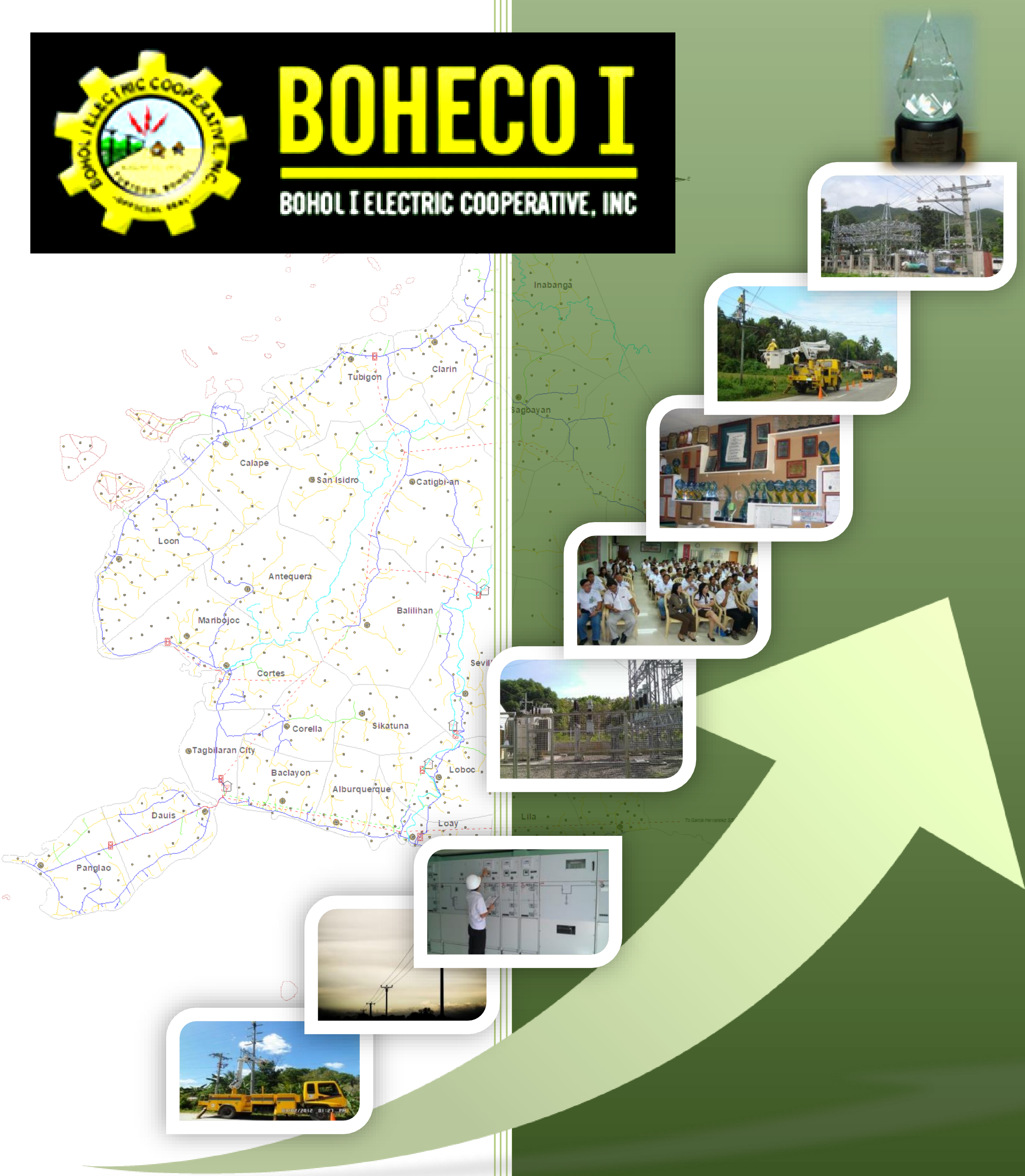
BOHECO I

BOHOL I ELECTRIC COOPERATIVE, INC



2016-2025 DISTRIBUTION DEVELOPMENT PLAN

Prepared By: **BOHECO I Technical Working Group**

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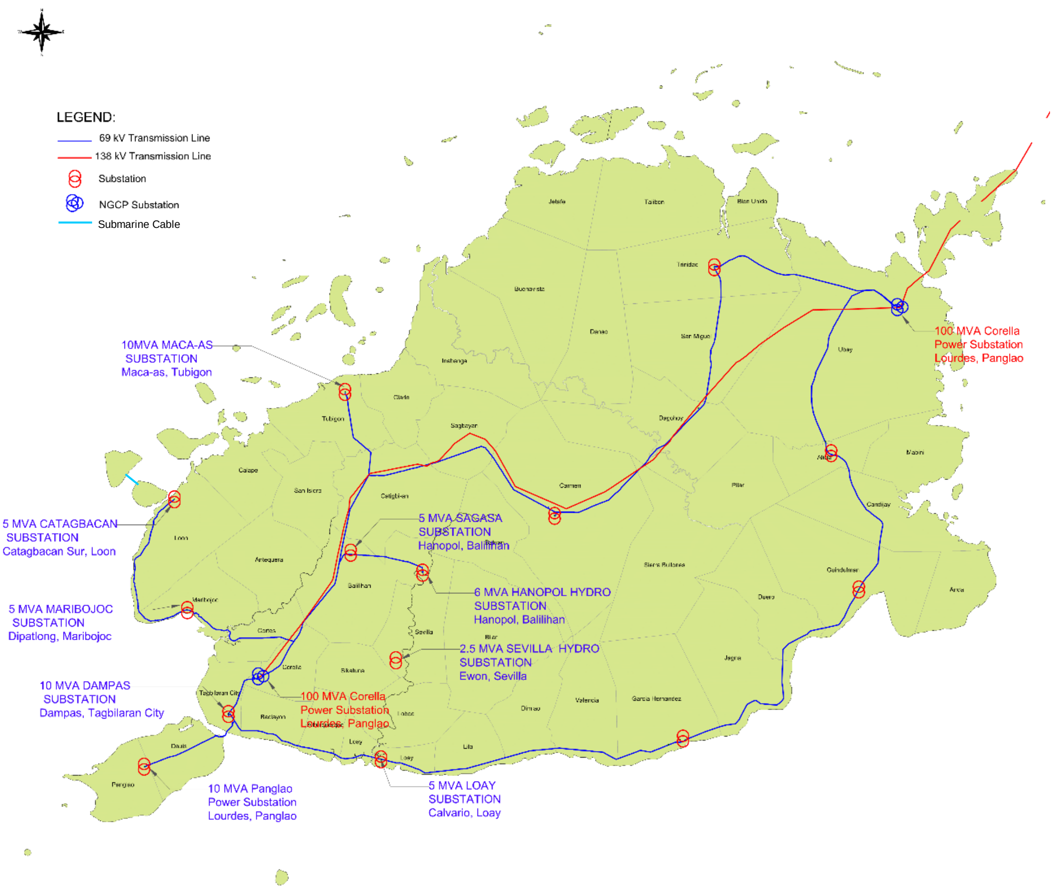
1.1. Mandate of Franchised Electric Cooperative

To provide safe, reliable, dependable and least-cost electric service, and to help enhance the economic condition of the people within its coverage area, Bohol I Electric Cooperative was established on August 11, 1971 as a non-stock, non-profit, member-owned electric cooperative. It aims to render the highest possible level of service to its members-consumers throughout its coverage area.

1.2. BOHECO I Distribution System

Bohol I Electric Cooperative, Inc. (BOHECO I) is an electric distribution utility that serves 26 out of 48 municipalities in the southwest portion of Bohol excluding its capital city—*Tagbilaran City*. It covers 603 barangays in the mainland and 15 barangays in the islands. Ten of these island-barangays are connected off-grid through the Small Power Utility Group of the National Power Corporation (NPC-SPUG) while the remaining five barangays of Cabilao Island in the municipality of Loon were recently connected to the main grid through a 13.2-kV submarine cable.

Figure 1-1 BOHECO I System Map



Anchored in providing an electric service in accordance with service quality performance standards, BOHECO I maintains nine (9) power substations: two (2) are used for step-up from the power generation of Janopol Mini Hydro Electric Power Plant and BOHECO I Sevilla Mini Hydro Plant, and seven (7) are utilized to serve the coverage area. Also, additional substations will be commissioned by the first quarter of 2017; (1) 5-MVA Sagasa Substation in Sagasa, Balilihan and (2) Privately owned 3-MVA Liwayway Corp. Substation in Vilarcayo, Carmen.

In 2016, the 139, 269 consumers of BOHECO I were served with a rated 55-MVA total installed capacity which is 70% loaded with a peak demand of 34.455 MW, a load factor of 67% and a power factor of 98%. BOHECO I operates and maintains 45.58-km 69-kV sub-transmission lines and twenty-four (24) feeders that include 1,726.44 km of primary distribution lines and 1,844.16 km of secondary distribution lines.

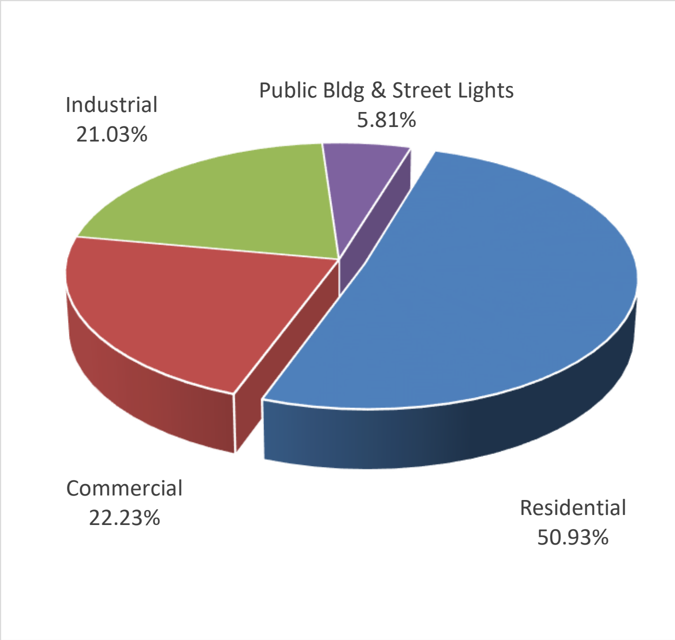


Figure 1-2: BOHECO I Sales per Customer Type

It consistently maintains a single digit system loss and diligently complies with the standards of the Philippine Distribution Code where none of the customers served have voltages higher or lower than 10% of the nominal 230 Volts. BOHECO I's voltage unbalances in its three-phase lines are less than 2.5%. Its System Average Interruption Frequency Index (SAIFI) is at 7.3 interruptions per customer-year and its System Average Interruption Duration Index (SAIDI) is only 13.7 hours per customer-year.

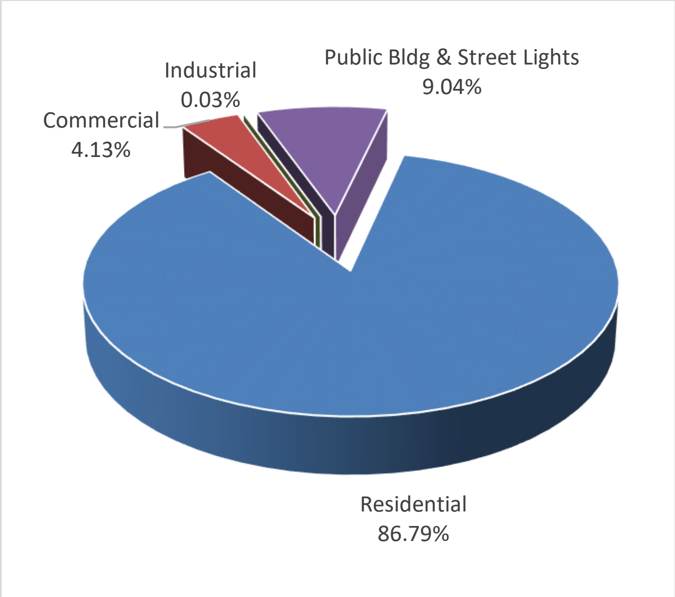


Figure 1-3: Customer Count per Customer Type

In that same year, BOHECO I had a total energy sales of 170 GWh at an average system rate of 7.54 PhP/kWh.

1.3. Consumer Demand and Energy

Bohol is one of the major tourist destinations in the country, thus making tourism industry one of the major economic drivers in the franchised area of BOHECO I. Statistical Data from year 2011 to 2015 show that the demand for power (kW) and energy (kWh) were increasing as shown in the tables below.

Table 1-1 Historical Yearly Average No. Of Customers

Year	Residential	Commercial Small	Commercial Large	Public Buildings	Street Lights	Industrials	BAPA & ECA
2010	63,790	5,063	363	2,453	7,342	28	36,055
2011	65,262	5,131	331	2,544	7,857	30	37,228
2012	67,018	5,219	329	2,633	8,242	29	38,694
2013	68,217	5,254	328	2,656	8,515	33	39,528
2014	68,341	5,128	328	2,547	8,702	34	40,167
2015	71,391	5,212	333	2,706	9,112	39	41,817
2016	75,777	5,419	337	2,934	9,522	46	43,271

Table 1-2: Historical Yearly Energy Consumptions (Megawatt-Hour)

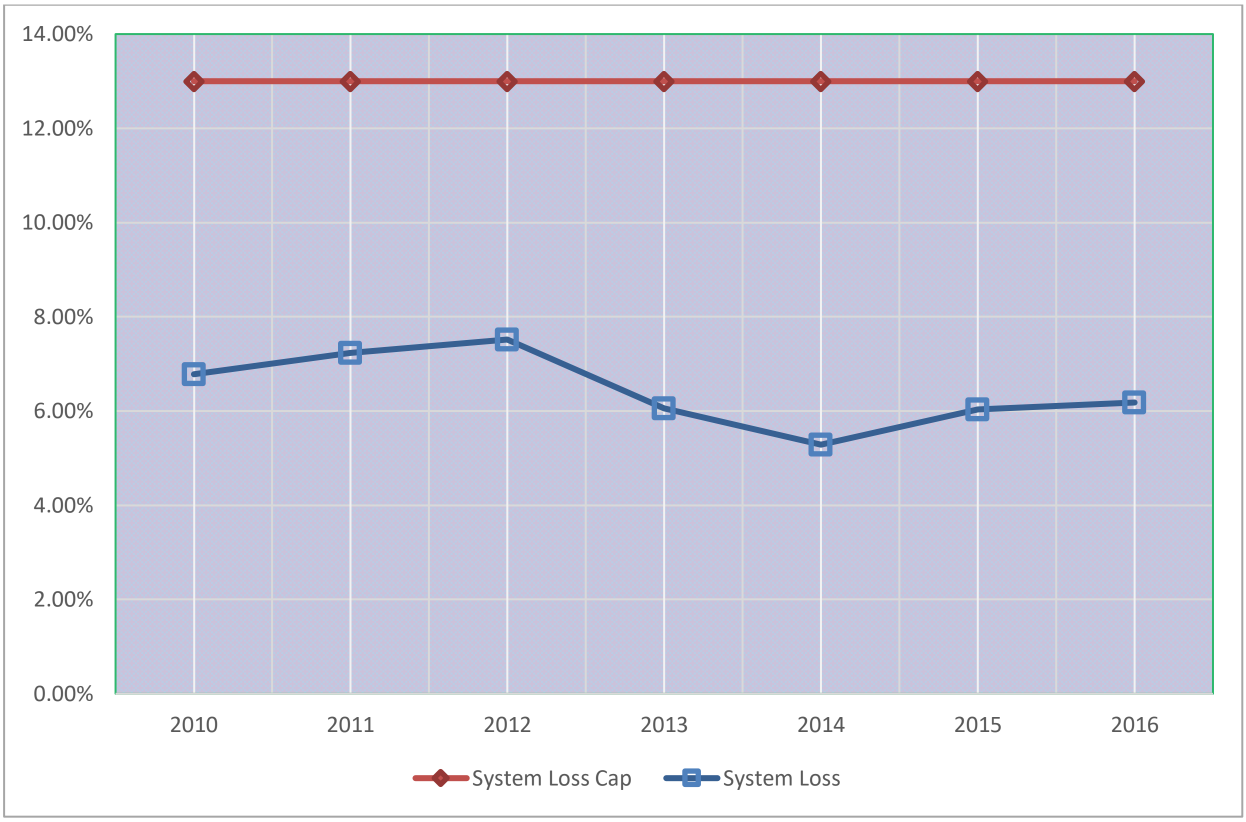
Year	Residential	Commercial Small	Commercial Large	Public Buildings	Street Lights	Industrials	BAPA & ECA
2010	45,639	12,458	20,612	5,799	1,094	12,951	9,655
2011	47,207	14,088	20,386	6,191	1,191	15,031	10,016
2012	49,966	15,394	22,020	6,557	1,309	15,531	10,328
2013	50,356	15,347	14,253	6,446	1,317	22,375	10,318
2014	53,297	15,652	14,371	6,691	1,404	23,125	11,460
2015	60,113	18,404	15,449	7,615	1,440	29,373	12,462
2016	71,913	21,614	16,361	8,424	1,502	35,932	14,694

1.4. Utility Performance

In the last five years, BOHECO I has maintained a single digit systems loss as shown in Figure 1-4. BOHECO I is mandated to provide the least possible cost of power to its customers, therefore it strives to maintain its efficiency at the highest optimal level.

BOHECO I's efficiency performance for the past years has always been way below the NEA's thirteen percent (13.0%) established cap level of losses for electric cooperatives *(shown in Figure 1-4).* The Electric Cooperative is committed to maintain a single digit systems loss in the forthcoming years.

Figure 1-4 Historical Systems Loss Performance of BOHECO I in percent

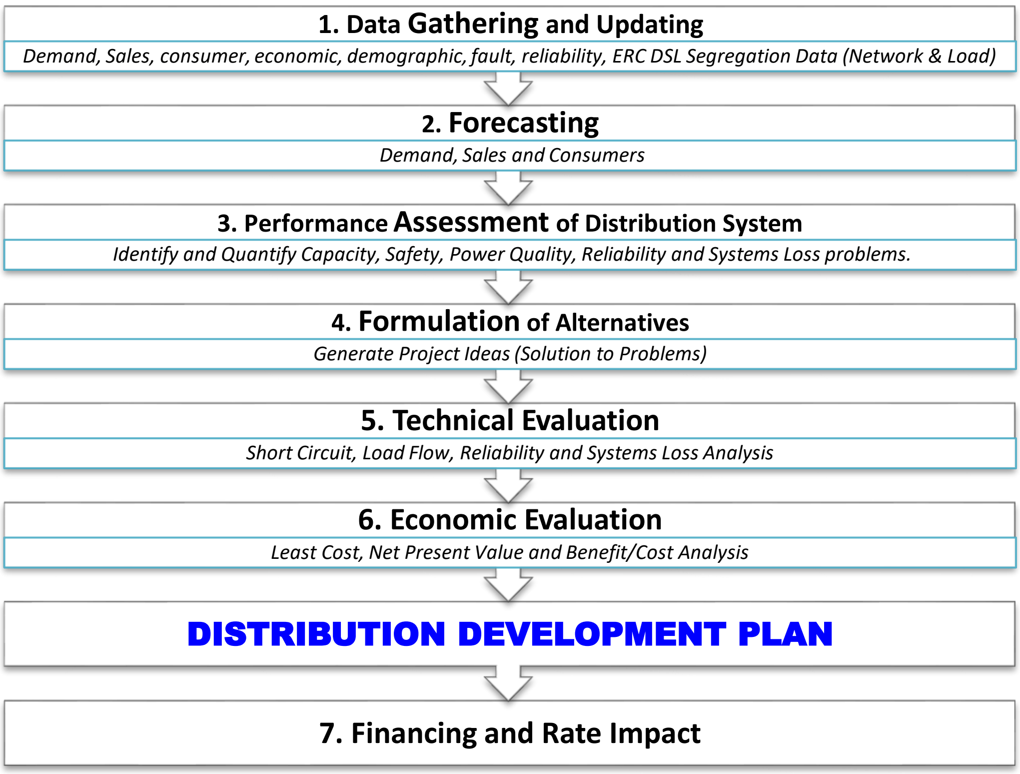


Chapter 2: Distribution Planning Process, Methodology and Criteria

A comprehensive distribution system planning is essential in providing the management with an economic perspective in the development of BOHECO I's distribution system. This will ensure adequate and reliable service at the least-cost manner to its consumers.

The Distribution System Planning process consists of several steps which includes: (1) data gathering and updating, (2) forecasting, (3) performance assessment of the distribution system, (4) formulation of possible solutions/alternatives, (5) technical evaluation of solutions/alternatives according to standard performance criteria, and (6) economic evaluation or selection of the most suitable least-cost alternative solutions that form part of the distribution development strategy, and (7) financial analysis and rate impact assessment.

Figure 2-1 Distribution Development Planning Flowchart



2.1. Data Gathering and Updating

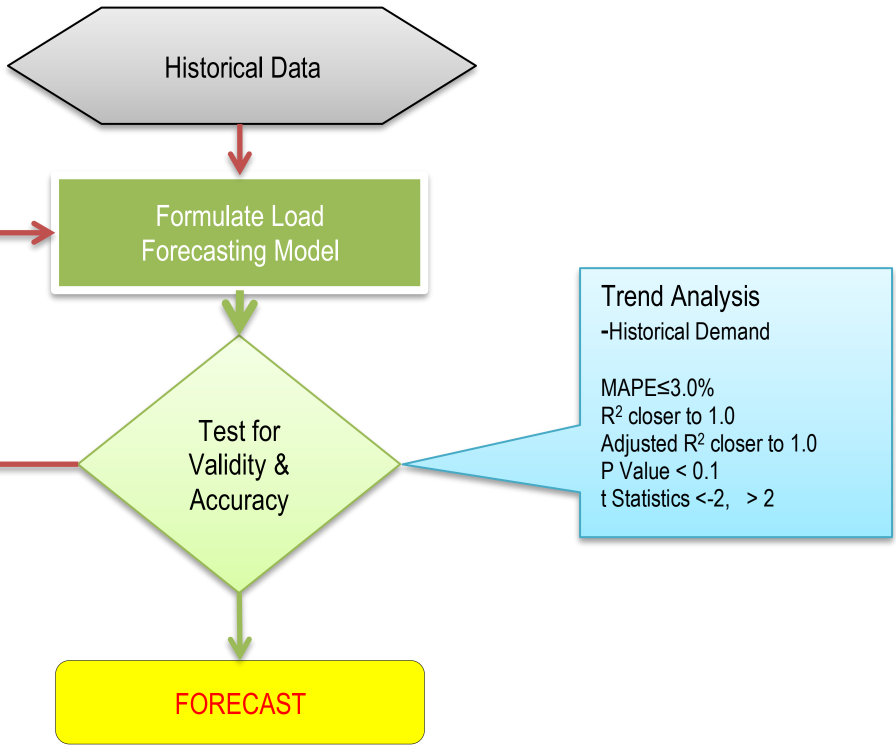
Historical data pertinent to the required forecasts and system performance analysis are gathered regularly. Accurate historical data such as number of customers per customer class, energy sales, hourly demand, outage data, etc… are needed in forecasting future demand and system requirements, and performance evaluation.

2.2. Forecasting

Electricity demand forecasting is a fundamental process for distribution development planning. Forecasts allow us to prepare for future system requirements and help us predict and evaluate future performance of the distribution system. The forecasting methodology used depends on factors such as the type of and availability of data such as historical energy and peak demand data, econometric data (population GDP, DRDP, and the like), and municipal and development plans.

BOHECO I employs historical data and trend analysis using regression models to predict future energy consumption and peak demand. We apply scientific and statistical methods in validating our forecasting models using internationally accepted standards and criteria. Figure 2-2 shows the flowchart describing our forecasting methodology and the technical criteria used.

Figure 2-2 Methodology of Forecasting



2.3. Technical Performance Assessment and Analysis

Technical simulation, performance evaluation and analysis of the distribution system is performed to determine the current and future performance of the distribution system against technical standards and criteria set forth by the Philippine Distribution Code (PDC), Philippine Grid Code (PGC), and the Philippine Electrical

Code (PEC) and performance requirements stipulated by ERC. During this analysis we are able to identify and problems or deficiency in the existing as well as future distribution system. The required analyses include: (a) Capacity Analysis, (b) Power Quality Analysis, (c) Safety Analysis, (d) Systems Loss Analysis, and (e) Reliability Analysis. The same set of analyses are also performed to test the effectivity and feasibility of proposed projects that are expected to provide solutions to the identified problems. Projects that pass the technical criteria set by the PDC, PGC, and PEC are identified as technically feasible projects that will be subjected to economic evaluation.

2.4. <u>Economic Evaluation</u>

Economic evaluation is performed on two or more technically feasible alternatives/ solutions to an identified distribution system problem. The technically feasible solution that is determined as the least-cost (lifetime cost) alternative will be the one chosen to be implemented. Two forms of economic analyses are typically done: the (a) Net Present Value, and (b) Benefit/Cost analysis. The NPV analysis is used to evaluate mandatory projects when the system does not comply to the minimum standards, while Benefit/Cost Ratio is used to evaluate non-mandatory projects such as in Systems Loss Reduction and Reliability Improvement projects where the system loss or reliability already complies with minimum required standards.

2.5. <u>Financial Analysis and Rate Impact Assessment</u>

Financial analysis is performed to simulate and evaluate the effect of proposed project costs on the current and future expected cashflows and loan amortizations to creditor banks and other financial institutions. When heavy negative cash flows are expected, prioritization of projects may be done to minimize the impact on the DU's cashflow. Some non-mandatory projects and other projects of lesser priority may be deferred. It is also important to determine whether the existing rates can still provide for the expected capital expenditures. If rates are insufficient, a rate increase may be proposed and submitted to the ERC for approval. Furthermore, some projects may be deferred if the rate impact is too much for the consumers to handle. Financial Analysis and Rate Impact Assessment, although not presented in this DDP, forms part of the DUs submission to ERC for Capex Application of this DDP.

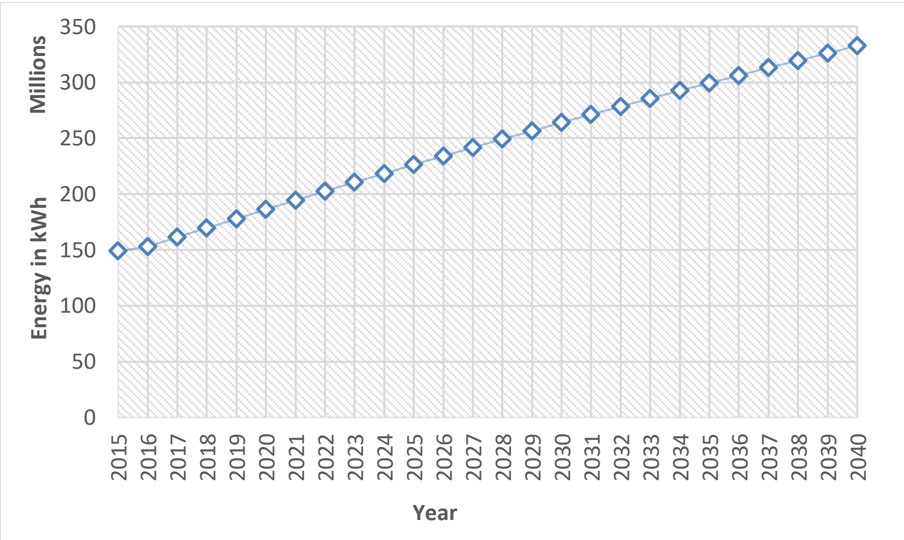
BOHECO I applied a combined approach where the forecasted system energy is allocated based on the forecast of each of its feeders.

3.1. System Energy Forecast

The historical data used in forecasting the system energy were based on the annual registered energy in the BOHECO I metering per feeder.

In accordance with the forecasting methodology presented in Section 1.6, BOHECO I applied a combined approach where the forecasted system energy is allocated based on the forecast of each feeders.

Figure 3-1 BOHECO I System Energy Forecast



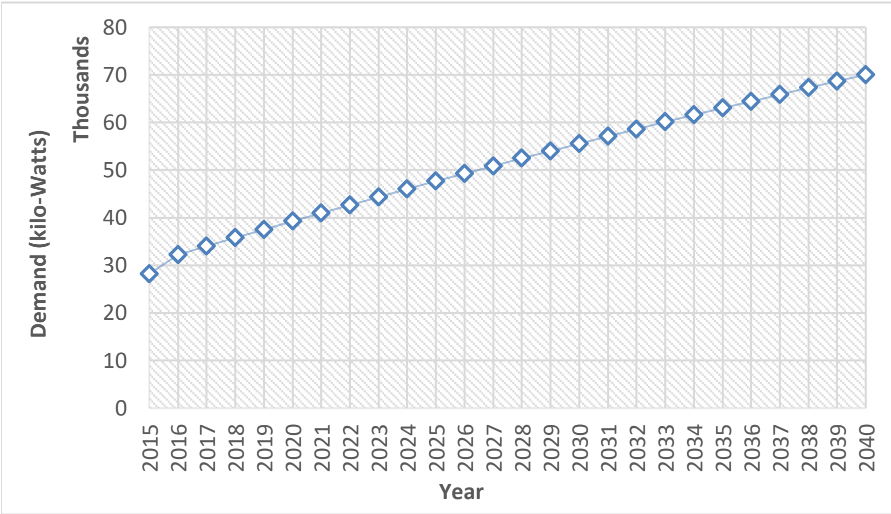
YEAR	Energy (kWh)
2015	149,010,061
2016	152,965,634
2017	161,282,582
2018	169,611,216
2019	177,914,416
2020	186,166,940
2025	***226,234,169***
2030	***263,958,571***
2035	***299,392,024***
2040	***332,766,219***

The forecasted output (see Annex A) was used in evaluating the system's technical performance, loading and capacity for the next five years. The need for systems capacity augmentation projects and capital-intensive projects were identified through this. The detailed forecasted data per feeders are shown in Annex B-2.

3.2. System Demand Forecast

The forecasted system demand (kW) presented in Annex B-3 is an integral part in system capacity analysis where it measures whether the installed capacity is sufficient to cater to the projected requirement in each substation. Figure 3-2 below shows the 25-year forecasted demand of BOHECO I. The detailed forecasted data per feeder are shown in Annex B-3.

Figure 3-2 System Demand Forecast (kW)

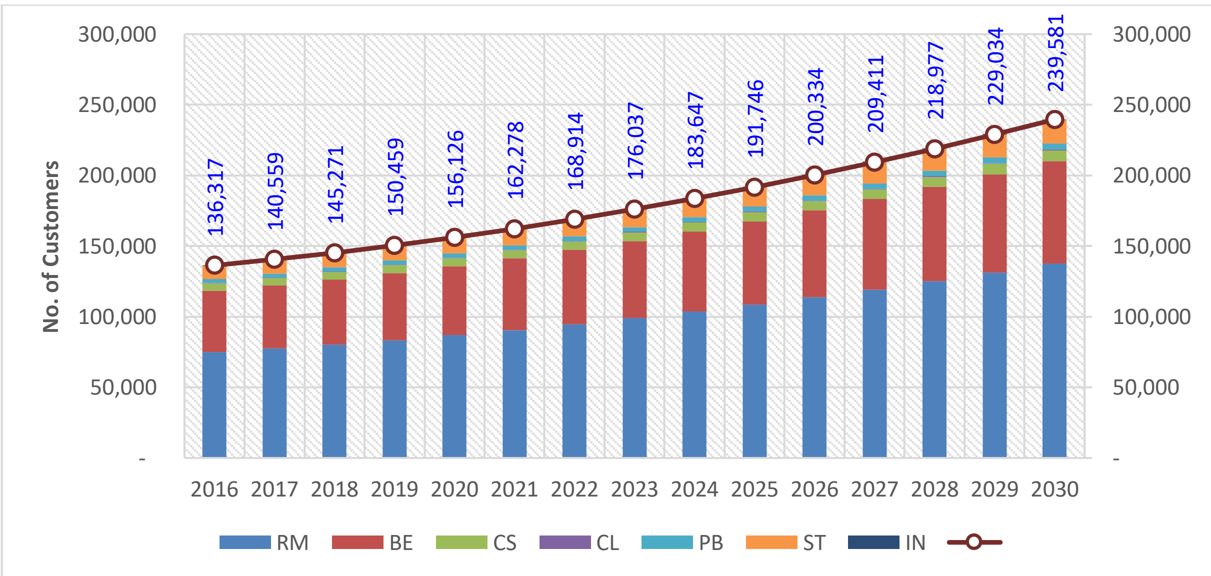


Year	Demand (kW)
2015	28,227
2016	32,278
2017	34,023
2018	35,771
2019	37,513
2020	39,245
2025	***47,653***
2030	***55,573***
2035	***63,020***
2040	***70,047***

3.3. <u>Njumber of Customers per Customer Type Forecast</u>

The forecast of number of customers plays a vital role in the planning process because this determines future revenue that will cover capital expenditure and operating costs and additional expenses for meters and other equipment. Figure 3-3 below shows the forecasted number of customers, add-ons per customer type with the total number of customers in the base year 2015.

Figure 3-3 Forecasted No. of Customer per Type



3.4. Substation Capacity

With a total installed capacity of 55-MVA, BOHECO I has adequate capacity to serve the maximum coincidental peak demand of 28.227 MW at a power factor of 98.98 percent as registered in the year 2015. The seven (7) substations are strategically located in the load centers in every feeder system served.

Table 3-1 Substation Data – 2015

Substation	Rated Capacity (MVA)	Peak Demand (MW)	Percent Loading	Power Factor	Load Factor
Maca-as	10	7.54	77%	98%	59.85%
Dampas	10	5.6	59%	95%	65.62%
Carmen	5	3.8	76%	100%	52.25%
Loay	10	5.0	50%	100%	54.68%
Maribojoc	5	3.3	70%	95%	55.12%
Panglao	10	5.9	60%	99%	63.07%
Catagbacan	5				
Total	**55**	**28.3**	51%	100%	62.23%

According to the Electric Cooperative Distribution Utility Planning Manual (ECDUPM), it is recommended to make plans for additional capacity when the percent loading of the substation reaches seventy percent (70%).

Table 3-2 Forecasted Percent Loading Per Substation

Substation	Rated Capacity (kVA)	Power Factor	PERCENT LOADING PER YEAR									
			2015	2016	2017	2018	2019	2020	***2025***	***2030***	***2035***	***2040***
Macaas	10,000	95%	63%	72%	61%	64%	67%	70%	*84%*	*97%*	*109%*	*118%*
Dampas	10,000	95%	53%	67%	70%	74%	56%	80%	*96%*	*110%*	*123%*	*136%*
Carmen	5,000	95%	78%	89%	95%	101%	106%	112%	*141%*	*168%*	*194%*	*220%*
Loay	10,000	95%	32%	37%	38%	40%	42%	44%	*53%*	*62%*	*71%*	*79%*
Maribojoc	5,000	95%	46%	53%	55%	57%	60%	62%	*73%*	*83%*	*93%*	*102%*
Panglao	10,000	95%	65%	68%	72%	76%	81%	85%	*105%*	*125%*	*144%*	*162%*
Catagbacan	5,000	95%		50%	52%	55%	58%	60%	*73%*	*85%*	*95%*	*103%*
Sagasa	5,000	95%		0%	29%	31%	32%	33%	*40%*	*46%*	*52%*	*57%*
Total	62,500	95%	48%	54%	57%	60%	60%	66%	*80%*	*80%*	*80%*	*80%*

4.1. Distribution System Power Quality Performance

Under Section 3.2.1 of the Philippine Distribution Code (PDC), power quality is defined as the quality of the voltage, including its frequency and the resulting current, which are measured in the Distribution System during normal conditions. Section 3.2.3.3 states that the nominal voltage of the system should not be less than 90% or 110% above its nominal voltage.

BOHECO I has a nominal voltage level at the secondary distribution system of 230 volts. The regulated minimum and maximum threshold for this voltage level according to the PDC is 207 Volts and 253 Volts, respectively.

To evaluate the power quality of the BOHECO I Distribution System, technical assessment through load flow simulation was conducted to determine the loading conditions of the lines in every node, transformers under certain conditions, electric current flows, voltage drops and technical system losses.

Table 4-1 below shows the technical performance of BOHECO I Distribution Feeder System in terms of power quality and system efficiency. It shows that the rest of the feeders have passed the standard level except for Feeder-06 where the minimum voltage starting in the year 2016 will be below the minimum threshold voltage. Network development and correction shall address this deficiency of Feeder-20. A project related to the known power quality problem of Feeder-06 is discussed in Section 5.1 where alternative solutions are evaluated techno-economically.

Table 4-1 Forecasted Power Quality Performance of BOHECO I Distribution System

Substation	Feeder	Power Quality Performance per Year					
		2015	2016	2017	2018	2019	2020
	F01	0.96	0.95	0.95	0.94	0.94	0.93
	F02	0.94	0.94	0.94	0.93	0.93	0.93
	F03	0.97	0.97	0.97	0.96	0.96	0.96
	F12	0.98	0.98	0.98	0.98	0.98	0.97
	F04	0.97	0.96	0.96	0.96	0.95	0.95
	F05	0.94	0.94	0.94	0.94	0.93	0.93
	F06	0.90	0.89	0.89	0.88	0.88	0.88
	F07	0.96	0.96	0.96	0.95	0.95	0.94
	F08	0.96	0.95	0.94	0.94	0.93	0.92

	F13	0.97	0.97	0.96	0.96	0.95	0.95
	F09	0.94	0.94	0.94	0.94	0.94	0.93
	F10	0.96	0.96	0.96	0.96	0.96	0.95
	F11	0.96	0.95	0.95	0.95	0.94	0.94
	F15	0.97	0.97	0.97	0.96	0.96	0.96
	F16	0.93	0.93	0.92	0.92	0.92	0.91
	F17	0.98	0.98	0.98	0.98	0.98	0.98
	F18	1.00	1.00	0.99	0.99	0.99	0.99
	F18A	0.98	0.98	0.97	0.97	0.97	0.97
	F19	0.95	0.94	0.94	0.93	0.93	0.93
	F20	0.92	0.92	0.91	0.91	0.90	0.90
	F20A	0.97	0.97	0.97	0.97	0.97	0.96
	F21	0.98	0.98	0.98	0.97	0.97	0.97
	F22	0.98	0.98	0.98	0.98	0.97	0.97
	F23	1.00	1.00	0.99	0.99	0.99	0.99
	F24	1.00	1.00	1.00	1.00	1.00	1.00
	F25	0.95	0.94	0.94	0.94	0.93	0.93
	F26	0.98	0.98	0.97	0.97	0.97	0.97

4.2. Protection and Safety

We conducted Short circuit calculations and analyses to determine whether BOHECO I distribution system adheres to minimum safety and protection standards. Calculations were performed for various types of fault: three-phase, single line to ground fault, and double line to ground fault at every node of the entire distribution system. The calculated fault current levels were used to select fuses, circuit breakers and protective relays and to determine whether current protection equipment can detect minimum fault levels and withstand maximum fault levels.

Shown in Table 4-2 below is the NGCP Fault Data used, together with our distribution system's line and transformer models, in the calculation of short circuit currents in the distribution system.

Table 4-2 NGCP Fault Data per Substation

		3-PH Fault		1LG Fault	
		MVA	X / R Ratio	MVA	X / R Ratio
Tubigon	69	157.87	4.51	126.55	4.28

Dampas	69	328.42	7.59	282.98	7.42
Carmen	69	114.13	3.58	81.89	4.01
Loay	69	179.27	4.89	152.42	4.56
Maribojoc	69	218.23	4.96	187.52	5.07
Panglao	69	199.94	5.35	170.42	4.92

4.3. Assessment of Duties and Adequacy of Protective Devices

Tables 4-4 and 4-5 below show the assessment of duties and adequacy of the protective devices installed in BOHECO I Distribution Substation and Feeder system. A 10% safety margin for all installed protective device in the system was adopted in the evaluation. These tables show that the installed protection equipment in each feeder have sufficient margin of safety and that the setting of the down-line recloser before the location of the minimum fault per feeder is sufficient enough to protect the system from the said fault current. Single line diagrams of the representation of the minimum faults of all feeders of the distribution system are shown in Annex F-1.

Aside from the prescribed safety assessment, we also conducted physical inventory where we identified *deteriorated protective devices* whose mechanical and physical conditions were found to be unsafe for the public.

Table 4-3: Fault Current Duties per Feeder of BOHECO I Distribution System

Substaion	Feeder Name	Protections Short Ckt. Rating (AIC)	Maximum Fault @ Zf = 0Ω (Amp)	Margin of Safety 13.2KV Sec. Protection	Remarks (10% Margin of Safety)
	Feeder-01	12,500	2,243	557%	Safe
	Feeder-02	12,500	3,376	370%	Safe
	Feeder-03	12,500	3,323	376%	Safe
	Feeder-12	12,500	4,327	289%	Safe
	Feeder-04	12,500	2,927	427%	Safe
	Feeder-05	12,500	2,927	427%	Safe
	Feeder-06	12,500	4,344	288%	Safe
	Feeder-07	12,500	2,023	618%	Safe
	Feeder-08	12,500	3,075	406%	Safe
	Feeder-13	12,500	2,038	613%	Safe
	Feeder-09	12,500	2,932	426%	Safe
	Feeder-10	12,500	3,421	365%	Safe
	Feeder-11	12,500	3,414	366%	Safe

Maribojoc	Feeder-15	12,500	2,210	566%	Safe
	Feeder-16	12,500	1,718	728%	Safe
	Feeder-17	12,500	2,183	573%	Safe
	Feeder-18	12,500	3,415	366%	Safe
	Feeder-18A	12,500	3,439	363%	Safe
	Feeder-19	12,500	3,480	359%	Safe
	Feeder-20	12,500	3,505	357%	Safe
	Feeder-20A	12,500	3,456	362%	Safe
	Feeder-21	12,500	3,414	366%	Safe
	Feeder-22	12,500	2,001	625%	Safe
	Feeder-23	12,500	1,973	634%	Safe
	Feeder-24	12,500	1,899	658%	Safe
	Feeder-25	12,500	2,083	600%	Safe
	Feeder-26	12,500	2,123	589%	Safe

Table 4-5: Feeder - Recloser Protection Setting data per Feeder

Substation	Feeder Name	Feeder Protection Pick-Up Setting	Next Down-Line Recloser		Minimum Fault	
			Pick-Up Current Setting	Bus Location	Fault Current	Location
	Feeder-01	176	35		147	F01-87-40-9-7K-13
	Feeder-02	160	50	F02-101	142	F02-251-32B-19A
	Feeder-03	160			143	F03-55-71B-28-6-45C
	Feeder-12	50	-	-	177	F12-38-74
	Feeder-04	300	25	F04-3-5	187	F04-3-82-10
	Feeder-05	130	-	-	154	F05-28-31-22
	Feeder-06	130	25	F06-81	137	F06-237
	Feeder-07	60	50	F07-191	130	F07-109-88-20
	Feeder-08	75	50	F08-445	133	F08-537-152-36
	Feeder-13	52	25	F13-352-7	138	F13-352-57-47B-8
	Feeder-09	96	30	F09-327	134	F09-411-74-6
	Feeder-10	112	-	-	175	F10-176-73-15
	Feeder-11	40	35	F11-100	142	F11-175-95-3
	Feeder-15	35	-	-	125	F15-231-140-63R
	Feeder-16	125	50	F16-510	163	F16-25-20-19-18-5
	Feeder-17	72	-	-	170	F17-333-35

Panglao	Feeder-18	60	-	-	220	F18-57-15
	Feeder-18A				191	F18A-12-58-24
	Feeder-19				190	F19-134-8-38-9-4
	Feeder-20A				216	F20A-3-145-3M
	Feeder-20	60	-	-	224	F20-116-29-9
	Feeder-21	60	-	-	194	F21-198
	Feeder-22	60	-	-	163	F22-296-25-5-9-1B
	Feeder-23	60	-	-	188	F23-166-30-25
	Feeder-24	60	-	-	127	F24-231-71-81
	Feeder-25	60	35	F02-120	140	F25-120-114-24H
	Feeder-26	60	-	-	155	F26-269-60

4.4. Distribution Feeder Reliability

Reliability performance criteria and targets are essential to strategic planning and these are currently being developed at BOHECO I. After several reviews and public consultations (pub-con) of the Distribution Management Committee (DMC) together with other relevant sectors, an established level of performance in terms of reliability of electric service—currently measured through SAIFI, MAIFI and SAIDI were released. Table 4-6 below shows the minimum required levels of reliability as established by DMC.

Table 4-4 Distribution System Reliability Standards

STANDARD DETAIL	UNIT	LEVEL
System Average Interruption Frequency Index (SAIFI)	interruption/customer-year	20
System Average Interruption Duration Index (SAIDI)	hour/interruption-year	45
Momentary Average Interruption Frequency Index (MAIFI)	interruption/customer-year	–

4.4.1 Historical Reliability Performance

In the last few years, the ERC, through its technical arm–the DMC, established a cap of the reliability performance indices. The pro-consumer commitment of the ERC–DMC provides reliability goals for the electric cooperatives to attain.

Bounded with these imperatives, BOHECO I develop methodologies in order to optimize its reliability performance. Table 4-7 below shows the five-year historical reliability performance of BOHECO I Distribution System.

Table 4-5 5-Year Historical System Reliability Performance

Year	SAIFI	SAIDI	CAIDI	MAIFI
2011	5.159	7.321	1.419	2.863
2012	5.135	8.423	1.64	14.945
2013	6.113	9.505	1.555	12.36
2014	5.138	8.303	1.616	14.26
2015	6.919	11.655	1.684	12.966

Table 4-6 BOHECO I Reliability Performance Indices per substation for year 2015

Substations	Maca-as	Dampas	Carmen	Loay	Maribojoc	Panglao	System
Average No Consumers	45,496	22,421	16,023	16,277	21,650	12,836	**134,703**
No Consumers Interruption	963,226	259,301	311,936	371,418	682,214	90,587	**2,678,682**
Interruption Duration (Hours)	1,224	808.97	577.92	1485.5	760.8	111.18	**4,969**
Cust-Hrs Interruption	541,107	224,819	171,786	242,413	416,160	25,073	**1,621,358**
Average Energy Not Sold (kWh)	45,779	27,712	10,409	11,589	36,327	9,245	**141,061**
Momentary Consumer Interruptions	13	7	13	14	22	5	**13**
SAIFI	7.736	4.725	6.041	8.401	9.629	2.507	**6.919**
SAIDI	11.542	9.806	10.125	14.271	18.798	1.833	**11.655**

SAIFI – System Average Interruption Frequency Index (interruptions/customer-year)

SAIDI – System Average Interruption Duration frequency Index (hours/customer-year)

The indices shown in Table 4-8 indicate that BOHECO I efficiently delivers electric service which is above and beyond the minimum regulatory standards established by the ERC's DMC. Even with this very good level of reliability BOHECO I continues to improve its services as it reaches the optimal level of reliability of service to the end-users. Power system reliability improvement will be an attribute to power quality improvement related projects.

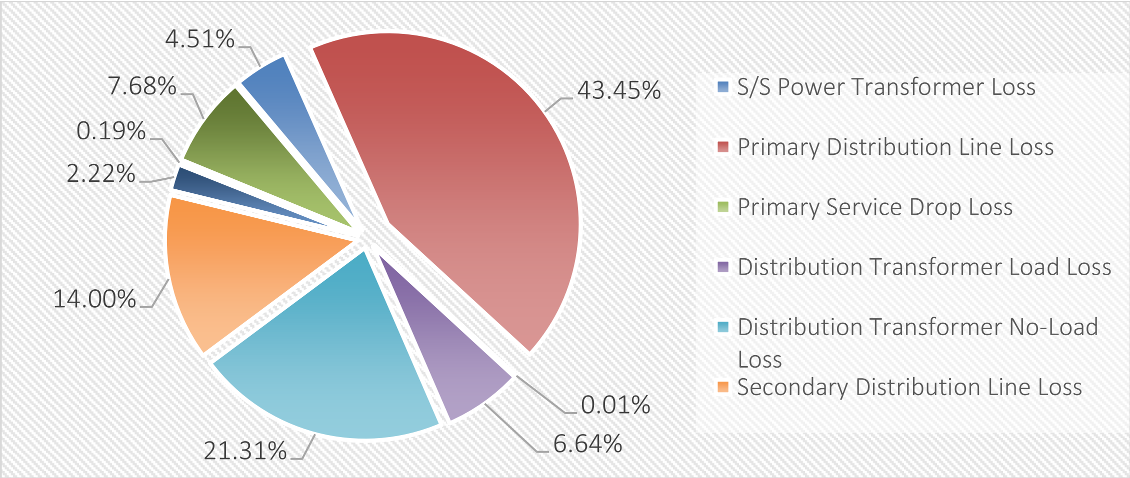
4.5. Distribution System Loss Performance

Technical and non-technical losses incurred in the delivery of electrical power and energy delivered to consumers is a cost that cannot be ignored. It is the responsibility of the DU to reduce system loss as this is also paid for by the consumers. Also, losses above the system loss cap cannot be recovered from consumers and will form part of the DU's losses which will affect its viability.

4.5.1 Assessment of Historical Systems Loss Performance

Based on the Philippine Distribution Code (PDC) article 9.1.1.1, System Loss must be segregated into two (2) components: Technical loss and Non-Technical Loss. The segregated systems loss will help identify areas in need of improvement and will help the DU come up with an effective system loss reduction program. Figure 4-1 below shows the segregated system loss by component of the BOHECO I Distribution System.

Figure 4-1: ***2012-2013 BOHECO I System Segregated Systems Loss***



System loss is mainly due to primary distribution line loss and distribution transformer no load loss. System loss management is an ongoing consideration in the planning, design, operation, purchase, upgrading and replacement of networks' distribution facilities and equipment.

4.5.2 Assessment of Future Systems Loss Performance

In the planning perspective, systems loss reduction could often be attributed to many of the proposed projects. Therefore, systems loss reduction projects are not directly analyzed but instead but form part of the economic evaluation of all projects. It is noted in the benefits to be earned in any given project for any identified power quality and capacity problems. Table 4-9 below shows the forecasted technical loss performance of BOHECO I Distribution System per substation.

Table 4-7 Forecasted Technical Systems Loss per Substation

SUBSTATION	2015	2016	2017	2018	2019	2020
MACAAS	**198.5**	**216.5**	**255.0**	**256.3**	**278.8**	**302.5**
DAMPAS	**228.6**	**247.0**	**296.5**	**319.3**	**341.8**	**366.1**
CARMEN	152.4	170.2	192.0	215.4	239.8	266.0
LOAY	105.7	112.9	121.3	130.8	140.2	151.0
MARIBOJOC	67.0	71.7	76.7	82.0	87.5	93.2
PANGLAO	**249.1**	**277.1**	**438.8**	**339.7**	**373.9**	**409.9**
CATAGBACAN	87.4	92.7	101.4	108.4	127.7	123.6
SAGASA	63.8	68.3	73.6	79.1	84.7	90.6
TOTAL	**1152.4**	**1256.5**	**1555.5**	**1531.0**	**1674.3**	**1802.9**

5.1. 15-MVA Bolod Substation

5.1.1 Project Description and Justification

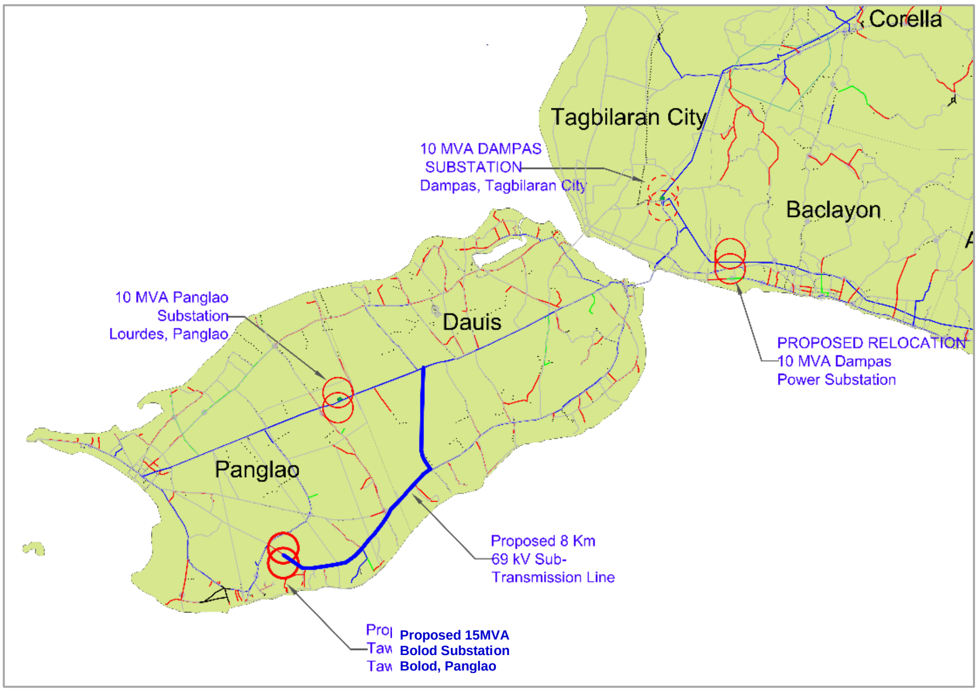
As forecasted, the Panglao Substation will be loaded at eighty percent (80%) by the year 2018 (Table 5-1). Thus, additional capacity must be added to ease the forecasted capacity problem of the Panglao Substation. The proposed Bolod Substation should be at the load center, as evident from the load density map shown in Figure 5-1. This substation project will require and 8 km 69-kV sub-transmission line as illustrated in Figure 5-2.

Figure 5-1: Panglao Substation Load Density Map

Table 5-1: 10-Year Percent Loading of Panglao Substation

Substation	Rated Capacity (kW)	Projected Demand/ Loading	Year						
			2015	2016	2017	2018	2019	2020	2025
		Demand (kW)	6,171	6,466	6,865	7,264	7,663	8,060	9,999
		% Loading @90% PF	69%	72%	76%	81%	85%	90%	111%
		Demand (kW)	5,043	6,357	6,678	6,995	7,307	7,614	9,079
		% Loading @90% PF	56%	71%	74%	78%	81%	85%	101%

Figure 5-2: Proposed 15-MVA Tawala Substation



Capacity Analysis

The proposed Bolod substation will ease the loading of the Panglao, the Dampas and the Loay Substations, as shown in Table 5-2, through optimal system reconfiguration.

Table 5-2: Percent Loading of Tawala, Panglao & Dampas Substation

Substation	Panglao		Dampas		Bolod		Loay SS	
Rated Capacity	10,000		10,000		15,000		10,000	
Year	Demand (kW)	% Loading	Demand (kW)	% Loading	Demand (kW)	% Loading	Demand (kW)	% Loading
2015	6,171	69%	5,043	56%			3,051	34%
2016	6,466	72%	6,357	71%			3,489	39%
2017	6,865	76%	6,678	74%			3,651	41%
2018	3,558	40%	4,336	48%	6,091	41%	5,091	51%
2019	3,770	42%	4,513	50%	6,364	42%	5,309	53%
2020	3,981	44%	4,686	52%	6,636	44%	5,527	55%
2025	5,020	56%	5,500	61%	7,967	53%	6,606	66%
2030	6,021	67%	6,245	69%	9,242	62%	7,651	77%
2035	6,988	78%	6,942	77%	10,470	70%	8,666	87%
2040	7,935	88%	7,611	85%	11,670	78%	9,664	97%
2045	8,877	99%	8,268	92%	12,861	86%	10,662	107%

Assessment of Technical Performance

The Tawala substation will not just augment the existing capacity of BOHECO I but will also improve its system efficiency and uphold technical performance measured by the quality of power delivery as shown in Table 5-3 below.

Table 5-3: Technical & Efficiency Performance of Tawala, Panglao

YEAR	Bolod SS				Panglao SS			
	Power Quality		Systems Loss		Power Quality		Systems Loss	
	Min. Voltage	% Voltage Unbalance	(kwhr)	%	Min. Voltage	% Voltage Unbalance	(kwhr)	%
2018	0.9315	0.90%	63.91	1.08%	0.9614	1.28%	27	1.08%
2019	0.9296	0.96%	69.38	1.15%	0.959	1.34%	30.07	1.15%
2020	0.9231	1.02%	79.42	1.21%	0.9566	1.40%	33.36	1.21%
2025	0.9058	1.37%	104.23	1.40%	0.9469	1.64%	43.94	1.40%

5.1.2 <u>Alternative Solutions to Panglao Substation Capacity Problem</u>

The fundamental consideration to augment the existing capacity of the Panglao substation is the capacity expansion pattern which will be determined through Substation Capacity Analysis. The capacity analysis considered the connected load of Panglao Island (Panglao and Dauis) which is within the twenty-kilometer (20 km) radius of economic load reach of the 13.2-kV Distribution System. A detailed presentation of the methodology is presented in Annex B.

Table 5-4: Substation Capacity Expansion Pattern (Panglao Island)

Substation Capacity Used	No. of Substations Added	Present Worth	Ranking
5 MVA	5	*129,262,932.78*	3
10 MVA	3	*103,935,853.96*	2
15 MVA	2	*95,051,629.10*	1
25 MVA	2	*142,522,204.10*	4

Table 5-4 above indicates that an expansion with an increment of 15-MVA is the most economical for Panglao Island which is categorized as a fast developing urbanized area.

5.1.3 Economic Evaluation of Alternative Solutions to Panglao Substation Capacity Problem

The capacity expansion pattern analysis already includes economic substation sizing analysis, thus it already represents the economic evaluation in the selection of capacity to address the 30-year forecasted demand of Panglao Island.

5.2. Uprating of Carmen Substation (5-MVA—10-MVA)

5.2.1 Project Description and Justification

Based on the forecasts, the Carmen substation will be 84% loaded by the year 2018 as shown in Table 5-5. Because of this, an additional capacity must be added to ease the projected capacity problem of Carmen Substation.

Table 5-5: 20-Year Percent Loading of Carmen Substation

Substation	Rated Capacity (kW)	Projected Demand/ Loading	Year								
			2015	2016	2017	2018	2019	2020	2025	2030	2035
		Demand (kW)	2,701	3,232	3,507	3,782	4,058	4,333	5,683	7,980	9,232
		% Loading	60%	72%	78%	84%	90%	96%	126%	177%	205%

Figure 5-3 below shows the load density map of rural areas including the municipalities of Carmen, Batuan, Bilar and Sagbayan which are currently being supplied through the Carmen substation. It is then recommended that the substation be located at the load center.

Capacity Analysis

Uprating the existing 5-MVA Carmen substation into 10-MVA will address the capacity problem in the next fifteen (15) years. But this will cause the quality of power delivered by one of its feeders (Feeder-08) to drop below ninety percent (90%) of its nominal voltage of 230-Volts. As such, the existing 5-MVA substation will be installed at Brgy. Luyo, Dimiao, Bohol as shown by Figure 5-3.

With the installation of the Dimiao substation on 2022, the 50-km kilometer over-extended primary distribution line of Feeder-08 will be shortened at its economic load reach of twenty-kilometer (20 km) radius for a 13.2-kV Distribution System.

Figure 5-3: BOHECO I Load Density Map of a Rural Area

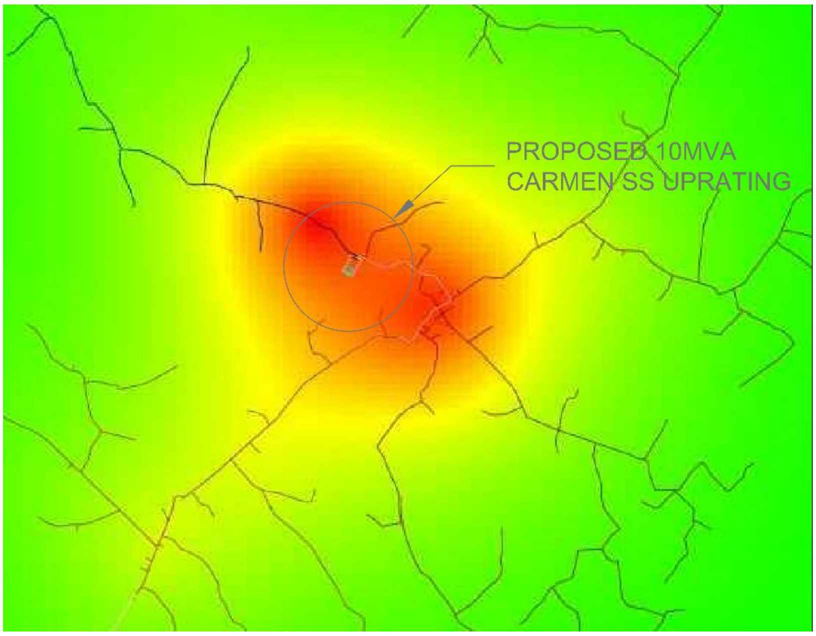


Table 5-6 Percent Loading of Carmen & Dimiao Substation

Substation	Carmen		Dimiao[1]	
Rated Capacity	10,000		5,000	
Year	Demand (kW)	% Loading	Demand (kW)	% Loading
2015	3,701	60%		
2016	4,232	72%		
2017	4,507	78%		
2018	4,782	43%		
2019	5,058	46%		
2020	5,333	48%		
2025	5,162	46%	*2,021*	*36%*
2030	6,131	55%	*2,338*	*42%*
2035	7,067	64%	*2,638*	*47%*
2040	7,985	72%	*2,929*	*53%*
2045	8,897	80%	*3,215*	*58%*

[1] An indicative project for the year 2022, this will address projected capacity and power quality problem of Carmen substation and Feeder-08 of Carmen substation respectively.

Assessment of Technical Performance

Uprating of Carmen substation will not just augment the existing capacity of BOHECO I but will also improve its system efficiency and uphold technical performance measured by the quality of power delivery as shown in Table 5-7 below.

Table 5-7: Technical & Efficiency Performance of Carmen & Dimiao Substation

YEAR	Carmen Substation (F08)				DIMIAO Substation			
	Min Voltage	% Voltage Unbalance	Loss (kWhr)	% Loss	Min Voltage	% Voltage Unbalance	Loss (kWhr)	% Loss
2016	0.9726	0.86%	17.78	3.11%	0.9726	0.40%	6.24	0.66%
2017	0.9657	1.07%	22.29	3.46%	0.9710	0.49%	6.53	0.66%
2018	0.9603	1.18%	26.48	3.78%	0.9696	0.56%	6.93	0.68%
2019	0.9549	1.30%	30.98	4.10%	0.9682	0.62%	7.48	0.72%
2020	0.9496	1.41%	35.76	4.41%	0.9669	0.71%	7.73	0.72%

5.2.2 Alternative Solutions to Carmen Substation Capacity Problem

Although the same methodology is adopted in the formulation of alternative solutions to the Carmen substation capacity problem, it differs in its primary consideration; from a developing urbanized area in the previous chapter into a rural area for this case.

Table 5-8: Substation Capacity Expansion Pattern (Rural Area)

Substation Capacity Used	No. of Substations Added	Present Worth of Expansion	Ranking
5 MVA	3	*86,214,841.92*	2
10 MVA	**2**	**78,206,139.37**	**1**

Table 5-8 above indicates that a capacity expansion pattern with an increment of 10-MVA is the most economical for the rural areas under the coverage of BOHECO I which are categorized as developing urbanized areas.

5.2.3 Economic Evaluation of Alternative Solutions to Carmen Substation Capacity Problem

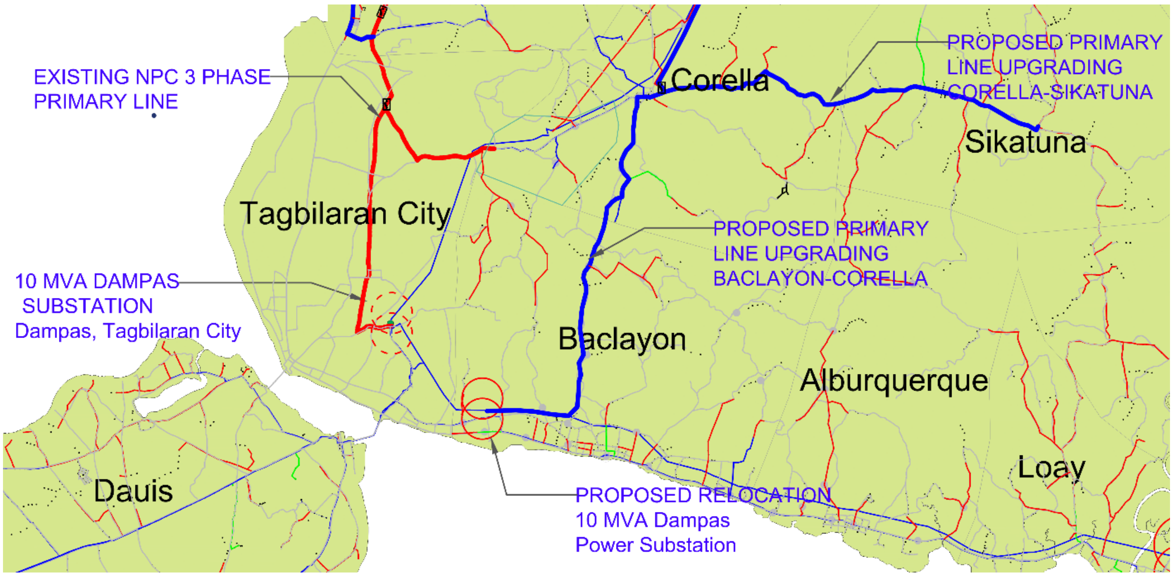
As shown again in Table 5-8 above, the capacity expansion pattern analysis includes its economic feasibility, thus it already represents the economic evaluation in selecting either 5-MVA or 10-MVA to address the capacity problem of Carmen substation in the next thirty (30) years.

6.1. Relocation of 10-MVA Dampas Substation and Feeder-06 Uprating & Upgrading

6.1.1 Project Description and Justification

The proposal to uproot the Dampas substation from Dampas District in Tagbilaran City and its relocation to Brgy. Guiwanon, Baclayon includes the construction of three-phase 13.2-kV primary distribution lines that will connect the proposed new substation location to the municipality of Corella as shown in Figure 6-1 below. In addition, uprating of the two-phase Corella—Sikatuna Primary Distribution Backbone Line is associated with this proposal.

Figure 6-1 Proposed Relocation of Dampas Substation



The primary distribution line of Feeder-06 shown in Figure 6-1 traverses the city of Tagbilaran which is not part of BOHECO I's franchised coverage area. Also, Right-Of-Way procurement has been deemed difficult and expensive, thus making it problematic to operate, maintain and develop the necessary facilities to ensure reliability and quality of electric service. As per technical performance assessment of Feeder-06, the minimum calculated quality of power is below ninety percent (90%) of its nominal voltage. An improved power quality is foreseen with the implementation of the project as shown in Table 6-1.

Table 6-1: 5-Year Voltage Profile of Dampas Substation

Feeder	Minimum Voltage per Year						
	2015	2016	2017	2018	2019	2020	Remarks
F04	0.97	0.96	0.96	0.96	0.95	0.95	w/o Project
F05	0.94	0.94	0.94	0.94	0.93	0.93	w/o Project
F06	0.90	**0.89**	**0.89**	**0.88**	**0.88**	**0.88**	w/o Project
Min Voltage		0.9408	0.9382	0.9336	0.9355	0.9306	
% Voltage Unbalance		0.71%	0.74%	0.77%	0.75%	0.81%	
Loss (kWhr)		48.42	52.97	58.96	60.95	67.39	
% Loss		1.32%	1.38%	1.48%	1.46%	1.55%	

6.1.2 Solution to Feeder-06 Power Quality Problem

6.1.2.1 Feeder-06 Uprating and ROW Procurement of Existing Line Route

To address the imminent power quality problem of Feeder-06, ROW procurement of its existing line route and uprating the existing primary distribution line from 2/0-AWG to 4/0-AWG ACSR as shown in Table 6-2 must be conducted. It is also the most economical conductor size for Feeder-06 with an initial load of 2.1 MW. Detailed presentation of Line Sizing Economics is discussed in Annex D.

Table 6-2 Economic Load Reach of 13.2-kV Primary Distribution Line

Phase	Size (AWG)	*Economic Load (kW)*		Max (Zeff,a; Zeff,b; Zeff,c)	Voltage Drop		Economic Load Reach
		Minimum	Maximum		Volts/km	% / km	
1	4	0.0	45.6	1.323	8.8	0.12%	64.94
1	2	45.6	165.9	0.831	20.1	0.26%	28.44
3	4	165.9	335.3	1.323	21.6	0.28%	26.51
3	2	335.3	1,081.5	0.831	43.7	0.57%	13.09
3	2/0	1,081.5	1,767.6	0.415	35.6	0.47%	16.03
3	**4/0**	**1,767.6**	**2,787.3**	**0.261**	**35.4**	**0.46%**	**16.17**
3	336.4	2,787.3	4,644.9	0.166	37.5	0.49%	15.25
3	477	4,644.9	7,725.5	0.117	43.9	0.58%	13.01
				Average Economic Load Reach			*19.25*

6.2. 13.2-kV Primary Line Upgrading (Poblacion—De Lapaz, Cortes)

6.2.1 Project Description and Justification

As a neighboring town of Tagbilaran City, the municipality of Cortes is currently the alternative residential area of choice. As shown in Figure 6-2, a single-phase primary distribution line from Poblacion to De Lapaz, Cortes supplied the area closest to the city. Thus, with the density of load shown by the same figure, the voltage unbalance exceeds the maximum allowable threshold of 2.5% as set by the PDC. Associated with this project is an improvement of reliability since the existing backbone line (formerly owned by NPC and acquired by BOHECO I) traverse private properties, therefore making it less accessible during troubleshooting and preventive maintenance measures.

Figure 6-2 13.2-kV Primary Line Upgrading (Poblacion—De Lapaz, Cortes)

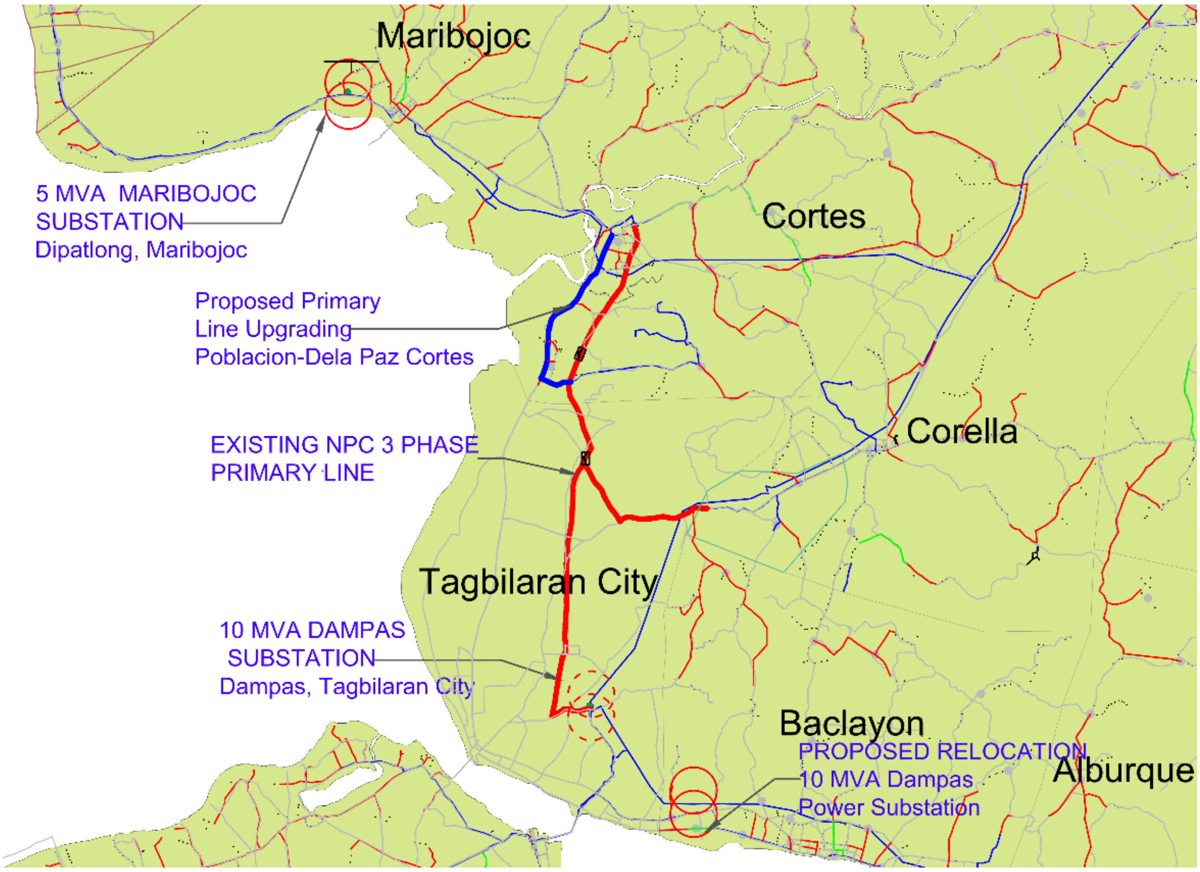
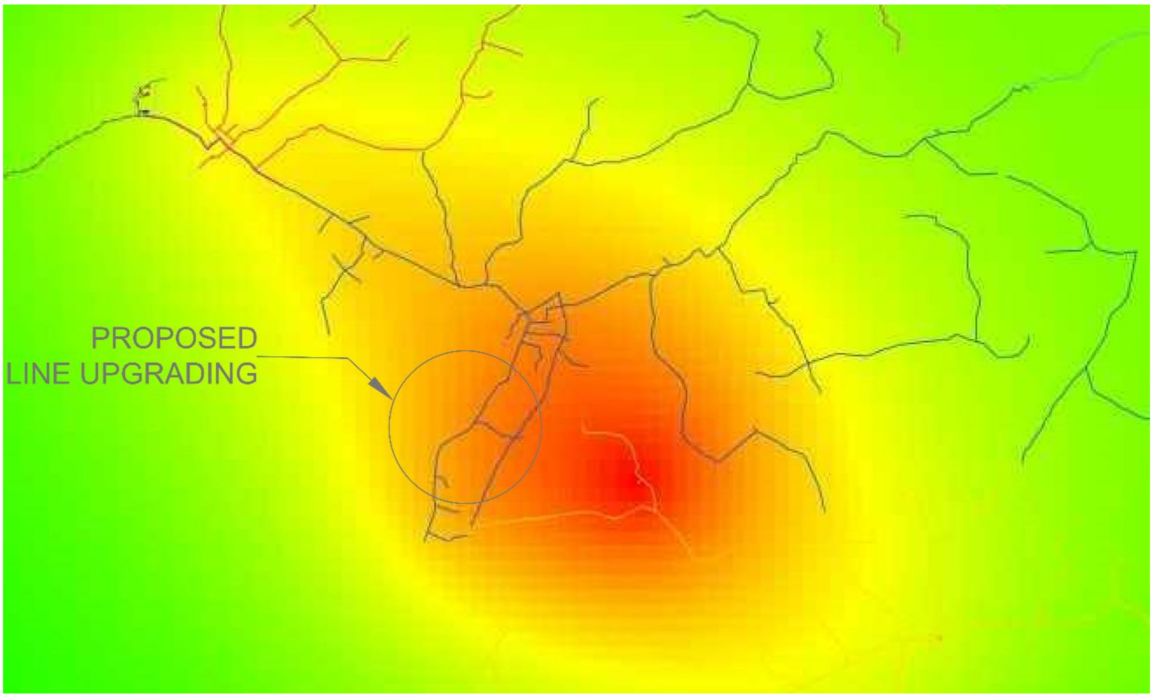


Figure 6-3 Load Density Map at De Lapaz, Cortes



The proposed project will form part of the existing backbone line of Feeder-16, therefore, with an initial load of 1,600-kW, a 4/0-ACSR is the most economical size to be used to address the voltage unbalance. Table 6-3 below shows the technical performance assessment with the implementation of the project.

Table 6-3 Feeder-16 Technical Performance Assessment

YEAR	Min Voltage	% Voltage Unbalance	Loss (kWhr)	% Loss
2016	0.9155	0.61%	70.52	3.77%
2017	0.9121	0.62%	76.49	3.92%
2018	0.9082	0.68%	82.72	4.07%
2019	0.9045	0.74%	89.09	4.21%
2020	0.9008	0.80%	95.45	4.35%

6.2.2 Alternative Solution and Economic Evaluation of 13.2-kV Primary Line Upgrading (Poblacion—De Lapaz, Cortes)

The coverage of the proposed project belongs to primary distribution lines therefore the line sizing economics discussed in Annex D will represent the technically and economically feasible solutions to resolve the projected voltage unbalance of Feeder-16.

6.3. 13.2-kV Primary Distribution Line Upgrading (Balilihan—Corella)

6.3.1 Project Description and Justification

Relative to the uprooting and relocation of the Dampas substation, part of the existing Feeder-06, the primary distribution backbone line traversing Tagbilaran City will be de-energized and retired. Consequently, its probability to be supplied through an adjacent substation (presently Maribojoc SS) will be omitted, thus a reliable power supply is at risk. Therefore, a tie-up primary distribution line from its strategically adjoining substation will eliminate that risk.

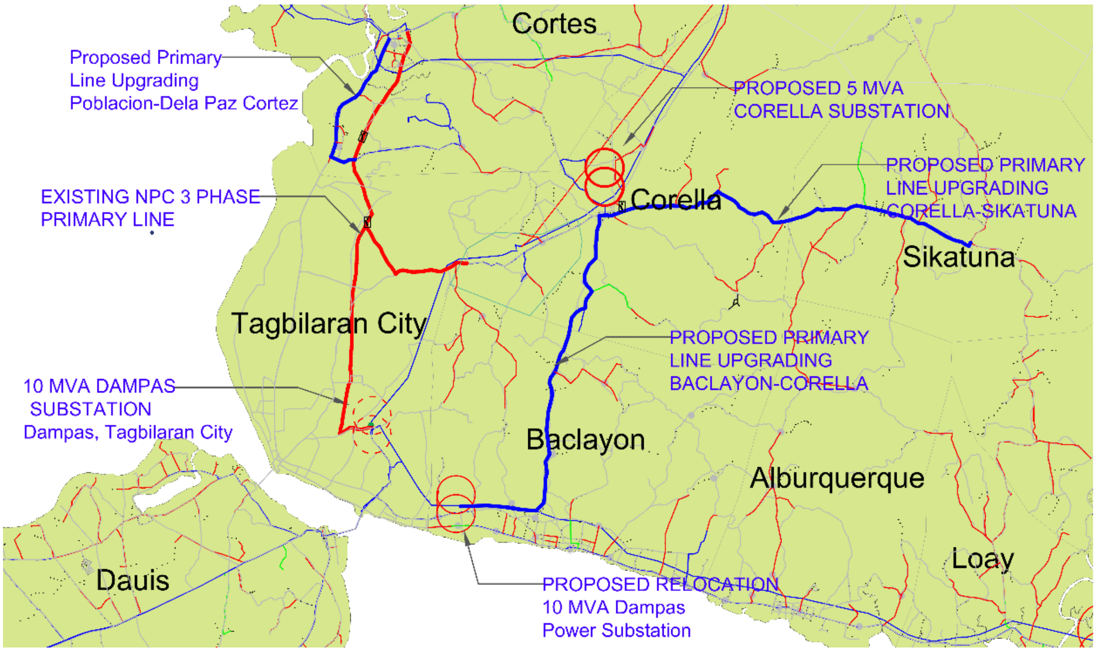
Through line sizing economics, a 4/0-AWG ACSR is the most economical size for an initial load of 1,600-kW (F06) with an economic load reach of 16.0-km. Figure 6-4 below shows the geographical presentation of the proposed project.

Figure 6-4 13.2-kV Primary Distribution Line Upgrading (Balilihan—Corella)

6.3.2 Alternative Solution of Balilihan—Corella Tie-Up Line

Installation of 5-MVA substation using the refurbished former power transformer of the Loay substation will be an alternative solution to improve power supply reliability of Feeder-06.

Figure 6-5 Proposed 5-MVA Corella Substation



6.4. Distribution Line Upgrading at Coverage Area

6.4.1 Project Description and Justification

Community development and load growth are often associated with eventual power quality problems. Therefore, upgrading of the existing distribution network is essential to accommodate forecasted load growth and resolve power quality problems. Since this entails direct connection to the distribution network, installation of Open and Under-built Secondary line is needed.

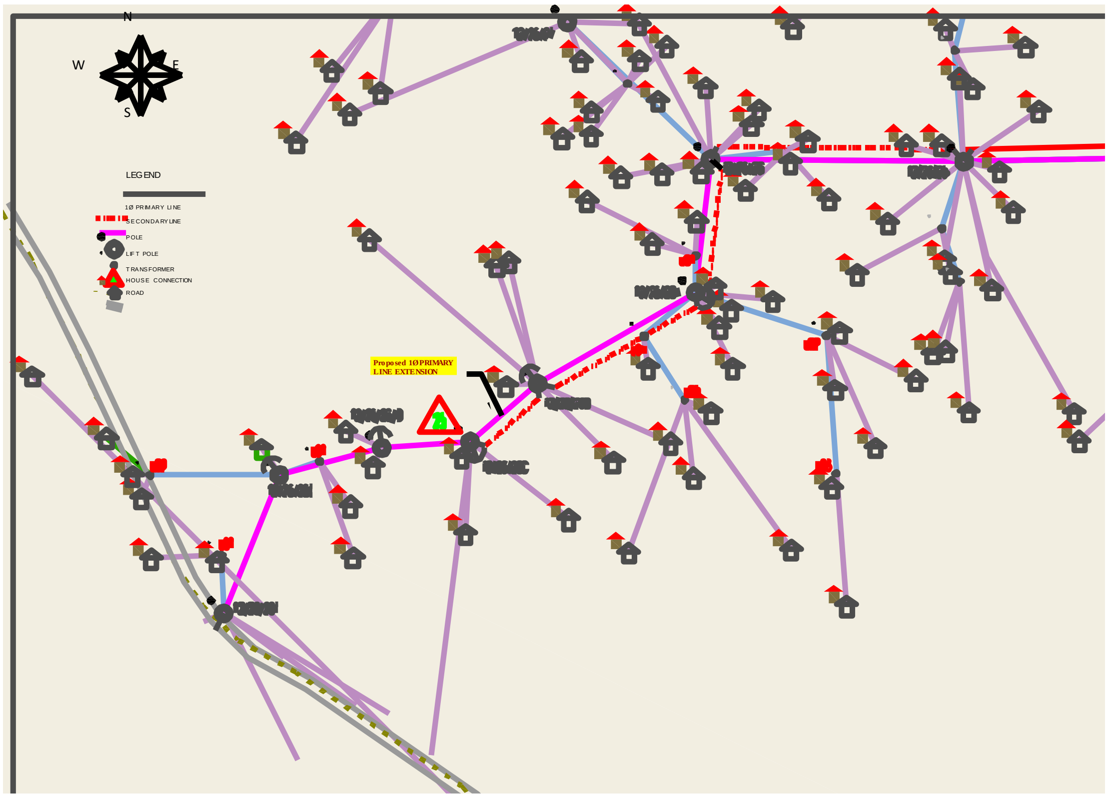
The length of line for each type of project is based on a five-year historical accomplishment of BOHECO I as shown in Table 6-4 below.

Table 6-4 2011-2015 Line Upgrading & Uprating Accomplishment

Year	Three-Phase	Single Phase	Open Secondary	Secondary Underbuilt
2011	4.42	1.50	10.80	8.99
2012	11.39	1.80	19.67	12.89
2013	4.18	0.39	14.52	10.51
2014	4.72	0.41	14.75	15.68
2015	4.05	0.82	12.77	14.38
Average	**6.0**	**1.0**	**14.0**	**12.0**

Figure 6-6 illustrates a line section sample identified of having low power quality. It is, therefore, necessary to upgrade the existing distribution network to address the deficiency, to improve power quality and reliability, and to augment capacity and boost efficiency.

Figure 6-6 Sample Fragmented Projects Located Barangay Tabalong, Dauis



The sample project was identified through load flow analysis and validated thru ocular inspection. The proposal is to rehabilitate and upgrade #6-AWG Duplex Wire that were used as secondary lines, to #4 AWG Primary Line #2 AWG Secondary Line and create a new transformer section. A summary of test results is shown in Table 6-5 below.

Table 6-5 Upgrading [Tabalong, Dauis]

Load [kW]	Without Project			With Project		
	Loss [kW]	Loss %	Minimum Voltage [%]	Loss [kW]	Loss %	Minimum Voltage [%]
22.08	0.66	2.99%	89.14%	0.304	1.38%	96.5%

As shown above, the system efficiency and power quality are improved through rehabilitation and upgrading of over-extended secondary lines. In addition, uprating of existing secondary distribution system, augments network capacity, improves reliability and safety.

As a franchised electric utility, BOHECO I is mandated to provide customers with the necessary facilities and equipment for connections (new and old) which includes: (1) an access to electric service voltage in its useful level—*the nominal voltage level (230-Volts)*—through the distribution transformer; (2) an extension of facility up to thirty meters from the existing standard facility—#6-AWG Duplex conductor; (3) revenue electric meters for new service connections; and (4) revenue electric meters for existing customers whose meters are identified to have reached its economic life. Table 7-1 below shows the summary of forecasted additional facilities and equipment required for the secondary distribution development.

Table 7-1 Additional Equipment for Secondary Distribution Development

Description	Unit	2016	2017	2018	2019	2020
Single Phase Distribution Transformer						
15-kVA	*pcs*	93	42	42	42	39
25-kVA	*pcs*	69	30	30	30	30
37.5-kVA	*pcs*	27	12	12	12	12
50-kVA	*pcs*	18	9	9	9	9
75-kVA	*pcs*	9	6	6	6	6
100-kVA	*pcs*	9	6	6	6	6
167-kVA	*pcs*	6	3	3	3	3
Service Entrance Equipment *(#6-AWG Duplex & Accessories)*	*set*	3,078	4,020	4,458	4,900	5,342
Revenue kWh Meters *(Additional Customers)*	*pcs*	4,369	4,271	4,172	4,081	3,986
Revenue kWh Meters *(End of Economic Life)*	*pcs*	2,600	2,600	2,600	2,600	2,600

8.1. Replacement of 69kV Protection, Control & Transformer Monitoring

The 69kV Protection, Control & Transformer Monitoring equipment of the Carmen, Maribojoc and Dampas Substations are proposed to be replaced. The existing refurbished & oil-insulated three phase power circuit breakers in these substations were determined to have already served their useful economic life, thus the need for replacement.

8.2. Replacement of 15kV Main & Sub-Feeder Protection and Control

The existing feeder protection of the Maca-as, Carmen, Dampas, and Maribojoc Substations are oil type refurbished circuit reclosers which were identified to have served their useful economic life. These existing units had been in service for more than fifty years. The breaker contacts are already deteriorated thereby a failure in its closing and opening mechanism. This causes nuisance tripping and reclosing of the feeders. Replacement of the said units thus require immediate attention. The Single Line Diagrams of the proposed replacement are shown in Annex F-2.

8.3. Installation of Feeder Recloser Bypass Switch

The feeder recloser bypass switch are necessary equipment at the substation feeders that will help minimize power interruption during feeder protection maintenance works. The Single Line Diagrams of the proposed replacement are shown in Annex F-2.

Non-network assets are logistics, tools, and equipment not directly used for the delivery of power to consumers but are nonetheless essential in providing services and systems that facilitate prompt response to the different needs of customers.

9.1. Maintenance Vehicle, Service Vehicle and Boom/Bucket Truck

An efficient logistics system is important in providing services to the consumers to facilitate prompt response to the consumers' varying needs. From maintenance to Operations, from Engineering to Construction or other obligations, BOHECO I needs vehicles in all of those activities. Tabulated in Table 9-1 are the existing vehicles that BOHECO I uses to operate and maintain the distribution network and to deliver services to its member-consumers.

Based on the historical data, a properly maintained vehicle used in daily activities is projected to have a useful economic life of ten (10) years. Table 9-1 below shows the total number of vehicles used in BOHECO I's delivery of electric service and its projected number of annual replacement.

Table 9-1 No. of Vehicles Used in Operation and Maintenance and Auxiliary Service

Description	Type	Usage	Quantity	No. of Vehicle due for Replacement per Year
Maintenance Vehicle	LCV	O & M	22	2
Service Vehicle	AUV	Service	10	1
Boom Truck	5 Tonners	Construction	4	
Boom Truck	20 Tonners	Construction	2	
Boom Truck	Bucket	Clearing	4	

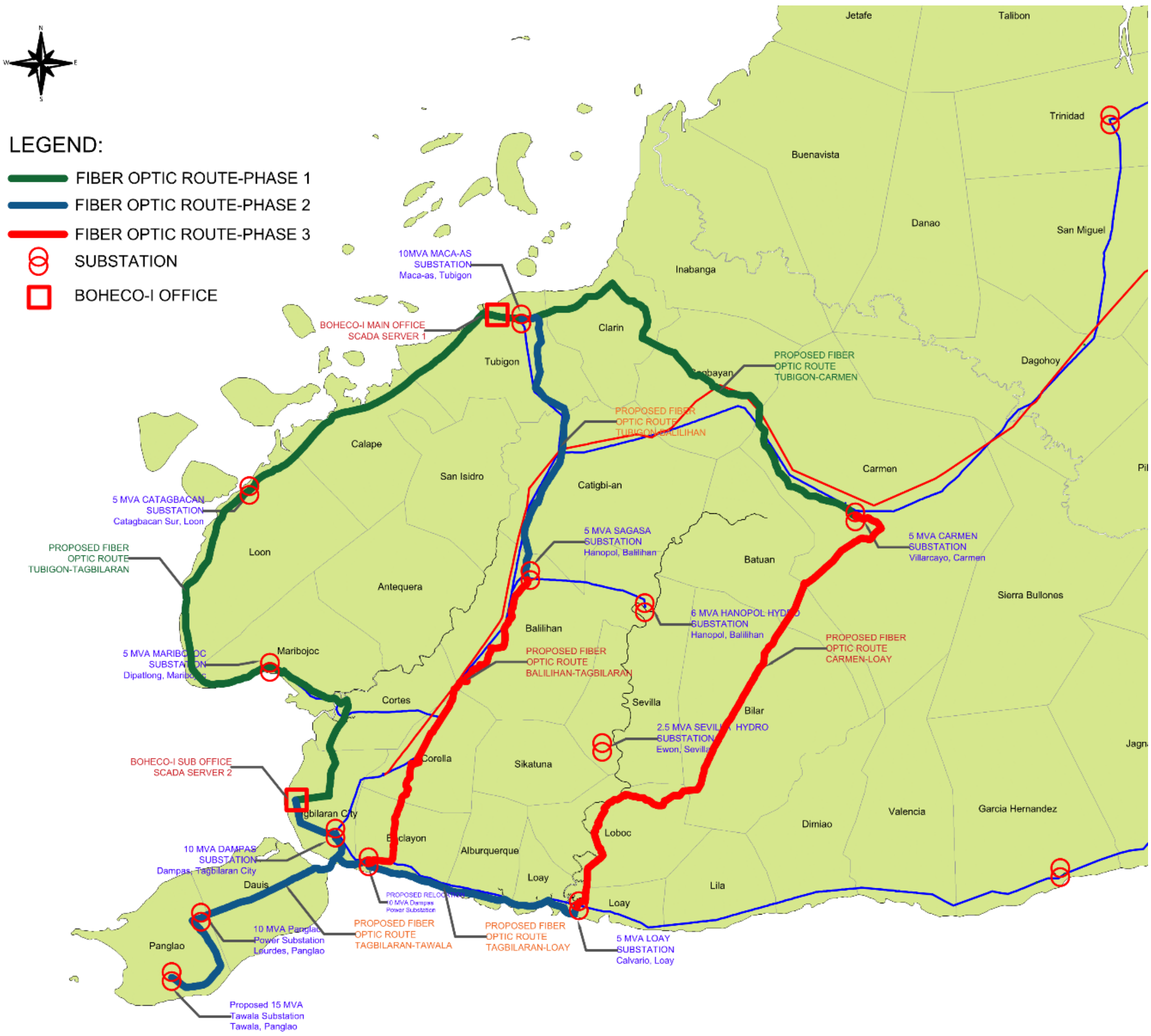
9.2. Substation Automation & Fiber Optic Communication Network

As BOHECO I ventures into innovative and reliability-centered key services, automation systems are needed. There is a need to improve the integrity and capacity of its IT and Communications Network to cater new business initiatives including: (1) SCADA System; (2) the Integrated Billing System; (3) Bills payment through remittance centers; and (4) security cameras and communication.

Among these IT initiatives, the SCADA System requires the most stringent communication and network reliability since it affects the availability of power supply and the safety of distribution network. At present, the SCADA system depends on the IP-Radio Communication Network of BOHECO I without the required redundancy or backup system. Thus, it is recommended that another communication network be established, specifically a fiber-optic cable network to serve as the new backbone of BOHECO I Data and Communication Network Infrastructure. The existing IP-Radio Communication will serve as its redundant backup communication system. Figure 9-1 below shows the proposed fiber-optic communication backbone.

In 2017 and 2018, the Sagasa and the Tawala substations will be added to the distribution network respectively. Together with the fiber optic network communications, this will be implemented as the 3rd phase of BOHECO I SCADA system and substation automation.

Figure 9-1 BOHECO I Fiber Optic Cable Communication Backbone Line



9.3. Power System Simulator Software Upgrading

Software maintenance is also essential for the timely upgrading and technical support for existing technical simulation software programs that BOHECO I's engineers use. It is widely known that every year software programs are continuously being upgraded to improve the quality and efficiency of these software tools. To cope with these upgrades, BOHECO I has included the cost of software maintenance and support in its capital expenditure program.

9.4. Replacement of Instrument Transformers, Electric Revenue Meter and Metering Panels for Feeder Metering

In compliance with the implementation of the revised systems loss cap wherein the technical loss will be reckoned from the feeder metering, BOHECO I proposes to replace the existing dilapidated instrument transformers (CT & PT) and the revenue meters installed in each feeder which are rated at an accuracy class of 1.0. It is recommended that the feeder revenue metering shall be at an accuracy level of better than than 0.3. Although each feeder is designed for a 2.5MW demand, it shall also have provisions to allow temporary load transfers without overloading the instrument transformers. As such, each feeder's current transformer is rated at 5.0MW loading. In addition, since each feeder draws power from the same bus, each revenue meter will be served by the same potential transformer.

9.5. Engineering Sub-Office and Motorpool

At present, the aged engineering sub-office located in Bool District, Tagbilaran City is due for rehabilitation. Instead of a simple restoration/rehabilitation, the building will renovated to include a motorpool that will cater to preventive maintenance and repair of utility vehicles under its coverage area. Strategically, this Engineering sub-office will be equipped with a warehouse to facilitate release of fast-moving hardware materials for line operation and maintenance.

Figure 9-2 Proposed Engineering Sub-Office, Bool District, Tagbilaran City

9.6. <u>Line Tensioner and puller Engine</u>

Having the correct tension stringing equipment for the construction and maintenance of electrical distribution lines helps ensure the project will go as planned and meet deadlines as part of the EC's prompt services to its member-consumers. It is also important that distribution lines meet the tension stringing requirements based on established standards.

9.7. <u>Relay Tester</u>

The multiple protection function of today's protection relay systems requires a new level of sophisticated hardware and software testing equipment to completely simulate and analyze the operation of the unit in a "real life" situation. Periodic relay testing is, first and foremost, preventive maintenance. Thus, procedures and records should be designed with preventive maintenance as the guide. The tests themselves will reveal failures which would have prevented the relay from performing when called upon to operate. On the other hand, properly maintained records will reveal trends which could lead to such failures

9.8. Distribution Transformer Efficiency Tester

With the widespread application of Distribution Transformer and the continuous energization of large consumers, distribution transformer losses make up a considerable portion of the total losses incurred in distribution systems. Even a minor improvement in transformer efficiency could lead to significant energy savings.

Transformer loss reduction is therefore an optimization process that involves physical, technological, and economical factors tempered by life-cycle performance analysis. A Distribution Transformer Efficiency Tester will be crucial in studying the performance of different brands, technologies, and sizes of DTs currently in use in the distribution system, ideal usage and loading levels, and other factors that play an important role in the reduction of transformer losses and system loss in general.

10.1. Consumer Initiated Projects

Project Description. BOHECO I consumer-initiated projects costs are entirely shouldered by the applicant as detailed in BOHECO I's Policy No 7-84 (Amended) as shown in Annex G. In the process, whenever there is an applicant for large load or sole user, the Planning & Design personnel will conduct an engineering survey and plan a design suitable for the customer's requirement. From the design, a Bill of Materials (BOM) will be generated and will be charged solely to the consumer/applicant in need of the service facility.

In case there will be additional users in that service facility, Policy No. 7-84 still applies, since the policy has a provision for a multi-user sharing of the facility and the cost.

Justification. The Distribution and Open Access Rules (DSOAR) which took effect on February 17, 2006 has a provision for refund (Article 2.6.2 Refund) of amounts paid for the extension of Distribution connection assets beyond the EC's standard connection facilities (Article 2.7.10 Non-Standard Connection) and for non-residential, it is treated as Contribution In Aid of Construction (CIAC) which is shared (Article 2.7.10 Proportionate Sharing of Line Extensions) with succeeding non-residential users.

BOHECO I treats both non-residential and residential payments as CIAC by its Policy No. 7-84 which also has the provision for computing the sharing cost for succeeding users of the same facility. Problems occur when the 1st user does not allow succeeding users to use the facility, claiming to own the extended facility and not honoring the policy for cost sharing. It mostly happens when the succeeding user/s haven't established a good relationship with the latter. An additional problem occurs when BOHECO I as its sound judgment will not compute sharing cost to the preceding user/s (i.e. small residential and small commercial) that exists after the completion of the distribution line considered as CIAC and BOHECO I allowed them to use the same extended facility treated as CIAC.

Geographic presentation below is a sample scenario of a user initiated extension of line that will fit to the description of the problems stated above. This is located in Sitio Riverside, Brgy. Songculan, Dauis where some small residential customers are already connected to a #6 twisted conductor and as time passed, a large load applicant or a sole user customer applying for service facility extension in the area that is subject to EC Policy No. 7-84.

Figure 10-1 "Base Scenario": Before User Initiated Line Construction is inexistent.

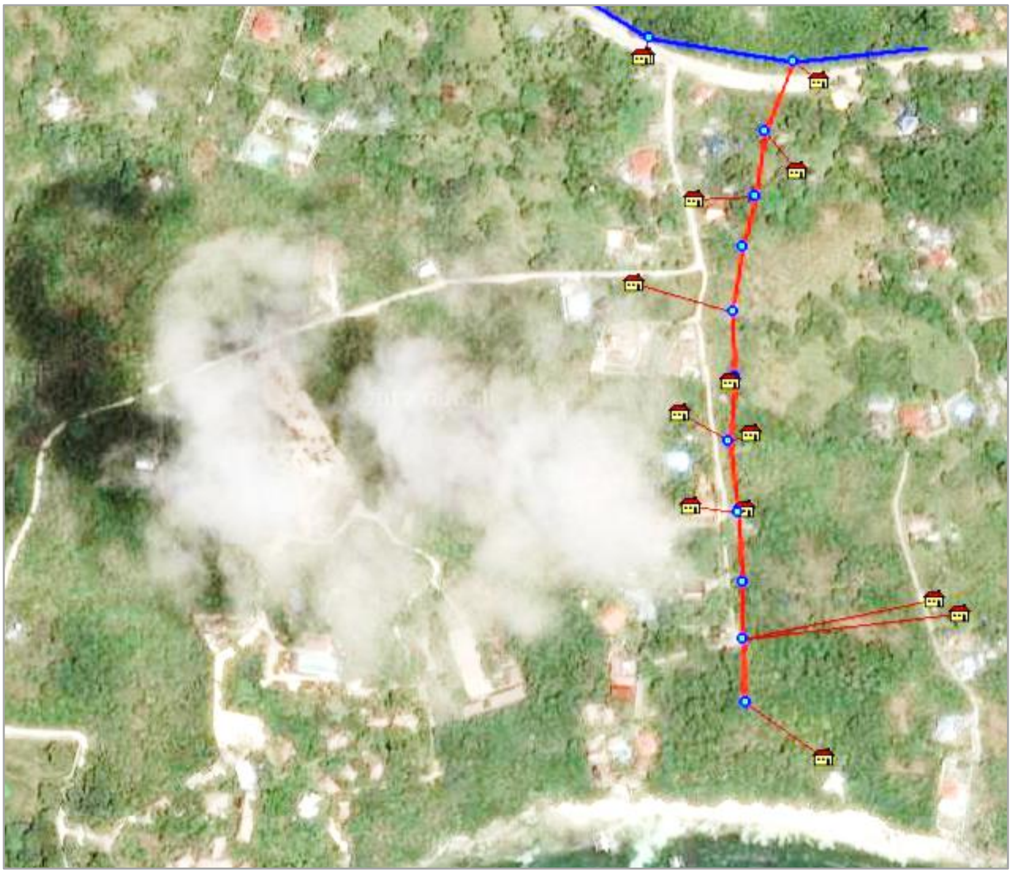


Figure 10-2 Where 1st User Initiated Line Construction extends from existing facility.

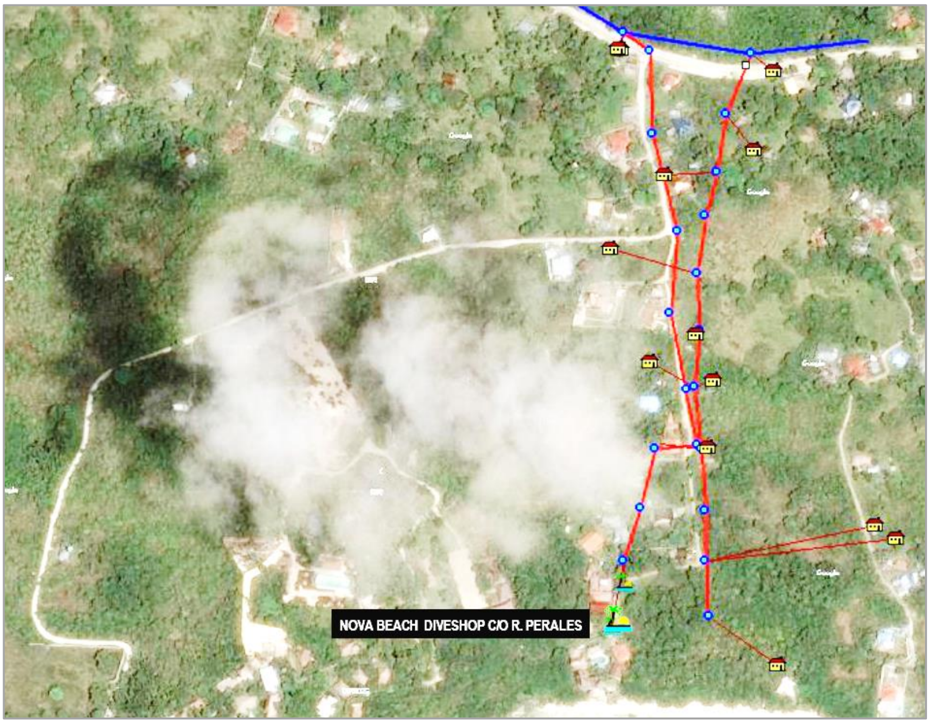


Figure 10-3 Where 2nd User Initiated Line Construction extends from the last user.

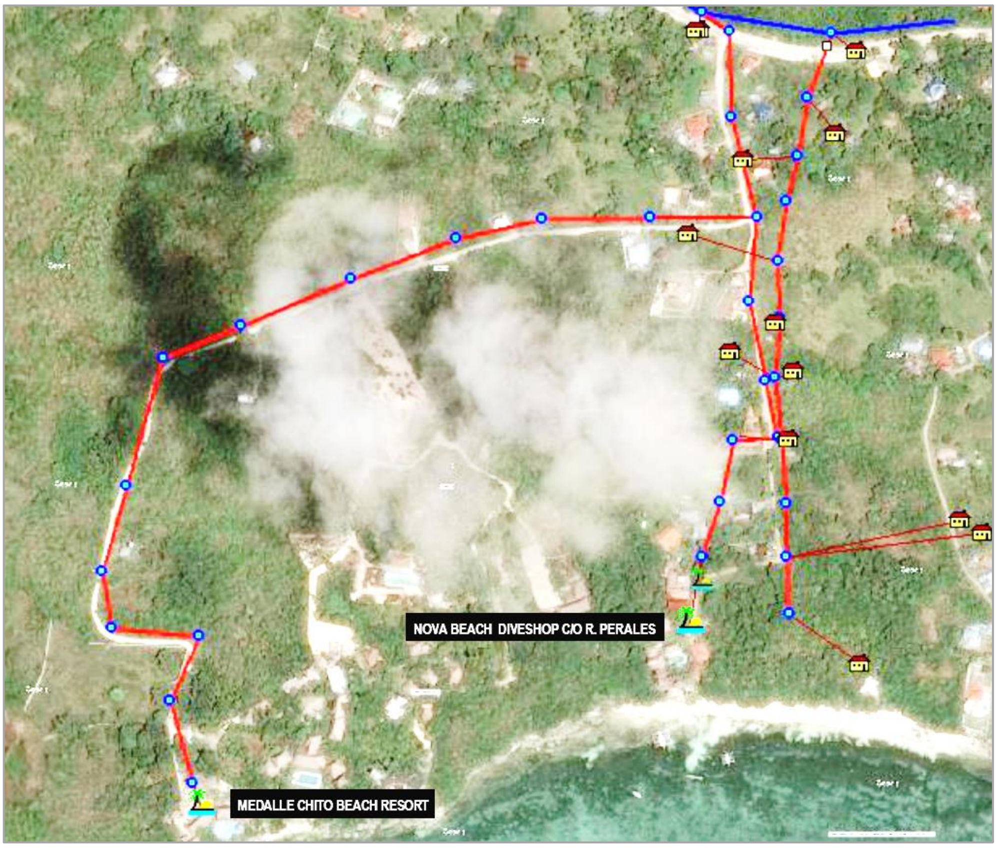


Figure 10-4 Where 3rd User Initiated Line Construction extends from the last user.

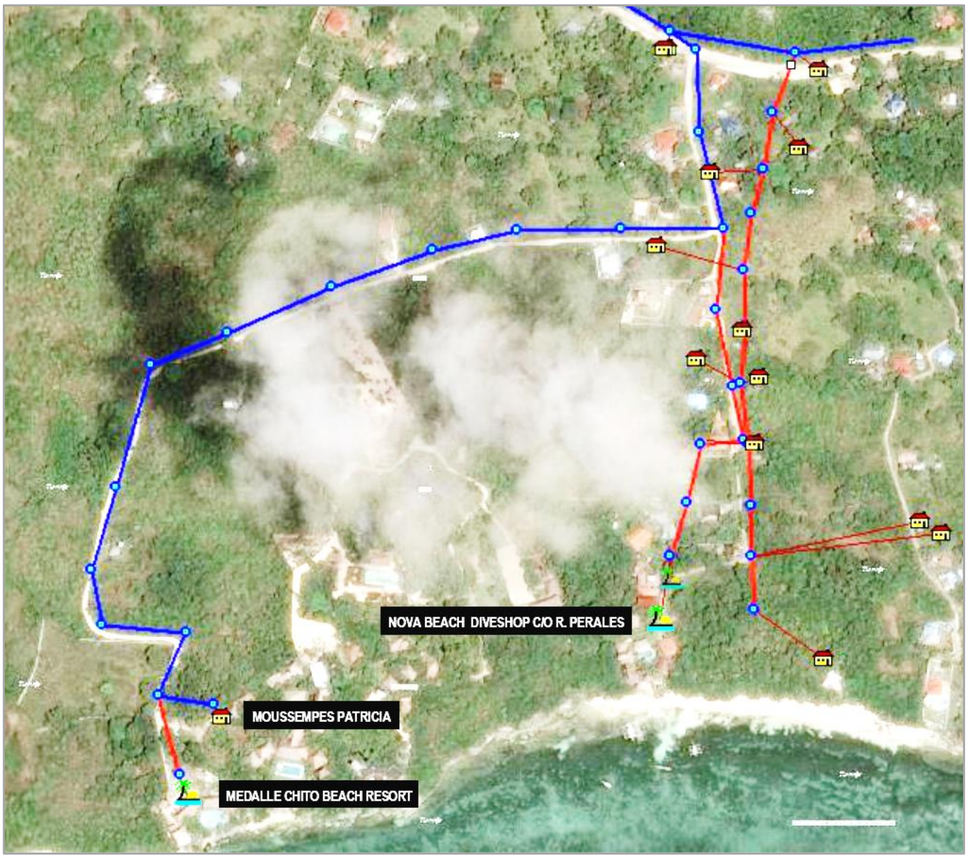
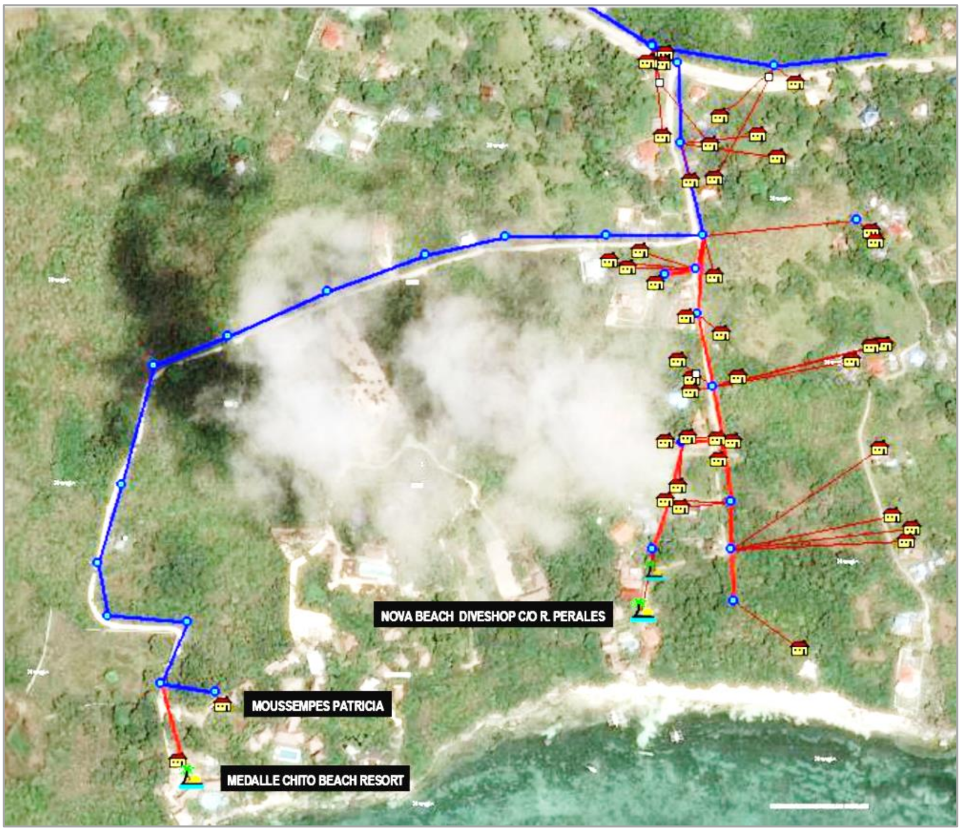


Figure 10-5 Where existing and new House connection are tapped to existing multiple-user initiated Line Construction.



Another to be refunded is the line constructed by a developer for a housing project. BOHECO I entered a Memorandum of Agreement (MOA) with Housing developers and it was agreed that the EC will refund the cost of the project upon the approval of ERC.

Below is the list of user-initiated projects where the costs are to be refunded by the EC.

Table 10-1 Summary of User-Initiated Distribution Development Project

No.	Project Description	Location	Cost	1st User
1	3Ø Primary Line Construction	Cambaquiz, Cabilao Is., Loon	234,854.37	Cabilao Beach Club c/o Regin Peñaranda
2	3Ø Primary Line Construction	Pantudlan, Cabilao Is., Loon	364,875.75	Polaris c/o Maria Victoria Baumann
3	1Ø Primary Line Construction	Brgy. Tangnan, Panglao	155,013.89	SMCT c/o Marilou Lumapas
4	3Ø Primary Line Construction	Brgy. Montaña, Baclayon	416,038.91	CalichanResources
5	3Ø Primary Line Construction	Brgy. Montaña, Baclayon	251,168.4	LABB Const. c/o Rodrigo Labunog
6	3Ø Primary Line Construction	Brgy. Montaña, Baclayon	327,520.13	7H Const. c/o Gerosa Ay-ad
7	1Ø Primary Line Construction	Brgy. Libaong, Panglao	192,046.13	Carmencita Nickles
8	1Ø Primary Line Construction	Brgy. Candajec, Clarin	552,284.89	ADNAMA c/o Danilo Teves
9	1Ø Primary Line Construction	Brgy. Bil-isan, Panglao	273,313.13	Jomer Guiritan
10	3Ø Primary Line Construction	Brgy. Totolan, Dauis	1,696,457.00	Chatue De Paz c/o Fortunato Lim
11	3Ø Primary Line Construction	Brgy. Sambog, Corella	197,056.08	South Balibago c/o Robert Umali Jr.
12	3Ø Primary Line Construction	Brgy. Katipunan, Carmen	162,470.85	Pilmon c/o Bryan Rejas
13	1Ø Primary Line Construction	Brgy. Tawala, Panglao	92,361.64	Mary Ann Malabon
14	1Ø Primary Line Construction	Brgy. Hinawanan, Loay	195,826.76	Mark Franklin C. Abraham II

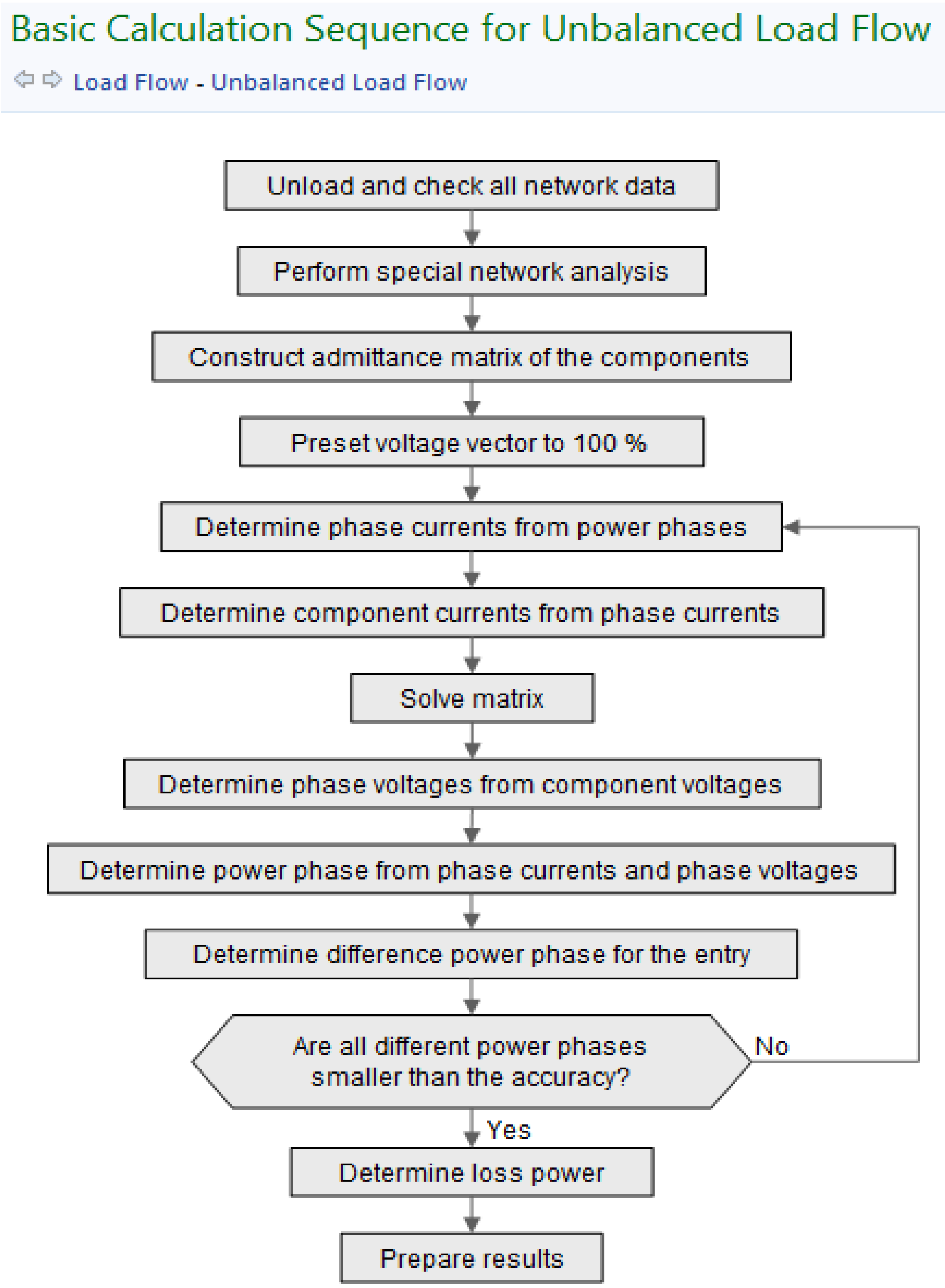
15	1Ø Primary Line Construction	Brgy. Cambuac Norte Sikatuna	115,269.74	BCCAP c/o Annabelle N. Paler
16	3Ø Primary Line Construction	Brgy. Guiwanon, Baclayon	1,139,594.12	Colorado Homes, c/o Marlon Dioquino
17	3Ø Primary Line Construction	Brgy. Dao, Dauis	1,877,787.56	Royal Palm II c/o Christopher John Palacio
18	1Ø Primary Line Construction	Brgy. Cambacay, Batuan	119,140.131	Delfino Redempta
19	1Ø Primary Line Construction	Brgy. Totlan, Dauis	122,099.71	Ryan Sigue
20	1Ø Primary Line Construction	Brgy. Ubojan, Sandinga Is., Loon	96,261.83	MAHALO c/o Erwin Van Doorne
TOTAL IN PHP			8,581,441.00	

To minimize the impact on BOHECO I's cash flow, the total amount of PhP 8,581,441.00 will be equally distributed in three years (CY 2018-2020).

Flowcharts, Methodologies and Detailed Results

Annex A Technical Simulation Flowchart

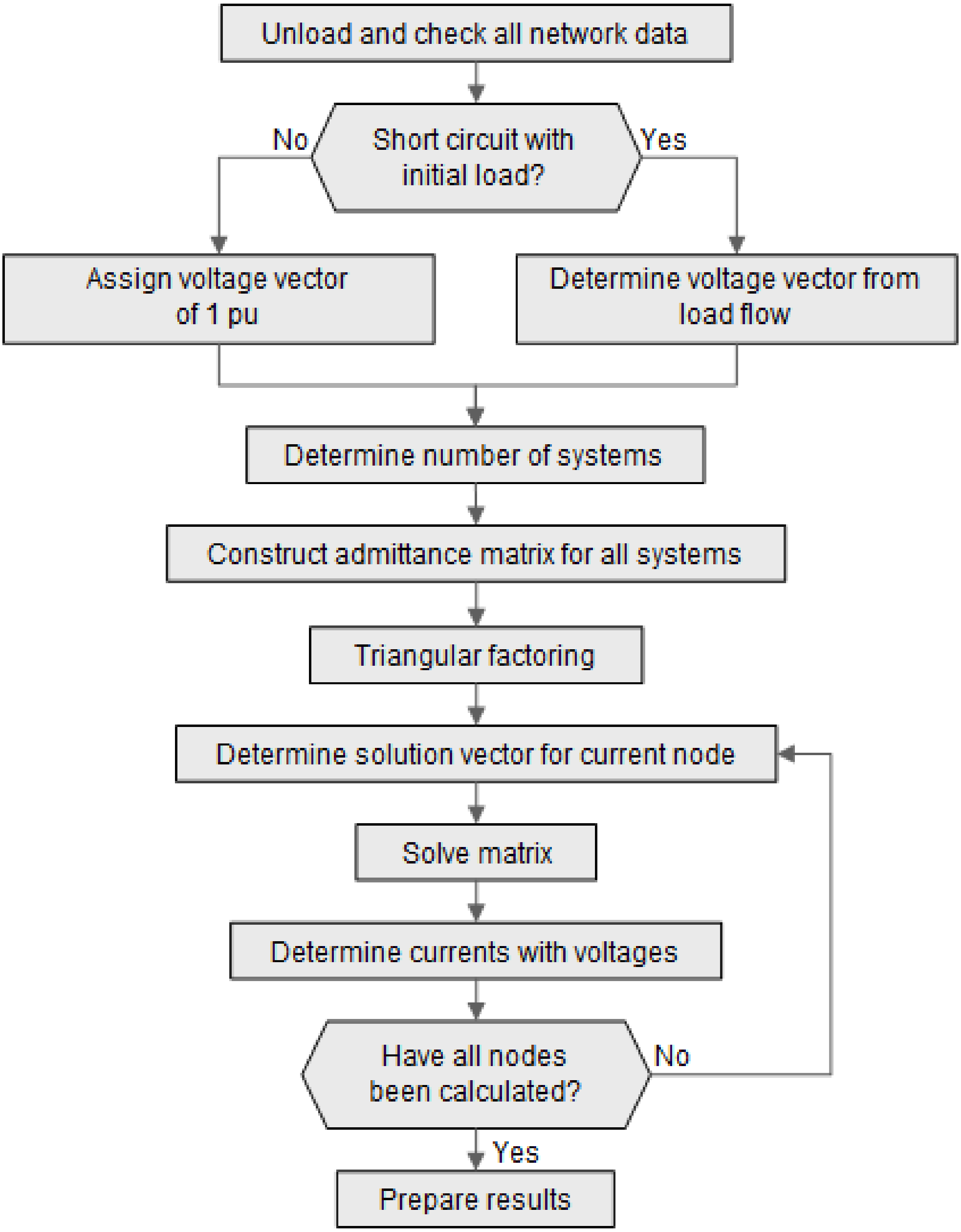
A-1 <u>Unbalanced Load Analysis Flowchart</u>



A-2 Short Circuit Calculation Procedure

Short Circuit Calculation Procedure

Short Circuit - Short Circuit Calculation Method



Annex B BOHECO I Forecasting Methodology

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

B-1 System Energy Demand Forecast

Equation 1: *System Energy Mathematical Model.*

$$Energy_{system} = a(t)^{-1} + b(\ln t)^{1} + c(lnt)^{2} + d$$

Table below shows the parameters/criteria being considered.

Table 11-1: System Energy Forecasting Criteria and Intercepts

Intercepts		P Value	t Statistic
Coefficient	Value	< 0.1	< -2, >2
a	(215,022,902.92)	(3.204473)	0.049163
b	(190,873,621.42)	(3.435959)	0.041358
c	65,342,660.14	4.754762	0.017657
d	323,554,830.64	4.850179	0.016727

Table 11-2: System Energy Forecast Validity Test Parameters and Result

Test Parameters	MAPE	r^2	r^2adj	Growth Rate
Actual	0.676%	0.9965	0.99295	7.65%
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 BOHECO I metering per feeder.

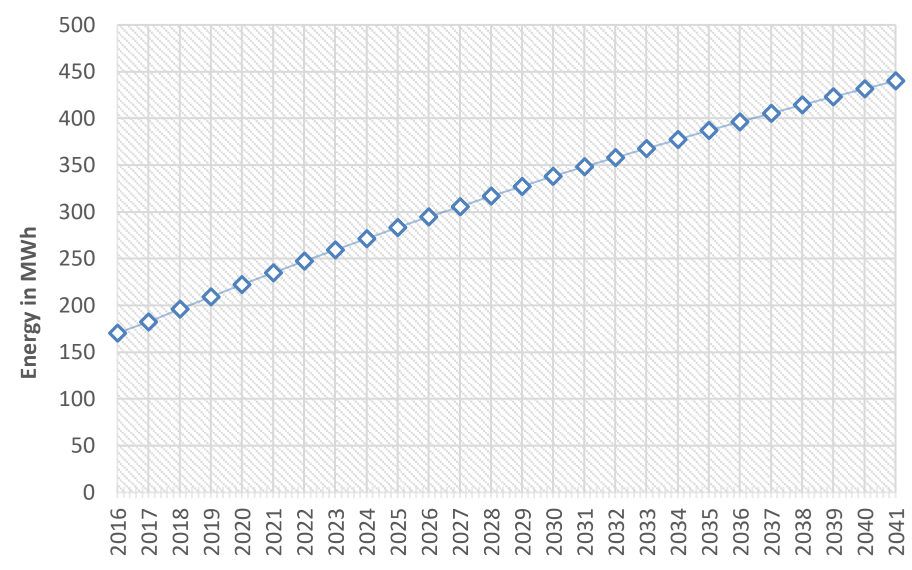
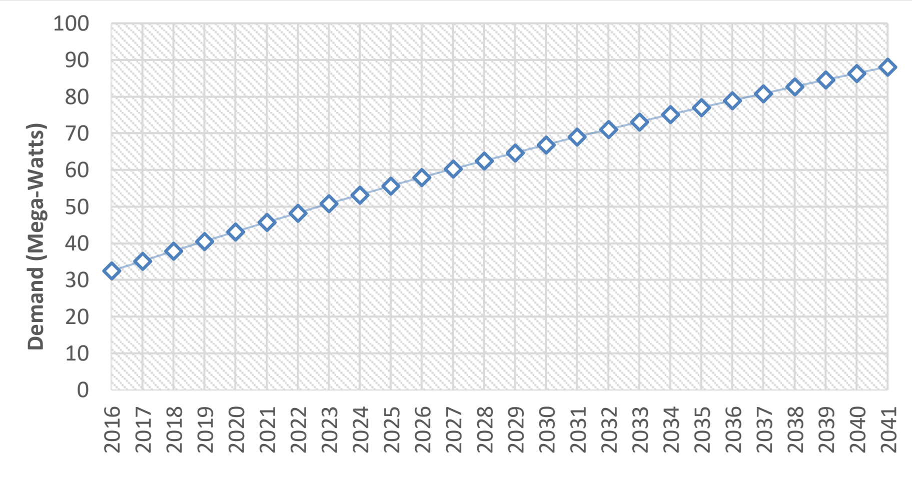


Figure 11-1: BOHECO I System Energy Forecast

YEAR	Energy (kWh)
2016	170,426,641
2017	182,313,132
2018	195,732,208
2019	208,989,911
2020	222,026,215
2021	234,808,438
2026	***294,632,660***
2031	***348,101,881***
2036	***396,290,003***
2041	***440,169,752***



Year	Demand (kW)
2016	32,473
2017	35,167
2018	37,861
2019	40,531
2020	43,165
2021	45,756
2026	***57,969***
2031	***68,990***
2036	***78,991***
2041	***88,146***

Figure 11-2: System Demand Forecast (kW)

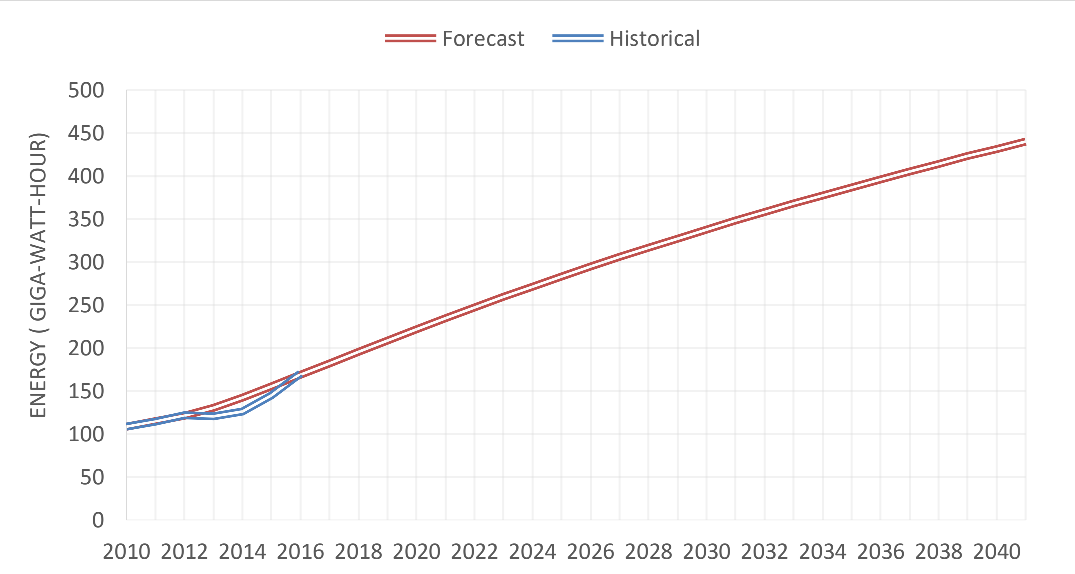


Figure 11-3: Historical, Forecasted, and Adjusted System Demand Forecast (kWh)

B-2 Per Feeder Energy Forecast

The forecasted energy of its feeder is adjusted with the system energy as shown in Equation below.

Equation 2:

$$Feeder\ Energy_i^{scaled} = Feeder\ Energy_i \times \sum_{i=1}^{n} \frac{Feeder\ Energy_i}{Load\ Factor_{Feeder=i} \times 8760}$$

Table 11-3: Per Feeder Energy Forecast Mathematical Models

Feeder	*Forecast Mathematical Model*	*Feeder*	*Forecast Mathematical Model*
F01	$a(Int)^3 + b(Int)^2 + c(Int)^1 + d$	F13	$a(Int)^3 + b$
F02	$a(Int)^3 + b$	F15	$a(Int)^3 + b$
F03	$a(Int)^2 + b$	F16	$a(Int)^3 + b(Int)^1 + c$
F04	$a(Int)^3 + b(Int)^1 + c$	F17	$a(Int)^3 + b(Int)^2 + c(Int)^1 + d$
F05	$a(Int)^3 + b$	F19	$a(Int)^{-1} + b(Int)^1 + c(Int)^3 + d$
F06	$a(Int)^2 + b$	F20	$a(Int)^{-1} + b(Int)^1 + c(Int)^2 + d$
F07	$a(Int)^3 + b$	F21	$a(Int)^3 + b(Int)^1 + c$
F08	$a(Int)^3 + b(Int)^1 + c$	F22	$a(Int)^{-1} + b(Int)^1 + c(Int)^2 + d$
F09	$a(Int)^3 + b(Int)^2 + c(Int)^1 + d$	F23	$a(Int)^3 + b$
F10	$a(Int)^3 + b$	F24	$a(Int)^{-1} + b(Int)^1 + c(Int)^3 + d$
F11	$a(Int)^{-1} + b(Int)^1 + c(Int)^2 + d$		
F12	$a(Int)^3 + b$		

Table 11-4: System Energy Forecast Validity Test Parameters and Result

Feeder	Test Parameter and Criteria			
	MAPE	r^2	r^2adj	Growth Rate
F01	0.011%	0.999998	0.999997	4.99%
F02	0.749%	0.985830	0.982996	3.75%
F03	1.333%	0.979383	0.975260	5.73%
F04	0.230%	0.999337	0.999006	5.61%
F05	2.701%	0.965219	0.958263	7.84%
F06	2.792%	0.968112	0.961735	9.13%
F07	2.368%	0.940955	0.929146	5.58%
F08	2.154%	0.980517	0.970775	10.93%
F09	0.243%	0.999372	0.998745	5.67%

F10	1.002%	0.940068	0.928082	2.70%
F11	0.471%	0.994039	0.988077	3.93%
F12	1.599%	0.974523	0.969427	5.36%
F13	2.988%	0.965466	0.958559	9.52%
F15	0.558%	0.986598	0.983918	2.84%
F16	0.647%	0.998204	0.997305	8.99%
F17	0.009%	0.999995	0.999990	2.61%
F19	2.134%	0.970452	0.940905	8.41%
F20	0.223%	0.999779	0.999559	10.43%
F21	2.250%	0.994807	0.992211	18.29%
F22	2.534%	0.963363	0.926726	6.40%
F23	2.237%	0.925210	0.910252	2.24%
F24	2.007%	0.952115	0.904230	4.84%
Requisite	< 5%	Closer to 1	Closer to 1	Reasonable

Table 11-5: BOHECO I Energy Sales Forecast per Feeder (kWh)

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
F01	12,499,824	13,152,398	13,775,232	14,369,233	14,936,023	15,477,484	15,995,531	16,492,001	16,968,601	17,426,894	17,868,298	18,294,094	18,705,434	19,103,357	19,488,799
F02	9,839,241	10,465,413	11,080,890	11,683,456	12,272,117	12,846,578	13,406,946	13,953,553	14,486,855	15,007,370	15,515,639	16,012,207	16,497,604	16,972,344	17,436,917
F03	769,356	814,184	856,638	896,812	934,847	970,897	1,005,117	1,037,655	1,068,647	1,098,220	1,126,485	1,153,546	1,179,496	1,204,416	1,228,383
F04	8,954,429	9,466,447	9,959,113	10,432,560	10,887,539	11,325,070	11,746,265	12,152,235	12,544,041	12,922,675	13,289,053	13,644,013	13,988,319	14,322,666	14,647,690
F05	9,954,192	10,914,592	11,873,048	12,824,150	13,764,431	14,691,704	15,604,633	16,502,454	17,384,799	18,251,569	19,102,849	19,938,848	20,759,862	21,566,241	22,358,369
F06	12,429,184	13,342,957	14,214,060	15,043,689	15,833,914	16,587,166	17,305,964	17,992,772	18,649,921	19,279,580	19,883,748	20,464,253	21,022,762	21,560,794	22,079,733
F07	5,330,976	5,755,916	6,177,389	6,593,361	7,002,650	7,404,602	7,798,895	8,185,422	8,564,212	8,935,382	9,299,104	9,655,584	10,005,047	10,347,725	10,683,856
F08	8,529,985	9,231,398	9,916,440	10,583,907	11,233,471	11,865,311	12,479,897	13,077,852	13,659,877	14,226,702	14,779,053	15,317,637	15,843,135	16,356,192	16,857,417
F09	6,083,468	6,678,085	7,284,206	7,896,595	8,511,519	9,126,287	9,738,937	10,348,037	10,952,543	11,551,696	12,144,954	12,731,935	13,312,382	13,886,131	14,453,092
F10	6,143,746	6,470,276	6,788,378	7,097,292	7,396,883	7,687,341	7,969,016	8,242,332	8,507,737	8,765,678	9,016,585	9,260,863	9,498,894	9,731,029	9,957,598
F11	5,613,451	6,009,419	6,399,854	6,782,616	7,156,564	7,521,160	7,876,232	8,221,834	8,558,158	8,885,475	9,204,101	9,514,377	9,816,648	10,111,259	10,398,546
F12	8,588,894	9,258,325	9,921,756	10,576,061	11,219,447	11,850,949	12,470,116	13,076,825	13,671,163	14,253,347	14,823,676	15,382,497	15,930,183	16,467,118	16,993,688
F13	5,088,356	5,470,108	5,834,215	6,181,156	6,511,770	6,827,050	7,128,027	7,415,712	7,691,066	7,954,982	8,208,285	8,451,731	8,686,009	8,911,748	9,129,521
F15	2,330,847	2,428,118	2,519,077	2,604,074	2,683,571	2,758,054	2,827,987	2,893,803	2,955,891	3,014,601	3,070,241	3,123,088	3,173,386	3,221,352	3,267,177
F16	8,621,336	9,366,593	10,101,672	10,823,939	11,531,974	12,225,112	12,903,157	13,566,208	14,214,548	14,848,569	15,468,726	16,075,508	16,669,416	17,250,951	17,820,603
F17	1,170,439	1,221,775	1,270,889	1,317,809	1,362,644	1,405,530	1,446,613	1,486,035	1,523,928	1,560,416	1,595,607	1,629,602	1,662,490	1,694,352	1,725,259
F19	9,486,588	10,836,882	12,256,986	13,727,599	15,234,030	16,764,990	18,311,742	19,867,481	21,426,888	22,985,793	24,540,920	26,089,693	27,630,095	29,160,548	30,679,825
F20	39,442,004	41,331,735	43,141,334	44,870,144	46,520,842	48,097,628	49,605,265	51,048,593	52,432,278	53,760,695	55,037,888	56,267,557	57,453,074	58,597,505	59,703,635
F21	3,547,366	3,708,041	3,862,012	4,009,324	4,150,272	4,285,255	4,414,700	4,539,028	4,658,637	4,773,892	4,885,127	4,992,642	5,096,711	5,197,578	5,295,465
F22	6,514,908	7,475,845	8,473,825	9,494,562	10,527,726	11,565,781	12,603,202	13,635,928	14,660,983	15,676,197	16,680,003	17,671,293	18,649,303	19,613,535	20,563,693
F23	2,489,767	2,801,255	3,114,192	3,426,534	3,736,877	4,044,263	4,348,042	4,647,784	4,943,215	5,234,176	5,520,585	5,802,422	6,079,708	6,352,494	6,620,850
F24	864,133	1,005,843	1,158,276	1,318,825	1,485,475	1,656,653	1,831,122	2,007,902	2,186,216	2,365,440	2,545,077	2,724,725	2,904,064	3,082,833	3,260,824
F25	4,312,994	4,564,297	4,802,293	5,027,510	5,240,732	5,442,828	5,634,665	5,817,072	5,990,816	6,156,598	6,315,054	6,466,758	6,612,229	6,751,933	6,886,290
F26	3,707,644	3,962,305	4,208,137	4,445,008	4,673,118	4,892,830	5,104,585	5,308,847	5,506,075	5,696,713	5,881,177	6,059,857	6,233,112	6,401,275	6,564,651
Total	182,313,132	195,732,208	208,989,911	222,026,215	234,808,438	247,320,522	259,556,654	271,517,365	283,207,097	294,632,660	305,802,236	316,724,731	327,409,361	337,865,375	348,101,881

B-3 System Demand Forecast (kW)

The forecasted system demand (in kW) was derived in a global approach as shown in Equation 3. 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 3: *System Demand Forecasting Mathematical Model:*

$$\boldsymbol{Demand}_{system} = \sum_{i=1}^{n} \frac{Feeder\ Energy_i}{Load\ Factor_{Feeder=i} \times 8760}$$

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

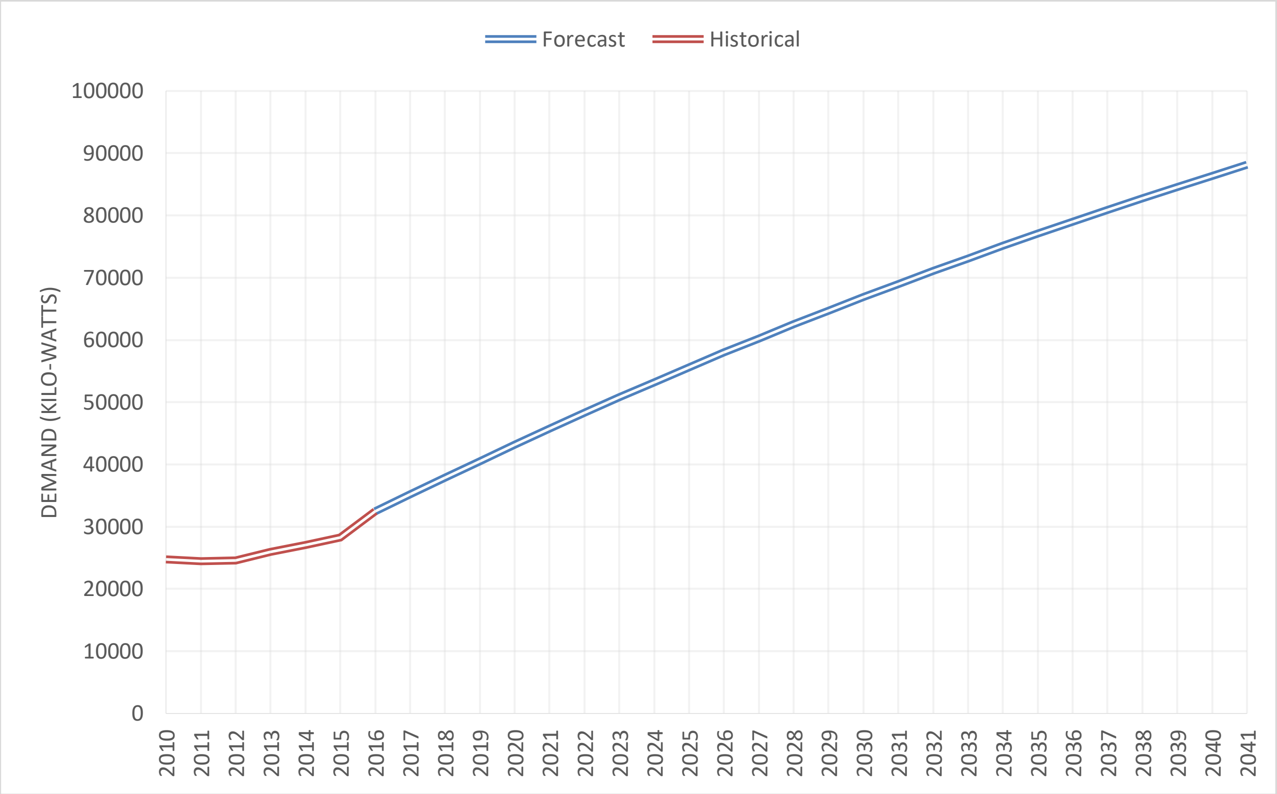


Figure 11-4: BOHECO I System Demand Forecast

The forecasted output was used in evaluating the system's technical performance, loading and capacity for the next five years. Through this, the need for systems capacity augmentation projects and capital-intensive projects were identified.

The forecasted demand per substation was derived through the same process. It is the sum of the individual forecasted demand per feeder obtained through Equation 4. The Detailed forecasted data per feeders are shown in Annex "B".

Equation 4: *Mathematical Model for Substation Demand forecast:*

$$\boldsymbol{Demand}_{substation} = \sum_{i=1}^{n} \frac{Feeder\ Energy\ Forecast_i}{Feeder\ Load\ Factor_i \times 8760}$$

Where:

n = *no. of feeders in a substation*

L.F. = *load factor of a given feeder*

i = *feeders number (i.e. F01, F02, F03, etc…)*

A constant load factor is considered in Equation 4 throughout the next thirty (30) years. It is presumed to be constant based on its historical trend for the past years. Table below shows the forecasted demand per substation including the off-grid customers and industrial customer directly tapped to the 69-kV grid, the PSIC.

Table 11-6: BOHECO I Demand Forecast per Substation (kilowatts)

Year	Macaas	Dampas	Carmen	Loay	Mari-bojoc	Panglao	Catag-bacan	Sagasa	Island	SYSTEM (TOTAL)
2017	6,409	6,694	4,304	3,607	3,266	7,951	970	1,967	300	35,167
2018	6,812	7,184	4,647	3,882	3,500	8,634	1,110	2,091	331	37,861
2019	7,206	7,660	4,982	4,158	3,730	9,331	1,255	2,210	362	40,531
2020	7,589	8,121	5,307	4,432	3,954	10,035	1,404	2,324	393	43,165
2021	7,961	8,567	5,624	4,702	4,172	10,743	1,554	2,432	423	45,756
2022	8,323	9,000	5,932	4,970	4,384	11,450	1,705	2,536	453	48,298
2023	8,674	9,419	6,230	5,233	4,590	12,154	1,857	2,635	482	50,791
2024	9,015	9,824	6,521	5,493	4,791	12,853	2,007	2,730	511	53,234
2025	9,347	10,218	6,803	5,748	4,986	13,547	2,157	2,822	540	55,626
2026	9,669	10,599	7,078	5,998	5,177	14,234	2,305	2,909	568	57,969
2027	9,984	10,970	7,345	6,244	5,362	14,913	2,452	2,994	595	60,264
2028	10,290	11,330	7,605	6,486	5,543	15,585	2,598	3,075	622	62,512
2029	10,588	11,680	7,859	6,724	5,720	16,249	2,742	3,153	648	64,714
2030	10,879	12,021	8,106	6,958	5,892	16,904	2,883	3,229	674	66,873
2031	11,163	12,354	8,347	7,187	6,061	17,551	3,023	3,303	699	68,990

Table 11-7 : BOHECO I Demand Forecast per Feeder (kilowatts)

Year	LOAD FACTOR	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
F01	0.652379	2,345	2,467	2,584	2,696	2,802	2,904	3,001	3,094	3,183	3,269
F02	0.595859	2,235	2,377	2,517	2,654	2,788	2,918	3,045	3,170	3,291	3,409
F03	0.498428	188	199	209	219	228	237	245	253	261	268
F04	0.659991	2,654	2,806	2,952	3,092	3,227	3,357	3,481	3,602	3,718	3,830
F05	0.627835	1,778	1,949	2,121	2,290	2,458	2,624	2,787	2,947	3,105	3,260
F06	0.70573	2,262	2,429	2,587	2,738	2,882	3,019	3,150	3,275	3,395	3,509
F07	0.260724	1,304	1,408	1,511	1,613	1,713	1,811	1,908	2,002	2,095	2,186
F08	0.610147	1,929	2,088	2,243	2,394	2,541	2,684	2,823	2,958	3,089	3,218
F09	0.634874	1,413	1,551	1,692	1,835	1,977	2,120	2,263	2,404	2,544	2,684
F10	0.480465	1,011	1,065	1,118	1,168	1,218	1,266	1,312	1,357	1,401	1,443
F11	0.52456	1,182	1,266	1,348	1,429	1,507	1,584	1,659	1,732	1,802	1,871
F12	0.604634	1,641	1,769	1,896	2,021	2,144	2,264	2,383	2,498	2,612	2,723
F13	0.551439	1,071	1,151	1,228	1,301	1,370	1,437	1,500	1,561	1,619	1,674
F15	0.647221	566	590	612	633	652	670	687	703	718	733
F16	0.571453	2,171	2,359	2,544	2,726	2,905	3,079	3,250	3,417	3,580	3,740
F17	0.571453	528	551	573	595	615	634	653	670	688	704
F19	0.571453	3,212	3,670	4,151	4,649	5,159	5,677	6,201	6,728	7,256	7,784
F20	0.684517	4,258	4,462	4,657	4,844	5,022	5,192	5,355	5,511	5,660	5,804
F21	0.838506	480	502	523	543	562	580	598	615	631	646
F22	0.571453	635	729	826	926	1,027	1,128	1,229	1,330	1,430	1,529
F23	0.571453	220	248	276	303	331	358	385	411	437	463
F24	0.571453	114	133	153	175	197	219	243	266	290	313
F25	0.498428	1,052	1,113	1,171	1,226	1,278	1,327	1,374	1,418	1,461	1,501
F26	0.571453	915	978	1,039	1,098	1,154	1,209	1,261	1,312	1,361	1,408
Total	0.676530	35,167	37,861	40,531	43,165	45,756	48,298	50,791	53,234	55,626	57,969

B-4 No. of Distribution Transformer Forecast

The forecasted number of Single-Phase Distribution Transformer is derived in the methodology as shown in Figure 11-6 below.

Figure 11-5 Forecasted Single-Phase Distribution Transformer Methodology

1. Calculate the Contribution Factor per kVA Rating *(Eq. 5)*
2. Calculate the Yearly Increment of System Demand *(Eq. 6)*
3. Mulltiply the Contribution Factor per kVA Rating to the Increment of System Demand and 60% Loading *(Eq. 7)*
4. Divide the Product by the Rated kVA *(15kVA, 25kVA, 37.5kVA, 50kVA, 75kVA, 100kVA & 167kVA)*
5. Round-Up the Quotient to a Multiple of 3

Equation 5: *Distribution Transformer Contribution Factor per Rated kVA*

$$Cf_{per\ kVA} = \frac{No.of\ Units \times Rated\ kVA}{\sum_{i=15kVA}^{j} No.of\ Units \times Rated\ kVA}$$

Where:

j=Rated kVA, (15kVA, 25kVA, 37.5kVA, 50kVA, 75kVA, 100kVA, 167kVA)

Equation 6: *Yearly Increment of System Demand*

$$\Delta\ \boldsymbol{Demand}_{yearly} = \boldsymbol{Demand}_{present\ year} - \boldsymbol{Demand}_{previous\ year}$$

Equation 7: *Allocated Demand per kVA Rating*

$$Allocated\ Demand\ (kW)_{per\ kVA} = \frac{Cf_{per\ kVA} \times \Delta Demand_{yearly}}{0.60\ (\%\ loading)}$$

Table 11-8 : Forecasted Annual Number of Distribution Transformers Requirement per kVA

Year	kVA Rating, Single Phase Distribution Transformers						
	15	25	37.5	50	75	100	167
2017	57	42	21	12	6	6	3
2018	57	42	21	12	6	6	3
2019	57	42	21	12	6	6	3
2020	54	42	21	12	6	6	3
2021	54	39	21	12	6	6	3
2022	54	39	21	12	6	6	3
2023	51	39	18	12	6	6	3
2024	51	39	18	12	6	6	3
2025	51	39	18	12	6	6	3
2026	48	36	18	12	6	6	3

B-5 BOHECO I Customer Forecast

The number of customers forecast played a vital role in the planning process because this entails additional revenue and expenses in which the viability of the electric utility will be measured. Through all available input data, the following mathematical models represents the historical trend of each customer type that passes all the forecasting parameters and criteria being set.

Table 11-9 : No. of Customer Mathematical Forecasting Model per Customer Type

Type of Customer	Forecast Mathematical Model
Residential Mainland (RM)	$a(lnt)^3 + b$
BAPA & ECA (BE)	$a(lnt)^2 + b$
Commercial Small (CS)	$a(lnt)^3 + b$
Commercial Large (CL)	$a(lnt)^3 + b$
Public Building (PB)	$a(lnt)^3 + b(lnt)^1 + c$
Street Lights (ST)	$a(lnt)^3 + b$
Island (INDL)	$a(lnt)^3 + b$
Industrial (INDL)	$a(lnt)^2 + b$

Consumer Type	a			b			c		
	Coefficient	P Value	t Statistic	Coefficient	P Value	t Statistic	Coefficient	P Value	t Statistic
	Value	< 0.1	< -2, >2	Value	< 0.1	< -2, >2	Value	< 0.1	< -2, >2
RM	1,351.29	13.555428	0.000039	65,258.01	162.411084	0.000000			
BE	1,720.40	19.220860	0.000007	36,868.69	179.808117	0.000000			
CS	30.37	7.479580	0.000675	5,176.30	316.249550	0.000000			
CL	1.93	8.209906	0.000436	327.47	345.908551	0.000000			
PB	32.67	3.808867	0.018959	79.08	2.256147	0.087051	2,518.83	105.956539	0.000000
ST	232.19	13.146322	0.000045	7,929.69	111.388187	0.000000			
IS	88.61	13.744223	0.000037	1,499.53	101.534211	0.000000			
INDL	2.06	11.235864	0.000098	28.79	39.003297	0.000000			

Table 11-10 : No. of Consumer Forecast per Type Validity Test Parameters and Result

	Test Parameters	MAPE (%)	r^2	r^2adj	Growth Rate (%)
	RM	0.740%	0.973509882	0.968211858	2.40%
	BE	0.561%	0.986646778	0.983976133	2.75%
	CS	0.354%	0.917957626	0.901549151	0.71%
	CL	0.331%	0.93094166	0.917129992	0.71%
	PB	0.614%	0.979936218	0.969904327	2.46%
	ST	0.992%	0.971882594	0.966259112	3.32%
	IS	0.943%	0.974213999	0.969056799	3.42%
	INDL	2.689%	0.961903208	0.95428385	7.33%
Requisite		< 3%	*>0.99*	*>0.99*	Reasonable

Table 11-11 : Forecasted No. of Customer Add-Ons per Customer Type

Year	RM	BE	CS	CL	PB	SL	IN	Island	Total
2017	78,106	44,707	5,498	348	3,004	10,108	47	1,883	143,701
2018	80,958	45,950	5,593	354	3,091	10,571	51	1,927	148,494
2019	83,826	47,155	5,688	360	3,178	11,037	54	1,969	153,267
2020	86,690	48,322	5,782	366	3,264	11,503	57	2,009	157,992
2021	89,538	49,450	5,875	372	3,349	11,966	60	2,047	162,657
2022	92,362	50,541	5,967	378	3,433	12,426	64	2,082	167,252
2023	95,157	51,595	6,057	383	3,515	12,883	67	2,117	171,773
2024	97,920	52,616	6,145	389	3,596	13,334	70	2,149	176,218
2025	100,649	53,603	6,232	394	3,675	13,781	73	2,181	180,587
2026	103,343	54,561	6,316	400	3,753	14,222	76	2,211	184,881
2027	106,001	55,489	6,400	405	3,829	14,658	78	2,240	189,100
2028	108,624	56,389	6,481	410	3,904	15,089	81	2,268	193,248
2029	111,212	57,264	6,561	415	3,978	15,515	84	2,295	197,324
2030	113,766	58,115	6,639	420	4,051	15,935	87	2,321	201,333
2031	116,285	58,942	6,715	425	4,122	16,350	90	2,346	205,276

Table 11-11 shows the forecasted number of customer add-ons per customer type with the total number of customers in the base year 2016.

Annex C Predictive Reliability Assessment per Feeder

Table 11-12 : Predictive Reliability Assessment per Feeder

Feeder	SAIFI						SAIDI					
	2015	2016	2017	2018	2019	2020	2015	2016	2017	2018	2019	2020
F01	8.54	8.06	8.06	8.06	8.06	8.06	10.80	7.53	7.53	7.53	7.53	7.53
F02	2.51	2.51	2.51	2.51	2.51	2.51	5.56	5.56	5.56	5.56	5.56	5.56
F03	11.71	9.74	9.74	9.74	9.74	9.74	20.75	20.06	20.06	20.06	20.06	20.06
F04	6.36	6.36	6.36	6.36	6.36	6.36	8.63	8.63	8.63	8.63	8.63	8.63
F05	1.77	1.77	1.77	1.77	1.77	1.77	5.97	5.97	5.97	5.97	5.97	5.97
F06	7.49	7.49	7.49	6.68	6.68	6.68	21.40	21.40	21.40	6.84	6.84	6.84
F07	1.31	1.31	1.31	1.31	1.31	1.31	5.01	5.01	5.01	5.01	5.01	5.01
F08	3.45	3.45	3.45	3.45	3.45	3.45	5.15	5.15	5.15	5.15	5.15	5.15
F09	10.68	10.68	10.68	10.68	10.68	10.68	18.85	18.85	18.85	18.85	18.85	18.85
F10	5.14	5.14	5.14	5.14	5.14	5.14	7.62	7.62	7.62	7.62	7.62	7.62
F11	6.00	6.00	6.00	6.00	6.00	6.00	10.40	10.40	10.40	10.40	10.40	10.40
F12	9.38	9.38	9.38	9.38	9.38	9.38	6.68	6.68	6.68	6.68	6.68	6.68
F13	7.64	7.64	7.64	7.64	7.64	7.64	8.94	8.94	8.94	8.94	8.94	8.94
F15	8.64	8.64	8.64	8.64	8.64	8.64	10.32	10.32	10.32	10.32	10.32	10.32
F16	7.44	7.44	7.44	7.44	7.44	7.44	6.29	6.29	6.29	6.29	6.29	6.29
F17	12.43	9.04	9.04	9.04	9.04	9.04	33.07	20.81	20.81	20.81	20.81	20.81
F18	4.92	4.92	4.92	4.92	4.92	4.92	3.87	3.87	3.87	3.87	3.87	3.87
F18A	4.83	4.83	4.83	4.83	4.83	4.83	4.05	4.05	4.05	4.05	4.05	4.05
F19	3.23	3.23	3.23	3.23	3.23	3.23	1.76	1.76	1.76	1.76	1.76	1.76
F20	1.06	1.06	1.06	0.47	0.47	0.47	0.33	0.33	0.33	0.08	0.08	0.08
F20A	8.29	8.29	8.29	8.29	8.29	8.29	7.90	7.90	7.90	7.90	7.90	7.90
F21	0.75	0.75	0.75	0.75	0.75	0.75	1.74	1.74	1.74	1.74	1.74	1.74
F22		14.34	14.34	14.34	14.34	14.34		39.96	39.96	39.96	39.96	39.96
F23		8.61	8.61	8.61	8.61	8.61		10.86	10.86	10.86	10.86	10.86
F24		9.75	9.75	9.75	9.75	9.75		19.28	19.28	19.28	19.28	19.28
F25			12.42	12.42	12.42	12.42			22.13	22.13	22.13	22.13
F26			10.35	10.35	10.35	10.35			17.32	17.32	17.32	17.32

Annex D Economic Sizing of 13.2kV Primary Distribution Line

In a well-designed distribution system, the sizes of lines and transformer will be proportional to loading. Since a distribution line is used throughout its life cycle, line sizing economics methodology considers the: (1) initial costs (*investment cost of primary distribution line*); (2) initial load & load growth; (3) continuing lifetime costs (*cost of losses*); (4) increases in power cost; (5) annual fixed cost; and (6) net present value of the cost of money spent.

The load was expressed as the current annual peak load on the distribution line considered and assumed to grow over its thirty-year life cycle. The cost of power was assumed to stay constant and a thirty-year present worth factor was developed for the cost of losses and for the annual fixed cost Equation 11.7 shows the total cost function of line.

Equation 8: *Total Cost Function of Primary Distribution Line*

$$C_{total} = k_1 + k_2 * kW_{peak}^2$$

Equation 9: *Fixed Cost Function of Primary Distribution Line*

$$k_1 = \left(C_{acq} + C_{inst}\right) + \left(C_{O\&M} \times PWF_{O\&M}\right)$$

Equation 10: *Variable Cost Function of Primary Distribution Line*

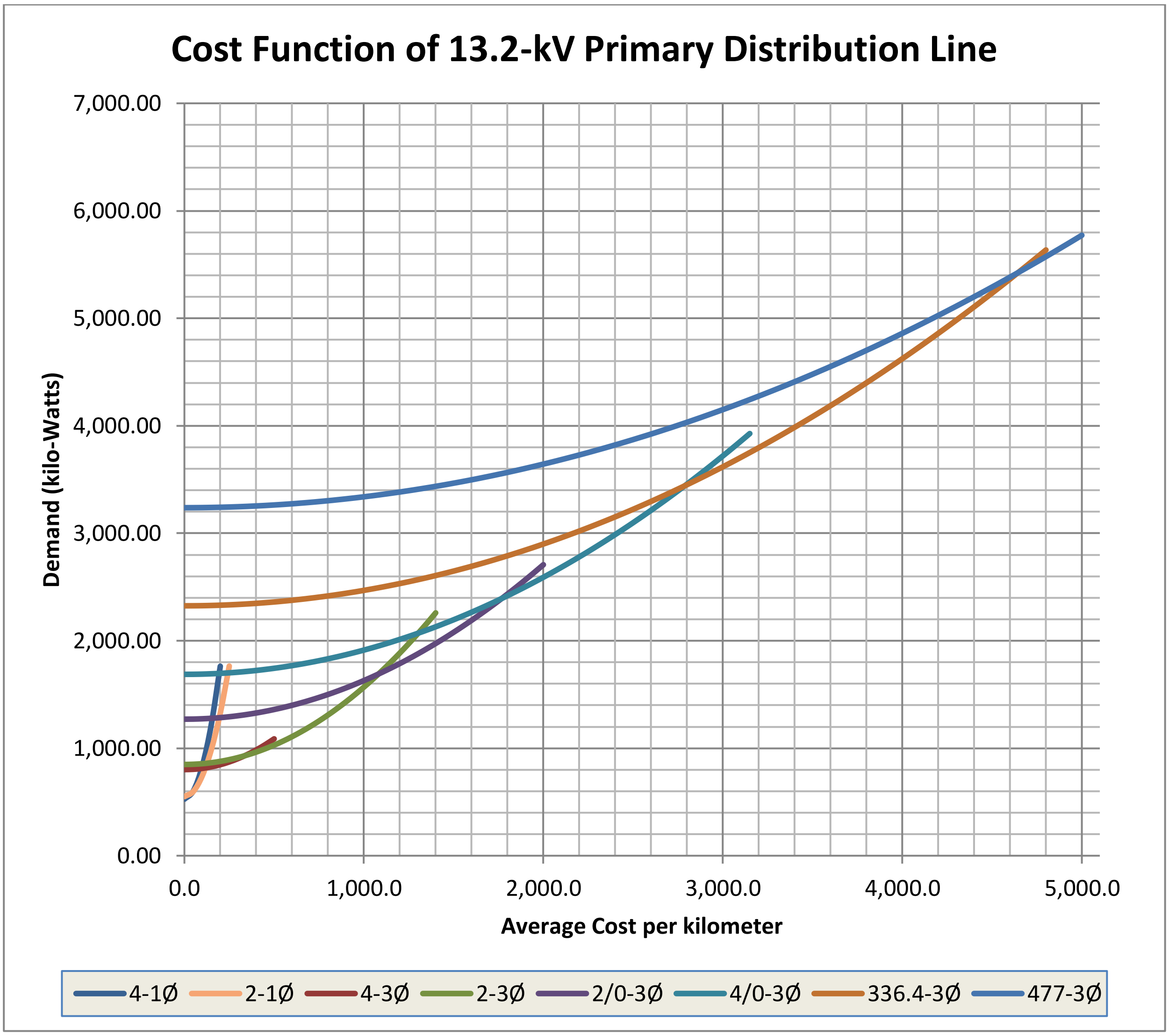
$$k_2 = \frac{1}{1000}\left[\frac{r_1}{nPF^2 kV_{LN}^2}\right] \times \left[(8760 * LSF * C_{EC} * PWF_{EC}) + (RF * C_{DC} * PWF_{DC})\right]$$

Where:

C_{total}	=	Total Cost of Line
kW_{peak}	=	Peak demand of the line in its first year (kW)
kV_{LN}	=	Line-to-Neutral voltage (kV)
C_{acq}	=	Acquisition Cost
C_{inst}	=	Installation Cost
$C_{O\&M}$	=	Operation and Maintenance Cost
C_{EC}	=	Energy charge (PhP/kWh)
C_{DC}	=	Demand charge (PhP/kWh)
$PWF_{O\&M}$	=	Present worth factor (O&M Charge Component)
PWF_{DC}	=	Present worth factor (Demand Charge Component)
PWF_{EC}	=	Present worth factor (Energy Charge Component)
LSF	=	System Loss Factor
RF	=	Peak loss responsibility factor
PF	=	power factor of the load
r_1	=	Effective resistance of the line (ohms/km)
n	=	number of phases present

Figure 11-6 shows the curves derived from Equation 11.7, the total cost function of primary distribution line, which excludes the redundant line types.

Figure 11-6 Cost Functions of 13.2kV Primary Distribution Line



D-1 Economic Load Reach

Load Reach is defined as the source-to-load distance that a feeder system can move power before encountering the applicable voltage drop limit. Economic load reach is the load reach if the feeder system is loaded at the maximum load within their economic loading range.

Equation 11: *Economic Load Reach of Conductor*

$$Load\ Reach = \frac{[\%VD_{criteria}]}{[\%VD_{(at\ maximum\ economic\ load)}]/_{km}}$$

Above equation shows that the load reach of a given conductor is affected by its voltage level. When you double the voltage, it doubles the load reach because load current is halved, which effectively halves the voltage drop (assuming similar impedance), and doubles the distance before the voltage drop limit is reached. In this viewpoint, it is practical to go for high voltage distribution line, however, it has higher fixed costs. Therefore, it is economical to use an appropriate voltage level but in the case of BOHECO I, the voltage has been chosen at 13,200 Volts line-to-line.

This study uses a voltage criterion of 7.5% per unit drop for the primary distribution line at ninety (90%) percent power factor.

Table 11-13 : Average Economic Load Reach (13.2-kV Primary Distribution Line)

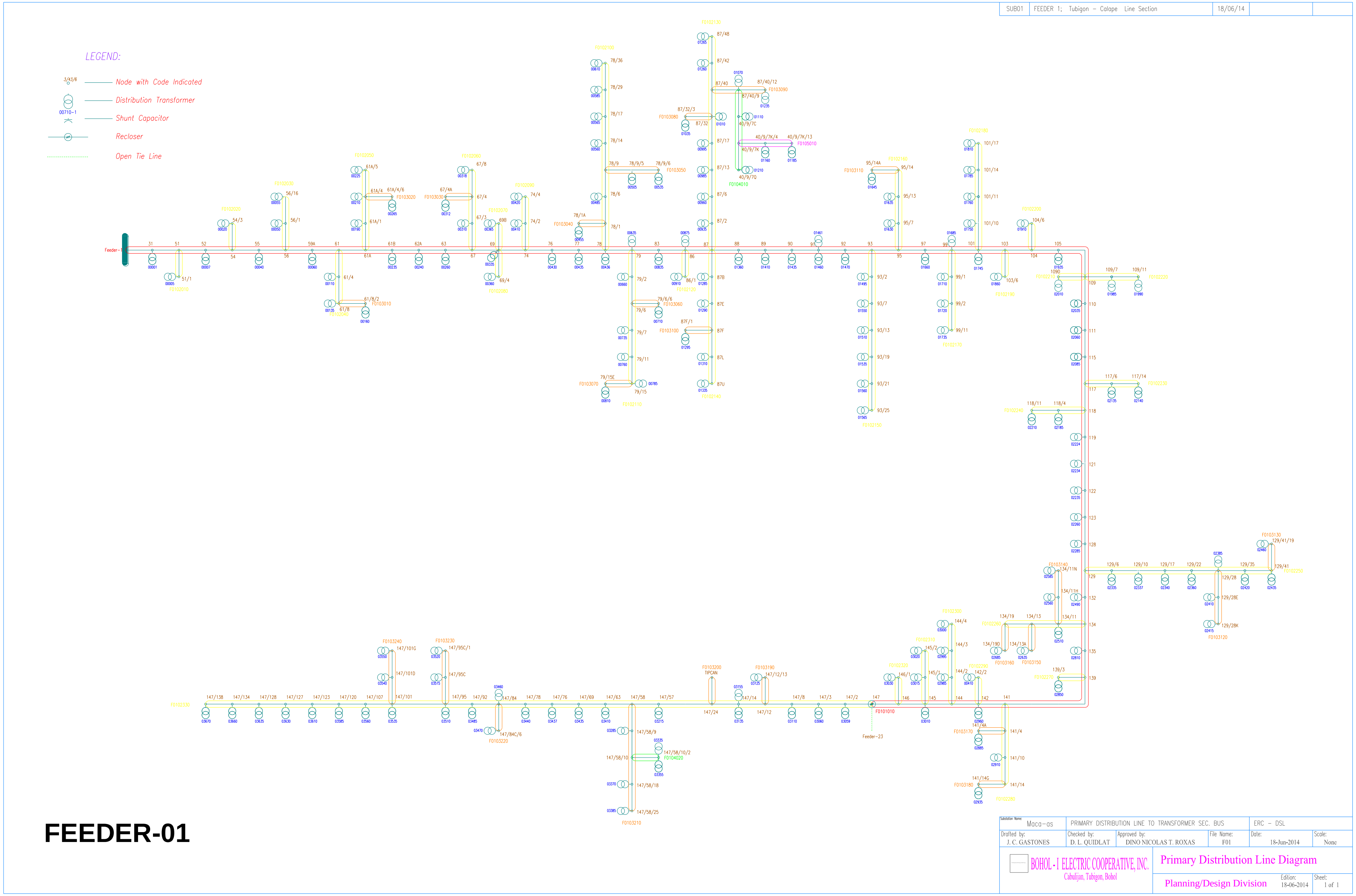
Phase	Size (AWG)	*Economic Load (kW)*		Max (Zeff,a; Zeff,b; Zeff,c)	Voltage Drop		Economic Load Reach
		Minimum	Maximum		Volts/km	% / km	
1	4	0.0	45.6	1.323	8.8	0.12%	64.94
1	2	45.6	165.9	0.831	20.1	0.26%	28.44
3	4	165.9	335.3	1.323	21.6	0.28%	26.51
3	2	335.3	1,081.5	0.831	43.7	0.57%	13.09
3	2/0	1,081.5	1,767.6	0.415	35.6	0.47%	16.03
3	4/0	1,767.6	2,787.3	0.261	35.4	0.46%	16.17
3	336.4	2,787.3	4,644.9	0.166	37.5	0.49%	15.25
3	477	4,644.9	7,725.5	0.117	43.9	0.58%	13.01
				Average Economic Load Reach			*19.25*

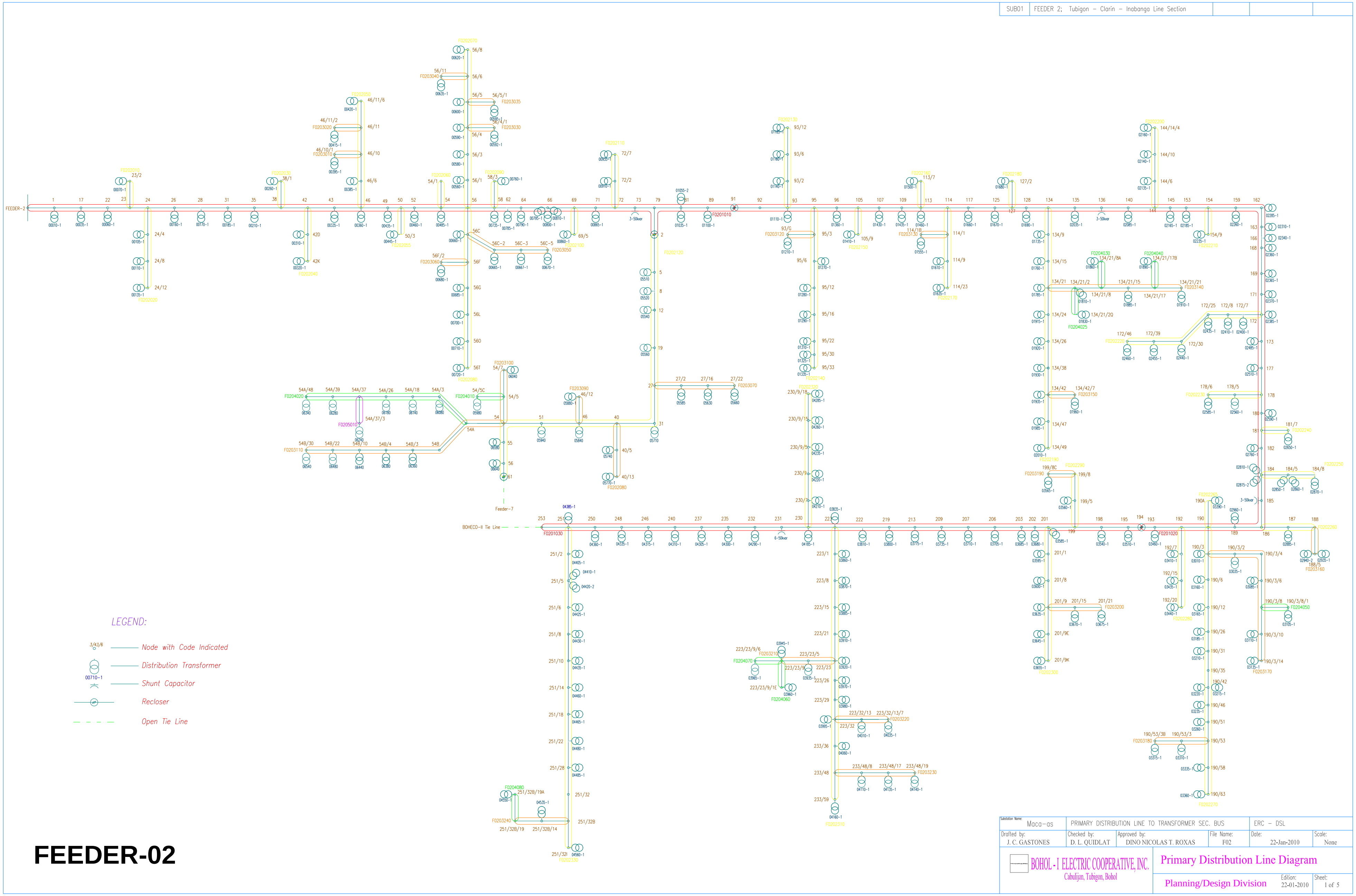
Annex E Distribution Feeder Protection and Safety Development

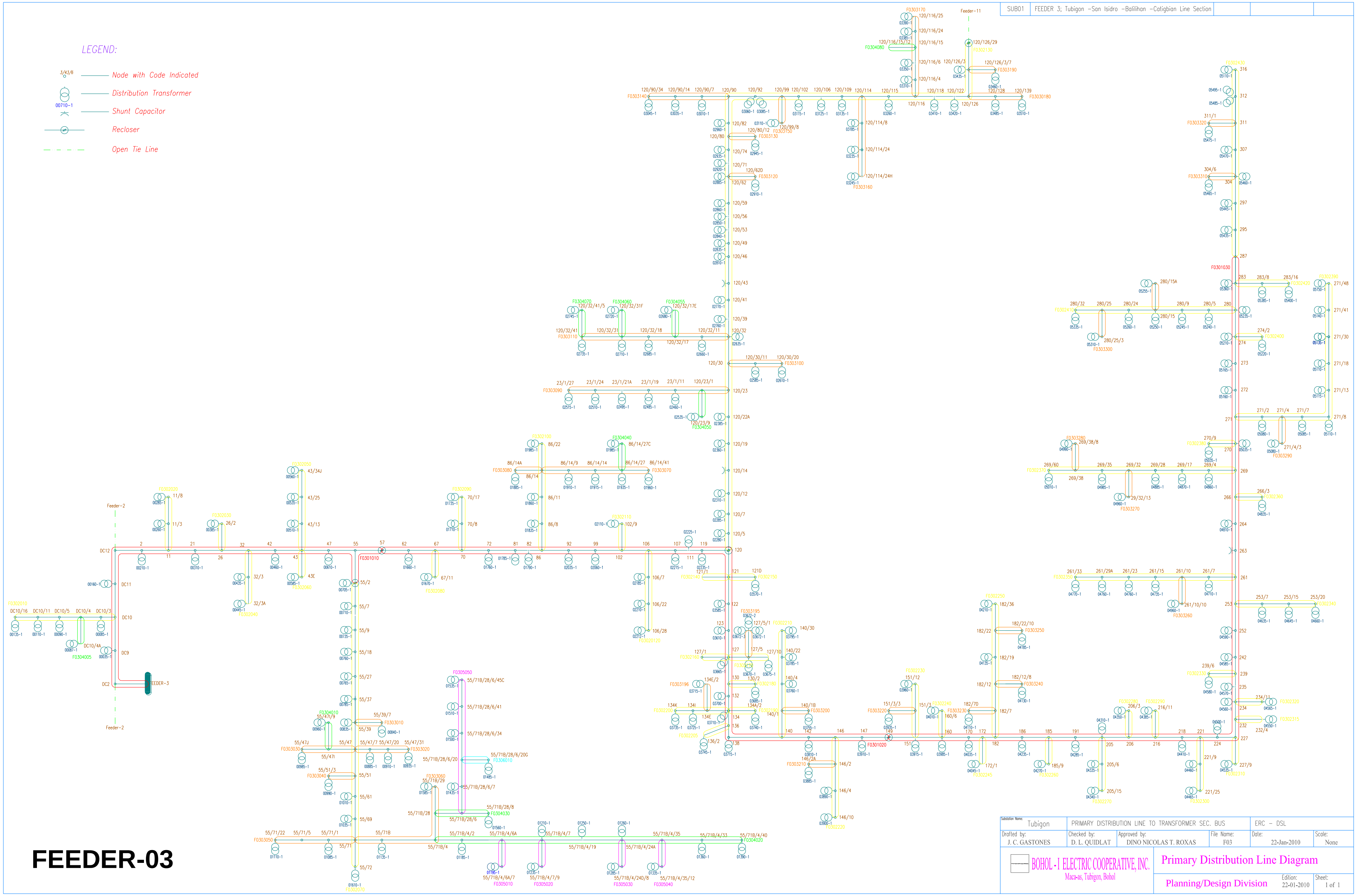
Table 11-14 : Distribution Feeder Protection and Safety Development Project Cost

Count	Project Description	Commissioning Year	Project Cost
1	Replacement of 69-kV Power Circuit Breaker of Dampas and Maribojoc Substations with Protection Control Panel	2018-2019	5,000,000.00
2	Installation of 69-kV Motor Operated Disconnect Switch of Maribojoc Substation	2019	600,000.00
3	Replacement of 15 kV Circuit Breaker of Maca-as, Dampas, Carmen, Loay and Maribojoc Substations	2018-2020	30,000,000.00
4	Replacement of 15 kV Motor Operated Disconnect Switch of Maca-as, Dampas, Carmen, Loay and Maribojoc Substations	2018-2020	7,000,000.00
5	Replacement of 15 kV Bypass Fuse Switch of Maca-as, Dampas and Carmen Substations	2018-2019	2,900,000.00
	Total Amount in PhP		45,500,000

E-1 Per Feeder Single Line Diagram




SUB01
FEEDER 2: Tubigon - Clarin - Inabanga Line Section
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
FEEDER-2
BOHECO-II Tie Line
Feeder-7
Maca-as
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by:
J. C. GASTONES
Checked by:
D. L. QUIDLAT
Approved by:
DINO NICOLAS T. ROXAS
File Name:
F02
Date:
22-Jan-2010
Scale:
None
BOHOL - I ELECTRIC COOPERATIVE, INC.
Cabulijan, Tubigon, Bohol
Primary Distribution Line Diagram
Planning/Design Division
Edition:
22-01-2010
Sheet:
1 of 5
FEEDER-02



LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
SUB01
FEEDER 3; Tubigon -San Isidro -Balilihan -Catigbian Line Section
FEEDER-03
Tubigon
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by:
J. C. GASTONES
Checked by:
D. L. QUIDLAT
Approved by:
DINO NICOLAS T. ROXAS
File Name:
F03
Date:
22-Jan-2010
Scale:
None
BOHOL - I ELECTRIC COOPERATIVE, INC.
Maca-as, Tubigon, Bohol
Primary Distribution Line Diagram
Planning/Design Division
Edition:
22-01-2010
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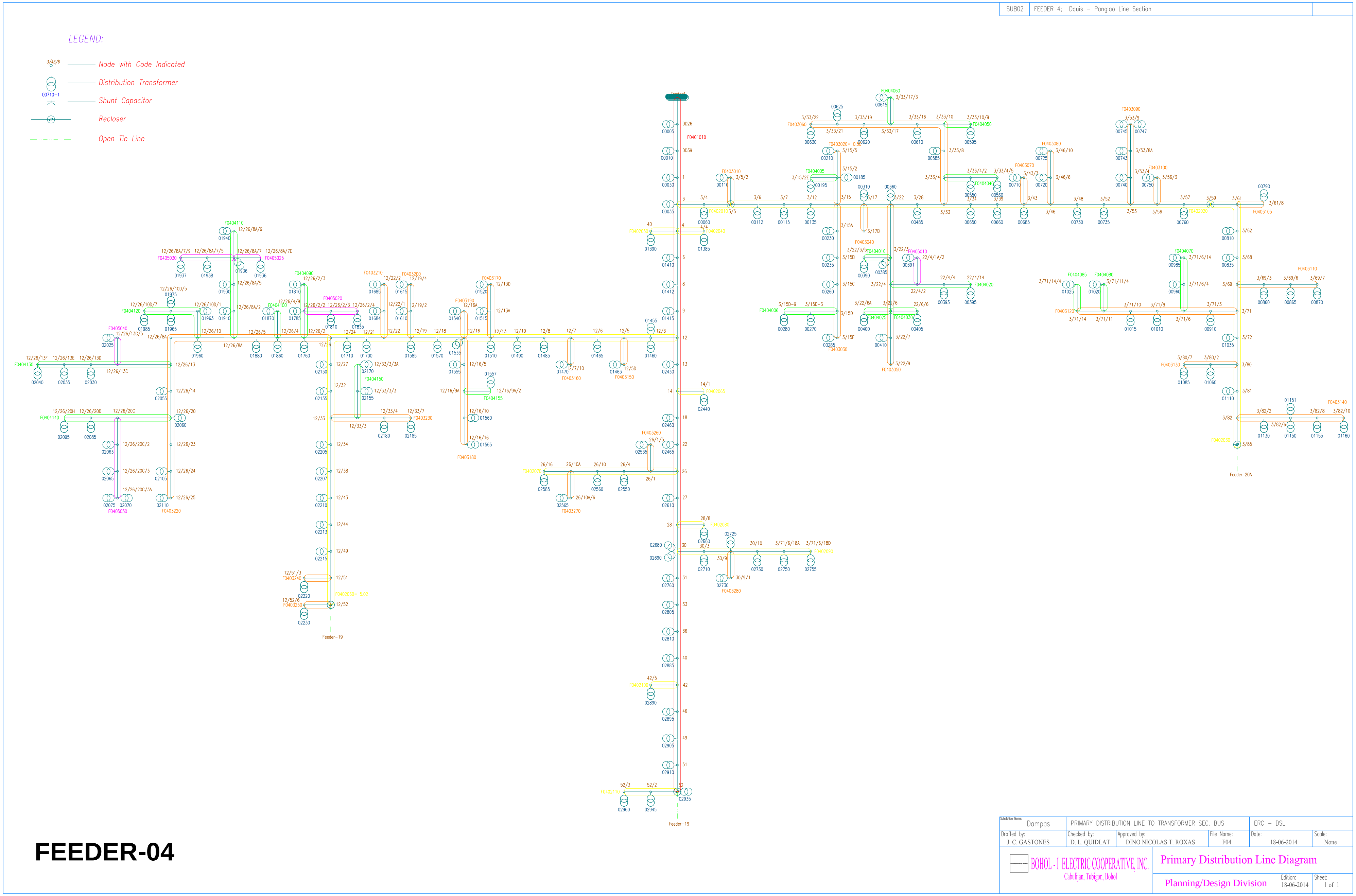
SUB02
FEEDER 4: Dauis - Panglao Line Section
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
Feeder-19
Feeder 20A
Dampas
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by:
J. C. GASTONES
Checked by:
D. L. QUIDLAT
Approved by:
DINO NICOLAS T. ROXAS
File Name:
F04
Date:
18-06-2014
Scale:
None
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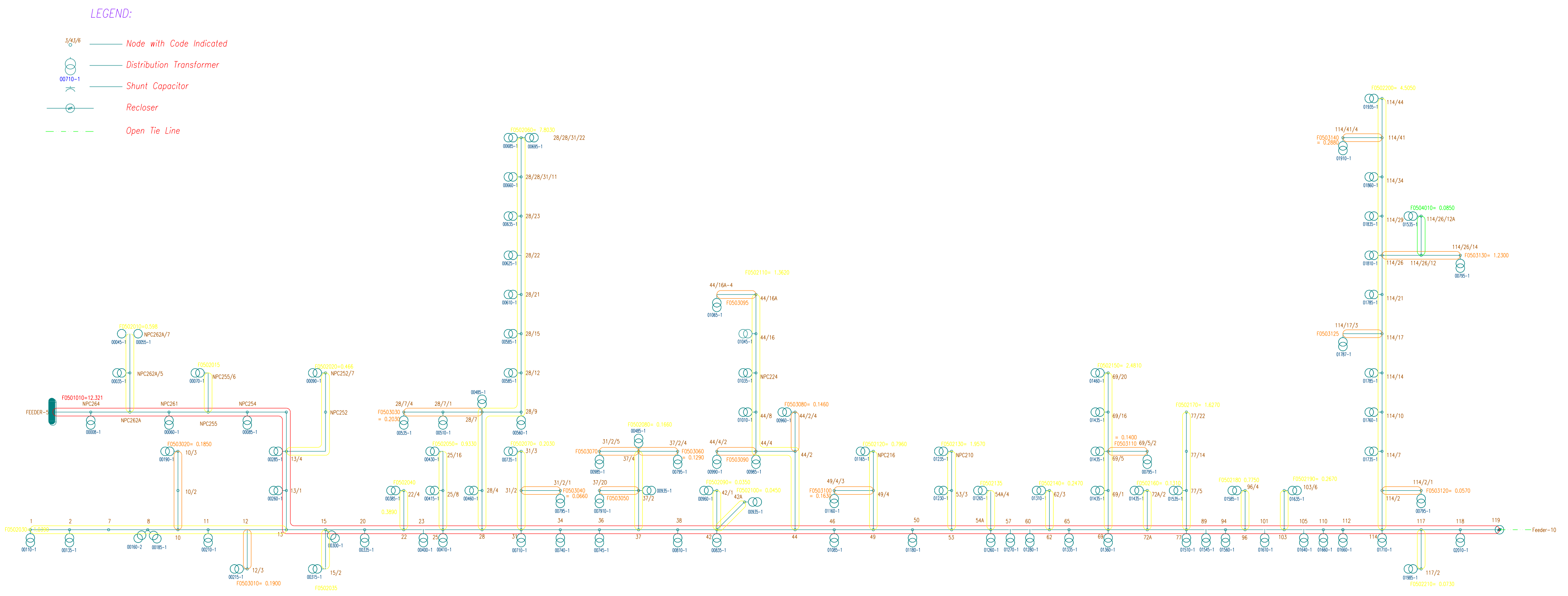
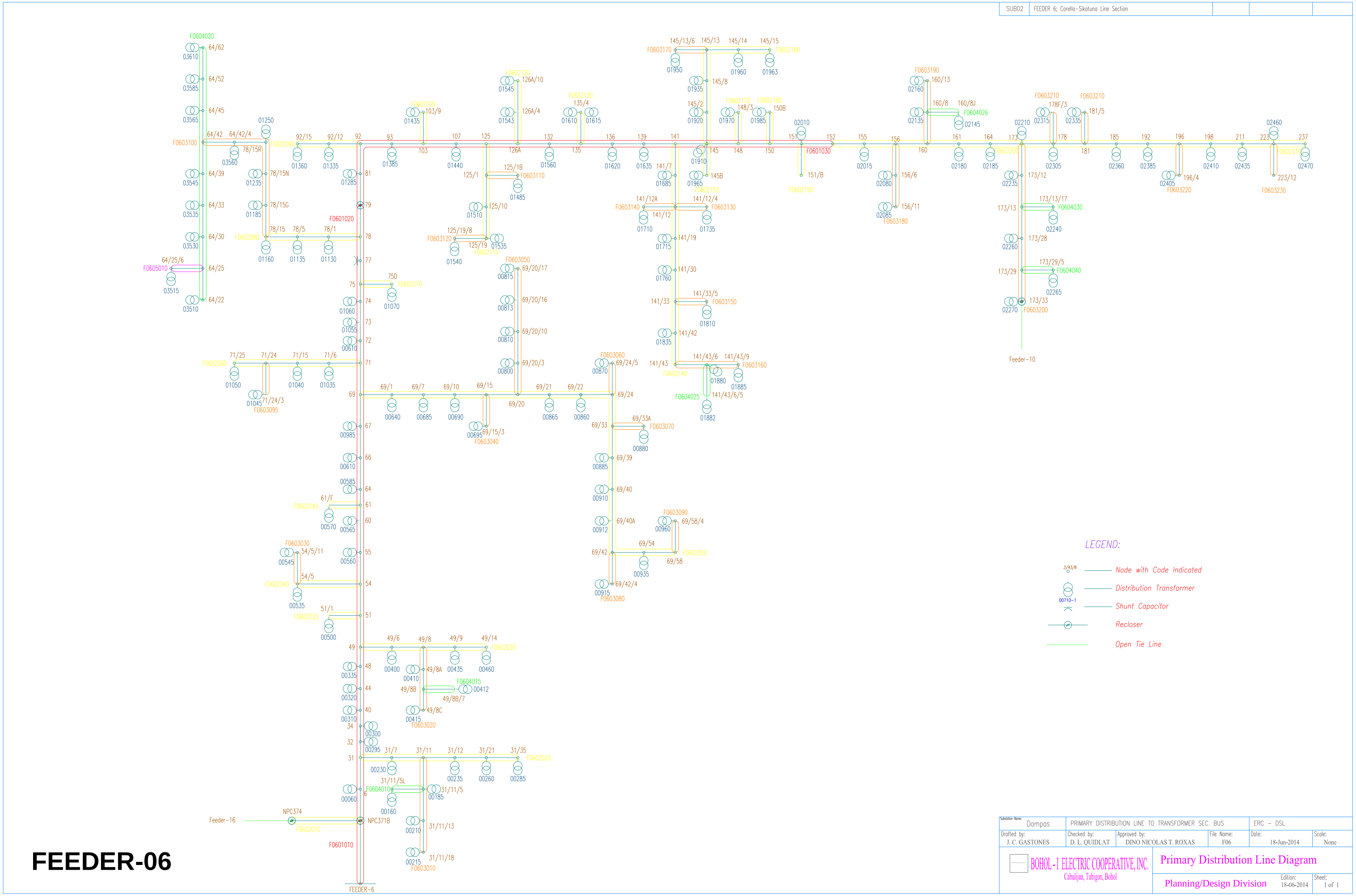
FEEDER-04

SUB02 | FEEDER 5; Baclayon - Alburqueque Line Section | 7/4/05



FEEDER-05

Substation Name: Dampas	PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS			ERC - DSL	
Drafted by: J. C. GASTONES	Checked by: D. L. QUIDLAT	Approved by: DINO NICOLAS T. ROXAS	File Name: F05	Date: 18-Jun-2014	Scale: None
BOHOL - I ELECTRIC COOPERATIVE, INC. Cabulijan, Tubigon, Bohol	Primary Distribution Line Diagram				
	Planning/Design Division			Edition: 18-06-2014	Sheet: 1 of 1


SUB02
FEEDER 6; Corella-Sikatuna Line Section
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
Feeder-16
Feeder-10
FEEDER-6
Dampas
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by: J. C. GASTONES
Checked by: D. L. QUIDLAT
Approved by: DINO NICOLAS T. ROXAS
File Name: F06
Date: 18-Jun-2014
Scale: None
BOHOL - I ELECTRIC COOPERATIVE, INC.
Cabulijan, Tubigon, Bohol
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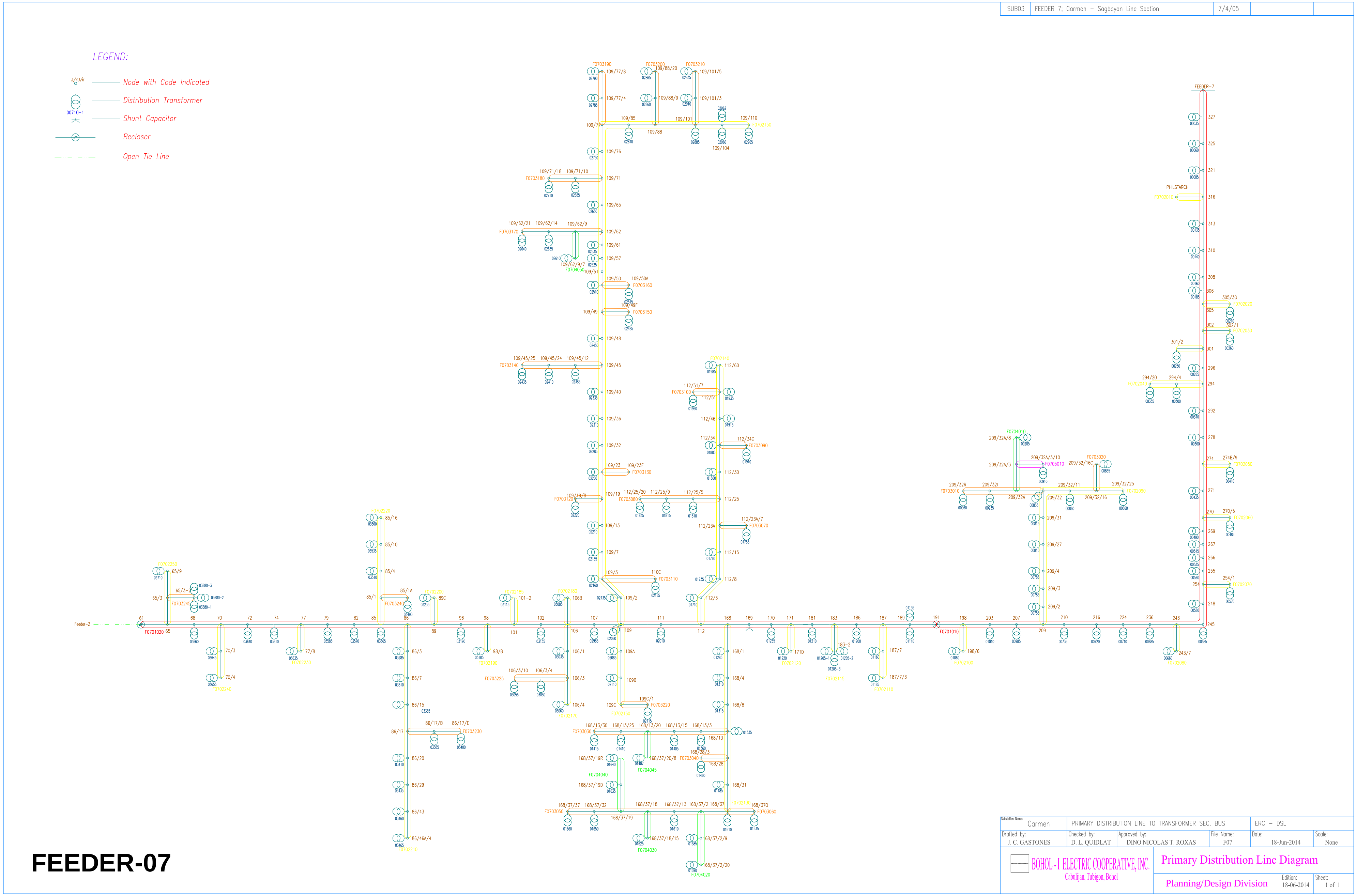
FEEDER-06



SUB03
FEEDER 7: Carmen - Sagbayan Line Section
7/4/05
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
FEEDER-7
PHILSTARCH
Carmen
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by:
J. C. GASTONES
Checked by:
D. L. QUIDLAT
Approved by:
DINO NICOLAS T. ROXAS
File Name:
F07
Date:
18-Jun-2014
Scale:
None
BOHOL-I ELECTRIC COOPERATIVE, INC.
Cabulijan, Tubigon, Bohol
Primary Distribution Line Diagram
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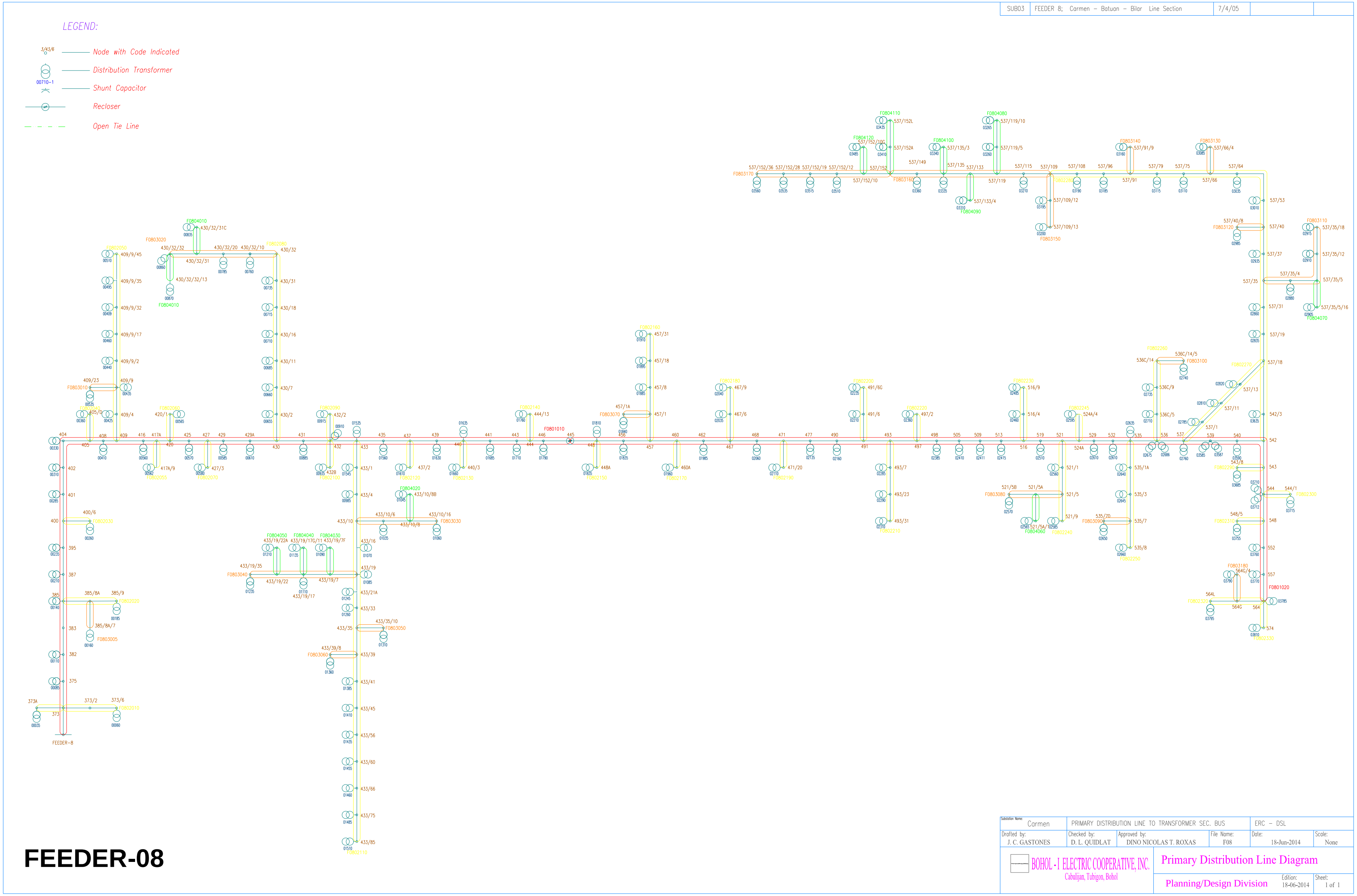
FEEDER-07


SUB03
FEEDER 8; Carmen - Batuan - Bilar Line Section
7/4/05
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
FEEDER-8
Substation Name: Carmen
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by: J. C. GASTONES
Checked by: D. L. QUIDLAT
Approved by: DINO NICOLAS T. ROXAS
File Name: F08
Date: 18-Jun-2014
Scale: None
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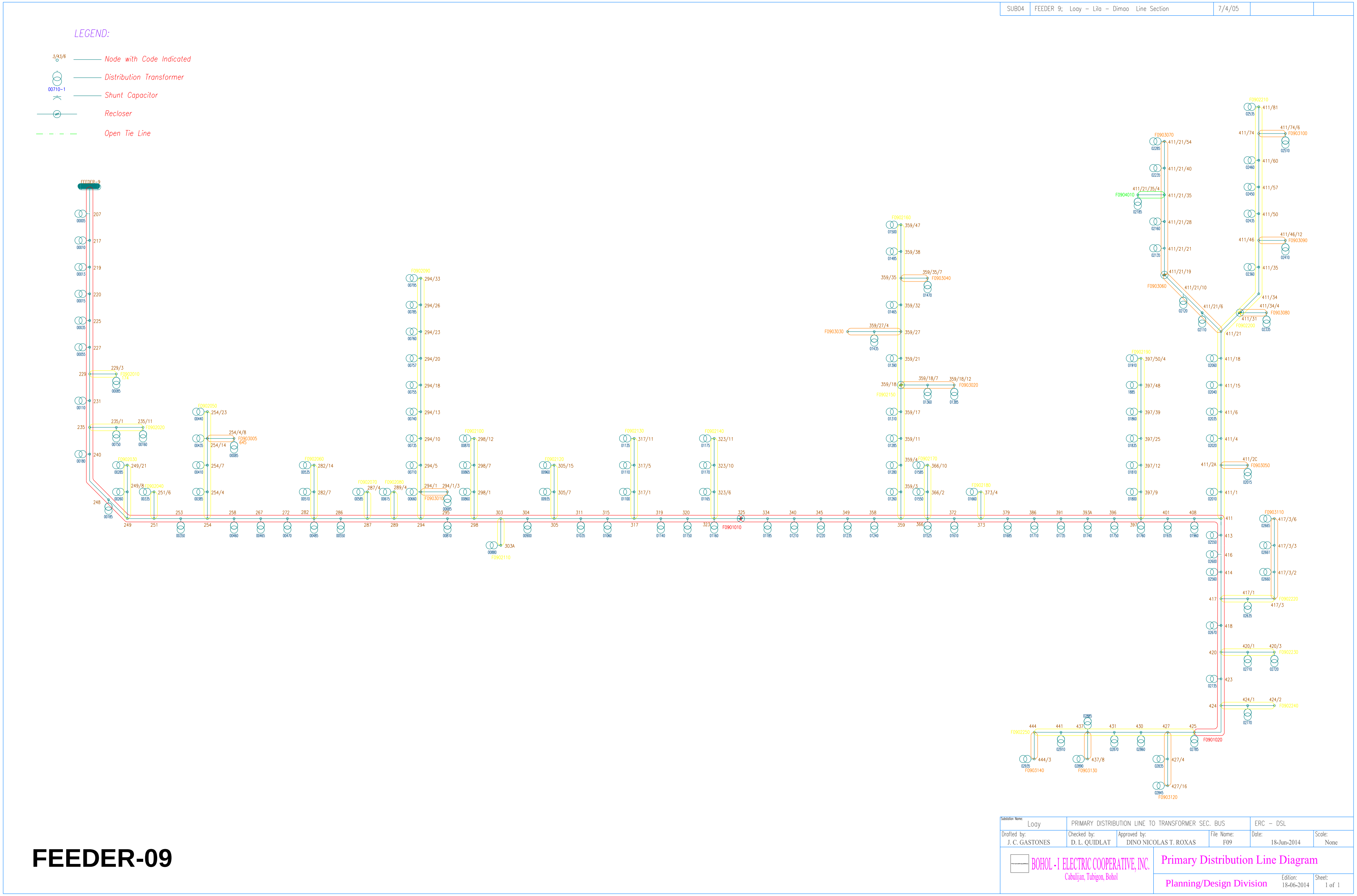
FEEDER-08


SUB04
FEEDER 9; Loay - Lila - Dimao Line Section
7/4/05
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
FEEDER-9
Loay
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by: J. C. GASTONES
Checked by: D. L. QUIDLAT
Approved by: DINO NICOLAS T. ROXAS
File Name: F09
Date: 18-Jun-2014
Scale: None
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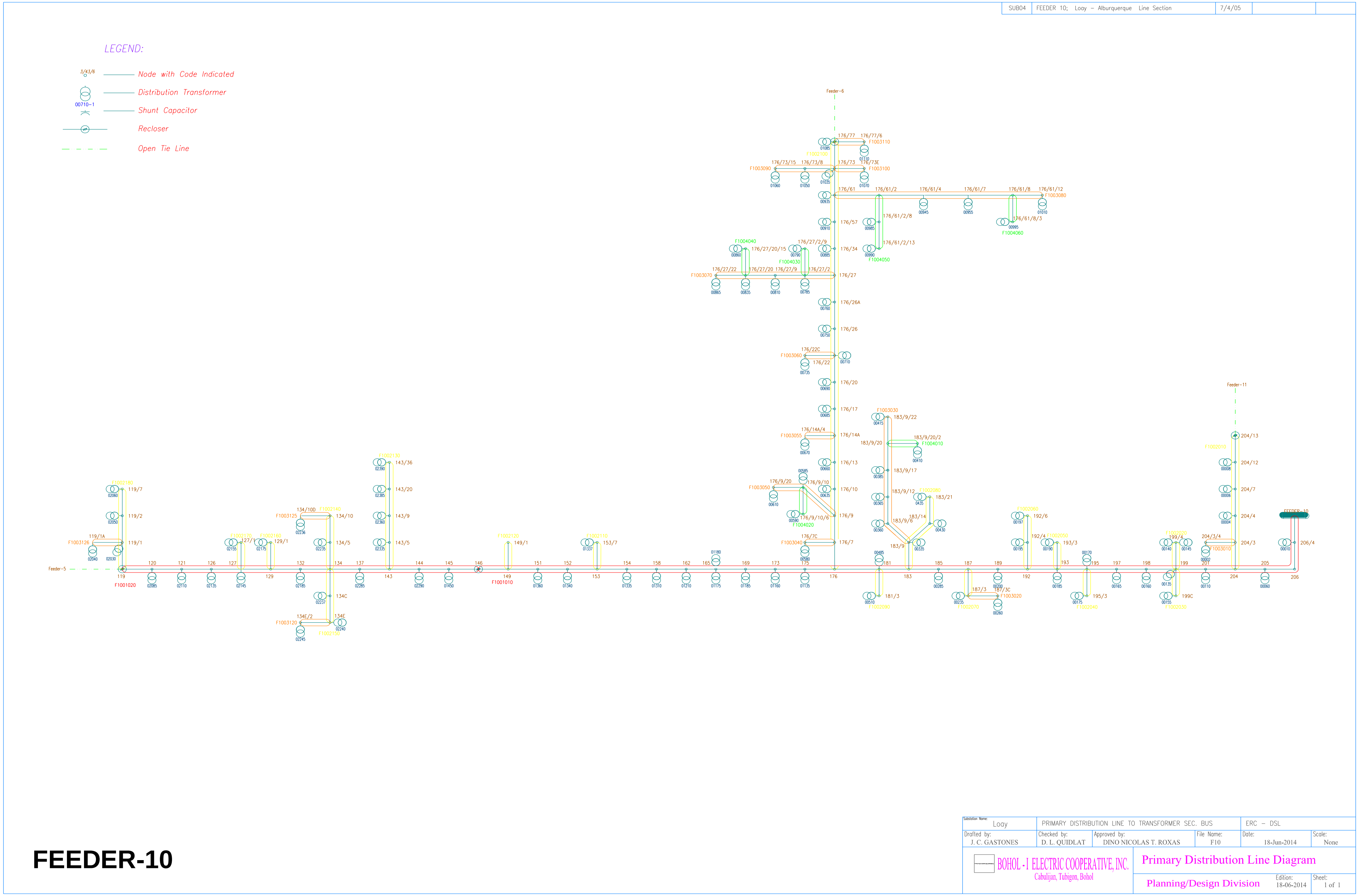
SUB04
FEEDER 10; Loay - Alburquerque Line Section
7/4/05
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
Feeder-6
Feeder-11
Feeder-5
Loay
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by:
J. C. GASTONES
Checked by:
D. L. QUIDLAT
Approved by:
DINO NICOLAS T. ROXAS
File Name:
F10
Date:
18-Jun-2014
Scale:
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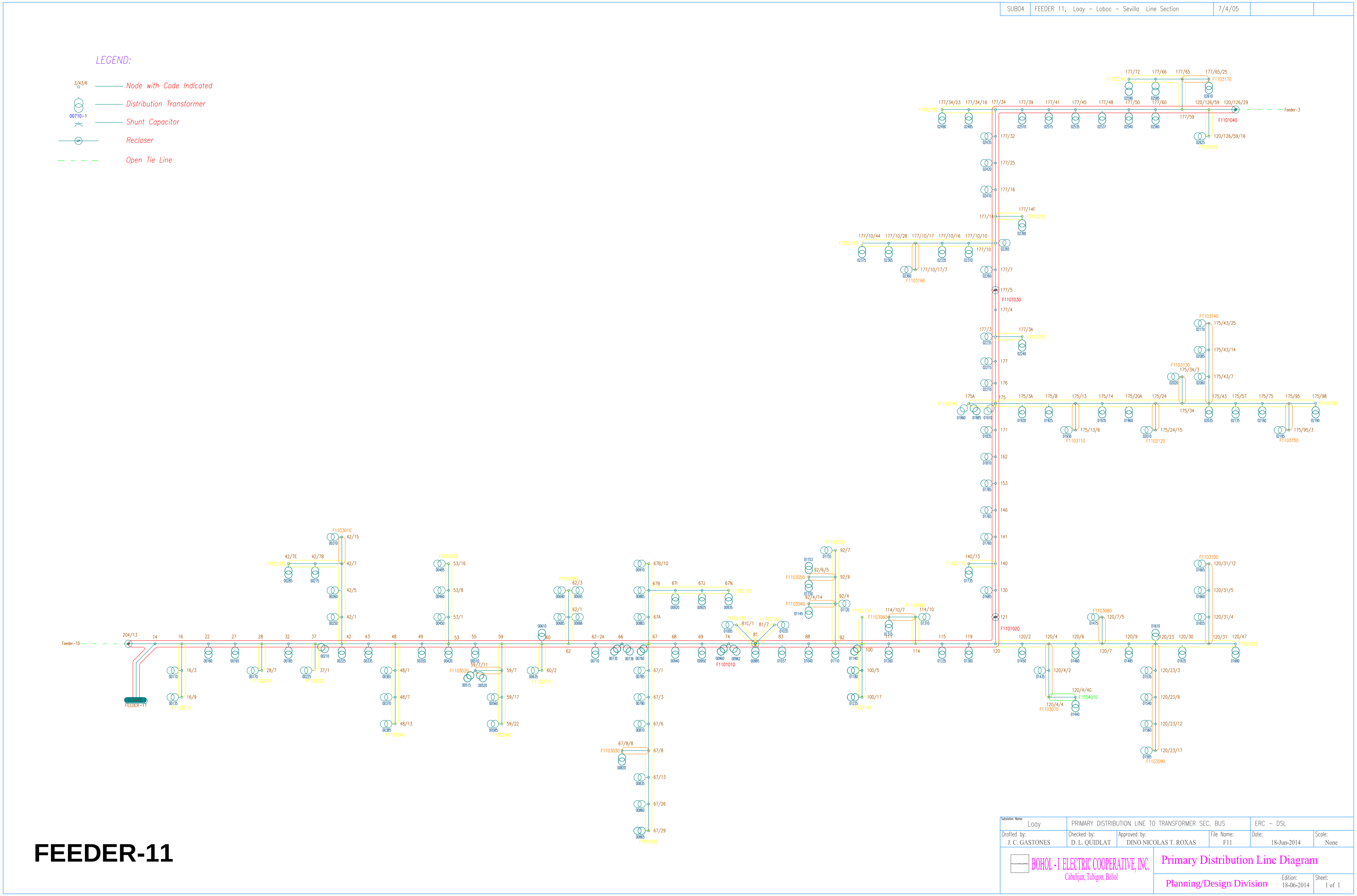

SUB04
FEEDER 11; Looy - Loboc - Sevilla Line Section
7/4/05
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
FEEDER-11
Looy
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by: J. C. GASTONES
Checked by: D. L. QUIDLAT
Approved by: DINO NICOLAS T. ROXAS
File Name: F11
Date: 18-Jun-2014
Scale: None
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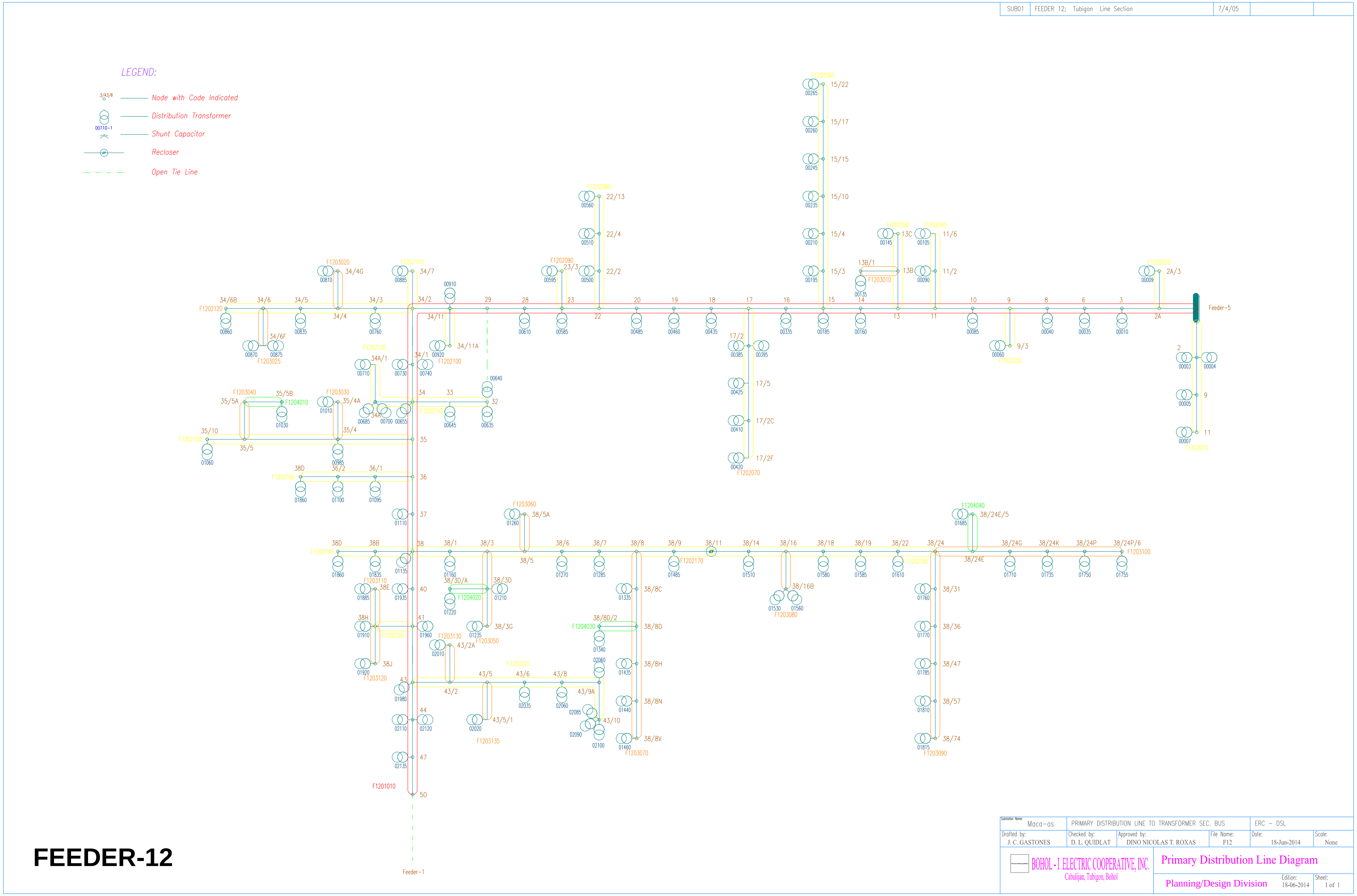
SUB01
FEEDER 12; Tubigon Line Section
7/4/05
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
Feeder-5
Feeder-1
Maca-as
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by:
J. C. GASTONES
Checked by:
D. L. QUIDLAT
Approved by:
DINO NICOLAS T. ROXAS
File Name:
F12
Date:
18-Jun-2014
Scale:
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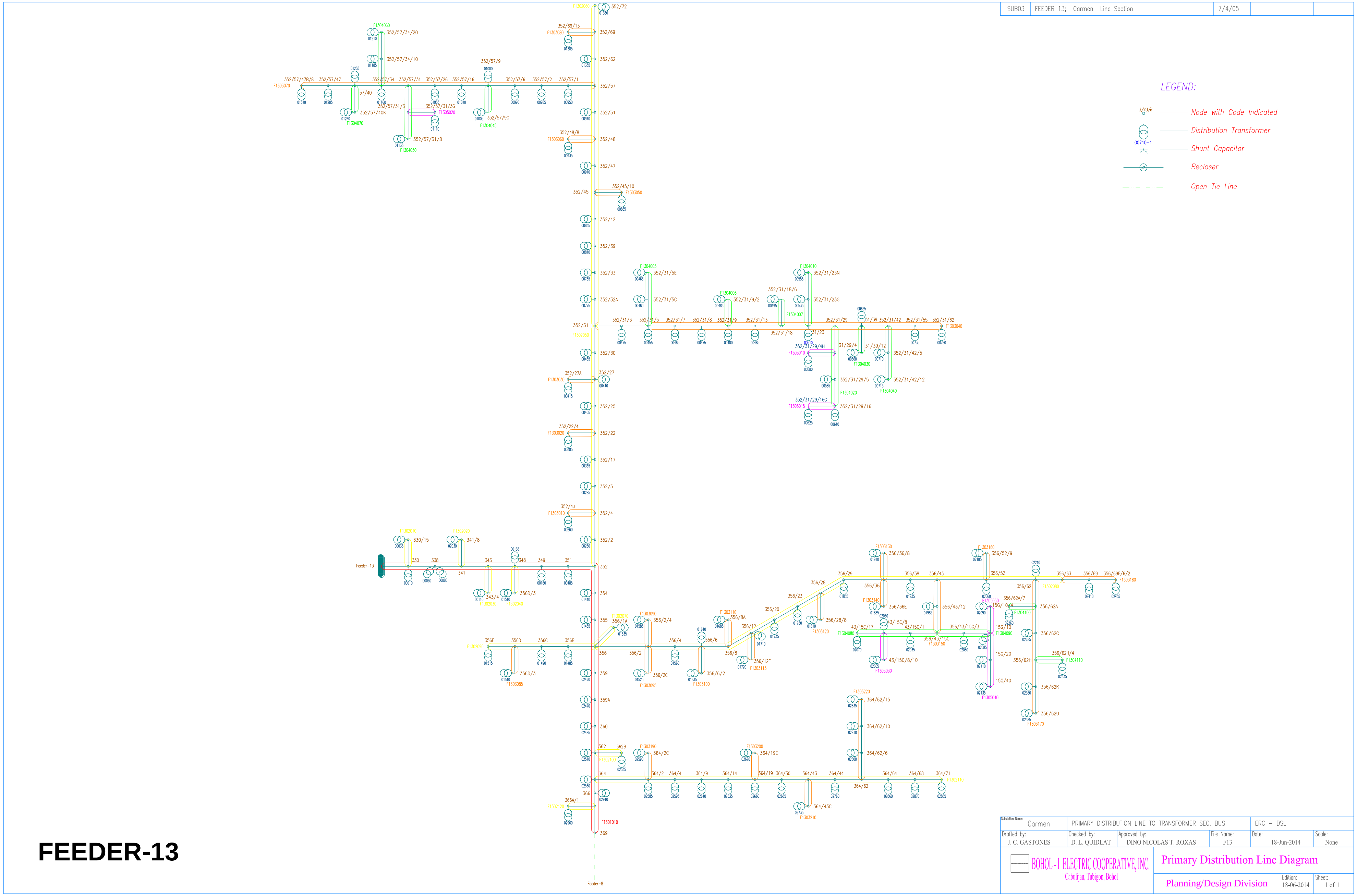
SUB03
FEEDER 13; Carmen Line Section
7/4/05
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
Feeder-13
Feeder-8
Carmen
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by: J. C. GASTONES
Checked by: D. L. QUIDLAT
Approved by: DINO NICOLAS T. ROXAS
File Name: F13
Date: 18-Jun-2014
Scale: None
BOHOL - I ELECTRIC COOPERATIVE, INC.
Cabulijan, Tubigon, Bohol
Primary Distribution Line Diagram
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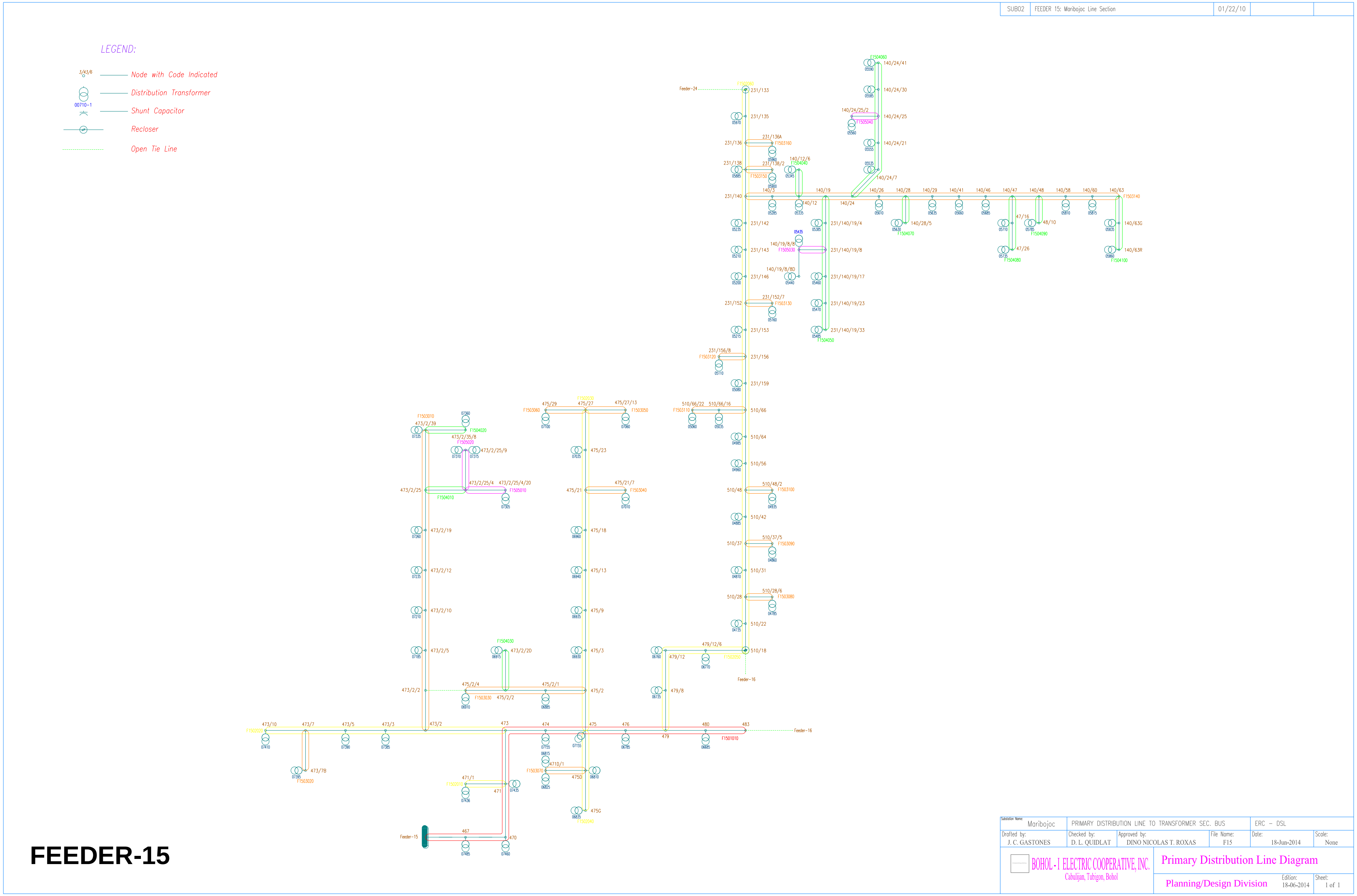
SUB02
FEEDER 15: Maribojoc Line Section
01/22/10
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
Feeder-24
Feeder-16
Feeder-15
Maribojoc
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by: J. C. GASTONES
Checked by: D. L. QUIDLAT
Approved by: DINO NICOLAS T. ROXAS
File Name: F15
Date: 18-Jun-2014
Scale: None
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Cabulijan, Tubigon, Bohol
Primary Distribution Line Diagram
Planning/Design Division
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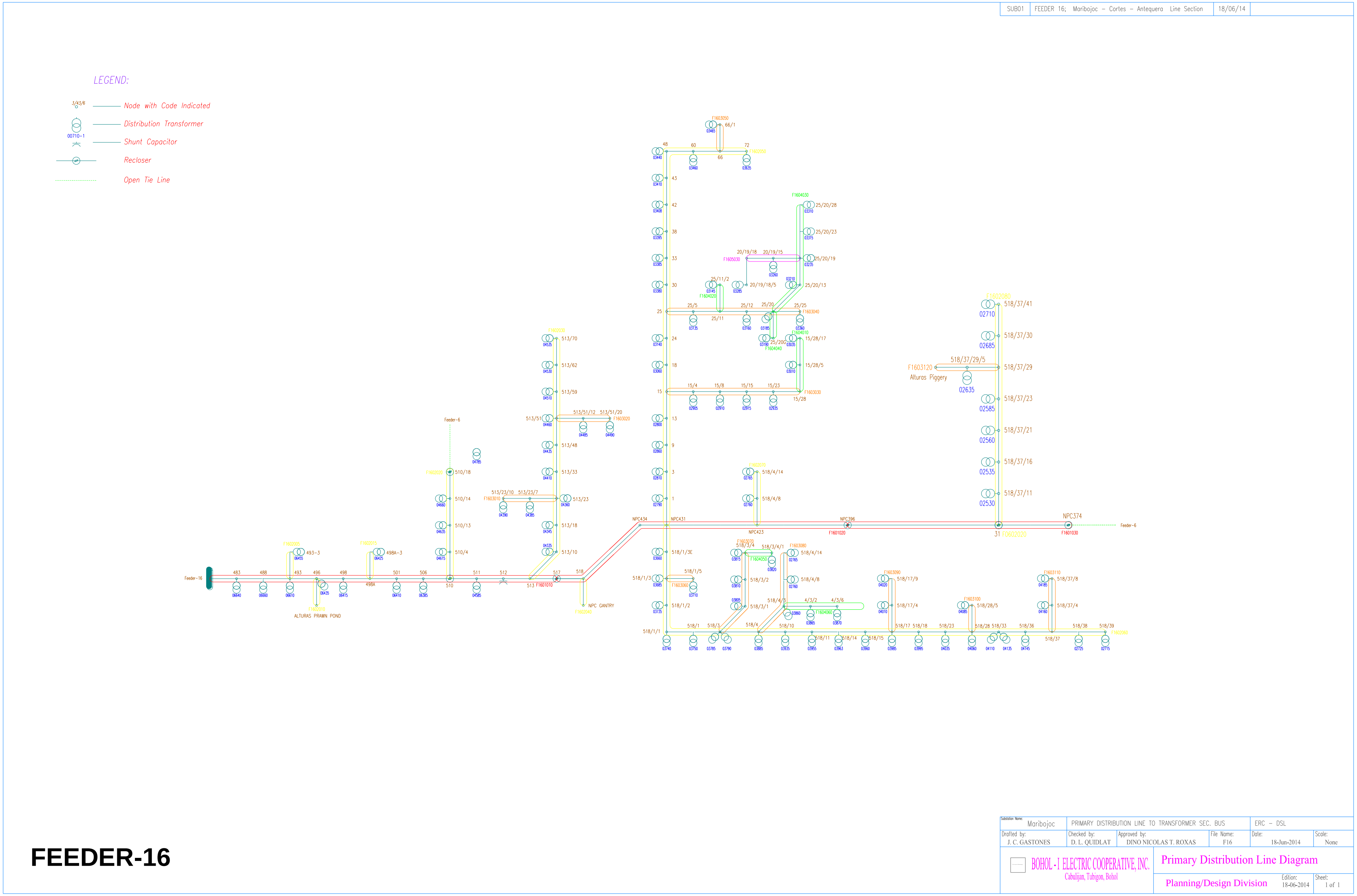
FEEDER-15


SUB01
FEEDER 16; Maribojoc - Cortes - Antequera Line Section
18/06/14
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
Feeder-16
Feeder-6
ALTURAS PRAWN POND
NPC GANTRY
F1603120 Alturas Piggery
NPC374
Maribojoc
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by: J. C. GASTONES
Checked by: D. L. QUIDLAT
Approved by: DINO NICOLAS T. ROXAS
File Name: F16
Date: 18-Jun-2014
Scale: None
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Cabulijan, Tubigon, Bohol
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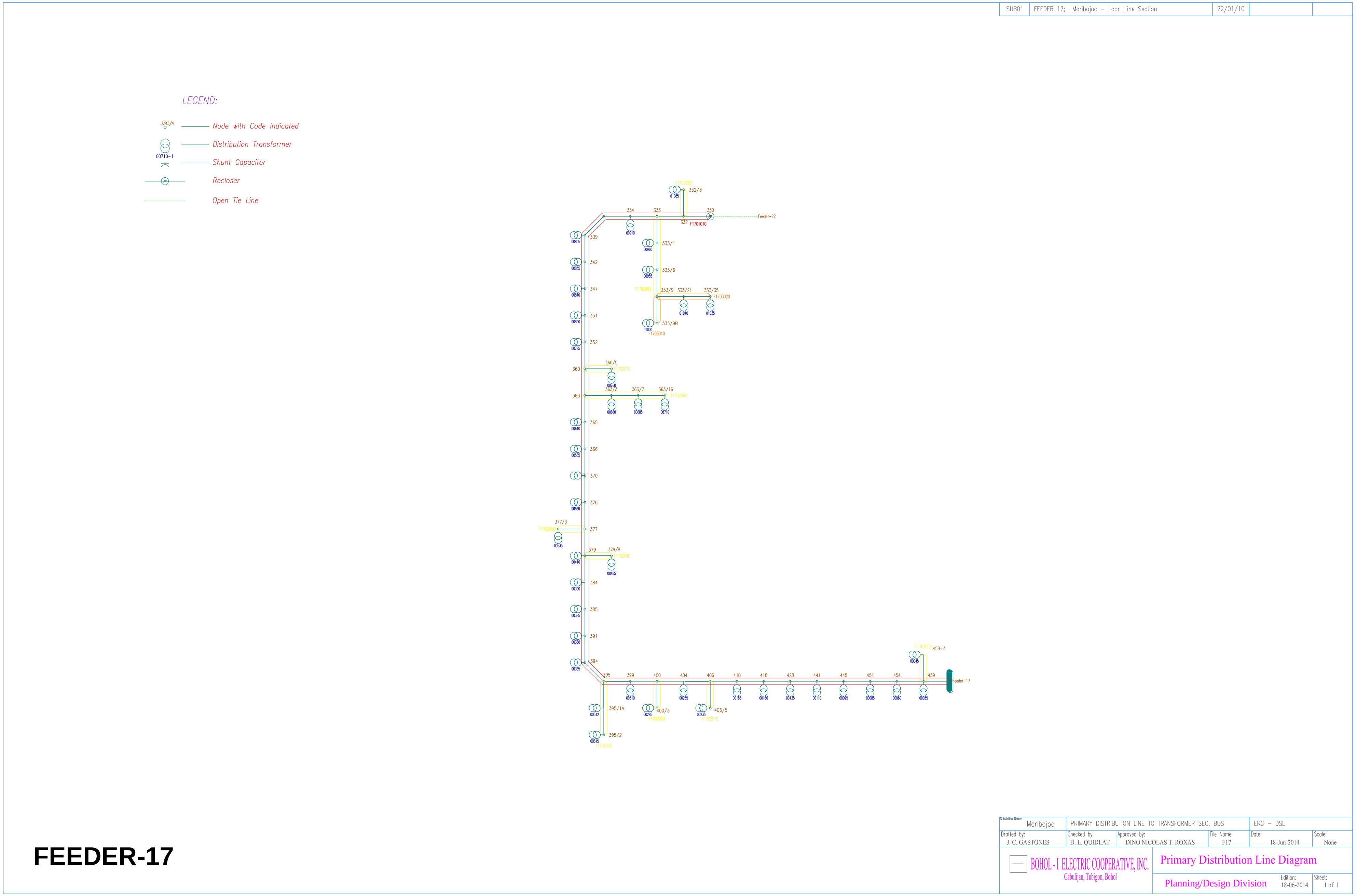
FEEDER-16


SUB01
FEEDER 17; Maribojoc - Loon Line Section
22/01/10
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
Feeder-22
Feeder-17
Substation Name:
Maribojoc
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by:
J. C. GASTONES
Checked by:
D. L. QUIDLAT
Approved by:
DINO NICOLAS T. ROXAS
File Name:
F17
Date:
18-Jun-2014
Scale:
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Cabulijan, Tubigon, Bohol
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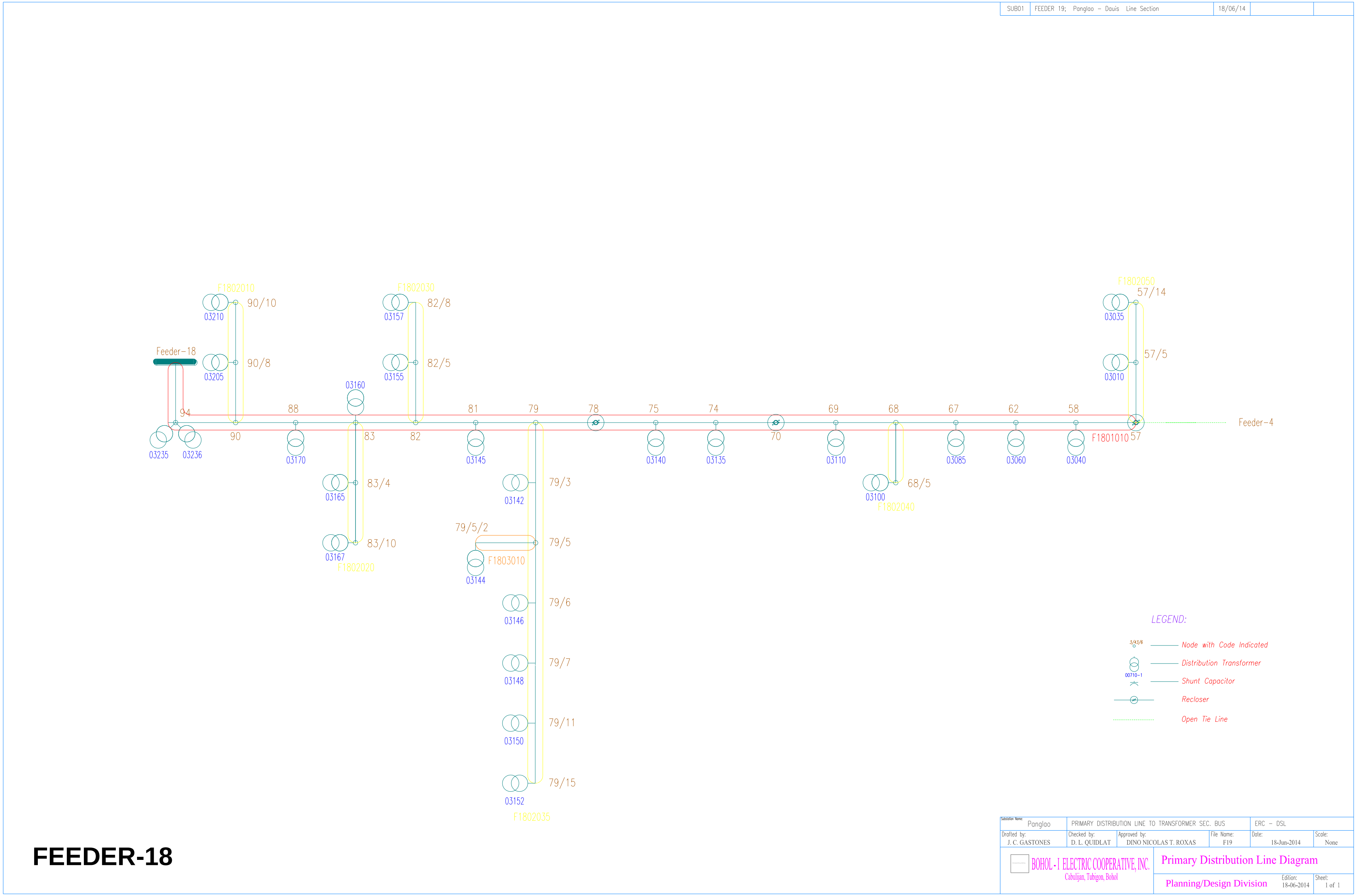
FEEDER-17


SUB01
FEEDER 19; Panglao - Dauis Line Section
18/06/14
Feeder-18
F1802010
90/10
90/8
03210
03205
F1802030
82/8
82/5
03157
03155
03160
F1802050
57/14
57/5
03035
03010
94
88
83
82
81
79
78
75
74
70
69
68
67
62
58
57
90
03235
03236
03170
03145
03140
03135
03110
03085
03060
03040
F1801010
Feeder-4
83/4
83/10
03165
03167
F1802020
79/3
79/5/2
79/5
79/6
79/7
79/11
79/15
03142
03144
F1803010
03146
03148
03150
03152
F1802035
68/5
03100
F1802040
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
Panglao
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by:
J. C. GASTONES
Checked by:
D. L. QUIDLAT
Approved by:
DINO NICOLAS T. ROXAS
File Name:
F19
Date:
18-Jun-2014
Scale:
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BOHOL - I ELECTRIC COOPERATIVE, INC.
Cabulijan, Tubigon, Bohol
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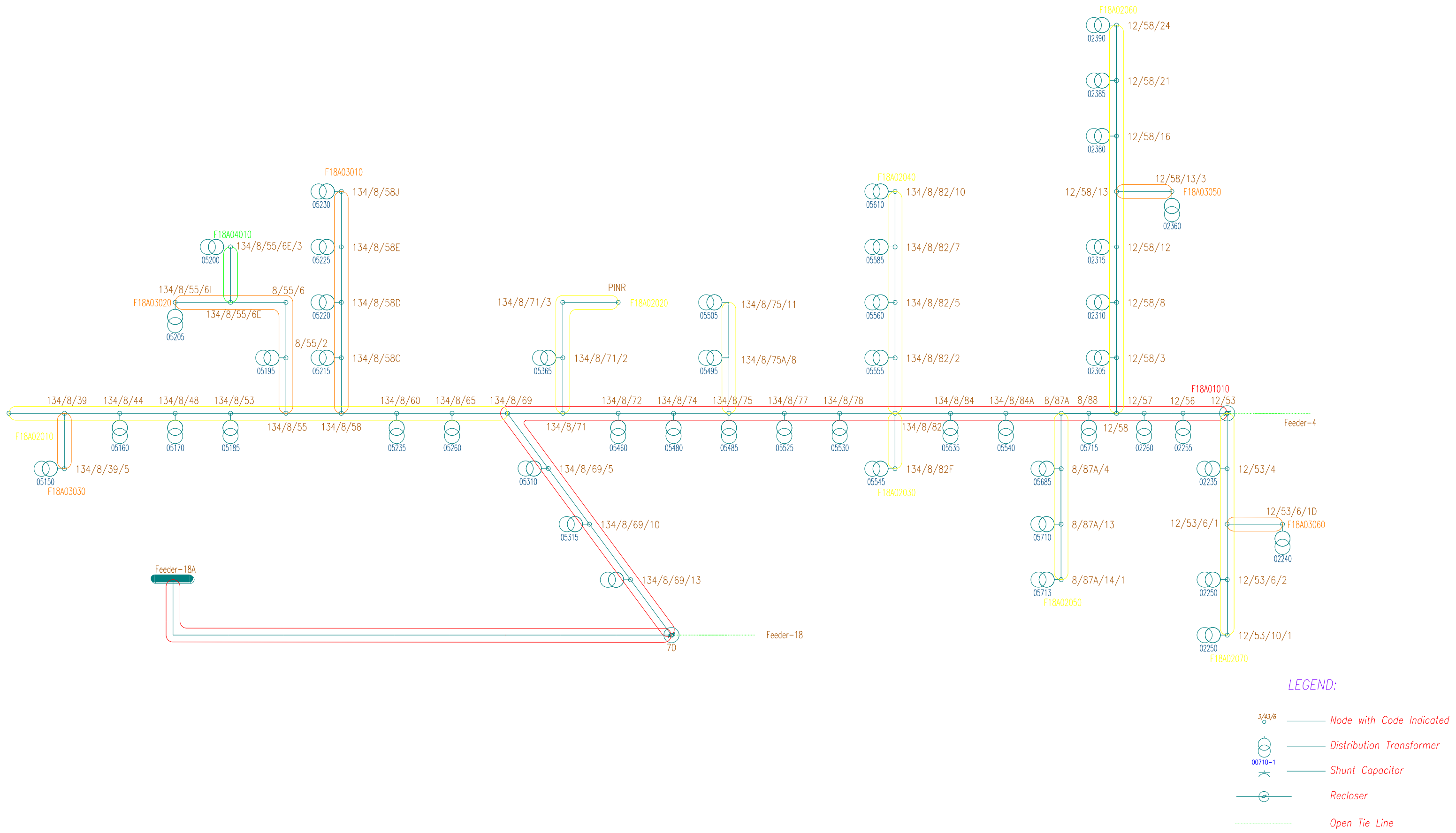
FEEDER-18

SUB01 | FEEDER 19; Panglao – Dauis Line Section | 18/06/14



Substation Name: Panglao

Drafted by: J. C. GASTONES | Checked by: D. L. QUIDLAT

PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS | ERC – DSL

Cabulijan, Tubigon, Bohol | Approved by: DINO NICOLAS T. ROXAS | File Name: F19 | Date: 18-Jun-2014 | Scale: None

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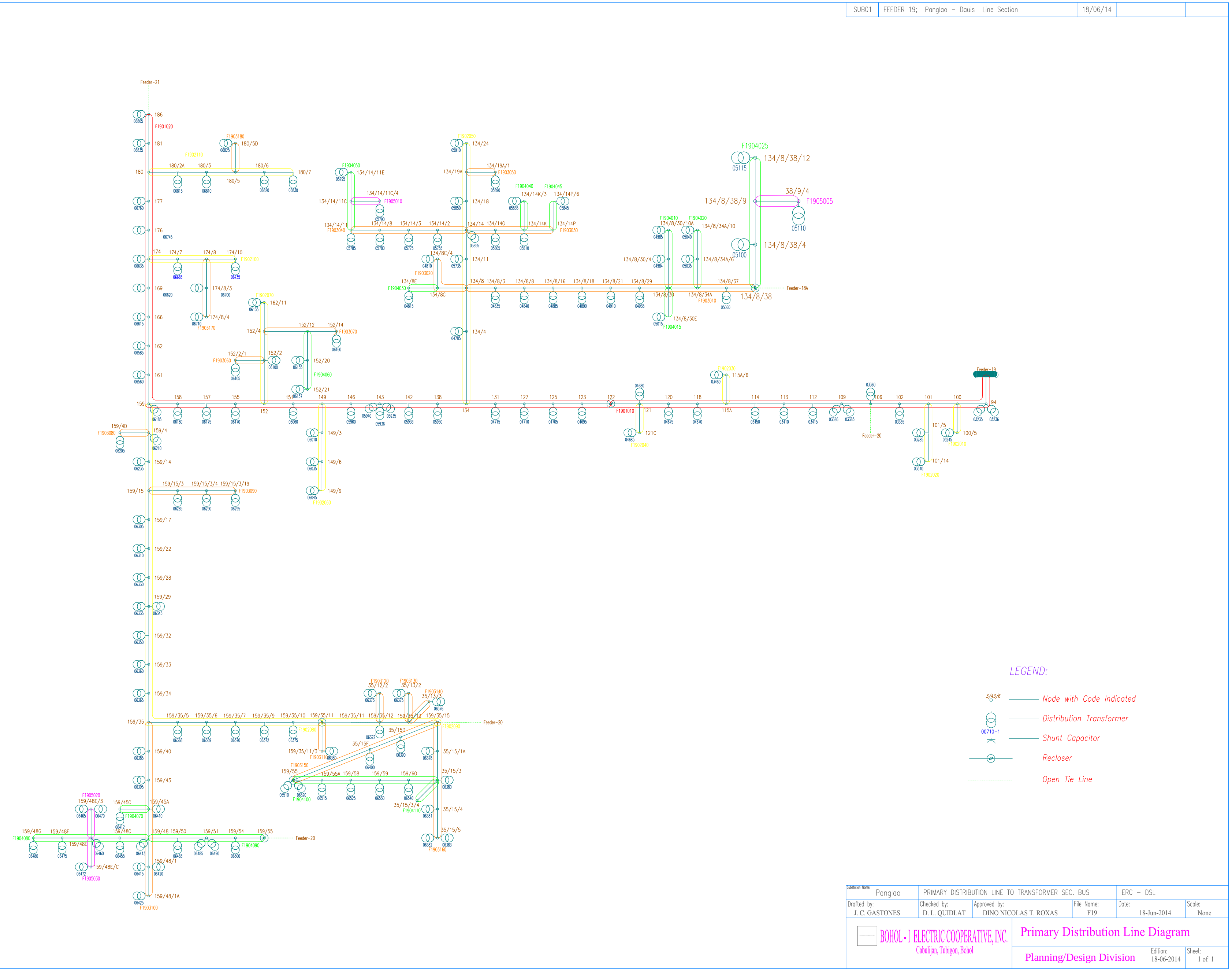
FEEDER-18A


SUB01
FEEDER 19; Panglao - Dauis Line Section
18/06/14
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
Panglao
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by: J. C. GASTONES
Checked by: D. L. QUIDLAT
Approved by: DINO NICOLAS T. ROXAS
File Name: F19
Date: 18-Jun-2014
Scale: None
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Cabulijan, Tubigon, Bohol
Primary Distribution Line Diagram
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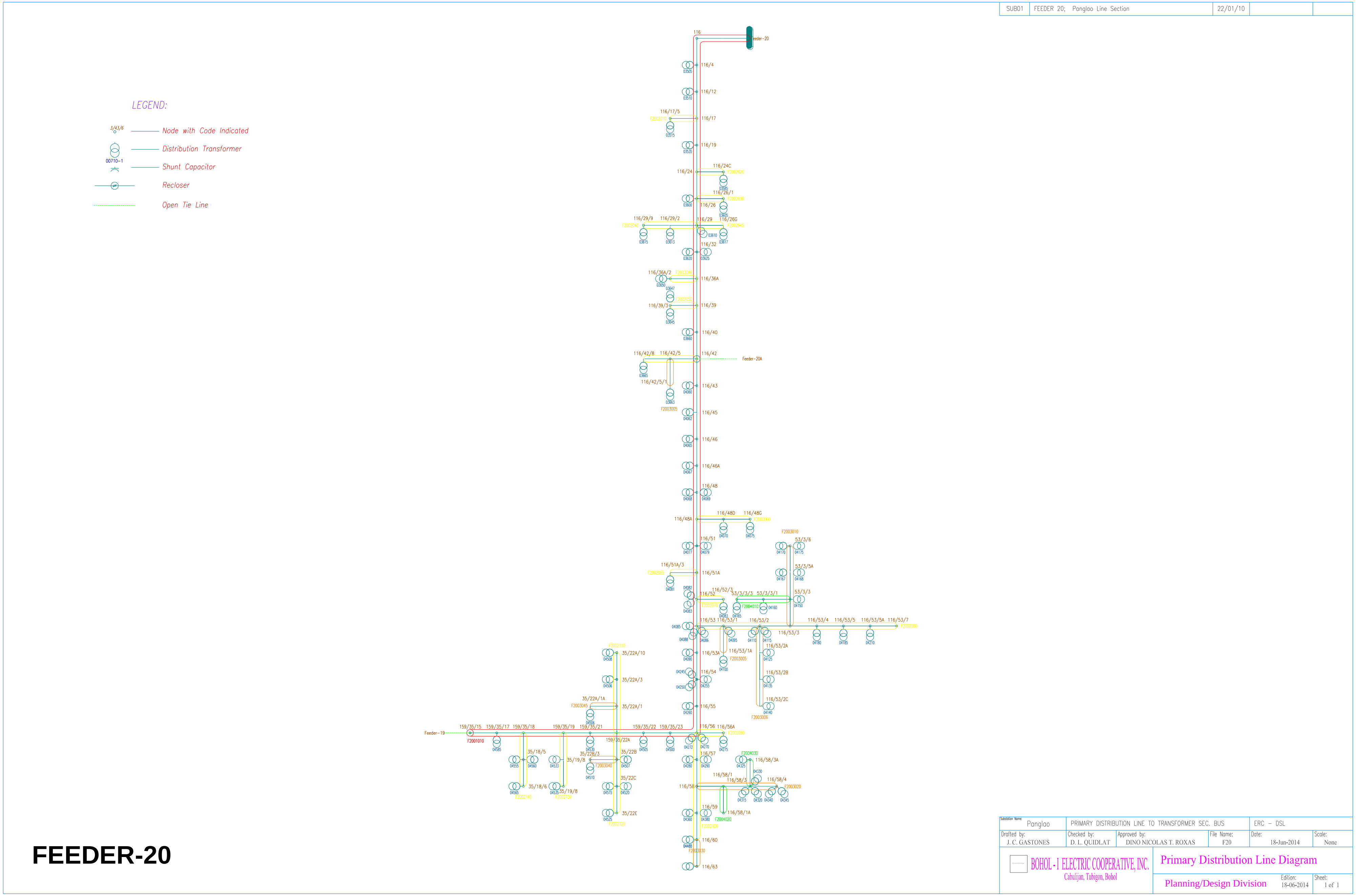
FEEDER-19


SUB01
FEEDER 20; Panglao Line Section
22/01/10
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
Feeder-20
Feeder-20A
Feeder-19
Panglao
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by:
J. C. GASTONES
Checked by:
D. L. QUIDLAT
Approved by:
DINO NICOLAS T. ROXAS
File Name:
F20
Date:
18-Jun-2014
Scale:
None
BOHOL - I ELECTRIC COOPERATIVE, INC.
Cabulijan, Tubigon, Bohol
Primary Distribution Line Diagram
Planning/Design Division
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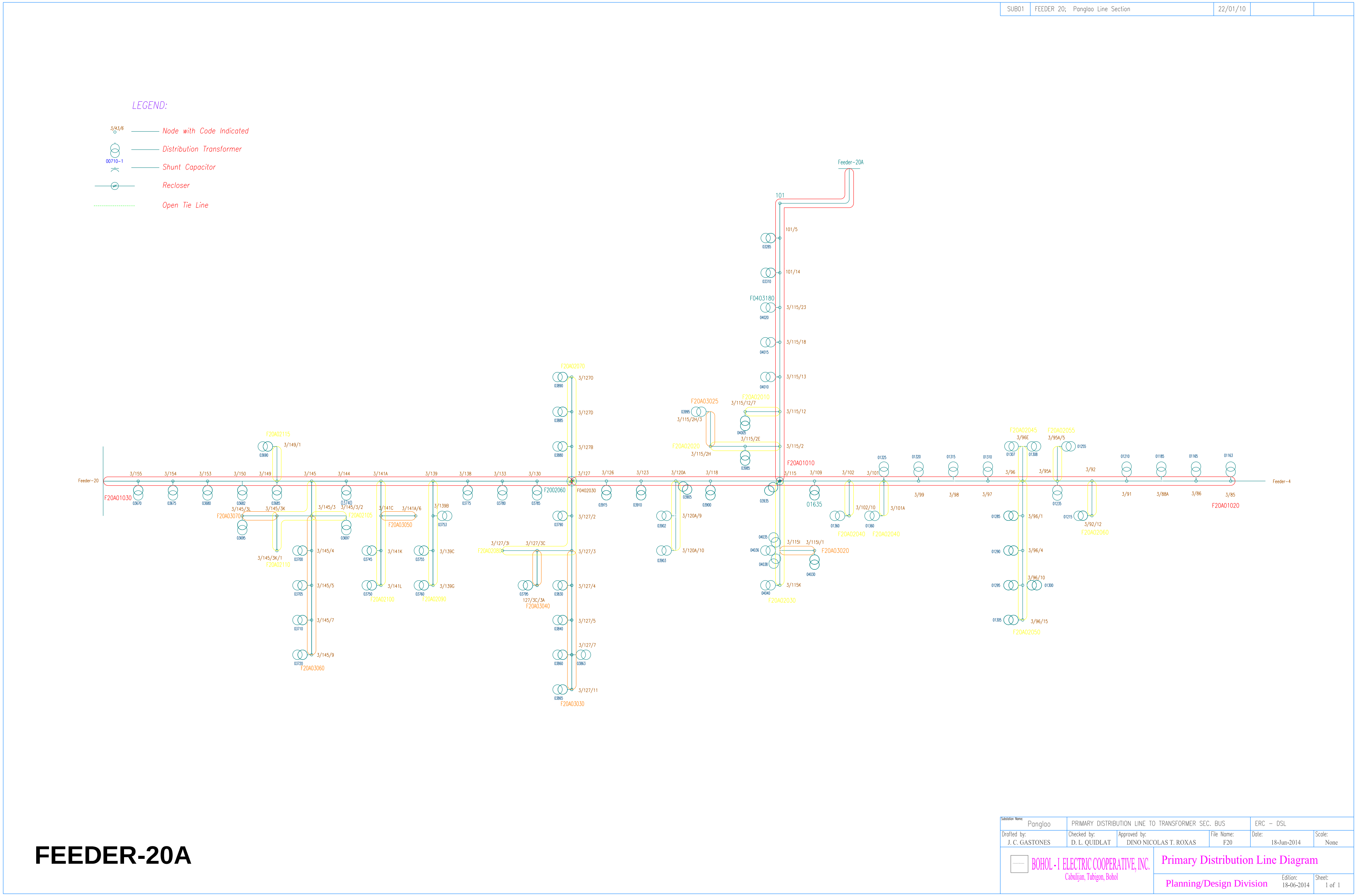
1 of 1

FEEDER-20


SUB01
FEEDER 20; Panglao Line Section
22/01/10
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
Feeder-20A
Feeder-20
Feeder-4
Panglao
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by: J. C. GASTONES
Checked by: D. L. QUIDLAT
Approved by: DINO NICOLAS T. ROXAS
File Name: F20
Date: 18-Jun-2014
Scale: None
BOHOL-I ELECTRIC COOPERATIVE, INC.
Cabulijan, Tubigon, Bohol
Primary Distribution Line Diagram
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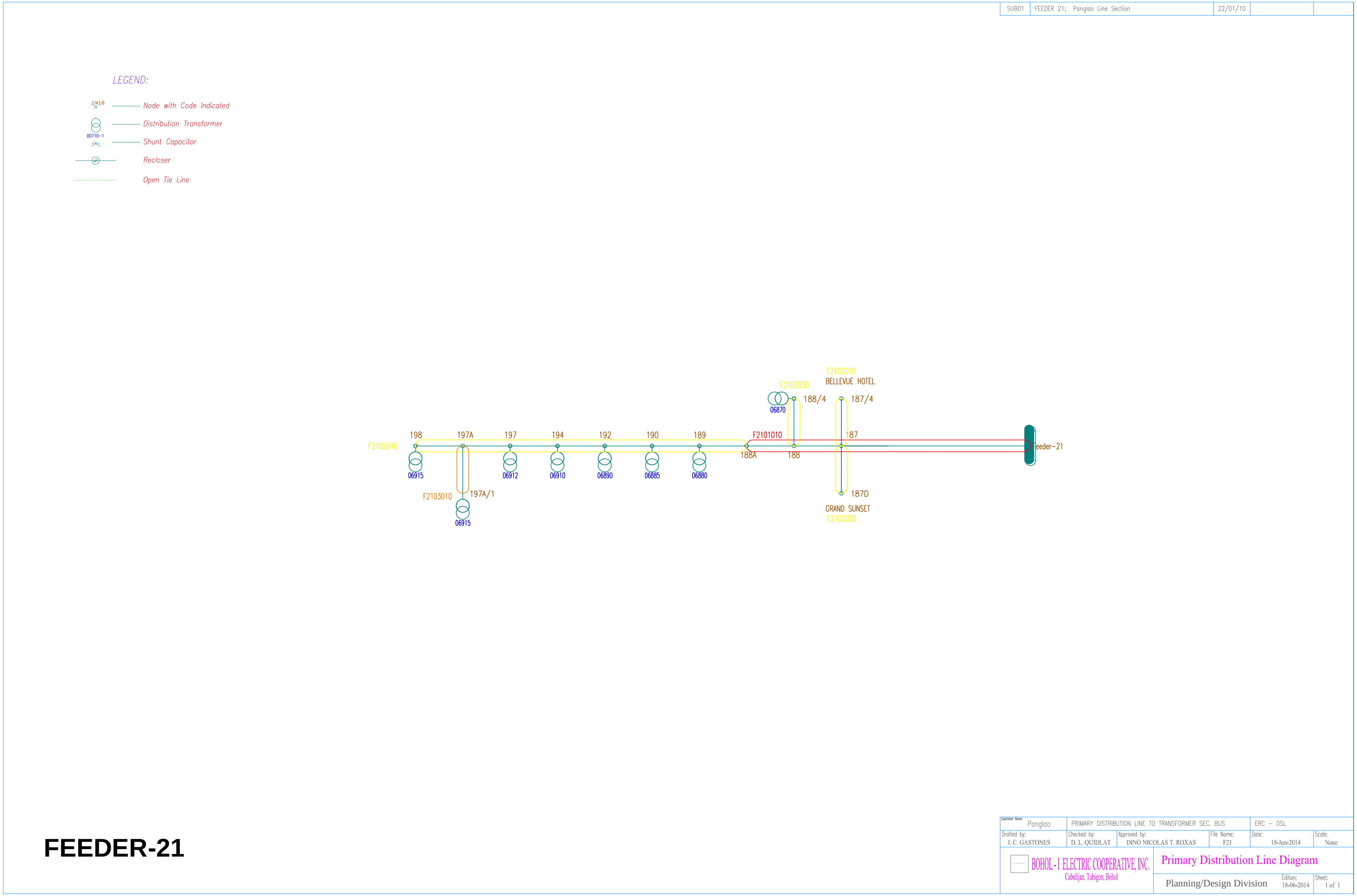
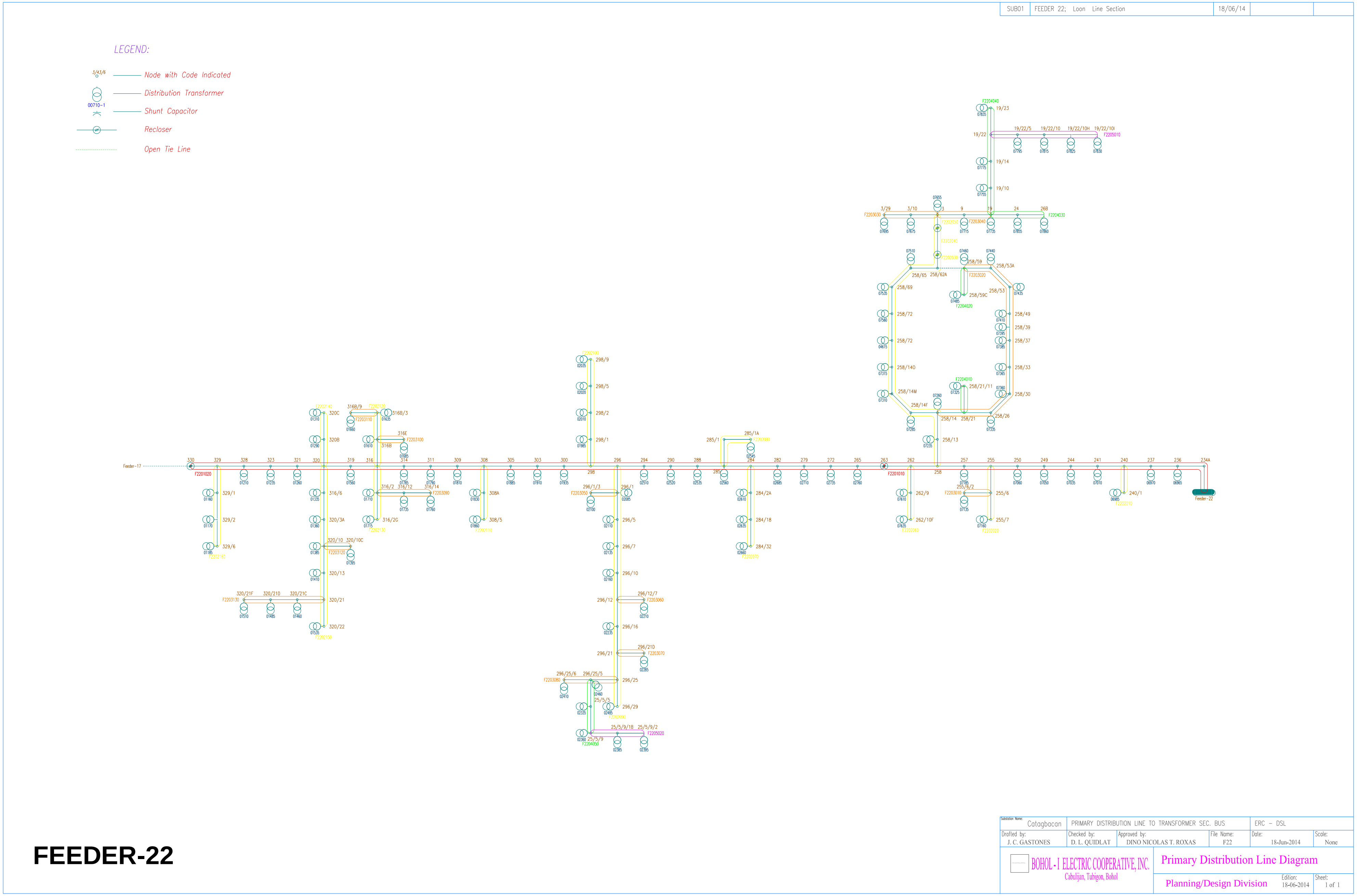
FEEDER-20A

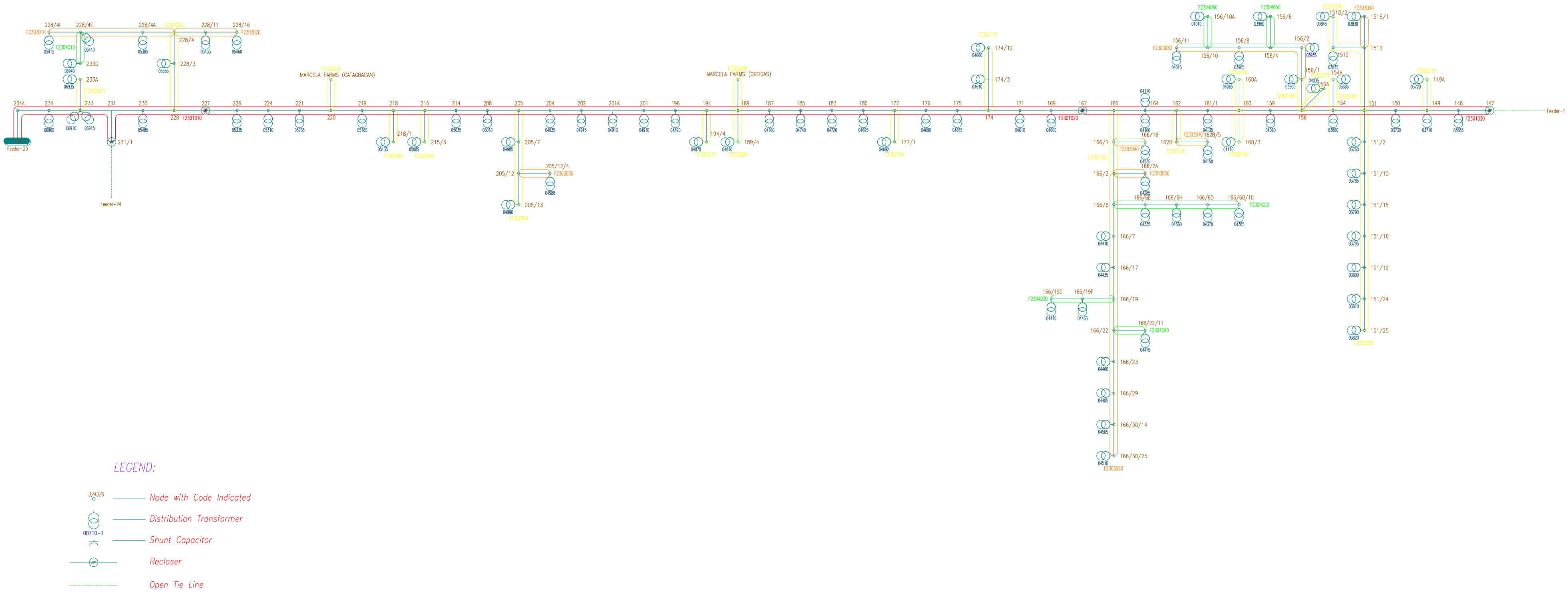

SUB01
FEEDER 21; Panglao Line Section
22/01/10
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
F2102040
198
197A
197
194
192
190
189
06915
06912
06910
06890
06885
06880
F2103010
197A/1
06915
F2101010
188A
188
F2102030
188/4
06870
F2102010
BELLEVUE HOTEL
187/4
187
187D
GRAND SUNSET
F2102020
Feeder-21
Substation Name:
Panglao
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC – DSL
Drafted by:
J. C. GASTONES
Checked by:
D. L. QUIDLAT
Approved by:
DINO NICOLAS T. ROXAS
File Name:
F21
Date:
18-Jun-2014
Scale:
None
BOHOL - I ELECTRIC COOPERATIVE, INC.
Cabulijan, Tubigon, Bohol
Primary Distribution Line Diagram
Planning/Design Division
Edition:
18-06-2014
Sheet:
1 of 1

FEEDER-21


SUB01
FEEDER 22: Loon Line Section
18/06/14
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
Feeder-17
Feeder-22
Catagbacan
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by: J. C. GASTONES
Checked by: D. L. QUIDLAT
Approved by: DINO NICOLAS T. ROXAS
File Name: F22
Date: 18-Jun-2014
Scale: None
BOHOL - I ELECTRIC COOPERATIVE, INC.
Cabulijan, Tubigon, Bohol
Primary Distribution Line Diagram
Planning/Design Division
Edition: 18-06-2014
Sheet: 1 of 1

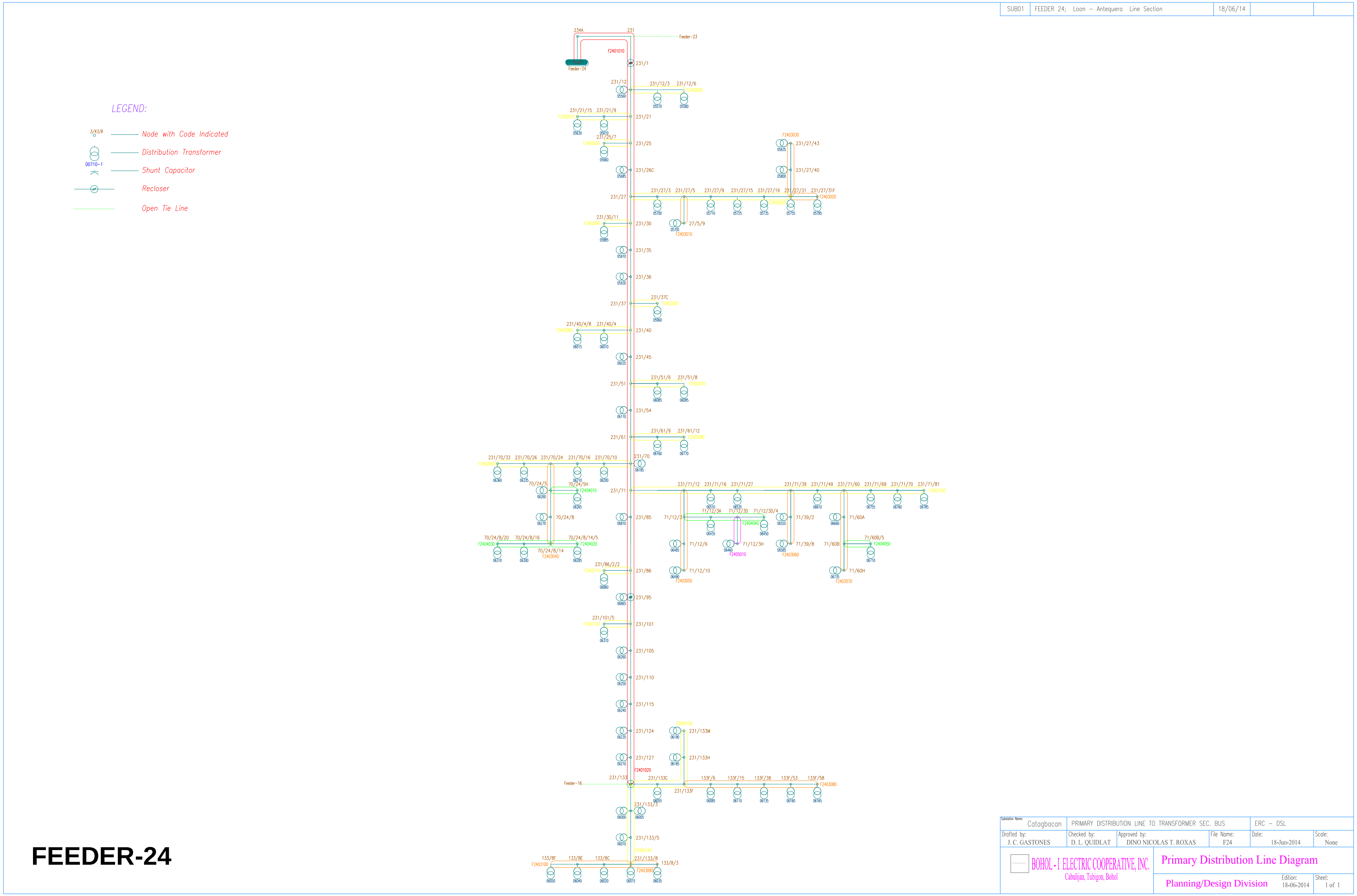
FEEDER-22

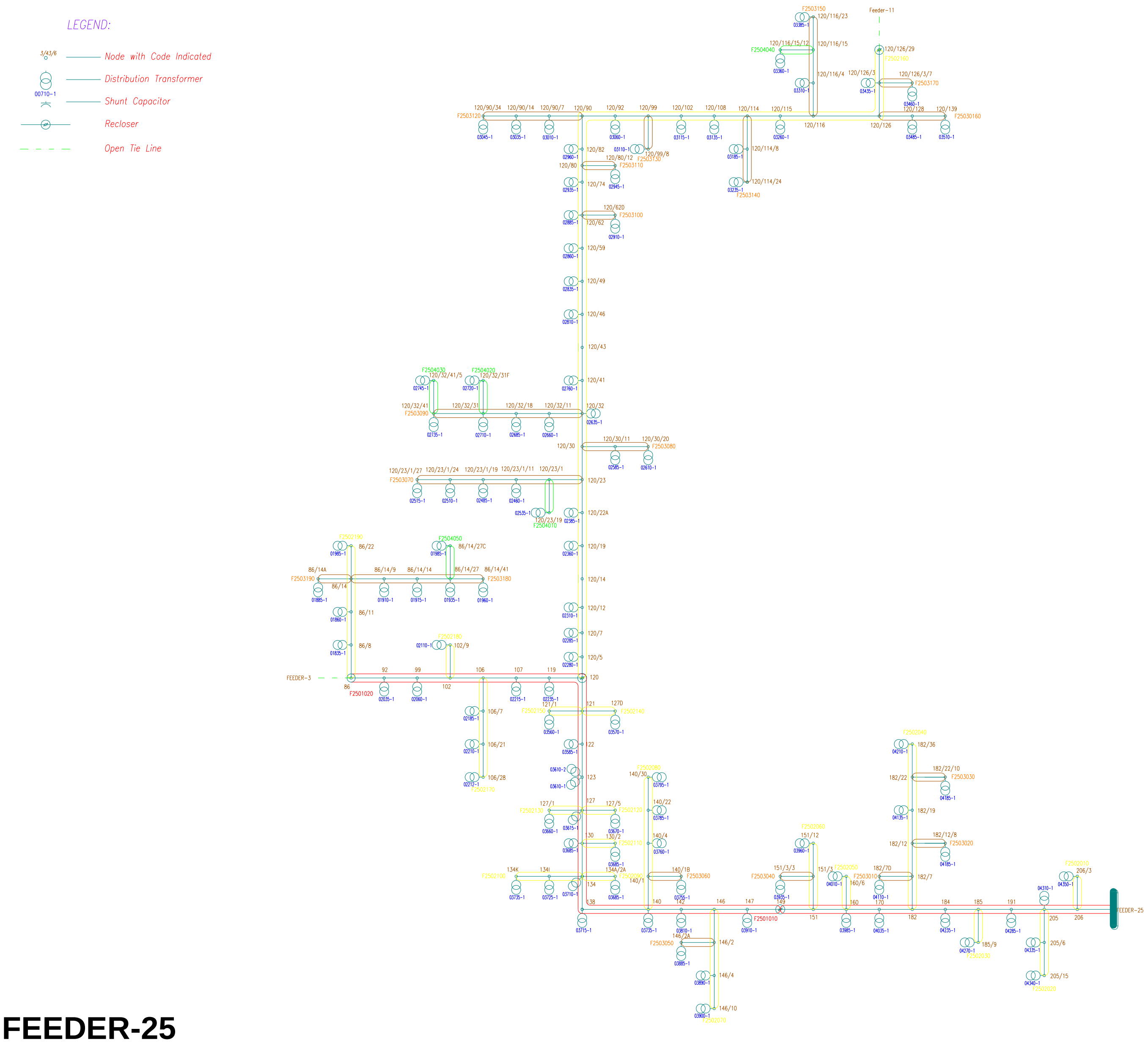
SUB01	FEEDER 23; Loon – Calape Line Section	18/06/14	



FEEDER-23

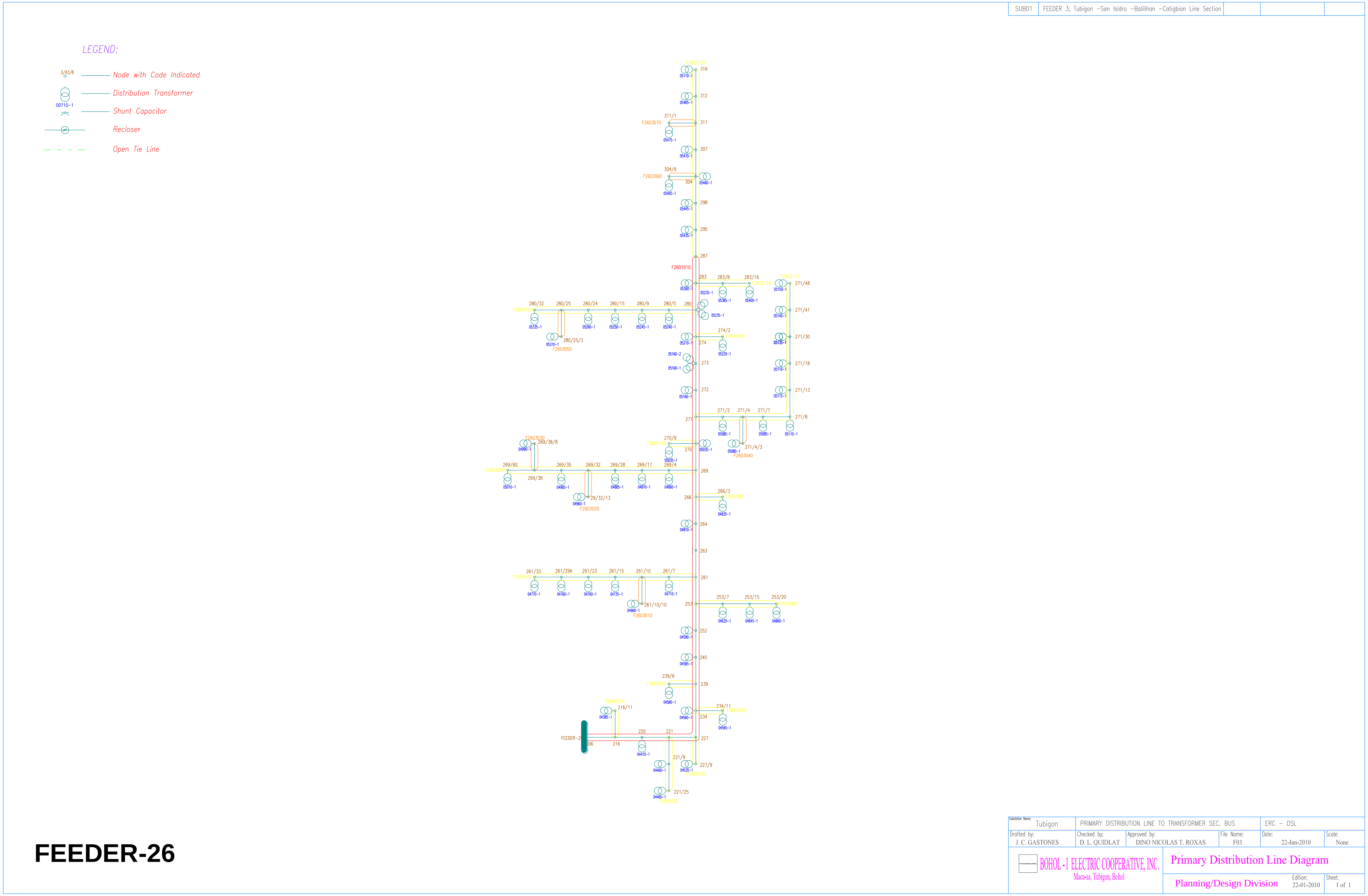
Substation Name: Catagbacan	PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS			ERC – DSL	
Drafted by: J. C. GASTONES	Checked by: D. L. QUIDLAT	Approved by: DINO NICOLAS T. ROXAS	File Name: F23	Date: 18-Jun-2014	Scale: None
BOHOL - I ELECTRIC COOPERATIVE, INC. Cabulijan, Tubigon, Bohol		Primary Distribution Line Diagram			
		Planning/Design Division		Edition: 18-06-2014	Sheet: 1 of 1


SUB01
FEEDER 24; Loon - Antequera Line Section
18/06/14
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
Feeder-23
Feeder-24
Feeder-16
FEEDER-24
Catagbacan
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by: J. C. GASTONES
Checked by: D. L. QUIDLAT
Approved by: DINO NICOLAS T. ROXAS
File Name: F24
Date: 18-Jun-2014
Scale: None
BOHOL - I ELECTRIC COOPERATIVE, INC.
Cabulijan, Tubigon, Bohol
Primary Distribution Line Diagram
Planning/Design Division
Edition: 18-06-2014
Sheet: 1 of 1



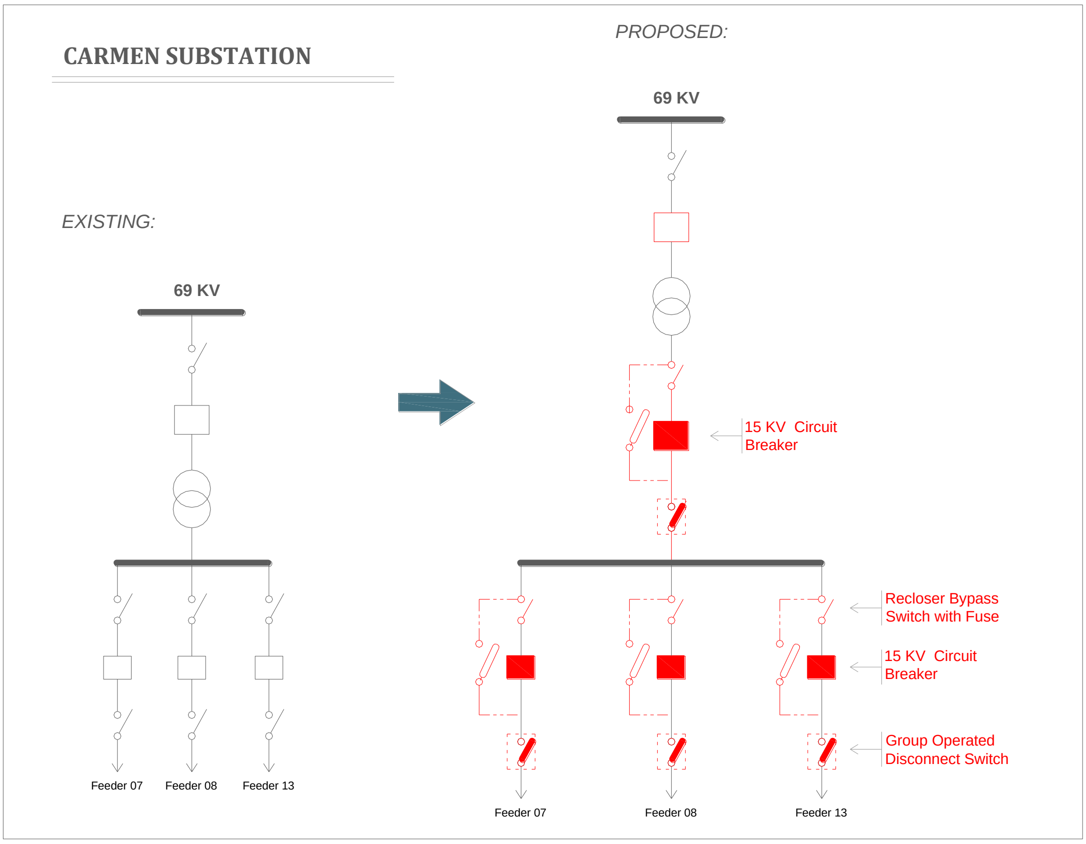
FEEDER-25

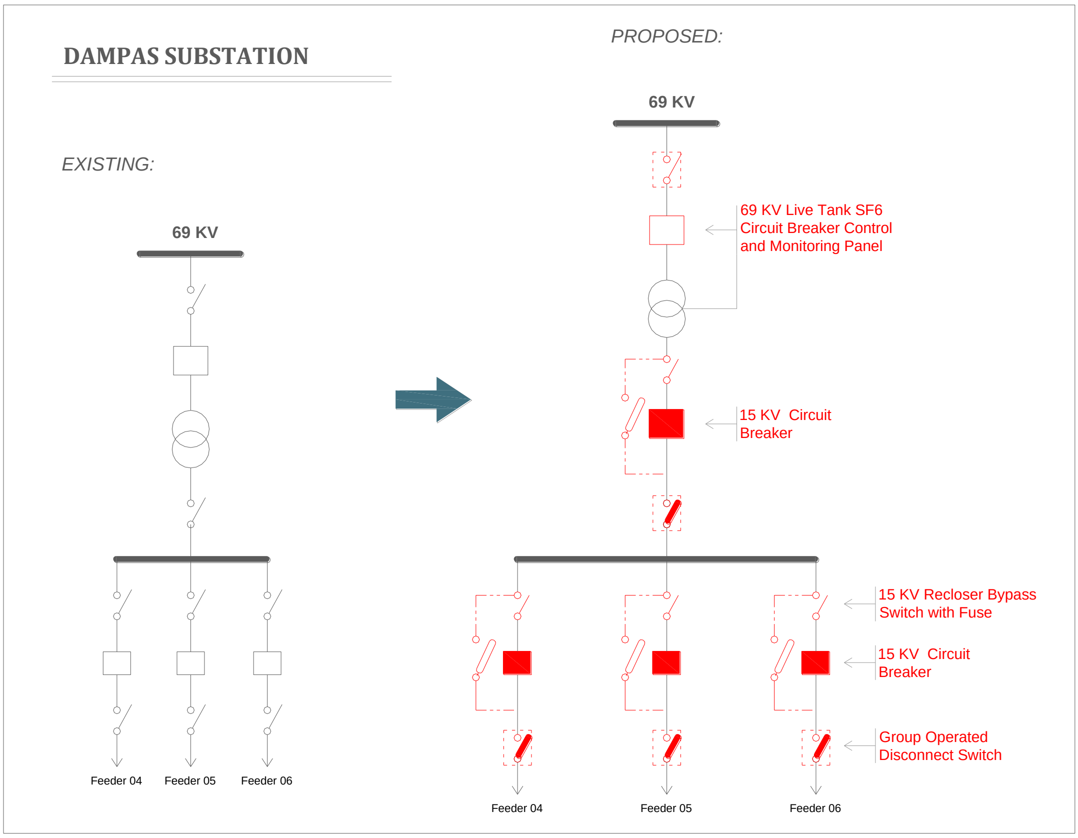
Substation Name: Tubigon	PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS		ERC - DSL	
Drafted by: J. C. GASTONES	Checked by: D. L. QUIDLAT	Approved by: DINO NICOLAS T. ROXAS	File Name: F03	Date: 22-Jan-2010 / Scale: None
BOHOL - I ELECTRIC COOPERATIVE, INC. Maca-as, Tubigon, Bohol	Primary Distribution Line Diagram			
	Planning/Design Division		Edition: 22-01-2010	Sheet: 1 of 1


SUB01
FEEDER 3; Tubigon -San Isidro -Balilihan -Catigbian Line Section
LEGEND:
Node with Code Indicated
Distribution Transformer
Shunt Capacitor
Recloser
Open Tie Line
Tubigon
PRIMARY DISTRIBUTION LINE TO TRANSFORMER SEC. BUS
ERC - DSL
Drafted by: J. C. GASTONES
Checked by: D. L. QUIDLAT
Approved by: DINO NICOLAS T. ROXAS
File Name: F03
Date: 22-Jan-2010
Scale: None
BOHOL - I ELECTRIC COOPERATIVE, INC.
Maca-as, Tubigon, Bohol
Primary Distribution Line Diagram
Planning/Design Division
Edition: 22-01-2010
Sheet: 1 of 1

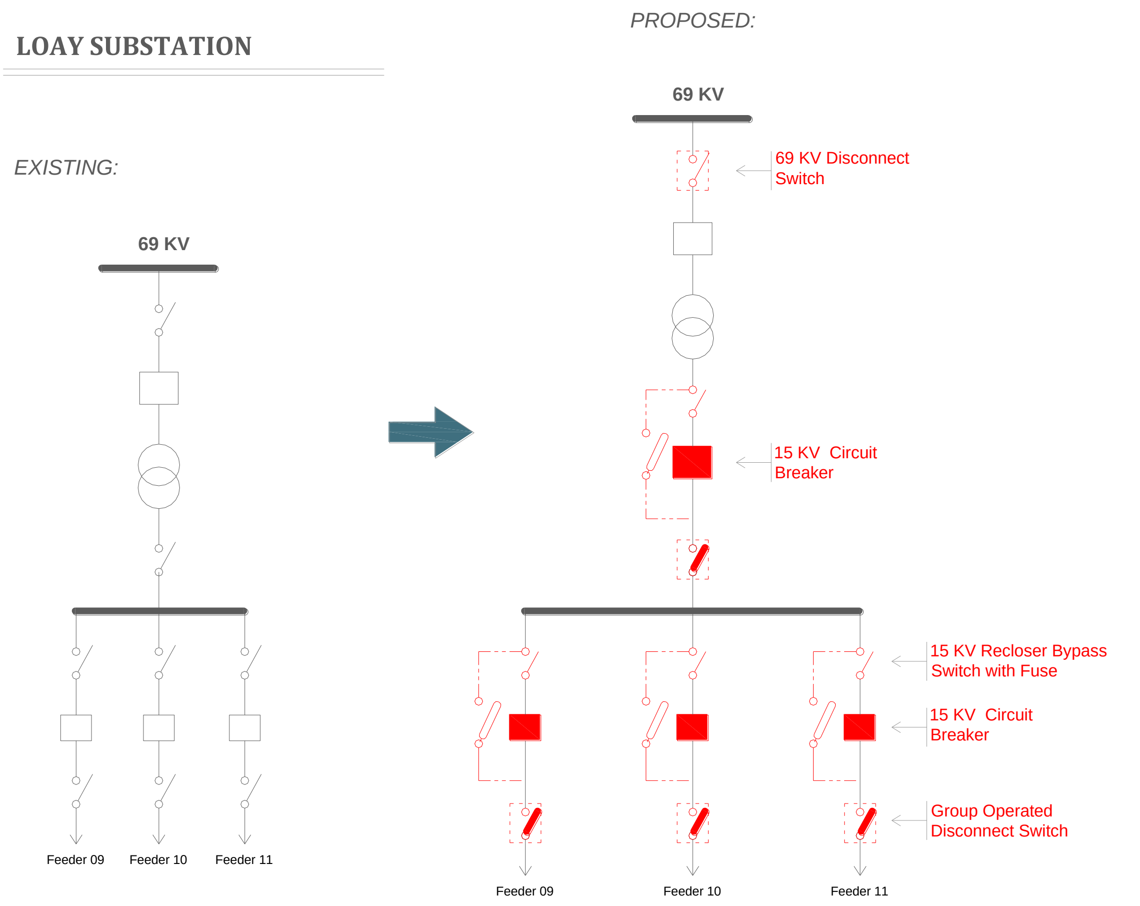
FEEDER-26

E-2 Single Line Diagrams: Replacement of 15kV Main & Sub-Feeder Protection & Control

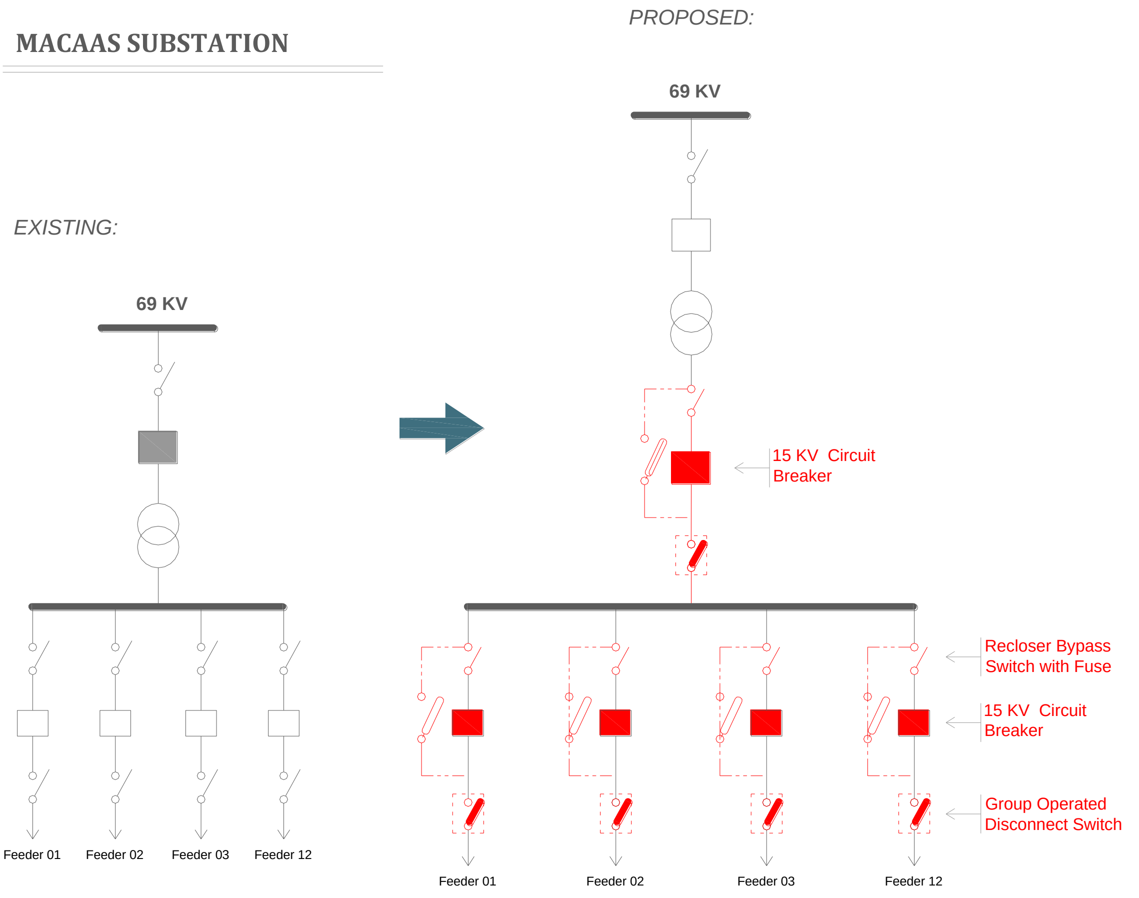




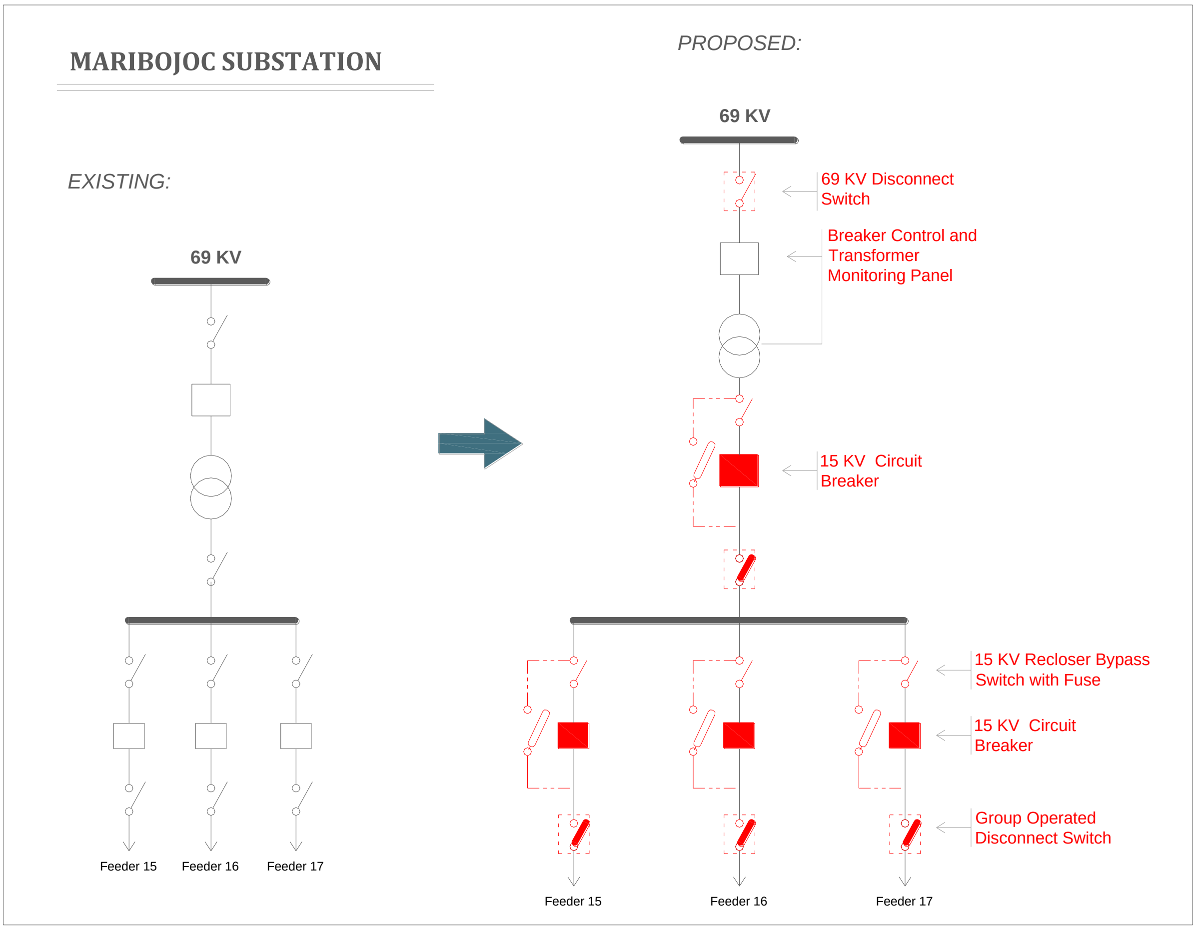
LOAY SUBSTATION



MACAAS SUBSTATION



MARIBOJOC SUBSTATION



Annex F BOHECO I's Policy No. 7-84: Consumer's Furnished Line

BOHOL I ELECTRIC COOPERATIVE, INC.

Cabulijan, Tubigon, Bohol

POLICY NO.	:	**07 - 84 (Amended)**
TITLE	:	CONSUMER'S FURNISHED LINE
OBJECTIVE	:	TO RAISE FUNDS FOR THE CONSTRUCTION OF LINE SOLELY OR PARTLY USED BY CONSUMER

POLICY : It shall be the policy of the BOHECO I that prospective consumer who will be using solely or partly a proposed line to operate their business shall shoulder all or partly their expenses to be incurred to construct said line.

A. DEFINITION

USING SOLELY – Shall mean a condition when the applicant shall solely use the line and shall solely bear the cost thereof when he is still alone in the area. The establishment of other would-be users in the area shall change the condition to "USING PARTLY" with the cost to be shared by both and prorated based on the capacity applied for.

USING PARTLY – Shall mean a condition when two or more consumers that are already existing and the line can be availed of by them. Single-Phase residential clustered consumers shall be considered one consumer and the Fifty (50%) percent of the cost of the single-phase and neutral line shall be deducted from the bill materials with the balance to be shouldered by the large load consumer.

B. COMPUTATION OF SHARE

L_1 – Connected Load of the first consumer

C_1 – Cost to be charged to the 1ST connected consumer

L_2 – Connected load of the second consumer

C_2 – Cost to be charged to the 2ND connected consumer

L_T – Total Connected Load on the Line

C_T – Total Project Cost

$$L_T = L_1 + L_2$$

$$C_1/L_1 = C_T/L_T \qquad C_1 = L_1 \times \left(C_T/L_T\right)$$

$$C_2/L_2 = C_T/L_T \qquad C_2 = L_2 \times \left(C_T/L_T\right)$$

PROCEDURES:

I. CONSUMERS' RESPONSIBILITY

1. The consumer will file a written request for a service stating his type of business, type of load and other data;
2. The consumer will make avail of the right-of-way and other requirement he can produce as required by the cooperative;
3. The consumer will remit to the office the amount, as computed, necessary for the construction of the said line;
4. The consumer will assist in maintaining said line in form of right-of-way clearing and other repairs; and
5. In a situation where in a consumer is solely using the line and bear the total cost thereof, and when the time come where another consumer or consumers will apply for power connection using same line, first consumer is bound to allow the use of same line provided the new consumer or consumer's will share the total cost of the line following the formula on letter "B" Computation of share cost.

II. COOP's RESPONSIBILITY

1. The coop sends representative to survey and stake the proposed line;
2. The coop prepared the bill of materials and costing of the project;
3. The coop informs the consumer on the cost of the proposed line;
4. The coop constructs the line as soon as payment is being made by the consumer;
5. The coop supplies labor in maintaining said line; and
6. In the situation wherein the consumer's furnished line will no longer be used or utilized, the same shall be retrieved by the coop and the total cost of the line less labor cost for retrieving/dismantling and depreciation cost will be refunded to the consumer or consumers.

III. COSTING – costing will be based on the NEA standard unit cost on labor and the prevailing price of materials.

IV. COMSUMER's OPTION – requesting consumer may opt to purchase their materials to be used as specified by the cooperative.

C. EFFECTIVITY :
The policy shall take effect immediately and shall cover existing consumers who are using SOLELY a particular line.

D. RESPONSIBILITY:

The General Manager shall be responsible in the effective implement of this policy which shall be passed on the following departments:

1. Member Services Department for dissemination.
2. Engineering Services Department for survey and costing.
3. Construction, Operation and Maintenance Department for construction.

PRIOR TO AMENDMENT, this was approved per BOD Rec. 29, Series of 1984.

BOHOL I ELECTRIC COOPERATIVE, INC.

Cabulijan, Tubigon, Bohol

POLICY NO. : 07 - 84

TITLE : CONSUMER'S FURNISHED LINE

OBJECTIVE : TO RAISE FUNDS FOR THE CONSTRUCTION OF LINE SOLELY OR PARTLY USED BY CONSUMER

POLICY : It shall be the policy of the BOHECO I that prospective consumers who will be using solely or partly a proposed line to operate their business shall shoulder all or partly their expenses to be incurred to construct said line.

DEFINITION:

USING SOLELY – when consumers request for the line construction so that the line shall be used by him and cannot be availed by other consumers.

USING PARTLY – when said line is requested by the consumer to run his business and can be availed by other consumers, the said consumer will shoulder partly the total cost of the line.

PROCEDURES:

A. CONSUMERS' RESPONSIBILITY

1. The consumer will file a written request for a service stating his type of business, type of load and other data.
2. The consumer will make avail of the right-of-way and other requirement he can produce as required by the cooperative.
3. The consumer will remit to the office the amount, as computed, necessary for the construction of the said line.
4. The consumer will assist in maintaining said line in form of right-of-way clearing and other repairs.
5. In a situation where in a consumer is solely using the line and bear the total cost thereof, and when the time come where another consumer or consumers will apply for power connection using same line, first consumer is bound to allow the use of same line provided the new consumer or consumer's will share the total cost of the line following the formula on letter "B" Computation of share cost.

B. COOP's RESPONSIBILITY

1. The coop sends representative to survey and stake the proposed line
2. The coop prepared the bill of materials and costing of the project.
3. The coop informs the consumer on the cost of the proposed line.
4. The coop constructs the line as soon as payment is being made by the consumer.
5. The coop supplies labor in maintaining said line.

C. COSTING

Costing will be based on the NEA standard unit cost on labor and the prevailing price of materials.

D. COMSUMER's OPTION

Requesting consumer may opt to purchase their materials to be used as specified by the cooperative.

EFFECTIVITY:

The policy shall take effect immediately.

RESPONSIBILITY:

The General Manager shall be responsible in the effective implement of this policy which shall be passed on the following departments:

1. Member Services Department for dissemination.
2. Engineering Services Department for survey and costing.
3. Construction, Operation and Maintenance Department for construction.

Approved per Board Resolution Number 29, Series of 1984.