Bohol Light Company, Inc.
Distribution Development Plan
(2016-2025)

Prepare by:

Technical Working Group
Bohol Light Company, Inc.

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1. INTRODUCTION

1.1. Historical Background

Power is considered a vital component to the economic growth of every society. It intrinsically integrates various factors that contribute progress in a locality transcending even beyond boundaries contributing to the attainment of the national goals. Conscious of these needs and the awareness to perform its sworn duties and responsibilities, the Provincial Government of Bohol (PGBh), which then operated and maintained the Provincial Electric System (PES) providing electricity to the few barangays of the City of Tagbilaran, issued an Invitation to Pre-qualify and Bid for the rehabilitation, ownership, operation, maintenance and management of the Provincial Electric System (PES) through a Rehabilitate-Own-Operate-Maintain and Manage Scheme (ROOMM) in December, 1999.

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 Tagbilaran City 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, on August 28, 2000, BLCI acquired the rights, interest, assets and equipment of the Consortium composed of SII, SPC and other members of the Joint Venture Agreement (JVA).

1.2. Corporate Profile

Bohol Light Company, Inc. (BLCI) was organized and registered with the Securities and Exchange Commission last July 21, 2000. It is 70% privately owned and 30% owned by the Provincial Government of Bohol (PGBh). Its business address catering to consumers is at R. Enerio St., Poblacion 3, Tagbilaran City, Bohol, while its President, the Chairman of the

Board of Directors and other corporate officials hold their respective offices at the 7th Floor, Citibank Center, 8741 Paseo de Roxas, Makati City, Philippines.

BLCI was awarded the Certificate of Public Convenience and Necessity by the Energy Regulatory Commission (ERC), the government regulating body of the Philippines under RA No 9136, for the construction, installation, operation and maintenance of an electric service in the City of Tagbilaran valid from June 12, 1996 to June 12, 2021 subject to the rules and regulations issued by the Commission in accordance with law. BLCI was also granted by the National Electrification Commission (NEC) the Certificate of Franchise with the authority to operate light and power services for a period of twenty-five (25) years valid until 19 October 2025.

The company has seven (7) Board of Directors, two of which are from the Provincial Government of Bohol namely:

Mr. Alfredo L. Henares	Chairman
Mr. Dennis T. Villareal	President
Mr. Ricardo A. Galano	Member
Mr. Alberto P. Fenix	Member
Mr. Joven T. Uy	Member
Atty. David B. Tirol	Member (PGBh)
Atty. Inocentes C. Lopez	Member (PGBh)
Mr. Lim Chan Lok	Consultant

1.3. Franchise Area

The BLCI franchise area covers the whole City of Tagbilaran which consists of 15 Barangays. Tagbilaran City is a Second Class City in the Central Visayas with a total land area of 3,270.1 hectares (32.7 sq km). On the Northern boundaries are the Municipality of Cortes and Corella; on the East is the town of Baclayon; on the south is the Tagbilaran Straight; and on the west side is the Maribojoc Bay.

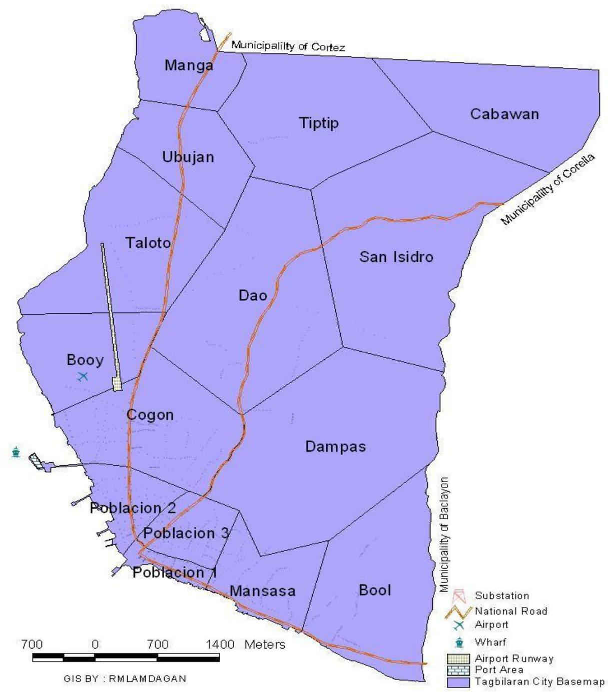


Figure 1: BLCI Franchise Area

1.4. Historical Statistics

BLCI has a total of 19,416 connected customers as of December 2015, 86% of which are residential, 13% are commercial, 0.9% are government buildings and 0.1% are hospitals/radio stations. The total sales for the year is 104,252,800 kWh, residential customers taking up 38%, commercial loads 51%, government 6% and hospitals and radio stations 4%. The peak months of Tagbilaran City usually occur from May to September, the highest of which in 2015 was in May at 22.4MW. This coincides with the fiesta month of Bohol which falls on summer. The off-peak months usually occur around January to March with the lowest in January at 19.2MW. As of CY2015, BLCI's Energy Sales were the following: Residential – 40,097 MWh; Commercial – 53,299 MWh; Public Buildings & Street Lights – 6,288 MWh and Hospital & Radio Stations – 4,569 MWh.

BLCI has two (2) substations at present with a total capacity of 35 MVA located in Dampas District and R. Enerio Street, Poblacion 3, Tagbilaran City. Its distribution system includes 1.5 km of 69kV sub-transmission lines and 13.8kV primary lines that are 3-phase at 53.77 circuit-km, 2-phase at 9.30 circuit-km, single phase at 44.35 circuit km and secondary lines at 268.65 circuit-km.

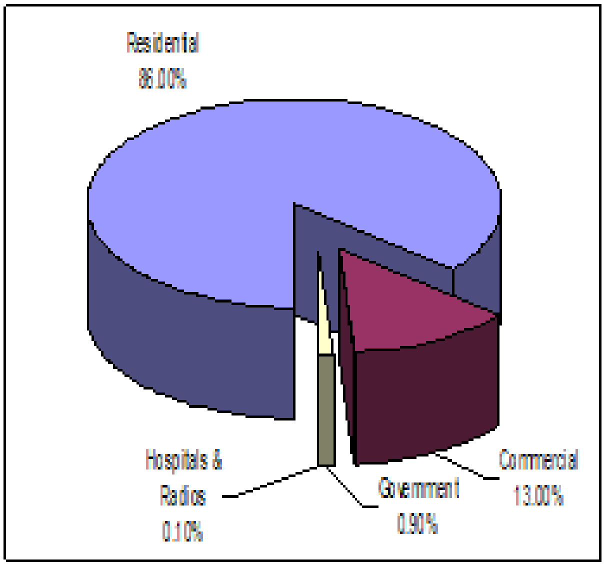


Figure 3: Connected Consumers

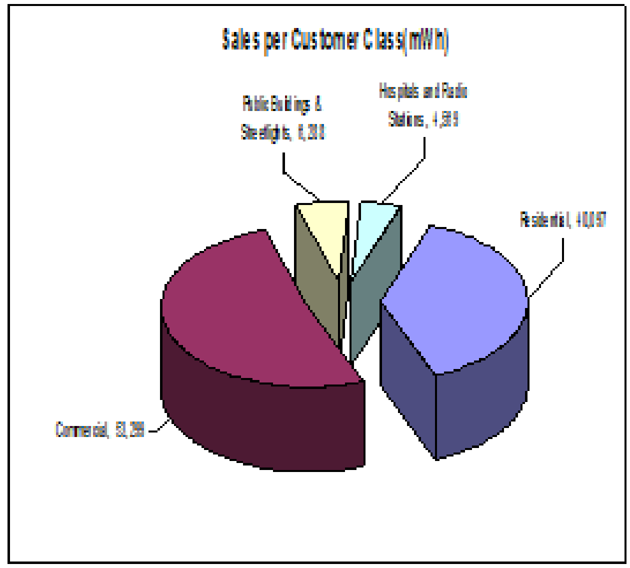


Figure 2: Sales per Customer Class

BLCI distribution system is divided into six (6) main feeders namely; Feeder-A, Feeder-B, 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 and government centers, load centers, coincident and non-coincident peak loads, flexibility of Feeders and others to ensure reliability and efficiency at the least cost.

BLCI maintains a database of its operation's historical parameters as reference in the continuous improvement of the BLCI Distribution System. Important performance data are tabulated and presented herewith in attached List of Tables (please refer to Annexes) for reference in the performance analysis. The data encompasses all available historical and forecast data of the BLCI distribution system

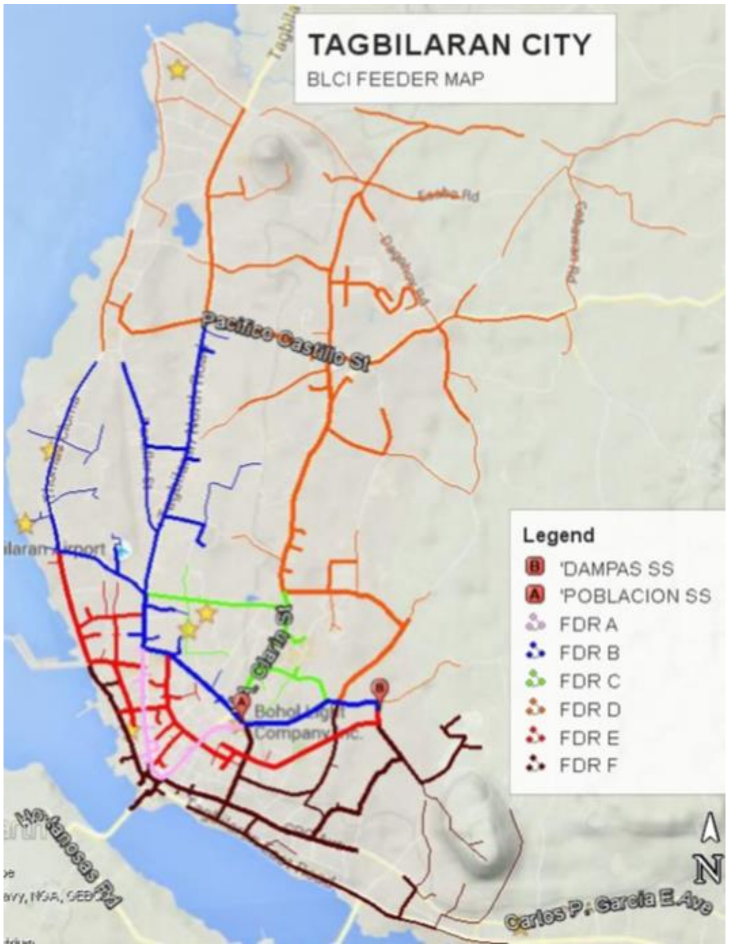


Figure 4: BLCI Distribution System

System performance analyses were conducted based on historical parameters and data were simulated using licensed Power Distribution Engineering Software and Programs. Problems and deficiencies of the distribution system facilities were identified, prioritized, categorized and proposals to address the problems were assessed if technically feasible and cost effective. The proposal also includes requirements to address the maintenance requirement of the system and various improvement measures and is simplified and presented below following the established category.

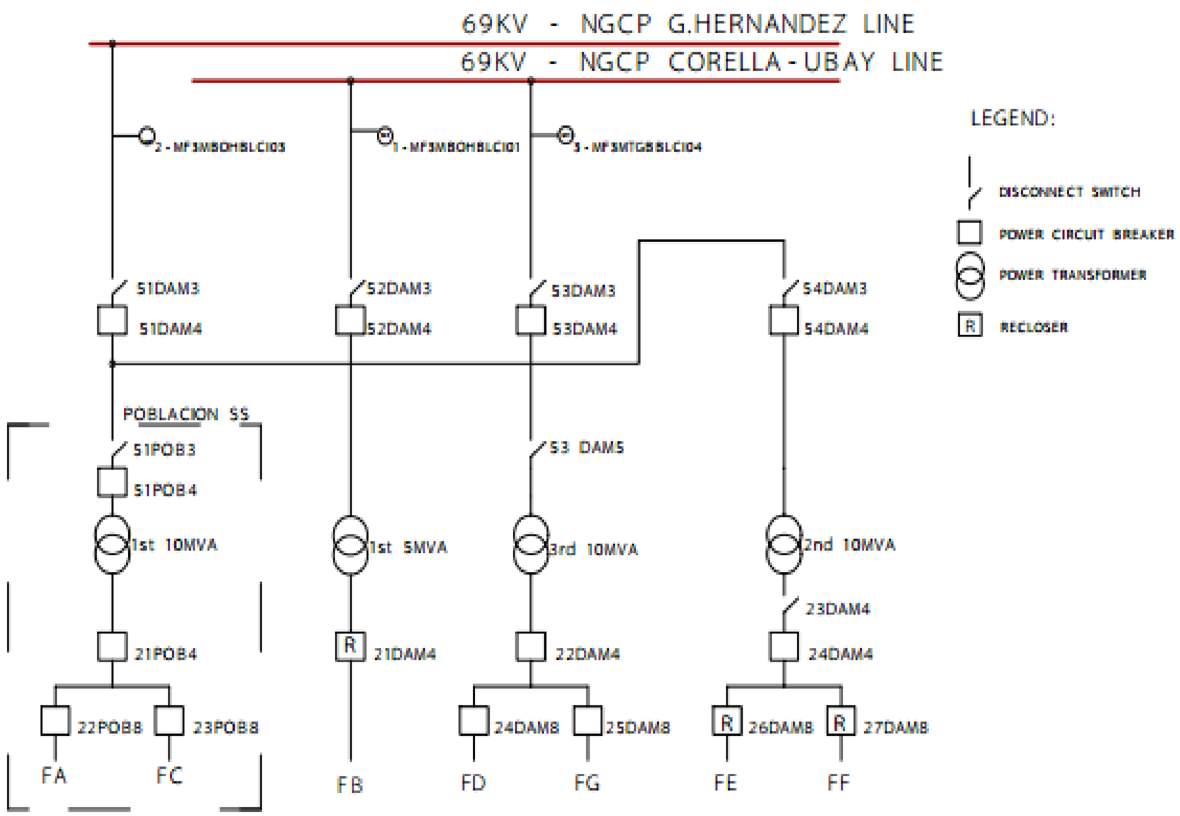


Figure 5: BLCI Distribution System Single Line Diagram

2. DISTRIBUTION DEVELOPMENT PLANNING PROCESS

This Distribution Development Planning for 2016-2020 was prepared in accordance to the mandates of RA 9136, or the Electric Power Industry Reform Act (EPIRA Law) of 2001. The Bohol Light Company, Inc., (BLCI) is a private distribution company which aims to provide adequate, efficient, reliable, least-cost and quality electric power distribution services to its consumers in compliance to all regulations.

Providing the needs with due care for consumers, society and environment while ensuring continuous quality services are the major thrusts of BLCI in its power distribution business. The CAPEX projects in this application support these aspirations. The projects are necessary in responding to the needs of the consumers and in meeting safety, performance standards, regulatory requirements, and institutional development.

The Planning process as set forth in the ECDU Planning Manual are as follows:

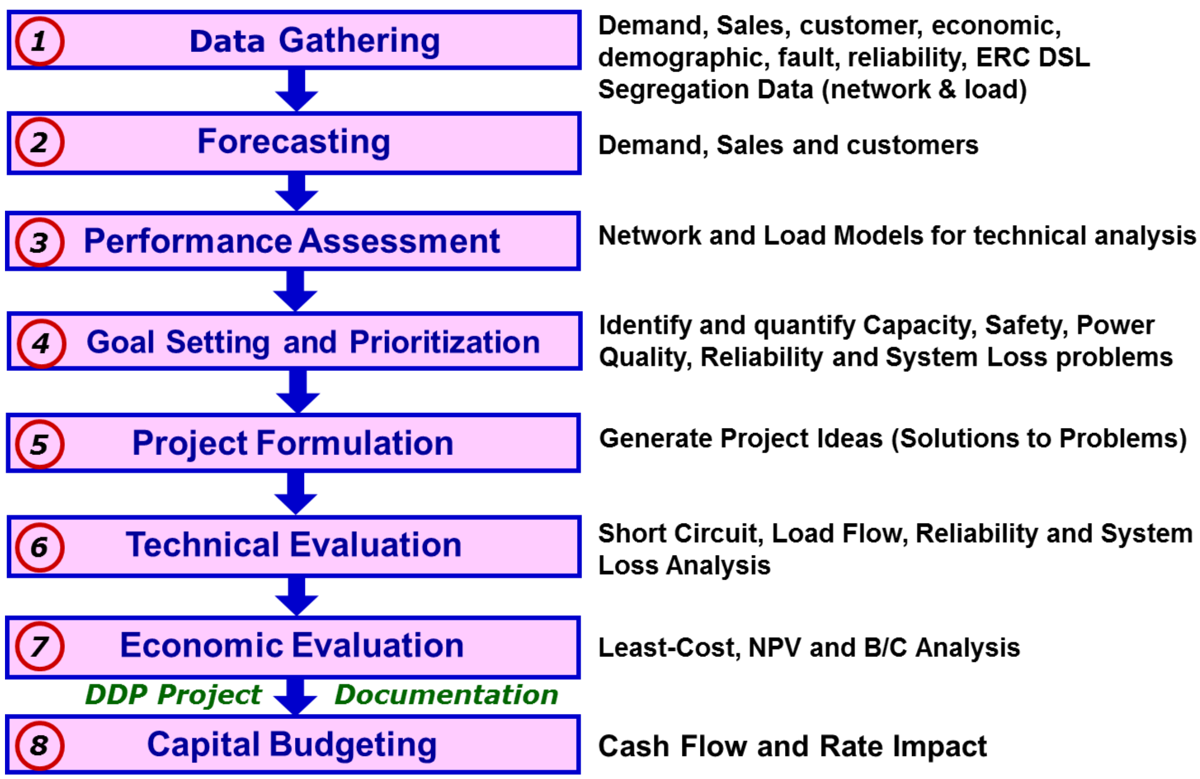


Figure 6: Distribution Planning Process Flow

In the data gathering process, actual evaluations of the distribution system were conducted and analyzed through actual physical inspection and technical operation monitoring and database. Projects were arrived at to address Capacity, Power Quality, Safety and Security, Systems Loss, and Reliability according to standards set forth in the Philippine Grid Code, Philippine Distribution Code, and Philippine Electrical Code, and in compliance with regulations and policies issued by the Energy Regulatory Commission and the Department of Energy.

The data gathered encompasses available historical and forecast data and updated as follows:

1. BLCI Customer, Demand and Sales Data
2. Distribution System Performance and Statistical Data
3. Econometric, Demographic and City Development Data (as applicable)
4. Distribution System Maps and Diagrams
5. Distribution Network and Load Data
6. Grid Connection Point Fault and Interruption Data
7. Planned Projects as identified

2.1. BLCI Forecasts

Forecasting is an essential activity in electric distribution utilities. Growth of electricity consumption and demand need to be predicted for the utility to be able to source adequate power supply needed by its captive customers, ensure adequate capacity of its substation and other distribution equipment, and come up with timely solutions for problems in the distribution system that may arise due to an increase in demand. Forecasts of number of consumers and expected consumption are also needed to ascertain the sufficiency of revenue from electricity rates required for an efficient, quality, safe and reliable operation, and maintenance of the distribution system.

2.2. Forecasting Methodology

There are different types of Forecasting Approaches and Methods, among them are the following: forecasting of peak demand, forecasting of total load, and small area forecasting. These forecasting schemes are classified according to period of forecast (short, medium or long term) and according to use of information (qualitative or quantitative).

Any of the three abovementioned load forecasting methods are affected by the following factors i.e. historical load data, load density, population growth, geography, weather, land use, city/municipal plans, industrial plans, and development plans. The use and purpose of these load forecasting methods and the availability of data will determine which factors stated above must be considered in forecasting.

During the workshops conducted, the participants were oriented and made to work hands on with the different load forecasting methods of Regression Analysis such as the Ordinary Least Squares Method, Simple Linear Regression, Multiple Regression, and Regression Analysis using Microsoft Excel. But before one can finally arrive at a conclusion as to which method he shall use, given two or more dependent or independent variables – he should undergo a forecasting process wherein he should take note of what it is to be forecasted and for what purpose, given the historical data available. A flow diagram on load forecasting is illustrated below in aiding the participant to go through the process:

a. Selection of a family of relationships (lines/curves) that closely describe the historical data for Energy, Power demand and number of consumers; each family will have one or more parameters that determine the exact family member that will be used to describe the data.
b. Calculate the values of the parameters of the particular member of the family that will "most closely" fit the historical data in the sense that the sum of the squared vertical deviations from the actual data points to the line or curve is as small as can be made with members of the family of relationships chosen in Step a). Once the parameters are selected the relationship is often called the trend line.

c. Use the family member which "most closely" fits the data to calculate the Hist. values for future time periods. If the forecasting model yielded statistically invalid result, the model is rejected.

Generally, forecasting follow the methodology shown in the figure below.

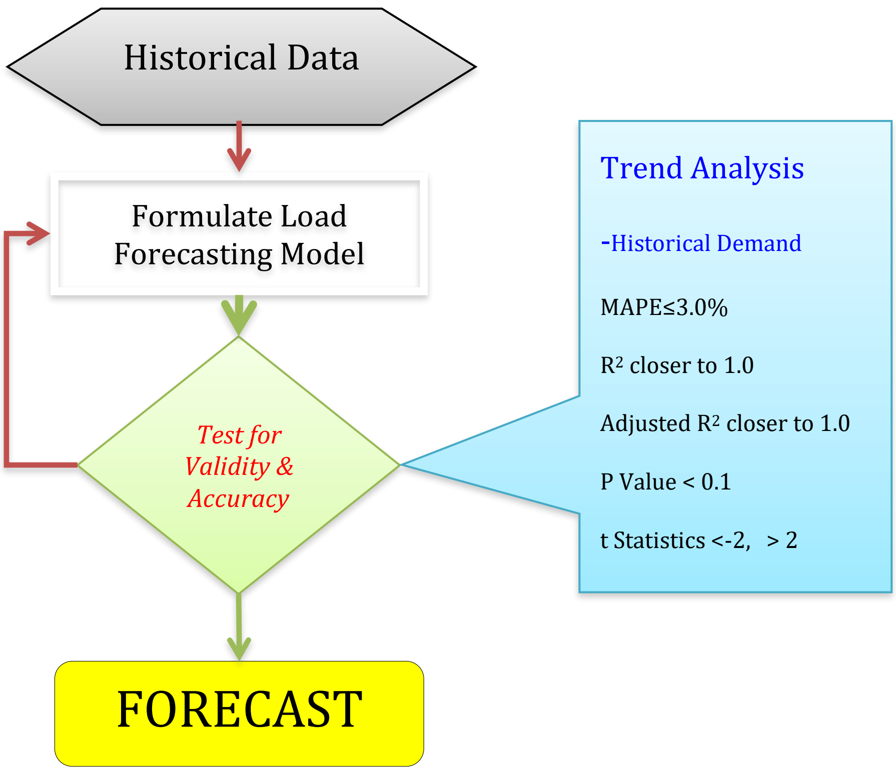


Figure 7: Methodology of Forecasting

BLCI Historical Data (Energy Purchased and Demand)

Table 1: BLCI System Historical Data

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

2.3. BLCI System Energy and Demand Forecast

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 vary or when there are activities in the distribution system. To attain higher forecasting accuracy BLCI used the system energy and demand historical data in the forecasting instead of the per feeder approach. The historical data of BLCI for use will be from CY2007 to CY2013 only as the BLCI data 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 were normalized based on historical data. A Simple Linear Regression Analysis was used to obtain the normalized data as presented below.

Table 2: Simple Linear Regression Analysis

YEAR	1	2	3	4	5	6	7	2013 Normalized data
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013Actual**	ENERGY
JANUARY	6,194,111	6,800,373	6,923,847	7,563,759	8,005,382	8,416,688	8,566,846	8,566,846
FEBRUARY	6,422,052	6,974,483	7,557,074	7,838,411	8,189,384	8,658,062	8,513,670	8,513,670
MARCH	6,050,686	6,418,484	7,049,322	7,497,399	7,425,649	8,204,505	8,370,934	8,370,934
APRIL	6,854,669	7,548,236	7,817,173	8,322,804	8,147,230	8,916,944	9,528,161	9,528,161
MAY	7,076,111	7,332,545	8,075,592	8,182,956	8,668,838	9,227,868	9,532,690	9,532,690
JUNE	7,247,065	7,483,466	8,467,536	9,148,534	8,924,270	9,513,261	9,660,998	9,660,998
JULY	7,019,563	7,313,370	7,917,350	8,326,985	8,756,062	8,912,097	9,306,670	9,306,670
AUGUST	7,501,139	7,702,432	8,528,030	8,934,340	9,091,880	9,470,842	9,386,042	9,386,042
SEPTEMBER	7,270,106	7,749,675	8,638,217	8,942,731	9,284,709	9,269,974	9,689,186	9,689,186
OCTOBER	7,380,500	7,698,560	8,034,261	8,279,089	8,710,996	8,950,492	8,579,304	9,288,860
NOVEMBER	7,768,065	7,981,256	8,115,380	8,436,505	8,800,295	8,704,753	4,317,776	9,047,211
DECEMBER	7,035,421	7,352,952	7,697,938	7,810,977	8,577,247	8,500,949	7,409,592	8,940,604
TOTAL	**83,819,488**	**88,355,832**	**94,821,720**	**99,284,489**	**102,581,942**	**106,746,435**	**102,861,869**	**109,831,870**

The graph of the actual energy purchased and normalized energy purchased from year 2007 to 2013 is shown in Figure 8 and Figure 9 respectively.

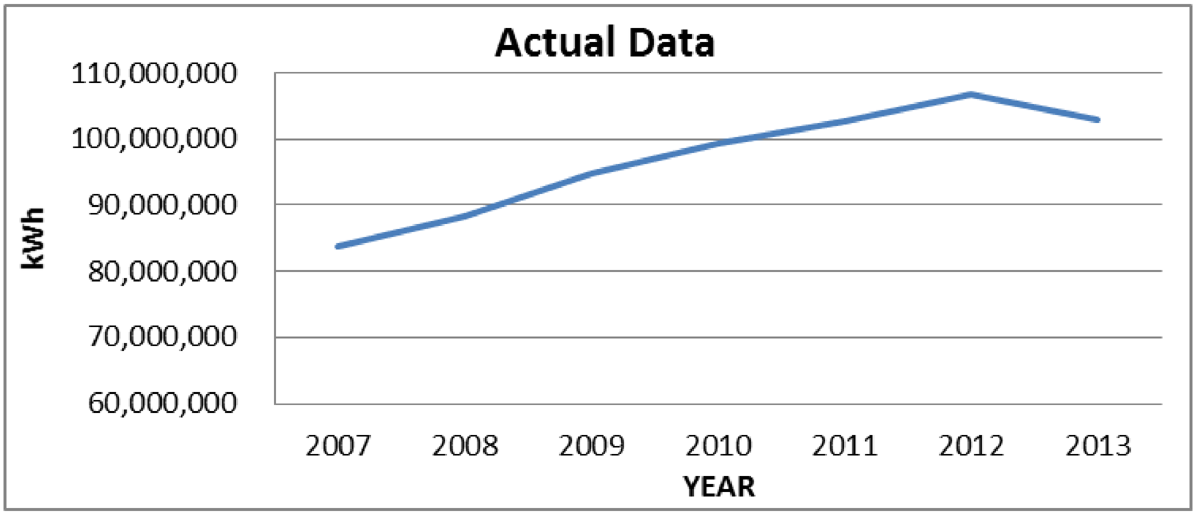


Figure 9: 2013 Actual Energy Purchased

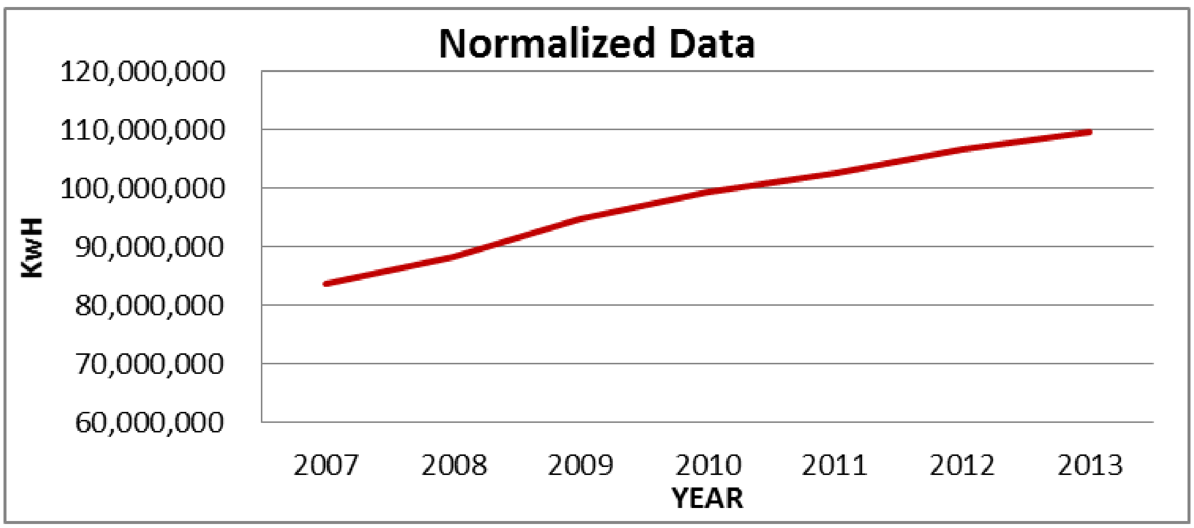


Figure 8: 2013 Normalized Data on Energy Purchased

The forecasting methodology was used by BLCI in the forecasting of energy and demand for the next 30 years. BLCI came up with thirty-three (33) forecasting models which were analyzed according to structure judgment, statistical criteria and validity test parameters. The best fit model was then identified that when tested passed all the related criteria using the methodology of Simple Linear Regression Analysis.

Table 3: System Energy Forecasting Criteria and Intercepts

Intercepts		**P Value**	**t Statistics**
Coefficient	**Value**	**<0.1**	**<-2, >2**
A	10,547,031	0.05360426	2.71
B	2,979,803	0.0051275	5.56
C	80,422,521	2.53E-08	124.1

The BLCI chose the best fit equation ***a (lnt)+b(t)+c*** (number 23) of the 33 forecast equations formulated. Table 3 shows the system energy forecasting criteria and intercepts where for the intercepts, the coefficient **a** have a value of 10,547.031, the coefficient **b** has a value of 2,979.803, while the coefficient **c** has a value of 80,422.521. The P values are 0.053604264, 0.005127496, and 2.52892x10^-8 respectively. The **t statistics** are 2.71, 5.56 and 124.10 respectively.

The results of the system energy validity test parameters are also shown in Table 4. The actual MAPE based on calculated values is 0.51% which is below the requisite value of less than 3 %. The actual R squared value is 0.9965, while the requisite value is 0.99. The actual R squared adjusted value is 0.9946, compared with the requisite value of 0.99. The growth rate has a computed actual value of 2.97 %, with a requisite value of 1 % to 4 %.

Table 4: System Energy Validity Test Parameters and Results

Test Parameters	**MAPE**	**R^2**	**R^2 adj**	**Growth Rate**
Actual	0.51%	0.9965	0.9946	2.97%
Requisite	<3%	0.99	0.99	1% to 4%

Table 5: BLCI System Forecast (Energy Purchased and Demand)

	FORECAST (kWh)	Growth Rate (%)	FORECAST (kW)
2007	83,819,488	6.49%	15,315
2008	88,355,832	5.41%	16,263
2009	94,821,720	7.32%	18,041
2010	99,284,484	4.71%	18,890
2011	102,581,940	3.32%	19,517
2012	106,746,432	4.06%	20,254
2013	102,861,869	-3.64%	19,570
2014	105,270,512	2.34%	20,029
2015	113,321,797	7.65%	22,304
2016	122,063,217	4.01%	23,553
2017	130,644,450	3.35%	25,278
2018	136,607,009	3.20%	26,431
2019	139,953,449	3.08%	27,079
2020	143,297,484	2.97%	27,650
2021	146,568,530	2.87%	28,359
2022	149,843,952	2.58%	28,992
2023	153,101,447	2.31%	29,623
2024	156,367,844	2.25%	30,172
2025	159,570,523	2.19%	30,874
2026	162,785,275	2.14%	31,496
2027	165,988,562	2.08%	32,116
2028	169,206,230	2.03%	32,649
2029	172,364,865	1.99%	33,350
2030	175,539,612	1.94%	33,964
2031	178,706,401	1.90%	34,577
2032	181,890,634	1.86%	35,097
2033	185,018,527	1.82%	35,798
2034	188,164,912	1.79%	36,407
2035	191,305,451	1.75%	37,014
2036	194,465,320	1.72%	37,523
2037	197,570,537	1.69%	38,227
2038	200,695,765	1.66%	38,831
2039	203,816,518	1.63%	39,435
2040	206,957,842	1.60%	39,934
2041	210,045,643	1.57%	40,640
2042	213,154,482	1.55%	41,242
2043	216,259,786	1.52%	41,843
2044	219,386,523	1.50%	42,332
2045	222,460,527	1.47%	43,042

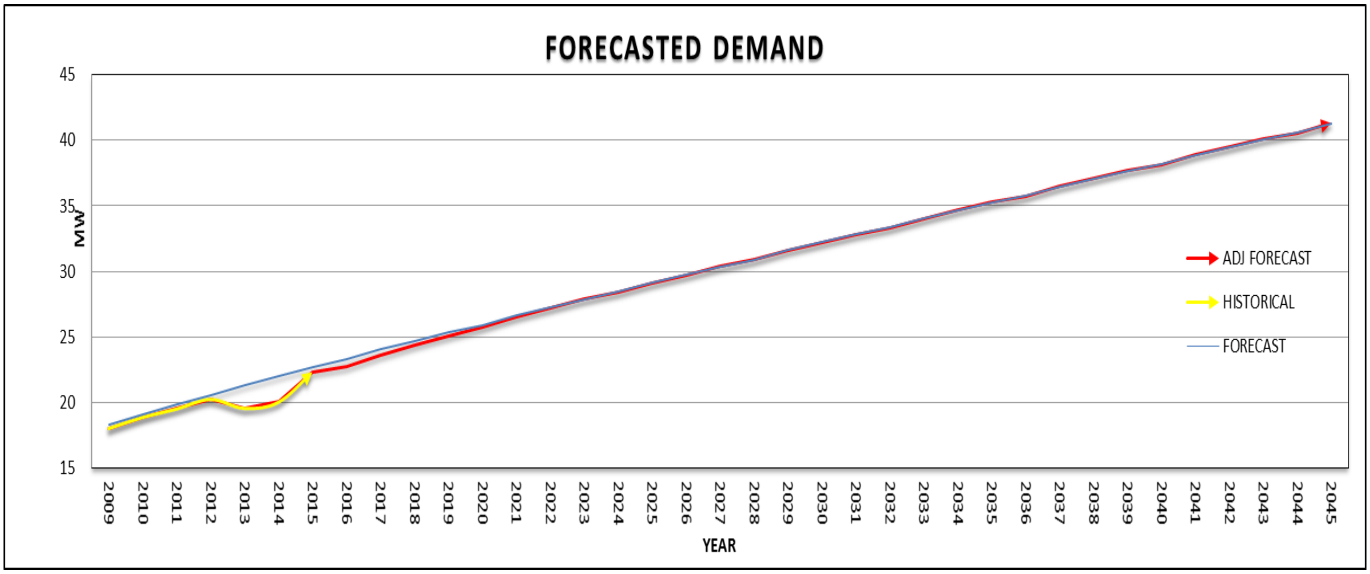


Figure 10: BLCI Demand Forecast (MW)

Note: Before the earthquake last October 2013 BLCI's demand was around 21MW and forecasted to go higher to 23MW by 2016, but unfortunately after the earthquake demand went down due to major damages and then typhoon Yolanda followed wherein supply was scarce which causes BLCI to be behind from its forecasted demand even until at present.

Table 6: Forecasted Substation Capacity

YEAR	FORECASTED DEMAND	SUBSTATION CAPACITY	Loading	REMARKS
	(MW)	(MW)	%	
2007	15.32	20	77%	
2008	16.26	20	81%	
2009	18.04	20	90%	
2010	18.89	28	67%	
2011	19.52	28	70%	
2012	20.25	28	72%	
2013	19.57	28	70%	
2014	20.03	28	72%	
2015	22.3	28	80%	
2016	23.55	36	65%	ADDITIONAL 10 MVA IN CY 2016 WITH PROVISION FOR FEEDER TRANSFER OPTIONS.
2017	25.28	36	70%	
2018	26.43	36	73%	
2019	27.08	36	75%	

2020	27.65	36	77%	
2021	28.36	36	79%	
2022	28.99	36	81%	
2023	29.62	44	67%	ADDITIONAL 10 MVA IN CY 2023 WITH PROVISION FOR FEEDER TRANSFER OPTIONS.
2024	30.17	44	69%	
2025	30.87	44	70%	
2026	31.5	44	72%	
2027	32.12	44	73%	
2028	32.65	44	74%	
2029	33.35	44	76%	
2030	33.96	44	77%	
2031	34.58	44	79%	
2032	35.1	44	80%	
2033	35.8	52	69%	ADDITIONAL 10 MVA IN CY 2033 WITH PROVISION FOR FEEDER TRANSFER OPTIONS.
2034	36.41	52	70%	
2035	37.01	52	71%	
2036	37.52	52	72%	
2037	38.23	52	74%	
2038	38.83	52	75%	
2039	39.44	52	76%	
2040	39.93	52	77%	
2041	40.64	52	78%	
2042	41.24	52	79%	
2043	41.84	60	70%	ADDITIONAL 10 MVA IN CY 2043 WITH PROVISION FOR FEEDER TRANSFER OPTIONS.
2044	42.33	60	71%	
2045	43.04	60	72%	

3. TECHNICAL PERFORMANCE ASSESSMENT

3.1. Capacity Analysis

BLCI has two (2) substations named Dampas and Poblacion 3, located in Barangay Dampas and Barangay Poblacion 3 respectively, both in Tagbilaran City. These two substations provide a total capacity of 35MVA. The Dampas Substation has a total capacity of 25MVA composed of 2x10MVA and 1x5MVA power transformers while the Poblacion 3 Substation has a 10MVA Power Transformer installed. As of 2015, the 5MVA Power Transformer at Dampas Substation has been temporarily decommissioned due to high technical losses.

At present (2015), the three (3) 10MVA Power Transformers has a combined percentage loading equal to 74.33% of the total available capacity, as shown in Table 7. Load forecasts reveal that by 2016, the total combined system load will be 75.8% of total capacity and 78.6% by 2017. These loading levels are in already in excess of the recommended loading level of 70% for initiating procurement of new capacity prescribed in the ECDU Planning Manual. It is also recommended that power transformers be loaded at a maximum of 80% to allow flexibility in transferring loads to other substations during maintenance or outage of an adjacent substation which will improve the reliability of the system. These recommendations are given to ensure there is enough capacity is added to the system in a timely manner and to avoid overloading especially during contingencies.

Thus, to address the growing future demand of the distribution system immediately, it will be necessary for BLCI to install additional capacities in CY 2017 and such project should start early in 2016. After the conduct of technical and cost benefit analysis, BLCI proposed for the installation of a new 10MVA Substation to be located at San Isidro District, Tagbilaran City.

In line with the new proposed substation location at San Isidro District, an additional budget for the purchase of lot is also requested. The existing BLCI substations have very limited space and cannot accommodate any additional substation transformer. The proposed new location is the most strategic point of the BLCI Distribution System. It is adjacent to the 69kV line of NGCP. The road network in the area also provides an ideal exit for BLCI's distribution lines going to the North, South and Westward load centers.

Table 7: Substation Data (2011-2015)

Substation	Rated MVA	Power Factor	Max. MVA Capacity	Max. MW Capacity	Load Factor	Capacity Parameters	Actual Data				
							2011	2012	2013	2014	2015
Poblacion SS 1st 10MVA	10	80.00%	12.5	10	57.00%	Demand (MW)	7.59	5.4	5.89	6.03	6.71
						% Loading	75.90%	54.00%	58.90%	60.03%	61.00%
Dampas SS	5	80.00%	6.25	5	76.90%	Demand (MW)	3.7	3.97			
						% Loading	74.00%	79.38%			
Dampas SS 2nd 10MVA	10	80.00%	12.5	10	73.00%	Demand (MW)	7.6	5.04	6.33	6.48	7.21
						% Loading	76.00%	50.40%	63.30%	64.80%	72.10%
Dampas SS 3rd 10MVA	10	80.00%	12.5	10	81.00%	Demand (MW)		5.84	7.35	7.52	8.38
						% Loading		58.40%	73.50%	75.20%	83.38%
Entire System	35	80.00%	43.75	35	71.98%	Demand (MW)	18.89	20.254	19.57	20.03	22.3
						% Loading	75.56%	57.86%	65.23%	66.76%	74.33%

Table 8: Substation Demand Forecast (2016-2025)

Capacity Parameters		Forecast Demand (MW)									
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Poblacion SS 1st 10MVA	Demand (MW)	6.84	7.09	7.32	7.55	7.75	7.99	8.2	8.39	8.55	8.76
	% Loading	68.40%	70.90%	73.20%	75.50%	77.50%	79.90%	82.00%	83.90%	85.50%	87.60%
Dampas SS 2nd 10MVA	Demand (MW)	7.36	7.62	7.87	8.11	8.33	8.59	8.81	9.01	9.19	9.42
	% Loading	73.60%	76.20%	78.70%	81.10%	83.30%	85.90%	88.10%	90.10%	91.90%	94.20%
Dampas SS 3rd 10MVA	Demand (MW)	8.54	8.85	9.14	9.42	9.67	9.98	10.23	10.47	10.67	10.94
	% Loading	85.40%	88.50%	91.40%	94.20%	96.70%	99.80%	102.30%	104.70%	106.70%	109.40%
Entire System	Demand (MW)	22.74	23.57	24.33	25.07	25.75	26.56	27.24	27.87	28.42	29.12
	% Loading	75.80%	78.60%	81.10%	83.60%	85.80%	88.50%	90.80%	92.90%	94.70%	97.10%
	% Tech-Loss	4.89%	5.07%	5.20%	5.32%	5.44%	5.57%	5.66%	5.75%	5.85%	5.95%

The new substation will serve the load centers located in the nearest barangays of San Isidro District (1.4 km from new substation), Dao District (1.7km from new substation) and the neighboring barangays or districts of Manga, Tiptip and Cabawan. The farthest barangay from the new substation is Manga estimated at 4.4 kilometers from the new substation. Due to the compact service area of BLCI the distance between substations and also of the load centers is not much of a concern. Feeder flexibility and load center connection points combination can be done easily.

To connect the new substation to the system, the extension of lines along F. Toledo St to Zamora St is proposed in the budget. The project was considered technically feasible and cost effective in the simulations conducted.

3.2. Safety Analysis

The main isolating equipment used in all BLCI substations in the 69KV side is SF6 Gas Circuit Breaker while the 13.8KV feeders use Vacuum Breakers and Reclosers. Feeders are protected using electronic relays while the power transformers are protected with standard protective devices. It is imperative that protective devices in the substation can safely interrupt the maximum available fault currents in the system. There should be a margin of at least 10% between protective device maximum interrupting current rating above the maximum fault current.

The following formula is used in determining the Interrupting Duty Safety Margin of Substation Equipment:

$$Safety\ Margin = \left[\frac{Eqpt.\ Protections\ Short\ Ckt.\ Rating\ (Amps)}{Maximum\ Short\ Circuit\ Current\ (Amps)} - 1\right] \times 100\%$$

In Table 9 below, we find that the interrupting duties of the protective devices have sufficient margin. Thus, all of these devices can interrupt fault currents safely.

Table 9: Interrupting Duties and Safety Margin of Protective Devices

SUBSTATION	FEEDER	Maximum Fault @ Zf = 0Ω (Amp)	Protections Short Ckt. Rating (AIC)	SAFETY MARGIN	REMARKS
POBLACION SS	A	4,059	16,000	294%	SAFE
	C	4,059	16,000	294%	SAFE
DAMPAS SS	B	3,958	25,000	532%	SAFE
	D	3,958	25,000	532%	SAFE
	E	4,044	12,500	209%	SAFE
	F	4,044	12,500	209%	SAFE

Another important measure of performance of protection systems is their ability to detect and successfully interrupt minimum faults. Protective devices must be able to sence minimum faults at the end of their zone of protection. It is recommended that protective relay settings be set at least 2x the maximum load to avoid nuisance tripping and a setting not exceeding 2/3 or 67% of the minimum fault for it to successfully detect minimum fault currents. In Table 10 below, we show that the protective device can adequately detect and therefore interrupt minimum faults successfully.

Tables 9 and 10 show that the BLCI system is adequately protected. All BLCI distribution equipment facilities are all within the required standard parameters and BLCI is continuously working to maintain the integrity of the equipment to ensure the safety and security of the distribution system. Hence part of the proposal of BLCI is the acquisition of necessary test equipment, tools and devices related to protection.

On the other hand, existing in some areas of the BLCI distribution system franchise area are old, over-extended and sagging service drop wires that crisscross roads and traversing private lots. Such situations are unsafe and hazardous to the general public. BLCI considers these as one of the priorities that need to be corrected through extension of line projects to ensure safety of the residents in the area and the general public. Also included are the proposed purchase of grounding clusters and other safety devices to enhance safety of BLCI working personnel.

Table 10: Minimum Fault Analysis for the Year 2016

SUBSTATION	FEEDER	Double Line to Ground Fault (LLG)			Line to Ground Fault (LG)			Remarks
		Min. LLG Fault (Amp)	LLG Setting (Amp)	Safety Margin	Min. LG Fault (Amp)	LG Setting (Amp)	Safety Margin	
POBLACION SS	A	2,476	294	11.87%	240	150	62.50%	adequate
	C	2,288	294	12.85%	237	150	63.29%	adequate
DAMPAS SS	B	1,407	300	21.32%	239	140	58.58%	adequate
	D	992	300	30.24%	217	140	64.52%	adequate
	E	1,681	300	17.85%	241	100	41.49%	adequate
	F	1,809	320	17.69%	245	112	45.71%	adequate

3.3. Reliability Analysis

As earlier stated, BLCI has a compact distribution system. Feeder reconfigurations are done from time to time to ensure reliability and efficiency of the system as feeder loads vary or when there are activities in the distribution system. Table 11 below shows the reliability performance of BLCI in terms of SAIFI, SAIDI, MAIFI and CAIDI. BLCI's performances from year 2015 are all within limits with reference to the standards prescribed in the Philippine Distribution Code (PDC).

Table 11: 2015 Reliability Performance

YEAR	RELIABILITY PERFORMANCE			
	SAIFI	SAIDI	MAIFI	CAIDI
2015	4.67	44.27	5.28	9.49
2017 – Option 1	3.19	42.29	4.00	13.27
2017 – Option 2	4.38	47.51	4.53	10.86

These performance parameters are expected to improve further after implementation and installation of the new 10MVA Transformer, the upgrading and extension of line projects, and upgrading of lines as affected by government projects.

Reliability of the BLCI system can also be improved by more efficient configurations of the feeder system which can be done as part of routine operations and maintenance programs.

These performance parameters of BLCI distribution system needs to be maintained and continuously improved. BLCI proposed in the budget the purchase of tools, laboratory equipment, test equipment, transportation equipment and boom trucks and others to help improve system reliability.

3.4. Systems Loss Analysis

The Systems Loss of BLCI has gradually improved annually. In CY2005 System loss of BLCI was higher because of ongoing rehabilitation projects during that time. It is noticeable however that as the load increases the systems also loss increases. In CY 2008 the 2nd 10 MVA Power Transformer at Dampas SS was energized and by CY 2009 the systems loss has improved but as the load continue to increase the losses also correspondingly increased. In CY 2012 the 3rd 10MVA Power Transformer and Dampas SS was energized to accommodate the increasing load of the systems. As we can see in the graph, the systems loss decreased but gradually increases as the demand also increases. We are positive enough that in 2017 the systems loss will also decrease after the installation of the proposed new 10MVA power transformer and for BLCI to maintain a Systems Loss below threshold level.

Figure 11: Historical Graphical System Loss

Table 12: Forecasted Technical Loss

	YEAR	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
TECHNICAL LOSS	MWH	4,178	4,497	3,280	4,853	5,141	5,769	6,176	6,532	6,897	7,263
	%	4.09%	4.24%	3.18%	4.61%	4.54%	4.89%	5.07%	5.20%	5.32%	5.44%

Table 13: Percent Contribution on BLCI Systems Loss for 2015

Loss	MWhrs	% Contr	% SL
Technical Loss	5,141	57%	4.54%
Non-Tech loss	3,929	43%	3.47%
Total	9,070	100%	8.00%

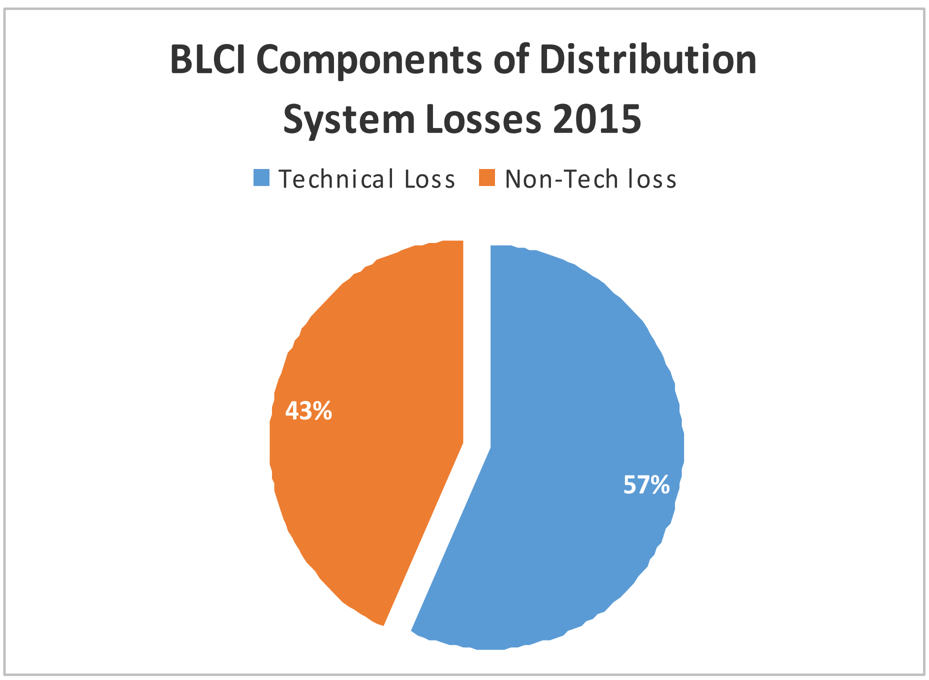


Figure 12: 2015 Components of Distribution System Loss

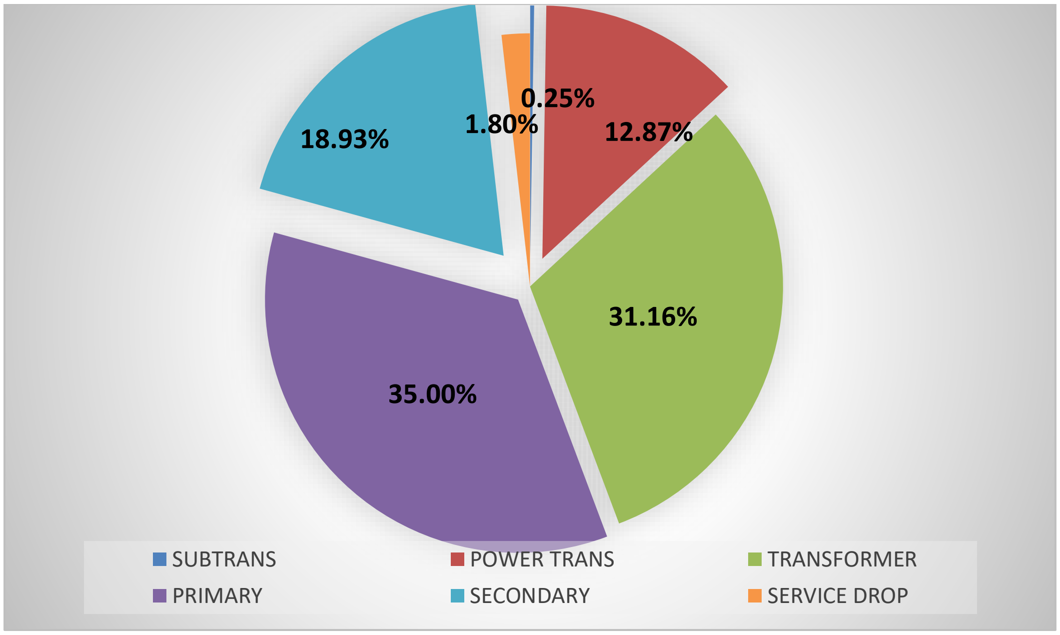


Figure 13: Technical Loss Components

Primarily the major components of System Losses are as follows:

1. Technical Loss-All electrical equipment necessary for the operation of the distribution system
2. Non-Technical Loss-The component that is not related to physical characteristics and functions of the electrical system, and is cause primarily by human error (e.g. meter reading errors) and pilferage.

The area of non-technical loss needs more effort and equipment on the side of BLCI to ensure compliance to the Systems Loss reduction program of the ERC. An anti-pilferage program is a major concern. In relation to this, BLCI is proposing the acquisition of standard kWh meters, current and potential transformers, meter calibration devices, pilferage detection meters and other pilferage detection devices.

With regard to the Technical Loss of BLCI, the following major contributors need to be continuously and carefully studied and simulated:

1. Primary Lines -35% SL-This can be improved further by uprating of lines and installation of new substation to shorten the length of lines to load centers.
2. Distribution Transformer - 31.16% SL-The losses of distribution transformer is inherent in copper loss; however transformer combinations, proper sizing and other related activities shall be carefully considered.
3. Secondary Lines - 18.93% SL-This can be improved further by uprating the existing line.

The installation of the new substation and the implementation of various distribution line projects will also help reduce technical losses.

3.5. Power Quality Analysis

Power quality is very essential for every distribution utility specifically the delivery of voltages required by consumers at various levels. BLCI is in compliance to ERC regulations. ERC periodically conducts inspection, measurement and monitoring of voltage unbalance and voltage variation of substations and feeders of the distribution system. At least 100 connection points nearest and farthest from the substations were tested. As per monitoring report and audit from ERC Investigation and Enforcement Division last April 27-30, 2015, BLCI System voltage delivered to consumers is within the range of the ± 10% of the nominal voltage which is 230 volts. The compliance to voltage standards is also be attributed in part to the shorter lengths of lines due to the compact nature of the franchise are. Please refer to Table 14 below.

Table 14: Historical Power Quality Data

Substation	Feeder Name	Voltage Variation (p.u)					Voltage Unbalance (%)				
		2011	2012	2013	2014	2015	2011	2012	2013	2014	2015
Dampas SS	Feeder B	0.99	0.99	0.98	0.98	0.97	0.70%	0.99%	0.51%	0.76%	0.80%
	Feeder D	1	0.99	1	1	0.99	0.21%	0.84%	0.53%	0.70%	0.72%
	Feeder E	1.04	0.99	1	0.99	0.99	0.21%	0.33%	0.25%	0.31%	0.38%
	Feeder F			0.99	0.99	0.99			0.25%	0.76%	1.11%
Poblacion SS	Feeder A	1.01	1.04	1	0.99	1	0.76%	1.13%	0.56%	1.32%	1.15%
	Feeder C	1.02	1.02	1.01	1	1	0.76%	1.13%	0.56%	1.32%	1.15%

To maintain these parameters compliant to regulations, BLCI needs to acquire power conditioning equipment such as capacitors, etc., power-conditioning monitoring mobile devices and others.

4. PROJECT PLANNING AND EVALUATION

Problems and deficiencies of the distribution system were identified in the System Performance Assessment. These are then prioritized in accordance to established categories to ensure that goals and objectives are met and all aspects are considered.

4.1. Substation Project

4.1.1. Installation of 10MVA Substation at San Isidro District, Tagbilaran City

Project Justification:

The proposed project will provide enough capacity to supply forecasted load in the coming years and spare capacity for operational flexibility. The project will improve BLCI systems reliability, efficiency and quality of power supply compliant to regulations and standards of the PDC. It will enhance safe operation of BLCI System, reduce systems technical losses and provide transferability of power supply in case of emergency.

The procurement process of the substation transformer and related accessories is scheduled to start in the 2nd quarter of 2016 and scheduled for completion in the 1st quarter of 2017 to catch up with the increasing demand in the franchise area and avoid overloading of existing transformers.

Technical Analysis:

In the selection process, we considered the option of installing either a 5MVA, a 10MVA or a 20MVA substation transformer. Technical and financial simulations were conducted and the installation of the 10MVA Substation transformer gives a favorable result.

The installation of the 10MVA Substation Transformer as compared to other options will reduce BLCI's system loss by 0.14% and it has the highest substantial kWh saving per year. In terms of loading (at 70% allowable demand capacity) the 10MVA Transformer will not be overloaded nor will it be underloaded for the next 6 to 7 years prior to the schedule of additional substation capacity by 2023.

Besides, factors such as the maintenance of substations, inventory of spare parts and related equipment, flexibility of feeders and others were also considered.

The proposed 4th 10MVA Substation Transformer will be located at San Isidro District, Tagbilaran City. The location is the most strategic point of the BLCI System as it is adjacent to the 69kV line of NGCP and the road network also provides an ideal exit of BLCI's distribution lines. The location also enhances savings on the high cost of the construction of a sub-transmission line and its' related structures, equipment and devices.

In the simulation of feeders and substation transformer loading, the existing old 5MVA transformer which is already inefficient was not anymore considered. The transformer was shut down in December 2014 and declared as reserve capacity that is ready for energization in case of emergencies or preventive maintenance of other substations.

Quantitative Performance Measures With or Without the Project

4th 10 MVA SUBSTATION TRANSFORMER PROJECT

Existing BLCI System

Year	Computed Energy Purchase	Computed Technical Loss		Computed Energy Sales	Total Demand	Voltage level	
	kWh	kWh	% Loss	kWh	kW	Max (p.u)	Min (p.u)
2016	117,868,857	5,769,078	4.89%	112,099,779	22,743	0.9863	0.9834
2017	121,818,750	6,175,818	5.07%	115,642,932	23,570	0.9853	0.9822
2018	125,722,709	6,531,602	5.20%	119,191,107	24,325	0.9844	0.9812
2019	129,594,749	6,896,556	5.32%	122,698,193	25,074	0.9835	0.9802
2020	133,437,444	7,262,800	5.44%	126,174,644	25,747	0.9826	0.9792
2021	137,261,030	7,640,242	5.57%	129,620,788	26,558	0.9817	0.9782
2022	140,799,252	7,962,630	5.66%	132,836,622	27,242	0.9810	0.9774
2023	144,056,747	8,287,428	5.75%	135,769,319	27,873	0.9802	0.9766
2024	147,298,364	8,613,439	5.85%	138,684,925	28,422	0.9795	0.9758
2025	150,525,823	8,954,387	5.95%	141,571,436	29,124	0.9788	0.9750

Alternative 1 (5MVA)

Year	Computed Energy Purchase	Computed Technical Loss		Computed Energy Sales	Total Demand	Voltage level @ 4km	
	kWh	kWh	% Loss	kWh	kW	Max (p.u)	Min (p.u)
2016	118,236,971	5,876,938	4.97%	112,360,033	22,814	0.9925	0.9800
2017	122,225,890	6,284,620	5.14%	115,941,270	23,649	0.9919	0.9786
2018	126,153,410	6,634,884	5.26%	119,518,525	24,408	0.9914	0.9775
2019	130,060,788	7,007,122	5.39%	123,053,666	25,164	0.9909	0.9764
2020	133,933,161	7,374,111	5.51%	126,559,050	25,843	0.9904	0.9752
2021	137,792,355	7,752,287	5.63%	130,040,068	26,661	0.9899	0.9741
2022	141,355,723	8,075,281	5.71%	133,280,443	27,350	0.9895	0.9732
2023	144,649,524	8,400,668	5.81%	136,248,856	27,988	0.9891	0.9722
2024	147,915,678	8,727,255	5.90%	139,188,423	28,541	0.9887	0.9713
2025	151,185,393	9,068,788	6.00%	142,116,605	29,252	0.9883	0.9704

Alternative 2 (10MVA)

Year	Computed Energy Purchase	Computed Technical Loss		Computed Energy Sales	Total Demand	Voltage level	
	kWh	kWh	% Loss	kWh	kW	Max (p.u)	Min (p.u)
2016	118,472,322	5,688,571	4.80%	112,783,751	22,859	0.9925	0.9853
2017	122,483,347	6,079,019	4.96%	116,404,328	23,699	0.9919	0.9841
2018	126,434,561	6,414,534	5.07%	120,020,028	24,463	0.9915	0.9832
2019	130,359,531	6,769,576	5.19%	123,589,955	25,222	0.9910	0.9823
2020	134,261,648	7,120,913	5.30%	127,140,735	25,906	0.9905	0.9814
2021	138,144,582	7,482,987	5.42%	130,661,595	26,729	0.9900	0.9805
2022	141,732,688	7,792,252	5.50%	133,940,436	27,423	0.9896	0.9797
2023	145,044,708	8,103,829	5.59%	136,940,880	28,064	0.9893	0.9790
2024	148,341,205	8,416,573	5.67%	139,924,633	28,623	0.9889	0.9782
2025	151,629,103	8,743,650	5.77%	142,885,453	29,337	0.9885	0.9775

Alternative 3 (20MVA)

Year	Computed Energy Purchase	Computed Technical Loss		Computed Energy Sales	Total Demand	Voltage level	
	kWh	kWh	% Loss	kWh	kW	Max (p.u)	Min (p.u)
2016	118,611,119	5,788,021	4.88%	112,823,098	22,886	0.9949	0.9853
2017	122,627,043	6,178,917	5.04%	116,448,126	23,726	0.9945	0.9841
2018	126,590,092	6,514,835	5.15%	120,075,257	24,493	0.9942	0.9832
2019	130,526,827	6,869,884	5.26%	123,656,944	25,254	0.9939	0.9823
2020	134,434,850	7,221,592	5.37%	127,213,258	25,939	0.9936	0.9814
2021	138,323,681	7,584,059	5.48%	130,739,621	26,764	0.9933	0.9805
2022	141,924,162	7,893,667	5.56%	134,030,495	27,460	0.9931	0.9797
2023	145,242,301	8,205,595	5.65%	137,036,705	28,102	0.9928	0.9790
2024	148,544,979	8,518,699	5.73%	140,026,280	28,663	0.9926	0.9782
2025	151,838,967	8,846,158	5.83%	142,992,808	29,378	0.9923	0.9775

Comparative Summary of Losses for Alternative 1, Alternative 2, Alternative 3

Year	Existing System				Alternative 1						
	Total Demand (kW)	Computed Energy Sales (kWh)	Computed Technical Loss (kWh)	Technical Loss (%)	Total Demand (kW)	Computed Energy Sales (kWh)	Computed Technical Loss (kWh)	Technical Loss (%)	Technical Loss kWh	Reduction in Technical Loss (%)	Increase in Energy Sales (%)
2016	22,743	112,099,779	5,769,078	4.89%	22,814	112,360,033	5,876,938	4.97%	(107,860)	-0.08%	0.23%
2017	23,570	115,642,932	6,175,818	5.07%	23,649	115,941,270	6,284,620	5.14%	(108,803)	-0.07%	0.26%
2018	24,325	119,191,107	6,531,602	5.20%	24,408	119,518,525	6,634,884	5.26%	(103,282)	-0.06%	0.27%
2019	25,074	122,698,193	6,896,556	5.32%	25,164	123,053,666	7,007,122	5.39%	(110,566)	-0.07%	0.29%
2020	25,747	126,174,644	7,262,800	5.44%	25,843	126,559,050	7,374,111	5.51%	(111,311)	-0.06%	0.30%
2021	26,558	129,620,788	7,640,242	5.57%	26,661	130,040,068	7,752,287	5.63%	(112,046)	-0.06%	0.32%
2022	27,242	132,836,622	7,962,630	5.66%	27,350	133,280,443	8,075,281	5.71%	(112,651)	-0.06%	0.33%
2023	27,873	135,769,319	8,287,428	5.75%	27,988	136,248,856	8,400,668	5.81%	(113,241)	-0.05%	0.35%
2024	28,422	138,684,925	8,613,439	5.85%	28,541	139,188,423	8,727,255	5.90%	(113,816)	-0.05%	0.36%
2025	29,124	141,571,436	8,954,387	5.95%	29,252	142,116,605	9,068,788	6.00%	(114,401)	-0.05%	0.39%
Average		**1,274,289,746**	**74,093,979**	**5.50%**		**1,278,306,938**	**75,201,955**	**5.56%**	**(1,107,976)**	**-0.06%**	**0.32%**

Year	Alternative 2							Alternative 3						
	Total Demand (kW)	Computed Energy Sales (kWh)	Computed Technical Loss (kWh)	Technical Loss (%)	Technical Loss (kWh)	Reduction in Technical Loss (%)	Increase in Energy Sales (%)	Total Demand (kW)	Computed Energy Sales (kWh)	Computed Technical Loss (kWh)	Technical Loss (%)	Technical Loss (kWh)	Reduction in Technical Loss (%)	Increase in Energy Sales (%)
2016	22,859	112,783,751	5,688,571	4.80%	80,506	0.17%	0.61%	22,886	112,823,098	5,788,021	4.88%	(18,943)	0.01%	0.65%
2017	23,699	116,404,328	6,079,019	4.96%	96,799	0.18%	0.66%	23,726	116,448,126	6,178,917	5.04%	(3,099)	0.03%	0.70%
2018	24,463	120,020,028	6,414,534	5.07%	117,069	0.19%	0.70%	24,493	120,075,257	6,514,835	5.15%	16,768	0.05%	0.74%
2019	25,222	123,589,955	6,769,576	5.19%	126,980	0.19%	0.73%	25,254	123,656,944	6,869,884	5.26%	26,672	0.06%	0.78%
2020	25,906	127,140,735	7,120,913	5.30%	141,887	0.20%	0.77%	25,939	127,213,258	7,221,592	5.37%	41,208	0.07%	0.82%
2021	26,729	130,661,595	7,482,987	5.42%	157,254	0.21%	0.80%	26,764	130,739,621	7,584,059	5.48%	56,182	0.08%	0.86%
2022	27,423	133,940,436	7,792,252	5.50%	170,378	0.21%	0.83%	27,460	134,030,495	7,893,667	5.56%	68,963	0.09%	0.90%
2023	28,064	136,940,880	8,103,829	5.59%	183,599	0.22%	0.86%	28,102	137,036,705	8,205,595	5.65%	81,832	0.10%	0.93%
2024	28,623	139,924,633	8,416,573	5.67%	196,866	0.23%	0.89%	28,663	140,026,280	8,518,699	5.73%	94,740	0.11%	0.97%
2025	29,337	142,885,453	8,743,650	5.77%	210,737	0.23%	0.93%	29,378	142,992,808	8,846,158	5.83%	108,229	0.12%	1.00%
Average		**1,284,291,793**	**72,611,905**	**5.35%**	**1,482,075**	**0.14%**	**0.78%**		**1,285,042,594**	**73,621,427**	**5.42%**	**472,552**	**0.08%**	**0.84%**

4.2. Primary Distribution Development Project

4.2.1. Extension and Upgrading of primary lines

Project Justification:

Existing in the area are over-extended and sagging service drop wires, unsafe and hazardous to the general public. The area is also developing and the extension/upgrading projects will improve power quality of residential consumers in the area.

The project is also in compliance with DSOAR Art. 1.6 General Description of Services – Every DU under the supervision, control and jurisdiction of the ERC shall operate, maintain, and provide safe, reliable, adequate, efficient and continuous electric service; and Art. 2.6.6

Nearest Source - The DU shall design the line extension from the nearest existing source of available capacity to the End user's delivery point along the shortest practical route. The DU may, however, design the line extension along an alternative route in anticipation of additional customers; and in such situations, all additional costs attributed specifically to the alternative route shall be at the DU's sole cost and expense, and treated as Electric Plant Held for Future use.

The installation when completed will also enhance compliance to PEC Art. 2.25.1.6a - Conductor Size and Support for Overhead Spans – Open individual conductors shall not be smaller than the following: for 600 volts, nominal, or less, 5.5 mm^2 (10AWG) copper, 8.0 mm^2 (#8AWG) aluminum for spans up to 15m in length and 8.0 mm^2 copper or 14 mm^2 aluminum for a longer span, unless supported by a messenger wire; and PEC Art. 2.25.1.14a – Open Conductor Spacing – Conductors of 600 volts, nominal, or less, shall comply with the spacing provided in Table 2.30.4.12(c).

1. Extension of Single phase primary line with secondary line @ Purok 4, Booy District
2. Extension of Primary and Secondary Line to Capitol Valley Phase 3, Dao District
3. Extension of Primary Line at Sitio Badjong, Dao District
4. Relocation of Distribution Lines Along Maria Clara Street
5. Relocation of Distribution Lines Along Butalid Street
6. Upgrading of lines along Vissara St.

4.3. Secondary Distribution Development Project

Installation of secondary line using 2/0 AWG ACSR insulated for the supply line and bare wire for the neutral line.

Project Justification:

Existing secondary distribution wires are undersized, unsafe and hazardous to the general public. The lines also contribute to the increase in system loss, poor quality electric power service, and is prone to pilferage. The project when completed will improve safety and power quality in the area. The area is also developing and the extension project will help signal for the increase of residential consumers in the area.

The project is in compliance with DSOAR Art. 1.6 General Description of Services – Every DU under the supervision, control and jurisdiction of the ERC shall operate, maintain, and provide safe, reliable, adequate, efficient and continuous electric service; and Art. 2.6.6 Nearest Source - The DU shall design the line extension from the nearest existing source of available capacity to the End user's delivery point along the shortest practical route.

The installation when completed will also be compliant to PEC Art. 2.25.1.6a - Conductor Size and Support for Overhead Spans – Open individual conductors shall not be smaller than the following: for 600 volts, nominal, or less, 5.5 mm^2 (10AWG) copper, 8.0 mm^2 (#8AWG) aluminum for spans up to 15m in length and 8.0 mm^2 copper or 14 mm^2 aluminum for a longer span, unless supported by a messenger wire; and PEC Art. 2.25.1.14a – Open Conductor Spacing – Conductors of 600 volts, nominal, or less, shall comply with the spacing provided in Table 2.30.4.12(c).

1. Extension of secondary line from Remolador Extension going to Pinlac Drive
2. Extension of Secondary Line from CPG North to Pinlac Drive
3. Extension of secondary line at St Joseph Village, Dampas District
4. Extension of Secondary Line at Jumamil St., Manga District along Apao Private Road
5. Extension of Secondary Line to Purok 1 Dao, district (Site Ville Homes)
6. Extension of Secondary line at Bagaonga Pvt Road , Dao District
7. Extension of Secondary Line in St. Joseph at the back of HNU, Dampas District

4.4. Other Network Project

4.4.1. Installation of Circuit Recloser for Feeder D sectional Dao proper

Project Description/Specifications/Quantity:

Installation of one (1) unit recloser for the sectional at Dao proper to supply the district of Dao, Taloto, Ubujan, Mangga, Tiptip, San Isidro, Cabawan.

Technical Analysis:

The project if implemented will enhance proper coordination and selectivity of protection system thus improving efficiency and reliability of power supply to the service area in terms of momentary fault and fault duration. This project is also in preparation for the proposed SCADA of BLCI distribution system. Compliance to (PDC), Section 7.2.1.4 - The Distributor is responsible for designing, installing, and maintaining a distribution protection that will ensure the timely disconnection of faulted facilities and equipment.

At present any fault occurring downstream usually affect the whole feeder. Switching on/off also of a conventional fuse cut-out results to unbalance loading and single phasing which will greatly affect the network or feeder tripping.

4.4.2. Acquisition of Distribution Transformer and Accessories

Project Description/Specifications/Quantity:

Acquisition of Distribution Transformers and Accessories to accommodate load growth in the franchise area & enhance economic loading of every transformer in the distribution network. This is also in compliance to PDC (7.2.1.1) - The Distributor shall be responsible for operating and maintaining power quality in the distribution system during normal conditions and in proposing solutions to power quality problems in accordance with the provision of PDC Article 3.2 as scheduled below.

Technical Analysis:

The project if implemented will accommodate load growth in the franchise area, enhance economic loading of every distribution transformers in the network, avoid overloading, minimize low voltages and improve power quality for consumers. Demand growth is forecasted at 1.5MVA per year or 0.8MVA for common transformers and 0.7MVA for dedicated consumers, all at 80% maximum load.

Description	2016			2017			Total Qty	Total Cost
	2016 Qty	Unit Price	Cost	2017 Qty	Unit Price	Cost		
Common Distribution Transformer, 75KVA (LG)	8	136,504	1,092,032	8	143,329	1,146,631	16	2,238,663
Dedicated Distribution Transformer, 25 KVA (LG)	6	62,843	377,058	6	65,985	395,911	12	772,969
Dedicated Distribution Transformer, 37.5 KVA (LG)	6	79,515	477,090	6	83,491	500,945	12	978,035
Dedicated Distribution Transformer, 50 KVA (LG)	6	88,065	528,390	6	92,468	554,810	12	1,083,200
Dedicated Distribution Transformer, 10 KVA (LL)	6	41,895	377,055	9	43,990	395,908	15	772,963
Dedicated Distribution Transformer, 15 KVA (LL)	9	61,560	554,040	9	64,638	581,742	18	1,135,782
Dedicated Distribution Transformer, 25 KVA (LL)	15	64,125	961,875	15	67,331	1,009,969	30	1,971,844
Dedicated Distribution Transformer, 37.5 KVA (LL)	15	79,515	1,192,725	15	83,491	1,252,361	30	2,445,086
Dedicated Distribution Transformer, 50 KVA (LL)	15	88,065	1,320,975	15	92,468	1,387,024	30	2,707,999
Lightning Arrester	89	2,500	222,500.00	89	2,653	236,072.50	178	458,573
Fuse Cut-out	89	3,169	282,041.00	89	3,300	293,700.00	178	575,720
Total, Overall	84		7,385,773	84		7,755,061	168	15,140,834

4.4.3. Acquisition of Power Conditioning Equipment

Project Description/Specifications/Quantity:

Acquisition of power conditioning equipment such as capacitors, capacitor switches, lightning arresters, cutouts and other related accessories as scheduled below:

Description	2016			2017			Total Qty	Total Cost
	Qty	Unit Price	Cost	Qty	Unit Price	Cost		
Capacitors 100 KVAR	3	38,854	116,562	3	40,156	120,467	6	237,030
Capacitor Switch	1	578,813	578,813				1	578,813

Protection Accessories, LA & Cutout	6	6,113	36,680	6	6,419	38,514	6	75,194
Total, Overall			735,960			155,076		891,037

Technical Analysis:

The project will improve power factor, voltage and power quality of BLCI distribution system and eventually help reduce systems losses. It will also minimize On-Load Tap Changer (OLTC) operation & enhance life span of Power Transformers. The equipment will compensate the KVAR requirement of the system as the demand in the franchise area also increases. The sizes and location of installations are based on Synergy Software simulations.

4.4.4. Purchase of Materials, Supplies and Spares

Project Description/Specifications/Quantity:

Acquisition of materials, supplies and spares for the repair and maintenance of substation and distribution system equipment as scheduled below:

Year	2016	2017	Total
Materials, supplies and spares for substation equipment (TS)	314,748	330,485	645,233
Materials, supplies and spares for distribution lines (MAI)	836,943	878,790	1,715,733
Materials, supplies and spares for distribution operations equipment (OPN)	300,000	315,000	615,000
Total, Overall	1,451,691	1,524,275	2,975,966

Technical Analysis:

The availability of materials, supplies and spares will ensure reliability of BLCI system, proper maintenance of equipment and immediate restoration of power in case of equipment failure. Maintenance can be properly scheduled and implemented due to availability of materials, supplies and spares and emergencies can be responded immediately.

4.4.5. Purchase of poles, overhead conductor & devices

Project Description/Specifications/Quantity:

Purchase of poles, overhead conductor & devices for BLCI distribution system scheduled as follow:

Description	2016			2017			Total
	QTY	UNIT PRICE	TOTAL	QTY	UNIT PRICE	TOTAL	
Poles, Towers & Fixtures (20 customers at averages of 3 span per customer)	59 sets	16,950.00	1,000,000	59 set	17,797.00	1,050,000	2,050,000
Overhead Conductors and Devices(20 customers at average of 3 span per customer)	59 sets	16,950.00	1,000,000	59 set	17,797.00	1,050,000	2,050,000
Pole Metering Accessories (Estimated for 1000 Customers)	1,000 lot	581.00	580,513	1,000 lot	610.00	609,538	1,190,051
Total, Overall			2,580,513			2,709,538	5,290,051

Technical Analysis:

The purchase of poles, overhead conductor & devices will accommodate extension of lines for new connections and applications, system load growth and to improve the quality of service to the valued consumers. These items are also needed to improve reliability, efficiency and safe operation of the BLCI distribution system.

4.4.6. Replacement of Rotten Wood Poles

Project Description/Specifications/Quantity:

Replacement of Rotten Wood Poles in the BLCI Distribution System that poses danger to the general public scheduled as follows:

Description	2016			2017			Total Qty	Total Cost
	Qty	Unit Price	Total Cost	Qty	Unit Price	Total Cost		
Replacement of Rotten Poles (40'concrete)	16	16,548	264,760.00	15	18,533	277,998.00	31	542,758.00

Technical Analysis:

Replacement of rotten or dilapidated wood poles in the distribution network will improve reliability of BLCI Distribution System and prevent unscheduled tripping and outages of lines and ensure delivery of standard services as expected by the consumers. Pole replacement activities can be properly scheduled and prioritized based on the condition of the poles to enhance safe operation.

4.4.7. Acquisition of kWhr Meters

Project Description/Specifications/Quantity:

Acquisition of KWHR Meter for Residential, Non-Residential Customers, Load Center Metering, Feeder Metering & Replacement of Defective meters in compliance to regulations

Description	2016			2017			Total Qty	Total Cost
	Qty	Unit Price	Cost	Qty	Unit Price	Cost		
Load Center Metering, FM3S	15	12,518	187,768	15	13,144	197,156	30	384,924
Residential Metering, 60amp & 100amp, 2W, FM1S	1,200	1,080	1,296,000	1,200	1,134	1,360,800	2,400	2,656,800

Big Residential/Commercial Metering, FM3S & Current Transformers	25	22,532	563,304	25	23,659	591,469	50	1,154,773
Non-Residential Metering, FM5A, 4W Delta& Current Transformers	13	34,065	442,843	13	35,768	464,986	26	907,829
Replacement of Non-Res Meter, FM5A, 4W Delta	12	28,717	344,598	12	30,152	361,828	24	706,427
Non-Residential Metering, FM10A, 4W Delta & Instrument Transformers	9	94,522	850,695	9	99,248	893,229	18	1,743,924
Feeder Check Metering, FM10A, 4W Delta included & Instrument transformer	1	239,335	239,335				1	239,335
Total, Overall	1,275		3,924,543	1,275		3,869,468	2,550	7,794,012

Technical Analysis:

The availability of KWHR meters and accessories will ensure that all applicants for new electrical connection can be served promptly. It will also enhance compliance to meter sampling plan and defective kWhr meters can be responded to and replaced immediately. All BLCI distribution equipment facilities are all within the required standard parameters and BLCI is continuously working on to maintain the integrity of the equipment to ensure security of the distribution system hence part of the proposal of BLCI is the acquisition of necessary test equipment, tools and devices. The small amount for Load Center Metering will help BLCI monitor and compare the energy sales of a common transformer against what is delivered and trace any pilferages in the area. This will reduce non-technical losses in the system.

4.5. Non-Network Project

4.5.1. New Billing & Collection System

Project Description:

Acquisition of new computer software and program for billing and accounting system of BLCI to include accounting and other consumer related services.

Project Justification:

Our existing system was developed 15 years ago. It is a DOS-based 16-bit application running on a 16-bit operating system. This 16-bit application is only compatible with lower versions of Windows particularly Windows XP, Windows 98 and Windows 95. This operating system is no longer supported by its developer Microsoft. Security patches to this system are not available and is vulnerable to any viruses, malwares and spywares.

The new software and program will replace the old and outdated existing Billing & Collection System of BLCI. Secondly the support service of the vendor is not or rarely available.

Below are the major improvements of the new system are:

- Compatible with the latest windows operating system
- Faster teller transactions
- Faster generation & printing of bills
- Linkage of operations data, consumer applications and complaint system
- Fixed Asset Register
- Warehouse Inventory & Withdrawal/Ordering System
- Fast generation of reports, statistics and other consumer related services

If not Implemented:

- Workstations will be forced to use the old DOS program and windows operating system which is already outdated, vulnerable to viruses and malware and only limited to purely billing and collection system.
- Revision in billing system takes time or may not be possible in the future as there is no support from the software vendor.
- Slow generation & printing of bills will not be solve or upgraded.

4.5.2. Replacement Computers/Servers

Project Description:

Replacement of damaged or unserviceable computer parts particularly CPU's, motherboards, printers and other computer hardware parts and peripherals

Project Justification:

Replacement computers/servers/devices are essential equipment to ensure continuous operation of BLCI billing and collection system, accounting, warehousing and other consumer related services to include upgrade of units.

4.5.3. Repainting of BLCI Building

Project Description:

Repainting of BLCI Bldg. (internal and external)

Project Justification:

To preserve the building and make it look clean and presentable.

4.5.4. Acquisition of New Cash Vault, Queuing Machine, Bill Counter

Project Description:

Purchase of New Cash Vault, Queuing Machine and Bill Counter for replacement of the old and defective vault and teller devices.

Project Justification:

To further enhance security measures of the company's asset & properties and to provide better services to the consumers.

4.5.5. Acquisition of New Lineman's Belt

Project Description:

Acquisition of three (3) units New Lineman's Belt with pole strap

Project Justification:

Lineman's belts ensure the safety of personnel. It will also improve the efficiency of personnel tending complaints and repair works, improve productivity especially during group work and enhance effective customer service.

4.5.6. Acquisition of One (1) Unit Boom Truck

Project Description:

Acquisition of One (1) Unit Boom Truck complete with accessories, good surplus only.

Project Justification:

The boom truck to be acquired will be for use in the operation and maintenance of BLCI Substation and Distribution System. BLCI at present has only two (2) unit boom trucks which are very old and subject for replacement. These units were purchased from surplus in the late1990s and are costly to maintain.

The boom truck to be acquired will facilitate immediate response to customer's complaints and system emergencies. It will facilitate immediate completion of substation and distribution system activities, reduced downtime and enhance effective customer service. The purchase of boom trucks will reduce the repair time of maintenance personnel, thereby improving reliability, specifically SAIDI.

The boom truck will be used by operations and maintenance crew in their day to day activities such as installation of distribution transformers and accessories, erection of poles, repair of structures, clearing of trees and others.

5. ANNEXES

5.1. Forecasting Model Validity Test

The validity test of forecasting models is measured through scientifically proven parameters. The following tests are used to measure the validity of the forecast

- **The P-Value Test**

P value is associated with a test statistic. It is "the probability, if the test statistic really were distributed as it would be under the null hypothesis, of observing a test statistic [as extreme as, or more extreme than] the one actually observed. The smaller the P value, the more strongly the test rejects the null hypothesis, that is, the hypothesis being tested.

A *P-value* of .05 or less rejects the null hypothesis "at the 5% level" that is, the statistical assumptions used imply that only 5% of the time would the supposed statistical process produce a finding this extreme if the null hypothesis were true.

- **The T-Statistics Test**

After an estimation of a coefficient, the t-statistic for that coefficient is the ratio of the coefficient to its standard error. That can be tested against a t distribution to determine how probable it is that the true value of the coefficient is really zero.

It shows the significance of each explanatory variable in predicting the dependent variable.

The t-statistic greater than 2 (> 2) or less than −2 (< −2) for each variable generally acceptable.

- **The R-Squared Test**

R-squared—usually written R^2, also called the coefficient of determination. It tells how good the estimated regression equation is (also a measure of “goodness of fit”). It also indicates the total variation in the dependent variable around its mean (average) that is accounted for by the independent variable(s) in the estimated regression function.

Value ranges from 0 to 1; the closer the value to 1, the better the estimated function fit the data.

$$\boldsymbol{R^2 = 1 - \frac{ESS}{TSS}}$$

Where;

$$ESS = \sum_{i=1}^{n} \left(Y_i - \check{Y}_i\right)^2$$

$$TSS = \sum_{i=1}^{n} (Y_i - \bar{Y}_i)^2$$

ESS —*Error Sum of Squares*

TSS —*Total Sum of Squares*

Y_i —*Actual Value (Historical)*

$\hat{Y}_i$ —*Estimated Value*

$\bar{Y}_i$ —*Average Value*

➢ The Adjusted R-Squared Test

Another goodness-of-fit measure, which accounts for the number of independent variables included in a regression model; more appropriate measure than R Square for multiple regression. It can be used as a rule-of-thumb to help decide whether an additional independent variable enhances the predictive ability of a model or if it simply inflates the R Square statistic artificially. Value ranges from 0 to 1; the closer the value to 1, the better the estimated function fit the data. A value of 0.8 (80%) or higher indicates a very good fit.

$$\boldsymbol{R^2{}_{adj} = 1 - \left(\frac{ESS}{TSS}\right)\left(\frac{n-1}{n-k-1}\right)}$$

Where:

n — *no. of data points*

k — no. of independent variables

➢ The Mean Absolute Percentage Error (MAPE) Test

MAPE is a measure of accuracy of a method for constructing fitted time series values in statistics, specifically in trend estimation. It usually expresses accuracy as a percentage, and is defined by the formula: *where A_t is the actual value and F_t is the forecast value.*

$$MAPE = \frac{\sum_{t=1}^{n} \frac{|e^t|}{Y_t}}{n}$$

5.2. Summary of Capex Projects (2016-2017)

DESCRIPTION	CATEGORY	CY 2016	CY 2017
Purchase of Lot and Related Improvements			
- Purchase of Lot	Growth	12,800,000	
- Site Development and Grading		1,393,116	
- Fencing of San Isidro Lot			1,021,600
4th 10MVA Transformer Project	Capacity	23,738,000	12,782,000
Extension of Primary Lines			
- Extension of 1 - phase primary line with secondary line at Purok 4, Booy District	Safety	142,621	
- Extension of Primary and Secondary Line to Capitol Valley Phase 3, Dao District	Safety	141,135	
- Extension of primary line at Sitio Badjong, Dao Dist	Safety	284,181	
- Extension of 3 phase primary lines from San Isidro SS along F. Toledo St.	Capacity		1,534,304
- Re-routing of 3 - phase primary line at Taloto District	Safety		119,295
- Extension of 1 - phase Primary & Secondary Lines along Gondong St., Sitio Quijaw, Ubujan District	Safety		147,951
Upgrading of Primary Lines			
- Relocation of Distribution Lines along Maria Clara	Safety & Government Project	579,940	
- Relocation of Distribution Lines along Butalid St	Safety & Government Project	234,388	
- Upgrading of Poles along Visarra St.	Safety	37,044	

Extension of Secondary Lines			
- Upgrading of Secondary Line from Remolador to Pinlac Drive	Safety	35,698	
- Upgrading of Secondary Line from CPG Ave. going to Pinlac Drive	Safety	35,698	
- Extension of Secondary Line at St Joseph Village, Dampas District	Safety	22,907	
- Extension of Secondary Line at Jumamil St., Mangga District along Apao Road	Safety	56,247	
- Extension of Secondary Line to Purok 1, Dao District (Site Ville Homes)	Safety	147,180	
- Extension of Secondary Line at Bagaonga Private Road, Dao Dist	Safety	150,440	
- Extension of secondary line in St. Joseph Village, back of HNU, Dampas District	Safety	87,318	
- Extension of Secondary Line to Sitio Antipolo, Dampas District	Safety		66,388
- Extension of Secondary Line at Magsaysay Extension, Manga District	Safety		33,990
- Extension of Secondary Line at Cajes – Gonzaga Road, Dao District	Safety		70,275
- Extension of Secondary Line going to Bishop Zafra's Residence, Dao District	Safety		91,908
Other Network Projects			
- Installation of Re-closer for Feeder D Sectional Dao Proper	Reliability	500,000	
- Acquisition of Distribution Transformer and Accessories	Capacity	7,385,773	7,755,061
- Acquisition of Power Conditioning Equipment	Reliability	735,960	155,076
- Purchase of Materials, Supplies and Spares	Capacity	1,451,691	1,524,275
- Purchase of Poles, Overhead Conductor & Devices	Capacity & Reliability	2,580,513	2,709,538
- Replacement of Wood Poles	Safety	264,760	277,998
- Acquisition of KWHR Meters	Capacity	3,924,543	3,869,468

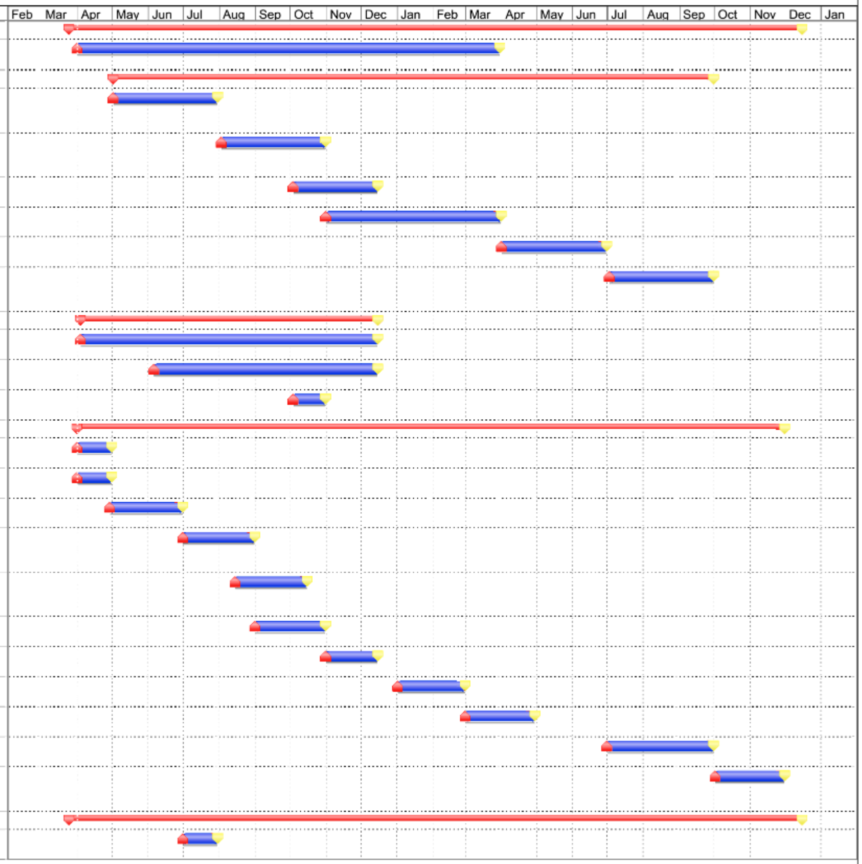
Non-Network Projects			
- New Billing & Collection System	Non-Network	5,000,000	
ICT Non Network Project			
- Replacement of computer servers	Non-Network	163,800	
- Sound System	Non-Network	25,000	
- Acquisition of UPS	Non-Network	20,000	
- Anti-virus software	Non-Network	52,849	
- Server Room Equipment	Non-Network	82,000	
- Replacement of Computer/Servers	Non-Network		163,800
- Upgrading of PABX	Non-Network		48,000
- Acquisition of Surveillance Camera	Non-Network		60,000
- Acquisition of Computer Network Peripherals	Non-Network		20,000
- Acquisition of GPS	Non-Network		10,000
- Acquisition of base radio	Non-Network		70, 000
Admin Non Network Project			
- Repainting of BLCI Bldg	Non-Network	140,000	
- Repair of BLCI Drainage	Non-Network	70,000	
- Revision & Improvement of Fire Exit	Non-Network	80,000	
- Renovation /Expansion of BLCI Server Room	Non-Network		150,000
- Acquisition of new Cash Vault, Queuing Machine, Bill counter	Non-Network	60,000	
- Acquisition of AC	Non-Network	25,000	
Tools Shop Garage and Lab Eqpts.	Non-Network		
- Acquisition of Clamp Meter Multi Tester	Non-Network		14,112
- Acquisition of Single Phase KWH Meter Tester	Non-Network		680,000
- Acquisition of oil pump	Non-Network	70,000	
- Acquisition of micro ohm meter	Non-Network	240,000	
- Acquisition of Electric Drill	Non-Network		30,000
- Acquisition of new bolt meter	Non-Network		9,572
- Acquisition of New grounding cluster	Non-Network		140,000

- Acquisition of Clamp Meter Multi tester	Non-Network		21,000
- Acquisition of new fiber glass ladder	Non-Network		40,000
- Acquisition of new hot stick	Non-Network		30,000
- Acquisition of New compression tool	Non-Network		25,000
- Acquisition of New Tool box	Non-Network		10,000
- Acquisition of new ratchet	Non-Network		10,000
- Acquisition of new Chicago grips	Non-Network		10,000
- Acquisition of 2 units of new line men's belt	Non-Network		30,000
- Acquisition of new box wrench	Non-Network	5,000	
- Acquisition of 2 units fiber glass ladder	Non-Network	40,000	
- Acquisition of 3 units of New linemen's belt	Non-Network	45,000	
Acquisition of 1 unit boom truck	Non-Network		1,200,000
TOTAL		**62,847,802**	**34,895,611**
GRAND TOTAL			**97,743,413**

5.3. Capex Project Schedule (2016-2017)

CAPEX 2016 - 2017 GANTT CHART

WBS	Task Name	Duration	Start
0	**CAPEX 2016 -2017**	**464 days**	**Fri 3/25/16**
1	**INSTALLATION OF 4TH 10MVA SUBSTATION**	**268 days**	Fri 4/1/16
2	**EXTENSION OF PRIMARY LINES**	**381 days**	**Mon 5/2/16**
2.1	Extension of 1-phase primary line and secondary line at Purok 4, Booy District	67 days	Mon 5/2/16
2.2	Extension of Primary and Secondary Line at Capitol Valley Phase 3, Dao District	67 days	Wed 8/3/16
2.3	Extension of Primary Line at Sitio Bajong, Dao District	55 days	Tue 10/4/16
2.4	Installation of Primary Line from San Isidro S/S along F. Toledo St. to H.	110 days	Tue 11/1/16
2.5	Re-routing of 3-phase primary line along P. Cabalit St., Taloto District	67 days	Sat 4/1/17
2.6	Extension of 1-Primary and Secondary Lines along Gondong St., Sitio Quijaw, Ubujan District	67 days	Mon 7/3/17
3	**UPGRADING OF PRIMARY LINES**	**191 days**	**Mon 4/4/16**
3.1	Relocation of Distribution Line along Ma. Clara St.	191 days	Mon 4/4/16
3.2	Relocation of Distribution Line Butalid St.	143 days	Mon 6/6/16
3.3	Upgrading of Lines along Vissara St.	22 days	Tue 10/4/16
4	**EXTENSION OF SECONDARY LINES**	**448 days**	**Fri 4/1/16**
4.1	Extension of Secondary Line from Remolador St., going to Pinlac Drive	23 days	Fri 4/1/16
4.2	Extension of Secondary Line from CPG Ave., going to Pinlac Drive	23 days	Fri 4/1/16
4.3	Extension of Secondary Line at St. Joseph Village, Dampas District	46 days	Fri 4/29/16
4.4	Extention of Secondary Line at Jumamil St., Manga District along Apao Private Road	45 days	Fri 7/1/16
4.5	Extension of Secondary Line at Purok 1 Dao, District (Site Ville Homes)	47 days	Mon 8/15/16
4.6	Extension of Secondary Line at Bagaonga Private Road, Dao District	46 days	Thu 9/1/16
4.7	Extension of Secondary Line in St. Joseph Village back of HNU, Dampas	33 days	Tue 11/1/16
4.8	Extension of Secondary Line to Sitio Antipolo, Dampas District	42 days	Mon 1/2/17
4.9	Extension of Secondary Line at Magsaysay Extension Manga District	45 days	Wed 3/1/17
4.10	Extension of Secondary Line at Cajes-Gonzaga Road, Dao District	68 days	Sat 7/1/17
4.11	Extension of Secondary Line going to Bishop Zaffra's Residence, Dao District	44 days	Mon 10/2/17
5	**OTHER NETWORK PROJECT**	**464 days**	**Fri 3/25/16**
5.1	Installation of Re-closer for Feeder D Sectional Dao Proper	22 days	Fri 7/1/16



Project Name: CAPEX 2016 - 2017
Date: Fri 4/1/16

Project Duration — Start — In Progress
Project Summary — End

Page 1

CAPEX 2016 - 2017 GANTT CHART

WBS	Task Name	Duration	Start
5.2	Acquisition of Distribution Transformer and Accessories	464 days	Fri 3/25/16
5.3	Acquisition of Power Conditioning Equipment	459 days	Fri 4/1/16
5.4	Purchase of Materials, Supplies and Spares	459 days	Fri 4/1/16
5.5	Purchase of Poles, Overhead Conductor and Divices	459 days	Fri 4/1/16
5.6	Replacement of Wood Poles	459 days	Fri 4/1/16
5.7	Acquisition of KWHR Meters	459 days	Fri 4/1/16