BHUTAN POWER CORPORATION LIMITED

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

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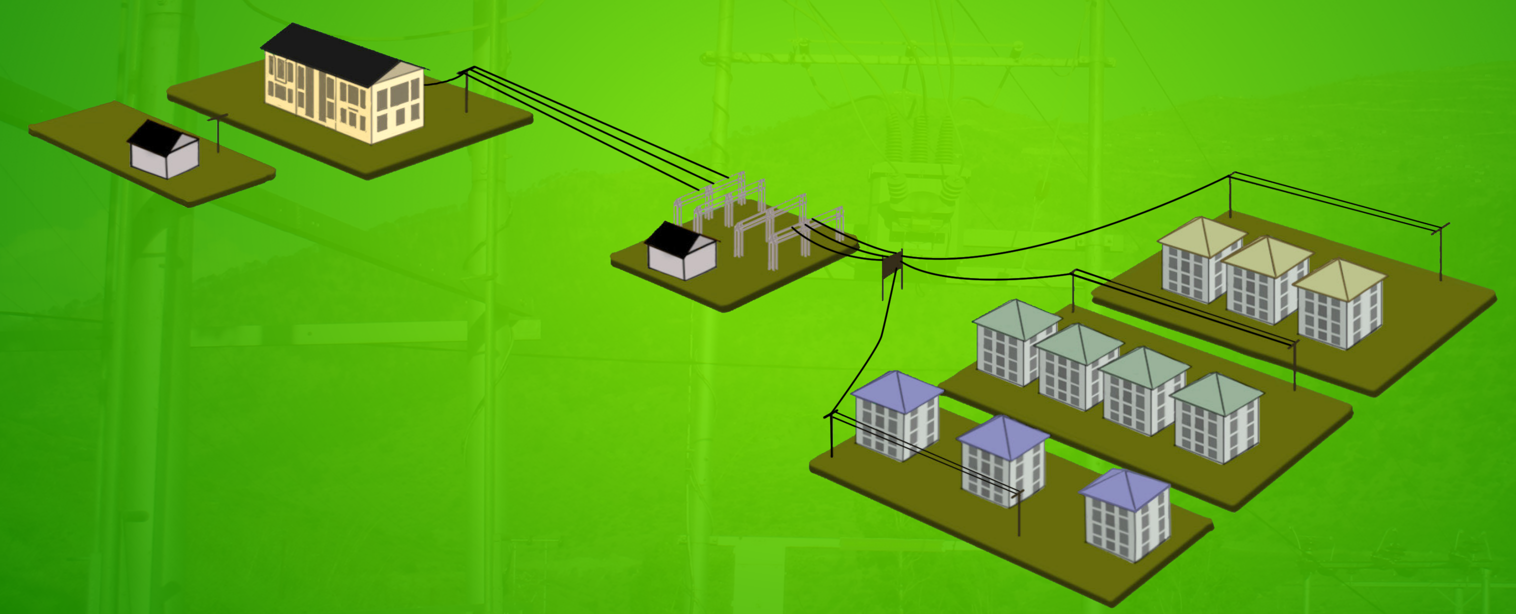
DISTRIBUTION SYSTEM MASTER PLAN (2020-2030)

SARPANG DZONGKHAG



Distribution and Customer Services Department
Distribution Services
Bhutan Power Corporation Limited

2020

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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

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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**

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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

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

USS: Unitized Substation

DMS: Distribution Management System

ADMS: Advanced DMS

SCADA: Supervisory Control and Data Acquisition

DSCADA: Distribution SCAD

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 with Linear Regression Method, the power requirement for the 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 Plan2019 including the investment (2020-2027). The identification of the system deficiencies and qualitative remedial measures that would require system automation and remote control as per the existing and projected load is 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 include but are not limited to a reliable power supply to the customers, reduction of distribution losses, and network capability with the anticipated load growth, optimization of the resources and to develop an 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) are 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

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 the 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.

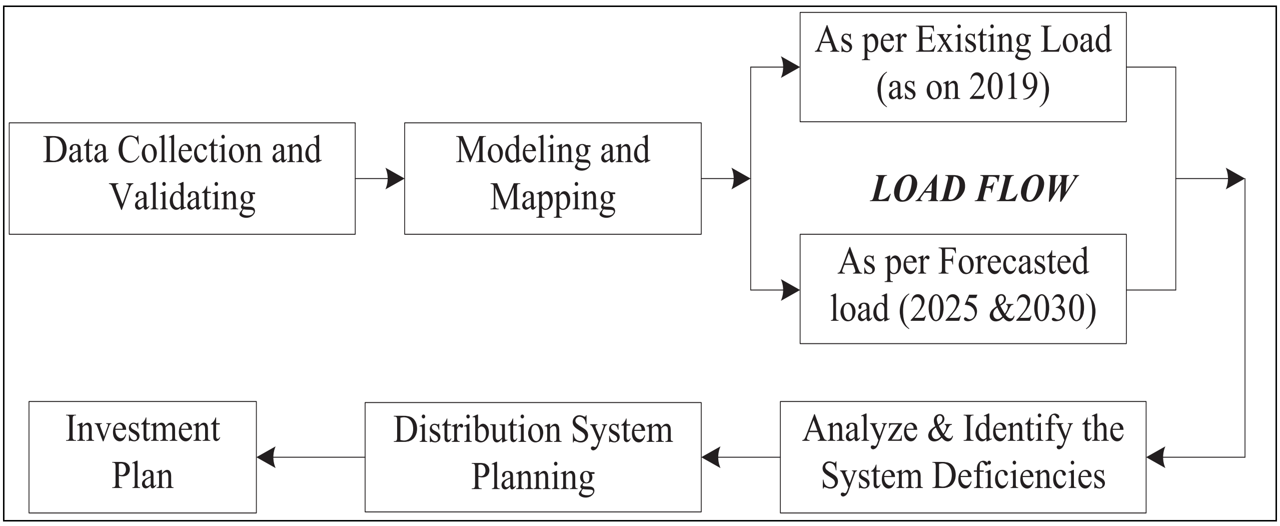


Figure 1: Block diagram for distribution system planning for thematic studies

5.1 Data Collection and Validation

In order to carry out the detailed studies with greater accuracy, complete and reliable data of the existing distribution infrastructure is required. Therefore, intensive field investigation was carried out during the months of April and May (2019-2020) 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 Modelling 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 (Detailed parameters 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 2024) 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 Power Supply Sources

The power supply to twelve (12) Gewogs and industries under Sarpang Dzongkhag are being fed from 132/66/33/11kV Gelephu and 220/132/33kV Jigmeling substations. The basic electricity distribution network model as seen from the source is predominantly radial as shown in **Figure 2.**

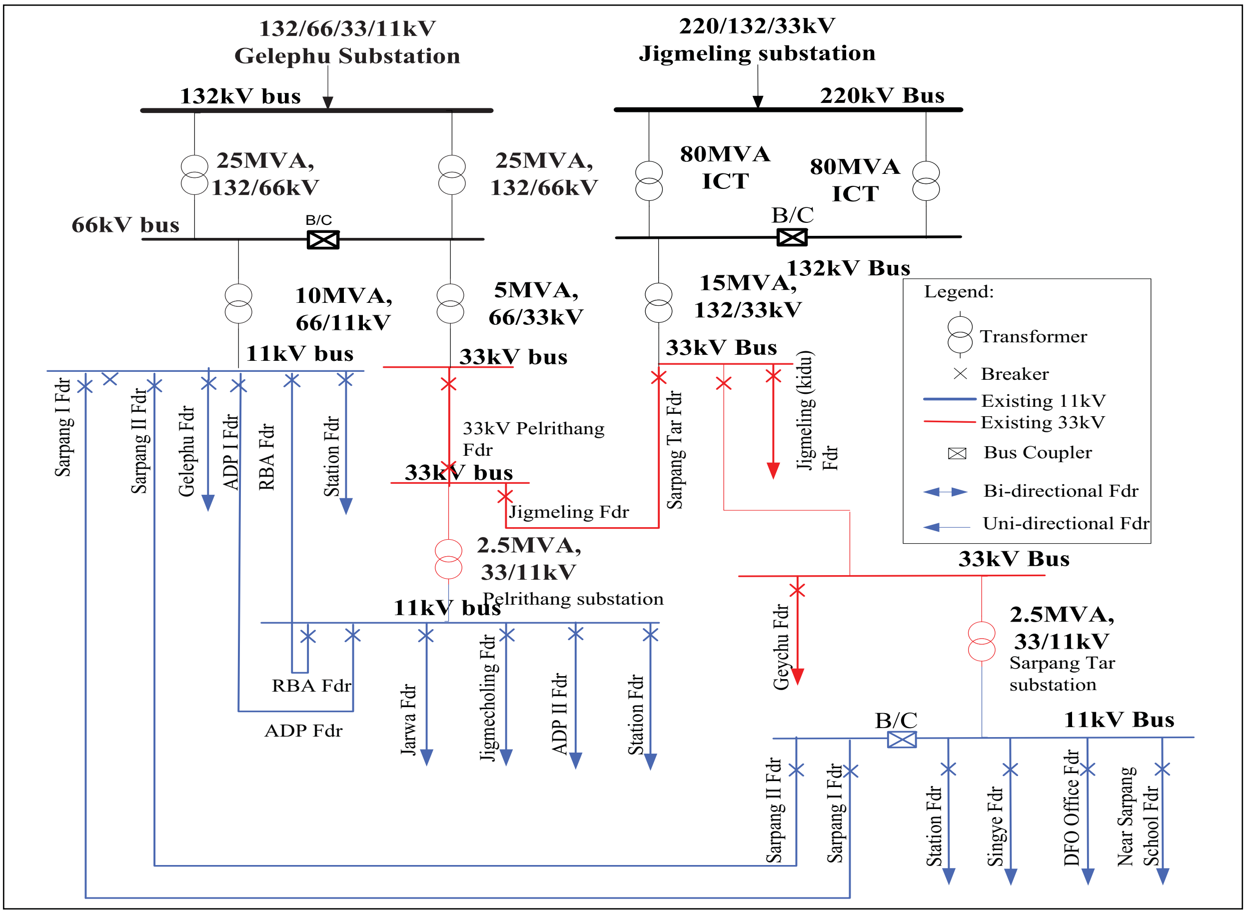


Figure 2: Electricity Distribution Schematic Diagram of Sarpang Dzongkhag

The customers under ESD, Gelephu receive the power supply from 132/66, 2X25MVA and 220/132kV, 2x80MVA ICT Jigmeling substations.

The above HV substations are further stepped to 66/11kV, 10MVA and 66/33kV, 5MVA Gelephu substations and 132/33kV, 15MVA Jigmeling substation. There are two 33/11KV, 2.5MVA MV substations each in Pelrithang and Sarpang Tar. From 220kV Jigmeling substation, there are three (3) 33kV outgoing feeders; Sarpang Tar, Kidu and Pelrithang feeders. The 33kV Pelrithang feeder from Jigmeling substation is connected in LILO (Loop in Loop out) to 33/11kV Pelrithang substation.

The 33kV feeder of Sarpang Tar is stepped down to 11kV through 33/11kV, 2.5MVA Sarpang Tar substation. These feeders cater power supply to four (4) gewogs (Sompangkha, Gakidling, Singye and part of Dekiling) of Sarpang Dzongkhag.

The 11kV Sarpang I and Sarpang II outgoing feeders of 132kV Gelephu substation are interconnected to 33/11kV Sarpang Tar substation forming ring system. The 11kV feeders of Sarpang Tar can be operated by providing power supply from Sarpang I and Sarpang II feeders during emergency.

Similarly, the 11kV ADP and RBA feeders of 33/11kV Pelrithang substation form ring system by connecting 11kV feeders of 132kV Gelephu substation.

6.2 Electricity Distribution Lines

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

Table 1: MV and LV Line Details

Sl. No.	33 kV (in km)		11 kV (in km)			Total MV line (in km)			LV lines (in km) *			Total length (in km)
	OH	UG	OH	UG	HV ABC	OH	UG	HV ABC	OH	UG	LV ABC	
1	77.12	0	294.69	2.31	19.45	373.76	2.31	19.45	129.35	0.00	454.50	979.37

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

The total MV line length is 395.52 km and the total LV line length is 583.85km. The ratio of LV to MV line length is 1.48 which reflects a high proportion of power distribution through LV network. 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 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 Transformer

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

As of October 2019, there were 290 (263 BPC & 27 Private) distribution transformers with a total installed capacity of 34,256kVA. As evidenced from **Table 2,** the installed capacity of transformer per customer is 2.60 kVA as on June 2019. The installed transformers are generally large in capacity and few in number rather than small in capacity and more in numbers.

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

Sl. No.	Name of Feeder	Voltage Ratio	Number of Transformers	Total installed capacity (kVA)	Total number of customers
1	Sarpang I Feeder (M10)	11/0.415kV	38	5635	1769
2	Sarpang II Feeder (M20)	11/0.415kV	27	3521	2047
3	Gelephu Feeder (M30)	11/0.415kV	14	5517	1128
4	ADP Feeder (M40)	11/0.415kV	20	2891	2293
5	RBA Feeder (M50)	11/0.415kV	22	3092	1146
6	Station Feeder (M60)	11/0.415kV	1	500	27
7	Geychu Feeder (M70)	33/0.415kV	7	351	527
		33/0.240kV	26	443	
8	Pelrithang Feeder (M80)	33/0.415kV	3	375	250
		33/11kV	1	2500	0
9	Jigmecholing Feeder (M90)	11/0.240kV	6	96	1384
		11/0.415kV	39	2541	
10	Jarwa Feeder (M100)	11/0.415kV	6	350	268

Sl. No.	Name of Feeder	Voltage Ratio	Number of Transformers	Total installed capacity (kVA)	Total number of customers
11	Jigmeling Feeder (M110)	33kV line from Pelrithang 33/11kv substation to Jigmeling			
12	Sarpang Tar Feeder (M120)	33/11kV	1	2500	
13	Singye Feeder (M130)	11/0.415kV	17	1528	743
		11/0.240kV	1	10	
14	Near DFO office Feeder (M140)	11/0.415kV	1	500	210
15	Dzong feeder Sarpang (M150)	11/0.415kV	1	500	449
16	Jigmeling Feeder (M160)	33/0.415kV	1	63	
17	Dovan Feeder (M170)	11/0.415kV	39	963	938
		11/0.240kV	17	254	
18	Sarpang Tar Station Feeder (M180)	11/0.415kV	1	63	1
19	Pelrithang Station Feeder (M190)	11/0.415kV	1	63	1
	Total		**290.00**	**34,256.00**	**13,181.00**

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 load and the forecasted load.

Table 3: HV Power Sources

Sl.No.	Name of Substation	Installed Capacity		Total Forecasted Load Growth (MW)		
		MVA	MW*	2019	2025	2030
1	132/66kV, 2X25MVA Gelephu SS	50.00	42.50	8.28	24.45	28.24
2	66/11kV, 1X10MVA Gelephu SS	10.00	8.50	6.41	20.84	24.38
3	66/33kV, 1x5MVA Gelephu SS	10.00	8.50	1.87	3.60	3.86
4	132/33kV, 1X15MVA Jigmeling SS	15.00	12.75	0.81	3.39	4.52

From the above table it is conclusive that the existing installed HV substations would be adequate to meet the power requirement except the 66/11kV, 10MVA Gelephu substation. The power demand from this substation is expected to grow drastically over the years due to developmental activities in the designated LAPs. Therefore, it is proposed to up-grade the existing substation to 20MVA which will not only meet the increasing power demand, it is also anticipated to improve the power quality (voltage profile) of the 11kV outgoing feeders of the substations.

As tabulated in **Table 4,** the total load would reach 133.92MW by 2025 if all the listed industries of the Jigmeling Industrial Park (IP) as submitted by the IIDD, MoEA get materialized. Therefore, Jigmeling substation will have to be accordingly up-graded to meet the load requirement including the domestic load.

Table 4: Industrial Load

Sl. No.	Type of Industry	Total Forecasted Load Growth (MW)		
		2019	2025	2030
1	LV Industry	0.00	0.74	0.74
2	MV Industry	0.00	55.58	55.58
3	HV Industry	0.00	77.60	77.60
	Total Load (MW)	**0.00**	**133.92**	**133.92**

7.1.2 MV Substation

Table 5: MV Power Sources

Sl.No.	Name of Substation	Installed Capacity		Total Forecasted Load Growth (MW)		
		MVA	MW*	2019	2025	2030
1	33/11kV, 1x2.5MVA Perlithang SS	2.5	2.125	1.75	3.39	3.60
2	33/11kV, 1x2.5MVA Sarpang Tar SS	2.5	2.125	0.53	2.16	2.71

With the forecasted load of 3.39MW and 3.60MW by 2025 and 2030 respectively, the existing installed capacity of 33/11kV (2.5MVA) Pelrithang substation will not be adequate to meet the increasing power requirement. Therefore, it is proposed to up-grade the substation to 5MVA by installing additional 2.5MVA which shall also serve as the (n-1) contingency plan. Though, Sarpang Tar substation might get overloaded slightly by 2030, it is recommended to closely monitor the load growth and accordingly take the informed decision.

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 6** and the corresponding feeder-wise annual load curve is presented in **Figure 3.**

Table 6: Feeder Wise Peak Power Demand (2015-2019)

Sl.No.	Name of Feeder	Peak Load Consumption Pattern (MW)				
		2015	2016	2017	2018	2019
1	11kV Sarpang I Feeder (M10)	1.74	1.74	1.84	1.70	1.61
2	11kV Sarpang II Feeder (M20)	1.96	1.86	2.08	1.99	2.12
3	11kV Gelephu Feeder (M30)	1.34	1.33	1.97	1.92	1.44
4	11kV ADP Feeder (M40)	0.60	0.77	0.95	0.37	0.32
5	11kV RBA Feeder (M50)	0.57	1.13	1.54	0.87	0.92
6	11kV Station Feeder (M90)					0.08
7	33kV PelrithangFeeder (M80)	2.37	1.71	1.70	1.76	1.87
8	33kV Sarpang Tar Feeder (M120)	0.77	1.08	1.33	1.01	0.81
	Total	**9.35**	**9.63**	**11.41**	**9.62**	**9.17**

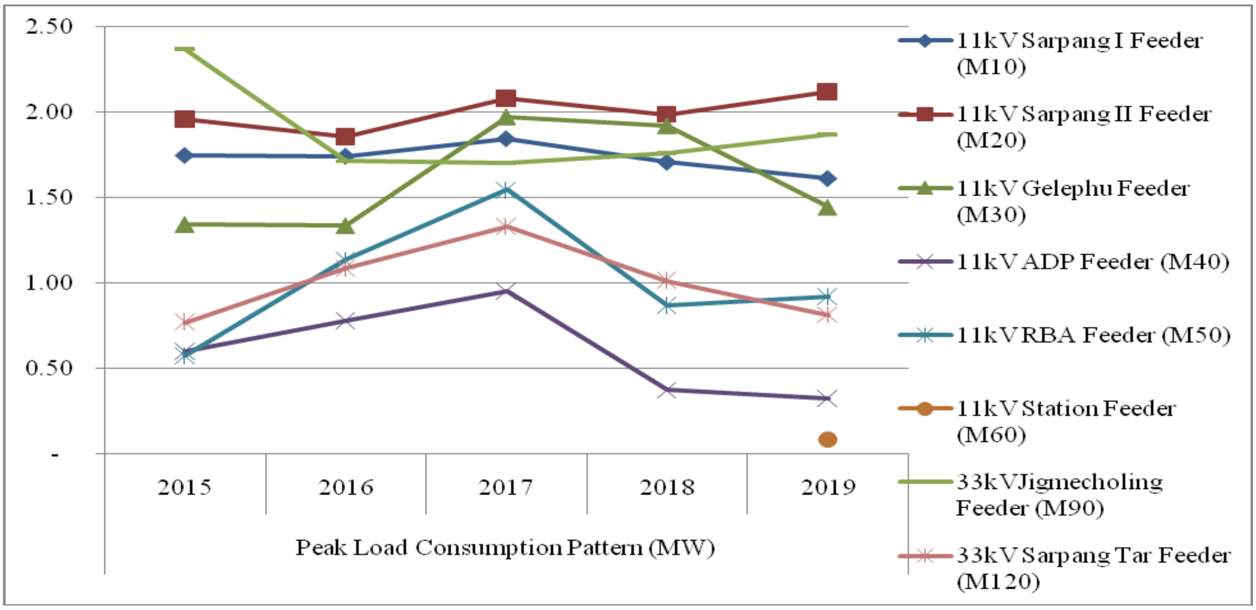


Figure 3: Plot of Feeder Wise Peak Power Demand

As can be inferred from **Figure 3,** the peak load growth pattern is irregular which may be due to interconnections and due to data anomalous to some extent.

The peak power demand for the MV feeders from 2015-2019 has been considered to forecast the peak power demand for next 10 years (2020-2030) which is tabulated in **Table 8.**

Although, the peak load growth from 2015-2019 is irregular; with the actualization of LAPs and IPs, the power requirement for Sarpang Dzongkhag (Jigmeling IPs and Gelephu town) would increase drastically. Therefore, the load forecast has been carried out including the load requirement of the IPs and the Thromde developments.

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 7.**

Table 7: 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
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 the feeders would be within the range with the existing load however, the 11kV RBA and 11kV Gelephu feeders constructed on Dog and Rabbit would exceed the thermal limit of the conductors as it is forecasted to reach around 6MW and 7MW by 2025 and 2030 respectively. However, due to shorter circuit line length, voltage profile is expected to be within the permissible range. Nevertheless, 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 2015-2019 has been considered to forecast the peak power demand for the next 10 years (2020-2030) as shown in **Table 8** and **Figure 4** 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 8: Feeder Peak Power Demand Forecast

Sl.No.	Feeder name	Total circuit line length (km)	Total Transformer	Connected kVA	Total Forecasted Load Growth (MW)		
					2019	2025	2030
1	11kV Sarpang I Feeder (M10)	52.96	38	5635	1.61	3.09	3.77
2	11kV Sarpang II Feeder (M20)	41.02	27	3521	2.12	3.13	3.01
3	11kV Gelephu Feeder (M30)	5.24	14	5517	1.44	6.22	7.47
4	11kV ADP Feeder (M40)	9.41	6	2002	0.32	3.34	3.91
5	11kV RBA Feeder (M50)	12.79	17	2279	0.92	5.58	6.86
6	11kV Station Feeder (M60)	0.06	1	500	0.08		
7	33kV Geychu Feeder (M70)	39.64	33	794		0.24	0.30
8	33kV Pelrithang Feeder (M80)	6.31	4	2875	0.12	0.21	0.26
9	11kV Jigmecholing Feeder (M90)	66.95	45	2637	0.62	1.11	1.34
10	11kV Jarwa Feeder (M100)	5.93	6	350	0.07	0.12	0.14
11	11kV ADP II Feeder	16.57	14	889	0.67	1.58	1.45

Sl.No.	Feeder name	Total circuit line length (km)	Total Transformer	Connected kVA	Total Forecasted Load Growth (MW)		
					2019	2025	2030
12	11kV RBA Feeder	3.71	5	813	0.39	0.59	0.67
13	33kV Jigmeling Feeder (M110)	12.42			-		
14	33kV Sarpang Tar Feeder (M120)	17.81	1	2500	0.81		
15	11kV Singye Feeder (M130)	20.97	18	1538		0.79	0.99
16	11kV Near DFO office Feeder (M140)	0.04	1	500		0.47	0.59
17	11kV Near Sarpang School Feeder (M150)	0.47	1	500		0.37	0.46
18	33kV Jigmeling Feeder (Kidu)(M160)	0.96	1	63		0.05	0.05
19	11kV Sarpang Tar Station Feeder (M180)		1	63		0.01	0.02
20	11kV Pelrithang Station Feeder (M190)		1	63			
21	11kV New Dovan Feeder (M170)	82.26	56	1217	-	0.54	0.65
	Total	**395.52**	**290.00**	**34256.00**	**9.17**	**27.42**	**31.94**

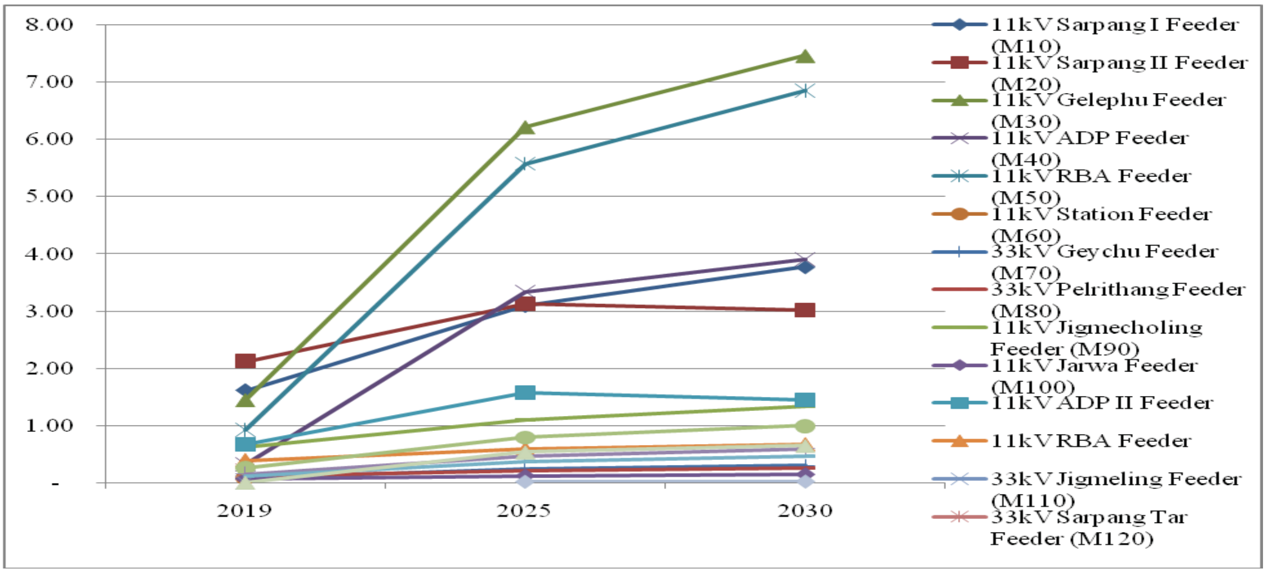


Figure 4: Plot of feeder wise peak power demand forecast of ESD, Gelephu

From the above table, it is observed that the highest peak load as on 2019 is 2.12MW for 11kV Sarpang II feeder which is expected to grow up to 3.13MW in 2025 but would reduce to 3.014MW by 2030 as 27DTs would be fed from Sarpang Tar substation which is arranged to improve the voltage profile of the existing feeder. Similarly, the highest peak load in case of 33kV feeder is 1.87MW for Pelrithang feeder and is expected to reach 3.60MW and 3.86MW by 2025 and 2030 respectively.

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 9**. 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 9: Feeders with Poor Voltage Profile (2019, 2025 & 2030)

Sl. No.	Name of Feeder	Circuit Length (km)	End Voltage (kV)	% Variation	Load (MW)		
					2019	2025	2030
A	**2019**						
1	11kV Sarpang I	135.22	9.73	11.55%	0.979	2.82	3.41
2	Sarpang II	41.02	9.61	12.64%	1.51	2.50	3.01
B	**2025**						
1	Sarpang I	135.22	7.99	27.36%	0.979	2.82	3.412
2	Sarpang II	41.02	7.07	35.73%	1.513	2.495	3.01
3	Gelephu	5.24	8.89	19.18%	0.946	1.92	2.09
4	ADP	25.98	8.82	19.82%	1.169	3.208	3.22
5	RBA	16.50	8.85	19.55%	1.022	1.578	1.79
6	33kV Pelrithang	6.31	29.48	10.67%			
8	ADP II		8.88	19.27%			
9	Jarwa	5.93	9.56	13.09%	0.07	0.12	0.14
10	11kV Jigmecholing	66.95	9.24	16.00%			
			9.02	18.00%			
C	**2030**						
1	Sarpang I	135.22	9.02	18.00%	0.979	2.82	3.412
2	Sarpang II	41.02	7.22	34.36%	1.51	2.50	3.01

Sl. No.	e of Feeder	rcuit ;th (km)	Voltage kV)		2019	2025	
4	Jigmecholing	66.95					
			).49				

The 11kV and 33kV 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 and 2030 which are detailed as follows:

a) 11kV Sarpang I Feeder

The Sarpang I feeder has 135.22km constructed on Dog (45.70) and Rabbit (56.36km) conductors. Most of the loads connected to this feeder are rural customer and therefore, the connected loads are static/impedance load in nature.

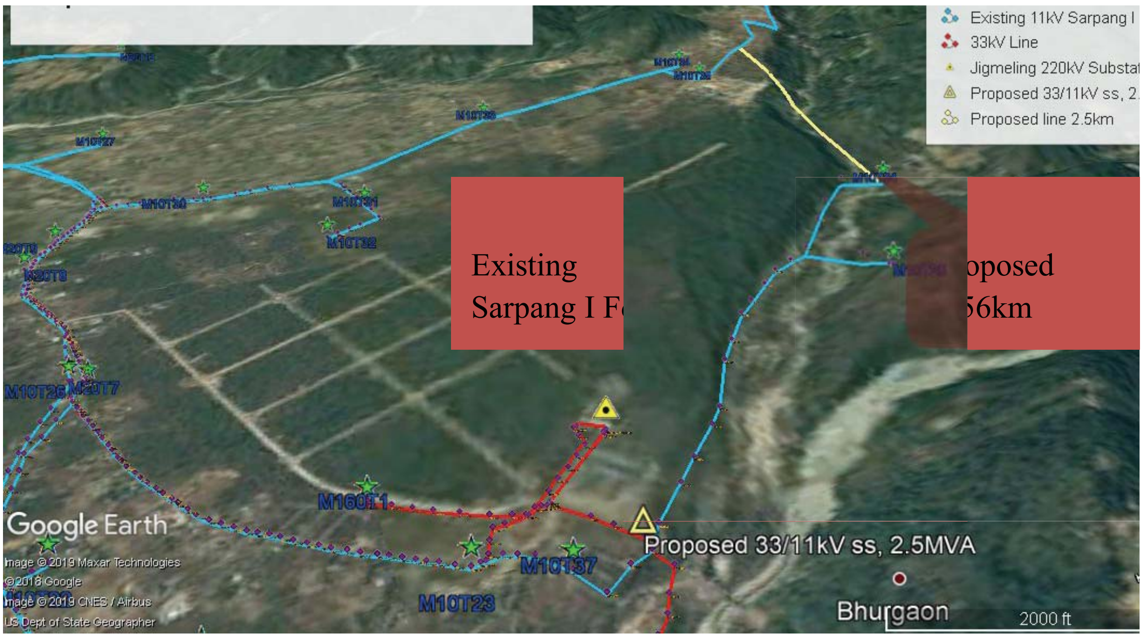


Figure 5: Proposed 11kV Doven feeder

The voltage profile at the end of the feeder is 88.45% with the existing load and would decrease with the increased forecasted load. Simulation result shows that it will be 72.64%

and 82.00% by (with the up-grading of the substation and utilizing the tap) 2025 and 2030 with the forecasted load. With the proposal to construct 33/11kV, 3MVA substation (3MVA transformer and accessories are available at Jigmeling) at Jigmeling and interconnecting 2.56km MV line from Rataygaon to Dologang; the 11kV Sarpang feeder would be reduced by 82.61km. With this reinforcement and reconfiguration of network, the voltage profile is expected to be improve up to 91% and reliability would be improved as well.

It is prudent to improve the voltage profile by making use of the incremental tap changes prior to resorting to other alternatives. Therefore, with the proposal to up-grade the 66/11kV, 10MVA Gelephu substation and utilizing the tap changer of power transformer, the voltage profile would improve to 84.22%. Further with ±5% provision available at DT level, the voltage regulation would be within the permissible range. However, the receiving voltage at the end of the feeder would be 79.00% with the 2030 loading. Therefore, it is strongly recommended to monitor the load growth and accordingly the voltage regulation for this feeder post 2025.

b) 11kV Gelephu Feeder

The Gelephu I feeder has 5.24km constructed on Dog, 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 with the existing load is within the permissible range however, it would be below the set range with the forecasted load of 2025 and 2030.

It is prudent to improve the voltage profile by making use of the incremental tap changes prior to resorting to other alternatives. Therefore, with the proposal to up-grade the 66/11kV, 10MVA Gelephu substation and utilizing the tap changer of power transformer, the voltage profile would improve up to 98.46%. Further with ±5% provision available at DT level, the voltage regulation would be within the permissible range even with the forecasted load of 2030.

c) 11kV ADP Feeder

The ADP feeder has 25.98km constructed on Dog, Rabbit and UG conductor. 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 with the existing load will be within the permissible range however, it would be below the set range for 2025 & 2030 forecasted load. Simulation result shows that it will be 80.18% with the forecasted load of 2025.

It is prudent to improve the voltage profile by making use of the incremental tap changes prior to resorting to other alternatives. Therefore, with the proposal to up-grade the 66/11kV, 10MVA Gelephu substation and utilizing the tap changer of power transformer, the voltage profile would improve to 93.82%. Further with ±5% provision available at DT level, the voltage regulation would be within the permissible range even with the forecasted load of 2030.

d) 11kV RBA Feeder

The RBA feeder has 16.5km constructed on Dog, Rabbit and UG conductor. 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 with the existing load will be within the permissible range however, it would be below the set range for 2025 & 2030 forecasted load. Simulation result shows that it will be 80.45% with the forecasted load of 2025.

It is prudent to improve the voltage profile by making use of the incremental tap changes prior to resorting to other alternatives. Therefore, with the proposal to up-grade the 66/11kV, 10MVA Gelephu substation and utilizing the tap changer of power transformer, the voltage profile would improve up to 91.63%. Further with ±5% provision available at DT level, the voltage regulation would be within the permissible range even with the forecasted load of 2030.

e) 33kV Jigmecholing Feeder

The Jigmecholing feeder has 66.95km constructed on Dog, Rabbit and AAAC 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 with the existing load will be within the permissible range however, it would be below the set range for 2025 & 2030 forecasted load. Simulation result shows that it will be 84.00% with the forecasted load of 2025.

It is prudent to improve the voltage profile by making use of the incremental tap changes prior to resorting to other alternatives. Therefore, with the proposal to up-grade the 66/11kV, 10MVA Gelephu substation and utilizing the tap changer of power transformer, the voltage profile would improve to 89.82%. Further with ±5% provision available at DT level, the voltage regulation would be within the permissible range even with the forecasted load of 2030.

f) 11kV ADP II & 11kV Umling Feeders

Although, the 11kV ADP II & 11kV Umling feeders would experience low voltage regulation; by making use of the tap increment of the power transformer would improve it to permissible range.

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 load 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 10**.

Even with the proposal to change the conductor size would not result significant improvement in voltage profile due to longer circuit line length and magnitude of load connected. Therefore, techno-commercial analysis on the different types of mechanism to improve the voltage profile should be explored as some of the literature reviews indicates that AVR would be economical and technically feasible over the other alternatives (resizing, capacitor banks etc…) if it is exclusively meant for improving the voltage profile. Therefore, it is proposed to install AVR (2/3 of the circuit line length) at strategic locations.

Table 10: Feeder wise voltage improvement

Sl.No.	Name of Feeder	Before		After		Remarks
		Voltage (kV)	% Variation	Voltage (kV)	% Variation	
A	**2019**					
1	11kV Sarpang I	9.73	11.55%	10.09	8.27%	Reduction of load & line length by constructing 11kV Dovan from 220kV Jigmeling SS.
2	11kV Sarpang II	9.61	12.64%	9.92	9.82%	Reconfiguring the sources.
B	**2025**					
1	11kV Sarpang I	7.99	27.36%	9.45	14.09%	Source up-graded and tap utilized.
2	11kV Sarpang II	7.07	35.73%	9.27	15.73%	Source up-graded, tap utilized and sources reconfigured.
3	11kV Gelephu	8.89	19.18%	10.38	5.64%	Source up-graded and tap utilized.
4	11kV ADP	8.82	19.82%	10.32	6.18%	Source up-graded and tap utilized.
5	11kV RBA	8.85	19.55%	10.08	8.36%	Source up-graded and tap utilized.
6	33kV Pelrithang	29.48	10.67%	30.84	6.55%	Source up-graded and tap utilized.
7	RBA from 33/11kV Pelrithang SS	9.57	13.00%	10.36	5.82%	Source up-graded and tap utilized.
8	11kV ADP II	8.88	19.27%	9.55	13.18%	Source up-graded and tap utilized.
9	11kV Jarwa	9.56	13.09%	10.25	6.82%	Source up-graded and tap utilized.
10	11kV Jigmecholing	9.24	16.00%	10.00	9.09%	Source up-graded and tap utilized
		9.02	18.00%	9.77	11.18%	
C	**2030**					
1	11kV Sarpang I	9.02	18.00%			Tap of DTs to be utilized.
2	11kV Sarpang II	7.22	34.36%	8.70	20.91%	Source up-graded, tap utilized and sources reconfigured.
3	11kV New Dovan feeder	9.86	10.36%			Tap of DTs to be utilized.

Sl.No.	Name of Feeder	Before		After		Remarks
		Voltage (kV)	% Variation	Voltage (kV)	% Variation	
4	11kV Jigmecholing	9.77	11.18%			Tap of DTs to be utilized.
		9.49	13.73%			Tap of DTs to be utilized.
5	11kV ADP II	9.29	15.55%			Tap of DTs to be utilized.

7.2.2 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 11** and as shown in **Figure 6.**

Table 11: Summary of Total Energy Loss (MU)

Sl. No.	Particulars	2014	2015	2016	2017	2018	Average
1	Energy Requirement in kWh	25.95	27.62	28.60	30.45	32.24	**28.97**
2	Energy Sales in kWh (Category Wise)	22.86	24.24	27.50	27.96	29.38	**26.39**
3	Total Loss (MU)	3.09	3.38	1.10	2.49	2.86	**2.59**
	Total loss (%)	**11.92%**	**12.24%**	**3.85%**	**8.18%**	**8.88%**	**9.02%**

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.

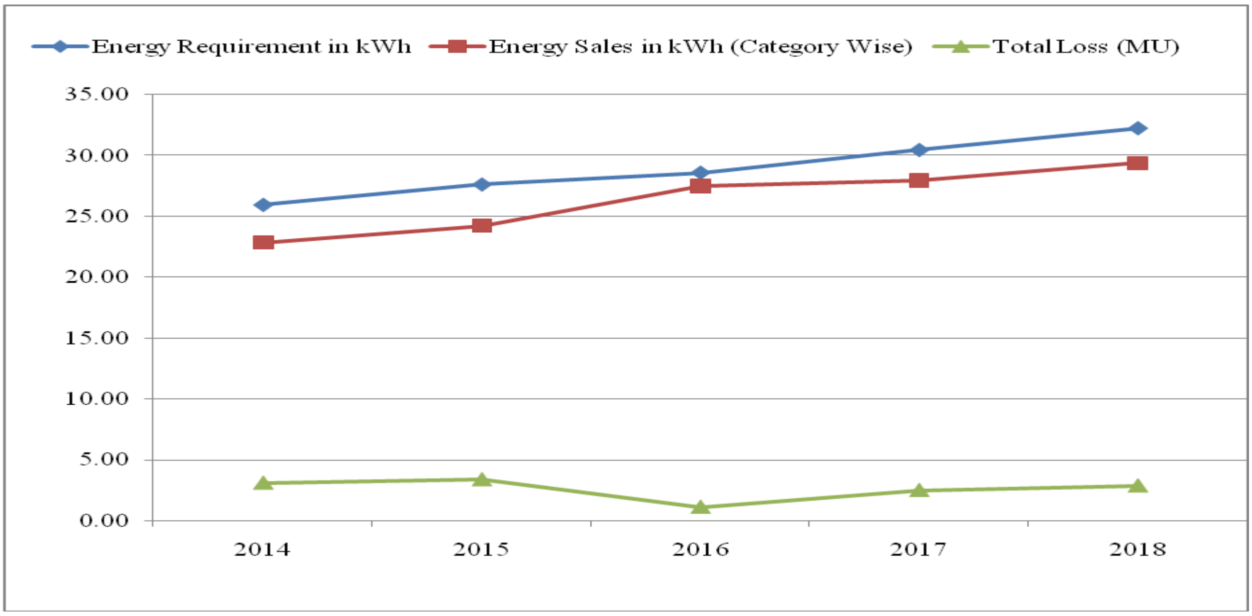


Figure 6: Plot of Total Energy Loss (MU)

The average energy loss of the entire feeder is 9.02% (2.59 million units on average) from 2014 to 2018 and Gelephu has experienced fluctuating trend of energy loss which may not be able to explicitly ascertain the reasons of fluctuations however, it could be due to mass rural homes connected to grid through rural electrification projects. The 2016 energy loss is 3.85% only which is way beyond the normal range (8%-11.92%).

Table 12: Feeder Wise Energy loss in (MU) of ESD, Gelephu

Sl. No.	Feeder Name	Circuit length (km)	2014	2015	2016	2017	2018	Average	Loss %
1	11kV Sarpang I Feeder (M10)	135.22	0.74	0.81	0.26	0.59	0.68	0.62	2.15%
2	11kV Sarpang II Feeder (M20)	41.02	0.40	0.44	0.14	0.32	0.37	0.33	1.17%
3	11kV Gelephu Feeder (M30)	5.24	0.15	0.17	0.05	0.12	0.14	0.13	0.45%
4	11kV ADP Feeder (M40)	25.98	0.37	0.41	0.13	0.30	0.34	0.31	1.08%
5	11kV RBA Feeder (M50)	16.50	0.20	0.22	0.07	0.16	0.18	0.17	0.58%
6	11kV Station Feeder (M60)	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.01%

Sl. No.	Feeder Name	Circuit length (km)	2014	2015	2016	2017	2018	Average	Loss %
7	33kV Geychu Feeder (M70)	39.64	0.22	0.24	0.08	0.17	0.20	0.18	0.63%
8	33kV Pelrithang Feeder (M80)	6.31	0.05	0.06	0.02	0.04	0.05	0.05	0.16%
9	33kV Jigmecholing Feeder (M90)	66.95	0.26	0.29	0.09	0.21	0.24	0.22	0.76%
10	11kV Jarwa Feeder (M100)	5.93	0.19	0.20	0.07	0.15	0.17	0.16	0.54%
11	11kV Jigmeling Feeder (M110)	12.42	0.08	0.09	0.03	0.06	0.07	0.07	0.23%
12	33kV Sarpang Tar Feeder (M120)	17.81	0.07	0.08	0.02	0.06	0.06	0.06	0.20%
13	11kV Singye Feeder (M130)	20.97	0.17	0.18	0.06	0.14	0.16	0.14	0.49%
14	11kV Near DFO office Feeder (M140)	**0.04**	0.02	0.03	0.01	0.02	0.02	0.02	0.07%
15	11kV Dzong feeder Sarpang (M150)	0.47	0.05	0.06	0.02	0.04	0.05	0.05	0.16%
16	33kV Jigmeling Feeder (M160)	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.01%
	11kV Doven Feeder (M170)		0.11	0.12	0.04	0.09	0.10	0.09	0.32%
17	11kV Sarpang Tar Station Feeder (M180)		0.00	0.00	0.00	0.00	0.00	0.00	0.00%
18	11kV Pelrithang Station Feeder (M190)		0.00	0.00	0.00	0.00	0.00	0.00	0.00%
	Total	**395.52**	**3.09**	**3.38**	**1.10**	**2.49**	**2.86**	**2.59**	**9.02%**

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 12.** The feeder wise energy loss as tabulated in **Table 12** and **Figure 7** indicates that 11kV Sarpang I, 11kV Sarpang II and 11kV ADP feeders had contributed the major portion of the energy loss of ESD, Gelephu. More or less, these feeders have more circuit length than the others.

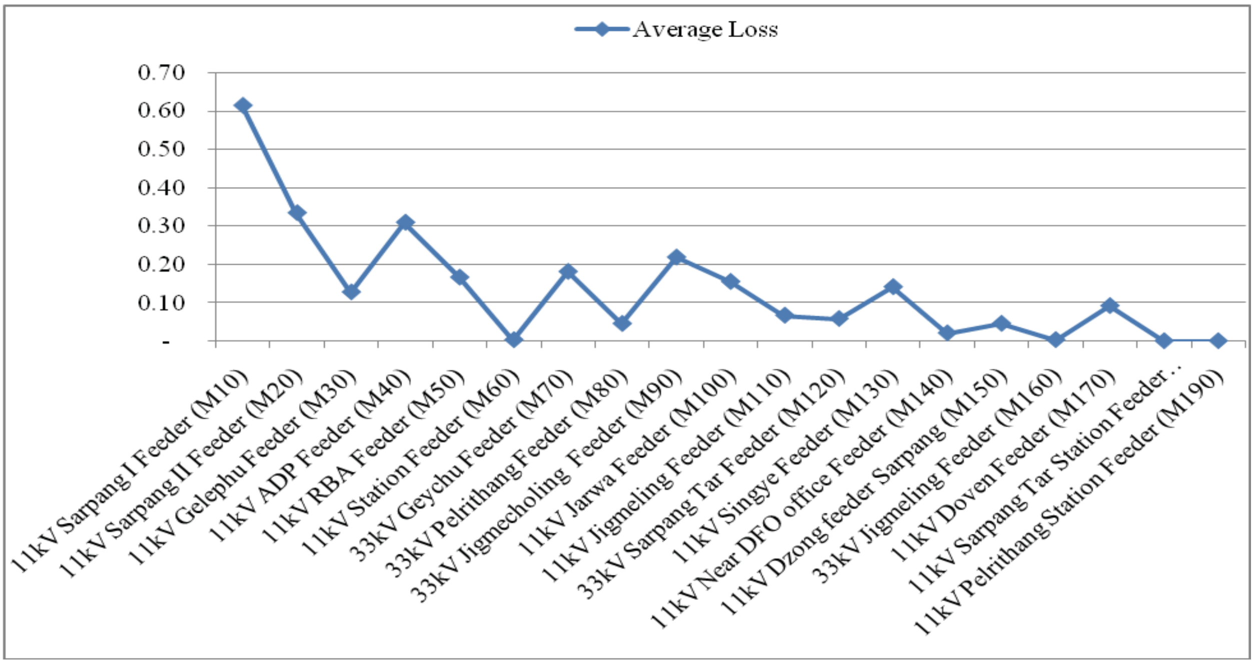


Figure 7: Feeder Wise Energy Loss (MU) of ESD, Gelephu

7.2.3 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 13** 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 from 2016-2019 are 46.45 & 70.72 respectively which is exceptionally high.

Table 13: The reliability indices (2016-2019)

Sl. No.	Year	Reliability Indices	11kV Sarpang I	11kV Sarpang II	11kV Gelephu	11kV ADP	11kV RBA	33kV Jigmeling	11kV Station
1	2016	SAIFI	10.36	8.31	5.29	4.83	5.19	2.63	0.00
		SAIDI	17.55	19.65	7.10	8.58	6.61	2.69	0.03
2	2017	SAIFI	15.66	10.46	6.71	2.95	4.96	2.84	-
		SAIDI	16.57	21.83	9.92	10.00	7.38	8.58	-
3	2018	SAIFI	13.36	13.96	8.37	4.32	6.78	9.52	0.01
		SAIDI	16.01	24.83	9.53	7.89	9.98	28.51	0.01
4	2019	SAIFI	15.31	12.14	6.39	5.69	7.11	2.65	-
		SAIDI	12.51	15.71	3.39	4.26	6.68	7.10	-
	Overall total	**SAIFI**	**13.67**	**11.22**	**6.69**	**4.45**	**6.01**	**4.41**	**0.00**
		SAIDI	**15.66**	**20.51**	**7.48**	**7.68**	**7.66**	**11.72**	**0.01**
	Average			***SAIFI***	***46.45***	***SAIDI***	***70.72***		

Generally, power interruptions are due to lightening, rainfall, and transient, followed by HT fuse replacement and line maintenance which are inter-related to each other.

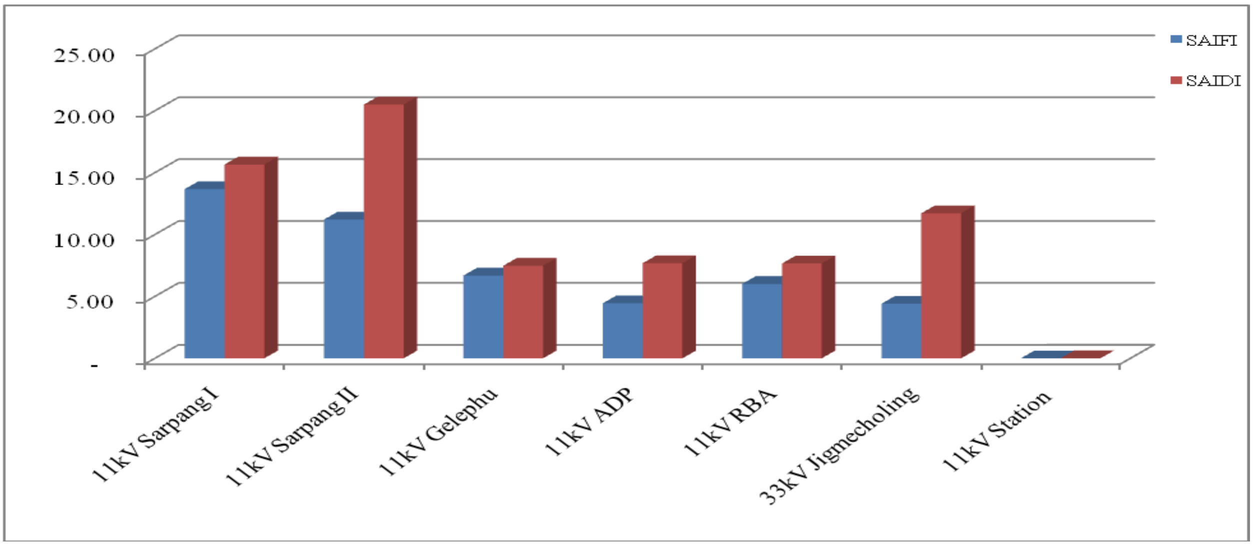
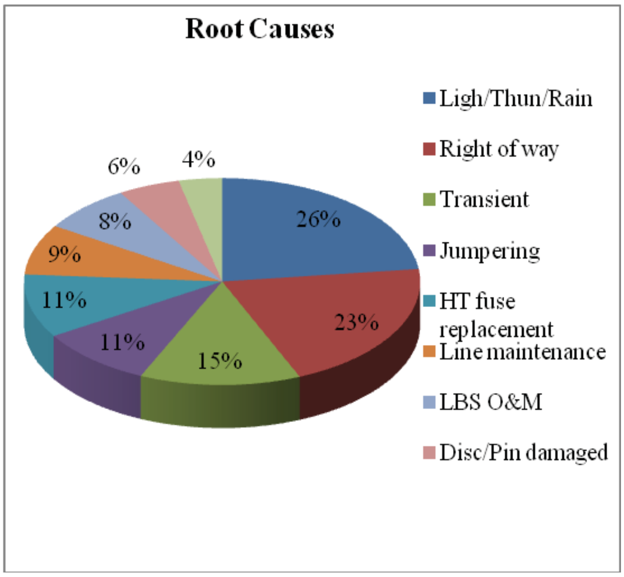


Figure 8: Feeder Wise SAIFI & SAIDI of ESD, Gelephu

To get a better understanding of the reliability index, the detailed root cause outages of the individual feeder had been computed as shown in **Figure 9.**



Root Causes	Frequency	% Distribution
Ligh/Thun/Rain	137	26%
Right of way	122	23%
Transient	78	15%
Jumpering	56	11%
HT fuse replacement	59	11%
Line maintenance	47	9%
LBS O&M	44	8%
Disc/Pin damaged	30	6%
Adhoc works	21	4%

Figure 9: Root Causes

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 Sarpang I Feeder

The circuit length of this feeder is 135.22km and passes through thick vegetation and rugged terrain and therefore, is more susceptible to faults compared to other feeders. The feeder recorded SAIFI and SAIDI of 13.67 and 15.66 respectively on average from 2016-2019. There are ARCBs and LBS as switching devices installed in this feeder for better operation and maintenance and more importantly to reduce the down time in restoring the power supply. In order to address the reliability issue of this feeder, following remedial and corrective measures are proposed:

- **Reduction of circuit length**

  By proposing to construct 2.56km from Rataygaon to Dologang, it will not only reduce the circuit length of the feeder by 82.61km and relieve significant portion of the load, it is also anticipated to improve the quality of power and reliability.

- **Installation of more and smart switching devices**

It is proposed to install more and smart switching devices like ARCBs, Sectionalizers (1 no.) and FPIs (4 nos).

- **Re-configuration of sources**

The customers of 11kV Sarpang I feeder are fed from Gelephu substation. It is proposed to feed some of the loads from the newly proposed 33/11kV, 3MVA substation.

b) 11kV Sarpang II Feeder

The circuit length of this feeder is 41.02km and passes through thick vegetation and rugged terrain and therefore, is more susceptible to faults compared to other feeders. The feeder recorded SAIFI and SAIDI of 11.22 and 20.51 respectively on average from 2016-2019. Only the LBSs are installed each on the termination of Gelephu and Sarpang Tar substations as switching devices. In order to address the reliability issue of this feeder, following remedial and corrective measures are proposed:

- **Reduction of circuit length**

Proposal to cater the power supply to the customers of 27DTs of the Sarpang II feeder from Sarpang Tar substation would not only improve the power quality, it will also enhance reliability by reducing the circuit length.

- **Installation of more and smart switching devices**

It is proposed to install more and smart switching devices like ARCBs (1 no.), Sectionalizers (1 no.) and FPIs (3 nos).

c) 11kV Jigmelcholing Feeder

The circuit length of this feeder is 66.95km and caters power to four (4) Gewogs (Jigmecholing, Umling, Tareythang and part of Sershong). As section of line passes through dense vegetation and rugged terrain, frequent power interruption occurs mostly in this en-route affecting the power supply to other three Gewogs. There is only an ARCB installed at the termination of the feeder at Perlithang substation. Therefore, to reduce the number of customers affected and improves the reliability, following remedial and corrective measures are proposed:

- **Installation of more and smart switching devices**

It is proposed to install more and smart switching devices like Sectionalizers (1 no.) and FPIs (2 nos) in this feeder.

d) 11kV New Dovan Feeder

There are no single switching devices installed on this feeder. Therefore, interruption due to any faults would mean that entire customers connected in this feeder would experience the outage. Due to non-availability of installed switching devices in the feeder, even to change the DO fuse, power has to be shutdown form the control room which affects the entire customer connected to the feeder and reliability. Therefore, to reduce dependency on control room for carrying out any O&M related works and to improve the reliability, it is proposed to install more and smart switching devices like ARCBs (1no.), Sectionalizers (2 no.) and FPIs (3 nos) in this feeder.

e) 11kV Singye Feeder

The 11kV Singye feeder of 33/11kV Sarpang Tar substation feeds power supply to Singye Gewog as well as part of Sarpang Tar. The maximum line fault occurs in Singye areas affecting customers of Sarpang Tar also. In order to avoid power interruption in the entire feeder and to improve the reliability of the feeder, an ARCB is proposed.

7.2.4 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 26.19 km and the estimate for such conversion would require Nu. 3.02 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 will 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 14**. The individual DT loading details used to derive the summary is attached as **Annexure-7**.

Table 14: List of overloaded distribution transformers

Sl. No	Name of Feeder	Capacity (kVA)	2019		2025		2030	
			3ph load (kVA)	% Loading	3ph load (kVA)	% Loading	3ph load (kVA)	% Loading
1	Upper Juprey I	63	23.39	37.12%	67.37	106.94%	81.52	129.39%
2	Juprey Top	16	8.04	50.28%	23.18	144.86%	28.04	175.27%
3	Paita Khola Village	250	105.09	42.03%	302.75	121.10%	366.30	146.52%
4	Bhur Zero	63	34.50	54.77%	99.41	157.79%	120.27	190.91%
6	Chokorling	125	53.12	42.49%	153.03	122.43%	185.16	148.13%
7	Lekithang(Majuwa)	63	53.42	84.79%	153.89	244.27%	186.19	295.54%
8	Above Sansari market (Torba	125	66.86	53.48%	192.61	154.09%	233.04	186.43%
14	Ramitay B	16	9.24	57.74%	26.61	166.33%	32.20	201.25%
15	Pangkhay BHU	25	8.88	35.52%	25.58	102.33%	30.95	123.82%
17	Bagjungay B	16	6.68	41.75%	19.25	120.28%	23.29	145.54%
18	Daragaon C	16	5.54	34.64%	15.97	99.80%	19.32	120.75%
20	Jigmeling II (Near	100	57.71	57.71%	130.06	130.06%	160.81	160.81%

Sl. No	Name of Feeder	Capacity (kVA)	2019		2025		2030	
			3ph load (kVA)	% Loading	3ph load (kVA)	% Loading	3ph load (kVA)	% Loading
	BHSL office)							
21	Dekling School	125	45.96	36.77%	103.60	82.88%	128.08	102.47%
22	Pantharigoan	63	22.63	35.92%	51.01	80.96%	63.06	100.10%
23	Glalley Busty	250	218.84	87.54%	240.45	96.18%	262.06	104.83%
24	market	500	1,329.83	265.97%	1,698.91	339.78%	2,067.98	413.60%
25	Hero Majan	63	56.59	89.82%	62.18	98.69%	67.76	107.56%
26	Charali	500	1,287.62	257.52%	1,627.75	325.55%	1,967.89	393.58%
27	Infront of RBP Division V office	500	679.76	135.95%	813.17	162.63%	946.58	189.32%
28	TeleCom	125	248.45	198.76%	320.58	256.46%	392.70	314.16%
29	Fishery	500	984.78	196.96%	1,279.60	255.92%	1,574.41	314.88%
30	Royal Guest House	500	719.47	143.89%	918.51	183.70%	1,117.56	223.51%
31	Maji Bastey below Tali Dratsang	125	561.13	448.91%	891.69	713.36%	1,074.55	859.64%
32	Magibusty	125	326.48	261.19%	646.04	516.83%	748.73	598.98%
34	RVL	250	888.96	355.58%	1,346.50	538.60%	1,638.12	655.25%
36	Lakitar/ Samdrupling	125	-	0.00%	1,505.28	1204.22%	1,871.01	1496.81%
37	Upper Lakitar	63	-	0.00%	96.21	152.72%	114.93	182.42%
38	Shetikhari	63	85.85	136.28%	2,116.61	3359.70%	2,640.43	4191.15%
39	Upper Pemathang	250	99.39	39.76%	281.92	112.77%	331.22	132.49%
40	DhoulaKhola	125	93.49	74.79%	141.12	112.90%	160.08	128.06%
41	Upper RBA (Family)	250	179.60	71.84%	271.10	108.44%	307.52	123.01%
42	Above forest range office (Forest Checkpost)	125	118.49	94.79%	1,699.67	1359.73%	2,114.00	1691.20%
43	Lungta Workshop (MRF)	125	144.95	115.96%	218.80	175.04%	248.20	198.56%
44	Middle Pelrithang, BPC compound.	63	42.66	67.72%	64.39	102.21%	73.05	115.95%
49	Jogidara	25	8.72	34.87%	26.97	107.89%	33.98	135.92%
51	Khopitar	25	25.73	102.92%	79.61	318.46%	100.30	401.20%
53	Muga 'A'	16	4.82	30.13%	14.91	93.22%	18.79	117.44%

Sl. No	Name of Feeder	Capacity (kVA)	2019		2025		2030	
			3ph load (kVA)	% Loading	3ph load (kVA)	% Loading	3ph load (kVA)	% Loading
54	Sisty 'B'	25	7.16	28.66%	22.17	88.67%	27.93	111.71%
58	Pemathang (near Throema Lhakhang)	125	77.83	62.26%	138.65	110.92%	168.17	134.53%
59	Pemathang	25	12.70	50.80%	22.62	90.49%	27.44	109.76%
60	Upper Chasakhar	25	19.13	76.53%	34.08	136.34%	41.34	165.37%
61	Middle Chasakhar	100	52.52	52.52%	93.56	93.56%	113.48	113.48%
62	Lower Chasakhar	63	53.40	84.76%	95.13	151.00%	115.38	183.15%
63	Thongjabi under Chhuzagang Gewog	63	43.17	68.52%	76.90	122.07%	93.28	148.06%
64	Barthang	63	56.09	89.03%	99.92	158.61%	121.20	192.38%
65	Zombabee	63	34.06	54.06%	60.68	96.31%	73.59	116.82%
66	Upper Dewathang	63	52.84	83.87%	94.13	149.41%	114.17	181.23%
67	Lingar	63	40.10	63.65%	71.43	113.38%	86.64	137.53%
70	Jurwa-I (Eddhi)	63	46.88	74.41%	83.51	132.56%	101.30	160.79%
71	Pangkhar	25	20.65	82.62%	36.79	147.18%	44.63	178.51%
72	Pemaling	125	71.00	56.80%	126.48	101.19%	153.41	122.73%
73	Norbuling Village	100	58.34	58.34%	103.92	103.92%	126.05	126.05%
74	Norbuling MSS	125	113.32	90.66%	201.88	161.50%	244.86	195.89%
75	Infront of Norbuling MSS	63	58.85	93.41%	104.84	166.42%	127.16	201.85%
76	Pangzor (Youling)	160	86.45	54.03%	154.01	96.26%	186.80	116.75%
77	Shawapang	63	37.06	58.82%	66.01	104.78%	80.07	127.09%
78	Near Chuzaygang School	63	48.49	76.96%	86.38	137.10%	104.77	166.30%
79	Tashiphu, Below Lhakhang	63	53.16	84.38%	94.70	150.32%	114.87	182.33%

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 17 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 15.**

Table 15: Proposed Lists of DTs Requiring Up-Grading

Sl. No.	List of Transformers	Capacity (kVA)	Peak Load	% Loading	Proposed Capacity (kVA)	Adjustment/New
	List of Transformers for 2019					
1	Lungta Workshop (MRF)	125	218.80	175%	250	New
	List of Transformers for 2025					
1	Juprey Top	16	23.18	144.86%	25	Adjustment-Pangkhay
2	Bhur Zero	63	99.41	157.79%	125	Adjustment-Above Sansari
3	Chokorling	125	153.03	122.43%	250	
4	Above Sansari Market (Torba	125	192.61	154.09%	250	New
5	Jigmeling II (Near BHSL office)	100	130.06	130.06%	250	New
6	DhoulaKhola	125	141.12	112.90%	250	New
7	Khopitar	25	79.61	318.46%	100	Adjustment-Jigmeling
8	Upper Chasakhar	25	34.08	136.34%	63	Adjustment-Lower Chasakhar
9	Lower Chesakhar	63	95.13	151.00%	125	Adjustment-Dhoulakhola
10	Barthang	63	99.92	158.61%	125	Adjustment-Chokhorling
11	Upper Dawathang	63	94.13	149.41%	125	Adjustment-Lungta Workshop
12	Pangkhar	25	36.79	147.18%	63	Adjustment-Barthang
13	Infront of Norbuling MSS	63	104.84	166.42%	125	New
14	Near Chuzaygang School	63	86.38	137.10%	125	New

Sl. No.	List of Transformers	Capacity (kVA)	Peak Load	% Loading	Proposed Capacity (kVA)	Adjustment/New
15	Tashiphu, Below Lhakhang	63	94.70	150.32%	125	New
	List of Transformers for 2030					
1	Paita Khola Village	250	302.75	121.10%	500	New
	Total Transformers required to up-grade			**17**		
	Extra Transformers	16	1	2019-2025		
		63	5	2025-2030		
		25	2	2025-2030		
	Total extra		**8**			

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.

As per the record available in the ERP-SAP system and the transformer mapping carried out in 2017, there isn't single transformer which has outlived life span. It was found that maximum number of years put to use is 18 years. Therefore, there is a need to re-validate the actual life span of the all the transformers installed in Gelephu to re-confirm on the information available.

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

Gelephu is one of the Thromdes located in the south-central foothills of the country bordering the Indian State of Assam. It has an area of 11.52 sq.km and population of 8,643.00 (PHCB 2017). It is the commercial hub for six central Dzongkhags and gateway to the Indian market as well. Structurally, six LAPs had been identified for development with well-established core town in Gelephu Thromde. Further, Industrial Service Center (ISC) LAP has been also developed mainly for small manufacturing and servicing industries. In addition to above identified developments, Industrial Parks (IPs) at Jigmeling would partake significantly in terms of power requirement. Therefore, in order to meet the increasing power requirement of the customers, proper distribution system is necessary for Gelephu Thromde.

The existing distribution network and reinforcement required as per the forecasted load are detailed LAP wise as follows:

a) **Core Town**

The Gelephu Thromde in general has been growing at 5.5% annually and therefore had experienced many structures in the last couple of years with voluminous inhabitants settled in and around the town. It is imperative that overhead distribution infrastructure would pose more risk to the general public than it used to be. Therefore, it prudent to convert the overhead distribution to underground system to not only enhance the safety of the general public but would be convenient for the operation and maintenance team and aesthetic of the area would be also maintained.

Currently, the power is being fed from Market (M30T3) and Charali (M30T4) substations for the customers of core town. As per the load forecast, the existing 500kVA Market substation would be required to be up-graded to 2000kVA and Charali substation to 2000kVA by 2025. However, the Charali substation has to be relocated since it falls under the route of upcoming Royal Boulevard project and the same has been jointly identified with the Gelephu Thromde.

Figure 10: Delimitation of Core Town of Gelephu

b) LAP-I

LAP-I extends from town area till Rabdeyling with eight (8) number of DTs (4.50MVA) catering power supply to this locality. Out of eight DTs, two (2) DTs (2.50MVA) are private (belongs to CRRH) and are adequate to meet the existing load. However, it is forecasted that the power requirement for the LAP would reach 4.25MW by 2025 which would demand to up-grade the existing transformers as tabulated in **Table 16.**

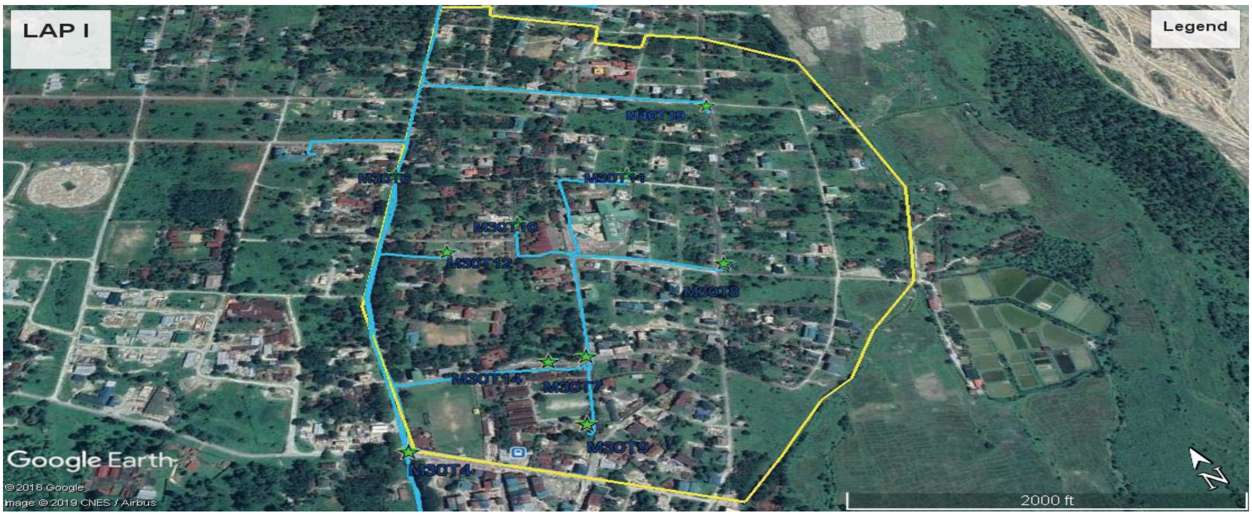


Figure 11: Delimitation of LAP-I

Table 16: Existing and Proposed Lists of DTs in LAP -I

Sl. No.	Location	Existing Capacity (kVA)	GPS No.	Load Forecast (kVA)	Proposed kVA	% Loading
1	RBP Division-V Office	500	M30T7	813.17	1500	54.21%
2	Telecom	125	M30T9	320.58	500	64.12%
3	Fishery	500	M30T8	1279.60	2000	63.98%
4	Royal Guest House	500	M30T6	918.51	1500	61.23%
5	RVL	250	M40T3	1346.50	2000	67.33%
	TOTAL	**1875**		**4678.36**	**7500**	

The above computation has been arrived as per the building construction clearances issued from 2018 to October 2019.

c) LAP-II

In this LAP-II, there are three (3) DTs providing power supply to the customers of Trashiling and part of Samdrupling area. As per the building construction clearance issued and load forecast, the load demand would increase up to 2.83MW by 2025. Therefore, up-grading of the existing transformers would be necessary to meet the increasing power demand as tabulated in **Table 17**.

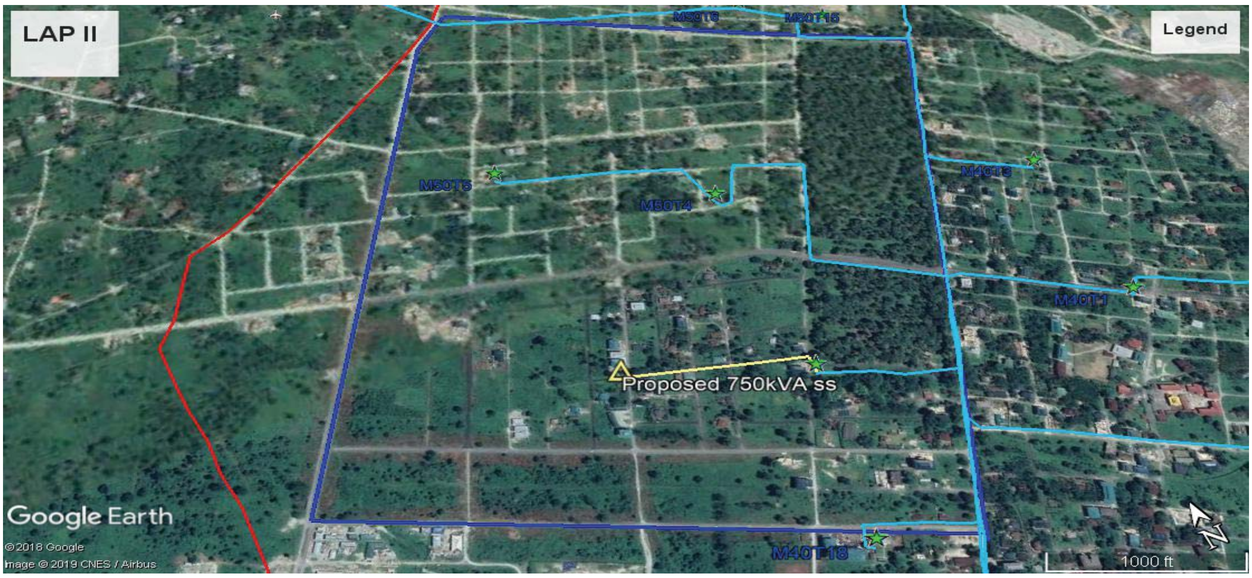


Figure 12: Delimitation of LAP-II

Table 17: Existing and proposed list in LAP-II

Sl.No.	Location	Existing Capacity (kVA)	GPS No.	Load Forecast (kVA)	Proposed kVA	% Loading
1	Lakitar/ Samdrupling	125	M50T4	1505.28	2000	75.26%
2	Upper Lakitar	63	M50T5	96.21	125	76.97%
3	Above Forest Range Office	125	M50T14	1699.67	2000	84.98%
	TOTAL	**188**		**3301.15**	**4125**	

d) LAP-III

LAP-III constitutes the customers of Rabdeyling Demkhong with two (2) DTs, i.e Magi Busty (M40T1) and RVL (M40T3) substations with total installed capacity of 375.00kVA and currently 86.91% and 33.25% loaded respectively. The load demand is expected to reach 1.69MW by 2025 and 2.03MW respectively for Magi Busty and RVL by 2030. Therefore, to meet the increasing power demand, it is proposed to install additional transformers in the areas.

Figure 13: Delimitation of LAP-III

e) LAP-IV

The power supply to the customers of LAP-IV is catered by Sethikhari (M50T6) and new Pemathang (125kVA) substations. Since rapid development is taking place in this LAP at present, Sethikhari (M50T6) substation is already loaded to 136.3%. The load demand of this LAP is expected to grow up to 1.92MW and 2.39MW by 2025 and 2030 respectively. Therefore, it is proposed to up-grade the existing and install new transformers as per the load demand of the LAP.

Figure 14: Delimitation of LAP-IV

f) LAP-V and LAP-VI

LAP-V & LAP-VI is fed by Sarpang-I (M10), Gelephu (M30) and ADP (M40) feeders. Since LAP-V and LAP-VI are under planning stage, power requirement is would be also steady unlike the LAPs. However, the existing DTs shall be monitored closely and up-graded if necessary.

g) ISC LAP

Industrial Service Centre (ISC) LAP has been developed exclusively for small scale industries with 140 plots which have been already allocated for manufacturing and servicing industries. The total load requirement for the LAP works out to be 1.61MW and would be fed from ADP (M40) feeder since this feeder is lightly loaded i.e. only 6 DTs with total peak load of 306.56kW is connected currently.

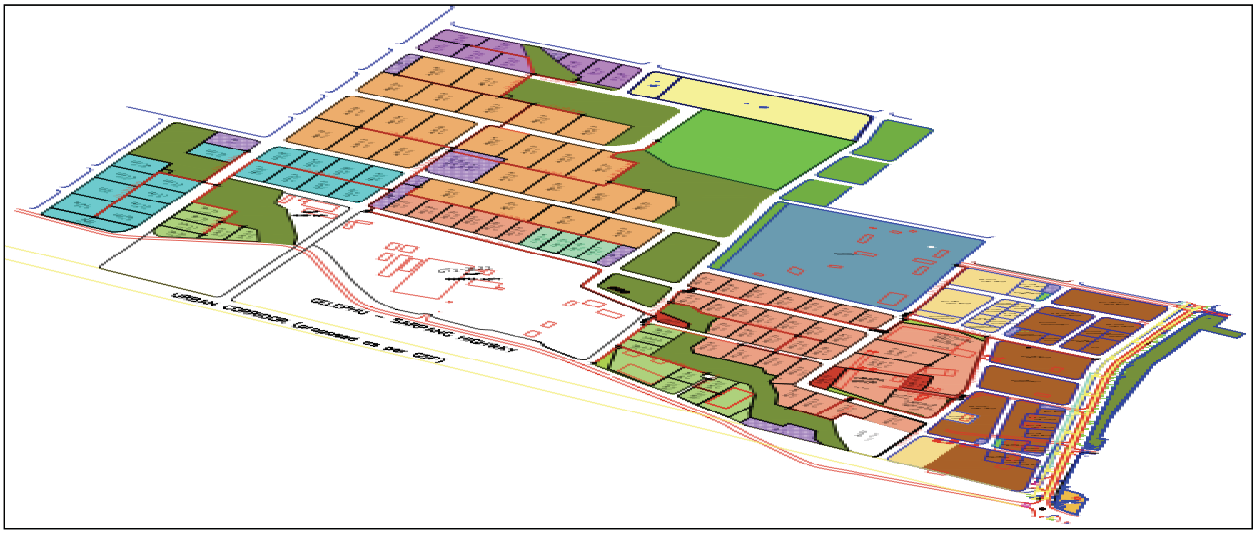


Figure 15: Delimitation of LAP-ISC

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 Substation

Although, the existing installed capacity of 66/11kV Gelephu substation would be adequate to meet the existing load, the power requirement from this substation would surpass the installed capacity. Therefore, to meet the power requirement as reflected **in Section 7.1.1,** it is proposed to up-grade the Gelephu substation to 20MVA.

Table 18: Proposed up-grading of HV substations

Sl. No.	Name of Substation	Source Capacity		Forecasted Load (MW)		
		Existing	Proposed	2019	2025	2030
1	66/11kV, 1X10MVA Gelephu SS	10	20	6.41	20.84	24.38
2	132/33kV, 1X15MVA Jigmeling SS	15	100	2.47	51.49	64.70

Similarly, should the IPs materialized as submitted by IIDD, MoEA, the 132/33kV, 15MVA Jigmeling would not be adequate to meet the power requirement. Therefore, to meet the power requirement of the IPs and the domestic load, it is proposed to up-grade the substation capacity to 100MVA by 2025. However, the proposal on the up-gradation of the substation has to be coordinated with Transmission services for the anticipatory load growth and requirement of HV & MV substation based on the type of load.

8.1.2 MV Substations

As detailed in **Section 7.1.2,** in order to meet the power requirement, the 33/11kV, 2.5MVA Pelrithang substation is proposed to be up-graded to 5MVA. Similarly, new 33/11kV, 3MVA Jigmeling is proposed to be constructed to relieve some of the loads of 11kV Sarpang I feeder, to reduce the circuit line length, improve the voltage profile and to improve the reliability of Sarpang I feeder. Further, the proposal would only require constructing 2.56km of line as 3MVA transformer is available in Gelephu. This would result in optimum usage of the available resources as well as reinforcing the distribution network.

Table 19: Proposed up-grading of MV substations

Sl. No.	Name of Substation	Source Capacity		Forecasted Load (MW)		
		Existing	Proposed	2019	2025	2030
1	33/11kV, 1x2.5MVA Perlithang SS	2.5	5	1.75	3.39	3.60
2	33/11kV, 1x3MVA Jigmeling SS	0	3	New substation at Jigmeling		

8.2 MV and LV Lines

a) Core Town

i. Conversion of 11kV to 3x300 sq. mm UG network in Gelephu core areas along with the trench

ii. Construction of LV UG network in Gelephu core area

b) LAP-II

i. Construction of 11kV Cable trench at Gelephu LAP-II

c) Others

i. In order to improve the power quality of 11kV Sarpang I feeder and to optimize the available resources of Gelephu, it is proposed to construct 2.56 km of MV on Dog from Rataygaon to Dologang. This line is expected to reduce the circuit length of 11kV Sarpang I feeder by 82.61km.

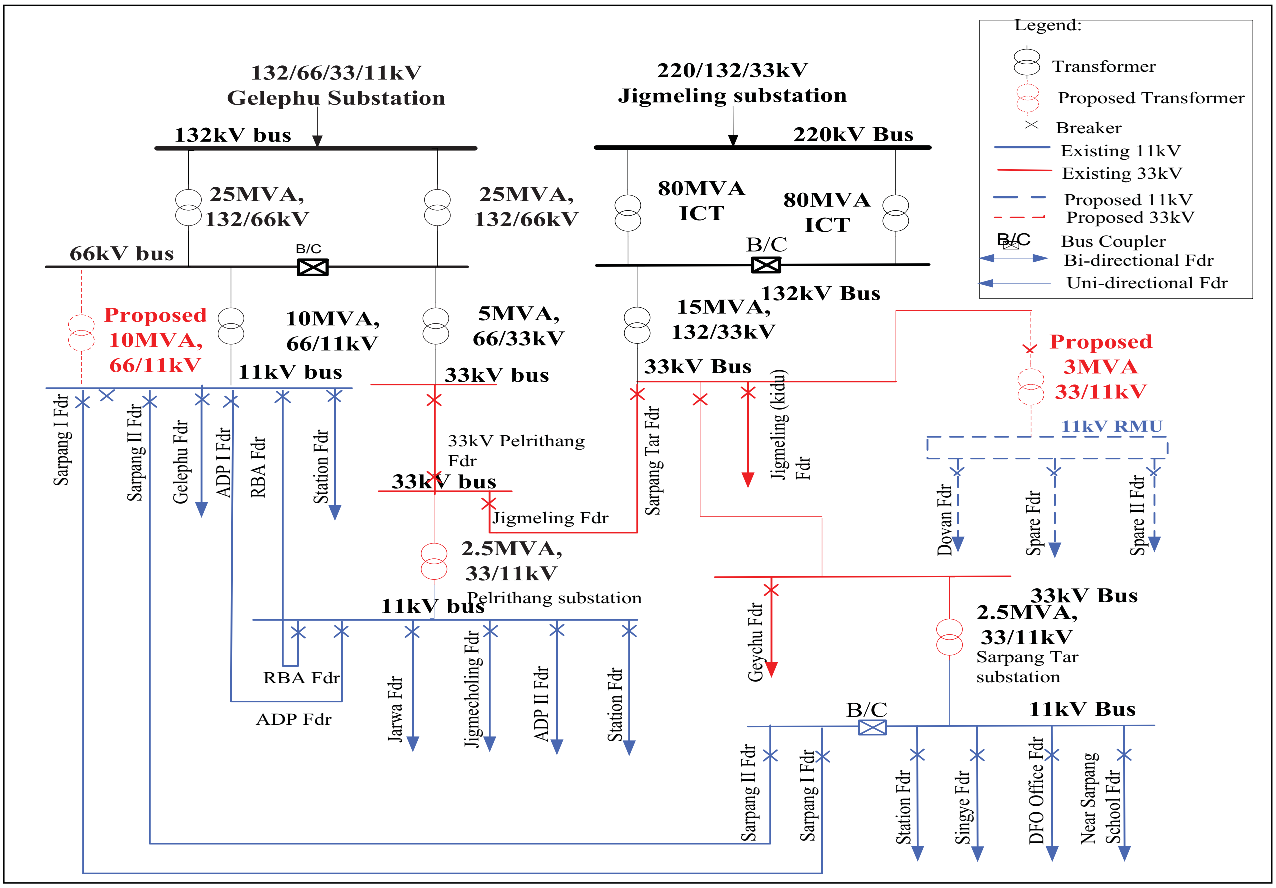


Figure 16: Proposed Distribution Network

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 17 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 offices. Further, as detailed in **Section 7.4,** the up-grading of existing DTs and new DTs required for the LAP, towns and ISC areas have to be constructed and up-graded to meet the power requirement.

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 Sarpang I & Sarapng II, 11kV Jigmecholing, 11kV New Dovan and 11kV Singye feeders sustained more interruptions compared to other feeders. Therefore, additional preventive and corrective measure for these feeders needs 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. **Figure 17** shows the existing installed breakers, isolators RMUs and proposed plan is shown in **Figure 18 & Table 20** for distribution network for easing operation and maintenance and for improving the reliability of the power supply of the Dzongkhag.

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

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.

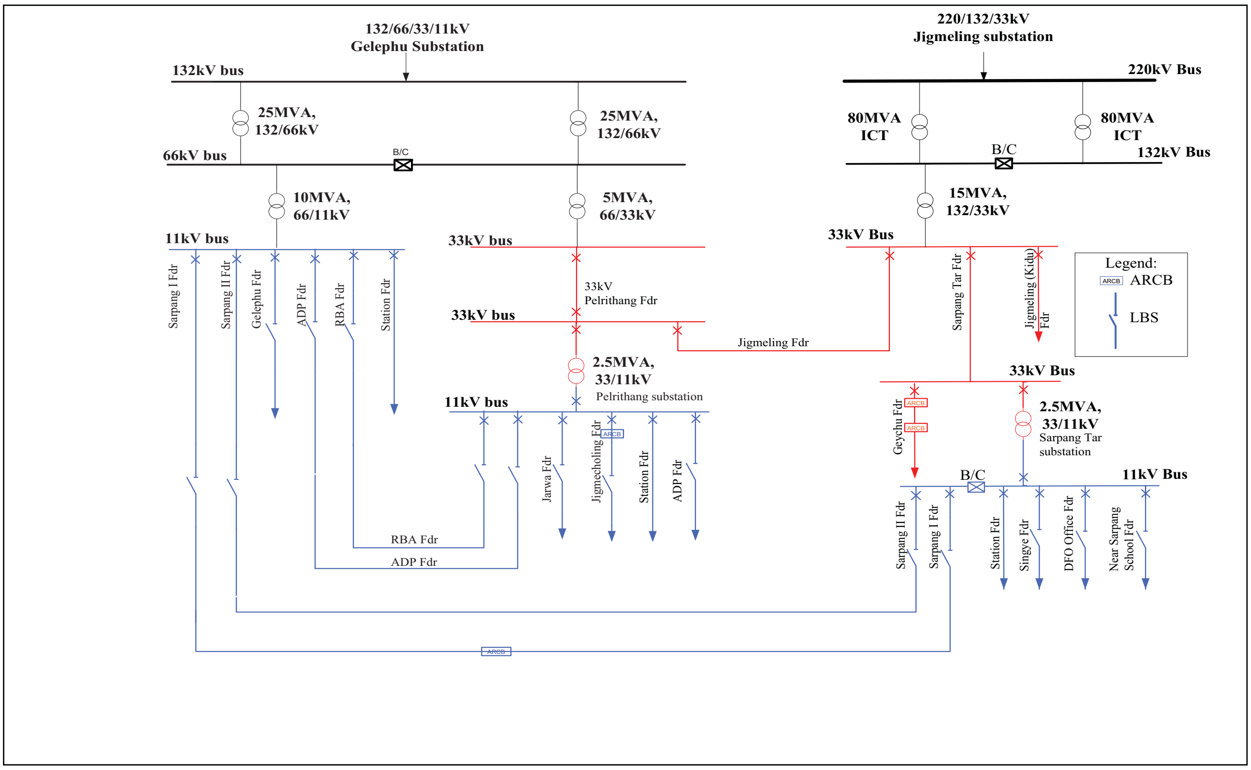


Figure 17: Existing Installed Switching Equipment for Distribution Network

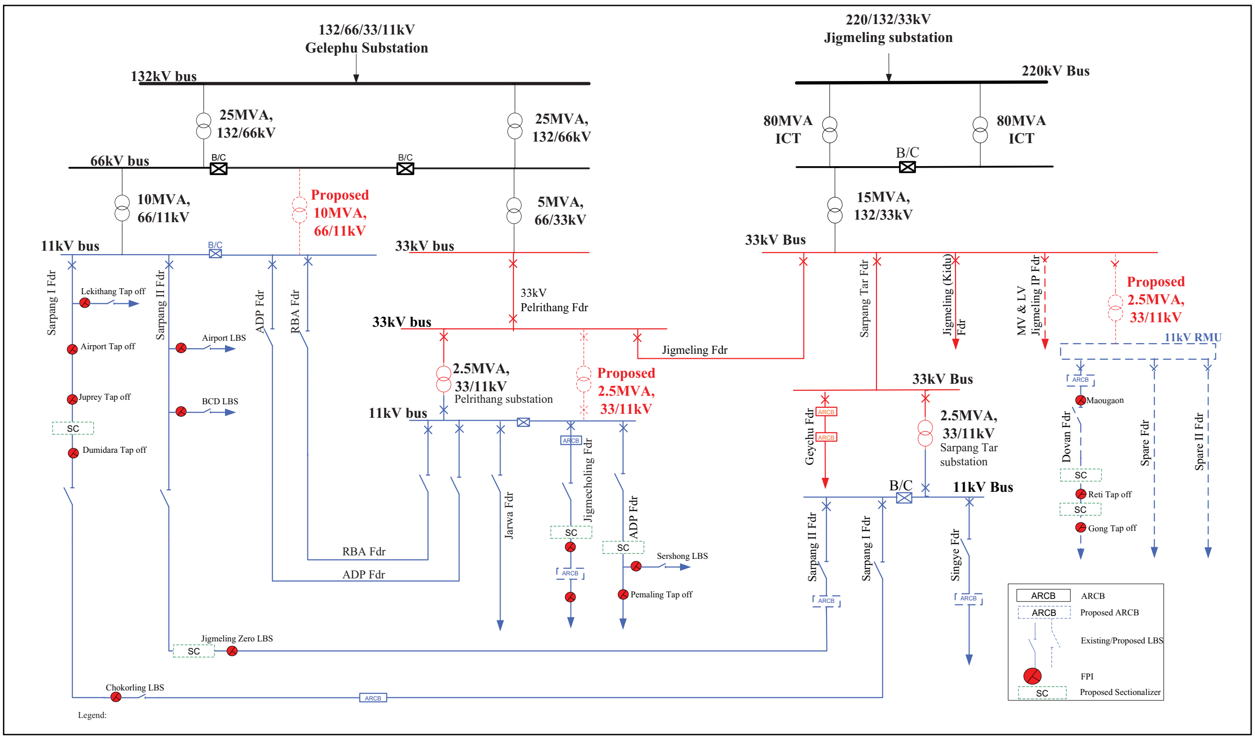


Figure 18: Proposed Switching Equipment for Distribution Network of ESD, Gelephu

Table 20: Existing and Proposed switching equipment

Sl.No.	Feeder name	ARCBs		Sectionalizers		FPIs		LBS	
		Exist	Prop	Exist	Prop	Exist	Prop	Exist	Prop
1	11kV Sarpang I Feeder (M10)	1			1		5	2	
2	11kV Sarpang II Feeder (M20)		1		1		3	2	
3	11kV Gelephu Feeder (M30)							1	
4	11kV ADP Feeder (M40)				1		2	1	
5	11kV RBA Feeder (M50)							2	
6	33kV Geychu Feeder (M70)	2							
7	11kV Jigmecholing Feeder (M90)	1	1		1		2	1	
8	11kV Jarwa Feeder (M100)							1	
9	11kV ADP II Feeder							1	
10	11kV Singye Feeder (M130)	0	1					1	
11	11kV Near DFO office Feeder (M140)							1	
12	11kV Near Sarpang School Feeder (M150)							1	

Sl.No.	Feeder name	ARCBs		Sectionalizers		FPIs		LBS	
		Exist	Prop	Exist	Prop	Exist	Prop	Exist	Prop
13	11kV New Dovan Feeder (M170)	0	1	0	2	0	3	0	1
	Total	**8**	**4**	**6**	**6**	**15**	**15**	**15**	**1**

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 Plans

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 19.**

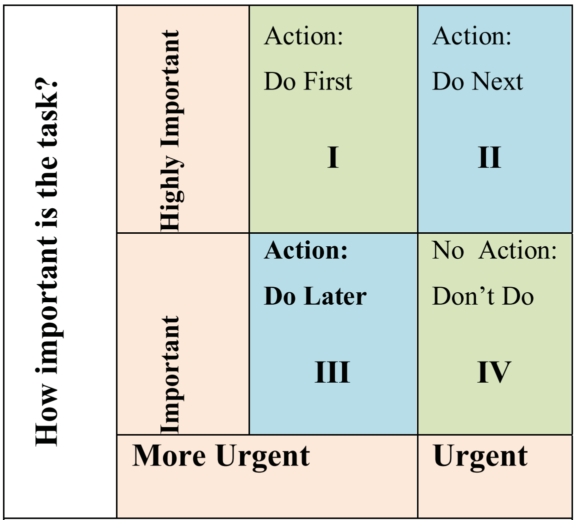


Figure 19: Priority Matrix

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 21** 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 Sarpang Dzongkhag is Nu. 352.31 million (Nu. 35.23 million per year).

Table 21: Yearly Investment Plans (2020-2030)

Sl. No.	Activities	Investment Plan											Total
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1	Augmentation/Extension of LV ABC lines in and around Gelephu/Sarpang	1.50	2.00	2.00	1.50	-							**7.00**
2	Construction of underground network at Rabdeyling area: (a) 11kV UG cable 3x300sqmm Aluminium conductor and (b) LV UG network at Rabdeling, Gelephu Thromde	0.46		0.76	-	-							**1.22**
3	(A) Extension of 11kV line (0.4km) and construction of 500KVA substation with Chain Link fencing at Dologang.	-	-	-	-	-							**-**
4	Construction of MV lines and LV lines (Approx. 5km) for power supply to Jigmeling Industrial Estate			8.00	5.00	2.00							**15.00**
5	Construction of 33/0.415kV, 750kVA substations for providing power supply to Jigmeling Industrial Estate			10.00	2.00	-							**12.00**
6	Construction of HT & LT network and RMU at Gelephu new LAP			4.24	-	-							**4.24**
7	Construction of radial network at small scale industries, Gelephu; (A) 3km of 11kV, 3X300sq mm XLPE UG Cable(B) 750KVA 11/0.415kV Package substations, (C) RMU (3 Nos.), (D) 4km of LV 4c 150sq mm UG cable			8.62									**8.62**
8	Construction of 33 kV AAAC dedicated line from 33/11 kV Pelrithang substation to Jigmecholing	-	-	5.00	15.00	-							**20.00**

Sl. No.	Activities	Investment Plan											Total
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
	(Surey)												
9	Installation of 11kV LBS in Sarpang I feeder (9 Nos.), Jigmecholing feeder (1 No.), Sarpang II (3 Nos.)	0.47	-		-	-							**0.47**
10	Construction of 5km, 11kV ACSR- Rabbit conductor from Gopidara to Simkharka village to interconnect between 11kV Jigmecholing and 11kV Dovan line.	-		3.90	-	-							**3.90**
11	Construction of; (i) 0.35km, 33kV underground network (3x300sq mm) from M120H009 to M10H431, (ii) 2.5km, 11kV, ACSR-Dog conductor from Ratigaon substation to Dologang Top (iii) 33/11kV substation structure with chain link fencing	8.12		-	-	-							**8.12**
12	Construction of 33/11 kV, 2 x 2.5 MVA substation with the provision of 2 Nos. 33 kV incomer feeders and 4 Nos. of 11 kV outgoing feeders at Pelrithang	-	5.96	-	-	-							**5.96**
13	Construction of substations in Gelephu area LAP IV	-	-	1.00	1.00	-							**2.00**
14	Construction of 11/0.415kV, 500KVA Package Substation for New Dzong at Sarpang.	-	-	-	2.50	-							**2.50**
15	Construction of 11/0.415kV, 500kVA package substation for new town shift at Shaychangthang, Sarpang.			2.50	-	-							**2.50**
16	Upgradation of existing overhead distribution network to underground network at Gelephu Core Area.	-	-	5.00	10.00	-							**15.00**
17	Conversion of MV and LV overhead lines to underground network (33kV, 3x150sq mm XLPE	-	15.54	-	-	-							**15.54**

Sl. No.	Activities	Investment Plan											Total
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
	(0.96km); 11kV, 3x300sq mm XLPE (2.44km); 0.415kV, 4x150sq mm LV (3.12km) UG) including 2 Nos. of 500kVA Package substation and 1No. of 11kV RMUs at Sarpang Tar.												
18	Installation of 11kV RMU (10 Nos.) in and around Gelephu.	-	-	-	3.00	3.00							**6.00**
19	Conversion of LV (Composite lines) and MV lines (11kV- ADP, RBA, Gelephu feeders and 33kV, Jigmecholing feeder) into underground network (including RMUs) with the construction of Royal Boulevard road at Gelephu Throm area.	-	-	20.00	30.00	30.00							**80.00**
20	Upgradation of 66/11kV, 10MVA to 2x10MVA of Gelephu SS												**-**
21	Construction of 66/11kV, 10MVA substation at 132kV Gelephu SS												**-**
22	Upgradation of 132/33kV, 15MVA to 100MVA of Jigemling SS												**-**
23	Construction of 132/33kV, 100MVA substation at 220kV Jigmeling SS												**-**
24	Construction of additional 33/11kV, 3MVA substation at Jigmeling SS				22.50								**22.50**
25	Upgradation of 125KVA Lungta Workshop (MRF) to 250KVA			0.55									**0.55**
26	Upgradation of 16KVA Juprey Top SS to 25KVA												**-**
27	Upgradation of 63KVA Bhur Zero SS to 125kVA			0.63									**0.63**

Sl. No.	Activities	Investment Plan											Total
		2020	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	
28	Upgradation of 125KVA Chokorling SS to 250KVA						1.04						**1.04**
29	Upgradation of 125KVA Above Sansari Bazaar SS to 250KVA				0.92								**0.92**
30	Upgradation of 100KVA Jigmeling II SS to 250KVA									1.50			**1.50**
31	Upgradation of 125KVA Dhoulakhola SS to 250KVA				0.63								**0.63**
32	Upgradation of 25KVA Khopitar SS to 100KVA							1.00					**1.00**
33	Upgradation of 25KVA Upper Chaskar SS to 63KVA								0.80				**0.80**
34	Upgradation of 63KVA Lower Chaskar SS to 125KVA								1.00				**1.00**
35	Upgradation of 63KVA Barthang SS to 125KVA									1.00			**1.00**
36	Upgradation of 63KVA Upper Dawathang SS to 125KVA									1.00			**1.00**
37	Upgradation of 25KVA Pangkhar SS to 63KVA					0.50							**0.50**
38	Upgradation of 63KVA in front of Nobbling MSS SS to 125KVA						0.75						**0.75**
39	Upgradation of 63KVA Near Chuzegang School SS to 125KVA						0.75						**0.75**
40	Upgradation of 63KVA Tashiphu SS to 125KVA								0.84				**0.84**
41	Upgradation of 250KVA Paitakhola SS to 500KVA										1.33		**1.33**
42	LBS		0.37	0.15		0.15		0.20					**0.87**
43	RE-Fill in works	2.50	2.59	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	**27.59**
44	Conversion of single to three-phase line			0.34	0.41.04	0.34	0.34	0.34	0.34	0.34	0.34	0.34	**3.06**
45	Replacement of single phase by three phase transformers			1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	**9.36**
46	Power Supply to left out households from off-grid project	2.67											**2.67**

Sl. No.	Activities	Investment Plan											Total
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
	(a) Dechenling (Noonpani) and (b) Galleythang (Ramitey 'C')												
47	Electrification of village above Tshachu (Kholapari)	1.16											**1.16**
	Core Town												
48	Construction of 11kV, 3x300sq mm UG network		0.24	0.36									**0.60**
49	Construction of LV UG network		1.96	2.94									**4.90**
50	Installation of 11kV RMU (1No.)			1.13									**1.13**
51	Upgradation of 500kVA Charali ss and market ss to 1000kVA USS each		3.59	5.39									**8.98**
52	Construction of 11kV UG Cable Trench at Gelephu Core Town		3.64										**3.64**
	LAP I												
53	Upgradation of 500kVA RBP Division-V Office ss to 1000kVA USS						4.82						**4.82**
54	Upgradation of 125kVA Telecom substation to 500kVA ss							1.53					**1.53**
55	Upgradation of 500kVA Fishery ss to 1000kVA USS					5.46							**5.46**
56	Upgradation of 500kVA Royal Guest house ss to 750kVA USS			3.83									**3.83**
57	Upgradation of 125kVA Near Tali Dratshang ss to 500kVA USS				2.96								**2.96**
	LAP II												**-**
58	Construction of 11/0.415kV, 500kVA ss with 3x300sq mm UG network at LAP II				1.35								**1.35**
59	Construction of 11kV UG Cable Trench at Gelephu				4.71								**4.71**

Sl. No.	Activities	Investment Plan											Total
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
	(LAP II)												
60	Upgradation of 125kVA Forest Checkpost ss to 750kVA USS					4.33							**4.33**
61	Upgradation of 63kVA Upper Lakitar ss to 125kVA ss						0.75						**0.75**
62	Upgradation of 125kVA Lakitar ss to 500kVA ss							1.53					**1.53**
	LAP III												**-**
63	Upgradation of 250kVA Magi busty ss to 500kVA ss		0.89										**0.89**
64	Upgradation of 250kVA RVL ss to 500kVA ss				0.95								**0.95**
	LAP IV												**-**
65	Upgradation of 63kVA Sethikhari ss to 500kVA ss		0.89										**0.89**
	LAP V												
66	Upgradation of 63kVA Tashiling ss to 315kVA ss			0.90									**0.90**
67	Construction of 250kVA, 11/0.415kV ss with 11kV MV UG cable	-								2.09			**2.09**
	ISC												
68	Construction of additional 500kVA USS for ISC							4.55					**4.55**
	Total	**16.88**	**37.67**	**90.78**	**107.90**	**49.32**	**11.99**	**12.69**	**6.52**	**9.47**	**5.21**	**3.88**	**352.31**

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 leas-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, 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. Recommendation

Sl.	Parameters	Recommendations
A. Power Supply Sources		
1	HV Substations	As detailed in **Sections 7&8** of this report, 66/11kV, 1X10MVA Gelephu and 132/33kV, 1X15MVA Jigmeling substations had to be up-graded to 20MVA and 100MVA respectively under Sarpang Dzongkhag.
2	MV Substations	As detailed in **Sections 7&8** of this report, 33/11kV, 1x3MVA Perlithang and 33/11kV, 1x2.5MVA Jigmeling substations have to be up-graded as proposed to meet the increasing load demand.
B. MV and LV Lines		
1	11kV New Dovan Line	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 Transformers	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 needs 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

Sl.	Parameters	Recommendations
		recommended.
2	Review of the DSMP	Practically the projections will hold only true in the nearest future therefor, it is 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.
7	Asset life of DTs	The asset life of DTs needs 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.
8	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.
9	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).
10	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

Sl.	Parameters	Recommendations
		towers; and 3) To increase the frequency of Row clearing in a year.
11	IPs and Conversion Works	As the joint survey for laying the UG has not been 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.
12	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.

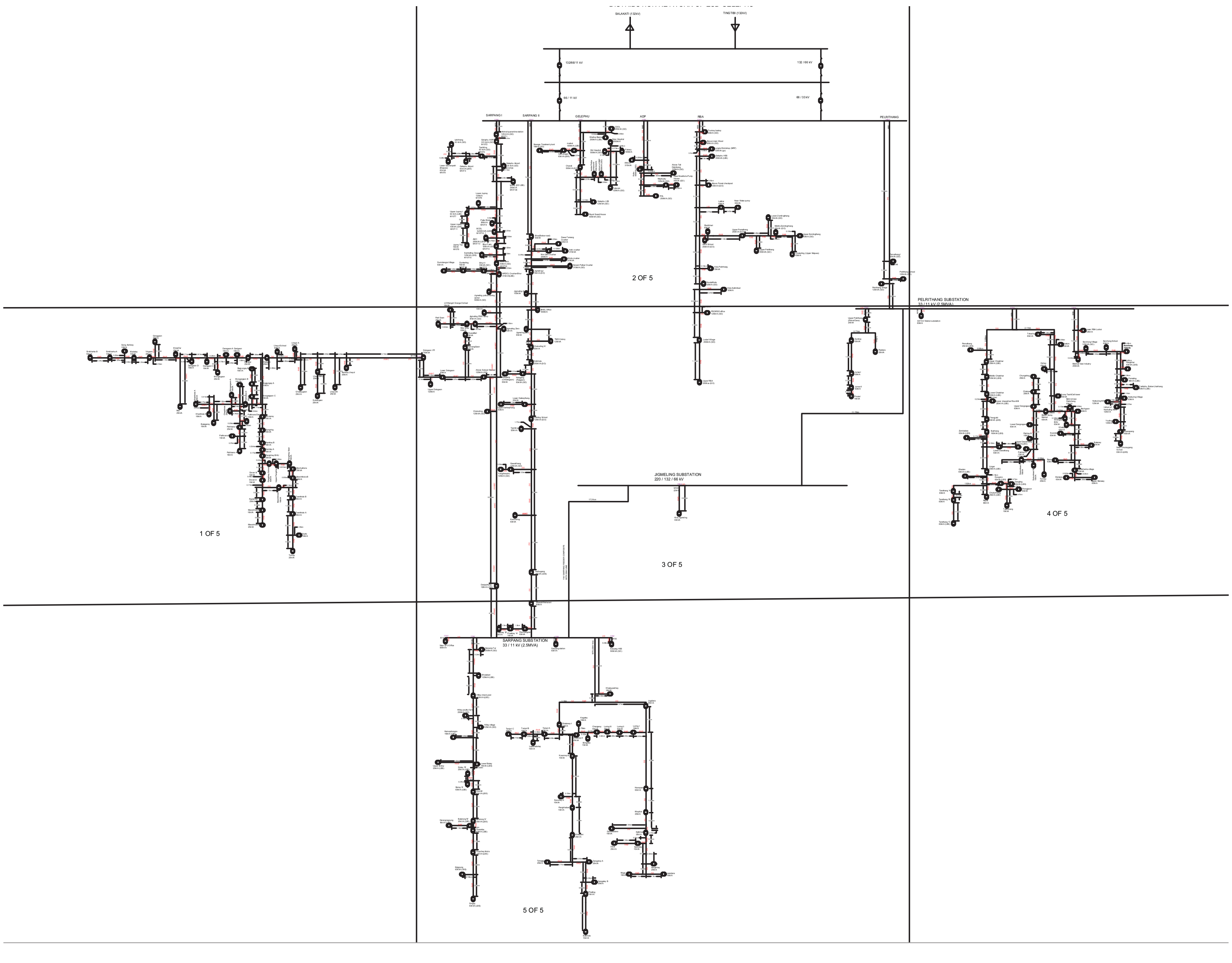
15. Challenges

Sl. No.	Parameters	Challenges	Opportunities/Proposals
1	Software Tool (ETAP)	a) Only one key & offline Key a) Balanced Load Flow b) Limitations of No. of buses (1000)	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.
2	Data	a) No recorded data (reliability & energy) on the out-going feeders of	a) Feeder Meters could be install for outgoing feeders of MV substations to record actual data (reliability &

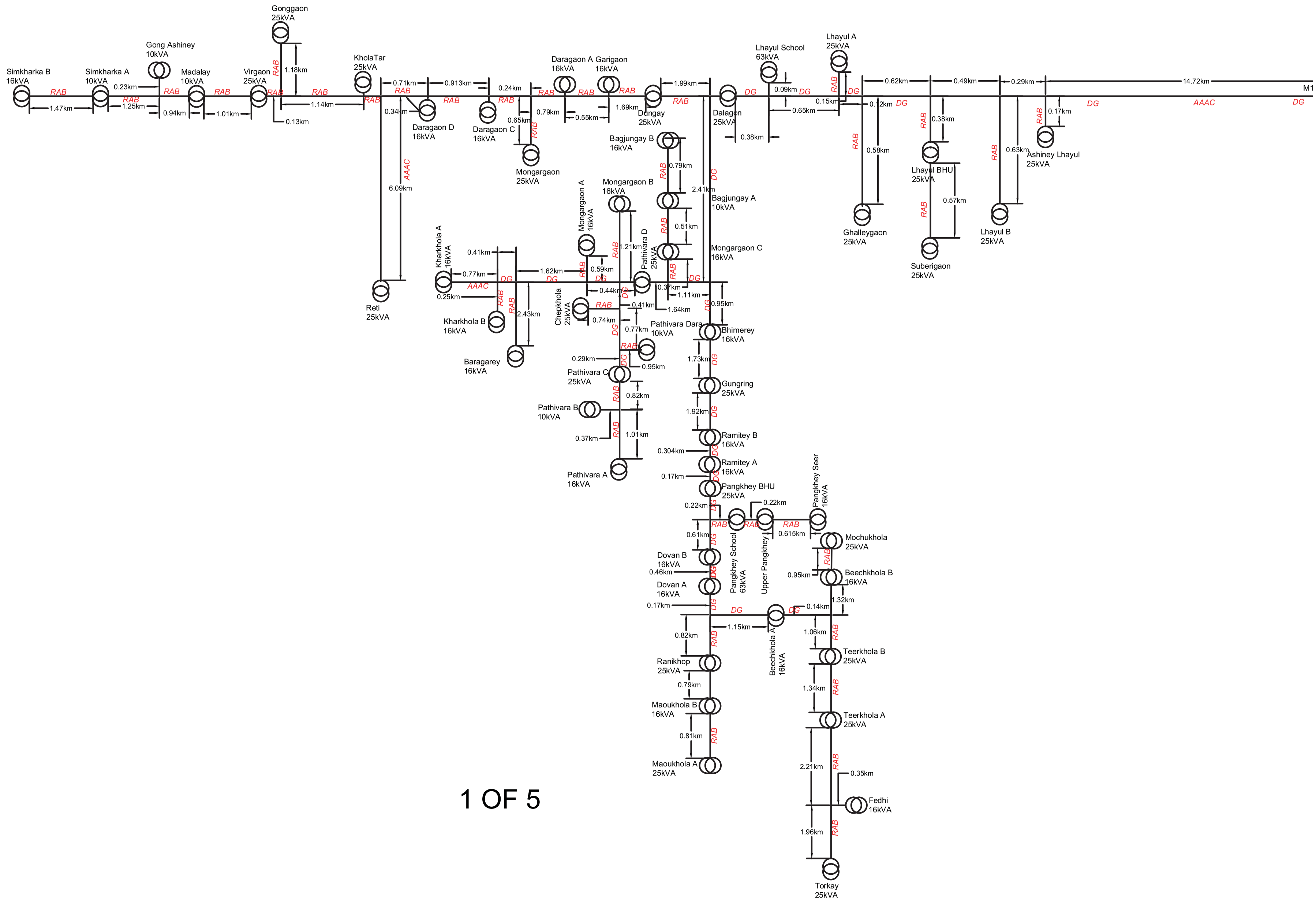
Sl. No.	Parameters	Challenges	Opportunities/Proposals
		MV SS	energy)
		b) Peak Load data of DTs which were recorded manually may be inaccurate due to timing and number of DTs.	b) In order to get the accurate Transformer Load Management (TLM)/loading, it is proposed to install DT meters which could also 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 (e.g. for Thimphu Dzongkhag)

12.Annexures

Annexure-1: MV Line Details and Single Line Diagram

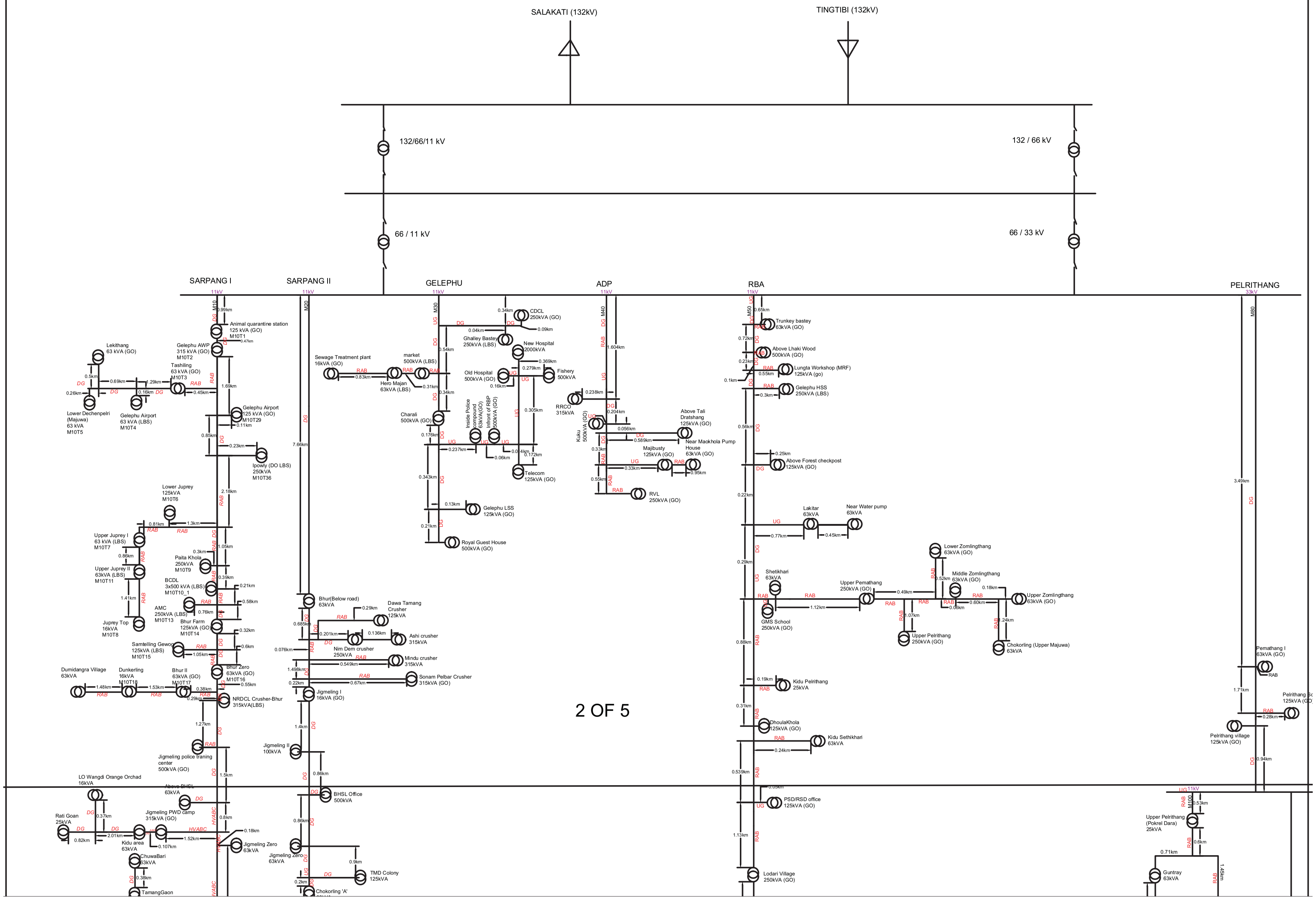


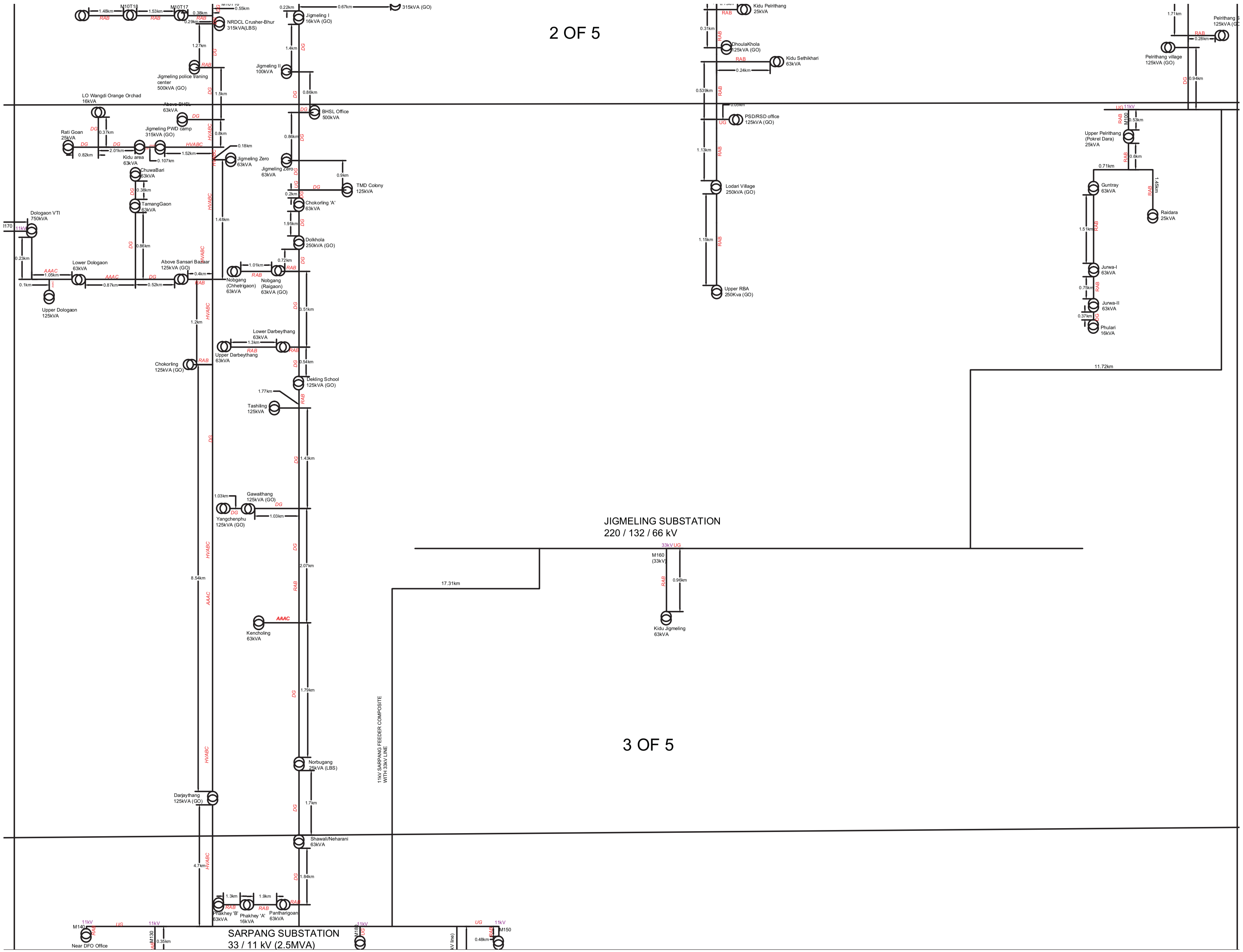
GALANATI (132kV)
TINGTIBI (132kV)
132/66/11 kV
132 / 66 kV
66 / 11 kV
66 / 33 kV
SARPANG I
SARPANG II
GELEPHU
ADP
RBA
PELRITHANG
PELRITHANG SUBSTATION
33 / 11 kV (2.5MVA)
JIGMELING SUBSTATION
220 / 132 / 66 kV
SARPANG SUBSTATION
33 / 11 kV (2.5MVA)
1 OF 5
2 OF 5
3 OF 5
4 OF 5
5 OF 5

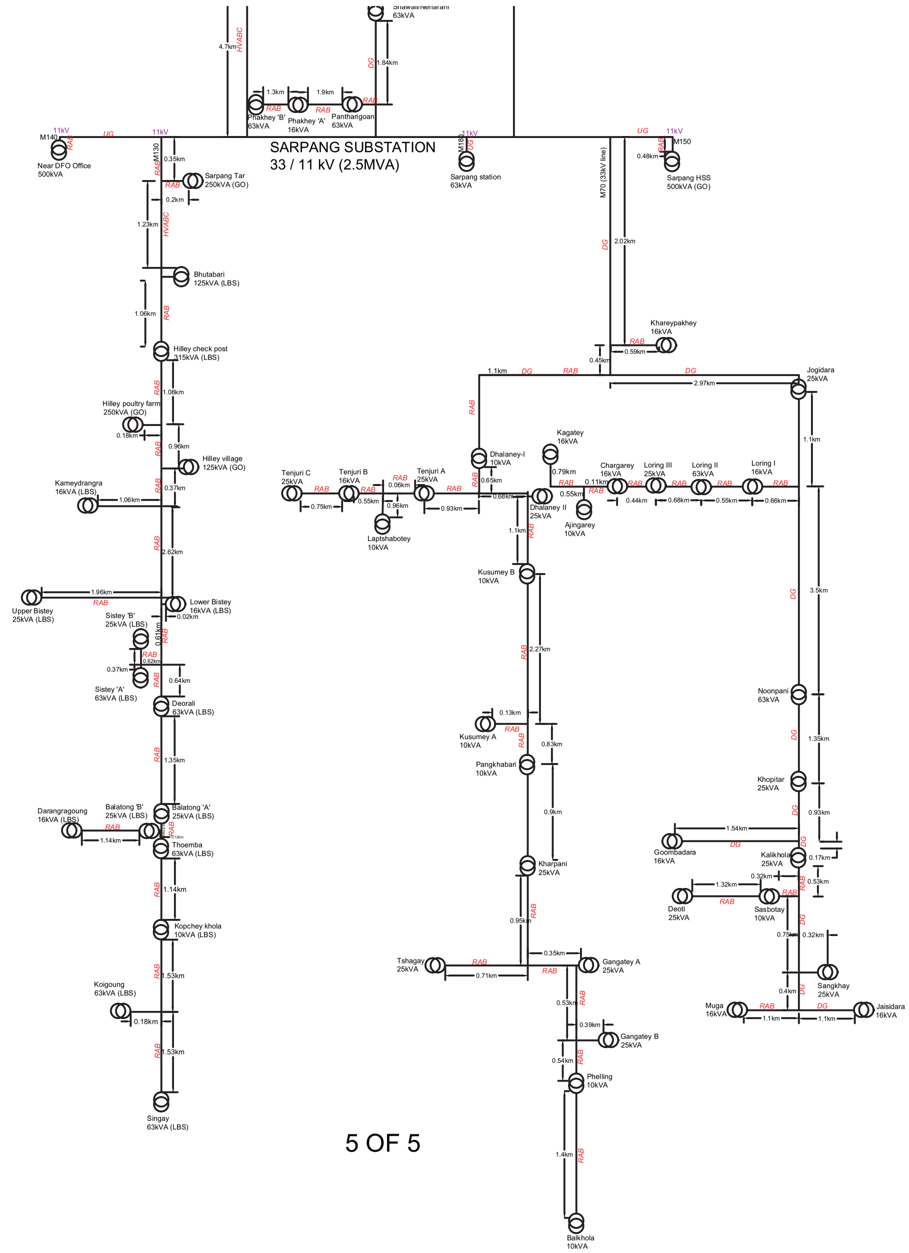

M1
Simkharka B 16kVA
Simkharka A 10kVA
Gong Ashiney 10kVA
Madalay 10kVA
Virgaon 25kVA
Gonggaon 25kVA
KholaTar 25kVA
Reti 25kVA
Daragaon D 16kVA
Daragaon C 16kVA
Mongargaon 25kVA
Daragaon A 16kVA
Garigaon 16kVA
Dongay 25kVA
Dalagon 25kVA
Lhayul School 63kVA
Lhayul A 25kVA
Ghalleygaon 25kVA
Lhayul BHU 25kVA
Suberigaon 25kVA
Lhayul B 25kVA
Ashiney Lhayul 25kVA
Bagjungay B 16kVA
Bagjungay A 10kVA
Mongargaon B 16kVA
Mongargaon A 16kVA
Mongargaon C 16kVA
Pathivara D 25kVA
Kharkhola A 16kVA
Kharkhola B 16kVA
Baragarey 16kVA
Chepkhola 25kVA
Pathivara Dara 10kVA
Pathivara C 25kVA
Pathivara B 10kVA
Pathivara A 16kVA
Bhimerey 16kVA
Gungring 25kVA
Ramitey B 16kVA
Ramitey A 16kVA
Pangkhey BHU 25kVA
Pangkhey School 63kVA
Upper Pangkhey
Pangkhey Seer 16kVA
Mochukhola 25kVA
Beechkhola B 16kVA
Beechkhola A 16kVA
Dovan B 16kVA
Dovan A 16kVA
Ranikhop 25kVA
Maoukhola B 16kVA
Maoukhola A 25kVA
Teerkhola B 25kVA
Teerkhola A 25kVA
Fedhi 16kVA
Torkay 25kVA

1 OF 5

DISTRIBUTION NETWORK OF ESD GELEPHU




2 OF 5
3 OF 5
JIGMELING SUBSTATION
220 / 132 / 66 kV
SARPANG SUBSTATION
33 / 11 kV (2.5MVA)
11kV SARPANG FEEDER COMPOSITE
WITH 33kV LINE
Jigmeling I
16kVA (GO)
Jigmeling II
100kVA
BHSL Office
500kVA
Jigmeling Zero
63kVA
TMD Colony
125kVA
Chokorling 'A'
63kVA
Dolkhola
250kVA (GO)
NRDCL Crusher-Bhur
315kVA(LBS)
Jigmeling police traning
center
500kVA (GO)
LO Wangdi Orange Orchad
16kVA
Above BHSL
63kVA
Jigmeling PWD camp
315kVA (GO)
Rati Goan
25kVA
Kidu area
63kVA
ChuwaBari
63kVA
TamangGaon
63kVA
Dologaon VTI
750kVA
Lower Dologaon
63kVA
Upper Dologaon
125kVA
Above Sansari Bazaar
125kVA (GO)
Nobgang
(Chhetrigaon)
63kVA
Nobgang
(Raigaon)
63kVA (GO)
Lower Darbeythang
63kVA
Upper Darbeythang
63kVA
Chokorling
125kVA (GO)
Dekling School
125kVA (GO)
Tashiling
125kVA
Gawaithang
125kVA (GO)
Yangchenphu
125kVA (GO)
Kencholing
63kVA
Norbugang
25kVA (LBS)
Darjeythang
125kVA (GO)
Shawali/Neharani
63kVA
Phakhey 'B'
63kVA
Phakhey 'A'
16kVA
Panthangoan
63kVA
Near DFO Office
Kidu Pelrithang
25kVA
DhoulaKhola
125kVA (GO)
Kidu Sethikhari
63kVA
PSD/RSD office
125kVA (GO)
Lodari Village
250kVA (GO)
Upper RBA
250Kva (GO)
Pelrithang village
125kVA (GO)
Upper Pelrithang
(Pokrel Dara)
25kVA
Guntray
63kVA
Raidara
25kVA
Junwa-I
63kVA
Junwa-II
63kVA
Phulari
16kVA
M160
(33kV)
Kidu Jigmeling
63kVA
315kVA (GO)
17.31km
11.72km



SARPANG SUBSTATION
33 / 11 kV (2.5MVA)
11kV
M140
Near DFO Office
500kVA
M130
Sarpang Tar
250kVA (GO)
Bhutabari
125kVA (LBS)
Hilley check post
315kVA (LBS)
Hilley poultry farm
250kVA (GO)
Hilley village
125kVA (GO)
Kameydrangra
16kVA (LBS)
Upper Bistey
25kVA (LBS)
Lower Bistey
16kVA (LBS)
Sistey 'B'
25kVA (LBS)
Sistey 'A'
63kVA (LBS)
Deorali
63kVA (LBS)
Darangragoung
16kVA (LBS)
Balatong 'B'
25kVA (LBS)
Balatong 'A'
25kVA (LBS)
Thoemba
63kVA (LBS)
Kopchey khola
10kVA (LBS)
Koigoung
63kVA (LBS)
Singay
63kVA (LBS)
Phakhey 'B'
63kVA
Phakhey 'A'
16kVA
Panthangoan
63kVA
63kVA
M180
Sarpang station
63kVA
M70 (33kV line)
M150
Sarpang HSS
500kVA (GO)
Khareypakhey
16kVA
Jogidara
25kVA
Dhalaney-I
10kVA
Kagatey
16kVA
Tenjuri C
25kVA
Tenjuri B
16kVA
Tenjuri A
25kVA
Laptshabotey
10kVA
Dhalaney II
25kVA
Ajingarey
10kVA
Chargarey
16kVA
Loring III
25kVA
Loring II
63kVA
Loring I
16kVA
Kusumey B
10kVA
Kusumey A
10kVA
Pangkhabari
10kVA
Kharpani
25kVA
Tshagay
25kVA
Gangatey A
25kVA
Gangatey B
25kVA
Phelling
10kVA
Balkhola
10kVA
Noonpani
63kVA
Khopitar
25kVA
Goombadara
16kVA
Kalikhola
25kVA
Deoti
25kVA
Sasbotay
10kVA
Sangkhay
25kVA
Muga
16kVA
Jaisidara
16kVA
UG
RAB
HVABC
DG

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MV Line Detials of Sarpang Dzongkhag

Sl#	Feeder Name	Line Description	Ring or Radial	Source Substation like TD or 33/11kV substation	Feeder Details		Line (Section 1) details						
					Voltage level(kV)	UG/Overhead or Mixed	Line	Cable / Conductor size	First GPS code	Final GPS code	Line length (KM)	Location	Termination point
1	Sarpang I(M10)	Underground cable	Radial	132/66/33/11kV Gelephu substation	11	UG	Trunk Line	300 sq mm	Substation	GEE10M000	0.075	132kV Gelephu ss	132kV Gelephu ss
		ACSR DOG				Overhead	Trunk line	100 sq mm	GEE10M000	GEE10M035	2.028	132kV Gelephu ss	Trashiling (Near Airport)
		ACSR DOG				Overhead	Trunk line	100 sq mm	GEE10M035	GEE10M127	4.071	Trashiling (Near Airport)	Juprey T-off
		ACSR DOG				Overhead	Trunk line	100 sq mm	GEE10M127	GEE10M188	0.546	Juprey T-off	Paitakhola
									GEE10M188	GEE10M196	0.499	Paitakhola T-off	Paitakhola T-off
		ACSR DOG				Overhead	Trunk line	100 sq mm	GEE10M196	GEE10M206	0.235	Paitakhola T-off	BCDT-off Bhur
		ACSR DOG				Overhead	Trunk line	100 sq mm	GEE10M206	GEE10M214	0.203	BCDT-off Bhur	AMC T-off
		ACSR DOG				Overhead	Trunk line	100 sq mm	GEE10M214	GEE10M246	0.906	AMC T-off	Samtenling gewog office T-off
		ACSR DOG				Overhead	Trunk line	100 sq mm	GEE10M246	GEE10M283	1.145	Samtenling gewog office T-off	Dungkarling T-off
		ACSR DOG				Overhead	Trunk line	100 sq mm	GEE10M283	GEE10M368	2.869	Dungkarling T-off	Wamrongpa village T-off
		ACSR DOG				Overhead	Trunk line	100 sq mm	GEE10M368	GEE10M379	0.710	Wamrongpa village T-off	Jigmeling zero
		HVABC				Overhead	Trunk line	95 sq mm	GEE10M379	GEE10M380	0.090	Jigmeling zero	Jigmeling zero
		HVABC				Overhead	Trunk line	95 sq mm	GEE10M380	GEE10M455	0.132	Jigmeling zero	Jigmeling zero
		HVABC				Overhead	Trunk line	95 sq mm	GEE10M455	GEE10M521	2.269	Jigmeling zero	Chokorling
		ACSR-RABBIT				Overhead	Trunk line	50 sq mm	GEE10M521	GEE10M522	0.047	Chokorling	Chokorling
		HVABC				Overhead	Trunk line	95 sq mm	GEE10M522	GEE10M553	0.915	Chokorling	Dholkhola
		ACSR DOG				Overhead	Trunk line	100 sq mm	GEE10M553	GEE10M554	0.048	Dholkhola	Dholkhola
		HVABC				Overhead	Trunk line	95 sq mm	GEE10M554	GEE10M606	2.402	Dholkhola	Leokhola
		AAAC				Overhead	Trunk line	158 sq mm	GEE10M606	GEE10M609	0.312	Leokhola	Leokhola
		HVABC				Overhead	Trunk line	95 sq mm	GEE10M609	GEE10M716	5.007	Leokhola	Patabari ss
		HVABC				Overhead	Trunk line	95 sq mm	GEE10M716	GEE10M741	0.933	Patabari ss	Sompangkha Gewog Office
		AAAC				Overhead	Trunk line	158 sq mm	GEE10M741	GEE10M742	0.050	Sompangkha Gewog Office	Sompangkha Gewog Office
		HVABC				Overhead	Trunk line	95 sq mm	GEE10M742	GEE10M837	3.526	Sompangkha Gewog Office	Sarpang Tar ESSD Office
		Underground cable				UG	Trunk line	300 sq mm	GEE10M837	Gangtry	0.119	Sarpang Tar ESSD Office	33/11kV Sarpang ss
		ACSR RABBIT				Overhead	Spur line 1	50 sq mm	GEE10M035	GEE10M042	0.451	Trashiling (Near Airport)	Trashiling ss
		ACSR DOG				Overhead	Spur line 2	100 sq mm	GEE10M042	GEE10M064	1.289	Trashiling ss	Airport T off
		ACSR DOG				Overhead	Spur line	101 sq mm	GEE10M064	GEE10M078	0.945	Airport T off	Dechenpelri
		ACSR DOG				Overhead	Spur line	100 sq mm	GEE10M064	GEE10M067	0.153	U.Airport	U.Airport
		ACSR RABBIT				Overhead	Spur line 3	50 sq mm	GEE10M127	GEE10M155	2.114	Juprey T-off	Upper Juprey ss
		ACSR RABBIT				Overhead		50 sq mm	GEE10M155	GEE10M182	2.272	Upper Juprey ss	Juprey Top ss
		ACSR RABBIT				Overhead	Spur line 4	50 sq mm	GEE10M196	GEE10M203	0.295	Paitakhola T-off	Paitakhola ss
		ACSR RABBIT				Overhead	Spur line 5	50 sq mm	GEE10M206	GEE10M210	0.176	BCDT-off Bhur	BCD ss (1,2,3)
		ACSR RABBIT				Overhead	Spur line 6	50 sq mm	GEE10M214	GEE10M231	0.762	AMC T-off	AMC ss
		ACSR RABBIT				Overhead	Spur line 7	50 sq mm	GEE10M246	GEE10M266	1.050	Samtenling gewog office T-off	Samtenling gewog office ss
		ACSR RABBIT				Overhead	Spur line 8	50 sq mm	GEE10M276	GEE10M277	0.005	Bhur zero ss	Bhur zero ss
		ACSR RABBIT				Overhead	Spur line 9	50 sq mm	GEE10M283	GEE10M288	0.383	Dungkarling T-off	Bhur II ss
									GEE10M289	GEE10M329	3.016	Bhur II ss	Dumidara ss
		ACSR DOG				Overhead	Spur line 10	100 sq mm	GEE10M332	GEE10M333	0.060	NRDCL Crusher ss	NRDCL Crusher ss
		ACSR DOG				Overhead	Spur line 11	100 sq mm	GEE10M368	GEE10M370	0.102	Wamrongpa village T-off	Wamrongpa village ss
		HVABC				Overhead	Spur line 12	95 sq mm	GEE10M380	GEE10M427	1.696	Jigmeling zero	Below PWD Camp, Jigmeling
		ACSR DOG				Overhead	Spur line 13	100 sq mm	GEE10M428	GEE10M444	2.838	Below PWD Camp, Jigmeling	LO Wangdi Orchard T-off
									GEE10M444	GEE10M451	0.370	LO Wangdi Orchard T-off	LO Wangdi Orchard ss
		ACSR DOG				Overhead	Spur line	100 sq mm	GEE10M444	GEE10M448	0.827	Ratigaon	Ratigaon
		HVABC				Overhead	Spur line 14	95 sq mm	GEE10M455	GEE10M457	0.046	Jigmeling zero	Jigmeling zero ss
		ACSR RABBIT				Overhead	Spur line 15	50 sq mm	GEE10M522	GEE10M530	0.354	Chokorling	Chokorling ss
		ACSR RABBIT				Overhead	Spur line 16	50 sq mm	GEE10M349	GEE10M838	0.027	Jigmeling Police Training Centre	Jigmeling Police Training Centre ss
		HVABC				Overhead	Spur line 17	95 sq mm	GEE10M717	GEE10M718	0.003	Patabari ss	Patabari ss
		ACSR RABBIT				Overhead	Spur line 18	50 sq mm	GEE10M090	GEE10M840	0.109	Gelephu Airport	Gelephu Airport ss (125kVA)
		ACSR RABBIT				Overhead	Spur line 19	50 sq mm	GEE10M841	GEE10M850	0.520	Majuwa/Lekithang	Lekithang ss
		ACSR RABBIT				Overhead	Spur line 20	50 sq mm	GEE10M500	GEE10M866	0.922	Tapping point towards Dologang	Chuwabari Tapping point
		ACSR DOG				Overhead	Spur line 21	100 sq mm	GEE10M866	GEE10M877	0.724	Chuwabari Tapping point	Chuwabari ss
		AAAC				Overhead	Spur line 22	158 sq mm	GEE10M878	GEE10M938	2.188	Chuwabari ss	JWPTI Tapping point
		AAAC				Overhead	Spur line	158 sq mm	GEE10M930	GEE10M932	0.101	U.Dologang	U.Dolongang
		AAAC				Overhead	Spur line 23	158 sq mm	GEE10M938	GEE10M939	0.028	JWPTI Tapping point	JWPTI ss
		ACSR DOG				Overhead	Spur line 24	100 sq mm	GEE10M099	GEE10M943	0.228	Ipoli T-off	Ipoli ss
		ACSR RABBIT				Overhead	Spur line 25	50 sq mm	GEE10M944	GEE10M946	0.145	Lower Juprey T-off	Lower Juprey ss (63kVA)
											53.332		
		Underground cable					Trunk line	300 sq mm	Substation	GEE20M000	0.076	11kV UG line at 132kV substation	132kV Gelephu ss
		ACSR DOG					Trunk line	100 sq mm	GEE20M000	GEE20M099	7.264	132kV substation	BCD LBS Bhur
		ACSR DOG					Trunk line	100 sq mm	GEE20M099	GEE20M104	0.324	BCD LBS	Bhur substation below road
		ACSR DOG					Trunk line	100 sq mm	GEE20M104	GEE20M112	0.685	Bhur substation	T-Off point Nim Dem crusher

MV Line Detials of Sarpang Dzongkhag

Sl#	Feeder Name	Line Description	Ring or Radial	Source Substation like TD or 33/11kV substation	Feeder Details: Voltage level(kV)	Feeder Details: UG/Overhead or Mixed	Line (Section 1) details: Line	Cable / Conductor size	First GPS code	Final GPS code	Line length (KM)	Location	Termination point
2	Sarpang II(M20)	ACSR DOG	Radial	132/66/33/11kV Gelephu substation	11	Mixed	Trunk line	100 sq mm	GEE20M112	GEE20M118	0.076	T-Off point Nim Dem crusher	T-Off point Mindu crusher
		ACSR DOG					Trunk line	100 sq mm	GEE20M118	GEE20M134	1.720	T-Off point Mindu crusher	Jigmeling,Raigaon
		ACSR DOG					Trunk line	100 sq mm	GEE20M134	GEE20M148	1.097	Raigaon substation	Jigmeling II substation T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE20M148	GEE20M163	0.746	T-Off point Jigmeling II	BHSL T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE20M163	GEE20M177	0.847	BHSL T-Off	Jigmeling Zero
		ACSR DOG					Trunk line	100 sq mm	GEE20M177	GEE20M190	0.916	Jigmeling Zero	TMD colony T-Off
		AAAC					Trunk line	158 sq mm	GEE20M190	GEE20M194	0.207	TMD colony T-Off	Chokorling substation
		ACSR DOG					Trunk line	100 sq mm	GEE20M194	GEE20M225	1.946	Chokorling substation	Dolkhola substation
		ACSR DOG					Trunk line	100 sq mm	GEE20M225	GEE20M226	0.240	Dolkhola substation	Dolpani T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE20M226	GEE20M272	2.751	Dolpani T-Off to	Darbethang T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE20M272	GEE20M307	0.535	Darbethang T-Off	Dekiling substation
		ACSR DOG					Trunk line	100 sq mm	GEE20M307	GEE20M327	1.293	Dekiling substation	Tashiling Lampatey
		ACSR DOG					Trunk line	100 sq mm	GEE20M327	GEE20M355	1.428	Tashiling T-Off	Norbuthang below Gawaithang
		ACSR DOG					Trunk line	100 sq mm	GEE20M355	GEE20M393	0.514	Gawaithang T-Off	Khafleykhola
		ACSR RABBIT					Trunk line	50 sq mm	GEE20M393	GEE20M403	0.835	Khafleykhola	Kencholing T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE20M403	GEE20M439	1.791	Kencholing T-Off	Norbugang
		ACSR DOG					Trunk line	100 sq mm	GEE20M439	GEE20M465	1.598	Norbugang substation	Akhow
		ACSR DOG					Trunk line	100 sq mm	GEE20M465	GEE20M481	1.010	Akhow substation	Panthareygaon T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE20M481	GEE20M529	0.696	Panthareygaon T-Off	Sarpangtar,33/11kV substation
		Underground cable					Trunk line	300 sq mm	GEE20M529	Substation	0.025	33/11kV substation, Sarpangtar	Sarpangtar, 33/11kV substation
		ACSR DOG					Spur line 1	100 sq mm	GEE20M099	GEE20M100	0.078	Bhur BCD	BCD,Bhur
		ACSR DOG					Spur line 2	100 sq mm	GEE20M112	GEE20M113	0.006	Nim Dem crusher T-Off	Dawa Tamang T-Off
		ACSR DOG					Spur line 3	100 sq mm	GEE20M113	GEE20M115	0.201	Dawa Tamang T-Off	Nim Dem Crusher substation
		ACSR DOG					Spur line 4	100 sq mm	GEE20M115	GEE20M117	0.136	Nim Dem crusher substation	White Tara crusher
		ACSR DOG					Spur line 5	100 sq mm	GEE20M113	GEE20M533	0.298	Dawa Tamang T-Off	Dawa Tamang crusher
		ACSR RABBIT					Spur line 6	50 sq mm	GEE20M118	GEE20M539	0.549	Mindu crusher T-Off	Mindu crusher
		ACSR RABBIT					Spur line 7	50 sq mm	GEE20M131	GEE20M548	0.668	Sonam Pelbar T-Off	Sonam Pelbar crusher
		ACSR DOG					Spur line 8	100 sq mm	GEE20M148	GEE20M153	0.308	T-Off point Jigmeling II	Jigmeling II substation
		ACSR DOG					Spur line 9	100 sq mm	GEE20M163	GEE20M165	0.112	BHSL T-Off	BHSL Jigmeling
		ACSR DOG					Spur line 10	100 sq mm	GEE20M177	GEE20M178	0.009	Jigmeling Zero	Jigmeling Zero substation
		HVABC					Spur line 11	95 sq mm	GEE20M190	GEE20M191	0.025	TMD colony T-Off	TMD colony, Jigmeling
		ACSR RABBIT					Spur line 12	50 sq mm	GEE20M226	GEE20M236	0.483	T-Off point Nobgang	Nobgang(Dolpany) substation
		ACSR RABBIT					Spur line 14	50 sq mm	GEE20M236	GEE20M243	1.012	Raigaon substation	Nobgang(Dolpany)
		ACSR RABBIT					Spur line 15	50 sq mm	GEE20M272	GEE20M283	0.766	Darbethang T-Off	Dekiling, Lower Darbethang
		ACSR RABBIT					Spur line 16	50 sq mm	GEE20M283	GEE20M299	1.304	Lower Darbethang substation	Dekiling, Upper Darbethang
		ACSR RABBIT					Spur line 17	50 sq mm	GEE20M327	GEE20M335	0.477	Tashiling T-Off	Dekiling,Tashiling
		ACSR DOG					Spur line 18	100 sq mm	GEE20M355	GEE20M369	1.028	Gawaithang T-Off	Gawaithang
		ACSR DOG					Spur line 19	100 sq mm	GEE20M369	GEE20M385	0.880	Gawaithang substation	Yangchenphu
		ACSR RABBIT					Spur line 20	50 sq mm	GEE20M403	GEE20M409	0.395	Darjaythang	Kencholing
		AAAC					Spur line 21	158 sq mm	GEE20M409	GEE20M414	0.326	Kencholing	Kencholing substation
		ACSR RABBIT					Spur line 22	50 sq mm	GEE20M481	GEE20M489	0.795	Sarpangtar	Panthareygaon T-Off
		ACSR RABBIT					Spur line 23	50 sq mm	GEE20M489	GEE20M490	0.052	Panthareygaon T-Off	Panthareygaon substation
		ACSR RABBIT					Spur line 24	50 sq mm	GEE20M489	GEE20M505	1.188	Panthareygaon T-Off	Lower Pakhey
		ACSR RABBIT					Spur line 25	50 sq mm	GEE20M505	GEE20M517	1.305	ACSR Rabbit from Thongjazor A	Upper Pakhey
											41.019		
3	Gelephu (M30)	Underground cable	Radial	132/66/33/11kV Gelephu substation	11	Mixed	Trunk line	300 sq mm	Substation	GEE30M000	0.062	11kV UG 3x300sqmm 132kV substation	132kV Gelephu ss
		ACSR DOG					Trunk line	100 sq mm	GEE30M000	GEE30M003	0.132	ACSR Dog Gelephu 132 kV substation area	132kV Gelephu ss
		ACSR DOG					Trunk line	100 sq mm	GEE30M003	GEE30M006	0.145	ACSR Dog Gelephu CDCL area	Gelephu,CDCL
		ACSR DOG					Trunk line	100 sq mm	GEE30M003	GEE30M015	0.274	132kV substation area	Gelephu market
		ACSR DOG					Trunk line	100 sq mm	GEE30M015	GEE30M047	0.340	ACSR Dog from Market substation	Charali
		ACSR DOG					Trunk line	100 sq mm	GEE30M047	GEE30M050	0.176	ACSR Dog from Charali substation	RBP Division V office
		ACSR RABBIT					Trunk line	100 sq mm	GEE30M050	GEE30M051	0.016	ACSR Rabbit RBP T-Off	RBP Division V office
		ACSR DOG					Trunk line	100 sq mm	GEE30M051	GEE30M056	0.315	ACSR Dog from RBP T-Off	RBP Division V office
		ACSR RABBIT					Trunk line	50 sq mm	GEE30M056	GEE30M072	0.529	ACSR Rabbit from RBP substation	Fishery,Gelephu
		ACSR DOG					Trunk line	100 sq mm	GEE30M072	GEE30M082	0.508	ACSR Dog from Fishery	Magibusty
		ACSR RABBIT					Spur line 1	50 sq mm	GEE30M073	GEE30M094	0.434	ACSR Rabbit from T-Off	Old hospital
		ACSR RABBIT					Spur line 2	50 sq mm	GEE30M057	GEE30M061	0.191	ACSR Rabbit from T-Off	Bhutan Telecom, Gelephu
		ACSR DOG					Spur line 3	100 sq mm	GEE30M050	GEE30M0100	0.343	ACSR Dog from T-Off	Gelephu LSS T-Off
		ACSR DOG					Spur line 4	100 sq mm	GEE30M0100	GEE30M0104	0.127	ACSR Dog from T-Off	Gelephu LSS
		ACSR DOG					Spur line 5	100 sq mm	GEE30M0100	GEE30M0112	0.201	ACSR Dog from T-Off	Royal guest house, Gelephu
		ACSR RABBIT					Spur line 6	50 sq mm	GEE30M015	GEE30M019	0.260	ACSR Rabbit from T-Off	Market ss
		ACSR RABBIT					Spur line 7	50 sq mm	GEE30M019	GEE30M026	0.306	ACSR Rabbit from Market ss	Heromajan ss

MV Line Detials of Sarpang Dzongkhag

Sl#	Feeder Name	Line Description	Ring or Radial	Source Substation like TD or 33/11kV substation	Feeder Details		Line	Line (Section 1) details					
					Voltage level(kV)	UG/Overhead or Mixed		Cable / Conductor size	First GPS code	Final GPS code	Line length (KM)	Location	Termination point
		ACSR RABBIT					Spur line 8	50 sq mm	GEE30M026	GEE30M039	0.823	ACSR Rabbit from Heromajan	Sewage Treatment Plant
		ACSR DOG					Spur line 9	100 sq mm	GEE30M006	GEE30M007	0.038	ACSR Dog from T-Off	Galleybusty
		ACSR DOG					Spur line 10	100 sq mm	GEE30M006	GEE30M009	0.090	ACSR Dog from T-Off to CDCL ss	CDCL SS
											5.311		
4	ADP (M40)	Underground cable	Ring	132/66/33/11kV substation, Gelephu	11	Mixed	Trunk line	300 sq mm	Substation	GEE40M001	0.060	11kV UG 3x300sqmm 132kV substation	132 kV ss,Gelephu
		ACSR DOG					Trunk line	100 sq mm	GEE40M001	GEE40M031	1.604	ACSR Dog from 132kV ss	RRCO T-Off, Gelephu
		ACSR DOG					Trunk line	100 sq mm	GEE40M031	GEE40M043	0.260	ACSR Dog from RRCO T-Off	Majibusty T-Off,Gelephu
		ACSR DOG					Trunk line	100 sq mm	GEE40M035	GEE50M050	0.329	ACSR Dog from Majibusty T-Off	Pump house T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE50M051	GEE40M040	0.019	ACSR Rabbit from Majibusty T-Off	Pump house T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE50M051	GEE50M052	0.049	ACSR Dog below match factory	Match factory
		ACSR RABBIT					Trunk line	50 sq mm	GEE50M052	GEE50M072	0.284	ACSR Rabbit from Match factory	RVL T Off
		ACSR DOG					Trunk line	100 sq mm	GEE50M072	GEE50M076	0.334	ACSR Dog from RVL T-Off	Shetikhari
		ACSR DOG					Trunk line	100 sq mm	GEE50M076	GEE50M053	0.054	ACSR Dog Shetikhari	Shetikhari
		ACSR DOG					Trunk line	100 sq mm	GEE50M053	GEE50M077	0.039	ACSR Dog Shetikhari	Shetikhari
		ACSR DOG					Trunk line	100 sq mm	GEE50M077	GEE50M079	0.096	ACSR Dog below GHSS, Shetikhari	Shetikhari
		ACSR RABBIT					Trunk line	50 sq mm	GEE50M079	GEE50M168	1.750	ACSR Rabbit from Shetikhari	RSD office,Pelrithang
		ACSR RABBIT					Trunk line	50 sq mm	GEE50M168	GEE50M180	1.130	ACSR Rabbit from RSD office	33/11kV T-Off, Pelrithang
		ACSR RABBIT					Trunk line	50 sq mm	GEE50M180	GEE40M077	0.939	ACSR Rabbit from 33/11kV T-Off	RBA substation, L.Lodarai
		ACSR RABBIT					Trunk line	50 sq mm	GEE40M077	GEE40M103	1.907	ACSR Rabbit from RBA substation	Gas Industry T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE40M103	GEE40M115	0.452	ACSR Rabbit from Gas Industry	Sershong substation
		ACSR RABBIT					Trunk line	50 sq mm	GEE40M115	GEE40M138	1.537	ACSR Rabbit from Sershong substation	Sershong school T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE40M138	GEE40M150	0.925	ACSR Rabbit from Sershong school T-Off	Barshong T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE40M150	GEE40M177	1.696	ACSR RABBIR from Barshong T-Off	Pangkhar T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE40M177	GEE40M191	0.687	ACSR Rabbit from Pangkhar T-Off	Pemaling T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE40M191	GEE40M203	0.537	ACSR Rabbit from Pemaling T-Off	Tashiphu T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE40M203	GEE40M214	0.724	ACSR Rabbit from Tashiphu T- Off	Norbuling village T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE40M214	GEE40M218	0.151	ACSR Rabbit from Norbuling village T-Off	Norbuling school T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE40M218	GEE40M238	0.367	ACSR Rabbit from Norbuling school T-Off	Infront of school substation
		ACSR RABBIT					Trunk line	50 sq mm	GEE40M238	GEE40M258	1.186	ACSR Rabbit from Infronyt of school substa	Pangzor T- Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE40M258	GEE40M271	0.698	ACSR RABBIRT from Pangzor T-Off	Shawapang substation
		ACSR RABBIT					Trunk line	50 sq mm	GEE40M271	GEE40M282	0.792	ACSR Rabbit from Shawapang substation	Chuzaggang substation
		ACSR RABBIT					Spur line 1	50 sq mm	GEE40M031	GEE40M041	0.025	ACSR Rabbit RRCO T-Off	RRCO T-Off, Gelephu
		Underground cable					Spur line 2	300 sq mm	GEE40M041	GEE40M042	0.239	UG 3x300sqmm from T-Off	RRCO substation
		Underground cable					Spur line 3	300 sq mm	GEE40M034	GEE40M298	0.160	UG 3x300sqmm, Kuku guest house	Kuku guest house
		ACSR RABBIT					Spur line 5	50 sq mm	GEE40M040	GEE40M045	0.325	Magibusty substation I	Magibusty substation I
		ACSR RABBIT					Spur line 6	50 sq mm	GEE40M045	GEE40M058	0.945	ACSR Rabbit Magibusty substatio I	Pump house substation
		ACSR RABBIT					Spur line 7	50 sq mm	GEE50M168	GEE40M066	0.082	ACSR Rabbit Pelrithang above RSD office	Pelrithang
		ACSR RABBIT					Spur line 8	50 sq mm	GEE40M103	GEE40M109	0.417	ACSR Rabbit from T-Off to Gas industry sub	Gas industry substation
		ACSR RABBIT					Spur line 9	50 sq mm	GEE40M138	GEE40M139	0.022	ACSR Rabbit Sershong school substation	Sershong school substation
		ACSR RABBIT					Spur line 10	50 sq mm	GEE40M150	GEE40M157	0.474	ACSR Rabbit from T-Off	Barshong substation
		ACSR RABBIT					Spur line 11	50 sq mm	GEE40M177	GEE40M183	0.407	ACSR Rabbit from T-Off	Pangkhar substation
		ACSR RABBIT					Spur line 12	50 sq mm	GEE40M191	GEE40M195	0.237	ACSR Rabbit from T-Off	Pemaling substation
		ACSR RABBIT					Spur line 13	50 sq mm	GEE40M203	GEE40M296	1.159	ACSR Rabbit from T-Off	Tashiphu substation
		ACSR RABBIT					Spur line 14	50 sq mm	GEE40M214	GEE40M216	0.141	ACSR Rabbit from T-Off	Norbuling village substation
		ACSR RABBIT					Spur line 15	50 sq mm	GEE40M218	GEE40M232	0.747	ACSR Rabbit from T-Off	Norbuling school substation
		ACSR RABBIT					Spur line 16	50 sq mm	GEE40M238	GEE40M241	0.170	ACSR Rabbit Norbuling substation near scho	Norbuling substation near school
		ACSR RABBIT					Spur line 17	50 sq mm	GEE40M258	GEE40M261	0.198	ACSR Rabbit from T-Off	Pangzor substation
		ACSR RABBIT					Spur line 18	50 sq mm	GEE50M072	GEE50M063	0.209	ACSR Rabbit from T-Off	RVL substation
		HVABC					Spur line 19	95 sq mm	GEE50M180	GEE40M297	0.795	HVABC from T-Off to 33/11kV substation,	33/11kV ss, Pelrithang
		Underground cable					Spur line 20	300 sq mm	GEE40M297	SS Pelrithang	0.029	UG 3x3oosqmm, 33/11kV substation, Pelritl	33/11kV ss, Pelrithang
											25.387		
		Underground cable					Trunk line	300 sq mm	Substation	GEE50M001	0.064	11kV UG 3x300sqmm 132kV substation	132 kV ss,Gelephu
		ACSR DOG					Trunk line	100 sq mm	GEE50M001	GEE50M007	0.418	ACSR Dog from 132kV ss	Trunkeybusty T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE50M007	GEE50M023	0.632	ACSR Dog from Trunkeybusty T-Off	Lhaki wood T-off
		ACSR DOG					Trunk line	100 sq mm	GEE50M023	GEE50M029	0.222	ACSR Dog from Lhaki wood T-Off	Lungta w/shop T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE50M029	GEE50M201	0.028	ACSR Dog Lungta w/shop T-Off	Lungta w/shop T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE50M201	GEE50M031	0.103	ACSR Dog from Lungta w/shop T-Off	GHSS T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE50M031	GEE50M046	0.555	ACSR Dog from GHSS T-Off	Forest checkpost T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE50M046	GEE50M196	0.047	ACSR Dog Forestcheckpost	Forest checkpost
		ACSR DOG					Trunk line	100 sq mm	GEE50M196	GEE50M051	0.222	ACSR Dog from Forest checkpost T-Off	Lakitar T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE50M051	GEE50M076	0.667	ACSR Dog from Lakitar T-Off	Shetikhari

MV Line Detials of Sarpang Dzongkhag

Sl#	Feeder Name	Line Description	Ring or Radial	Source Substation like TD or 33/11kV substation	Feeder Details: Voltage level(kV)	Feeder Details: UG/Overhead or Mixed	Line (Section 1) details: Line	Cable / Conductor size	First GPS code	Final GPS code	Line length (KM)	Location	Termination point
5	RBA (M50)	ACSR DOG	Radial	132/66/33/11kV substation, Gelephu	11	Mixed	Trunk line	100 sq mm	GEE50M076	GEE50M053	0.054	ACSR Dog from Shetikhari	GMSS T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE50M053	GEE50M079	0.134	ACSR Dog Shetikhari	Shetikhari
		ACSR RABBIT					Trunk line	50 sq mm	GEE50M079	GEE50M158	0.741	ACSR Rabbit from Shetikhari	Kidu Area above Shetikhari
		ACSR RABBIT					Trunk line	50 sq mm	GEE50M158	GEE50M161	0.300	ACSR Rabbit from Kidu area	Doulakhola
		ACSR RABBIT					Trunk line	50 sq mm	GEE50M161	GEE50M168	0.708	ACSR Rabbit from Doulakhola substation	RSD office T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE50M168	GEE50M175	0.652	ACSR Rabbit from RSD office T-Off	Lodarai village substation
		ACSR RABBIT					Trunk line	50 sq mm	GEE50M175	GEE50M195	1.153	ACSR Rabbit from Lodarai village substatio	RBA substation, U.Lodarai
		HVABC					Trunk line	95 sq mm	GEE50M180	GEE50M256	0.854	HVABC from T-Off to 33/11kV substation,	33/11kV ss, Pelrithang
		Underground cable					Trunk line	300 sq mm	GEE50M256	SS PelritMang	0.038	UG 3x300sqmm, 33/11kV substation,Pelrith	33/11kV ss, Pelrithang
		ACSR RABBIT					Spur line 1	50 sq mm	GEE50M007	GEE50M011	0.168	ACSR Rabbit from T-Off	Trunkeybusty substation
		ACSR RABBIT					Spur line 2	50 sq mm	GEE50M023	GEE50M025	0.087	ACSR Rabbit from T-Off	Lhaki wood substation
		ACSR DOG					Spur line 3	100 sq mm	GEE50M201	GEE50M209	0.447	ACSR Dog from T-Off	Lungta w/shop
		ACSR RABBIT					Spur line 4	50 sq mm	GEE50M209	GEE50M210	0.099	ACSR Rabbit Lungta w/shop substation	Lungta w/shop substation
		ACSR RABBIT					Spur line 5	50 sq mm	GEE50M031	GEE50M037	0.295	ACSR Rabbit T-Off	GHSS substation
		ACSR DOG					Spur line 6	100 sq mm	GEE50M196	GEE50M200	0.243	ACSR Dog from T-Off	Forest Division substation
		Underground cable					Spur line 7	300 sq mm	GEE50M051	GEE50P8	0.767	UG 3x300sqmm from T-Off	Samdrupling
		Underground cable					Spur line 8	300 sq mm	GEE50P8	GEE50M055	0.017	UG 3x300sqmm Samdrupling substation	Samdrupling substation
		Underground cable					Spur line 9	300 sq mm	GEE50M055	GEE50P12	0.448	Samdrupling substation	U.Lakitar
		ACSR RABBIT					Spur line 10	50 sq mm	GEE50P12	GEE50M069	0.018	ACSR Rabbit U.Lakitar substation	U.Lakitar substation
		Underground cable					Spur line 11	300 sq mm	GEE50M053	GEE50P15	0.233	UG 3x300sqmm from T-Off	GMSS
		Underground cable					Spur line 12	300 sq mm	GEE50P15	GEE50M083	0.070	UG 3x300sqmm to Pemathang T-Off	Pemathang T-off
		Underground cable					Spur line 13	300 sq mm	GEE50M083	GEE50M054	0.054	UG 3x300sqmm T-Off to GMSS substation	GMSS substation
		ACSR DOG					Spur line 14	100 sq mm	GEE50M083	GEE50M084	0.064	ACSR Dog Shetikhari	Shetikhari
		ACSR RABBIT					Spur line 15	50 sq mm	GEE50M084	GEE50M085	0.064	ACSR Rabbit Shetikhari substation	Shetikhari substation
		ACSR RABBIT					Spur line 16	50 sq mm	GEE50M085	GEE50M103	1.131	ACSR Rabbit Shetikhari substation	U.Pemathang substation
		ACSR RABBIT					Spur line 17	50 sq mm	GEE50M103	GEE50M108	0.310	ACSR Rabbit U.Pemathang substation	U.Pelrithang T-Off
		ACSR RABBIT					Spur line 18	50 sq mm	GEE50M108	GEE50M111	0.180	ACSR Rabbit U.Pelrithang T-Off	L.Zomlingthang T-Off
		ACSR RABBIT					Spur line 19	50 sq mm	GEE50M111	GEE50M119	0.517	ACSR Rabbit from T-Off	L.Zomlingthang substation
		ACSR RABBIT					Spur line 20	50 sq mm	GEE50M111	GEE50M120	0.057	M.Zomlingthang substation	M.Zomlingthang substation
		ACSR RABBIT					Spur line 21	50 sq mm	GEE50M108	GEE50M150	1.065	ACSR Rabbit from T-Off	U.Pelrithang substation
		ACSR RABBIT					Spur line 22	50 sq mm	GEE50M120	GEE50M133	0.776	ACSR Rabbit from M.Zomlingthang	U.Zomlingthang substation
		ACSR RABBIT					Spur line 23	50 sq mm	GEE50M212	GEE50M228	1.234	ACSR Rabbit from T-Off	Chokorling substation
		ACSR RABBIT					Spur line 24	50 sq mm	GEE50M158	GEE50M061	0.061	ACSR Rabbit Kidu area above Shetikhari	Above Shetikhari
		ACSR RABBIT					Spur line 25	50 sq mm	GEE50M061	GEE50M064	0.191	ACSR Rabbit Kidu area substation above She	Kidu area substation above Shetikhari
		ACSR RABBIT					Spur line 26	50 sq mm	GEE50M161	GEE50M056	0.022	ACSR Rabbit Kidu area below Gelephu Gew	Kidu area below Gelephu Gewog office
		ACSR RABBIT					Spur line 27	50 sq mm	GEE50M056	GEE50M060	0.239	ACSR Rabbit Kidu area substation below Ge	Kidu area below Gelephu Gewog office
		Underground cable					Spur line 28	300 sq mm	GEE50M168	GEE50M211	0.049	UG 3x300sqmm RSD office substation,Pelrit	RSD office substation, Pelrithang
											16.500		
6	Station service,132kV SS,Gelephu.	Underground cable	Radial	132/66/33/11kV substation, Gelephu	11	UG	Trunk line	300 sq mm	Substation	GEE60M001	0.063	UG 3x300sqmm, 132 kV substation,Gelephu	132kV ss, Gelephu
		Underground cable					Trunk line	150 sq mm	Substation	GEE70M415	0.042	UG 3x150sqmm, 33/11kV substation,Sarpan	33/11kV ss, Sarpangtar
		ACSR DOG					Trunk line	100 sq mm	GEE70M415	GEE130M028	1.018	ACSR Dog from Sarpangtar	Kamikhola
		AAAC					Trunk line	158 sq mm	GEE130M028	GEE130M032	0.226	AAAC, above old market,Sarpang	Above old market,Sarpang
		ACSR RABBIT					Trunk line	50 sq mm	GEE130M032	GEE70M001	0.629	ACSR Rabbit, below BOD,Sarpang	Below BOD,Sarpang
		ACSR DOG					Trunk line	100 sq mm	GEE70M001	GEE70M007	0.579	ACSR Dog from Butabari	Sarpangsear T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE70M007	GEE70M205	2.842	ACSR Dog from T-Off	Jogidara substation
		ACSR DOG					Trunk line	100 sq mm	GEE70M205	GEE70M218	1.060	ACSR Dog from Jogidara	Loring T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE70M218	GEE70M293	3.480	ACSR Dog from Loring T-Off	Noonpani substation
		ACSR DOG					Trunk line	100 sq mm	GEE70M293	GEE70M309	1.346	ACSR Dog from Noonpani substation	Khopitar substation
		ACSR DOG					Trunk line	100 sq mm	GEE70M309	GEE70M322	0.930	ACSR Dog from Khopitar	Rateypani T-off
		ACSR DOG					Trunk line	100 sq mm	GEE70M322	GEE70M342	0.162	ACSR Dog from T-Off	Kalikhola substation
		ACSR DOG					Trunk line	100 sq mm	GEE70M342	GEE70M350	0.531	ACSR Dog from Kalikhola	Deoti T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE70M350	GEE70M358	0.752	ACSR Dog from Deoti T-Off	Sangkhay T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE70M358	GEE70M374	1.486	ACSR Dog from Sangkhay T-Off	Jaisidara substation
		ACSR DOG					Spur line 1	100 sq mm	GEE70M003	GEE70M168	0.340	ACSR Dog from T-Off	Amaleydara
		ACSR RABBIT					Spur line 2	50 sq mm	GEE70M168	GEE70M173	0.245	ACSR Rabbit from Amaleydara	Kharaypakhay substation
		ACSR RABBIT					Spur line 3	50 sq mm	GEE70M007	GEE70M020	1.065	ACSR Rabbit from T-Off	Dalani I substation

MV Line Detials of Sarpang Dzongkhag

Sl#	Feeder Name	Line Description	Ring or Radial	Source Substation like TD or 33/11kV substation	Feeder Details: Voltage level(kV)	Feeder Details: UG/Overhead or Mixed	Line	Cable / Conductor size	First GPS code	Final GPS code	Line (Section 1) details: Line length (KM)	Location	Termination point
7	Geychu/Sarpangsear	ACSR RABBIT	Radial	33/11kV substation,Sarpang	33	Mixed	Spur line 4	50 sq mm	GEE70M020	GEE70M026	0.644	ACSR Rabbit from Dalani I	Tenjuri T-Off
		ACSR RABBIT					Spur line 5	50 sq mm	GEE70M026	GEE70M039	0.923	ACSR Rabbit from T-Off	Tenjuri A substation
		ACSR RABBIT					Spur line 6	50 sq mm	GEE70M039	GEE70M040	0.054	ACSR Rabbit from Tenjuri A	Laptsabotey T-Off
		ACSR RABBIT					Spur line 7	50 sq mm	GEE70M040	GEE70M046	0.548	ACSR Rabbit from Laptsabotey T-Off	Tenjuri B substation
		ACSR RABBIT					Spur line 8	50 sq mm	GEE70M046	GEE70M056	0.744	ACSR Rabbit from Tenjuri B	Tenjuri C substation
		ACSR RABBIT					Spur line 9	50 sq mm	GEE70M040	GEE70M067	0.963	ACSR Rabbit from T-Off	Laptsabotey substation
		ACSR RABBIT					Spur line 10	50 sq mm	GEE70M026	GEE70M069	0.526	ACSR Rabbit from T-Off	Dalani II T-Off
		ACSR RABBIT					Spur line 11	50 sq mm	GEE70M069	GEE70M070	0.146	ACSR Rabbit Dalani II substation	Dalani II substation
		ACSR RABBIT					Spur line 12	50 sq mm	GEE70M069	GEE70M081	1.087	ACSR Rabbit from T-Off	Kusumey B substation
		ACSR RABBIT					Spur line 13	50 sq mm	GEE70M081	GEE70M103	2.231	ACSR Rabbit from Kusumey B	Kusumey A T-Off
		ACSR RABBIT					Spur line 14	50 sq mm	GEE70M103	GEE70M104	0.123	ACSR Rabbit Kusumey A substation	Kusumey A substation
		ACSR RABBIT					Spur line 15	50 sq mm	GEE70M103	GEE70M110	0.822	ACSR Rabbit from T-Off	Pangkhabari substation
		ACSR RABBIT					Spur line 16	50 sq mm	GEE70M110	GEE70M119	0.891	ACSR Rabbit from Pangkhabari	Kharpani substation
		ACSR RABBIT					Spur line 17	50 sq mm	GEE70M119	GEE70M138	1.644	ACSR Rabbit from Kharpani substation	Tsagay substation
		ACSR RABBIT					Spur line 18	50 sq mm	GEE70M130	GEE70M139	0.313	ACSR Rabbit from T-Off	Gangatey B T-Off
		ACSR RABBIT					Spur line 19	50 sq mm	GEE70M139	GEE70M164	0.038	ACSR Rabbit, Gangatey B substation	Gangatey B substation
		ACSR RABBIT					Spur line 20	50 sq mm	GEE70M139	GEE70M143	0.523	ACSR Rabbit from T-Off	Gangatey A T-Off
		ACSR RABBIT					Spur line 21	50 sq mm	GEE70M143	GEE70M163	0.382	ACSR Rabbit, Gangatey A substation	Gangatey A substation
		ACSR RABBIT					Spur line 22	50 sq mm	GEE70M143	GEE70M146	0.538	ACSR Rabbit from T-Off	Pheling substation
		ACSR RABBIT					Spur line 23	50 sq mm	GEE70M146	GEE70M158	1.385	ACSR Rabbit from Pheling	Balkhola substation
		ACSR RABBIT					Spur line 24	50 sq mm	GEE70M218	GEE70M224	0.652	ACSR Rabbit from T-Off	Saguri substation
		ACSR RABBIT					Spur line 25	50 sq mm	GEE70M224	GEE70M229	0.541	ACSR Rabbit from Loring I	Loring II substation
		ACSR RABBIT					Spur line 26	50 sq mm	GEE70M229	GEE70M237	0.672	ACSR Rabbit from Loring II	Loring III substation
		ACSR RABBIT					Spur line 27	50 sq mm	GEE70M237	GEE70M241	0.432	ACSR Rabbit from Loring III	Chargarey substation
		ACSR RABBIT					Spur line 28	50 sq mm	GEE70M241	GEE70M242	0.107	ACSR Rabbit from Chargarey	Kagatey T-Off
		ACSR RABBIT					Spur line 29	50 sq mm	GEE70M242	GEE70M253	0.547	ACSR Rabbit from T-Off	Ajingarey substation
		ACSR RABBIT					Spur line 30	50 sq mm	GEE70M242	GEE70M247	0.785	ACSR Rabbit from T-Off	Kagatey substation
		ACSR RABBIT					Spur line 31	50 sq mm	GEE70M299	GEE70M416	0.083	ACSR Rabbit Mega Broiler farm substation	Mega Broiler farm substation.
		ACSR RABBIT					Spur line 32	50 sq mm	GEE70M322	GEE70M340	1.540	ACSR Rabbit from T-Off	Rateypani substation
		ACSR DOG					Spur line 33	100 sq mm	GEE70M358	GEE70M379	0.319	ACSR Dog from T-Off	Sangkhay substation
		ACSR RABBIT					Spur line 34	50 sq mm	GEE70M363	GEE70M414	1.088	ACSR Rabbit from T-Off	Muga substation
		ACSR RABBIT					Spur line 35	50 sq mm	GEE70M350	GEE70M385	0.316	ACSR Rabbit from T-Off	Sasbotey substation
		ACSR RABBIT					Spur line 36	50 sq mm	GEE70M385	GEE70M401	1.313	ACSR Rabbit from Sasbotey	Deoti substation
											39.652		
8	Pelrithang	Underground cable	Radial	132/66/33/11kV substation, Gelephu	33	Mixed	Trunk line	400 sq mm	Substtion	GEE80M001	0.061	UG 3x400sqmm,132kV substation,Gelephu	132kV ss, Gelephu
		ACSR DOG					Trunk line	100 sq mm	GEE80M001	GEE80M013	3.997	ACSR Dog from 132kV ss	Near Trunkey busty
									GEE80M013	GEE80M061	0.786	Near Trunkey busty	Pelrithang school T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE80M061	GEE80M081	0.229	ACSR Dog from Pelrithang school T-Off	L.Pelrithang village T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE80M081	GEE80M083	0.904	ACSR Dog from T-Off	33/11kV ss,Pelrithang
		Underground cable					Trunk line	400 sq mm	GEE80M083	SS PelritMang	0.036	UG 3x400sqmm, 33/11kV substation,Pelrith	33/11kV ss,Pelrithang
		ACSR RABBIT					Spur line 1	50 sq mm	GEE80M061	GEE80M067	0.277	ACSR Rabbit from T-off	Pelrithang school substation
		ACSR DOG					Spur line 2	100 sq mm	GEE80M081	GEE80M082	0.008	ACSR Dog L.Pelrithang village substation	L.Pelrithang village substation
		ACSR RABBIT					Spur line 3	50 sq mm	GEE80M084	GEE80M085	0.012	ACSR Rabbit Pemathang substation,near Thr	Pemathang substation
											6.309		
		Underground cable					Trunk line	300 sq mm	Substation	GEE90M000	0.031	UG 3x300sqmm, 33/11kV substation,Pelrith	33/11kV ss, Pelrithang
		ACSR DOG					Trunk line	100 sq mm	GEE90M000	GEE90M042	3.584	ACSR Dog from 33/11kV ss,Pelrithang	T-Off at Sershong
		ACSR DOG					Trunk line	100 sq mm	GEE90M042	GEE90M396	2.101	ACSR Dog T-Off	Tshachu T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE90M396	GEE90M456	5.608	ACSR Dog from Tshachu T-Off	Ossey T-off
		ACSR DOG					Trunk line	100 sq mm	GEE90M456	GEE90M483	3.045	ACSR Dog from Ossey T-Off	T.Cell tower substation
		ACSR DOG					Trunk line	100 sq mm	GEE90M483	GEE90M497	1.226	ACSR Dog from T.Cell tower	Suray market Off
		ACSR DOG					Trunk line	100 sq mm	GEE90M497	GEE90M504	0.420	ACSR Dog from T-Off	Suray market substation
		ACSR DOG					Trunk line	100 sq mm	GEE90M504	GEE90M509	0.576	ACSR Dog from Market substation	U.Daragaon T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE90M509	GEE90M510	0.048	ACSR Dog, U.Daragaon substation	U.Daragaon substation
		ACSR RABBIT					Trunk line	50 sq mm	GEE90M509	GEE90M700	1.178	ACSR Rabbit from T-Off	L.Daragaon substation
		ACSR RABBIT					Trunk line	50 sq mm	GEE90M700	GEE90M714	1.250	ACSR Rabbit from L.Daragaon	Pakhay B substation
		ACSR RABBIT					Trunk line	50 sq mm	GEE90M714	GEE90M724	0.941	ACSR Rabbit from Pakhay B	Pakhay A T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE90M724	GEE90M735	0.777	ACSR Rabbit from Pakhay A T-Off	Sukumbasi B T-Off
		HVABC					Trunk line	158 sq mm	GEE90M735	GEE90M766	1.107	AAAC from T-Off	Sukumbasi A substation
		ACSR RABBIT					Trunk line	50 sq mm	GEE90M766	GEE90M778	1.991	ACSR Rabbit,Sukumbasi	Sukumbasi
		ACSR DOG					Spur line 1	100 sq mm	GEE90M042	GEE90M067	2.060	ACSR Dog from T-Off	Pemathang T-Off
		ACSR DOG					Spur line 2	100 sq mm	GEE90M067	GEE90M068	0.078	ACSR Dog, Pemathang substation	Pemathang substation
		ACSR DOG					Spur line 3	100 sq mm	GEE90M067	GEE90M080	1.046	ACSR Dog from T-Off	U.Chasakhar substation

MV Line Detials of Sarpang Dzongkhag

Sl#	Feeder Name	Line Description	Ring or Radial	Source Substation like TD or 33/11kV substation	Feeder Details		Line	Line (Section 1) details					
					Voltage level(kV)	UG/Overhead or Mixed		Cable / Conductor size	First GPS code	Final GPS code	Line length (KM)	Location	Termination point
9	Jigmecholing	ACSR DOG	Radial	33/11kV substation,Pelrithang	11	Mixed	Spur line 4	100 sq mm	GEE90M080	GEE90M093	0.833	ACSR Dog from U.Chasakhar	M.Chasakhar substation
		ACSR DOG					Spur line 5	100 sq mm	GEE90M093	GEE90M113	1.491	ACSR Dog from L.Chasakhar substation	L.Chasakhar substation
		ACSR DOG					Spur line 6	100 sq mm	GEE90M113	GEE90M116	0.222	ACSR Dog from L.Chasakhar	Chasakhar rice mill T-Off
		ACSR DOG					Spur line 7	100 sq mm	GEE90M116	GEE90M117	0.026	ACSR Dog Chasakhar rice mill substation	Chasakhar rice mill substation
		ACSR DOG					Spur line 8	100 sq mm	GEE90M116	GEE90M147	2.088	ACSR Dog from T-Off	Thongjabi substation
		ACSR DOG					Spur line 9	100 sq mm	GEE90M147	GEE90M160	0.859	ACSR Dog from Thongjabi	Barthang substation
		ACSR DOG					Spur line 10	100 sq mm	GEE90M160	GEE90M162	0.109	ACSR Dog from Barthang	Zombabee T-Off
		ACSR DOG					Spur line 11	100 sq mm	GEE90M162	GEE90M175	0.850	ACSR Dog from T-Off	Zombabee substation
		ACSR DOG					Spur line 12	100 sq mm	GEE90M162	GEE90M186	0.835	ACSR Dog from T-Off	Dawathang T-off
		ACSR DOG					Spur line 13	100 sq mm	GEE90M186	GEE90M188	0.119	ACSR Dog,L.Dawathang substation	L.Dawathang substation
		ACSR RABBIT					Spur line 14	50 sq mm	GEE90M188	GEE90M210	1.634	ACSR Rabbit from L.Dawathang	U.Dawathang substation
		ACSR DOG					Spur line 15	100 sq mm	GEE90M186	GEE90M236	2.387	ACSR Dog from T-Off	Lingar substation
		ACSR DOG					Spur line 16	100 sq mm	GEE90M236	GEE90M239	0.186	ACSR Dog from Lingar	Ghaden T-Off
		ACSR DOG					Spur line 17	100 sq mm	GEE90M239	GEE90M253	0.947	ACSR Dog from T-off	Ghaden substation
		ACSR DOG					Spur line 18	100 sq mm	GEE90M239	GEE90M261	0.501	ACSR Dog from T-Off	Dangling T-Off
		ACSR DOG					Spur line 19	100 sq mm	GEE90M261	GEE90M262	0.034	ACSR Dog from T-off	Rejuk T-Off
		ACSR RABBIT					Spur line 20	50 sq mm	GEE90M262	GEE90M266	0.222	ACSR Rabbit from T-off	Rejuk substation
		ACSR RABBIT					Spur line 21	50 sq mm	GEE90M261	GEE90M281	0.965	ACSR Rabbit from T-off	Dungmin substation
		ACSR RABBIT					Spur line 22	50 sq mm	GEE90M281	GEE90M290	0.673	ACSR rabbit from T-off	Dangling T-Off
		ACSR RABBIT					Spur line 23	50 sq mm	GEE90M290	GEE90M296	0.458	ACSR Rabbit from T-Off	Dangling substation
		ACSR RABBIT					Spur line 24	50 sq mm	GEE90M290	GEE90M303	0.776	ACSR Rabbit from T-Off	Thongjazor T-Off
		ACSR RABBIT					Spur line 25	50 sq mm	GEE90M303	GEE90M304	0.103	ACSR Rabbit,Chuburthang substation	Chuburthang substation
		ACSR RABBIT					Spur line 26	50 sq mm	GEE90M303	GEE90M314	0.936	ACSR Rabbit from T-Off	Tashithang substation
		ACSR RABBIT					Spur line 27	50 sq mm	GEE90M303	GEE90M319	0.470	ACSR Rabbit from T-Off	Thongjazor substation
		ACSR DOG					Spur line 28	100 sq mm	GEE90M262	GEE90M339	1.921	ACSR Dog from T-Off	Tarethang substation
		ACSR DOG					Spur line 29	100 sq mm	GEE90M339	GEE90M348	0.709	ACSR Dog from Tarethang A	Tarethang B substation
		ACSR DOG					Spur line 30	100 sq mm	GEE90M348	GEE90M375	1.761	ACSR Dog from Tarethang B	Tarethang C substation
		ACSR DOG					Spur line 31	100 sq mm	GEE90M497	GEE90M517	0.404	ACSR Dog from T-Off	Sirangaon T-off
		ACSR RABBIT					Spur line 32	50 sq mm	GEE90M517	GEE90M520	0.193	ACSR Rabbit,Sirangaon substation	Sirangaon substation
		ACSR DOG					Spur line 33	100 sq mm	GEE90M517	GEE90M522	0.134	ACSR Dog from T-off	New Dratsang T-off
		ACSR DOG					Spur line 34	100 sq mm	GEE90M522	GEE90M524	0.089	ACSR Dog, New Dratsang substation	New Dratsang substation
		ACSR DOG					Spur line 35	100 sq mm	GEE90M522	GEE90M530	0.685	ACSR Dog from T-off	Beachgaon substation
		ACSR DOG					Spur line 36	100 sq mm	GEE90M530	GEE90M543	1.041	ACSR Dog from Beachgaon	Khatey t-off
		ACSR RABBIT					Spur line 37	50 sq mm	GEE90M543	GEE90M549	0.366	ACSR Rabbit,Khatey substation	Khatey substation
		ACSR DOG					Spur line 38	100 sq mm	GEE90M543	GEE90M557	0.701	ACSR Dog from T-Off	Soundalai T-off
		ACSR DOG					Spur line 39	100 sq mm	GEE90M557	GEE90M565	0.531	ACSR Dog,Soundalai substation	Soundalai substation
		ACSR DOG					Spur line 40	100 sq mm	GEE90M557	GEE90M572	0.516	ACSR Dog from T-off	Bataney T-Off
		ACSR RABBIT					Spur line 41	50 sq mm	GEE90M572	GEE90M579	0.580	ACSR Rabbit,Bataney substation	Bataney substation
		ACSR DOG					Spur line 42	100 sq mm	GEE90M572	GEE90M588	0.742	ACSR Dog from T-off	Basay T-Off
		ACSR RABBIT					Spur line 43	50 sq mm	GEE90M588	GEE90M597	0.679	ACSR Rabbit,Basay substation	Basay substation
		ACSR DOG					Spur line 44	100 sq mm	GEE90M588	GEE90M605	0.500	ACSR Dog from T-Off	Samkhara T-off
		ACSR RABBIT					Spur line 45	50 sq mm	GEE90M605	GEE90M606	0.061	ACSR Rabbit,Samkhara village substation	Samkhara village substation
		ACSR RABBIT					Spur line 46	50 sq mm	GEE90M605	GEE90M609	0.323	ACSR Rabbit from T-Off	Batasay T-off
		ACSR RABBIT					Spur line 47	50 sq mm	GEE90M609	GEE90M612	0.593	ACSR Rabbit,Batasay substation	Batasay substation
		ACSR RABBIT					Spur line 48	50 sq mm	GEE90M396	GEE90M624	1.085	ACSR Rabbit from T-Off	Tshachu substation
		ACSR RABBIT					Spur line 49	50 sq mm	GEE90M609	GEE90M642	1.579	ACSR Rabbit from T-Off	U.Batasay substation
		ACSR RABBIT					Spur line 50	50 sq mm	GEE90M510	GEE90M655	1.332	ACSR Rabbit from T-Off	Chakpai substation
		ACSR RABBIT					Spur line 51	50 sq mm	GEE90M655	GEE90M671	1.435	ACSR Rabbit from Chakpai	Chungshing substation
		ACSR RABBIT					Spur line 52	50 sq mm	GEE90M456	GEE90M685	0.682	ACSR Rabbit from T-Off	Ossey substation
		ACSR RABBIT					Spur line 53	50 sq mm	GEE90M409	GEE90M701	0.092	ACSR Rabbit,Serkim substation	Serkim substation
		ACSR RABBIT					Spur line 54	50 sq mm	GEE90M724	GEE90M726	0.209	ACSR Rabbit,Pakhay A substation	Pakhay A substation
		ACSR RABBIT					Spur line 55	50 sq mm	GEE90M735	GEE90M736	0.093	ACSR Rabbit,Sukumbasi B substation	Sukumbasi B substation
		AAAC					Spur line 56	158 sq mm	GEE90M735	GEE90M756	2.927	AAAC from T-Off to Tormay substation	Tormay substation
											66.747		
10	Jarwa	Underground cable	Radial	33/11kV substation,Pelrithang	11	Mixed	Trunk line	300 sq mm	Substation	GEE100M000	0.037	UG 3x300sqmm,33/11kV substation,Pelritha	33/11kV ss, Pelrithang
		ACSR RABBIT					Trunk line	50 sq mm	GEE100M000	GEE100M008	0.530	ACSR Rabbit from 33/11kV ss,Pelrithang to	U.Pelrithang substation
		ACSR RABBIT					Trunk line	50 sq mm	GEE100M008	GEE100M016	0.599	ACSR Rabbit from U.Pelrithang	Raidara T-off
		ACSR RABBIT					Trunk line	50 sq mm	GEE100M016	GEE100M048	0.706	ACSR Rabbit from T-Off	Guntray substation
		ACSR RABBIT					Trunk line	50 sq mm	GEE100M048	GEE100M065	1.507	ACSR Rabbit from Guntray	Eddhi substation
		ACSR RABBIT					Trunk line	50 sq mm	GEE100M065	GEE100M076	0.747	ACSR Rabbit from Eddhi	Jurwa substation
		ACSR DOG					Trunk line	100 sq mm	GEE100M076	GEE100M082	0.362	ACSR Dog from Jurwa	Phulari substation
		ACSR RABBIT					Spur line 1	50 sq mm	GEE100M016	GEE100M039	1.441	ACSR Rabbit from T-off	Raidara substation

MV Line Detials of Sarpang Dzongkhag

Sl#	Feeder Name	Line Description	Ring or Radial	Source Substation like TD or 33/11kV substation	Feeder Details: Voltage level(kV)	Feeder Details: UG/Overhead or Mixed	Line (Section 1) details: Line	Cable / Conductor size	First GPS code	Final GPS code	Line length (KM)	Location	Termination point
											5.929		
11	Jigmeling	Underground cable	Radial	33/11kV substation,Pelrithang	33	Mixed	Trunk line	400 sq mm	Substation	GEE110M000	0.047	UG 3x400sqmm,33/11kV substation,Pelritha	33/11kV ss, Pelrithang
		AAAC					Trunk line	158 sq mm	GEE110M000	GEE110M133	11.723	AAAC from 33/11kV ss,Pelrithang	220kV ss, Jigmeling
		Underground cable					Trunk line	400 sq mm	GEE110M133	GEE110M134	0.630	UG 3x400sqmm,220kV Jigmeling	220kV ss, Jigmeling
		Underground cable					Trunk line	400 sq mm	GEE110M134	SS Jigmeling	0.017	UG 3x400sqmm,220kV Jigmeling	220kV ss, Jigmeling
											12.417		
12	Sarpangtar	Underground cable	Radial	220kV substation,Jigmeling	33	Mixed	Trunk line	400 sq mm	Substation	GEE120M000	0.015	UG 3x400sqmm,220kV Jigmeling	220kV ss, Jigmeling
		Underground cable					Trunk line	400 sq mm	GEE120M000	GEE120M009	0.368	UG 3x400sqmm,220kV Jigmeling	220kV ss, Jigmeling
		Underground cable					Trunk line	150 sq mm	GEE10M837	GEE120M015	0.106	UG 3x150sqmm, 33/11kV substation,Sarpan	33/11kV ss, Sarpangtar
		Underground cable					Trunk line	150 sq mm	GEE120M015	SS Sarpang	0.068	UG 3x150sqmm, 33/11kV substation,Sarpan	33/11kV ss, Sarpangtar
		AAAC					Trunk line	158 sq mm	GEE120M009	GEE10M837	17.308	AAAC from 220kV ss, Jigmeling	Infront of ESSD office, Sarpang
											17.865		
13	Sengye	Underground cable	Radial	33/11kV substation,Sarpang	11	Mixed	Trunk line	300 sq mm	Substation	GEE130M001	0.026	UG 3x300sqmm, 33/11kV substation,Sarpan	33/11kV ss,Sarpangtar
		AAAC					Trunk line	158 sq mm	GEE130M001	GEE130M002	0.024	AAAC, 33/11kV substation, Sarpangtar	33/11kV ss,Sarpangtar
		HVABC					Trunk line	95 sq mm	GEE130M002	GEE130M012	0.309	HVABC, 33/11kV ss	IB T-Off
		HVABC					Trunk line	95 sq mm	GEE130M012	GEE130M028	0.684	HVABC from IB T-Off	Kamikhola
		AAAC					Trunk line	158 sq mm	GEE130M028	GEE130M032	0.226	AAAC, above the Police OP	Police OP
		ACSR RABBIT					Trunk line	50 sq mm	GEE130M032	GEE130M043	0.380	ACSR Rabbit, Old market,Sarpang	Old market
		HVABC					Trunk line	95 sq mm	GEE130M043	GEE130M049	0.210	HVABC from old market	Butabari T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE130M049	GEE130M058	0.798	ACSR Rabbit from Butabari	Checkpost substation
		ACSR RABBIT					Trunk line	50 sq mm	GEE130M058	GEE130M074	1.080	ACSR Rabbit from Checkpost	NPDC T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE130M074	GEE130M079	0.384	ACSR Rabbit from T-Off	Hilley village T-off
		ACSR RABBIT					Trunk line	50 sq mm	GEE130M079	GEE130M094	0.367	ACSR Rabbit from T-Off	Kamidara T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE130M094	GEE130M149	2.621	ACSR Rabbit from T-Off	U.Bisty T-off
		ACSR RABBIT					Trunk line	50 sq mm	GEE130M149	GEE130M187	0.605	ACSR Rabbit from T-Off	Sisty T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE130M187	GEE130M212	0.608	ACSR Rabbit from T-Off	Deorali substation
		ACSR RABBIT					Trunk line	50 sq mm	GEE130M212	GEE130M230	1.350	ACSR Rabbit from Deorali	Balatung A substation
		ACSR RABBIT					Trunk line	50 sq mm	GEE130M230	GEE130M236	0.373	ACSR Rabbit from Balatung A	Balatung B T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE130M236	GEE130M257	0.133	ACSR Rabbit from T-Off	Thoemba substation
		ACSR RABBIT					Trunk line	50 sq mm	GEE130M257	GEE130M277	1.132	ACSR Rabbit from Thoemba	Kopchey substation
		ACSR RABBIT					Trunk line	50 sq mm	GEE130M277	GEE130M298	1.526	ACSR Rabbit from Kopchey	Koigaon T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE130M298	GEE130M321	1.525	T-Off Sengye substation	Sengye substation
		HVABC					Spur line 1	95 sq mm	GEE130M049	GEE130T1	0.040	HVABC,Butabari substation	Butabari substation
		ACSR RABBIT					Spur line 2	50 sq mm	GEE130M079	GEE130M086	0.568	ACSR Rabbit from T-Off	Hilley village substation
		ACSR RABBIT					Spur line 3	50 sq mm	GEE130M094	GEE130M111	1.060	ACSR Rabbit from T-Off	Kamidara substation
		ACSR RABBIT					Spur line 4	50 sq mm	GEE130M149	GEE130M150	0.019	ACSR Rabbit L.Bisty substation	L.Bisty substation
		ACSR RABBIT					Spur line 5	50 sq mm	GEE130M149	GEE130M180	1.960	ACSR Rabbit from T-Off	U.Bisty substation
		ACSR RABBIT					Spur line 6	50 sq mm	GEE130M187	GEE130M196	0.618	ACSR Rabbit from T-off	Sisty A T-off
		ACSR RABBIT					Spur line 7	50 sq mm	GEE130M196	GEE130M201	0.368	ACSR Rabbit from T-off	Sisty B substation
		ACSR RABBIT					Spur line 8	50 sq mm	GEE130M196	GEE130M204	0.171	ACSR Rabbit from T-off	Sisty A substation
		ACSR RABBIT					Spur line 9	50 sq mm	GEE130M236	GEE130M238	0.090	ACSR Rabbit from T-Off	Daragaon T-Off
		ACSR RABBIT					Spur line 10	50 sq mm	GEE130M238	GEE130M239	0.029	ACSR Rabbit from T-Off	Balatung B substation
		ACSR RABBIT					Spur line 11	50 sq mm	GEE130M238	GEE130M254	1.139	ACSR Rabbit from T-Off	Daragaon substation
		ACSR RABBIT					Spur line 12	50 sq mm	GEE130M298	GEE130M301	0.179	ACSR Rabbit from T-Off	Koigaon substation
		ACSR RABBIT					Spur line 13	50 sq mm	GEE130M074	GEE130M325	0.178	ACSR Rabbit from T-Off	NPDC farm substation
		ACSR RABBIT					Spur line 14	50 sq mm	GEE130M012	GEE130M328	0.194	ACSR Rabbit from T-Off	Sarpangtar substation near DOR office
											20.973		
14	DFO	Underground cable	Radial	33/11kV substation,Sarpang	11	Mixed	Trunk line	300 sq mm	Substation	GEE140M001	0.019	UG 3x300sqmm,33/11kV substation,Sarpan	33/11kV ss, Sarpangtar
		ACSR RABBIT					Trunk line	50 sq mm	GEE140M001	GEE140M002	0.023	ACSR Dog from 33/11kV ss	Sarpangtar substation near DFO office
											0.042		
15	Dzong(Inside SCS)	Underground cable	Radial	33/11kV substation,Sarpang	11	Mixed	Trunk line	300 sq mm	Substation	GEE150M001	0.021	UG 3x300sqmm,33/11kV substation,Sarpan	33/11kV ss, Sarpangtar
		Underground cable					Trunk line	300 sq mm	GEE150M001	GEE150P1	0.038	UG 3x300sqmm,33/11kV substation,Sarpan	33/11kV ss, Sarpangtar
		Underground cable					Trunk line	300 sq mm	GEE150P1	GEE150M002	0.061	UG 3x300sqmm from 33/11kV ss	ESSD office
		ACSR RABBIT					Trunk line	50 sq mm	GEE150M002	GEE150M009	0.353	ACSR Rabbit from ESSD office	Sarpangtar substation inside school campass
											0.473		
16	Jigmeling,Kidu	ACSR RABBIT	Radial	220kV	33	Mixed	Trunk line	50 sq mm	Substation	GEE160M017	0.959	ACSR Rabbit From 220kV ss,Jigmeling	Kidu Jigmeling I substation
		ACSR DOG			11	Overhead	Trunk line	100 sq mm	GEE170M001	GEE170M050	6.059	ACSR Dog from Dolongang	Ranibagan

MV Line Detials of Sarpang Dzongkhag

Sl#	Feeder Name	Line Description	Ring or Radial	Source Substation like TD or 33/11kV substation	Feeder Details: Voltage level(kV)	Feeder Details: UG/Overhead or Mixed	Line	Line (Section 1) details: Cable / Conductor size	First GPS code	Final GPS code	Line length (KM)	Location	Termination point
17	Chhuzom	AAAC	Radial	132/66/33/11kV substation, Gelephu			Trunk line	111 sq mm	GEE170M001	GEE170M126	8.663	AAAC from Ranibagan	Ashiney top
		ACSR DOG					Trunk line	100 sq mm	GEE170M126	GEE170M127	0.132	ACSR Dog from Ashiney top	Ashiney T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE170M129	GEE170M130	0.089	ACSR Dog from Ashiney T-Off	Lhayul B T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE170M130	GEE170M143	0.485	ACSR Dog from T-Off	Suberigaon T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE170M143	GEE170M157	0.615	ACSR Dog from Suberigaon T-Off	Lhayul A T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE170M157	GEE170M165	0.115	ACSR Dog from Lhayul A T-Off	Galleygaon T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE170M165	GEE170M171	0.647	ACSR Dog from Galleygaon T-Off	Lhayul school T-Off
		ACSR DOG					Trunk line	100 sq mm	GEE170M171	GEE170M175	0.405	ACSR Dog from Lhayul school T-Off	Dalgaon substation
		ACSR DOG					Trunk line	100 sq mm	GEE170M175	GEE170M199	2.139	ACSR Dog from Dalgaon substation	BhimerayT-Off
		ACSR DOG					Trunk line	100 sq mm	GEE170M199	GEE170M205	0.948	ACSR Dog from T-Off	Bhimeray substation
		ACSR DOG					Trunk line	100 sq mm	GEE170M205	GEE170M217	1.728	ACSR Dog from Bhimeray	Gungring substation
		ACSR DOG					Trunk line	100 sq mm	GEE170M217	GEE170M230	1.918	ACSR Dog from Gungring	Ramitay B substation
		ACSR DOG					Trunk line	100 sq mm	GEE170M230	GEE170M237	0.909	ACSR Dog from Ramitay B	Pangkhey school T-off
		ACSR DOG					Trunk line	100 sq mm	GEE170M237	GEE170M254	1.236	ACSR Dog from Pangkhey school T-Off	Ranikhop T-off
		ACSR DOG					Trunk line	100 sq mm	GEE170M254	GEE170M273	1.280	ACSR Dog from Ranikhop T-off	Tirkhola T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE170M273	GEE170M304	4.616	ACSR Rabbit from T-Off	Fedhi T-Off
		ACSR RABBIT					Trunk line	50 sq mm	GEE170M304	GEE170M313	1.960	ACSR Rabbit from Fedhi T-off	Torkay substation
		ACSR RABBIT					Spur line 1	50 sq mm	GEE170M127	GEE170M129	0.169	ACSR Rabbit from T-Off	Ashiney substation
		ACSR RABBIT					Spur line 2	50 sq mm	GEE170M130	GEE170M138	0.625	ACSR Rabbit from T-Off	Lhayul B substation
		ACSR RABBIT					Spur line 3	50 sq mm	GEE170M143	GEE170M151	0.943	ACSR Rabbit from T-Off	Suberigaon substation
		ACSR RABBIT					Spur line 4	50 sq mm	GEE170M157	GEE170M163	0.581	ACSR Rabbit from T-Off	Lhayul A substation
		ACSR RABBIT					Spur line 5	50 sq mm	GEE170M165	GEE170M166	0.150	ACSR Rabbit,Galleygaon substation	Galleygaon substation
		ACSR RABBIT					Spur line 6	50 sq mm	GEE170M171	GEE170M172	0.089	ACSR Rabbit,Lhayul school substation	Lhayul school substation
		ACSR RABBIT					Spur line	50 sq mm	GEE170M237	GEE170M245	1.056	ACSR Rabbit from T-Off	Pangkhey sear substation
		ACSR RABBIT					Spur line	50 sq mm	GEE170M254	GEE170M265	2.422	ACSR Rabbit from T-Off	Maukhola A substation
		ACSR DOG					Spur line	100 sq mm	GEE170M273	GEE170M274	0.098	ACSR Dog,Beachkhola	Beachkhola
		ACSR RABBIT					Spur line	50 sq mm	GEE170M274	GEE170M283	2.262	ACSR Rabbit from Beachkhola	Mochukhola substation
		ACSR RABBIT					Spur line	50 sq mm	GEE170M304	GEE170M306	0.335	ACSR Rabbit from T-Off	Fedhi substation
		ACSR DOG					Spur line	100 sq mm	GEE170M199	GEE170M324	1.109	ACSR Dog from T-Off	Bagjungay T-Off
		ACSR RABBIT					Spur line	50 sq mm	GEE170M324	GEE170M335	1.672	ACSR Rabbit from T-Off	Bagjungay A substation
		ACSR DOG					Spur line	100 sq mm	GEE170M324	GEE170M343	1.158	ACSR Dog from Bagjungay T-Off	Pathivara
		AAAC					Spur line	111 sq mm	GEE170M343	GEE170M348	0.572	AAAC,T-Off point Pathivara ORC	Pathivara ORC
		ACSR RABBIT					Spur line	50 sq mm	GEE170M348	GEE170M355	1.213	ACSR Rabbit from Pathivara ORC	Dovan Mongargaon B substation
		ACSR DOG					Spur line	100 sq mm	GEE170M348	GEE170M358	0.411	ACSR Dog from Pathivara ORC	Chapkhola T-Off
		ACSR RABBIT					Spur line	50 sq mm	GEE170M358	GEE170M361	0.741	ACSR Rabbit from T-Off	Chapkhola substation
		ACSR DOG					Spur line	100 sq mm	GEE170M358	GEE170M366	0.774	ACSR Dog from T-Off	Pathivaradara T-Off
		ACSR RABBIT					Spur line	50 sq mm	GEE170M366	GEE170M371	0.953	ACSR Rabbit from T-Off	Pathivaradara substation
		ACSR DOG					Spur line	100 sq mm	GEE170M366	GEE170M374	0.291	ACSR Dog from T-Off	Pathivara C substation
		ACSR RABBIT					Spur line	50 sq mm	GEE170M374	GEE170M377	0.817	ACSR Rabbit from Pathivara C	Pathivara B T-Off
		ACSR RABBIT					Spur line	50 sq mm	GEE170M377	GEE170M380	0.372	ACSR Rabbit from T-Off	Pathivara B substation
		ACSR RABBIT					Spur line	50 sq mm	GEE170M377	GEE170M384	1.006	ACSR Rabbit from T-Off	Pathivara A substation
		ACSR DOG					Spur line	100 sq mm	GEE170M348	GEE170M386	0.437	ACSR Dog from Pathivara ORC	Dovan Mongargaon A T-Off
		ACSR RABBIT					Spur line	50 sq mm	GEE170M386	GEE170M390	0.594	ACSR Rabbir from T-Off	Dovan mongargaon A substation
		ACSR DOG					Spur line	100 sq mm	GEE170M386	GEE170M398	1.620	ACSR Dog from T-Off	Kharkhola T-off
		ACSR RABBIT					Spur line	50 sq mm	GEE170M398	GEE170M408	2.427	ACSR Rabbit from T-Off	Baragaray substation
		ACSR DOG					Spur line	100 sq mm	GEE170M398	GEE170M410	0.414	ACSR Dog from T-Off	Kharkhola B T-Off
		ACSR RABBIT					Spur line	50 sq mm	GEE170M410	GEE170M412	0.246	ACSR Rabbit from T-Off	Kharkhola B substation
		AAAC					Spur line	111 sq mm	GEE170M410	GEE170M417	0.768	AAAC from T-Off	Kharkhola A substation
		ACSR RABBIT					Spur line	50 sq mm	GEE170M175	GEE170M431	1.995	ACSR Rabbit from T-Off	Dungay substation
		ACSR RABBIT					Spur line	50 sq mm	GEE170M431	GEE170M443	1.691	ACSR Rabbit from Dungay	Gairigaon substation
		ACSR RABBIT					Spur line	50 sq mm	GEE170M443	GEE170M447	0.546	ACSR Rabboit from Gairigaon	Daragaon A T-Off
		ACSR RABBIT					Spur line	50 sq mm	GEE170M447	GEE170M450	0.454	ACSR Rabbit from T-Off	Daragaon A Substation
		ACSR RABBIT					Spur line	50 sq mm	GEE170M447	GEE170M456	0.796	ACSR Rabbit from T-Off	Daragaon B T-Off
		ACSR RABBIT					Spur line	50 sq mm	GEE170M456	GEE170M459	0.654	ACSR Rabbit from T-Off	Mongargaon substation
		ACSR RABBIT					Spur line	50 sq mm	GEE170M456	GEE170M466	1.151	ACSR Rabbit from Daragaon B T-Off	Daragaon C s/s
		ACSR RABBIT					Spur line	50 sq mm	GEE170M466	GEE170M471	0.708	Daragaon C s/s	Kholatar T-off
		ACSR RABBIT					Spur line	50 sq mm	GEE170M471	GEE170M513	0.335	ACSR Rabbit from Kholatar T-off	Kholatar s/s
		ACSR RABBIT					Spur line	50 sq mm	GEE170M471	GEE170M491	2.772	ACSR Rabbit from T-Off	Reti
		AAAC					Spur line	111 sq mm	GEE170M491	GEE170M511	3.532	AAAC,Reti substation	Reti substation
		ACSR RABBIT					Spur line	50 sq mm	GEE170M513	GEE170M526	1.271	ACSR Rabbit from Kholatar s/s	Virgaon s/s

MV Line Detials of Sarpang Dzongkhag

Sl#	Feeder Name	Line Description	Ring or Radial	Source Substation like TD or 33/11kV substation	Feeder Details			Line (Section 1) details					
					Voltage level(kV)	UG/Overhead or Mixed	Line	Cable / Conductor size	First GPS code	Final GPS code	Line length (KM)	Location	Termination point
		ACSR RABBIT					Spur line	50 sq mm	GEE170M518	GEE170M525	1.182	ACSR Rabbit from T-off	Gongaon s/s
		ACSR RABBIT					Spur line	50 sq mm	GEE170M526	GEE170M532	1.012	ACSR Rabbit from Virgaon s/s	Madalay s/s
		ACSR RABBIT					Spur line	50 sq mm	GEE170M532	GEE170M589	1.175	ACSR Rabbit from Madalay s/s	Gong Ashiney s/s
		ACSR RABBIT					Spur line	50 sq mm	GEE170M537	GEE170M546	1.251	ACSR Rabbit from Gong Ashiney s/s	Simikharka A
		ACSR RABBIT					Spur line	50 sq mm	GEE170M546	GEE170M553	1.468	ACSR Rabbit from Simikharka A	Simikharka B
											82.261		
											395.241		

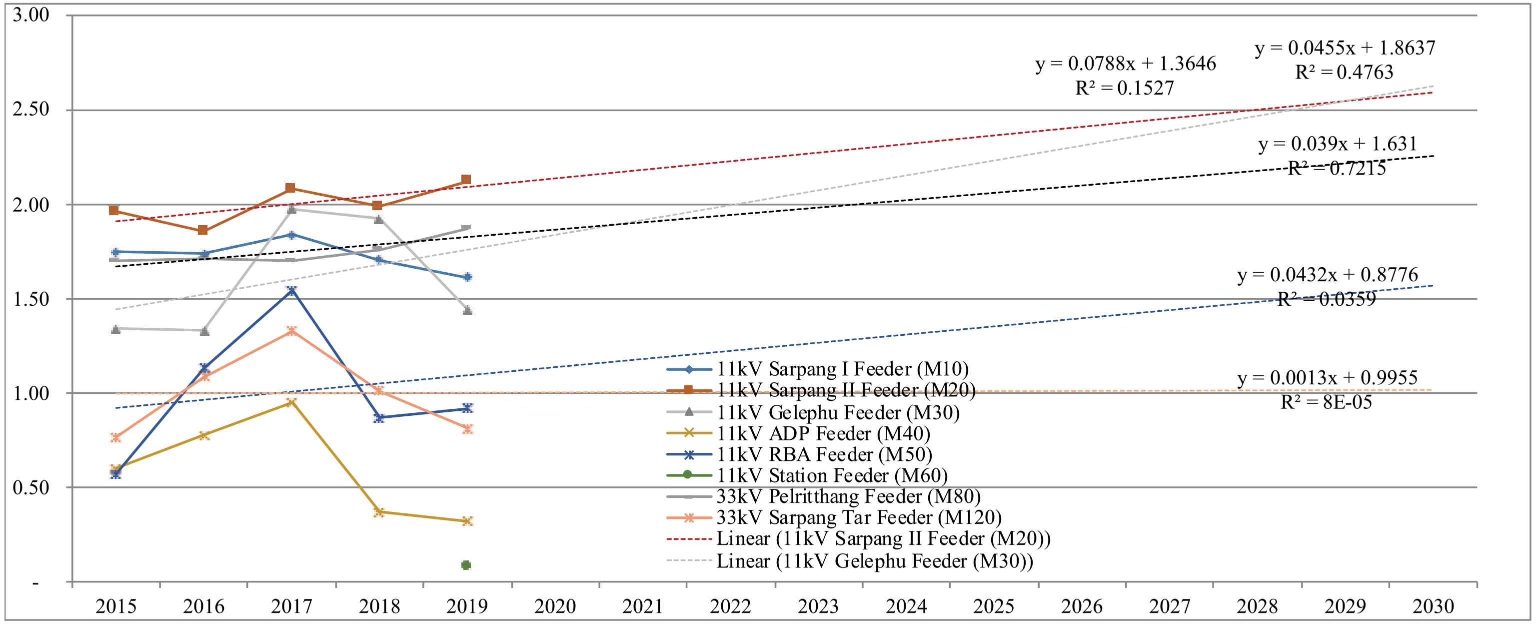
Annexure-2: IS 2026, IEC 60076 (Technical parameters for Distribution Lines and Transformers)

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 Sarpang Dzongkhag

Sl.No.	Name of Feeder	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
1	11kV Sarpang I Feeder (M10)	1.74	1.74	1.84	1.70	1.61	2.41	2.55	2.68	2.82	2.96	3.09	3.23	3.36	3.50	3.64	3.77
2	11kV Sarpang II Feeder (M20)	1.96	1.86	2.08	1.99	2.12	2.60	2.77	2.93	3.09	3.25	3.13	3.57	3.73	3.89	4.05	3.01
3	11kV Gelephu Feeder (M30)	1.34	1.33	1.97	1.92	1.44	4.97	5.22	5.47	5.72	5.97	6.22	6.47	6.72	6.97	7.22	7.47
4	11kV ADP Feeder (M40)	0.60	-	0.95	0.37	0.32	2.78	2.89	3.00	3.12	3.23	3.34	3.45	3.57	3.68	3.79	3.91
5	11kV RBA Feeder (M50)	0.57	1.13	1.54	0.87	0.92	4.81	5.08	5.35	5.62	5.90	5.58	6.44	6.71	6.98	7.26	6.86
6	11kV Station Feeder (M60)					0.08											
7	33kV Geychu Feeder (M70)					0.08						0.24					0.30
8	33kV Pelrithang Feeder (M80)					0.12						0.21					0.26
9	11kV Jigmecholing Feeder (M90)	2.37	1.71	1.70	1.76	0.62	2.07	2.18	2.30	2.41	2.52	1.11	2.74	2.86	2.97	3.08	1.34
10	11kV Jarwa Feeder (M100)					0.07						0.12					0.14
11	11kV ADP II Feeder					0.67						1.58					1.45
12	11kV RBA Feeder					0.39						0.59					0.67
13	11kV Jigmeling Feeder (M110)					-											
14	33kV Sarpang Tar Feeder (M120)	0.77	1.08	1.33	1.01	0.20	1.39	1.48	1.58	1.68	1.78		1.97	2.07	2.16	2.26	
15	11kV Singye Feeder (M130)					0.26						0.79					0.99
16	11kV Near DFO office Feeder (M140)					0.15						0.47					0.59
17	11kV Dzong feeder Sarpang (M150)					0.12						0.37					0.46
18	33kV Jigmeling Feeder (M160)																
19	11kV Sarpang Tar Station Feeder (M180)											0.01					0.02
20	11kV Pelrithang Station Feeder (M190)																
21	New Dovan Feeder (M170)					-	0.42	0.45	0.47	0.49	0.51	0.54	0.56	0.58	0.60	0.62	0.65
	Total					**9.17**						**27.37**					**31.89**



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.**

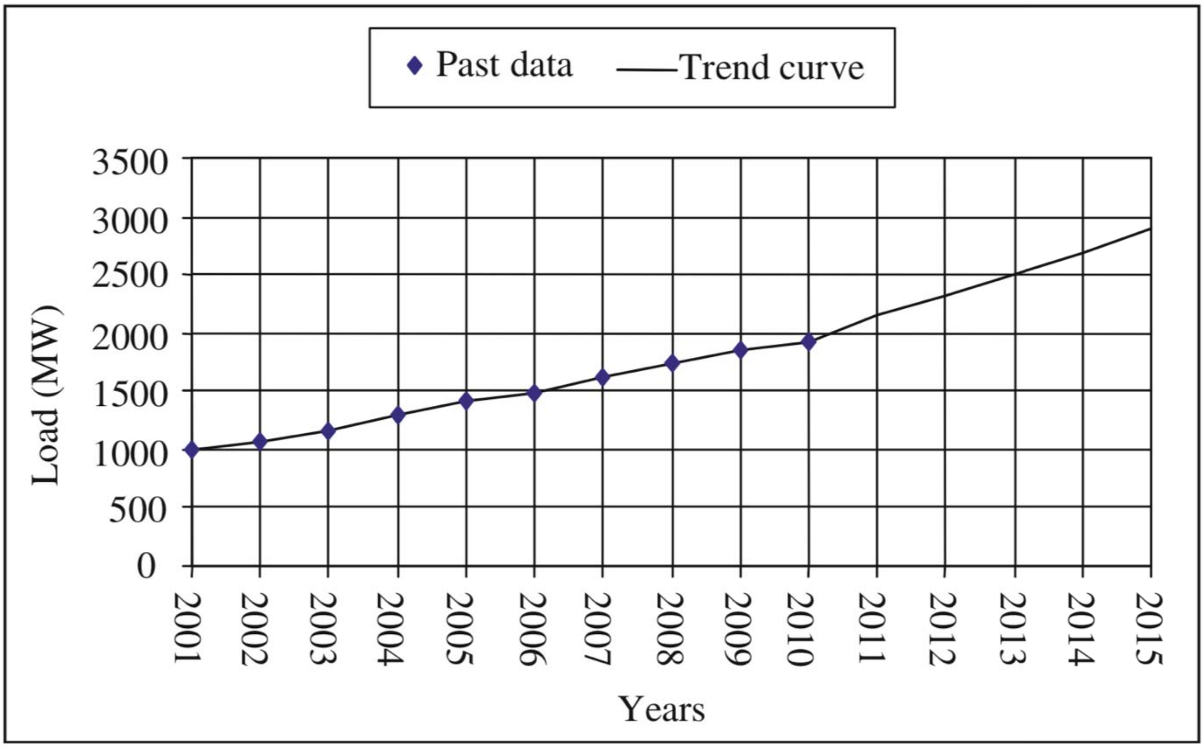


Figure 1: Typical trend curve[1]

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.

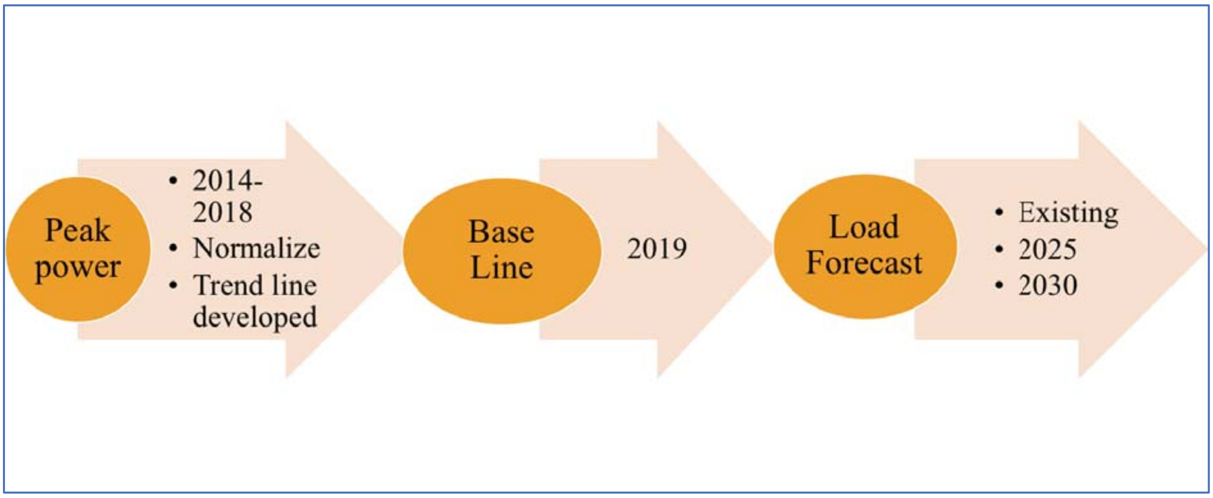


Figure 2: Flow diagram for load forecast

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**

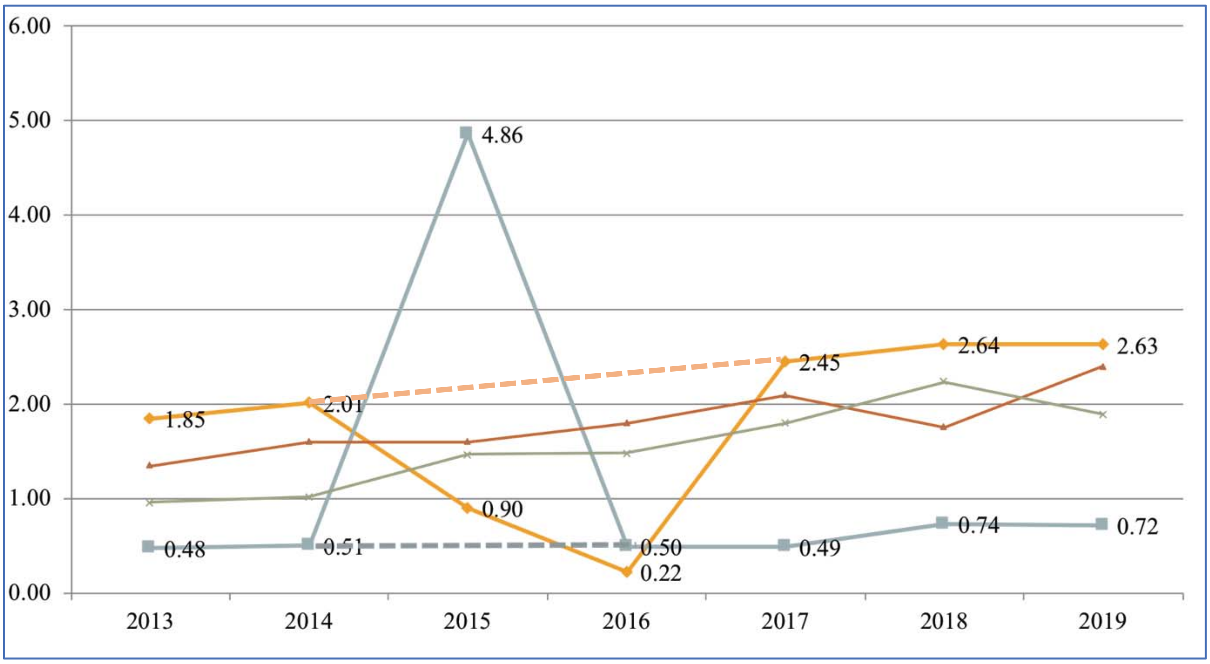


Figure 3: Actual data of Punakha Dzongkhag

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

$Where:$
$x \text{ is the normalized data}$

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.**

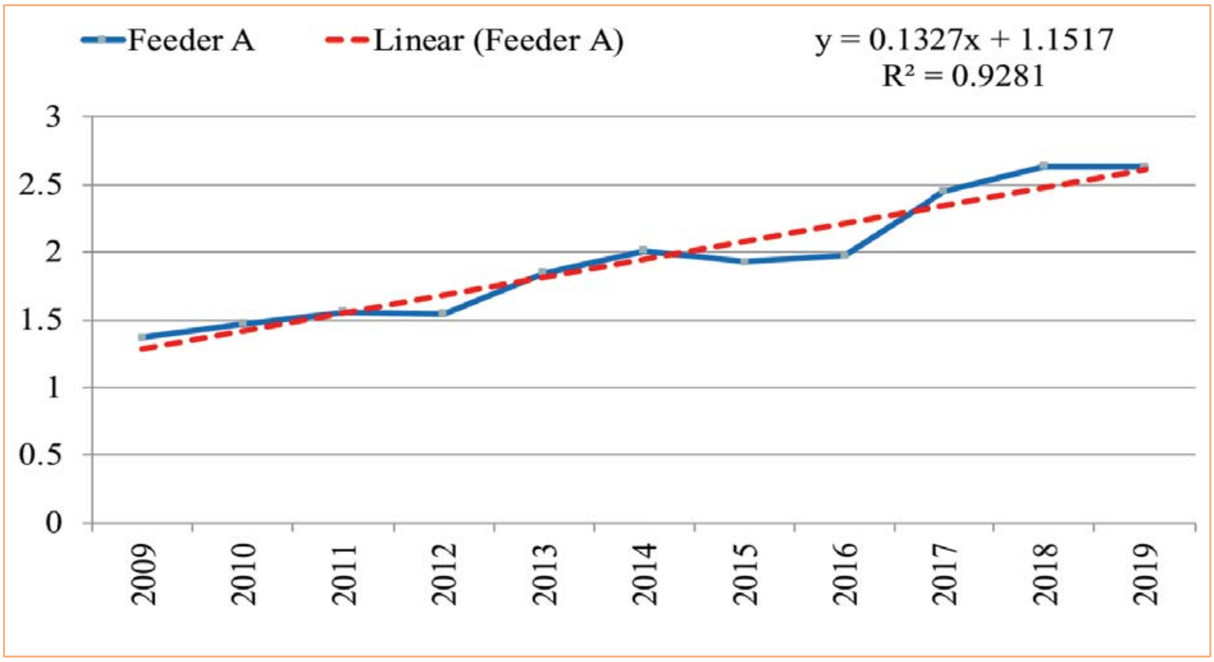


Figure 4: Trend line and load forecast for Punakha Dzongkhag

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.

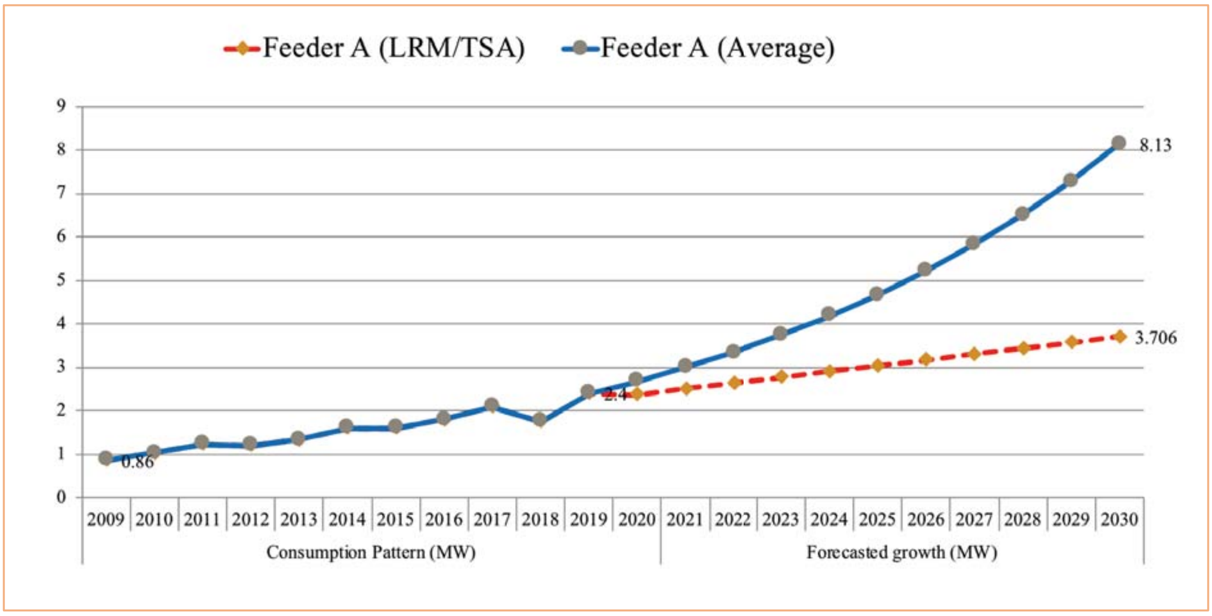


Figure 5: Forecasted load (trend line with red shows the linear regression and one with blue shows the forecast with average method)

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.

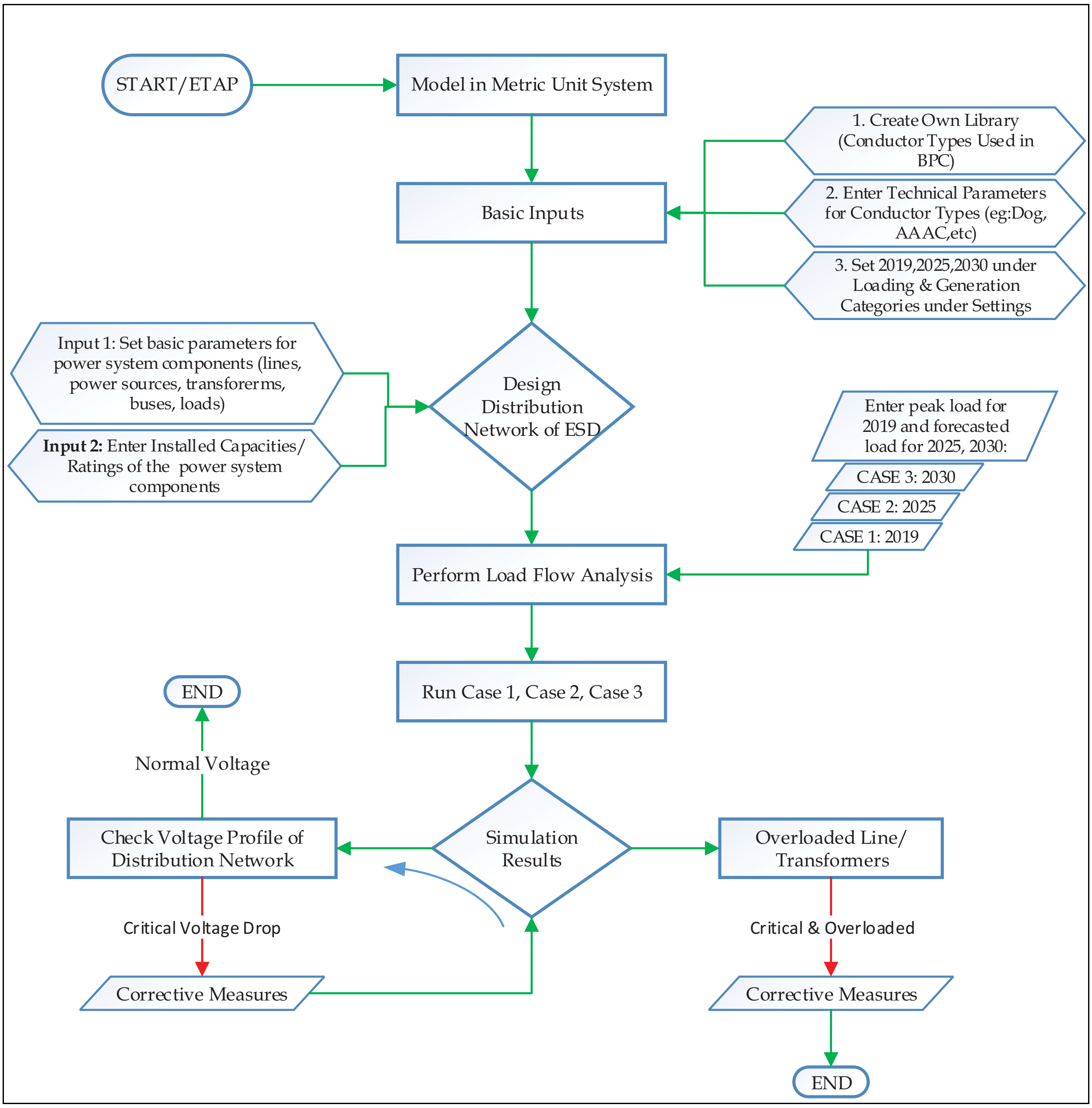


Figure 6: Flow Chart for Network Modelling & Load Flow Analysis (ETAP)

[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

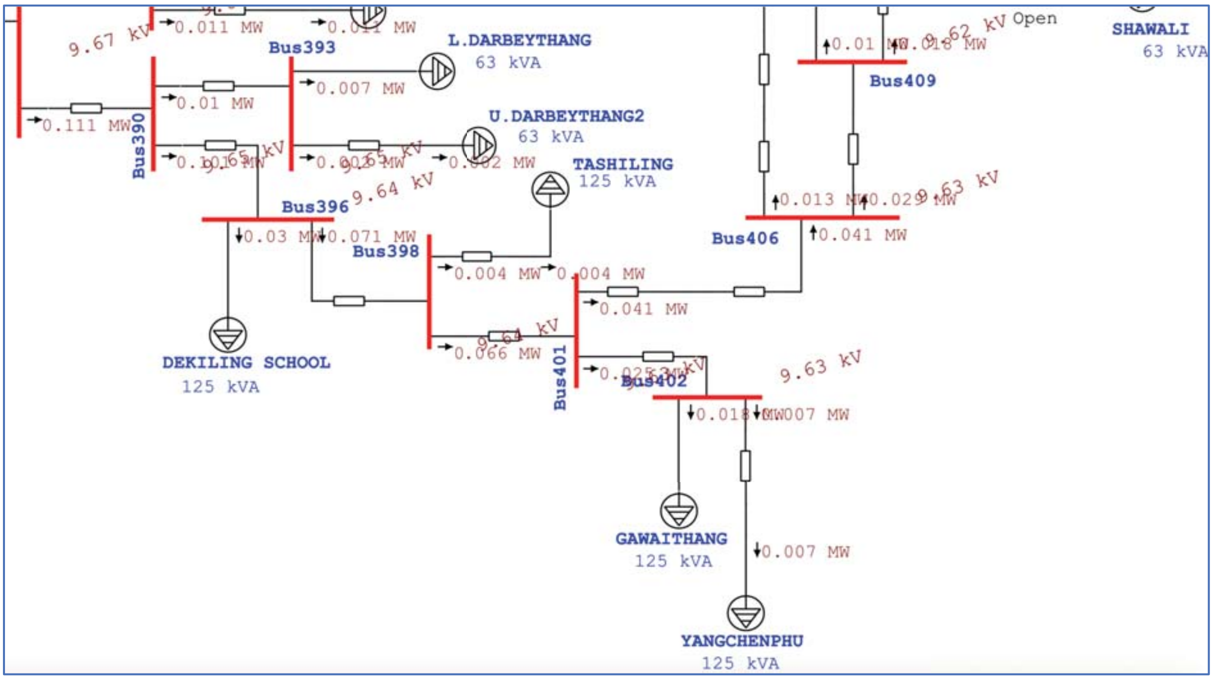
[3]http://www.powerqualityworld.com/2011/05/etap-tutorials-load-flow-analysis.html dated September 30, 2020

Annexure 4: The Simulation Results

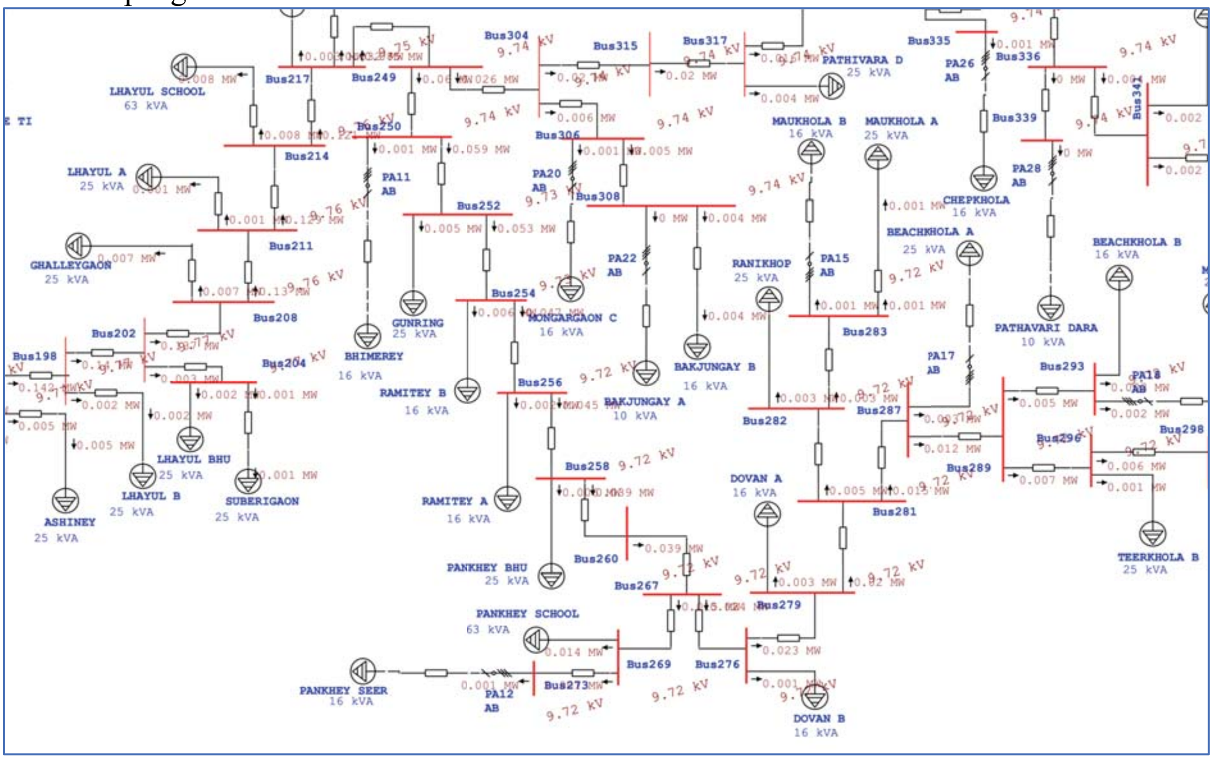
Simulation results for feeders with voltage profile issues

Time Horizon 2019

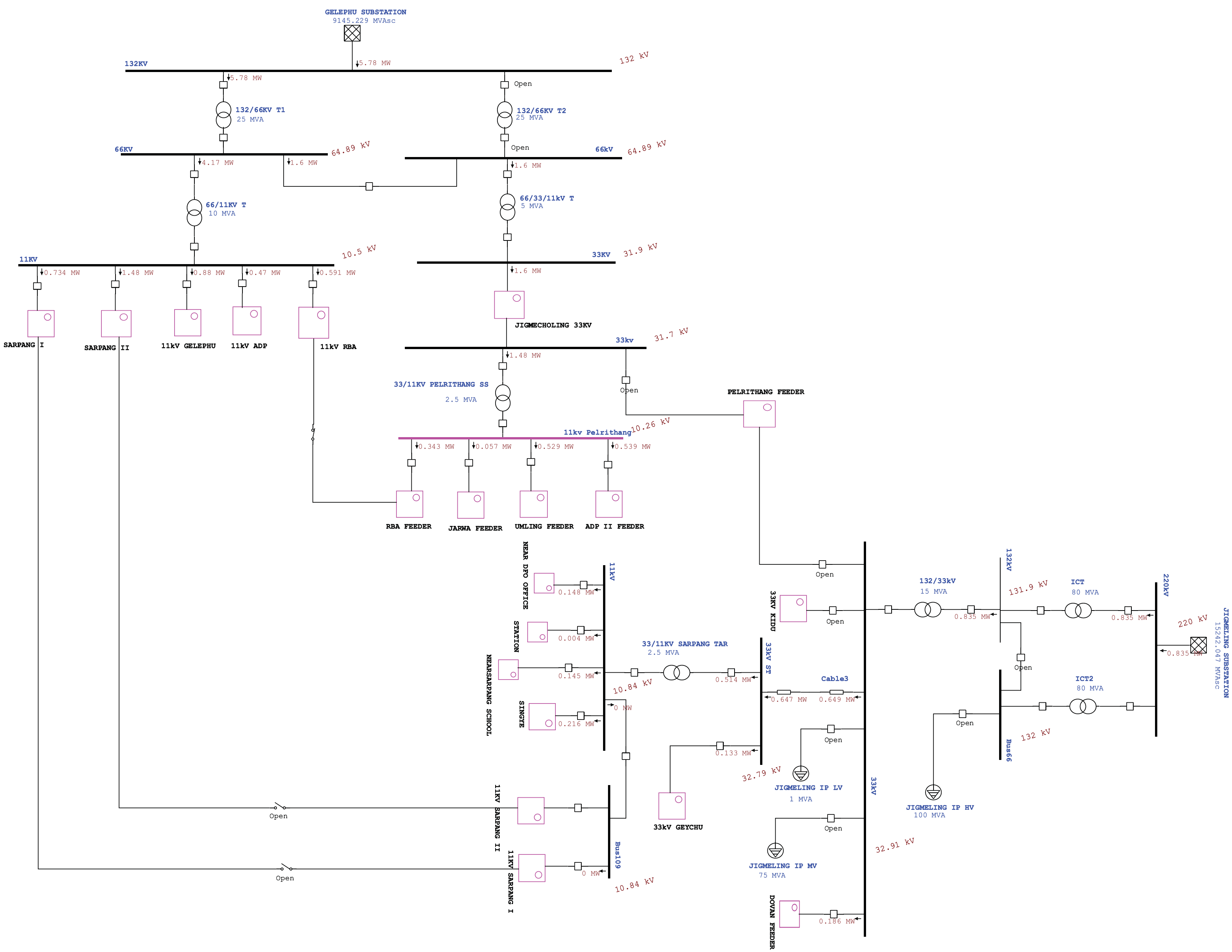
11kV Sarpang II Feeder

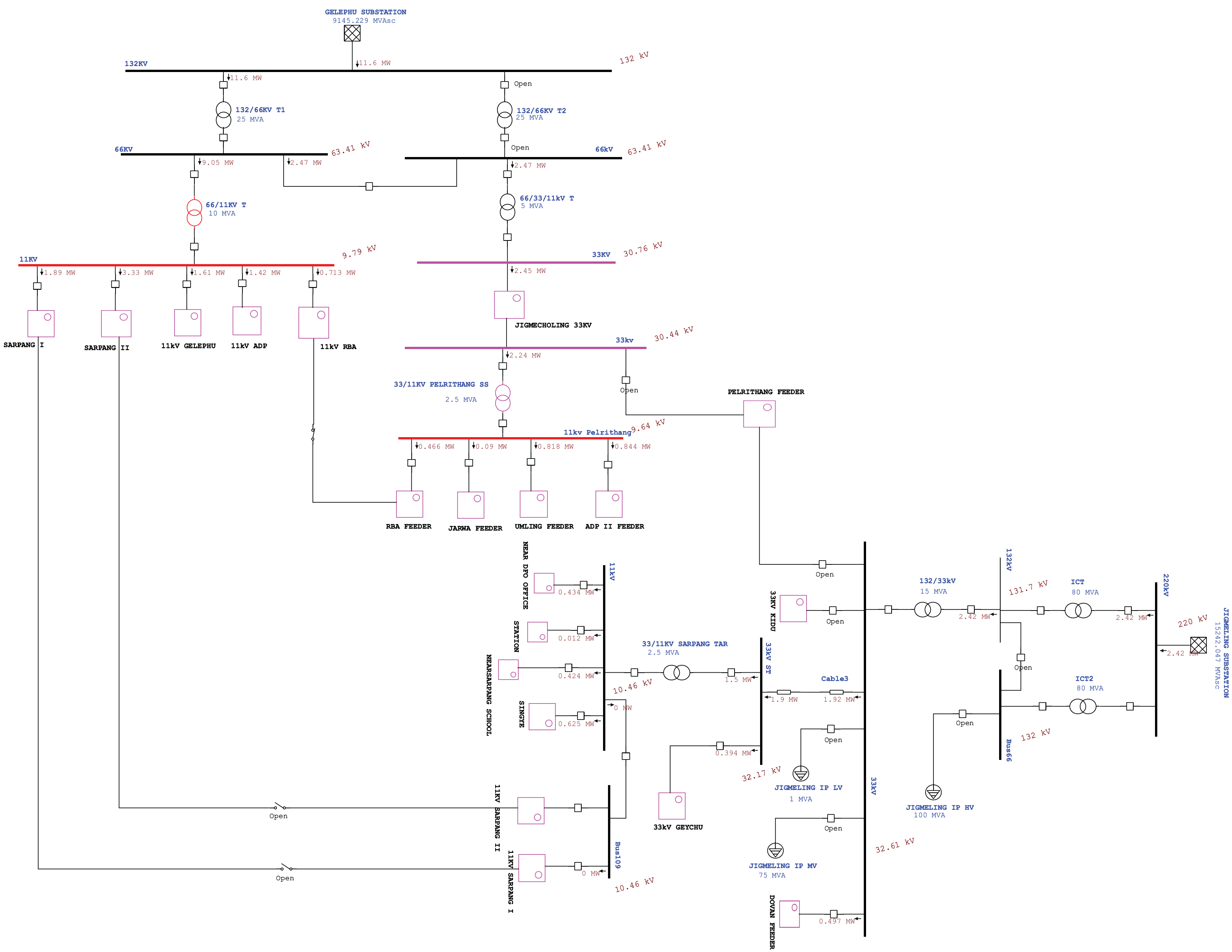


11kV Sarpang Feeder I

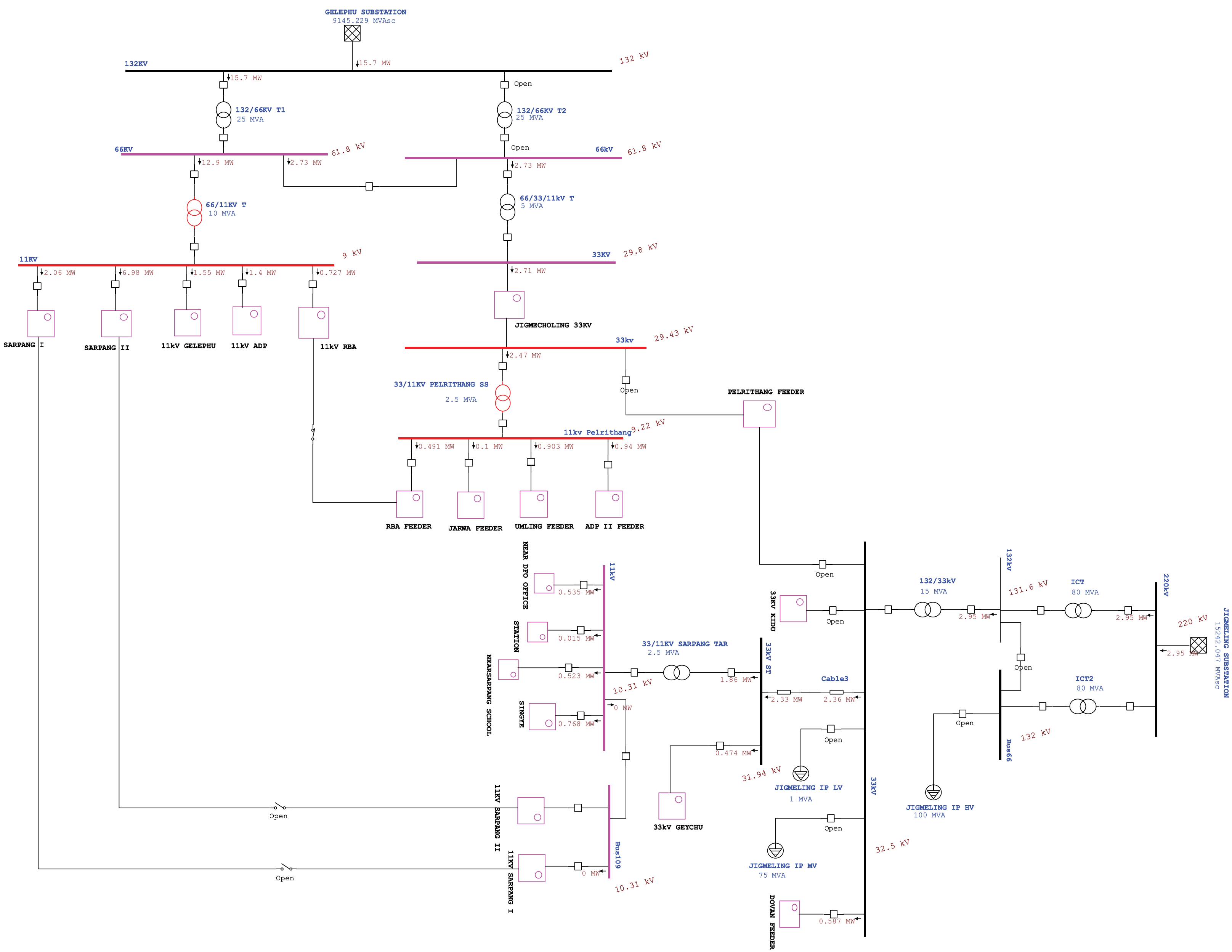


One-Line Diagram - ESD GELEPHU 2019 (Load Flow Analysis)

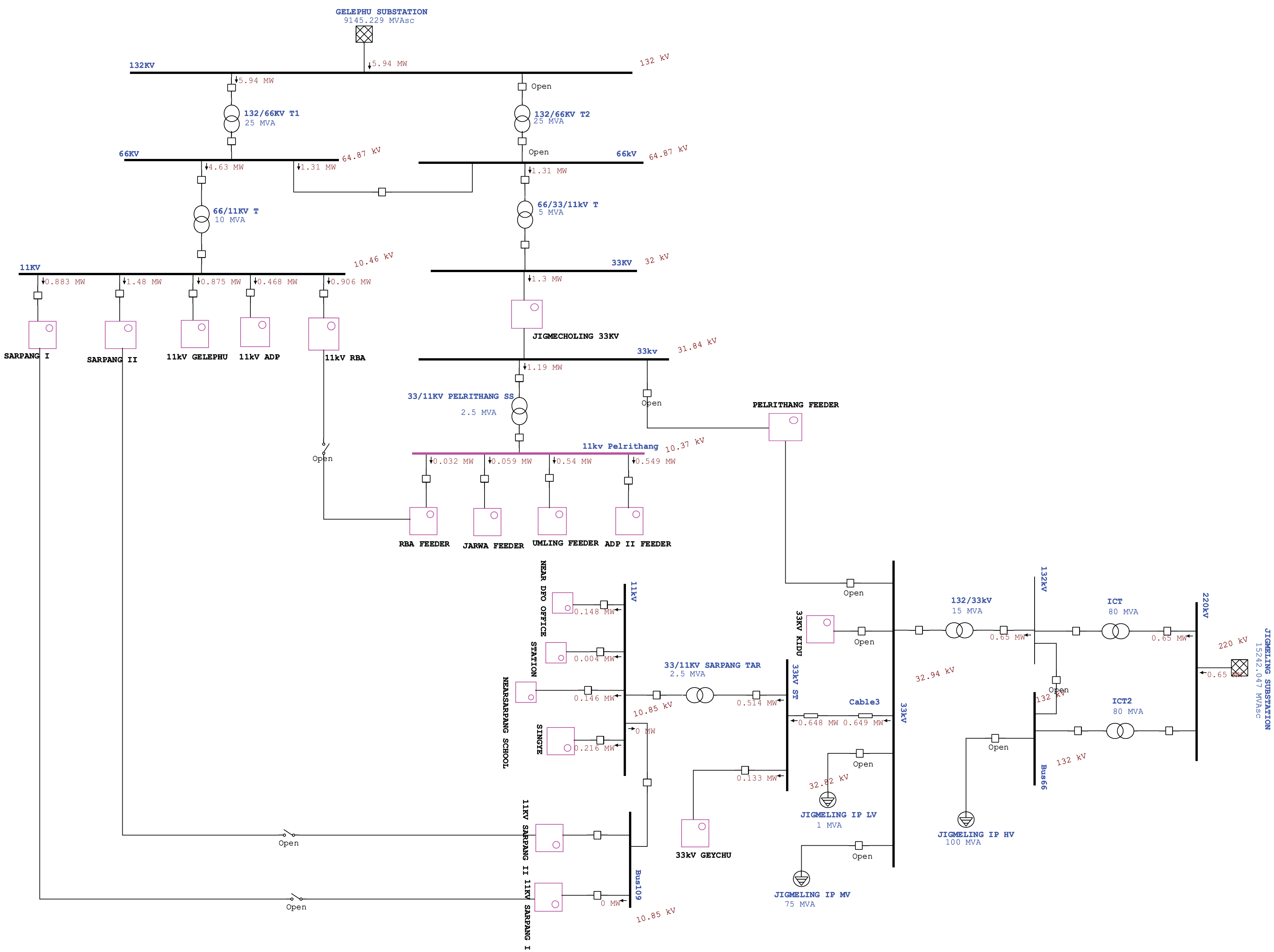



GELEPHU SUBSTATION
9145.229 MVAsc
132KV
11.6 MW
132 kV
Open
132/66KV T1
25 MVA
132/66KV T2
25 MVA
66KV
66kV
63.41 kV
9.05 MW
2.47 MW
66/11KV T
10 MVA
66/33/11kV T
5 MVA
11KV
9.79 kV
33KV
30.76 kV
1.89 MW
3.33 MW
1.61 MW
1.42 MW
0.713 MW
2.45 MW
SARPANG I
SARPANG II
11kV GELEPHU
11kV ADP
11kV RBA
JIGMECHOLING 33KV
33kv
30.44 kV
2.24 MW
33/11KV PELRITHANG SS
2.5 MVA
PELRITHANG FEEDER
11kv Pelrithang
9.64 kV
0.466 MW
0.09 MW
0.818 MW
0.844 MW
RBA FEEDER
JARWA FEEDER
UMLING FEEDER
ADP II FEEDER
NEAR DFO OFFICE
STATION
NEARSARPANG SCHOOL
SINGYE
11kV
0.434 MW
0.012 MW
0.424 MW
0.625 MW
0 MW
10.46 kV
33/11KV SARPANG TAR
2.5 MVA
33kV ST
1.5 MW
Cable3
1.9 MW
1.92 MW
0.394 MW
32.17 kV
33kV GEYCHU
33KV KIDU
JIGMELING IP LV
1 MVA
JIGMELING IP MV
75 MVA
DOVAN FEEDER
0.497 MW
33kV
32.61 kV
11KV SARPANG II
11KV SARPANG I
Bus109
132/33kV
15 MVA
2.42 MW
132kV
131.7 kV
ICT
80 MVA
ICT2
80 MVA
Bus66
132 kV
JIGMELING IP HV
100 MVA
220kV
220 kV
JIGMELING SUBSTATION
15242.047 MVAsc

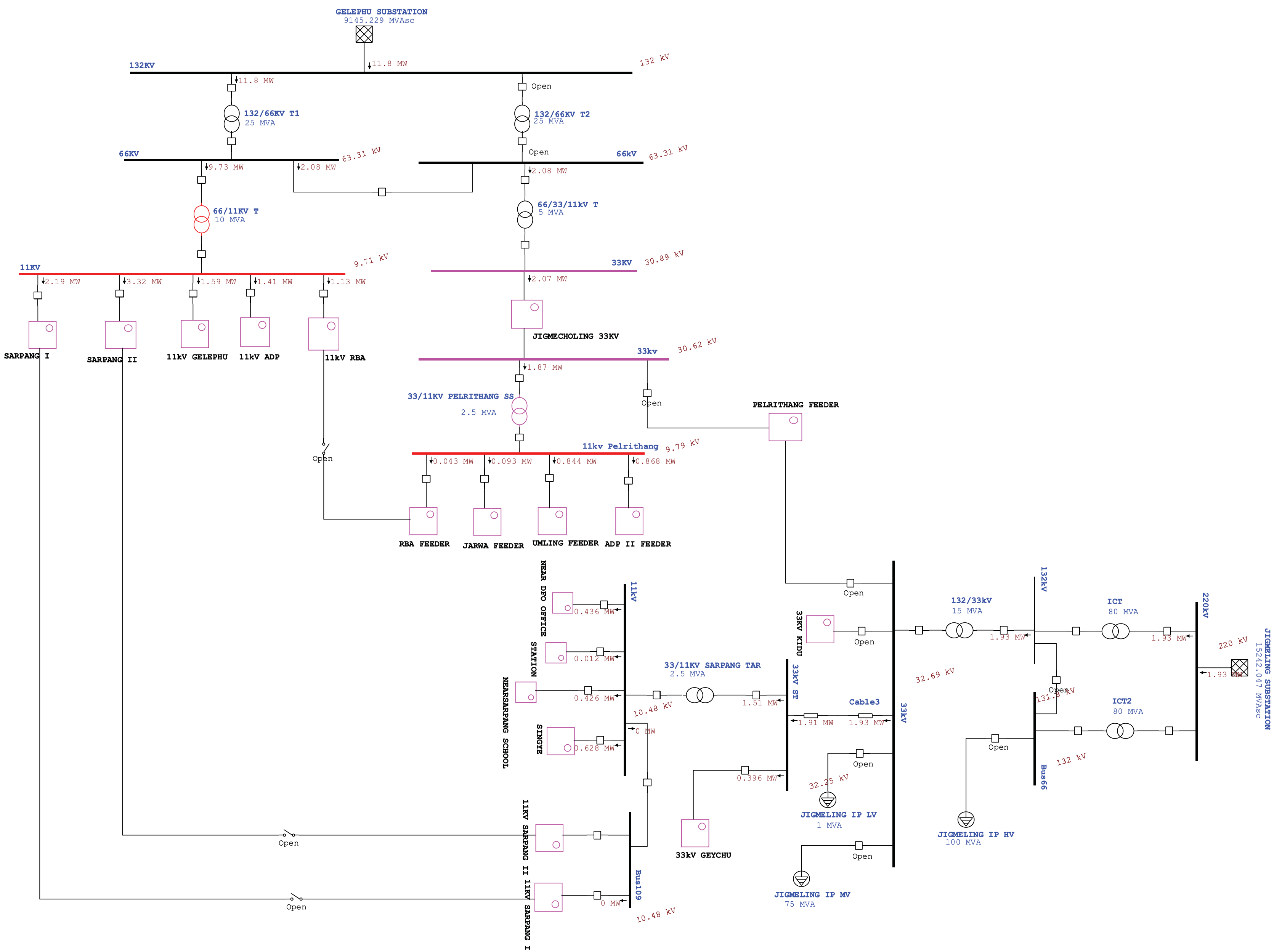
One-Line Diagram - ESD GELEPHU 2030 (Load Flow Analysis)



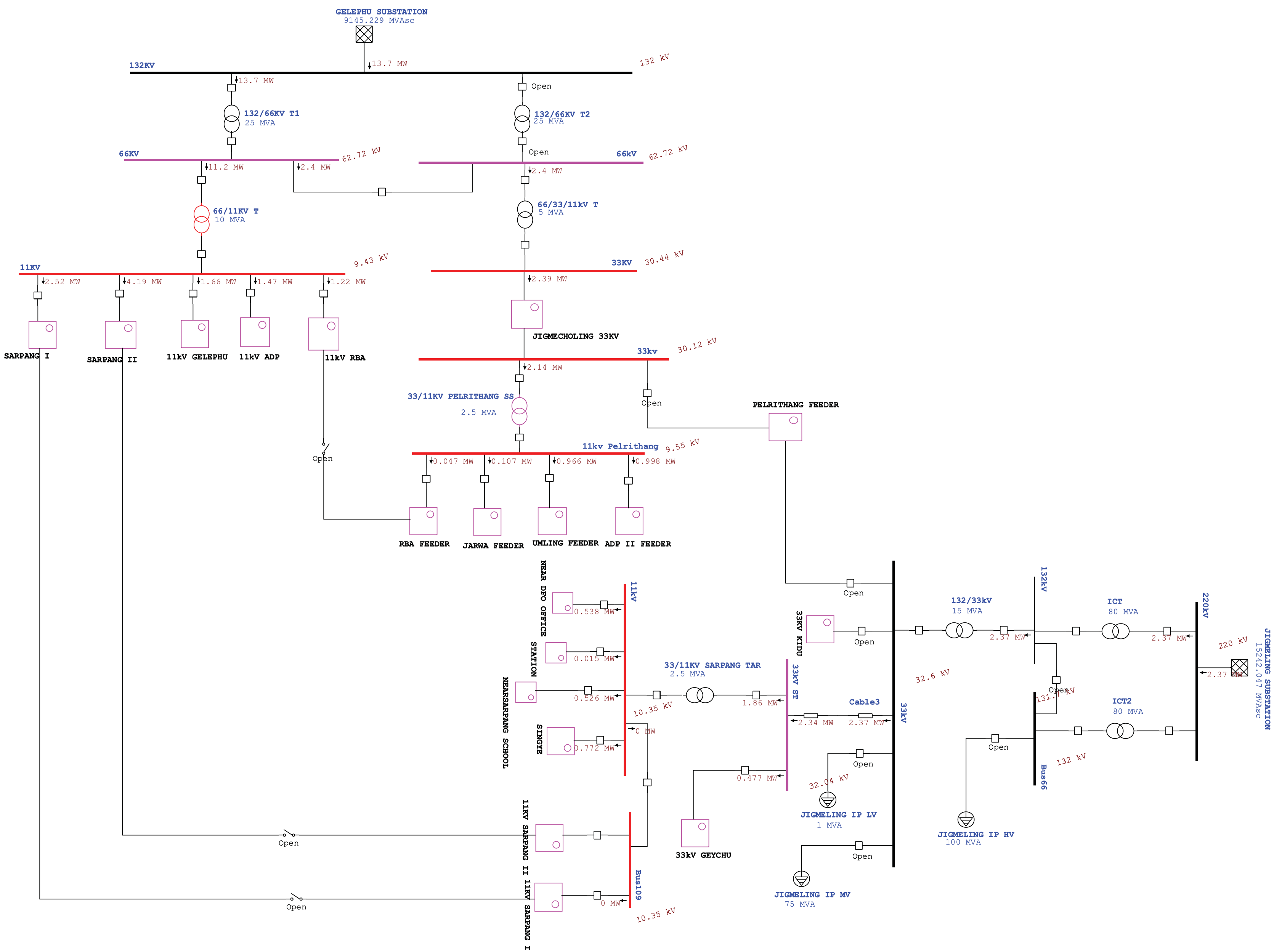
One-Line Diagram - ESD GELEPHU 2019 (Load Flow Analysis)



One-Line Diagram - ESD GELEPHU 2025 (Load Flow Analysis)



One-Line Diagram - ESD GELEPHU 2030 (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
11kV	11.000										2.162	85.2	121.0	
11kv Pelrithang	11.000										2.851	85.4	178.5	
33kV	33.000										3.423	86.0	60.8	
33kV ST	33.000										2.721	85.6	49.2	
66KV	66.000										21.006	74.5	196.2	
132kV	132.000										3.465	85.1	15.2	
220kV	220.000										3.475	84.9	9.1	
Bus1	33.000										0.686	85.5	12.2	
Bus3	11.000		0.020	0.012	0.054	0.034					1.076	85.4	68.8	
Bus4	11.000				0.059	0.036					0.768	85.4	50.3	
Bus5	11.000										0.634	86.2	35.6	
Bus6	11.000										0.673	85.3	44.9	
Bus7	11.000										1.825	85.0	117.2	
Bus8	11.000										0.215	85.0	13.8	
Bus9	11.000										0.691	85.3	45.8	
Bus10	33.000										2.737	86.2	48.6	
Bus11	11.000		0.045	0.028	0.119	0.074					0.192	85.0	12.4	
Bus12	11.000		0.005	0.003	0.014	0.009					0.023	85.0	1.5	
Bus13	11.000										1.605	85.0	103.3	
Bus14	11.000		0.064	0.040	0.171	0.106					0.330	85.0	21.3	
Bus15	11.000		0.012	0.007	0.031	0.019					0.053	85.2	3.4	
Bus16	11.000		0.003	0.002	0.000	-					0.004	85.0	0.2	
Bus17	11.000		0.077	0.048	0.204	0.127					1.271	85.0	82.1	
Bus18	11.000										0.939	85.0	60.7	
Bus19	11.000										0.753	85.0	48.7	
Bus20	11.000		0.081	0.050	0.213	0.132					0.753	85.0	48.7	
Bus21	11.000										0.368	85.0	23.8	
Bus22	11.000		0.009	0.006	0.024	0.015					0.040	85.0	2.6	
Bus23	11.000										0.635	85.2	43.0	
Bus24	11.000		0.006	0.004	0.006	0.004					0.015	85.0	1.0	
Bus25	11.000		0.098	0.061	0.097	0.060					0.229	85.0	14.8	
Bus26	11.000		0.029	0.018	0.076	0.047					0.124	85.0	8.0	
Bus27	11.000										0.186	85.0	12.0	
Bus28	11.000		0.008	0.005	0.021	0.013					0.034	85.0	2.2	
Bus29	11.000		0.035	0.022	0.093	0.058					0.151	85.0	9.8	
Bus30	11.000										1.650	84.9	105.9	
Bus31	11.000										1.630	85.0	105.9	
Bus32	11.000										0.020	85.0	1.3	
Bus33	11.000		0.005	0.003	0.012	0.007					0.020	85.0	1.3	

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
Bus34	11.000										0.605	85.2	41.1	
Bus35	11.000										0.790	85.0	51.6	
Bus36	11.000		0.045	0.028	0.115	0.071					0.188	85.0	12.3	
Bus37	11.000										0.601	85.0	39.3	
Bus38	11.000		0.050	0.031	0.129	0.080					0.211	85.0	13.8	
Bus39	11.000		0.064	0.040	0.164	0.102					0.390	85.0	25.5	
Bus40	11.000		0.089	0.055	0.014	0.009					0.122	85.0	8.0	
Bus41	11.000										0.919	85.0	60.0	
Bus42	11.000		0.030	0.019	0.078	0.049					0.128	85.0	8.4	
Bus43	11.000										0.854	85.1	54.8	
Bus44	11.000										0.852	85.1	54.8	
Bus45	33.000				0.009	0.006					0.010	85.0	0.2	
Bus46	33.000										0.131	96.4	2.4	
Bus47	11.000										0.512	85.2	34.9	
Bus48	11.000				0.033	0.020					0.039	85.0	2.5	
Bus49	11.000										0.811	85.1	52.3	
Bus50	11.000		0.033	0.020	0.033	0.020					0.077	85.0	5.0	
Bus51	11.000										0.733	85.1	47.4	
Bus52	11.000										0.214	85.0	13.9	
Bus53	11.000		0.127	0.078	0.056	0.034					0.214	85.0	13.9	
Bus54	11.000										0.518	85.2	33.5	
Bus55	11.000		0.001	0.001	0.004	0.002					0.006	85.0	0.4	
Bus56	11.000										0.511	85.2	33.1	
Bus57	11.000		0.018	0.011	0.046	0.029					0.075	85.0	4.9	
Bus58	11.000										0.436	85.2	28.2	
Bus59	11.000												-	
Bus60	11.000													
Bus61	11.000										0.443	85.1	30.3	
Bus62	11.000										0.435	85.2	28.3	
Bus64	11.000										0.435	85.2	28.3	
Bus65	11.000		0.004	0.003	0.011	0.007					0.019	85.0	1.2	
Bus66	132.000													
Bus67	11.000		0.009	0.006	0.023	0.014					0.416	85.2	27.1	
Bus68	11.000				0.040	0.025					0.107	85.1	7.4	
Bus69	11.000		0.035	0.022	0.091	0.057					0.377	85.1	24.6	
Bus70	11.000										0.228	85.2	14.9	
Bus71	11.000		0.017	0.010	0.043	0.027					0.071	85.0	4.6	
Bus72	11.000										0.157	85.2	10.3	
Bus73	11.000		0.009	0.005	0.022	0.014					0.036	85.0	2.4	
Bus74	11.000		0.011	0.007	0.027	0.017					0.121	85.1	7.9	
Bus75	33.000										0.504	94.1	9.1	
Bus76	11.000		0.010	0.006	0.027	0.017					0.044	85.0	2.9	

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
Bus77	11.000		0.008	0.005	0.020	0.013					0.033	85.0	2.2	
Bus78	11.000										0.000	-	-	
Bus79	11.000												-	
Bus80	11.000		0.027	0.017	0.075	0.047					0.120	85.0	7.6	
Bus81	11.000												-	
Bus82	11.000										0.144	85.1	9.1	
Bus83	11.000		0.005	0.003	0.015	0.009					0.023	85.0	1.5	
Bus84	11.000				0.124	0.077					0.290	85.1	18.3	
Bus85	11.000		0.052	0.032	0.145	0.090					0.232	85.0	14.6	
Bus86	11.000										2.445	84.4	157.0	
Bus87	11.000		0.002	0.001	0.005	0.003					2.409	84.5	157.0	
Bus88	11.000		0.067	0.041	0.064	0.040					2.383	84.5	156.5	
Bus89	11.000		0.042	0.026	0.144	0.089					0.703	85.4	40.0	
Bus90	11.000										0.481	85.5	27.5	
Bus91	11.000		0.060	0.037	0.076	0.047					0.161	85.0	9.2	
Bus92	11.000										0.321	85.7	18.3	
Bus93	11.000										2.208	84.6	146.4	
Bus94	11.000				0.023	0.014					0.173	85.2	11.5	
Bus95	11.000										0.146	85.1	9.7	
Bus96	11.000		0.004	0.002	0.009	0.006					0.015	85.0	1.0	
Bus97	11.000										0.131	85.0	8.7	
Bus98	11.000				0.013	0.008					0.015	85.0	1.0	
Bus99	11.000				0.099	0.061					0.116	85.0	7.7	
Bus100	11.000										2.005	84.7	135.0	
Bus101	11.000		0.005	0.003	0.011	0.007					0.019	85.0	1.3	
Bus102	11.000										1.962	84.7	133.7	
Bus103	11.000		0.164	0.101	0.065	0.040					0.269	85.0	18.3	
Bus104	11.000										1.647	84.9	115.4	
Bus105	11.000										0.116	85.3	8.2	
Bus106	11.000		0.009	0.006	0.021	0.013					0.036	85.0	2.5	
Bus107	33.000										0.504	94.1	9.1	
Bus108	11.000		0.014	0.009	0.031	0.019					0.081	85.3	5.7	
Bus109	11.000										0.002	-	0.1	
Bus110	11.000		0.003	0.002	0.007	0.005					0.028	85.5	2.0	
Bus111	11.000				0.013	0.008					0.016	85.0	1.1	
Bus112	11.000										1.512	85.0	107.3	
Bus113	11.000		0.125	0.077	0.101	0.063					0.266	85.0	18.9	
Bus114	11.000										1.242	85.0	88.3	
Bus116	11.000										1.240	85.0	88.3	
Bus117	33.000										0.503	94.3	9.1	
Bus118	11.000		0.005	0.003	0.004	0.002					0.010	85.0	0.7	
Bus119	11.000										0.369	85.1	25.3	

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
Bus120	11.000		0.041	0.025	0.033	0.020					1.222	85.1	87.6	
Bus121	33.000										0.505	93.8	9.1	
Bus122	11.000										1.132	85.1	81.4	
Bus123	11.000		0.014	0.009	0.029	0.018					0.051	85.0	3.7	
Bus124	11.000										0.225	85.1	15.4	
Bus125	11.000		0.020	0.013	0.043	0.027					1.076	85.1	77.8	
Bus126	33.000										0.495	93.8	9.0	
Bus127	11.000										0.996	85.2	72.4	
Bus128	11.000										0.150	85.1	10.3	
Bus129	11.000		0.005	0.003	0.011	0.007					0.041	85.6	3.0	
Bus130	33.000										0.504	93.9	9.1	
Bus131	11.000				0.012	0.007					0.022	85.6	1.6	
Bus132	11.000				0.007	0.004					0.008	85.0	0.6	
Bus133	33.000				0.009	0.005					0.140	96.2	2.5	
Bus134	11.000										0.953	85.2	69.4	
Bus135	11.000		0.145	0.090	0.019	0.012					0.193	85.0	14.0	
Bus136	33.000				0.009	0.005					0.034	93.0	0.6	
Bus137	11.000										0.754	85.3	55.3	
Bus138	11.000		0.042	0.026	0.085	0.053					0.149	85.0	10.9	
Bus139	33.000										0.024	95.3	0.4	
Bus140	11.000										0.601	85.4	44.4	
Bus141	11.000				0.021	0.013					0.025	85.0	1.9	
Bus142	33.000				0.007	0.004					0.008	85.0	0.1	
Bus143	11.000										0.064	85.1	3.7	
Bus144	33.000				0.008	0.005					0.018	90.1	0.3	
Bus145	33.000				0.011	0.007					0.061	94.1	1.1	
Bus146	33.000										0.098	96.2	1.8	
Bus147	11.000		0.008	0.005	0.016	0.010					0.040	85.8	2.9	
Bus148	33.000				0.007	0.005					0.087	96.1	1.6	
Bus149	33.000				0.010	0.006					0.012	85.0	0.2	
Bus150	11.000				0.000	-					0.010	87.6	0.8	
Bus151	33.000										0.081	94.5	1.5	
Bus152	11.000										0.011	85.9	0.8	
Bus153	33.000										0.050	94.1	0.9	
Bus154	11.000				0.009	0.006					0.011	85.0	0.8	
Bus155	33.000				0.009	0.006					0.011	85.0	0.2	
Bus156	11.000				0.035	0.022					0.041	85.0	2.4	
Bus157	11.000				0.020	0.012					0.023	85.0	1.3	
Bus161	11.000										0.574	85.4	42.6	
Bus162	33.000				0.009	0.006					0.071	94.3	1.3	
Bus163	11.000										0.574	85.4	42.6	
Bus164	11.000										0.010	87.7	0.8	

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
Bus165	11.000				0.000	-					0.000	85.0	-	
Bus166	11.000				0.017	0.010					0.020	85.0	1.1	
Bus167	33.000				0.009	0.006					0.011	85.0	0.2	
Bus168	11.000										0.534	85.3	39.6	
Bus169	11.000		0.009	0.006	0.019	0.012					0.033	85.0	2.5	
Bus170	33.000										0.040	93.4	0.7	
Bus171	11.000										0.495	85.2	37.2	
Bus172	33.000										0.030	94.0	0.5	
Bus173	11.000		0.040	0.025	0.077	0.048					0.327	85.1	24.6	
Bus174	33.000				0.007	0.005					0.009	85.0	0.2	
Bus175	11.000										0.189	85.1	14.2	
Bus176	33.000				0.011	0.007					0.013	85.0	0.2	
Bus177	11.000		0.002	0.001	0.004	0.003					0.012	85.3	0.9	
Bus178	33.000				0.009	0.006					0.018	94.0	0.3	
Bus179	11.000				0.003	0.002					0.004	85.0	0.3	
Bus180	33.000				0.027	0.017					0.361	91.4	6.5	
Bus181	11.000		0.015	0.009	0.029	0.018					0.177	85.1	13.3	
Bus182	33.000										0.011	88.1	0.2	
Bus183	11.000										0.126	85.0	9.5	
Bus184	11.000				0.038	0.024					0.045	85.0	3.4	
Bus185	11.000										0.081	85.0	6.1	
Bus186	11.000		0.052	0.032	0.017	0.010					0.081	85.0	6.1	
Bus187	33.000										0.331	91.6	6.0	
Bus188	11.000										0.168	85.5	12.6	
Bus189	11.000		0.031	0.020	0.061	0.038					0.109	85.0	8.2	
Bus190	33.000				0.015	0.009					0.107	88.8	1.9	
Bus191	11.000		0.017	0.011	0.033	0.021					0.059	85.0	4.5	
Bus192	33.000				0.045	0.028					0.090	88.7	1.6	
Bus194	33.000				0.009	0.005					0.022	92.9	0.4	
Bus197	33.000										0.012	96.9	0.2	
Bus200	33.000				0.008	0.005					0.009	85.0	0.2	
Bus201	33.000				0.003	0.002					0.004	85.0	0.1	
Bus203	33.000				0.013	0.008					0.229	90.6	4.2	
Bus206	33.000				0.066	0.041					0.215	90.7	3.9	
Bus207	33.000				0.059	0.037					0.139	92.6	2.5	
Bus210	33.000										0.071	96.2	1.3	
Bus213	33.000				0.006	0.004					0.008	85.0	0.1	
Bus216	33.000				0.003	0.002					0.065	95.2	1.2	
Bus219	33.000										0.063	94.8	1.1	
Bus221	33.000										0.019	95.0	0.3	
Bus224	33.000				0.015	0.009					0.018	85.0	0.3	
Bus234	11.000										0.615	85.0	34.4	

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
Bus238	11.000										0.630	85.0	35.3	
Bus239	11.000		0.119	0.073	0.417	0.258					0.630	85.0	35.3	
Bus240	11.000										0.897	85.4	50.4	
Bus241	11.000										0.899	85.4	50.4	
Bus242	11.000										0.790	85.4	44.5	
Bus246	11.000										0.789	85.4	44.5	
Bus248	11.000										0.788	85.4	44.5	
Bus251	11.000		0.016	0.010	0.053	0.033					0.081	85.0	4.7	
Bus253	11.000				0.017	0.010					0.142	85.7	8.2	
Bus255	11.000				0.015	0.009					0.017	85.0	1.0	
Bus257	11.000										0.786	85.4	44.5	
Bus259	11.000										0.239	85.9	13.7	
Bus262	11.000				0.018	0.011					0.122	85.7	7.1	
Bus263	11.000										0.101	85.8	5.9	
Bus268	11.000										0.206	85.6	11.9	
Bus270	11.000										0.225	85.7	13.0	
Bus271	11.000										0.017	85.9	1.0	
Bus272	11.000				0.043	0.027					0.085	85.7	4.9	
Bus275	11.000				0.011	0.007					0.013	85.0	0.8	
Bus278	11.000										0.034	85.7	2.0	
Bus280	11.000				0.000	-					0.034	86.3	2.0	
Bus284	11.000				0.006	0.004					0.007	85.0	0.4	
Bus288	33.000				0.003	0.002					0.004	85.0	0.1	
Bus292	11.000												-	
Bus295	11.000				0.018	0.011					0.021	85.0	1.2	
Bus297	11.000		0.407	0.252	0.177	0.109					0.687	85.0	44.7	
Bus299	33.000										0.040	93.8	0.7	
Bus303	33.000				0.014	0.009					0.038	91.1	0.7	
Bus305	11.000			0.000							3.881	85.1	427.0	
Bus311	11.000										0.939	85.0	61.2	
Bus312	11.000		3.060	1.896	0.167	0.103					3.796	85.0	427.0	
Bus316	11.000										0.678	86.2	36.6	
Bus322	11.000				0.009	0.005					0.010	85.0	0.6	
Bus324	11.000				0.000	-					0.000	85.0	-	
Bus326	11.000										0.675	86.2	36.6	
Bus328	11.000										0.674	86.2	36.6	
Bus340	33.000				0.009	0.005					0.024	91.8	0.4	
Bus352	11.000			0.000							8.578	81.2	551.2	
Bus354	11.000		0.005	0.003	0.005	0.003					1.127	84.8	124.2	
Bus355	11.000										1.098	85.0	122.8	
Bus356	11.000				0.038	0.024					0.045	85.0	5.0	
Bus358	11.000		0.001	0.000	0.000	-					0.001	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
Bus359	11.000		0.159	0.099	0.009	0.005					0.462	85.0	51.8	
Bus360	11.000		0.213	0.132	0.012	0.007					0.265	85.0	29.7	
Bus362	11.000										0.588	84.9	65.9	
Bus364	11.000		0.174	0.108	0.010	0.006					0.216	85.0	24.3	
Bus366	11.000				0.002	0.001					0.366	85.0	41.6	
Bus367	11.000										0.361	85.1	41.3	
Bus368	11.000		0.027	0.017	0.023	0.014					0.059	85.0	6.8	
Bus370	11.000										0.301	85.1	34.5	
Bus371	11.000				0.005	0.003					0.006	85.0	0.7	
Bus373	11.000				0.009	0.006					0.293	85.1	33.9	
Bus374	11.000										0.281	85.2	32.7	
Bus382	11.000		0.011	0.007	0.009	0.006					0.024	85.0	2.8	
Bus383	11.000		0.004	0.003	0.003	0.002					0.257	85.2	29.9	
Bus384	11.000		0.079	0.049	0.024	0.015					0.246	85.3	28.8	
Bus386	11.000										0.124	85.5	14.6	
Bus388	11.000				0.006	0.004					0.017	85.2	2.0	
Bus390	11.000										0.107	85.5	12.6	
Bus391	11.000				0.008	0.005					0.010	85.0	1.1	
Bus393	11.000				0.005	0.003					0.008	85.5	1.0	
Bus395	11.000				0.002	0.001					0.002	85.0	0.2	
Bus396	11.000				0.021	0.013					0.099	85.5	11.7	
Bus398	11.000										0.073	85.6	8.7	
Bus399	11.000				0.003	0.002					0.004	85.0	0.4	
Bus401	11.000										0.070	85.6	8.3	
Bus402	11.000		0.012	0.007	0.009	0.006					0.036	85.1	4.2	
Bus403	11.000		0.005	0.003	0.004	0.002					0.011	85.0	1.3	
Bus404	11.000										0.034	86.0	4.0	
Bus406	11.000										0.034	85.9	4.0	
Bus409	11.000				0.007	0.004					0.023	85.9	2.8	
Bus410	11.000										0.010	85.1	1.2	
Bus411	11.000				0.009	0.006					0.010	85.0	1.2	
Bus412	11.000										0.015	86.1	1.8	
Bus414	11.000										0.015	85.7	1.8	
Bus415	11.000										0.015	85.5	1.8	
Bus416	11.000				0.010	0.006					0.012	85.0	1.5	
Bus418	11.000				0.002	0.001					0.003	86.4	0.4	
Bus419	11.000				0.001	-					0.001	85.0	0.1	
Bus420	11.000										0.621	86.4	35.7	
Bus428	11.000				0.007	0.004					0.008	85.0	0.4	
Bus429	33.000										3.313	81.9	64.2	
Bus430	33.000		0.029	0.018	0.092	0.057					0.142	85.0	2.8	
Bus431	33.000										3.295	81.8	64.3	

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
Bus432	33.000		0.008	0.005	0.026	0.016					0.041	85.0	0.8	
Bus433	33.000				0.058	0.036					3.105	81.5	60.8	
Bus434	33.000										3.146	81.6	61.6	
Bus436	11.000										0.599	86.4	34.5	
Bus437	11.000				0.044	0.027					0.577	85.1	36.1	
Bus438	11.000										0.523	85.1	32.9	
Bus439	11.000										0.117	85.6	7.3	
Bus441	11.000				0.007	0.004					0.117	85.5	7.3	
Bus443	11.000										0.108	85.5	6.8	
Bus444	11.000				0.007	0.004					0.008	85.0	0.5	
Bus446	11.000				0.013	0.008					0.100	85.3	6.3	
Bus448	11.000				0.060	0.037					0.085	85.2	5.3	
Bus449	11.000				0.011	0.007					0.014	85.3	0.9	
Bus450	11.000				0.002	0.001					0.002	85.0	0.1	
Bus451	11.000										1.060	85.2	66.4	
Bus453	11.000										1.035	85.4	66.4	
Bus454	11.000										0.263	86.3	16.9	
Bus455	11.000		0.006	0.004	0.015	0.009					0.025	85.0	1.6	
Bus457	11.000										0.238	86.3	15.4	
Bus459	11.000				0.003	0.002					0.004	85.0	0.2	
Bus461	11.000										0.234	86.2	15.2	
Bus463	11.000				0.003	0.002					0.004	85.0	0.2	
Bus465	11.000				0.002	0.001					0.230	86.1	15.0	
Bus470	11.000										0.227	86.0	14.8	
Bus472	11.000				0.018	0.011					0.077	86.6	5.0	
Bus474	11.000										0.055	87.1	3.6	
Bus475	11.000				0.013	0.008					0.028	87.7	1.8	
Bus477	11.000				0.013	0.008					0.028	86.1	1.8	
Bus479	11.000				0.004	0.003					0.012	86.2	0.8	
Bus480	11.000				0.006	0.004					0.007	85.0	0.5	
Bus482	11.000				0.003	0.002					0.012	90.0	0.8	
Bus486	11.000				0.001	-					0.009	90.7	0.6	
Bus490	11.000				0.003	0.002					0.008	90.3	0.5	
Bus494	11.000				0.001	0.001					0.002	85.0	0.1	
Bus495	11.000				0.003	0.002					0.004	85.0	0.3	
Bus498	11.000										0.150	85.7	9.8	
Bus499	11.000				0.018	0.011					0.022	85.0	1.4	
Bus501	11.000										0.129	85.7	8.4	
Bus503	11.000				0.015	0.009					0.017	85.0	1.1	
Bus505	11.000				0.019	0.012					0.112	85.8	7.3	
Bus507	11.000										0.090	85.8	5.9	
Bus508	11.000				0.012	0.008					0.015	85.0	1.0	

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
Bus509	11.000			0.000							5.038	85.0	551.2	
Bus510	11.000										0.075	85.9	4.9	
Bus512	11.000				0.013	0.008					0.016	85.0	1.0	
Bus514	11.000										0.060	85.9	3.9	
Bus515	11.000				0.003	0.002					0.004	85.0	0.3	
Bus517	11.000										0.056	85.7	3.7	
Bus519	11.000				0.006	0.004					0.007	85.0	0.5	
Bus521	11.000										0.049	85.6	3.2	
Bus523	11.000				0.019	0.012					0.023	85.0	1.5	
Bus525	11.000										0.026	85.9	1.7	
Bus527	11.000				0.014	0.009					0.017	85.0	1.1	
Bus529	11.000				0.008	0.005					0.009	85.0	0.6	
Bus531	11.000										0.764	85.1	49.5	
Bus532	11.000				0.015	0.009					0.018	85.0	1.2	
Bus533	11.000										0.646	86.2	35.5	
Bus534	11.000				0.023	0.014					0.742	85.2	48.4	
Bus536	11.000		0.019	0.012	0.050	0.031					0.713	85.2	46.6	
Bus538	11.000		0.020	0.012	0.050	0.031					0.628	85.3	41.3	
Bus540	11.000										0.545	85.3	36.0	
Bus542	11.000		0.000	0.000	0.000	-					0.000	85.0	-	
Bus543	11.000				0.049	0.031					0.541	85.3	35.9	
Bus545	11.000				0.064	0.040					0.481	85.4	32.1	
Bus547	11.000										0.406	85.4	27.1	
Bus548	11.000				0.039	0.024					0.046	85.0	3.0	
Bus550	11.000										0.360	85.5	24.0	
Bus552	11.000				0.029	0.018					0.104	85.2	6.9	
Bus554	11.000										0.202	85.7	13.6	
Bus555	11.000				0.060	0.037					0.070	85.0	4.7	
Bus557	11.000				0.045	0.028					0.255	85.5	17.1	
Bus558	11.000				0.022	0.014					0.026	85.0	1.7	
Bus560	11.000										0.176	85.7	11.8	
Bus562	11.000										0.077	85.9	5.1	
Bus563	11.000				0.033	0.020					0.038	85.0	2.6	
Bus565	11.000				0.009	0.006					0.039	85.7	2.6	
Bus567	11.000				0.018	0.011					0.028	85.7	1.9	
Bus568	11.000				0.006	0.003					0.007	85.0	0.4	
Bus570	11.000				0.034	0.021					0.100	85.3	6.7	
Bus572	11.000										0.060	85.5	4.0	
Bus573	11.000				0.030	0.019					0.036	85.0	2.4	
Bus575	11.000										0.024	85.6	1.6	
Bus576	11.000				0.006	0.004					0.007	85.0	0.5	
Bus577	11.000				0.006	0.004					0.007	85.0	0.5	

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
Bus578	11.000				0.009	0.005					0.010	85.0	0.7	
Bus580	11.000										1.098	85.6	68.8	
Bus581	11.000										1.088	85.5	68.8	
Bus583	11.000										0.969	85.3	63.2	
Bus584	11.000		0.118	0.073	0.051	0.031					0.198	85.0	12.9	
Bus585	11.000				0.011	0.007					0.013	85.0	0.8	
Bus586	11.000				0.025	0.016					0.030	85.0	2.0	
Bus587	11.000				0.023	0.014					0.027	85.0	1.8	
Bus588	11.000				0.078	0.048					0.091	85.0	6.2	
Bus589	11.000				0.058	0.036					0.068	85.0	4.6	
Bus590	11.000				0.063	0.039					0.074	85.0	5.1	
Bus591	11.000				0.122	0.075					0.143	85.0	9.8	
Bus592	11.000				0.063	0.039					0.074	85.0	5.1	
Bus593	11.000				0.036	0.023					0.043	85.0	2.9	
Bus594	11.000				0.052	0.032					0.061	85.0	4.2	
Bus595	33.000				0.009	0.006					0.011	85.0	0.2	
Bus610	33.000				0.013	0.008					0.016	85.0	0.3	
Bus612	33.000				0.010	0.006					0.011	85.0	0.2	
Bus623	33.000				0.019	0.012					0.023	85.0	0.4	
Bus626	11.000		0.116	0.072	0.406	0.252					0.614	85.0	34.4	
Bus627	11.000		0.020	0.012	0.069	0.043					0.104	85.0	5.8	
Bus628	11.000		0.015	0.010	0.053	0.033					0.080	85.0	4.6	
Bus629	11.000				0.008	0.005					0.009	85.0	0.5	
Bus630	11.000				0.011	0.007					0.013	85.0	0.8	
Bus631	11.000				0.003	0.002					0.004	85.0	0.2	
Bus632	11.000				0.023	0.014					0.027	85.0	1.6	
Bus633	11.000				0.004	0.003					0.005	85.0	0.3	
Bus634	11.000				0.006	0.004					0.013	85.6	0.7	
Bus635	11.000										0.591	86.4	34.0	
Bus636	11.000				0.025	0.016					0.030	85.0	1.7	
Bus637	11.000										0.577	86.4	33.3	
Bus638	11.000				0.005	0.003					0.006	85.0	0.3	
Bus639	11.000										0.547	86.5	31.6	
Bus640	11.000				0.028	0.017					0.033	85.0	1.9	
Bus641	11.000										0.541	86.5	31.2	
Bus642	11.000												-	
Bus643	11.000				0.008	0.005					0.009	85.0	0.6	
Bus644	11.000				0.029	0.018					0.034	85.0	2.0	
Bus645	11.000										0.033	86.4	1.9	
Bus646	11.000				0.008	0.005					0.009	85.0	0.6	
Bus648	11.000				0.002	0.001					0.003	85.0	0.2	
Bus649	11.000				0.007	0.004					0.008	85.0	0.5	

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
Bus651	11.000				0.002	0.001					0.011	86.8	0.6	
Bus652	11.000										0.013	87.9	0.8	
Bus654	11.000				0.002	0.002					0.016	88.1	0.9	
Bus655	11.000				0.009	0.006					0.027	87.4	1.5	
Bus656	11.000										0.036	87.3	2.1	
Bus657	11.000				0.006	0.004					0.043	87.2	2.5	
Bus658	11.000										0.076	87.4	4.4	
Bus659	11.000				0.009	0.005					0.086	87.2	5.0	
Bus660	11.000				0.013	0.008					0.102	87.0	5.9	
Bus661	11.000										0.111	86.9	6.5	
Bus662	11.000										0.111	87.0	6.4	
Bus663	11.000				0.011	0.007					0.123	86.9	7.2	
Bus664	11.000				0.010	0.006					0.135	86.9	7.9	
Bus665	11.000				0.012	0.008					0.508	86.6	29.4	
Bus667	11.000				0.004	0.002					0.005	85.0	0.3	
Bus668	11.000				0.050	0.031					0.063	85.2	3.7	
Bus670	11.000				0.005	0.003					0.006	85.0	0.4	
Bus671	11.000				0.005	0.003					0.012	85.9	0.7	
Bus672	11.000				0.009	0.006					0.023	85.9	1.3	
Bus675	11.000				0.017	0.010					0.019	85.0	1.1	
Bus677	11.000				0.010	0.006					0.012	85.0	0.7	
Bus678	11.000				0.004	0.003					0.017	86.7	1.0	
Bus679	11.000				0.007	0.004					0.025	87.3	1.5	
Bus680	11.000				0.004	0.003					0.030	87.5	1.7	
Bus681	11.000										0.049	87.1	2.9	
Bus682	11.000				0.011	0.007					0.062	86.7	3.6	
Bus683	11.000										0.084	86.8	4.9	
Bus684	11.000				0.011	0.007					0.096	86.6	5.6	
Bus685	11.000				0.003	0.002					0.100	86.6	5.9	
Bus686	11.000										0.164	86.1	9.6	
Bus687	11.000										0.164	86.2	9.6	
Bus688	11.000				0.021	0.013					0.188	86.0	11.0	
Bus689	11.000				0.007	0.005					0.197	86.0	11.5	
Bus690	11.000				0.022	0.014					0.223	86.0	13.0	
Bus691	11.000				0.019	0.012					0.245	86.0	14.3	
Bus693	11.000				0.003	0.002					0.249	86.1	14.5	
Bus694	11.000										0.357	86.4	20.7	
Bus697	11.000				0.016	0.010					0.019	85.0	1.1	
Bus698	11.000				0.002	0.001					0.021	85.5	1.2	
Bus699	11.000				0.004	0.002					0.025	85.7	1.5	
Bus700	11.000										0.107	87.0	6.2	
Bus701	11.000										0.083	87.2	4.8	

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
Bus702	11.000				0.014	0.009					0.083	87.1	4.8	
Bus703	11.000				0.011	0.007					0.013	85.0	0.7	
Bus704	11.000				0.009	0.005					0.010	85.0	0.6	
Bus706	11.000				0.002	0.002					0.003	85.0	0.2	
Bus707	11.000				0.008	0.005					0.009	85.0	0.6	
Bus708	11.000				0.010	0.006					0.012	85.0	0.7	
Bus709	11.000										0.021	85.7	1.2	
Bus710	11.000										0.024	87.2	1.4	
Bus711	11.000										0.033	87.4	1.9	
Bus712	11.000										0.067	87.6	3.9	
Bus714	11.000				0.003	0.002					0.003	85.0	0.2	
Bus715	11.000										0.021	88.1	1.2	
Bus717	11.000				0.004	0.002					0.005	85.0	0.3	
Bus719	11.000				0.004	0.002					0.005	85.0	0.3	
Bus720	11.000										0.009	87.0	0.5	
Bus721	11.000				0.006	0.004					0.016	86.8	0.9	
Bus722	11.000										0.017	87.6	1.0	
Bus723	11.000				0.001	0.001					0.002	85.0	0.1	

* Indicates operating load of a bus exceeds the bus critical limit (110.0% of the Continuous Ampere rating).
# Indicates operating load of a bus exceeds the bus marginal limit (90.0% 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	338.03	35.26	10.43					
Cable2	Cable	338.03	0.96	0.28					
Cable3	Cable	314.67	48.62	15.45					
Cable4	Cable	190.58	9.08	4.77					
Cable5	Cable	338.03	117.17	34.66					
Cable6	Cable	338.03	34.44	10.19					
Cable7	Cable	338.03	48.69	14.41					
Cable8	Cable	338.03	50.35	14.90					
Cable9	Cable	338.03	48.69	14.41					
Cable11	Cable	338.03	23.78	7.03					
Cable12	Cable	338.03	44.71	13.23					
Cable13	Cable	314.67	12.18	3.87					
Cable15	Cable	338.03	0.95	0.28					
Cable17	Cable	338.03	14.81	4.38					
Cable19	Cable	338.03	8.02	2.37					
Cable22	Cable	338.03	1.27	0.38					
Cable28	Cable	338.03	25.52	7.55					
Cable30	Cable	338.03	8.36	2.47					
Cable33	Cable	338.03	54.81	16.21					
Cable34	Cable	338.03	0.00	0.00					
Cable36	Cable	338.03							
Cable39	Cable	338.03	28.27	8.36					
Cable41	Cable	338.03	1.21	0.36					
Cable43	Cable	338.03	1.48	0.44					
Cable44	Cable	338.03	156.95	46.43					
* Cable46	Cable	338.03	551.17	163.05					
Cable48	Cable	338.03	64.19	18.99					
Cable49	Cable	338.03	36.11	10.68					
Cable51	Cable	338.03	7.30	2.16					
Cable53	Cable	338.03	66.38	19.64					
Cable55	Cable	338.03	68.75	20.34					
UG	Cable	338.03	105.92	31.33					
33/11 KV DOVAN	Transformer				2.500	0.686	27.4	0.678	27.1

CKT / Branch		Cable & Reactor			Transformer				
						Loading (input)		Loading (output)	
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	MVA	%	MVA	%
* 33/11KV PELRITHANG SS	Transformer				2.500	3.033	121.3	2.851	114.0
33/11KV SARPANG TAR	Transformer				2.500	2.231	89.2	2.161	86.4
* 66/11KV T	Transformer				10.000	17.582	175.8	15.357	153.6
66/33/11kV T	Transformer				5.000	3.435	68.7	3.313	66.3
132/33kV	Transformer				15.000	3.465	23.1	3.423	22.8
132/66KV T1	Transformer				25.000	22.433	89.7	21.006	84.0
ICT	Transformer				80.000	3.475	4.3	3.465	4.3
ICT2	Transformer				80.000				

* 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	
Cable1	0.535	0.332	-0.535	-0.332	0.0	0.0	93.7	93.7	0.00
Cable2	0.015	0.009	-0.015	-0.009	0.0	0.0	93.7	93.7	0.00
Cable6	0.523	0.324	-0.523	-0.324	0.1	0.0	93.7	93.7	0.01
Cable8	0.768	0.467	-0.768	-0.467	0.0	0.0	93.7	93.7	0.00
33/11KV SARPANG TAR	-1.841	-1.130	1.855	1.239	13.6	109.0	93.7	96.8	3.05
Cable5	1.551	0.963	-1.551	-0.962	0.3	0.2	81.8	81.8	0.02
Cable33	0.727	0.449	-0.727	-0.449	0.1	0.1	81.8	81.8	0.01
Cable44	2.063	1.313	-2.062	-1.313	0.7	0.5	81.8	81.8	0.03
Cable46	6.976	5.010	-6.967	-5.004	8.6	6.1	81.8	81.7	0.10
UG	1.401	0.872	-1.401	-0.872	0.0	0.0	81.8	81.8	0.00
66/11KV T	-12.718	-8.607	12.925	11.920	207.0	3312.6	81.8	93.6	11.85
Cable49	0.491	0.303	-0.491	-0.303	0.0	0.0	83.8	83.8	0.00
Cable51	0.100	0.060	-0.100	-0.060	0.0	0.0	83.8	83.8	0.00
Cable53	0.903	0.555	-0.903	-0.555	0.1	0.0	83.8	83.8	0.01
Cable55	0.940	0.568	-0.940	-0.568	0.0	0.0	83.8	83.8	0.00
33/11KV PELRITHANG SS	-2.434	-1.485	2.468	1.763	34.7	277.9	83.8	89.2	5.36
Cable3	2.358	1.389	-2.358	-1.389	0.3	0.0	98.5	98.5	0.01
Cable13	0.587	0.355	-0.587	-0.355	0.0	0.0	98.5	98.5	0.00
132/33kV	-2.945	-1.744	2.949	1.819	4.2	74.9	98.5	99.7	1.22
Cable48	2.712	1.903	-2.712	-1.903	0.1	0.1	90.3	90.3	0.00
66/33/11kV T	-2.712	-1.903	2.727	2.089	15.5	186.5	90.3	93.6	3.35
Line555	-2.468	-1.763	2.472	1.764	3.9	0.9	89.2	89.3	0.15
Cable4	0.474	0.167	-0.474	-0.167	0.0	0.0	96.8	96.8	0.00
Line35	-2.329	-1.406	2.358	1.389	28.7	-17.0	96.8	98.5	1.67
132/66KV T1	-15.652	-14.009	15.738	15.986	85.9	1976.8	93.6	100.0	6.36
ICT	-2.949	-1.819	2.950	1.838	0.6	18.9	99.7	100.0	0.30
ICT2	0.000	0.000	0.000	0.000			100.0	100.0	
33/11 KV DOVAN	0.587	0.355	-0.585	-0.343	2.0	12.0	98.5	97.4	1.13
Line1	0.845	0.513	-0.827	-0.505	18.3	8.1	82.2	80.5	1.67
Line718	-0.920	-0.559	0.930	0.564	10.7	4.8	82.2	83.1	0.90
Line3	0.597	0.363	-0.589	-0.360	7.7	3.3	80.2	79.2	0.98
Line720	-0.656	-0.400	0.659	0.401	2.7	1.2	80.2	80.5	0.32
Line754	-0.547	-0.322	0.556	0.328	9.3	6.0	93.6	95.4	1.80
Line755	0.547	0.322	-0.536	-0.313	10.7	9.1	93.6	91.3	2.25

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
Line5	0.549	0.336	-0.541	-0.333	7.5	3.2	78.6	77.6	1.01
Line7	0.025	0.016	-0.025	-0.016	0.0	-0.1	78.6	78.6	0.01
Line9	-0.574	-0.351	0.579	0.353	4.5	1.9	78.6	79.2	0.58
Line6	0.183	0.113	-0.183	-0.113	0.1	0.0	81.8	81.7	0.03
Line12	1.368	0.849	-1.364	-0.846	3.6	3.0	81.8	81.5	0.24
Line8	0.164	0.101	-0.164	-0.101	0.0	0.0	81.7	81.7	0.00
Line10	0.020	0.012	-0.020	-0.012	0.0	0.0	81.7	81.7	0.00
Line4	0.011	0.007	-0.011	-0.007	0.0	0.0	79.2	79.2	0.00
Line14	0.281	0.174	-0.281	-0.174	0.3	0.1	81.5	81.5	0.08
Line20	1.083	0.672	-1.081	-0.670	2.8	2.3	81.5	81.3	0.23
Line16	0.045	0.028	-0.045	-0.028	0.0	-0.1	81.5	81.4	0.01
Line18	0.003	0.002	-0.003	-0.002	0.0	-0.2	81.4	81.4	0.00
Line22	0.799	0.495	-0.798	-0.495	0.8	0.6	81.3	81.2	0.09
Cable7	0.640	0.397	-0.640	-0.397	0.2	0.1	81.2	81.2	0.03
Line28	0.158	0.098	-0.158	-0.098	0.1	0.0	81.2	81.2	0.03
Cable9	0.640	0.397	-0.640	-0.397	0.1	0.0	81.2	81.2	0.01
Cable11	0.313	0.194	-0.313	-0.194	0.1	0.0	81.2	81.2	0.02
Line26	0.034	0.021	-0.034	-0.021	0.0	0.0	81.2	81.2	0.01
Cable15	0.013	0.008	-0.013	-0.008	0.0	0.0	81.2	81.2	0.00
Cable17	0.195	0.121	-0.195	-0.121	0.0	0.0	81.2	81.1	0.01
Cable19	0.105	0.065	-0.105	-0.065	0.0	0.0	81.2	81.1	0.01
Line11	0.023	0.014	-0.023	-0.014	0.0	-0.1	77.6	77.6	0.01
Line13	0.518	0.318	-0.516	-0.317	2.8	1.2	77.6	77.2	0.39
Line30	0.029	0.018	-0.029	-0.018	0.0	0.0	81.2	81.2	0.00
Line32	0.129	0.080	-0.129	-0.080	0.0	0.0	81.2	81.2	0.02
Line34	1.401	0.872	-1.385	-0.859	15.7	13.5	81.8	80.8	1.02
Cable12	0.585	0.362	-0.584	-0.362	0.9	0.6	80.8	80.6	0.12
Line170	0.801	0.496	-0.799	-0.495	2.1	1.7	80.8	80.5	0.23
Cable22	0.017	0.010	-0.017	-0.010	0.0	0.0	80.5	80.5	0.00
Line36	-0.017	-0.010	0.017	0.010	0.0	0.0	80.5	80.5	0.00
Line15	0.078	0.048	-0.078	-0.048	0.0	0.0	77.2	77.2	0.02
Line17	0.438	0.269	-0.436	-0.269	1.6	0.6	77.2	77.0	0.26
Line38	0.512	0.317	-0.511	-0.317	0.6	0.5	80.4	80.3	0.11
Line46	-0.672	-0.416	0.672	0.416	0.2	0.1	80.4	80.4	0.02
Line48	0.160	0.099	-0.160	-0.099	0.1	-0.1	80.4	80.3	0.06
Cable28	0.332	0.205	-0.332	-0.205	0.1	0.1	80.3	80.3	0.02
Line40	0.179	0.111	-0.179	-0.111	0.2	0.0	80.3	80.2	0.09

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
Line42	0.104	0.064	-0.104	-0.064	0.1	-0.2	80.3	80.2	0.10
Cable30	0.109	0.067	-0.109	-0.067	0.0	0.0	80.4	80.4	0.00
Line44	-0.781	-0.484	0.782	0.484	0.9	0.7	80.4	80.5	0.10
Line49	0.727	0.449	-0.725	-0.448	1.5	1.2	81.8	81.6	0.19
Line53	0.033	0.020	-0.033	-0.020	0.0	0.0	81.6	81.6	0.01
Line55	0.692	0.427	-0.690	-0.426	2.1	1.7	81.6	81.3	0.28
Line66	-0.009	-0.006	0.009	0.003	0.0	-2.3	96.7	96.7	0.00
Line51	0.032	0.010	-0.032	-0.013	0.0	-2.9	96.7	96.7	0.00
Line58	-0.126	-0.035	0.126	0.033	0.0	-2.0	96.7	96.7	0.01
Line60	0.094	0.025	-0.094	-0.027	0.0	-1.6	96.7	96.7	0.00
Line19	0.058	0.036	-0.058	-0.036	0.1	-0.2	77.0	76.9	0.07
Line21	0.378	0.233	-0.377	-0.232	1.6	0.6	77.0	76.7	0.30
Line57	0.066	0.041	-0.066	-0.041	0.0	0.0	81.3	81.3	0.01
Line59	0.624	0.385	-0.624	-0.384	0.6	0.5	81.3	81.2	0.09
Line61	0.182	0.113	-0.182	-0.113	0.1	0.0	81.2	81.2	0.05
Line65	0.441	0.272	-0.441	-0.271	0.1	0.1	81.2	81.2	0.03
Line63	0.182	0.113	-0.182	-0.113	0.0	0.0	81.2	81.1	0.02
Line67	0.005	0.003	-0.005	-0.003	0.0	-0.1	81.2	81.2	0.00
Line69	0.436	0.268	-0.436	-0.268	0.7	0.5	81.2	81.0	0.16
Line71	0.064	0.040	-0.064	-0.040	0.0	-0.1	81.0	81.0	0.01
Line73	0.372	0.228	-0.371	-0.228	0.2	0.1	81.0	81.0	0.05
Cable34	0.000	0.000	0.000	0.000			81.0	81.0	0.00
Line75	0.371	0.228	-0.371	-0.228	0.6	0.4	81.0	80.8	0.15
Cable36	0.000	0.000	0.000	0.000			81.0	81.0	
Line23	0.063	0.039	-0.063	-0.039	0.0	0.0	76.7	76.6	0.01
Line74	0.314	0.193	-0.314	-0.193	0.2	0.1	76.7	76.6	0.05
Cable39	0.371	0.228	-0.371	-0.228	0.1	0.0	80.8	80.8	0.02
Line96	0.000	0.000	0.000	0.000	0.0	-0.2	80.8	80.8	0.00
Cable41	0.016	0.010	-0.016	-0.010	0.0	0.0	80.8	80.8	0.00
Line77	0.355	0.218	-0.355	-0.218	0.1	0.0	80.8	80.8	0.02
Line79	0.323	0.198	-0.321	-0.198	1.6	0.5	80.8	80.4	0.39
Line27	-0.091	-0.056	0.091	0.056	0.1	-0.1	76.3	76.4	0.07
Line29	0.052	0.032	-0.052	-0.032	0.0	-0.2	76.3	76.2	0.05
Line81	0.194	0.119	-0.194	-0.119	0.2	0.0	80.4	80.3	0.06
Line83	0.060	0.037	-0.060	-0.037	0.1	-0.2	80.3	80.3	0.07
Line85	0.134	0.082	-0.134	-0.082	0.0	0.0	80.3	80.3	0.03
Line87	0.031	0.019	-0.031	-0.019	0.0	-0.1	80.3	80.3	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
Line89	0.103	0.064	-0.103	-0.064	0.1	-0.1	80.3	80.3	0.06
Line91	0.037	0.023	-0.037	-0.023	0.0	0.0	80.3	80.3	0.01
Line94	0.028	0.017	-0.028	-0.017	0.0	-0.3	80.3	80.2	0.04
Line37	-0.474	-0.170	0.474	0.167	0.1	-3.6	96.8	96.8	0.03
Line39	0.474	0.170	-0.474	-0.171	0.0	-0.8	96.8	96.8	0.00
Line98	0.000	0.000	0.000	0.000	0.0	0.0	80.8	80.8	0.00
Line100	0.000	0.000	0.000	0.000	0.0	-0.1	80.8	80.8	0.00
Line102	0.000	0.000	0.000	0.000	0.0	-0.1	83.1	83.1	0.00
Line104	-0.102	-0.063	0.102	0.063	0.1	-0.1	83.1	83.2	0.06
Cable43	0.020	0.012	-0.020	-0.012	0.0	0.0	83.2	83.2	0.00
Line106	-0.122	-0.076	0.123	0.075	0.2	-0.2	83.2	83.3	0.14
Line107	-0.247	-0.152	0.247	0.153	0.4	0.1	83.3	83.4	0.13
Line558	-0.197	-0.122	0.198	0.122	0.3	0.0	83.3	83.4	0.13
Line108	2.062	1.313	-2.035	-1.289	27.4	23.8	81.8	80.6	1.20
Line110	2.029	1.285	-2.015	-1.273	13.9	12.1	80.6	79.9	0.61
Line116	1.884	1.192	-1.867	-1.178	16.8	14.6	79.9	79.1	0.79
Line111	-0.600	-0.366	0.603	0.367	3.1	1.2	92.2	92.7	0.44
Line112	0.414	0.250	-0.412	-0.250	2.0	0.6	92.2	91.8	0.41
Line113	0.275	0.165	-0.275	-0.165	0.3	0.0	91.8	91.7	0.10
Line127	0.136	0.085	-0.136	-0.085	0.0	0.0	91.8	91.8	0.02
Line129	0.069	0.043	-0.069	-0.043	0.0	-0.2	91.7	91.7	0.04
Line131	0.206	0.122	-0.206	-0.122	0.2	0.0	91.7	91.6	0.07
Line118	0.147	0.090	-0.147	-0.090	0.1	0.0	79.1	79.1	0.07
Line130	1.720	1.087	-1.697	-1.067	23.0	19.9	79.1	78.0	1.17
Line120	0.124	0.076	-0.124	-0.077	0.1	-0.2	79.1	79.0	0.10
Line122	0.012	0.008	-0.012	-0.008	0.0	0.0	79.0	79.0	0.00
Line124	0.112	0.069	-0.112	-0.069	0.1	-0.1	79.0	78.9	0.05
Line126	0.013	0.008	-0.013	-0.008	0.0	-0.1	78.9	78.9	0.00
Line128	0.099	0.061	-0.099	-0.061	0.0	0.0	78.9	78.9	0.02
Line132	0.016	0.010	-0.016	-0.010	0.0	0.0	78.0	78.0	0.00
Line134	1.682	1.058	-1.663	-1.042	18.6	16.1	78.0	77.0	0.96
Line136	0.228	0.142	-0.228	-0.142	0.1	0.0	77.0	77.0	0.03
Line138	1.434	0.900	-1.399	-0.870	35.3	30.5	77.0	74.9	2.11
Line140	0.100	0.061	-0.099	-0.061	0.2	-0.1	74.9	74.8	0.12
Line150	1.300	0.809	-1.285	-0.796	14.6	12.6	74.9	74.0	0.94
Line142	0.031	0.019	-0.031	-0.019	0.0	-0.2	74.8	74.8	0.04
Line144	0.069	0.042	-0.069	-0.042	0.1	-0.1	74.8	74.7	0.06

	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
Line41	0.474	0.171	-0.474	-0.173	0.1	-1.9	96.8	96.7	0.03
Line146	0.024	0.014	-0.024	-0.015	0.0	-0.2	74.7	74.7	0.02
Line160	0.000	-0.002	0.000	0.000	0.0	-1.6	93.7	93.7	0.00
Line148	0.013	0.008	-0.013	-0.008	0.0	-0.3	74.7	74.7	0.02
Line153	0.227	0.140	-0.226	-0.140	0.9	0.2	74.0	73.7	0.27
Line155	1.058	0.656	-1.056	-0.654	2.2	1.9	74.0	73.8	0.17
Line159	1.056	0.654	-1.054	-0.653	1.9	1.6	73.8	73.6	0.15
Line161	0.009	0.005	-0.009	-0.005	0.0	-0.2	73.6	73.6	0.01
Line163	1.045	0.647	-1.040	-0.643	5.4	4.6	73.6	73.2	0.43
Line2	0.122	0.075	-0.122	-0.075	0.2	-0.1	76.6	76.5	0.10
Line162	0.192	0.118	-0.192	-0.118	0.2	0.0	76.6	76.5	0.08
Line165	0.966	0.597	-0.963	-0.595	2.6	2.2	73.2	73.0	0.22
Line43	-0.474	-0.175	0.474	0.173	0.1	-1.9	96.7	96.7	0.01
Line45	0.009	0.005	-0.009	-0.005	0.0	-0.4	96.7	96.7	0.00
Line52	0.465	0.170	-0.465	-0.172	0.0	-1.5	96.7	96.7	0.01
Line167	0.043	0.027	-0.043	-0.027	0.0	-0.2	73.0	72.9	0.05
Line169	0.920	0.568	-0.916	-0.564	4.4	3.7	73.0	72.6	0.39
Line24	0.128	0.079	-0.128	-0.079	0.3	-0.1	76.5	76.4	0.17
Line168	0.063	0.039	-0.063	-0.039	0.0	0.0	76.5	76.5	0.01
Line171	0.852	0.525	-0.849	-0.522	3.5	2.9	72.6	72.3	0.33
Line54	0.330	0.137	-0.330	-0.146	0.1	-9.3	96.7	96.7	0.05
Line56	0.134	0.035	-0.134	-0.038	0.0	-3.3	96.7	96.7	0.01
Line173	0.035	0.021	-0.035	-0.021	0.0	-0.1	72.3	72.3	0.02
Line179	0.813	0.501	-0.812	-0.500	1.3	1.1	72.3	72.1	0.13
Line25	0.036	0.023	-0.036	-0.023	0.0	0.0	76.4	76.3	0.01
Line175	0.019	0.011	-0.019	-0.012	0.0	-0.3	72.3	72.2	0.03
Line177	0.007	0.004	-0.007	-0.004	0.0	-0.3	72.2	72.2	0.01
Line181	0.164	0.102	-0.164	-0.102	0.0	0.0	72.1	72.1	0.01
Line184	0.648	0.398	-0.643	-0.394	4.6	3.8	72.1	71.6	0.57
Line62	0.023	0.007	-0.023	-0.007	0.0	-0.2	96.7	96.7	0.00
Line186	0.127	0.078	-0.127	-0.078	0.0	0.0	71.6	71.6	0.00
Line188	0.517	0.316	-0.513	-0.313	3.2	2.6	71.6	71.1	0.50
Line64	0.017	0.006	-0.017	-0.008	0.0	-1.7	96.7	96.7	0.00
Line185	0.007	0.001	-0.007	-0.004	0.0	-3.0	96.7	96.7	0.00
Line190	0.021	0.013	-0.021	-0.013	0.0	0.0	71.1	71.1	0.00
Line192	0.492	0.300	-0.490	-0.299	1.6	1.2	71.1	70.8	0.25
Line141	0.020	0.012	-0.020	-0.012	0.0	-0.1	91.0	91.0	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
Line143	0.035	0.022	-0.035	-0.022	0.0	-0.1	91.0	91.0	0.01
Line208	-0.055	-0.034	0.055	0.034	0.0	-0.2	91.0	91.1	0.03
Line72	-0.058	-0.021	0.058	0.018	0.0	-2.8	96.7	96.7	0.00
Line76	0.047	0.014	-0.047	-0.017	0.0	-2.9	96.7	96.7	0.00
Line50	0.010	0.006	-0.010	-0.006	0.0	-0.5	96.7	96.7	0.00
Line193	0.083	0.021	-0.083	-0.024	0.0	-3.4	96.7	96.7	0.01
Line196	-0.034	-0.020	0.034	0.020	0.0	-0.3	70.7	70.8	0.06
Line212	0.009	0.005	-0.009	-0.005	0.0	0.0	70.7	70.7	0.00
Line68	0.076	0.019	-0.076	-0.026	0.0	-7.0	96.7	96.7	0.01
Line198	-0.009	-0.005	0.009	0.005	0.0	0.0	70.7	70.7	0.00
Line200	0.009	0.005	-0.009	-0.005	0.0	-0.4	70.7	70.7	0.01
Line70	0.067	0.021	-0.067	-0.024	0.0	-2.6	96.7	96.7	0.00
Line199	0.009	0.005	-0.009	-0.006	0.0	-0.4	96.7	96.7	0.00
Line202	0.000	0.000	0.000	0.000	0.0	-0.1	70.7	70.7	0.00
Line204	0.009	0.005	-0.009	-0.006	0.0	-0.2	70.7	70.7	0.01
Line80	0.037	0.013	-0.037	-0.014	0.0	-1.0	96.7	96.7	0.00
Line211	0.009	0.004	-0.009	-0.006	0.0	-2.2	96.7	96.7	0.00
Line194	0.490	0.299	-0.490	-0.298	0.4	0.2	70.8	70.8	0.05
Line214	0.456	0.278	-0.456	-0.278	0.5	0.2	70.8	70.7	0.07
Line187	-0.017	-0.010	0.017	0.010	0.0	-0.1	96.7	96.7	0.00
Line216	0.028	0.017	-0.028	-0.017	0.0	0.0	70.7	70.7	0.00
Line218	0.427	0.261	-0.422	-0.259	5.0	1.8	70.7	69.9	0.76
Line78	0.028	0.009	-0.028	-0.010	0.0	-1.6	96.7	96.7	0.00
Line737	0.010	0.006	-0.010	-0.006	0.0	-0.1	96.7	96.7	0.00
Line220	0.278	0.172	-0.278	-0.172	0.6	0.2	69.9	69.8	0.14
Line241	0.144	0.087	-0.144	-0.087	0.3	0.0	69.9	69.8	0.14
Line82	0.017	0.004	-0.017	-0.006	0.0	-1.7	96.7	96.7	0.00
Line219	0.011	0.006	-0.011	-0.007	0.0	-1.2	96.7	96.7	0.00
Line222	0.161	0.099	-0.161	-0.099	0.3	0.0	69.8	69.7	0.10
Line84	-0.007	-0.005	0.007	0.000	0.0	-4.3	96.7	96.7	0.00
Line224	0.010	0.006	-0.010	-0.006	0.0	-0.1	69.7	69.7	0.00
Line229	0.151	0.093	-0.151	-0.093	0.2	0.0	69.7	69.6	0.09
Line226	0.003	0.002	-0.003	-0.002	0.0	-0.1	69.7	69.7	0.00
Line225	0.303	0.129	-0.303	-0.133	0.0	-3.5	96.7	96.7	0.02
Line233	0.107	0.066	-0.107	-0.066	0.1	-0.1	69.6	69.5	0.07
Line47	0.009	0.005	-0.009	-0.006	0.0	-0.8	96.7	96.7	0.00
Line235	0.038	0.024	-0.038	-0.024	0.0	0.0	69.5	69.5	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
Line237	0.069	0.043	-0.069	-0.043	0.0	0.0	69.5	69.5	0.01
Line239	0.069	0.043	-0.069	-0.043	0.0	0.0	69.5	69.5	0.00
Line86	0.095	0.047	-0.095	-0.049	0.0	-2.0	96.7	96.6	0.01
Line90	0.208	0.086	-0.208	-0.097	0.1	-11.5	96.7	96.6	0.04
Line243	0.093	0.057	-0.093	-0.057	0.1	0.0	69.8	69.7	0.04
Line245	0.051	0.030	-0.050	-0.031	0.4	-1.5	69.8	69.3	0.51
Line88	0.080	0.040	-0.080	-0.041	0.0	-1.7	96.6	96.6	0.00
Line203	0.035	0.014	-0.035	-0.016	0.0	-2.1	96.6	96.6	0.00
Line92	-0.020	-0.008	0.020	0.007	0.0	-1.3	96.6	96.6	0.00
Line93	0.011	0.003	-0.011	-0.003	0.0	-0.3	96.6	96.6	0.00
Line95	0.008	0.003	-0.008	-0.005	0.0	-2.4	96.6	96.6	0.00
Line97	0.003	0.000	-0.003	-0.002	0.0	-1.7	96.6	96.6	0.00
Line223	0.195	0.089	-0.195	-0.090	0.0	-1.2	96.6	96.6	0.00
Line99	0.128	0.049	-0.128	-0.052	0.0	-3.2	96.6	96.6	0.01
Line746	0.069	0.016	-0.069	-0.019	0.0	-3.1	96.6	96.6	0.00
Line268	0.006	-0.001	-0.006	-0.004	0.0	-4.8	96.6	96.6	0.00
Line270	0.062	0.019	-0.062	-0.020	0.0	-0.5	96.6	96.6	0.00
Line278	0.059	0.018	-0.059	-0.020	0.0	-1.8	96.6	96.6	0.00
Line282	0.037	0.011	-0.037	-0.014	0.0	-2.5	96.6	96.6	0.00
Line284	0.022	0.008	-0.022	-0.009	0.0	-1.0	96.6	96.6	0.00
Line101	0.015	0.006	-0.015	-0.009	0.0	-3.4	96.6	96.6	0.00
Line285	0.003	-0.002	-0.003	-0.002	0.0	-3.7	96.6	96.6	0.00
Line381	-0.018	-0.004	0.018	0.003	0.0	-1.2	96.6	96.6	0.00
Line105	0.523	0.324	-0.522	-0.323	1.0	0.4	93.7	93.6	0.17
Line103	0.535	0.332	-0.535	-0.332	0.1	0.0	93.7	93.7	0.01
Line109	-0.766	-0.467	0.768	0.467	1.9	0.7	93.5	93.7	0.22
Line115	0.088	0.055	-0.088	-0.055	0.0	-0.1	93.5	93.5	0.02
Line117	0.678	0.412	-0.675	-0.411	3.3	1.2	93.5	93.1	0.42
Line119	0.675	0.411	-0.674	-0.410	0.4	0.5	93.1	93.0	0.07
Line121	0.674	0.410	-0.673	-0.410	1.8	0.7	93.0	92.8	0.23
Line123	0.673	0.410	-0.672	-0.409	1.0	0.4	92.8	92.7	0.13
Line139	-0.122	-0.073	0.122	0.073	0.1	-0.2	91.0	91.1	0.08
Line145	0.105	0.063	-0.105	-0.063	0.2	-0.3	91.0	90.9	0.13
Line125	0.068	0.042	-0.068	-0.042	0.0	0.0	92.7	92.7	0.00
Line133	0.011	0.007	-0.011	-0.007	0.0	-0.3	91.6	91.6	0.01
Line135	0.194	0.116	-0.193	-0.116	1.1	-0.3	91.6	91.2	0.47
Line151	0.087	0.052	-0.087	-0.052	0.0	-0.1	90.9	90.8	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
Line149	0.014	0.009	-0.014	-0.009	0.0	0.0	90.8	90.8	0.00
Line152	0.073	0.044	-0.073	-0.044	0.0	0.0	90.8	90.8	0.01
Line206	-0.177	-0.106	0.177	0.106	0.2	-0.1	91.1	91.2	0.10
Line137	0.008	0.005	-0.008	-0.005	0.0	0.0	91.2	91.2	0.00
Line752	0.009	0.005	-0.009	-0.005	0.0	-0.6	91.2	91.2	0.02
Line147	0.011	0.007	-0.011	-0.007	0.0	0.0	90.8	90.8	0.00
Line154	0.003	0.002	-0.003	-0.002	0.0	-0.3	90.8	90.8	0.00
Line156	0.030	0.017	-0.030	-0.017	0.0	-0.3	90.8	90.8	0.03
Line158	-0.029	-0.018	0.029	0.017	0.0	-0.5	90.8	90.8	0.04
Line164	0.023	0.014	-0.023	-0.014	0.0	-0.1	90.8	90.8	0.00
Line166	0.006	0.003	-0.006	-0.004	0.0	-0.5	90.8	90.7	0.01
Line532	0.000	0.000	0.000	0.000	0.0	-0.1	44.0	44.0	0.00
Line756	-0.018	-0.011	0.018	0.011	0.0	-0.1	91.3	91.3	0.00
Line749	0.019	0.011	-0.019	-0.012	0.0	-1.1	96.6	96.6	0.00
Line172	-3.304	-2.036	3.321	2.051	17.3	15.2	47.7	48.0	0.28
Line176	3.304	2.036	-3.226	-2.000	77.2	36.3	47.7	46.7	1.04
Line189	0.585	0.343	-0.582	-0.342	2.6	1.7	97.4	96.9	0.49
Line415	0.000	0.000	0.000	0.000	0.0	-0.1	96.9	96.9	0.00
Line191	0.582	0.342	-0.581	-0.341	1.0	0.7	96.9	96.7	0.19
Line201	0.564	0.331	-0.556	-0.328	7.8	2.8	96.7	95.4	1.27
Line735	0.013	0.004	-0.013	-0.008	0.0	-4.1	96.6	96.6	0.00
Line449	6.967	5.004	-4.283	-2.653	2683.8	2351.2	81.7	48.0	33.71
Line174	-0.956	-0.597	0.962	0.602	6.1	5.3	47.6	48.0	0.34
Line451	0.946	0.590	-0.933	-0.579	12.8	11.1	47.6	46.9	0.72
Line183	0.038	0.024	-0.038	-0.024	0.0	0.0	46.9	46.9	0.04
Line453	0.001	0.000	-0.001	0.000	0.0	0.0	46.9	46.9	0.00
Line456	0.394	0.244	-0.393	-0.244	0.7	0.6	46.9	46.8	0.09
Line460	0.500	0.311	-0.500	-0.310	0.4	0.3	46.9	46.9	0.04
Line458	0.225	0.140	-0.225	-0.140	0.1	0.1	46.8	46.8	0.03
Line462	0.185	0.114	-0.184	-0.114	0.8	0.3	46.9	46.7	0.19
Line464	0.315	0.196	-0.311	-0.193	3.6	3.0	46.9	46.3	0.60
Line466	0.309	0.192	-0.307	-0.190	2.3	1.9	46.3	45.9	0.38
Line468	0.050	0.031	-0.050	-0.031	0.0	0.0	45.9	45.9	0.02
Line470	0.257	0.159	-0.256	-0.158	1.1	0.9	45.9	45.7	0.22
Line472	0.005	0.003	-0.005	-0.003	0.0	0.0	45.7	45.7	0.00
Line474	0.251	0.155	-0.250	-0.154	1.2	1.0	45.7	45.4	0.24
Line476	0.241	0.148	-0.240	-0.147	1.2	1.0	45.4	45.2	0.25

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
Line478	0.020	0.013	-0.020	-0.013	0.0	0.0	45.2	45.2	0.00
Line489	0.219	0.135	-0.219	-0.135	0.2	0.2	45.2	45.1	0.05
Line491	0.211	0.130	-0.209	-0.128	2.0	1.6	45.1	44.7	0.47
Line495	0.106	0.064	-0.106	-0.064	0.1	0.0	44.7	44.6	0.03
Line497	0.014	0.009	-0.014	-0.009	0.0	0.0	44.6	44.6	0.01
Line498	0.092	0.056	-0.091	-0.055	0.5	0.3	44.6	44.4	0.29
Line500	0.008	0.005	-0.008	-0.005	0.0	-0.1	44.6	44.6	0.02
Line502	0.007	0.004	-0.007	-0.004	0.0	-0.1	44.4	44.3	0.01
Line506	0.084	0.051	-0.084	-0.051	0.1	0.0	44.4	44.3	0.05
Line504	0.002	0.001	-0.002	-0.001	0.0	-0.1	44.3	44.3	0.00
Line508	0.063	0.038	-0.063	-0.038	0.1	0.0	44.3	44.2	0.09
Line510	0.003	0.002	-0.003	-0.002	0.0	0.0	44.2	44.2	0.00
Line512	0.060	0.036	-0.059	-0.036	0.1	0.0	44.2	44.1	0.10
Line514	0.030	0.019	-0.030	-0.019	0.0	-0.1	44.1	44.1	0.04
Line518	0.029	0.017	-0.029	-0.017	0.0	0.0	44.1	44.1	0.02
Line516	0.009	0.005	-0.009	-0.006	0.0	-0.1	44.1	44.1	0.01
Line520	0.029	0.017	-0.029	-0.017	0.0	0.0	44.1	44.0	0.05
Line522	0.009	0.005	-0.009	-0.005	0.0	0.0	44.0	44.0	0.01
Line524	0.020	0.012	-0.020	-0.012	0.0	-0.1	44.0	44.0	0.04
Line528	0.013	0.008	-0.013	-0.008	0.0	-0.1	44.0	44.0	0.02
Line526	0.009	0.005	-0.009	-0.006	0.0	0.0	44.0	44.0	0.00
Line530	0.013	0.008	-0.013	-0.008	0.0	-0.1	44.0	44.0	0.02
Line533	0.013	0.008	-0.013	-0.008	0.0	-0.1	44.0	43.9	0.02
Line535	0.010	0.006	-0.010	-0.006	0.0	0.0	43.9	43.9	0.00
Line537	0.003	0.001	-0.003	-0.002	0.0	-0.1	43.9	43.9	0.01
Line539	0.001	0.000	-0.001	0.000	0.0	-0.1	43.9	43.9	0.00
Line757	0.518	0.302	-0.518	-0.302	0.1	0.1	91.3	91.3	0.03
Line758	-0.007	-0.004	0.007	0.004	0.0	-0.2	91.3	91.3	0.00
Line549	2.712	1.903	-2.694	-1.897	17.5	5.3	90.3	89.7	0.63
Line550	-0.121	-0.075	0.121	0.075	0.0	0.0	89.7	89.7	0.00
Line551	2.574	1.823	-2.566	-1.821	7.9	2.0	89.7	89.4	0.30
Line552	-0.035	-0.022	0.035	0.021	0.0	-0.7	89.4	89.4	0.00
Line553	-2.530	-1.800	2.531	1.800	1.0	0.3	89.3	89.4	0.04
Line759	0.512	0.298	-0.511	-0.297	0.7	0.4	91.3	91.2	0.14
Line556	0.447	0.276	-0.445	-0.275	2.3	0.7	83.8	83.4	0.39
Line559	0.100	0.060	-0.100	-0.060	0.1	-0.1	83.8	83.8	0.05
Line561	0.093	0.056	-0.092	-0.056	0.1	-0.1	83.8	83.7	0.06

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
Line563	0.007	0.004	-0.007	-0.004	0.0	-0.4	83.7	83.7	0.01
Line565	0.086	0.052	-0.085	-0.052	0.1	-0.2	83.7	83.6	0.06
Line567	0.072	0.044	-0.072	-0.044	0.1	-0.3	83.6	83.5	0.11
Line569	0.012	0.007	-0.012	-0.007	0.0	-0.2	83.5	83.5	0.01
Line571	0.002	0.001	-0.002	-0.001	0.0	-0.1	83.5	83.5	0.00
Line573	0.903	0.555	-0.884	-0.539	19.2	15.9	83.8	81.8	1.99
Line577	0.228	0.133	-0.227	-0.133	0.7	0.1	81.8	81.5	0.30
Line663	0.656	0.406	-0.650	-0.401	6.1	4.8	81.8	81.0	0.85
Line579	0.021	0.013	-0.021	-0.013	0.0	-0.3	81.5	81.5	0.02
Line581	0.206	0.120	-0.206	-0.120	0.4	0.0	81.5	81.3	0.17
Line583	0.003	0.002	-0.003	-0.002	0.0	0.0	81.3	81.3	0.00
Line585	0.203	0.119	-0.202	-0.119	0.9	0.0	81.3	80.9	0.42
Line587	0.003	0.002	-0.003	-0.002	0.0	-0.3	80.9	80.9	0.00
Line589	0.199	0.117	-0.198	-0.117	0.8	-0.1	80.9	80.6	0.38
Line593	0.196	0.116	-0.195	-0.116	0.3	0.0	80.6	80.4	0.15
Line595	0.066	0.038	-0.066	-0.038	0.0	-0.1	80.4	80.4	0.02
Line597	0.129	0.078	-0.129	-0.078	0.0	-0.1	80.4	80.4	0.03
Line599	0.048	0.027	-0.048	-0.027	0.0	-0.1	80.4	80.4	0.02
Line601	0.024	0.014	-0.024	-0.014	0.0	0.0	80.4	80.4	0.00
Line602	0.024	0.013	-0.024	-0.013	0.0	-0.3	80.4	80.3	0.03
Line608	0.011	0.005	-0.011	-0.005	0.0	-0.3	80.3	80.3	0.01
Line604	0.010	0.006	-0.010	-0.006	0.0	-0.3	80.4	80.4	0.01
Line606	0.006	0.003	-0.006	-0.004	0.0	-0.3	80.4	80.3	0.01
Line612	0.008	0.004	-0.008	-0.004	0.0	-0.2	80.3	80.3	0.01
Line616	0.007	0.003	-0.007	-0.003	0.0	-0.2	80.3	80.3	0.01
Line623	0.001	0.001	-0.001	-0.001	0.0	-0.3	80.3	80.3	0.00
Line625	0.003	0.001	-0.003	-0.002	0.0	-0.8	80.3	80.3	0.00
Line629	0.018	0.011	-0.018	-0.011	0.0	0.0	80.4	80.4	0.00
Line631	0.111	0.066	-0.111	-0.066	0.0	0.0	80.4	80.4	0.01
Line633	0.015	0.009	-0.015	-0.009	0.0	0.0	80.4	80.4	0.00
Line635	0.096	0.057	-0.096	-0.057	0.0	-0.1	80.4	80.3	0.04
Line637	0.077	0.046	-0.077	-0.046	0.0	-0.2	80.3	80.3	0.05
Line639	0.012	0.008	-0.012	-0.008	0.0	-0.1	80.3	80.3	0.00
Line641	0.064	0.038	-0.064	-0.038	0.0	-0.2	80.3	80.2	0.03
Line643	0.013	0.008	-0.013	-0.008	0.0	-0.1	80.2	80.2	0.00
Line645	0.051	0.030	-0.051	-0.030	0.0	-0.1	80.2	80.2	0.02
Line647	0.003	0.002	-0.003	-0.002	0.0	-0.1	80.2	80.2	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
Line649	0.048	0.029	-0.048	-0.029	0.0	-0.2	80.2	80.2	0.02
Line651	0.006	0.004	-0.006	-0.004	0.0	-0.1	80.2	80.2	0.00
Line653	0.042	0.025	-0.042	-0.025	0.0	-0.1	80.2	80.2	0.01
Line655	0.019	0.012	-0.019	-0.012	0.0	0.0	80.2	80.2	0.00
Line657	0.022	0.013	-0.022	-0.013	0.0	-0.1	80.2	80.2	0.01
Line659	0.014	0.009	-0.014	-0.009	0.0	-0.1	80.2	80.2	0.01
Line661	0.008	0.005	-0.008	-0.005	0.0	-0.4	80.2	80.2	0.01
Line665	0.015	0.009	-0.015	-0.009	0.0	0.0	81.0	81.0	0.00
Line667	0.635	0.391	-0.632	-0.389	3.0	2.3	81.0	80.5	0.42
Line669	0.609	0.375	-0.607	-0.373	2.2	1.7	80.5	80.2	0.32
Line671	0.538	0.330	-0.535	-0.328	3.1	2.3	80.2	79.7	0.52
Line673	0.466	0.285	-0.465	-0.285	0.3	0.3	79.7	79.6	0.07
Line675	0.000	0.000	0.000	0.000	0.0	0.0	79.6	79.6	0.00
Line677	0.465	0.284	-0.462	-0.282	3.3	2.4	79.6	79.0	0.63
Line679	0.412	0.251	-0.411	-0.251	1.1	0.7	79.0	78.8	0.23
Line681	0.347	0.211	-0.347	-0.211	0.1	0.1	78.8	78.7	0.02
Line683	0.039	0.024	-0.039	-0.024	0.0	-0.2	78.7	78.7	0.02
Line684	0.308	0.187	-0.308	-0.187	0.6	0.3	78.7	78.6	0.17
Line686	0.088	0.054	-0.088	-0.054	0.0	0.0	78.6	78.6	0.01
Line690	0.219	0.132	-0.218	-0.132	0.9	0.2	78.6	78.2	0.34
Line688	0.060	0.037	-0.060	-0.037	0.1	-0.3	78.6	78.5	0.11
Line694	-0.173	-0.104	0.173	0.104	0.0	0.0	78.2	78.2	0.02
Line696	0.151	0.091	-0.151	-0.091	0.1	0.0	78.2	78.2	0.05
Line697	0.022	0.013	-0.022	-0.014	0.0	-0.2	78.2	78.2	0.01
Line701	0.066	0.039	-0.066	-0.039	0.0	0.0	78.2	78.2	0.00
Line703	0.085	0.052	-0.085	-0.052	0.1	-0.2	78.2	78.1	0.09
Line692	0.033	0.020	-0.033	-0.020	0.0	-0.4	78.2	78.1	0.04
Line699	0.033	0.020	-0.033	-0.020	0.0	-0.6	78.2	78.1	0.05
Line705	0.024	0.014	-0.024	-0.014	0.0	-0.2	78.1	78.1	0.01
Line707	0.006	0.003	-0.006	-0.003	0.0	-0.4	78.1	78.1	0.01
Line698	0.051	0.031	-0.051	-0.031	0.0	-0.1	78.1	78.0	0.04
Line709	0.021	0.012	-0.021	-0.013	0.0	-0.2	78.0	78.0	0.02
Line710	0.030	0.019	-0.030	-0.019	0.0	-0.1	78.0	78.0	0.02
Line712	0.006	0.004	-0.006	-0.004	0.0	0.0	78.0	78.0	0.00
Line713	0.006	0.004	-0.006	-0.004	0.0	-0.1	78.0	78.0	0.00
Line714	0.009	0.005	-0.009	-0.005	0.0	-0.2	78.0	78.0	0.01
Line716	0.940	0.568	-0.930	-0.564	9.3	3.7	83.8	83.1	0.76

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
Line719	0.169	0.104	-0.168	-0.104	0.2	0.0	80.5	80.4	0.07
Line760	-0.004	-0.003	0.004	0.003	0.0	-0.2	91.2	91.2	0.00
Line761	-0.011	-0.007	0.011	0.006	0.0	-0.1	91.2	91.2	0.00
Line762	0.500	0.291	-0.499	-0.290	0.8	0.5	91.2	91.0	0.17
Line763	-0.025	-0.016	0.025	0.016	0.0	-0.2	91.0	91.0	0.01
Line764	0.474	0.275	-0.474	-0.275	0.1	0.1	91.0	91.0	0.03
Line765	-0.005	-0.003	0.005	0.003	0.0	0.0	91.0	91.0	0.00
Line766	0.469	0.272	-0.468	-0.271	0.8	0.5	91.0	90.8	0.17
Line767	-0.028	-0.017	0.028	0.017	0.0	0.0	90.8	90.8	0.00
Line768	0.440	0.254	-0.440	-0.254	0.4	0.2	90.8	90.7	0.09
Line769	0.000	0.000	0.000	0.000	0.0	-0.1	90.3	90.3	0.00
Line770	-0.008	-0.005	0.008	0.005	0.0	-0.2	90.2	90.2	0.00
Line771	-0.029	-0.018	0.029	0.017	0.0	-1.0	90.0	90.0	0.05
Line772	-0.029	-0.017	0.029	0.016	0.0	-0.8	90.0	90.1	0.07
Line773	-0.008	-0.005	0.008	0.005	0.0	-0.4	90.0	90.0	0.01
Line775	-0.002	-0.001	0.002	0.001	0.0	-0.1	90.0	90.0	0.00
Line776	-0.007	-0.004	0.007	0.004	0.0	-0.4	90.0	90.0	0.01
Line778	-0.009	-0.005	0.009	0.005	0.0	-0.4	90.0	90.0	0.01
Line779	-0.012	-0.006	0.012	0.006	0.0	-0.3	90.0	90.0	0.01
Line781	-0.014	-0.007	0.014	0.007	0.0	-0.3	90.0	90.0	0.01
Line782	-0.023	-0.013	0.023	0.013	0.0	0.0	90.0	90.0	0.00
Line783	-0.031	-0.017	0.031	0.017	0.0	-0.3	90.0	90.1	0.03
Line784	-0.038	-0.021	0.038	0.021	0.0	-0.1	90.1	90.1	0.01
Line785	-0.066	-0.037	0.066	0.037	0.0	-0.2	90.1	90.1	0.04
Line786	-0.075	-0.042	0.075	0.042	0.1	-0.2	90.1	90.2	0.06
Line787	-0.088	-0.050	0.088	0.050	0.0	-0.1	90.2	90.2	0.02
Line788	-0.096	-0.055	0.097	0.055	0.1	-0.2	90.2	90.3	0.07
Line789	-0.097	-0.054	0.097	0.054	0.1	-0.1	90.3	90.3	0.05
Line790	-0.107	-0.061	0.107	0.060	0.2	-0.4	90.3	90.5	0.17
Line791	-0.118	-0.067	0.118	0.066	0.3	-0.5	90.5	90.7	0.22
Line792	0.309	0.180	-0.308	-0.179	1.1	0.3	90.7	90.4	0.37
Line794	-0.004	-0.002	0.004	0.002	0.0	-0.2	89.6	89.6	0.00
Line795	-0.054	-0.033	0.054	0.033	0.0	-0.1	89.6	89.6	0.01
Line797	-0.005	-0.003	0.005	0.003	0.0	-0.2	89.5	89.5	0.00
Line798	-0.010	-0.006	0.010	0.006	0.0	-0.2	89.5	89.5	0.01
Line799	-0.019	-0.012	0.019	0.011	0.0	-0.2	89.5	89.5	0.01
Line802	-0.017	-0.010	0.017	0.010	0.0	-0.4	89.4	89.5	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
Line804	-0.010	-0.006	0.010	0.006	0.0	-0.7	89.4	89.4	0.02
Line805	-0.015	-0.008	0.015	0.008	0.0	-0.7	89.4	89.4	0.03
Line806	-0.022	-0.012	0.022	0.012	0.0	-0.4	89.4	89.4	0.03
Line807	-0.026	-0.014	0.026	0.014	0.0	-0.3	89.4	89.5	0.03
Line808	-0.043	-0.024	0.043	0.024	0.0	0.0	89.5	89.5	0.00
Line809	-0.053	-0.031	0.053	0.030	0.0	-0.3	89.5	89.5	0.03
Line810	-0.073	-0.042	0.073	0.041	0.0	0.0	89.5	89.5	0.01
Line811	-0.083	-0.048	0.083	0.048	0.0	-0.1	89.5	89.5	0.02
Line812	-0.087	-0.050	0.087	0.050	0.0	-0.2	89.5	89.6	0.03
Line813	-0.141	-0.083	0.141	0.083	0.0	-0.1	89.6	89.6	0.03
Line814	-0.141	-0.083	0.141	0.083	0.0	0.0	89.6	89.6	0.01
Line815	-0.162	-0.096	0.162	0.096	0.0	-0.1	89.6	89.6	0.03
Line816	-0.169	-0.100	0.170	0.100	0.3	-0.3	89.6	89.8	0.18
Line817	-0.192	-0.114	0.192	0.114	0.4	-0.3	89.8	90.0	0.21
Line818	-0.211	-0.125	0.212	0.125	0.4	-0.2	90.0	90.2	0.21
Line820	-0.214	-0.127	0.215	0.127	0.2	-0.1	90.2	90.4	0.11
Line821	0.094	0.053	-0.094	-0.053	0.1	-0.3	90.4	90.3	0.06
Line824	-0.016	-0.010	0.016	0.010	0.0	-0.2	90.3	90.3	0.01
Line825	-0.018	-0.011	0.018	0.011	0.0	-0.2	90.3	90.3	0.01
Line826	-0.021	-0.013	0.021	0.013	0.0	-0.1	90.3	90.3	0.01
Line827	0.072	0.040	-0.072	-0.040	0.0	-0.3	90.3	90.3	0.05
Line828	0.072	0.040	-0.072	-0.041	0.0	-0.1	90.3	90.2	0.02
Line829	0.058	0.032	-0.058	-0.032	0.0	0.0	90.2	90.2	0.00
Line830	-0.011	-0.007	0.011	0.006	0.0	-0.4	90.2	90.2	0.01
Line831	-0.009	-0.005	0.009	0.005	0.0	-0.2	90.2	90.2	0.00
Line833	-0.002	-0.002	0.002	0.001	0.0	-0.7	90.2	90.2	0.01
Line834	-0.008	-0.005	0.008	0.005	0.0	-0.1	90.2	90.2	0.00
Line835	-0.010	-0.006	0.010	0.006	0.0	-0.2	90.2	90.2	0.00
Line836	-0.018	-0.011	0.018	0.011	0.0	-0.1	90.2	90.2	0.00
Line837	-0.021	-0.012	0.021	0.011	0.0	-0.5	90.2	90.2	0.02
Line838	-0.029	-0.016	0.029	0.016	0.0	-0.1	90.2	90.2	0.01
Line839	0.018	0.010	-0.018	-0.010	0.0	-0.1	90.2	90.2	0.00
Line841	-0.003	-0.002	0.003	0.002	0.0	-0.2	90.2	90.2	0.00
Line842	0.015	0.008	-0.015	-0.008	0.0	-0.2	90.2	90.2	0.01
Line844	-0.004	-0.002	0.004	0.002	0.0	-0.3	90.2	90.2	0.00
Line846	-0.004	-0.002	0.004	0.002	0.0	-0.1	90.2	90.2	0.00
Line847	-0.008	-0.004	0.008	0.004	0.0	-0.2	90.2	90.2	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
Line848	-0.014	-0.008	0.014	0.008	0.0	-0.1	90.2	90.2	0.00
Line849	0.001	0.001	-0.001	-0.001	0.0	-0.3	90.2	90.2	0.00
					3642.6	8500.1			

Alert Summary Report

	% Alert Settings	
	Critical	**Marginal**
Loading		
Bus	110.0	90.0
Cable	110.0	90.0
Reactor	100.0	95.0
Line	110.0	90.0
Transformer	110.0	90.0
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
11KV	Bus	Under Voltage	11.000	kV	8.996	81.8	3-Phase
11kv Pelrithang	Bus	Under Voltage	11.000	kV	9.22	83.8	3-Phase
33/11KV PELRITHANG SS	Transformer	Overload	2.500	MVA	3.03	121.3	3-Phase
33kv	Bus	Under Voltage	33.000	kV	29.43	89.2	3-Phase
66/11KV T	Transformer	Overload	10.000	MVA	17.58	175.8	3-Phase
Bus100	Bus	Under Voltage	11.000	kV	8.58	78.0	3-Phase
Bus101	Bus	Under Voltage	11.000	kV	8.58	78.0	3-Phase
Bus102	Bus	Under Voltage	11.000	kV	8.47	77.0	3-Phase
Bus103	Bus	Under Voltage	11.000	kV	8.47	77.0	3-Phase
Bus104	Bus	Under Voltage	11.000	kV	8.24	74.9	3-Phase
Bus105	Bus	Under Voltage	11.000	kV	8.23	74.8	3-Phase
Bus106	Bus	Under Voltage	11.000	kV	8.22	74.8	3-Phase
Bus108	Bus	Under Voltage	11.000	kV	8.22	74.7	3-Phase
Bus11	Bus	Under Voltage	11.000	kV	8.99	81.7	3-Phase
Bus110	Bus	Under Voltage	11.000	kV	8.22	74.7	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus111	Bus	Under Voltage	11.000	kV	8.215	74.7	3-Phase
Bus112	Bus	Under Voltage	11.000	kV	8.14	74.0	3-Phase
Bus113	Bus	Under Voltage	11.000	kV	8.11	73.7	3-Phase
Bus114	Bus	Under Voltage	11.000	kV	8.12	73.8	3-Phase
Bus116	Bus	Under Voltage	11.000	kV	8.10	73.6	3-Phase
Bus118	Bus	Under Voltage	11.000	kV	8.10	73.6	3-Phase
Bus119	Bus	Under Voltage	11.000	kV	8.43	76.6	3-Phase
Bus12	Bus	Under Voltage	11.000	kV	8.99	81.7	3-Phase
Bus120	Bus	Under Voltage	11.000	kV	8.05	73.2	3-Phase
Bus122	Bus	Under Voltage	11.000	kV	8.03	73.0	3-Phase
Bus123	Bus	Under Voltage	11.000	kV	8.02	72.9	3-Phase
Bus124	Bus	Under Voltage	11.000	kV	8.42	76.5	3-Phase
Bus125	Bus	Under Voltage	11.000	kV	7.99	72.6	3-Phase
Bus127	Bus	Under Voltage	11.000	kV	7.95	72.3	3-Phase
Bus128	Bus	Under Voltage	11.000	kV	8.40	76.4	3-Phase
Bus129	Bus	Under Voltage	11.000	kV	7.95	72.3	3-Phase
Bus13	Bus	Under Voltage	11.000	kV	8.97	81.5	3-Phase
Bus131	Bus	Under Voltage	11.000	kV	7.95	72.2	3-Phase
Bus132	Bus	Under Voltage	11.000	kV	7.94	72.2	3-Phase
Bus134	Bus	Under Voltage	11.000	kV	7.94	72.1	3-Phase
Bus135	Bus	Under Voltage	11.000	kV	7.94	72.1	3-Phase
Bus137	Bus	Under Voltage	11.000	kV	7.87	71.6	3-Phase
Bus138	Bus	Under Voltage	11.000	kV	7.87	71.6	3-Phase
Bus14	Bus	Under Voltage	11.000	kV	8.96	81.5	3-Phase
Bus140	Bus	Under Voltage	11.000	kV	7.82	71.1	3-Phase
Bus141	Bus	Under Voltage	11.000	kV	7.82	71.1	3-Phase
Bus147	Bus	Under Voltage	11.000	kV	7.78	70.7	3-Phase
Bus15	Bus	Under Voltage	11.000	kV	8.96	81.4	3-Phase
Bus150	Bus	Under Voltage	11.000	kV	7.78	70.7	3-Phase
Bus152	Bus	Under Voltage	11.000	kV	7.78	70.7	3-Phase
Bus154	Bus	Under Voltage	11.000	kV	7.77	70.7	3-Phase
Bus16	Bus	Under Voltage	11.000	kV	8.96	81.4	3-Phase
Bus161	Bus	Under Voltage	11.000	kV	7.79	70.8	3-Phase
Bus163	Bus	Under Voltage	11.000	kV	7.78	70.8	3-Phase
Bus164	Bus	Under Voltage	11.000	kV	7.78	70.7	3-Phase
Bus165	Bus	Under Voltage	11.000	kV	7.78	70.7	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus168	Bus	Under Voltage	11.000	kV	7.776	70.7	3-Phase
Bus169	Bus	Under Voltage	11.000	kV	7.78	70.7	3-Phase
Bus17	Bus	Under Voltage	11.000	kV	8.94	81.3	3-Phase
Bus171	Bus	Under Voltage	11.000	kV	7.69	69.9	3-Phase
Bus173	Bus	Under Voltage	11.000	kV	7.68	69.8	3-Phase
Bus175	Bus	Under Voltage	11.000	kV	7.67	69.7	3-Phase
Bus177	Bus	Under Voltage	11.000	kV	7.67	69.7	3-Phase
Bus179	Bus	Under Voltage	11.000	kV	7.67	69.7	3-Phase
Bus18	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus181	Bus	Under Voltage	11.000	kV	7.66	69.6	3-Phase
Bus183	Bus	Under Voltage	11.000	kV	7.65	69.5	3-Phase
Bus184	Bus	Under Voltage	11.000	kV	7.65	69.5	3-Phase
Bus185	Bus	Under Voltage	11.000	kV	7.65	69.5	3-Phase
Bus186	Bus	Under Voltage	11.000	kV	7.65	69.5	3-Phase
Bus188	Bus	Under Voltage	11.000	kV	7.68	69.8	3-Phase
Bus189	Bus	Under Voltage	11.000	kV	7.67	69.7	3-Phase
Bus19	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus191	Bus	Under Voltage	11.000	kV	7.62	69.3	3-Phase
Bus20	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus21	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus22	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus23	Bus	Under Voltage	11.000	kV	8.54	77.6	3-Phase
Bus24	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus25	Bus	Under Voltage	11.000	kV	8.93	81.1	3-Phase
Bus26	Bus	Under Voltage	11.000	kV	8.93	81.1	3-Phase
Bus27	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus28	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus29	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus292	Bus	Under Voltage	11.000	kV	4.84	44.0	3-Phase
Bus297	Bus	Under Voltage	11.000	kV	8.87	80.6	3-Phase
Bus3	Bus	Under Voltage	11.000	kV	9.04	82.2	3-Phase
Bus30	Bus	Under Voltage	11.000	kV	9.00	81.8	3-Phase
Bus305	Bus	Under Voltage	11.000	kV	5.25	47.7	3-Phase
Bus31	Bus	Under Voltage	11.000	kV	8.88	80.8	3-Phase
Bus311	Bus	Under Voltage	11.000	kV	8.86	80.5	3-Phase
Bus312	Bus	Under Voltage	11.000	kV	5.13	46.7	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus32	Bus	Under Voltage	11.000	kV	8.858	80.5	3-Phase
Bus33	Bus	Under Voltage	11.000	kV	8.86	80.5	3-Phase
Bus34	Bus	Under Voltage	11.000	kV	8.49	77.2	3-Phase
Bus35	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus352	Bus	Under Voltage	11.000	kV	8.99	81.7	3-Phase
Bus354	Bus	Under Voltage	11.000	kV	5.24	47.6	3-Phase
Bus355	Bus	Under Voltage	11.000	kV	5.16	46.9	3-Phase
Bus356	Bus	Under Voltage	11.000	kV	5.16	46.9	3-Phase
Bus358	Bus	Under Voltage	11.000	kV	5.16	46.9	3-Phase
Bus359	Bus	Under Voltage	11.000	kV	5.15	46.8	3-Phase
Bus36	Bus	Under Voltage	11.000	kV	8.84	80.3	3-Phase
Bus360	Bus	Under Voltage	11.000	kV	5.15	46.8	3-Phase
Bus362	Bus	Under Voltage	11.000	kV	5.16	46.9	3-Phase
Bus364	Bus	Under Voltage	11.000	kV	5.14	46.7	3-Phase
Bus366	Bus	Under Voltage	11.000	kV	5.09	46.3	3-Phase
Bus367	Bus	Under Voltage	11.000	kV	5.05	45.9	3-Phase
Bus368	Bus	Under Voltage	11.000	kV	5.05	45.9	3-Phase
Bus37	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus370	Bus	Under Voltage	11.000	kV	5.03	45.7	3-Phase
Bus371	Bus	Under Voltage	11.000	kV	5.03	45.7	3-Phase
Bus373	Bus	Under Voltage	11.000	kV	5.00	45.4	3-Phase
Bus374	Bus	Under Voltage	11.000	kV	4.97	45.2	3-Phase
Bus38	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus382	Bus	Under Voltage	11.000	kV	4.97	45.2	3-Phase
Bus383	Bus	Under Voltage	11.000	kV	4.97	45.1	3-Phase
Bus384	Bus	Under Voltage	11.000	kV	4.91	44.7	3-Phase
Bus386	Bus	Under Voltage	11.000	kV	4.91	44.6	3-Phase
Bus388	Bus	Under Voltage	11.000	kV	4.91	44.6	3-Phase
Bus39	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus390	Bus	Under Voltage	11.000	kV	4.88	44.4	3-Phase
Bus391	Bus	Under Voltage	11.000	kV	4.91	44.6	3-Phase
Bus393	Bus	Under Voltage	11.000	kV	4.88	44.3	3-Phase
Bus395	Bus	Under Voltage	11.000	kV	4.88	44.3	3-Phase
Bus396	Bus	Under Voltage	11.000	kV	4.87	44.3	3-Phase
Bus398	Bus	Under Voltage	11.000	kV	4.86	44.2	3-Phase
Bus399	Bus	Under Voltage	11.000	kV	4.86	44.2	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus4	Bus	Under Voltage	11.000	kV	8.819	80.2	3-Phase
Bus40	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus401	Bus	Under Voltage	11.000	kV	4.85	44.1	3-Phase
Bus402	Bus	Under Voltage	11.000	kV	4.85	44.1	3-Phase
Bus403	Bus	Under Voltage	11.000	kV	4.85	44.1	3-Phase
Bus404	Bus	Under Voltage	11.000	kV	4.85	44.1	3-Phase
Bus406	Bus	Under Voltage	11.000	kV	4.85	44.0	3-Phase
Bus409	Bus	Under Voltage	11.000	kV	4.84	44.0	3-Phase
Bus41	Bus	Under Voltage	11.000	kV	8.85	80.4	3-Phase
Bus410	Bus	Under Voltage	11.000	kV	4.84	44.0	3-Phase
Bus411	Bus	Under Voltage	11.000	kV	4.84	44.0	3-Phase
Bus412	Bus	Under Voltage	11.000	kV	4.84	44.0	3-Phase
Bus414	Bus	Under Voltage	11.000	kV	4.84	44.0	3-Phase
Bus415	Bus	Under Voltage	11.000	kV	4.83	43.9	3-Phase
Bus416	Bus	Under Voltage	11.000	kV	4.83	43.9	3-Phase
Bus418	Bus	Under Voltage	11.000	kV	4.83	43.9	3-Phase
Bus419	Bus	Under Voltage	11.000	kV	4.83	43.9	3-Phase
Bus42	Bus	Under Voltage	11.000	kV	8.85	80.4	3-Phase
Bus43	Bus	Under Voltage	11.000	kV	9.00	81.8	3-Phase
Bus430	Bus	Under Voltage	33.000	kV	29.59	89.7	3-Phase
Bus431	Bus	Under Voltage	33.000	kV	29.59	89.7	3-Phase
Bus432	Bus	Under Voltage	33.000	kV	29.49	89.4	3-Phase
Bus433	Bus	Under Voltage	33.000	kV	29.48	89.3	3-Phase
Bus434	Bus	Under Voltage	33.000	kV	29.49	89.4	3-Phase
Bus437	Bus	Under Voltage	11.000	kV	9.22	83.8	3-Phase
Bus438	Bus	Under Voltage	11.000	kV	9.18	83.4	3-Phase
Bus439	Bus	Under Voltage	11.000	kV	9.22	83.8	3-Phase
Bus44	Bus	Under Voltage	11.000	kV	8.97	81.6	3-Phase
Bus441	Bus	Under Voltage	11.000	kV	9.21	83.8	3-Phase
Bus443	Bus	Under Voltage	11.000	kV	9.21	83.7	3-Phase
Bus444	Bus	Under Voltage	11.000	kV	9.21	83.7	3-Phase
Bus446	Bus	Under Voltage	11.000	kV	9.20	83.6	3-Phase
Bus448	Bus	Under Voltage	11.000	kV	9.19	83.5	3-Phase
Bus449	Bus	Under Voltage	11.000	kV	9.19	83.5	3-Phase
Bus450	Bus	Under Voltage	11.000	kV	9.19	83.5	3-Phase
Bus451	Bus	Under Voltage	11.000	kV	9.22	83.8	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus453	Bus	Under Voltage	11.000	kV	8.999	81.8	3-Phase
Bus454	Bus	Under Voltage	11.000	kV	8.97	81.5	3-Phase
Bus455	Bus	Under Voltage	11.000	kV	8.96	81.5	3-Phase
Bus457	Bus	Under Voltage	11.000	kV	8.95	81.3	3-Phase
Bus459	Bus	Under Voltage	11.000	kV	8.95	81.3	3-Phase
Bus461	Bus	Under Voltage	11.000	kV	8.90	80.9	3-Phase
Bus463	Bus	Under Voltage	11.000	kV	8.90	80.9	3-Phase
Bus465	Bus	Under Voltage	11.000	kV	8.86	80.6	3-Phase
Bus47	Bus	Under Voltage	11.000	kV	8.47	77.0	3-Phase
Bus470	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus472	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus474	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus475	Bus	Under Voltage	11.000	kV	8.84	80.3	3-Phase
Bus477	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus479	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus48	Bus	Under Voltage	11.000	kV	8.97	81.6	3-Phase
Bus480	Bus	Under Voltage	11.000	kV	8.84	80.3	3-Phase
Bus482	Bus	Under Voltage	11.000	kV	8.84	80.3	3-Phase
Bus486	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus49	Bus	Under Voltage	11.000	kV	8.94	81.3	3-Phase
Bus490	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus494	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus495	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus498	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus499	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus50	Bus	Under Voltage	11.000	kV	8.94	81.3	3-Phase
Bus501	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus503	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus505	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus507	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus508	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus509	Bus	Under Voltage	11.000	kV	5.28	48.0	3-Phase
Bus51	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus510	Bus	Under Voltage	11.000	kV	8.83	80.2	3-Phase
Bus512	Bus	Under Voltage	11.000	kV	8.83	80.2	3-Phase
Bus514	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus515	Bus	Under Voltage	11.000	kV	8.824	80.2	3-Phase
Bus517	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus519	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus52	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus521	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus523	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus525	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus527	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus529	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus53	Bus	Under Voltage	11.000	kV	8.93	81.1	3-Phase
Bus531	Bus	Under Voltage	11.000	kV	8.91	81.0	3-Phase
Bus532	Bus	Under Voltage	11.000	kV	8.91	81.0	3-Phase
Bus534	Bus	Under Voltage	11.000	kV	8.86	80.5	3-Phase
Bus536	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus538	Bus	Under Voltage	11.000	kV	8.77	79.7	3-Phase
Bus54	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus540	Bus	Under Voltage	11.000	kV	8.76	79.6	3-Phase
Bus542	Bus	Under Voltage	11.000	kV	8.76	79.6	3-Phase
Bus543	Bus	Under Voltage	11.000	kV	8.69	79.0	3-Phase
Bus545	Bus	Under Voltage	11.000	kV	8.66	78.8	3-Phase
Bus547	Bus	Under Voltage	11.000	kV	8.66	78.7	3-Phase
Bus548	Bus	Under Voltage	11.000	kV	8.66	78.7	3-Phase
Bus55	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus550	Bus	Under Voltage	11.000	kV	8.64	78.6	3-Phase
Bus552	Bus	Under Voltage	11.000	kV	8.64	78.6	3-Phase
Bus554	Bus	Under Voltage	11.000	kV	8.60	78.2	3-Phase
Bus555	Bus	Under Voltage	11.000	kV	8.63	78.5	3-Phase
Bus557	Bus	Under Voltage	11.000	kV	8.61	78.2	3-Phase
Bus558	Bus	Under Voltage	11.000	kV	8.60	78.2	3-Phase
Bus56	Bus	Under Voltage	11.000	kV	8.91	81.0	3-Phase
Bus560	Bus	Under Voltage	11.000	kV	8.60	78.2	3-Phase
Bus562	Bus	Under Voltage	11.000	kV	8.60	78.2	3-Phase
Bus563	Bus	Under Voltage	11.000	kV	8.59	78.1	3-Phase
Bus565	Bus	Under Voltage	11.000	kV	8.59	78.1	3-Phase
Bus567	Bus	Under Voltage	11.000	kV	8.59	78.1	3-Phase
Bus568	Bus	Under Voltage	11.000	kV	8.59	78.1	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus57	Bus	Under Voltage	11.000	kV	8.913	81.0	3-Phase
Bus570	Bus	Under Voltage	11.000	kV	8.59	78.1	3-Phase
Bus572	Bus	Under Voltage	11.000	kV	8.58	78.0	3-Phase
Bus573	Bus	Under Voltage	11.000	kV	8.58	78.0	3-Phase
Bus575	Bus	Under Voltage	11.000	kV	8.58	78.0	3-Phase
Bus576	Bus	Under Voltage	11.000	kV	8.58	78.0	3-Phase
Bus577	Bus	Under Voltage	11.000	kV	8.58	78.0	3-Phase
Bus578	Bus	Under Voltage	11.000	kV	8.58	78.0	3-Phase
Bus58	Bus	Under Voltage	11.000	kV	8.91	81.0	3-Phase
Bus580	Bus	Under Voltage	11.000	kV	9.22	83.8	3-Phase
Bus581	Bus	Under Voltage	11.000	kV	9.14	83.1	3-Phase
Bus583	Bus	Under Voltage	11.000	kV	8.85	80.5	3-Phase
Bus584	Bus	Under Voltage	11.000	kV	8.85	80.4	3-Phase
Bus585	Bus	Under Voltage	11.000	kV	8.71	79.2	3-Phase
Bus586	Bus	Under Voltage	11.000	kV	8.65	78.6	3-Phase
Bus587	Bus	Under Voltage	11.000	kV	8.54	77.6	3-Phase
Bus588	Bus	Under Voltage	11.000	kV	8.49	77.2	3-Phase
Bus589	Bus	Under Voltage	11.000	kV	8.46	76.9	3-Phase
Bus59	Bus	Under Voltage	11.000	kV	8.91	81.0	3-Phase
Bus590	Bus	Under Voltage	11.000	kV	8.43	76.6	3-Phase
Bus591	Bus	Under Voltage	11.000	kV	8.41	76.5	3-Phase
Bus592	Bus	Under Voltage	11.000	kV	8.42	76.5	3-Phase
Bus593	Bus	Under Voltage	11.000	kV	8.40	76.3	3-Phase
Bus594	Bus	Under Voltage	11.000	kV	8.39	76.2	3-Phase
Bus6	Bus	Under Voltage	11.000	kV	8.65	78.6	3-Phase
Bus60	Bus	Under Voltage	11.000	kV	8.91	81.0	3-Phase
Bus61	Bus	Under Voltage	11.000	kV	8.43	76.7	3-Phase
Bus62	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus64	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus644	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus65	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus667	Bus	Under Voltage	11.000	kV	9.85	89.6	3-Phase
Bus668	Bus	Under Voltage	11.000	kV	9.85	89.6	3-Phase
Bus67	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus670	Bus	Under Voltage	11.000	kV	9.84	89.5	3-Phase
Bus671	Bus	Under Voltage	11.000	kV	9.84	89.5	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus672	Bus	Under Voltage	11.000	kV	9.844	89.5	3-Phase
Bus675	Bus	Under Voltage	11.000	kV	9.84	89.4	3-Phase
Bus677	Bus	Under Voltage	11.000	kV	9.83	89.4	3-Phase
Bus678	Bus	Under Voltage	11.000	kV	9.83	89.4	3-Phase
Bus679	Bus	Under Voltage	11.000	kV	9.84	89.4	3-Phase
Bus68	Bus	Under Voltage	11.000	kV	8.39	76.3	3-Phase
Bus680	Bus	Under Voltage	11.000	kV	9.84	89.4	3-Phase
Bus681	Bus	Under Voltage	11.000	kV	9.84	89.5	3-Phase
Bus682	Bus	Under Voltage	11.000	kV	9.84	89.5	3-Phase
Bus683	Bus	Under Voltage	11.000	kV	9.85	89.5	3-Phase
Bus684	Bus	Under Voltage	11.000	kV	9.85	89.5	3-Phase
Bus685	Bus	Under Voltage	11.000	kV	9.85	89.5	3-Phase
Bus686	Bus	Under Voltage	11.000	kV	9.85	89.6	3-Phase
Bus687	Bus	Under Voltage	11.000	kV	9.86	89.6	3-Phase
Bus688	Bus	Under Voltage	11.000	kV	9.86	89.6	3-Phase
Bus689	Bus	Under Voltage	11.000	kV	9.86	89.6	3-Phase
Bus69	Bus	Under Voltage	11.000	kV	8.85	80.4	3-Phase
Bus690	Bus	Under Voltage	11.000	kV	9.88	89.8	3-Phase
Bus7	Bus	Under Voltage	11.000	kV	8.99	81.8	3-Phase
Bus70	Bus	Under Voltage	11.000	kV	8.84	80.3	3-Phase
Bus71	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus72	Bus	Under Voltage	11.000	kV	8.84	80.3	3-Phase
Bus73	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus74	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus76	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus77	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus78	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus79	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus8	Bus	Under Voltage	11.000	kV	8.99	81.7	3-Phase
Bus80	Bus	Under Voltage	11.000	kV	9.14	83.1	3-Phase
Bus81	Bus	Under Voltage	11.000	kV	9.14	83.1	3-Phase
Bus82	Bus	Under Voltage	11.000	kV	9.15	83.2	3-Phase
Bus83	Bus	Under Voltage	11.000	kV	9.15	83.2	3-Phase
Bus84	Bus	Under Voltage	11.000	kV	9.16	83.3	3-Phase
Bus85	Bus	Under Voltage	11.000	kV	9.16	83.3	3-Phase
Bus86	Bus	Under Voltage	11.000	kV	8.99	81.8	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus87	Bus	Under Voltage	11.000	kV	8.861	80.6	3-Phase
Bus88	Bus	Under Voltage	11.000	kV	8.79	79.9	3-Phase
Bus9	Bus	Under Voltage	11.000	kV	8.71	79.2	3-Phase
Bus93	Bus	Under Voltage	11.000	kV	8.71	79.1	3-Phase
Bus94	Bus	Under Voltage	11.000	kV	8.70	79.1	3-Phase
Bus95	Bus	Under Voltage	11.000	kV	8.69	79.0	3-Phase
Bus96	Bus	Under Voltage	11.000	kV	8.69	79.0	3-Phase
Bus97	Bus	Under Voltage	11.000	kV	8.68	78.9	3-Phase
Bus98	Bus	Under Voltage	11.000	kV	8.68	78.9	3-Phase
Bus99	Bus	Under Voltage	11.000	kV	8.68	78.9	3-Phase
Cable46	Cable	Overload	338.032	Amp	551.17	163.1	3-Phase

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
11kV	Bus	Under Voltage	11.000	kV	10.312	93.7	3-Phase
33KV	Bus	Under Voltage	33.000	kV	29.80	90.3	3-Phase
66KV	Bus	Under Voltage	66.000	kV	61.80	93.6	3-Phase
66kV	Bus	Under Voltage	66.000	kV	61.80	93.6	3-Phase
Bus109	Bus	Under Voltage	11.000	kV	10.31	93.7	3-Phase
Bus143	Bus	Under Voltage	11.000	kV	10.02	91.0	3-Phase
Bus156	Bus	Under Voltage	11.000	kV	10.01	91.0	3-Phase
Bus157	Bus	Under Voltage	11.000	kV	10.01	91.0	3-Phase
Bus234	Bus	Under Voltage	11.000	kV	10.31	93.7	3-Phase
Bus238	Bus	Under Voltage	11.000	kV	10.31	93.7	3-Phase
Bus239	Bus	Under Voltage	11.000	kV	10.31	93.7	3-Phase
Bus240	Bus	Under Voltage	11.000	kV	10.29	93.5	3-Phase
Bus241	Bus	Under Voltage	11.000	kV	10.31	93.7	3-Phase
Bus242	Bus	Under Voltage	11.000	kV	10.24	93.1	3-Phase
Bus246	Bus	Under Voltage	11.000	kV	10.23	93.0	3-Phase
Bus248	Bus	Under Voltage	11.000	kV	10.21	92.8	3-Phase
Bus251	Bus	Under Voltage	11.000	kV	10.09	91.7	3-Phase
Bus253	Bus	Under Voltage	11.000	kV	10.01	91.0	3-Phase
Bus255	Bus	Under Voltage	11.000	kV	10.31	93.7	3-Phase
Bus257	Bus	Under Voltage	11.000	kV	10.19	92.7	3-Phase
Bus259	Bus	Under Voltage	11.000	kV	10.08	91.6	3-Phase
Bus262	Bus	Under Voltage	11.000	kV	10.00	90.9	3-Phase

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus263	Bus	Under Voltage	11.000	kV	9.992	90.8	3-Phase
Bus268	Bus	Under Voltage	11.000	kV	10.02	91.1	3-Phase
Bus270	Bus	Under Voltage	11.000	kV	10.03	91.2	3-Phase
Bus271	Bus	Under Voltage	11.000	kV	9.99	90.8	3-Phase
Bus272	Bus	Under Voltage	11.000	kV	9.99	90.8	3-Phase
Bus275	Bus	Under Voltage	11.000	kV	10.08	91.6	3-Phase
Bus278	Bus	Under Voltage	11.000	kV	9.98	90.8	3-Phase
Bus280	Bus	Under Voltage	11.000	kV	9.99	90.8	3-Phase
Bus284	Bus	Under Voltage	11.000	kV	9.98	90.7	3-Phase
Bus295	Bus	Under Voltage	11.000	kV	10.05	91.3	3-Phase
Bus322	Bus	Under Voltage	11.000	kV	10.03	91.2	3-Phase
Bus420	Bus	Under Voltage	11.000	kV	10.05	91.3	3-Phase
Bus428	Bus	Under Voltage	11.000	kV	10.05	91.3	3-Phase
Bus429	Bus	Under Voltage	33.000	kV	29.79	90.3	3-Phase
Bus436	Bus	Under Voltage	11.000	kV	10.05	91.3	3-Phase
Bus5	Bus	Under Voltage	11.000	kV	10.30	93.6	3-Phase
Bus626	Bus	Under Voltage	11.000	kV	10.29	93.6	3-Phase
Bus627	Bus	Under Voltage	11.000	kV	10.29	93.5	3-Phase
Bus628	Bus	Under Voltage	11.000	kV	10.19	92.7	3-Phase
Bus629	Bus	Under Voltage	11.000	kV	10.03	91.2	3-Phase
Bus630	Bus	Under Voltage	11.000	kV	9.99	90.8	3-Phase
Bus631	Bus	Under Voltage	11.000	kV	9.99	90.8	3-Phase
Bus632	Bus	Under Voltage	11.000	kV	9.98	90.8	3-Phase
Bus633	Bus	Under Voltage	11.000	kV	10.03	91.2	3-Phase
Bus634	Bus	Under Voltage	11.000	kV	10.03	91.2	3-Phase
Bus635	Bus	Under Voltage	11.000	kV	10.03	91.2	3-Phase
Bus636	Bus	Under Voltage	11.000	kV	10.01	91.0	3-Phase
Bus637	Bus	Under Voltage	11.000	kV	10.01	91.0	3-Phase
Bus638	Bus	Under Voltage	11.000	kV	10.01	91.0	3-Phase
Bus639	Bus	Under Voltage	11.000	kV	10.01	91.0	3-Phase
Bus640	Bus	Under Voltage	11.000	kV	9.99	90.8	3-Phase
Bus641	Bus	Under Voltage	11.000	kV	9.99	90.8	3-Phase
Bus642	Bus	Under Voltage	11.000	kV	9.93	90.3	3-Phase
Bus643	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus645	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus646	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus648	Bus	Under Voltage	11.000	kV	9.902	90.0	3-Phase
Bus649	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus651	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus652	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus654	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus655	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus656	Bus	Under Voltage	11.000	kV	9.91	90.0	3-Phase
Bus657	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
Bus658	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
Bus659	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
Bus660	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus661	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus662	Bus	Under Voltage	11.000	kV	9.93	90.3	3-Phase
Bus663	Bus	Under Voltage	11.000	kV	9.94	90.3	3-Phase
Bus664	Bus	Under Voltage	11.000	kV	9.96	90.5	3-Phase
Bus665	Bus	Under Voltage	11.000	kV	9.98	90.7	3-Phase
Bus691	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus693	Bus	Under Voltage	11.000	kV	9.93	90.2	3-Phase
Bus694	Bus	Under Voltage	11.000	kV	9.94	90.4	3-Phase
Bus697	Bus	Under Voltage	11.000	kV	9.93	90.3	3-Phase
Bus698	Bus	Under Voltage	11.000	kV	9.93	90.3	3-Phase
Bus699	Bus	Under Voltage	11.000	kV	9.93	90.3	3-Phase
Bus700	Bus	Under Voltage	11.000	kV	9.93	90.3	3-Phase
Bus701	Bus	Under Voltage	11.000	kV	9.93	90.3	3-Phase
Bus702	Bus	Under Voltage	11.000	kV	9.93	90.2	3-Phase
Bus703	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus704	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus706	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus707	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus708	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus709	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus710	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus711	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus712	Bus	Under Voltage	11.000	kV	9.93	90.2	3-Phase
Bus714	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus715	Bus	Under Voltage	11.000	kV	9.93	90.2	3-Phase

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus717	Bus	Under Voltage	11.000	kV	9.923	90.2	3-Phase
Bus719	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus720	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus721	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus722	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus723	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus89	Bus	Under Voltage	11.000	kV	10.15	92.2	3-Phase
Bus90	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Bus91	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Bus92	Bus	Under Voltage	11.000	kV	10.09	91.7	3-Phase

SUMMARY OF TOTAL GENERATION , LOADING & DEMAND

	MW	Mvar	MVA	% PF
Source (Swing Buses):	18.687	17.824	25.825	72.36 Lagging
Source (Non-Swing Buses):	0.000	0.000	0.000	
Total Demand:	18.687	17.824	25.825	72.36 Lagging
Total Motor Load:	6.727	4.169	7.914	85.00 Lagging
Total Static Load:	8.318	5.155	9.785	85.00 Lagging
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	3.643	8.500		
System Mismatch:	0.000	0.000		

Number of Iterations: 6

Alert Summary Report

% Alert Settings

	Critical	Marginal
Loading		
Bus	110.0	90.0
Cable	110.0	90.0
Reactor	100.0	95.0
Line	110.0	90.0
Transformer	110.0	90.0
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
11KV	Bus	Under Voltage	11.000	kV	8.996	81.8	3-Phase
11kv Pelrithang	Bus	Under Voltage	11.000	kV	9.22	83.8	3-Phase
33/11KV PELRITHANG SS	Transformer	Overload	2.500	MVA	3.03	121.3	3-Phase
33kv	Bus	Under Voltage	33.000	kV	29.43	89.2	3-Phase
66/11KV T	Transformer	Overload	10.000	MVA	17.58	175.8	3-Phase
Bus100	Bus	Under Voltage	11.000	kV	8.58	78.0	3-Phase
Bus101	Bus	Under Voltage	11.000	kV	8.58	78.0	3-Phase
Bus102	Bus	Under Voltage	11.000	kV	8.47	77.0	3-Phase
Bus103	Bus	Under Voltage	11.000	kV	8.47	77.0	3-Phase
Bus104	Bus	Under Voltage	11.000	kV	8.24	74.9	3-Phase
Bus105	Bus	Under Voltage	11.000	kV	8.23	74.8	3-Phase
Bus106	Bus	Under Voltage	11.000	kV	8.22	74.8	3-Phase
Bus108	Bus	Under Voltage	11.000	kV	8.22	74.7	3-Phase
Bus11	Bus	Under Voltage	11.000	kV	8.99	81.7	3-Phase
Bus110	Bus	Under Voltage	11.000	kV	8.22	74.7	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus111	Bus	Under Voltage	11.000	kV	8.215	74.7	3-Phase
Bus112	Bus	Under Voltage	11.000	kV	8.14	74.0	3-Phase
Bus113	Bus	Under Voltage	11.000	kV	8.11	73.7	3-Phase
Bus114	Bus	Under Voltage	11.000	kV	8.12	73.8	3-Phase
Bus116	Bus	Under Voltage	11.000	kV	8.10	73.6	3-Phase
Bus118	Bus	Under Voltage	11.000	kV	8.10	73.6	3-Phase
Bus119	Bus	Under Voltage	11.000	kV	8.43	76.6	3-Phase
Bus12	Bus	Under Voltage	11.000	kV	8.99	81.7	3-Phase
Bus120	Bus	Under Voltage	11.000	kV	8.05	73.2	3-Phase
Bus122	Bus	Under Voltage	11.000	kV	8.03	73.0	3-Phase
Bus123	Bus	Under Voltage	11.000	kV	8.02	72.9	3-Phase
Bus124	Bus	Under Voltage	11.000	kV	8.42	76.5	3-Phase
Bus125	Bus	Under Voltage	11.000	kV	7.99	72.6	3-Phase
Bus127	Bus	Under Voltage	11.000	kV	7.95	72.3	3-Phase
Bus128	Bus	Under Voltage	11.000	kV	8.40	76.4	3-Phase
Bus129	Bus	Under Voltage	11.000	kV	7.95	72.3	3-Phase
Bus13	Bus	Under Voltage	11.000	kV	8.97	81.5	3-Phase
Bus131	Bus	Under Voltage	11.000	kV	7.95	72.2	3-Phase
Bus132	Bus	Under Voltage	11.000	kV	7.94	72.2	3-Phase
Bus134	Bus	Under Voltage	11.000	kV	7.94	72.1	3-Phase
Bus135	Bus	Under Voltage	11.000	kV	7.94	72.1	3-Phase
Bus137	Bus	Under Voltage	11.000	kV	7.87	71.6	3-Phase
Bus138	Bus	Under Voltage	11.000	kV	7.87	71.6	3-Phase
Bus14	Bus	Under Voltage	11.000	kV	8.96	81.5	3-Phase
Bus140	Bus	Under Voltage	11.000	kV	7.82	71.1	3-Phase
Bus141	Bus	Under Voltage	11.000	kV	7.82	71.1	3-Phase
Bus147	Bus	Under Voltage	11.000	kV	7.78	70.7	3-Phase
Bus15	Bus	Under Voltage	11.000	kV	8.96	81.4	3-Phase
Bus150	Bus	Under Voltage	11.000	kV	7.78	70.7	3-Phase
Bus152	Bus	Under Voltage	11.000	kV	7.78	70.7	3-Phase
Bus154	Bus	Under Voltage	11.000	kV	7.77	70.7	3-Phase
Bus16	Bus	Under Voltage	11.000	kV	8.96	81.4	3-Phase
Bus161	Bus	Under Voltage	11.000	kV	7.79	70.8	3-Phase
Bus163	Bus	Under Voltage	11.000	kV	7.78	70.8	3-Phase
Bus164	Bus	Under Voltage	11.000	kV	7.78	70.7	3-Phase
Bus165	Bus	Under Voltage	11.000	kV	7.78	70.7	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus168	Bus	Under Voltage	11.000	kV	7.776	70.7	3-Phase
Bus169	Bus	Under Voltage	11.000	kV	7.78	70.7	3-Phase
Bus17	Bus	Under Voltage	11.000	kV	8.94	81.3	3-Phase
Bus171	Bus	Under Voltage	11.000	kV	7.69	69.9	3-Phase
Bus173	Bus	Under Voltage	11.000	kV	7.68	69.8	3-Phase
Bus175	Bus	Under Voltage	11.000	kV	7.67	69.7	3-Phase
Bus177	Bus	Under Voltage	11.000	kV	7.67	69.7	3-Phase
Bus179	Bus	Under Voltage	11.000	kV	7.67	69.7	3-Phase
Bus18	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus181	Bus	Under Voltage	11.000	kV	7.66	69.6	3-Phase
Bus183	Bus	Under Voltage	11.000	kV	7.65	69.5	3-Phase
Bus184	Bus	Under Voltage	11.000	kV	7.65	69.5	3-Phase
Bus185	Bus	Under Voltage	11.000	kV	7.65	69.5	3-Phase
Bus186	Bus	Under Voltage	11.000	kV	7.65	69.5	3-Phase
Bus188	Bus	Under Voltage	11.000	kV	7.68	69.8	3-Phase
Bus189	Bus	Under Voltage	11.000	kV	7.67	69.7	3-Phase
Bus19	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus191	Bus	Under Voltage	11.000	kV	7.62	69.3	3-Phase
Bus20	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus21	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus22	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus23	Bus	Under Voltage	11.000	kV	8.54	77.6	3-Phase
Bus24	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus25	Bus	Under Voltage	11.000	kV	8.93	81.1	3-Phase
Bus26	Bus	Under Voltage	11.000	kV	8.93	81.1	3-Phase
Bus27	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus28	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus29	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus292	Bus	Under Voltage	11.000	kV	4.84	44.0	3-Phase
Bus297	Bus	Under Voltage	11.000	kV	8.87	80.6	3-Phase
Bus3	Bus	Under Voltage	11.000	kV	9.04	82.2	3-Phase
Bus30	Bus	Under Voltage	11.000	kV	9.00	81.8	3-Phase
Bus305	Bus	Under Voltage	11.000	kV	5.25	47.7	3-Phase
Bus31	Bus	Under Voltage	11.000	kV	8.88	80.8	3-Phase
Bus311	Bus	Under Voltage	11.000	kV	8.86	80.5	3-Phase
Bus312	Bus	Under Voltage	11.000	kV	5.13	46.7	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus32	Bus	Under Voltage	11.000	kV	8.858	80.5	3-Phase
Bus33	Bus	Under Voltage	11.000	kV	8.86	80.5	3-Phase
Bus34	Bus	Under Voltage	11.000	kV	8.49	77.2	3-Phase
Bus35	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus352	Bus	Under Voltage	11.000	kV	8.99	81.7	3-Phase
Bus354	Bus	Under Voltage	11.000	kV	5.24	47.6	3-Phase
Bus355	Bus	Under Voltage	11.000	kV	5.16	46.9	3-Phase
Bus356	Bus	Under Voltage	11.000	kV	5.16	46.9	3-Phase
Bus358	Bus	Under Voltage	11.000	kV	5.16	46.9	3-Phase
Bus359	Bus	Under Voltage	11.000	kV	5.15	46.8	3-Phase
Bus36	Bus	Under Voltage	11.000	kV	8.84	80.3	3-Phase
Bus360	Bus	Under Voltage	11.000	kV	5.15	46.8	3-Phase
Bus362	Bus	Under Voltage	11.000	kV	5.16	46.9	3-Phase
Bus364	Bus	Under Voltage	11.000	kV	5.14	46.7	3-Phase
Bus366	Bus	Under Voltage	11.000	kV	5.09	46.3	3-Phase
Bus367	Bus	Under Voltage	11.000	kV	5.05	45.9	3-Phase
Bus368	Bus	Under Voltage	11.000	kV	5.05	45.9	3-Phase
Bus37	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus370	Bus	Under Voltage	11.000	kV	5.03	45.7	3-Phase
Bus371	Bus	Under Voltage	11.000	kV	5.03	45.7	3-Phase
Bus373	Bus	Under Voltage	11.000	kV	5.00	45.4	3-Phase
Bus374	Bus	Under Voltage	11.000	kV	4.97	45.2	3-Phase
Bus38	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus382	Bus	Under Voltage	11.000	kV	4.97	45.2	3-Phase
Bus383	Bus	Under Voltage	11.000	kV	4.97	45.1	3-Phase
Bus384	Bus	Under Voltage	11.000	kV	4.91	44.7	3-Phase
Bus386	Bus	Under Voltage	11.000	kV	4.91	44.6	3-Phase
Bus388	Bus	Under Voltage	11.000	kV	4.91	44.6	3-Phase
Bus39	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus390	Bus	Under Voltage	11.000	kV	4.88	44.4	3-Phase
Bus391	Bus	Under Voltage	11.000	kV	4.91	44.6	3-Phase
Bus393	Bus	Under Voltage	11.000	kV	4.88	44.3	3-Phase
Bus395	Bus	Under Voltage	11.000	kV	4.88	44.3	3-Phase
Bus396	Bus	Under Voltage	11.000	kV	4.87	44.3	3-Phase
Bus398	Bus	Under Voltage	11.000	kV	4.86	44.2	3-Phase
Bus399	Bus	Under Voltage	11.000	kV	4.86	44.2	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus4	Bus	Under Voltage	11.000	kV	8.819	80.2	3-Phase
Bus40	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus401	Bus	Under Voltage	11.000	kV	4.85	44.1	3-Phase
Bus402	Bus	Under Voltage	11.000	kV	4.85	44.1	3-Phase
Bus403	Bus	Under Voltage	11.000	kV	4.85	44.1	3-Phase
Bus404	Bus	Under Voltage	11.000	kV	4.85	44.1	3-Phase
Bus406	Bus	Under Voltage	11.000	kV	4.85	44.0	3-Phase
Bus409	Bus	Under Voltage	11.000	kV	4.84	44.0	3-Phase
Bus41	Bus	Under Voltage	11.000	kV	8.85	80.4	3-Phase
Bus410	Bus	Under Voltage	11.000	kV	4.84	44.0	3-Phase
Bus411	Bus	Under Voltage	11.000	kV	4.84	44.0	3-Phase
Bus412	Bus	Under Voltage	11.000	kV	4.84	44.0	3-Phase
Bus414	Bus	Under Voltage	11.000	kV	4.84	44.0	3-Phase
Bus415	Bus	Under Voltage	11.000	kV	4.83	43.9	3-Phase
Bus416	Bus	Under Voltage	11.000	kV	4.83	43.9	3-Phase
Bus418	Bus	Under Voltage	11.000	kV	4.83	43.9	3-Phase
Bus419	Bus	Under Voltage	11.000	kV	4.83	43.9	3-Phase
Bus42	Bus	Under Voltage	11.000	kV	8.85	80.4	3-Phase
Bus43	Bus	Under Voltage	11.000	kV	9.00	81.8	3-Phase
Bus430	Bus	Under Voltage	33.000	kV	29.59	89.7	3-Phase
Bus431	Bus	Under Voltage	33.000	kV	29.59	89.7	3-Phase
Bus432	Bus	Under Voltage	33.000	kV	29.49	89.4	3-Phase
Bus433	Bus	Under Voltage	33.000	kV	29.48	89.3	3-Phase
Bus434	Bus	Under Voltage	33.000	kV	29.49	89.4	3-Phase
Bus437	Bus	Under Voltage	11.000	kV	9.22	83.8	3-Phase
Bus438	Bus	Under Voltage	11.000	kV	9.18	83.4	3-Phase
Bus439	Bus	Under Voltage	11.000	kV	9.22	83.8	3-Phase
Bus44	Bus	Under Voltage	11.000	kV	8.97	81.6	3-Phase
Bus441	Bus	Under Voltage	11.000	kV	9.21	83.8	3-Phase
Bus443	Bus	Under Voltage	11.000	kV	9.21	83.7	3-Phase
Bus444	Bus	Under Voltage	11.000	kV	9.21	83.7	3-Phase
Bus446	Bus	Under Voltage	11.000	kV	9.20	83.6	3-Phase
Bus448	Bus	Under Voltage	11.000	kV	9.19	83.5	3-Phase
Bus449	Bus	Under Voltage	11.000	kV	9.19	83.5	3-Phase
Bus450	Bus	Under Voltage	11.000	kV	9.19	83.5	3-Phase
Bus451	Bus	Under Voltage	11.000	kV	9.22	83.8	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus453	Bus	Under Voltage	11.000	kV	8.999	81.8	3-Phase
Bus454	Bus	Under Voltage	11.000	kV	8.97	81.5	3-Phase
Bus455	Bus	Under Voltage	11.000	kV	8.96	81.5	3-Phase
Bus457	Bus	Under Voltage	11.000	kV	8.95	81.3	3-Phase
Bus459	Bus	Under Voltage	11.000	kV	8.95	81.3	3-Phase
Bus461	Bus	Under Voltage	11.000	kV	8.90	80.9	3-Phase
Bus463	Bus	Under Voltage	11.000	kV	8.90	80.9	3-Phase
Bus465	Bus	Under Voltage	11.000	kV	8.86	80.6	3-Phase
Bus47	Bus	Under Voltage	11.000	kV	8.47	77.0	3-Phase
Bus470	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus472	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus474	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus475	Bus	Under Voltage	11.000	kV	8.84	80.3	3-Phase
Bus477	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus479	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus48	Bus	Under Voltage	11.000	kV	8.97	81.6	3-Phase
Bus480	Bus	Under Voltage	11.000	kV	8.84	80.3	3-Phase
Bus482	Bus	Under Voltage	11.000	kV	8.84	80.3	3-Phase
Bus486	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus49	Bus	Under Voltage	11.000	kV	8.94	81.3	3-Phase
Bus490	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus494	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus495	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus498	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus499	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus50	Bus	Under Voltage	11.000	kV	8.94	81.3	3-Phase
Bus501	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus503	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus505	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus507	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus508	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus509	Bus	Under Voltage	11.000	kV	5.28	48.0	3-Phase
Bus51	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus510	Bus	Under Voltage	11.000	kV	8.83	80.2	3-Phase
Bus512	Bus	Under Voltage	11.000	kV	8.83	80.2	3-Phase
Bus514	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus515	Bus	Under Voltage	11.000	kV	8.824	80.2	3-Phase
Bus517	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus519	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus52	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus521	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus523	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus525	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus527	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus529	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus53	Bus	Under Voltage	11.000	kV	8.93	81.1	3-Phase
Bus531	Bus	Under Voltage	11.000	kV	8.91	81.0	3-Phase
Bus532	Bus	Under Voltage	11.000	kV	8.91	81.0	3-Phase
Bus534	Bus	Under Voltage	11.000	kV	8.86	80.5	3-Phase
Bus536	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus538	Bus	Under Voltage	11.000	kV	8.77	79.7	3-Phase
Bus54	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus540	Bus	Under Voltage	11.000	kV	8.76	79.6	3-Phase
Bus542	Bus	Under Voltage	11.000	kV	8.76	79.6	3-Phase
Bus543	Bus	Under Voltage	11.000	kV	8.69	79.0	3-Phase
Bus545	Bus	Under Voltage	11.000	kV	8.66	78.8	3-Phase
Bus547	Bus	Under Voltage	11.000	kV	8.66	78.7	3-Phase
Bus548	Bus	Under Voltage	11.000	kV	8.66	78.7	3-Phase
Bus55	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus550	Bus	Under Voltage	11.000	kV	8.64	78.6	3-Phase
Bus552	Bus	Under Voltage	11.000	kV	8.64	78.6	3-Phase
Bus554	Bus	Under Voltage	11.000	kV	8.60	78.2	3-Phase
Bus555	Bus	Under Voltage	11.000	kV	8.63	78.5	3-Phase
Bus557	Bus	Under Voltage	11.000	kV	8.61	78.2	3-Phase
Bus558	Bus	Under Voltage	11.000	kV	8.60	78.2	3-Phase
Bus56	Bus	Under Voltage	11.000	kV	8.91	81.0	3-Phase
Bus560	Bus	Under Voltage	11.000	kV	8.60	78.2	3-Phase
Bus562	Bus	Under Voltage	11.000	kV	8.60	78.2	3-Phase
Bus563	Bus	Under Voltage	11.000	kV	8.59	78.1	3-Phase
Bus565	Bus	Under Voltage	11.000	kV	8.59	78.1	3-Phase
Bus567	Bus	Under Voltage	11.000	kV	8.59	78.1	3-Phase
Bus568	Bus	Under Voltage	11.000	kV	8.59	78.1	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus57	Bus	Under Voltage	11.000	kV	8.913	81.0	3-Phase
Bus570	Bus	Under Voltage	11.000	kV	8.59	78.1	3-Phase
Bus572	Bus	Under Voltage	11.000	kV	8.58	78.0	3-Phase
Bus573	Bus	Under Voltage	11.000	kV	8.58	78.0	3-Phase
Bus575	Bus	Under Voltage	11.000	kV	8.58	78.0	3-Phase
Bus576	Bus	Under Voltage	11.000	kV	8.58	78.0	3-Phase
Bus577	Bus	Under Voltage	11.000	kV	8.58	78.0	3-Phase
Bus578	Bus	Under Voltage	11.000	kV	8.58	78.0	3-Phase
Bus58	Bus	Under Voltage	11.000	kV	8.91	81.0	3-Phase
Bus580	Bus	Under Voltage	11.000	kV	9.22	83.8	3-Phase
Bus581	Bus	Under Voltage	11.000	kV	9.14	83.1	3-Phase
Bus583	Bus	Under Voltage	11.000	kV	8.85	80.5	3-Phase
Bus584	Bus	Under Voltage	11.000	kV	8.85	80.4	3-Phase
Bus585	Bus	Under Voltage	11.000	kV	8.71	79.2	3-Phase
Bus586	Bus	Under Voltage	11.000	kV	8.65	78.6	3-Phase
Bus587	Bus	Under Voltage	11.000	kV	8.54	77.6	3-Phase
Bus588	Bus	Under Voltage	11.000	kV	8.49	77.2	3-Phase
Bus589	Bus	Under Voltage	11.000	kV	8.46	76.9	3-Phase
Bus59	Bus	Under Voltage	11.000	kV	8.91	81.0	3-Phase
Bus590	Bus	Under Voltage	11.000	kV	8.43	76.6	3-Phase
Bus591	Bus	Under Voltage	11.000	kV	8.41	76.5	3-Phase
Bus592	Bus	Under Voltage	11.000	kV	8.42	76.5	3-Phase
Bus593	Bus	Under Voltage	11.000	kV	8.40	76.3	3-Phase
Bus594	Bus	Under Voltage	11.000	kV	8.39	76.2	3-Phase
Bus6	Bus	Under Voltage	11.000	kV	8.65	78.6	3-Phase
Bus60	Bus	Under Voltage	11.000	kV	8.91	81.0	3-Phase
Bus61	Bus	Under Voltage	11.000	kV	8.43	76.7	3-Phase
Bus62	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus64	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus644	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus65	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus667	Bus	Under Voltage	11.000	kV	9.85	89.6	3-Phase
Bus668	Bus	Under Voltage	11.000	kV	9.85	89.6	3-Phase
Bus67	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus670	Bus	Under Voltage	11.000	kV	9.84	89.5	3-Phase
Bus671	Bus	Under Voltage	11.000	kV	9.84	89.5	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus672	Bus	Under Voltage	11.000	kV	9.844	89.5	3-Phase
Bus675	Bus	Under Voltage	11.000	kV	9.84	89.4	3-Phase
Bus677	Bus	Under Voltage	11.000	kV	9.83	89.4	3-Phase
Bus678	Bus	Under Voltage	11.000	kV	9.83	89.4	3-Phase
Bus679	Bus	Under Voltage	11.000	kV	9.84	89.4	3-Phase
Bus68	Bus	Under Voltage	11.000	kV	8.39	76.3	3-Phase
Bus680	Bus	Under Voltage	11.000	kV	9.84	89.4	3-Phase
Bus681	Bus	Under Voltage	11.000	kV	9.84	89.5	3-Phase
Bus682	Bus	Under Voltage	11.000	kV	9.84	89.5	3-Phase
Bus683	Bus	Under Voltage	11.000	kV	9.85	89.5	3-Phase
Bus684	Bus	Under Voltage	11.000	kV	9.85	89.5	3-Phase
Bus685	Bus	Under Voltage	11.000	kV	9.85	89.5	3-Phase
Bus686	Bus	Under Voltage	11.000	kV	9.85	89.6	3-Phase
Bus687	Bus	Under Voltage	11.000	kV	9.86	89.6	3-Phase
Bus688	Bus	Under Voltage	11.000	kV	9.86	89.6	3-Phase
Bus689	Bus	Under Voltage	11.000	kV	9.86	89.6	3-Phase
Bus69	Bus	Under Voltage	11.000	kV	8.85	80.4	3-Phase
Bus690	Bus	Under Voltage	11.000	kV	9.88	89.8	3-Phase
Bus7	Bus	Under Voltage	11.000	kV	8.99	81.8	3-Phase
Bus70	Bus	Under Voltage	11.000	kV	8.84	80.3	3-Phase
Bus71	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus72	Bus	Under Voltage	11.000	kV	8.84	80.3	3-Phase
Bus73	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus74	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus76	Bus	Under Voltage	11.000	kV	8.83	80.3	3-Phase
Bus77	Bus	Under Voltage	11.000	kV	8.82	80.2	3-Phase
Bus78	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus79	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus8	Bus	Under Voltage	11.000	kV	8.99	81.7	3-Phase
Bus80	Bus	Under Voltage	11.000	kV	9.14	83.1	3-Phase
Bus81	Bus	Under Voltage	11.000	kV	9.14	83.1	3-Phase
Bus82	Bus	Under Voltage	11.000	kV	9.15	83.2	3-Phase
Bus83	Bus	Under Voltage	11.000	kV	9.15	83.2	3-Phase
Bus84	Bus	Under Voltage	11.000	kV	9.16	83.3	3-Phase
Bus85	Bus	Under Voltage	11.000	kV	9.16	83.3	3-Phase
Bus86	Bus	Under Voltage	11.000	kV	8.99	81.8	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus87	Bus	Under Voltage	11.000	kV	8.861	80.6	3-Phase
Bus88	Bus	Under Voltage	11.000	kV	8.79	79.9	3-Phase
Bus9	Bus	Under Voltage	11.000	kV	8.71	79.2	3-Phase
Bus93	Bus	Under Voltage	11.000	kV	8.71	79.1	3-Phase
Bus94	Bus	Under Voltage	11.000	kV	8.70	79.1	3-Phase
Bus95	Bus	Under Voltage	11.000	kV	8.69	79.0	3-Phase
Bus96	Bus	Under Voltage	11.000	kV	8.69	79.0	3-Phase
Bus97	Bus	Under Voltage	11.000	kV	8.68	78.9	3-Phase
Bus98	Bus	Under Voltage	11.000	kV	8.68	78.9	3-Phase
Bus99	Bus	Under Voltage	11.000	kV	8.68	78.9	3-Phase
Cable46	Cable	Overload	338.032	Amp	551.17	163.1	3-Phase

Annexure 5: Feeder Wise Reliability Indices

Sl.No.	Year	Month	Reliability Indices	11kV Sarpang I	11kV Sarpang II	11kV Gelephu	11kV ADP	11kV RBA	33kV Jigmecholing	11kV Station
1	2016	January	SAIFI	0.63	0.26	0.15	-	-	0.26	-
			SAIDI	0.36	0.17	0.03	-	-	0.54	-
2		February	SAIFI	0.63	0.51	-	-	0.57	-	-
			SAIDI	0.76	0.66	-	-	0.42	-	-
3		March	SAIFI	0.63	0.51	0.31	0.31	0.43	-	-
			SAIDI	0.80	0.67	0.24	0.81	0.80	-	-
4		April	SAIFI	0.79	0.78	0.39	0.31	0.43	0.15	-
			SAIDI	0.56	1.29	1.16	0.50	0.16	0.10	-
5		May	SAIFI	0.95	0.26	0.77	0.62	0.14	0.64	-
			SAIDI	0.71	0.21	0.58	0.33	0.04	0.18	-
6		June	SAIFI	0.96	1.02	0.76	0.31	0.29	0.26	-
			SAIDI	1.32	1.32	0.30	0.12	0.07	0.38	-
7		July	SAIFI	1.61	1.94	0.60	1.25	0.86	0.40	0.00
			SAIDI	5.11	7.87	3.00	3.88	2.44	0.92	0.03
8		August	SAIFI	0.80	1.52	0.77	0.31	0.72	0.13	-
			SAIDI	2.62	0.89	0.62	1.15	1.23	0.07	-
9		September	SAIFI	0.64	0.76	0.46	0.62	0.29	-	-
			SAIDI	0.61	0.55	0.12	1.01	0.63	-	-
10		October	SAIFI	1.12	0.76	0.31	0.47	0.73	0.26	-
			SAIDI	2.20	6.00	0.22	0.23	0.52	0.04	-
11		November	SAIFI	0.96	-	-	-	0.14	0.26	-
			SAIDI	0.46	-	-	-	0.06	0.38	-
12		December	SAIFI	0.63	-	0.78	0.62	0.58	0.26	-
			SAIDI	2.04	-	0.82	0.54	0.23	0.08	-
	Total		**SAIFI**	**10.36**	**8.31**	**5.29**	**4.83**	**5.19**	**2.63**	**0.00**
			SAIDI	**17.55**	**19.65**	**7.10**	**8.58**	**6.61**	**2.69**	**0.03**
1	2017	January	SAIFI	0.96	-	0.31	-	0.43	-	-
			SAIDI	1.07	-	0.50	-	0.80	-	-
2		February	SAIFI	0.32	-	0.31	-	0.43	0.13	-
			SAIDI	0.15	-	0.06	-	0.23	0.07	-
3		March	SAIFI	0.48	1.01	0.46	0.31	0.44	0.13	-
			SAIDI	1.45	4.97	2.66	2.52	2.43	1.05	-
4		April	SAIFI	2.24	0.76	0.61	0.31	-	0.13	-
			SAIDI	1.02	0.64	0.90	0.07	-	0.02	-
5		May	SAIFI	1.28	1.01	1.22	0.47	0.58	0.78	-
			SAIDI	2.22	0.94	1.80	2.62	0.96	0.64	-
6		June	SAIFI	0.64	1.02	0.61	0.31	-	-	-
			SAIDI	0.58	4.21	0.22	0.87	-	-	-
7		July	SAIFI	2.56	2.04	0.61	-	0.44	-	-
			SAIDI	2.26	2.79	0.19	-	0.17	-	-
8		August	SAIFI	1.92	1.79	1.52	0.78	1.31	1.03	-
			SAIDI	4.02	3.84	2.61	1.22	1.50	4.71	-
9		September	SAIFI	1.60	1.54	0.30	0.31	0.44	0.13	-
			SAIDI	1.99	3.42	0.09	1.97	0.09	0.10	-
10		October	SAIFI	0.32	0.26	0.30	0.15	0.44	0.26	-
			SAIDI	0.18	0.22	0.21	0.09	0.41	0.08	-
11		November	SAIFI	0.80	0.26	0.31	0.31	0.29	0.26	-
			SAIDI	0.26	0.06	0.63	0.64	0.78	1.91	-
12		December	SAIFI	2.55	0.77	0.15	-	0.15	-	-
			SAIDI	1.38	0.75	0.04	-	0.01	-	-
	Total		**SAIFI**	**15.66**	**10.46**	**6.71**	**2.95**	**4.96**	**2.84**	**-**
			SAIDI	**16.57**	**21.83**	**9.92**	**10.00**	**7.38**	**8.58**	**-**
1		January	SAIFI	0.64	0.51	0.60	-	0.44	0.26	-
			SAIDI	1.00	0.23	1.25	-	0.23	0.64	-

2	2018	February	SAIFI	0.16	0.77	0.60	0.15	0.29	0.13	-
			SAIDI	0.06	3.60	0.56	1.40	1.16	2.13	-
3		March	SAIFI	1.76	1.53	1.06	0.16	0.88	0.13	-
			SAIDI	2.06	2.65	1.61	1.31	2.68	0.19	-
4		April	SAIFI	1.28	0.51	1.21	0.16	1.03	0.13	-
			SAIDI	1.67	0.57	1.32	0.03	0.68	0.11	-
5		May	SAIFI	1.78	3.05	0.61	0.62	0.15	0.13	-
			SAIDI	3.67	7.94	1.10	1.27	0.95	0.07	-
6		June	SAIFI	1.62	1.52	1.99	1.08	1.47	0.26	-
			SAIDI	3.44	5.31	2.31	2.74	2.69	2.06	-
7		July	SAIFI	1.61	2.28	0.76	0.77	1.19	1.15	-
			SAIDI	1.40	2.85	0.35	0.12	0.26	2.83	-
8		August	SAIFI	1.29	2.53	0.62	0.77	0.29	0.38	0.01
			SAIDI	0.94	0.87	0.47	0.71	0.47	0.34	0.01
9		September	SAIFI	1.13	0.25	0.31	0.31	0.30	0.26	-
			SAIDI	0.47	0.31	0.06	0.12	0.67	0.64	-
10		October	SAIFI	0.81	-	0.15	-	0.15	0.38	-
			SAIDI	0.77	-	0.43	-	0.03	0.12	-
11		November	SAIFI	0.97	0.75	0.31	0.31	0.15	0.13	-
			SAIDI	0.49	0.45	0.08	0.19	0.03	0.83	-
12		December	SAIFI	0.32	0.25	0.15	-	0.45	6.18	-
			SAIDI	0.04	0.06	0.00	-	0.14	18.55	-
	Total		**SAIFI**	**13.36**	**13.96**	**8.37**	**4.32**	**6.78**	**9.52**	**0.01**
			SAIDI	**16.01**	**24.83**	**9.53**	**7.89**	**9.98**	**28.51**	**0.01**
1	2019	January	SAIFI	0.32	0.75	-	0.15	0.60	-	-
			SAIDI	0.07	2.77	-	0.05	0.27	-	-
2		February	SAIFI	1.93	0.75	0.78	0.77	0.45	-	-
			SAIDI	1.02	0.89	0.21	0.20	0.36	-	-
3		March	SAIFI	0.32	0.25	0.31	0.31	0.45	0.25	-
			SAIDI	0.14	0.27	0.04	0.08	0.13	1.67	-
4		April	SAIFI	0.48	0.49	0.79	0.16	0.45	0.13	-
			SAIDI	0.17	1.63	0.24	0.10	1.03	0.21	-
5		May	SAIFI	2.39	1.48	0.48	1.04	0.76	0.63	-
			SAIDI	1.09	0.76	0.19	1.07	0.41	1.33	-
6		June	SAIFI	2.23	1.49	0.96	0.93	0.91	0.37	-
			SAIDI	2.13	0.81	0.59	0.57	0.61	0.43	-
7		July	SAIFI	3.51	2.98	0.96	1.09	1.51	0.37	-
			SAIDI	3.28	2.50	0.77	1.02	2.39	0.19	-
8		August	SAIFI	2.23	1.98	-	0.62	0.76	0.12	-
			SAIDI	2.75	2.87	-	0.52	0.40	0.07	-
9		September	SAIFI	1.90	1.23	1.13	0.31	0.61	-	-
			SAIDI	1.85	1.18	0.44	0.13	0.40	-	-
10		October	SAIFI	-	0.74	0.97	0.31	0.62	0.78	-
			SAIDI	-	2.02	0.92	0.52	0.68	3.21	-
	Total		**SAIFI**	**15.31**	**12.14**	**6.39**	**5.69**	**7.11**	**2.65**	**-**
			SAIDI	**12.51**	**15.71**	**3.39**	**4.26**	**6.68**	**7.10**	**-**
	Overall total		**SAIFI**	**54.69**	**44.87**	**26.75**	**17.79**	**24.04**	**17.64**	**0.01**
			SAIDI	**62.64**	**82.02**	**29.93**	**30.73**	**30.66**	**46.88**	**0.04**

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 Feeder	Capacity (kVA)	2019		2025		2030	
			3ph load (kVA)	% Loading	3ph load (kVA)	% Loading	3ph load (kVA)	% Loading
1	Upper Juprey I	63	23.39	37.12%	67.37	106.94%	81.52	129.39%
2	Juprey Top	16	8.04	50.28%	23.18	144.86%	28.04	175.27%
3	Paita Khola Village	250	105.09	42.03%	302.75	121.10%	366.30	146.52%
4	Bhur Zero	63	34.50	54.77%	99.41	157.79%	120.27	190.91%
6	Chokorling	125	53.12	42.49%	153.03	122.43%	185.16	148.13%
7	Lekithang(Majuwa)	63	53.42	84.79%	153.89	244.27%	186.19	295.54%
8	Above sansari bazar(Torba	125	66.86	53.48%	192.61	154.09%	233.04	186.43%
14	Ramitay B	16	9.24	57.74%	26.61	166.33%	32.20	201.25%
15	Pangkhay BHU	25	8.88	35.52%	25.58	102.33%	30.95	123.82%
17	Bagjungay B	16	6.68	41.75%	19.25	120.28%	23.29	145.54%
18	Daragaon C	16	5.54	34.64%	15.97	99.80%	19.32	120.75%
20	Jigmeling II (Near BHSL office)	100	57.71	57.71%	130.06	130.06%	160.81	160.81%
21	Dekling School	125	45.96	36.77%	103.60	82.88%	128.08	102.47%
22	Pantharigoan	63	22.63	35.92%	51.01	80.96%	63.06	100.10%
23	Glalley Busty	250	218.84	87.54%	240.45	96.18%	262.06	104.83%
24	market	500	1,329.83	265.97%	1,698.91	339.78%	2,067.98	413.60%
25	Hero Majan	63	56.59	89.82%	62.18	98.69%	67.76	107.56%
26	Charali	500	1,287.62	257.52%	1,627.75	325.55%	1,967.89	393.58%
27	Infront of RBP Division V office	500	679.76	135.95%	813.17	162.63%	946.58	189.32%
28	TeleCom	125	248.45	198.76%	320.58	256.46%	392.70	314.16%
29	Fishery	500	984.78	196.96%	1,279.60	255.92%	1,574.41	314.88%
30	Royal Guest House	500	719.47	143.89%	918.51	183.70%	1,117.56	223.51%
31	Maji bastey below Tali Dratsang	125	561.13	448.91%	891.69	713.36%	1,074.55	859.64%
32	Magibusty	125	326.48	261.19%	646.04	516.83%	748.73	598.98%
34	RVL	250	888.96	355.58%	1,346.50	538.60%	1,638.12	655.25%
36	Lakitar/ Samdrupling	125	-	0.00%	1,505.28	1204.22%	1,871.01	1496.81%
37	Upper Lakitar	63	-	0.00%	96.21	152.72%	114.93	182.42%
38	Shetikhari	63	85.85	136.28%	2,116.61	3359.70%	2,640.43	4191.15%
39	Upper Pemathang	250	99.39	39.76%	281.92	112.77%	331.22	132.49%
40	DhoulaKhola	125	93.49	74.79%	141.12	112.90%	160.08	128.06%
41	Upper RBA (Family)	250	179.60	71.84%	271.10	108.44%	307.52	123.01%
42	Above forest range office(Forest checkpost)	125	118.49	94.79%	1,699.67	1359.73%	2,114.00	1691.20%
43	Lungta Workshop (MRF)	125	144.95	115.96%	218.80	175.04%	248.20	198.56%
44	Middle Pelrithang, BPC compound.	63	42.66	67.72%	64.39	102.21%	73.05	115.95%
49	Jogidara	25	8.72	34.87%	26.97	107.89%	33.98	135.92%
51	Khopitar	25	25.73	102.92%	79.61	318.46%	100.30	401.20%
53	Muga 'A'	16	4.82	30.13%	14.91	93.22%	18.79	117.44%
54	Sisty 'B'	25	7.16	28.66%	22.17	88.67%	27.93	111.71%
58	Pemathang(near Throema Lhakhang)	125	77.83	62.26%	138.65	110.92%	168.17	134.53%
59	Pemathang	25	12.70	50.80%	22.62	90.49%	27.44	109.76%
60	Upper chasakhar	25	19.13	76.53%	34.08	136.34%	41.34	165.37%
61	Middle chasakhar	100	52.52	52.52%	93.56	93.56%	113.48	113.48%
62	Lower Chesakhar	63	53.40	84.76%	95.13	151.00%	115.38	183.15%
63	Thongjabi under Chhuzagang Gewog	63	43.17	68.52%	76.90	122.07%	93.28	148.06%
64	Barthang	63	56.09	89.03%	99.92	158.61%	121.20	192.38%
65	Zombabee	63	34.06	54.06%	60.68	96.31%	73.59	116.82%
66	Upper Dewathang	63	52.84	83.87%	94.13	149.41%	114.17	181.23%
67	Lingar	63	40.10	63.65%	71.43	113.38%	86.64	137.53%
70	Jurwa-I (Eddhi)	63	46.88	74.41%	83.51	132.56%	101.30	160.79%
71	Pangkhar	25	20.65	82.62%	36.79	147.18%	44.63	178.51%
72	Pemaling	125	71.00	56.80%	126.48	101.19%	153.41	122.73%
73	Norbuling Village	100	58.34	58.34%	103.92	103.92%	126.05	126.05%
74	Norbuling MSS	125	113.32	90.66%	201.88	161.50%	244.86	195.89%
75	Infront of Norbuling MSS	63	58.85	93.41%	104.84	166.42%	127.16	201.85%
76	Pangzor (Youling)	160	86.45	54.03%	154.01	96.26%	186.80	116.75%
77	Shawapang	63	37.06	58.82%	66.01	104.78%	80.07	127.09%
78	Near Chuzaygang School	63	48.49	76.96%	86.38	137.10%	104.77	166.30%
79	Tashiphu, Below Lhakhang	63	53.16	84.38%	94.70	150.32%	114.87	182.33%

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**