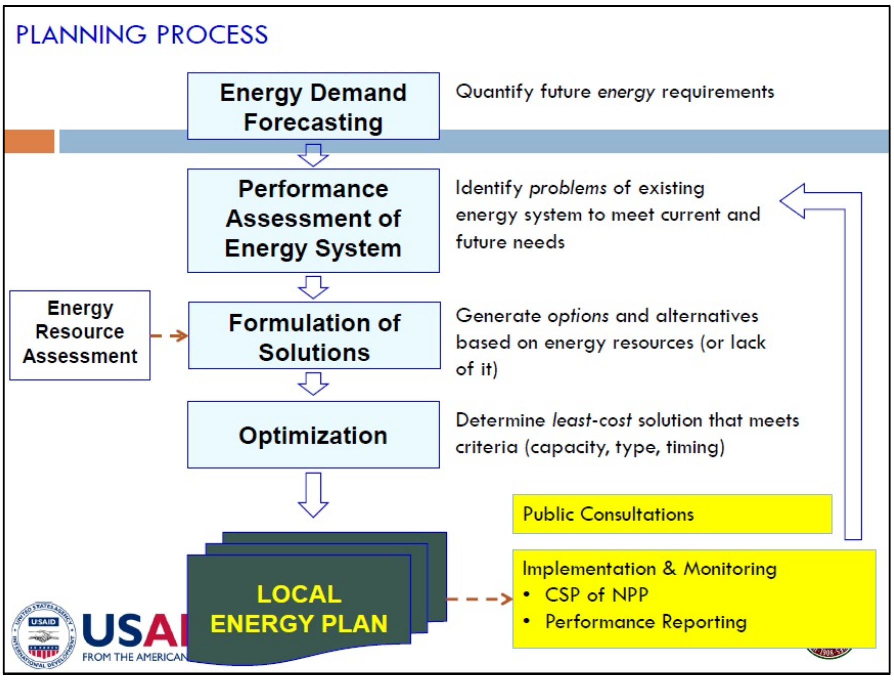


Figure 1-2 Bohol Local Energy Planning Process

The Power Development Plan is to be submitted to the DOE for integration with other local power development plans to come up with a National Power Development Plan.

A key element in the success of Power Development Planning and implementation is the capacity building of the BEDAG-TWG, especially its members from the DUs and the academe, so that the BIPDP planning process and implementation and monitoring may be institutionalized.

2.1 Bohol Province

Bohol is the tenth largest island in the Philippines covering a land area of 411,726 hectares and 654 kilometers of coastline. Located in the Central Visayas Region (Region VII), it consists of the Bohol mainland, the island of Panglao, and 74 other islands. Its capital is Tagbilaran City. Bohol is endowed with rich biodiversity and natural resources that greatly shape the province's future in various sectors like agriculture, industry, tourism, settlement, culture and heritage and infrastructure. This island province is within four major resource boundaries, i.e., upland/forestry, lowland/agriculture, coastal/marine and water boundaries.

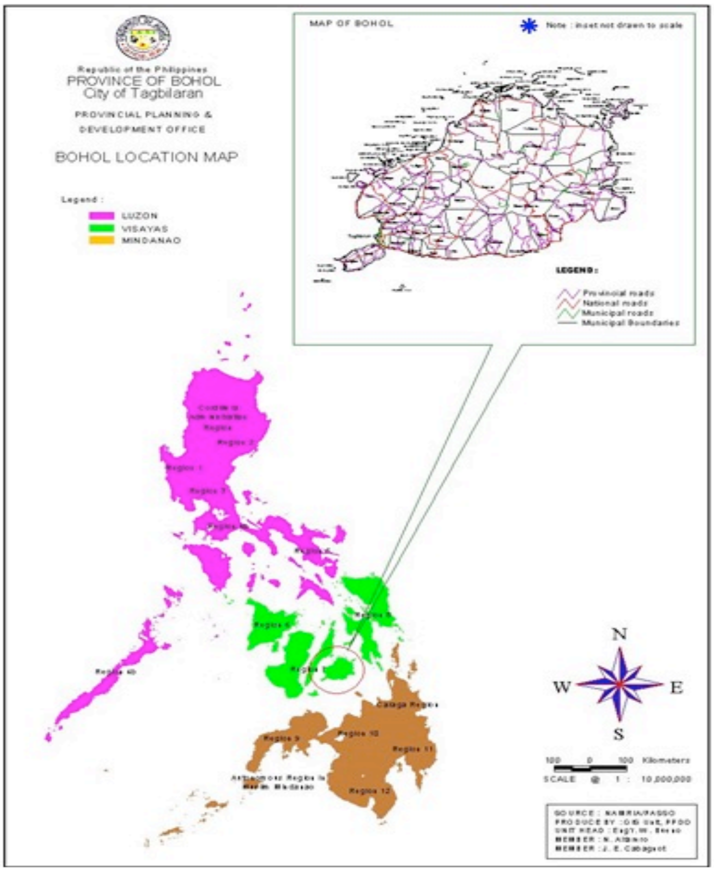


Figure 2-1. Philippine Map - Emphasizing Bohol.

2.1.1 Population

Based on the National Statistics Office (NSO) Census of Population and Housing (CPH) in 2015, Bohol posted a total population of 1,313,560. This represents a 4.7% increase from the 2010 population count of 1,255,128 persons.

2.1.2 Economy and Priority Industries

Bohol optimizes its two economic drivers – agriculture and tourism. Cultivating 45 percent of the total land for sustainable agriculture, the economy of Bohol is substantially agriculture-based. Of the total agricultural area, 50 percent or 156,944 hectares is utilized for the planting of major crops such as rice, corn, coconut and root crops. The government also provides support to the development and production of high value commercial crops, fisheries through upland and marine aquaculture, organic agriculture and livestock. The agriculture sector provides employment to 42 percent of the total employed persons in the province.

Being a haven of natural splendor, Bohol's tourism sector is significantly gaining influence on the province's economy. The province offers a plethora of wonders for local and foreign tourists as Bohol is blessed with beautiful coves, white sand beaches and dive sites, abundant flora and fauna, eco-cultural adventure parks, picturesque hills and plateaus, centuries-old stone churches and antique structures, among others. Additionally, Bohol takes pride in the warmth and hospitability of Boholanos, which is considered one of the most important facets of tourism.

To sustain its burgeoning tourism ventures Bohol, through the Provincial Government, conducted the Tourism Summit which paved the way for the promotion and marketing of the province's unified tagline "Heart of the Islands, Truly Philippines!". The government is pushing for the standardization of tourism products and services through accreditation of primary and secondary enterprises, product evaluation and capability enhancement activities of front-liners, creation and reactivation of community-based projects and programs to promote, support and improve local economies.

2.1.3 Trade and Industry

Apart from the growth of investments in the tourism sector, the provincial government is also promoting the development of the service industry, specifically on business process outsourcing (BPO) and off-shoring, which holds high potential for an improved labor force in the province. Meanwhile, the continued operation and stable growth of micro-, small and medium economic enterprises (MSMEs) in the province has led to the generation of jobs. Government provides support for trainings, business consultancies, trade facilitation and business registration for social and economic growth.

2.1.4 Information Technology

Bohol has taken up the challenge to become the next destination for Business Process Outsourcing (BPO) and Knowledge Process Outsourcing (KPO). In partnership and in cooperation with the private sector, necessary Information, Communication and Technology (ICT) infrastructures are currently being upgraded and installed to ensure that the province will be able to provide investors the broadband highway required to set up BPO/KPO business ventures. Such industry prospects will be able to provide a significant new source of employment for the province's competitive labor force.

2.1.5 Special Economic Zone/Industrial Estates Development

The establishment of special economic and industrial zones in the province is important in the generation, promotion and diversification of investments. Possible areas of investments are in light manufacturing and agro-industries that support primary production and processing. The northern part of Bohol, which is near the industrial center of Cebu, is identified and prepared for the eventual industrialization of Bohol. The northern corridor of Bohol was identified as the zone for industrial development in the province.

With Bohol's fast-moving socio-economic development and vulnerability to the effects of natural disasters, it is absolutely necessary for it to have reliable and resilient power supply and distribution system that would support and complement such growth. As such, investments for grid and off-grid power resource development, generation and transmission are also being sought.

2.2 Bohol Light Company, Inc. (BLCI)

In December 1999, the Provincial Government of Bohol (PGBh), which operate and maintain the Provincial Electric System (PES) serving and providing electricity to the barangays of the City of Tagbilaran, issued an invitation to pre-qualify and bid for the rehabilitation, ownership, operation, maintenance and management of the PES through a Rehabilitate-Own-Operate-Maintain and Manage Scheme (ROOMM). The Consortium of Salcon International, Inc.(SII), Salcon Power Corporation (SPC), and Pure and Palm Inc. was awarded the ROOMM contract after the PGBh adjudged the Consortium's bid as the best complying and the most advantageous to the government and the people of the City of Tagbilaran among all bids received and evaluated. A Joint Venture Agreement (JVA) was signed which allowed the Consortium to purchase, own, rehabilitate, operate, maintain and manage the PES and for PGBh to sell and transfer the franchise to operate the PES in the City of Tagbilaran to the Consortium. Through an Accession Agreement signed on 28 August, 2000, BLCI acquired the rights, interest, assets and equipment of the Consortium

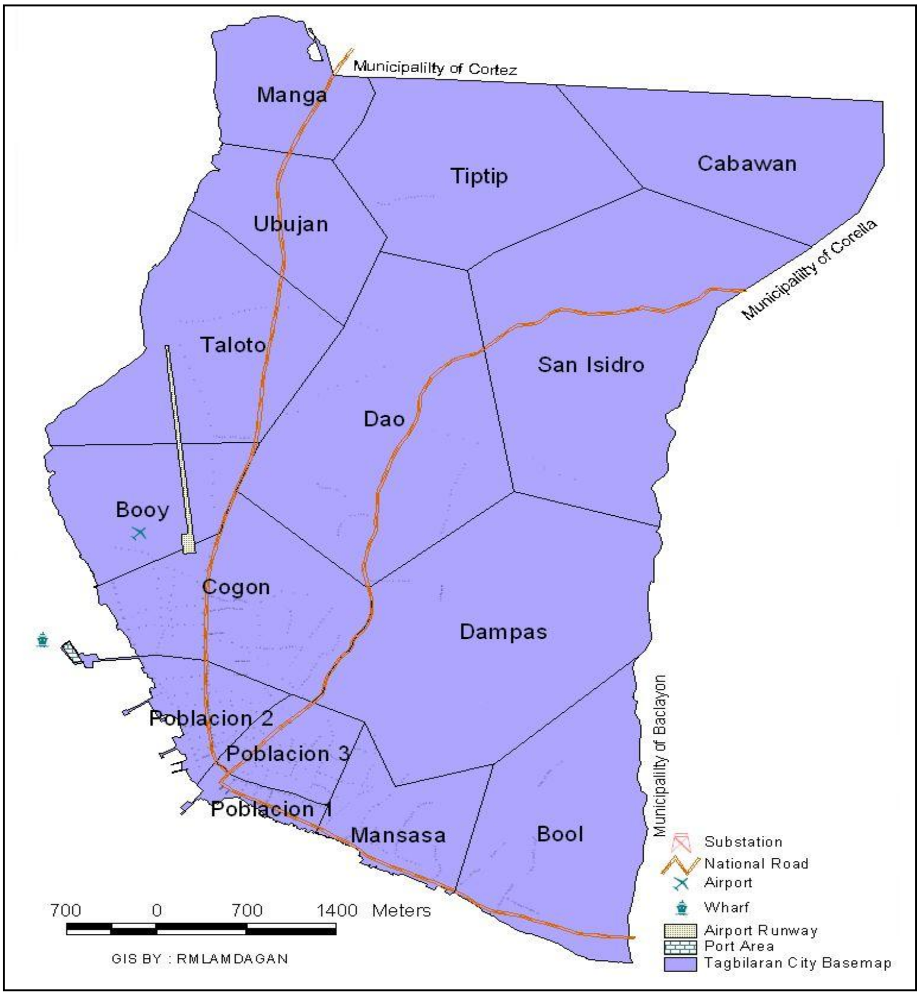


Figure 2-3. BLCI System Map and Coverage Area.

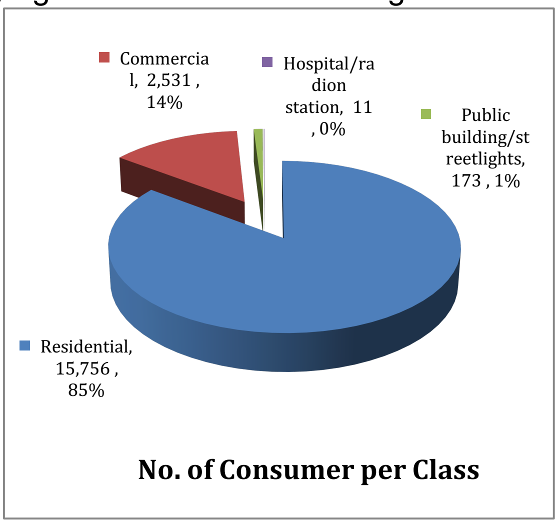


Figure 2-2. BLCI No. of Customers per Class.

composed of SII, SPC and other members of the JVA.

The BLCI franchise area covers the whole City of Tagbilaran consisting of 15 barangays. BLCI has two (2) substations with a total capacity of 35 MVA located in Dampas District and Poblacion 3, Tagbilaran City. Its distribution system includes 1.5 circuit kilometers of 69kV sub-transmission lines, 107.42 circuit kilometers of 13.8kV primary lines and 268.65 circuit kilometers of 230V secondary lines. The BLCI distribution system is divided into six (6) main feeders namely; Feeder-A, Feeder-B/G, Feeder-C, Feeder-D, Feeder-E and Feeder-F. The feeder design carefully considers the type of load, the criticality of load such as hospitals, the load centers, the coincident and non-coincident peak loads among others, to ensure least-cost, reliability and efficiency of the system. BLCI has a total of 18,471 number of connections as of December 2013 where 15,756 of its connections are residential, 1,2,53 are commercial, 173 are public buildings/streetlights and 11 are hospitals and radio stations. We had a total of 99,494,005 kWh sold, 39.82% of which are from residential customers, 49.39% from commercial customers, 6.63% from public buildings and 4.16% from hospitals and radio stations. BLCI has a recorded Customer Average Interruption Duration Index (CAIDI) of 65.75, System Average Interruption Frequency Index (SAIFI) of 6.11, Momentary Average Interruption Frequency Index (MAIFI) of 2.78. BLCI's average power factor is 97.42%, average load factor is 59.27% and average system loss of 6.44%.

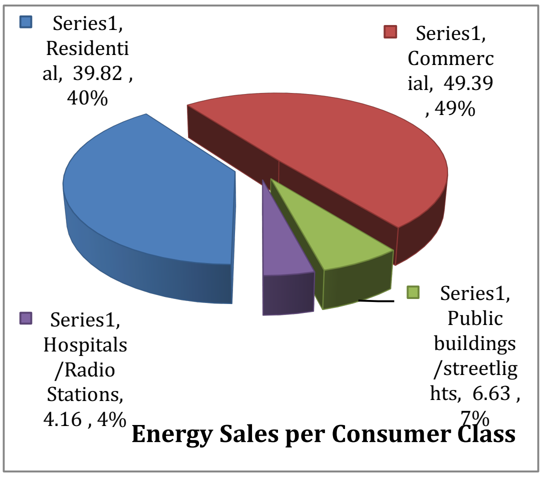


Figure 2-4. BLCI Energy Sales per Class.

2.3 Bohol I Electric Cooperative, Inc. (BOHECO I)

Bohol I Electric Cooperative, Inc. (BOHECO I) is an electric distribution utility that serves 26 of the 48 municipalities of the Province of Bohol. It covers 603 barangays in the mainland and 15 barangays in the islands. Ten of these islands are off-grid and belong to the Small Power Utility Groups of the National Power Corporation (NPC-SPUG) while the five remaining barangays are recently connected to the main grid via submarine cable. To provide electric service in accordance to service quality performance standards, BOHECO I maintains eight (8) substations: two (2) of which step up power from the power generation of Janopol Mini Hydro Electric Power Plant and BOHECO I Sevilla Mini Hydro Corporation, while six (6) are utilized to serve the coverage area. Another substation is currently under construction at Barangay Catagbacan, Loon, which is expected to be operational later this year.

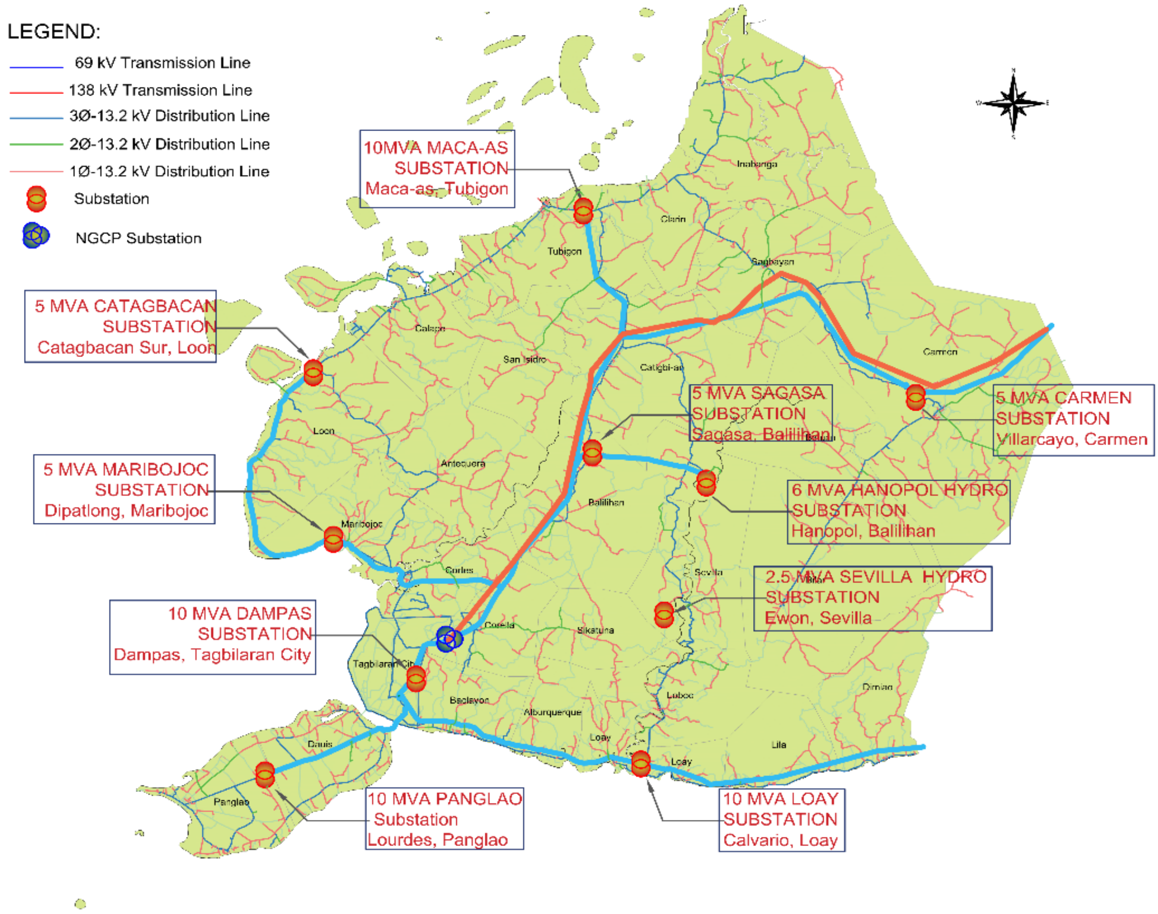


Figure 2-5. BOHECO I System Map and Coverage Area.

At present, BOHECO I has a total substation capacity of 50 MVA with an aggregate loading of 57%. The system is operating at a power factor of 97.57%. BOHECO I has a maximum demand of 27.117 MW at a load factor of 63%. BOHECO-I operates and maintains 27-km of 69-kV subtransmission lines, 2,602 km of primary distribution lines and 1,792 km of secondary distribution lines. Consistently, it

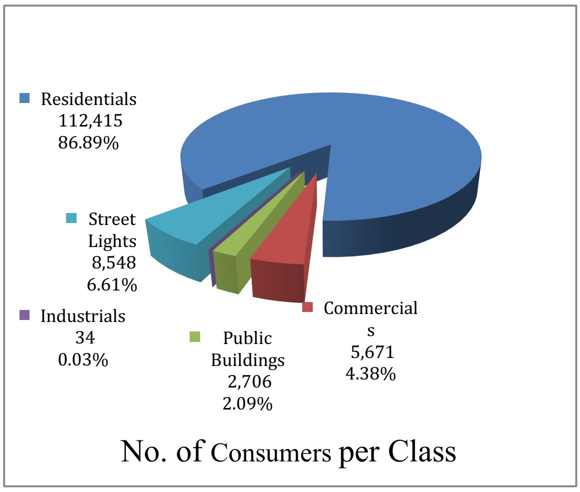


Figure 2-6. BOHECO I No. of Consumers per Class.

upholds a single digit system loss and diligently complies with the standards of the Philippine Distribution Code where none of the voltage served are higher or lower than 10% of its nominal voltage. This electric cooperative's voltage unbalances are less than 2.5%. Its System Average Interruption Frequency Index (SAIFI) is 6.10 interruptions per customer-year while the standard is 20 interruptions per customer-year. Its System Average Interruption Duration Index (SAIDI) is 9.505 hours customers-interruption duration while the standard is 45 hours.

As shown in Figure 2-6, BOHECO I is serves 112,415 residential consumers which is 87% of its total consumers served, 4% commercial consumers, 7% street lightings, 2% public buildings, and less than 1% industrial loads and a ratio of 435 consumers per employee. Presently, half of the power consumption, as shown in Figure 2-9, is used up by residential consumers at 51% and the other half is shared by the commercial consumers (25%), industrial customers (18%), public buildings (5%) and 1% for the street lightings.

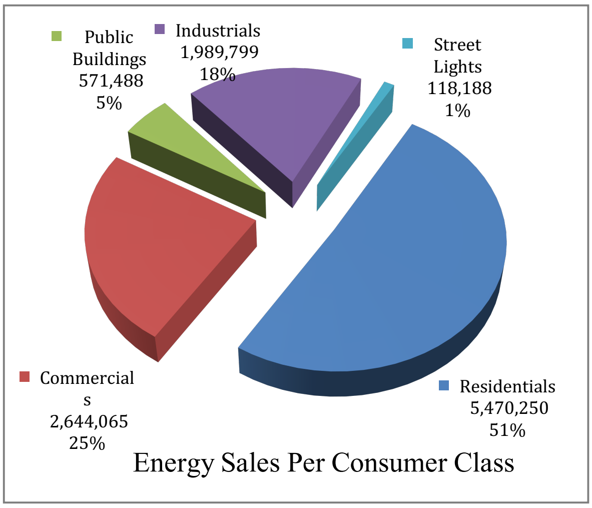


Figure 2-7. BOHECO I Energy Sales per Class.

2.4 Bohol II Electric Cooperative, Inc. (BOHECO II)

Bohol II Electric Cooperative, Inc. (BOHECO II), an integral part of the economic engine of Bohol, is a non-stock—nonprofit entity incorporated in the Philippines to operate an electric light and power service. It covers areas northeast of Bohol with an approximate topographical area of 2,101 square kilometers. BOHECO II main office is at Cantagay, Jagna, Bohol. The electric

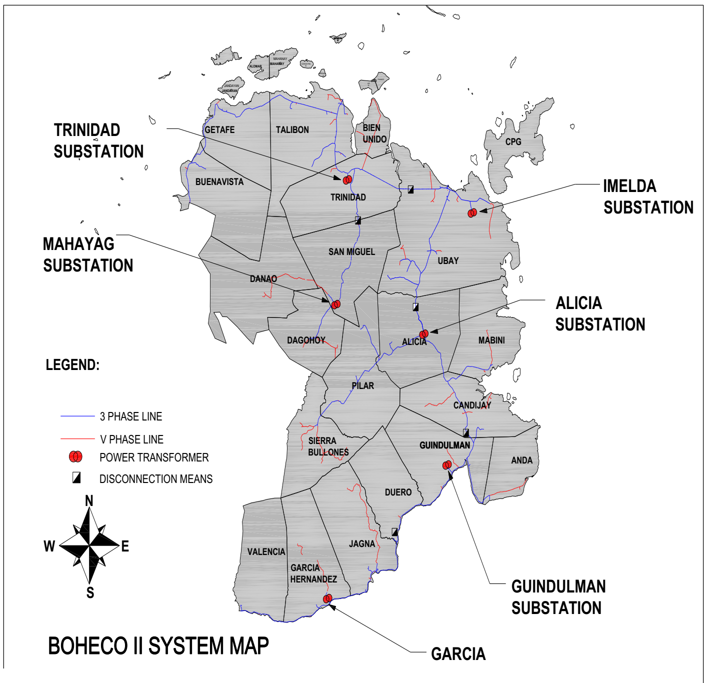


Figure 2-8. BOHECO II System Map and Coverage Area.

cooperative was organized on May 13, 1978. The first load was energized last March 7, 1980. BOHECO-II was given a certificate of Franchise from the National Electrification Administration last June 11, 1980, providing electric service to 491 barangays & 21 municipalities, one of which is an island municipality— the President Carlos P. Garcia (CPG) island.

BOHECO II has four substations connected to the 100 MVA NGCP Imelda Substation with an total capacity of 35 MVA at 55.6% loading. Currently it has 19 MW peak demand with a power factor of 99% and a 52% load factor.

BOHECO-II operates and maintains 0.355 km of 69kV subtransmission lines, 1,305 km of primary distribution lines, and 3,742 km of secondary distribution lines. The current customer mix served as shown in Figure 2-9 below is largely residential at 90%, and the rest are Commercial at 4%, Public Building at 2%, Street lighting at 3%, and Industrial Loads at less than 1%. The current average energy consumption per customer type is also presented in Figure 2-10, from which it is shown that the residential customers draws the largest part of the total energy requirements at 65%, and the remaining requirement is for Commercial at 14%, Street Lighting at 1%, Public Building at 9%, and industrial at 11%.

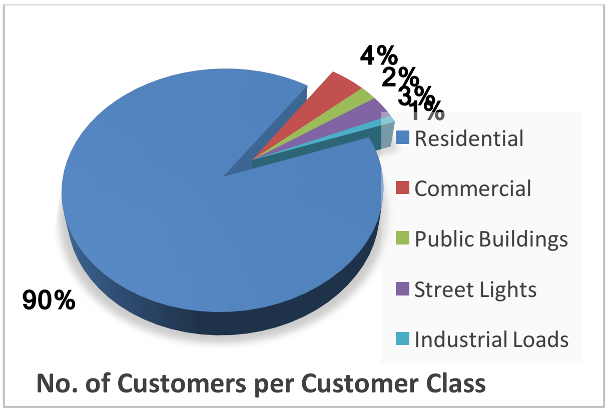


Figure 2-10. BOHECO II No. of Customers per Class.

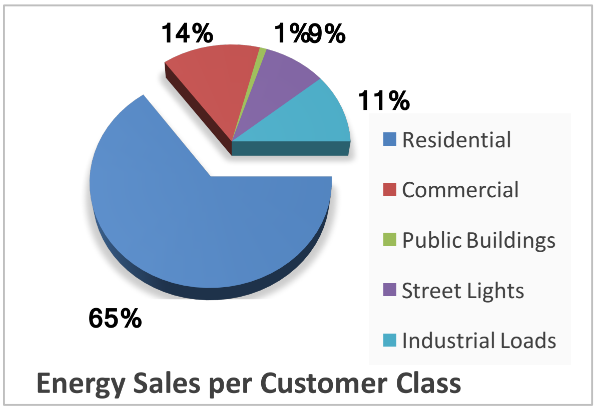


Figure 2-9. BOHECO II Energy Sales per Class.

Section 3: Load Forecasting

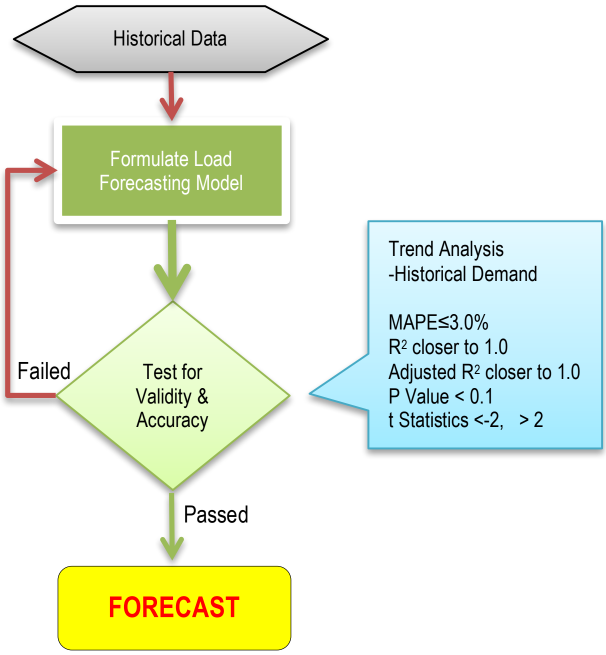
Forecasting of electricity consumption and load growth (demand) is a crucial activity that needs to be done before planning the development of electric distribution systems and procurement of power supply. Electricity forecasts determine the right amount of power supply that needs to be procured and the improvement of future electrical systems required.

Electricity consumption and demand are affected by factors such as population growth, economic conditions, price of basic commodities, geography, weather, land use, city/municipal plans, industrial plans, and development plans.

There are a variety of forecasting methodologies and models used in forecasting electricity consumption and demand. Econometric load forecasting models use economic and demographic data such as population, metrics for economic activity such as Gross Domestic Products (GDP), price of commodities, number of visitors, and others, to predict electricity consumption. However, in the local Philippine setting, the availability of econometric data remains a challenge for using such models. Trend Analysis using regression models is one forecasting methodology that is widely used in the Philippines. This forecasting methodology takes advantage of the characteristic of electricity demand that normally has an increasing trend and can be described by simple polynomial equations arrived at using regression analysis. This forecasting methodology only requires historical load data which is readily available. The use and purpose of these load forecasting methods and the availability of data will determine which factors stated above must be considered.

Figure 3-1 Load Forecasting Flowchart below describes a flow diagram for our load forecasting process. We used 7 years of historical annual peak demand and energy data as inputs to our forecasting methodology. Forecasting models using polynomial equations are then formulated and tested to see if any of these models fit the historical data. The models are tested for validity using statistical tests such as R^2 and Adjusted R^2 which should have a value of at least 0.99, p-value < 0.1, t-stat < -2 or >2, and an accuracy better than 3%. If a forecast model does not pass the tests for validity and accuracy, other equations are formulated and tested until we find models that pass the validity and accuracy requirements.

Figure 3-1 Load Forecasting Flowchart



3.1 Forecasting Models

The power supply requirement of the province of Bohol is served by three distribution utilities (DUs), two of which are Electric Cooperatives (BOHECO I and BOHECO II) and one is a privately-owned DU (BLCI). The three electric utilities supplies the power requirements of the whole province except large consumers directly connected to the grid such as the Alturas Group of Companies and the Philippine Sinter Mining Corp.

The projected future power supply requirement of each distribution utility can be derived in two ways: (1) the composite approach which considers the three electric service providers in Bohol as one and (2) the individual approach which considers the load growth and forecast of each DU separately. In the first approach, the historical load data of each DU are combined and forecasted as one using a single mathematical model that best fits the composite demand. In the second, the load growth behavior in the respective franchise areas of the DUs are captured. Since the three DUs are operating as three independent entities which will procure their respective power supply requirements separately, we adopted the second approach in forecasting the total electricity demand and energy consumption for the whole island of Bohol. Thus, the total forecasted energy or demand of Bohol is described by the following equation:

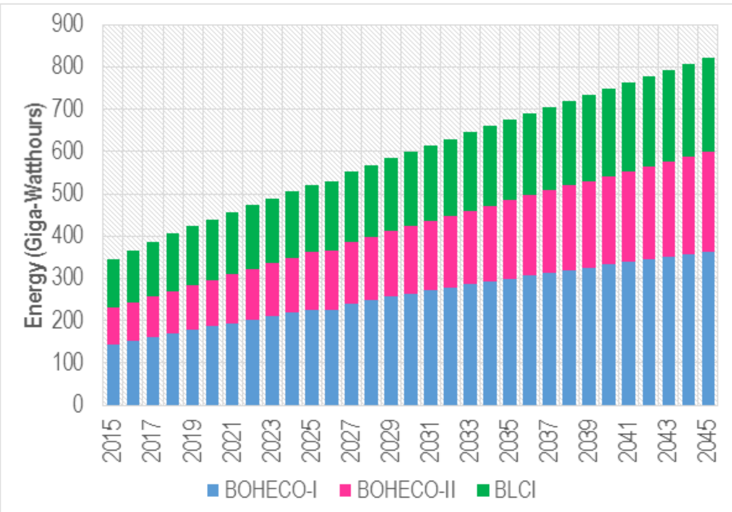
$$Forecast_{Bohol} = \sum Forecasts(BLCI, BOHECO\ I\ \&BOHECO\ II)$$

The first approach is expected to produce lower load forecasts than the 2nd approach since the diversity of hourly demand of the three DUs would even out and lower the peak demand for the whole province. The first approach could demonstrate that savings in power supply procurement will be achieved if the three DUs aggregate the procurement and dispatch of their power supply.

3.2 Energy Forecasts

With the forecasting methodology presented in Figure 3-1, each distribution utility forecasts the projected energy requirement for the next thirty years through trend analysis. Figure 3-2 Total Forecasted Energy per Distribution Utilitybelow shows the total forecasted energy requirement of Bohol. The total energy is 344.66 GWh in 2015 and is expected to rise to 440.10 GWh by the year 2020. BOHECO I is expected to have the highest energy purchase among the 3 DUs. Details of forecasts for each distribution utility is shown in Annex A.

Figure 3-2 Total Forecasted Energy per Distribution Utility

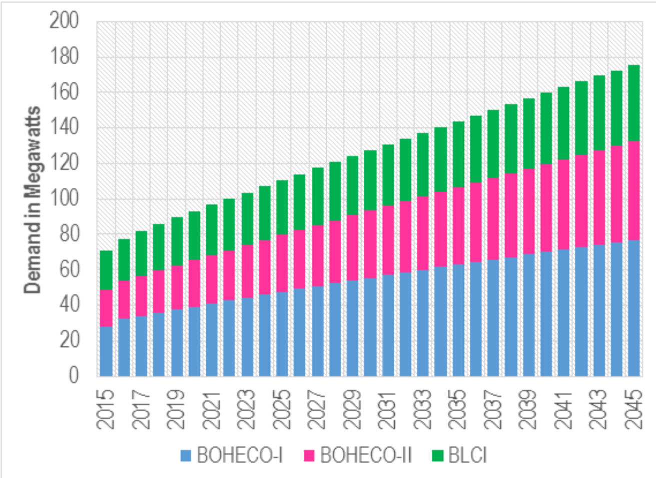


YEAR	Energy (Giga-Watthours)
2015	344.660
2016	365.867
2017	387.715
2018	406.956
2019	423.555
2020	440.102
2025	521.191
2030	599.634
2035	675.583
2040	749.359
2045	821.183

3.3 Peak Demand Forecast

The annual maximum or peak demand forecast for each DU is forecasted to determine the power supply capacity to be procured from generating companies and to likewise ensure substation capacity and line equipment in the distribution utility can accommodate the peak demand. The annual peak demand can be forecasted using the historical annual peak demand, or from the historical annual energy and the historical load factor. The total maximum demand forecast for all three DUs is shown in Figure 3-3. The expected peak demand for the Bohol province in 2016 is 78 MW. Peak demand is forecasted to reach 93 MW by the year 2020. Details of forecasts per distribution utility are shown in Annex A.

Figure 3-3 Forecasted Demand per Distribution Utility



YEAR	Demand (Mega-Watts)
2015	71
2016	78
2017	82
2018	86
2019	90
2020	93
2025	111
2030	127
2035	144
2040	160
2045	176

4.1 Current Situation

In 2015, the 77-MW peak demand of Bohol was primarily supplied by power plants located in Leyte and Cebu through the Leyte-Bohol Transmission Interconnection. Power plants outside Bohol supply about 68.86 MW or 89% of the peak demand of the province through the Leyte-Bohol Interconnection. The remaining 8.4 MW (11%) is collectively supplied by the three mini-hydro plants inside Bohol.

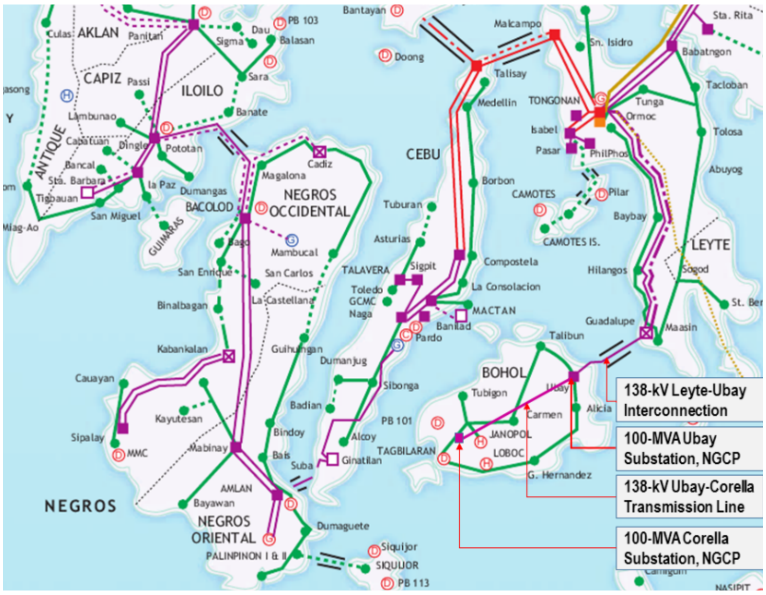


Figure 4-1 Peak Demand per Distribution Utility and Direct-Connected Load

DU/DC	BOHECO I	BOHECO II	BLCI	AGC	MF	PMSC	TOTAL
Peak Demand	28.227	19.480	22.304	3.847	2.200	1.200	**77.258**

The Province of Bohol has four (4) in-land power plants with a total of 20.4-MW dependable capacity. The Bohol Diesel Power Plant (BDPP) in Tagbilaran has a dependable capacity of 12 MW while three hydroelectric power plants have a total of 8.4 MW . The DUs however do not have existing power supply contracts (PSA) with the BDPP which presently serves as ancillary service provider of NGCP. The hydro power resources account for 41% of the total capacity in Bohol. A proposed 8 MW Cantakoy Mini-Hydro Power Plant has yet to be constructed for safety and environmental reasons.

Figure 4-2 Bohol Plants Capability/Demand Profile Calendar Year 2013

Bohol Hydroelectric Power Plants	Installed Capacity (MW)	Dependable Capacity (MW)
SIPC (Formerly BDPP), Dampas, Tagbilaran City	16.5	12.0
Santa Clara Corporation (Formerly LHEP), Tontonan, Loboc, Bohol	1.2	1.0
BOHECO-I-Sevilla Mini-Hydro Corp. (BSMHC) Ewon, Sevilla, Bohol	2.5	2.4
Janopol Hydroelectric Plant (JHEP), Janopol, Balilihan, Bohol	5.0	5.0
TOTAL	**25.2**	**20.4**

4.2 Power Crises during Calamities

During the last quarter of 2013, Bohol was beset by a power crisis due to Supertyphoon Yolanda (International Code: Haiyan), a very strong typhoon that devastated many parts of Eastern Visayas (Leyte and Samar). The scarcity of power supply in Bohol at that time was brought about by the destruction of major power transmission lines including the transmission interconnection linking Bohol to Leyte. The Leyte-Bohol transmission link is the only means by which power from major generating plants in Leyte, Cebu, and Luzon could be transmitted to the island.

During that period, the power sector of Bohol was forced to allocate among themselves the limited available power supply coming from the Bohol Diesel Power Plant (BDPP) and the mini-hydro power plants of BOHECO-1 of about 20 MW. Bohol's power supply requirement at this time was about 62 MW. The 20 MW capacity was allocated according to the following schedule: BOHECO I (8 MW), BOHECO 2 (3 MW), BLCI (6 MW), and spinning reserve (3MW).

The occurrence of Supertyphoon Yolanda awakened the consciousness of the Boholanos on the vulnerability of its electric power system and the need to make it resilient to the effects of natural disasters. They have recognized the need to put in place measures that can ensure sufficient power is supplied to the whole island-province in the event that it is disconnected from the rest of the Visayas Grid.

4.3 Power Supply Planning Methodology

Many Philippine islands typically face significant power supply problems due to their vulnerability to natural calamities such as typhoons and earthquakes, the lack of strong and reliable connectivity to the main electrical grid, and the lack of domestic conventional energy resources that can be tapped for sustainable local consumption. Given these power supply challenges and constraints, it is imperative that islands execute effective, systematic and efficient power supply planning and implementation that will ensure sufficient, reliable and resilient supply to the islands while maintaining affordable prices of electricity.

Power supply planning requires a systematic approach that utilizes accurate energy and demand forecasts, evaluation of load characteristics using load curves and load factors, power plant screening curves that takes into consideration the cost of generation for different representative technologies and types of generating plants, and takes account of pre-existing contracted demand to come up with a least-cost power supply plan.

Figure 4-3 shows a flowchart describing the power supply planning process:

- *Power Plant Cost Data and Power Plant Screening Curves.* Typical cost data of power plants representing baseload, intermediate and peaking power plants are gathered. These cost data include capital cost, annual fixed and variable operation and maintenance (O&M) costs, fuel costs and inflation, plant heat rates, discount rates, and foreign exchange. Using these data, a power plant screening curve is generated. The screening curve plots the generation cost for each power plant type or technology as a function of capacity factor or level of utilization. The screening curve show which power plant types or technologies are cheaper to use at different levels of utilization. Each intersection of generation cost curves represents a boundary where one power plant type is cheaper to operate than the other at a capacity factor lower or higher than the capacity factor at the intersection.

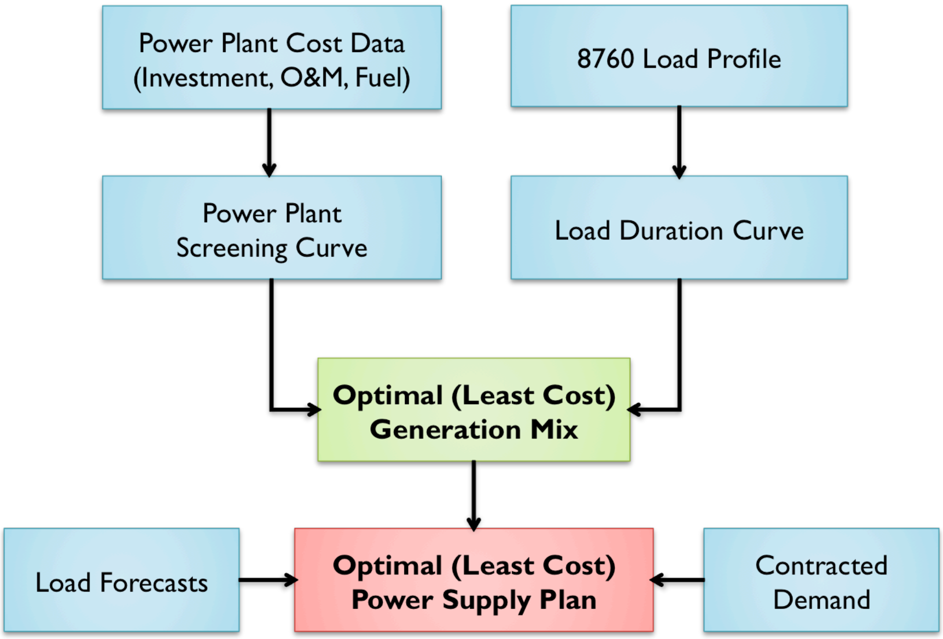
- *8760 Load Profile and Load Duration Curve.* The 8760 Load Profile describes the characteristics or variation of the load or demand that needs to be supplied. This load profile is a recording of typical hourly demand (8760 hours) in a year. The hourly demand is then arranged from the highest (peak demand) to the lowest hourly demand of the year to produce the Load Duration Curve.

- *Optimal (Least-Cost) Generation Mix.* The intersections of the different generation cost curves are mathematically derived and projected into the Load Duration Curve to determine the optimal mix, in percentage (%), of energy and demand that should be allotted to the different power plant types.

- *Load Forecasts and Contracted Demand.* The annual energy and peak demand forecasts are then used, in conjunction with the Contracted annual energy and demand, to get the level of Uncontracted Demand that needs to be procured.

- *Optimal Least Cost Power Supply Plan.* Using the Optimal Generation Mix (in percentage) we determine how much of the forecasted energy and demand (in %) forms part of the baseload energy and demand and how much forms part of the peaking energy and demand. The same is done for the Contracted Energy and Demand. The difference between the respective baseload and peaking energy and demand of the Forecast and the Contracted is the uncontracted energy and demand. This mix of uncontracted baseload and peaking energy and demand gives you the optimal power supply mix.

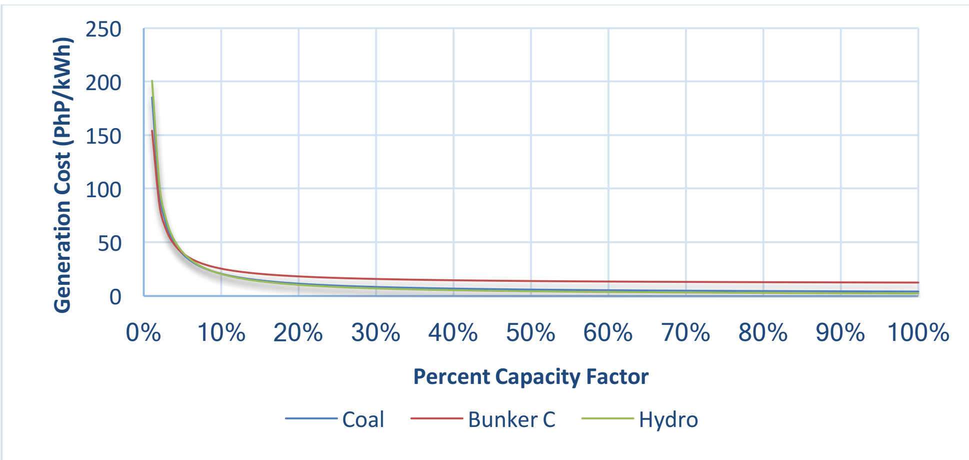
Figure 4-3 Power Supply Planning Flowchart



4.3.1 Power Plant Data and Generation Cost Curve

The formulation of the power supply plan starts with gathering of relevant typical power plant data which includes capital cost, operations and maintenance cost, and fuel cost. The cost of generation for different capacity factors or levels of utilization are computed as an annual levelized cost, e.g. for a period of 20 years. We calculate the costs of different power plant technologies, type and size that may be used in the franchise area either through power plants built in other areas to which it is inter-connected with, or through the development of local energy resources. The generation cost curve in 4-4 shows the cost of generation in PhP/kWh for different capacity factors. The generation cost curve can help us identify which plant is the least cost at a given capacity factor.

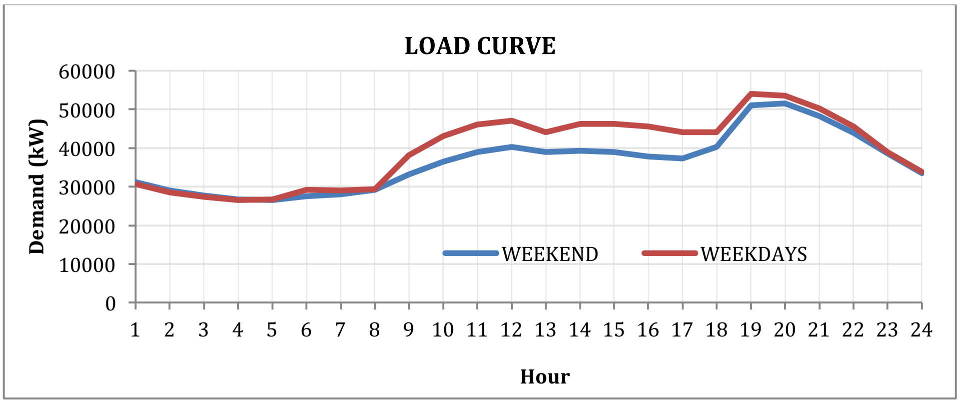
Figure 4-4 Generation Cost Curve



4.3.2 The 8760 Load Profile and the Load Duration Curve

The 8760-hour typical or average annual load profile of the franchise area is an important determinant in the mix of baseload and peaking capacity requirements. A load profile which is relatively flat or has a high load factor will require more baseload capacity in the mix compared to one with a lower load factor. On the other hand, a load profile that is relatively steep or has a low load factor will require more peaking capacity than that with a higher load factor. For purposes of illustration, we show the 24-hour combined load profile of the whole province of Bohol. Distribution utilities with predominantly rural loads, such as BOHECO I and BOHECO II, will tend to have lower load factors than those servicing urban loads like BLCI. The Load Duration Curve corresponding to the Load Profile in Figure 4-5 is shown in Figure 4.6b.

Figure 4-5 Province of Bohol 24-Hour Load Profile

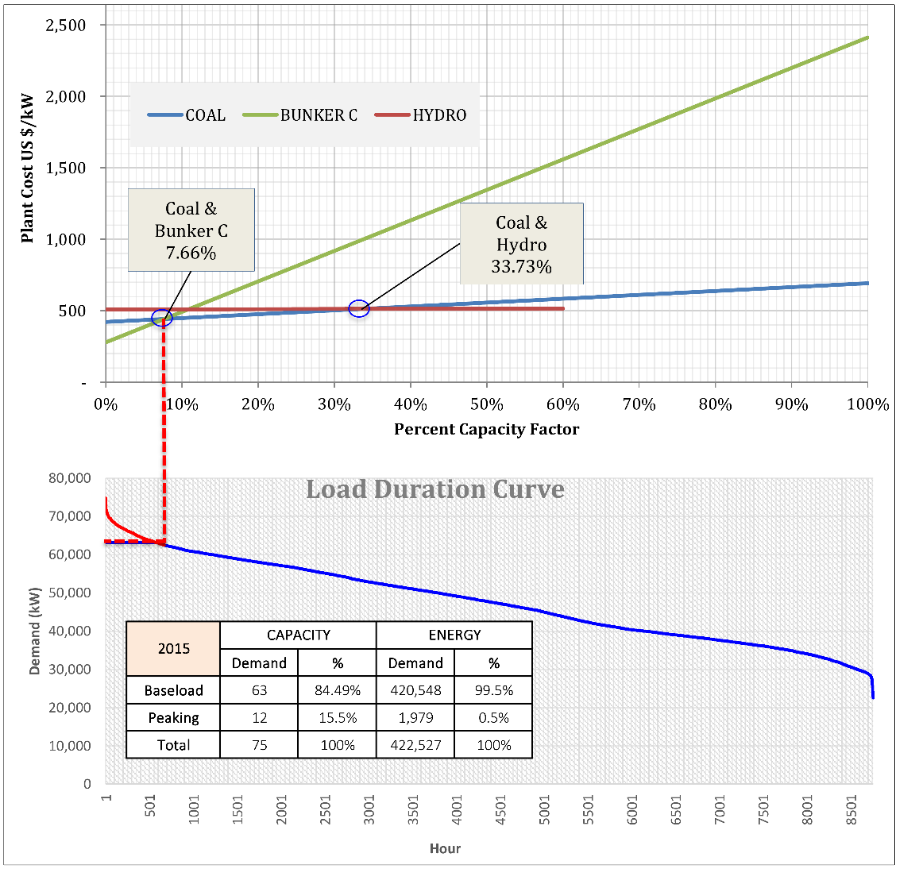


4.3.3 Screening Curve and Optimal Generation Mix

From the power plant data, we generate the Power Plant Screening Curve shown in Figure 4-6 below. We used power plant types representing peaking plants (Bunker Diesel) and typical baseload plants (Coal and Hydro). The graph shows that for capacity factor less than 7.66%, the Power Plant utilizing Bunker C fuel is the least cost among the three power plant types. This is due to the relatively low investment cost for construction of Diesel Plants. Above 7.66% capacity factor, the Coal Plant becomes least cost as coal is a much cheaper fuel than Bunker C. Due to the high cost of fuel of Diesel Plants, they are normally operated as peaking plants with low utilization levels. At above 33.73%, the Hydro Plant becomes the least cost option since although hydro has the highest investment cost, it has zero fuel cost. Coal and Hydro are typically used as baseload plants with high levels of capacity utilization. However, for the island of Bohol, the hydro resources are seasonal and are not enough to generate power that is needed to fill the baseload requirements of the whole island. Hydro, however, can be used as replacement energy for coal whenever it is available.

Projecting the intersection of the representative peaking plant (Bunker C) and the representative baseload plant (Coal) into the Load Duration Curve (LDC), we get the optimal (least cost) Generation Mix of 85% Baseload Capacity (represented by Coal) and only 15% Peaking Capacity (represented by Bunker C). In terms of annual energy requirement, the optimal mix is 99.5% baseload and 0.5% peaking energy. Also, a hydro-electric plant operated with a minimum plant capacity factor of 33.73% will contribute to the envisioned least-cost power supply mix. Detailed Power Plant Screening Curve and Optimal Generation Mix on a per DU basis are shown in Annex B.

Figure 4-6 Power Plant Screening Curve – (Province of Bohol)

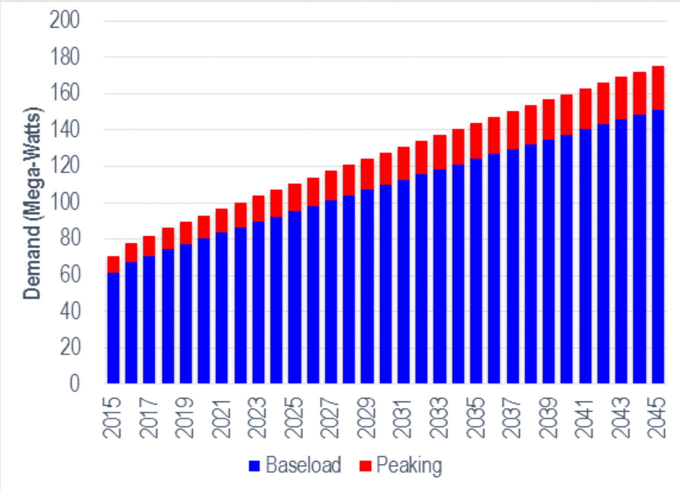


2015	CAPACITY		ENERGY	
	Demand	%	Demand	%
Baseload	63	84.49%	420,548	99.5%
Peaking	12	15.5%	1,979	0.5%
Total	75	100%	422,527	100%

4.4 Forecasted Baseload and Peaking Demand of Bohol

The forecasted baseload and peaking requirements for the province of Bohol is the sum of each DU's requirements for both the energy and capacity. Each DU has distinct baseload and peaking requirements which is attributable to its load factor. Figure 4-7 shows the total baseload and peaking requirements of Bohol for the next 30 years (2016-2045). The detailed baseload and peaking requirements per DU is shown in Annex C.

Figure 4-7 Total Baseload and Peaking Requirements of Bohol

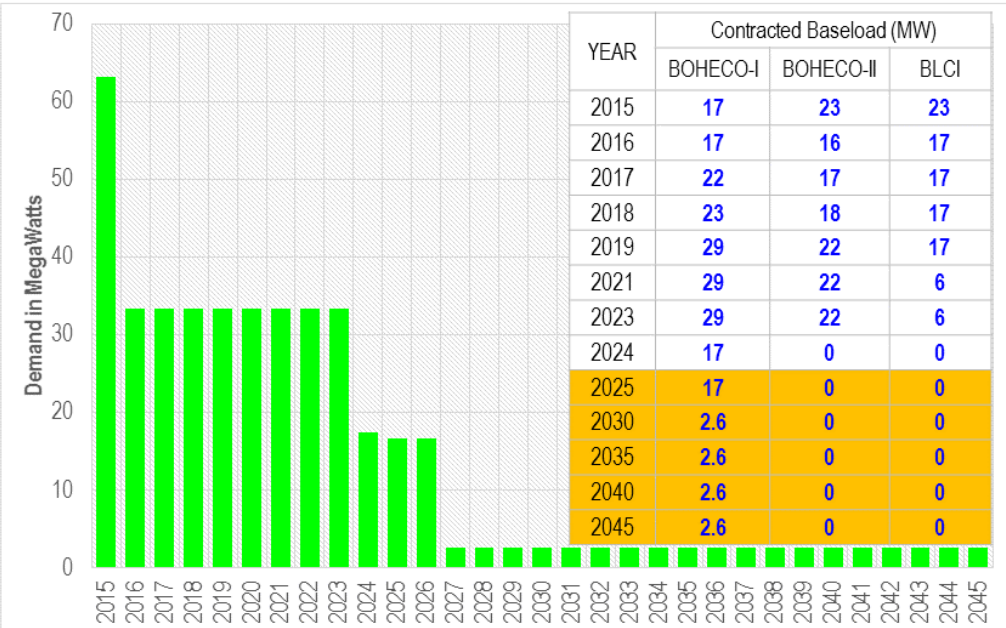


YEAR	Bohol	
	Base	Peaking
2015	61	10
2016	67	11
2017	71	11
2018	74	12
2019	77	12
2020	80	13
2025	95	15
2030	110	18
2035	124	20
2040	138	22
2045	151	24

4.5 One Bohol Contracted and Uncontracted Demand

Harmonization of power supply contracts with power supply requirements is needed in the formulation of alternatives to come up into an optimal and least-cost strategy to supply the power requirement of Bohol for the next thirty years. Figure 4-8 shows the existing Contracted Baseload Demand thru Power Supply Agreements (PSA) of Bohol DUs with different generating companies. It shows that by 2024, all Contracted Baseload PSA's of BLCI and BOHECO II will expire by 2023. Only BOHECO I has remaining 17 MW of Contracted Baseload Demand, most of which will expire by 2026.

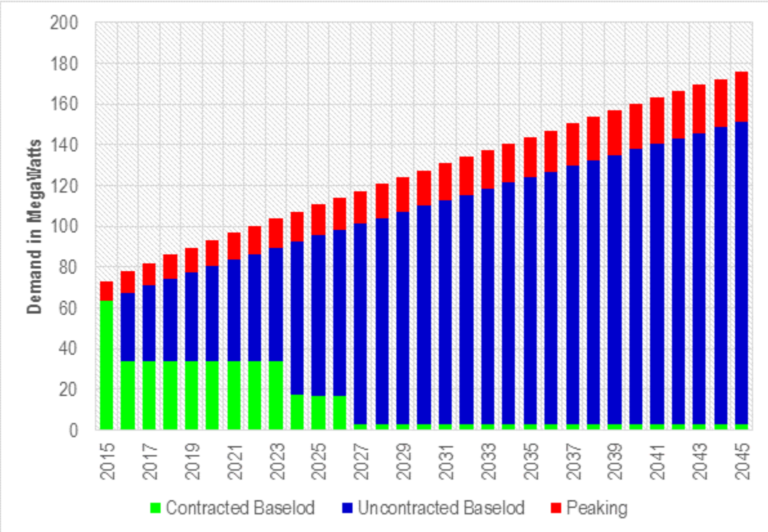
Figure 4-8 Total Contracted Baseload per Distribution Utility (PSA)



YEAR	Contracted Baseload (MW)		
	BOHECO-I	BOHECO-II	BLCI
2015	17	23	23
2016	17	16	17
2017	22	17	17
2018	23	18	17
2019	29	22	17
2021	29	22	6
2023	29	22	6
2024	17	0	0
2025	17	0	0
2030	2.6	0	0
2035	2.6	0	0
2040	2.6	0	0
2045	2.6	0	0

The power supply strategy is anchored on the Uncontracted Capacity requirement of the province that is derived by subtracting the Contracted Baseload and Peaking Demand from the corresponding Forecasted Baseload and Peaking Demand, details of which are shown in Annexes C, D, and E. The Baseload and Peaking Uncontracted Demand will be subjected to a least-cost and optimal power supply strategy. Figure 4-9 below shows the Uncontracted Baseload Demand of Bohol. We note that in the next 10 years, the most significant increase in Uncontracted Baseload Demand happens in 2024 (75 MW) from a value 56 MW in 2023. This is due to the baseload contracts of BLCI and BOHECO II expiring in 2023.

Figure 4-9 One Bohol Contracted and Uncontracted Demand



YEAR	Bohol - Uncontracted	
	Base	Peaking
2015	0	10
2016	29	11
2017	32	11
2018	36	12
2019	39	12
2020	42	13
2025	75	15
2030	79	15
2035	107	18
2040	121	20
2045	135	22

4.6 Optimal Power Supply Strategy

A power supply plan envisioned to secure a resilient, reliable, adequate and least-cost power for Bohol is the primary driver in the formulation of strategies to achieve its primary objectives. Synchronization of DUs' power supply contracts is considered in the process. As shown in Figure 4-8, the PSAs of each distribution utility have different terms and inclusive periods, resulting in the volume of Uncontracted Demand to be sourced out lacking in the required economies of scale to be able to secure the best available price of electricity for a new power plant, at least for the first eight years. A look at existing market conditions (given the limited available capacities in the grid and prices in the electricity market), the price of electricity is expected to remain relatively high in 2016 to 2018. Prices are expected to drop by 2019 due to new power plants expected to be online late 2018 and early 2019.

Even though WESM is available to draw power from for quantities in excess of the currently contracted demand, it is recommended to secure bilateral contracts for the remaining uncontracted baseload demand to ensure stability of prices and lessen the vulnerability to price surges in the market. The peaking requirement, however, may be sourced from WESM since it is only 0.5% of the total energy requirement, thus WESM price hikes will have minimal impact on the electricity rates.

4.6.1 <u>Main Power Supply Strategy</u>

Given the above, we can therefore strategically divide the implementation of the power supply plan into three stages:

(1) Short-Term, for CY 2016-2018

(2) Medium-Term, for CY 2019-2023*;* and

(3) Long-Term, for CY 2024-2043.

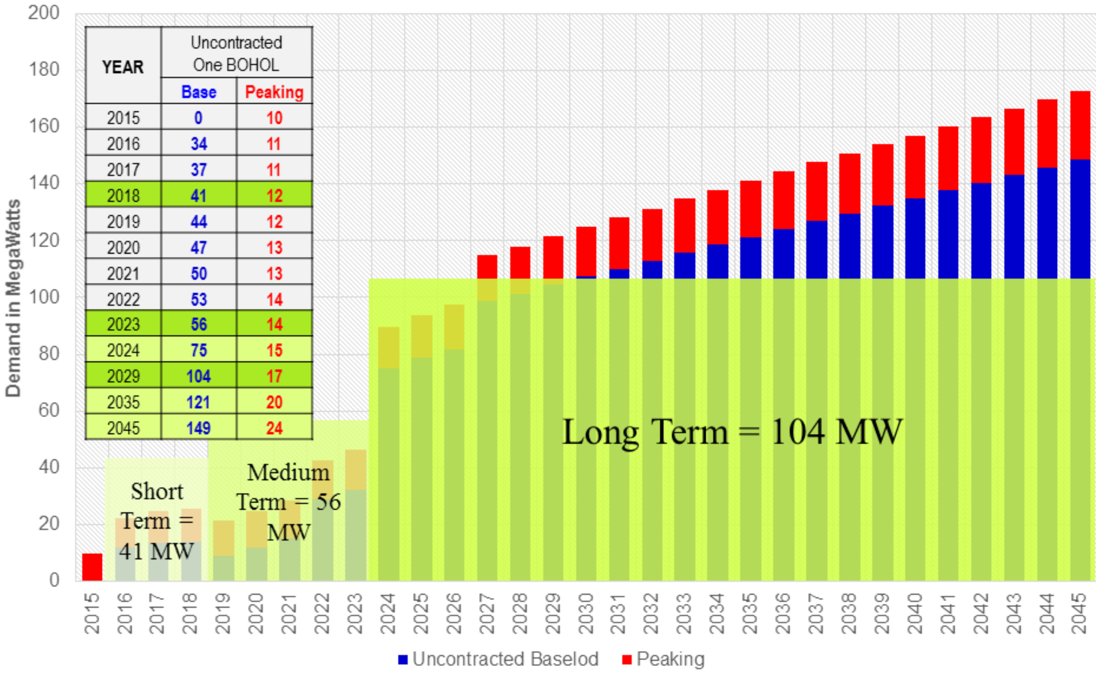
All these should result in the signing of bilateral Power Supply Agreements with GenCos (to ensure adequate and stable supply) through the conduct of a transparent Competitive Selection Process (to achieve least-cost).

The Short-Term (CY 2016-2018) baseload power supply requirement shall be procured and sourced from existing power plants in the Luzon or Visayas Grid since Bohol's requirement is too small and too soon to require construction of a new power plant.

Meanwhile, the Medium-Term (CY 2019-2023) baseload power requirements may be sourced either from existing power plants or new capacity that will be operational by CY 2019. The divide between the Short-Term and Medium-Term power supply procurement is due to the fact that new and cheaper baseload capacities are expected to be available by late 2018 and 2019. The Medium-Term procurement is expected to result in much lower generation rates than the Short-Term procurement.

The Long-Term (CY 2024-2043) power supply requirement should cause the construction of additional capacity to the grid and achieve the objective of the BIPSP for a least-cost, reliable and secure supply for the island of Bohol. To achieve resiliency, it is imperative that the new power plant be built inside the island of Bohol so that Bohol will still have power even if natural calamities strike the external sources of power or if the transmission link from Leyte to Bohol is disconnected. Figure 4-10 below illustrates the power supply plan strategies for the Uncontracted Demand of Bohol.

Figure 4-10 One Bohol Power Supply Strategy



4.6.2 <u>Essential Supplemental Power Supply Strategies</u>

Aside from the above strategies, the following actions are also recommended:

(1) Rapid Resource Assessment. Conduct rapid hydro resource assessment and feasibility studies on prospective hydro power generation sites to augment power supply available within Bohol. The development of feasible hydro sites for power generation must be bid out in a competitive selection process so that the use of such hydro resources will result in the lowest possible electricity rates;

(2) Strengthen Networks. Strengthen sub-transmission and distribution networks to ensure reliable distribution and delivery of power to end users through systematic distribution planning and project implementation;

(3) Interruptible Load Programs. Design and implement Interruptible Load Programs that will be implemented during power crises brought about by natural disasters. These programs will allow large commercial and industrial loads with emergency power generators to contribute supply to the Bohol Grid during such emergencies, with reasonable compensation or incentives; and

(4) Lobby for Cebu-Bohol Interconnection. Lobby for an alternate transmission line linking Bohol to Cebu to ensure N-1 reliability and connectivity to the main Visayas Grid. This is discussed further in the next section.

4.6.3 Significance of Alternative Cebu-Bohol Transmission Interconnection

In addition to requiring the presence of sufficient power plant capacity in the island of Bohol, the construction of an alternative transmission link to the rest of the Visayas Grid is also crucial. The BEDAG-TWG, of which the NGCP is also a member, proposed that instead of adding a second line to the existing Leyte-Bohol transmission link, a separate transmission line connecting Bohol to Cebu should be actively pursued instead.

If the Cebu-Bohol transmission link shown is erected before a new power plant in Bohol becomes operational in CY 2024, this will improve reliability (complying with the Philippine Grid Code's N-1 Reliability Criterion) and resiliency of Bohol's supply. It will also make the price of Bohol's power supply become competitive since the power plant will have the opportunity to export power to Cebu and the rest of the Visayas. Furthermore, since the Cebu-Bohol line will effectively loop the transmission system in Bohol with Leyte and Cebu, this will reduce the Line Rental paid by Bohol's DUs and contribute to further reduction of power rates.

In the Draft 2014-2015 Transmission Development Plan (2014-2015 TDP Draft, December 2015) of the NGCP, the Cebu-Bohol Interconnection is already proposed but with no specific date of construction or completion. With the concerted and persistent efforts of the BEDAG-TWG, BEDAG, the Bohol Provincial Governor who chairs BEDAG, and the DOE Secretary who serves as co-Chair of BEDAG, and the different stakeholders of Bohol, the 2014-2015 TDP Final Report (December 2016) already includes 2020 as the target year of completion.

Figure 4-11. Proposed Cebu-Bohol Transmission Interconnection

Section 5: ANNEXES

Annex A Energy and Demand Forecasts per Distribution Utility

A-1 Bohol I Electric Cooperative, Inc. (BOHECO I)

1. Actual and Normalized Historical Data

In accordance with the forecasting methodology presented in Section 3.1, BOHECO I used the normalized historical data in forecasting through trend analysis. Table 5-1 below shows the actual and normalized data of BOHECO I. Data was normalized due to the effects of the Bohol earthquake and Typhoon Yolanda on then normal load growth.

Table 5-1 BOHECO I Historical Data (Energy Sales and Demand)

Year	Actual		Normalized	
	Energy (kWh)	Demand (kW)	Energy (kWh)	Demand (kW)
2009	99,535,276	18,862	99,535,276	18,862
2010	108,615,129	20,397	108,615,129	20,397
2011	114,530,487	24,456	114,530,487	21,942
2012	121,537,040	24,553	121,537,040	23,528
2013	120,600,013	25,963	129,019,282	25,117
2014	126,072,887	27,029	136,117,900	26,687
2015	144,933,885	28,227	144,933,885	28,227

2. System Energy Sales Forecast

System Energy Sales Mathematical Model:

$$\boldsymbol{Energy\ Sales}_{System} = \boldsymbol{a}(\ln \boldsymbol{t})^3 + \boldsymbol{b}(\ln \boldsymbol{t})^2 + \boldsymbol{c}(\ln \boldsymbol{t}) + \boldsymbol{d}$$

Table 5-2 and Table 5-3 below show the parameters/criteria being considered.

Table 5-2 System Energy Forecasting Criteria and Intercepts

Intercepts		P Value	t Statistic
Coefficient	Value	< 0.1	< -2, >2
a	7,541,463.67	0.002707	9.210275
b	(11,809,825.45)	0.016981	(4.823505)
c	17,643,655.49	0.002623	9.310427
d	99,532,960.58	0.0000001	276.438220

Table 5-3 System Energy Forecast Validity Test Parameters and Result

Test Parameters	MAPE	r^2	r^2adj	Growth Rate
Actual	0.136%	0.9997	0.9995	3.82%
Requisite	≤ 3%	>0.99	>0.99	Reasonable

The historical data used in forecasting the system energy were based on the total annual energy sales of BOHECO I as reported in its reports to regulating bodies.

3. **System Energy Purchased Forecast**

The power supply plan is referenced to the total purchased energy and demand per distribution utility. In BOHECO I Forecasts, the system energy purchased is derived through Equation 5.1 below.

Equation 5.1 BOHECO I System Energy Forecast

$$\boldsymbol{System\ Energy_{Purchased} = System\ Energy_{Sales} \times (1 + Sytems\ Loss\ Cap)}$$

Where;

$$System\ Energy_{Sales} = Forecasted\ Energy\ Sales$$

$$Sytems\ Loss\ Cap = Systems\ Loss\ Cap\ Median\ Applied\ on\ 2008\ (8.07\%)$$

4. **System Purchased Demand Forecast (kW)**

The forecasted system demand (in kW) was derived using a global approach as shown in Equation below. It is the quotient of the forecasted energy to the product of the Load Factor and the total number of hours in a year which is 8,760 Hrs.

Equation 5.2 BOHECO I System Demand Forecast

$$\boldsymbol{Purchased\ Demand_{system} = \sum_{i=1}^{n} \frac{Forecasted\ Feeder\ Energy\ Sales_i^{Scaled}}{Load\ Factor_{Feeder=i}^{Scaled,cPD} \times 8760}}$$

Where; *i=Feeder No. (i.e., F01, F02, etc…); n=total number of feeders*

$$Load\ Factor_{Feeder=i}^{Scaled,cPD} = is\ the\ average\ load\ factor\ of\ the\ feeder$$
$$Scaled\ to\ the\ Coincidental\ Peak\ Demand\ of\ the\ System$$

A constant load factor is considered in the above equation throughout the next thirty (30) years as shown in Table 5-6. It is presumed to be constant based on its historical trend for the past years.

A-1.4.1 *Energy Forecast per Feeder*

A per feeder energy forecast is needed as shown in Equation 5.3. The forecast per feeder is derived through the same methodology used in forecasting the system energy using trend analysis. Table 5-4 below shows the historical metered energy data per feeder.

Equation 5.3 BOHECO I Per Feeder Energy Forecast

$$\boldsymbol{Feeder\ Energy\ Purchased_i} = \boldsymbol{Feeder\ Energy\ Sales_i}^{scaled} \times (\mathbf{1} + \boldsymbol{Sytems\ Loss\ Cap})$$

Where;

$$Feeder\ Energy\ Sales_i^{scaled} = Scaled\ Forecasted\ Energy\ Sales\ of\ Feeder\ i$$

$$Sytems\ Loss\ Cap = Systems\ Loss\ Cap\ Median\ Applied\ on\ 2008\ (8.07\%)$$

Table 5-4 Historical Data – Metered Energy Per Feeder (MegaWatt-hours)

YEAR	METERED ENERGY PER FEEDER (MWH)						
	2009	2010	2011	2012	2013	2014	2015
F01	9,091	9,800	10,597	11,436	12,292	13,152	14,008
F02	5,813	6,442	6,642	6,866	7,141	7,288	7,995
F03	3,800	4,278	4,725	5,140	5,525	5,884	6,221
F04	7,434	8,129	8,566	9,266	9,787	10,290	11,272
F05	5,355	5,485	6,006	6,504	6,842	7,232	7,345
F06	5,911	7,695	8,732	9,205	9,426	10,876	10,884
F07	3,482	3,714	3,927	4,079	4,282	4,462	4,583
F08	4,022	4,420	5,458	5,841	6,077	6,959	7,312
F09	3,922	4,236	4,315	4,551	4,727	4,891	4,908
F10	3,901	4,193	4,479	4,752	5,011	5,255	5,486
F11	3,669	4,088	4,150	4,146	4,349	4,596	4,743
F12	5,928	6,082	6,243	6,719	6,990	7,309	7,620
F13	2,822	2,971	3,114	3,380	3,721	4,169	4,305
F15	1,632	1,744	1,760	1,819	1,923	1,986	2,046
F16	5,502	5,834	6,313	6,663	7,021	7,355	7,988
F17	5,033	5,292	5,273	5,455	5,622	5,735	6,164
F19	6,839	7,421	8,016	8,821	9,666	10,658	11,025
F20	7,809	8,531	9,956	10,702	11,798	12,773	13,719
F21	248	468	608	749	891	1,025	1,154

The forecast per feeder is necessary in system demand forecast as shown in Equation 5.2. The forecasted energy of each feeder is adjusted with the system energy as shown in Equation 5.4 below.

Equation 5.4 Per Feeder Energy Sales Forecast

$$Energy\ Sales_{Feeder=i}^{scaled} = Energy\ Sales_{Feeder=i}{}^{Forecast} \times \sum_{i=1}^{n} \frac{Energy\ Sales_{Feeder=i}{}^{Forecast}}{System\ Energy\ Sales^{Forecast}}$$

Through curve fitting and regression analysis, Table 5-5 below is the summary of best-fit forecast (mathematical) models for each feeder that passed all forecasting criteria and parameters.

Table 5-5 *Per Feeder Energy Forecast Mathematical Models*

Feeder	*Forecast Mathematical Model*	Feeder	*Forecast Mathematical Model*
F01	$L = at^3 + bt + c\log t + d$	F11	$L = a(\ln t)^3 + b(\ln t)^2 + c\ln t + d$
F02	$L = a(\ln t)^2 + b$	F12	$L = a(\ln t)^3 + b$
F03	$L = a(\ln t)^3 + b(\ln t)^2 + c\ln t + d$	F13	$L = a(\ln t)^3 + b$
F04	$L = a(\ln t)^3 + b$	F15	$L = a(\ln t)^3 + b(\ln t)^2 + c\ln t + d$
F05	$L = a(\ln t)^2 + b$	F16	$L = a(\ln t)^2 + b$
F06	$L = a(\ln t) + b$	F17	$L = a(\ln t)^3 + b$
F07	$L = a(\ln t)^3 + b$	F19	$L = a(\ln t)^3 + b\ln t + c$
F08	$L = a(\ln t)^3 + b\ln t + c$	F20	$L = a(\ln t)^3 + b(\ln t) + c$
F09	$L = a(\ln t)^2 + b$	F21	$L = a(\ln t)^3 + b(\ln t)^2 + c\ln t + d$
F10	$L = a(\ln t)^3 + b(\ln t)^2 + c\ln t + d$		

Through regression analysis and interpolating the per feeder historical data with the equations shown in Table 5-4, shown in Table 5-6 and 5-7 below is the summary of forecasting parameters/criteria being considered and per feeder energy forecast respectively.

Table 5-6 System Energy Forecast Validity Test Parameters and Result

Feeder	Test Parameter and Criteria				Feeder	Test Parameter and Criteria			
	MAPE < 5%	r^2 >0.99	r^2adj >0.99	Growth Rate		MAPE < 5%	r^2 >0.99	r^2adj >0.99	Growth Rate
F01	0.014%	0.999999	0.999998	3.76%	***F11***	0.58%	0.9894	0.9787	4.24%
F02	2.15%	0.933852	0.920623	2.76%	***F12***	0.76%	0.9895	0.9874	3.51%
F03	0.006%	0.9999998	0.9999996	2.61%	***F13***	1.28%	0.9878	0.9854	6.62%
F04	1.93%	0.973735	0.968481	4.56%	***F15***	0.69%	0.9894	0.9788	2.98%
F05	1.09%	0.987777	0.985332	3.39%	***F16***	0.97%	0.9887	0.9864	3.49%
F06	2.11%	0.970962	0.965155	2.41%	***F17***	1.23%	0.9392	0.9271	3.17%
F07	1.84%	0.945823	0.934988	4.34%	***F19***	0.85%	0.9937	0.9905	5.46%
F08	2.55%	0.979063	0.968595	3.92%	***F20***	0.95%	0.9963	0.9944	4.32%
F09	1.34%	0.961927	0.954313	2.34%	***F21***	0.35%	0.9999	0.9998	2.64%
F10	0.004%	0.9999999	0.9999997	2.17%					

Table 5-7 BOHECO-I Energy Forecast Purchased per Feeder (Mega-Watthours)

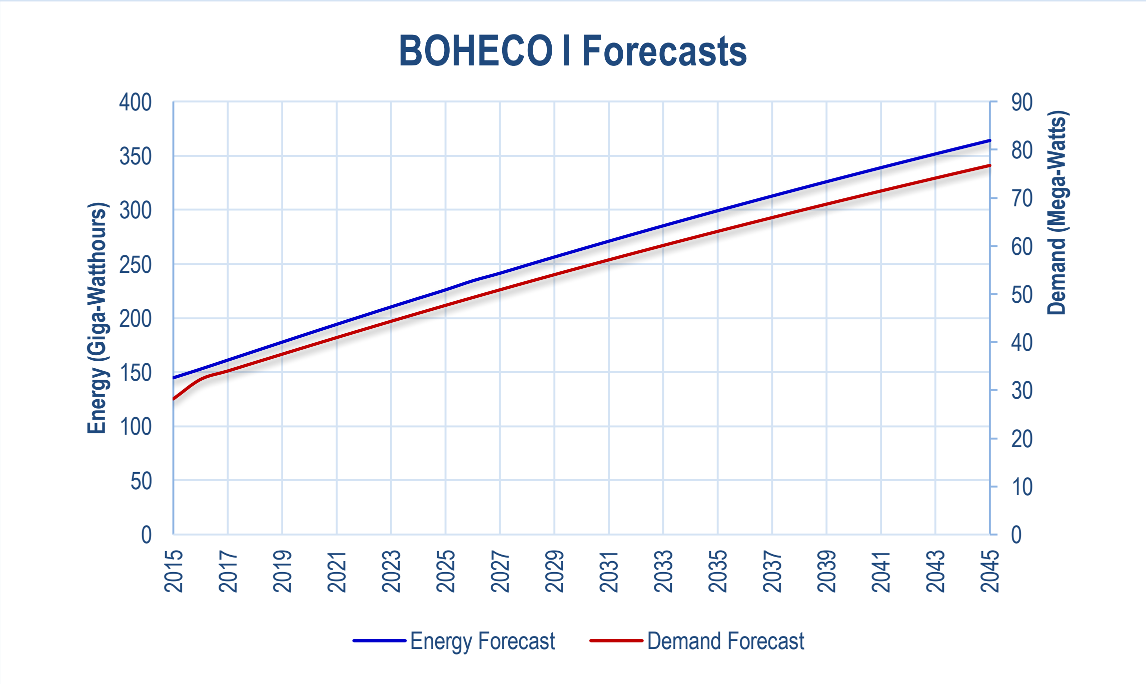
Year	LOAD FACTOR	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2029	2030	2035	2040	2045
F01	56.70%	15,140	16,126	17,273	18,326	19,382	20,436	21,483	22,519	23,539	24,541	25,521	29,159	29,983	33,453	35,584	36,014
F02	45.12%	8,416	8,726	9,107	9,424	9,733	10,035	10,329	10,615	10,894	11,167	11,433	12,440	12,679	13,822	14,903	15,954
F03	45.09%	6,723	7,096	7,524	7,899	8,267	8,627	8,980	9,326	9,666	9,999	10,326	11,582	11,884	13,344	14,744	16,117
F04	54.52%	12,151	13,020	14,024	14,954	15,889	16,827	17,763	18,697	19,627	20,552	21,471	25,092	25,983	30,368	34,674	38,962
F05	53.03%	8,079	8,442	8,870	9,234	9,589	9,934	10,270	10,597	10,915	11,226	11,529	12,677	12,950	14,252	15,480	16,673
F06	58.82%	11,678	12,091	12,582	12,971	13,339	13,689	14,023	14,343	14,649	14,942	15,225	16,267	16,508	17,637	18,676	19,675
F07	37.93%	5,046	5,310	5,628	5,915	6,205	6,495	6,785	7,074	7,361	7,647	7,932	9,049	9,324	10,676	12,002	13,325
F08	53.22%	7,926	8,484	9,116	9,689	10,258	10,820	11,377	11,928	12,472	13,010	13,542	15,613	16,118	18,585	20,984	23,360
F09	47.93%	5,398	5,569	5,786	5,964	6,137	6,307	6,472	6,634	6,791	6,945	7,095	7,663	7,798	8,443	9,054	9,650
F10	60.72%	5,928	6,191	6,505	6,776	7,044	7,307	7,565	7,819	8,069	8,315	8,557	9,487	9,711	10,798	11,845	12,875
F11	48.27%	5,161	5,471	5,863	6,245	6,648	7,067	7,499	7,941	8,392	8,850	9,314	11,210	11,691	14,125	16,600	19,125
F12	57.97%	8,298	8,734	9,258	9,732	10,210	10,689	11,167	11,644	12,118	12,590	13,059	14,903	15,356	17,586	19,775	21,957
F13	49.52%	4,740	5,124	5,562	5,971	6,382	6,794	7,206	7,616	8,025	8,432	8,836	10,429	10,822	12,752	14,648	16,536
F15	51.70%	2,225	2,327	2,455	2,573	2,694	2,818	2,943	3,069	3,196	3,323	3,451	3,962	4,090	4,727	5,363	6,006
F16	49.17%	8,467	8,859	9,318	9,709	10,090	10,461	10,822	11,173	11,515	11,849	12,174	13,407	13,700	15,098	16,417	17,698
F17	47.06%	6,549	6,801	7,121	7,401	7,684	7,968	8,251	8,533	8,814	9,093	9,370	10,459	10,726	12,039	13,327	14,613
F19	56.76%	12,107	12,992	14,001	14,929	15,856	16,780	17,698	18,611	19,516	20,415	21,306	24,796	25,652	29,849	33,953	38,029
F20	59.60%	19,392	20,542	21,850	23,024	24,194	25,358	26,513	27,657	28,791	29,914	31,026	35,366	36,428	41,619	46,684	51,710
F21	59.67%	3,250	3,409	3,597	3,764	3,932	4,100	4,268	4,434	4,600	4,764	4,927	5,569	5,727	6,502	7,265	8,026
Total		156,673	165,310	175,441	184,500	193,532	202,509	211,413	220,230	228,952	237,574	246,094	279,129	287,130	325,674	361,978	396,305

Applying the forecasted per feeder data shown in Table 5-7 to Equation 5.1, Table 5-8 and Figure 5-1 below shows the forecasted system demand of BOHECO I together with the forecasted system energy.

Table 5-8 BOHECO I Forecasted Purchased Energy and Demand

YEAR	Energy (kWh)	Demand (kW)	YEAR	Energy (kWh)	Demand (kW)
2015	144,933,885	28,227			
2016	152,959,068	32,278	2031	271,210,728	57,098
2017	161,275,665	34,023	2032	278,383,550	58,606
2018	169,603,954	35,771	2033	285,468,009	60,094
2019	177,906,817	37,513	2034	292,466,074	61,566
2020	186,159,009	39,245	2035	299,379,756	63,020
2021	194,343,389	40,963	2036	306,211,077	64,457
2022	202,448,427	42,664	2037	312,962,052	65,878
2023	210,466,527	44,346	2038	319,634,674	67,283
2024	218,392,881	46,010	2039	326,230,904	68,672
2025	226,224,676	47,653	2040	332,752,665	70,047
2026	234,597,786	49,277	2041	339,215,640	71,407
2027	241,600,101	50,881	2042	345,594,295	72,753
2028	249,143,788	52,464	2043	351,903,959	74,085
2029	256,592,529	54,028	2044	358,146,357	75,405
2030	263,947,646	55,573	2045	364,323,160	76,711

Figure 5-1 ***BOHECO-I System Demand Forecast***



A-2 Bohol II Electric Cooperative, Inc. (BOHECO II)

1. Actual and Normalized Historical Data

BOHECO-II came up with thirty-three (33) mathematical forecasting models to represent the trend of the historical Energy Sales (see annex C). Using the forecasting methodology discussed in Chapter 3, BOHECO-II selects the best fit forecasting model from candidate polynomial equations. Unfortunately no model passed the set criteria using the historical data that we have. After several validation of the data, we concluded that the historical data trend was affected by the earthquake and typhoon Yolanda in year 2013. Thus, we needed to normalize the historical data as shown in Table 5-9. By using the historical monthly growth rate of sales BOHECO II we came up with the estimated values to normalize the affected sales from the month of November 2013 to February 2014.

Table 5-9. BOHECO II Historical and Normalized Energy Sales Data.

Year	Actual		Normalized	
	Energy (kWh)	Demand (kW)	Energy (kWh)	Demand (kW)
2009	56,582,784.94	14,194.01	56,582,784.94	14,194.01
2010	61,212,572.89	15,580.14	61,212,572.89	15,580.14
2011	64,717,139.32	16,163.11	64,717,139.32	16,163.11
2012	71,890,505.64	17,039.99	71,890,505.64	17,039.99
2013	73,087,659.74	17,776.22	76,714,703.04	17,776.22
2014	78,073,454.91	18,317.96	79,783,291.17	18,317.96
2015	86,404,738.92	18,870.58	86,404,738.92	18,870.58

BOHECO II used the *normalized data* with the per component forecasting method and directly forecasting method.

In accordance with the forecasting methodology presented in Section 3.1, BOHECO II applied a combined approach where the forecasted system energy is allocated based on the forecast of each feeders.

2. System Energy Sales Forecast

Equation 5.5 BOHECO II System Energy Sales Forecast.

$$\boldsymbol{System\ Energy\ Sales = at + b}$$

Table 5-10 and Table 5-11 below show the parameters/criteria being considered.

Table 5-10 System Energy Forecasting Criteria and Intercepts

Intercepts		P Value	t Statistic
Coefficient	Value	< 0.1	< -2, >2
a	4,950,173.65	0.00000144	26.47145
b	51,242,981.96	0.00000002	61.27407

Table 5-11 System Energy Forecast Validity Test Parameters and Result

Test Parameters	MAPE	r^2	r^2adj	Growth Rate
Actual	1.01%	0.9929	0.9915	3.41%
Requisite	≤ 3%	>0.99	>0.99	Reasonable

3. System Energy Purchased Forecast

The power supply plan is referenced to the total purchased energy and demand per distribution utility. In BOHECO II Forecasts, the system energy purchased is derived through Equation 5.6 below.

Equation 5.6 BOHECO II System Energy Purchased Forecast

$$\boldsymbol{System\ Energy_{Purchased}} = \boldsymbol{System\ Energy_{Sales}} \times (\mathbf{1} + \boldsymbol{Sytems\ Loss\ Cap})$$

Where;

$$System\ Energy_{Sales} = Forecasted\ Energy\ Sales$$

$$Sytems\ Loss\ Cap = Average\ Forecasted\ Systems\ Loss$$

4. System Purchased Demand Forecast (kW)

The forecasted system demand (in kW) was derived in a global approach as shown in Equation 5.7 below. It is the quotient of the forecasted energy to the product of the Load Factor and the total number of hours in a year which is 8,760 Hrs.

Equation 5.7 BOHECO II System Purchased Demand Forecast

$$\boldsymbol{Purchased\ Demand_{system}} = \frac{\boldsymbol{System\ Energy_{Purchased}}}{Load\ Factor_{System} \times 8760}$$

Where;

$$Load\ Factor_{System} = is\ the\ average\ system\ load\ factor, 2015\ (0.58)$$

A constant load factor is considered in the above equation throughout the next thirty (30) years. It is presumed to be constant based on its historical trend for the past years.

Table 5-12 BOHECO II Forecasted Purchased Energy and Demand

YEAR	Energy (kWh)	Demand (kW)	YEAR	Energy (kWh)	Demand (kW)
2015	86,404,739	20,332			
2016	90,844,371	21,860	2031	165,096,976	39,102
2017	95,794,545	22,671	2032	170,047,150	40,285
2018	100,744,718	23,838	2033	174,997,323	41,469
2019	105,694,892	25,005	2034	179,947,497	42,654
2020	110,645,066	26,173	2035	184,897,671	43,841
2021	115,595,239	27,343	2036	189,847,844	45,029
2022	120,545,413	28,513	2037	194,798,018	46,219
2023	125,495,587	29,685	2038	199,748,191	47,410
2024	130,445,760	30,858	2039	204,698,365	48,602
2025	135,395,934	32,032	2040	209,648,539	49,796
2026	140,346,108	33,207	2041	214,598,712	50,991
2027	145,296,281	34,383	2042	219,548,886	52,188
2028	150,246,455	35,561	2043	224,499,060	53,386
2029	155,196,629	36,740	2044	229,449,233	54,586
2030	160,146,802	37,920	2045	234,399,407	55,786

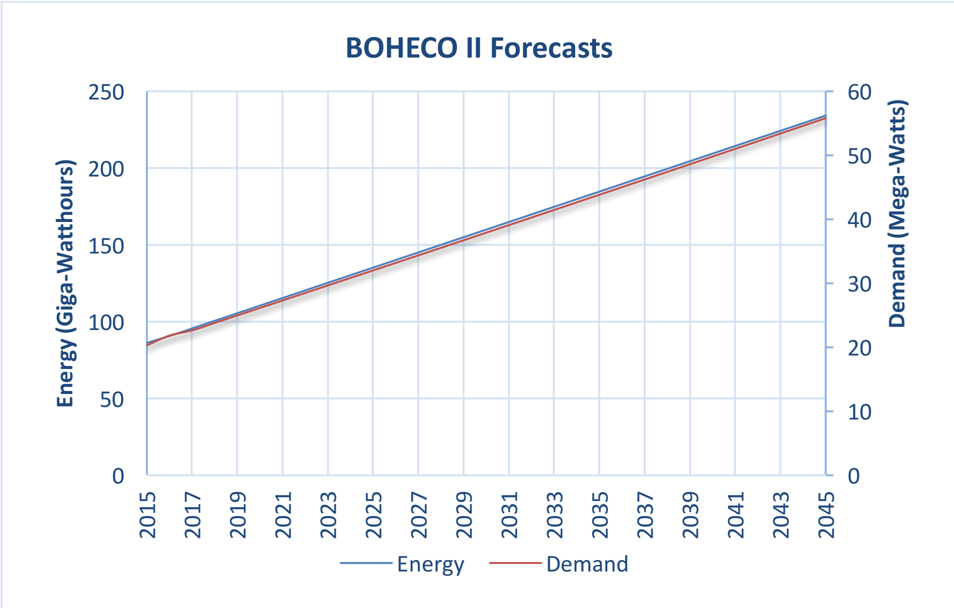


Figure 5-2. BOHECO II Energy Sales and Demand Forecast.

A-3 Bohol Light Company, Inc. (BLCI)

1. Actual and Normalized Historical Data

BLCI has a compact distribution system and feeder reconfigurations are done from time to time to ensure reliability and efficiency of the system as feeder loads varies or when there are activities in the distribution system. To attain higher forecasting accuracy BLCI will be using the System Energy and Peak Demand historical data in forecasting instead of using the per component (or per feeder) approach. The historical data that BLCI used was from the years CY 2007 to CY 2013 only as historical data trend was abnormal when Bohol was heavily affected by the Earthquake last October 15, 2013 and typhoon Yolanda on November 8, 2013 that left Bohol with no power for almost a month. The data for the month of October, November and December in 2013 were normalized based on historical data trends. A simple Linear Regression Analysis was used to obtain the normalized data as presented below.

Table 5-13 BLCI Historical Data (Energy Purchased and Demand)

Year	Actual		Normalized		
	Energy (kWh)	Demand (kW)	Energy (kWh)	Demand (kW)	Load Factor (%)
2007	83,819,488	16,300	83,819,488	16,300	58.70
2008	88,355,832	16,800	88,355,832	16,800	60.04
2009	94,821,720	18,641	94,821,720	18,641	58.07

2010	99,284,484	19,853	99,284,484	19,853	57.09
2011	102,581,940	20,724	102,581,940	20,724	56.51
2012	106,746,432	22,029	106,746,432	22,029	55.32
2013	102,861,869	21,692	109,831,870	21,692	57.80

2. System Energy Demand Forecast

Equation 5.8 System Energy Mathematical Model.

$$Energy\ Sales_{system} = a(\ln t)^2 + b(lnt) + c$$

Table 5-15 and Table 5-16 below show the parameters/criteria being considered.

Table 5-14 System Energy Forecasting Criteria and Intercepts

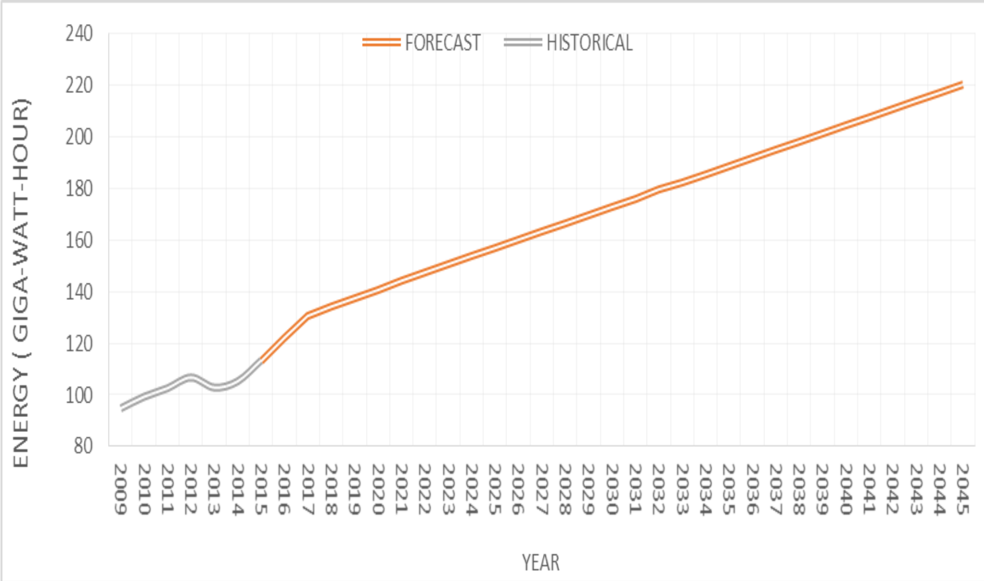
Intercepts		P Value	t Statistic
Coefficient	Value	< 0.1	< -2, >2
a	10,547,031	0.053604264	2.71
b	2,979,803	0.005127496	5.56
c	80,422,521	2.52892E-08	124.10

Table 5-15 System Energy Forecast Validity Test Parameters and Result

Test Parameters	MAPE	r^2	r^2adj	Growth Rate
Actual	0.51%	0.9965	0.9946	2.97%
Requisite	≤ 3%	>0.99	>0.99	Reasonable

The historical data used in forecasting the system energy were based on the annual registered energy in the BLCI NGCP metering.

Figure 5-3 Historical and Forecasted and Adjusted System Demand Forecast (GWh)



3. System Demand Forecast (kW)

The forecasted system demand (in kW) was derived in a global approach as shown in Equation below. It is the quotient of the forecasted energy to the product of the Load Factor and the total number of hours in a year which is 8,760 Hrs.

Equation 5.9 System Demand Forecasting Mathematical Model:

$$\boldsymbol{Purchased\ Demand}_{system} = \frac{\boldsymbol{System\ Energy}_{Purchased}}{Load\ Factor_{System} \times 8760}$$

Where;

$$Load\ Factor_{System} = is\ the\ average\ system\ load\ factor, 2015$$

Figure 5-4 *BLCI System Demand Forecast*

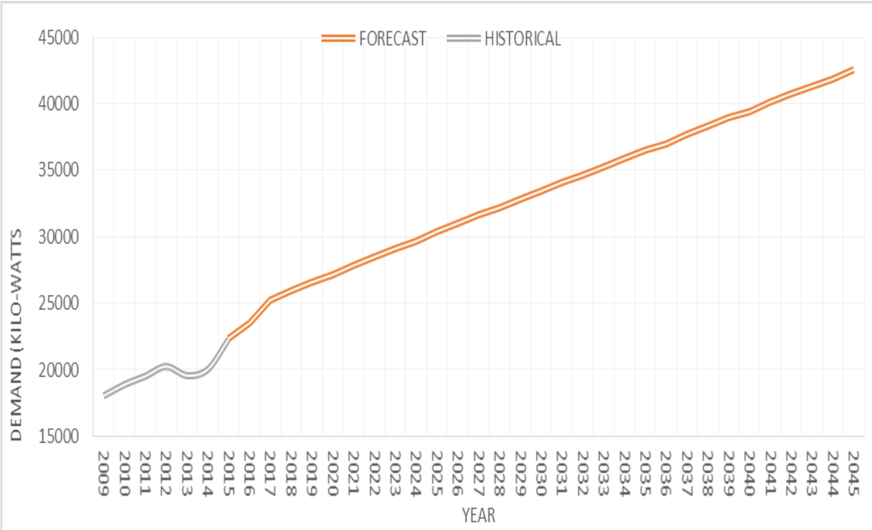


Table 5-16 BLCI Forecasted Energy and Demand

YEAR	Energy (kWh)	Demand (kW)	*YEAR*	Energy (kWh)	Demand (kW)
2015	2015	113,321,797	22,304		
2016	2016	122,063,217	23,553	2031	178,706,401
2017	2017	130,644,450	25,278	2032	181,890,634
2018	2018	136,607,009	26,431	2033	185,018,527
2019	2019	139,953,449	27,079	2034	188,164,912
2020	2020	143,297,484	27,650	2035	191,305,451
2021	2021	146,568,530	28,359	2036	194,465,320
2022	2022	149,843,952	28,992	2037	197,570,537
2023	2023	153,101,447	29,623	2038	200,695,765
2024	2024	156,367,844	30,172	2039	203,816,518
2025	2025	159,570,523	30,874	2040	206,957,842
2026	2026	162,785,275	31,496	2041	210,045,643
2027	2027	165,988,562	32,116	2042	213,154,482
2028	2028	169,206,230	32,649	2043	216,259,786
2029	2029	172,364,865	33,350	2044	219,386,523
2030	2030	175,539,612	33,964	2045	222,460,527

A-4 Summary of Energy and Demand Forecasts per DU

Table 5-17. Summary of Energy and Demand Forecasts per DU.

YEAR	FORECASTED ENERGY (2015 Base Year)				FORECASTED DEMAND (2015 Base Year)			
	BOHECO-I	BOHECO-II	BLCI	TOTAL	BOHECO-I	BOHECO-II	BLCI	TOTAL
2015	144,933,885	86,404,739	113,321,797	**344,660,421**	28,227	20,332	22,304	**70,864**
2016	152,959,068	90,844,371	122,063,217	**365,866,656**	32,278	21,860	23,553	**77,691**
2017	161,275,665	95,794,545	130,644,450	**387,714,659**	34,023	22,671	25,278	**81,973**
2018	169,603,954	100,744,718	136,607,009	**406,955,682**	35,771	23,838	26,431	**86,040**
2019	177,906,817	105,694,892	139,953,449	**423,555,158**	37,513	25,005	27,079	**89,597**
2020	186,159,009	110,645,066	143,297,484	**440,101,559**	39,245	26,173	27,650	**93,069**
2021	194,343,389	115,595,239	146,568,530	**456,507,158**	40,963	27,343	28,359	**96,665**
2022	202,448,427	120,545,413	149,843,952	**472,837,792**	42,664	28,513	28,992	**100,169**
2023	210,466,527	125,495,587	153,101,447	**489,063,560**	44,346	29,685	29,623	**103,654**
2024	218,392,881	130,445,760	156,367,844	**505,206,486**	46,010	30,858	30,172	**107,039**
2025	226,224,676	135,395,934	159,570,523	**521,191,132**	47,653	32,032	30,874	**110,559**
2026	234,597,786	140,346,108	162,785,275	**537,729,169**	49,277	33,207	31,496	**113,980**
2027	241,600,101	145,296,281	165,988,562	**552,884,944**	50,881	34,383	32,116	**117,380**
2028	249,143,788	150,246,455	169,206,230	**568,596,473**	52,464	35,561	32,649	**120,674**
2029	256,592,529	155,196,629	172,364,865	**584,154,022**	54,028	36,740	33,350	**124,118**
2030	263,947,646	160,146,802	175,539,612	**599,634,060**	55,573	37,920	33,964	**127,457**
2031	271,210,728	165,096,976	178,706,401	**615,014,104**	57,098	39,102	34,577	**130,777**
2032	278,383,550	170,047,150	181,890,634	**630,321,334**	58,606	40,285	35,097	**133,987**
2033	285,468,009	174,997,323	185,018,527	**645,483,859**	60,094	41,469	35,798	**137,361**
2034	292,466,074	179,947,497	188,164,912	**660,578,483**	61,566	42,654	36,407	**140,627**
2035	299,379,756	184,897,671	191,305,451	**675,582,878**	63,020	43,841	37,014	**143,875**
2036	306,211,077	189,847,844	194,465,320	**690,524,241**	64,457	45,029	37,523	**147,009**
2037	312,962,052	194,798,018	197,570,537	**705,330,607**	65,878	46,219	38,227	**150,324**
2038	319,634,674	199,748,191	200,695,765	**720,078,630**	67,283	47,410	38,831	**153,524**
2039	326,230,904	204,698,365	203,816,518	**734,745,787**	68,672	48,602	39,435	**156,710**
2040	332,752,665	209,648,539	206,957,842	**749,359,046**	70,047	49,796	39,934	**159,777**
2041	339,215,640	214,598,712	210,045,643	**763,859,996**	71,407	50,991	40,640	**163,039**
2042	345,594,295	219,548,886	213,154,482	**778,297,663**	72,753	52,188	41,242	**166,183**
2043	351,903,959	224,499,060	216,259,786	**792,662,805**	74,085	53,386	41,843	**169,315**
2044	358,146,357	229,449,233	219,386,523	**806,982,114**	75,405	54,586	42,332	**172,322**
2045	364,323,160	234,399,407	222,460,527	**821,183,094**	76,711	55,786	43,042	**175,539**

Annex B Generation Cost Data and Screening Curves per Distribution Utility

B-1 Power Generation Plant Data

Table 5-18 below shows the typical Plant Data used in the development of Screening Curves and calculation of generation cost given the capacity factor.

Table 5-18 Power Generation Plant Data

PLANT TYPE	*UNIT*	COAL	Bunker-C Diesel	Hydro
Plant Capacity	*MW*	246	5	2.5
Plant Cost	*US$/kW*	2,500	1,207	3,000
Heat Rate	*BTU/kWh*	13,000	0	0
Fixed O&M	*US$/kW-yr*	60.164	135.767	34.610
Variable O&M	*US$/MWh*	7.376	0.019	1.225
Fuel Cost	*US$/MMBTU*	2.432	0.833	0.000
Fuel Escalation	*p.a.*	1.0%	3.0%	
Discount Rate	*p.a.*	11.0%	11.0%	11.0%
Levelizing Period	*years*	25	25	25
FOREX	*PHP/US$*	45	45	45
Annuity Factor		8.4217	8.4217	8.4217
PWF with Inflation		9.0560	10.5735	7.9633
Fuel Cost	*US$/kWh*	0.031616	0.1917	0

B-2 Generation Cost Equations

With the data shown in Table 5-18 above, Equations 5.10 to 5.17 below are used to compute for the different costs associated in the formulation of Generation Cost Screening Curve, particularly in the price of Generation.

Equation 5.10 Annual Investment Cost

$$Investment\ Cost^{yr} = \frac{1}{AF} \times Capacity \times Cost_{Plant} \times 1000$$

Equation 5.11 Annual Fixed O&M Cost

$$FOM\ Cost^{yr} = Capacity \times Cost_{FOM} \times 1000 \times (1 + VAT)$$

Equation 5.12 Annual Variable O&M Cost

$$VOM\ Cost^{yr} = Cost_{VOM} \times \frac{Energy^{yr}}{1000} \times (1 + VAT)$$

Equation 5.13 Annual Fuel Cost

$$FUEL\ Cost^{yr} = Energy^{yr} \times Cost_{Fuel} \times \frac{PWF_{inflation}}{AF_{no\_inflation}} \times (1 + VAT)$$

Equation 5.14 Total Annual Fixed O&M Costs

$$Total\ Fixed\ Cost^{yr}(US\$) = Investment\ Cost^{yr} + FOM\ Cost^{yr}$$

Equation 5.15 Total Annual Variable Costs

$$Total\ Variable\ Cost^{yr}(US\$) = VOM\ Cost^{yr} + FUEL\ Cost^{yr}$$

Equation 5.16 Total Annual Generation Costs

$$Total\ Cost^{yr}(US\$) = Total\ Fixed\ Cost^{yr} + Total\ Variable\ Cost^{yr}$$

Equation 5.17 Price of Generation

$$Price = \frac{Total\ Cost^{yr}}{Energy^{yr}} \times FOREX$$

Where;

$$Capacity = Rated\ Plant\ Capacity\ (MW)$$

$$Cost_{Plant} = Plant\ Cost\ Installation \left(\frac{US\$}{MW}\right)$$

$$Cost_{FOM} = Fixed\ Operation\ and\ Maintenance\ Cost \left(\frac{US\$}{kW}\right)$$

$$Cost_{VOM} = Variable\ Operation\ and\ Maintenance\ Cost \left(\frac{US\$}{MWh}\right)$$

$$AF = Annuity\ Factor\ for\ a\ Levelizing\ Period\ of\ 25 years$$

$$Energy^{yr} = 8760 \times Capacity \times 1000 \times CF, (kWh)$$

$$PWF_{inflation} = Present\ Worth\ Factor\ with\ Inflation\ Rate\ Considered$$

$$Cost_{Fuel} = Fuel\ Cost\ per\ Unit\ (i.e. Liter, MMBTU, etc \ldots)$$

$$FOREX = {}^{PhP}/_{US\$}$$

B-3 BASE GENERATION PRICE PER PLANT TYPE (PhP/kWh)

With the data power generation plant data and generation cost equations presented, Table 5-19 below shows the generation price per plant type per kWh. This data will be used in the formulation of Generation Cost Screening Curve.

Table 5-19 BASE GENERATION PRICE PER PLANT TYPE (PhP/kWh)

CF(%)	COAL	BUNKER C	HYDRO	CF(%)	COAL	BUNKER C	HYDRO
1%	218.0952	154.3054	261.8209	51%	5.6402	13.7743	5.1878
2%	109.7431	82.6345	130.9380	52%	5.5585	13.7203	5.0891
3%	73.6258	58.7443	87.3104	53%	5.4799	13.6683	4.9941
4%	55.5671	46.7991	65.4966	54%	5.4041	13.6182	4.9027
5%	44.7319	39.6320	52.4083	55%	5.3312	13.5699	4.8145
6%	37.5084	34.8540	43.6828	56%	5.2608	13.5234	4.7295
7%	32.3488	31.4411	37.4502	57%	5.1929	13.4785	4.6475
8%	28.4791	28.8814	32.7759	58%	5.1274	13.4351	4.5683
9%	25.4693	26.8906	29.1402	59%	5.0640	13.3932	4.4919
10%	23.0615	25.2979	26.2317	60%	5.0028	13.3527	4.4179
11%	21.0915	23.9948	23.8520	61%	4.9436	13.3136	4.3464
12%	19.4498	22.9088	21.8690	62%	4.8863	13.2757	4.2772
13%	18.0606	21.9900	20.1910	63%	4.8308	13.2390	4.2102
14%	16.8700	21.2024	18.7527	64%	4.7771	13.2034	4.1452
15%	15.8380	20.5198	17.5062	65%	4.7250	13.1690	4.0823
16%	14.9351	19.9226	16.4155	66%	4.6745	13.1355	4.0213
17%	14.1384	19.3956	15.4531	67%	4.6255	13.1031	3.9621
18%	13.4302	18.9271	14.5977	68%	4.5779	13.0717	3.9046
19%	12.7966	18.5080	13.8323	69%	4.5317	13.0411	3.8488
20%	12.2263	18.1308	13.1434	70%	4.4869	13.0114	3.7947
21%	11.7103	17.7895	12.5202	71%	4.4433	12.9826	3.7420
22%	11.2413	17.4792	11.9536	72%	4.4009	12.9546	3.6908
23%	10.8130	17.1959	11.4363	73%	4.3596	12.9273	3.6410
24%	10.4204	16.9363	10.9620	74%	4.3195	12.9007	3.5925
25%	10.0593	16.6974	10.5258	75%	4.2805	12.8749	3.5454
26%	9.7259	16.4768	10.1231	76%	4.2425	12.8498	3.4994
27%	9.4172	16.2727	9.7502	77%	4.2054	12.8253	3.4547
28%	9.1305	16.0830	9.4039	78%	4.1694	12.8014	3.4111
29%	8.8637	15.9065	9.0815	79%	4.1342	12.7782	3.3686
30%	8.6146	15.7418	8.7807	80%	4.0999	12.7555	3.3272
31%	8.3816	15.5876	8.4992	81%	4.0665	12.7334	3.2868
32%	8.1631	15.4431	8.2353	82%	4.0338	12.7118	3.2474
33%	7.9579	15.3074	7.9874	83%	4.0020	12.6907	3.2089
34%	7.7647	15.1796	7.7541	84%	3.9709	12.6701	3.1714
35%	7.5826	15.0592	7.5342	85%	3.9406	12.6501	3.1347
36%	7.4107	14.9454	7.3264	86%	3.9109	12.6305	3.0989
37%	7.2480	14.8378	7.1299	87%	3.8819	12.6113	3.0639
38%	7.0938	14.7358	6.9437	88%	3.8536	12.5926	3.0298
39%	6.9476	14.6391	6.7671	89%	3.8260	12.5743	2.9963
40%	6.8087	14.5472	6.5993	90%	3.7989	12.5564	2.9637
41%	6.6766	14.4598	6.4397	91%	3.7725	12.5389	2.9317
42%	6.5507	14.3766	6.2877	92%	3.7466	12.5218	2.9004

43%	6.4307	14.2972	6.1427	***93%***	3.7212	12.5050	2.8698
44%	6.3162	14.2215	6.0044	***94%***	3.6965	12.4886	2.8399
45%	6.2067	14.1491	5.8722	***95%***	3.6722	12.4726	2.8106
46%	6.1021	14.0798	5.7457	***96%***	3.6484	12.4568	2.7819
47%	6.0018	14.0135	5.6246	***97%***	3.6252	12.4414	2.7538
48%	5.9058	13.9500	5.5086	***98%***	3.6024	12.4264	2.7262
49%	5.8136	13.8890	5.3973	***99%***	3.5800	12.4116	2.6992
50%	5.7252	13.8305	5.2905	***100%***	3.5581	12.3971	2.6728

B-4 24-Hour Load Curve Per Distribution Utility

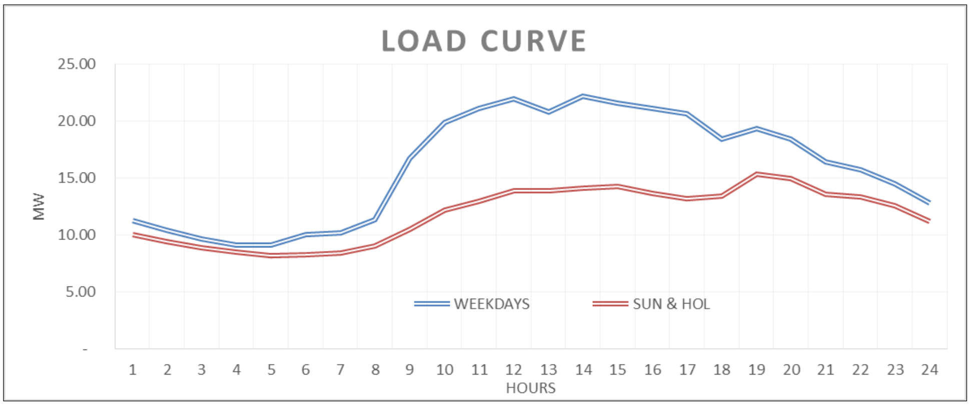


Figure 5-5 BLCI 24-Hour Average Load Profile

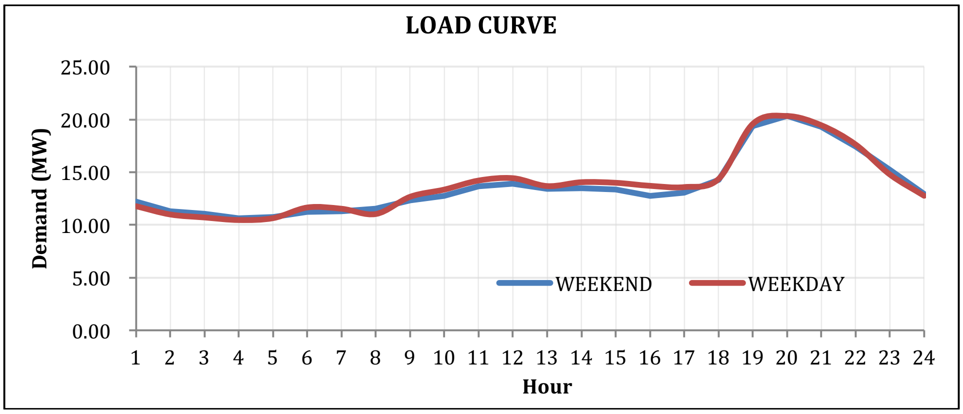


Figure 5-6 BOHECO-I 24-Hour Load Profile

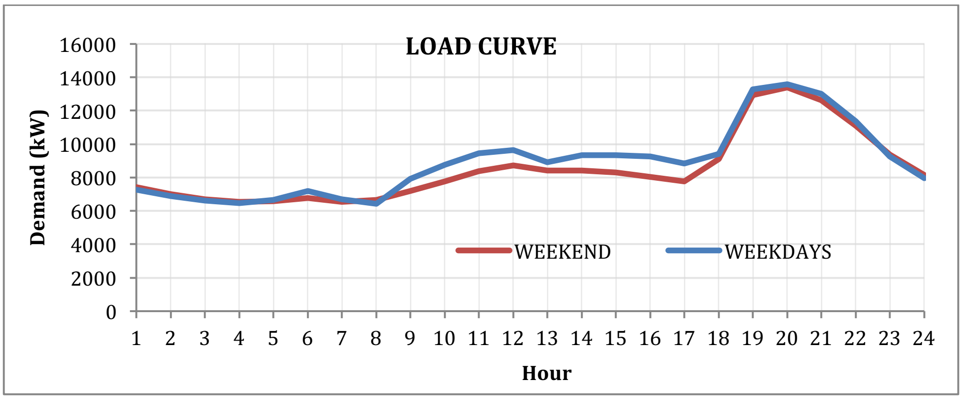
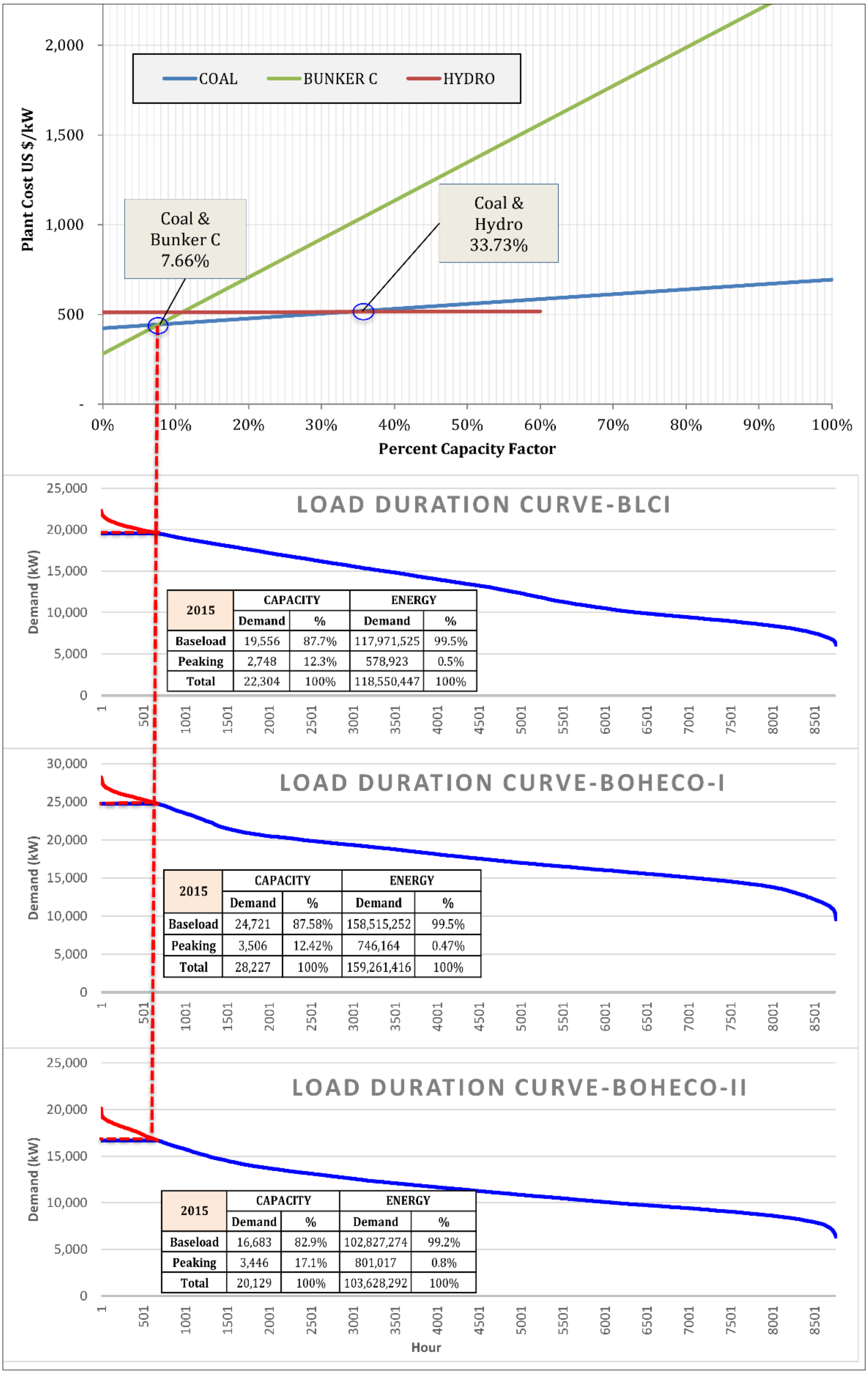


Figure 5-7 BOHECO-II 24-Hour Load Profile

B-5 Generation Screening Curves per Distribution Utility

Figure 5-8 Generation Cost Screening Curve- PER Distribution Utility



LOAD DURATION CURVE-BLCI

2015	CAPACITY		ENERGY	
	Demand	%	Demand	%
Baseload	19,556	87.7%	117,971,525	99.5%
Peaking	2,748	12.3%	578,923	0.5%
Total	22,304	100%	118,550,447	100%

LOAD DURATION CURVE-BOHECO-I

2015	CAPACITY		ENERGY	
	Demand	%	Demand	%
Baseload	24,721	87.58%	158,515,252	99.5%
Peaking	3,506	12.42%	746,164	0.47%
Total	28,227	100%	159,261,416	100%

LOAD DURATION CURVE-BOHECO-II

2015	CAPACITY		ENERGY	
	Demand	%	Demand	%
Baseload	16,683	82.9%	102,827,274	99.2%
Peaking	3,446	17.1%	801,017	0.8%
Total	20,129	100%	103,628,292	100%

Annex C Forecasted Baseload and Peaking Demand per Distribution Utility

	BOHOL	BOHECO-I	BOHECO-II	BLCI
Baseload	**84.49%**	87.58%	82.88%	87.68%
Peaking	**15.5%**	12.4%	17.1%	12.3%

YEAR	BASELOAD (kW)				PEAKING (kW)			
	BOHECO-I	BOHECO-II	BLCI	**TOTAL**	BOHECO-I	BOHECO-II	BLCI	**TOTAL**
2015	24,721	16,852	19,556	**61,130**	3,506	3,480	2,748	**9,734**
2016	28,269	18,118	20,652	**67,038**	4,009	3,742	2,901	**10,653**
2017	29,797	18,790	22,164	**70,752**	4,226	3,881	3,114	**11,221**
2018	31,328	19,757	23,175	**74,260**	4,443	4,080	3,256	**11,780**
2019	32,854	20,725	23,743	**77,322**	4,660	4,280	3,336	**12,276**
2020	34,371	21,693	24,244	**80,307**	4,875	4,480	3,406	**12,761**
2021	35,875	22,662	24,865	**83,402**	5,088	4,680	3,494	**13,262**
2022	37,364	23,632	25,420	**86,417**	5,299	4,881	3,572	**13,752**
2023	38,838	24,604	25,974	**89,415**	5,508	5,081	3,649	**14,239**
2024	40,295	25,576	26,455	**92,325**	5,715	5,282	3,717	**14,714**
2025	41,734	26,549	27,071	**95,353**	5,919	5,483	3,803	**15,206**
2026	43,156	27,523	27,616	**98,295**	6,121	5,684	3,880	**15,685**
2027	44,561	28,498	28,160	**101,218**	6,320	5,886	3,956	**16,162**
2028	45,948	29,474	28,627	**104,048**	6,517	6,087	4,022	**16,626**
2029	47,317	30,451	29,242	**107,010**	6,711	6,289	4,108	**17,108**
2030	48,670	31,429	29,780	**109,879**	6,903	6,491	4,184	**17,578**
2031	50,006	32,408	30,317	**112,732**	7,092	6,693	4,260	**18,045**
2032	51,326	33,389	30,773	**115,488**	7,280	6,896	4,324	**18,499**
2033	52,630	34,370	31,388	**118,388**	7,464	7,099	4,410	**18,973**
2034	53,918	35,353	31,922	**121,193**	7,647	7,301	4,485	**19,434**
2035	55,192	36,337	32,454	**123,982**	7,828	7,505	4,560	**19,892**
2036	56,450	37,321	32,901	**126,672**	8,006	7,708	4,622	**20,337**
2037	57,695	38,307	33,518	**129,520**	8,183	7,912	4,709	**20,804**
2038	58,925	39,294	34,047	**132,267**	8,357	8,116	4,784	**21,257**
2039	60,142	40,283	34,577	**135,002**	8,530	8,320	4,858	**21,708**
2040	61,346	41,272	35,015	**137,633**	8,701	8,524	4,919	**22,144**
2041	62,537	42,263	35,634	**140,434**	8,870	8,729	5,006	**22,605**
2042	63,716	43,255	36,161	**143,132**	9,037	8,933	5,081	**23,051**
2043	64,883	44,248	36,688	**145,819**	9,202	9,139	5,155	**23,496**
2044	66,038	45,242	37,117	**148,397**	9,366	9,344	5,215	**23,925**
2045	67,182	46,237	37,740	**151,159**	9,528	9,549	5,302	**24,380**

Annex D Contracted Baseload and Peaking Demand per Distribution Utility

YEAR	BOHECO-I			BOHECO-II			BLCI			BOHOL		
	Base	Peaking	ST&MT	Base	Peaking	ST&MT	Base	Peaking	ST&MT	Base	Peaking	ST&MT
2015	17.4	0.0	0.0	22.8	0.0	0.0	23.0	0.0	0.0	63.2	0.0	0.0
2016	17.4	0.0	5.0	10.0	0.0	6.0	6.0	0.0	11.0	33.4	0.0	22.0
2017	17.4	0.0	6.0	10.0	0.0	7.0	6.0	0.0	11.0	33.4	0.0	24.0
2018	17.4	0.0	8.0	10.0	0.0	8.0	6.0	0.0	11.0	33.4	0.0	27.0
2019	17.4	0.0	12.0	10.0	0.0	12.0	6.0	0.0	11.0	33.4	0.0	35.0
2020	17.4	0.0	12.0	10.0	0.0	12.0	6.0	0.0	11.0	33.4	0.0	35.0
2021	17.4	0.0	12.0	10.0	0.0	12.0	6.0	0.0	11.0	33.4	0.0	35.0
2022	17.4	0.0	12.0	10.0	0.0	12.0	6.0	0.0		33.4	0.0	24.0
2023	17.4	0.0	12.0	10.0	0.0	12.0	6.0	0.0		33.4	0.0	24.0
2024	17.4	0.0		0.0	0.0		0.0	0.0		17.4	0.0	0.0
2025	16.6	0.0		0.0	0.0		0.0	0.0		16.6	0.0	0.0
2026	16.6	0.0		0.0	0.0		0.0	0.0		16.6	0.0	0.0
2027	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0
2028	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0
2029	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0
2030	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0
2031	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0
2032	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0
2033	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0
2034	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0
2035	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0
2036	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0
2037	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0
2038	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0
2039	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0
2040	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0
2041	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0
2042	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0
2043	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0
2044	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0
2045	2.6	0.0		0.0	0.0		0.0	0.0		2.6	0.0	0.0

Annex E Uncontracted Baseload and Peaking Demand per Distribution Utility

YEAR	BOHECO-I		BOHECO-II		BLCI		BOHOL	
	Base	Peaking	Base	Peaking	Base	Peaking	Base	Peaking
2015	7.3	3.5	0.0	3.5	0.0	2.7	7.3	9.7
2016	10.9	4.0	8.1	3.7	14.7	2.9	33.6	10.7
2017	12.4	4.2	8.8	3.9	16.2	3.1	37.4	11.2
2018	13.9	4.4	9.8	4.1	17.2	3.3	40.9	11.8
2019	15.5	4.7	10.7	4.3	17.7	3.3	43.9	12.3
2020	17.0	4.9	11.7	4.5	18.2	3.4	46.9	12.8
2021	18.5	5.1	12.7	4.7	18.9	3.5	50.0	13.3
2022	20.0	5.3	13.6	4.9	19.4	3.6	53.0	13.8
2023	21.4	5.5	14.6	5.1	20.0	3.6	56.0	14.2
2024	22.9	5.7	25.6	5.3	26.5	3.7	74.9	14.7
2025	25.1	5.9	26.5	5.5	27.1	3.8	78.8	15.2
2026	26.6	6.1	27.5	5.7	27.6	3.9	81.7	15.7
2027	42.0	6.3	28.5	5.9	28.2	4.0	98.6	16.2
2028	43.3	6.5	29.5	6.1	28.6	4.0	101.4	16.6
2029	44.7	6.7	30.5	6.3	29.2	4.1	104.4	17.1
2030	46.1	6.9	31.4	6.5	29.8	4.2	107.3	17.6
2031	47.4	7.1	32.4	6.7	30.3	4.3	110.1	18.0
2032	48.7	7.3	33.4	6.9	30.8	4.3	112.9	18.5
2033	50.0	7.5	34.4	7.1	31.4	4.4	115.8	19.0
2034	51.3	7.6	35.4	7.3	31.9	4.5	118.6	19.4
2035	52.6	7.8	36.3	7.5	32.5	4.6	121.4	19.9
2036	53.9	8.0	37.3	7.7	32.9	4.6	124.1	20.3
2037	55.1	8.2	38.3	7.9	33.5	4.7	126.9	20.8
2038	56.3	8.4	39.3	8.1	34.0	4.8	129.7	21.3
2039	57.5	8.5	40.3	8.3	34.6	4.9	132.4	21.7
2040	58.7	8.7	41.3	8.5	35.0	4.9	135.0	22.1
2041	59.9	8.9	42.3	8.7	35.6	5.0	137.8	22.6
2042	61.1	9.0	43.3	8.9	36.2	5.1	140.5	23.1
2043	62.3	9.2	44.2	9.1	36.7	5.2	143.2	23.5
2044	63.4	9.4	45.2	9.3	37.1	5.2	145.8	23.9
2045	64.6	9.5	46.2	9.5	37.7	5.3	148.6	24.4