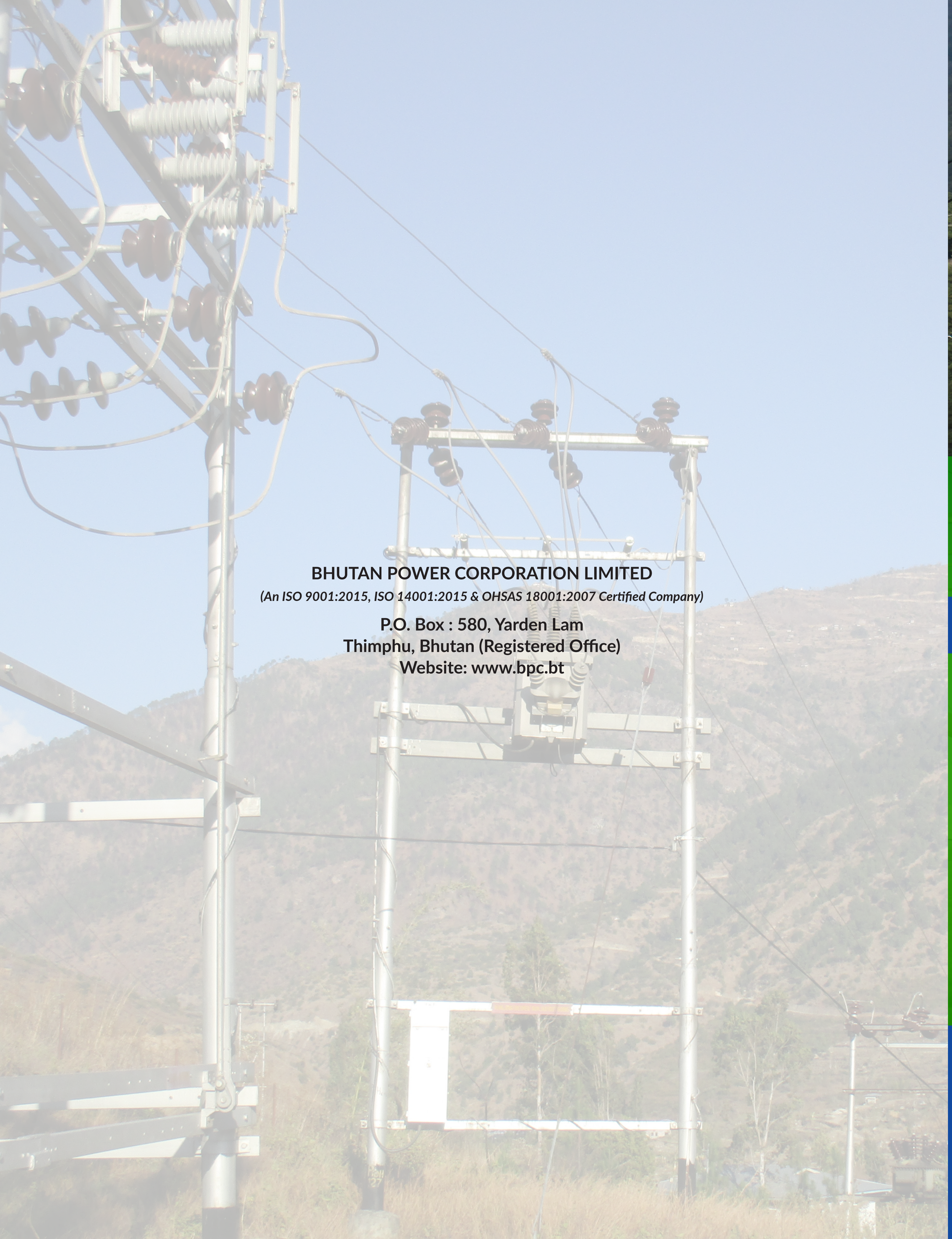

BHUTAN POWER CORPORATION LIMITED

(An ISO 9001:2015, ISO 14001:2015 & OHSAS 18001:2007 Certified Company)

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Thimphu, Bhutan (Registered Office)

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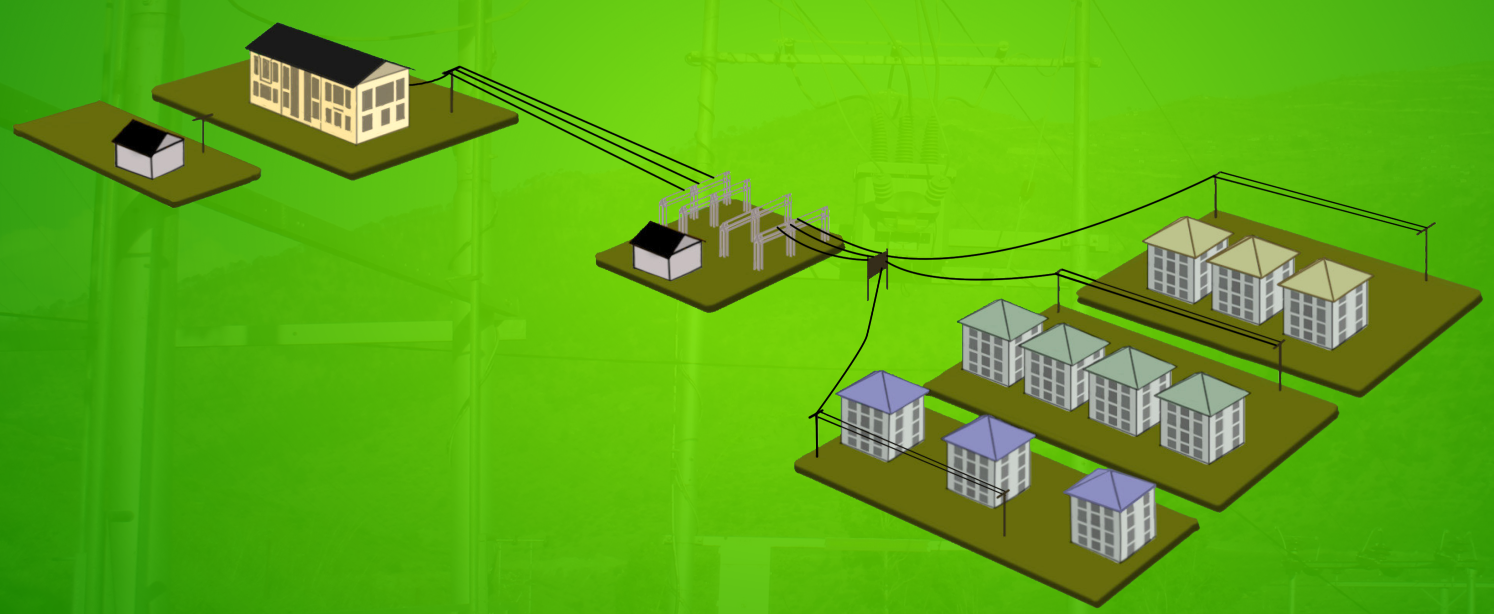
DISTRIBUTION SYSTEM MASTER PLAN (2020-2030)

CHHUKHA DZONGKHAG



Distribution and Customer Services Department

Distribution Services

Bhutan Power Corporation Limited

2020

DISTRIBUTION SYSTEM MASTER PLAN (2020-2030)
CHHUKHA DZONGKHAG

Distribution and Customer Services Department
Distribution Services
Bhutan Power Corporation Limited
2020

FOREWORD

The Distribution System Master Plan (DSMP) identifies, prioritizes and opts for adequate and optimal distribution system expansion and augmentation programs to meet the expected electricity growth and demand development in the Country. This timely formulation of DSMP is in line with the stated corporate strategic objective of providing affordable, reliable and quality services to customers and will enable to traverse the changing technological, regulatory and social constraints for the time horizons considered.

The DSMP has been finalized after a series of consultative discussions with all the relevant stakeholders to obtain a shared outcome. In particular, adequate efforts have been taken to ensure that the DSMP aligns and integrates with the stated plans and programs of the Royal Government of Bhutan (RGoB) for the energy sector.

Based on the expected demand development for the time horizons considered, the DSMP outlines the road map for the implementation of optimized distribution network expansion programs and projects in stages with the expected investment required and financial commitments. The DSMP will be updated on a regular basis to incorporate changing business imperatives and contexts to ensure its relevance.

Appreciation goes to all the officials of the Distribution Services for formulating and coming out a comprehensive document that is timely which will serve as a blueprint for the Distribution Services to build a robust distribution system that will go a long way in contributing towards realization of BPC's objectives of providing a reliable electricity supply to its valued customers.

(Sonam Tobjey)
Chief Executive Officer

Preparation, Review & Approval of the Document

Prepared by:	Distribution & Customer Services Department, Distribution Services, Bhutan Power Corporation Limited, Thimphu.	**GM, DCSD**
Reviewed& Vetted by:	Management, Bhutan Power Corporation Limited, Thimphu. (22nd December 2019 – Meeting No. 557)	**CEO, BPC**
Approved by:	Board Tender & Technical Committee (BTTC), Bhutan Power Corporation Limited, Thimphu. (26th December, 2019 - 15th BTTC Meeting)	**Chairman, BTCC**

Table of Contents

List of Tables

List of Figures

Abbreviations

BPC: Bhutan Power Corporation Limited

ESD: Electricity Services Division

DSMP: Distribution System Master Plan

GIS: Geographical Information System

SLD: Single Line Diagram

ETAP: Electrical Transient and Analysis Program

IS: Indian Standard on Transformers

IEC: International Electrotechnical Commission

DT: Distribution Transformer

TSA: Time Series Analysis

LRM: Linear Regression Method

USS: Unitized Substation

DMS: Distribution Management System

ADMS: Advanced DMS

SCADA: Supervisory Control and Data Acquisition

DSCADA: Distribution SCAD

MV: Medium voltage (33kV, 11kV and 6.6kV (if it exists))

DDCS: Distribution Design and Construction Standards

kVA: Kilo Volt Ampere

W: Watt

kWh: Kilo Watt Hour

RMU: Ring Main Unit

PHCB: Population and Housing and Census of Bhutan

BDBL: Bhutan Development Bank Limited

BNB: Bhutan National Bank

RSTA: Road Safety and Transport Authority

RICB: Royal Insurance Corporation Limited

BoB: Bank of Bhutan Limited

Definitions

Asset Life: The period of time (or total amount of activity) for which the asset will be economically feasible for use in a business.

Balanced system: A system is said to be balanced when all phase conductors carry approximately the same current. For delta systems, this applies to two-phase conductors, and for three-phase wye systems, this applies to three-phase conductors.

Contingency plan: Power that is needed when regularly used electric generating units are not in service, such as during short-term emergencies or longer unplanned outages, and during periods of scheduled maintenance when the units must be shut sown. Short-term backup power is generally called emergency power. Long-range backup power is often provided for in reserve sharing agreements.

Capacity: Also known as the power or capability of an electric generating plant. Facilities and place to serve electric customers. 2) The total amount of electrical energy a power line is able to transport at any given time (Measured in kVA).

Clearance: The clear distance between two objects measured surface to surface. For safety reasons, proper clearance must be maintained between power lines and the ground, buildings, trees, etc.

Critical Value: The value of the random variable at the boundary between the acceptance region and the rejection region in the testing of a hypothesis.

Distribution line: That part of the electrical supply system that distributes electricity at medium voltage (33kV, 11kV & 6.6kV) from a transformer substation to transformers or other step-down devices service customer premises, which finally supply power at the voltage required for customer use.

Distribution loss: Energy losses in the process of supplying electricity to the consumers due to commercial and technical losses.

Distribution system: The portion of the transmission and facilities of an electric system that is dedicated to delivering electric energy to an end-user.

Energy: Delivered power measured in kilowatt-hours (kWh).

Generating station: A plant wherein electric energy is produced by conversion from some other forms of energy.

Grid: A system of high-voltage transmission and power-generating facilities that is interconnected with a number of other bulk power supply agencies on a regional basis. A grid enables power to be transmitted from areas having a surplus to areas experiencing a shortage. A grid also eliminates some duplication of costly facilities in a given region.

Investment: the action or process of investing money for certain activities with return and profit.

Lines (electrical supply) - Those conductors used to transmit or deliver electric energy and their necessary support or containing structures.

Linear Regression Method: In **statistical modeling**, regression analysis is a set of statistical processes for **estimating** the relationships between a **dependent variable** (often called the 'outcome variable') and one or more **independent variables.**

Load: 1) A device, or resistance of a device, to which power is delivered in a circuit. 2) The measure of electrical demand placed on an electric system at any given time.

Load forecasting: The methods used in determining a system's short and long-term growth in peak load and kilowatt-hour sales by consumers.

Load Growth: The increase in the demand of power required over time.

Marginal Value: Just barely adequate or within a lower Limit.

On line - Term generally used to indicate when a generating plant and transmission line is scheduled to be in operation. When an operational plant and line is not on line, it is said to be "down."

Outage - Interruption of service to an electric consumer.

Overload - Operation of equipment in excess of normal, full-load rating, or of a conductor in excess of rated ampacity that, when it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload.

Optimization: the action of making the best or most effective use of a situation or resource.

Pad-mounted equipment- General term describing enclosed equipment, the exterior of which enclosure is at ground potential, positioned on a surface-mounted pad. Example: underground transformers and junction boxes.

Peak demand - The maximum amounts of electricity used by a utility customer at any given time during the year. The peak is used to measure the amount of electric transmission, distribution, and generating capacity required to meet that maximum demand, even if it occurs infrequently and only for very short durations.

Peak load - The greatest amount of electricity used during a time period by the consumers in a utility's system.

Power - The time rate of electric energy in a device or circuit, measured in watts.

Power factor - A measurement of efficiency in the use of electricity. For example: a 100% power factor would be like a horse pulling a wagon on rails directly forward with no resistance. If the horse turns and pulls at a right angle to the rails, he may pull just as hard, but his efforts will not move the car. This would be a zero percent power factor. Now, if he pulls at a 45-degree angle to the rails, he will pull the car, but not with as high efficiency as if he were pulling straight down the rails. In the use of electricity, not every kilowatt generated translates into equivalent horsepower efficiency.

Power grid - A network of generation, transmission and distribution system that are interconnected

Power quality - The extent to which a utility system is able to maintain its delivery of electric energy within the tolerable limits of voltage and without outages or other problems with affect a customer's equipment use.

Power supply - Source of current and voltage.

Reliability - A measure of a utility's ability to deliver uninterrupted electric service to its customers.

Substation - An electrical facility containing switches, circuit breakers, buses, and transformers for switching power circuits and transforming power from one voltage to another, or from one system to another.

Time Series Analysis: The statistical techniques used when several years' data are available to forecast the load growth.

1. Executive Summary

Bhutan Power Corporation Limited is mandated to provide affordable, adequate, reliable and quality electricity services to the customers through transmission and distribution networks established across the country. Towards realizing the mission, vision and destination statement of BPC as outlined in the Corporate Strategic Plan (2019-2030), there is a need to carry out comprehensive studies of the distribution system to address the system deficiencies as the ground realities are different triggered by technological advancement and economic growth.

The existing distribution networks are modeled and accordingly, the technical evaluation is carried out adopting the generally accepted load forecasting framework i.e. Time Series Analysis in conjunction to Linear Regression Method, the power requirement for next ten (10) years are forecasted. Subsequently, the network capability and the system gaps are identified with proposed distribution system planning. The investments are proposed (based on the priority matrix) to address the system inadequacies with the intent to improve the Customer Services Excellence, Operational and Resource Optimization Excellence, Innovation and Technology Excellence and Business Growth Excellence.

The single to three-phase distribution network conversion across the country is reproduced in this report based on the studies carried out by BPC "Technical and Financial Proposal on Converting Single Phase to Three-Phase Power Supply in Rural Areas".

The details on the distribution grid modernization are outlined in Smart Grid Master Plan 2019 including the investment (2020-20230). The identification of the system deficiencies and qualitative remedial measures which would require system automation and remote control as per the existing and projected load are only outlined in this report.

Similarly, the system study beyond the Distribution Transformers had to be captured during the annual rolling investment and budget approval.

The ETAP tool is used to carry out the technical evaluation and validate the system performances. Finally, necessary contingency plans, up gradation and reinforcement plans are proposed as annual investment plans based on the outcome of the simulation result.

2. Introduction

The system study is intended to improve the power distribution system in Bhutan by formulating a comprehensive, national level and district wise DSMP (2020-2030) till 2030 that provides measures for renewing and reinforcing power distribution facilities. BPC's distribution system has grown in size and complexities over the years. While many network additions and alterations carried out so far were as per the recommendations of the Druk Care Consultancy Study Report (2006), the ground realities are evermore different now than anticipated during the study. There is a need to explore opportunities for optimizing the available resources and develop a master plan for future investments.

Some of the prominent driving factors required for the development of the master plan includes but not limited to reliable power supply to the customers, reduction of distribution losses, network capability with the anticipated load growth, optimization of the resources and to develop annual investment plan.

BPC has never carried out comprehensive system studies to improve the distribution system and optimize the available resources. The recurring investment plans (annual) is based on the on-site and field proposals without any technical evaluation being carried out which could have resulted in preventable and excessive investments. Therefore, proper planning is necessary to improve the system for optimal usage of resources.

It is also intended that this master plan is to provide general guidance in preparing long-range system planning. The analysis indicates where up-grades are most likely to be economical and provides insight into the development of a practical transition from the existing system to the proposed long-range system. Based on this analysis, recommendations are made for improving system performance and increasing system capacity for expansion. Periodic reviews of the master plan will be required to examine the applicability of the preferred plan considering actual system developments.

3. Objectives of the Master Plan

The objective(s) of the DSMP (are):

3.1 To carry out the system study of the existing distribution network, forecast and come out with the comprehensive ten (10) years strategic distribution plan;

3.2 To provide affordable and adequate electricity, reduce losses, improve power quality, reliability, optimize the resources and gear towards excellent customer services; and

3.3 To come out with annual investment plans.

4. Scope of the Distribution System Master Plan

Formulation of detailed DSMP (2020-2030) of the Dzongkhag for renewal, reinforcement, and extension of the power distribution system up to DT.

5. Methodology and Approach

In order to better understand the existing distribution system and postulate the credible investment plans; standard framework and procedures had been adopted. However, in the absence of any standardized procedures in BPC for planning of distribution system, the following customized procedures detailed in **Section 5.1** through **Section 5.5**and as shown in **Figure 1** are considered to suit BPC's requirement for developing the DSMP.

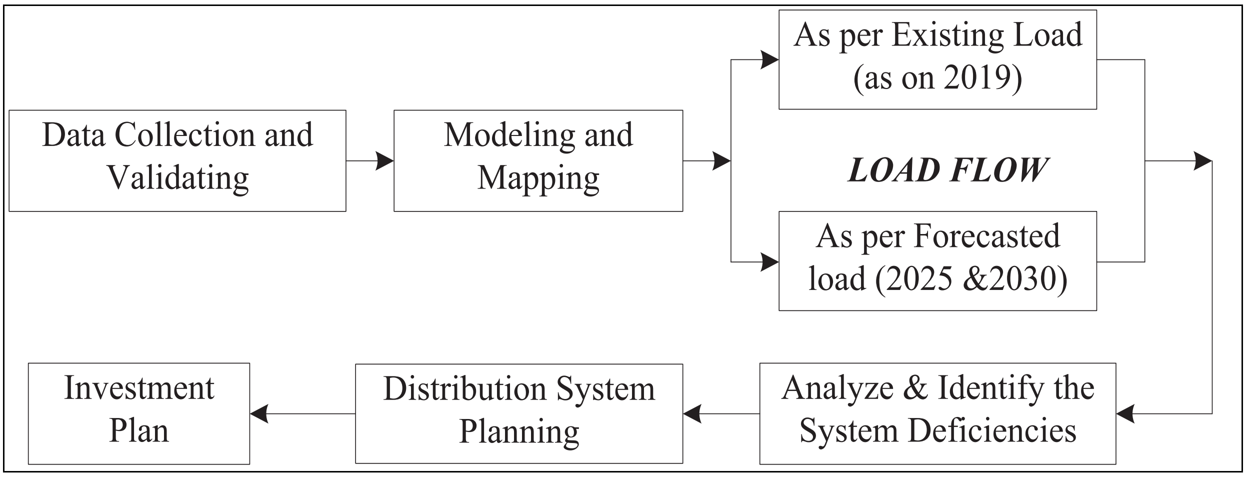


Figure 1: Block diagram for distribution system planning for thematic studies

5.1 Data Collection and Validation

In order to carry out the detailed studies with greater accuracy, complete and reliable data for the existing distribution infrastructure is required. Therefore, intensive field investigation was carried out during the months of April and May (2020) to validate the information that was collected. The information required for the studies does not confine to the BPC's internal distribution network but also the developmental activities of the cross-governmental sectors. The power arrangement requirements from these developmental activities were also used to forecast the power demand. The data validation on the distribution system includes the review of all the power sources, medium voltage lines and transformers with that of GIS data of Environment and GIS Division and SLD submitted by respective ESDs which is attached as **Annexure-1.**

5.2 Modeling and Mapping

The feeder wise distribution lines and transformers were modeled and mapped in ETAP tool and the base case was developed for the existing distribution network. The technical parameters for the lines and transformers were considered based on IS 2026, IEC 60076 (Details attached as **Annexure-2**) to develop the base model. Modeling and Mapping detail is attached as **Annexure-1.**

5.3 Analysis and Identification of System Deficiencies

The existing distribution system model was analyzed in the ETAP involving balanced load flow to figure out the network capabilities against the set distribution standards. The load growth was projected using the commonly adopted methodology that is LRM in conjunction to TSA which is based on the historical data and accordingly the behavior of the distribution system was analyzed, and the system deficiencies were identified. The details on load forecast methodology is attached as **Annexure-3.**

5.4 Distribution System Planning

Necessary deterministic and probable distribution system planning methods are proposed to address the system gaps focusing on reduction of losses, improving the reliability and power quality. Accordingly, any contingency plans, up gradation and reinforcement plans are proposed along with the investment plans incorporating best fit technology.

5.5 Investment Plan

The approved investment plans (from 2020 to 2023) have been validated based on the outcome of the system studies and accordingly, the yearly investment plans are outlined as per the priority matrix as detailed in **Section 9.**

6. Existing Electricity Distribution Network

6.1 Overview of the Power Supply Sources

The power supply to ten (10) Gewogs of Chukha Dzongkhag and industries based in Phuentsholing Gewog is from Phuentsholing, Malbase, Singyegoan, Gedu, Chukha and Watsa HV substations. There are also two MV substations in Phuentsholing and Gurungdangra. The basic electricity distribution network model as seen from the source is illustrated in the schematic diagram is predominantly redial as shown in **Figures 2 & 3.**

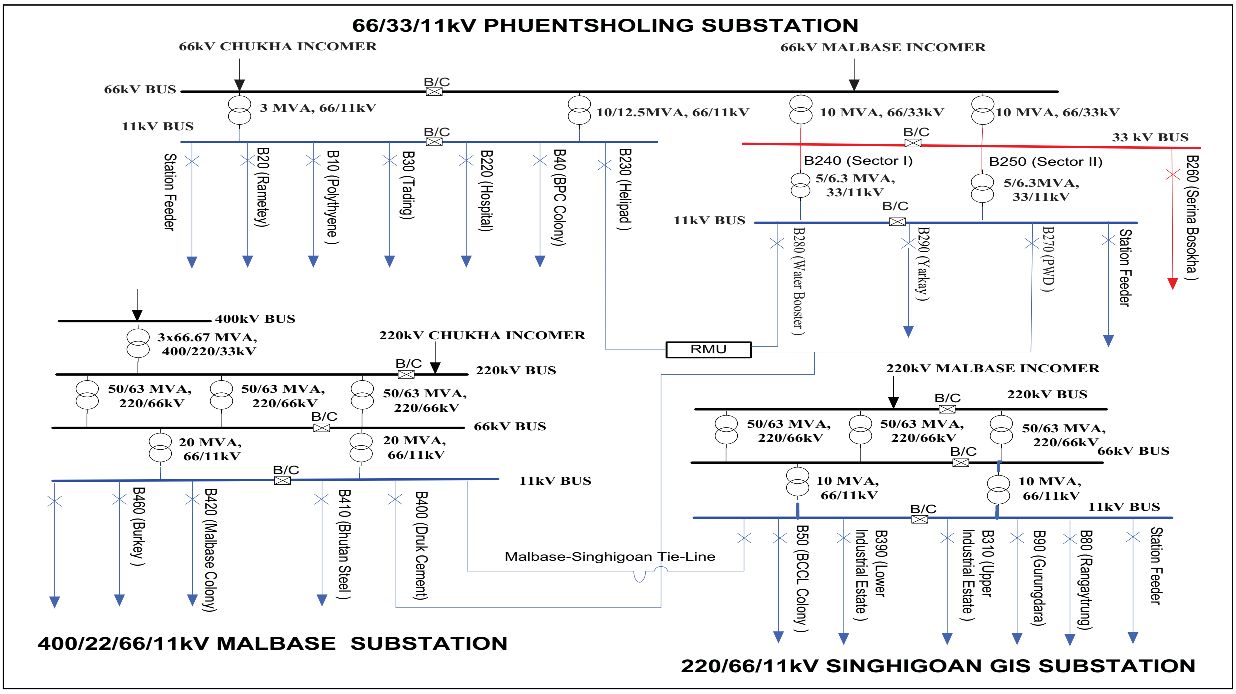


Figure 2: Electricity Distribution Schematic Network of Chukha Dzongkhag (Phuentsholing, Singyegoan and Malbase substations)

The customers of Chukha Dzongkhag receive power supply from 66/33kV, 3MVA & 10MVA and 66/11kV, 2x10MVA Phuentsholing substations; 66/11kV, 2x20MVA Malbase substation; 66/11kV, 2x10MVA Singaygoan substation; 66/11kV, 2x5MVA and 66/33kV, 5MVA & 8 MVA Gedu substations; 66/11kV, 3x3MVA Chukha substation and 66/33kV, 8MVA Watsa substation.

There are two 33/11kV substations installed at Phuentsholing and Gurungdangra as MV substations.

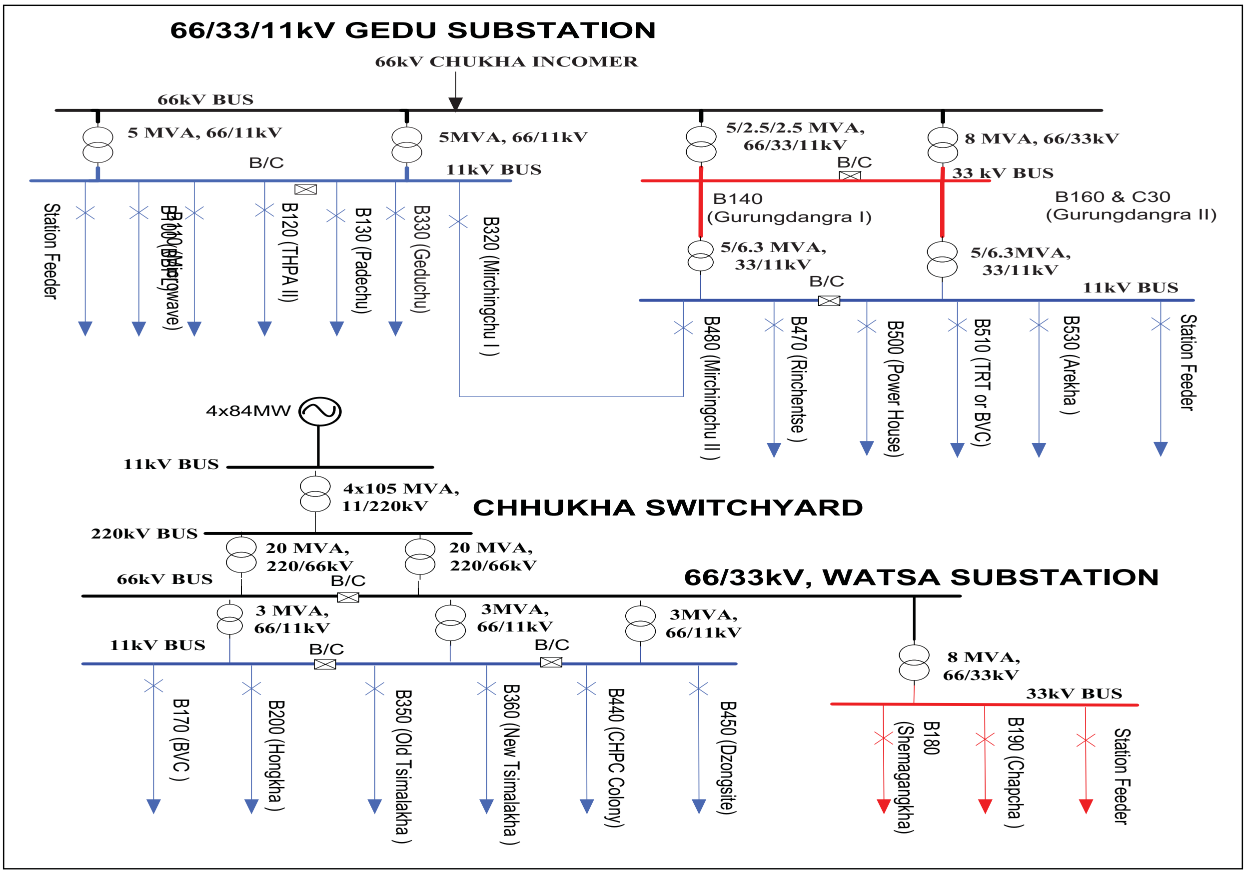


Figure 3: Electricity Distribution Schematic Network of Chukha Dzongkhag (Gedu and Watsa Substations and Chukha Switchyard)

6.2 Electricity Distribution Lines

The quantity of MV and LV lines operated and maintained by ESD, Phuentsholing is summarized in **Table 1**.

Table 1: MV and LV Line Details

Sl. No.	33 kV		11 kV		Total MV line		LV lines		Total line length
	OH	UG	OH	UG	OH	UG	OH	UG	
ESD, Phuentsholing									
1	111.11	0.98	160.34	13.01	271.46	13.99			923.09
ESSD, Gedu & Lhamoizingkha									,
2	219.08	0.13	87.30	5.61	306.38	5.74	625.64	12	312.13
ESSD, Tsimalakha									,
3	23.71	0.07	50.46	0.64	74.17	0.71			74.88
Overall Total									
	353.90	**1.19**	**298.11**	**19.26**	**652.01**	**20.45**	**625.64**	**12.00**	**1,310.10**

**LV line length is as per Power Data Book 2018.*

The total MV line length is 672.46 km and the total LV line length is 637.64km. The ratio of LV to MV line length is 0.95 which reflects an equal proportion of power distribution through MV & LV distribution and is recommended to maintain the ratio. While the ratio of LV to MV line length would vary according to the site conditions, as a general thumb rule, network ratio of 1.2:1 (LV to MV) should be maintained for optimum initial capex and the running and maintenance costs. The majority of the MV distribution network is through 33 kV and 11 kV overhead lines with some network in the town areas being through underground cables.

6.3 Distribution Transformers

The number of distribution transformers operated and maintained by the ESD, Phuentsholing and its ESSDs (Gedu, Tsimasham & Lhamoizingkha) is tabulated in **Table 2**.

Table 2: Total Numbers of Transformers, Installed Capacity and Customers

Sl. No.	Name of Feeder	Voltage Ratio	Number of Transformers	Installed capacity (kVA)	Total number of customers
ESD, Phuentsholing					
1	11 kV Feeder B10 (New Polythyene)	11/0.415kV	9	4933	284

Sl. No.	Name of Feeder	Voltage Ratio	Number of Transformers	Installed capacity (kVA)	Total number of customers
2	11kV Feeder B20 (Karbraytar & Rametey)	11/0.415kV	21	4348	1181
3	11kV Feeder B30 (Tading)	11/0.415kV	91	6475	1034
4	11kV Feeder B40 (BPC Colony)	11/0.415kV	12	5110	544
5	11kV Feeder B220 (Hospital)	11/0.415kV	1	750	23
6	11kV Feeder B230 (Helipad)	11/0.415kV	2	1500	268
9	11kV Feeder B280 (Water Booster)	11/0.415kV	18	9475	1650
10	11kV Feeder B270 (PWD)	11/0.415kV	17	8938	1824
11	11kV Feeder B290 (Yarkay)	11/0.415kV	1	315	10
12	11kV Feeder B300 (Station)	11/0.415kV	1	63	1
13	33kV Feeder B260 (Serina Bosokha)	11/0.415kV	94	2952	1822
14	11kV Feeder B80 (Rangaytrung)	11/0.415kV	15	819	939
15	11kV Feeder B90 (Gurungdangra)	11/0.415kV	3	251	378
16	11kV Feeder B400 (Druk Cement)	11/0.415kV	28	14005	800
17	11kV Feeder B410 (Bhutan Steel)	11/0.415kV	2	3750	1
18	11kV Feeder B420 (Malbase Colony)	11/0.415kV	1	630	31
19	11kV Feeder B460 (Burkey)	11/0.415kV	3	189	152
20	11kV Feeder B50 (BCCL Colony)	11/0.415kV	10	5221	566
21	11kV Feeder B390 (Lower Industrial Estate)	11/0.415kV	17	11686	29
22	11kV Feeder B310 (Upper Industrial Estate)	11/0.415kV	5	6025	10
	Total		**351.00**	**87,435.00**	**11,547.00**
ESSD, Gedu & Lhamoizingkha					
1	11 kV Feeder B100 (BBPL)	11/0.415kV	11	4,102.00	465

Sl. No.	Name of Feeder	Voltage Ratio	Number of Transformers	Installed capacity (kVA)	Total number of customers
2	11kV Feeder B110 (Microwave)	11/0.415kV	1	100	1
3	11kV Feeder B120 (THPA II)	11/0.415kV	9	7150	458
4	11kV Feeder B130 (Padechu)	11/0.415kV	10	600	380
5	11kV Feeder B320 (Mirchingchu I)	11/0.415kV	2	275	689
6	11kV Feeder B330 (Geduchu)	11/0.415kV	5	454	84
7	33kV Feeder B160 & C30 (Gurungdangra II)	33/0.415kV	104	10324	2602
8	11kV Feeder B470 (Rinchentse)	11/0.415kV	6	4335	1890
9	11kV Feeder B480 (Mirchingchu II)	11/0.415kV	3	263	175
10	11kV Feeder B500 (Power House)	11/0.415kV	1	100	1
11	11kV Feeder B510 (TRT or BVC)	11/0.415kV	6	750	1
12	11kV Feeder B520 (Surgeshaft)	11/0.415kV	4	2750	1
13	11kV Feeder B530 (Arekha/ Sinchekha)	11/0.415kV	5	3510	657
	Total		**167.00**	**34,713.00**	**7,404.00**
ESSD, Tsimalakha					
1	11 kV Feeder B170 (BVC)	11/0.415kV	5	1001	153
2	11kV Feeder B200 (Hongkha)	11/0.415kV	3	850	313
3	11kV Feeder B350 (Old Tsimalakha)	11/0.415kV	13	1804	1174
4	11kV Feeder B360 (New Tsimalakha)	11/0.415kV	6	2258	
5	11kV Feeder B440 (CHPC Colony)	11/0.415kV	5	1813	439
6	11kV Feeder B450 (Dzong site)	11/0.415kV	2	500	46
7	33kV Feeder B180 (Shemagangkha)	33/0.415kV	11	517	233
8	33kV Feeder B190 (Chapcha)	33/0.415kV	8	889	259
	Total		**53.00**	**9,632.00**	**2,617.00**
Overall Total			**571.00**	**131,780.00**	**21,568.00**

As of June 2019, there were 571 transformers with a total installed capacity of 131,780.00kVA. As evidenced from **Table 2,** the installed capacity of transformer per customer is 6.11kVA per customer. The installed transformers are generally large in capacity and few in number rather than generally small in capacity and more in numbers. The 11kV Tading feeder with a connected installed capacity of 1158kVA (for 53 transformers) which is being operated and maintained by ESSD, Dorokha has its source from 66/11kV Phuentsholing substation. Therefore, this report is inclusive of the above transformers along with the Tading feeder.

7. Analysis of Distribution System

Based on the model developed in ETAP for the existing feeder wise distribution network, analysis of the system was carried out by considering the forecasted load growth from 2020-2030. The quality of power, reliability and energy loss of the existing network were assessed and accordingly the augmentation and reinforcement works are proposed which shall be the integral part of the investment plan. The assessment of MV lines, DTs, power sources, reliability of the power supply and energy & power consumption pattern are presented from **Section 7.1** through **Section 7.4**.

7.1 Assessment of Power Sources

The assessments of the capabilities of the power sources were exclusively done based on the existing (as on 2019) and forecasted load. The source capability assessment had to be carried out to ascertain the adequacy of the installed capacity against the existing load and the forecasted load. The source capability assessment had been carried out bifurcating HV and MV substations as detailed below.

7.1.1 HV Substation

The assessment of 66kV and above substations had to be carried out to ascertain the adequacy of the installed capacity against the existing and the forecasted load.

Table 3: HV Power Sources

Sl.No.	Name of Source	Source Capacity		Forecasted Peak Load (MW)		
		MVA	MW*	2019	2025	2030
1	220/66kV, 50/63MVA Malbase SS (T1)	50.00	42.50	36.00	41.89	44.30
2	220/66kV, 50/63MVA Malbase SS (T2)	50.00	42.50	35.00	40.00	44.00
3	220/66kV, 50/63MVA Malbase SS (T3)	50.00	42.50	38.00	39.30	40.95
	Total	**150.00**	**127.50**	**109.00**	**121.19**	**129.25**
4	66/11kV, 20MVA Malbase SS (T1)	20.00	17.00	2.60	4.25	5.36
5	66/11kV, 20MVA Malbase SS (T2)	20.00	17.00	2.60	4.12	5.57
	Total	**40.00**	**34.00**	**5.20**	**8.37**	**10.93**
6	220/66kV, 50/63MVA GIS Singigoan (T1)	50.00	42.50	38.23	39.90	42.24
7	220/66kV, 50/63MVA GIS Singhigoan (T2)	50.00	42.50	33.02	40.24	43.45
8	220/66kV, 50/63MVA GIS Singhigoan (T3)	50.00	42.50	33.18	39.42	42.60
	Total	**150.00**	**132.50**	**104.42**	**119.56**	**128.29**
9	66/11kV, 10MVA GIS Singhigoan (T1)	10.00	8.50	2.71	4.91	6.69
10	66/11kV, 10MVA GIS Singhigoan (T2)	10.00	8.50	3.02	4.65	5.39
	Total	**20.00**	**17.00**	**5.73**	**9.56**	**12.08**
11	66/33kV, 10MVA Pling SS (T1)	10.00	8.50	Kept ideal charge		
12	66/33kV, 10MVA Pling SS (T2)	10.00	8.50	4.80	5.60	6.25
	Total	**20.00**	**17.00**	**4.80**	**5.60**	**6.25**
13	66/11kV, 10MVA Pling SS	10.00	8.50	6.71	7.13	7.79
14	66/11kV, 5MVA Pling SS	5.00	4.25	2.95	3.16	3.96
15	66/33kV, 8MVA Gedu SS	8.00	6.80	2.41	3.51	4.42
16	66/33/11kV, 5/2.5/2.5MVA Gedu SS	2.50	2.13	0.90	1.20	1.50
17	66/11kV, 5MVA Gedu SS (T1)	5.00	4.25	1.56	2.33	2.95
18	66/11kV, 5MVA Gedu SS (T2)	5.00	4.25	1.31	1.49	1.66
	Total	**10.00**	**8.50**	**2.87**	**3.82**	**4.61**
19	66/11kV, 3x3MVA Chukha Switchyard	9.00	7.65	2.09	2.22	2.40
20	66/33kV, 8MVA Watsa SS	8.00	6.80	1.11	1.45	1.74
	Total	**432.50**	**367.63**	**248.20**	**286.76**	**313.22**

**pf of 0.85 was considered for study purpose only.*

From the above table it is conclusive that the existing installed HV substation would be adequate to meet the forecasted load till 2030. The total peak power required for the customers of Chukha Dzongkhag as of 2019 is 248.20MW and is expected to reach 286.76MW & 313.22 MW in 2025 & 2030 respectively against the installed capacity of 367.63MW (@0.85x432.50 MVA). The load forecast (power requirement) has been carried out including the load requirement of the LAPs and industries.

The existing peak load of 220/66kV, 3x50/63MVA Malbase substation is 109.00MW as of 2019 and is expected to reach 121.19MW & 129.25MW by 2025 & 2030 respectively against the installed capacity of 127.50/160.65MW (0.85x150/189MVA). Similarly, the existing peak load of 66/11kV, 2x10MVA Malbase substation is 5.73MW and is expected to reach 9.56MW & 12.08MW by 2025 & 2030 respectively against the installed capacity of 17.00MW (0.85x20MVA). Therefore, the installed capacities of both the substations would be adequate to meet the forecasted load growth.

The existing peak load of 220/66kV, 3x50/63MVA Singyegoan GIS substation was 104.42MW and is expected to reach 119.56MW & 128.29MW by 2025 & 2030 respectively against the installed capacity of 127.50MW (150/189MVA). Similarly, the existing peak load of 66/11kV, 2x20MVA Malbase substation is 5.20MW and is expected to reach 8.37MW & 10.93MW by 2025 & 2030 respectively against the installed capacity of 34MW (40MVA). Therefore, the installed capacities of both the substations would be adequate to meet the forecasted load growth.

The existing peak load of 66/33kV, 2x10/63MVA Phuentsholing substation is 4.80MW and is expected to reach 5.60MW & 6.25MW by 2025 & 2030 respectively against the installed capacity of 17.00MW (20MVA). Similarly, the existing peak loads of 66/11kV, 10MVA & 5MVA are 6.71MW & 2.95MW respectively and are expected to reach 7.13MW & 3.16MW and 7.79MW & 3.96MW respectively by 2025 & 2030 respectively against the installed capacity of 8.5MW (10MVA) & 4.25MW (5MVA). Therefore, the installed capacities of both the substations would be adequate to meet the forecasted load growth.

Similarly, the Gedu and Watsa substations and Chukha switch yard would be adequate to cater the load requirement till 2030.

7.1.2 MV Substation

The assessment of 33kV and below substations had to be also carried out to ascertain the adequacy of the installed capacity against the existing load and the forecasted load.

Table 4: MV Power Sources

Sl.No.	Name of Source	Source Capacity		Feeder Load (MW)		
		MVA	MW*	2019	2025	2030
1	33/11kV, 5/6.3 MVA (Pling) Sector I SS	5.00	4.25	2.87	3.39	3.82
2	33/11kV, 5/6.3 MVA (Pling) Sector II SS	5.00	4.25	3.58	4.35	4.98
3	33/11kV, 5/6.3 MVA Gurungdanra I SS (T1)	5.00	4.25	0.95	1.47	1.82
4	33/11kV, 5/6.3 MVA Gurungdanra I SS (T2)	5.00	Ideal charge			
	Total	**20.00**	**12.75**	**7.40**	**9.21**	**10.63**

Single out assessment of MV substations are carried as follows:

a) 33/11kV, 2x5/6.3MVA (Phuentsholing) Sector I Substation

The FWPL for Sector I (Phuentsholing) substation as on 2019 is 2.87MW and is expected to reach 3.39MW & 3.82MW by 2025 & 2030 respectively which would be adequate. Similarly, the Sector II (Phuentsholing) substation would be adequate enough to meet the increasing power requirement till 2030 as can be inferred from **Table 4.**

b) 33/11kV, 2x5/6.3MVA Gurungdangra Substation

The power supply for the customers of Lhamoizingkha and part of Gedu (Phuentsholing) are directly fed from 66/33kV, 8MVA Gedu substation. Therefore, the total FWPL of this feeder is being included in the HV power source assessment. The FWPL for Gurungdangra I substation as on 2019 is 0.95MW and is expected to reach 1.47MW & 1.82MW by 2025 & 2030 respectively. The installed capacity would be adequate to cater the forecasted power demand of Arekha, TRT, Power House, Rinchentse and Mirchingchu II till 2030. Further, the power can be also fed from 33/11kV, Gurungdangra II substation which is currently ideal.

7.2 Assessment of MV Feeders

Feeder wise planning is necessary to ensure that the power delivery capacity, power quality and reliability requirements of the customers are met. In distribution system, capacity assessment of existing MV feeders is important to ensure that feeders are adequate to transmit the peak demand of the load connected to the feeders. Particularly, the capacity assessment of the feeders enables identification of feeders that require reinforcement and reconfiguration works.

The behavior of the MV feeders are assessed based on the existing and forecasted load, feeder wise energy loss, reliability, and single to three-phase line conversions which are outlined vividly in **Section 7.2.1** through **Section 7.2.4**. Further, recognizing that the asset life of the distribution system is thirty years (30), our system should be able to handle the load growth (peak demand) for next 30 years. Therefore, it is equally important to consider the asset life of the system in addition to the assessment of the system in different time horizons.

7.2.1 Assessment of MV Feeder Capacity with Load

The feeder wise peak power consumption was compiled based on the historical data. The array of daily and monthly peak demand was sorted to obtain the annual peak demand. The feeder-wise historical peak demand recorded at the source is presented in **Table 5** and the corresponding feeder-wise annual load curve is presented in **Figures 4** and **5.**

Table 5: Feeder Wise Peak Power Demand (2015-2019)

Sl. No.	Feeder Name	Peak Load Consumption Pattern (MW)				
		2015	2016	2017	2018	2019
ESD, Phuentsholing						
1	11 kV Feeder B10 (New Polythyene)	0.47	0.52	0.53	1.09	1.02
2	11kV Feeder B20 (Karbraytar & Rametey)	0.86	0.84	0.85	0.89	0.90
3	11kV Feeder B30 (Tading)	0.92	0.96	1.12	1.09	1.24
4	11kV Feeder B40 (BPC Colony)	1.86	1.45	1.47	2.22	2.08
5	11kV Feeder B220 (Hospital)	0.14	0.18	0.12	0.15	0.14
6	11kV Feeder B230 (Helipad)	0.50	0.41	0.53	0.41	0.41
7	33kV Feeder B260 (Serina Bosokha)	1.06	1.29	0.80	0.98	1.28
8	11kV Feeder B280 (Water Booster)	2.66	3.20	3.03	3.96	3.58
9	11kV Feeder B270 (PWD)	3.21	1.91	2.56	3.03	2.87

Sl. No.	Feeder Name	Peak Load Consumption Pattern (MW)				
		2015	2016	2017	2018	2019
10	11kV Feeder B290 (Yarkay)	0.17	0.17	0.12	0.16	0.17
11	11kV Feeder B300 (Station)	0.01	0.02	0.02	0.02	0.02
12	11kV Feeder B80 (Rangaytrung)	0.45	0.40	0.50	0.29	0.28
13	11kV Feeder B90 (Gurungdangra)	0.18	0.03	0.02	0.09	0.09
14	11kV Feeder B50 (BCCL Colony)	1.25	1.11	1.03	1.38	1.41
15	11kV Feeder B390 (Lower Industrial Estate)	3.46	3.31	3.31	4.29	4.27
16	11kV Feeder B310 (Upper Industrial Estate)	4.12	3.28	4.40	4.52	3.51
17	11kV Feeder B400 (Druk Cement)	2.09	2.01	2.77	4.19	3.56
18	11kV Feeder B410 (Bhutan Steel)	2.91	2.94	2.89	2.98	2.88
19	11kV Feeder B420 (Malbase Colony)	0.92	0.91	0.87	1.11	1.11
20	11kV Feeder B460 (Burkey)	0.09	0.12	0.10	0.14	0.10
21	33kV Feeder B240 (Sector I)	3.21	1.91	2.56	3.03	2.87
22	33kV Feeder B250 (Sector II)	2.84	2.85	2.80	2.84	2.85
Total		**33.39**	**29.81**	**32.39**	**38.86**	**36.64**
ESSD, Gedu & Lhamoizingkha						
1	11 kV Feeder B100 (BBPL)	1.32	1.43	1.43	1.56	1.73
2	11kV Feeder B110 (Microwave)	0.00	0.02	0.01	0.01	0.02
3	11kV Feeder B120 (THPA II)	0.40	0.78	0.50	0.60	0.70
4	11kV Feeder B130 (Padechu/THPA I)	0.15	0.20	0.19	0.17	0.21
5	11kV Feeder B320 (Mirchingchu I)	0.05	0.08	0.09	0.08	0.09
6	11kV Feeder B330 (Geduchu)	0.01	0.01	0.03	0.05	0.09
7	33kV Feeder B160 & C30 (Gurungdangra II)	0.60	0.77	0.95	0.93	0.66
8	11kV Feeder B470 (Rinchentse)	0.20	0.21	0.30	0.20	0.46
9	11kV Feeder B480 (Mirchingchu II)	0.03	0.02	0.01	0.04	0.06
10	11kV Feeder B500 (Power House)	0.01	0.01	0.03	0.02	0.02
11	11kV Feeder B510 (TRT or BVC)	0.09	0.18	0.10	0.13	0.14
12	11kV Feeder B520 (Surgeshaft)	0.04	0.03	0.01	0.08	0.09
13	11kV Feeder B530 (Arekha/ Sinchekha)	0.21	0.30	0.20	0.32	0.44
14	33kV Feeder B140 (Gurungdangra I)	1.20	1.20	1.20	1.20	0.95
Total		**4.31**	**5.24**	**5.05**	**5.39**	**5.66**
ESSD, Tsimalakha						
1	11 kV Feeder B170 (BVC)	0.21	0.31	0.16	0.32	0.37
2	11kV Feeder B200 (Hongkha)	0.11	0.20	0.12	0.19	0.20
3	11kV Feeder B350 (Old Tsimalakha)	0.30	0.50	0.48	0.58	0.50

Sl. No.	Feeder Name	Peak Load Consumption Pattern (MW)				
		2015	2016	2017	2018	2019
4	11kV Feeder B360 (New Tsimalakha)					
5	11kV Feeder B440 (CHPC Colony)	0.29	0.49	0.30	0.47	0.55
6	11kV Feeder B450 (Dzong site)	0.21	0.30	0.26	0.22	0.29
7	33kV Feeder B180 (Shemagangkha)	0.13	0.13	0.15	0.13	0.18
8	33kV Feeder B190 (Chapcha)	0.12	0.22	0.17	0.20	0.21
Total		**1.37**	**2.14**	**1.64**	**2.10**	**2.30**
Overall Total		**39.07**	**37.19**	**39.08**	**46.35**	**44.59**

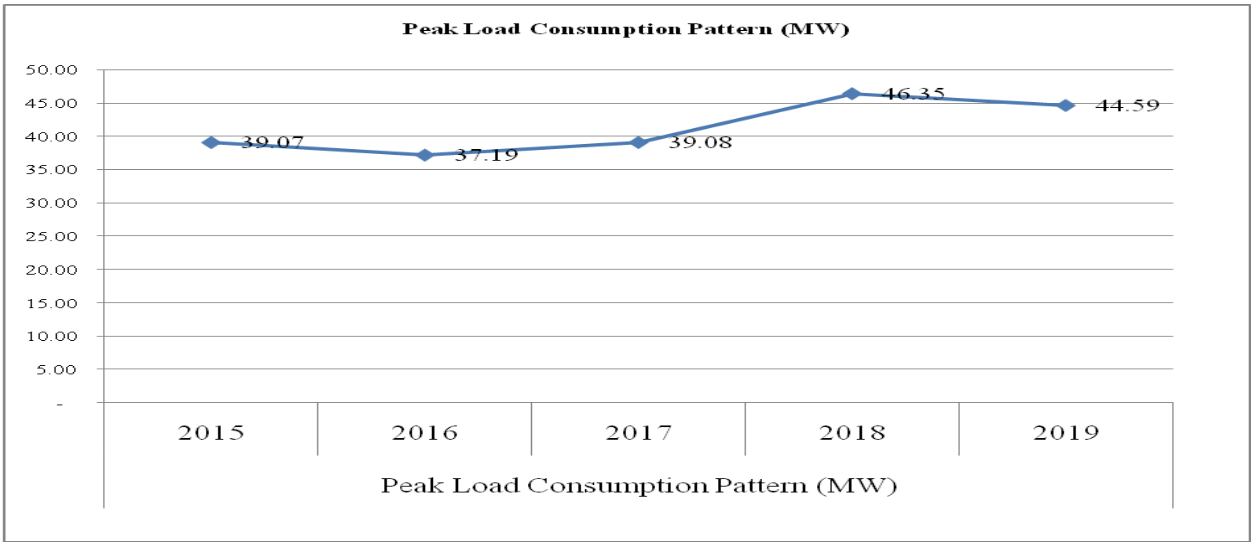
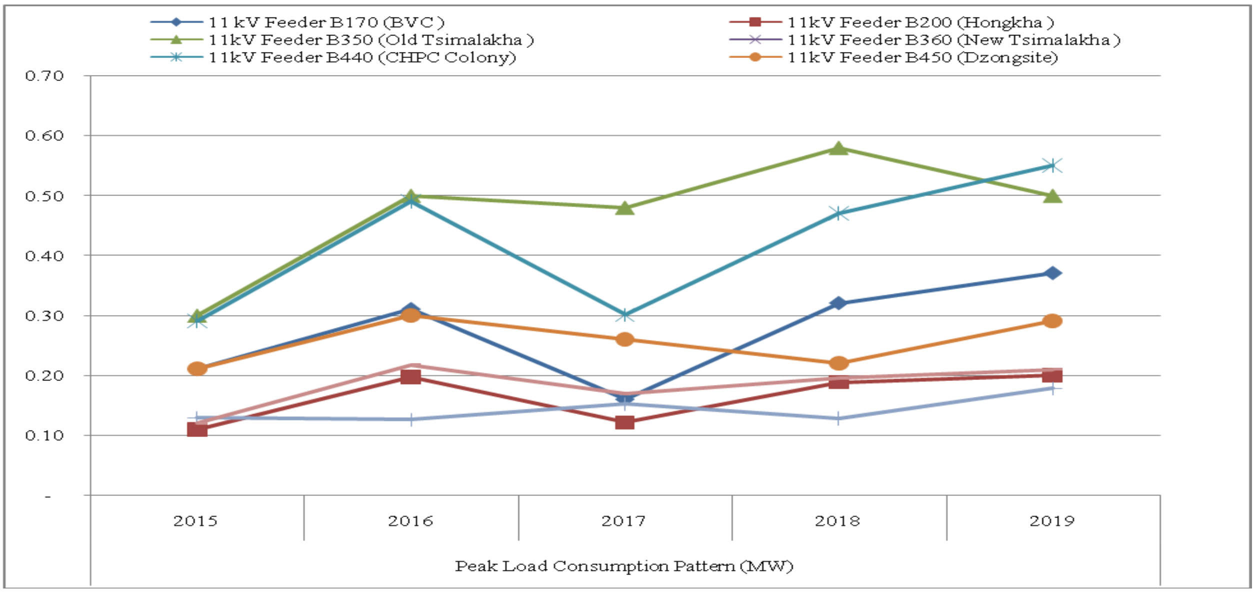
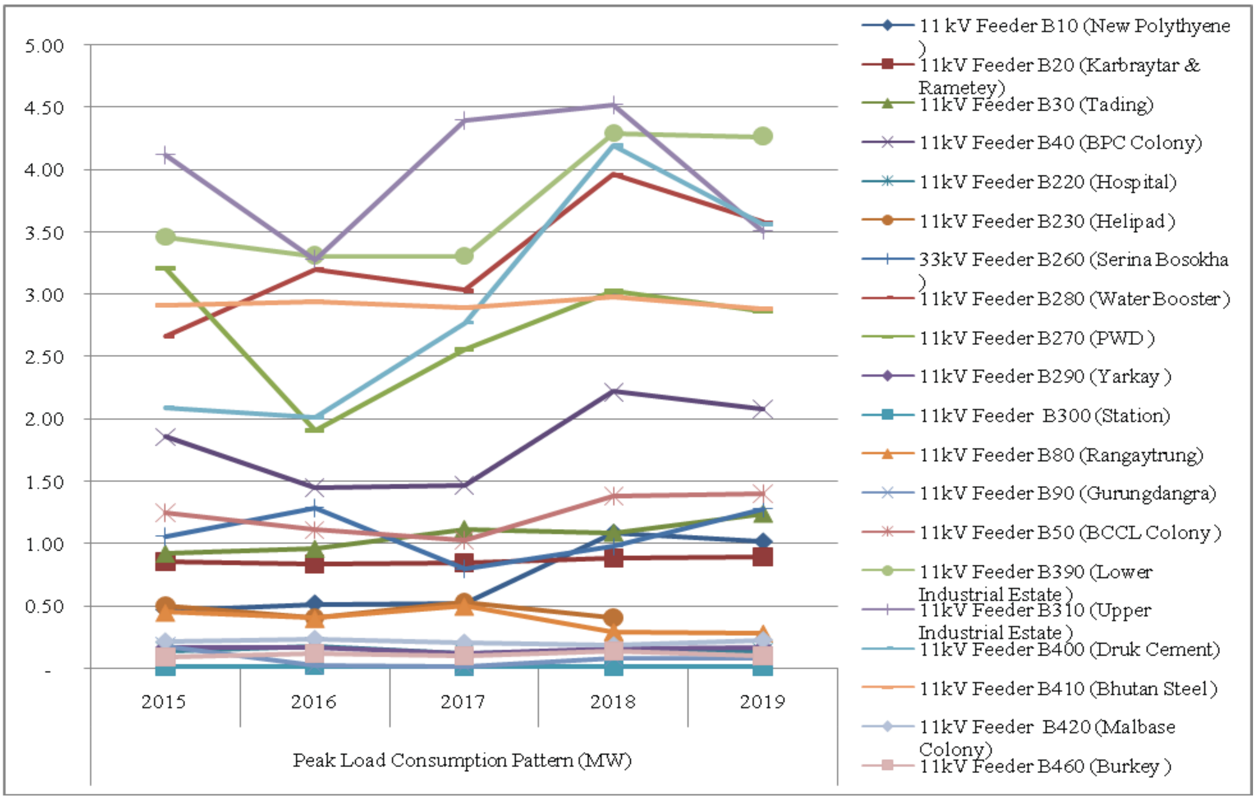


Figure 4: Overall Plot of Peak Power Demand of ESD, P/Ling & ESSD, Gedu & Tsimasham





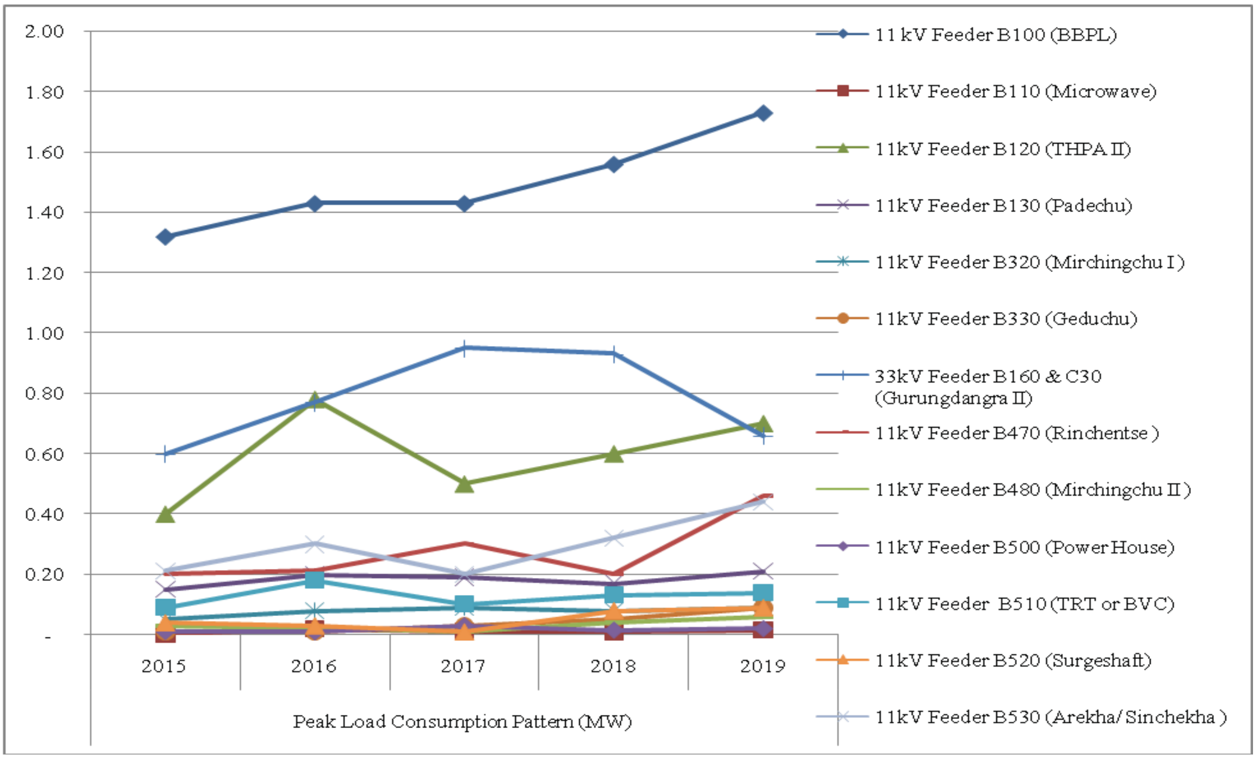


Figure 5: Plot of Feeder Wise Peak Power Demand of ESD, P/Ling & ESSD, Gedu & Tsimasham

As evident from **Table 5**, compared to 33kV system, Chukha has more 11kV system and accordingly the 11kV network is more loaded than 33kV system. The 33kV Gurungdangra feeder II which caters power supply to the customers of Lhamoizingkha and part of Gedu has the longest circuit length which is distributed as far as Lhamoizingkha of Dagana Dzongkhag. Apart from the LV customers, Chukha has also MV and HV customers and in fact Chukha has the highest HV & MV customers in the country.

The peak power demand for Chukha Dzongkhag has steadily increased from 39.07MW in 2015 to 44.59MW in 2019. As per the load forecast however, the peak power requirement in 2018 is 46.35MW which is higher than that of 2019. This is attributed due to reduction in power consumption by MV & HV industries.

The assessment of the feeder is carried out based on the following aspects:

a) System study: Existing load

b) System study based on forecasted load: 2025 & 2030 scenario

a) System Study (Existing Load)

Based on the peak load (2019-2020) and the thermal capacity of the line, the load flow and accordingly the assessment of the feeder was carried out. The simulation result shows no abnormality and the ampacity capability of the feeders will be within the range with the existing load. The thermal capacity of the different conductor sizes is as shown in **Table 6.**

Table 6: Thermal loading of ACSR conductor at different voltage levels.

Sl. No.	ACSR Conductor Type	Ampacity of Conductor	MVA rating corresponding to the Ampacity
33 kV Voltage Level			
1	RABBIT	193	11.031
2	DOG	300	17.146
3	WOLF	398	22.748
11 kV Voltage Level			
1	RABBIT	193	3.677

Sl. No.	ACSR Conductor Type	Ampacity of Conductor	MVA rating corresponding to the Ampacity
2	DOG	300	5.715
3	WOLF	398	7.582

Ampacity (thermal loading) of the lines have been calculated based on IS 398 (Part-II): 1996 for maximum conductor temperature 85°C for ACSR conductors considering an ambient temperature of 40°C.

The ampacity of all the feeders would be within the permissible range with the existing load however, the 11kV Water Booster feeder would exceed the thermal limit of the conductor as it is forecasted to reach 4.27MW 2030. Due to shorter circuit line length (5.17km only), voltage profile is expected to be within the permissible range and therefore, would pose no technical glitches. However, degree of the feeder loading has to be closely monitored as the accuracy of the forecasted load would deviate more in the distant future.

b) System Study with Forecasted Load (2025 and 2030)

The peak power demand from 2014-2019 has been considered to forecast the peak power demand for the next 10 years (2020-2030) as shown in **Table 7** and **Figures 6, 7** and **8** adopting the commonly practiced methodology of LRM and TSA with the help of ETAP. The detailed load simulation result is attached as **Annexure-4.**

Table 7: Feeder Peak Power Demand Forecast

Sl. No.	Feeder name	Circuit Length (km)	Total Transformer	Connected (kVA)	Total Forecasted Load Growth (MW)		
					2019	2025	2030
	ESD, Phuentsholing						
1	11 kV Feeder B10 (New Polythyene)	1.06	9.00	4,933.00	1.02	1.09	1.32
2	11Kv Feeder B20 (Karbraytar & Rametey)	21.22	21.00	4,348.00	0.90	1.13	1.22
3	11Kv Feeder B30 (Tading)	86.16	91.00	6,475.00	1.24	1.57	1.83

Sl. No.	Feeder name	Circuit Length (km)	Total Transformer	Connected (kVA)	Total Forecasted Load Growth (MW)		
					2019	2025	2030
4	11Kv Feeder B40 (BPC Colony)	1.50	12.00	5,110.00	2.08	2.56	2.96
5	11Kv Feeder B220 (Hospital)	0.14	1.00	750.00	0.14	0.14	0.14
6	11Kv Feeder B230 (Helipad)	1.84	2.00	1,500.00	0.41	0.53	0.63
7	33Kv Feeder B260 (Serina Bosokha)	110.65	94.00	2,952.00	1.28	1.46	1.51
8	11Kv Feeder B280 (Water Booster)	5.17	18.00	9,475.00	3.58	4.35	4.98
9	11Kv Feeder B270 (PWD)	6.36	17.00	8,938.00	2.87	3.39	3.82
1	11Kv Feeder B290 (Yarkay)	0.43	1.00	315.00	0.17	0.21	0.24
11	11Kv Feeder B300 (Station)	0.03	1.00	63.00	0.02	0.02	0.02
12	11Kv Feeder B80 (Rangaytrung)	17.11	15.00	819.00	0.28	0.48	0.50
13	11Kv Feeder B90 (Gurungdangra)	1.36	3.00	251.00	0.09	0.13	0.14
14	11Kv Feeder B50 (BCCL Colony)	3.79	10.00	5,221.00	1.41	1.54	1.65
15	11Kv Feeder B390 (Lower Industrial Estate)	4.49	17.00	11,686.00	4.27	4.51	4.79
16	11Kv Feeder B310 (Upper Industrial Estate)	2.78	5.00	6,025.00	3.51	4.45	4.52
17	11Kv Feeder B400 (Druk Cement)	14.25	28.00	14,005.00	3.56	3.82	4.29
18	11Kv Feeder B410 (Bhutan Steel)	2.42	2.00	3,750.00	2.88	3.02	3.04
19	11Kv Feeder B420 (Malbase Colony)	0.46	1.00	630.00	1.11	1.45	1.74
20	11Kv Feeder B460 (Burkey)	2.77	3.00	189.00	0.10	0.12	0.13
21	33Kv Feeder B240 (Sector I)	0.71	1.00	5,000.00	2.87	3.39	3.82
22	33Kv Feeder B250 (Sector II)	0.73	1.00	5,000.00	2.85	3.93	3.97
Total		**283.97**	**351.00**	**87,435.00**	**36.64**	**43.27**	**47.28**
ESSD, Gedu & Lhamoizingkha							
1	11 kV Feeder B100 (BBPL)	12.54	10.00	4,102.00	1.73	2.26	2.73
2	11Kv Feeder B110 (Microwave)	11.74	1.00	25.00	0.02	0.03	0.04
3	11Kv Feeder B120 (THPA II)	2.96	9.00	7,150.00	0.70	1.00	1.24
4	11Kv Feeder B130 (Padechu)	21.48	10.00	600.00	0.21	0.26	0.30
5	11Kv Feeder B320 (Mirchingchu	7.72	2.00	275.00	0.09	0.14	0.18

Sl. No.	Feeder name	Circuit Length (km)	Total Transformer	Connected (kVA)	Total Forecasted Load Growth (MW)		
					2019	2025	2030
	I)						
6	11Kv Feeder B330 (Geduchu)	10.30	6.00	1,084.00	0.09	0.20	0.30
7	33Kv Feeder B160 & C30 (Gurungdangra II)	208.83	102.00	4,524.00	0.66	1.01	1.15
8	11Kv Feeder B470 (Rinchentse)	3.71	6.00	4,335.00	0.46	0.68	0.94
9	11Kv Feeder B480 (Mirchingchu II)	4.94	3.00	478.00	0.06	0.10	0.14
10	11Kv Feeder B500 (Power House)	2.48	1.00	100.00	0.02	0.04	0.05
11	11Kv Feeder B510 (TRT or BVC)	7.36	6.00	750.00	0.14	0.17	0.19
12	11Kv Feeder B520 (Surgeshaft)	4.38	5.00	2,100.00	0.09	0.17	0.25
13	11Kv Feeder B530 (Arekha/ Sinchekha)	3.26	5.00	3,510.00	0.44	0.68	0.92
14	33Kv Feeder B140 (Gurungdangra I)	10.38	2.00	10,000.00	0.95	1.47	1.82
Total		**312.08**	**168.00**	**39,033.00**	**5.66**	**8.19**	**10.24**
ESSD, Tsimasham							
1	11 kV Feeder B170 (BVC)	10.35	5.00	1,001.00	0.37	0.54	0.70
2	11kV Feeder B200 (Hongkha)	1.89	3.00	850.00	0.20	0.30	0.39
3	11kV Feeder B350 (Old Tsimalakha)	27.16	13.00	1,804.00	0.50	0.86	1.10
4	11kV Feeder B360 (New Tsimalakha)	8.28	6.00	2,258.00			
5	11kV Feeder B440 (CHPC Colony)	3.29	5.00	1,813.00	0.55	0.82	1.07
6	11kV Feeder B450 (Dzong site)	0.13	2.00	500.00	0.29	0.30	0.34
7	33kV Feeder B180 (Shemagangkha)	13.02	11.00	517.00	0.18	0.22	0.27
8	33kV Feeder B190 (Chapcha)	10.77	8.00	889.00	0.21	0.31	0.39
Total		**74.88**	**53.00**	**9,632.00**	**2.30**	**3.34**	**4.26**
Overall Total		**670.93**	**572.00**	**136,100.00**	**44.59**	**54.81**	**61.77**

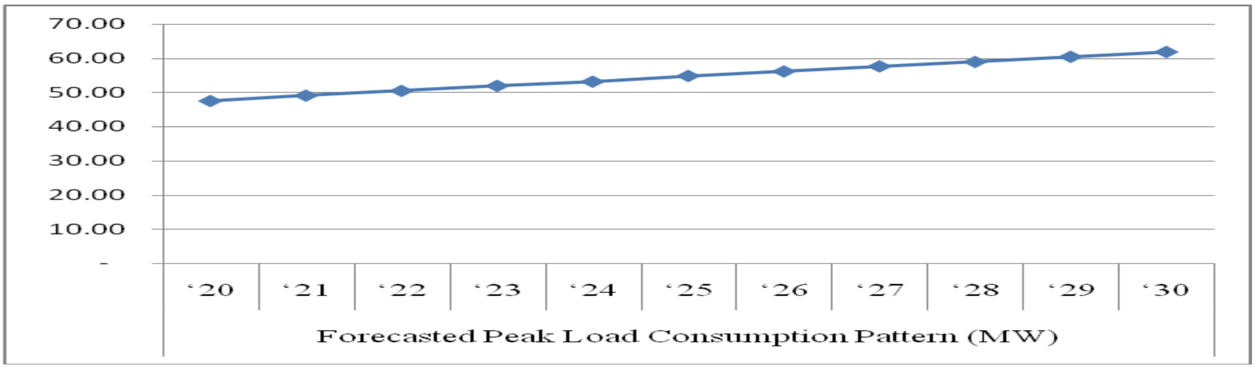


Figure 6:Overall Plot of Forecasted Peak Power Demand of ESD, Phuentsholing (Including ESSDs)

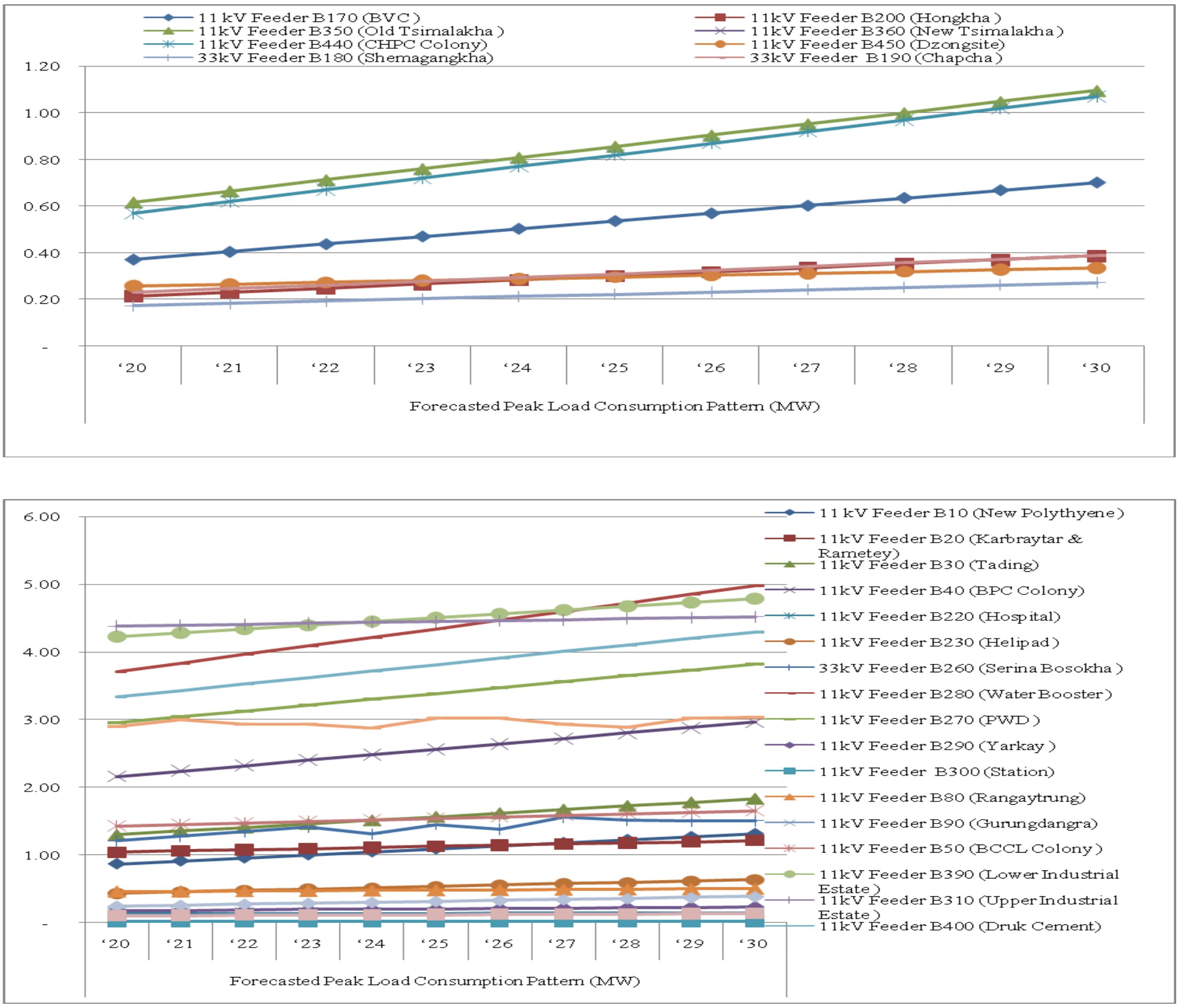


Figure 7: *Plot of Forecasted Peak Power Demand of ESD, Phuentsholing*

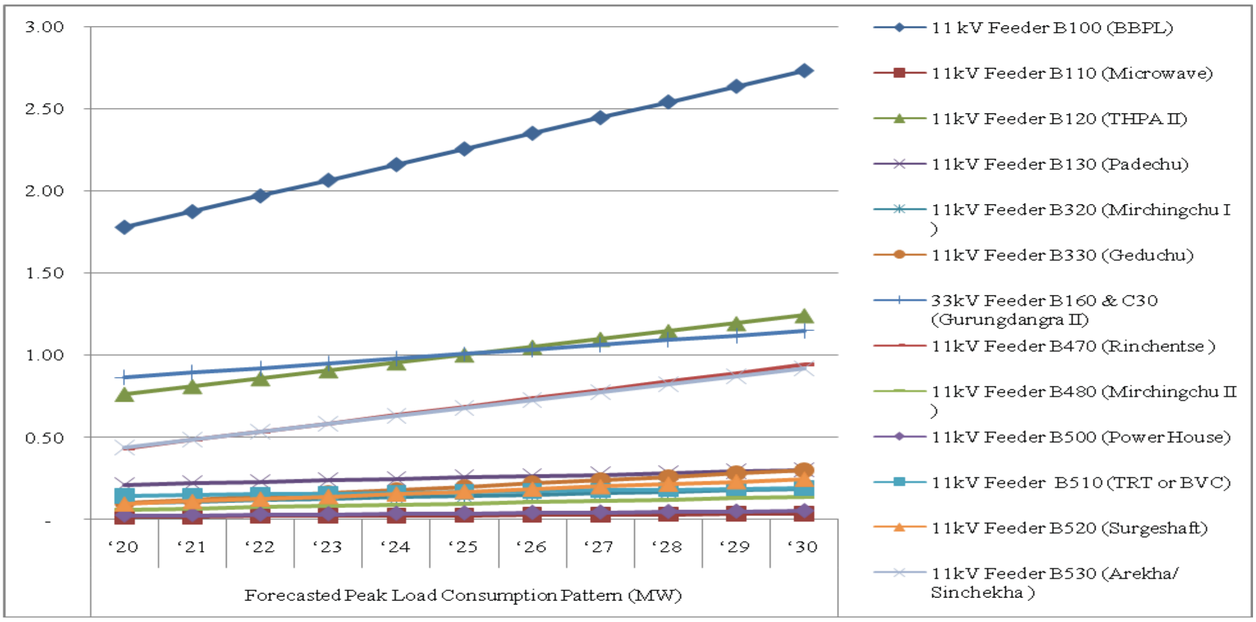


Figure 8: Plot of Forecasted Peak Power Demand of ESSD, Gedu & Lhamoizingkhag.

From the above table, it is observed that the highest 33kV feeder peak load as on 2019 is 2.87MW for Sector I Feeder which is expected to grow up to 3.39MW & 3.82MW by 2025 and 2030 respectively followed by 33kV Sector II feeder. In fact, it is forecasted that Sector II feeder would surpass Sector I peak power requirement by 2030. Nonetheless, both the feeders can re-distribute the load as and when necessary as they can be operated in parallel mode. Similarly, the highest 11kV feeder peak load is 3.58MW as on 2019 experienced by Water Booster Feeder and is forecasted to reach 4.35MW &4.98MW by 2025 and 2030 respectively. Therefore, it is conclusive that the existing MV lines would be adequate to evacuate the power to the customers till 2030 without having to do any augmentation works (size of the conductors) as the load carrying capacity of the feeder is within the conductor capacity.

Although it is conclusive that the existing MV lines are adequate to evacuate the power if assessed independently, the voltage profile would go below the standard accepted range of (±) 10% should the existing network supply the forecasted load as tabulated in **Table 8**. The load carrying capacity of a feeder is determined by the line length and degree of load connected in addition to other parameters (e.g., ampacity).

Table 8: Feeders with Poor Voltage Profile (2019, 2025 and 2030)

Sl. No.	Name of Feeder	Conductor	Total Circuit Length (km)	End Voltage (kV)	% Variation	Load (MW)		
						2019	2025	2030
A	**2019**							
1	11kV Tading Feeder(B30)	R/UG	86.16	9.79	11%	1.24	1.57	1.83
2	11kV BBPL Feeder (B100)	D/UG	12.54	9.78	11%	1.72	2.26	2.73
B	**2025**							
1	11kV Tading Feeder(B30)	R/UG/HV ABC	87.57	9.43	14%	1.24	1.57	1.83
2	11kV BBPL Feeder (B100)	D/UG/HV-ABC	12.54	9.39	15%	1.72	2.26	2.73
C	**2030**							
1	11kV Tading Feeder(B30)	R/UG	89.07	9.3	15%	1.24	1.57	1.83
2	11kV BBPL Feeder (B100)	D/UG/HV ABC	13.848	9.01	18%	1.72	2.26	2.73

The 11kV feeders which are reflected in the table above would violate the voltage profile with the current loading (as of 2019) and the forecasted load for 2025 & 2030 which are detailed as follows:

a) 11kV Tading Feeder

The Tading feeder has 86.16km constructed on Rabbit and UG conductors. Most of the loads connected to this feeder are rural customer and therefore, the connected loads are static/impedance load (90%) in nature. the voltage profile at the end of the feeder is 11% with the existing load and would decrease with the increased forecasted load. Simulation result shows that it will be 14% & 15% with the 2025 & 2030 forecasted load. As the load considered for carrying out the technical evaluation is based on the peak load, the actual voltage profile would be within the permissible range for the existing load. However, the incremental tap of the PT has to be utilized to improve the voltage regulation for 2025 forecasted load. However, to maintain the voltage regulation within the range with 2030 forecasted load and to improve the reliability, the power supply has to be arranged from Samtse. To address this issue, 1.5km on Rabbit is proposed to be constructed to interconnect the two feeders (construct from Samtse's Feeder) and the voltage profile would be improved to 9.34% from 15%.

b) 11kV BBPL Feeder

The BBPL Feeder has 13.85km constructed on mixed of conductors (Dog/UG/HV ABC). Most of the loads connected to this feeder are rural customer and therefore, the connected loads are static/impedance load (90%) in nature. the voltage profile at the end of the feeder is 11% with the existing load and would decrease with the increased forecasted load. Simulation result shows that it will be 15% & 18% with the 2025 & 2030 forecasted load respectively. As the load considered for carrying out the technical evaluation is based on the peak load, the actual voltage profile would be within the permissible range for the existing load. However, the incremental tap of the PT has to be utilized to improve the voltage regulation for 2025 forecasted load. However, to maintain the voltage regulation within the range with 2030 forecasted load and to improve the reliability, the power supply has to be arranged from Gurungdangra II feeder and with this arrangement it is expected to improve the voltage regulation from 18% to 7%.

Knowing the degree of significance of quality of power (voltage profile), it is inevitable that voltage regulation be maintained within the permissible range which is required as per the distribution code and the requirement of the end user appliances. Therefore, the feeders whose voltage regulation aren't within the permissible range due to existing or forecasted load would be improved by implementing the corrective measures identified in the foregoing sections. The improvement of voltage profiles after implementing the corrective measures is as detailed in table **Table 9**.

Table 9: Feeder Wise Voltage Improvement

Sl. No.	Name of Feeder	Before		After		Remarks
		Voltage (kV)	% Variation	Voltage (kV)	% Variation	
A	**2019**					
1	11kV Tading Feeder(B30)	9.79	11%	10.34	5.96%	Tap of the PT utilized
2	11kV BBPL Feeder (B100)	9.78	11%	10.32	6.09%	

Sl. No.	Name of Feeder	Before		After		Remarks
		Voltage (kV)	% Variation	Voltage (kV)	% Variation	
B	**2025**					
1	11kV Tading Feeder(B30)	9.43	14%	10.10	9.27%	Tap of the PT utilized
2	11kV BBPL Feeder (B100)	9.39	15%	10.00	9.59%	
C	**2030**					
1	11kV Tading Feeder(B30)	9.3	15%	10.60	9.34%	Re-configuring the source (From Samtse)
2	11kV BBPL Feeder (B100)	9.01	18%	10.24	6.88%	Re-configuring the source (From Gurungdangra)

It is also important for BPC to explore the best fit technology (e.g. installing AVR/voltage boosters) to improve the voltage profile rather than proposing to up-grade the entire conductor size which would be inconvenient to implement as it will involve frequent power interruptions.

7.2.1 Energy Loss Assessment of MV Feeders

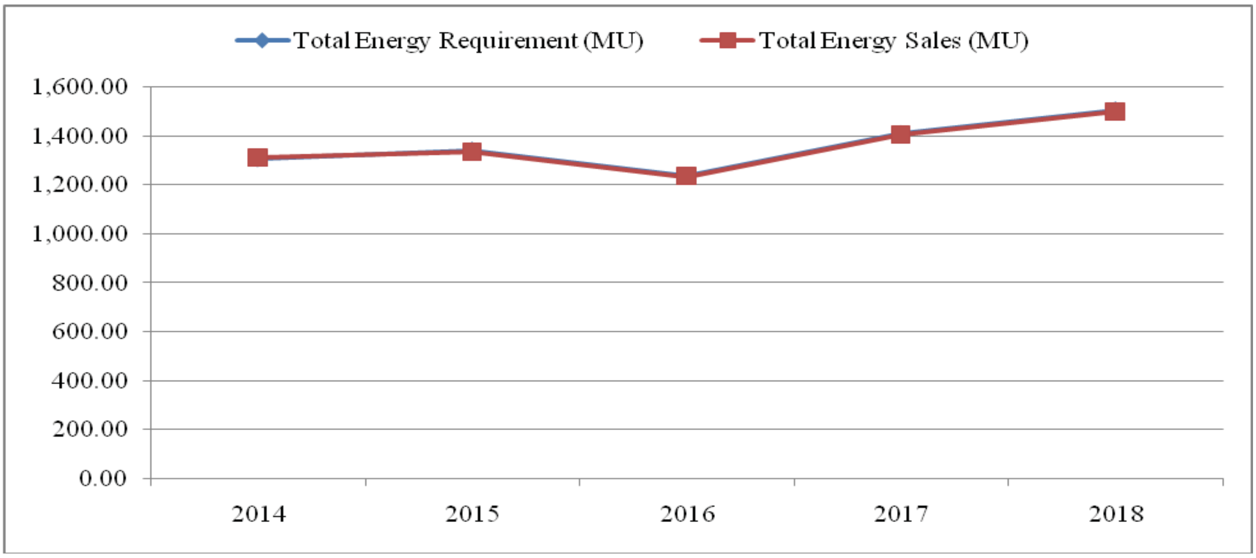
Energy losses in the distribution network are inherent as the power transmission and distribution system are associated with the transformers and lines. However, it is crucial to maintain the energy loss at an optimal level by engaging in timely improvement of the distribution infrastructures and not reacting to the localized system deficiencies. The objective of the energy loss assessment is to single out the feeder (s) with maximum loss (es) and put in additional corrective measures to minimize to the acceptable range.

To carry out the assessment, the energy sales, purchase and loss is as tabulated in **Table 10** and as shown in **Figure 9.**

Table 10: Summary of Total Energy Loss (MU)

Sl.No.	Energy	2014	2015	2016	2017	2018	Average
1	Total Energy Requirement (MU)	1,309.38	1,341.48	1,236.39	1,408.94	1,505.47	**1,360.33**
2	Total Energy Sales (MU)	1,311.75	1,335.01	1,234.38	1,404.69	1,500.25	**1,357.22**
	Total energy loss (MU)	**-2.37**	**6.46**	**2.02**	**4.25**	**5.22**	**3.12**

Sl.No.	Energy	2014	2015	2016	2017	2018	Average
	Total Loss (%)	-0.18%	0.48%	0.16%	0.30%	0.35%	0.22%



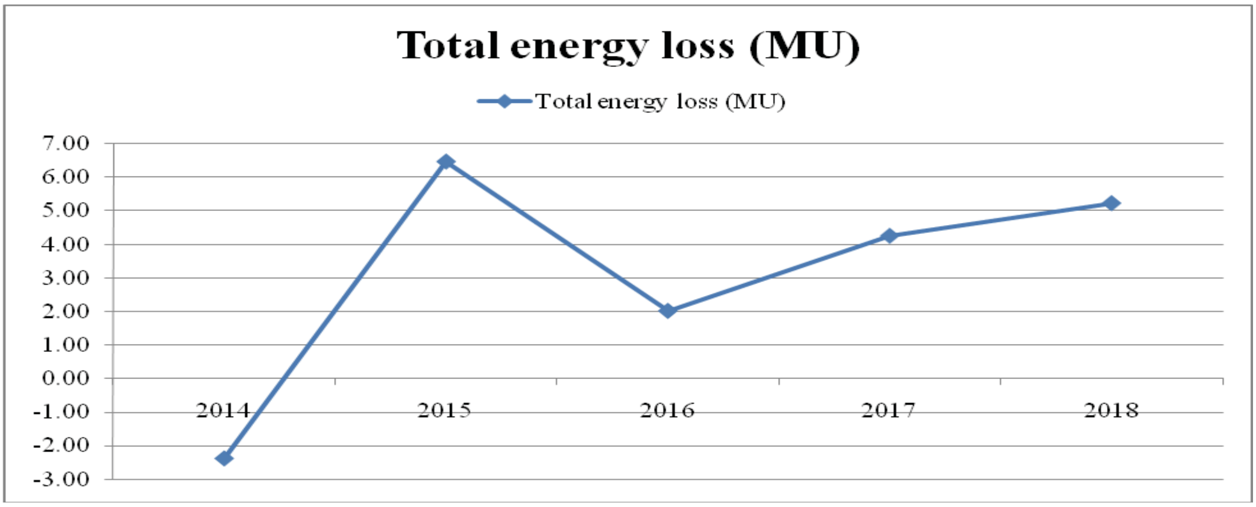


Figure 9: Plot of Total Energy Loss (MU) of ESD, Phuentsholing

Generally, the system loss (MV & LV) is 8.9% and any loss more than this for the distribution network would require in-depth study. An independent study carried out by 19 ESDs for 38 feeders in 2017 (two feeders each in ESD with more loss) showed that average of 6.84% is due to technical loss. The study also showed that loss pattern was never consistent because of variant characteristics of distribution network and loading pattern.

The average energy loss of the entire feeder is 0.22% (3.12 million units on average) from 2014 to 2018. Due to presence of high proportion of HV & MV customers, the average loss is very less compared to the losses of other Dzongkhags. The fluctuating energy loss trend which cannot be able explicitly ascertain may be due to mass rural homes connected to grid through rural electrical projects and anomalous in energy accounting (especially for negative energy loss).

As the feeder wise energy details were not available, the energy loss was redistributed to the feeders based on number of customers connected and circuit line length and accordingly the feeder wise energy loss was worked as shown in **Table 11.** It was computed to single out the problematic feeder with high losses for any remedial and corrective measures that can be arranged to minimize the loss in the future.

Table 11: Feeder Wise Energy Loss (in MU) of ESD, Chukha

Sl. No.	Name of Feeder	Total customer	Circuit Length (km)	2014	2015	2016	2017	2018	Average	%Loss
	ESD, Phuentsholing									
1	11 kV Feeder B10 (New Polythyene)	284	1.06	(0.02)	0.05	0.01	0.03	0.04	0.02	0.00%
2	11kV Feeder B20 (Karbraytar & Rametey)	1,181	21.22	(0.10)	0.28	0.09	0.18	0.23	0.13	0.01%
3	11kV Feeder B30 (Tading)	1,034	86.16	(0.21)	0.57	0.18	0.37	0.46	0.27	0.02%
4	11kV Feeder B40 (BPC Colony)	544	1.50	(0.03)	0.09	0.03	0.06	0.07	0.04	0.00%
5	11kV Feeder B220 (Hospital)	23	0.14	(0.00)	0.00	0.00	0.00	0.00	0.00	0.00%
6	11kV Feeder B230 (Helipad)	268	1.84	(0.02)	0.05	0.02	0.03	0.04	0.02	0.00%
7	33kV Feeder B240 (Sector I)		0.71	(0.00)	0.00	0.00	0.00	0.00	0.00	0.00%
8	33kV Feeder B250 (Sector II)		0.73	(0.00)	0.00	0.00	0.00	0.00	0.00	0.00%
9	33kV Feeder B260 (Serina Bosokha)	1,822	110.65	(0.30)	0.80	0.25	0.53	0.65	0.39	0.03%
10	11kV Feeder B280 (Water Booster)	1,650	5.17	(0.10)	0.27	0.08	0.18	0.22	0.13	0.01%
11	11kV Feeder B270 (PWD)	1,824	6.36	(0.11)	0.30	0.09	0.20	0.25	0.15	0.01%

Sl. No.	Name of Feeder	Total customer	Circuit Length (km)	2014	2015	2016	2017	2018	Average	%Loss
12	11kV Feeder B290 (Yarkay)	10	0.43	(0.00)	0.00	0.00	0.00	0.00	0.00	0.00%
13	11kV Feeder B300 (Station)	1	0.03	(0.00)	0.00	0.00	0.00	0.00	0.00	0.00%
14	11kV Feeder B80 (Rangaytrung)	939	17.11	(0.08)	0.22	0.07	0.15	0.18	0.11	0.01%
15	11kV Feeder B90 (Gurungdangra)	378	1.36	(0.02)	0.06	0.02	0.04	0.05	0.03	0.00%
16	11kV Feeder B50 (BCCL Colony)	566	3.79	(0.04)	0.10	0.03	0.07	0.08	0.05	0.00%
17	11kV Feeder B390 (Lower Industrial Estate)	29	4.49	(0.01)	0.03	0.01	0.02	0.02	0.01	0.00%
18	11kV Feeder B310 (Upper Industrial Estate)	10	2.78	(0.01)	0.01	0.00	0.01	0.01	0.01	0.00%
19	11kV Feeder B400 (Druk Cement)	800	14.25	(0.07)	0.19	0.06	0.12	0.15	0.09	0.01%
20	11kV Feeder B410 (Bhutan Steel)	1	2.42	(0.00)	0.01	0.00	0.01	0.01	0.01	0.00%
21	11kV Feeder B420 (Malbase Colony)	31	0.46	(0.00)	0.01	0.00	0.00	0.01	0.00	0.00%
22	11kV Feeder B460 (Burkey)	152	2.77	(0.01)	0.04	0.01	0.02	0.03	0.02	0.00%
ESSD, Gedu & Lhamoizingkha										
1	11 kV Feeder B100 (BBPL)	465	12.54	(0.05)	0.13	0.04	0.09	0.11	0.06	0.00%
2	11kV Feeder B110 (Microwave)	1	11.74	(0.02)	0.06	0.02	0.04	0.05	0.03	0.00%
3	11kV Feeder B120 (THPA II)	458	2.96	(0.03)	0.08	0.03	0.05	0.07	0.04	0.00%
4	11kV Feeder B130 (Padechu)	380	21.48	(0.06)	0.16	0.05	0.11	0.13	0.08	0.01%
5	11kV Feeder B320 (Mirchingchu I)	689	7.72	(0.05)	0.14	0.04	0.09	0.11	0.07	0.00%
6	11kV Feeder B330 (Geduchu)	84	10.30	(0.02)	0.06	0.02	0.04	0.05	0.03	0.00%
7	33kV Feeder B160 & C30 (Gurungdangra II)	2,602	208.83	(0.51)	1.39	0.44	0.92	1.13	0.67	0.05%
8	33kV Feeder B140		10.38	(0.02)	0.05	0.02	0.03	0.04	0.02	0.00%

Sl. No.	Name of Feeder	Total customer	Circuit Length (km)	2014	2015	2016	2017	2018	Average	%Loss
	(Gurungdangra I)									
9	11kV Feeder B470 (Rinchentse)	1,890	3.71	(0.11)	0.30	0.09	0.20	0.24	0.15	0.01%
10	11kV Feeder B480 (Mirchingchu II)	175	4.94	(0.02)	0.05	0.02	0.03	0.04	0.02	0.00%
11	11kV Feeder B500 (Power House)	1	2.48	(0.00)	0.01	0.00	0.01	0.01	0.01	0.00%
12	11kV Feeder B510 (TRT or BVC)	1	7.36	(0.01)	0.04	0.01	0.02	0.03	0.02	0.00%
13	11kV Feeder B520 (Surgeshaft)	1	4.38	(0.01)	0.02	0.01	0.01	0.02	0.01	0.00%
14	11kV Feeder B530 (Arekha/ Sinchekha)	657	3.26	(0.04)	0.11	0.04	0.08	0.09	0.06	0.00%
ESSD, Tsimalakha										
1	11 kV Feeder B170 (BVC)	153	10.35	(0.03)	0.07	0.02	0.05	0.06	0.04	0.00%
2	11kV Feeder B200 (Hongkha)	313	1.89	(0.02)	0.06	0.02	0.04	0.05	0.03	0.00%
3	11kV Feeder B350 (Old Tsimalakha)	1,174	27.16	(0.11)	0.31	0.10	0.20	0.25	0.15	0.01%
4	11kV Feeder B360 (New Tsimalakha)		8.28	(0.01)	0.04	0.01	0.03	0.03	0.02	0.00%
5	11kV Feeder B440 (CHPC Colony)	439	3.29	(0.03)	0.08	0.03	0.05	0.07	0.04	0.00%
6	11kV Feeder B450 ()	46	0.13	(0.00)	0.01	0.00	0.00	0.01	0.00	0.00%
7	33kV Feeder B180 (Shemagangkha)	233	13.02	(0.04)	0.10	0.03	0.06	0.08	0.05	0.00%
8	33kV Feeder B190 (Chapcha)	259	10.77	(0.03)	0.09	0.03	0.06	0.07	0.04	0.00%
	Overall Total	**21,568**	**672**	**-2.37**	**6.46**	**2.02**	**4.25**	**5.22**	**3.12**	**0.22%**

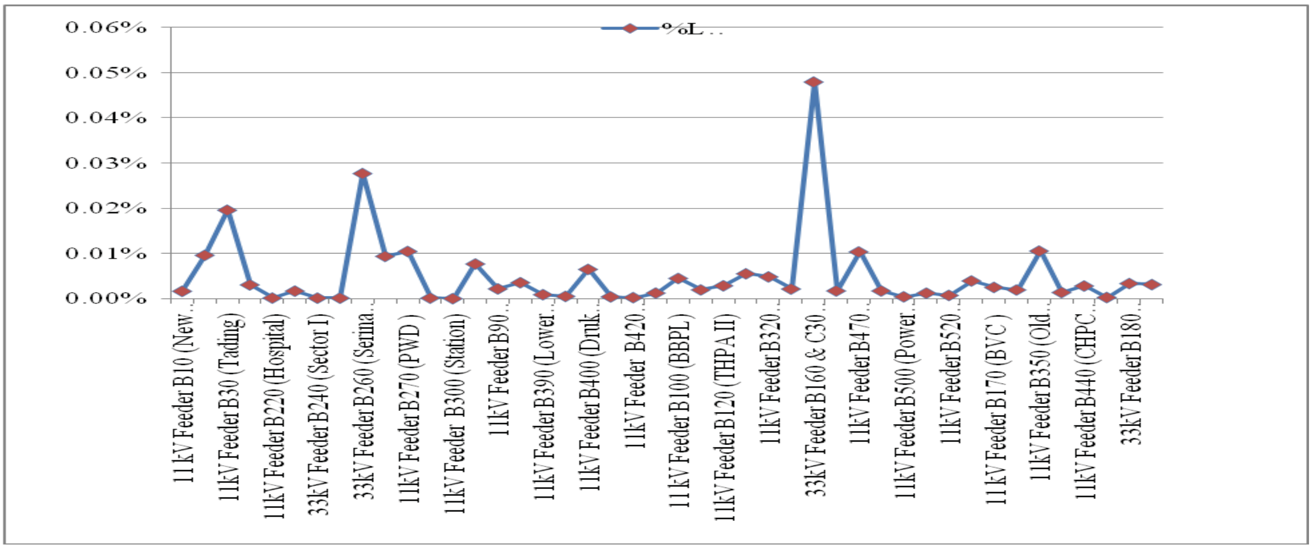


Figure 10: Feeder Wise Energy Losses (MU) of ESD, Phuentsholing

The feeder wise energy loss as tabulated in **Table 11 and Figure 10** indicates that 33kV Gurungdangra II (for Gedu and Lhamoizingkha customers) and 11kV Serina Bosokha feeders had contributed the major portion of the energy loss of ESD, Phuentsholing. These feeders have high proportion of circuit length and customers compared to other feeders.

7.2.2 Reliability Assessment of the MV Feeders

Today's emphasis in the power sector has shifted to providing reliable power supply as electricity itself is positioned as one of the essential needs. However, improving reliability comes with its inherent costs as it involves embracing additional preventive and corrective measures leading to substantial up-front capital investment. Any major reliability improvement strategies need to be adopted only after carefully understanding the costs involved and the benefits that will be accrued from implementing such strategies. Failure rate, repair time and restoration time are some important parameters defining reliability. Reducing the values of one or more of the above parameters can improve reliability considerably.

In addition to ensuring that the MV feeders have the required capacity, it is also very important to ensure that the MV feeders are reliable. In order to assess the reliability of the distribution system, the historical data was referred. The yearly (2017-2019) feeder reliability indices summary is compiled as tabulated in **Table 12** and details used to derive such summary is attached as **Annexure-5**. The interruptions with less than five minutes were omitted from the computation. The actual records (both within and beyond ESDs control) were considered for actual representation to compute the reliability indices. The average reliability indices viz a viz. SAIFI & SAIDI compiled for 2017-2018 are 100.75 & 160.46 respectively which is exceptionally high.

Table 12: Feeder Wise Reliability Indices

Sl.No.	Name of Feeder	2017		2018		Overall Total	
		SAIFI	SAIDI	SAIFI	SAIDI	SAIFI	SAIDI
1	11 KV THPA-Polythene feeder-B010	0.12	0.10	0.43	1.11	**0.28**	**0.61**
2	11 KV Karbarey-Ramety Feeder-B020	5.47	4.35	10.17	14.13	**7.82**	**9.24**
3	11 KV Tading Rural Feeder-B030	4.01	4.49	14.93	22.02	**9.47**	**13.25**
4	11 KV Pepsi BPC Colony Feeder-B40	0.28	0.34	1.60	1.86	**0.94**	**1.10**
5	11 KV New Hospital Feeder-B220	0.00	0.01	0.02	0.00	**0.01**	**0.00**
6	11 KV Helipad linked feeder-B230	0.57	4.97	1.34	0.84	**0.96**	**2.91**
7	33 kV Druk Iron & Steel feeder-B150	0.00	0.02	-	-	**0.00**	**0.01**
8	33 kV Sector II-B240	3.48	0.53	6.02	6.13	**4.75**	**3.33**
9	33 kV Sector II-B250	7.25	0.42	13.74	9.33	**10.49**	**4.88**
10	33 kV Serina Bosokha-B260	17.27	23.69	22.70	53.74	**19.99**	**38.72**
11	11 kV Gurungdara rural -B80	0.49	1.41	0.47	0.70	**0.48**	**1.06**
12	11 kV TCBL Fdr-B50	0.02	0.04	0.01	0.03	**0.02**	**0.04**
13	11 kV Industrial area upper terrace-B310	0.00	0.01	0.00	0.01	**0.00**	**0.01**
14	11 kV Industrial area lower terrace-B390	0.02	0.10	0.01	0.04	**0.02**	**0.07**
15	11 kV Druk Cement Fdr-B400	0.55	0.73	0.92	2.01	**0.73**	**1.37**
16	11 kV Bhutan Steel Fdr	0.00	0.01	0.00	0.00	**0.00**	**0.01**
17	11 kV Malbase Colony Fdr	0.01	0.01	0.03	0.07	**0.02**	**0.04**
18	11 kV Malbase Burkey Fdr-B460	0.01	0.01	0.05	0.15	**0.03**	**0.08**
19	33kV Gurungdara I-B140	0.00	0.00	0.00	0.00	**0.00**	**0.00**
20	33kV Gurungdara II-B160&C30	22.43	25.71	20.87	47.15	**21.65**	**36.43**
21	33kV Mirchingchu-B320	0.92	0.80	0.70	0.83	**0.81**	**0.81**
22	11kV BBPL Fdr-B100	4.36	3.31	3.39	3.99	**3.87**	**3.65**
23	11kV M/Wave Fdr-B110	0.77	26.60	0.75	6.19	**0.76**	**16.40**
24	11kV THPA-1 Fdr-B120	0.61	1.23	0.80	0.88	**0.71**	**1.06**

Sl.No.	Name of Feeder	2017		2018		Overall Total	
		SAIFI	SAIDI	SAIFI	SAIDI	SAIFI	SAIDI
25	11kV Geduchu Fdr-B330	0.00	0.00	0.78	1.30	**0.39**	**0.65**
26	11kV Padechu Fdr-B130						
27	11kv Old & new Tsimalakha -B350	7.58	7.74	13.41	8.69	**10.50**	**8.21**
28	11kv THPA I- B370	-	-	-	-	**-**	**-**
29	11KV BVC Fdr-B170	0.44	0.01	0.68	3.18	**0.56**	**1.60**
30	11kV THPA II-B380	-	-	-	-	**-**	**-**
31	11kV THPA III-B200	0.06	0.00	-	-	**0.03**	**0.00**
32	33kV Shemagangkha-B180	1.22	0.77	3.41	17.88	**2.32**	**9.33**
33	33kV Chapcha-B190	0.79	0.20	1.69	8.55	**1.24**	**4.38**
34	11kV Chukha Colony-B440	1.67	0.14	2.04	2.06	**1.85**	**1.10**
35	11kV colony-B450	0.06	0.22	0.08	0.07	**0.07**	**0.14**
	Total	**80.48**	**107.97**	**121.02**	**212.96**	**100.75**	**160.46**

The above summary indicates that the 11kV Karbary-Rametey, Tading Rural Feeder, Old Tsimalakha and 33kV Sector-I (B240), Sector-II (B250), Serina Bosokha and Gurungdara II feeders sustained more interruptions compared to other feeders. Generally, power interruptions are due to transient, operation and maintenance, HT fuse replacement, over current/earth fault current, lightning and rainfall which are inter-related to each other for most of the cases.

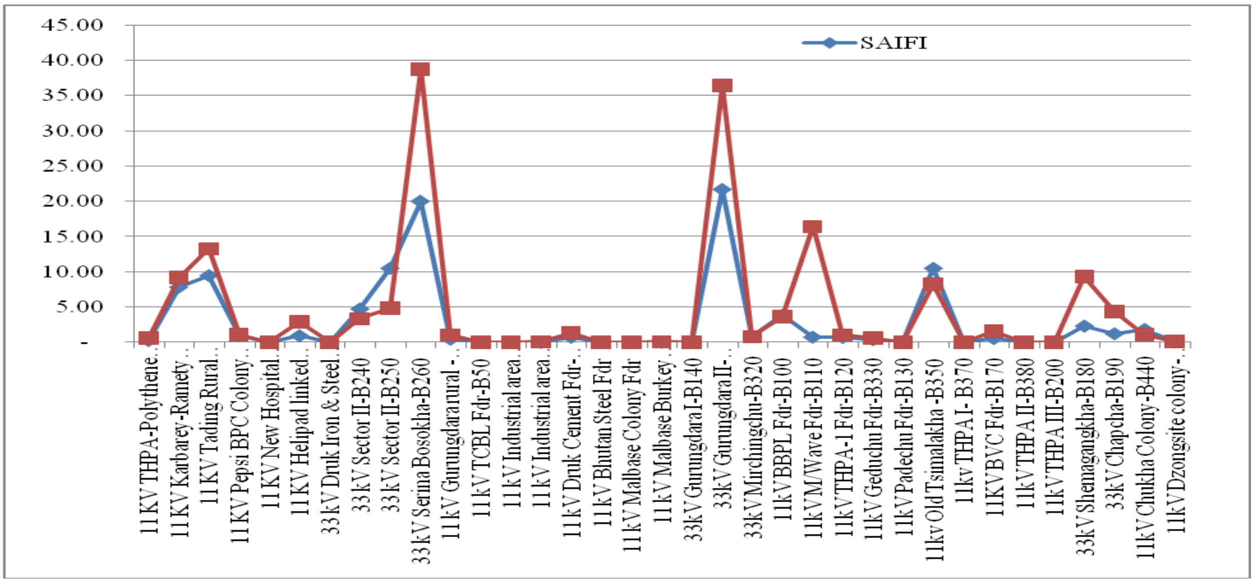


Figure 11: Feeder Wise SAIFI & SAIDI of ESD, Phuentsholing

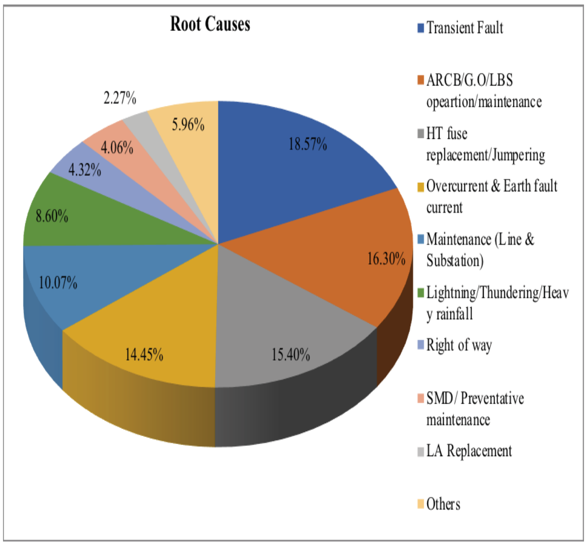


Figure 12: Root Causes of the Interruptions

Root Causes	Frequency	% Distribution
Transient Fault	352	18.57%
ARCB/G.O/LBS O&M	309	16.30%
HT fuse replacement/Jump	292	15.40%
OC & Earth fault current	274	14.45%
Maintenance (Line & SS)	191	10.07%
Lightning/Thundering/Heavy rainfall	163	8.60%
Right of way	82	4.32%
SMD/ Preventative Maintenance)	77	4.06%
LA Replacement	43	2.27%
Others*	113	2.11%
Total	**1896**	**100%**

**Others: Adhoc works, disc/pin insulator damage, fallen trees and grid failure.*

The root causes of the power interruptions are due to transient fault, operation and maintenance of switching equipment, HT fuse replacement, OC & earth fault current, maintenance of lines and substations and lightning, thunder and heavy rainfall had also significantly contributed towards the power interruptions.

There are switching devices (ARCBs and LBS) installed in these feeders for better operation and maintenance flexibility. In order to address the reliability issue of the feeders, following remedial and corrective measures are proposed:

a) 11kV Tading Feeder

The circuit length of this feeder is 86.16km and passes through thick vegetation and rugged terrain and becomes inaccessible due to swelling of Amochu river. The area receives heavy rainfall during the summer seasons and lightning strikes. The feeder recorded SAIFI & SAIDI of 9.47 & 13.25 on average for recent three years. There are 6 LBS and an ARCB installed in this feeder as a switching and control mechanism. In order to further improve the reliability of the feeder, it is proposed to install additional ARCB, Sectionalizer and FPIs.

- Re-configuration of sources

It is proposed to construct interconnecting line from Samtse feeder with that of Tading and arrange the power supply to 53DTs from Samtse. This would enable the power system improvement for customers connected to both the feeders.

- Installation of more and smart switching devices

b) 33kV Serina Bosokha Feeder

The circuit length of this feeder is 110.65km and passes through thick vegetation and rugged terrain and becomes inaccessible. The area receives heavy rainfall and lightning strikes during summer season. The feeder recorded SAIFI & SAIDI of 19.99 & 38.72 on average for recent three years and is one of the worst amongst all the feeders in terms of reliability indices. There are 7 LBS and an ARCB installed in this feeder as a switching and control mechanism. In order to further improve the reliability of the feeder, it is proposed to install additional an ARCB, 3 Sectionalizer, 5 FPIs and 2 LBS.

c) 33kV Gedu-Lhamoizingkha Feeder

The circuit length of this feeder is 208.83km and passes through thick vegetation and rugged terrain. This feeder has the longest circuit length and is extended as far as Lhamoizingkha under Dagana Dzongkhag, thus sustaining more interruptions. The area receives heavy rainfall and lightning strikes during summer season. The feeder recorded SAIFI & SAIDI of 21.65 & 36.43 on average for recent three years and is the worst amongst all the feeders in terms of reliability indices. There are 10 LBS and 4ARCBs installed in this feeder as a switching and control mechanism. In order to further improve the reliability of the feeder, it is proposed to install additional 5 Sectionalizers and 14 FPIs.

d) 11kV Karbatar-Rametay Feeder

The circuit length of this feeder is 21.22km and passes through thick vegetation and rugged terrain. The area receives heavy rainfall and lightning strikes during summer season. The feeder recorded SAIFI & SAIDI of 7.82 & 9.24 on average for recent three years. There are only 5 LBS installed in this feeder as a switching and control mechanism only. In order to further improve the reliability of the feeder, it is proposed to install additional two Sectionalizers, 3 FPIs, 2 Sectionalizers, an ARCB and 2 LBSs.

e) 33kV Sector II Feeder

With the circuit length of 0.73km for this feeder, it is not anticipated to experience many interruptions as in the case of feeder with longer circuit length and more loads connected. However, the record shows that it has recorded 10.49 & 4.88 as an SAIFI & SAIDI in recent years which is exceptionally high. The reason behind this incredible figure is due to faulty incomer breaker. As the area experiences longer humid weather, there is continuous formation of moisture and thus conventional breakers fails to operate as it is intended to. Therefore, it is proposed to install breaker (GIS) similar to those installed in the HV substations (Malbase, Singyegoan etc…). Currently, the breaker is bypassed which is not a good practice.

f) 11kV Old Tsimalakha Feeder

The reliability index of the 11kV Old Tsimalakha is 10.50 & 8.21 on average for recent years. On the contrary, the reliability in reality is half the recorded indices as the data captured is the total of two feeders i.e. 11kV Old and New feeders.

7.2.2 Single Phase to Three-Phase Conversion

BPC during the RE expansion programs considered for low-load remote and rural homes with two of the three-phases of the MV designed with single phase transformers. However, with the adoption of mechanized agricultural machinery, the requirement of three-phase power to cater these loads is gaining an importance even in the rural areas. Therefore, R&DD, BPC in 2017 has carried out the "Technical and Financial Proposal on Converting Single Phase to Three-phase Supply" to come out with the alternatives for providing three-phase power supply where there are single phase power supplies. It was reported that while all the alternatives required the third conductor of the MV system to be extended on the existing poles following three proposals along with the financial impact were proposed:

a) Alternative -I

It was proposed to replace all the single-phase with three-phase transformers and this option as contemplated as not feasible as a replacement by three-phase transformers and distribution boards will lead to idle storage of single phase transformers of BPC.

b) Alternative -II

It was proposed to utilize the existing single-phase transformers to form three-phase transformations along with the additional purchase of three-phase transformers and additional pole structures. Further, single phase transformers of identical make, type, and rating can be only used to make three-phase power available.

c) Alternative -III

Option 3 is found to be a techno-commercially viable alternative as the lines can be easily upgraded to three-phase by constructing third conductor on existing pole structures. The transformer can be upgraded from single phase to three-phase as and when the demand for 3-phase supply comes. The line up-gradation across the country would amount to Nu. 96.67 million (Detail in **Annexure-6**) excluding the cost of three-phase transformers which have to be procured on need-basis, rather than one-time conversion in general.

The total single-phase line length required to be converted to three-phase in the Dzongkhag is 99.84 km and the estimate for such conversion would require Nu. 12.21 Million.

As the single phase to three network conversions is a demand-driven planning, conversions works shall be carried out based on the demand from the customers which would be more techno-commercially viable alternatives. Therefore, considering the anticipatory conversion requirement, the conversion of networks is proposed in the later stage of the DSMP.

7.3 Assessment of the Distribution Transformers

The number of distribution transformers operated and maintained by the ESD is tabulated in **Table 2.**

7.3.1 Distribution Transformer Loading

The DTs are one of the most critical equipment of the distribution network and assessment of loading pattern along with the remaining asset life are crucial to ascertain the adequacy and performance of the transformer. The capability evaluation is based on historical peak load loading pattern and forecasted peak load growth of the feeder.

As per the peak loading pattern, some of the existing transformer capacities would not be adequate to cater the forecasted load growth for next ten (10) years. Accordingly, the capacities of the transformers need to be up-graded and such proposal is tabulated in **Table 13**. The individual DT loading details used to derive the summary is attached as **Annexure-7**.

Table 13: Forecasted Transformer Loading of ESD, Phuentsholing

Sl.No.	Name of substation location	Capacity (kVA)	Peak Load (kVA)	% Loading	Peak Load(kVA)	% Loading	Peak Load(kVA)	% Loading
			2019		2025		2030	
1	Damdara DT	125	90.89	72.71%	114.28	91.42%	133.78	107.02%
2	Sector II DT (33/11kV)	5000	3.40	68.00%	4.39	87.76%	5.15	103.02%
3	Lower Market USS	750	525.05	70.01%	680.84	90.78%	780.97	104.13%
4	Upper Market DT	1000	789.68	78.97%	921.12	92.11%	1037.62	103.76%
5	Tinkilo DT	125	100.89	80.71%	117.68	94.15%	132.57	106.05%
6	Rangaytrung DT	125	89.56	71.65%	155.88	124.71%	162.38	129.90%
7	Barsa DT	63	44.67	70.90%	61.54	97.68%	67.84	107.68%
8	Bmobile DT	63	58.99	93.63%	64.92	103.05%	69.56	110.41%
9	Bmobile DT (Balujora)	500	428.56	85.71%	466.21	93.24%	524.79	104.96%
10	Toribari DT	250	220.90	88.36%	240.31	96.12%	270.50	108.20%
11	Malbase Village DT	63	44.90	71.27%	66.24	105.15%	73.97	117.42%
	Total Distribution Transformers		**11**					

Assuming that the load growth of the rural homes is not expected to grow similar to that of urban dwellings, it is strongly recommended to closely monitor the actual load growth and accordingly plan remedial measures for those transformers although some of the transformers would get overloaded as per the forecasted load. Nevertheless, considering the actual site-specific growth rate and judgment of the field offices, it is recommended that arrangements be made for the up-gradation of 11 transformers. However, cross-swapping the existing transformers prior to procurement of new transformers would mean that, only eight (8) transformers have to be procured as tabulated in **Table 14.**

In addition to above, 2x750 kVA & 500kV transformers would be required to cater the power requirement of the Toribari town plan.

Table 14: Proposed Lists of DTs Requiring Up-grading

Sl.No.	Name of Feeder	Capacity (kVA)	Peak Load (kVA)	% Loading	Proposed kVA	Adjustment/New	Remarks
	List of Transformers for 2019-2025						
1	Lower Market USS	750	525.05	70.00%	1000	New	Need 750kVA also and new is for lower and upper markets
2	Tinkilo DT	125	117.68	94.15%	125	New	Additional 125kVA required
3	Rangaytrung DT	125	155.88	124.71%	500	New	125kVa not required
4	Bmobile DT	63	64.92	103.05%	125	Adjustment-Rangaytrung DT	63kVA not required
5	Malbase Village DT	63	66.24	105.15%	125	New	63kVA not required
	List of Transformers for 2025-2030						
1	Damdara DT	125	133.78	107.02%	500	New	125kVA not required
2	Barsa DT	63	67.84	107.68%	125	Adjustment-Damdara DT	63kVA not required
3	Bmobile DT (Balujora)	500	524.79	104.96%	1000	New	Need the 500kVA also
4	Toribari DT	250	270.50	108.20%	3x750	New	3 nos of 750kVA required
5	Toribari DT				500	New	
	Total number of transformers required to up-grade					**10**	
	Extra Transformers		63		2	2019-2025	**Can cross check with the nearest ESDs for adjustment**
			63		1	2025-2030	
			125		1	2025-2030	
	Total extra				**4**		

7.3.2 Asset life of Distribution Transformers

The DTs are one of the most critical equipment of the distribution network. Therefore, assessment of existing loading pattern together with the remaining asset life is crucial to ascertain its capabilities to cater the projected load growth. The life cycle of transformer and its mapping provides the clear information for its optimal utilization and development of an asset replacement framework.

The record was generated from the SAP-ERP system on December 9, 2019 and compiled for those DTs which have been put to use for 25 years and more.

Table 15: List of Outlived Transformers

Sl. No.	Asset	Name of Location	Unit	Qty	Cap. Date	No. of Years put to Use	Sl. No.
1	1502205	250 KVA, Stanelce Pvt Ltd.Yer of mfg: 1989, Gedu	NO	1	1-Jul-89	30.44	820123
2	1502212	125 KVA, Stanelec Pvt. Ltd. Yer of Mfg. 1989	NO	1	1-Jul-89	30.44	S/4160
3	1502232	63 KVA, Kirloskar Electric. Yer of Mfg: 1988	NO	1	1-Aug-89	30.35	86AD-125/3
4	1502237	400 KVA,11/400, Winpower make,at	NO	1	1-Jul-89	30.44	SL # 132489
5	1502243	500 KVA, uttam Bharat,11/400, at L. Market	NO	1	1-Jul-89	30.44	SL # 17645
6	1502244	500 KVA, Winpower,11/400 at ECE Ind Estate	NO	1	1-Jul-82	37.44	SL# 132989
		Total Transformers		**6**			

7.3.3 Replacement of Single Phase Transformers

As discussed in the "Single Phase to Three-phase Conversion" of the distribution network it will be more economical and technically feasible to convert the single to three-phase transformers on need basis. Total of Nu. 283.00 million is estimated for replacing all single-phase transformers including the distribution board. The detailed work out is produced as **Annexure-8.**

There are 48 single phase transformers in the Dzongkhag and the estimate for up-grading all the single to three-phase transformers would require Nu. 9.38 Million. As the conversion from single to three-phase transformer is demand base, the plan has been distributed in ten year-span.

7.4 Power Requirement for Urban Areas by 2030

Phuentsholing is one of the Thromdes located in south-western foothills of the country bordering the Indian state of Bengal. It is the commercial hub for western Dzongkhags and is the gateway of the country India. It has been envisioned to uniformly develop the Thromde and as a result it has planned and demarcated the LAPs. Under the Phuentsholing Thromde jurisdiction, there are 9 LAPs identified so far as tabulated in **Table 16.**

Table 16: LAPs under Chukha Dzongkhag

Sl. No.	Name of LAP	Approximate Number of Plots	Approximate Power Demand (MW)
1	Ahlay LAP	124	7.055
2	Pekarzhing Lap	150	10.160
3	Pasakha Lap	117	7.26
4	Rinchending LAP	195	9.596
5	Kharayphu LAP	35	1.93
6	DamdaraKarbray LAP	134	7.635
7	Ammochu Lap	58	3.160
8	Chamkuna LAP	17	0.970
9	Toorsatar Lap	63	3.685
Total		**893**	**51.451**

a) Ahlay LAP

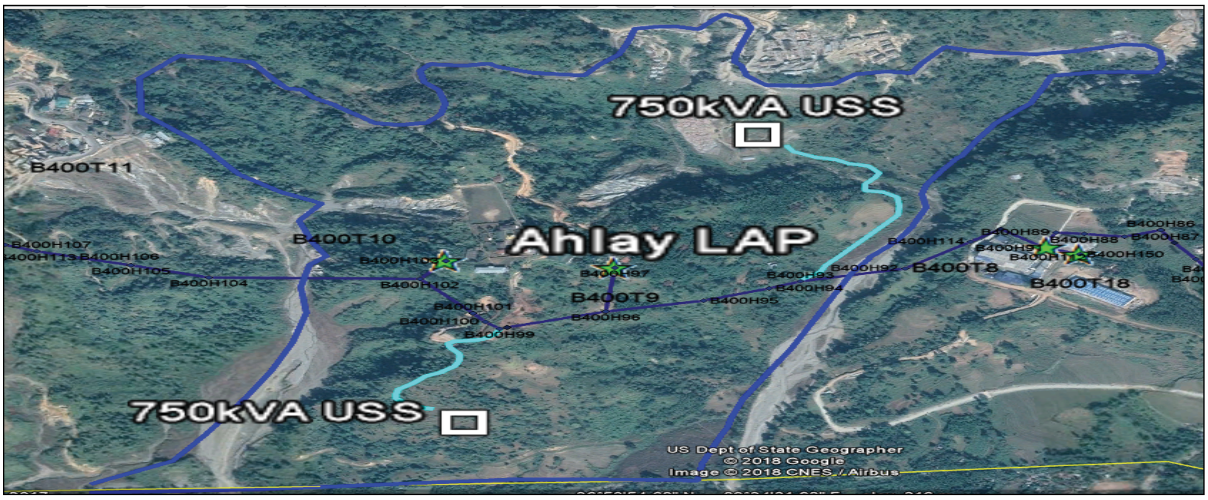


Figure 13: Ahlay LAP

The Ahlay LAP has fewer numbers of customers at present and major portion of the load is being drawn by Yoenten Kunjung Private School. However, the LAP has been already earmarked to be developed and accordingly the power requirement would increase. Therefore, total power requirement for the LAP is forecasted to be 7.055 MW and to meet the demand load, 2x750KVA USS is proposed along with proposal to up-grade the existing 63kVA Ahaly transformer to 500kVA substation.

b) Pekarzhing LAP

Currently, there are two MV customers in this LAP (M/s. Zimdra Foods Pvt. Ltd and M/s. Neetshel Pvt. Ltd. and are fed from existing 25kVA Khogla transformer. There is a plan that there will be mixture of small scale industries, MV customers, LV bulk customers and residential cum commercial buildings which would require a load of 10.16MW. Therefore, to meet the increasing power demand, it is proposed to install 3x750kVA USS along with proposal to up-grade the existing 25kVA to 500kVA pad substation.

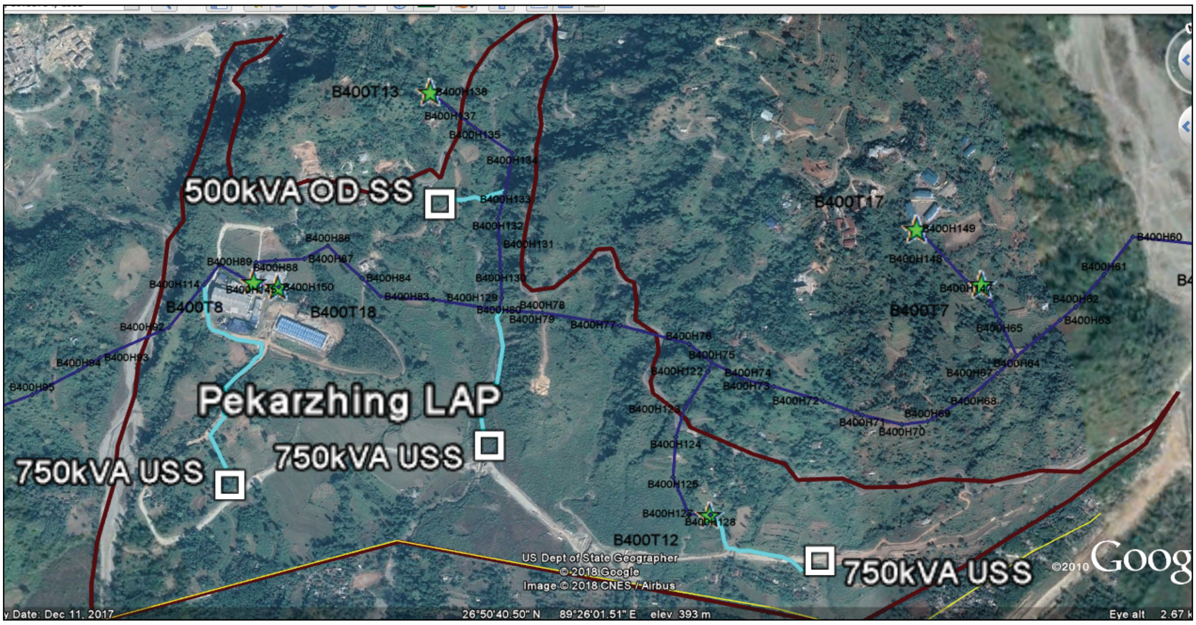


Figure 14: Pekarzhing LAP

c) Pasakha LAP

The Pasakha LAP includes Malbase, Gurungdangra, Chengamri (Balujora) and other non-pollutant industries in Pasakha area.

Figure 15: Pasakha LAP

The total forecasted load for this LAP is 7.26MW by 2030 and therefore, 750kVA USS at Malbase, 1000kVA package SS at Bhalujora and 750kVA at Gurungdara (up-grade from existing 63kVA). The existing 500kVA at Bhalujora would be still required to meet the power requirement with the proposed 1000kVA.

d) Rinchending LAP

Rinchending LAP is the biggest identified LAP covering maximum area starting from Tinkilo and the highest power consumer of this LAP is the College of Science and Technology. However, most of the areas are geographically unstable for developmental activities to be initiated. The developmental activities in this area have really picked up and the existing distribution network may not be adequate to meet the increasing power requirement. It is forecasted that the power requirement would reach 9.60 MW by 2030. The existing 125kVA transformer of Tinkilo is 94.15 % loaded and might get overloaded by next year and similar trend is expected with the Rinchending 500kVa transformer. Therefore, it is proposed to install additional 125kVA in Tinkilo and up-grade the 500kVA to 1000kVA (USS) for Rinchending transformer.

Recently, BPC has installed 250kVA transformer on cost sharing basis with Thromde at Lower Rinchending which may not be adequate to meet the power requirement. Therefore, additional 750kVA USS is proposed at Lower Rinchending. The existing 500kVA substation above Kharbandi Goenpa will feed to Middle Rinchending LAP. As there is no source for the LAP below Goenpa, 500kVA Pad substation is proposed.

Figure 16: Rinchending LAP

e) Kharayphu LAP

Kharayphu LAP is located opposite to Karbraytar and this LAP is still developing. BPC has recently installed 500kVA Pad substation to cater the demand load for construction.

Figure 17:Kharayphu LAP

The forecasted demand load of the LAP till 2030 is 1.93MW and to cater the forecast demand load, 2x750kVA USS is proposed.

f) Damdara LAP

Damdara Karbray LAP is one of the rapid developing LAPs and it consists of two different areas called Damdara and Karbraytar. The total forecasted demand load for the LAP for Damdara and Karbraytar is 3.670 MW and 3.965MW respectively till 2030. The existing 1000kVA USS has lengthy LT network and the customers of Karbraytar top have been expressing the grievances of erratic power supply lately. The quality of power is anticipated to worsen with the increase in power requirement. Therefore, it is proposed install additional 125kVA transformer to address the issue. Similarly, the existing 125kVA transformer at Damdara is 72.71% loaded and is forecasted to be overloaded by 2030. Therefore, it is proposed to up-grade the existing 125kVA to 500kVA and install additional 500kVA Pad SS. Addition to this, Thromde also suggested BPC to convert the overhead line to UG network especially at Damdara LAP.

Figure 18: Damdara LAP

g) Amochu LAP

The Thromde has demarcated the LAP area without including the Amochu Land Reclamation Township Project (ALRT). The total forecasted demand load for the LAP is 3.161MW. The ALRT is under full swing and Thromde is also scheduling to execute the development of the LAP simultaneously with the project. Therefore, to meet the demand load, 750kVA USS and 500kVA Pad SS is proposed for the LAP.

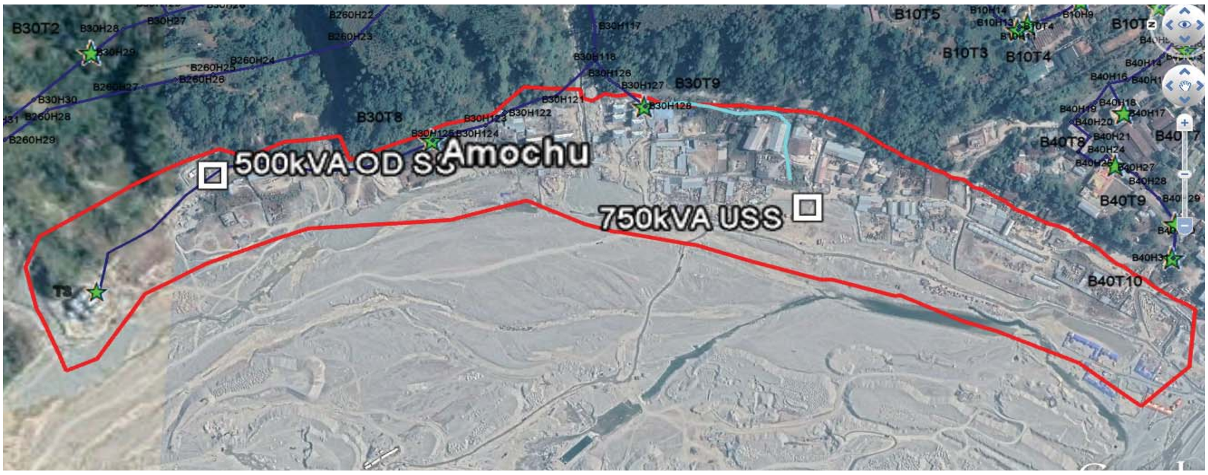


Figure 19: Amochu LAP

h) Chamkuna LAP

Chamkuna LAP is located alongside the Amochu river bank and on the way to Samtse high way. With the steep slope and unstable area in the proposed LAP, the Thromde has planned only few infrastructures in this LAP and the forecasted demand load for this LAP is only 0.96MW. However, since there is no electrical infrastructure in this proposed area, 125kVA pole mounted SS is proposed for the LAP.

Figure 20: Chamkuna LAP

i) Toorsatar LAP

With the space constraint in the Phuentsholing, Thromde has demarcated the Toorsatar area as one of the Thromdes LAP and further, the ALRT project will also cover till Toorsatar base. The forecasted demand load for this lap is 3.685MW. Currently, Toorsatar area has 25kVA substation which is adequate to cater the load to this area.

Figure 21: Toorsatar LAP

However, if the Thromde initiates the Toorsatar LAP development, the existing power supply arrangement may be adequate to meet the demand. Therefore, the existing 25kVA is proposed to up-graded to 750kVA package SS and another additional 750kVA package SS is proposed in this LAP.

7.4.1 MV & LV lines for LAPs

The LV & MV lines have to be proposed for distribution of power to the identified LAPs which are detailed as follows:

a) The extension of 11kV HV ABC (95sqmm) from BPC Colony to Bangay (Amochu) as an alternative source is proposed mainly to improve the reliability to the customers who reside at Amochu. With the Thromde's LAP development strategies, reliable power source is must and further, these customers fall under Thromde's jurisdiction. Currently, customers of Amochu are fed from Tading feeder which is susceptible to interruptions compared to other feeders. Therefore, it is proposed to extend the 11kV line from BPC colony.

b) The re-alignment of 33 kV double circuit feeder from Phuentsholing 66 kV substation to 33/11 kV Sector 2 Substation by 33kV 3Cx150sqmm UG XLPE cable (0.38km) & 33kV HV ABC 1cx95sqmm (0.69km) is proposed due to new NPPF colony which would directly fall under the line. Although, proposal was approved in 2017, the work was not executed due to non-availability of clearances which should have been arranged by By-Pass Road, SASEC project. However, the work is kept as spill over and it will be executed by mid of 2020, as the project is in the verge of completion.

c) As per the result of ETAP, the additional line needs to be extended from 33/11kV Gurungdangra SS in order to improve the voltage profile of BBPL feeder.

d) The conversion of ASCR conductor to HV ABC 1cx95sqmm cable (1.5km) line within the Tsimasham town area is proposed for better safety and to resolve the right of way issue with private land owners.

e) As a contingency plan (in case of any breakdown or any O&M works to be carried out at 66kV Phuentsholing substation) the power supply to Phuentsholing has to be fed from 400KV Malbase substation through Druk Cement feeder. Therefore, the re-sizing of ACSR Dog conductor to wolf conductor is proposed.

f) The study carried out for HT network in the core town of Phuentsholing shows normal, but, all the LT cable under core town get overloaded and need to be resized with proportional to load forecast.

g) 33kV Gedu-Lhamoizingkha feeder being a worst feeder in reliability front and if Wangchu project gets materialized, the proposal for extending additional back up source from Gamana (Point of 66/33kV substation by Wangchu project) and connect the existing 33kV line feeding towards Lhamoizingkha need to be incorporated, so that the reliability indices of Lhamoizingkha will be improved.

h) By the proposal of upcoming LAP by Thromde, the conversion of bare conductor to UG cable has to be incorporated in order to resolve the Right of way issues with public, aesthetic view of Thromde LAP and to improve the safety of the general public. Addition to this, the bare conductors passing nearby the school and colonies also have to convert to insulated conductor.

7.4.2 Distribution Transformers

Currently, there are nine (9) identified LAPs under Phuentsholing Thromde which would get materialized sooner or later. Therefore, to arrange the power supply, existing installed transformers may not be adequate to meet the forecasted power demand; it is therefore, proposed to up-grade and install additional transformers in various LAPs as tabulated in **Table 17**.

Table 17: Proposed Distribution Transformers in LAPs

Sl.No.	Name of LAP	Capacity (kVA)	Qty	Unit	Remarks
1	Ahaley LAP	750	2	No	Package SS
		500	1	No	OD SS
2	Pekarzhing LAP	750	3	No	Package SS
		500	2	No	OD SS
3	Pasakha LAP	1000	1	No	Package SS
		750	2	No	Package SS
4	Rinchending LAP	1000	1	No	Package SS
		750	1	No	Package SS
		500	1	No	OD SS
		125	1	No	OD SS
5	Kharayphu LAP	750	2	No	Package SS
6	Damdara & Karbray LAP	500	2	No	OD SS
		125	1	No	OD SS
7	Amochu LAP	750	1	No	Package SS
		500	1	No	OD SS
		125	1	No	OD SS
8	Chamkuna LAP	125	1	No	OD SS
9	Toorsatar LAP	750	2	No	Package SS

8. Distribution System Planning

The distribution network of the Dzongkhag has a radial topology with significant risk of high interruptions (fault in one location would mean that the entire customer in the network would experience the outage). Having alternate routes, sources or any contingency plan would significantly improve the reliability and power quality. In order to have robust and hard-lined distribution network, there is a need for good contingency plans with adequate sources to reduce the downtime. However, any provision to improve the power system would incur additional capital cost in addition to recurring additional preventive and corrective costs.

Therefore, to meet the system shortfalls against the set standard and to keep abreast with the forecasted load growth, proper distribution system planning is required which are detailed from **Section 8.1** through **Section 8.4.**

8.1 Power Supply Sources

8.1.1 HV Substations

As detailed in **Section 7.1.1**, the installed HV substation capacities would be adequate to cater the forecasted load of the customers of Chukha Dzongkhag. Therefore, neither the existing substation capacities would be required to be up-graded nor construction of additional substations.

8.1.2 MV Substations

As detailed in **Section 7.1.2,** the installed MV substation capacities would be adequate to cater the forecasted load of the customers of Chukha Dzongkhag. Therefore, neither the existing substation capacities would be required to be up-graded nor construction of additional substations.

8.2 MV and LV Lines

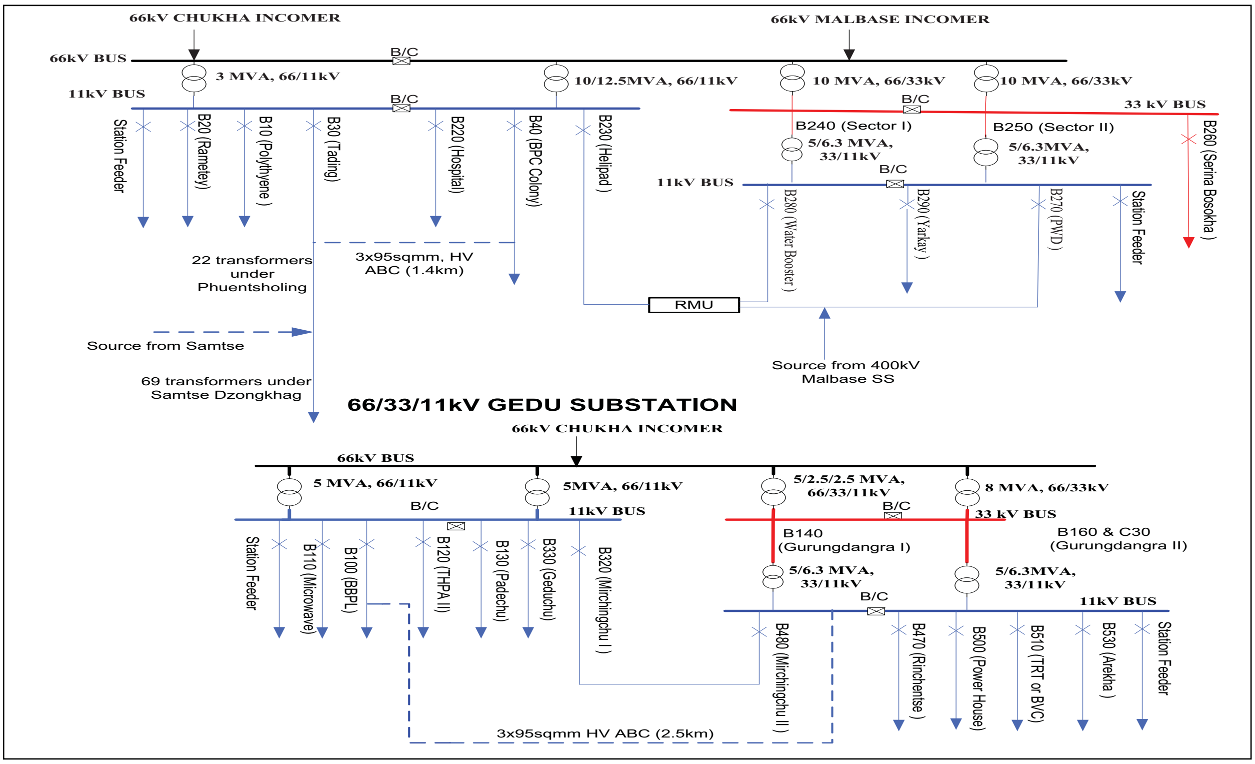


Figure 22: Proposed Distribution Network under ESD, Phuentsholing

As detailed in **Section 7.4.1** of this report, it is proposed to extend, construct MV and LV lines to in various locations to arrange power supply according to the load forecast, developmental activities, to improve reliability, reduce loss and improve the power quality. **Figure 22** shows the proposed distribution network.

8.3 Distribution Transformers

As listed in **Section 7.3.1,** these transformers need to be up-graded either by procuring or by cross-swapping the required capacities. Out of 11 listed transformers, procurement of only 8 DTs would be required which has been worked out based on the likelihood of load growth of the areas and inculcating the fair judgment of the field personnel. Similarly, twenty-six (26) DTs would be required to cater the power supplies to nine (9) identified LAPs under Phuentsholing Thromde which would be executed over the period of time.

8.4 Switching and Control

Switching and control system is required to take care of the system during faulty situations which ultimately is going to take care of the failure rate, repair and restoration time. This in turn would improve the reliability, safety of the equipment and online staff, optimizes the resource usage and more importantly the revenue generation will be enhanced. Similarly, in order to capture the real time data and information, it is inevitable to have automated and smart distribution system. The feeders which are more susceptible to faults are identified with proposed restorative measures through the studies. With the exception of tripping of breakers in the sending end substations, existing distribution network is neither automated nor smart to detect the faults and respond in real-time manner. The automation and smart grid components are detailed in Smart Grid Master Plan 2019.

8.4.1 Intelligent Switching Devices

As reflected in **Section 7.2.3,** 11kV Karbary-Rametey, Tading Feeder, Old Tsimalakha and 33kV Sector-I (B240), Sector-II (B250), Serina Bosokha and Gurungdara II feeders sustained more interruptions compared to other feeders. Therefore, additional preventive and corrective measure for these feeders need to be put in place. In order to improve reliability and power quality of these feeders, it is proposed to have technology in place to respond to fault and clear it accordingly rather than through ex post facto approach. Therefore, it is proposed to enhance the existing switching and control system by having latest suitable and user-friendly technology (automatic). The coordinated arrangement of Intelligent Switching Devices (ISD) like ARCBs, Sectionalizers and FPIs would significantly improve the control and operation mechanism of the network. **Table 18** and **Figures 23, 24 & 25** shows the proposed switching devices and RMUs for the distribution network for easing operation and maintenance and for improving the reliability of the power supply of the Dzongkhag.

Reliability of the lines and substations can also be enhanced through training of line staff. They need to be equipped with the knowledge, skills, and the confidence to operate and maintain the distribution infrastructure. For instance, the linemen of the ESDs need to develop the confidence to change DO fuses online using hot sticks instead of the usual practice of taking shut down of the whole feeder. However, having the right tools, equipment, and especially spares (of appropriate specifications) is a prerequisite. Although it is not possible to quantify the reliability indices that can be achieved with preventive and corrective measures in place, the proposed contingency plans would significantly improve the power quality.

However, the quantum and location of the devices to be installed shall be based on the Smart Grid Master Plan 2019.

Table 18: Existing and Proposed Switching Equipment

Sl. No.	Feeder Name	ARCBs		Sectionalizers		FPIs		LBS	
		Exist	**Prop**	**Exist**	**Prop**	**Exist**	**Prop**	**Exist**	**Prop**
1	11kV Feeder B30 (Tading)	1	2		1		5	6	
2	11kV Karbraytar & Rametey	1			2		2		1
3	11 kV Feeder B10 (New Polythyene)						1		
4	11kV Feeder B40 (BPC Colony)						1		
5	11kV Feeder B230 (Helipad)				1		2		
6	33kV Feeder B260 (Serina Bosokha)	1	1		3		5		
7	11kV Feeder B350 (Old Tsimalakha)				2		3	1	
8	11kV Feeder B360 (New Tsimalakha)				2		3	1	
9	11kV Feeder B80 (Rangaytrung)						2	1	
10	33kV Feeder B160 & C30 (Gurungdangra-II)	2			5		14		1
	Overall Total	**5**	**3**	**0**	**16**	**0**	**38**	**9**	**2**

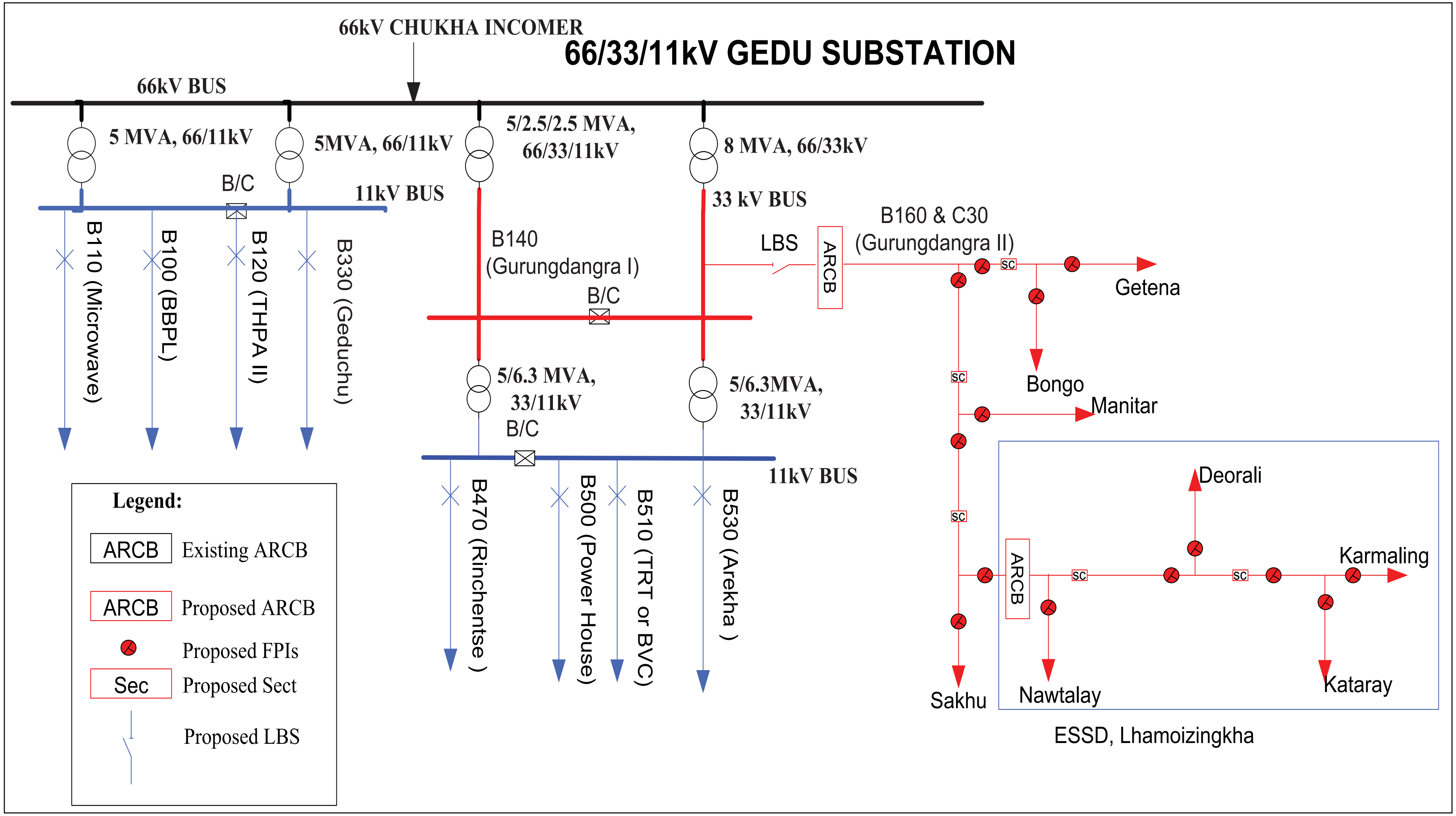


Figure 23: Overall Switching Equipment for Distribution Network of Gedu SS

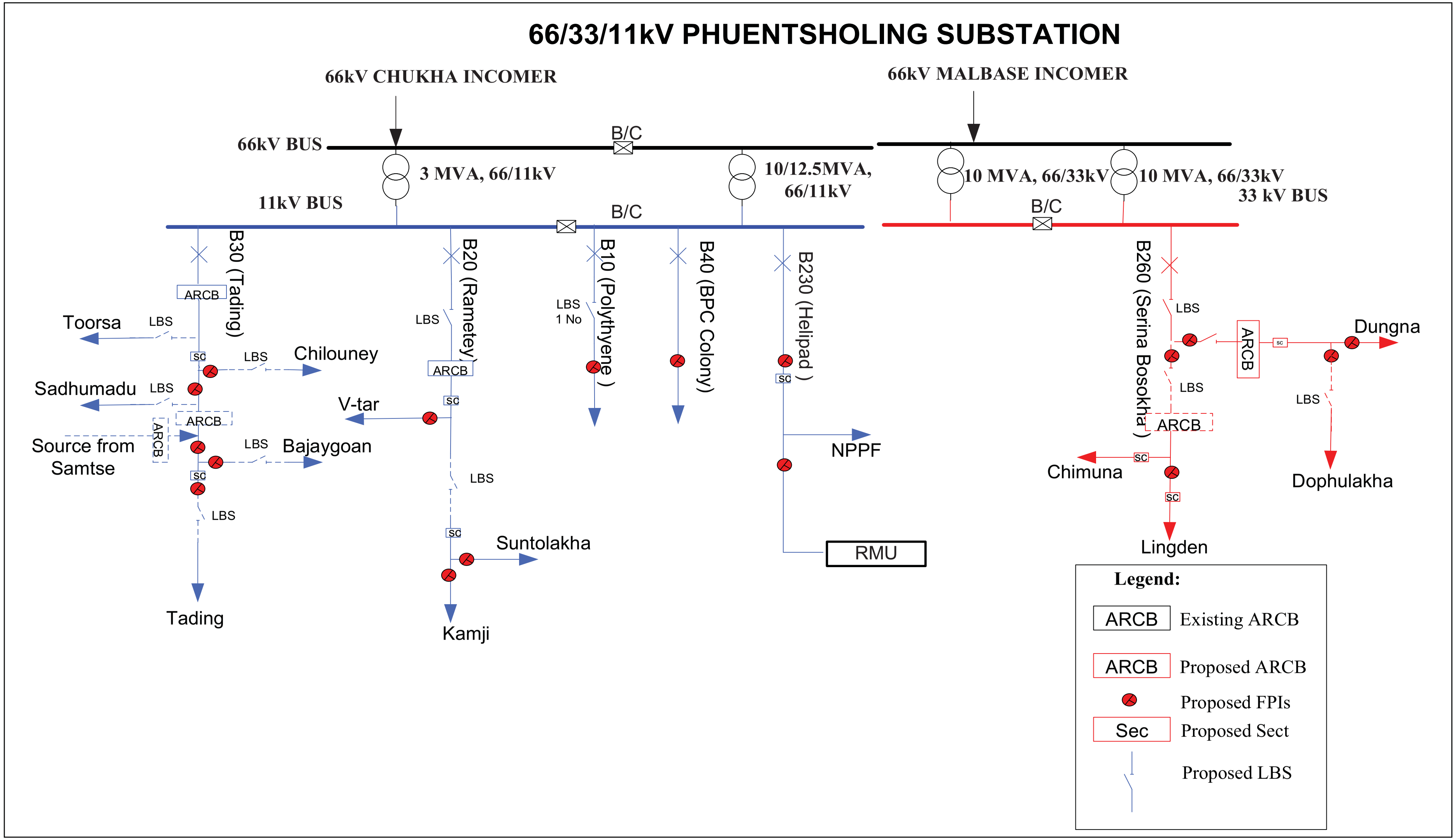


Figure 24: Proposed Switching Equipment for Distribution Network of Phuentsholing SS

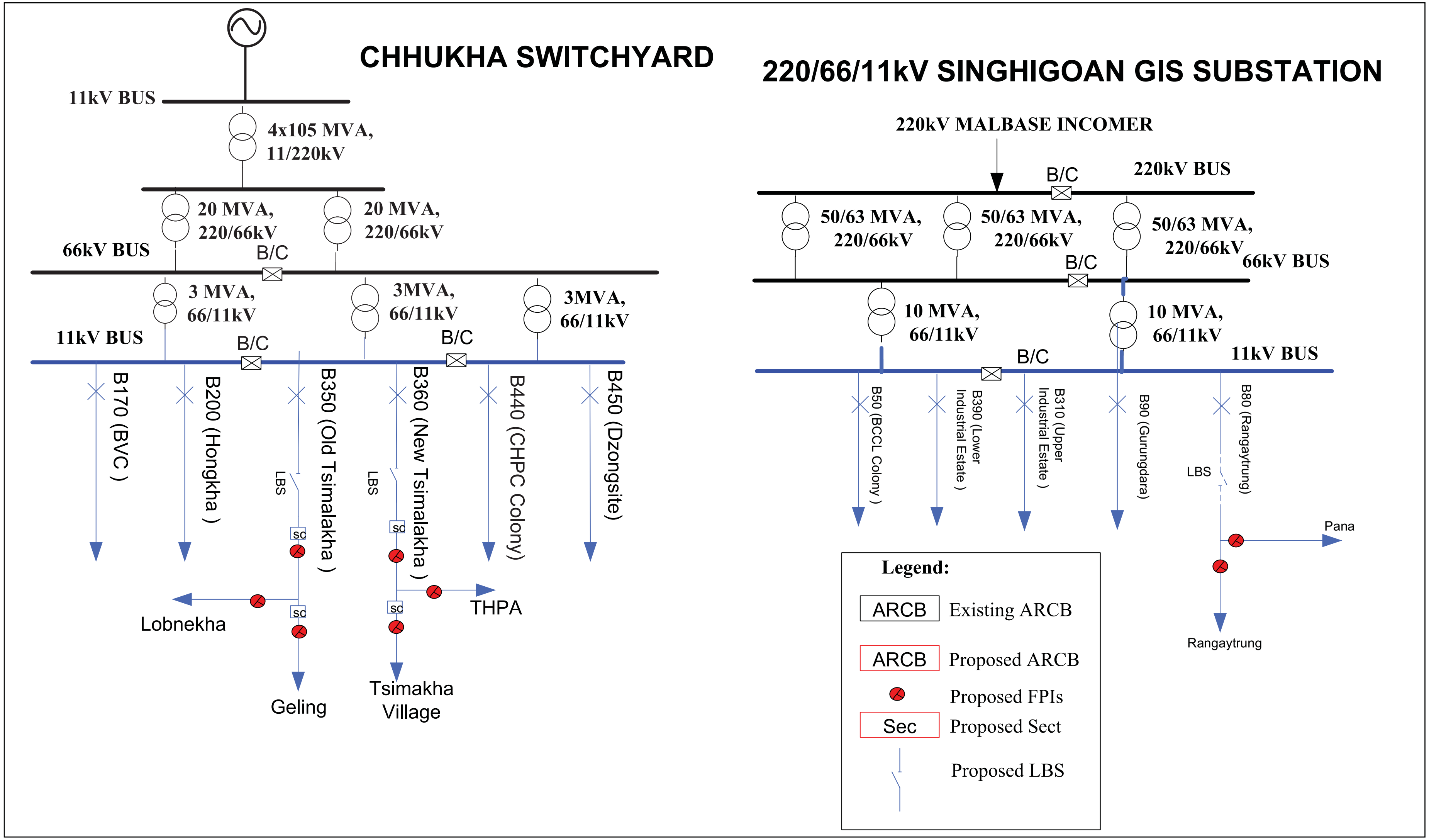


Figure 25: Proposed Switching Equipment for Distribution Network of Chukha Switch Yard and Singyegoan GIS SS.

8.4.2 Distribution System Smart Grid

The distribution grid modernization is outlined in Smart Grid Road Map 2019 including the investment (2020-2027). The DMS, ADMS, DSCADA features along with their components and functionalities, the timeline for the programs and the cost estimates of the smart grid are lucidly reflected. Therefore, this report exclusively entails the identification of the system deficiencies and qualitative remedial measures which would require system augmentation and reinforcement as per the existing and projected load.

9. Investment Plan

In accordance to the above mentioned contingency plans targeted to improve the power quality, reduce losses and improve reliability indices of the Dzongkhag, investment proposal is developed. The investment plan has been confined to power supply sources, MV lines, DTs, switching and control equipment and RoW. The proposed/approved (2020-2024) investment plan and any new investment plans have been validated and synced with the system studies carried out. The annual investment plan (2020-2030) has been worked out based on the priority parameters set out as shown in **Figure 26.**

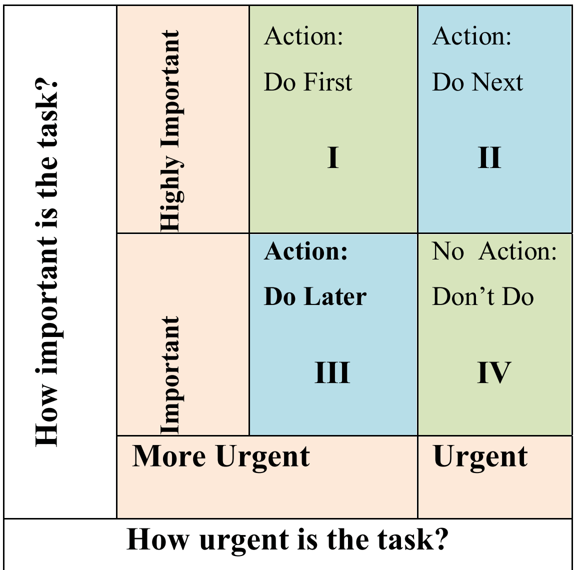


Figure 26: Priority Matrix

The matrix gives us the basis on the prioritization of the investments to be made in the ten-year schedule as every activity cannot be carried out at a time. The activities which have to be carried out due to load growth, developmental activities and retrofitting of obsolete/defective switchgears and equipment will have the highest level of importance and urgency. These activities have to be prioritized and invested in the initial years which are grouped in the first quadrant (Do First).

Similarly, there are certain activities although might be very important but not so urgent can be planned in the later stage of the year (Do Next). These activities can be but not limited to improving the reliability, reducing losses and reconfiguration of lines and substations to reduce the losses and improving the power quality. The activities which are not so important but are highly urgent have to be also planned in later stage of the period.

According to the investment prioritization matrix framework, the yearly investment plan along with the cost estimation is derived and is consolidated in **Table 19** as an investment plan. The cost estimates have been worked out based on the BPC ESR-2015 and annual inflation is cumulatively applied to arrive the actual investment cost for the following years.

In the span of next 10 years (2020-2030), the total projected investment required to adequately deliver the power to the customers of Chukha Dzongkhag is Nu. 189.45 million (Nu. 18.95 million per year).

Table 19: Investment Plan (2020-2030)

Sl. No	Activities	Investment Plan (Nu. In Million)											Total
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1	Construction of composite 11kV, 3cx95sqmm HV ABC (2.5 km) line from Gurungdara s/s to BBPL feeder.							3.58					**3.58**
2	Realignment of 33 KV overhead double circuit feeder from P/ling 66 KV substation to 33/11 kV Sector 2 Substation (RCO Building) (Laying of 33kV, 3cx150sqmm XLPE (0.750km) and paying of overhead AAAC-100sqmm (.15km) over Dotikhola river).	2.57											**2.57**
3	Extension of power supply and construction of substation to new proposed site of Land User Right Certificate (LURC) under Chukha Dzongkhag	2.24			2.24			2.24		2.24			**8.96**
4	Extension of 11kV, 3cx150sqmm XLPE (0.3km) UG cable and construction of 11/0.415kV, 1MVA USS substation at Integrated checkpost, Rinchending	4.36											**4.36**
5	Extension of 11 kV, 3cx95sqmm HV ABC (1.2km) from CHPC colony to Bangay alternatives to construction Separate feeder	2.77											**2.77**
6	Extension of 11kV, 3cx50sqmm (0.120km) &	1.28											**1.28**

Sl. No	Activities	Investment Plan (Nu. In Million)											Total
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
	construction of 11/0.415kV, 125kVA substation at Tinkilo, Batomuni												
7	Extension of 11kV, 3cx150sqmm XLPE (0.3km) UG cable, Installation of 1MVA Packaged Substation and Upgradation of LT UG line from 4cx70sqmm to 4cx150sqmm (1.5km) in Phuntsholing core town.	5.25											**5.25**
8	Extension of 4cx95sqmm (0.7 km) LV ABC line at near Gedu Zero.		0.47										**0.47**
9	Installation of Shield wire (5km) on 33kV Gurungdara Feeder II (Gedu-Lhamoizingkha)		0.71										**0.71**
10	Upgradation of 33KV panels & breakers for Sector II & Gurungdangra substation		8.13										**8.13**
11	RE-Fill in works	2	10.7	2	2	2	2	2	2	2	2	2	**30.7**
12	Conversion of ACSR-Squirrel/ Rabbit conductor (2km) to 4c x 95 sq.mm LV ABC at old Dzong site, Chukha Colony.			0.79									**0.79**
13	Conversion of overhead ACSR conductor to 3cx240sqmm XLPE UG Cable (Damdara Karbray, Amochu, Toorsatar, Town & Kharayphu LAP-2.5km, Pasakha, Ahalay, Pekarzhing & Rinchending LAP-3.5km) under Thromde LAP for aesthetic view of town.				2.71		2.71		2.71	2.71			**10.84**

Sl. No	Activities	Investment Plan (Nu. In Million)											Total
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
14	Conversion of ACSR-Squirrel/Rabbit conductor (1.5km) to 4c x 50 sq.mm LV ABC at Junior School, Tsiamalakha.				0.69								**0.69**
15	Up-rating of 125kVA Rangaytrung substation to 500kVA Pad mounted substation				1.11								**1.11**
16	Up-grading of 63kVA Pasakha Bmobile substation to 125kVA pole mounted substation				0.43								**0.43**
17	Construction of 4cx400sqmm UG Cable LT ring system between Packaged Substation in Phuentsholing City Core Area (Direct Burial Method) (2km) for load sharing.					1.89	1.89						**3.78**
18	Extension of 11kV, 3cx240sqmm XLPE (0.92km) and construction of 2x750kVA USS and 500kVA Pad substation at Ahaly LAP.					2.68		2.68			2.68		**8.04**
19	Extension of 11kV, 3cx240sqmm XLPE (0.45km) UG cable and construction of 750kVA USS and 500KVA Pad substation at Rinchending LAP.					1.53			1.53			1.53	**4.59**
20	Extension of 11kV, 3cx240sqmm XLPE (0.40km) UG Cable and construction of 750kVA USS, 500kVA Pad substation and 125kVA pol mounted substation at Amochu LAP.					1.66		1.66				1.66	**4.98**
21	Conversion of HV ABC 3cx95sqmm cable (1.5km) line within the Tsimasham town area for better						2						**2**

Sl. No	Activities	Investment Plan (Nu. In Million)											Total
		2020	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	
	safety and lesser ROW requirement.												
22	Re-sizing of 11kV, ASCR-Dog to Wolf conductor (6.3km) in Druk cement feeder and re-sizing of 3cx95sqmm HV ABC to 3cx120sqmm HV ABC (1.5km) between Goenpa and Pemaling as back up supply from 400kV Malbase substation to whole Phuentsholing town.						2.12	2.12	2.12				**6.36**
23	Extension of 11kV, 3cx150sqmm XLPE (0.3km) UG cable, extension of 3cx95sqmm HV ABC cable (0.29km) and construction of 2x500kVA Pad substation and 125kVA pole mounted substation at Damdara & Karbraytar LAP.						2.01			2.01			**4.02**
24	Up-grading of 63kVA Malbase village substation to 125kVA pole mounted substation						0.45						**0.45**
25	Extension of 11kV, 3cx240sqmm XLPE (1.2km) UG cable and construction of 2x750kVA USS and 2x500kVA Pad substation at Pekarzhing LAP.							3.2		3.2		3.2	**9.6**
26	Extension of 11kV, 3cx50sqmm HV ABC Cable (0.35km) and construction of 125kVA pole mounted substation at Chamkuna LAP.		2.41										**0**
27	Up-grading of 63kVA Barsa substation to 125kVA pole mounted substation							0.45					**0.45**
28	Construction of 33kV line ACSR Dog conductor								1.67	1.67	1.67		**5.01**

Sl. No	Activities	Investment Plan (Nu. In Million)											Total
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
	(7km) from Gamana (Point of 66/33kV substation by Wangchu project) to connect to the existing 33kV line feeding towards Lhamoizingkha.												
29	Extension of 11kV, 3cx240sqmm XLPE (0.63km) UG Cable and construction of 2x750kVA USS and 1000kVA USS at Pasakha LAP.								3.26		3.26	3.26	**9.78**
30	Extension of 11kV, 3cx240sqmm XLPE (0.26km) UG Cable and construction of 2x750kVA USS at Toorsatar LAP.								3			3	**6**
31	Extension of 11kV, 3cx240sqmm XLPE (0.55km) UG cable and construction of 2x750kVA USS at Kharayphu LAP.									3.19		3.19	**6.38**
32	Re-alignment of Existing HT and LT networks, Uprating and installation of new substation for new township of Lhamoizingkha.									2.22	2.22	2.22	**6.66**
33	Conversion of single to three-phase line			1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	**12.24**
34	Replacement of single phase by three phase transformers			1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	**16.47**
	Total	**20.47**	**20.01**	**5.98**	**12.37**	**12.95**	**16.37**	**21.12**	**19.48**	**22.43**	**15.02**	**23.25**	**189.45**

10. Conclusion

Based on the inputs from Divisional office, validated data, assessment of the existing distribution network, and the reliability analysis, recommendations are made for system modifications and improvements. Costs associated with each recommendation are presented in several phases so that work may continue at a pace that is determined by fund availability and the capacity of the office to execute the work. An attempt is made to prioritize the recommendations; however, there will undoubtedly be adjustments in the order and priority by which the investments will be actually implemented.

The third option which would be the least-cost alternatives for converting the single to three-phase distribution network where all the MV lines will have to be converted to three-phase and replacing the single phase to three-phase transformers on need basis.

Although the report entails the identification of system deficiencies and reinforcement required, for automation and smart operation of the distribution network, the smart grid infrastructure development with functionalities are detailed in "Smart Grid Master Plan 2019". Therefore, the DSMP-Smart Grid Master Plan-Hybrid is necessary which can be amalgamated during the rolling out of annual investment and budget approvals.

Proportion of LV is higher in comparison to MV line length; accordingly, the independent study carried out by BPC in 2017 showed that large portion of loss is due to LV and DT. Therefore, similar system study beyond DT has to be carried out in order to capture the entire network and strategize to develop the blue print.

11. Recommendations

Sl. No.	Parameters	Recommendations
A. Power Supply Sources		
1	HV Substations	As detailed in **Sections 7 & 8** of this report, there is no up-grading or requirement of new HV substations required under Chukha Dzongkhag.
2	MV Substations	As detailed in **Sections 7 & 8** of this report, there is no up-grading or requirement of new MV substations required under Chukha Dzongkhag.
B. MV and LV Lines		
1	MV & LV lines	As detailed in **Sections 7 & 8** of this report, realignment, re-sizing of the conductors, construction of new MV & LV lines for LAPs and conversion of overhead to UG system are proposed.
2	ACSR to ABC (LV)	In order to minimize the safety of the inhabitants and to address the RoW issues, it is proposed to convert LV ACSR to LV ABC in and around the town.
C. Distribution Transformers		
1	Distribution Transformer	As reflected in **Section 7.3.1** of this report, it is proposed to regularly monitor the loading pattern especially of the urban transformers. It is desired to load the transformers less than 85% so as to ensure that transformer is operated at maximum efficiency. As the system study is restricted to DTs, the loads need to be uniformly distributed amongst the LV feeders to balance the load.
2	Single to Three Phase Transformers	As reported in the "Technical and Financial Proposal on Converting Single Phase Power Supply to Three Phase in Rural Areas", it is recommended to replace the single to three phase transformers on need basis.
D. Switching and Control Equipment		
1	Switching and Control Equipment	It is recommended to install Intelligent Switching Devices (ISD) like ARCBs, Sectionalizers and FPIs as proposed which would reduce the downtime for clearing faults. 1) Install FPI, Sectionalizes and ARCBs at various identified locations. 2) Installation of 11kV& 33kV RMUs at various identified locations.
E. others		
1	Investment Plan	As reflected in **Section 9** of this report, overall investment plan as proposed is recommended.
2	Review of the	Practically the projections will hold only true in the nearest future therefor, it is

Sl. No.	Parameters	Recommendations
	DSMP	strongly recommended to review the DSMP in 2025 (after five years) or if need be as and when situation demands.
3	System Studies beyond DT	It is observed that distribution of electricity is more through LV than MV & HV and the scope of DSMP terminates at DT. However, it is equally important to carry out similar system studies for LV networks till meter point. Due to time constraint and non-availability of required LV data, it is recommended to carry out the studies on LV network including the DTs. Nevertheless, with the entire distribution network captured in the GIS and ISU, the system studies should be carried out including the LV network in the future.
4	Customer Mapping	One of the important parameters required especially for reaffirming the capability of the DTs is by examining customer growth patterns. Therefore, it is recommended to consistently update the customers via customer mapping process carried out annually.
5	Right of Way	RoW should be maintained as per the DDCS 2016. However, increased frequency of RoW clearing in the problematic sections of the line and in fast growth sub-tropical forest is recommended.
6	Asset life of DTs	The asset life of DTs need to be gathered to enable development of asset replacement framework. However, it is recommended to regularly monitor the health of the transformers which have already outlived their lives.
7	Overloading of DTs	As per the load forecast, some of the rural DTs might overload. While the probability of realizing such an event is quite low. It is, however, recommended that the DTs that have already exhausted its statutory life (25 years and above) be regularly monitored.
8	New extension through 33kV network	The power carrying capacity of 33kV system is almost 3-fold compared to that of 11kV system. Therefore, any new extension of lines may be done through 33kV system (based on fund availability and practical convenience).
9	Reliability	In order to improve the reliability of the feeder/network, it is recommended that fault should be located within short period of time there by reducing the restoration time and the number of customers affected. In this regard, the following initiatives are recommended: 1) To install ISDs (communicable FPIs, Sectionalizers & ARCBs); 2) To explore with construction of feeders with customized 11kV & 33kV towers; and 3) To increase the frequency of Row clearing in a year.

Sl. No.	Parameters	Recommendations
10	Conversion Works	As the joint survey for laying the UG had not be done, the investment has been worked out based on assumptions of likely scenarios. Therefore, actual activities should be incorporated during the rolling out of the investment plans.
11	Lightning Protection	The top root cause of the power interruption is due lightning and storm. Therefore, more focus should on how to control and safeguard the equipment from lightning and storm (especially for the southern foothills).

12. Annexure

Annexure-1: MV Line Details and Single Line Diagram

Annexure-2: IS 2026, IEC 60076 (Technical parameters for Distribution Lines and Transformers)

Annexure-3: The details on load forecast methodology

Annexure-4: Detailed Simulation Results

Annexure 5: Feeder Wise Reliability Indices

Annexure-6: Material Cost for Upgrading single phase (11 kV and 33 kV) Lines to three-phase

Annexure 7: Distribution Transformer loading

Annexure-8: Material Cost of three phase (3Φ) Transformers

13. References

1. The FWPL and CPL from TD, BPC as of 2018.
2. BPC Power Data Book 2018.
3. BPC Distribution Design and Construction Standards (DDCS)-2016.
4. BPC Smart Grid Master Plan (2019-2027).
5. BPC National Transmission Grid Master Plan (2020 & 2030).
6. BPC Operation and Maintenance Manual for Distribution System (2012).
7. BPC Corporate Strategic Plan (2019-2030).
8. Population and Housing Census of Bhutan 2019.
9. The Structural Plan (2004-2027) for every Dzongkhag.
10. Industrial Parks (Department of Industry).
11. BPC Electrical Schedule of Rates 2015.

14. Assumptions

1. All the distribution network was considered as Balanced System (Restriction with the existing ETAP Key);
2. All DTs considered as lump load and depending upon the type of load connected to the feeder, ratio of 80% (static load) to 20% (industrial feeders) were assumed;
3. The voltage level of ±10% is given as critical value which is indicated by red color while simulating and voltage level of ±5% is given as marginal value which is indicated by pink color while simulating.
4. The typical inbuilt value of X/R ratio of ETAP tool was considered for all the transformers;
5. Dimensions and parameters of some cables/UG cables are customized in the library as per the requirement;
6. The technical parameters which are required for analysis of the distribution network have been considered as per the set standard of DDCS.

15. Challenges

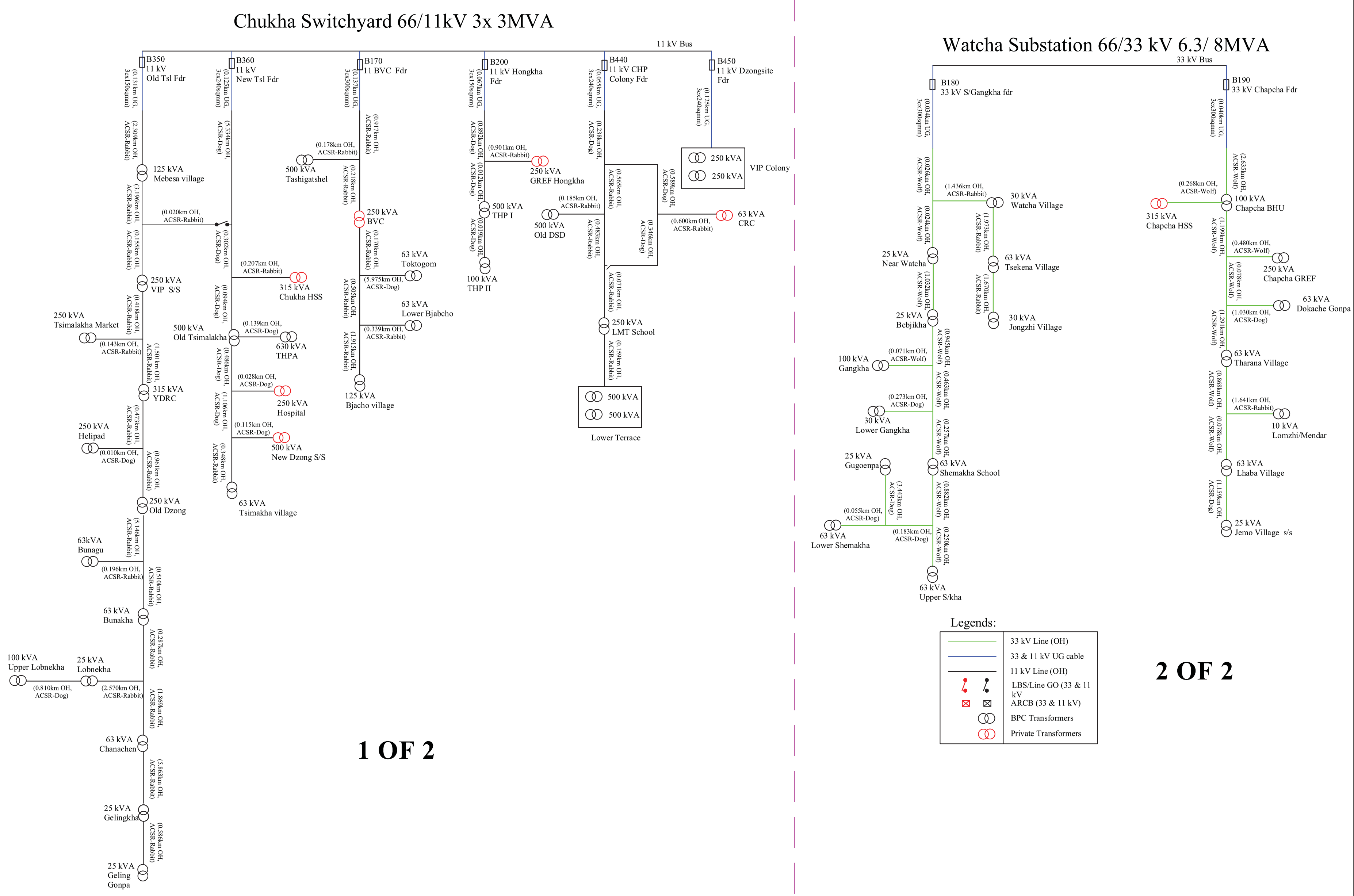
Sl. No.	Parameters	Challenges	Opportunities/Proposals
1	Software Tool (ETAP)	a) Only one key & offline Key	a) Can opt for on line key with fewer more modules specially to carry out the technical evaluation of un-balanced load flow system. This would be more applicable and accrue good result for LV networks.
		a) Balanced Load Flow	
		b) Limitations of No. of buses (1000)	
2	Data	a) No recorded data (reliability & energy) on the out-going feeders of MV SS	a) Feeder Meters could be install for outgoing feeders of MV substations to record actual data (reliability & energy)
		b) Peak Load data of DTs which were recorded	b) In order to get the accurate Transformer Load Management

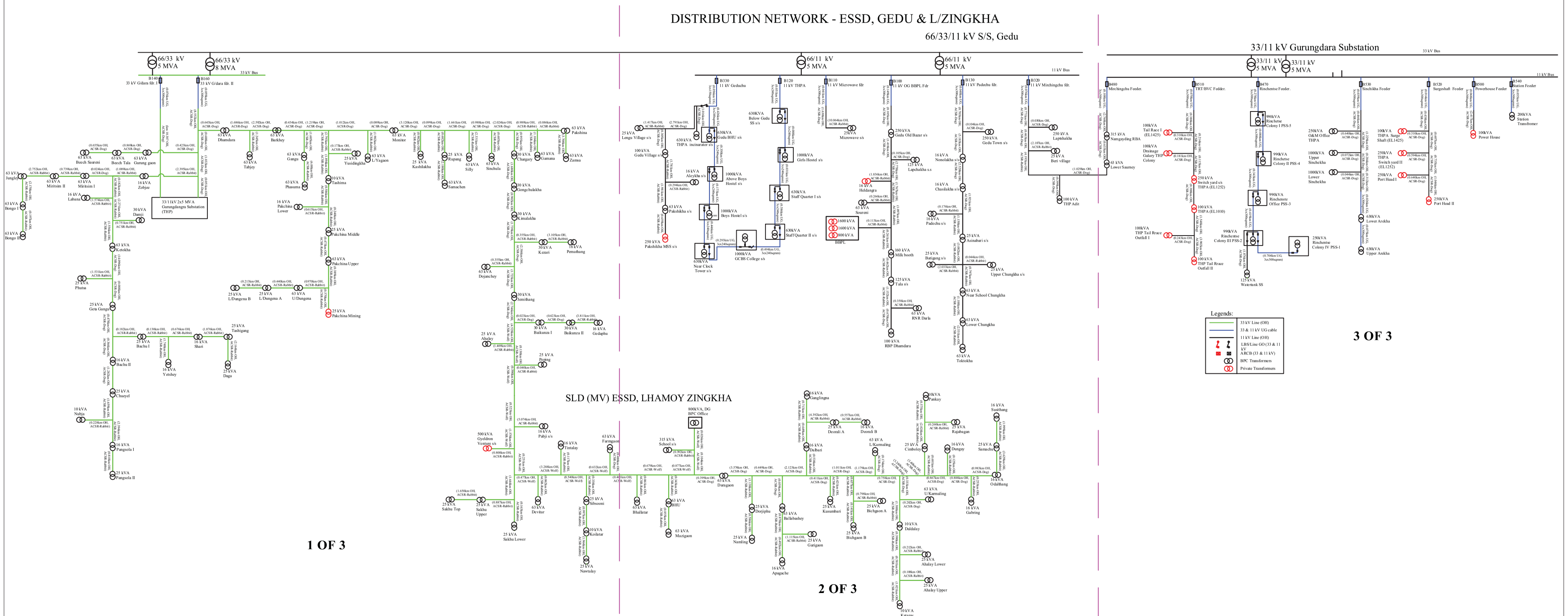
Sl. No.	Parameters	Challenges	Opportunities/Proposals
		manually may be inaccurate due to timing and number of DTs.	(TLM)/loading, it is proposed to install DT meters which could also have additional features to capture other required information.
		c) No proper feeder and DT wise Customer Mapping recorded	c) Customer Information System (CIS) of the feeder/DT would enable to have proper TLM and replacement framework.
3	Manpower	a) Resource gap in terms of trained (ETAP) and adequate engineers (numbers)	a) Due to lesser number of trained engineers in the relevant fields (software), engineers from other areas were involved.

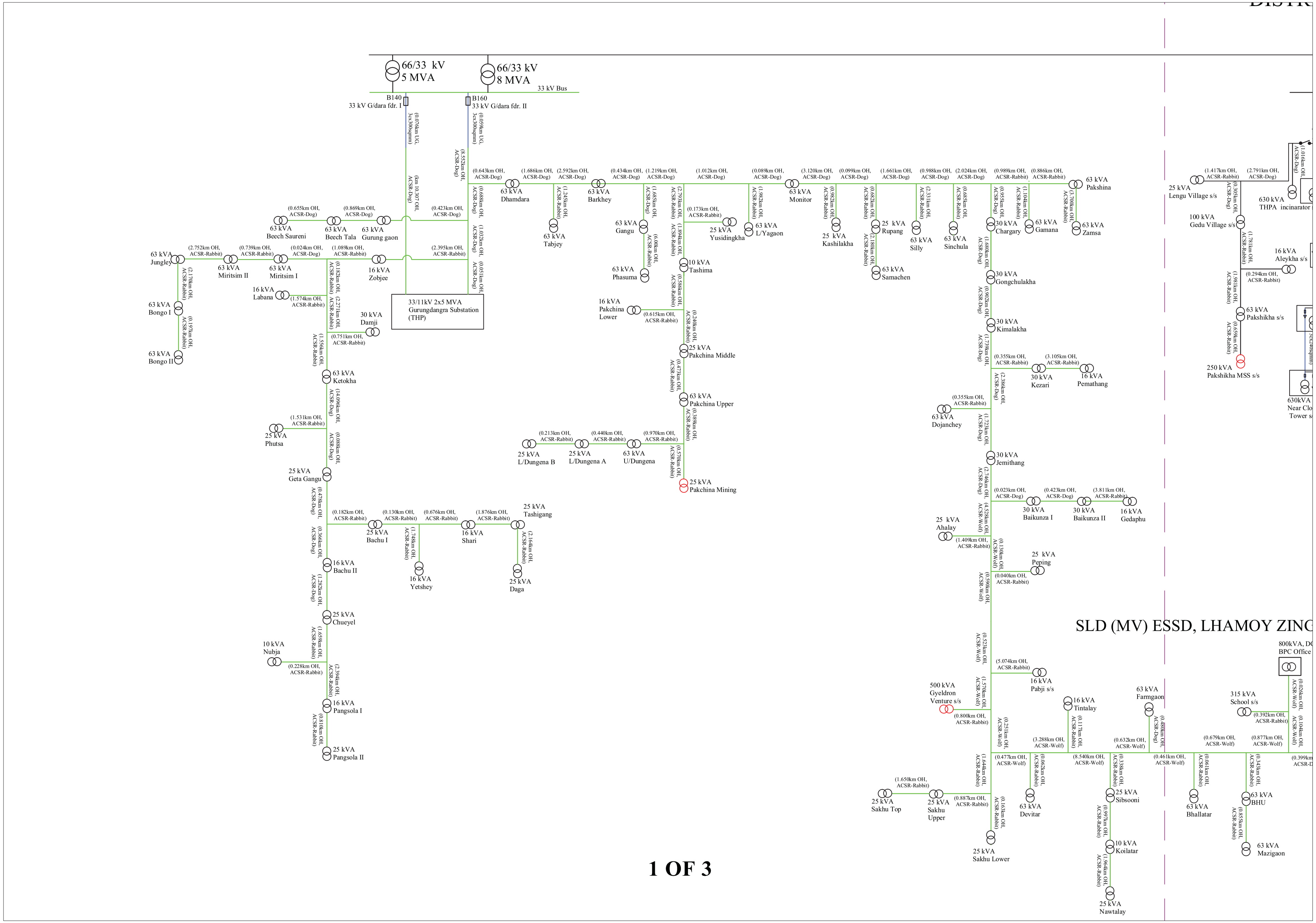
12. Annexures

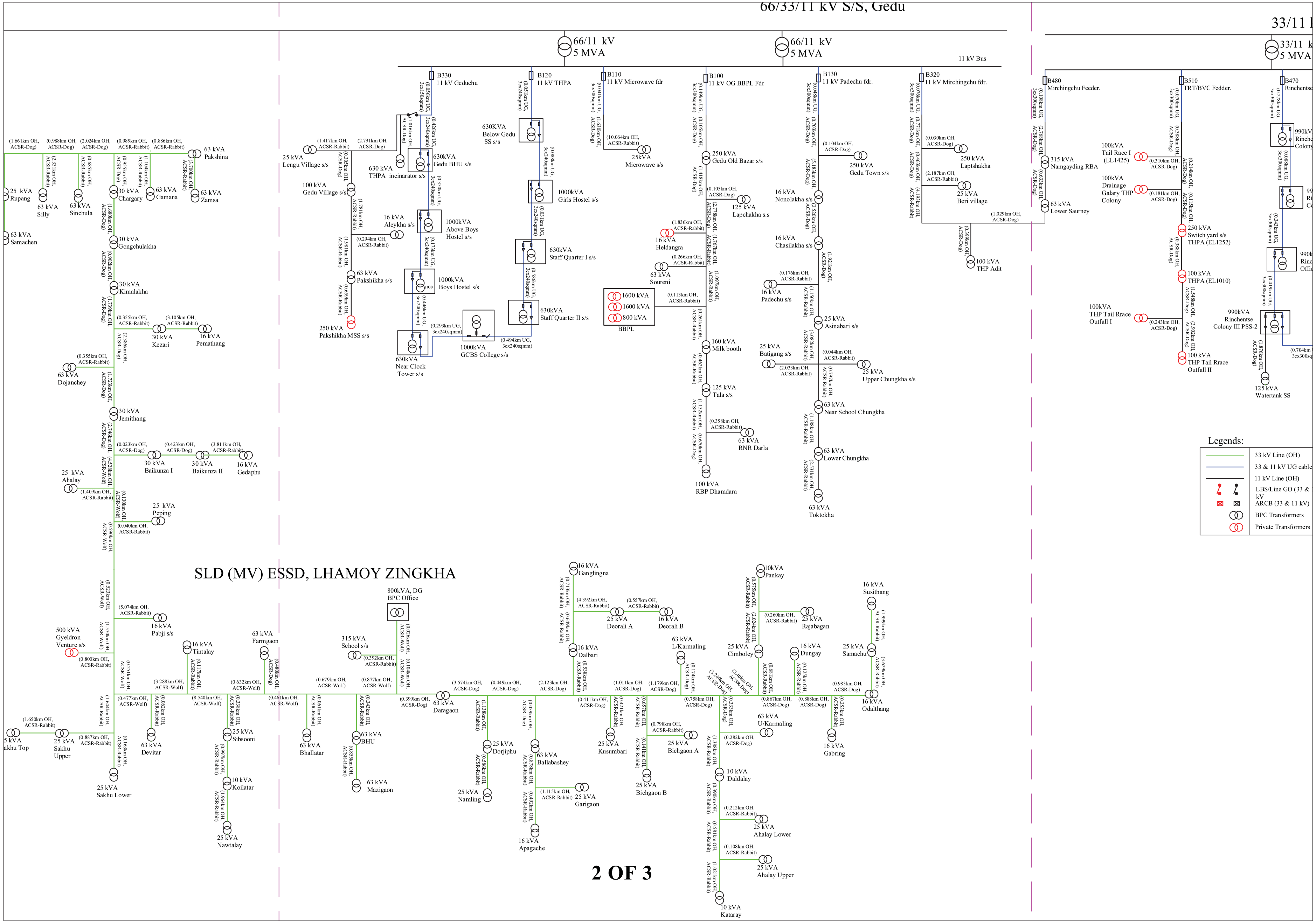
Annexure-1: MV Line Details and Single Line Diagram

DISTRIBUTION NETWORK - ESSD, TSIMALAKHA



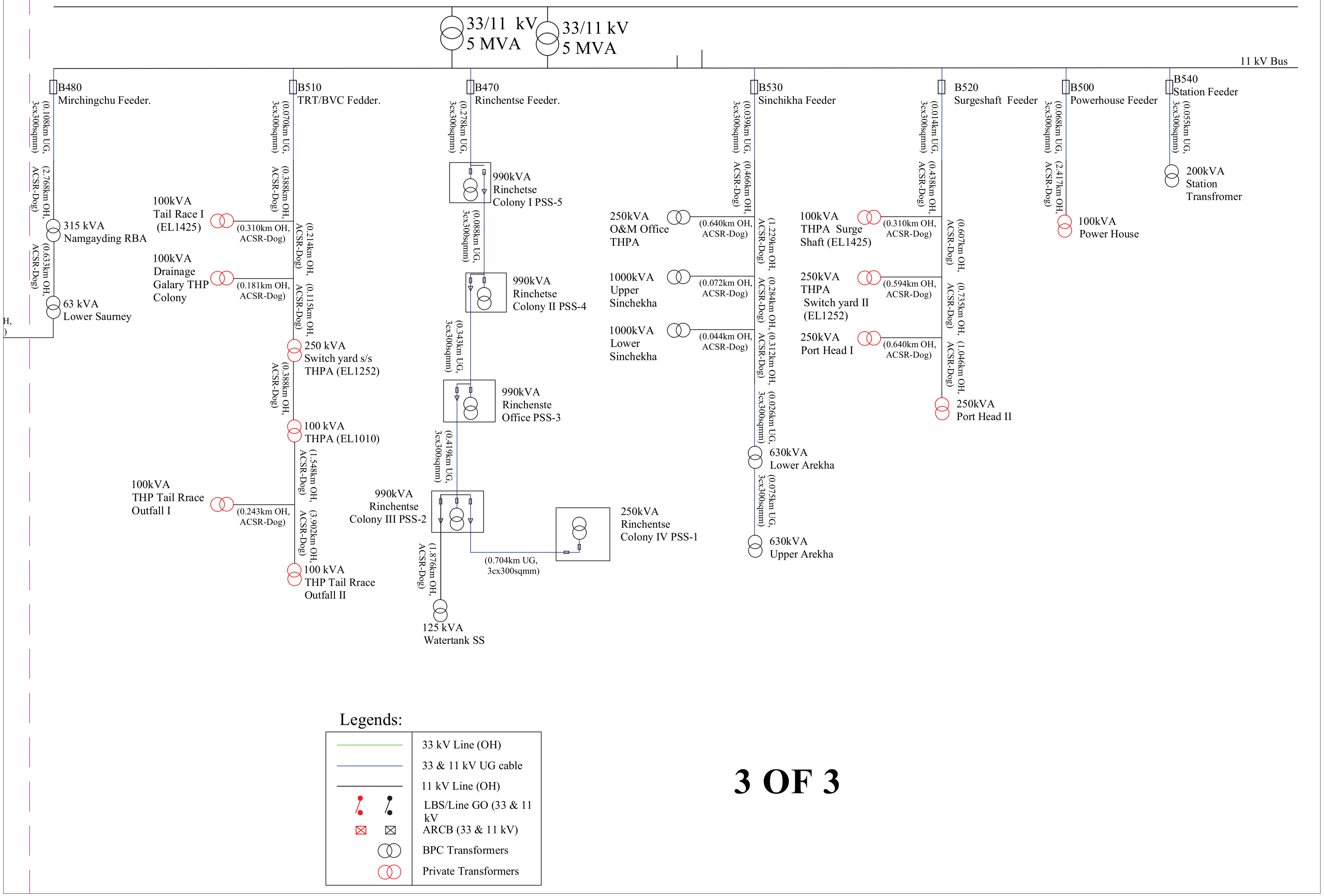

DISTRIBUTION NETWORK - ESSD, GEDU & L/ZINGKHA
66/33/11 kV S/S, Gedu
33/11 kV Gurungdara Substation
SLD (MV) ESSD, LHAMOY ZINGKHA
66/33 kV 5 MVA
66/33 kV 8 MVA
66/11 kV 5 MVA
33/11 kV 5 MVA
33/11kV 2x5 MVA Gurungdara Substation (THP)
600kVA, DG BPC Office
Legends:
33 kV Line (OH)
33 & 11 kV UG cable
11 kV Line (OH)
LBS/Line OD (33 & 11 kV)
ASCB (33 & 11 kV)
BPC Transformers
Private Transformers
1 OF 3
2 OF 3
3 OF 3


SLD (MV) ESSD, LHAMOY ZINC
1 OF 3
66/33 kV
5 MVA
66/33 kV
8 MVA
33 kV Bus
B140
33 kV G/dara fdr. I
B160
33 kV G/dara fdr. II
(0.076km UG, 3cx300sqmm)
(0.059km UG, 3cx300sqmm)
(km 10.307 OH, ACSR-Dog)
(8.552km OH, ACSR-Dog)
33/11kV 2x5 MVA Gurungdangra Substation (THP)
63 kVA Dhamdara
63 kVA Tabjey
63 kVA Barkhey
63 kVA Gangu
63 kVA Phasuma
25 kVA Yusidingkha
10 kVA Tashima
16 kVA Pakchina Lower
25 kVA Pakchina Middle
63 kVA Pakchina Upper
25 kVA Pakchina Mining
63 kVA U/Dungena
25 kVA L/Dungena A
25 kVA L/Dungena B
63 kVA L/Yagaon
63 kVA Monitor
25 kVA Kashilakha
25 kVA Rupang
63 kVA Samachen
63 kVA Silly
63 kVA Sinchula
30 kVA Chargary
63 kVA Gamana
63 kVA Pakshina
63 kVA Zamsa
30 kVA Gongchulakha
30 kVA Kimalakha
30 kVA Kezari
16 kVA Pemathang
63 kVA Dojanchey
30 kVA Jemithang
30 kVA Baikunza I
30 kVA Baikunza II
16 kVA Gedaphu
25 kVA Ahalay
25 kVA Peping
16 kVA Pabji s/s
500 kVA Gyeldron Venture s/s
16 kVA Tintalay
63 kVA Devitar
25 kVA Sakhu Lower
25 kVA Sakhu Upper
25 kVA Sakhu Top
25 kVA Sibsooni
10 kVA Koilatar
25 kVA Nawtalay
63 kVA Farmgaon
63 kVA Bhallatar
63 kVA BHU
63 kVA Mazigaon
315 kVA School s/s
800kVA, DC BPC Office
25 kVA Lengu Village s/s
100 kVA Gedu Village s/s
630 kVA THPA incinarator
16 kVA Aleykha s/s
63 kVA Pakshikha s/s
250 kVA Pakshikha MSS s/s
630kVA Near Clo Tower s
63 kVA Gurung gaon
63 kVA Beech Tala
63 kVA Beech Saureni
16 kVA Zobjee
63 kVA Miritsim I
63 kVA Miritsim II
16 kVA Labana
63 kVA Jungley
63 kVA Bongo I
63 kVA Bongo II
30 kVA Damji
63 kVA Ketokha
25 kVA Phutsa
25 kVA Geta Gangu
25 kVA Bachu I
16 kVA Bachu II
16 kVA Yetshey
16 kVA Shari
25 kVA Tashigang
25 kVA Daga
25 kVA Chueyel
10 kVA Nubja
16 kVA Pangsola I
25 kVA Pangsola II
(14.096km OH, ACSR-Dog)
(6.00km OH, ACSR-Rabbit)



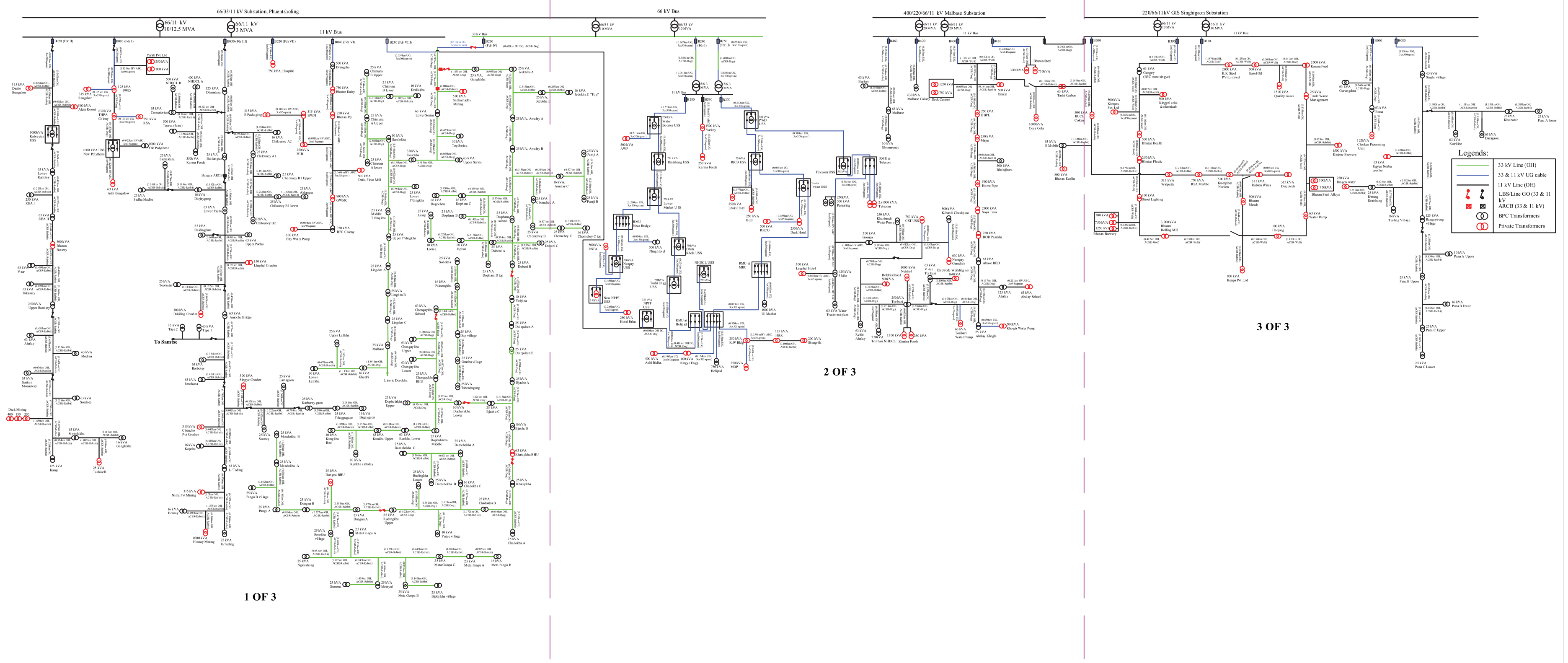
66/33/11 kV S/S, Gedu
33/11
66/11 kV
5 MVA
66/11 kV
5 MVA
33/11 kV
5 MVA
11 kV Bus
B330
11 kV Geduchu
B120
11 kV THPA
B110
11 kV Microwave fdr
B100
11 kV OG BBPL Fdr
B130
11 kV Padechu fdr.
B320
11 kV Mirchingchu fdr.
B480
Mirchingchu Feeder.
B510
TRT/BVC Fedder.
B470
Rinchentse
630KVA
Below Gedu
SS s/s
630 kVA
Gedu BHU s/s
630 kVA
THPA incinarator s/s
1000kVA
Girls Hostel s/s
1000kVA
Above Boys
Hostel s/s
1000kVA
Boys Hostel s/s
630kVA
Staff Quarter I s/s
630kVA
Staff Quarter II s/s
1000kVA
GCBS College s/s
630kVA
Near Clock
Tower s/s
16 kVA
Aleykha s/s
63 kVA
Pakshikha s/s
250 kVA
Pakshikha MSS s/s
25 kVA
Lengu Village s/s
100 kVA
Gedu Village s/s
25kVA
Microwave s/s
250 kVA
Gedu Old Bazar s/s
125 kVA
Lapchakha s.s
16 kVA
Heldangra
63 kVA
Soureni
1600 kVA
1600 kVA
800 kVA
BBPL
160 kVA
Milk booth
125 kVA
Tala s/s
63 kVA
RNR Darla
100 kVA
RBP Dhamdara
250 kVA
Gedu Town s/s
16 kVA
Nonolakha s/s
16 kVA
Chasilakha s/s
16 kVA
Padechu s/s
25 kVA
Asinabari s/s
25 kVA
Batigang s/s
25 kVA
Upper Chungkha s/s
63 kVA
Near School Chungkha
63 kVA
Lower Chungkha
63 kVA
Toktokha
250 kVA
Laptshakha
25 kVA
Beri village
100 kVA
THP Adit
315 kVA
Namgayding RBA
63 kVA
Lower Saurney
100kVA
Tail Race I
(EL1425)
100kVA
Drainage
Galary THP
Colony
250 kVA
Switch yard s/s
THPA (EL1252)
100 kVA
THPA (EL1010)
100kVA
THP Tail Rrace
Outfall I
100 kVA
THP Tail Rrace
Outfall II
990kVA
Rinchentse
Colony III PSS-2
125 kVA
Watertank SS
Legends:
33 kV Line (OH)
33 & 11 kV UG cable
11 kV Line (OH)
LBS/Line GO (33 & 11 kV)
ARCB (33 & 11 kV)
BPC Transformers
Private Transformers
63 kVA
Pakshina
25 kVA
Rupang
63 kVA
Silly
63 kVA
Sinchula
30 kVA
Chargary
63 kVA
Gamana
63 kVA
Zamsa
63 kVA
Samachen
30 kVA
Gongchulakha
30 kVA
Kimalakha
30 kVA
Kezari
16 kVA
Pemathang
63 kVA
Dojanchey
30 kVA
Jemithang
30 kVA
Baikunza I
30 kVA
Baikunza II
16 kVA
Gedaphu
25 kVA
Ahalay
25 kVA
Peping
SLD (MV) ESSD, LHAMOY ZINGKHA
800kVA, DG
BPC Office
16 kVA
Pabji s/s
500 kVA
Gyeldron
Venture s/s
16 kVA
Tintalay
63 kVA
Farmgaon
315 kVA
School s/s
63 kVA
Daragaon
5 kVA
Sakhu Top
25 kVA
Sakhu
Upper
25 kVA
Sakhu Lower
63 kVA
Devitar
25 kVA
Sibsooni
10 kVA
Koilatar
25 kVA
Nawtalay
63 kVA
Bhallatar
63 kVA
BHU
63 kVA
Mazigaon
25 kVA
Dorjiphu
25 kVA
Namling
63 kVA
Ballabashey
25 kVA
Garigaon
16 kVA
Apagache
16 kVA
Ganglingna
25 kVA
Deorali A
16 kVA
Deorali B
16 kVA
Dalbari
25 kVA
Kusumbari
63 kVA
L/Karmaling
25 kVA
Bichgaon A
25 kVA
Bichgaon B
10kVA
Pankay
25 kVA
Rajabagan
25 kVA
Cimboley
16 kVA
Dungay
63 kVA
U/Karmaling
10 kVA
Daldalay
25 kVA
Ahalay Lower
25 kVA
Ahalay Upper
10 kVA
Kataray
16 kVA
Susithang
25 kVA
Samachu
16 kVA
Odalthang
16 kVA
Gabring
2 OF 3

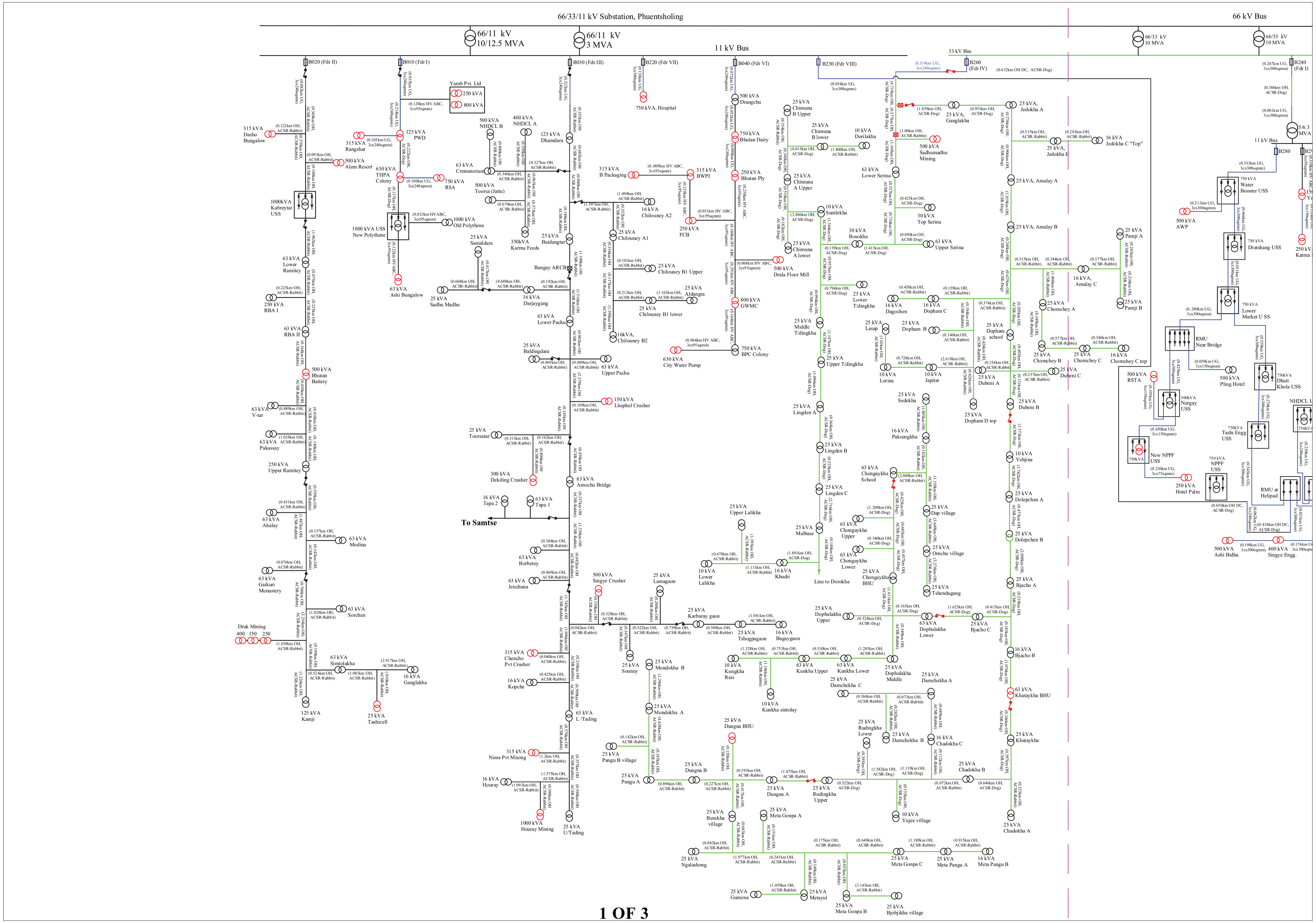
33/11 kV Gurungdara Substation

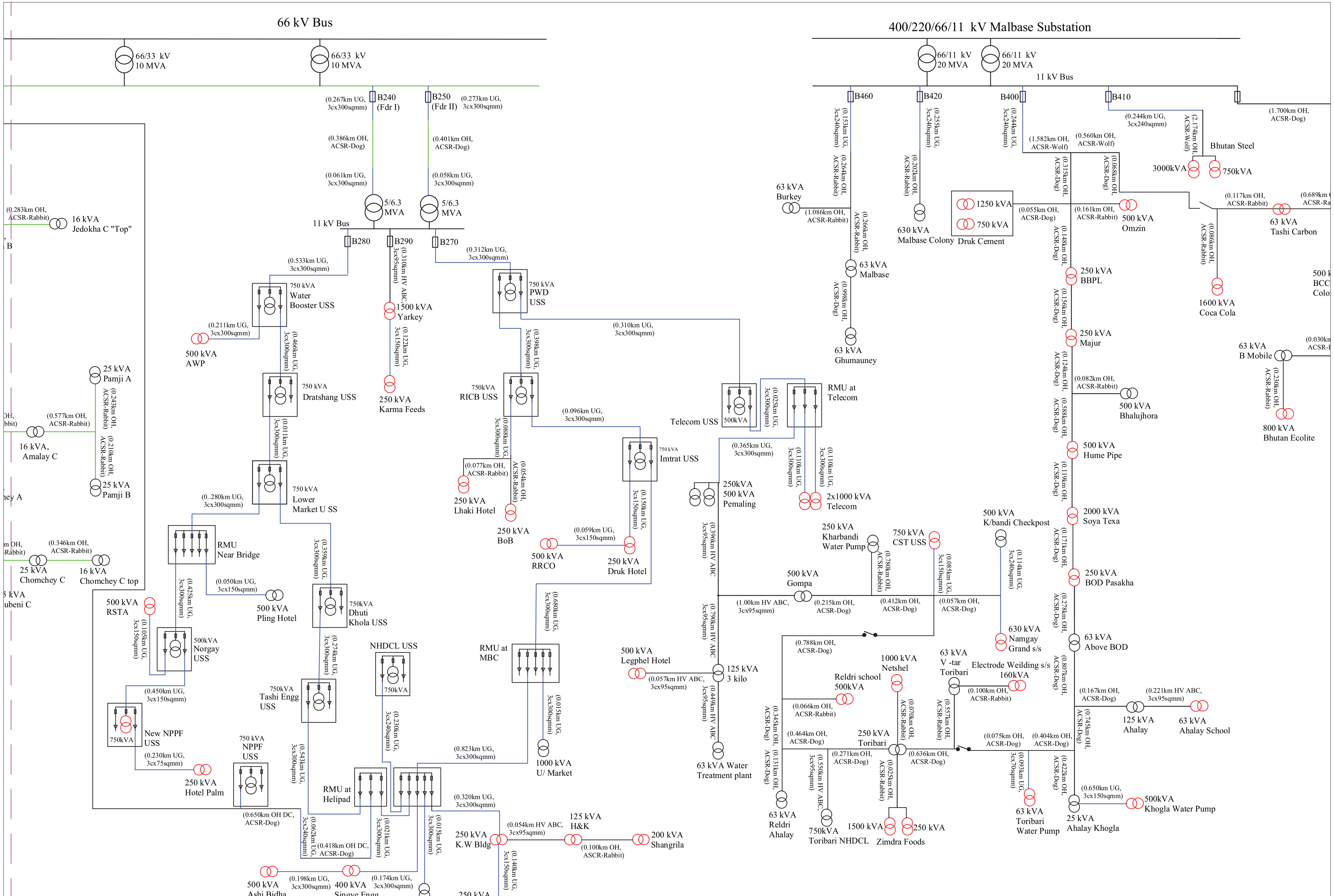


3 OF 3

DISTRIBUTION NETWORK OF ESD, PHUENTSHOLING

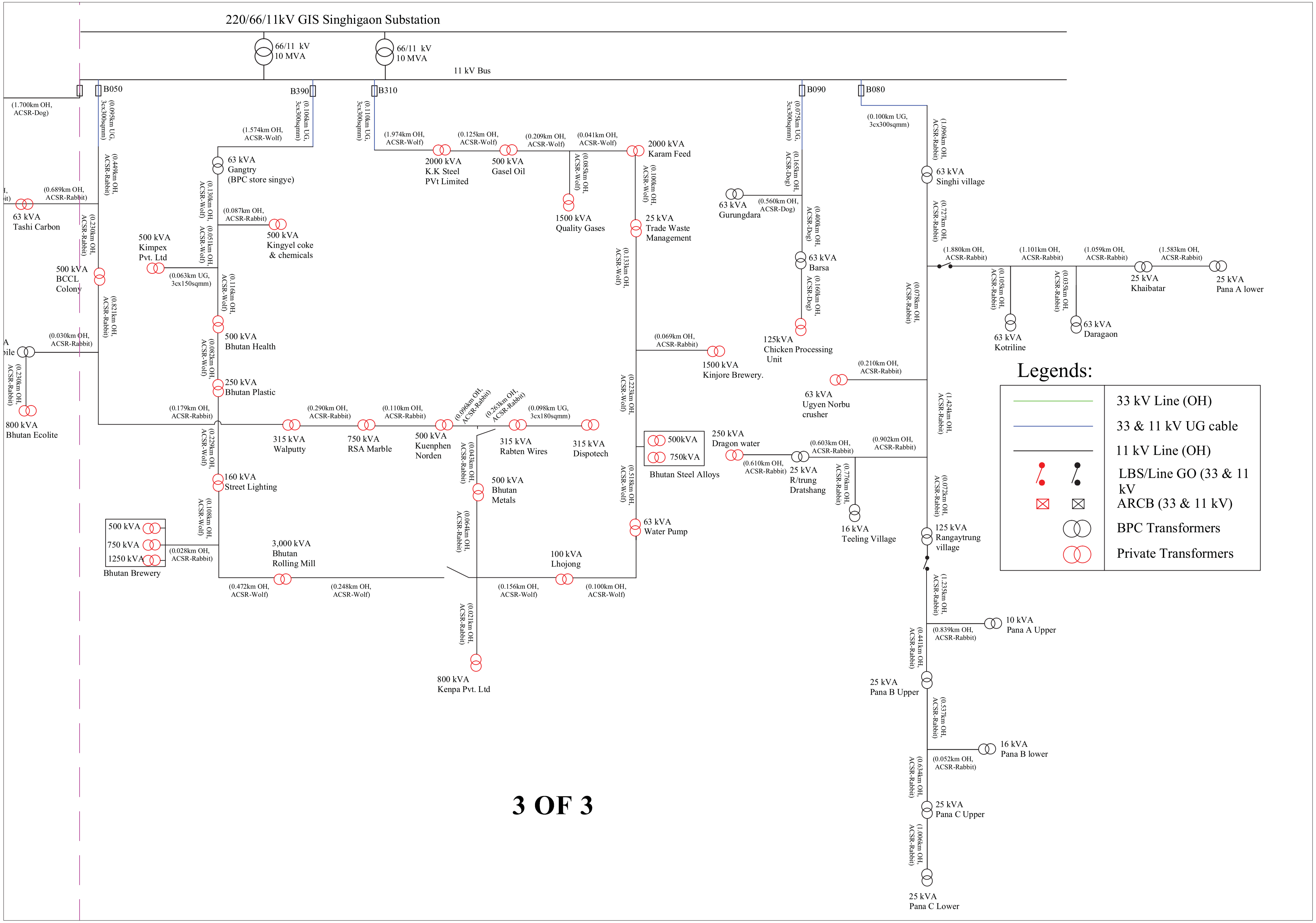



66/33/11 kV Substation, Phuentsholing
66 kV Bus
66/11 kV
10/12.5 MVA
66/11 kV
3 MVA
11 kV Bus
33 kV Bus
66/33 kV
10 MVA
66/33 kV
10 MVA
To Samtse
1 OF 3



66 kV Bus
66/33 kV 10 MVA
66/33 kV 10 MVA
B240 (Fdr I)
B250 (Fdr II)
5/6.3 MVA
5/6.3 MVA
11 kV Bus
B280
B290
B270
750 kVA Water Booster USS
500 kVA AWP
1500 kVA Yarkey
250 kVA Karma Feeds
750 kVA PWD USS
750 kVA Dratshang USS
750kVA RICB USS
250 kVA Lhaki Hotel
250 kVA BoB
750 kVA Lower Market U SS
RMU Near Bridge
500 kVA Pling Hotel
750kVA Dhuti Khola USS
NHDCL USS
750kVA Tashi Engg USS
500kVA Norgay USS
500 kVA RSTA
New NPPF USS
750 kVA NPPF USS
250 kVA Hotel Palm
RMU at Helipad
750 kVA Helipad
250 kVA MDP
250 kVA K.W Bldg
125 kVA H&K
200 kVA Shangrila
500 kVA Ashi Bidha.
400 kVA Singye Engg.
RMU at MBC
1000 kVA U/ Market
750 kVA Imtrat USS
500 kVA RRCO
250 kVA Druk Hotel
Telecom USS
RMU at Telecom
2x1000 kVA Telecom
250kVA 500 kVA Pemaling
500 kVA Legphel Hotel
125 kVA 3 kilo
63 kVA Water Treatment plant
500 kVA Gompa
250 kVA Kharbandi Water Pump
750 kVA CST USS
500 kVA K/bandi Checkpost
630 kVA Namgay Grand s/s
16 kVA Jedokha C "Top"
25 kVA Pamji A
25 kVA Pamji B
16 kVA, Amalay C
25 kVA Chomchey C
16 kVA Chomchey C top
400/220/66/11 kV Malbase Substation
66/11 kV 20 MVA
66/11 kV 20 MVA
11 kV Bus
B460
B420
B400
B410
63 kVA Burkey
63 kVA Malbase
63 kVA Ghumauney
630 kVA Malbase Colony
1250 kVA
750 kVA
Druk Cement
500 kVA Omzin
250 kVA BBPL
250 kVA Majur
500 kVA Bhalujhora
500 kVA Hume Pipe
2000 kVA Soya Texa
250 kVA BOD Pasakha
63 kVA Above BOD
Bhutan Steel
3000kVA
750kVA
63 kVA Tashi Carbon
1600 kVA Coca Cola
63 kVA B Mobile
800 kVA Bhutan Ecolite
125 kVA Ahalay
63 kVA Ahalay School
500kVA Khogla Water Pump
25 kVA Ahalay Khogla
63 kVA Toribari Water Pump
63 kVA V -tar Toribari
Electrode Weilding s/s 160kVA
1000 kVA Netshel
Reldri school 500kVA
250 kVA Toribari
1500 kVA
250 kVA
Zimdra Foods
750kVA Toribari NHDCL
63 kVA Reldri Ahalay

2 OF 3



220/66/11kV GIS Singhigaon Substation
66/11 kV 10 MVA
66/11 kV 10 MVA
11 kV Bus
B050
B390
B310
B090
B080
(1.700km OH, ACSR-Dog)
(0.095km UG, 3cx300sqmm)
(0.449km OH, ACSR-Rabbit)
(0.689km OH, ACSR-Rabbit)
63 kVA Tashi Carbon
(0.230km OH, ACSR-Rabbit)
500 kVA BCCL Colony
(0.821km OH, ACSR-Rabbit)
(0.030km OH, ACSR-Rabbit)
(0.230km OH, ACSR-Rabbit)
800 kVA Bhutan Ecolite
(0.106km UG, 3cx300sqmm)
(1.574km OH, ACSR-Wolf)
63 kVA Gangtry (BPC store singye)
(0.130km OH, ACSR-Wolf)
(0.087km OH, ACSR-Rabbit)
500 kVA Kingyel coke & chemicals
500 kVA Kimpex Pvt. Ltd
(0.051km OH, ACSR-Wolf)
(0.063km UG, 3cx150sqmm)
(0.116km OH, ACSR-Wolf)
500 kVA Bhutan Health
(0.082km OH, ACSR-Wolf)
250 kVA Bhutan Plastic
(0.179km OH, ACSR-Rabbit)
(0.229km OH, ACSR-Wolf)
160 kVA Street Lighting
(0.108km OH, ACSR-Wolf)
500 kVA
750 kVA
1250 kVA
Bhutan Brewery
(0.028km OH, ACSR-Rabbit)
3,000 kVA Bhutan Rolling Mill
(0.472km OH, ACSR-Wolf)
(0.248km OH, ACSR-Wolf)
(0.290km OH, ACSR-Rabbit)
315 kVA Walputty
(0.110km OH, ACSR-Rabbit)
750 kVA RSA Marble
500 kVA Kuenphen Norden
(0.096km OH, ACSR-Rabbit)
(0.263km OH, ACSR-Rabbit)
315 kVA Rabten Wires
(0.098km UG, 3cx180sqmm)
315 kVA Dispotech
(0.043km OH, ACSR-Rabbit)
500 kVA Bhutan Metals
(0.064km OH, ACSR-Rabbit)
(0.021km OH, ACSR-Rabbit)
800 kVA Kenpa Pvt. Ltd
(0.156km OH, ACSR-Wolf)
100 kVA Lhojong
(0.100km OH, ACSR-Wolf)
(0.110km UG, 3cx300sqmm)
(1.974km OH, ACSR-Wolf)
2000 kVA K.K Steel PVt Limited
(0.125km OH, ACSR-Wolf)
500 kVA Gasel Oil
(0.209km OH, ACSR-Wolf)
(0.085km OH, ACSR-Wolf)
1500 kVA Quality Gases
(0.041km OH, ACSR-Wolf)
2000 kVA Karam Feed
(0.100km OH, ACSR-Wolf)
25 kVA Trade Waste Management
(0.133km OH, ACSR-Wolf)
(0.069km OH, ACSR-Rabbit)
1500 kVA Kinjore Brewery.
(0.223km OH, ACSR-Wolf)
500kVA
750kVA
Bhutan Steel Alloys
(0.518km OH, ACSR-Wolf)
63 kVA Water Pump
(0.075km UG, 3cx300sqmm)
(0.165km OH, ACSR-Dog)
(0.560km OH, ACSR-Dog)
63 kVA Gurungdara
(0.400km OH, ACSR-Dog)
63 kVA Barsa
(0.160km OH, ACSR-Dog)
125kVA Chicken Processing Unit
(0.100km UG, 3cx300sqmm)
(1.096km OH, ACSR-Rabbit)
63 kVA Singhi village
(0.727km OH, ACSR-Rabbit)
(1.880km OH, ACSR-Rabbit)
(0.105km OH, ACSR-Rabbit)
63 kVA Kotriline
(1.101km OH, ACSR-Rabbit)
(0.035km OH, ACSR-Rabbit)
63 kVA Daragaon
(1.059km OH, ACSR-Rabbit)
25 kVA Khaibatar
(1.583km OH, ACSR-Rabbit)
25 kVA Pana A lower
(0.078km OH, ACSR-Rabbit)
(0.210km OH, ACSR-Rabbit)
63 kVA Ugyen Norbu crusher
(1.424km OH, ACSR-Rabbit)
(0.902km OH, ACSR-Rabbit)
(0.603km OH, ACSR-Rabbit)
25 kVA R/trung Dratshang
(0.610km OH, ACSR-Rabbit)
250 kVA Dragon water
(0.776km OH, ACSR-Rabbit)
16 kVA Teeling Village
(0.072km OH, ACSR-Rabbit)
125 kVA Rangaytrung village
(1.235km OH, ACSR-Rabbit)
(0.839km OH, ACSR-Rabbit)
10 kVA Pana A Upper
(0.441km OH, ACSR-Rabbit)
25 kVA Pana B Upper
(0.537km OH, ACSR-Rabbit)
(0.052km OH, ACSR-Rabbit)
16 kVA Pana B lower
(0.634km OH, ACSR-Rabbit)
25 kVA Pana C Upper
(1.006km OH, ACSR-Rabbit)
25 kVA Pana C Lower
Legends:
33 kV Line (OH)
33 & 11 kV UG cable
11 kV Line (OH)
LBS/Line GO (33 & 11 kV
ARCB (33 & 11 kV)
BPC Transformers
Private Transformers

3 OF 3

MV line details of Chukha Dzongkhag

MV line detials of Chukha Dzongkhag

Sl#	Asset Code	Feeder Name	Line Description	Source Substation like TD or 33/11kV substation	Feeder Details: Voltage level(kV)	Feeder Details: UG/Overhead or Mixed	Sl#: Line	Line (Section 1) details: Asset Code	Asset description	Cable / Conductor size(sq.mm)	First GPS code	Final GPS code	Line length (KM)	Location	Termination point	Year of construction	Remarks
1	Not applicable	B180-Shemagangkha	33kV, ACSR-Wolf Overhead line	66/33kV Watsa substation	33	Overhead	Trunk Line	Not applicable	No	150	B180H1	B180H75	3.74	Watsa s/s	Upper Shemakha s/s	1996-97	
		B180-Shemagangkha	33kV, ACSR-Wolf Overhead line	66/33kV Watsa substation	33	Overhead	Spur Line		No	150	B180H36	B180H37	0.07	Gangkha	Gangkha s/s	1996-97	
		B180-Shemagangkha	33kV, ACSR-Wolf Overhead line	66/33kV Watsa substation	33	Overhead	Spur Line		No	150	B180H44	B180H49	0.26	Gangkha	Lower Gangkha s/s	1996-97	
		B180-Shemagangkha	33kV, ACSR-Wolf Overhead line	66/33kV Watsa substation	33	Overhead	Spur Line		No	150	B180H68	B180H71	0.21	Shemakha	Lower Shemakha s/s	1996-97	
2	1600349.00	B180-Gugoenpa	33kV, ACSR-Dog Overhead line	66/33kV Watsa substation	33	Overhead	Spur Line	1600349		100	B180H133	B180H161	4.02	Lower Shemakha	Gugoanpa s/s	2011	
3	1600100.00	B180-Watsa-Jongshi	33kV, ACSR-Rabbit Overhead line	66/33kV Watsa substation	33	Overhead	Trunk Line	1600100		50	B180H76	B180H132	4.08	Watsa	Jongshi s/s	2007	
4	Not applicable	B190-Chapcha	33kV, ACSR-Wolf Overhead line	66/33kV Watsa substation	33	Overhead	Trunk Line	Not applicable	No	150	B190H1	B190H136	5.73	Watsa	Lhaba s/s	2003	
		B190-Chapcha	33kV, ACSR-Wolf Overhead line	66/33kV Watsa substation	33	Overhead	Spur Line		No	150	B190H76	B190H155	0.45	Chapcha	Chapcha GREF s/s	2005	
		B190-Chapcha	33kV, ACSR-Dog Overhead line	66/33kV Watsa substation	33	Overhead	Spur Line		No	100	B190H77	B190H95	0.95	Chapcha	Dokache Goenpa s/s	1996-97	
5	1600095	B190-Lhaba-Jemo	33kV, ACSR-Dog Overhead line	66/33kV Watsa substation	33	Overhead	Spur Line	1600095		100	B190H136	B190H154	1.35	Lhaba	Jemo s/s	2003	
6	1600542.00	B190-Lhaba-Lomzhi Menda	33kV, ACSR-Rabbit Overhead line	66/33kV Watsa substation	33	Overhead	Spur Line	1600542		50	B190H156	B190H167	1.508	Lhaba	Lomzhi Menda	2014	Total Length= 12.256km & 10.748km under ESD Haa (Project Pakage B-7)
7	17040.00	Gate Chamder, Chukha	11kV, ASCR-Rabbit and Dog Overhead	Chukha Switchyard	11	Overhead	Trunk	17040		100/50	GPS not done	GPS not done	4.77	Chkha Switchyard Gantry	Gate Chamber s/s	2016	Asset taken over from DGPC
8	17041.00	B200-Wangkha (GREF-THPA Colony)	11kV, ACSR-Dog/Rabbit Overhead line	Chukha Switchyard	11	Mixed	Trunk Line	17041		100/50	B200H1	B200H33	1.72	Chukha Switchyard gantry	Wangkha GREF s/s	2016	
		B200-Wangkha (GREF-THPA Colony)	11kV, ACSR-Dogt Overhead line	Chukha Switchyard	11	Overhead	Spur Line			100	B200H18	B200H20	0.03	THPA T-off	THPA s/s		
		B200-Wangkha (GREF-THPA Colony)	11kV, ACSR-Rabbit Overhead line	Chukha Switchyard	11	Mixed	Spur Line			50	B200H003	B200H008	0.41	Wangkha GREF T-off	THPA Wangkha colony s/s		
9	1700317.00	B440-CHPC Colony	11kV, ACSR-Dog/Rabbit Overhead line	Chukha Switchyard	11	Overhead	Trunk Line	1700317		100/50	B440H1	B440H17	1.223	Chukha Switchyard gantry	CHPC Lower Terrace s/s	2002	
		B440-CHPC Colony	11kV, ACSR-Rabbit Overhead line	Chukha Switchyard	11	Overhead	Spur Line			50	B440H9	B440H20	0.16	OLD/DSD T-off (CHPC)	OLD/DSD s/s (CHPC)		
10	1700587.00	B440-Tie-Line (CHPC Colony)	11kV, ACSR-Dog Overhead Tie-line	Chukha Switchyard	11	Overhead	Tie Line	1700587		100	B440H003	B440H032	1.235	Near Security barrack (CHPC colony Tapping)	Near Wangkha school s/s	2011	
11	1700312.00	B170-Tashigatshel-Bjabcho	11kV, ACSR-Rabbit Overhead line	Chukha Switchyard	11	Overhead	Trunk Line	1700312		50	B170H1	B170H35	2.83	Chukha Switchyard gantry	Bjabcho s/s	2002	
12		B170-Tashigatshel-Bjabcho	11kV, ACSR-Rabbit Overhead line	Chukha Switchyard	11	Overhead	Spur Line			50	B170H9	B170H11	0.17	Tasgigatshel T-off	Tashigatshel s/s		
13	Not applicable	B170-Tashigatshel-Toktogom	11kV, ACSR-DogOverhead line	Chukha Switchyard	11	Overhead	Spur Line	Not applicable	No	100	B170H16	B170H100	5.7	Toktogom T-off	Toktogom s/s	2011	Asset taken over from DGPC
14	1700650.00	B170-Tie-Line (Tashigatshel-Bjabc	11kV, ACSR-Rabbit Overhead Tie-line	Chukha Switchyard	11	Overhead	Tie-Line	1700650		50	B170H11	GPS not done	0.84	Tashigatshel s/s	Road side (shortcut way to BVC s/s)	2012	
15	17090.00	B170-Tie-Line (Tashigatshel-Bjabcho)	11kV, ACSR-Rabbit Overhead Tie-line	Chukha Switchyard	11	Overhead	Tie-Line	17090		50	GPS not done	GPS not done	0.095	Road side (shortcut way to BVC s/s)	Trunk line to Bjabcho (below surge shaft)	2016	
16	17089.00	B170-Lower Bjabcho	11kV, ACSR-Rabbit Overhead line	Chukha Switchyard	11	Overhead	Spur Line	17089		50	B170H37	GPS not done	0.339	Lower Bjabcho T-off	Lower Bjabcho s/s	2016	
17	1700114.00	B360-New Tsimalakha	11kV, ACSR-Dog Overhead line	Chukha Switchyard	11	Overhead	Trunk Line	1700114		100	B360H1	B360H83	6.837	Chukha Switchyard gantry	Tsimalakha Zero	2008	
		B360-New Tsimalakha	11kV, ACSR-Rabbit Overhead line	Chukha Switchyard	11	Overhead	Spur Line			50	B360H66	B360H91	0.34	Chukha SS T-off	Chukha SS s/s		
		B360-New Tsimalakha	11kV, ACSR-Dog Overhead line	Chukha Switchyard	11	Overhead	Spur Line			100	B360H74	B360H75	0.03	Tsimalakha Hospital T-off	Tsimalakha Hospital s/s		
		B360-New Tsimalakha	11kV, ACSR-Dog Overhead line	Chukha Switchyard	11	Overhead	Spur Line			100	B360H99	B360H101	0.12	Tsimakha village tapping	New Dzong s/s		
18	1700651.00	B-360Tsimakha	11kV, ACSR-Rabbit Overhead line	Chukha Switchyard	11	Overhead	Spur Line	1700651		50	B360H99	B360H107	0.25	Lower Tsimakha	Tsimakha s/s	2012	
19	1700103.00	B350-Old Tsimalakha	11kV, ACSR-Rabbit Overhead line	Chukha Switchyard	11	Overhead	Trunk Line	1700103		50	B350H1	B350H63	6.25	Chukha Switchyard gantry	Tsimalakha Market s/s	2003	
20	1700100.00	B350-Tsimalakha - Tsimasham	11kV, ACSR-Rabbit Overhead line	Chukha Switchyard	11	Overhead	Trunk Line	1700100		50	B350H61	B350H96	3.36	Tsimalakha Market T-off	Tsimasham Police camp	2003	
		B350-Tsimalakha - Tsimasham	11kV, ACSR-Rabbit Overhead line	Chukha Switchyard	11	Overhead	Spur Line			50	B350H84	B350H182	0.01	Helipad T-off (Tsimasham)	Helipad s/s (Tismasham)		
21	1700101.00	B350-Tsimasham- Lobnekha	11kV, ACSR-Rabbit Overhead line	Chukha Switchyard	11	Overhead	Trunk Line	1700101		50	B350H96	B350H108	1.65	Tsimasham Police camp	Pole No.B350H108 (On the way to Bunagu)	2003	
22	Not applicable	B350-Tsimasham- Lobnekha	11kV, ACSR-Rabbit Overhead line	Chukha Switchyard	11	Overhead	Trunk Line	Not applicable	No	50	B350H108	B350H140	3.868	Pole No.B350H108 (On the way to Bunagu)	Bunagu T-off	2003	
		B350-Tsimasham- Lobnekha	11kV, ACSR-Rabbit Overhead line	Chukha Switchyard	11	Overhead	Spur Line		No	50	B350H140	B350H176	3.38	Bunagu T-off	Lobnekha s/s		
23	17088.00	B350-Bunakha Village	11kV, ACSR-Rabbit Overhead line	Chukha Switchyard	11	Overhead	Trunk Line	17088		50	B350H135	GPS not done	0.196	Bunakha T-off	Bunakha s/s	2016	
24	1700603.00	B350-Chanachen	11kV, ACSR-Rabbit Overhead line	66/33/11kV Phuentsholing substation	11	Overhead	Trunk Line	1700603		50	B350H140	B350H204	2.12	Bunagu	Chanachen s/s	2011	
		B30-Chilouney	11kV, ACSR-Rabbit Overhead line	66/33/11kV Phuentsholing substation	11	Overhead	Trunk Line			50	B30H27	B30H179	4.12	Baidangtar	Chilouney B2 s/s		
		B30-Chilouney	11kV, ACSR-Rabbit Overhead line	66/33/11kV Phuentsholing substation	11	Overhead	Spur Line			50	B30H147	B30H160	2.12	Chilouney A2 T-off	Chilouney A2 s/s		
		B30-Chilouney	11kV, ACSR-Rabbit Overhead line	66/33/11kV Phuentsholing substation	11	Overhead	Spur Line			50	B30H165	B30H167	0.263	Chilouney B1 Upper T-off	Chilouney B1 Upper s/s		
		B30-Chilouney	11kV, ACSR-Rabbit Overhead line	66/33/11kV Phuentsholing substation	11	Overhead	Spur Line			50	B30H169	B30H171	0.212	Chilouney B1 LowerT-off	Chilouney B1 Lower s/s		
		B30-Samaldangra	11kV, ACSR-Rabbit Overhead line	66/33/11kV Phuentsholing substation	11	Overhead	Spur Line			50	B30H49	B30H58	0.42	Samaldangra T-off	Samaldangra s/s		
		B30-Toorsatar	11kV, ACSR-Rabbit Overhead line	66/33/11kV Phuentsholing substation	11	Overhead	Spur Line			50	B30H111	B30H186	0.58	Toosatar T-off	Toorsatar s/s		
		B20-Sorchen	11kV, ACSR-Rabbit Overhead line	66/33/11kV Phuentsholing substation	11	Overhead	Spur Line			50	B20H130	B20H138	1.32	Sorchen T-off	Sorchen s/s		
		B20-Kamji	11kV, ACSR-Rabbit Overhead line	66/33/11kV Phuentsholing substation	11	Overhead	Spur Line			50	B20H162	B20H180	1.56	Kamji T-off	Kamji s/s		
		B20-Simtolakha	11kV, ACSR-Rabbit Overhead line	66/33/11kV Phuentsholing substation	11	Overhead	Trunk Line			50	B20H121	B20H167	3.7	Gaiguri	Sintolakha s/s		
25	1700775.00	B350-Geling	11kV, ACSR-Rabbit Overhead line	Chukha Switchyard	11	Overhead	Spur Line	1700775		50	B350H204	B350H245	7.516	Chanachen	Geling goenpa s/s	2014	

MV line detials of Chukha Dzongkhag

Sl#	Asset Code	Feeder Name	Line Description	Source Substation like TD or 33/11kV substation	Feeder Details		Sl#	Line (Section 1) details									Remarks
					Voltage level(kV)	UG/Overhead or Mixed	Line	Asset Code	Asset description	Cable / Conductor size(sq.mm)	First GPS code	Final GPS code	Line length (KM)	Location	Ternmination point	Year of construction	
26	1700313.00	B350-Chukha Switchyard (Old Tsimalakha Fdr)	11kV, 150sqmm XLPE UG cable line	Chukha Switchyard	11	UG	Trunk Line	1700313		150	66kV s/s Switchyard	B350H1	0.131	66kV s/s switchyard	Chukha Switchyard gantry		
	Not applicable	B360-Chukha Switchyard (New Tsimalakha Fdr)	11kV, 150sqmm XLPE UG cable line	Chukha Switchyard	11	UG	Trunk Line	Not applicable		150	66kV s/s Switchyard	B360H1	0.125	66kV s/s switchyard	Chukha Switchyard gantry	2002	
	Not applicable	B370-Chukha Switchyard (BVC Fdr)	11kV, 150sqmm XLPE UG cable line	Chukha Switchyard	11	UG	Trunk Line	Not applicable		150	66kV s/s Switchyard	B370H1	0.135	66kV s/s switchyard	Chukha Switchyard gantry		
27	1700314.00	B200-Chukha Switchyard (Hongkha Fdr)	11kV, 150sqmm XLPE UG cable line	Chukha Switchyard	11	UG	Trunk Line	1700314		150	66kV s/s Switchyard	B200H1	0.065	66kV s/s switchyard	Chukha Switchyard gantry	2002	
28	1700315.00	B450-Chukha Switchyard (Dzongsite Fdr)	11kV, 2x150sqmm XLPE UG cable line	Chukha Switchyard	11	UG	Trunk Line	1700315		2x150	66kV s/s Switchyard	B450H1	0.242	66kV s/s switchyard	Chukha Switchyard gantry	2002	
29	1700316.00	B440-Chukha Switchyard (Colony Fdr)	11kV, 150sqmm XLPE UG cable line	Chukha Switchyard	11	UG	Trunk Line	1700316		150	66kV s/s Switchyard	B440H1	0.062	66kV s/s switchyard	Chukha Switchyard gantry	2002	
30	1700751.00	B360-THPA Tsimalakha (Above ESSD Office)	11kV, ACSR-Dog Overhead line	Chukha Switchyard	11	Overhead	Spur Line	1700751		100	B360H68	B360H88	0.139	Old Tsimalakha s/s	THPA s/s	2014	Asset taken over from DGPC
31	1600097.00	B130-Pedechu-Chungkha	11kV, ACSR-Dog/Rabbit Overhead line	66/33/11kV Gedu substation	11	Overhead	Trunk Line	1600097		100/50	B130H1	B130H125	10.688	Gedu switchyard gantry	Pedechu T-off	2007	Total Length= 20.08km & 5.428km is dismantled and rerouted in 2011.
		B130-Pedechu-Chungkha	11kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	11	Overhead	Spur Line			50	B130H125	B130H264	0.175	Pedechu T-off	Pedechu s/s		
		B130-Pedechu-Chungkha	11kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	11	Overhead	Spur Line			50	B130H168	B130H169	0.04	Chungkha T-off	Upper Chungkha s/s		
		B130-Pedechu-Chungkha	11kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	11	Overhead	Spur Line			50	B130H168	B130H197	1.829	Chungkha	Bangtigang s/s		
		B130-Pedechu-Chungkha	11kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	11	Overhead	Spur Line			50	B130H168	B130H227	1.92	Chungkha T-off	Lower Chungkha s/s		
32	1700586.00	B130-Pedechu-Chungkha Rerouting	11kV, ACSR Rabbit overhead line	66/33/11kV Gedu substation	11	Overhead	Trunk Line	1700586		50	B130H125	B130H168	4.65	Padechu tap off	Bangtigang tapoff	2011	
33	1700116.00	B130-Gedu new town	11kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	11	Overhead	Spur Line	1700116		50	B130H14	B130H16	0.16	Gedu new town T-off	Gedu new town s/s	2008	
34	1700112.00	B130-Totokha & Beri	11kV, ACSR-Dog Overhead line	66/33/11kV Gedu substation	11	Overhead	Spur Line	1700112		100	B130H160	B130H261	3.17	Chungkha Lower	Totokha s/s	2007	
		B320-Totokha & Beri	11kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	11	Overhead	Spur Line			50	B320H21	B320H50	2.08	Beri T-off	Beri s/s		
35	1700365.00	B110-Microwave	11kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	11	Overhead	Trunk Line	1700365		50	B110H1	B110H209	11.593	Gedu switchyard gantry	Microwave s/s	1998	
36	Not applicable	B110-Geduchu	11kV, ACSR-Dog/Rabbit Overhead line	66/33/11kV Gedu substation	11	Overhead	Trunk Line	Not applicable	No	100/50	B110H1	B110H116	6.88	Gedu switchyard gantry	Pakshikha s/s	1999	
		B110-Geduchu	11kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	11	Overhead	Spur Line		No	50	B110H1	GPS not done	1.016	Gedu switchyard gantry	Gedu Incinarator s/s		
		B110-Geduchu	11kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	11	Overhead	Spur Line		No	50	B110H89	B110H93	0.294	Alleykha T-off	Alleykha s/s		
37	1700133.00	B110-Lengu	11kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	11	Overhead	Spur Line	1700133		50	B110H62	B110H231	1.2	Lengu T-off	Lengu s/s	2010	
38	1700366.00	B100-11kV BBPL (Till Laptsakha)	11kV, ACSR-Dog Overhead line	66/33/11kV Gedu substation	11	Overhead	Trunk line	1700366		50	B100H1	B100H26	1.205	Gedu switchyard gantry	Lhapchakha s/s	1989	
39	1700367.00	B100-11kV BBPL (Laptsakha-RNR s/s)	11kV, ACSR-Dog/Rabbit Overhead line	66/33/11kV Gedu substation	11	Overhead	Trunk Line	1700367		100/50	B100H24	B100H147	7.52	Lhachakha	RNR Drala s/s	1995	
		B100-11kV BBPL (Laptsakha-RNR s/s)	11kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	11	Overhead	Spur Line			50	B100H94	B100H99	0.26	Sourina T-off	Sourini s/s		
40	1700368.00	B100-11kV BBPL (RNR T-off to Damdara RBP)	11kV, ACSR-Dog Overhead line	66/33/11kV Gedu substation	11	Overhead	Trunk Line	1700368		100	B100H141	B100H154	0.589	Darla	Damdara RBP s/s	1996	
41	1700753.00	Gedu Collge UG Network	11kV, 3cx240sqmm XLPE UG cable	66/33/11kV Gedu substation	11	UG	Trunk Line	1700753		240	GPS not done	GPS not done	3.975	Gedu switchyard gantry	Gedu switchyard gantry	2014	Asset taken over from DGPC
42	17034.00	B320-Gedu-Mirchingchu	11kV, ACSR-Dog Overhead line	66/33/11kV Gedu substation	11	Overhead	Trunk Line	17034		100	B320H1	GPS not done	5.4	Gedu switchyard gantry	Mirchung Adit T-off	2016	Asset taken over from DGPC
		B320-Gedu-Mirchingchu	11kV, ACSR-Dog Overhead line	66/33/11kV Gedu substation	11	Overhead	Spur Line			100	B320H14	B329H15	0.03	Lhaptsakha T-off	Lhaptsakha s/s		
43	17035.00	Gurungdara-Mirchingchu Adit	11kV, 3cx300sqmm & ACSR-Dog Overhead line	33/11kV Gurungdangra substation	11	Mixed	Trunk Line	17035		300/100	GPS not done	GPS not done	4.83	33/11kV Gurungdara switchyard	Mirchung Adit	2016	Asset taken over from DGPC
44	17036.00	Sinchikha-Arekha	11kV, 3cx300sqmm & ACSR-Dog Overhead line	33/11kV Gurungdara substation	11	Mixed	Trunk Line	17036		300/100	GPS not done	GPS not done	2.5	33/11kV Gurungdara switchyard	Upper Arekha s/s	2016	Asset taken over from DGPC
		Sinchikha-Arekha	11kV, ACSR-Dog Overhead line	33/11kV Gurungdara substation	11	Overhead	Spur Line			100	GPS not done	GPS not done	0.65	O&M office, THPA T-off	O&M office, THPA s/s		
		Sinchikha-Arekha	11kV, ACSR-Dog Overhead line	33/11kV Gurungdara substation	11	Overhead	Spur Line			100	GPS not done	GPS not done	0.07	Upper Sinchikha T-off	Upper Sinchikha s/s		
		Sinchikha-Arekha	11kV, ACSR-Dog Overhead line	33/11kV Gurungdara substation	11	Overhead	Spur Line			100	GPS not done	GPS not done	0.33	Lower Sinchikha T-off	Lower Sinchikha s/s		
45	Not applicable	Rinchentse	11kV, 3cx300sqmm XLPE UG	33/11kV Gurungdara substation	11	UG	Trunk Line	Not applicable	No	300	GPS not done	GPS not done	3.5	33/11kV Gurungdara switchyard	Rinchentse Colony IV PSS-1	2016	Asset taken over from DGPC, however, the line is seem to be capitalized with Substation
		Rinchentse	11kv, ACSR-Dog Overhead line	33/11kV Gurungdara substation	11	Overhead	Spur Line		No	100	GPS not done	GPS not done	1.67	Rinchentse Water Tank T-off	Rinchentse Water Tank		
46	17037.00	Gurungdara -Surge shaft	11kV, ASCR-Dog Overhead	33/11kV Gurungdara substation	11	Overhead	Trunk Line	17037		100	GPS not done	GPS not done	2.83	33/11kV Gurungdara switchyard	Port Head II s/s	2016	Asset taken over from DGPC
		Gurungdara -Surge shaft	11kV, ASCR-Dog Overhead	33/11kV Gurungdara substation	11	Overhead	Spur Line			100	GPS not done	GPS not done	0.31	THPA Surge Shaft (EL1425) T-off	THPA Surge Shaft (EL1425) s/s		
		Gurungdara -Surge shaft	11kV, ASCR-Dog Overhead	33/11kV Gurungdara substation	11	Overhead	Spur Line			100	GPS not done	GPS not done	0.59	THPA Switch yard II (EL1252) T-off	THPA Switch yard II (EL1252) s/s		
		Gurungdara -Surge shaft	11kV, ASCR-Dog Overhead	33/11kV Gurungdara substation	11	Overhead	Spur Line			100	GPS not done	GPS not done	0.64	Port Head I T-off	Port Head I s/s		
47	17038.00	Gurungdara- Power House	11kV, ASCR-Dog Overhead	33/11kV Gurungdara substation	11	Overhead	Trunk Line	17038		100	GPS not done	GPS not done	2.42	33/11kV Gurungdara switchyard	Power House s/s	2016	Asset taken over from DGPC
48	17039.00	Gurungdara -Tail Race (BVC)	11kV, ASCR-Dog Overhead	33/11kV Gurungdara substation	11	Overhead	Trunk Line	17039		100	GPS not done	GPS not done	6.63	33/11kV Gurungdara switchyard	THP Tail Rrace Outfall II s/s	2016	Asset taken over from DGPC
		Gurungdara -Tail Race (BVC)	11kV, ASCR-Dog Overhead	33/11kV Gurungdara substation	11	Overhead	Spur Line			100	GPS not done	GPS not done	0.34	Tail Race I (EL1425) T-off	Tail Race I (EL1425) s/s		

MV line detials of Chukha Dzongkhag

Sl#	Asset Code	Feeder Name	Line Description	Source Substation like TD or 33/11kV substation	Feeder Details: Voltage level(kV)	Feeder Details: UG/Overhead or Mixed	Sl#: Line	Asset Code	Asset description	Cable / Conductor size(sq.mm)	First GPS code	Final GPS code	Line length (KM)	Location	Termination point	Year of construction	Remarks
48	17039.00	Gurungdara -Tail Race (BVC)	11kV, ASCR-Dog Overhead	33/11kV Gurungdara substation	11	Overhead	Spur Line	17039		100	GPS not done	GPS not done	0.18	Drainage Galary THP Colony T-off	Drainage Galary THP Colony s/s	2016	Asset taken over from DGPC
		Gurungdara -Tail Race (BVC)	11kV, ASCR-Dog Overhead	33/11kV Gurungdara substation	11	Overhead	Spur Line			100	GPS not done	GPS not done	0.24	THP Tail Rrace Outfall I T-off	THP Tail Rrace Outfall I s/s		
49	16038.00	B140-Gurungdara -I	33kV, ACSR-Dog Overhead Line	66/33/11kV Gedu substation	33	Overhead	Trunk Line	16038		100	B140H1	B140H132	10.54	Gedu switchyard gantry	33/11kV Gurungdara switchyard	2016	Asset taken over from DGPC
50	16039.00	B160-Gurungdara-II	33kV, ACSR-Dog Overhead Line	66/33/11kV Gedu substation	33	Overhead	Trunk Line	16039		100	B160H1	B160H112	10.9	Gedu switchyard gantry	33/11kV Gurungdara switchyard	2016	Asset taken over from DGPC
51	1600092.00	B160-Beech Tala	33kV, ACSR-Dog Overhead Line	66/33/11kV Gedu substation	33	Overhead	Trunk Line	1600092		100	B160H100	B160H135	2.015	Gurungdara (Beech Tala T-off)	Beech Tala -III (Beech Sarouni) s/s	2003	
		B160-Gedu-Baikunza	33kV, ACSR-Dog Overhead Line	66/33/11kV Gedu substation	33	Overhead	Trunk Line			100	B160H92	B160H595	22.01	Damdara T-off	Baikunza II s/s		
		B160-Gedu-Baikunza	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H161	B160H396	1.17	Tabjey T-off	Tabjey s/s		
		B160-Gedu-Baikunza	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H193	B160H657	1.15	Gangu T-off	Gangu s/s		
		B160-Gedu-Baikunza	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H220	B160H384	1.25	Lower Yagoan T-off	Lower Yagoan s/s		
		B160-Gedu-Baikunza	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H252	B160H368	2.01	Rupang T-off	Samachen s/s		
52	1600099.00	B160-Gedu-Baikunza	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line	1600099		50	B160H411	B160H437	1.11	Siley T-off	Siley s/s	2007	
		B160-Gedu-Baikunza	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H445	B160H453	0.35	Sinchula T-off	Sinchula s/s		
		B160-Gedu-Baikunza	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B169H471	B160H487	1.23	Gamana-Pakshina T-off	Pakshina s/s		
		B160-Gedu-Baikunza	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H479	B160H494	1.15	Gamana T- off	Gamana s/s		
		B160-Gedu-Baikunza	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H539	B160H543	0.32	Kezari T-off	Kezari s/s		
		B160-Gedu-Baikunza	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H558	B160H561	0.31	Dojangchey T-ff	Dojangchey s/s		
53	1600340.00	B160-Zamtsa	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line	1600340		50	B160H487	B160H884	2.878	Pakshina s/s	Zomtsa s/s	2011	
		B160-Mirtshim-Bongo	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Trunk Line			50	B160H292	B160H346	9.667	Gurungdara	Bongo-II s/s		
54	1600093.00	B160-Mirtshim-Bongo	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line	1600093		50	B160H596	B160H639	4.07	Mirtshim	Ketokha s/s	2003	
		B160-Mirtshim-Bongo	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H620	B1060H627	0.75	Damji T-off	Damjis/s		
		B160-Kashilakha	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H250	B160H754	0.89	Kashilakha T-off	Kashilakha s/s		
		B160-Labana/Laga	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H811	B160H821	1.54	Labana T-off	Labana s/s		
55	1600526.00	B160-Pemathang	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line	1600526		50	B160H543	B160H778	2.80	Kezari s/s	Pemathang s/s	2014	
		B160-Allay	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H802	B160H810	1.34	Ahaley T-off (Gedu)	Ahaley s/s		Under ESSD, Gedu
		B160-Gedaphu	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H595	B160H801	4.85	Baikunza II s/s	Gedaphu s/s		
56	1600537.00	B160-Getena Trunk Line	33kV, ACSR-Dog Overhead Line	66/33/11kV Gedu substation	33	Overhead	Trunk Line	1600537		100	B160H639	B160H983	14.43	Ketokha s/s	Gangu LBS	2014	
		B160-Getena	33kV, ACSR-Dog/Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Trunk Line			100	B160H983	B160H1056	2.47	Gangu LBS	Chenyuel s/s		
		B160-Getena	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H983	B160H995	1.99	Gangu	Putsa s/s		
57	1600554.00	B160-Getena	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line	1600554		50	B160H1003	B160H1045	4.97	Bachu T-off	Daga s/s	2015	
		B160-Getena	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H1010	B160H1020	1.92	Yetshey T-off	Yetshey		
		B160-Getena	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H1065	B160H1068	0.23	Nubja T-off	Nubja s/s		
		B160-Getena	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H1056	B160H1084	4.86	Chenyuel s/s	Pangsola II s/s		
58	Not applicable	B160-Phasuma	33kV, ACSR-Rabbit Overhead Line	66/33/11kV Gedu substation	33	Overhead	Spur Line	Not applicable	No	50	B160H657	B160H862	6.00	Gangu s/s	Phasuma s/s	2011	Asset taken over from DGPC
59	1600101.00	B160-Baikunza - Peeping	33kV, ACSR-Wolf Overhead line	66/33/11kV Gedu substation	33	Overhead	Trunk Line	1600101		150	B160H592	B160H717	5.41	Baikunza T-off	Jemichu/Peeping	2008	
		B160-Peping	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H711	B160H718	0.05	Peping T-off	Peping s/s		
		B160-Sakhu Top	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	C30H35	B160H744	4.75	Sakhu T-off	Sakhu Top s/s		
		B160-Sakhu Lower	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B60723	B160H724	0.17	Sakhu Lower T-off	Sakhu Lower s/s		
		C30-Devatar	33kV, ACSR-Dog Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			100	C30H42	C30H709	0.05	Devetar T-off	Devatar s/s		
		C30-Tintaly	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	C30H90	C30H711	0.13	Tintaly T-off	Tintaly s/s		
60	1600356.00	C30-Nawtaly	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line	1600356		50	C30H203	C30H304	3.02	Sibsoni T-off	Nawtaly s/s	2011	
		C30-Farmgoan	33kV, ACSR-dog Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			100	C30H211	C30H310	0.50	Farmgoan T-off	Farmgoan s/s		
		C30-Ballatar	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	C30H218	C30H311	0.05	Ballatar T-off	Ballatar s/s		
		C30-Daragoan- Dalbari T-off	33kV, ACSR-Dog Overhead line	66/33/11kV Gedu substation	33	Overhead	Trunk Line			100	C30H265	C30H430	6.90	Daragoan s/s	Dalbari T-off		
		C30-Namling	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	C30H352	C30H372	1.93	Dorjiphu T-off	Namling s/s		
		C30-Garigoan	33kV, ACSR-Dog/Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			100/50	C30H379	C30H405	2.94	Balabsey T-off	Garigoan s/s		
		C30-Apagachi	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	C30H390	C30H394	1.59	Apagachi T-off	Apagachi s/s		
		C30-Karmaling-Odalthang	33kV, ACSR-Dog Overhead line	66/33/11kV Gedu substation	33	Overhead	Trunk Line			100	C30H430	C30H706	13.72	Dalbari T-off	Odalthang s/s		
		C30-Karmaling-Odalthang	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	C30H453	C30H459	0.50	Kumsumbari T-off	Kusumbari s/s		
		C30-Karmaling-Odalthang	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	C30H475	C30H491	1.59	Bichgoan T-off	Bichgoan A s/s		
		C30-Karmaling-Odalthang	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	C30H479	C30H481	0.24	Bichgoan B T-off	Bichgoan B s/s		
		C30-Karmaling-Odalthang	33kV, ACSR-Dog Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			100	C30H512	C30H515	0.17	Lower Karmaling	Lower Karmaling s/s		
		C30-Karmaling-Odalthang	33kV, ACSR-Dog/Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			100/50	C30H528	C30H590	3.80	Upper Karmaling T-off	Katary s/s		
61	1600367.00	C30-Karmaling-Odalthang	33kV, ACSR-Dog Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line	1600367		100	C30H533	C30H537	0.28	Upper Karmaling T-off	Upper Karmaling s/s	2011	
		C30-Karmaling-Odalthang	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	C30H561	C30H565	0.21	Lower Alay T-off	Lower Alay s/s		
		C30-Karmaling-Odalthang	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	C30H574	C30H576	0.11	Upper Alay T-off	Upper Alay s/s		
		C30-Karmaling-Odalthang	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	C30H653	C30H678	3.34	Cimboley T-off	Pankey s/s		
		C30-Karmaling-Odalthang	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	C30H673	C30H675	0.272	Rajabagoan T-off	Rajabagoan s/s		
		C30-Karmaling-Odalthang	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	C30H687	C30H689	0.196	Dungay T-off	Dungay s/s		
		C30-Karmaling-Odalthang	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	C30H699	C30H708	0.287	Gabring T-off	Gabring s/s		
62	16175.00	C30-Odalthang - Samachu	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line	16175		50	C30H706	C30H747	3.587	Odalthang	Samachu	2016	Asset handed over by RECD, Gelephu
63	16176.00	C30-Samachu -Susithang	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line	16176		50	C30H747	C30H760	1.974	Samachu	Susithang	2016	Asset handed over by RECD, Gelephu
64	16181.00	C30-Dalbari (T-off)-Deorali A	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line	16181		50	C30H761	C30H798	3.969	Deorali A T-off	Deorali A s/s	2016	Asset handed over by RECD, Gelephu
65	16182.00	C30-Deorali A-Deorali B	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line	16182		50	C30H798	C30H803	0.554	Deorali A s/s	Deorali B s/s	2016	Asset handed over by RECD, Gelephu
66	16047.00	C30-Papji	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line	16047		50	C30H06	C30H838	5.634	Pabji T-off	susithang	2016	
67	1700117.00	C30-Lhamoizingkha Town	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line	1700117		50	C30H266	C30H272	0.25	L/Zingkha BPC colony	L/Zingkha School s/s	2008	
68	Not applicable	C30-Lhamoizingkha Town	33kV, ACSR-Dog Overhead line	66/33/11kV Gedu substation	33	Overhead	Trunk Line	Not applicable	No	100	C30H260	C30H265	0.399	Daragaon T-off	Daragaon s/s	2008	Under R&M Distribution services

MV line detials of Chukha Dzongkhag

Sl#	Asset Code	Feeder Name	Line Description	Source Substation like TD or 33/11kV substation	Feeder Details: Voltage level(kV)	Feeder Details: UG/Overhead or Mixed	Sl#: Line	Line (Section 1) details: Asset Code	Asset description	Cable / Conductor size(sq.mm)	First GPS code	Final GPS code	Line length (KM)	Location	Ternmination point	Year of construction	Remarks
68	Not applicable	C30-Lhamoizingkha Town	33kV, ACSR-Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line	Not applicable	No	50	C30H229	C30H247	1.198	BHU T-off	Majeygaon s/s		
69	Not applicable	C30-Lhamoizingkha Trunk line	33kV, ACSR-Wolf Overhead line	66/33/11kV Gedu substation	33	Overhead	Trunk Line	Not applicable	No	150	B160H717	C30H267	20.216	Peping T-off	DG House/Lhamoyzingkha	2008	
70	1600509.00	B160-Pakchina-Dungena	33kV, ACSR Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line	1600509		50	B160H1085	B160H1149	8.598	Manitar T-off	Lower Dungena s/s	2014	
		B160-Pakchina-Dungena	33kV, ACSR Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H1107	B160H1108	0.173	Yushidingkha T-off	Yeshudingkha s/s		
		B160-Pakchina-Dungena	33kV, ACSR Rabbit Overhead line	66/33/11kV Gedu substation	33	Overhead	Spur Line			50	B160H1126	B160H1129	0.621	Pakchina Lower T-off	Pakchina Lower s/s		
71	1700124.00	B80-Singye	11kV, ACSR-Rabbit Overhead line	220/66/11kV Singhigoan substation	11	Overhead	Trunk Line	1700124		50	B80H2	B80H46	1.374	Singhigoan Gantry	Singhi Village s/s	2009	
72	1700125.00	B80-Rangaytrung	11kV, ACSR-Rabbit Overhead line	220/66/11kV Singhigoan substation	11	Overhead	Trunk Line	1700125		50	B80H46	B80H70	2.24	Singye Village s/s	Rangaytrung Village s/s	2009	
73	1700126.00	B80-Rangaytrung Dratshang	11kV, ACSR-Rabbit Overhead line	220/66/11kV Singhigoan substation	11	Overhead	Spur Line	1700126		50	B80H69	B80H81	1.5	Rangaytrung	Rangaytrung Dratshang s/s	2009	
74	1700757.00	B80-Teeling	11kV, ACSR-Rabbit Overhead line	220/66/11kV Singhigoan substation	11	Overhead	Spur Line	1700757		50	B80H77	B80H193	0.796	Teeling T-off	Teeling s/s	2014	
		B30-Aldangra		66/33/11kV Phunetsholing substation	11	Overhead	Spur Line			50	B30H171	B30H192	1.152	Chilouney B1 Lower s/s	Aldangra s/s		
75	1700602.00	B80-Pana-Kotriline	11kV, ACSR-Rabbit Overhead line	220/66/11kV Singhigoan substation	11	Overhead	Spur Line	1700602		50	B80H70	B80H188	3.853	Rangaytrung Village s/s	Pana C Lower s/s	2011	
		B80-Pana-Kotriline	11kV, ACSR-Rabbit Overhead line	220/66/11kV Singhigoan substation	11	Overhead	Spur Line			50	B80H154	B80H162	0.822	Pana A Upper T-off	Pana A Upper s/s		
		B80-Pana-Kotriline	11kV, ACSR-Rabbit Overhead line	220/66/11kV Singhigoan substation	11	Overhead	Spur Line			50	B80H175	B80H176	0.052	Pana B Lower T-off	Pana B Lower s/s		
		B80-Pana-Kotriline	11kV, ACSR-Rabbit Overhead line	220/66/11kV Singhigoan substation	11	Overhead	Spur Line			50	B80H55	B80H140	4.923	Above Singye Bridge	Pana A Lower s/s		
		B80-Pana-Kotriline	11kV, ACSR-Rabbit Overhead line	220/66/11kV Singhigoan substation	11	Overhead	Spur Line			50	B80H102	B80H104	0.105	Kotriline T-off	Kotriline s/s		
		B80-Pana-Kotriline	11kV, ACSR-Rabbit Overhead line	220/66/11kV Singhigoan substation	11	Overhead	Spur Line			50	B80H114	B80H115	0.035	Daragoan T-off	Daragoan s/s		
76	17111.00	B70-Singhigoan-Malbase Tie line	11kV, ACSR-Dog Overhead line	Tie Line	11	Overhead	Trunk line	17111		100	B70H1	B70H17	1.7	Singhigoan Gantry	Malbase Gantry	2017	Asset taken over from SMD
77	1700113.00	B390-Pasakha Industrial Estate Lower & Upper	11kV, ACSR-Wolf Overhead line	220/66/11kV Singhigoan substation	11	Overhead	Trunk line (Lower)	1700113		150	B390H1	B390H91	4.34	Singhigoan Gantry	Kinjore T-off	2007	
		B390-Pasakha Industrial Estate Lower & Upper	11kV, ACSR-Wolf Overhead line	220/66/11kV Singhigoan substation	11	Overhead	Trunk line (Upper)			150	B390H1	B390H91	3.68	Singhigoan Gantry	Kinjore T-off		
78	1700120.00	B390-Pasakha Industrial Estate Lower & Upper	11kV, (3cx300sqmm XLPE)	220/66/11kV Singhigoan substation	11	UG	Trunk Line	1700120		300	B390H30	B390H31	0.15	Above Road, Singhi Store	Singhi Store Gantry	2009	
		B390-Pasakha Industrial Estate Lower & Upper	11kV, (3cx300sqmm XLPE)	220/66/11kV Singhigoan substation	11	UG	Trunk Line			300	B390H30	B310H1	0.1	Above Road, Singhi Store	Below Road, Singhi Store		
79	1700115.00	B400-DC Druk Cement / Bhutan Steel	11kV, DC ACSR-Wolf Overhead line	400/220/66/11, Malbase substation	11	Overhead	Trunk Line (Bhutan Steel)	1700115		150	B400H1	B400H32	2.216	Malbase gantry	Bhutan Steel T-off	2008	
		B400-DC Druk Cement / Bhutan Steel	11kV, DC ACSR-Wolf Overhead line	400/220/66/11, Malbase substation	11	Overhead	Trunk Line (Druk Cement)			150	B410H1	B410H32	2.216	Malbase gantry	Bhutan Steel T-off		
80	1700119.00	B400-Alay-Khogla	11kV, ACSR-Dog Overhead line	400/220/66/11, Malbase substation	11	Overhead	Trunk Line	1700119		50	B400H75	B400H128	0.42	Alay Khogla T-off	Alay Khogla s/s	2009	
81	1700118.00	B270-Tinkilo-Satkilo (Water Treatment)	11kV, HV ABC Overhead line	66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	1700118		95	B270H17	B270H78	1.09	Above Pemaling (Tin Kilo T-off)	Satkilo (Water Treatment) s/s	2009	
82	17042.00	B20-Ganglakha	11kV, ACSR-Rabbit Overhead line	66/33/11kV Phuentsholing Substation	11	Overhead	Trun Line	17042		50	B20H167	B20H200	4.046	Simtulakha s/s	Ganglakha s/s	2016	
83	Not applicable	B30-Haurey	11kV, ACSR-Rabbit Overhead line	66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line	Not applicable	No	50	L160H82	L160H168	2.837	Haurey T-off	Haurey s/s	2016	
84	1700649.00	B30-Kopchey	11kV, ASCR-Rabbit and HV ABC Overhead	66/33/11kV Phuentsholing Substation	11	Mixed	Trunk Line	1700649			L160H71	L160H149	0.44	Kopchey T-off	Kopchey s/s	2012	
85	1700595.00	B30-Titiring	11kV, ACSR-Rabbit Overhead line	66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line	1700595		50	L160H57	L160H143	3.313	Titiring T-Off	Bajagoan	2011	
		Titiring	11kV, ACSR-Rabbit Overhead line	66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line			50	L160H92	L160H99	0.347	Souney T-off	Souney s/s		
		B30-Titiring	11kV, ACSR-Rabbit Overhead line	66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line			50	L160H105	L160H108	0.3	Lamagoan T-off	Lamagoan s/s		
86	1600338.00	B260-Gantry to above Sonamgang school	33kV, 3cx150sqmm XLPE Underground	66/33/11kV Phuentsholing Substation	33	UG	Trunk Line	1600338		150	B260H1	B260H3	0.33	Near Sonamgang schoo gate	Above Sonamgang school	2011	
87	1600098.00	B260-Serina-Bosokha	33kV, ASCR-Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Trunk Line	1600098		100	B260H3	B260H90	8.979	Above Sonamgang school	Bosokha s/s	2007	
		B260-Serina-Bosokha	33kV, ASCR-Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			100	B260H70	B260H74	0.669	Top Serina T-Off	Top Serina s/s		
		B260-Serina-Bosokha	33kV, ASCR-Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			100	B260H80	B260H81	0.05	Upper Serina T-off	Upper Serina s/s		
88	1600436.00	B260-Lingden, Lalikha & Chimuna	33kV, ASCR-Rabbit & Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Trunk Line	1600436		100/50	B260H90	B260H705	11.922	Bosokkha s/s	Upper Lalikha s/s	2013	
		B260-Lingden, Lalikha & Chimuna	33kV, ASCR- Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			100	B260H607	B260H612	0.684	Lower Tashidingkha T-off	Lower tashidingkha s/s		
		B260-Lingden, Lalikha & Chimuna	33kV, ASCR-Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H695	B260H698	0.568	Lower Lalikha T-off	Lower Lalikha s/s		

MV line detials of Chukha Dzongkhag

Sl#	Asset Code	Feeder Name	Line Description	Source Substation like TD or 33/11kV substation	Feeder Details: Voltage level(kV)	Feeder Details: UG/Overhead or Mixed	Sl#: Line	Line (Section 1) details: Asset Code	Asset description	Cable / Conductor size(sq.mm)	First GPS code	Final GPS code	Line length (KM)	Location	Termnination point	Year of construction	Remarks
88	1600436.00	B260-Lingden, Lalikha & Chimuna	33kV, ASCR-Rabbit & Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line	1600436		100/50	B260H559	B260H714	5.704	Chimina T-off	Dorilakha s/s	2013	
		B260-Lingden, Lalikha & Chimuna	33kV, ASCR-Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			100	B260H591	B260H592	0.172	Chimuna Lower T-off	Chimuna Lower s/s		
		B260-Lingden, Lalikha & Chimuna	33kV, ASCR-Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H597	B260H600	0.35	Chimuna Upper T-off	Chimuna Upper s/s		
89	1600435.00	B260-Lokchina-Dolepchen	33kV, ACSR- Rabbit & Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Trunk Line	1600435		100/50	B260H54	B260H149	6.712	Sadhumadu Top	Pamji A s/s	2013	
		B260-Lokchina-Dolepchen	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H112	B260H118	0.77	Jedokha T-off	Jedokha C s/s		
		B260-Lokchina-Dolepchen	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H140	B260H168	2.738	Chomchey T-off	Chomchey Top s/s		
		B260-Lokchina-Dolepchen	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H148	B260H151	0.21	Pamji B T-off	Pamji B s/s		
		B260-Lokchina-Dolepchen	33kV, ACSR- Rabbit & Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Trunk line			100/50	B260H137	B260H189	2.033	Amalay	Dopham D Top s/s		
		B260-Lokchina-Dolepchen	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H178	B260H183	0.609	Dopham	Dagochen s/s		
		B260-Lokchina-Dolepchen	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H184	B260H185	0.146	Dopham B T-off	Dopham B s/s		
		B260-Lokchina-Dolepchen	33kV, ACSR- Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Trunk Line			100	B260H175	B260H227	4.521	Dopham	Dolepchen B s/s		
		B260-Lokchina-Dolepchen	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H194	B260H196	0.334	Dubeni A T-off	Dubeni A s/s		
		B260-Lokchina-Dolepchen	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H194	B260H198	0.237	Dubeni C T-off	Dubeni C s/s		
90	1600434.00	B260-Bjachu-Damchenkha & Kungkha	33kV, ACSR- Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Trunk Line	1600434		100	B260H227	B260H297	7.998	Dolopchen	Chungaykha school s/s	2013	
		B260-Bjachu-Damchenkha & Kungkha	33kV, ACSR-Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			100	B260H267	B260H272	0.524	Dophulakha	Dophulakha Upper s/s		
		B260-Bjachu-Damchenkha & Kungkha	33kV, ACSR- Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			100	B260H295	B260H307	0.59	Chungaykha Lower	Chungaykha Upper s/s		
		B260-Bjachu-Damchenkha & Kungkha	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H267	B260H336	4.487	Dophulakha Lower	Resi s/s		
		B260-Bjachu-Damchenkha & Kungkha	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H331	B260H335	1.786	Kungkha	Sintoley s/s		
		B260-Bjachu-Damchenkha & Kungkha	33kV, ACSR- Rabbit & Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Trunk Line			100/50	B260H247	B260H398	4.798	Bjabchu	Damchenkha B s/s		
		B260-Bjachu-Damchenkha & Kungkha	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H378	B260H381	0.483	Chadokha A T-off	Chadokha A s/s		
		B260-Bjachu-Damchenkha & Kungkha	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H395	B260H401	0.484	Damchenkha C T-off	Damchenkha C s/s		
91	1600484.00	B260-Dungna-Metakha	33kV, ACSR- Rabbit & Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Trunk Line	1600484		100/50	B260H387	B260H510	12.932	Farmgoan T-off	Mongdokha B s/s	2014	
		B260-Dungna-Metakha	33kV, ACSR- Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			100	B260H415	B260H417	0.195	Yujee T-off	Yujee s/s		
		B260-Dungna-Metakha	33kV, ACSR- Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			100	B260H433	B260H435	0.395	Rudingkha Lower T-off	Rudingkha Lower s/s		
		B260-Dungna-Metakha	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H473	B260H475	0.182	Pangu B T-off	Pangu B s/s		
		B260-Dungna-Metakha	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Trunk Line			50	B260H455	B260H545	6.448	Dungna	Metab Pangu B s/s		
		B260-Dungna-Metakha	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H464	B260H465	0.103	Ngalashong T-off	Ngalashomg s/s		
		B260-Dungna-Metakha	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H523	B260H524	0.231	Metagonpa A T-off	Metagonpa A s/s		
		B260-Dungna-Metakha	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H525	B260H557	1.88	Metayul	Gumena s/s		
		B260-Dungna-Metakha	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H526	B260H527	0.139	Metagonpa B T-off	Metagonpa B s/s		
92	1600502.00	B260-Omchu-Tshundugang-Dap	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line	1600502		50	B260H297	B260H819	10.018	Chungaykha	Tshundugang s/s	2014	
		B260-Omchu-Tshundugang-Dap	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H760	B260H769	1.185	Pasenkha	Sedenkha s/s		
		B260-Bjobjikha	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H527	B260H837	3.095	Metagonpa B	Bjobjikha s/s		
		B260-Japitar-Lassap/Nerichu-Lorina	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H715	B260H743	4.324	Dopham	Lhasap/Nerichu		
		B260-Japitar-Lassap/Nerichu-Lorina	33kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line			50	B260H598	B260H714	1.7	Chimuna	Doilakha s/s		
93	1600102.00	Sector I&II (RCO Building Office)	33kV, 3cx300sqmm XLPE	66/33/11kV Phuentsholing Substation	33	UG	Trunk Line	1600102		150	Control Pannel	B250H0A	0.2	66kV s/s control pannel	Gantry	2007	
		Sector I&II (RCO Building Office)	33kV, 3cx300sqmm XLPE	66/33/11kV Phuentsholing Substation	33	UG	Trunk Line			150	Control Pannel	B240H0A	0.2	66kV s/s control pannel	Gantry		

MV line detials of Chukha Dzongkhag

Sl#	Asset Code	Feeder Name	Line Description	Source Substation like TD or 33/11kV substation	Feeder Details: Voltage level(kV)	Feeder Details: UG/Overhead or Mixed	Sl#: Line	Line (Section 1) details: Asset Code	Asset description	Cable / Conductor size(sq.mm)	First GPS code	Final GPS code	Line length (KM)	Location	Termination point	Year of construction	Remarks
94	1600103.00	Sector I&II (RCO Building Office)	33KV DC, ASCR-Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Trunk Line	1600103		300	B250H0A	B240H2	0.5	Gantry	Tower (Infront RCO Building office)	2007	
		Sector I&II (RCO Building Office)	33KV DC, ASCR-Dog Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Trunk Line			300	B240H0A	B240H2	0.5	Gantry	Tower (Infront RCO Building office)		
95	17246.00	B30-Amochu B, NHDCL Colony	11kV, ACSR-Rabbit Overhead line	66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line	17246		50	B30H125	B30H210	0.8	Crematorium s/s	NHDCLColony s/s (Amochu B)	2018	FAS has capitalised the length of Conductor (3.115km)
		B30-Amochu A, NHDCL Colony	11kV, ACSR-Rabbit Overhead line	66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line			50	B30H119	B30H198	0.238	NHDCL Amochu A T-off	NHDCL Colony s/s (Amochu A)		
96	17247.00	B30-NHDCL Colony, near Rabten Workshop	11kV, 3cx150sqmm XLPE	66/33/11kV Phuentsholing Substation	11	UG	Spur Line	17247		150	B230H33	GPS not done	0.501	Helipad RMU	NHDCL Colony USS (near Rabten Workshop)	2018	
97	17248.00	B400-NHDCL Colony, Toribari	11kV, 3cx95sqmm HV ABC	400/220/66/11, Malbase substation & 66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line	17248		95	B400H92	GPS not done	0.5	NHDCL Colony Toribari T-off	NHDCL Colony USS(Toribari)	2018	
98	1700105.00	B400-Tie Line between Toribari - Balujora (Bmobile s/s)	11kV, ACSR- Dog Overhead	400/220/66/11, Malbase substation & 66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	1700105		100	B400H145	B400H43	3.86	Toribari s/s	Balujora Mobile T-off	2005	
99	1700106.00	B50-BCCL Colony to New Industrial Estate (Rabtenwire Pasakha)	11kV, ACSR- Rabbit Overhead	220/66/11, Singhigoan substation	11	Overhead	Trunk Line	1700106		50	B50H19	B390H100	2.22	BCCL colony T-off	Rabten Wire T-off (Pasakha)	2005	
100	1700108.00	B270-Kharbanidi Goenpa-Toribari	11kV, ACSR- Dog Overhead	400/220/66/11, Malbase substation & 66/33/11kV Phuentsholing Substation	11	Overhead	Trunk line	1700108		100	B270H39	B400H145	2.44	Kharbandi Goenpa s/s	Toribari s/s	2005	
		B400-Kharbanidi Goenpa-Toribari	11kV, ACSR- Dog Overhead	400/220/66/11, Malbase substation & 66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line			100	B400H108	B400H110	0.06	Karbandi checkpost T-off	Kharbandi Checkpost s/s	2005	
101	1700104.00	B30-Baldangra	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line	1700104		50	B30H77	B30H93	0.85	Baldangdara T-off	Baldangra s/s	2005	
102	1700107.00	B30-Sadumadhu	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line	1700107		50	B30H45	B30H54	1.16	Sadhumadu T-off	Sadhumadu s/s	2005	
103	1700109.00	B30-Tading (Rerouting)	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	1700109		50	B30H111	L160H22	2.07	Toorsatar	Borbotey T-off	2006	Rerouting of Tading feeder due to Toorsa flood. Earlier, the line is passing along the Toorsa river bank.
104	1700110.00	B30-Crematorium Fdr	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line	1700110		50	B30H118	B30H125	0.342	Crematorium T-off	Crematorium s/s	2006	
105	1700111.00	B400-Ahaley	11kV, ACSR- Dog Overhead	400/220/66/11, Malbase substation & 66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line	1700111		100	B400H64	B400H66	0.18	Ahaley T-off (Pasakha)	Ahaley s/s	2007	
		B460-Malbase Ghumauney	11kV, ACSR- Dog & Rabbit Overhead	400/220/66/11, Malbase substation	11	Overhead	Spur Line			100/50	B460H1	B460H36	1.54	Malbase gantry	Ghumauney s/s		
		B460- Malbase Burkey	11kV, ACSR- Rabbit Overhead	400/220/66/11, Malbase substation	11	Overhead	Spur Line			50	B460H5	B460H17	1.1	Burkey T-off	Burkey s/s		
		B80-Barsa	11kV, ACSR- Dog Overhead	220/66/11,Singhigoan substation	11	Overhead	Trunk Line			100	B80H1	B80H34	1.77	Singhigoan Gantry	Pole No.B80H34		
		B80-Gurungdangra	11kV, ACSR- Dog Overhead	220/66/11,Singhigoan substation	11	Overhead	Trunk Line			100	B80H2	B80H81	0.43	Gurungdangra T-off	Gurungdangra s/s (Pasakha)		
		B20-Pekassy	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line			50	B20H68	B20H83	1.03	Pekasey T-off	Pekasey s/s		
		B20-Modina	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line			50	B20H71	B20H119	0.72	Modina T-off	Modina s/s		
		B400-Relidri Ahaley	11kV, ACSR- Dog Overhead	400/220/66/11, Malbase substation & 66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line			100	B400H96	B400H97	0.14	Reldri Ahaley T-off	Reldri Ahaley s/s		
		B20-Gaikhuri Ahaley	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line			50	B20H91	B20H98	0.44	Gaiguri Ahaley T-off	Gaiguri Ahaley s/s		
		B20-Gaikhuri V-tar	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line			50	B20H57	B20H64	0.59	Gaikhuri V-tar T-off	Gaikhuri V-tar s/s		
106	1700122.00	B280-H&K (Below Mini Dry Port)	11kV, 3cx95sqmm HV ABC	66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line	1700122		95	B280H2	B280H3	0.065	KD building s/s	H&K s/s	2008	
107	1700123.00	B230-Helipad	11kV, Twin ACSR-Dog Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	1700123		100	B230H1	B230H33	1.708	66KV substation gantry	Helipad RMU	2007	Line length was taken the twin conductor length.
108	1700127.00	B400-Toribari V-tar	11kV, ACSR- Rabbit Overhead	400/220/66/11, Malbase substation & 66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line	1700127		50	B400H80	B400H138	0.55	Toribari V-tar T-off	Toribari V-tar s/s	2010	
109	1700128.00	B20-Gaiguri Lhakhang	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line	1700128		50	B20H117	B20H122	0.23	Gauguri Lhakhang T-off	Gaiguri Lhakhang s/s	2010	
110	1700130.00	B270-Pemaling-Kharbandi Goenpa	11kV, 3cx95sqmm HV ABC	400/220/66/11, Malbase substation & 66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	1700130		95	B270H7	B270H39	1.396	Pemaling s/s	Kharbandi Goenpa s/s	2010	
111	1700132.00	B420-Malbase colony	11kV, ACSR- Dog Overhead	400/220/66/11, Malbase substation	11	Overhead	Trunk Line	1700132		100	B420H1	B420H3	0.537	Malbase gantry	Malbase Colony s/s	2010	
112	1700352.00	B20-Rametey	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	1700352		50	B20H1	B20H15	0.808	66kV Pling Gantry	Karbraytar s/s	1984	

MV line detials of Chukha Dzongkhag

Sl#	Asset Code	Feeder Name	Line Description	Source Substation like TD or 33/11kV substation	Feeder Details		Sl#	Line (Section 1) details									
					Voltage level(kV)	UG/Overhead or Mixed	Line	Asset Code	Asset description	Cable / Conductor size(sq.mm)	First GPS code	Final GPS code	Line length (KM)	Location	Ternmination point	Year of construction	Remarks
113	1700353.00	B20-Rametey	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	1700353		50	B20H15	B20H34	1.962	Karbraytar s/s	Lower Rametey s/s	1989	
114	1700354.00	B20-Rametey	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	1700354		50	B20H34	B20H36	0.225	Lower Rametey s/s	Upper Rametey T-off	1990	
115	1700355.00	B20-Rametey	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	1700355		50	B20H36	B20H51	0.681	Rametey	Bhutan Battery s/s	1991	
		B20-Rametey	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line			50	B20H39	B20H44	0.325	Rametey RBA I T-off	Rametey RBA I s/s		
116	1700356.00	B20-Rametey	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	1700356		50	B20H51	B20H52	0.091	Bhutan Battery s/s	Rametey (pole no.B20H52)	1996	
117	1700357.00	B20-Rametey	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	1700357		50	B20H52	B20H71	0.86	Upper Rametey T-off	Upper Rametey s/s	1999	
118	1700358.00	B30-Damdara	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	1700358		50	B30H1	B30H11	0.31	66kV Pling Gantry	Damdara s/s	1983	0.250km is dismantled and replaced by UG cable in the year 2011 due to Sonamgang school.
119	1700359.00	B30-Baidangtar	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	1700359		50	B30H11	B30H29	1.56	Damdara s/s	Baidangtar s/s	1989	
120	1700360.00	B30-Darjaygoan	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	1700360		50	B30H29	B30H41	0.98	Baidangtar s/s	Darjaygoan s/s	1991	
121	1700361.00	B30-Pachu	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	1700361		50	B30H42	B30H79	2.46	Pachu T-off	Upper Pachu s/s	1995	
122	1700362.00	L160-Tading	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	1700362		50	B30H77	L160H40	3.562	Pachu T-off	Jenchuna s/s	1996	0.90km is dismantled due to Toorsa flood. Earlier, the line is passing along the Toorsa river bank.
		L160-Tading	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line			50	L160H30	L160H28	0.59	Borbotey T-off	Borbotey s/s		
123	1700363.00	L160-Tading	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	1700363		50	L160H33	L160H86	4.8	Jenchuna T-off	Upper Tading Tadding s/s	1997	
124	1700369.00	B400-Druk Cement (BBPL)	11kV, ACSR- Dog Overhead	400/220/66/11, Malbase substation & 66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	1700369		100	B400H23	B400H39	0.524	Bhutan Steel T-off	BBPL s/s	1988	
125	1700584.00	B30-Tading	11kV, 3cx240sqmm XLPE UG cable	66/33/11kV Phuentsholing Substation	11	UG	Trunk Line	1700584		240	B30H2	B30H3	0.25	66kV Pling Gantry	Above Sonamgang school	2011	Due to Sonamgang school construction
126	1700585.00	L160-Lower Tading	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Spur Line	1700585		50	L160H74	L160H74	0.017	Lower Tading T-off	Lower Tadding s/s	2011	RE-Fill work (Constructed s/s on line and capitalised the conductor length in the year 2011)
127	Not applicable	B10-Polythene	11kV, 3cx240sqmm XLPE UG cable	66/33/11kV Phuentsholing Substation	11	UG	Trunk Line	Not applicable	No	240	B10H1	B10H2	0.214	66kV Pling Gantry	PWD s/s	1988	
		B10-Polythene	11kV, ACSR- Dog Overhead	66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line		No	100	B10H2	B10H11	0.35	PWD s/s	Polythyne s/s		
128	Not applicable	B400-BPC Colony	11kV, 3cx95sqmm HV ABC	66/33/11kV Phuentsholing Substation	11	Overhead	Trunk Line	Not applicable	No	95	B400H00	B400H30	1.023	Drangchu s/s	BPC Colony s/s	2006-7	
129	Not applicable	B280-Water Booster	11kV, 3cx300sqmm XLPE UG cable	33/11kV Sector I&II Substation	11	UG	Trunk	Not applicable	No	300	11kV Breaker	B280P31	2.186	33/11kV Sector I&II breaker	Helipad RMU	2006-7	
		B280-Water Booster	11kV, 3cx300sqmm XLPE UG cable	33/11kV Sector I&II Substation	11	UG	Trunk Line		No	300	B280P15	B280P32	0.28	Dratshang USS	Dotikhola RMU	2006-7	
		B280-Water Booster	11kV, 3cx300sqmm XLPE UG cable	33/11kV Sector I&II Substation	11	UG	Spur Line		No	300	B280P32	B280P47	0.425	Dotikhola RMU	Norgay USS	2006-7	
130	Not applicable	B270-PWD-Pemaling	11kV, 3cx300sqmm XLPE UG cable	33/11kV Sector I&II Substation	11	UG	Trunk Line	Not applicable	No	300	11kV Breaker	B280P31	2.309	33/11kV Sector I&II breaker	Helipad RMU	2006-7	
		B270-PWD-Pemaling	11kV, 3cx300sqmm XLPE UG cable	33/11kV Sector I&II Substation	11	UG	Trunk Line		No	300	B270P1	B270P26	0.675	PWD USS	Pemaling s/s	2006-7	
131	16046	B260-Ziktenkha (Metakha)	11kV, ACSR- Rabbit Overhead	66/33/11kV Phuentsholing Substation	33	Overhead	Spur Line	16046		50	B260H824	B260H838	0.041	Zektenkha T-off	Zektenkha s/s	2016	

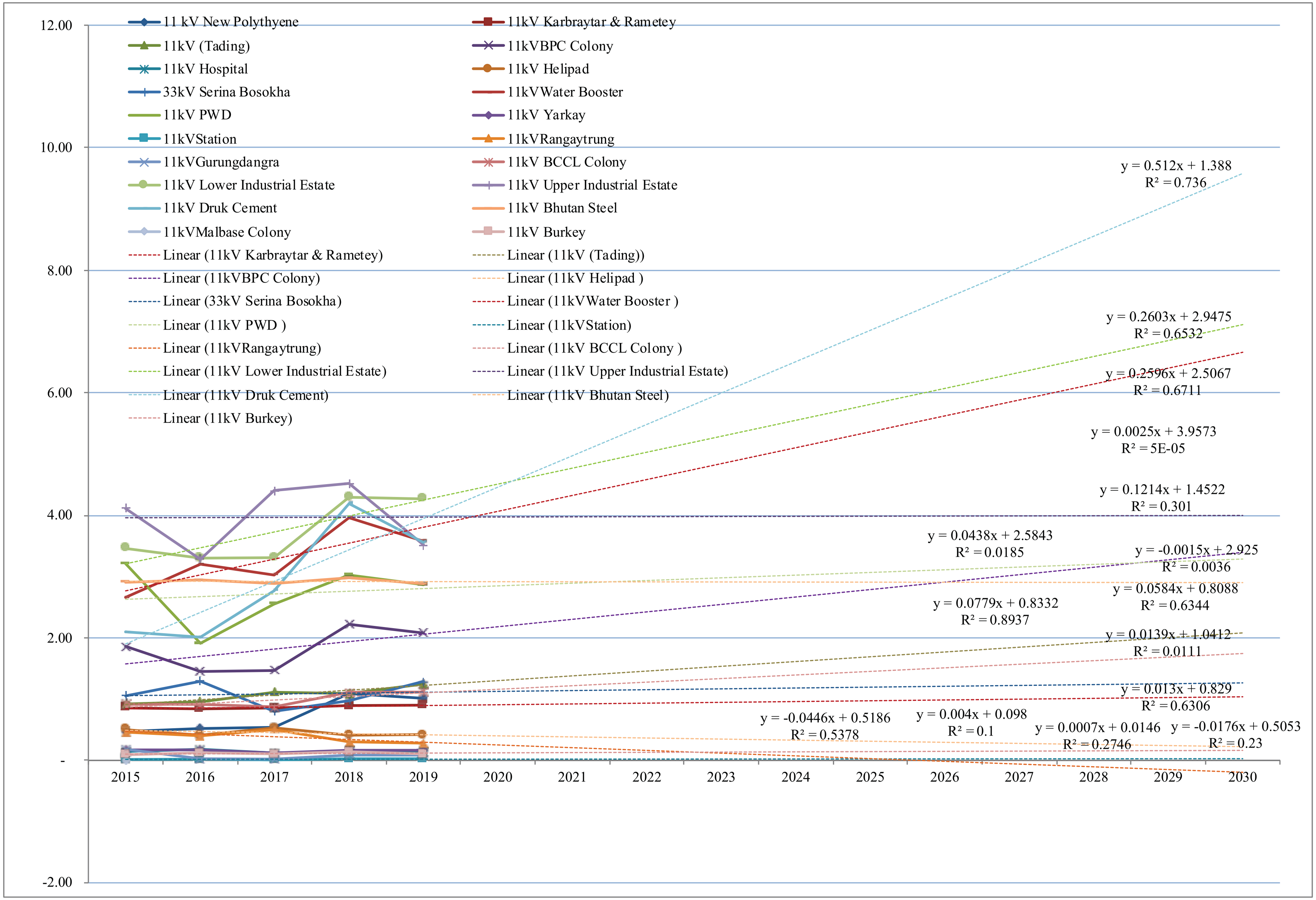
Annexure-2: IS 2026, IEC 60076 (Technical parameters for Distribution Lines and Transformers)

Sl. No.	Parameter	Requirement
1	Applicable standard	IS 2026, IEC 60076
2	Type	Oil filled[1] / two winding
3	Winding material	Copper
4	Core Material	CRGO silicon steel/Amorphous Metal
5	Cooling	Oil natural air natural (ONAN)
6	Terminations	
	· Primary	Outdoor Bushing or cable box[2]
	· Secondary	Outdoor Bushing or Cable box
7	Rated no load voltage	
	· Primary	33 kV or 11 kV
	· Secondary	415/240 V
8	% Impedance	
	10 kVA-24 kVA (1phase/3phase)	3%
	25 kVA-630 kVA	4%
	631 kVA-1250 kVA	5%
9	Vector group	Dyn11
10	Tap changer	
	· Type	Off load
	· Range	+5% to -5%
	· Step value	2.50%
11	Insulation Class (IEC-76)	A
12	Permissible Temperature rise	
	· Maximum winding temperature	55ºC
	· Max. Top oil temperature	50°C
13	Insulation levels	
	· Primary	170 kVp-70 kV/75 kVp-28 kV
	· Secondary	7500 Vp-3000 V

Annexure-3: Load Forecast adopting LRM & TSA

Load forecast for Chukha Dzongkhag

Sl. No	Feeder Name	Peak Load Consumption Pattern (MW)					Forecasted Peak Load Consumption Pattern (MW)										
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
ESD, Phuentsholing																	
1	11 kV New Polythyene	0.47	0.52	0.53	1.09	1.02	0.87	0.91	0.96	1.00	1.05	1.09	1.14	1.18	1.23	1.27	1.32
2	11kV Karbraytar & Rametey	0.86	0.84	0.85	0.89	0.90	1.04	1.06	1.07	1.09	1.11	1.13	1.14	1.16	1.18	1.20	1.22
3	11kV (Tading)	0.92	0.96	1.12	1.09	1.24	1.30	1.35	1.40	1.46	1.51	1.57	1.62	1.67	1.73	1.78	1.83
4	11kVBPC Colony	1.86	1.45	1.47	2.22	2.08	2.16	2.24	2.32	2.40	2.48	2.56	2.64	2.72	2.80	2.88	2.96
5	11kV Hospital	0.14	0.18	0.12	0.15	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
6	11kV Helipad	0.50	0.41	0.53	0.41	0.41	0.43	0.45	0.47	0.49	0.51	0.53	0.55	0.57	0.59	0.61	0.63
7	33kV Serina Bosokha	1.06	1.29	0.80	0.98	1.28	1.21	1.28	1.34	1.42	1.31	1.46	1.39	1.57	1.52	1.51	1.51
8	11kVWater Booster	2.66	3.20	3.03	3.96	3.58	3.71	3.83	3.96	4.09	4.22	4.35	4.47	4.60	4.73	4.86	4.98
9	11kV PWD	3.21	1.91	2.56	3.03	2.87	2.96	3.04	3.13	3.22	3.30	3.39	3.48	3.56	3.65	3.74	3.82
10	11kV Yarkay	0.17	0.17	0.12	0.16	0.17	0.18	0.18	0.19	0.19	0.20	0.21	0.21	0.22	0.23	0.23	0.24
11	11kVStation	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
12	11kVRangaytrung	0.45	0.40	0.50	0.29	0.28	0.46	0.46	0.47	0.47	0.48	0.48	0.48	0.49	0.49	0.50	0.50
13	11kVGurungdangra	0.18	0.03	0.02	0.09	0.09	0.11	0.12	0.12	0.12	0.13	0.13	0.13	0.13	0.14	0.14	0.14
14	11kV BCCL Colony	1.25	1.11	1.03	1.38	1.41	1.43	1.45	1.47	1.50	1.52	1.54	1.56	1.58	1.61	1.63	1.65
15	11kV Lower Industrial Estate	3.46	3.31	3.31	4.29	4.27	4.23	4.28	4.34	4.40	4.45	4.51	4.57	4.62	4.68	4.74	4.79
16	11kV Upper Industrial Estate	4.12	3.28	4.40	4.52	3.51	4.39	4.40	4.41	4.43	4.44	4.45	4.47	4.48	4.49	4.51	4.52
17	11kV Druk Cement	2.09	2.01	2.77	4.19	3.56	3.34	3.43	3.53	3.62	3.72	3.82	3.91	4.01	4.10	4.20	4.29
18	11kV Bhutan Steel	2.91	2.94	2.89	2.98	2.88	2.90	3.00	2.93	2.93	2.88	3.02	3.03	2.94	2.89	3.02	3.04
19	11kVMalbase Colony	0.92	0.91	0.87	1.11	1.11	1.16	1.22	1.27	1.33	1.39	1.45	1.51	1.57	1.63	1.68	1.74
20	11kV Burkey	0.09	0.12	0.10	0.14	0.10	0.10	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.13	0.13	0.13
21	33kV Sector I	3.21	1.91	2.56	3.03	2.87	2.96	3.04	3.13	3.22	3.30	3.39	3.48	3.56	3.65	3.74	3.82
22	33kV Sector II	2.84	2.85	2.80	2.84	2.85	3.90	3.91	3.91	3.92	3.93	3.93	3.94	3.95	3.95	3.96	3.97
	Total	**33.39**	**29.81**	**32.39**	**38.86**	**36.64**	**38.97**	**39.93**	**40.71**	**41.57**	**42.20**	**43.27**	**44.00**	**44.87**	**45.57**	**46.48**	**47.28**



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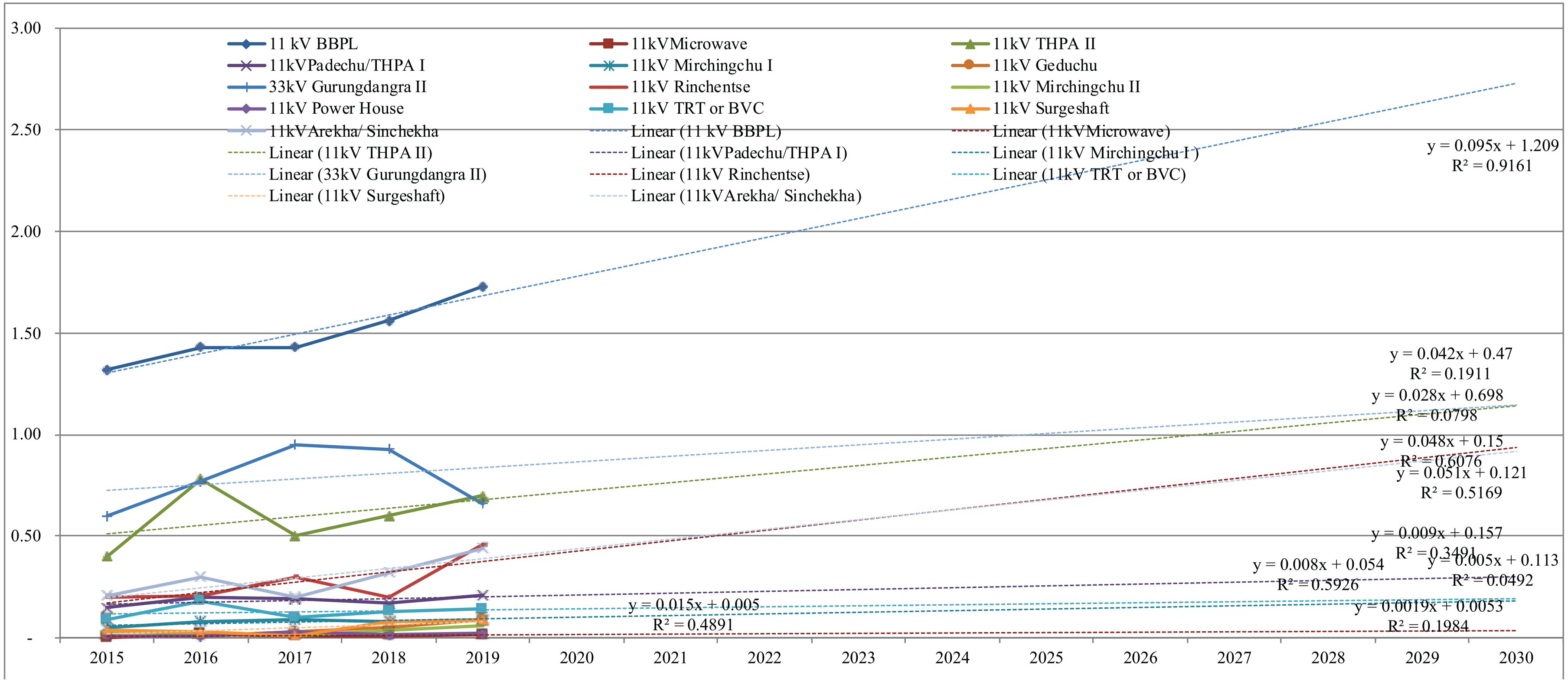
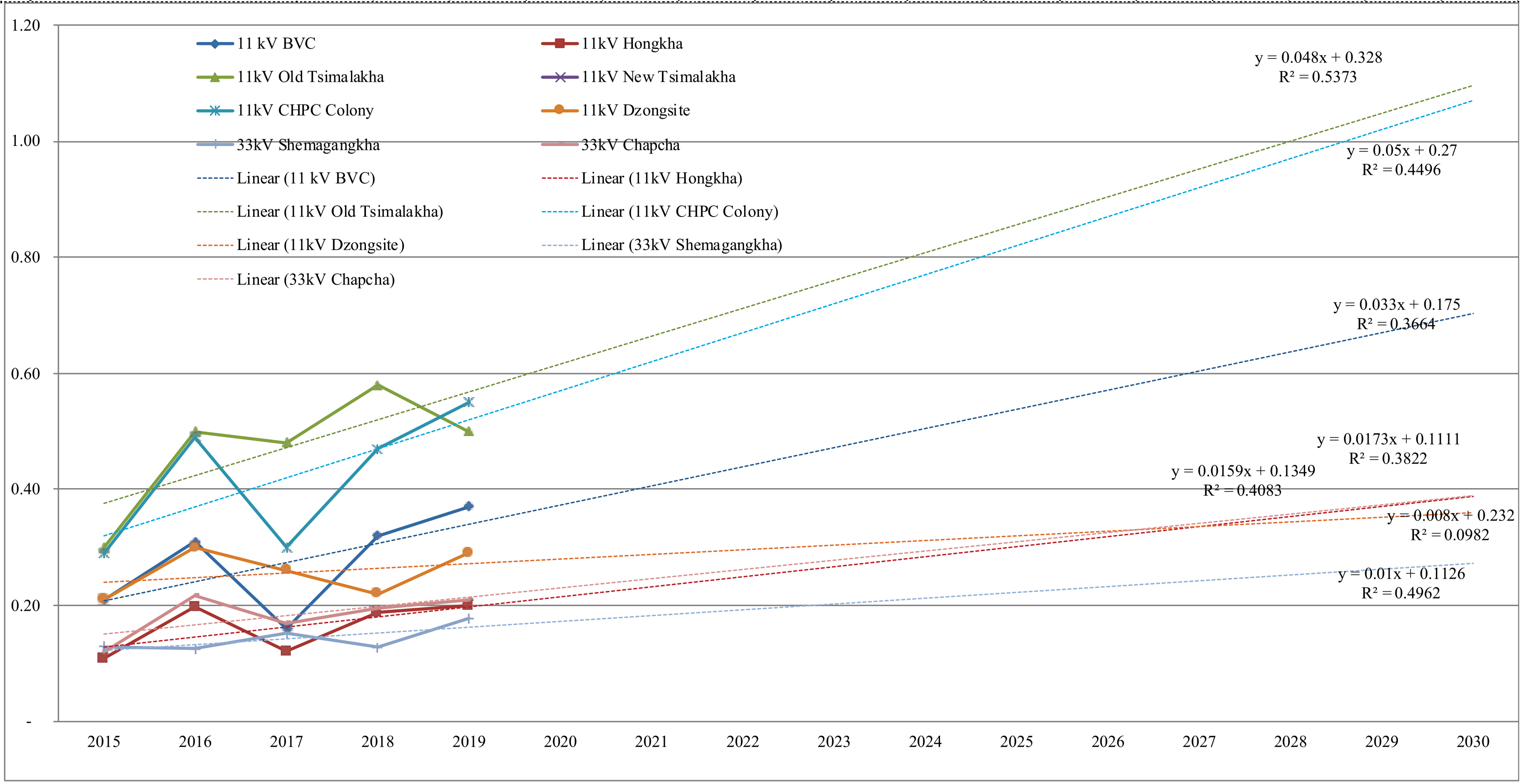
11 kV New Polythyene
11kV Karbraytar & Rametey
11kV (Tading)
11kVBPC Colony
11kV Hospital
11kV Helipad
33kV Serina Bosokha
11kVWater Booster
11kV PWD
11kV Yarkay
11kVStation
11kVRangaytrung
11kVGurungdangra
11kV BCCL Colony
11kV Lower Industrial Estate
11kV Upper Industrial Estate
11kV Druk Cement
11kV Bhutan Steel
11kVMalbase Colony
11kV Burkey
Linear (11kV Karbraytar & Rametey)
Linear (11kV (Tading))
Linear (11kVBPC Colony)
Linear (11kV Helipad)
Linear (33kV Serina Bosokha)
Linear (11kVWater Booster)
Linear (11kV PWD)
Linear (11kVStation)
Linear (11kVRangaytrung)
Linear (11kV BCCL Colony)
Linear (11kV Lower Industrial Estate)
Linear (11kV Upper Industrial Estate)
Linear (11kV Druk Cement)
Linear (11kV Bhutan Steel)
Linear (11kV Burkey)
y = 0.512x + 1.388
R² = 0.736
y = 0.2603x + 2.9475
R² = 0.6532
y = 0.2596x + 2.5067
R² = 0.6711
y = 0.0025x + 3.9573
R² = 5E-05
y = 0.1214x + 1.4522
R² = 0.301
y = 0.0438x + 2.5843
R² = 0.0185
y = -0.0015x + 2.925
R² = 0.0036
y = 0.0584x + 0.8088
R² = 0.6344
y = 0.0779x + 0.8332
R² = 0.8937
y = 0.0139x + 1.0412
R² = 0.0111
y = 0.013x + 0.829
R² = 0.6306
y = -0.0446x + 0.5186
R² = 0.5378
y = 0.004x + 0.098
R² = 0.1
y = 0.0007x + 0.0146
R² = 0.2746
y = -0.0176x + 0.5053
R² = 0.23

Sl. No	Feeder Name	Peak Load Consumption Pattern (MW)					Forecasted Peak Load Consumption Pattern (MW)										
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
ESSD, Gedu & Lhamoizingkha																	
1	11 kV BBPL	1.32	1.43	1.43	1.56	1.73	1.78	1.88	1.97	2.07	2.16	2.26	2.35	2.44	2.54	2.63	2.73
2	11kVMicrowave	0.00	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.04
3	11kV THPA II	0.40	0.78	0.50	0.60	0.70	0.76	0.81	0.86	0.90	0.95	1.00	1.05	1.10	1.14	1.19	1.24
4	11kVPadechu/THPA I	0.15	0.20	0.19	0.17	0.21	0.21	0.22	0.23	0.24	0.25	0.26	0.26	0.27	0.28	0.29	0.30
5	11kV Mirchingchu I	0.05	0.08	0.09	0.08	0.09	0.10	0.11	0.12	0.13	0.13	0.14	0.15	0.16	0.17	0.17	0.18
6	11kV Geduchu	0.01	0.01	0.03	0.05	0.09	0.10	0.12	0.14	0.16	0.18	0.20	0.22	0.24	0.26	0.28	0.30
7	33kV Gurungdangra II	0.60	0.77	0.95	0.93	0.66	0.87	0.89	0.92	0.95	0.98	1.01	1.03	1.06	1.09	1.12	1.15
8	11kV Rinchentse	0.20	0.21	0.30	0.20	0.46	0.43	0.48	0.53	0.58	0.63	0.68	0.74	0.79	0.84	0.89	0.94
9	11kV Mirchingchu II	0.03	0.02	0.01	0.04	0.06	0.06	0.06	0.07	0.08	0.09	0.10	0.10	0.11	0.12	0.13	0.14
10	11kV Power House	0.01	0.01	0.03	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.05
11	11kV TRT or BVC	0.09	0.18	0.10	0.13	0.14	0.14	0.15	0.15	0.16	0.16	0.17	0.17	0.18	0.18	0.19	0.19
12	11kV Surgeshaft	0.04	0.03	0.01	0.08	0.09	0.09	0.11	0.13	0.14	0.16	0.17	0.19	0.20	0.22	0.23	0.25
13	11kVArekha/ Sinchekha	0.21	0.30	0.20	0.32	0.44	0.44	0.49	0.53	0.58	0.63	0.68	0.73	0.77	0.82	0.87	0.92
14	33kV Gurungdangra I	1.20	1.20	1.20	1.20	0.95	1.12	1.19	1.26	1.33	1.40	1.47	1.54	1.61	1.68	1.75	1.82
	Total	**4.31**	**5.24**	**5.05**	**5.39**	**5.66**	**6.14**	**6.55**	**6.96**	**7.37**	**7.78**	**8.19**	**8.60**	**9.01**	**9.42**	**9.83**	**10.24**



Sl. No	Feeder Name	Peak Load Consumption Pattern (MW)					Forecasted Peak Load Consumption Pattern (MW)										
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
ESSD, Tsimalakha																	
1	11 kV BVC	0.21	0.31	0.16	0.32	0.37	0.37	0.41	0.44	0.47	0.50	0.54	0.57	0.60	0.64	0.67	0.70
2	11kV Hongkha	0.11	0.20	0.12	0.19	0.20	0.21	0.23	0.25	0.27	0.28	0.30	0.32	0.34	0.35	0.37	0.39
3	11kV Old Tsimalakha	0.30	0.50	0.48	0.58	0.50	0.62	0.66	0.71	0.76	0.81	0.86	0.90	0.95	1.00	1.05	1.10
4	11kV New Tsimalakha																
5	11kV CHPC Colony	0.29	0.49	0.30	0.47	0.55	0.57	0.62	0.67	0.72	0.77	0.82	0.87	0.92	0.97	1.02	1.07
6	11kV Dzongsite	0.21	0.30	0.26	0.22	0.29	0.26	0.26	0.27	0.28	0.29	0.30	0.30	0.31	0.32	0.33	0.34
7	33kV Shemagangkha	0.13	0.13	0.15	0.13	0.18	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.27
8	33kV Chapcha	0.12	0.22	0.17	0.20	0.21	0.23	0.25	0.26	0.28	0.29	0.31	0.33	0.34	0.36	0.37	0.39
	Total	**1.37**	**2.14**	**1.64**	**2.10**	**2.30**	**2.43**	**2.62**	**2.80**	**2.98**	**3.16**	**3.34**	**3.53**	**3.71**	**3.89**	**4.07**	**4.26**
	Overall Total	**39.07**	**37.19**	**39.08**	**46.35**	**44.59**	**47.55**	**49.10**	**50.47**	**51.92**	**53.14**	**54.81**	**56.13**	**57.59**	**58.88**	**60.38**	**61.77**



Load forecast methodology

1. Load Forecast

1.1 Type of Load Forecast and Power System Planning

One of the power system planning element is the load forecast. Although, there are no documented standards specifying the type of planning however, the power system planning can be short-term planning (STP) (less than one year), medium-term planning (MTP) (1-3 years) and long-term planning (LTP) (3-10 years and even higher). It is necessary to predict the power requirement for a specified time-horizon which is referred to as load (power) forecasting based on the historical consumption pattern for better planning and optimizing the available resources. Analogy to power system planning, the load forecast can be also short-term load forecasting (STLF), medium-term load forecasting (MTLF) and long-term load forecasting (LTLF) and accordingly the distribution network expansion programs are proposed[1] for distributing the electricity.

There are number of driving factors which are listed below affecting the forecasted load.

a) Time
   - Hours of the day (day or night)
   - Day of the week (weekdays or weekend)
   - Time of the year (winter or summer season)

b) Weather conditions (temperature and humidity)
c) Type of customers (residential, commercial, industries etc.)
d) Population
e) Economic indicators (per capita income, Gross Domestic Product (GDP) etc.)
f) Prices of the electricity

As the DSMP is being developed for 10-year period, the load forecast has to be done for same time horizon. Therefore, some of the driving factors as listed above which affects the LTLF may not impact the accuracy as daily, weekly and monthly time factors and weather conditions will have minimum contribution to the load variance.

1.2 Methods of Load (LTLF) Forecast

The LTLF methods are generally the trend analysis or time series analysis, economic modelling, end-use analysis and hybrid analysis. As the DSMP is for 10-year period, the methods of LTFL is being outlined for forecasting the load[1].

1.2.1 Trend Analysis

In the trend analysis, the historical data (power) is used to forecast the load. The details on load forecast adopting power consumption trend is reflected in **Section 1.3.** Typical load forecast is as shown in **Figure 1.**

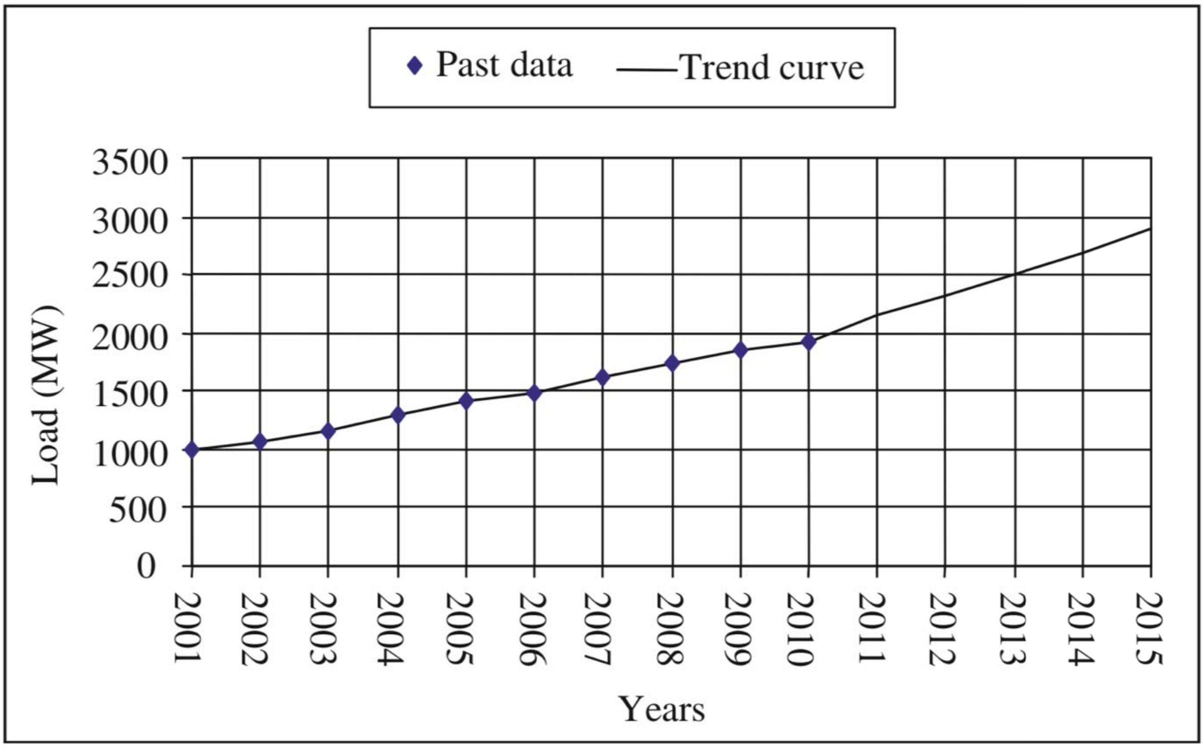


Figure 1: Typical trend curve[1]

1.2.2 Economic Modelling

In this method, the relationship between the load and the driving parameters are established and accordingly the future values of the driving factors are projected. Although, this approach is widely being used, as most of the data for driving factors are not available and for simplicity the trend analysis is adopted to forecast the load.

1.2.3 End-use Analysis

This approach is exclusively used for residential loads which is forecasted in terms of energy and therefore, it requires some methods to convert the predicted energy consumption to load (power demand). There is uncertainty in the accuracy of the predicted load and is also confined to residential customers. Therefore, end-use analysis approach is not adopted to predict the load.

1.2.4 Hybrid Analysis

Although, the end-use and econometric methods may be simultaneously used to forecast the load, it is not widely used as it has advantages and disadvantages of both the approaches.

1.3 Trend Line Analysis

The LTLF is carried out using the trend analysis approach and accordingly for planning the distribution system network. In order to forecast the load, the peak power demand prior to 2020 was considered and the power requirement trend is obtained. Load requirement is then predicted for next ten-year period (2020-2030) by extrapolating the trend line considering the load of 2019 as a base data. The case study of Punakha Dzongkhag is chosen to get insight of actual load forecast.

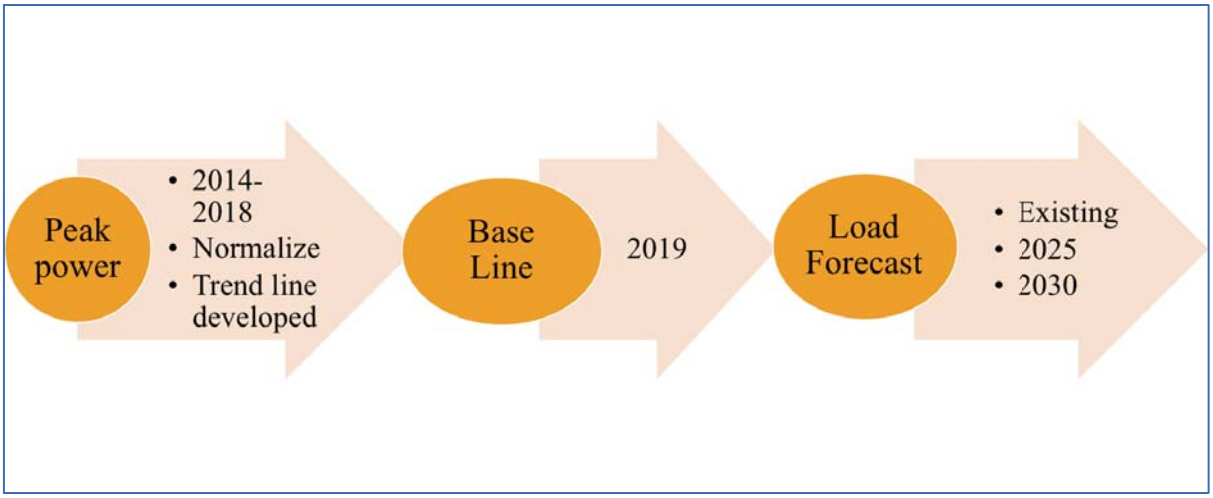


Figure 2: Flow diagram for load forecast

1.3.1 Normalizing the Data

Some of the distribution network do have ring feeders and multiple sources for better reliability and contingency. This in turn has resulted in abnormality in the power consumption data (recordings). Further, in the absence of meters or malfunctioning of the reading equipment or recorded data, some of the feeders have unreliable data for some of the years. Therefore, data is normalized by omitting the outliers or by taking the average of the past data (or average of preceding and future load if a year's data is missing). Such exercise is carried out for all the feeders and substation loads.

Table 1: Actual power data of Punakha Dzongkhag

Sl.No.	Name of Feeder	Consumption Pattern (MW)						
		2013	2014	2015	2016	2017	2018	2019
1	Feeder A	1.85	2.01	0.90	0.22	2.45	2.64	2.63
2	Feeder B	0.48	0.51	4.86	0.50	0.49	0.74	0.72
3	Feeder C	1.35	1.60	1.60	1.80	2.10	1.76	2.40
4	Feeder D	0.96	1.02	1.47	1.48	1.80	2.24	1.89
	Total	**4.64**	**5.14**	**8.83**	**4.00**	**6.84**	**7.37**	**7.64**

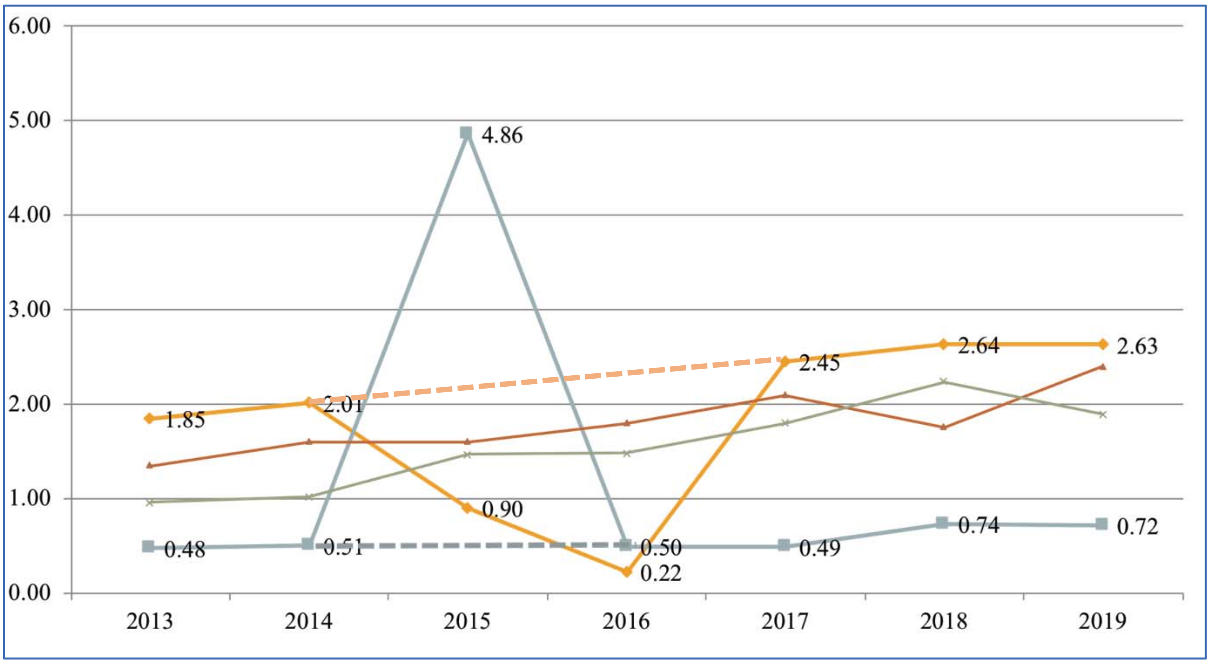


Figure 3: Actual data of Punakha Dzongkhag

$$x = \left(\frac{x_1 + x_2}{2}\right)$$

Where:

x is the normalized data

x_1 and x_2 is the data for two years

Table 2: Normalized power data of Punakha Dzongkhag

Sl.No.	Name of Feeder	Consumption Pattern (MW)						
		2013	2014	2015	2016	2017	2018	2019
1	Feeder A	1.85	2.01	1.93	1.97	2.45	2.64	2.63
2	Feeder B	0.48	0.51	0.49	0.50	0.49	0.74	0.72
3	Feeder C	1.35	1.60	1.60	1.80	2.10	1.76	2.40
4	Feeder D	0.96	1.02	1.47	1.48	1.80	2.24	1.89
	Total	**4.64**	**5.14**	**8.83**	**4.00**	**6.84**	**7.37**	**7.64**

1.3.2 Trend Line and Load Forecast

Based on the power data, the trend line is added to portray the power consumption pattern which gets generated as per the linear regression equation[1]. The trend line added is then extrapolated to forecast the load for next ten years which is as shown in **Figure 4.**

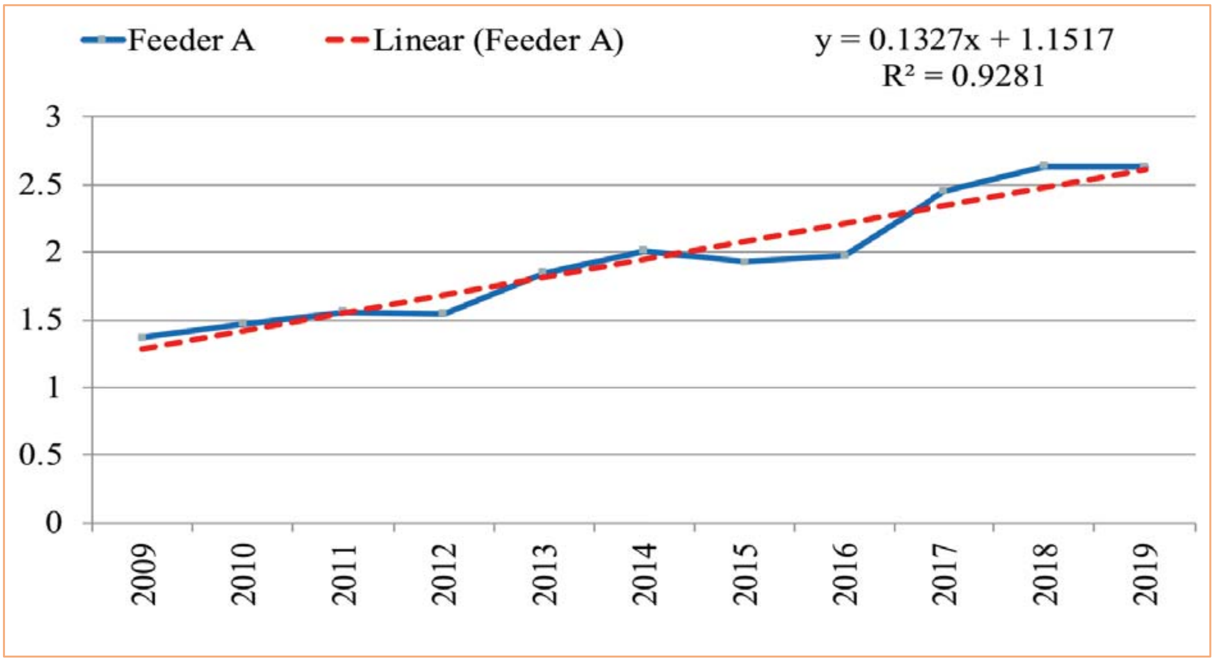


Figure 4: Trend line and load forecast for Punakha Dzongkhag

The trend line equation is given by[2]:

$$y = ax + b$$

Where:

y *is the dependent variable or forecasted load*
a *is the slope which is the average change in* y *for every increment of* x (*increase in year*).
It also gives x *is the independent variable or time in year*
b *is the intercept which is the predicted value of* y *when* x *is zero* (*time is zero*)

The Pearson correlation coefficient *'r',* which can take values between -1 & 1 corresponds to the linear relationship between variables *x & y*. If the *r* value is either -1 or 1, dependent variable can be perfectly explained by a linear function of the other.

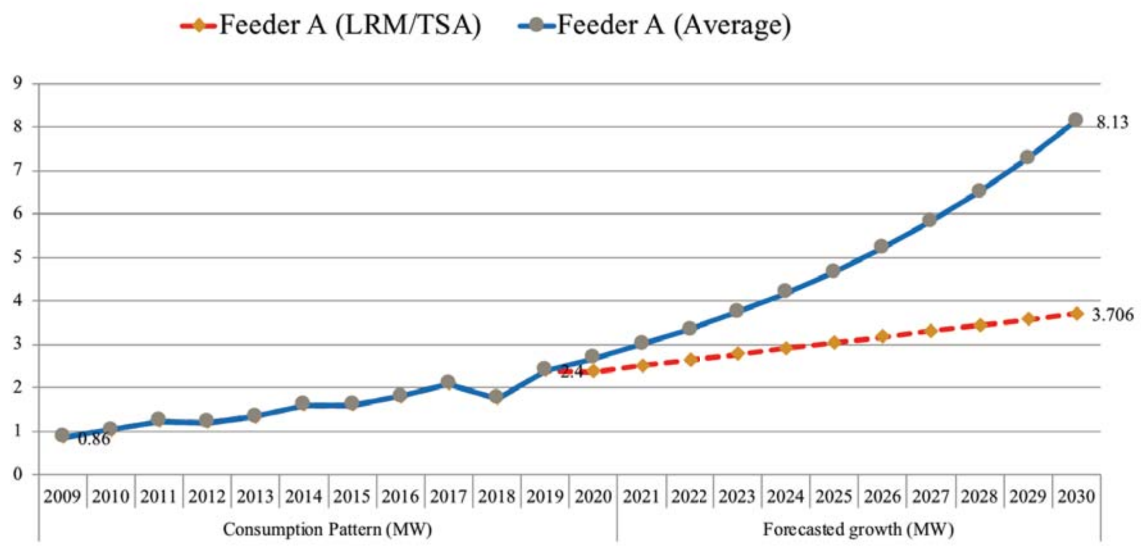


Figure 5: Forecasted load (trend line with red shows the linear regression and one with blue shows the forecast with average method)

2. Electrical Transient Analyser Program (ETAP) –Modelling and Load Flow Analysis

2.1 ETAP Software

"**ETAP** is an analytical engineering solution tool specializing in the simulation, design, monitoring, control, operator training, optimizing, and automating power systems[3]. ETAP's integrated digital platform offers the best comprehensive suite of enterprise solutions."
ETAP software is used in DSMP for modelling/designing, network simulation and to carry out the technical evaluation for distribution power system. The modelled network is fed with the essential data (such as specifications, constraints and parameters for network components) and the simulation results are assessed and analysed. Conclusively, different measures are considered and performed in ETAP for improving the efficiency of a system.

2.2 Load Flow Analysis (ETAP)

Load Flow Analysis (LFA) is a major tool to study and analyse the operation of a power system and determines voltage drops and power flow throughout the electrical system. Using network parameters (Input) for power sources, lines, transformers and connected loads, LFA provides voltages magnitude, real/reactive power, currents, and power losses as a result from the load flow simulation. The study also allows for swing, voltage regulated, and unregulated power sources with multiple power grids and generator connections and the analysis can be performed on both radial and loop systems.

Numerical analysis method such as Adaptive Newton-Raphson, Newton-Raphson, Fast Decoupled, & Accelerated Gauss Seidel methods are accessible in ETAP and can be used for solving the load flow analysis problems.

In this analysis, Adaptive Newton-Raphson method is used for load flow study of distribution networks and the study is carried out under 3-time horizon: present (2019), 2025 and 2030 (forecast load). The results (total generation, loading, system losses, and critical report of load flow) obtained under the scenarios are analysed and corresponding corrective measures are proposed.

2.2.1 Creating the Library

Although, the electrical parameters and specifications are inbuilt, to suit the requirements of the study, the missing electrical parameters are customized by creating a library. The units are set to metric system and accordingly the network is modelled and the relative data for network components such as transformers, line types, power sources and load details are fed in which are detailed as follows:

a) Transmission Cable

- Library-Transmission Line-Phase Conductor-Add-Transmission line library
- In transmission line library: change unit system into Metric, conductor type into ACSR and frequency into 50HZ, and Source name as BPC.
- Click BPC and click edit properties.
- In edit properties add the required conductor parameter by referring the Excel sheet (technical parameters.)
- For AAAC use the source name "Pirelli" and select the required size.

b) UG cable (Since 33kV Al UG Cable is not available):

- Library- Cable- Add-change the source name to BPC and make the necessary changes especially type of conductor to Aluminium and installation into non-magnetic.
- Change insulation type to XLPE.
- Select BPC from the Cable library table and click edit properties
- In edit properties add the required UG cable parameters referring the Excel sheet as shown in Pictures below.

c) Set Loading and Generation Categories.

- Go to Project- Settings- Loading and generation categories
- In Generation Category, set 3 categories as Maximum, Normal and Minimum.
- In AC Load, set 3 categories as 2019, 2025 and 2030.
- Keep the DC Load Empty.

2.2.2 Network Modelling and Load Flow Analysis

a) Draw Distribution Network (SLD).
b) Enter the height=8 and spacing =1.25 in the Transmission line table.
c) Enter the electrical parameters (kW, kVA, kV, etc.) ratings for power sources, transformers, line type, bus kV and loading details.

d) Under the Lump Load, in "Nameplate" edit and enter DT % loading and forecasted % loading details for 2019,2025,2030. Set the load type (80% as constant impedance and 20% as constant KVA) as most of the loads are impedance load.

e) Make sure to run the load flow for each composite network before you continue with other network. This is to avoid numerous errors at the end.

f) After completing the SLD, study case for different load scenarios needs to be created.

g) Switch to "Load Flow Analysis" mode in Mode Toolbar. Go to "Study Case," select present Case 1 as 2019 and select "Prompt" in "Output Report"

h) Edit the "Load Flow Study Case [Brief Case Symbol]." Go to "Loading" and set to "2019" under Loading Category and set "Normal" under Generation Category. Check the Margins set under Alerts and set "Marginal (±5% for Over and Under Voltage Category)" and set "Critical (±10% for Over and Under Voltage Category)"

i) Close "Load Flow Study Case" and run "Run Load Flow" and save the result as 2019.

j) Similarly, follow step b), c) and d) for 2025 and 2030.

k) To generate the report (SLD drawings) in PDF, go to print preview- set up- change the printer name "Microsoft print to PDF".

2.3 Consideration/Assumptions made while simulating in ETAP software

a) All Network is considered as balanced system as there is limitation of unbalanced system in ETAP Key.

b) The voltage level of ±10% is given as critical value which is indicated by red colour while simulating and voltage level of ±5% is given as marginal value which is indicated by pink colour while simulating.

c) The typical value of X/R ratio from ETAP inbuilt system is taken for all the power transformers for the simulation.

d) Some of the types of transmission cables /underground cables used in BPC are not available in ETAP library therefore, a new source is created in ETAP library by inserting all the parameters of those unavailable cables/transmission lines.

e) There are three cases created in ETAP simulation depending on the load forecast namely the 2019, 2025 and 2030 where the forecasted loads are given respectively and simulated/analysed accordingly.

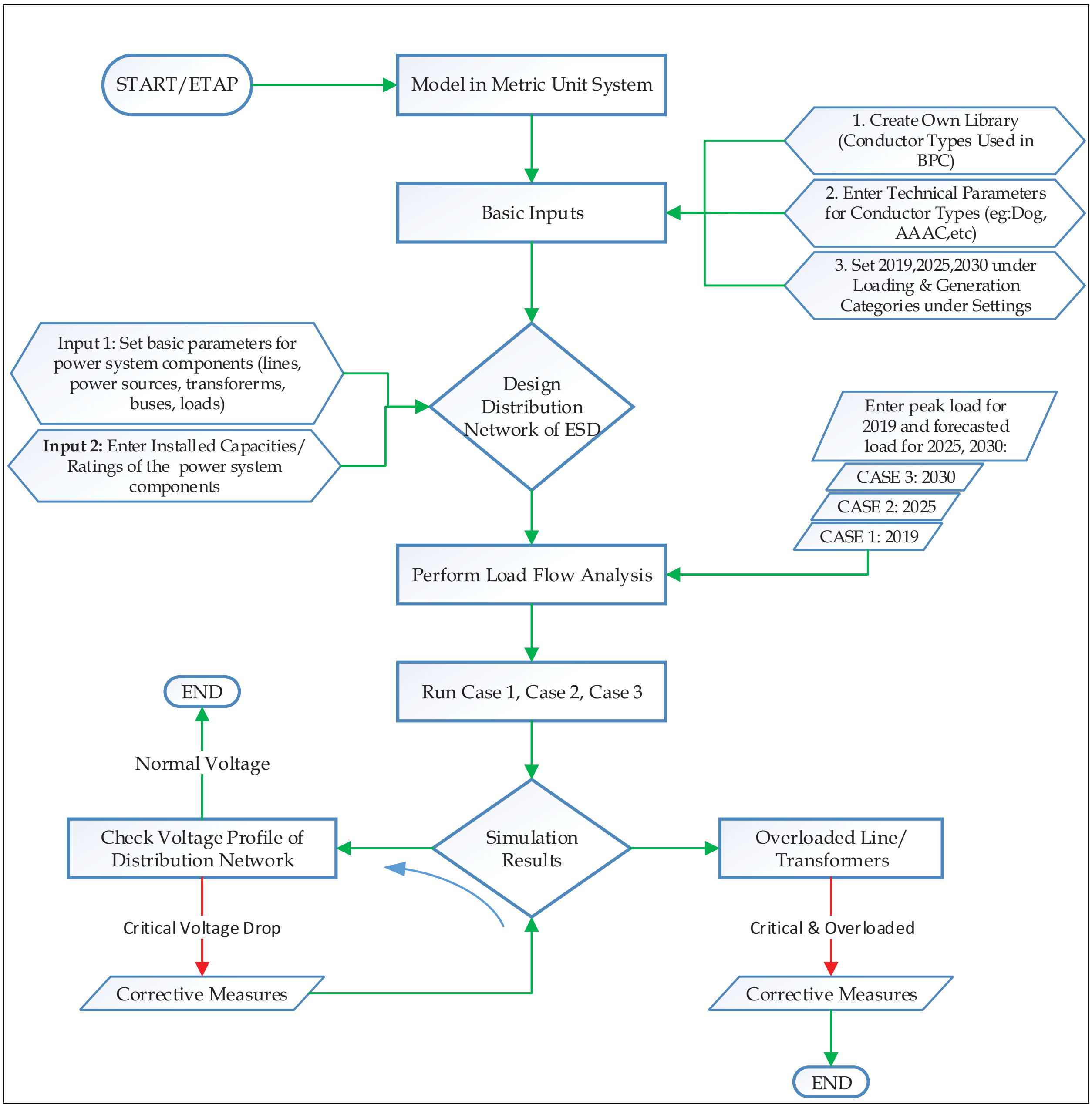


Figure 6: Flow Chart for Network Modelling & Load Flow Analysis (ETAP)

[1]Electric Power System Planning Issues, Algorithms and Solutions by Hossein Seifi Mohammad Sadegh Sepasian

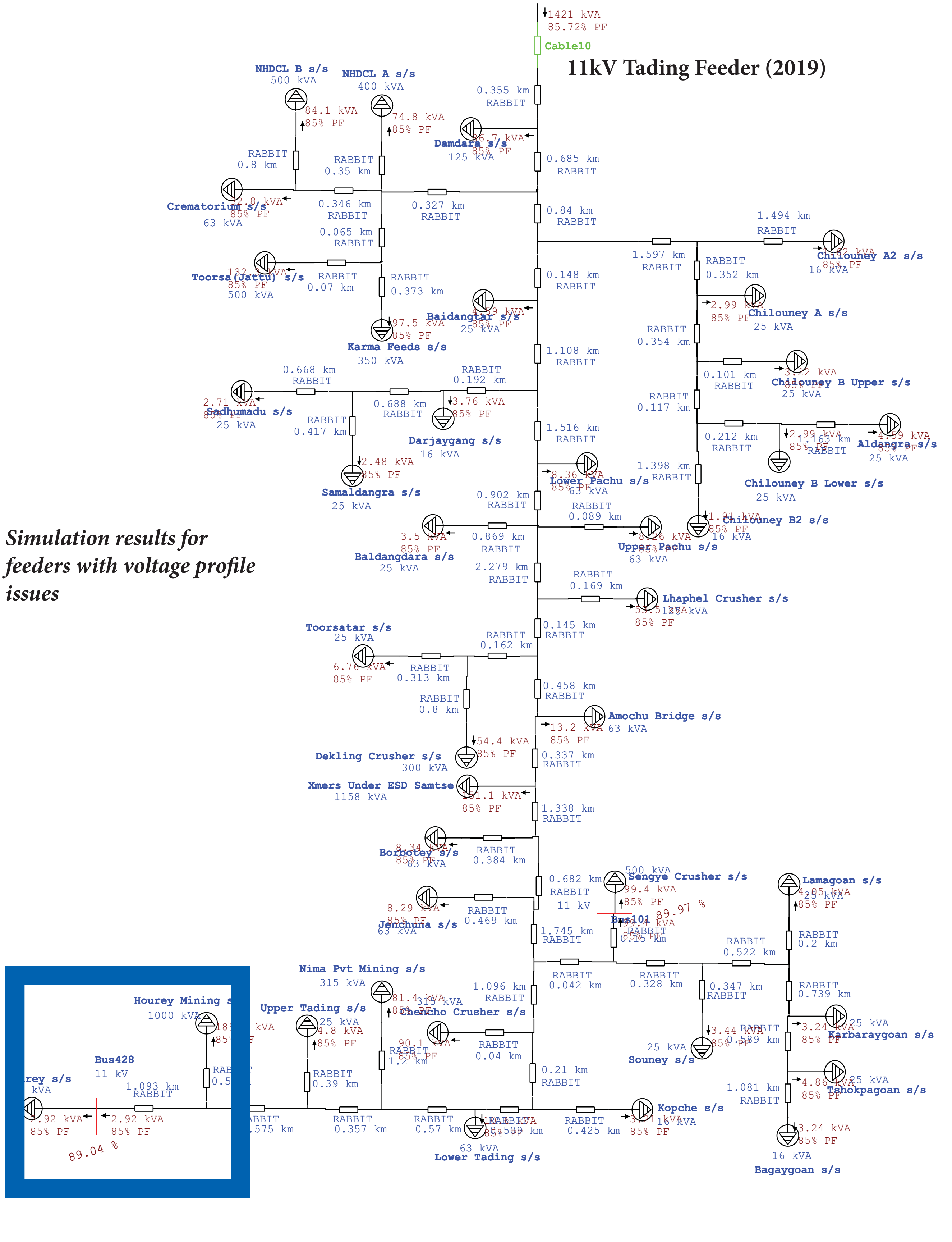
[2]http://sites.utexas.edu/sos/guided/inferential/numeric/bivariate/cor/: dated September 29, 2020

[3]http://www.powerqualityworld.com/2011/05/etap-tutorials-load-flow-analysis.html dated September 30, 2020

Annexure 4: The Simulation Results

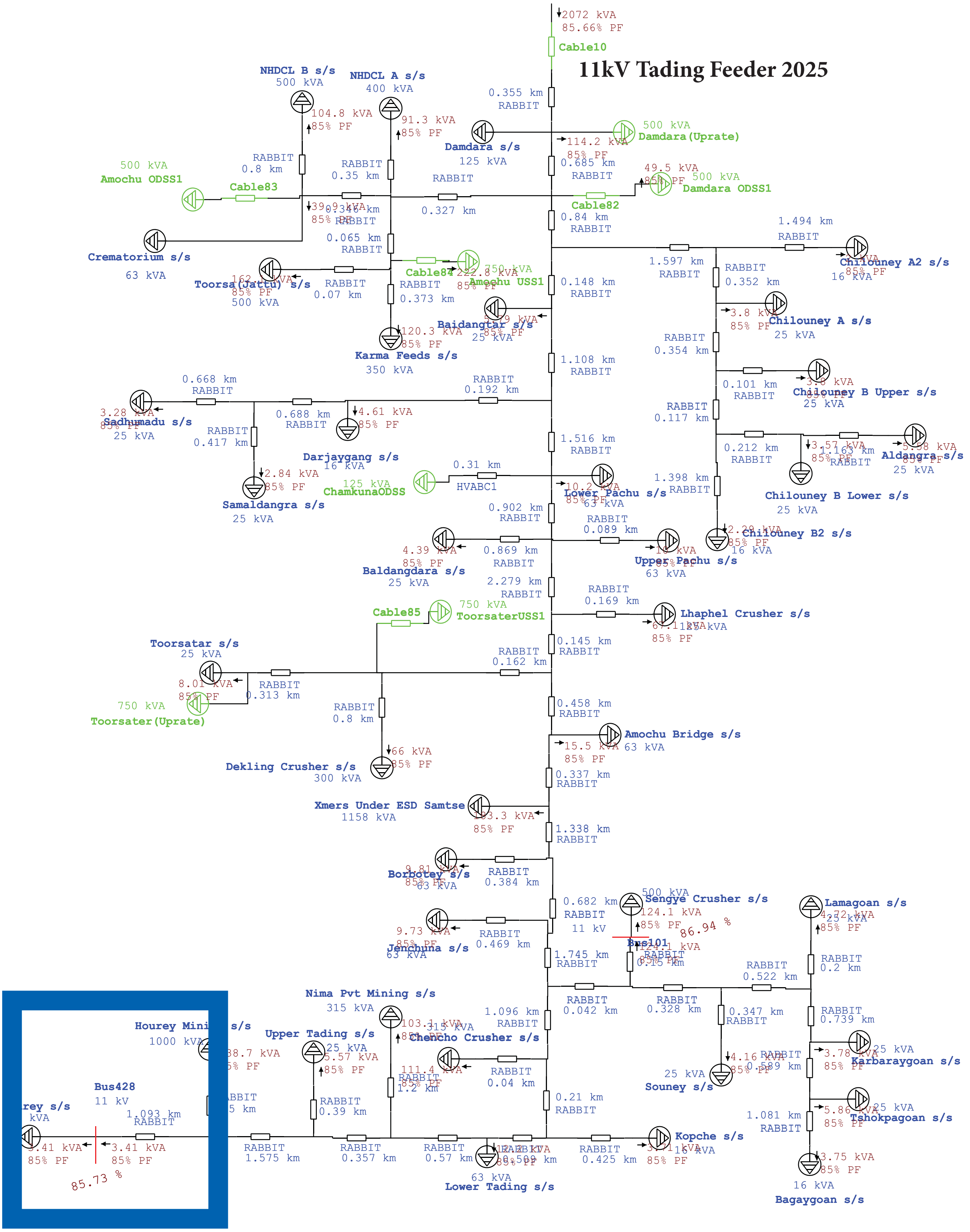
One-Line Diagram - ESD Pling=>B30 (Load Flow Analysis)

11kV Tading Feeder (2019)

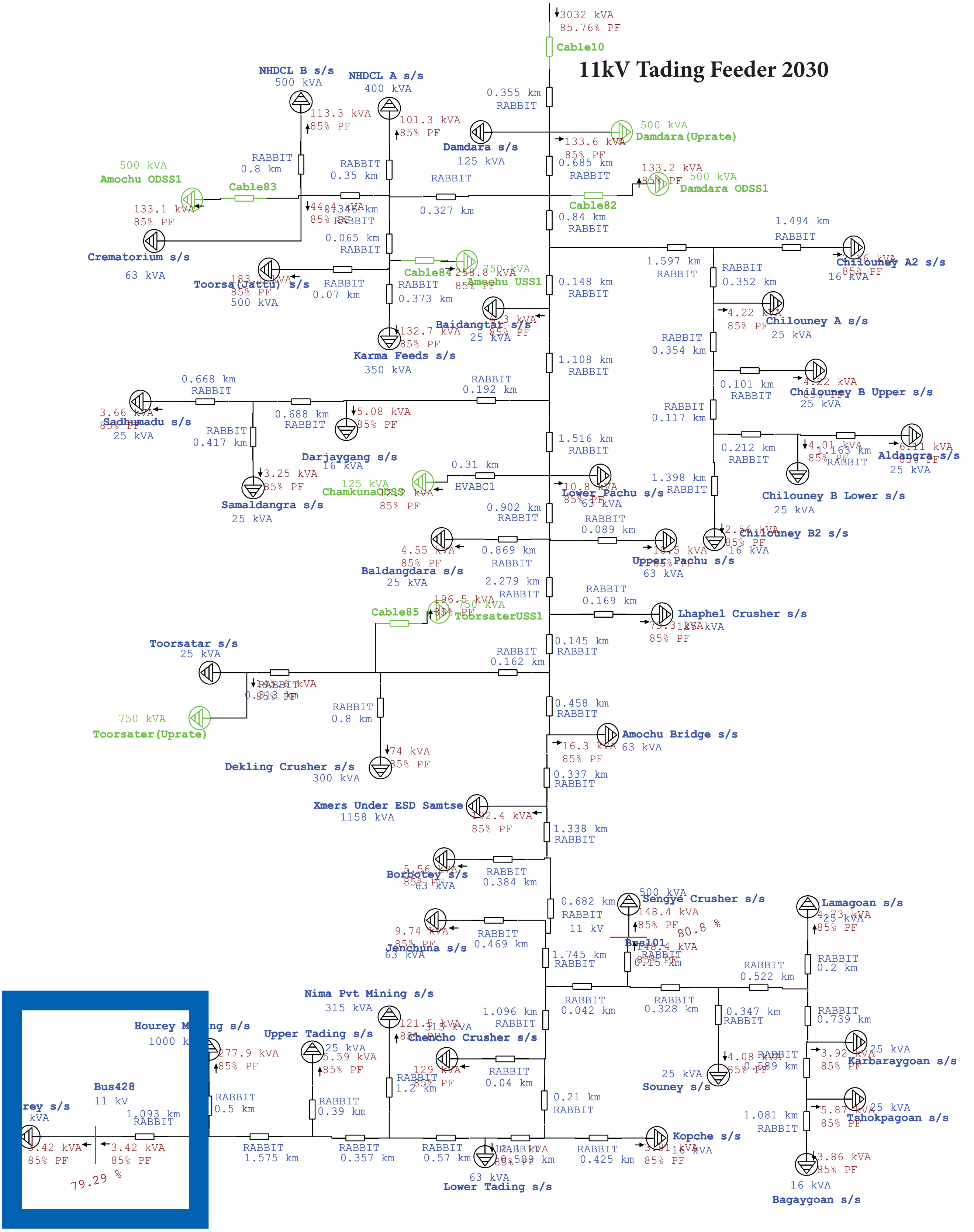


Simulation results for feeders with voltage profile issues

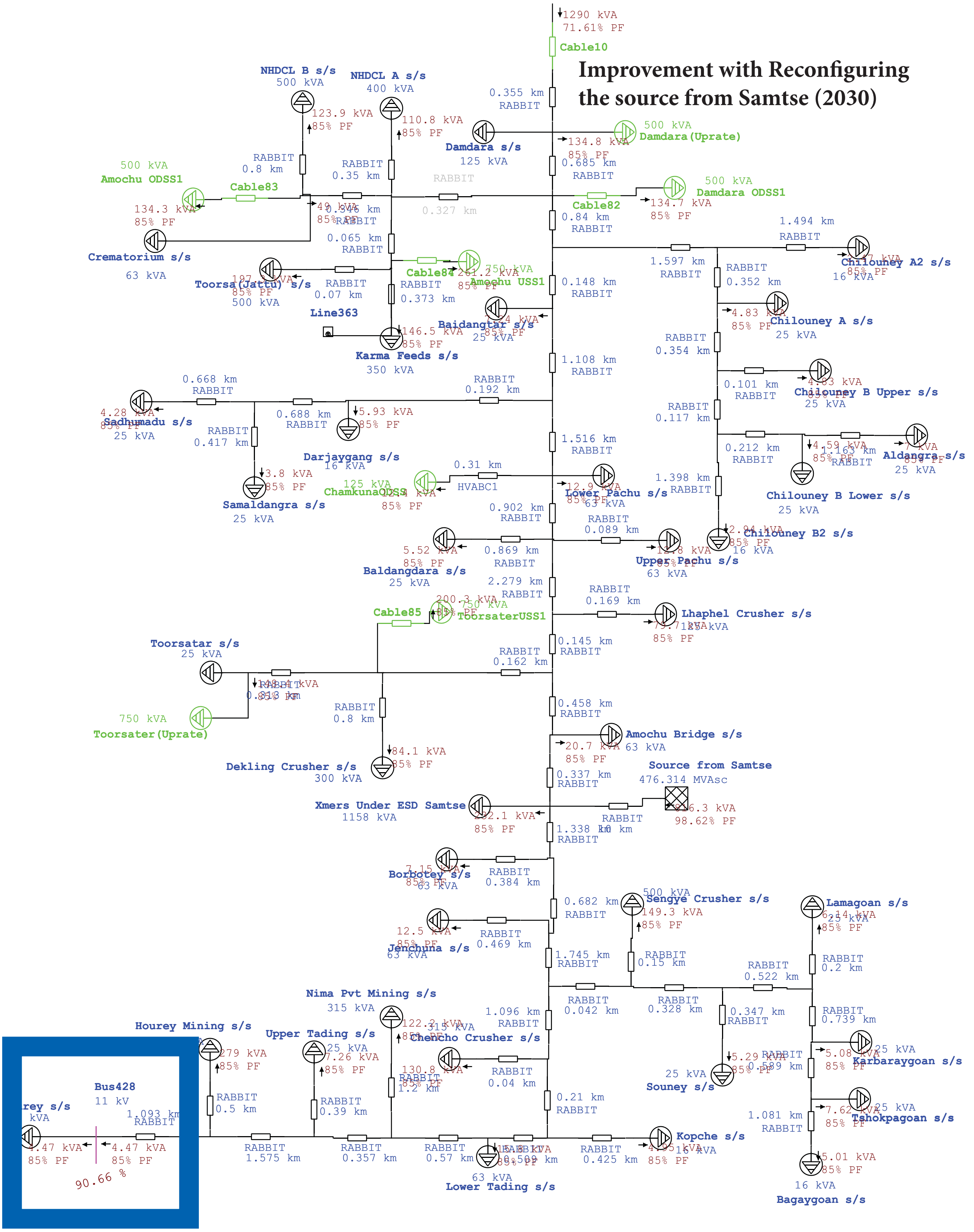
One-Line Diagram - ESD Pling=>B30 (Load Flow Analysis)



One-Line Diagram - ESD Pling=>B30 (Load Flow Analysis)

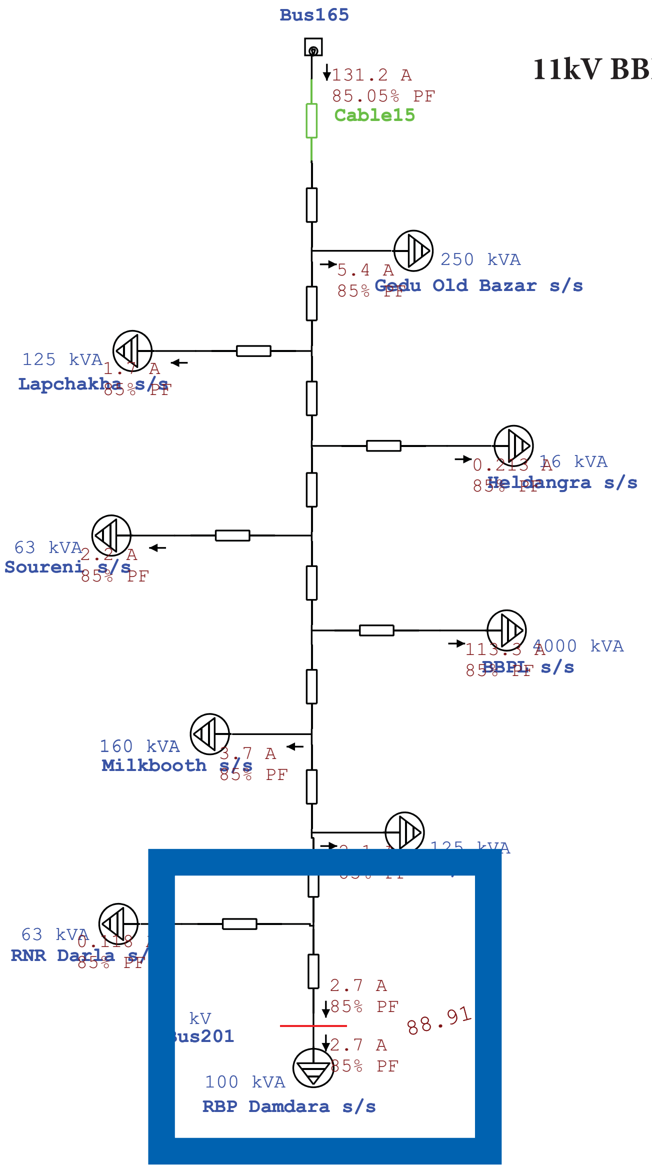


One-Line Diagram - ESD Pling=>B30 (Load Flow Analysis)

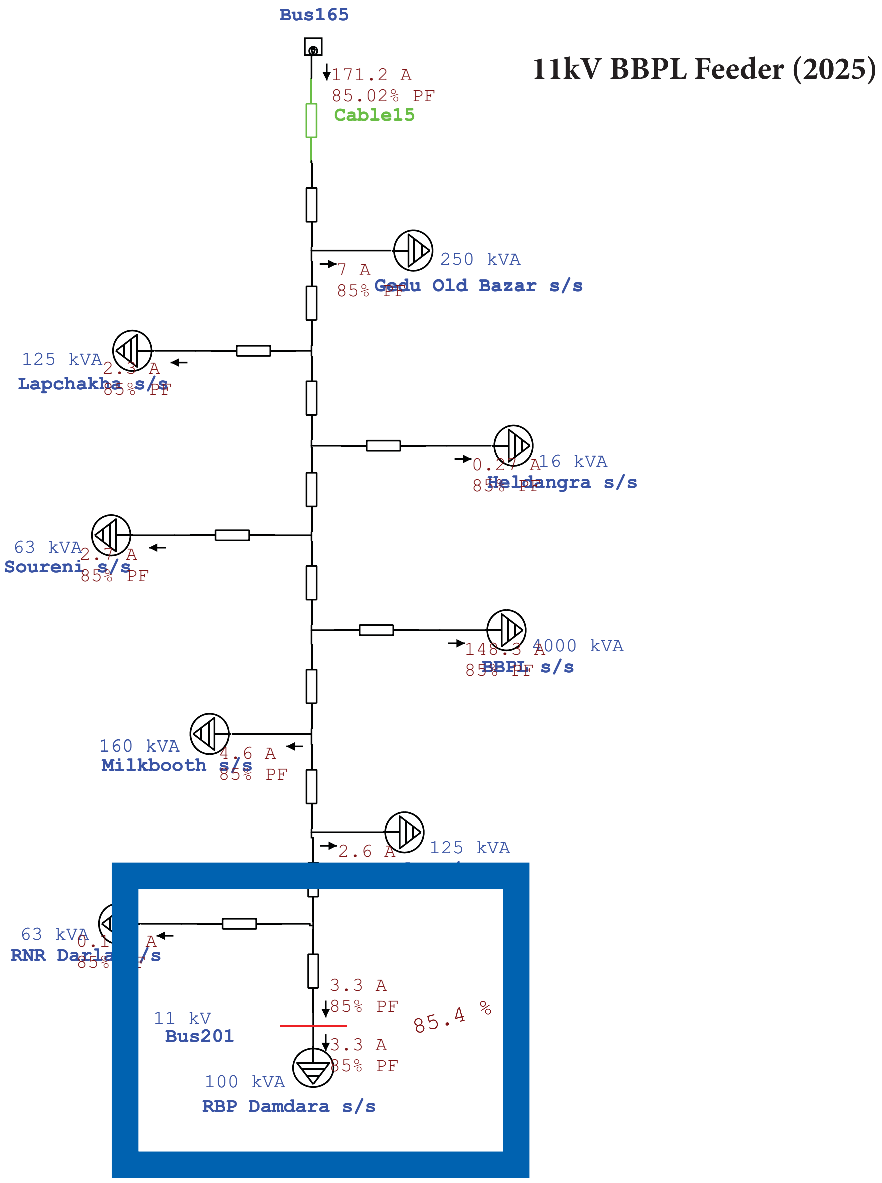


One-Line Diagram - ESSD Gedu=>B100 (Load Flow Analysis)

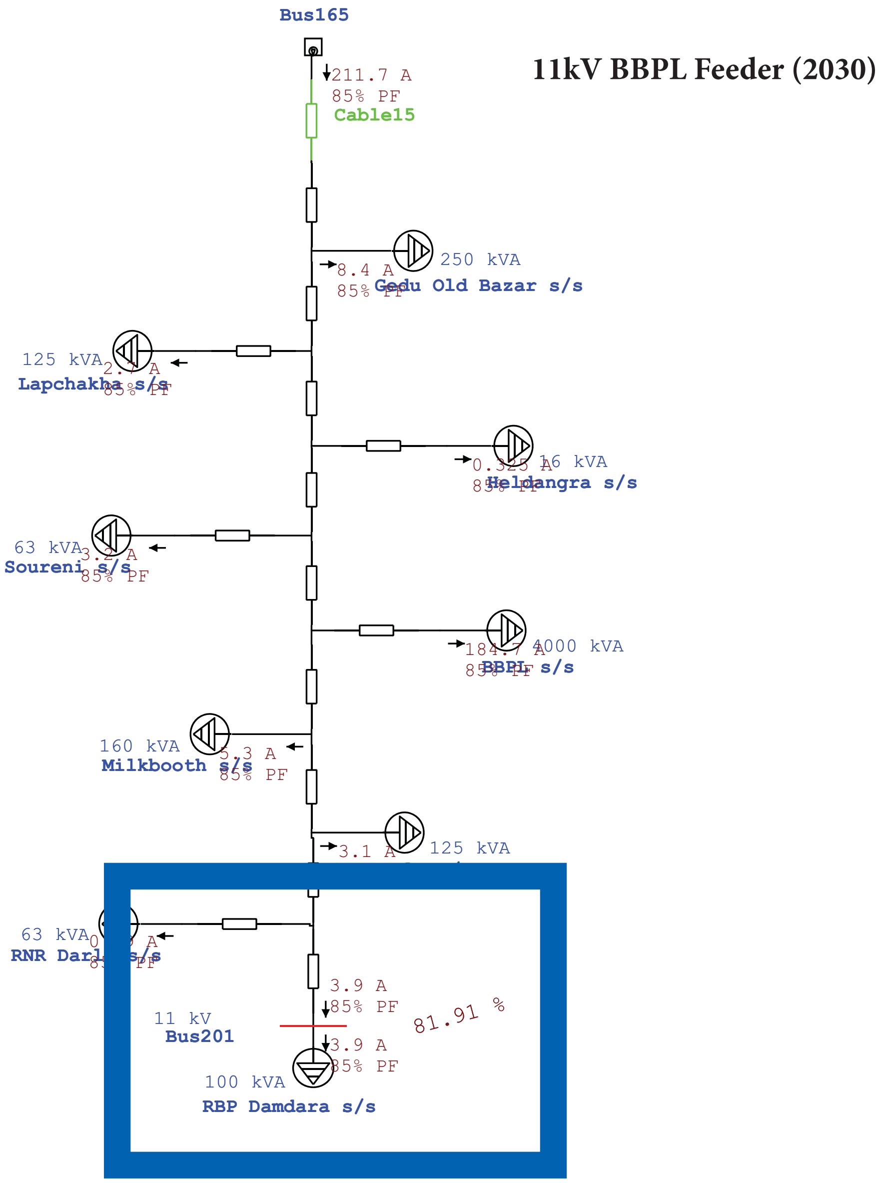
11kV BBPL Feeder (2019)



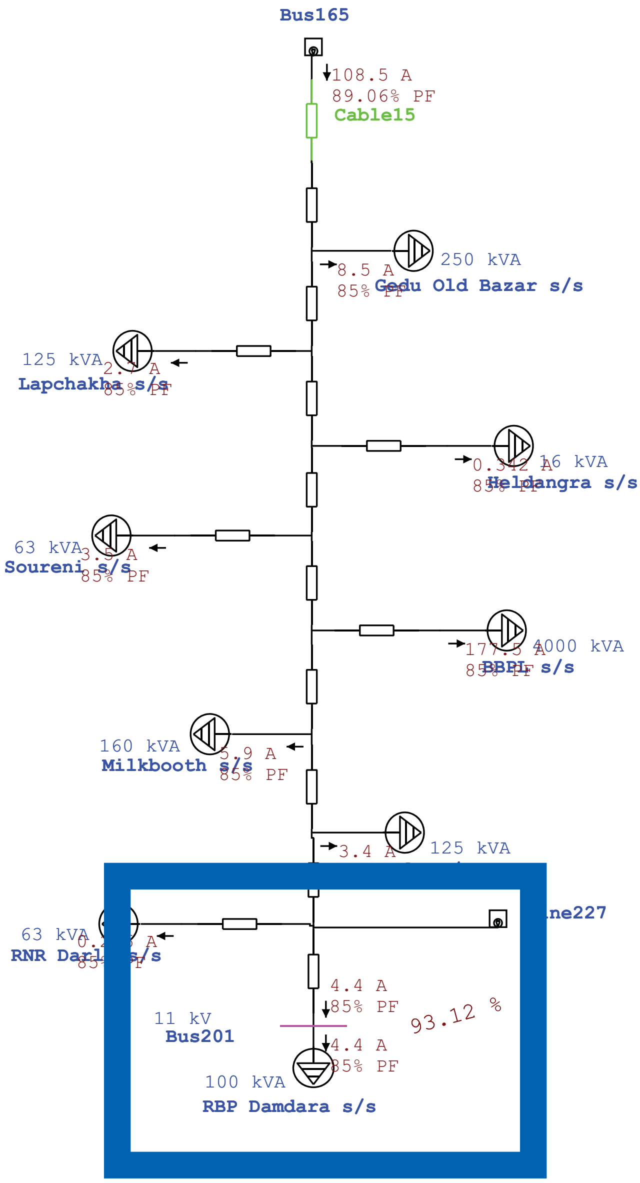
One-Line Diagram - ESSD Gedu=>B100 (Load Flow Analysis)



One-Line Diagram - ESSD Gedu=>B100 (Load Flow Analysis)

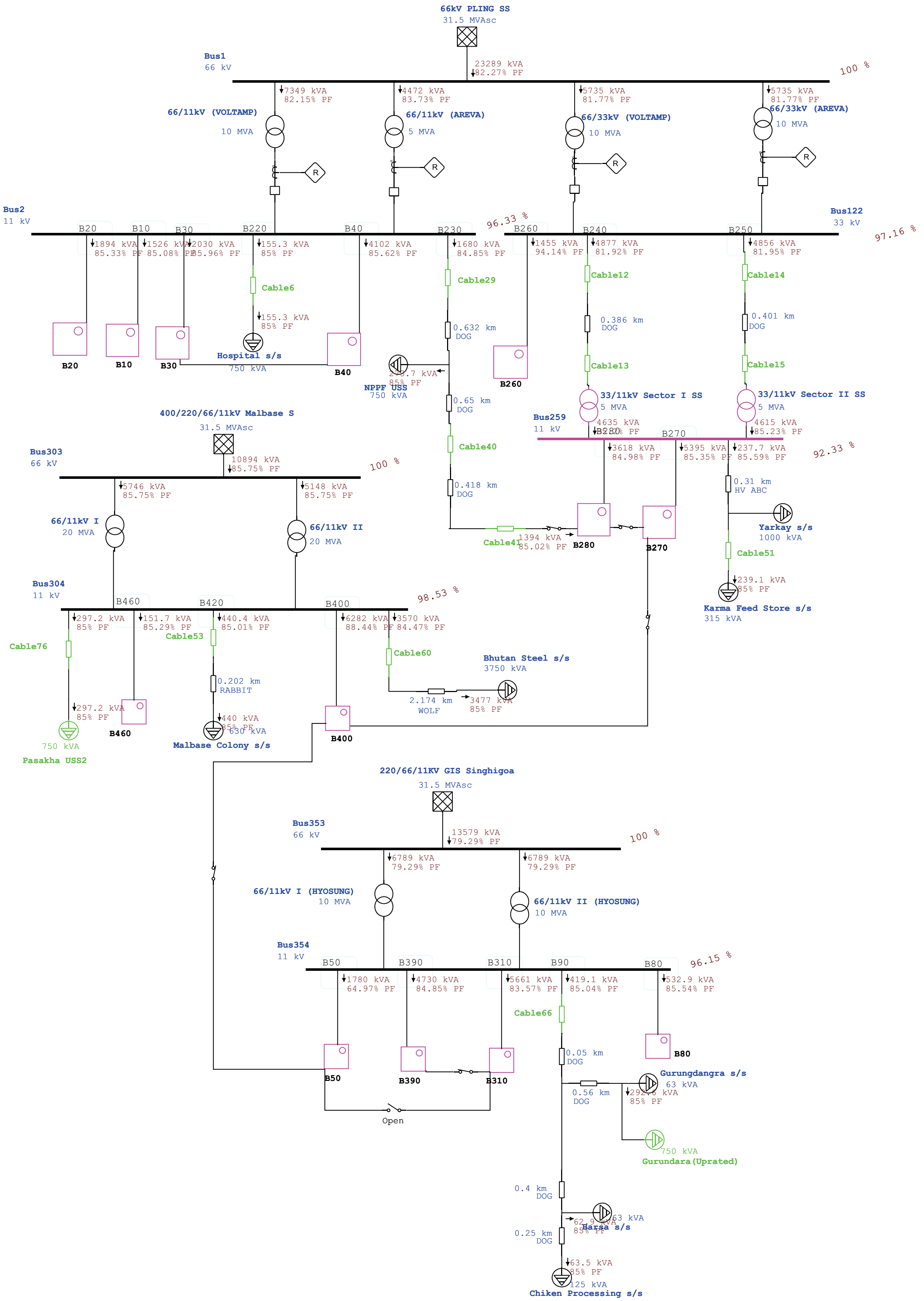


One-Line Diagram - ESSD Gedu=>B100 (Load Flow Analysis)



11kV BBPL Feeder Improved (Reconfiguring the source from Gurungdangra)-2030

One-Line Diagram - ESD Pling (Load Flow Analysis)



Bus Loading Summary Report

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					Percent
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Loading
Bus1	66.000										23.289	82.3	203.7	
Bus2	11.000										11.387	85.4	620.4	
Bus3	11.000										1.894	85.3	103.2	
Bus4	11.000										1.884	85.3	103.2	
Bus5	11.000		0.007	0.004	0.072	0.045					0.093	85.0	5.1	
Bus6	11.000										1.781	85.3	98.1	
Bus7	11.000		0.014	0.009	0.106	0.066					0.142	85.0	7.8	
Bus8	11.000		0.054	0.034	0.197	0.122					1.605	85.3	88.6	
Bus9	11.000		0.001	0.001	0.016	0.010					0.815	85.4	45.6	
Bus10	11.000										0.792	85.4	44.5	
Bus11	11.000		0.004	0.002	0.062	0.038					0.077	85.0	4.3	
Bus12	11.000		0.001	0.001	0.016	0.010					0.714	85.4	40.1	
Bus13	11.000		0.007	0.004	0.120	0.074					0.694	85.4	39.0	
Bus14	11.000		0.001	0.001	0.014	0.009					0.018	85.0	1.0	
Bus15	11.000										0.544	85.5	30.6	
Bus16	11.000		0.001	0.000	0.013	0.008					0.016	85.0	0.9	
Bus17	11.000										0.525	85.5	29.6	
Bus18	11.000		0.004	0.003	0.066	0.041					0.509	85.5	28.7	
Bus19	11.000		0.001	0.001	0.014	0.008					0.017	85.0	1.0	
Bus20	11.000										0.425	85.6	24.1	
Bus21	11.000		0.001	0.000	0.012	0.008					0.015	85.0	0.9	
Bus22	11.000										0.406	85.5	23.1	
Bus23	11.000		0.001	0.001	0.019	0.012					0.023	85.0	1.3	
Bus24	11.000										0.391	85.5	22.3	
Bus25	11.000		0.001	0.000	0.011	0.007					0.014	85.0	0.8	
Bus26	11.000										0.367	85.5	21.0	
Bus27	11.000		0.233	0.144	0.010	0.006					0.286	85.0	16.5	
Bus28	11.000										0.351	85.3	20.2	
Bus29	11.000		0.002	0.001	0.032	0.020					0.040	85.0	2.3	
Bus30	11.000										0.065	86.2	3.7	
Bus31	11.000		0.000	0.000	0.013	0.008					0.025	87.2	1.5	
Bus35	11.000										1.525	85.1	83.1	
Bus36	11.000		0.224	0.139	0.069	0.043					0.345	85.0	18.8	
Bus37	11.000		0.011	0.007	0.049	0.030					1.180	85.1	64.3	
Bus38	11.000		0.080	0.049	0.008	0.005					0.103	85.0	5.6	
Bus39	11.000		0.018	0.011	0.122	0.076					1.005	85.1	54.9	
Bus40	11.000		0.143	0.089	0.015	0.009					0.186	85.0	10.2	
Bus41	11.000		0.064	0.039	0.208	0.129					0.654	85.1	35.7	
Bus42	11.000		0.188	0.116	0.078	0.048					0.312	85.0	17.1	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus43	11.000		0.003	0.002	0.017	0.010					0.023	85.0	1.3	
Bus44	33.000				0.011	0.007					0.013	85.0	0.2	
Bus45	11.000		0.025	0.016	0.107	0.066					0.155	85.0	8.5	
Bus46	11.000		0.225	0.139	0.103	0.064					4.100	85.6	223.5	
Bus47	11.000		0.324	0.201	0.090	0.056					3.713	85.7	202.5	
Bus48	11.000		0.091	0.056	0.042	0.026					3.225	85.8	175.9	
Bus49	11.000										3.055	85.6	167.5	
Bus50	11.000		0.011	0.007	0.113	0.070					0.559	85.2	30.7	
Bus51	11.000		0.179	0.111	0.010	0.006					0.415	85.0	22.8	
Bus52	11.000		0.108	0.067	0.056	0.034					0.192	85.0	10.6	
Bus53	11.000										2.490	85.6	136.9	
Bus54	11.000		0.163	0.101	0.099	0.061					0.309	85.0	17.0	
Bus55	11.000		0.300	0.186	0.116	0.072					2.174	85.5	120.0	
Bus56	11.000		0.083	0.051	0.391	0.242					1.683	85.6	93.1	
Bus57	11.000		0.111	0.069	0.010	0.006					0.143	85.0	7.9	
Bus58	11.000										2.028	86.0	110.6	
Bus59	11.000		0.103	0.064	0.011	0.007					2.016	85.9	110.6	
Bus60	11.000										1.864	85.9	103.3	
Bus61	11.000		0.010	0.006	0.078	0.049					0.104	85.0	5.8	
Bus62	11.000										0.399	85.1	22.3	
Bus63	11.000		0.003	0.002	0.113	0.070					0.136	85.0	7.6	
Bus64	11.000										0.982	85.0	54.8	
Bus65	11.000		0.042	0.026	0.117	0.073					0.187	85.0	10.4	
Bus66	11.000		0.011	0.007	0.088	0.054					0.116	85.0	6.5	
Bus67	11.000		0.000	0.000	0.038	0.024					0.295	85.0	16.5	
Bus68	11.000										1.710	85.9	95.9	
Bus69	11.000				0.004	0.002					0.021	87.2	1.2	
Bus70	11.000										0.023	88.1	1.3	
Bus71	11.000										0.017	87.5	1.0	
Bus72	11.000				0.004	0.002					0.004	85.0	0.2	
Bus73	11.000										0.013	88.0	0.7	
Bus74	11.000				0.004	0.002					0.010	86.6	0.6	
Bus75	11.000				0.005	0.003					0.006	85.0	0.4	
Bus78	11.000				0.006	0.003					1.683	85.9	94.6	
Bus79	11.000										1.651	85.8	94.2	
Bus80	11.000				0.004	0.003					0.012	87.0	0.7	
Bus81	11.000				0.003	0.002					0.003	85.0	0.2	
Bus82	11.000										0.007	87.1	0.4	
Bus83	11.000				0.003	0.002					0.004	85.0	0.2	
Bus84	11.000				0.010	0.006					1.604	85.6	93.5	
Bus85	11.000				0.009	0.006					0.011	85.0	0.6	
Bus86	11.000										1.561	85.6	92.2	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus87	11.000				0.004	0.002					0.005	85.0	0.3	
Bus88	11.000		0.066	0.041	0.002	0.001					0.079	85.0	4.8	
Bus89	11.000										1.496	85.3	91.3	
Bus90	11.000										1.414	85.3	86.5	
Bus91	11.000		0.115	0.071	0.009	0.006					0.146	85.0	8.9	
Bus92	11.000										0.419	85.0	25.6	
Bus93	11.000		0.031	0.019	0.034	0.021					0.076	85.0	4.6	
Bus94	11.000				0.014	0.009					0.990	85.4	60.8	
Bus95	11.000		0.043	0.027	0.126	0.078					0.970	85.4	59.8	
Bus96	11.000				0.005	0.003					0.006	85.0	0.4	
Bus97	11.000										0.764	85.4	47.5	
Bus98	11.000				0.009	0.005					0.010	85.0	0.6	
Bus99	11.000										0.754	85.4	47.2	
Bus100	11.000										0.734	85.3	46.6	
Bus101	11.000		0.124	0.077	0.003	0.002					0.149	85.0	9.4	
Bus102	11.000										0.172	85.3	10.9	
Bus103	11.000				0.004	0.002					0.004	85.0	0.3	
Bus104	11.000										0.023	86.7	1.5	
Bus105	11.000				0.004	0.003					0.005	85.0	0.3	
Bus106	11.000										0.019	86.6	1.2	
Bus107	11.000				0.003	0.002					0.014	86.3	0.9	
Bus108	11.000				0.005	0.003					0.010	86.2	0.6	
Bus109	11.000				0.003	0.002					0.004	85.0	0.3	
Bus110	11.000		0.105	0.065	0.005	0.003					0.129	85.0	8.3	
Bus111	11.000										0.559	85.2	35.7	
Bus112	11.000				0.003	0.002					0.004	85.0	0.3	
Bus113	11.000										0.429	85.2	27.4	
Bus114	11.000				0.011	0.007					0.424	85.2	27.2	
Bus115	11.000		0.101	0.063	0.002	0.001					0.122	85.0	7.8	
Bus116	11.000										0.411	85.2	26.4	
Bus117	11.000		0.000	0.000	0.005	0.003					0.006	85.0	0.4	
Bus118	11.000										0.289	85.2	18.6	
Bus119	11.000		0.233	0.145	0.003	0.002					0.278	85.0	18.0	
Bus120	11.000										0.282	85.1	18.2	
Bus122	33.000			0.000							11.144	83.9	200.7	
Bus123	33.000										1.455	94.1	26.2	
Bus124	33.000										1.455	93.8	26.3	
Bus125	33.000										0.640	90.6	11.6	
Bus126	33.000		0.313	0.194	0.029	0.018					0.403	85.0	7.3	
Bus127	33.000		0.000	0.000	0.030	0.018					0.247	96.4	4.5	
Bus128	33.000				0.017	0.010					0.020	85.0	0.4	
Bus129	33.000										0.214	97.3	3.9	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					Percent
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Loading
Bus130	33.000				0.031	0.019					0.036	85.0	0.7	
Bus131	33.000										0.196	97.7	3.5	
Bus132	33.000				0.017	0.011					0.163	98.5	2.9	
Bus133	33.000										0.145	99.2	2.6	
Bus134	33.000				0.004	0.003					0.052	97.7	0.9	
Bus135	33.000												-	
Bus136	33.000										0.050	92.6	0.9	
Bus137	33.000				0.017	0.010					0.051	91.4	0.9	
Bus138	33.000										0.032	93.3	0.6	
Bus139	33.000				0.012	0.008					0.014	85.0	0.3	
Bus140	33.000				0.014	0.009					0.020	89.2	0.4	
Bus142	33.000				0.013	0.008					0.016	85.0	0.3	
Bus143	33.000										0.094	98.8	1.7	
Bus144	33.000				0.012	0.007					0.081	98.9	1.5	
Bus145	33.000				0.011	0.007					0.069	99.2	1.2	
Bus146	33.000				0.014	0.009					0.058	98.8	1.0	
Bus147	33.000				0.011	0.007					0.044	98.1	0.8	
Bus148	33.000				0.010	0.006					0.034	93.0	0.6	
Bus149	33.000				0.010	0.006					0.024	92.4	0.4	
Bus150	33.000				0.002	0.001					0.013	96.2	0.2	
Bus151	33.000				0.008	0.005					0.010	85.0	0.2	
Bus152	33.000										0.011	99.8	0.2	
Bus154	33.000				0.011	0.007					0.820	95.6	14.8	
Bus155	33.000				0.008	0.005					0.809	95.6	14.6	
Bus156	33.000										0.800	95.7	14.5	
Bus157	33.000				0.008	0.005					0.014	87.8	0.2	
Bus159	33.000				0.011	0.007					0.788	95.6	14.3	
Bus160	33.000				0.010	0.006					0.776	95.6	14.1	
Bus161	33.000										0.765	95.7	13.9	
Bus162	33.000										0.075	91.9	1.3	
Bus163	33.000				0.014	0.009					0.050	88.3	0.9	
Bus167	33.000				0.003	0.002					0.027	90.1	0.5	
Bus168	33.000										0.024	87.6	0.4	
Bus169	33.000				0.010	0.006					0.012	85.0	0.2	
Bus170	33.000				0.011	0.007					0.013	85.0	0.2	
Bus171	33.000										0.692	95.9	12.5	
Bus172	33.000										0.051	97.6	0.9	
Bus175	33.000				0.014	0.009					0.017	85.0	0.3	
Bus176	33.000										0.042	98.0	0.8	
Bus177	33.000										0.027	97.6	0.5	
Bus178	33.000				0.003	0.002					0.015	97.1	0.3	
Bus179	33.000				0.010	0.006					0.011	85.0	0.2	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus180	33.000				0.002	0.001					0.012	94.5	0.2	
Bus181	33.000				0.012	0.007					0.014	85.0	0.3	
Bus182	33.000				0.018	0.011					0.642	95.7	11.6	
Bus183	33.000										0.623	95.8	11.3	
Bus184	33.000				0.014	0.009					0.017	85.0	0.3	
Bus185	33.000												-	
Bus186	33.000				0.012	0.007					0.607	96.0	11.0	
Bus187	33.000				0.003	0.002					0.595	95.9	10.8	
Bus188	33.000				0.013	0.008					0.592	95.7	10.7	
Bus189	33.000				0.014	0.009					0.578	95.8	10.5	
Bus190	33.000				0.015	0.009					0.564	95.7	10.2	
Bus191	33.000										0.547	95.9	9.9	
Bus192	33.000				0.013	0.008					0.253	95.6	4.6	
Bus193	33.000				0.029	0.018					0.239	95.5	4.3	
Bus194	33.000										0.207	96.6	3.8	
Bus195	33.000				0.017	0.010					0.121	97.5	2.2	
Bus196	33.000												-	
Bus197	33.000										0.104	98.3	1.9	
Bus198	33.000				0.026	0.016					0.031	85.0	0.6	
Bus199	33.000										0.104	97.8	1.9	
Bus200	33.000				0.014	0.009					0.088	92.1	1.6	
Bus201	33.000				0.031	0.019					0.073	91.5	1.3	
Bus202	33.000				0.035	0.022					0.042	85.9	0.8	
Bus206	33.000				0.033	0.021					0.078	96.5	1.4	
Bus207	33.000										0.043	98.0	0.8	
Bus208	33.000				0.008	0.005					0.030	94.3	0.5	
Bus209	33.000				0.008	0.005					0.021	97.0	0.4	
Bus210	33.000				0.012	0.007					0.014	85.0	0.3	
Bus211	33.000				0.005	0.003					0.015	92.9	0.3	
Bus212	33.000				0.009	0.006					0.011	85.0	0.2	
Bus213	33.000				0.004	0.003					0.295	96.0	5.3	
Bus214	33.000				0.018	0.011					0.291	95.8	5.3	
Bus215	33.000				0.013	0.008					0.271	96.2	4.9	
Bus216	33.000				0.011	0.007					0.013	85.0	0.2	
Bus217	33.000										0.256	96.5	4.7	
Bus218	33.000				0.011	0.007					0.245	96.6	4.5	
Bus219	33.000										0.232	97.0	4.2	
Bus220	33.000				0.004	0.002					0.041	89.4	0.8	
Bus221	33.000				0.012	0.007					0.038	87.5	0.7	
Bus222	33.000										0.024	88.4	0.4	
Bus223	33.000				0.011	0.007					0.013	85.0	0.2	
Bus224	11.000		0.073	0.046	0.024	0.015					4.232	85.0	240.7	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus225	33.000										0.193	97.6	3.5	
Bus227	33.000				0.011	0.007					0.013	85.0	0.2	
Bus228	33.000										0.192	97.1	3.5	
Bus229	33.000				0.007	0.005					0.180	97.2	3.3	
Bus230	33.000				0.015	0.009					0.173	96.9	3.1	
Bus231	33.000				0.014	0.009					0.017	85.0	0.3	
Bus232	33.000										0.157	97.4	2.8	
Bus233	33.000				0.009	0.005					0.088	97.7	1.6	
Bus234	33.000				0.010	0.006					0.011	85.0	0.2	
Bus235	33.000										0.079	98.0	1.4	
Bus236	33.000				0.013	0.008					0.016	85.0	0.3	
Bus237	33.000										0.069	97.3	1.3	
Bus238	33.000										0.055	98.6	1.0	
Bus239	33.000				0.011	0.007					0.023	92.8	0.4	
Bus240	33.000				0.010	0.006					0.012	85.0	0.2	
Bus241	33.000										0.033	99.4	0.6	
Bus242	33.000				0.008	0.005					0.015	89.0	0.3	
Bus243	33.000				0.005	0.003					0.006	85.0	0.1	
Bus244	33.000				0.008	0.005					0.021	96.2	0.4	
Bus245	33.000				0.007	0.004					0.013	93.7	0.2	
Bus247	33.000				0.014	0.009					0.054	98.3	1.0	
Bus248	33.000				0.012	0.007					0.039	98.2	0.7	
Bus249	33.000				0.009	0.005					0.010	85.0	0.2	
Bus250	33.000										0.028	95.9	0.5	
Bus251	33.000				0.008	0.005					0.019	93.2	0.3	
Bus252	33.000				0.010	0.006					0.012	85.0	0.2	
Bus253	33.000										4.869	81.8	87.8	
Bus254	33.000										4.865	81.8	87.8	
Bus255	33.000			0.000							4.863	81.8	87.8	
Bus256	33.000										4.847	81.9	87.4	
Bus257	33.000										4.843	81.9	87.5	
Bus258	33.000			0.000							4.841	81.9	87.5	
Bus259	11.000			0.000							9.250	85.2	525.9	
Bus260	11.000		0.078	0.048	0.209	0.130					3.608	85.0	205.7	
Bus261	11.000		0.017	0.010	0.105	0.065					0.143	85.0	8.1	
Bus262	11.000		0.112	0.069	0.299	0.185					3.120	85.0	178.2	
Bus263	11.000		0.159	0.099	0.425	0.264					2.637	85.0	150.7	
Bus264	11.000													
Bus265	11.000		0.036	0.022	0.224	0.139					1.022	85.0	58.4	
Bus266	11.000		0.029	0.018	0.176	0.109					0.241	85.0	13.8	
Bus267	11.000		0.021	0.013	0.176	0.109					0.475	85.0	27.2	
Bus268	11.000		0.022	0.014	0.185	0.115					0.244	85.0	13.9	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus269	11.000		0.037	0.023	0.318	0.197					0.926	85.0	53.0	
Bus270	11.000		0.118	0.073	0.314	0.195					0.508	85.0	29.1	
Bus271	11.000										1.680	84.8	91.5	
Bus272	11.000		0.045	0.028	0.188	0.116					1.674	84.9	91.5	
Bus273	11.000		0.066	0.041	0.177	0.110					5.381	85.4	306.7	
Bus274	11.000		0.090	0.056	0.242	0.150					2.466	85.0	140.7	
Bus275	11.000										0.256	85.0	14.6	
Bus276	11.000		0.029	0.018	0.076	0.047					0.124	85.0	7.1	
Bus277	11.000		0.031	0.019	0.082	0.051					0.132	85.0	7.6	
Bus278	11.000		0.076	0.047	0.205	0.127					1.818	85.0	103.8	
Bus279	11.000		0.031	0.019	0.083	0.052					0.346	85.0	19.8	
Bus280	11.000		0.049	0.030	0.131	0.081					0.212	85.0	12.1	
Bus281	11.000		0.053	0.033	0.701	0.434					0.887	85.0	50.7	
Bus282	11.000										1.397	85.0	76.6	
Bus283	11.000										1.397	85.0	76.6	
Bus284	11.000										1.394	85.0	76.6	
Bus285	11.000		0.047	0.029	0.312	0.194					0.422	85.0	23.2	
Bus286	11.000		0.009	0.006	0.206	0.127					0.524	85.0	28.8	
Bus287	11.000		0.020	0.012	0.211	0.130					0.271	85.0	14.9	
Bus288	11.000		0.009	0.006	0.108	0.067					0.447	85.1	24.6	
Bus289	11.000		0.003	0.002	0.125	0.078					0.151	85.0	8.3	
Bus290	11.000		0.001	0.001	0.056	0.035					0.159	85.0	8.7	
Bus291	11.000		0.004	0.003	0.074	0.046					0.092	85.0	5.0	
Bus292	11.000										2.624	85.7	149.7	
Bus293	11.000		0.013	0.008	0.169	0.105					0.214	85.0	12.2	
Bus294	11.000		0.013	0.008	0.169	0.105					0.214	85.0	12.2	
Bus295	11.000		0.024	0.015	0.205	0.127					2.192	85.9	125.3	
Bus296	11.000										1.913	85.7	110.0	
Bus297	11.000		0.020	0.012	0.161	0.100					1.447	85.0	84.1	
Bus298	11.000		0.010	0.006	0.085	0.053					0.317	85.7	18.3	
Bus299	11.000		0.012	0.007	0.100	0.062					0.131	85.0	7.5	
Bus300	11.000		0.004	0.003	0.011	0.007					0.018	85.0	1.0	
Bus301	11.000										0.239	85.0	13.6	
Bus302	11.000		0.002	0.001	0.201	0.124					0.239	85.0	13.6	
Bus303	66.000										10.894	85.8	95.3	
Bus304	11.000										10.734	86.9	571.8	
Bus305	11.000										0.152	85.3	8.1	
Bus306	11.000										0.152	85.3	8.1	
Bus307	11.000				0.032	0.020					0.038	85.0	2.0	
Bus308	11.000				0.061	0.038					0.114	85.1	6.1	
Bus309	11.000				0.036	0.023					0.043	85.0	2.3	
Bus310	11.000		0.012	0.007	0.362	0.225					0.440	85.0	23.5	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus311	11.000										0.440	85.0	23.5	
Bus312	11.000										6.270	88.5	334.6	
Bus313	11.000										6.252	86.7	344.3	
Bus314	11.000										0.575	76.8	31.7	
Bus315	11.000		0.211	0.131	0.077	0.048					0.339	85.0	18.8	
Bus316	11.000										5.821	84.8	323.4	
Bus317	11.000		0.071	0.044	0.031	0.019					0.121	85.0	6.7	
Bus318	11.000		0.063	0.039	0.027	0.017					5.341	84.8	297.9	
Bus319	11.000		0.038	0.024	0.017	0.010					5.214	84.9	292.0	
Bus320	11.000		0.045	0.028	0.351	0.217					0.465	85.0	26.1	
Bus321	11.000										4.751	84.9	266.8	
Bus322	11.000		0.404	0.250	0.133	0.082					4.107	85.0	234.2	
Bus323	11.000		0.029	0.018	0.026	0.016					3.465	85.0	198.1	
Bus324	11.000				0.016	0.010					3.384	85.0	194.5	
Bus325	11.000				0.059	0.037					0.086	87.3	4.9	
Bus326	11.000		0.000	0.000	0.015	0.010					0.018	85.0	1.1	
Bus327	11.000										3.238	85.1	188.5	
Bus328	11.000				0.138	0.085					0.489	85.0	28.5	
Bus329	11.000		0.084	0.052	0.025	0.016					0.128	85.0	7.5	
Bus330	11.000		0.013	0.008	0.001	0.001					0.017	85.0	1.0	
Bus331	11.000										2.732	85.1	160.0	
Bus332	11.000										2.712	85.1	159.0	
Bus333	11.000				0.015	0.009					0.058	85.0	3.4	
Bus334	11.000		0.026	0.016	0.008	0.005					0.041	85.0	2.4	
Bus335	11.000		0.135	0.084	0.048	0.030					0.215	85.0	12.7	
Bus336	11.000		0.016	0.010	0.168	0.104					2.305	85.2	136.2	
Bus337	11.000		0.405	0.251	0.150	0.093					0.653	85.0	38.6	
Bus338	11.000				0.135	0.084					0.159	85.0	9.4	
Bus339	11.000										0.939	85.5	55.6	
Bus340	11.000				0.200	0.124					0.235	85.0	13.9	
Bus341	11.000										0.604	85.0	35.8	
Bus342	11.000		0.004	0.003	0.160	0.099					0.193	85.0	11.4	
Bus343	11.000										0.193	85.0	11.4	
Bus344	11.000										0.982	85.0	57.3	
Bus345	11.000										0.641	85.0	37.4	
Bus346	11.000		0.268	0.166	0.024	0.015					0.343	85.0	20.0	
Bus347	11.000		0.006	0.004	0.246	0.153					0.297	85.0	17.3	
Bus348	11.000		0.004	0.002	0.286	0.177					0.341	85.0	19.9	
Bus349	11.000		0.030	0.019	0.024	0.015					0.249	85.0	14.5	
Bus350	11.000										1.233	85.0	71.8	
Bus351	11.000										3.565	84.5	190.2	
Bus352	11.000		1.744	1.081	1.211	0.751					3.477	85.0	190.2	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus353	66.000										13.579	79.3	118.8	
Bus354	11.000										13.055	82.1	712.7	
Bus355	11.000										1.779	65.0	97.2	
Bus356	11.000										1.769	64.8	97.2	
Bus357	11.000		0.007	0.004	0.026	0.016					0.732	17.5	40.3	
Bus358	11.000										0.881	60.8	48.5	
Bus359	11.000		0.318	0.197	0.218	0.135					0.630	85.0	34.7	
Bus360	11.000		0.002	0.001	0.087	0.054					1.191	85.1	65.5	
Bus361	11.000										1.078	85.0	59.8	
Bus362	11.000		0.002	0.001	0.051	0.032					0.539	85.0	29.9	
Bus363	11.000		0.266	0.165	0.140	0.087					0.477	85.0	26.4	
Bus364	11.000		0.052	0.032	0.045	0.028					0.538	85.0	29.9	
Bus365	11.000		0.056	0.035	0.035	0.022					0.424	85.0	23.6	
Bus366	11.000		0.047	0.029	0.037	0.023					0.317	85.0	17.6	
Bus367	11.000										0.217	85.0	12.1	
Bus368	11.000		0.054	0.033	0.033	0.021					0.217	85.0	12.1	
Bus369	11.000		0.062	0.038	0.035	0.022					0.115	85.0	6.4	
Bus370	11.000										4.726	84.8	258.2	
Bus371	11.000		0.001	0.000	0.019	0.012					4.609	85.4	258.2	
Bus372	11.000										4.576	85.4	256.9	
Bus373	11.000		0.003	0.002	0.005	0.003					0.009	85.0	0.5	
Bus374	11.000		0.068	0.042	0.138	0.085					0.241	85.0	13.6	
Bus375	11.000										4.563	85.5	256.4	
Bus376	11.000		0.013	0.008	0.026	0.016					4.314	85.5	242.8	
Bus377	11.000		0.026	0.016	0.052	0.032					4.263	85.6	240.3	
Bus378	11.000		0.017	0.011	0.022	0.014					4.158	85.6	235.2	
Bus379	11.000		0.383	0.237	0.766	0.475					1.351	85.0	76.5	
Bus380	11.000										4.105	85.7	232.5	
Bus381	11.000				1.966	1.219					2.736	86.1	156.0	
Bus382	11.000										5.657	83.6	309.1	
Bus383	11.000		0.964	0.598	0.527	0.326					5.443	84.4	309.1	
Bus384	11.000		0.210	0.130	0.114	0.071					3.683	84.1	209.5	
Bus385	11.000										3.293	84.1	187.8	
Bus386	11.000		0.677	0.419	0.366	0.227					1.227	85.0	70.0	
Bus387	11.000		0.881	0.546	0.477	0.296					2.065	83.5	117.8	
Bus388	11.000				0.016	0.010					0.469	78.1	26.8	
Bus389	11.000		0.210	0.130	0.114	0.070					0.381	85.0	21.7	
Bus390	11.000										0.451	77.7	25.7	
Bus391	11.000		0.176	0.109	0.058	0.036					0.275	85.0	15.7	
Bus392	11.000		0.012	0.007	0.000	-					0.230	95.4	13.1	
Bus393	11.000		0.017	0.010	0.005	0.003					0.255	94.6	14.6	
Bus394	11.000		0.079	0.049	0.043	0.026					0.143	85.0	8.2	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					Percent
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Loading
Bus395	11.000										0.425	91.3	24.3	
Bus396	11.000		0.024	0.015	0.001	0.001					0.030	85.0	1.7	
Bus397	11.000										0.419	85.0	22.9	
Bus398	11.000										0.419	85.0	22.9	
Bus399	11.000		0.173	0.107	0.075	0.047					0.293	85.0	16.0	
Bus400	11.000		0.001	0.000	0.053	0.033					0.126	85.0	6.9	
Bus401	11.000		0.026	0.016	0.028	0.017					0.064	85.0	3.5	
Bus402	11.000										0.533	85.5	29.1	
Bus403	11.000				0.042	0.026					0.531	85.5	29.1	
Bus404	11.000										0.480	85.5	26.4	
Bus405	11.000										0.039	86.5	2.1	
Bus406	11.000												-	
Bus407	11.000				0.021	0.013					0.025	85.0	1.4	
Bus408	11.000										0.039	86.0	2.2	
Bus409	11.000				0.006	0.004					0.015	86.6	0.8	
Bus410	11.000				0.006	0.004					0.007	85.0	0.4	
Bus411	11.000										0.441	85.3	24.3	
Bus412	11.000		0.025	0.016	0.012	0.008					0.044	85.0	2.4	
Bus413	11.000										0.396	85.3	21.9	
Bus415	11.000										0.208	85.2	11.5	
Bus416	11.000				0.024	0.015					0.204	85.1	11.3	
Bus417	11.000		0.101	0.062	0.049	0.030					0.176	85.0	9.8	
Bus418	11.000				0.125	0.077					0.187	85.3	10.4	
Bus420	11.000				0.004	0.002					0.041	85.9	2.3	
Bus421	11.000				0.010	0.006					0.037	85.9	2.0	
Bus423	11.000										0.026	85.9	1.4	
Bus424	11.000				0.007	0.004					0.018	85.8	1.0	
Bus425	11.000				0.009	0.005					0.010	85.0	0.6	
Bus426	11.000				0.002	0.001					0.002	85.0	0.1	
Bus427	11.000				0.002	0.001					0.003	85.0	0.1	
Bus428	11.000				0.003	0.002					0.004	85.0	0.2	
Bus429	11.000										0.010	88.8	0.6	
Bus430	11.000				0.004	0.002					0.004	85.0	0.2	
Bus431	11.000				0.005	0.003					0.006	85.0	0.4	
Bus432	33.000				0.003	0.002					0.004	85.0	0.1	
Bus433	33.000				0.004	0.002					0.004	85.0	0.1	
Bus434	33.000				0.005	0.003					0.009	91.3	0.2	
Bus435	33.000				0.003	0.002					0.004	85.0	0.1	
Bus438	33.000				0.013	0.008					0.034	88.5	0.6	
Bus439	33.000				0.012	0.007					0.019	87.4	0.4	
Bus440	33.000				0.005	0.003					0.006	85.0	0.1	
Bus441	33.000										0.007	18.5	0.1	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus442	33.000				0.001	0.001					0.002	85.0	-	
Bus443	33.000				0.003	0.002					0.003	85.0	0.1	
Bus444	33.000												-	
Bus445	33.000				0.002	0.001					0.003	85.0	0.1	
Bus446	33.000				0.005	0.003					0.005	85.0	0.1	
Bus447	11.000				0.004	0.002					0.005	85.0	0.3	
Bus448	11.000				0.007	0.004					0.008	85.0	0.4	
Bus449	11.000				0.150	0.093					0.176	85.0	10.5	
Bus450	11.000		0.013	0.008	0.140	0.087					0.180	85.0	10.7	
Bus451	11.000		0.173	0.107	0.064	0.040					0.280	85.0	16.5	
Bus452	11.000		0.103	0.064	0.009	0.006					0.132	85.0	7.8	
Bus453	11.000		0.155	0.096	0.014	0.009					0.198	85.0	11.6	
Bus454	11.000		0.155	0.096	0.014	0.009					0.199	85.0	11.6	
Bus455	11.000		0.231	0.143	0.096	0.059					0.384	85.0	21.5	
Bus456	11.000		0.087	0.054	0.034	0.021					0.142	85.0	8.2	
Bus457	11.000		0.173	0.107	0.079	0.049					0.297	85.0	15.8	
Bus458	11.000		0.072	0.045	0.031	0.019					0.303	85.0	16.7	
Bus459	11.000		0.013	0.008	0.144	0.089					0.185	85.0	10.8	
Bus460	11.000		0.036	0.022	0.014	0.009					0.059	85.0	3.4	
Bus461	11.000		0.108	0.067	0.046	0.029					0.182	85.0	10.0	
Bus462	11.000		0.108	0.067	0.046	0.029					0.182	85.0	10.0	
Bus463	11.000		0.018	0.011	0.008	0.005					0.030	85.0	1.7	
Bus464	11.000		0.103	0.064	0.010	0.006					0.134	85.0	7.4	
Bus465	11.000		0.103	0.064	0.010	0.006					0.133	85.0	7.5	
Bus466	11.000		0.201	0.124	0.020	0.012					0.259	85.0	14.5	
Bus467	11.000		0.010	0.006	0.001	0.001					0.012	85.0	0.7	
Bus468	11.000		0.155	0.096	0.013	0.008					0.197	85.0	12.1	
Bus469	11.000				0.215	0.133					0.253	85.0	14.5	
RMU Helipad	11.000										1.394	85.0	76.6	
RMU MBC	11.000										1.140	85.0	65.1	
RMU Near Bridge	11.000										1.022	85.0	58.4	
Telecom RMU	11.000										2.624	85.7	149.7	

* Indicates operating load of a bus exceeds the bus critical limit (100.0% of the Continuous Ampere rating).

\# Indicates operating load of a bus exceeds the bus marginal limit (95.0% of the Continuous Ampere rating).

Branch Loading Summary Report

CKT / Branch		Cable & Reactor			Transformer				
						Loading (input)		Loading (output)	
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	MVA	%	MVA	%
Cable1	Cable	301.98	103.22	34.18					
Cable2	Cable	301.98	83.13	27.53					
Cable3	Cable	301.98	64.34	21.31					
Cable4	Cable	301.98	5.63	1.86					
Cable5	Cable	301.98	10.16	3.36					
Cable6	Cable	338.03	8.46	2.50					
Cable7	Cable	301.98	223.48	74.01					
Cable8	Cable	301.98	202.47	67.05					
Cable9	Cable	301.98	175.93	58.26					
Cable10	Cable	301.98	110.60	36.63					
Cable11	Cable	265.92	26.21	9.85					
Cable12	Cable	274.79	87.82	31.96					
Cable13	Cable	274.79	87.84	31.97					
Cable14	Cable	274.79	87.44	31.82					
Cable15	Cable	274.79	87.45	31.82					
Cable16	Cable	338.03	205.67	60.84					
Cable17	Cable	338.03	8.14	2.41					
Cable18	Cable	338.03	178.25	52.73					
Cable19	Cable	338.03	58.44	17.29					
Cable20	Cable	338.03	150.68	44.57					
Cable21	Cable	229.86							
Cable22	Cable	338.03	58.44	17.29					
Cable23	Cable	229.86	13.79	6.00					
Cable24	Cable	229.86	27.17	11.82					
Cable25	Cable	147.19	13.95	9.48					
Cable26	Cable	338.03	52.96	15.67					
Cable27	Cable	338.03	29.07	8.60					
Cable29	Cable	338.03	91.53	27.08					
Cable30	Cable	338.03	306.68	90.73					
Cable31	Cable	338.03	140.71	41.63					
Cable32	Cable	338.03	149.72	44.29					
Cable33	Cable	338.03	14.61	4.32					
Cable34	Cable	338.03	103.81	30.71					

CKT / Branch		Cable & Reactor			Transformer				
					Capability (MVA)	Loading (input)		Loading (output)	
ID	Type	Ampacity (Amp)	Loading Amp	%		MVA	%	MVA	%
Cable35	Cable	229.86	19.77	8.60					
Cable36	Cable	229.86	12.09	5.26					
Cable37	Cable	338.03	65.15	19.27					
Cable38	Cable	229.86	50.69	22.05					
Cable40	Cable	301.98	76.58	25.36					
Cable41	Cable	338.03	76.59	22.66					
Cable42	Cable	338.03	23.21	6.87					
Cable43	Cable	338.03	28.80	8.52					
Cable44	Cable	338.03	14.90	4.41					
Cable45	Cable	338.03	24.58	7.27					
Cable46	Cable	229.86	8.29	3.61					
Cable47	Cable	338.03	149.72	44.29					
Cable48	Cable	229.86	12.20	5.31					
Cable49	Cable	229.86	12.20	5.31					
Cable50	Cable	229.86	125.32	54.52					
Cable51	Cable	229.86	13.60	5.92					
Cable52	Cable	301.98	8.08	2.68					
Cable53	Cable	301.98	23.46	7.77					
Cable54	Cable	338.03	334.64	99.00					
Cable55	Cable	229.86	7.47	3.25					
Cable56	Cable	147.19	0.98	0.66					
Cable57	Cable	301.98	20.02	6.63					
Cable58	Cable	301.98	17.34	5.74					
Cable59	Cable	229.86	19.89	8.65					
Cable60	Cable	301.98	190.18	62.98					
Cable61	Cable	338.03	97.16	28.74					
Cable62	Cable	261.41	6.37	2.44					
Cable63	Cable	338.03	258.19	76.38					
Cable64	Cable	229.86	13.56	5.90					
Cable65	Cable	338.03	309.06	91.43					
Cable66	Cable	338.03	22.88	6.77					
Cable67	Cable	338.03	29.09	8.61					
Cable68	Cable	301.98	10.46	3.46					
Cable69	Cable	301.98	10.67	3.53					
Cable70	Cable	301.98	16.53	5.48					

CKT / Branch		Cable & Reactor			Transformer				
						Loading (input)		Loading (output)	
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	MVA	%	MVA	%
Cable71	Cable	229.86	7.76	3.38					
Cable72	Cable	301.98	11.64	3.85					
Cable73	Cable	301.98	11.58	3.83					
Cable74	Cable	301.98	21.53	7.13					
Cable75	Cable	229.86	8.16	3.55					
Cable76	Cable	301.98	15.83	5.24					
Cable77	Cable	229.86	16.72	7.28					
Cable78	Cable	301.98	10.81	3.58					
Cable79	Cable	229.86	3.40	1.48					
Cable80	Cable	301.98	10.03	3.32					
Cable81	Cable	301.98	10.03	3.32					
Cable82	Cable	229.86	7.40	3.22					
Cable83	Cable	229.86	7.45	3.24					
Cable84	Cable	301.98	14.48	4.80					
Cable85	Cable	301.98	12.07	4.00					
Cable86	Cable	301.98	14.46	4.79					
33/11kV Sector I SS	Transformer				5.000	4.863	97.3	4.635	92.7
33/11kV Sector II SS	Transformer				5.000	4.841	96.8	4.615	92.3
66/11kV (AREVA)	Transformer				5.000	4.472	89.4	4.308	86.2
66/11kV (VOLTAMP)	Transformer				10.000	7.349	73.5	7.080	70.8
66/11kV I	Transformer				20.000	5.746	28.7	5.661	28.3
66/11kV I (HYOSUNG)	Transformer				10.000	6.789	67.9	6.528	65.3
66/11kV II	Transformer				20.000	5.148	25.7	5.072	25.4
66/11kV II (HYOSUNG)	Transformer				10.000	6.789	67.9	6.528	65.3
66/33kV (AREVA)	Transformer				10.000	5.735	57.3	5.572	55.7
66/33kV (VOLTAMP)	Transformer				10.000	5.735	57.3	5.572	55.7

* Indicates a branch with operating load exceeding the branch capability.

Branch Losses Summary Report

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
66/11kV (AREVA)	3.744	2.445	-3.720	-2.173	24.7	271.7	100.0	96.3	3.67
66/11kV (VOLTAMP)	6.038	4.190	-6.010	-3.743	28.0	447.4	100.0	96.3	3.67
66/33kV (AREVA)	4.689	3.301	-4.672	-3.036	16.6	265.9	100.0	97.2	2.84
66/33kV (VOLTAMP)	4.689	3.301	-4.672	-3.036	16.6	265.9	100.0	97.2	2.84
Cable1	1.617	0.988	-1.616	-0.987	0.4	0.2	96.3	96.3	0.02
Cable2	1.298	0.802	-1.298	-0.801	0.5	0.3	96.3	96.3	0.03
Cable6	0.132	0.082	-0.132	-0.082	0.0	0.0	96.3	96.3	0.00
Cable7	3.512	2.119	-3.510	-2.118	1.7	1.0	96.3	96.3	0.05
Cable10	1.745	1.037	-1.743	-1.036	1.9	1.1	96.3	96.2	0.10
Cable29	1.425	0.889	-1.425	-0.889	0.2	0.1	96.3	96.3	0.01
Line1	1.616	0.987	-1.607	-0.983	9.5	4.2	96.3	95.8	0.52
Line2	0.079	0.049	-0.079	-0.049	0.0	0.0	95.8	95.8	0.01
Line3	1.528	0.934	-1.519	-0.930	8.6	3.8	95.8	95.3	0.50
Line4	0.121	0.075	-0.121	-0.075	0.0	0.0	95.3	95.3	0.01
Line5	1.372	0.840	-1.369	-0.838	3.6	1.6	95.3	95.1	0.23
Line312	0.026	0.016	-0.026	-0.016	0.0	-0.1	95.3	95.3	0.01
Cable77	0.257	0.160	-0.257	-0.160	0.0	0.0	95.1	95.1	0.01
Cable81	0.154	0.096	-0.154	-0.096	0.0	0.0	95.1	95.1	0.01
Line6	0.706	0.427	-0.696	-0.423	9.8	3.8	95.1	93.8	1.23
Line7	0.679	0.413	-0.677	-0.412	2.3	0.9	93.8	93.5	0.29
Line8	0.066	0.041	-0.066	-0.041	0.0	-0.1	93.5	93.5	0.01
Line9	0.611	0.371	-0.610	-0.371	0.9	0.3	93.5	93.4	0.12
Line10	0.593	0.361	-0.593	-0.360	0.6	0.2	93.4	93.3	0.09
Line11	0.466	0.282	-0.465	-0.282	1.0	0.3	93.3	93.1	0.18
Line12	-0.015	-0.009	0.015	0.009	0.0	-0.2	93.1	93.1	0.01
Line13	0.450	0.272	-0.449	-0.272	0.9	0.3	93.1	93.0	0.17
Line14	-0.014	-0.009	0.014	0.008	0.0	-0.3	93.0	93.0	0.01
Line15	0.435	0.264	-0.435	-0.264	0.3	0.1	93.0	92.9	0.06
Line16	0.365	0.220	-0.364	-0.220	0.8	0.2	92.9	92.7	0.19
Line17	-0.014	-0.009	0.014	0.009	0.0	-0.1	92.7	92.7	0.01
Line18	0.349	0.211	-0.348	-0.211	1.9	0.4	92.7	92.3	0.47
Line19	-0.013	-0.008	0.013	0.008	0.0	-0.1	92.3	92.3	0.00
Line21	0.335	0.203	-0.334	-0.203	0.2	0.0	92.3	92.2	0.04
Line22	-0.020	-0.012	0.020	0.012	0.0	0.0	92.2	92.2	0.00

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line23	0.315	0.191	-0.314	-0.191	0.7	0.1	92.2	92.0	0.20
Line24	-0.012	-0.007	0.012	0.007	0.0	-0.3	92.0	92.0	0.01
Line25	0.302	0.184	-0.300	-0.183	2.2	0.3	92.0	91.4	0.63
Line26	-0.243	-0.150	0.244	0.150	1.1	0.0	91.0	91.4	0.37
Line27	0.056	0.033	-0.056	-0.033	0.0	-0.1	91.4	91.4	0.01
Line28	-0.034	-0.021	0.034	0.021	0.0	-0.4	91.3	91.4	0.04
Line29	0.022	0.012	-0.022	-0.012	0.0	-0.2	91.4	91.4	0.01
Line31	0.009	0.004	-0.009	-0.005	0.0	-0.3	91.4	91.4	0.01
Cable3	1.004	0.621	-1.004	-0.621	0.4	0.2	96.3	96.3	0.04
Line33	0.294	0.181	-0.294	-0.182	0.1	-1.3	96.3	96.3	0.03
Cable4	0.088	0.054	-0.088	-0.054	0.0	0.0	96.3	96.3	0.00
Line34	0.856	0.529	-0.855	-0.529	0.8	0.6	96.3	96.2	0.10
Cable5	0.158	0.098	-0.158	-0.098	0.0	0.0	96.2	96.2	0.00
Line35	0.557	0.344	-0.557	-0.344	0.2	0.1	96.2	96.1	0.04
Line36	0.266	0.164	-0.266	-0.165	0.0	-0.2	96.1	96.1	0.00
Line37	0.020	0.011	-0.020	-0.012	0.0	-1.3	96.1	96.1	0.00
Line208	-0.011	-0.007	0.011	0.005	0.0	-1.2	96.3	96.3	0.00
Cable8	3.183	1.915	-3.182	-1.914	1.0	0.6	96.3	96.3	0.03
Cable9	2.768	1.658	-2.767	-1.657	1.4	0.8	96.3	96.2	0.05
Line38	2.634	1.575	-2.616	-1.577	17.8	-2.1	96.2	95.7	0.49
Line39	0.477	0.292	-0.476	-0.293	0.1	-0.3	95.7	95.7	0.01
Line42	2.140	1.285	-2.132	-1.286	7.4	-1.4	95.7	95.5	0.25
Line40	0.353	0.216	-0.353	-0.218	0.3	-2.3	95.7	95.7	0.06
Line41	0.164	0.101	-0.164	-0.101	0.0	-0.1	95.7	95.7	0.00
Line43	0.262	0.162	-0.262	-0.163	0.0	-0.7	95.5	95.5	0.01
Line44	1.870	1.124	-1.860	-1.127	10.3	-2.7	95.5	95.1	0.40
Line45	1.443	0.869	-1.440	-0.871	3.5	-1.6	95.1	94.9	0.17
Line46	0.121	0.075	-0.121	-0.075	0.0	-0.7	94.9	94.9	0.01
Line363	0.845	0.503	-0.835	-0.517	10.3	-14.1	94.9	94.0	0.87
Line47	1.743	1.036	-1.733	-1.031	10.4	4.7	96.2	95.7	0.54
Line48	1.619	0.961	-1.601	-0.953	17.6	7.8	95.7	94.7	0.98
Cable82	0.114	0.070	-0.114	-0.070	0.0	0.0	94.7	94.7	0.00
Line20	1.488	0.883	-1.469	-0.874	18.6	8.2	94.7	93.6	1.11
Line50	-0.088	-0.055	0.088	0.055	0.0	-0.1	94.0	94.0	0.03
Line51	-0.339	-0.210	0.340	0.210	0.1	0.0	94.0	94.0	0.02
Line54	0.251	0.155	-0.251	-0.155	0.2	0.0	94.0	93.9	0.08
Line52	-0.116	-0.072	0.116	0.072	0.1	-0.1	94.0	94.0	0.04

Branch ID	From-To Bus Flow MW	From-To Bus Flow Mvar	To-From Bus Flow MW	To-From Bus Flow Mvar	Losses kW	Losses kvar	% Bus Voltage From	% Bus Voltage To	Vd % Drop in Vmag
Cable84	0.221	0.137	-0.221	-0.137	0.0	0.0	94.0	94.0	0.02
Line53	0.159	0.098	-0.159	-0.098	0.0	0.0	94.0	94.0	0.01
Line55	-0.099	-0.061	0.099	0.061	0.1	-0.2	93.9	93.9	0.07
Cable83	0.113	0.070	-0.113	-0.070	0.0	0.0	93.9	93.9	0.00
Line56	0.021	0.010	-0.021	-0.011	0.0	-0.5	93.6	93.6	0.03
Line66	1.449	0.864	-1.446	-0.863	3.2	1.4	93.6	93.4	0.19
Line57	-0.019	-0.010	0.019	0.010	0.0	-0.1	93.6	93.6	0.01
Line58	0.015	0.008	-0.015	-0.008	0.0	-0.1	93.6	93.6	0.00
Line65	0.002	0.001	-0.002	-0.001	0.0	-0.5	93.6	93.6	0.00
Line59	0.004	0.002	-0.004	-0.002	0.0	0.0	93.6	93.6	0.00
Line60	0.011	0.006	-0.011	-0.006	0.0	0.0	93.6	93.6	0.00
Line61	0.009	0.005	-0.009	-0.005	0.0	-0.1	93.6	93.6	0.00
Line63	0.002	0.001	-0.002	-0.001	0.0	-0.5	93.6	93.6	0.00
Line62	0.005	0.003	-0.005	-0.003	0.0	-0.4	93.6	93.6	0.01
Line67	1.440	0.859	-1.416	-0.849	23.7	10.5	93.4	92.0	1.44
Line68	0.011	0.006	-0.011	-0.006	0.0	-0.1	92.0	92.0	0.00
Line72	1.406	0.843	-1.374	-0.829	31.9	14.1	92.0	90.0	1.96
Line69	0.006	0.003	-0.006	-0.003	0.0	-0.2	92.0	92.0	0.00
Line70	-0.003	-0.002	0.003	0.002	0.0	-0.1	92.0	92.0	0.00
Line71	0.003	0.002	-0.003	-0.002	0.0	-0.2	92.0	92.0	0.00
Line73	1.354	0.816	-1.335	-0.808	18.4	8.2	90.0	88.9	1.15
Line342	0.010	0.006	-0.010	-0.006	0.0	-0.1	90.0	90.0	0.00
Line74	-0.009	-0.006	0.009	0.006	0.0	0.0	88.9	88.9	0.00
Line75	0.004	0.002	-0.004	-0.002	0.0	-0.3	88.9	88.9	0.00
Line76	1.322	0.800	-1.276	-0.780	45.7	20.2	88.9	86.0	2.87
Line77	-0.067	-0.042	0.067	0.042	0.0	0.0	86.0	86.0	0.01
Line78	1.209	0.738	-1.206	-0.737	2.6	1.2	86.0	85.8	0.17
Line79	0.356	0.220	-0.356	-0.220	0.3	0.1	85.8	85.8	0.06
Line83	0.850	0.517	-0.846	-0.515	4.1	1.7	85.8	85.4	0.38
Line80	-0.124	-0.077	0.124	0.077	0.1	-0.1	85.7	85.8	0.04
Cable85	0.168	0.104	-0.168	-0.104	0.0	0.0	85.8	85.8	0.01
Line81	0.064	0.040	-0.064	-0.040	0.0	-0.2	85.8	85.7	0.05
Line85	0.831	0.506	-0.828	-0.505	2.9	1.2	85.4	85.2	0.28
Line87	0.660	0.400	-0.652	-0.397	7.3	3.0	85.2	84.3	0.88
Line88	-0.005	-0.003	0.005	0.003	0.0	-0.1	84.3	84.3	0.00
Line89	0.647	0.394	-0.644	-0.393	3.7	1.5	84.3	83.8	0.44
Line90	-0.009	-0.005	0.009	0.005	0.0	-0.1	83.8	83.8	0.00

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line86	0.635	0.387	-0.626	-0.384	9.1	3.7	83.8	82.7	1.12
Line64	0.480	0.294	-0.476	-0.293	3.4	1.3	82.7	82.2	0.54
Line91	0.146	0.090	-0.146	-0.090	0.0	0.0	82.7	82.7	0.01
Line92	-0.126	-0.078	0.126	0.078	0.0	0.0	82.7	82.7	0.02
Line93	0.020	0.011	-0.020	-0.011	0.0	-0.1	82.7	82.7	0.01
Line94	-0.004	-0.002	0.004	0.002	0.0	-0.1	82.7	82.7	0.00
Line95	0.016	0.009	-0.016	-0.009	0.0	-0.1	82.7	82.7	0.01
Line96	-0.004	-0.003	0.004	0.003	0.0	-0.1	82.7	82.7	0.00
Line97	0.012	0.007	-0.012	-0.007	0.0	-0.2	82.7	82.7	0.01
Line98	0.009	0.005	-0.009	-0.005	0.0	-0.2	82.7	82.7	0.01
Line99	0.003	0.002	-0.003	-0.002	0.0	-0.3	82.7	82.7	0.00
Line82	-0.110	-0.068	0.110	0.068	0.0	0.0	82.2	82.2	0.00
Line84	0.366	0.225	-0.366	-0.224	0.4	0.1	82.2	82.1	0.08
Line100	-0.003	-0.002	0.003	0.002	0.0	-0.1	82.1	82.1	0.00
Line101	0.363	0.222	-0.362	-0.222	0.9	0.3	82.1	81.9	0.19
Line102	0.351	0.216	-0.350	-0.215	1.0	0.3	81.9	81.7	0.21
Line103	-0.103	-0.064	0.104	0.064	0.2	-0.2	81.6	81.7	0.13
Line104	0.246	0.151	-0.246	-0.151	0.3	0.0	81.7	81.6	0.09
Line105	-0.005	-0.003	0.005	0.003	0.0	-0.1	81.6	81.6	0.00
Line106	0.241	0.148	-0.240	-0.148	1.3	0.2	81.6	81.2	0.40
Line107	-0.236	-0.146	0.237	0.147	0.4	0.1	81.1	81.2	0.12
Line109	0.003	0.002	-0.003	-0.002	0.0	-0.3	81.2	81.2	0.00
Cable11	1.370	0.491	-1.369	-0.491	0.9	0.0	97.2	97.1	0.05
Cable12	3.995	2.797	-3.985	-2.797	10.5	0.0	97.2	97.0	0.17
Cable14	3.979	2.783	-3.969	-2.783	10.6	0.0	97.2	97.0	0.17
Line108	1.369	0.491	-1.365	-0.504	4.0	-12.8	97.1	96.8	0.32
Line110	0.581	0.269	-0.580	-0.271	0.1	-1.2	96.8	96.8	0.01
Line111	0.785	0.234	-0.784	-0.240	0.5	-5.8	96.8	96.7	0.07
Line112	0.342	0.209	-0.342	-0.212	0.1	-3.3	96.8	96.8	0.02
Line113	0.238	0.062	-0.238	-0.066	0.0	-4.0	96.8	96.8	0.01
Line114	0.208	0.047	-0.208	-0.049	0.0	-1.8	96.8	96.8	0.01
Line115	-0.017	-0.010	0.017	0.009	0.0	-1.4	96.8	96.8	0.00
Line116	0.191	0.040	-0.191	-0.042	0.0	-1.8	96.8	96.7	0.00
Line117	-0.031	-0.019	0.031	0.019	0.0	-0.2	96.7	96.7	0.00
Line118	0.161	0.023	-0.161	-0.028	0.0	-4.8	96.7	96.7	0.01
Line119	0.144	0.017	-0.144	-0.018	0.0	-0.5	96.7	96.7	0.00
Line120	0.051	0.007	-0.051	-0.011	0.0	-4.6	96.7	96.7	0.00

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line128	0.093	0.011	-0.093	-0.014	0.0	-3.3	96.7	96.7	0.00
Line121	0.047	0.009	-0.047	-0.018	0.0	-9.8	96.7	96.7	0.01
Line122	0.000	0.000	0.000	-0.001	0.0	-0.6	96.7	96.7	0.00
Line123	0.047	0.019	-0.047	-0.021	0.0	-1.7	96.7	96.7	0.00
Line126	0.030	0.010	-0.030	-0.011	0.0	-1.2	96.7	96.7	0.00
Line124	0.017	0.005	-0.017	-0.005	0.0	-0.1	96.7	96.7	0.00
Line125	0.012	0.006	-0.012	-0.008	0.0	-1.1	96.7	96.7	0.00
Line127	0.003	-0.004	-0.003	-0.002	0.0	-5.7	96.7	96.7	0.00
Line129	-0.013	-0.008	0.013	0.006	0.0	-2.7	96.7	96.7	0.00
Line130	0.080	0.009	-0.080	-0.012	0.0	-3.2	96.7	96.7	0.00
Line131	0.068	0.005	-0.068	-0.009	0.0	-4.0	96.7	96.7	0.00
Line132	0.057	0.002	-0.057	-0.006	0.0	-3.7	96.7	96.7	0.00
Line133	0.043	-0.003	-0.043	0.002	0.0	-1.2	96.7	96.7	0.00
Line134	0.032	-0.009	-0.032	0.007	0.0	-1.8	96.7	96.7	0.00
Line135	0.022	-0.013	-0.022	0.003	0.0	-9.2	96.7	96.7	0.00
Line136	0.013	-0.009	-0.013	0.002	0.0	-6.9	96.7	96.7	0.00
Line137	0.011	-0.004	-0.011	0.000	0.0	-3.8	96.7	96.7	0.00
Line138	-0.008	-0.005	0.008	0.001	0.0	-4.4	96.7	96.7	0.00
Line139	0.003	-0.001	-0.003	-0.002	0.0	-2.2	96.7	96.7	0.00
Line140	0.774	0.234	-0.773	-0.237	0.2	-3.0	96.7	96.7	0.04
Line141	0.765	0.232	-0.765	-0.233	0.1	-0.9	96.7	96.7	0.01
Line142	0.012	0.005	-0.012	-0.007	0.0	-1.6	96.7	96.7	0.00
Line144	0.753	0.228	-0.753	-0.231	0.2	-2.9	96.7	96.6	0.03
Line143	0.004	0.001	-0.004	-0.002	0.0	-0.9	96.7	96.7	0.00
Line145	0.742	0.224	-0.742	-0.227	0.2	-3.2	96.6	96.6	0.04
Line146	0.733	0.221	-0.732	-0.222	0.1	-0.8	96.6	96.6	0.01
Line147	0.068	0.028	-0.068	-0.029	0.0	-1.0	96.6	96.6	0.00
Line156	0.664	0.194	-0.664	-0.196	0.1	-2.0	96.6	96.6	0.02
Line148	0.045	0.019	-0.045	-0.024	0.0	-4.7	96.6	96.6	0.01
Line152	0.024	0.010	-0.024	-0.012	0.0	-1.1	96.6	96.6	0.00
Line149	0.030	0.015	-0.030	-0.016	0.0	-1.1	96.6	96.6	0.00
Line153	0.021	0.010	-0.021	-0.012	0.0	-1.8	96.6	96.6	0.00
Line154	0.010	0.006	-0.010	-0.006	0.0	-0.8	96.6	96.6	0.00
Line155	0.011	0.006	-0.011	-0.007	0.0	-0.7	96.6	96.6	0.00
Line157	0.049	0.010	-0.049	-0.011	0.0	-1.2	96.6	96.6	0.00
Line167	0.615	0.186	-0.615	-0.187	0.0	-0.7	96.6	96.6	0.01
Line158	0.041	0.008	-0.041	-0.008	0.0	-0.6	96.6	96.6	0.00

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line159	0.008	0.003	-0.008	-0.004	0.0	-0.5	96.6	96.6	0.00
Line161	-0.014	-0.009	0.014	0.008	0.0	-0.5	96.6	96.6	0.00
Line162	0.027	0.000	-0.027	-0.001	0.0	-1.3	96.6	96.6	0.00
Line163	0.015	-0.005	-0.015	-0.004	0.0	-8.3	96.6	96.6	0.00
Line166	0.012	0.006	-0.012	-0.007	0.0	-1.4	96.6	96.6	0.00
Line164	0.012	0.002	-0.012	-0.004	0.0	-2.3	96.6	96.6	0.00
Line165	-0.010	-0.006	0.010	0.003	0.0	-3.2	96.6	96.6	0.00
Line168	0.597	0.176	-0.597	-0.177	0.1	-1.3	96.6	96.6	0.01
Line169	0.014	0.008	-0.014	-0.009	0.0	-0.8	96.6	96.6	0.00
Line171	0.000	-0.001	0.000	0.000	0.0	-1.1	96.6	96.6	0.00
Line172	0.583	0.170	-0.583	-0.170	0.0	-0.4	96.6	96.5	0.00
Line173	0.571	0.163	-0.570	-0.168	0.2	-5.1	96.5	96.5	0.04
Line174	0.567	0.166	-0.567	-0.172	0.2	-5.7	96.5	96.5	0.05
Line175	0.554	0.164	-0.554	-0.165	0.1	-1.6	96.5	96.4	0.01
Line176	0.540	0.156	-0.539	-0.163	0.3	-6.9	96.4	96.4	0.05
Line177	0.524	0.154	-0.524	-0.155	0.0	-0.7	96.4	96.4	0.01
Line178	0.242	0.072	-0.242	-0.074	0.0	-1.4	96.4	96.4	0.00
Line199	0.283	0.082	-0.283	-0.083	0.0	-0.6	96.4	96.4	0.00
Line179	0.228	0.066	-0.228	-0.071	0.0	-5.5	96.4	96.4	0.02
Line180	0.199	0.053	-0.199	-0.054	0.0	-0.5	96.4	96.4	0.00
Line181	0.119	0.021	-0.118	-0.027	0.0	-5.4	96.4	96.4	0.01
Line186	0.081	0.032	-0.081	-0.034	0.0	-1.7	96.4	96.4	0.00
Line182	0.102	0.017	-0.102	-0.018	0.0	-1.5	96.4	96.3	0.00
Line183	0.000	0.000	0.000	-0.001	0.0	-1.1	96.3	96.3	0.00
Line184	0.102	0.019	-0.102	-0.022	0.0	-2.3	96.3	96.3	0.00
Line185	-0.026	-0.016	0.026	0.012	0.0	-4.1	96.3	96.3	0.00
Line192	0.076	0.009	-0.076	-0.011	0.0	-1.4	96.3	96.3	0.00
Line187	0.067	0.025	-0.067	-0.030	0.0	-4.1	96.4	96.3	0.01
Line188	0.036	0.010	-0.036	-0.012	0.0	-1.6	96.3	96.3	0.00
Line189	0.001	-0.010	-0.001	0.007	0.0	-2.4	96.3	96.3	0.00
Line193	0.042	-0.010	-0.042	0.003	0.0	-6.5	96.3	96.3	0.01
Line194	0.028	-0.009	-0.028	0.005	0.0	-3.6	96.3	96.3	0.00
Line197	0.014	0.005	-0.014	-0.006	0.0	-0.6	96.3	96.3	0.00
Line195	0.020	-0.010	-0.020	-0.002	0.0	-11.6	96.3	96.3	0.01
Line196	0.012	-0.003	-0.012	-0.007	0.0	-10.7	96.3	96.3	0.00
Line198	0.009	0.003	-0.009	-0.006	0.0	-3.2	96.3	96.3	0.00
Line200	0.278	0.080	-0.278	-0.084	0.0	-3.6	96.4	96.4	0.01

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line201	0.261	0.073	-0.261	-0.074	0.0	-0.8	96.4	96.4	0.00
Line202	0.248	0.065	-0.248	-0.067	0.0	-1.3	96.4	96.4	0.00
Line203	-0.011	-0.007	0.011	0.006	0.0	-0.7	96.4	96.4	0.00
Line204	0.237	0.061	-0.237	-0.063	0.0	-2.2	96.4	96.4	0.01
Line205	0.225	0.056	-0.225	-0.056	0.0	-0.2	96.4	96.4	0.00
Line206	0.037	0.018	-0.037	-0.019	0.0	-0.4	96.4	96.4	0.00
Line210	0.188	0.038	-0.188	-0.042	0.0	-3.8	96.4	96.3	0.01
Line207	0.033	0.016	-0.033	-0.018	0.0	-2.2	96.4	96.3	0.00
Line170	0.022	0.011	-0.022	-0.011	0.0	-0.2	96.3	96.3	0.00
Line209	0.011	0.006	-0.011	-0.007	0.0	-0.8	96.3	96.3	0.00
Line229	-3.595	-2.232	3.637	2.268	41.4	35.1	92.3	93.5	1.17
Line243	3.498	2.172	-3.490	-2.165	7.9	6.7	92.3	92.1	0.23
Line211	0.002	0.001	-0.002	-0.001	0.0	-0.5	96.3	96.3	0.00
Line212	0.186	0.041	-0.186	-0.046	0.0	-5.3	96.3	96.3	0.01
Line213	-0.011	-0.007	0.011	0.005	0.0	-1.3	96.3	96.3	0.00
Line214	0.175	0.041	-0.175	-0.043	0.0	-1.8	96.3	96.3	0.00
Line215	0.168	0.038	-0.168	-0.043	0.0	-4.7	96.3	96.3	0.02
Line216	0.153	0.033	-0.153	-0.035	0.0	-1.9	96.3	96.3	0.01
Line217	-0.014	-0.009	0.014	0.008	0.0	-0.4	96.3	96.3	0.00
Line218	0.086	0.017	-0.086	-0.019	0.0	-1.3	96.3	96.3	0.00
Line233	0.053	0.009	-0.053	-0.010	0.0	-0.7	96.3	96.3	0.00
Line219	0.077	0.013	-0.077	-0.016	0.0	-2.2	96.3	96.3	0.00
Line220	-0.010	-0.006	0.010	0.006	0.0	-0.3	96.3	96.3	0.00
Line221	0.068	0.010	-0.067	-0.016	0.0	-6.3	96.3	96.3	0.01
Line222	-0.013	-0.008	0.013	0.008	0.0	-0.5	96.3	96.3	0.00
Line223	0.054	0.008	-0.054	-0.009	0.0	-0.8	96.3	96.3	0.00
Line224	0.021	0.008	-0.021	-0.009	0.0	-0.5	96.3	96.3	0.00
Line226	0.033	0.001	-0.033	-0.002	0.0	-0.6	96.3	96.3	0.00
Line225	0.010	0.002	-0.010	-0.006	0.0	-4.6	96.3	96.3	0.00
Line227	0.013	-0.002	-0.013	0.002	0.0	-0.2	96.3	96.3	0.00
Line230	0.020	0.004	-0.020	-0.006	0.0	-2.1	96.3	96.3	0.00
Line228	0.005	-0.007	-0.005	-0.003	0.0	-9.9	96.3	96.3	0.00
Line231	0.012	0.001	-0.012	-0.004	0.0	-3.8	96.3	96.3	0.00
Line232	0.005	0.000	-0.005	-0.003	0.0	-2.9	96.3	96.3	0.00
Line234	0.038	0.001	-0.038	-0.004	0.0	-2.8	96.3	96.3	0.00
Line235	0.026	-0.003	-0.026	0.003	0.0	-0.6	96.3	96.3	0.00
Line236	-0.009	-0.005	0.009	0.005	0.0	-0.4	96.3	96.3	0.00

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line237	0.018	-0.008	-0.018	-0.007	0.0	-14.7	96.3	96.3	0.01
Line238	0.010	0.002	-0.010	-0.006	0.0	-4.1	96.3	96.3	0.00
Line239	3.985	2.797	-3.981	-2.795	3.6	1.8	97.0	96.9	0.09
Cable13	3.981	2.795	-3.979	-2.795	2.4	0.0	96.9	96.9	0.04
33/11kV Sector I SS	3.979	2.795	-3.949	-2.427	29.5	368.9	96.9	92.3	4.53
Line240	3.969	2.783	-3.965	-2.781	3.7	1.8	97.0	96.9	0.10
Cable15	3.965	2.781	-3.963	-2.781	2.3	0.0	96.9	96.9	0.04
33/11kV Sector II SS	3.963	2.781	-3.933	-2.414	29.4	367.1	96.9	92.3	4.53
Cable16	3.075	1.907	-3.066	-1.901	8.4	5.9	92.3	92.1	0.26
Cable30	4.605	2.811	-4.594	-2.803	10.9	7.7	92.3	92.1	0.23
Line254	0.203	0.123	-0.203	-0.126	0.1	-3.1	92.3	92.3	0.05
Cable17	0.121	0.075	-0.121	-0.075	0.0	0.0	92.1	92.1	0.01
Cable18	2.657	1.647	-2.652	-1.644	5.5	3.9	92.1	91.9	0.20
Cable20	2.242	1.389	-2.242	-1.389	0.1	0.1	91.9	91.9	0.00
Cable19	0.869	0.539	-0.869	-0.539	0.4	0.3	91.9	91.8	0.04
Cable26	0.788	0.488	-0.787	-0.488	0.4	0.3	91.9	91.8	0.05
Cable21	0.000	0.000	0.000	0.000			91.8	91.8	
Cable22	-0.869	-0.538	0.869	0.539	0.5	0.4	91.8	91.8	0.06
Cable23	0.205	0.127	-0.205	-0.127	0.0	0.0	91.8	91.8	0.01
Cable24	0.404	0.250	-0.404	-0.250	0.3	0.1	91.8	91.7	0.05
Cable25	0.207	0.128	-0.207	-0.128	0.1	0.0	91.7	91.7	0.03
Cable27	0.432	0.268	-0.432	-0.268	0.1	0.1	91.8	91.8	0.02
Line241	1.425	0.889	-1.422	-0.884	3.2	4.9	96.3	96.0	0.31
Line246	1.189	0.740	-1.187	-0.736	2.3	3.5	96.0	95.7	0.27
Cable31	2.099	1.301	-2.096	-1.299	2.9	2.1	92.1	92.0	0.13
Cable32	2.253	1.352	-2.250	-1.350	2.6	1.8	92.1	92.0	0.11
Cable33	0.218	0.135	-0.218	-0.135	0.0	0.0	92.0	92.0	0.00
Cable34	1.546	0.958	-1.546	-0.958	0.4	0.3	92.0	91.9	0.02
Line242	0.105	0.065	-0.105	-0.065	0.0	0.0	92.0	92.0	0.01
Line244	0.113	0.070	-0.113	-0.070	0.0	0.0	92.0	92.0	0.01
Cable35	0.294	0.182	-0.294	-0.182	0.0	0.0	91.9	91.9	0.01
Cable37	0.970	0.601	-0.969	-0.600	1.1	0.8	91.9	91.8	0.11
Cable36	0.180	0.112	-0.180	-0.112	0.0	0.0	91.9	91.9	0.00
Cable38	-0.754	-0.467	0.754	0.467	0.0	0.0	91.8	91.8	0.00
Cable40	1.187	0.736	-1.187	-0.736	0.2	0.1	95.7	95.7	0.01
Line245	1.187	0.736	-1.185	-0.734	1.5	2.2	95.7	95.6	0.17
Cable41	1.185	0.734	-1.185	-0.734	0.0	0.0	95.6	95.5	0.00

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Cable42	-0.359	-0.223	0.359	0.223	0.0	0.0	95.5	95.5	0.00
Cable43	-0.446	-0.276	0.446	0.276	0.1	0.0	95.5	95.5	0.01
Cable44	0.231	0.143	-0.231	-0.143	0.0	0.0	95.5	95.5	0.01
Cable45	-0.381	-0.235	0.381	0.235	0.1	0.1	95.5	95.5	0.02
Cable46	0.128	0.079	-0.128	-0.079	0.0	0.0	95.5	95.5	0.00
Line248	0.135	0.083	-0.135	-0.084	0.0	-0.6	95.5	95.5	0.01
Line247	0.078	0.048	-0.078	-0.048	0.0	0.0	95.5	95.5	0.01
Cable47	2.250	1.350	-2.250	-1.350	0.2	0.1	92.0	92.0	0.01
Cable48	-0.182	-0.113	0.182	0.113	0.0	0.0	92.0	92.0	0.01
Cable49	-0.182	-0.113	0.182	0.113	0.0	0.0	92.0	92.0	0.01
Cable50	-1.882	-1.123	1.886	1.125	4.3	1.7	91.8	92.0	0.19
Line249	1.653	0.981	-1.641	-0.985	11.8	-3.4	91.8	91.3	0.49
Cable75	0.121	0.075	-0.121	-0.075	0.0	0.0	91.3	91.3	0.00
Line250	1.248	0.754	-1.230	-0.763	17.4	-8.9	91.3	90.3	0.95
Line251	0.272	0.156	-0.272	-0.164	0.6	-7.6	91.3	91.1	0.16
Line294	1.050	0.651	-1.048	-0.650	1.3	1.1	90.3	90.2	0.13
Cable79	0.050	0.031	-0.050	-0.031	0.0	0.0	91.1	91.1	0.00
Line252	0.015	0.005	-0.015	-0.009	0.0	-4.3	91.1	91.1	0.01
Line253	0.111	0.068	-0.111	-0.069	0.0	-0.5	91.1	91.1	0.00
Cable51	0.203	0.126	-0.203	-0.126	0.0	0.0	92.3	92.3	0.01
66/11kV I	4.927	2.956	-4.920	-2.801	7.4	154.8	100.0	98.5	1.47
66/11kV II	4.415	2.648	-4.408	-2.509	6.6	138.7	100.0	98.5	1.47
Cable52	0.129	0.079	-0.129	-0.079	0.0	0.0	98.5	98.5	0.00
Cable53	0.374	0.232	-0.374	-0.232	0.1	0.0	98.5	98.5	0.02
Cable54	5.556	2.932	-5.546	-2.924	10.2	7.2	98.5	98.3	0.19
Cable60	3.016	1.911	-3.012	-1.909	4.1	2.4	98.5	98.4	0.13
Cable76	0.253	0.157	-0.253	-0.157	0.0	0.0	98.5	98.5	0.01
Line255	0.129	0.079	-0.129	-0.079	0.0	-0.1	98.5	98.5	0.03
Line256	0.032	0.020	-0.032	-0.020	0.0	-0.4	98.5	98.5	0.03
Line257	0.097	0.060	-0.097	-0.060	0.0	-0.1	98.5	98.5	0.02
Line258	0.036	0.022	-0.036	-0.023	0.0	-0.4	98.5	98.4	0.03
Line260	-0.374	-0.232	0.374	0.232	0.3	0.0	98.4	98.5	0.07
Line262	5.546	2.924	-5.420	-2.750	126.0	174.6	98.3	95.3	3.02
Line263	0.442	-0.368	-0.442	0.368	0.4	0.3	95.3	95.3	0.01
Line265	4.978	3.117	-4.938	-3.083	40.1	34.0	95.3	94.5	0.84
Line264	0.442	-0.368	-0.442	0.368	0.1	0.0	95.3	95.3	0.00
Line266	-0.288	-0.179	0.288	0.179	0.0	0.0	94.5	94.5	0.01

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line267	0.102	0.063	-0.102	-0.064	0.0	0.0	94.5	94.5	0.01
Line268	4.547	2.841	-4.531	-2.828	16.0	13.5	94.5	94.1	0.37
Line269	4.441	2.772	-4.425	-2.758	16.2	13.7	94.1	93.7	0.38
Cable74	0.327	0.203	-0.327	-0.202	0.1	0.0	93.7	93.7	0.02
Line270	4.043	2.522	-4.032	-2.513	10.7	9.1	93.7	93.5	0.27
Line271	-0.395	-0.245	0.395	0.245	0.1	0.0	93.4	93.5	0.03
Line259	2.953	1.832	-2.945	-1.825	8.2	6.9	92.1	91.8	0.28
Line261	2.890	1.792	-2.877	-1.781	12.8	10.8	91.8	91.3	0.45
Line272	0.075	0.042	-0.075	-0.042	0.0	-0.1	91.3	91.3	0.01
Line274	2.786	1.729	-2.754	-1.702	32.2	27.2	91.3	90.2	1.16
Line273	0.016	0.005	-0.016	-0.010	0.0	-4.6	91.3	91.3	0.00
Line275	0.416	0.258	-0.416	-0.258	0.4	0.2	90.2	90.1	0.10
Line276	2.338	1.444	-2.326	-1.434	12.6	10.6	90.2	89.6	0.54
Cable55	0.109	0.067	-0.109	-0.067	0.0	0.0	90.1	90.0	0.02
Cable73	0.169	0.105	-0.169	-0.105	0.0	0.0	90.1	90.0	0.01
Cable56	-0.014	-0.009	0.014	0.009	0.0	0.0	89.6	89.6	0.00
Line278	2.311	1.425	-2.309	-1.423	2.3	1.9	89.6	89.5	0.10
Cable71	0.112	0.070	-0.112	-0.070	0.0	0.0	89.5	89.5	0.00
Cable72	0.169	0.105	-0.169	-0.105	0.0	0.0	89.5	89.5	0.01
Line279	0.050	0.031	-0.050	-0.031	0.0	-0.2	89.5	89.5	0.03
Line281	1.978	1.218	-1.964	-1.206	14.4	12.0	89.5	88.8	0.72
Line280	0.035	0.021	-0.035	-0.021	0.0	0.0	89.5	89.5	0.00
Line282	-0.183	-0.113	0.183	0.113	0.0	0.0	88.8	88.8	0.01
Cable70	0.238	0.147	-0.238	-0.147	0.1	0.0	88.8	88.8	0.02
Line283	0.555	0.344	-0.555	-0.344	0.0	0.0	88.8	88.8	0.01
Line284	0.804	0.487	-0.803	-0.487	1.0	0.8	88.8	88.7	0.12
Line285	-0.135	-0.084	0.135	0.073	0.1	-10.9	88.6	88.7	0.06
Cable69	0.153	0.095	-0.153	-0.095	0.0	0.0	88.7	88.7	0.02
Line286	0.515	0.319	-0.514	-0.318	0.7	0.5	88.7	88.5	0.14
Line287	-0.200	-0.124	0.200	0.124	0.0	0.0	88.5	88.5	0.02
Cable68	0.150	0.093	-0.150	-0.093	0.0	0.0	88.5	88.5	0.01
Line288	0.164	0.102	-0.164	-0.102	0.1	-0.1	88.5	88.5	0.03
Line289	-0.164	-0.102	0.164	0.102	0.0	0.0	88.5	88.5	0.01
Cable59	0.290	0.180	-0.290	-0.180	0.0	0.0	90.0	90.0	0.01
Line291	0.545	0.338	-0.545	-0.338	0.1	0.1	90.0	90.0	0.02
Line292	-0.835	-0.517	0.836	0.519	1.6	1.3	90.0	90.2	0.20
Cable57	0.292	0.181	-0.292	-0.181	0.0	0.0	90.0	90.0	0.01

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Cable58	0.253	0.157	-0.253	-0.157	0.0	0.0	90.0	90.0	0.02
Cable78	0.158	0.098	-0.158	-0.098	0.0	0.0	90.1	90.1	0.01
Line293	-0.212	-0.131	0.212	0.131	0.4	-0.1	90.1	90.2	0.16
Line295	3.012	1.909	-2.956	-1.832	55.9	76.9	98.4	96.0	2.45
66/11kV I (HYOSUNG)	5.383	4.137	-5.356	-3.731	26.9	406.1	100.0	96.1	3.85
66/11kV II (HYOSUNG)	5.383	4.137	-5.356	-3.731	26.9	406.1	100.0	96.1	3.85
Cable61	1.156	1.353	-1.156	-1.353	0.3	0.2	96.1	96.1	0.02
Cable63	4.013	2.503	-4.010	-2.501	2.6	1.9	96.1	96.1	0.07
Cable65	4.731	3.109	-4.727	-3.106	3.9	2.8	96.1	96.1	0.08
Cable66	0.356	0.220	-0.356	-0.220	0.0	0.0	96.1	96.1	0.00
Cable67	0.456	0.276	-0.456	-0.276	0.0	0.0	96.1	96.1	0.01
Line296	1.156	1.353	-1.146	-1.348	10.2	4.5	96.1	95.6	0.55
Line297	0.131	0.722	-0.128	-0.721	2.7	1.0	95.6	95.4	0.22
Line300	1.015	0.627	-1.013	-0.626	2.4	1.0	95.6	95.4	0.21
Line298	0.095	0.700	-0.094	-0.700	0.4	0.2	95.4	95.3	0.03
Line299	0.536	0.332	-0.535	-0.332	0.3	0.1	95.3	95.3	0.06
Line301	0.924	0.570	-0.917	-0.568	7.1	2.9	95.4	94.7	0.68
Line302	0.459	0.284	-0.459	-0.284	0.1	0.0	94.7	94.7	0.01
Line304	0.458	0.283	-0.458	-0.283	0.4	0.1	94.7	94.6	0.07
Line303	0.406	0.251	-0.405	-0.251	0.4	0.1	94.7	94.6	0.08
Line305	0.361	0.224	-0.361	-0.223	0.4	0.1	94.6	94.5	0.09
Line277	0.269	0.167	-0.269	-0.167	0.1	0.0	94.5	94.5	0.03
Line306	0.185	0.114	-0.185	-0.114	0.0	0.0	94.5	94.5	0.02
Line307	0.185	0.114	-0.184	-0.114	0.1	0.0	94.5	94.4	0.04
Cable62	0.097	0.060	-0.097	-0.060	0.0	0.0	94.4	94.4	0.00
Line308	4.010	2.501	-3.936	-2.398	74.6	103.2	96.1	93.7	2.40
Line309	3.916	2.386	-3.910	-2.377	6.1	8.4	93.7	93.5	0.20
Line310	0.008	0.005	-0.008	-0.005	0.0	0.0	93.5	93.5	0.00
Line311	3.902	2.373	-3.900	-2.369	2.4	3.3	93.5	93.4	0.08
Cable64	-0.205	-0.127	0.205	0.127	0.0	0.0	93.4	93.4	0.00
Line313	3.694	2.242	-3.690	-2.235	4.9	6.7	93.4	93.2	0.17
Line314	3.651	2.212	-3.648	-2.207	3.4	4.7	93.2	93.1	0.12
Line315	3.570	2.159	-3.561	-2.147	9.0	12.4	93.1	92.8	0.32
Line316	3.522	2.122	-3.517	-2.116	4.2	5.7	92.8	92.7	0.15
Line317	-1.148	-0.712	1.149	0.712	0.4	0.2	92.6	92.7	0.03
Line318	2.369	1.404	-2.355	-1.393	14.0	11.7	92.7	92.1	0.61
Line319	0.388	0.174	-0.388	-0.174	0.1	0.1	92.1	92.0	0.03

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line320	4.727	3.106	-4.593	-2.920	134.1	185.7	96.1	92.4	3.63
Line321	3.102	1.996	-3.098	-1.991	3.9	5.4	92.4	92.3	0.16
Line322	2.774	1.790	-2.769	-1.783	5.2	7.2	92.3	92.0	0.23
Line323	1.043	0.647	-1.043	-0.646	0.3	0.4	92.0	92.0	0.04
Line324	1.725	1.136	-1.725	-1.135	0.4	0.5	92.0	92.0	0.03
Line325	0.366	0.293	-0.366	-0.293	0.1	0.0	92.0	92.0	0.02
Line326	0.350	0.284	-0.350	-0.283	0.1	0.0	92.0	92.0	0.02
Line327	-0.324	-0.201	0.324	0.201	0.1	0.0	92.0	92.0	0.02
Line328	0.027	0.083	-0.027	-0.083	0.0	-0.1	92.0	92.0	0.01
Line329	-0.207	-0.062	0.207	0.062	0.1	-0.1	92.0	92.0	0.03
Line330	-0.219	-0.069	0.219	0.069	0.0	0.0	92.0	92.0	0.01
Line331	-0.241	-0.083	0.241	0.083	0.0	0.0	92.0	92.0	0.01
Line332	-0.121	-0.075	0.121	0.075	0.0	0.0	92.0	92.0	0.00
Line333	0.025	0.016	-0.025	-0.016	0.0	0.0	92.0	92.0	0.00
Line334	0.000	0.000	0.000	0.000	0.0	0.0	92.0	92.0	0.00
Line335	0.356	0.220	-0.356	-0.220	0.0	0.0	96.1	96.1	0.01
Line336	0.249	0.154	-0.249	-0.154	0.2	-0.1	96.1	96.1	0.07
Line337	0.107	0.066	-0.107	-0.067	0.0	-0.1	96.1	96.1	0.02
Line338	0.054	0.033	-0.054	-0.033	0.0	-0.1	96.1	96.1	0.01
Line339	0.456	0.276	-0.454	-0.275	2.2	0.6	96.1	95.7	0.44
Line340	0.411	0.249	-0.410	-0.249	1.2	0.3	95.7	95.4	0.26
Line341	0.034	0.019	-0.034	-0.020	0.0	-0.6	95.4	95.4	0.06
Line348	0.376	0.230	-0.376	-0.230	0.1	0.0	95.4	95.4	0.03
Line343	0.000	0.000	0.000	0.000	0.0	0.0	95.4	95.4	0.00
Line344	0.034	0.020	-0.034	-0.020	0.0	-0.4	95.4	95.3	0.03
Line345	-0.021	-0.013	0.021	0.013	0.0	0.0	95.3	95.3	0.00
Line346	0.013	0.007	-0.013	-0.007	0.0	-0.4	95.3	95.3	0.01
Line347	0.006	0.003	-0.006	-0.004	0.0	-0.5	95.3	95.3	0.01
Line349	0.037	0.023	-0.037	-0.023	0.0	-0.1	95.4	95.4	0.01
Line350	0.339	0.207	-0.337	-0.207	1.6	0.3	95.4	95.0	0.43
Line351	0.178	0.109	-0.177	-0.109	0.3	-0.2	95.0	94.8	0.14
Line355	0.160	0.098	-0.160	-0.098	0.0	0.0	95.0	95.0	0.01
Line352	0.004	0.002	-0.004	-0.002	0.0	-0.3	94.8	94.8	0.00
Line353	0.173	0.107	-0.173	-0.107	0.2	-0.1	94.8	94.7	0.09
Line354	0.150	0.092	-0.149	-0.093	0.1	-0.1	94.7	94.7	0.08
Line356	0.035	0.021	-0.035	-0.021	0.0	-0.4	95.0	94.9	0.04
Line358	0.032	0.019	-0.032	-0.019	0.0	-0.1	94.9	94.9	0.01

Branch ID	From-To Bus Flow MW	From-To Bus Flow Mvar	To-From Bus Flow MW	To-From Bus Flow Mvar	Losses kW	Losses kvar	% Bus Voltage From	% Bus Voltage To	Vd % Drop in Vmag
Line359	0.022	0.013	-0.022	-0.013	0.0	-0.2	94.9	94.9	0.01
Line360	0.007	0.004	-0.007	-0.004	0.0	0.0	94.9	94.9	0.00
Line361	0.016	0.009	-0.016	-0.009	0.0	-0.2	94.9	94.9	0.01
Line362	0.009	0.005	-0.009	-0.005	0.0	-0.3	94.9	94.9	0.01
Line30	0.004	0.001	-0.004	-0.002	0.0	-0.9	91.4	91.3	0.01
Line32	0.005	0.003	-0.005	-0.003	0.0	0.0	91.4	91.4	0.00
Line160	0.003	0.001	-0.003	-0.002	0.0	-1.4	96.6	96.6	0.00
Line150	0.017	0.008	-0.017	-0.009	0.0	-1.8	96.6	96.6	0.00
Line151	0.005	0.002	-0.005	-0.003	0.0	-1.1	96.6	96.6	0.00
Line190	0.001	-0.003	-0.001	-0.001	0.0	-4.2	96.3	96.3	0.00
Line191	0.000	-0.004	0.000	0.000	0.0	-3.8	96.3	96.3	0.00
Cable80	0.154	0.096	-0.154	-0.096	0.0	0.0	95.1	95.0	0.01
Cable86	-0.215	-0.133	0.215	0.133	0.0	0.0	91.8	91.8	0.01
					1358.4	3621.5			

Alert Summary Report

	% Alert Settings	
	Critical	**Marginal**
Loading		
Bus	100.0	95.0
Cable	100.0	95.0
Reactor	100.0	95.0
Line	100.0	95.0
Transformer	100.0	95.0
Panel	100.0	95.0
Protective Device	100.0	95.0
Generator	100.0	95.0
Inverter/Charger	100.0	95.0
Bus Voltage		
OverVoltage	110.0	105.0
UnderVoltage	90.0	95.0
Generator Excitation		
OverExcited (Q Max.)	100.0	95.0
UnderExcited (Q Min.)	100.0	

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus100	Bus	Under Voltage	11.000	kV	9.100	82.7	3-Phase
Bus101	Bus	Under Voltage	11.000	kV	9.10	82.7	3-Phase
Bus102	Bus	Under Voltage	11.000	kV	9.10	82.7	3-Phase
Bus103	Bus	Under Voltage	11.000	kV	9.10	82.7	3-Phase
Bus104	Bus	Under Voltage	11.000	kV	9.10	82.7	3-Phase
Bus105	Bus	Under Voltage	11.000	kV	9.10	82.7	3-Phase
Bus106	Bus	Under Voltage	11.000	kV	9.10	82.7	3-Phase
Bus107	Bus	Under Voltage	11.000	kV	9.10	82.7	3-Phase
Bus108	Bus	Under Voltage	11.000	kV	9.10	82.7	3-Phase
Bus109	Bus	Under Voltage	11.000	kV	9.10	82.7	3-Phase
Bus110	Bus	Under Voltage	11.000	kV	9.04	82.2	3-Phase
Bus111	Bus	Under Voltage	11.000	kV	9.04	82.2	3-Phase
Bus112	Bus	Under Voltage	11.000	kV	9.03	82.1	3-Phase
Bus113	Bus	Under Voltage	11.000	kV	9.03	82.1	3-Phase
Bus114	Bus	Under Voltage	11.000	kV	9.01	81.9	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus115	Bus	Under Voltage	11.000	kV	8.974	81.6	3-Phase
Bus116	Bus	Under Voltage	11.000	kV	8.99	81.7	3-Phase
Bus117	Bus	Under Voltage	11.000	kV	8.98	81.6	3-Phase
Bus118	Bus	Under Voltage	11.000	kV	8.98	81.6	3-Phase
Bus119	Bus	Under Voltage	11.000	kV	8.92	81.1	3-Phase
Bus120	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus330	Bus	Under Voltage	11.000	kV	9.86	89.6	3-Phase
Bus331	Bus	Under Voltage	11.000	kV	9.86	89.6	3-Phase
Bus332	Bus	Under Voltage	11.000	kV	9.85	89.5	3-Phase
Bus333	Bus	Under Voltage	11.000	kV	9.84	89.5	3-Phase
Bus334	Bus	Under Voltage	11.000	kV	9.84	89.5	3-Phase
Bus335	Bus	Under Voltage	11.000	kV	9.77	88.8	3-Phase
Bus336	Bus	Under Voltage	11.000	kV	9.77	88.8	3-Phase
Bus337	Bus	Under Voltage	11.000	kV	9.77	88.8	3-Phase
Bus338	Bus	Under Voltage	11.000	kV	9.75	88.6	3-Phase
Bus339	Bus	Under Voltage	11.000	kV	9.75	88.7	3-Phase
Bus340	Bus	Under Voltage	11.000	kV	9.74	88.5	3-Phase
Bus341	Bus	Under Voltage	11.000	kV	9.74	88.5	3-Phase
Bus342	Bus	Under Voltage	11.000	kV	9.74	88.5	3-Phase
Bus343	Bus	Under Voltage	11.000	kV	9.74	88.5	3-Phase
Bus346	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus347	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus428	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus449	Bus	Under Voltage	11.000	kV	9.74	88.5	3-Phase
Bus450	Bus	Under Voltage	11.000	kV	9.75	88.7	3-Phase
Bus451	Bus	Under Voltage	11.000	kV	9.77	88.8	3-Phase
Bus452	Bus	Under Voltage	11.000	kV	9.85	89.5	3-Phase
Bus453	Bus	Under Voltage	11.000	kV	9.85	89.5	3-Phase
Bus468	Bus	Under Voltage	11.000	kV	9.43	85.8	3-Phase
Bus85	Bus	Under Voltage	11.000	kV	9.78	88.9	3-Phase
Bus86	Bus	Under Voltage	11.000	kV	9.78	88.9	3-Phase
Bus87	Bus	Under Voltage	11.000	kV	9.77	88.9	3-Phase
Bus88	Bus	Under Voltage	11.000	kV	9.46	86.0	3-Phase
Bus89	Bus	Under Voltage	11.000	kV	9.46	86.0	3-Phase
Bus90	Bus	Under Voltage	11.000	kV	9.44	85.8	3-Phase
Bus91	Bus	Under Voltage	11.000	kV	9.43	85.7	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus92	Bus	Under Voltage	11.000	kV	9.435	85.8	3-Phase
Bus93	Bus	Under Voltage	11.000	kV	9.43	85.7	3-Phase
Bus94	Bus	Under Voltage	11.000	kV	9.40	85.4	3-Phase
Bus95	Bus	Under Voltage	11.000	kV	9.37	85.2	3-Phase
Bus96	Bus	Under Voltage	11.000	kV	9.27	84.3	3-Phase
Bus97	Bus	Under Voltage	11.000	kV	9.27	84.3	3-Phase
Bus98	Bus	Under Voltage	11.000	kV	9.22	83.8	3-Phase
Bus99	Bus	Under Voltage	11.000	kV	9.22	83.8	3-Phase

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
33/11kV Sector I SS	Transformer	Overload	5.000	MVA	4.863	97.3	3-Phase
33/11kV Sector II SS	Transformer	Overload	5.000	MVA	4.84	96.8	3-Phase
Bus10	Bus	Under Voltage	11.000	kV	10.29	93.5	3-Phase
Bus11	Bus	Under Voltage	11.000	kV	10.29	93.5	3-Phase
Bus12	Bus	Under Voltage	11.000	kV	10.27	93.4	3-Phase
Bus13	Bus	Under Voltage	11.000	kV	10.27	93.3	3-Phase
Bus14	Bus	Under Voltage	11.000	kV	10.24	93.1	3-Phase
Bus15	Bus	Under Voltage	11.000	kV	10.25	93.1	3-Phase
Bus16	Bus	Under Voltage	11.000	kV	10.23	93.0	3-Phase
Bus17	Bus	Under Voltage	11.000	kV	10.23	93.0	3-Phase
Bus18	Bus	Under Voltage	11.000	kV	10.22	92.9	3-Phase
Bus19	Bus	Under Voltage	11.000	kV	10.20	92.7	3-Phase
Bus20	Bus	Under Voltage	11.000	kV	10.20	92.7	3-Phase
Bus21	Bus	Under Voltage	11.000	kV	10.15	92.3	3-Phase
Bus22	Bus	Under Voltage	11.000	kV	10.15	92.3	3-Phase
Bus224	Bus	Under Voltage	11.000	kV	10.15	92.3	3-Phase
Bus23	Bus	Under Voltage	11.000	kV	10.14	92.2	3-Phase
Bus24	Bus	Under Voltage	11.000	kV	10.14	92.2	3-Phase
Bus25	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus259	Bus	Under Voltage	11.000	kV	10.16	92.3	3-Phase
Bus26	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus260	Bus	Under Voltage	11.000	kV	10.13	92.1	3-Phase
Bus261	Bus	Under Voltage	11.000	kV	10.13	92.1	3-Phase
Bus262	Bus	Under Voltage	11.000	kV	10.11	91.9	3-Phase
Bus263	Bus	Under Voltage	11.000	kV	10.11	91.9	3-Phase

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus264	Bus	Under Voltage	11.000	kV	10.101	91.8	3-Phase
Bus265	Bus	Under Voltage	11.000	kV	10.09	91.8	3-Phase
Bus266	Bus	Under Voltage	11.000	kV	10.09	91.8	3-Phase
Bus267	Bus	Under Voltage	11.000	kV	10.09	91.7	3-Phase
Bus268	Bus	Under Voltage	11.000	kV	10.09	91.7	3-Phase
Bus269	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Bus27	Bus	Under Voltage	11.000	kV	10.01	91.0	3-Phase
Bus270	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Bus273	Bus	Under Voltage	11.000	kV	10.13	92.1	3-Phase
Bus274	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus275	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus276	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus277	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus278	Bus	Under Voltage	11.000	kV	10.11	91.9	3-Phase
Bus279	Bus	Under Voltage	11.000	kV	10.11	91.9	3-Phase
Bus28	Bus	Under Voltage	11.000	kV	10.05	91.4	3-Phase
Bus280	Bus	Under Voltage	11.000	kV	10.11	91.9	3-Phase
Bus281	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Bus29	Bus	Under Voltage	11.000	kV	10.05	91.3	3-Phase
Bus292	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus293	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus294	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus295	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Bus296	Bus	Under Voltage	11.000	kV	10.04	91.3	3-Phase
Bus297	Bus	Under Voltage	11.000	kV	9.94	90.3	3-Phase
Bus298	Bus	Under Voltage	11.000	kV	10.02	91.1	3-Phase
Bus299	Bus	Under Voltage	11.000	kV	10.02	91.1	3-Phase
Bus30	Bus	Under Voltage	11.000	kV	10.05	91.4	3-Phase
Bus300	Bus	Under Voltage	11.000	kV	10.02	91.1	3-Phase
Bus301	Bus	Under Voltage	11.000	kV	10.15	92.3	3-Phase
Bus302	Bus	Under Voltage	11.000	kV	10.15	92.3	3-Phase
Bus31	Bus	Under Voltage	11.000	kV	10.05	91.4	3-Phase
Bus315	Bus	Under Voltage	11.000	kV	10.39	94.5	3-Phase
Bus316	Bus	Under Voltage	11.000	kV	10.39	94.5	3-Phase
Bus317	Bus	Under Voltage	11.000	kV	10.39	94.5	3-Phase
Bus318	Bus	Under Voltage	11.000	kV	10.35	94.1	3-Phase

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus319	Bus	Under Voltage	11.000	kV	10.310	93.7	3-Phase
Bus320	Bus	Under Voltage	11.000	kV	10.28	93.4	3-Phase
Bus321	Bus	Under Voltage	11.000	kV	10.28	93.5	3-Phase
Bus322	Bus	Under Voltage	11.000	kV	10.13	92.1	3-Phase
Bus323	Bus	Under Voltage	11.000	kV	10.09	91.8	3-Phase
Bus324	Bus	Under Voltage	11.000	kV	10.05	91.3	3-Phase
Bus325	Bus	Under Voltage	11.000	kV	10.04	91.3	3-Phase
Bus326	Bus	Under Voltage	11.000	kV	10.04	91.3	3-Phase
Bus327	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus328	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
Bus329	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus344	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus345	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus348	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus349	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
Bus350	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus361	Bus	Under Voltage	11.000	kV	10.42	94.7	3-Phase
Bus362	Bus	Under Voltage	11.000	kV	10.41	94.7	3-Phase
Bus363	Bus	Under Voltage	11.000	kV	10.41	94.6	3-Phase
Bus364	Bus	Under Voltage	11.000	kV	10.41	94.6	3-Phase
Bus365	Bus	Under Voltage	11.000	kV	10.40	94.5	3-Phase
Bus366	Bus	Under Voltage	11.000	kV	10.39	94.5	3-Phase
Bus367	Bus	Under Voltage	11.000	kV	10.39	94.5	3-Phase
Bus368	Bus	Under Voltage	11.000	kV	10.39	94.4	3-Phase
Bus369	Bus	Under Voltage	11.000	kV	10.39	94.4	3-Phase
Bus371	Bus	Under Voltage	11.000	kV	10.31	93.7	3-Phase
Bus372	Bus	Under Voltage	11.000	kV	10.28	93.5	3-Phase
Bus373	Bus	Under Voltage	11.000	kV	10.28	93.5	3-Phase
Bus374	Bus	Under Voltage	11.000	kV	10.27	93.4	3-Phase
Bus375	Bus	Under Voltage	11.000	kV	10.28	93.4	3-Phase
Bus376	Bus	Under Voltage	11.000	kV	10.26	93.2	3-Phase
Bus377	Bus	Under Voltage	11.000	kV	10.24	93.1	3-Phase
Bus378	Bus	Under Voltage	11.000	kV	10.21	92.8	3-Phase
Bus379	Bus	Under Voltage	11.000	kV	10.19	92.6	3-Phase
Bus380	Bus	Under Voltage	11.000	kV	10.19	92.7	3-Phase
Bus381	Bus	Under Voltage	11.000	kV	10.13	92.1	3-Phase

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus383	Bus	Under Voltage	11.000	kV	10.168	92.4	3-Phase
Bus384	Bus	Under Voltage	11.000	kV	10.15	92.3	3-Phase
Bus385	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus386	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus387	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus388	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus389	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus390	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus391	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus392	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus393	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus394	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus395	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus396	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus413	Bus	Under Voltage	11.000	kV	10.45	95.0	3-Phase
Bus415	Bus	Under Voltage	11.000	kV	10.43	94.8	3-Phase
Bus416	Bus	Under Voltage	11.000	kV	10.42	94.7	3-Phase
Bus417	Bus	Under Voltage	11.000	kV	10.41	94.7	3-Phase
Bus418	Bus	Under Voltage	11.000	kV	10.45	95.0	3-Phase
Bus420	Bus	Under Voltage	11.000	kV	10.44	94.9	3-Phase
Bus421	Bus	Under Voltage	11.000	kV	10.44	94.9	3-Phase
Bus423	Bus	Under Voltage	11.000	kV	10.44	94.9	3-Phase
Bus424	Bus	Under Voltage	11.000	kV	10.44	94.9	3-Phase
Bus425	Bus	Under Voltage	11.000	kV	10.44	94.9	3-Phase
Bus426	Bus	Under Voltage	11.000	kV	10.29	93.6	3-Phase
Bus427	Bus	Under Voltage	11.000	kV	10.29	93.6	3-Phase
Bus429	Bus	Under Voltage	11.000	kV	10.05	91.4	3-Phase
Bus430	Bus	Under Voltage	11.000	kV	10.05	91.3	3-Phase
Bus431	Bus	Under Voltage	11.000	kV	10.05	91.4	3-Phase
Bus447	Bus	Under Voltage	11.000	kV	10.43	94.8	3-Phase
Bus448	Bus	Under Voltage	11.000	kV	10.44	94.9	3-Phase
Bus454	Bus	Under Voltage	11.000	kV	9.91	90.0	3-Phase
Bus455	Bus	Under Voltage	11.000	kV	10.31	93.7	3-Phase
Bus456	Bus	Under Voltage	11.000	kV	10.04	91.3	3-Phase
Bus459	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
Bus460	Bus	Under Voltage	11.000	kV	10.02	91.1	3-Phase

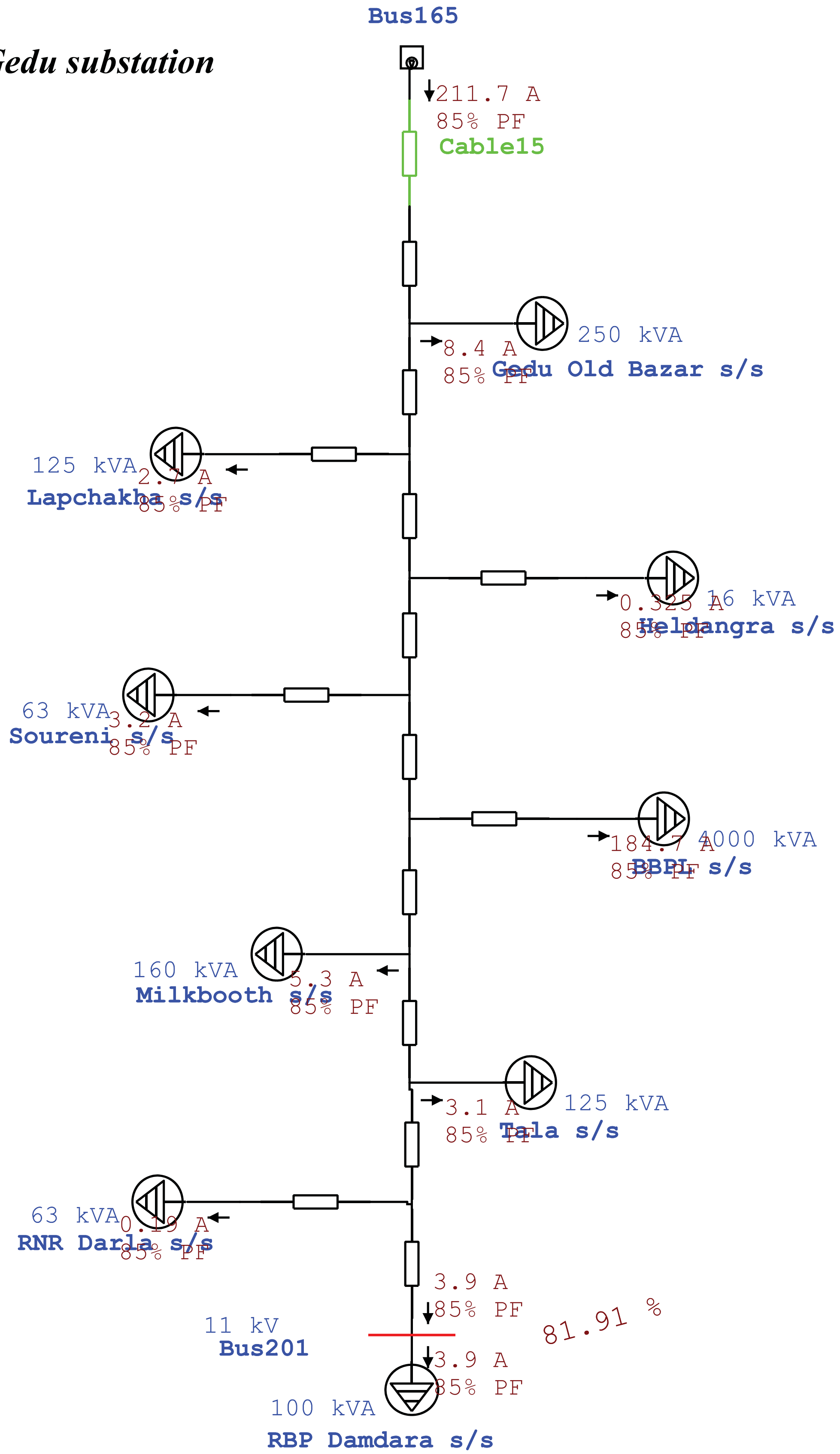
Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus464	Bus	Under Voltage	11.000	kV	10.418	94.7	3-Phase
Bus465	Bus	Under Voltage	11.000	kV	10.33	93.9	3-Phase
Bus466	Bus	Under Voltage	11.000	kV	10.34	94.0	3-Phase
Bus467	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus469	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Bus56	Bus	Under Voltage	11.000	kV	10.44	94.9	3-Phase
Bus57	Bus	Under Voltage	11.000	kV	10.44	94.9	3-Phase
Bus60	Bus	Under Voltage	11.000	kV	10.42	94.7	3-Phase
Bus61	Bus	Under Voltage	11.000	kV	10.34	94.0	3-Phase
Bus62	Bus	Under Voltage	11.000	kV	10.34	94.0	3-Phase
Bus63	Bus	Under Voltage	11.000	kV	10.34	94.0	3-Phase
Bus64	Bus	Under Voltage	11.000	kV	10.34	94.0	3-Phase
Bus65	Bus	Under Voltage	11.000	kV	10.34	94.0	3-Phase
Bus66	Bus	Under Voltage	11.000	kV	10.33	93.9	3-Phase
Bus67	Bus	Under Voltage	11.000	kV	10.33	93.9	3-Phase
Bus68	Bus	Under Voltage	11.000	kV	10.30	93.6	3-Phase
Bus69	Bus	Under Voltage	11.000	kV	10.29	93.6	3-Phase
Bus70	Bus	Under Voltage	11.000	kV	10.29	93.6	3-Phase
Bus71	Bus	Under Voltage	11.000	kV	10.29	93.6	3-Phase
Bus72	Bus	Under Voltage	11.000	kV	10.29	93.6	3-Phase
Bus73	Bus	Under Voltage	11.000	kV	10.29	93.6	3-Phase
Bus74	Bus	Under Voltage	11.000	kV	10.29	93.6	3-Phase
Bus75	Bus	Under Voltage	11.000	kV	10.29	93.6	3-Phase
Bus78	Bus	Under Voltage	11.000	kV	10.28	93.4	3-Phase
Bus79	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus80	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus81	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus82	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus83	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus84	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus9	Bus	Under Voltage	11.000	kV	10.32	93.8	3-Phase
Cable54	Cable	Overload	338.032	Amp	334.64	99.0	3-Phase
RMU MBC	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
RMU Near Bridge	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Telecom RMU	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase

SUMMARY OF TOTAL GENERATION , LOADING & DEMAND

	MW	Mvar	MVA	% PF
Source (Swing Buses):	39.269	27.116	47.721	82.29 Lagging
Source (Non-Swing Buses):	0.000	0.000	0.000	
Total Demand:	39.269	27.116	47.721	82.29 Lagging
Total Motor Load:	15.923	9.868	18.733	85.00 Lagging
Total Static Load:	21.988	13.627	25.868	85.00 Lagging
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	1.358	3.622		
System Mismatch:	0.000	0.000		

Number of Iterations: 3



Bus165
Gedu substation
211.7 A
85% PF
Cable15
250 kVA
8.4 A
85% PF
Gedu Old Bazar s/s
125 kVA
2.7 A
85% PF
Lapchakha s/s
0.325 A
85% PF
16 kVA
Heldangra s/s
63 kVA
3.2 A
85% PF
Soureni s/s
184.7 A
85% PF
4000 kVA
BBPL s/s
160 kVA
5.3 A
85% PF
Milkbooth s/s
3.1 A
85% PF
125 kVA
Tala s/s
63 kVA
0.19 A
85% PF
RNR Darla s/s
3.9 A
85% PF
81.91 %
11 kV
Bus201
3.9 A
85% PF
100 kVA
RBP Damdara s/s

Bus Loading Summary Report

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus1	66.000										10.021	86.5	87.7	
Bus2	33.000										3.577	92.1	63.3	
Bus3	33.000										2.076	95.9	36.7	
Bus4	33.000										2.067	95.6	36.9	
Bus5	33.000										1.295	88.4	23.1	
Bus6	33.000				0.018	0.011					0.111	87.1	2.0	
Bus7	33.000				0.058	0.036					0.092	86.1	1.6	
Bus8	33.000				0.021	0.013					0.025	85.0	0.4	
Bus9	33.000										1.226	85.5	21.9	
Bus10	33.000				0.001	0.001					0.138	84.3	2.5	
Bus11	33.000										0.139	82.5	2.5	
Bus12	33.000				0.015	0.009					0.045	97.9	0.8	
Bus13	33.000				0.008	0.005					0.030	98.7	0.5	
Bus14	33.000				0.005	0.003					0.022	96.8	0.4	
Bus15	33.000				0.010	0.006					0.019	86.5	0.3	
Bus16	33.000				0.007	0.004					0.008	85.0	0.1	
Bus17	33.000										0.105	67.1	1.9	
Bus19	33.000				0.005	0.003					0.006	85.0	0.1	
Bus20	33.000										0.096	71.2	1.7	
Bus21	33.000				0.021	0.013					0.098	64.1	1.8	
Bus22	33.000				0.002	0.001					0.002	85.0	-	
Bus23	33.000										0.049	84.8	0.9	
Bus24	33.000				0.005	0.003					0.047	85.2	0.8	
Bus25	33.000										0.042	83.9	0.8	
Bus26	33.000				0.003	0.002					0.021	78.7	0.4	
Bus29	33.000				0.004	0.002					0.013	65.6	0.2	
Bus30	33.000				0.003	0.002					0.008	67.5	0.1	
Bus31	33.000				0.002	0.002					0.003	85.0	0.1	
Bus32	33.000				0.005	0.003					0.023	81.7	0.4	
Bus33	33.000				0.003	0.002					0.017	78.7	0.3	
Bus38	33.000										0.831	100.0	14.8	
Bus39	33.000				0.009	0.006					0.011	85.0	0.2	
Bus40	33.000										0.830	100.0	14.8	
Bus41	33.000				0.010	0.006					0.821	100.0	14.7	
Bus42	33.000										0.810	100.0	14.5	
Bus43	33.000				0.014	0.009					0.024	93.3	0.4	
Bus44	33.000				0.009	0.005					0.010	85.0	0.2	
Bus45	33.000										0.787	100.0	14.1	
Bus46	33.000				0.006	0.004					0.007	85.0	0.1	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					Percent
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Loading
Bus47	33.000										0.083	95.4	1.5	
Bus48	33.000				0.002	0.001					0.080	92.2	1.4	
Bus49	33.000										0.078	91.5	1.4	
Bus51	33.000				0.008	0.005					0.076	90.4	1.4	
Bus52	33.000				0.019	0.012					0.067	90.1	1.2	
Bus53	33.000										0.045	91.4	0.8	
Bus54	33.000				0.008	0.005					0.010	85.0	0.2	
Bus55	33.000				0.011	0.007					0.038	87.4	0.7	
Bus56	33.000				0.012	0.008					0.025	86.2	0.4	
Bus57	33.000				0.009	0.006					0.011	85.0	0.2	
Bus58	33.000				0.008	0.005					0.009	85.0	0.2	
Bus59	33.000										0.707	100.0	12.6	
Bus60	33.000				0.024	0.015					0.700	100.0	12.5	
Bus61	33.000				0.006	0.004					0.007	85.0	0.1	
Bus62	33.000										0.676	100.0	12.1	
Bus63	33.000										0.670	100.0	12.0	
Bus64	33.000				0.008	0.005					0.014	93.6	0.2	
Bus65	33.000				0.005	0.003					0.006	85.0	0.1	
Bus66	33.000										0.657	100.0	11.8	
Bus67	33.000				0.009	0.005					0.010	85.0	0.2	
Bus68	33.000				0.018	0.011					0.022	85.0	0.4	
Bus69	33.000										0.648	100.0	11.6	
Bus70	33.000										0.629	99.9	11.3	
Bus71	33.000				0.005	0.003					0.005	85.0	0.1	
Bus72	33.000										0.020	93.2	0.4	
Bus73	33.000				0.003	0.002					0.004	85.0	0.1	
Bus74	33.000				0.011	0.007					0.017	80.6	0.3	
Bus75	33.000				0.011	0.007					0.611	99.9	10.9	
Bus76	33.000				0.007	0.005					0.600	99.9	10.7	
Bus77	33.000				0.004	0.003					0.592	99.9	10.6	
Bus78	33.000										0.588	99.9	10.5	
Bus79	33.000				0.007	0.005					0.013	66.1	0.2	
Bus81	33.000				0.002	0.001					0.002	85.0	-	
Bus82	33.000										0.580	99.8	10.4	
Bus83	33.000				0.004	0.003					0.579	99.7	10.4	
Bus84	33.000										0.575	99.5	10.3	
Bus85	33.000				0.004	0.003					0.015	75.2	0.3	
Bus86	33.000				0.004	0.003					0.013	52.2	0.2	
Bus88	33.000												-	
Bus89	33.000										0.566	99.1	10.2	
Bus90	33.000										0.566	99.0	10.2	
Bus91	33.000				0.003	0.002					0.004	85.0	0.1	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus93	33.000										0.566	98.6	10.2	
Bus94	33.000		0.101	0.062	0.025	0.016					0.148	85.0	2.7	
Bus95	33.000										0.565	98.4	10.2	
Bus96	33.000										0.432	99.7	7.8	
Bus97	33.000										0.012	94.8	0.2	
Bus98	33.000				0.004	0.003					0.005	85.0	0.1	
Bus99	33.000				0.005	0.003					0.008	87.2	0.1	
Bus100	33.000				0.002	0.001					0.003	85.0	-	
Bus101	33.000										0.420	99.6	7.6	
Bus102	33.000				0.029	0.018					0.034	85.0	0.6	
Bus104	33.000										0.391	99.7	7.0	
Bus105	33.000										0.387	98.9	7.0	
Bus106	33.000				0.008	0.005					0.020	96.5	0.4	
Bus109	33.000				0.021	0.013					0.024	85.0	0.4	
Bus110	33.000										0.369	98.8	6.6	
Bus111	33.000				0.025	0.015					0.029	85.0	0.5	
Bus112	33.000										0.347	99.0	6.2	
Bus113	33.000										0.321	99.4	5.8	
Bus114	33.000				0.014	0.008					0.059	87.0	1.1	
Bus115	33.000				0.038	0.023					0.045	85.0	0.8	
Bus116	33.000										0.284	94.0	5.1	
Bus117	33.000										0.187	85.3	3.4	
Bus118	33.000		0.002	0.001	0.158	0.098					0.187	85.0	3.4	
Bus119	33.000												-	
Bus120	33.000				0.018	0.011					0.145	74.5	2.6	
Bus121	33.000										0.123	73.1	2.2	
Bus122	33.000				0.002	0.001					0.005	95.5	0.1	
Bus123	33.000				0.002	0.001					0.003	85.0	0.1	
Bus124	33.000										0.117	72.9	2.1	
Bus125	33.000				0.004	0.002					0.009	77.5	0.2	
Bus126	33.000		0.000	0.000	0.002	0.001					0.003	85.0	0.1	
Bus127	33.000										0.005	76.9	0.1	
Bus129	33.000										0.104	75.0	1.9	
Bus130	33.000		0.000	0.000	0.002	0.001					0.019	53.9	0.3	
Bus131	33.000										0.016	49.4	0.3	
Bus133	33.000				0.003	0.002					0.007	94.9	0.1	
Bus135	33.000				0.007	0.004					0.008	85.0	0.2	
Bus136	33.000										0.088	78.0	1.6	
Bus137	33.000										0.082	74.6	1.5	
Bus138	33.000		0.000	0.000	0.007	0.004					0.008	85.0	0.1	
Bus139	33.000										0.014	93.1	0.3	
Bus140	33.000				0.007	0.004					0.008	85.0	0.1	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus141	33.000				0.016	0.010					0.019	85.0	0.3	
Bus142	33.000										0.077	62.4	1.4	
Bus143	33.000										0.065	48.4	1.2	
Bus144	33.000		0.000	0.000	0.012	0.007					0.014	85.0	0.2	
Bus145	33.000										0.020	93.2	0.4	
Bus159	33.000										0.046	27.9	0.8	
Bus165	11.000										6.257	85.4	337.9	
Bus166	11.000										0.926	85.4	50.0	
Bus167	11.000		0.099	0.061	0.073	0.045					0.203	85.0	11.0	
Bus168	11.000				0.010	0.006					0.012	85.0	0.6	
Bus169	11.000										0.135	85.8	7.3	
Bus170	11.000				0.010	0.006					0.124	85.6	6.7	
Bus171	11.000				0.004	0.002					0.005	85.0	0.2	
Bus172	11.000										0.113	85.4	6.1	
Bus173	11.000				0.035	0.021					0.108	85.1	5.9	
Bus174	11.000		0.001	0.001	0.056	0.035					0.068	85.0	3.7	
Bus175	11.000		0.001	0.001	0.044	0.027					0.800	84.7	43.2	
Bus176	11.000		0.006	0.003	0.171	0.106					0.747	84.7	40.3	
Bus177	11.000		0.003	0.002	0.093	0.058					0.538	84.6	29.1	
Bus178	11.000		0.003	0.002	0.098	0.061					0.425	84.5	23.0	
Bus179	11.000		0.006	0.003	0.171	0.106					0.306	84.3	16.5	
Bus180	11.000		0.004	0.002	0.108	0.067					0.131	85.0	7.1	
Bus181	11.000		0.005	0.003	0.156	0.096					0.222	86.0	12.0	
Bus182	11.000		0.007	0.004	0.218	0.135					0.487	85.5	26.3	
Bus183	11.000		0.003	0.002	0.083	0.052					0.588	85.4	31.8	
Bus184	11.000										0.004	2.7	0.2	
Bus185	11.000										0.004	3.2	0.2	
Bus186	11.000				0.000	-					0.000	85.0	-	
Bus187	11.000										3.917	85.0	211.7	
Bus188	11.000		0.003	0.002	0.129	0.080					3.910	85.0	211.7	
Bus189	11.000										3.662	85.2	203.3	
Bus190	11.000		0.001	0.001	0.040	0.025					0.048	85.0	2.7	
Bus191	11.000				0.005	0.003					0.006	85.0	0.3	
Bus192	11.000										3.438	85.6	200.7	
Bus193	11.000		0.001	0.001	0.043	0.027					0.052	85.0	3.2	
Bus194	11.000										3.247	85.3	200.4	
Bus195	11.000		1.756	1.089	0.690	0.428					2.878	85.0	184.7	
Bus196	11.000										3.083	85.0	197.1	
Bus197	11.000		0.001	0.001	0.070	0.043					0.195	85.2	12.4	
Bus198	11.000		0.001	0.000	0.040	0.025					0.111	85.2	7.1	
Bus199	11.000				0.003	0.002					0.003	85.0	0.2	
Bus200	11.000										0.063	85.2	4.0	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					Percent
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Loading
Bus201	11.000				0.051	0.032					0.060	85.0	3.9	
Bus202	11.000										0.328	86.0	17.7	
Bus203	11.000										0.328	86.0	17.7	
Bus204	11.000		0.003	0.002	0.155	0.096					0.186	85.0	10.1	
Bus205	11.000				0.006	0.004					0.142	86.7	7.7	
Bus206	11.000				0.010	0.006					0.135	86.5	7.3	
Bus207	11.000				0.004	0.002					0.005	85.0	0.3	
Bus208	11.000										0.123	86.4	6.7	
Bus209	11.000				0.022	0.014					0.119	86.3	6.5	
Bus210	11.000				0.011	0.007					0.013	85.0	0.7	
Bus211	11.000										0.093	86.1	5.1	
Bus212	11.000				0.010	0.006					0.012	85.0	0.7	
Bus213	11.000				0.022	0.014					0.068	85.8	3.7	
Bus214	11.000				0.019	0.012					0.043	85.9	2.3	
Bus215	11.000				0.017	0.011					0.020	85.0	1.1	
Bus216	11.000										2.633	84.3	142.8	
Bus217	33.000										1.532	85.0	27.1	
Bus218	33.000										1.539	84.0	27.4	
Bus219	33.000										1.128	82.6	20.1	
Bus220	11.000										0.285	91.7	15.4	
Bus221	11.000										0.285	91.7	15.4	
Bus222	11.000				0.159	0.098					0.187	85.0	10.1	
Bus223	11.000												-	
Bus224	11.000										0.104	98.8	5.6	
Bus225	11.000										0.064	37.7	3.5	
Bus226	11.000				0.098	0.061					0.115	85.0	6.2	
Bus227	11.000				0.020	0.012					0.094	99.1	5.1	
Bus228	11.000										0.104	98.6	5.6	
Bus229	11.000				0.009	0.005					0.010	85.0	0.6	
Bus230	11.000										0.212	85.6	11.5	
Bus231	11.000										0.212	85.5	11.5	
Bus232	11.000				0.034	0.021					0.040	85.0	2.2	
Bus233	11.000				0.023	0.014					0.027	85.0	1.5	
Bus234	11.000										0.172	85.6	9.3	
Bus235	11.000				0.038	0.023					0.145	85.7	7.9	
Bus236	11.000				0.041	0.026					0.101	85.9	5.5	
Bus237	11.000				0.025	0.015					0.029	85.0	1.6	
Bus238	11.000										0.052	86.3	2.8	
Bus239	11.000				0.021	0.013					0.024	85.0	1.3	
Bus240	11.000				0.228	0.142					1.038	85.0	56.3	
Bus241	11.000				0.221	0.137					0.769	85.0	41.7	
Bus242	11.000				0.213	0.132					0.509	85.1	27.6	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus243	11.000				0.189	0.117					0.259	85.1	14.1	
Bus244	11.000				0.014	0.009					0.016	85.0	0.9	
Bus245	11.000				0.018	0.011					0.021	85.0	1.1	
Bus246	11.000										1.007	85.0	54.6	
Bus247	11.000				0.170	0.106					0.200	85.0	10.9	
Bus248	11.000										1.005	85.0	54.6	
Bus249	11.000				0.212	0.131					0.249	85.0	13.6	
Bus250	11.000										0.801	85.0	43.7	
Bus251	11.000				0.212	0.131					0.249	85.0	13.6	
Bus252	11.000										0.551	85.0	30.1	
Bus253	11.000										0.302	85.0	16.5	
Bus254	11.000				0.128	0.080					0.302	85.0	16.5	
Bus255	11.000				0.128	0.080					0.151	85.0	8.3	
Bus264	11.000				0.075	0.047					0.089	85.0	4.8	
Bus265	11.000				0.081	0.050					0.096	85.0	5.2	
Bus266	11.000				0.020	0.012					0.023	85.0	1.3	
Bus267	11.000										0.268	85.3	14.5	
Bus268	11.000										0.268	85.2	14.5	
Bus269	11.000										0.245	85.2	13.3	
Bus270	11.000										0.149	85.2	8.1	
Bus271	11.000				0.052	0.032					0.061	85.0	3.3	
Bus272	11.000										0.056	85.7	3.0	
Bus273	11.000				0.048	0.030					0.056	85.0	3.0	
Bus274	11.000													
Bus275	33.000				0.006	0.004					0.008	85.0	0.1	
Bus276	33.000				0.002	0.001					0.011	99.2	0.2	
Bus277	33.000				0.008	0.005					0.010	85.0	0.2	
Bus278	33.000				0.001	0.001					0.001	85.0	-	
Bus279	33.000				0.001	0.001					0.002	85.0	-	
Bus280	33.000				0.003	0.002					0.004	85.0	0.1	
Bus281	33.000				0.001	0.001					0.008	89.1	0.1	
Bus282	33.000										0.007	86.3	0.1	
Bus283	33.000				0.003	0.002					0.003	85.0	0.1	
Bus284	33.000										0.004	75.5	0.1	
Bus285	33.000				0.002	0.001					0.003	85.0	0.1	
Bus286	33.000				0.001	-					0.001	85.0	-	
Bus287	33.000										0.035	36.8	0.6	
Bus288	33.000				0.001	-					0.008	52.0	0.1	
Bus289	33.000										0.004	91.4	0.1	
Bus290	33.000										0.022	38.2	0.4	
Bus291	33.000				0.000	-					0.001	85.0	-	
Bus292	33.000				0.003	0.002					0.004	85.0	0.1	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus293	33.000				0.000	-					0.000	85.0	-	
Bus294	33.000										0.019	42.3	0.3	
Bus295	33.000				0.001	0.001					0.001	85.0	-	
Bus296	33.000				0.003	0.002					0.017	42.3	0.3	
Bus297	33.000				0.003	0.002					0.007	60.6	0.1	
Bus298	33.000				0.001	0.001					0.001	85.0	-	
Bus299	33.000				0.002	0.001					0.002	85.0	-	
Bus300	33.000										0.019	72.4	0.3	
Bus301	33.000				0.005	0.003					0.006	85.0	0.1	
Bus302	33.000										0.011	90.3	0.2	
Bus303	33.000				0.006	0.004					0.010	93.0	0.2	
Bus304	33.000				0.001	0.001					0.002	85.0	-	
Bus305	33.000				0.003	0.002					0.004	85.0	0.1	
Bus306	33.000				0.003	0.002					0.004	85.0	0.1	
Bus307	33.000				0.001	0.001					0.001	85.0	-	
Bus308	33.000				0.001	0.001					0.001	85.0	-	
Bus309	33.000				0.002	0.001					0.003	85.0	-	

* Indicates operating load of a bus exceeds the bus critical limit (100.0% of the Continuous Ampere rating).

\# Indicates operating load of a bus exceeds the bus marginal limit (95.0% of the Continuous Ampere rating).

Branch Loading Summary Report

CKT / Branch		Cable & Reactor			Transformer				
						Loading (input)		Loading (output)	
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	MVA	%	MVA	%
Cable1	Cable	274.79	36.72	13.36					
Cable2	Cable	301.98	43.22	14.31					
Cable3	Cable	229.86	50.01	21.75					
Cable4	Cable	301.98	40.32	13.35					
Cable5	Cable	301.98	29.08	9.63					
Cable6	Cable	301.98	22.96	7.60					
Cable7	Cable	301.98	16.52	5.47					
Cable8	Cable	301.98	5.29	1.75					
Cable9	Cable	301.98	1.80	0.60					
Cable10	Cable	338.03	11.52	3.41					
Cable11	Cable	301.98	12.01	3.98					
Cable12	Cable	301.98	26.30	8.71					
Cable13	Cable	301.98	31.78	10.52					
Cable14	Cable	338.03	0.22	0.07					
Cable15	Cable	338.03	211.69	62.62					
Cable16	Cable	338.03	17.72	5.24					
Cable17	Cable	274.79	27.10	9.86					
Cable18	Cable	338.03	15.38	4.55					
Cable19	Cable	338.03	3.45	1.02					
Cable20	Cable	338.03	56.30	16.65					
Cable21	Cable	338.03	41.72	12.34					
Cable22	Cable	338.03	27.64	8.18					
Cable23	Cable	338.03	14.07	4.16					
Cable24	Cable	338.03	0.89	0.26					
Cable25	Cable	338.03	54.60	16.15					
Cable26	Cable	338.03	16.51	4.88					
Cable27	Cable	338.03	8.25	2.44					
Cable30	Cable	338.03	14.53	4.30					
Cable31	Cable	338.03	3.02	0.89					
Cable32	Cable	338.03							
33/11kV I	Transformer				5.000	1.539	30.8	1.519	30.4
33/11kV II	Transformer				5.000	1.128	22.6	1.115	22.3
66/11KV I	Transformer				5.000	3.217	64.3	3.127	62.5

CKT / Branch		Cable & Reactor			Transformer				
						Loading (input)		Loading (output)	
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	MVA	%	MVA	%
66/11KV II	Transformer				5.000	3.217	64.3	3.127	62.5
66/33kV II	Transformer				8.000	2.208	27.6	2.184	27.3
66/33/11kV	3W XFMR p				5.000	1.409	28.2		
	3W XFMR s				2.500	1.393	55.7		
	3W XFMR t				2.500	0.000	0.0		

* Indicates a branch with operating load exceeding the branch capability.

Branch Losses Summary Report

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
66/11KV I	2.685	1.773	-2.673	-1.624	12.4	148.6	100.0	97.2	2.80
66/11KV II	2.685	1.773	-2.673	-1.624	12.4	148.6	100.0	97.2	2.80
66/33kV II	2.013	0.906	-2.009	-0.856	3.9	50.7	100.0	98.9	1.08
Cable1	1.991	0.588	-1.991	-0.588	0.4	0.0	98.9	98.9	0.02
Cable17	1.303	0.806	-1.303	-0.806	0.3	0.0	98.9	98.9	0.02
Line1	1.991	0.588	-1.977	-0.606	14.1	-18.2	98.9	98.1	0.81
Line2	0.831	0.003	-0.831	-0.005	0.2	-2.1	98.1	98.1	0.02
Line3	1.146	0.603	-1.145	-0.605	0.4	-2.0	98.1	98.0	0.04
Line4	0.097	0.053	-0.097	-0.055	0.0	-1.5	98.0	98.0	0.00
Line7	1.048	0.552	-1.048	-0.555	0.6	-3.1	98.0	98.0	0.06
Line5	0.079	0.044	-0.079	-0.047	0.0	-3.0	98.0	98.0	0.00
Line6	0.021	0.011	-0.021	-0.013	0.0	-2.3	98.0	98.0	0.00
Line8	0.116	-0.081	-0.116	0.073	0.0	-8.3	98.0	98.0	0.00
Line201	0.932	0.636	-0.932	-0.636	0.0	-0.2	98.0	98.0	0.00
Line9	0.115	-0.074	-0.115	0.070	0.0	-3.8	98.0	98.0	0.00
Line10	0.070	-0.078	-0.070	0.078	0.0	-0.6	98.0	98.0	0.00
Line11	0.044	0.008	-0.044	-0.008	0.0	-0.1	98.0	98.0	0.00
Line12	0.029	-0.001	-0.029	-0.001	0.0	-2.4	98.0	98.0	0.00
Line13	0.022	-0.003	-0.022	-0.006	0.0	-9.0	98.0	98.0	0.00
Line14	0.016	0.002	-0.016	-0.010	0.0	-7.1	98.0	98.0	0.00
Line15	0.007	0.003	-0.007	-0.004	0.0	-0.6	98.0	98.0	0.00
Line16	0.002	-0.004	-0.002	-0.001	0.0	-5.2	98.0	98.0	0.00
Line17	0.068	-0.074	-0.068	0.066	0.0	-7.4	98.0	98.0	0.01
Line18	-0.005	-0.003	0.005	0.001	0.0	-2.5	98.0	98.0	0.00
Line19	0.063	-0.067	-0.063	0.062	0.0	-5.1	98.0	98.0	0.00
Line20	0.042	-0.075	-0.042	0.026	0.0	-49.2	98.0	98.0	0.00
Line21	-0.002	-0.001	0.002	-0.004	0.0	-5.0	98.0	98.0	0.00
Line22	0.040	-0.022	-0.040	0.022	0.0	-0.3	98.0	98.0	0.00
Line23	0.035	-0.025	-0.035	0.023	0.0	-1.7	98.0	98.0	0.00
Line24	0.017	-0.012	-0.017	0.011	0.0	-0.6	98.0	98.0	0.00
Line30	0.019	-0.011	-0.019	0.010	0.0	-1.3	98.0	98.0	0.00
Line25	0.013	-0.013	-0.013	0.013	0.0	-0.4	98.0	98.0	0.00
Line27	-0.009	0.008	0.009	-0.010	0.0	-2.2	98.0	98.0	0.00
Line28	0.005	-0.010	-0.005	0.004	0.0	-6.1	98.0	98.0	0.00

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line29	0.002	-0.006	-0.002	-0.002	0.0	-7.1	98.0	98.0	0.00
Line31	0.014	-0.013	-0.014	0.009	0.0	-4.5	98.0	98.0	0.00
Line32	0.010	-0.011	-0.010	0.005	0.0	-5.8	98.0	98.0	0.00
Line36	0.831	0.005	-0.830	-0.011	0.5	-5.5	98.1	98.0	0.05
Line37	-0.009	-0.006	0.009	0.002	0.0	-4.1	98.0	98.0	0.00
Line38	0.821	0.009	-0.820	-0.018	0.7	-8.5	98.0	97.9	0.08
Line39	0.810	0.011	-0.810	-0.013	0.1	-1.4	97.9	97.9	0.01
Line40	0.023	0.003	-0.023	-0.009	0.0	-5.9	97.9	97.9	0.00
Line42	0.787	0.010	-0.787	-0.014	0.3	-4.0	97.9	97.9	0.04
Line41	0.009	0.000	-0.009	-0.005	0.0	-5.3	97.9	97.9	0.00
Line43	0.080	0.015	-0.080	-0.024	0.0	-9.1	97.9	97.9	0.02
Line55	0.708	-0.001	-0.707	-0.002	0.2	-3.4	97.9	97.9	0.03
Line44	-0.006	-0.004	0.006	-0.001	0.0	-4.1	97.9	97.9	0.00
Line45	0.074	0.025	-0.074	-0.031	0.0	-6.2	97.9	97.9	0.01
Line46	0.072	0.030	-0.072	-0.032	0.0	-1.9	97.9	97.9	0.00
Line47	0.068	0.032	-0.068	-0.032	0.0	-0.8	97.9	97.8	0.00
Line48	0.003	0.000	-0.003	-0.002	0.0	-2.0	97.9	97.9	0.00
Line49	0.060	0.027	-0.060	-0.029	0.0	-1.5	97.8	97.8	0.00
Line50	0.041	0.017	-0.041	-0.018	0.0	-1.3	97.8	97.8	0.00
Line51	0.033	0.015	-0.033	-0.018	0.0	-3.2	97.8	97.8	0.00
Line52	0.008	0.003	-0.008	-0.005	0.0	-1.9	97.8	97.8	0.00
Line53	0.022	0.011	-0.022	-0.013	0.0	-1.4	97.8	97.8	0.00
Line54	0.009	0.005	-0.009	-0.006	0.0	-0.7	97.8	97.8	0.00
Line56	-0.008	-0.005	0.008	-0.002	0.0	-6.5	97.9	97.9	0.00
Line57	0.700	0.004	-0.700	-0.004	0.0	-0.3	97.9	97.9	0.00
Line58	0.676	-0.011	-0.676	0.000	0.6	-10.4	97.9	97.8	0.08
Line59	-0.006	-0.004	0.006	0.000	0.0	-3.2	97.8	97.8	0.00
Line60	0.670	-0.001	-0.670	0.000	0.0	-0.3	97.8	97.8	0.00
Line61	0.013	-0.001	-0.013	-0.001	0.0	-2.2	97.8	97.8	0.00
Line63	0.657	0.001	-0.657	-0.007	0.3	-5.5	97.8	97.7	0.04
Line62	0.005	-0.004	-0.005	-0.003	0.0	-7.1	97.8	97.8	0.00
Line64	0.009	-0.002	-0.009	-0.005	0.0	-7.6	97.7	97.7	0.00
Line65	0.648	0.009	-0.648	-0.012	0.2	-3.3	97.7	97.7	0.02
Line66	-0.018	-0.011	0.018	0.009	0.0	-2.2	97.7	97.7	0.00
Line67	0.629	0.003	-0.629	-0.010	0.3	-6.8	97.7	97.7	0.05
Line68	0.018	-0.010	-0.018	0.007	0.0	-3.2	97.7	97.7	0.00
Line72	0.611	0.020	-0.610	-0.023	0.1	-3.2	97.7	97.6	0.02

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line69	-0.005	-0.003	0.005	-0.001	0.0	-3.6	97.7	97.7	0.00
Line70	0.014	-0.006	-0.014	0.003	0.0	-2.9	97.7	97.7	0.00
Line71	-0.003	-0.002	0.003	-0.010	0.0	-12.0	97.7	97.7	0.00
Line73	0.599	0.016	-0.599	-0.022	0.2	-5.6	97.6	97.6	0.04
Line74	0.592	0.017	-0.592	-0.020	0.1	-3.0	97.6	97.6	0.02
Line75	0.587	0.018	-0.587	-0.024	0.2	-5.8	97.6	97.5	0.04
Line76	0.008	-0.006	-0.008	0.005	0.0	-1.2	97.5	97.5	0.00
Line81	0.579	0.030	-0.579	-0.038	0.3	-8.0	97.5	97.5	0.06
Line78	0.001	-0.009	-0.001	-0.001	0.0	-10.1	97.5	97.5	0.00
Line82	-0.002	-0.001	0.002	0.000	0.0	-1.2	97.5	97.5	0.00
Line83	0.577	0.038	-0.577	-0.044	0.2	-5.8	97.5	97.4	0.04
Line85	0.572	0.041	-0.572	-0.050	0.4	-9.2	97.4	97.4	0.06
Line86	0.011	-0.007	-0.011	0.007	0.0	-0.1	97.4	97.4	0.00
Line88	0.561	0.057	-0.561	-0.073	0.3	-15.9	97.4	97.3	0.07
Line87	0.007	-0.010	-0.007	0.008	0.0	-1.5	97.4	97.4	0.00
Line89	0.002	-0.011	-0.002	-0.001	0.0	-12.3	97.4	97.4	0.00
Line90	0.000	0.000	0.000	-0.005	0.0	-4.6	97.3	97.3	0.00
Line91	0.561	0.078	-0.561	-0.078	0.0	-0.5	97.3	97.3	0.00
Line92	0.003	0.002	-0.003	-0.002	0.0	-0.1	97.3	97.3	0.00
Line93	0.558	0.076	-0.557	-0.080	0.1	-3.9	97.3	97.3	0.02
Line77	0.556	0.096	-0.556	-0.101	0.1	-5.5	97.3	97.3	0.02
Line94	0.001	-0.016	-0.001	-0.001	0.0	-16.4	97.3	97.3	0.00
Line79	-0.126	-0.078	0.126	0.076	0.0	-2.6	97.3	97.3	0.01
Line80	0.430	0.026	-0.430	-0.027	0.0	-0.9	97.3	97.3	0.00
Line84	0.011	-0.007	-0.011	0.002	0.0	-5.3	97.3	97.3	0.00
Line98	0.419	0.034	-0.419	-0.035	0.0	-1.7	97.3	97.3	0.00
Line95	0.004	0.002	-0.004	-0.003	0.0	-0.5	97.3	97.3	0.00
Line96	0.007	-0.004	-0.007	0.001	0.0	-2.9	97.3	97.3	0.00
Line97	0.002	-0.004	-0.002	-0.001	0.0	-5.3	97.3	97.3	0.00
Line99	0.029	0.018	-0.029	-0.018	0.0	-0.2	97.3	97.3	0.00
Line100	0.390	0.018	-0.390	-0.029	0.1	-11.7	97.3	97.2	0.03
Line101	0.006	0.004	-0.006	-0.004	0.0	-0.4	97.2	97.2	0.00
Line102	0.383	0.026	-0.383	-0.056	0.3	-30.4	97.2	97.1	0.08
Line103	0.019	0.001	-0.019	-0.002	0.0	-1.1	97.1	97.1	0.00
Line108	0.364	0.055	-0.364	-0.057	0.0	-2.2	97.1	97.1	0.01
Line104	0.011	-0.003	-0.011	0.000	0.0	-3.2	97.1	97.1	0.00
Line107	-0.021	-0.013	0.021	0.011	0.0	-1.6	97.1	97.1	0.00

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line109	0.343	0.046	-0.343	-0.048	0.0	-1.6	97.1	97.1	0.00
Line110	-0.025	-0.015	0.025	0.015	0.0	-0.2	97.1	97.1	0.00
Line111	0.319	0.033	-0.319	-0.035	0.0	-2.4	97.1	97.1	0.01
Line112	0.052	0.028	-0.052	-0.029	0.0	-1.1	97.1	97.1	0.00
Line114	0.267	0.007	-0.267	-0.010	0.0	-3.1	97.1	97.1	0.01
Line113	0.038	0.021	-0.038	-0.023	0.0	-2.8	97.1	97.1	0.00
Line116	0.159	0.097	-0.159	-0.097	0.0	-0.4	97.1	97.1	0.00
Line119	0.108	-0.087	-0.108	0.086	0.0	-1.4	97.1	97.1	0.00
Line117	0.159	0.097	-0.159	-0.099	0.0	-1.3	97.1	97.1	0.01
Line118	0.000	0.000	0.000	0.000	0.0	-0.1	97.1	97.1	0.00
Line120	0.090	-0.096	-0.090	0.084	0.0	-12.2	97.1	97.1	0.00
Line121	0.005	-0.003	-0.005	-0.001	0.0	-3.7	97.1	97.1	0.00
Line124	0.085	-0.082	-0.085	0.080	0.0	-1.5	97.1	97.1	0.00
Line122	0.002	0.000	-0.002	-0.001	0.0	-1.9	97.1	97.1	0.00
Line123	0.007	-0.004	-0.007	0.004	0.0	-0.2	97.1	97.1	0.00
Line128	0.078	-0.076	-0.078	0.069	0.0	-7.3	97.1	97.1	0.00
Line125	0.004	-0.006	-0.004	0.003	0.0	-2.8	97.1	97.1	0.00
Line126	-0.002	-0.001	0.002	-0.002	0.0	-3.6	97.1	97.1	0.00
Line127	0.001	-0.001	-0.001	-0.001	0.0	-1.6	97.1	97.1	0.00
Line129	0.010	-0.016	-0.010	0.014	0.0	-1.7	97.1	97.1	0.00
Line134	0.068	-0.053	-0.068	0.052	0.0	-1.4	97.1	97.1	0.00
Line130	0.008	-0.016	-0.008	0.014	0.0	-2.1	97.1	97.1	0.00
Line131	0.006	-0.012	-0.006	-0.002	0.0	-14.1	97.1	97.1	0.00
Line132	0.001	-0.001	-0.001	-0.001	0.0	-2.4	97.1	97.1	0.00
Line133	0.003	0.000	-0.003	-0.002	0.0	-1.8	97.1	97.1	0.00
Line135	-0.007	-0.004	0.007	0.003	0.0	-1.4	97.1	97.1	0.00
Line136	0.061	-0.055	-0.061	0.051	0.0	-3.5	97.1	97.1	0.00
Line105	0.013	0.003	-0.013	-0.005	0.0	-2.1	97.1	97.1	0.00
Line138	0.048	-0.054	-0.048	0.050	0.0	-4.0	97.1	97.1	0.00
Line115	-0.007	-0.004	0.007	0.002	0.0	-2.6	97.1	97.1	0.00
Line137	0.007	0.004	-0.007	-0.004	0.0	-0.5	97.1	97.1	0.00
Line139	-0.016	-0.010	0.016	0.009	0.0	-0.6	97.1	97.1	0.00
Line140	0.032	-0.060	-0.032	0.057	0.0	-2.6	97.1	97.1	0.00
Line141	0.019	-0.002	-0.019	0.001	0.0	-1.1	97.1	97.1	0.00
Line158	0.013	-0.055	-0.013	0.044	0.0	-11.1	97.1	97.1	0.00
Line142	-0.012	-0.007	0.012	0.006	0.0	-1.0	97.1	97.1	0.00
Line143	0.007	-0.007	-0.007	0.003	0.0	-4.5	97.1	97.1	0.00

	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
Branch ID	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line149	0.013	-0.044	-0.013	0.032	0.0	-11.7	97.1	97.1	0.00
Cable2	0.678	0.425	-0.678	-0.425	0.0	0.0	97.2	97.2	0.01
Cable3	0.791	0.482	-0.791	-0.481	0.1	0.0	97.2	97.2	0.01
Cable14	0.000	-0.004	0.000	0.004	0.0	0.0	97.2	97.2	0.00
Cable15	3.332	2.065	-3.330	-2.063	2.5	1.8	97.2	97.1	0.08
Cable16	0.282	0.167	-0.282	-0.167	0.0	0.0	97.2	97.2	0.00
Cable18	0.261	0.113	-0.261	-0.113	0.0	0.0	97.2	97.2	0.00
Cable13	0.502	0.306	-0.502	-0.306	0.2	0.1	97.2	97.2	0.04
Line162	0.172	0.107	-0.172	-0.107	0.1	-0.3	97.2	97.1	0.09
Line163	0.116	0.069	-0.116	-0.070	0.2	-0.9	97.2	97.0	0.17
Line164	-0.010	-0.006	0.010	0.006	0.0	-0.5	97.0	97.0	0.01
Line165	0.106	0.064	-0.106	-0.064	0.0	-0.1	97.0	97.0	0.02
Line166	0.096	0.058	-0.096	-0.059	0.2	-0.6	97.0	96.9	0.15
Line167	-0.004	-0.002	0.004	0.002	0.0	-0.1	96.9	96.9	0.00
Line168	0.092	0.056	-0.092	-0.057	0.2	-0.6	96.9	96.7	0.16
Line169	0.058	0.036	-0.058	-0.036	0.0	-0.2	96.7	96.7	0.03
Cable4	0.632	0.397	-0.632	-0.397	0.1	0.0	97.2	97.2	0.01
Cable5	0.455	0.287	-0.455	-0.287	0.0	0.0	97.2	97.2	0.00
Cable6	0.359	0.228	-0.359	-0.227	0.1	0.1	97.2	97.1	0.04
Cable7	0.258	0.165	-0.258	-0.165	0.1	0.0	97.1	97.1	0.02
Cable8	0.081	0.055	-0.081	-0.055	0.0	0.0	97.1	97.1	0.00
Cable9	-0.030	-0.014	0.030	0.014	0.0	0.0	97.1	97.1	0.00
Cable11	-0.191	-0.113	0.191	0.113	0.0	0.0	97.1	97.1	0.01
Cable12	-0.416	-0.253	0.416	0.253	0.1	0.1	97.1	97.2	0.03
Line170	0.000	-0.004	0.000	0.004	0.0	-0.6	97.2	97.2	0.00
Line171	0.000	-0.004	0.000	0.000	0.0	-3.6	97.2	97.2	0.00
Line172	3.330	2.063	-3.324	-2.059	5.7	4.8	97.1	96.9	0.18
Line174	3.192	1.977	-3.121	-1.917	71.3	60.2	96.9	94.6	2.39
Line175	0.041	0.025	-0.041	-0.025	0.0	0.0	94.6	94.6	0.00
Line176	3.080	1.891	-2.944	-1.776	136.0	114.9	94.6	89.9	4.61
Line177	-0.005	-0.003	0.005	0.002	0.0	-0.6	89.9	89.9	0.01
Line178	2.939	1.774	-2.769	-1.697	170.6	77.5	89.9	85.1	4.88
Line179	-0.045	-0.028	0.045	0.028	0.0	-0.1	85.1	85.1	0.01
Line180	2.724	1.669	-2.622	-1.622	102.5	46.6	85.1	82.1	2.98
Line181	-2.447	-1.516	2.456	1.520	9.3	4.2	81.8	82.1	0.29
Line182	0.166	0.102	-0.166	-0.102	0.1	0.0	82.1	82.0	0.04
Line183	0.095	0.058	-0.095	-0.058	0.1	-0.1	82.0	82.0	0.05

	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
Branch ID	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line184	0.054	0.033	-0.054	-0.033	0.0	-0.3	82.0	81.9	0.06
Line185	-0.003	-0.002	0.003	0.001	0.0	-0.1	81.9	81.9	0.00
Line186	0.051	0.032	-0.051	-0.032	0.0	-0.2	81.9	81.9	0.02
Line187	0.282	0.167	-0.282	-0.167	0.3	0.0	97.2	97.1	0.10
Line188	0.158	0.098	-0.158	-0.098	0.0	0.0	97.1	97.1	0.01
Line189	0.124	0.069	-0.123	-0.071	0.4	-1.7	97.1	96.8	0.33
Line190	0.117	0.067	-0.117	-0.068	0.2	-0.8	96.8	96.6	0.15
Line191	0.107	0.062	-0.107	-0.062	0.1	-0.6	96.6	96.5	0.11
Line192	-0.004	-0.002	0.004	0.002	0.0	-0.1	96.5	96.5	0.00
Line193	0.103	0.060	-0.103	-0.060	0.1	-0.4	96.5	96.4	0.10
Line194	0.080	0.046	-0.080	-0.047	0.2	-1.0	96.4	96.2	0.22
Line195	-0.011	-0.007	0.011	0.007	0.0	0.0	96.2	96.2	0.00
Line196	0.010	0.006	-0.010	-0.006	0.0	-0.7	96.2	96.2	0.02
Line197	0.058	0.035	-0.058	-0.035	0.0	-0.3	96.2	96.2	0.04
Line198	0.037	0.021	-0.037	-0.022	0.0	-0.4	96.2	96.1	0.04
Line199	0.017	0.010	-0.017	-0.011	0.0	-0.9	96.1	96.1	0.04
Cable10	0.182	0.110	-0.182	-0.110	0.0	0.0	96.8	96.8	0.00
Cable19	0.024	0.059	-0.024	-0.059	0.0	0.0	96.8	96.8	0.00
Cable20	0.883	0.546	-0.882	-0.546	0.3	0.2	96.8	96.8	0.04
Cable25	0.856	0.530	-0.856	-0.530	0.0	0.0	96.8	96.8	0.01
Cable30	0.229	0.140	-0.229	-0.140	0.0	0.0	96.8	96.8	0.00
Cable31	0.048	0.029	-0.048	-0.029	0.0	0.0	96.8	96.8	0.00
Cable32	0.000	0.000	0.000	0.000			96.8	96.8	
33/11kV I	-1.291	-0.800	1.294	0.835	2.9	34.5	96.8	98.1	1.33
33/11kV II	-0.930	-0.614	0.932	0.636	1.8	22.0	96.8	98.0	1.20
Line200	1.303	0.806	-1.294	-0.835	9.3	-28.4	98.9	98.1	0.78
Line202	0.261	0.113	-0.261	-0.113	0.2	-0.1	97.2	97.1	0.10
Line203	0.159	0.098	-0.159	-0.098	0.0	0.0	97.1	97.1	0.00
Line204	0.102	0.015	-0.102	-0.015	0.0	-0.2	97.1	97.1	0.02
Line205	0.000	0.000	0.000	-0.001	0.0	-0.8	97.1	97.1	0.00
Line206	0.102	0.016	-0.102	-0.017	0.3	-1.3	97.1	96.8	0.31
Line207	0.024	0.059	-0.024	-0.060	0.0	-1.0	96.8	96.7	0.07
Line208	-0.074	-0.001	0.074	0.000	0.0	-0.2	96.7	96.7	0.02
Line209	-0.093	-0.012	0.093	0.012	0.0	-0.4	96.7	96.8	0.04
Line210	0.009	0.005	-0.009	-0.005	0.0	-0.2	96.8	96.8	0.00
Line173	0.182	0.110	-0.182	-0.110	0.1	-0.1	96.8	96.8	0.04
Line211	0.148	0.089	-0.147	-0.089	0.0	-0.1	96.8	96.7	0.02

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line212	0.034	0.021	-0.034	-0.021	0.0	-0.1	96.8	96.7	0.01
Line213	-0.023	-0.014	0.023	0.014	0.0	-0.1	96.7	96.7	0.00
Line214	0.124	0.075	-0.124	-0.075	0.0	0.0	96.7	96.7	0.01
Line215	0.087	0.051	-0.087	-0.052	0.0	-0.1	96.7	96.7	0.02
Line216	0.045	0.026	-0.045	-0.026	0.0	-0.6	96.7	96.7	0.04
Line217	-0.025	-0.015	0.025	0.014	0.0	-1.5	96.6	96.7	0.05
Line218	0.021	0.013	-0.021	-0.013	0.0	-0.1	96.7	96.7	0.00
Cable21	0.654	0.405	-0.654	-0.405	0.1	0.0	96.8	96.7	0.01
Cable22	0.433	0.268	-0.433	-0.268	0.1	0.1	96.7	96.7	0.02
Cable23	0.221	0.136	-0.221	-0.136	0.0	0.0	96.7	96.7	0.01
Cable24	0.014	0.009	-0.014	-0.009	0.0	0.0	96.7	96.7	0.00
Line219	0.018	0.010	-0.018	-0.011	0.0	-0.7	96.7	96.7	0.02
Line220	0.856	0.530	-0.854	-0.529	1.7	1.3	96.8	96.6	0.21
Line221	-0.170	-0.106	0.170	0.105	0.1	-0.2	96.5	96.6	0.06
Line222	0.684	0.424	-0.681	-0.422	2.9	2.0	96.6	96.1	0.45
Line223	-0.212	-0.131	0.212	0.131	0.0	0.0	96.1	96.1	0.01
Line224	0.469	0.290	-0.469	-0.290	0.3	0.2	96.1	96.1	0.07
Line225	-0.212	-0.131	0.212	0.131	0.0	0.0	96.1	96.1	0.00
Line226	0.257	0.159	-0.257	-0.159	0.1	0.0	96.1	96.0	0.04
Cable26	0.257	0.159	-0.257	-0.159	0.0	0.0	96.0	96.0	0.00
Cable27	0.128	0.080	-0.128	-0.080	0.0	0.0	96.0	96.0	0.00
Line234	-0.075	-0.047	0.075	0.046	0.0	-0.2	96.6	96.6	0.03
Line235	-0.081	-0.050	0.081	0.050	0.0	-0.2	96.6	96.7	0.03
Line236	-0.020	-0.012	0.020	0.012	0.0	-0.1	96.7	96.7	0.00
Line237	0.229	0.140	-0.228	-0.140	0.1	-0.1	96.8	96.7	0.05
Line238	0.209	0.128	-0.208	-0.128	0.1	-0.1	96.7	96.7	0.07
Line239	0.127	0.078	-0.127	-0.078	0.1	-0.2	96.7	96.6	0.05
Line240	0.052	0.032	-0.052	-0.032	0.0	-0.4	96.6	96.6	0.03
Line241	0.048	0.029	-0.048	-0.030	0.0	-0.9	96.8	96.7	0.06
Line106	0.008	-0.001	-0.008	-0.005	0.0	-6.3	97.1	97.1	0.00
Line144	0.006	-0.004	-0.006	0.002	0.0	-1.3	97.1	97.1	0.00
Line145	0.003	0.001	-0.003	-0.002	0.0	-0.7	97.1	97.1	0.00
Line146	0.003	-0.004	-0.003	0.002	0.0	-1.9	97.1	97.1	0.00
Line147	0.002	0.001	-0.002	-0.001	0.0	-0.3	97.1	97.1	0.00
Line148	0.001	-0.003	-0.001	0.000	0.0	-3.3	97.1	97.1	0.00
Line150	0.004	-0.009	-0.004	0.007	0.0	-2.2	97.1	97.1	0.00
Line154	0.008	-0.023	-0.008	0.020	0.0	-3.0	97.1	97.1	0.00

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line151	0.003	-0.007	-0.003	0.001	0.0	-6.5	97.1	97.1	0.00
Line152	0.003	0.001	-0.003	-0.002	0.0	-0.8	97.1	97.1	0.00
Line153	0.000	-0.002	0.000	0.000	0.0	-1.9	97.1	97.1	0.00
Line155	0.008	-0.020	-0.008	0.017	0.0	-3.0	97.1	97.1	0.00
Line156	0.000	0.000	0.000	0.000	0.0	-0.4	97.1	97.1	0.00
Line157	0.001	0.000	-0.001	-0.001	0.0	-0.8	97.1	97.1	0.00
Line159	0.007	-0.017	-0.007	0.014	0.0	-3.4	97.1	97.1	0.00
Line160	0.004	-0.015	-0.004	0.004	0.0	-11.7	97.1	97.1	0.00
Line161	0.001	-0.006	-0.001	-0.001	0.0	-6.4	97.1	97.1	0.00
Line26	0.005	-0.003	-0.005	-0.003	0.0	-5.7	98.0	98.0	0.00
Line33	0.001	0.000	-0.001	-0.001	0.0	-0.7	98.0	98.0	0.00
Line34	0.009	-0.005	-0.009	-0.003	0.0	-7.8	98.0	98.0	0.00
Line35	0.003	-0.001	-0.003	-0.002	0.0	-2.7	98.0	98.0	0.00
66/33/11kV	1.288	0.571	-1.285	-0.539	2.7	32.3	100.0	98.9	1.08
66/33/11kV	0.000	0.000	0.000	0.000			100.0	100.1	0.12
					574.9	5.2			

Alert Summary Report

	% Alert Settings	
	Critical	**Marginal**
Loading		
Bus	100.0	95.0
Cable	100.0	95.0
Reactor	100.0	95.0
Line	100.0	95.0
Transformer	100.0	95.0
Panel	100.0	95.0
Protective Device	100.0	95.0
Generator	100.0	95.0
Inverter/Charger	100.0	95.0
Bus Voltage		
OverVoltage	110.0	105.0
UnderVoltage	90.0	95.0
Generator Excitation		
OverExcited (Q Max.)	100.0	95.0
UnderExcited (Q Min.)	100.0	

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus191	Bus	Under Voltage	11.000	kV	9.893	89.9	3-Phase
Bus192	Bus	Under Voltage	11.000	kV	9.89	89.9	3-Phase
Bus193	Bus	Under Voltage	11.000	kV	9.36	85.1	3-Phase
Bus194	Bus	Under Voltage	11.000	kV	9.36	85.1	3-Phase
Bus195	Bus	Under Voltage	11.000	kV	9.00	81.8	3-Phase
Bus196	Bus	Under Voltage	11.000	kV	9.03	82.1	3-Phase
Bus197	Bus	Under Voltage	11.000	kV	9.02	82.0	3-Phase
Bus198	Bus	Under Voltage	11.000	kV	9.02	82.0	3-Phase
Bus199	Bus	Under Voltage	11.000	kV	9.01	81.9	3-Phase
Bus200	Bus	Under Voltage	11.000	kV	9.01	81.9	3-Phase
Bus201	Bus	Under Voltage	11.000	kV	9.01	81.9	3-Phase

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus189	Bus	Under Voltage	11.000	kV	10.401	94.6	3-Phase

Marginal Report

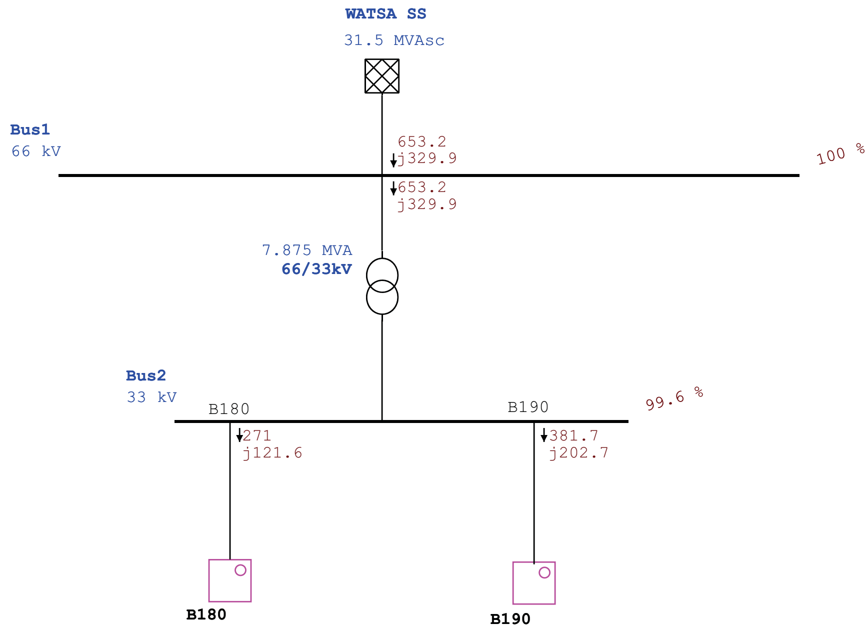
Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus190	Bus	Under Voltage	11.000	kV	10.401	94.6	3-Phase

SUMMARY OF TOTAL GENERATION , LOADING & DEMAND

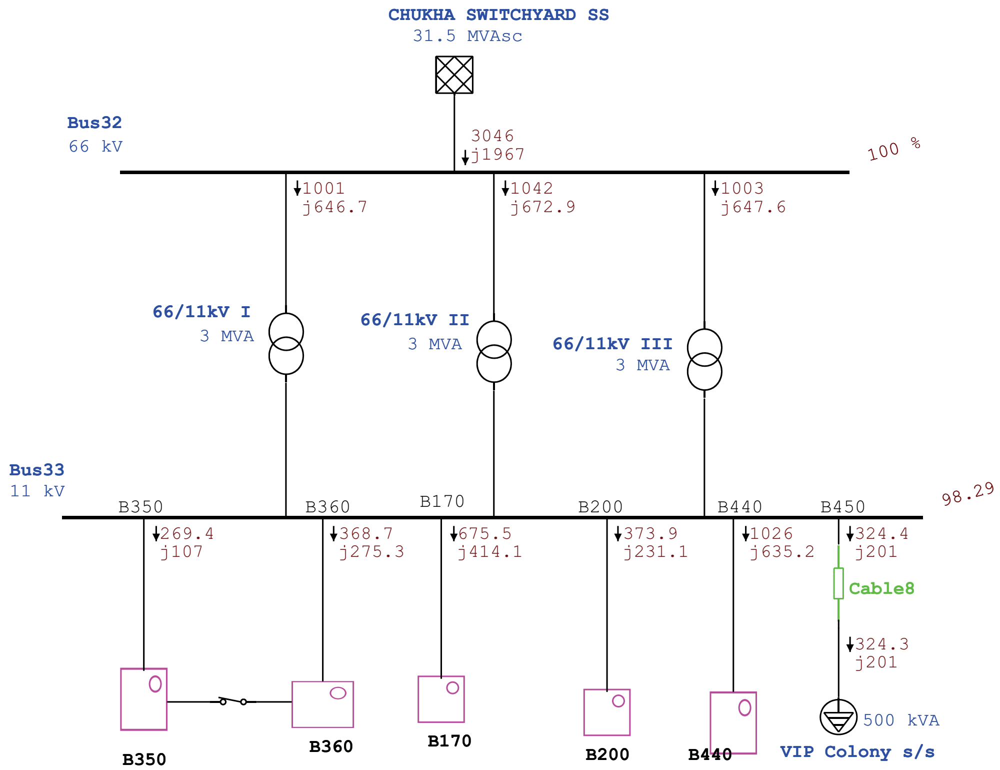
	MW	Mvar	MVA	% PF
Source (Swing Buses):	8.671	5.023	10.021	86.53 Lagging
Source (Non-Swing Buses):	0.000	0.000	0.000	
Total Demand:	8.671	5.023	10.021	86.53 Lagging
Total Motor Load:	2.007	1.244	2.361	85.00 Lagging
Total Static Load:	6.089	3.774	7.164	85.00 Lagging
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	0.575	0.005		
System Mismatch:	0.000	0.000		

Number of Iterations: 4

One-Line Diagram - OLV1 (Load Flow Analysis)



Tsimasham substation



Bus Loading Summary Report

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					Percent
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Loading
Bus1	66.000										0.732	89.3	6.4	
Bus2	33.000										0.729	89.6	12.8	
Bus3	33.000										0.297	91.2	5.2	
Bus4	33.000										0.297	91.2	5.2	
Bus5	33.000				0.018	0.011					0.061	92.8	1.1	
Bus6	33.000				0.023	0.014					0.042	90.4	0.7	
Bus7	33.000				0.015	0.010					0.018	85.0	0.3	
Bus8	33.000				0.016	0.010					0.239	90.0	4.2	
Bus9	33.000				0.015	0.009					0.221	89.7	3.9	
Bus10	33.000										0.205	89.4	3.6	
Bus11	33.000				0.046	0.028					0.054	85.0	0.9	
Bus12	33.000				0.014	0.009					0.017	85.0	0.3	
Bus13	33.000										0.153	90.2	2.7	
Bus14	33.000				0.041	0.025					0.137	90.2	2.4	
Bus15	33.000										0.091	91.3	1.6	
Bus16	33.000										0.062	91.7	1.1	
Bus17	33.000				0.017	0.010					0.020	85.0	0.3	
Bus18	33.000				0.040	0.025					0.047	85.0	0.8	
Bus19	33.000				0.025	0.016					0.030	85.0	0.5	
Bus20	33.000										0.432	88.3	7.6	
Bus21	33.000				0.034	0.021					0.437	87.4	7.7	
Bus22	33.000				0.093	0.058					0.109	85.0	1.9	
Bus23	33.000				0.194	0.120					0.228	85.0	4.0	
Bus24	33.000										0.291	87.7	5.1	
Bus25	33.000				0.010	0.006					0.012	85.0	0.2	
Bus26	33.000										0.065	94.3	1.1	
Bus27	33.000				0.015	0.009					0.057	90.6	1.0	
Bus29	33.000				0.003	0.002					0.041	89.6	0.7	
Bus30	33.000				0.026	0.016					0.037	89.6	0.7	
Bus31	33.000				0.007	0.005					0.009	85.0	0.2	
Bus32	66.000										3.626	84.0	31.7	
Bus33	11.000										3.564	85.2	190.3	
Bus34	11.000										0.290	92.9	15.5	
Bus35	11.000				0.027	0.017					0.289	92.8	15.5	
Bus36	11.000										0.706	85.5	38.1	
Bus37	11.000				0.030	0.019					0.706	85.5	38.1	
Bus38	11.000										0.669	85.5	36.2	
Bus39	11.000				0.106	0.066					0.124	85.0	6.7	
Bus40	11.000				0.228	0.142					0.541	85.6	29.5	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					Percent
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Loading
Bus41	11.000										0.272	86.1	14.9	
Bus42	11.000				0.142	0.088					0.167	85.0	9.1	
Bus43	11.000				0.065	0.040					0.106	87.5	5.8	
Bus44	11.000				0.008	0.005					0.010	85.0	0.5	
Bus45	11.000										0.031	90.8	1.7	
Bus46	11.000				0.001	0.001					0.021	92.6	1.2	
Bus47	11.000										0.020	92.8	1.1	
Bus48	11.000				0.000	-					0.011	86.2	0.6	
Bus49	11.000				0.009	0.006					0.011	85.0	0.6	
Bus50	11.000				0.005	0.003					0.010	93.6	0.5	
Bus51	11.000				0.002	0.001					0.004	87.2	0.2	
Bus52	11.000				0.002	0.001					0.002	85.0	0.1	
Bus53	11.000										0.460	80.1	24.6	
Bus54	11.000										0.457	79.8	24.7	
Bus55	11.000										0.001	-	0.1	
Bus56	11.000												-	
Bus57	11.000										0.001	-	-	
Bus58	11.000												-	
Bus59	11.000												-	
Bus60	11.000										0.001	-	-	
Bus61	11.000													
Bus62	11.000										0.000	-	-	
Bus63	11.000												-	
Bus64	11.000										0.792	85.3	42.3	
Bus65	11.000										0.788	85.2	42.3	
Bus66	11.000				0.389	0.241					0.458	85.0	24.6	
Bus67	11.000				0.199	0.123					0.330	85.5	17.7	
Bus68	11.000				0.015	0.009					0.018	85.0	1.0	
Bus69	11.000										0.096	86.5	5.1	
Bus70	11.000				0.027	0.017					0.032	85.0	1.7	
Bus71	11.000										0.079	85.5	4.2	
Bus72	11.000				0.040	0.025					0.048	85.0	2.6	
Bus73	11.000										0.439	85.1	23.5	
Bus74	11.000										0.439	85.0	23.5	
Bus75	11.000				0.169	0.105					0.199	85.0	10.7	
Bus76	11.000				0.172	0.106					0.240	85.0	12.8	
Bus77	11.000				0.032	0.020					0.038	85.0	2.0	
Bus78	11.000										1.207	85.0	64.5	
Bus79	11.000										1.205	85.0	64.5	
Bus80	11.000										0.476	91.8	25.5	
Bus81	11.000				0.167	0.104					0.197	85.0	10.5	
Bus82	11.000										0.954	85.0	51.2	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					Percent
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Loading
Bus83	11.000				0.148	0.092					0.953	85.0	51.2	
Bus84	11.000				0.661	0.410					0.778	85.0	41.8	
Bus85	11.000										0.736	79.7	39.4	
Bus86	11.000				0.044	0.027					0.052	85.0	2.8	
Bus87	11.000				0.324	0.201					0.382	85.0	20.4	

* Indicates operating load of a bus exceeds the bus critical limit (100.0% of the Continuous Ampere rating).
# Indicates operating load of a bus exceeds the bus marginal limit (95.0% of the Continuous Ampere rating).

Branch Loading Summary Report

CKT / Branch		Cable & Reactor			Transformer				
						Loading (input)		Loading (output)	
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	MVA	%	MVA	%
Cable1	Cable	274.79	5.22	1.90					
Cable2	Cable	274.79	7.59	2.76					
Cable3	Cable	229.86	15.48	6.73					
Cable4	Cable	301.98	24.57	8.14					
Cable5	Cable	338.03	42.31	12.52					
Cable6	Cable	229.86	23.47	10.21					
Cable7	Cable	301.98	64.46	21.34					
Cable8	Cable	301.98	20.38	6.75					
66/11kV I	Transformer				3.000	1.192	39.7	1.172	39.1
66/11kV II	Transformer				3.000	1.240	41.3	1.219	40.6
66/11kV III	Transformer				3.000	1.194	39.8	1.173	39.1
66/33kV	Transformer				7.875	0.732	9.3	0.729	9.3

* Indicates a branch with operating load exceeding the branch capability.

Branch Losses Summary Report

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
66/33kV	0.653	0.330	-0.653	-0.324	0.4	5.6	100.0	99.6	0.40
Cable1	0.271	0.122	-0.271	-0.122	0.0	0.0	99.6	99.6	0.00
Cable2	0.382	0.203	-0.382	-0.203	0.0	0.0	99.6	99.6	0.00
Line1	0.271	0.122	-0.271	-0.122	0.0	-0.1	99.6	99.6	0.00
Line2	0.056	0.018	-0.056	-0.023	0.0	-4.9	99.6	99.6	0.01
Line5	0.215	0.104	-0.215	-0.104	0.0	-0.1	99.6	99.6	0.00
Line3	0.038	0.011	-0.038	-0.018	0.0	-6.7	99.6	99.6	0.01
Line4	0.015	0.004	-0.015	-0.010	0.0	-5.7	99.6	99.6	0.00
Line6	0.199	0.094	-0.199	-0.098	0.0	-3.9	99.6	99.6	0.01
Line7	0.184	0.089	-0.184	-0.092	0.0	-3.6	99.6	99.6	0.01
Line8	0.046	0.028	-0.046	-0.028	0.0	-0.3	99.6	99.6	0.00
Line9	0.138	0.064	-0.138	-0.066	0.0	-1.7	99.6	99.6	0.00
Line10	-0.014	-0.009	0.014	0.008	0.0	-1.0	99.6	99.6	0.00
Line11	0.124	0.058	-0.124	-0.059	0.0	-1.0	99.6	99.6	0.00
Line12	0.083	0.034	-0.083	-0.037	0.0	-3.3	99.6	99.6	0.00
Line13	0.057	0.022	-0.057	-0.023	0.0	-0.7	99.6	99.6	0.00
Line16	0.025	0.015	-0.025	-0.016	0.0	-0.9	99.6	99.6	0.00
Line14	0.017	-0.002	-0.017	-0.010	0.0	-12.4	99.6	99.6	0.00
Line15	0.040	0.025	-0.040	-0.025	0.0	-0.2	99.6	99.6	0.00
Line17	0.382	0.203	-0.382	-0.213	0.1	-9.8	99.6	99.6	0.04
Line18	0.093	0.057	-0.093	-0.058	0.0	-1.0	99.6	99.6	0.00
Line19	0.255	0.135	-0.255	-0.140	0.0	-4.5	99.6	99.6	0.01
Line20	-0.194	-0.120	0.194	0.118	0.0	-1.8	99.5	99.6	0.00
Line21	0.061	0.021	-0.061	-0.022	0.0	-0.3	99.6	99.6	0.00
Line22	-0.010	-0.006	0.010	0.003	0.0	-3.7	99.5	99.6	0.00
Line23	0.051	0.019	-0.051	-0.024	0.0	-4.9	99.6	99.5	0.00
Line24	0.036	0.015	-0.036	-0.018	0.0	-3.3	99.5	99.5	0.00
Line26	0.033	0.016	-0.033	-0.017	0.0	-0.3	99.5	99.5	0.00
Line28	0.007	0.000	-0.007	-0.005	0.0	-4.2	99.5	99.5	0.00
66/11kV I	1.001	0.647	-0.999	-0.613	2.6	34.0	100.0	98.3	1.71
66/11kV II	1.042	0.673	-1.039	-0.638	2.7	35.4	100.0	98.3	1.71
66/11kV III	1.003	0.648	-1.000	-0.614	2.6	34.1	100.0	98.3	1.71
Cable3	0.269	0.107	-0.269	-0.107	0.0	0.0	98.3	98.3	0.01
Cable4	0.369	0.275	-0.369	-0.275	0.0	0.0	98.3	98.3	0.01

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Cable5	0.675	0.414	-0.675	-0.414	0.1	0.1	98.3	98.3	0.01
Cable6	0.374	0.231	-0.374	-0.231	0.0	0.0	98.3	98.3	0.01
Cable7	1.026	0.635	-1.026	-0.635	0.1	0.1	98.3	98.3	0.01
Cable8	0.324	0.201	-0.324	-0.201	0.0	0.0	98.3	98.3	0.01
Line27	0.269	0.107	-0.268	-0.107	1.3	-0.2	98.3	97.8	0.49
Line29	0.241	0.090	-0.239	-0.091	1.5	-0.5	97.8	97.2	0.61
Line30	0.604	0.366	-0.603	-0.366	0.5	0.2	97.2	97.1	0.08
Line46	-0.365	-0.275	0.365	0.275	0.0	0.0	97.2	97.2	0.01
Line31	0.573	0.347	-0.572	-0.347	1.3	0.5	97.1	96.9	0.21
Line32	0.106	0.065	-0.106	-0.066	0.0	0.0	96.9	96.9	0.01
Line33	0.466	0.281	-0.463	-0.280	3.1	0.9	96.9	96.3	0.61
Line34	0.235	0.139	-0.235	-0.139	0.3	-0.1	96.3	96.2	0.10
Line35	0.093	0.051	-0.093	-0.051	0.1	-0.3	96.2	96.1	0.08
Line36	0.142	0.088	-0.142	-0.088	0.0	0.0	96.2	96.2	0.00
Line37	0.028	0.011	-0.028	-0.013	0.0	-1.8	96.1	96.0	0.12
Line38	-0.008	-0.005	0.008	0.005	0.0	-0.1	96.0	96.0	0.00
Line39	0.020	0.008	-0.020	-0.008	0.0	-0.2	96.0	96.0	0.01
Line40	0.019	0.007	-0.019	-0.008	0.0	-0.1	96.0	96.0	0.00
Line41	0.010	0.005	-0.010	-0.006	0.0	-0.9	96.0	96.0	0.02
Line43	0.009	0.003	-0.009	-0.003	0.0	-0.7	96.0	96.0	0.01
Line42	0.009	0.006	-0.009	-0.006	0.0	-0.3	96.0	95.9	0.00
Line44	0.004	0.000	-0.004	-0.002	0.0	-2.0	96.0	95.9	0.02
Line45	0.002	0.001	-0.002	-0.001	0.0	-0.2	95.9	95.9	0.00
Line47	0.369	0.275	-0.365	-0.274	3.9	1.3	98.3	97.2	1.10
Line48	0.000	-0.001	0.000	0.001	0.0	-0.1	97.2	97.2	0.00
Line49	0.000	0.000	0.000	0.000	0.0	-0.1	97.2	97.2	0.00
Line50	0.000	-0.001	0.000	0.001	0.0	0.0	97.2	97.2	0.00
Line51	0.000	0.000	0.000	0.000	0.0	-0.1	97.2	97.2	0.00
Line52	0.000	-0.001	0.000	0.001	0.0	-0.2	97.2	97.2	0.00
Line53	0.000	0.000	0.000	0.000	0.0	0.0	97.2	97.2	0.00
Line54	0.000	-0.001	0.000	0.000	0.0	-0.4	97.2	97.2	0.00
Line55	0.000	0.000	0.000	0.000	0.0	0.0	97.2	97.2	0.00
Line56	0.000	0.000	0.000	0.000	0.0	-0.1	97.2	97.2	0.00
Line57	0.675	0.414	-0.671	-0.413	3.9	1.5	98.3	97.7	0.53
Line58	0.390	0.241	-0.389	-0.241	0.3	0.1	97.7	97.7	0.06
Line59	0.282	0.171	-0.282	-0.171	0.2	0.0	97.7	97.7	0.05
Line60	0.083	0.048	-0.083	-0.048	0.0	-0.1	97.7	97.7	0.01

	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
Branch ID	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line61	-0.015	-0.009	0.015	0.007	0.0	-2.3	97.6	97.7	0.05
Line62	0.068	0.041	-0.068	-0.041	0.0	-0.2	97.7	97.7	0.03
Line63	-0.027	-0.017	0.027	0.017	0.0	-0.1	97.6	97.7	0.01
Line64	0.041	0.024	-0.040	-0.025	0.0	-0.7	97.7	97.6	0.07
Line65	0.374	0.231	-0.373	-0.231	0.7	0.2	98.3	98.1	0.19
Line66	0.170	0.105	-0.169	-0.105	0.2	-0.2	98.1	98.0	0.13
Line67	0.204	0.126	-0.204	-0.126	0.0	0.0	98.1	98.1	0.00
Line68	0.032	0.020	-0.032	-0.020	0.0	0.0	98.1	98.1	0.00
Line69	1.026	0.635	-1.025	-0.634	1.2	0.9	98.3	98.2	0.13
Line71	0.437	0.189	-0.437	-0.189	0.9	0.2	98.2	98.0	0.20
Line76	0.588	0.445	-0.587	-0.444	1.1	0.7	98.2	98.0	0.19
Line70	0.167	0.104	-0.167	-0.104	0.0	0.0	98.0	97.9	0.03
Line72	0.269	0.086	-0.269	-0.086	0.3	-0.1	98.0	97.9	0.10
Line73	0.811	0.502	-0.811	-0.502	0.4	0.2	97.9	97.8	0.05
Line77	-0.542	-0.417	0.542	0.417	0.6	0.3	97.9	98.0	0.11
Line74	0.662	0.410	-0.661	-0.410	0.7	0.2	97.8	97.7	0.09
Line78	0.044	0.027	-0.044	-0.027	0.0	-0.2	98.0	97.9	0.02
					31.6	24.0			

Alert Summary Report

	% Alert Settings	
	Critical	**Marginal**
Loading		
Bus	100.0	95.0
Cable	100.0	95.0
Reactor	100.0	95.0
Line	100.0	95.0
Transformer	100.0	95.0
Panel	100.0	95.0
Protective Device	100.0	95.0
Generator	100.0	95.0
Inverter/Charger	100.0	95.0
Bus Voltage		
OverVoltage	110.0	105.0
UnderVoltage	90.0	95.0
Generator Excitation		
OverExcited (Q Max.)	100.0	95.0
UnderExcited (Q Min.)	100.0	

SUMMARY OF TOTAL GENERATION , LOADING & DEMAND

	MW	Mvar	MVA	% PF
Source (Swing Buses):	3.699	2.297	4.355	84.95 Lagging
Source (Non-Swing Buses):	0.000	0.000	0.000	
Total Demand:	3.699	2.297	4.355	84.95 Lagging
Total Motor Load:	0.000	0.000	0.000	
Total Static Load:	3.668	2.273	4.315	85.00 Lagging
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	0.032	0.024		
System Mismatch:	0.000	0.000		

Number of Iterations: 3

Annexure 5: Feeder Wise Reliability Indices

Sl.No.	Year	Month	Reliability Indices	11 KV THPA-Polythene feeder	11 KV Karbarey-Ramety Feeder	11 KV Tading Rural Feeder	11 KV Pepsi BPC Colony Feeder	11 KV New Hospital Feeder
1	2017	January	SAIFI	0.02	0.13	0.19	0.06	
			SAIDI	0.02	0.04	0.75	0.13	
2		February	SAIFI	0.02	0.32			
			SAIDI	0.01	0.08			
3		March	SAIFI	0.02	0.42	0.27		
			SAIDI	0.00	0.32	0.02		
4		April	SAIFI	0.01	0.21	0.34		
			SAIDI	0.00	0.09	0.21		
5		May	SAIFI	0.01	1.93	0.13		
			SAIDI	0.02	1.65	0.02		
6		June	SAIFI		1.10	0.86		
			SAIDI		0.60	0.59		
7		July	SAIFI	0.02	0.54	0.39		
			SAIDI	0.01	0.70	0.37		
8		August	SAIFI	0.03	0.54	0.72	0.09	
			SAIDI	0.02	0.75	1.72	0.03	
9		September	SAIFI			0.52	0.06	0.00
			SAIDI			0.46	0.16	0.01
10		October	SAIFI		0.27	0.39		
			SAIDI		0.11	0.18		
11		November	SAIFI	0.01		0.13		
			SAIDI	0.01		0.10		
12		December	SAIFI			0.07	0.06	0.00
			SAIDI			0.06	0.02	0.00
	Total		**SAIFI**	**0.12**	**5.47**	**4.01**	**0.28**	**0.00**
			SAIDI	**0.10**	**4.35**	**4.49**	**0.34**	**0.01**
1	2018	January	SAIFI		0.20	0.13		
			SAIDI		0.08	0.44		
2		February	SAIFI		0.14	0.26	0.06	
			SAIDI		0.03	0.15	0.79	
3		March	SAIFI		0.80	1.41		
			SAIDI		0.86	0.78		
4		April	SAIFI	0.01	0.99	0.70		
			SAIDI	0.01	0.61	0.95		
5		May	SAIFI	0.08	1.44	1.84	0.27	0.01
			SAIDI	0.04	4.10	5.12	0.14	0.00
6		June	SAIFI	0.21	2.74	3.97	0.75	0.01
			SAIDI	0.07	2.69	6.59	0.24	0.00
7		July	SAIFI	0.01	0.65	1.58	0.06	
			SAIDI	0.07	0.66	1.93	0.07	
8		August	SAIFI	0.06	0.91	1.75	0.06	
			SAIDI	0.18	0.59	2.03	0.03	
9		September	SAIFI	0.03	1.41	1.23	0.31	
			SAIDI	0.71	3.03	1.79	0.40	
10		October	SAIFI	0.02	0.57	1.39	0.07	
			SAIDI	0.03	0.61	1.80	0.16	
11		November	SAIFI		0.19	0.31	0.03	
			SAIDI		0.76	0.14	0.01	
12		December	SAIFI	0.02	0.13	0.36		
			SAIDI	0.01	0.11	0.29		
	Total		**SAIFI**	**0.43**	**10.17**	**14.93**	**1.60**	**0.02**
			SAIDI	**1.11**	**14.13**	**22.02**	**1.86**	**0.00**
	Overall total		**SAIFI**	**0.28**	**7.82**	**9.47**	**0.94**	**0.01**
			SAIDI	**0.61**	**9.24**	**13.25**	**1.10**	**0.00**

Sl.No.	Year	Month	Reliability Indices	11 KV Helipad linked feeder	33 kV Druk Iron & Steel feeder	33 kV Sector II	33 kV Sector II	33 kV Serina Bosokha	11 kV Gurungdara Rural
1	2017	January	SAIFI	0.03	0.00			1.48	
			SAIDI	0.07	0.00			2.35	
2		February	SAIFI	0.06			0.30	1.04	0.07
			SAIDI	0.02			0.01	1.98	0.37
3		March	SAIFI	0.03				1.13	0.11
			SAIDI	0.02				0.47	0.05
4		April	SAIFI	0.03	0.00		0.65	1.89	0.04
			SAIDI	0.00	0.00		0.08	2.03	0.01
5		May	SAIFI	0.07	0.00	0.32		4.10	0.04
			SAIDI	0.07	0.00	0.02		5.86	0.04
6		June	SAIFI		0.00		0.32	1.76	0.18
			SAIDI		0.00		0.02	2.87	0.88
7		July	SAIFI	0.03			5.05	2.30	
			SAIDI	0.04			0.24	3.92	
8		August	SAIFI		0.00	2.84		0.37	0.03
			SAIDI		0.01	0.17		0.16	0.04
9		September	SAIFI	0.10	0.00			1.74	
			SAIDI	0.05	0.00			0.87	
10		October	SAIFI	0.16		0.32		1.01	
			SAIDI	0.18		0.34		2.02	
11		November	SAIFI					0.36	0.03
			SAIDI					1.16	0.03
12		December	SAIFI	0.06			0.94	0.09	
			SAIDI	4.50			0.07	0.01	
	Total		**SAIFI**	**0.57**	**0.00**	**3.48**	**7.25**	**17.27**	**0.49**
			SAIDI	**4.97**	**0.02**	**0.53**	**0.42**	**23.69**	**1.41**
1	2018	January	SAIFI	0.00				0.64	
			SAIDI	0.00				0.31	
2		February	SAIFI					1.37	
			SAIDI					4.62	
3		March	SAIFI	0.03				2.07	
			SAIDI	0.07				4.25	
4		April	SAIFI	0.06		0.30		2.40	0.03
			SAIDI	0.07		0.02		4.01	0.02
5		May	SAIFI	0.28			1.83	0.98	0.20
			SAIDI	0.14			1.44	5.06	0.28
6		June	SAIFI	0.77		0.30	1.82	3.35	0.03
			SAIDI	0.25		2.55	2.55	4.81	0.05
7		July	SAIFI			3.33	5.46	3.09	0.03
			SAIDI			0.71	0.97	8.11	0.00
8		August	SAIFI	0.06		0.30	3.01	1.58	
			SAIDI	0.24		1.03	1.99	7.28	
9		September	SAIFI				0.62	3.43	0.17
			SAIDI				0.04	6.89	0.34
10		October	SAIFI				1.00	1.58	
			SAIDI				2.33	4.28	
11		November	SAIFI	0.10		0.60		1.21	
			SAIDI	0.04		1.77		3.25	
12		December	SAIFI	0.03		1.17		1.03	
			SAIDI	0.03		0.06		0.85	
	Total		**SAIFI**	**1.34**	**-**	**6.02**	**13.74**	**22.70**	**0.47**
			SAIDI	**0.84**	**-**	**6.13**	**9.33**	**53.74**	**0.70**
	Overall total		**SAIFI**	**0.96**	**0.00**	**4.75**	**10.49**	**19.99**	**0.48**
			SAIDI	**2.91**	**0.01**	**3.33**	**4.88**	**38.72**	**1.06**

Sl.No.	Year	Month	Reliability Indices	11 kV TCBL Fdr	11 kV Industrial area upper Terrace	11 kV Industrial area lower Terrace	11 kV Druk Cement Fdr	11 kV Bhutan Steel Fdr	11 kV Malbase Colony Fdr
1	2017	January	SAIFI	0.00		0.00	0.04		
			SAIDI	0.01		0.00	0.04		
2		February	SAIFI	0.00	0.00	0.00	0.04	0.00	
			SAIDI	0.02	0.00	0.01	0.23	0.00	
3		March	SAIFI				0.04		
			SAIDI				0.02		
4		April	SAIFI	0.01	0.00				
			SAIDI	0.01	0.00				
5		May	SAIFI				0.16	0.00	
			SAIDI				0.29	0.00	
6		June	SAIFI	0.00	0.00	0.00			
			SAIDI	0.01	0.00	0.00			
7		July	SAIFI					0.00	0.01
			SAIDI					0.00	0.01
8		August	SAIFI		0.00	0.00	0.12	0.00	
			SAIDI		0.00	0.01	0.02	0.00	
9		September	SAIFI			0.01	0.12	0.00	
			SAIDI			0.07	0.12	0.01	
10		October	SAIFI		0.00		0.04	0.00	
			SAIDI		0.00		0.01	0.00	
11		November	SAIFI		0.00	0.00		0.00	
			SAIDI		0.00	0.00		0.00	
12		December	SAIFI		0.00				
			SAIDI		0.00				
	Total		**SAIFI**	**0.02**	**0.00**	**0.02**	**0.55**	**0.00**	**0.01**
			SAIDI	**0.04**	**0.01**	**0.10**	**0.73**	**0.01**	**0.01**
1	2018	January	SAIFI	0.00	0.00	0.00	0.16	0.00	
			SAIDI	0.01	0.00	0.02	0.34	0.00	
2		February	SAIFI				0.04		
			SAIDI				0.13		
3		March	SAIFI						
			SAIDI						
4		April	SAIFI		0.00		0.04	0.00	
			SAIDI		0.00		0.01	0.00	
5		May	SAIFI	0.00	0.00	0.00	0.11	0.00	
			SAIDI	0.01	0.00	0.02	0.82	0.00	
6		June	SAIFI	0.00	0.00		0.11		0.01
			SAIDI	0.00	0.00		0.04		0.03
7		July	SAIFI	0.00	0.00	0.00	0.11	0.00	0.01
			SAIDI	0.00	0.00	0.00	0.20	0.00	0.01
8		August	SAIFI		0.00				
			SAIDI		0.00				
9		September	SAIFI		0.00		0.08	0.00	0.01
			SAIDI		0.00		0.14	0.00	0.03
10		October	SAIFI	0.00			0.04		
			SAIDI	0.00			0.04		
11		November	SAIFI	0.00			0.08		
			SAIDI	0.00			0.02		
12		December	SAIFI				0.15		
			SAIDI				0.25		
	Total		**SAIFI**	**0.01**	**0.00**	**0.01**	**0.92**	**0.00**	**0.03**
			SAIDI	**0.03**	**0.01**	**0.04**	**2.01**	**0.00**	**0.07**
	Overall total		**SAIFI**	**0.02**	**0.00**	**0.02**	**0.73**	**0.00**	**0.02**
			SAIDI	**0.04**	**0.01**	**0.07**	**1.37**	**0.01**	**0.04**

Sl.No.	Year	Month	Reliability Indices	11 kV Malbase Burkey Fdr-B460	33kV Gurungdara I-B140	33kV Gurungdara II	33kV Mirchingchu	11kV BBPL Fdr	11kV M/Wave Fdr
1	2017	January	SAIFI				0.09	0.26	0.04
			SAIDI				0.02	0.38	0.00
2		February	SAIFI				0.09		0.13
			SAIDI				0.02		2.01
3		March	SAIFI			1.54		0.26	0.17
			SAIDI			0.27		0.22	5.51
4		April	SAIFI		0.00	4.62	0.19	0.52	0.13
			SAIDI		0.00	5.07	0.08	0.16	1.87
5		May	SAIFI		0.00	5.63	0.26	1.16	0.09
			SAIDI		0.00	4.82	0.16	0.81	13.65
6		June	SAIFI		0.00	1.53	0.05	0.39	0.04
			SAIDI		0.00	0.68	0.01	0.29	0.06
7		July	SAIFI	0.01	0.00	1.02	0.05	0.26	0.04
			SAIDI	0.01	0.00	0.08	0.03	0.09	0.24
8		August	SAIFI			1.52		0.26	0.04
			SAIDI			1.14		0.06	0.00
9		September	SAIFI			1.01	0.14	0.64	0.04
			SAIDI			0.47	0.48	0.41	0.47
10		October	SAIFI			2.52	0.05	0.63	0.04
			SAIDI			10.93	0.00	0.89	2.79
11		November	SAIFI			1.51			
			SAIDI			1.03			
12		December	SAIFI			1.51			
			SAIDI			1.22			
	Total		**SAIFI**	**0.01**	**0.00**	**22.43**	**0.92**	**4.36**	**0.77**
			SAIDI	**0.01**	**0.00**	**25.71**	**0.80**	**3.31**	**26.60**
1	2018	January	SAIFI			1.51		0.13	
			SAIDI			3.83		0.13	
2		February	SAIFI			1.51		0.13	0.04
			SAIDI			3.67		0.15	0.53
3		March	SAIFI			3.49	0.42	0.88	0.54
			SAIDI			12.14	0.51	0.71	5.61
4		April	SAIFI		0.00		0.05	0.38	0.17
			SAIDI		0.00		0.01	0.20	0.00
5		May	SAIFI		0.00	2.00		0.63	
			SAIDI		0.00	1.65		0.64	
6		June	SAIFI	0.01	0.00	2.50	0.05	0.50	0.00
			SAIDI	0.01	0.00	3.87	0.11	0.97	0.01
7		July	SAIFI	0.01	0.00	2.96			
			SAIDI	0.01	0.00	4.99			
8		August	SAIFI		0.00	3.45	0.05	0.37	0.00
			SAIDI		0.00	6.14	0.02	0.12	0.00
9		September	SAIFI	0.02		1.48	0.05	0.12	0.00
			SAIDI	0.13		6.39	0.08	0.55	0.01
10		October	SAIFI		0.00				
			SAIDI		0.00				
11		November	SAIFI			0.49			
			SAIDI			0.25			
12		December	SAIFI			1.47	0.09	0.25	0.00
			SAIDI			4.22	0.10	0.54	0.02
	Total		**SAIFI**	**0.05**	**0.00**	**20.87**	**0.70**	**3.39**	**0.75**
			SAIDI	**0.15**	**0.00**	**47.15**	**0.83**	**3.99**	**6.19**
	Overall total		**SAIFI**	**0.03**	**0.00**	**21.65**	**0.81**	**3.87**	**0.76**
			SAIDI	**0.08**	**0.00**	**36.43**	**0.81**	**3.65**	**16.40**

Sl.No.	Year	Month	Reliability Indices	11kV THPA-1 Fdr	11kV Geduchu Fdr	11kV Padechu Fdr	11kv Old Tsimalakha	11kv THPA -I	11KV BVC Fdr
1	2017	January	SAIFI						
			SAIDI						
2		February	SAIFI	0.03			0.51		
			SAIDI	0.06			0.60		
3		March	SAIFI	0.24	0.00				0.06
			SAIDI	0.54	0.00				0.00
4		April	SAIFI		0.00		0.51		0.06
			SAIDI		0.00		4.72		0.00
5		May	SAIFI	0.24	0.00				0.13
			SAIDI	0.27	0.00				0.00
6		June	SAIFI				1.01		0.06
			SAIDI				0.07		0.00
7		July	SAIFI		0.00		1.52		0.06
			SAIDI		0.00		0.07		0.00
8		August	SAIFI	0.03			1.01		
			SAIDI	0.28			0.02		
9		September	SAIFI				1.01		0.06
			SAIDI				0.05		0.00
10		October	SAIFI	0.03	0.00		1.51		
			SAIDI	0.05	0.00		1.27		
11		November	SAIFI						
			SAIDI						
12		December	SAIFI	0.03			0.50		
			SAIDI	0.02			0.94		
	Total		**SAIFI**	**0.61**	**0.00**	**-**	**7.58**	**-**	**0.44**
			SAIDI	**1.23**	**0.00**	**-**	**7.74**	**-**	**0.01**
1	2018	January	SAIFI				2.01		0.06
			SAIDI				0.14		0.79
2		February	SAIFI		0.00				0.06
			SAIDI		0.00				0.12
3		March	SAIFI	0.10	0.00		2.00		0.18
			SAIDI	0.06	0.00		0.86		2.16
4		April	SAIFI	0.30			0.50		0.12
			SAIDI	0.12			0.80		0.10
5		May	SAIFI	0.13			0.99		
			SAIDI	0.03			0.71		
6		June	SAIFI	0.13	0.08		2.48		0.06
			SAIDI	0.16	0.15		0.12		0.00
7		July	SAIFI		0.49				
			SAIDI		0.81				
8		August	SAIFI		0.08		2.97		
			SAIDI		0.05		5.85		
9		September	SAIFI	0.03	0.04		0.99		0.18
			SAIDI	0.28	0.20		0.02		0.00
10		October	SAIFI	0.03					
			SAIDI	0.04					
11		November	SAIFI				0.99		
			SAIDI				0.17		
12		December	SAIFI	0.07	0.08		0.49		
			SAIDI	0.20	0.09		0.01		
	Total		**SAIFI**	**0.80**	**0.78**	**-**	**13.41**	**-**	**0.68**
			SAIDI	**0.88**	**1.30**	**-**	**8.69**	**-**	**3.18**
	Overall total		**SAIFI**	**0.71**	**0.39**	**-**	**10.50**	**-**	**0.56**
			SAIDI	**1.06**	**0.65**	**-**	**8.21**	**-**	**1.60**

Sl.No.	Year	Month	Reliability Indices	11kV THPA II	11kV THPA III	33kV Shemagangkha	33kV Chapcha	11kV Chukha Colony	11kV Dzongsite Colony
1	2017	January	SAIFI						
			SAIDI						
2		February	SAIFI			0.20			
			SAIDI			0.46			
3		March	SAIFI				0.24	0.63	
			SAIDI				0.05	0.10	
4		April	SAIFI			0.07	0.08	0.21	
			SAIDI			0.01	0.01	0.00	
5		May	SAIFI			0.27	0.16		
			SAIDI			0.10	0.03		
6		June	SAIFI			0.07	0.08		0.04
			SAIDI			0.05	0.02		0.19
7		July	SAIFI			0.20	0.16	0.21	
			SAIDI			0.06	0.02	0.01	
8		August	SAIFI			0.14	0.08	0.21	
			SAIDI			0.05	0.07	0.00	
9		September	SAIFI		0.03	0.13			
			SAIDI		0.00	0.02			
10		October	SAIFI			0.13		0.21	
			SAIDI			0.02		0.02	
11		November	SAIFI		0.03			0.21	
			SAIDI		0.00			0.00	
12		December	SAIFI						0.02
			SAIDI						0.03
	Total		**SAIFI**	**-**	**0.06**	**1.22**	**0.79**	**1.67**	**0.06**
			SAIDI	**-**	**0.00**	**0.77**	**0.20**	**0.14**	**0.22**
1	2018	January	SAIFI			1.01	0.08		0.02
			SAIDI			6.52	0.34		0.03
2		February	SAIFI			1.01	0.31		
			SAIDI			3.34	1.17		
3		March	SAIFI			1.00	0.31		
			SAIDI			5.35	4.49		
4		April	SAIFI			0.33	0.23		
			SAIDI			2.64	2.20		
5		May	SAIFI						
			SAIDI						
6		June	SAIFI			0.07	0.07		
			SAIDI			0.02	0.03		
7		July	SAIFI				0.07	1.02	
			SAIDI				0.00	0.98	
8		August	SAIFI				0.20	0.41	
			SAIDI				0.08	0.03	
9		September	SAIFI				0.20	0.20	
			SAIDI				0.07	0.00	
10		October	SAIFI						0.04
			SAIDI						0.02
11		November	SAIFI				0.15	0.41	0.02
			SAIDI				0.06	1.04	0.01
12		December	SAIFI				0.08		
			SAIDI				0.11		
	Total		**SAIFI**	**-**	**-**	**3.41**	**1.69**	**2.04**	**0.08**
			SAIDI	**-**	**-**	**17.88**	**8.55**	**2.06**	**0.07**
	Overall total		**SAIFI**	**-**	**0.03**	**2.32**	**1.24**	**1.85**	**0.07**
			SAIDI	**-**	**0.00**	**9.33**	**4.38**	**1.10**	**0.14**

Annexure 6: Material Cost for Upgrading single phase (11 kV and 33 kV) Lines to three-phase

Sl. No	Name of ESDs	Total Cost in Nu. For upgradation of Line to 3Φ from 1Φ		Total cost in Nu.
		11 kV Line in Km	33 kV Line in Km	
		Cost in Nu.	Cost in Nu.	
1	Bumthang	604,083.80	626,364.17	1,230,447.97
2	Chukhha	1,372,746.06	6,450,371.80	7,823,117.86
3	Dagana	–	2,495,645.61	2,495,645.61
4	Haa	–	341,755.04	341,755.04
5	Lhuntse	1,648,680.77	6,292,698.01	7,941,378.78
6	Mongar	–	–	–
7	Paro	1,576,599.08	1,663,407.47	3,240,006.55
8	Pemagatshel	–	2,467,625.51	2,467,625.51
9	Punakha	612,259.13	8,183,731.48	8,795,990.60
10	S/Jongkhar	–	7,593,301.40	7,593,301.40
11	Samtse	2,031,083.74	536,799.03	2,567,882.76
12	Sarpang	756,490.07	1,112,902.61	1,869,392.68
13	Trashi Gang	251,649.96	626,304.45	877,954.41
14	Trashiyangtse		2,207,281.49	2,207,281.49
15	Thimphu	5,228,316.74	-	5,228,316.74
16	Trongsa	–	651,860.25	651,860.25
17	Tsirang	–	1,693,286.88	1,693,286.88
18	Wangdue	98,146.90	3,133,078.14	3,231,225.04
19	Zhemgang	–	5,303,863.16	5,303,863.16
	TOTAL	**14,180,056.24**	**51,380,276.50**	**65,560,332.75**

The cost of extending one phase in case of ACSR conductor and AAAC covered conductor were considered and incase of HV ABC, the cost of constructing three core cable has been considered in estimation. Above estimation indicates the total material cost involved in upgrading the existing single-phase line to three phase under each ESD.

The total cost including material cost (Nu. 65 million), transportation cost (Nu. 3.47 million) and labor cost (Nu. 28 million) will amount to Nu. 97 million.

11 kV and 33 kV Single-phase Line Length in km under each ESD

Sl. No	Name of ESDs	11kV 1Φ Line (km)	33kV 1Φ Line (km)	Total 1Φ Line (km)
1	Bumthang	6.96276	5.6246	12.58736
2	Chukhha	21.569	78.274	99.843

Sl. No	Name of ESDs	11kV 1Φ Line (km)	33kV 1Φ Line (km)	Total 1Φ Line (km)
3	Dagana	0	30.527	30.527
4	Haa	0	4.391	4.391
5	Lhuntse	18.7075	80.851	99.5585
6	Mongar	0	0	0
7	Paro	24.772	14.937	39.709
8	Pemagatshel	0	31.705	31.705
9	Punakha	9.62	58.4	68.02
10	S/Jongkhar	0	93.672	93.672
11	Samtse	31.913	6.897	38.81
12	Sarpang	11.8862	14.299	26.1852
13	Trashigang	3.954	8.047	12.001
14	Trashiyangtse	0	28.36	28.36
15	Thimphu	5.93	0	5.93
16	Trongsa	0	5.383	5.383
17	Tsirang	0	21.756	21.756
18	Wangdue	1.01	29.7	30.71
19	Zhemgang	0	66.785	66.785
TOTAL		**136.32446**	**579.6086**	**715.93306**

Annexure 7: Distribution Transformer Loading

Sl.No.	Name of substation location	Capacity (kVA)	Peak Load (kVA)	% Loading	Peak Load(kVA)	% Loading	Peak Load(kVA)	% Loading	Transformer ID
			2019		2025		2030		
1	Damdara s/s	125	90.89	72.71%	114.28	91.42%	133.78	107.02%	B30T1
	33kV Feeder B250 (Sector II)								
2	Sector II s/s (33/11kV)	5000	3.40	68.00%	4.39	87.76%	5.15	103.02%	B250PT1
	11kV Feeder B280 (Water Booster)								
3	Lower Market USS	750	525.05	70.01%	680.84	90.78%	780.97	104.13%	B280T2
	11kV Feeder B270 (PWD)								
4	Uper Market s/s	1000	789.68	78.97%	921.12	92.11%	1037.62	103.76%	B280T7
5	Tinkilo s/s	125	100.89	80.71%	117.68	94.15%	132.57	106.05%	B270T11
	11kV Feeder B80 (Rangaytrung)								
6	Rangaytrung s/s	125	89.56	71.65%	155.88	124.71%	162.38	129.90%	B80T4
	11kV Feeder B90 (Gurungdara)								
7	Barsa s/s	63	44.67	70.90%	61.54	97.68%	67.84	107.68%	B80T2
	11kV Feeder B50 (BCCL Colony)								
8	Bmobile s/s	63	58.99	93.63%	64.92	103.05%	69.56	110.41%	B50T4
	11kV Feeder B400 (Druk Cement)								
9	Bmobile s/s (Balujora)	500	428.56	85.71%	466.21	93.24%	524.79	104.96%	B400T5
10	Toribari s/s	250	220.90	88.36%	240.31	96.12%	270.50	108.20%	B400T8
	11kV Feeder B460 (Burkey)								
11	Malbase Village s/s	63	44.90	71.27%	66.24	105.15%	73.97	117.42%	B460T2
	Total Distribution Transformers	**11**							

Annexure-8: Material Cost of three phase (3Φ) Transformers

Sl. No	Name of ESDs	Cost for replacement of single-phase transformers and distribution boards with three-phase		Total cost in Nu.
		11 kV transformers	33 kV transformers	
		Cost in Nu.	Cost in Nu.	
1	Bumthang	421,565.09	132,535.04	554,100.14
2	Chukhha	956,241.73	9,144,917.99	10,101,159.72
3	Dagana	–	6,361,682.08	6,361,682.08
4	Haa	–	3,048,306.00	3,048,306.00
5	Lhuntse	731,506.19	8,747,312.86	9,478,819.05
6	Mongar	182,876.55	4,108,586.34	4,291,462.89
7	Paro	836,897.46	1,060,280.35	1,897,177.81
8	Pemagatshel	91,438.27	6,759,287.21	6,850,725.48
9	Punakha	274,314.82	4,771,261.56	5,045,576.38
10	S/Jongkhar	–	15,506,600.07	15,506,600.07
11	Samtse	6,674,993.95	4,241,121.39	10,916,115.34
12	Sarpang	2,053,501.01	3,445,911.13	5,499,412.14
13	Trashi Gang	906,662.46	4,903,796.60	5,810,459.06
14	Trashiyangtse	–	4,638,726.52	4,638,726.52
15	Thimphu	723,785.91	–	723,785.91
16	Trongsa	91,438.27	3,445,911.13	3,537,349.40
17	Tsirang	–	5,168,866.69	5,168,866.69
18	Wangdue	182,876.55	1,457,885.48	1,640,762.02
19	Zhemgang	105,391.27	11,928,153.90	12,033,545.17
	TOTAL	**14,233,489.55**	**98,871,142.33**	**113,104,631.87**

Here the existing single-phase transformers and distribution boards were replaced by three phase system, therefore the estimation includes the cost of three phase transformers and distribution boards. In line with Distribution Design and Construction Standard (DDCS) 2015, the transformer capacities according to voltage level are standardized as shown below:

33 kV System		11 kV System	
3 Φ	1Φ	3 Φ	1Φ
25 kVA	25 kVA, 16 kVA	25 kVA, 16 kVA	25 kVA,16 kVA, 10 kVA

Therefore, during the estimation, on 33 kV system, the cost of 25 kVA transformers was taken for 10 kVA and 16 kVA transformers and for 11 kV system, the cost of 16 kVA transformers was taken for 10 kVA ratings. The total cost for replacing the 1-phase transformers under whole ESD including transportation cost (Nu. 2.6 million) and labor cost (Nu. 70 million) is Nu. 186 million. Therefore, the total cost under this option will amount to Nu. 283 million.

11 kV & 33 kV Single-phase Transformers used under each ESD

Sl. No	Name of ESDs	TRANSFORMERS (Nos.)					
		11/0.240 kV			33/0.240 kV		
		10 kVA	16kVA	25kVA	10 kVA	16kVA	25kVA
1	Bumthang	–	–	4	–	1	–
2	Chukhha	2	5	3	19	31	19
3	Dagana	–	–	–	4	43	1
4	Haa	–	–	–	8	13	2
5	Lhuntse	3	5	–	3	19	44
6	Mongar		2	–	12	17	2
7	Paro	5	3	1	6	2	–
8	Pemagatshel	–	1	–	4	8	39
9	Punakha	1	2	–	2	5	29
10	S/Jongkhar	–	–	–	18	24	75
11	Samtse	15	58	–	–	32	–
12	Sarpang	10	9	3	9	8	9
13	Trashi Gang	3	–	6	–	–	37
14	Trashiyangtse	–	–	–	16	19	–
15	Thimphu*	–	1	6	–	–	–
16	Trongsa	1	–	–	9	17	–
17	Tsirang	–	–	–	7	32	–
18	Wangdue	1	1	–	–	2	9
19	Zhemgang	–	–	1	27	36	27
	TOTAL	**41**	**87**	**24**	**144**	**309**	**293**