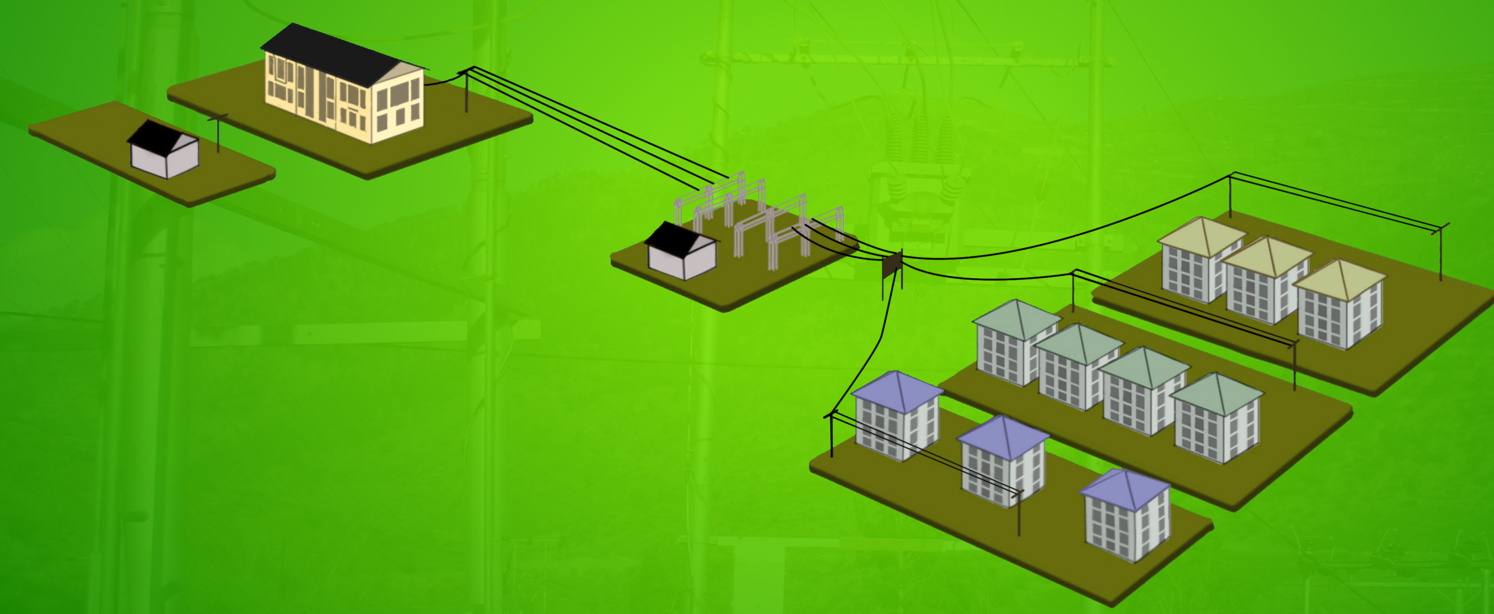
BHUTAN POWER CORPORATION LIMITED

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

P.O. Box : 580, Yarden Lam
Thimphu, Bhutan (Registered Office)
Website: www.bpc.bt

DISTRIBUTION SYSTEM MASTER PLAN (2020-2030)

SAMDRUP JONGKHAR 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

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

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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 Electro-Technical Commission

IP: Industrial Park

DT: Distribution Transformer

TSA: Time Series Analysis

LRM: Linear Regression Method

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

DDCS: Distribution Design and Construction Standards

kVA: Kilo Volt Ampere

W: Watt

kWh: Kilo Watt Hour

RMU: Ring Main Unit

ARCB: Auto Recloser Circuit Breaker

ISD: Intelligent Switching Device

FPI: Fault Passage Indicator

ICT: Interconnecting Transformer

Definitions

Asset Life: The period (or the 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 services, such as during short-term emergencies or longer unplanned outages, and during periods of scheduled maintenance when the units must be shut down. 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. 1) Facilities and places to serve electric customers. 2) The total amount of electrical energy a power line can 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 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 are interconnected with several 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 for 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 are not online, it is said to be "down."

Outage - Interruption of service to an electric consumer.

Overload - Operation of equipment over normal, full-load rating, or of a conductor above 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 can maintain its delivery of electric energy within the tolerable limits of voltage and without outages or other problems that 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 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 performance. 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 complexity 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; a 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.

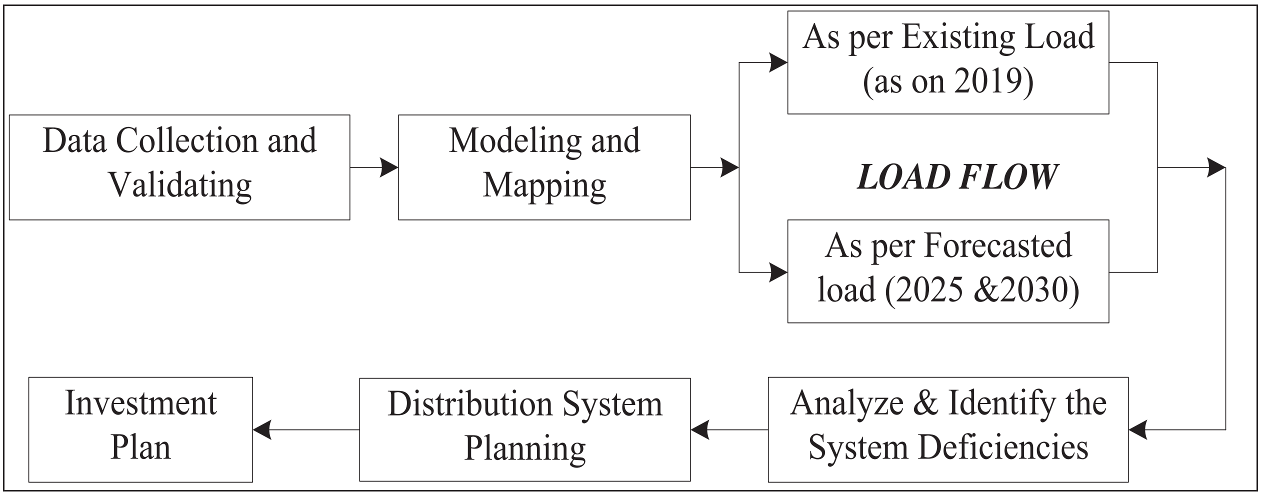


Figure 1: Block diagram for distribution system planning for thematic studies

5.1 Data Collection and Validation

To carry out the detailed studies with greater accuracy, complete and reliable data of the existing distribution infrastructure is required. Therefore, an intensive field investigation was carried out during 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 Modeling and Mapping

The feeder wise distribution lines and transformers were modeled and mapped in the 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 with 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 the load forecast methodology are 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 the 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 the power supply sources

Samdrupjongkhar Dzongkhag comprises of the two Drungkhags (Samdrupcholing and Jomotsangkha) and eleven Gewogs (Orong, Gomdar, Martshala, Phuntshothang, Pemathang Samrang, Lauri, Serthig, Dewathang, and Langchenphu). The power supply to these Gewogs is being fed from the 132/33/11 kV Dewathang substation. The overall power distribution network of Samdrupjongkhar Dzongkhag is illustrated in the schematic diagram shown in **Figure 2.**
The Kurichu hydro-power plant (4x15 MW) located in Monggar Dzongkhag is the principal power supply source for the whole eastern and central regions in the country. The Kurichu power consumption in Samdrupjongkhar Dzongkhag is channeled through the 132/33/11 kV substation at Dewathang.

The power distribution system of the Dzongkhag also has two 11 kV links with the ASEB (i.e. one at Diafam and the other at Samdrupjongkhar) which are used extensively when there is no power supply from the national grid. Nevertheless, with the extension of the grid, 11kV links are hardly used except during exigency circumstances. Dependency on these feeders is likely to reduce further with the interconnection of the 132/33kV Kanglung and Phuntshothang substations. The 132 kV transmission link between Nanglam and Motanga substations is expected to enhance the power reliability of Samdrupjongkhar Dzongkhag.

As seen in **Figure 2**, the 132/33/11 kV Dewathang substation is a primary HV source of Samdrupjongkhar. The substation has three (3) 33kV feeders (Bangtar, Gomdar, and Samdrupjongkhar) and has four (4) 11kV feeders (Colony, station, Dewathang, and Orong). The

33kV Samdrupjongkhar feeder links 2x2.5 MVA, 33/11 kV Samdrupjongkhar substation, and similarly, the 33kV Bangtar feeder links 1x1.5 MVA, 33/11 kV Langchenphu substation.

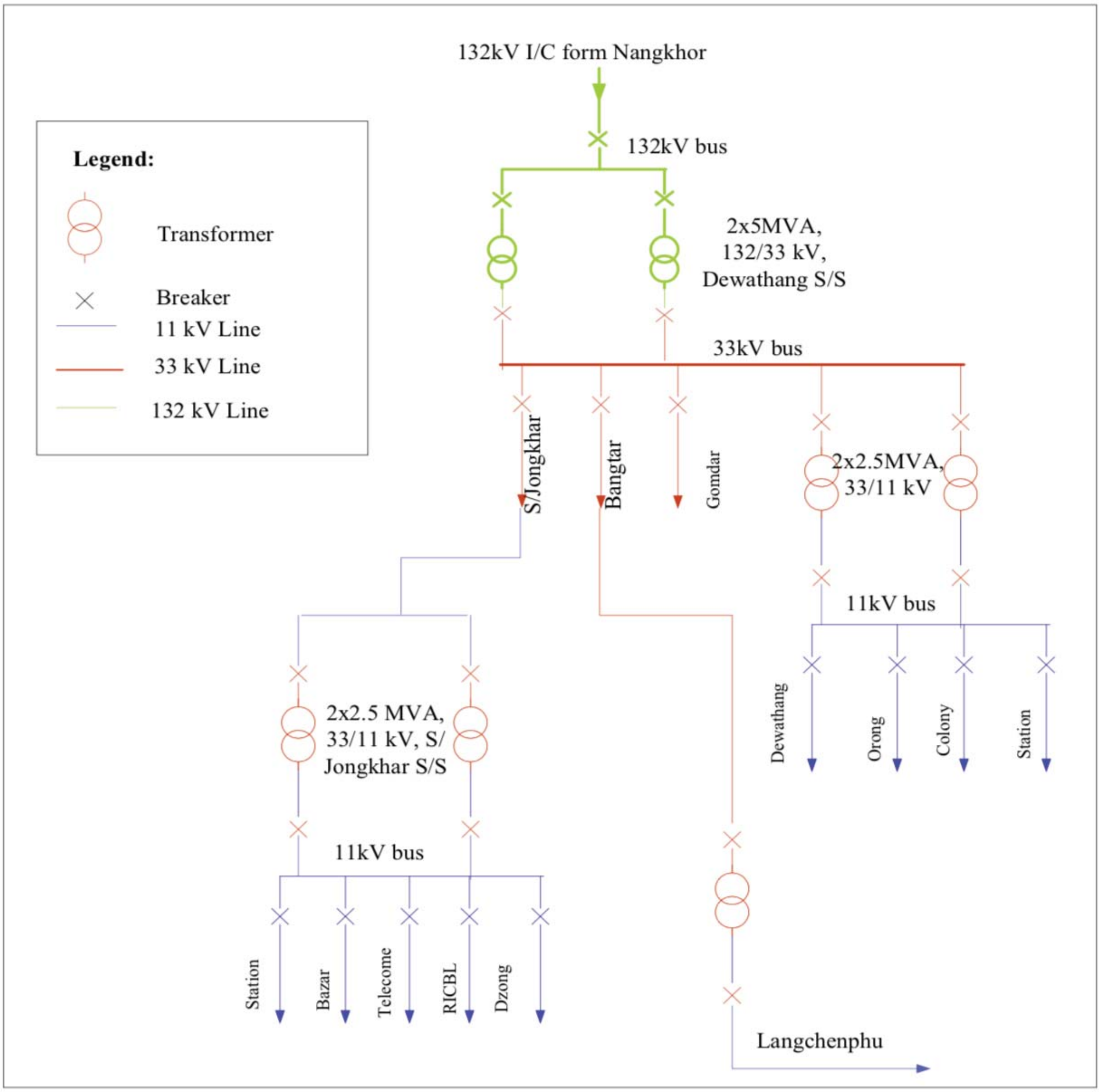


Figure 2: Electricity Distribution Schematic of Samdrupjongkhar Dzongkhag

6.2 Electricity Distribution Lines

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

Table 1: MV and LV Line Details

Sl. No.	33 kV(KM)		11 kV (KM)		Total MV line		LV line (KM)		Total line length (KM)
	OH	UG	OH	UG	OH	UG	OH	UG	
1	344.04	0.65	79.18	2.05	423.22	2.70	396.13	6.308	828.36

The total MV line length is 425.92 km and the total LV line length is 402.407 km. The ratio of MV to LV line length is 1:1.05, which is within the generally acceptable range of 1:1.2. Hence, it is recommended to maintain the same ratio for better power distribution. While the ratio of LV to MV line length would vary according to the site conditions, as a general rule, a ratio of 1.2:1 should be maintained which would balance the initial capex and optimize the running and maintenance costs. The MV distribution network is mainly through 33 kV and 11 kV overhead lines with some networks in the town areas being through underground cables.

6.3 Distribution Transformers

The number of distribution transformers at various kVA rating levels operated and maintained by the ESD Samdrupjongkhar is tabulated in **Table 2.**

Table 2: Total Numbers of Transformers, installed capacity & customers

Sl. No.	Name of Feeder	Transformer (Nos)	Installed Capacity (kVA)	No of Customer	Remarks
1	33kV Samdrupjongkhar feeder	2.00	565.00	1,815.00	33kV S/J feeder fed to 2x2.5 MVA, 33/11kV substation at town
i	11kV Dzong feeder	4.00	1,565.00		
ii	11kV Telecom feeder	2.00	223.00		
iii	11kV Bazar feeder	6.00	5,000.00		
iv	11kV RICBL feeder	1.00	250.00		
v	11kV Station feeder	1.00	500.00		
2	33kV Bangtar feeder	166.00	7,953.00	4,290.00	33kV Bangtar feeder fed to 1x1.5 MVA, 33/11kV
i	11kV Langchenphu feeder	14.00	2,235.00		

Sl. No.	Name of Feeder	Transformer (Nos)	Installed Capacity (kVA)	No of Customer	Remarks
					substation at Langchenphu
3	33kV Gomdar feeder	72.00	2,056.00	1,380.00	
4	11kV Dewathang feeder	14.00	2,891.00	747.00	
5	11kV Orong feeder	25.00	1,466.00	738.00	
6	11kV station feeder	1.00	100.00	1.00	
7	11kV colony feeder	1.00	100.00	39.00	
8	33kV Line form Motanga S/S	-	-	-	
	Total	**309.00**	**24,904.00**	**9,010.00**	

As of September 2019, there were 309 (283 BPC & 26 Private) transformers with a total capacity of 24,904.00 kVA. As evidenced from **Table 2**, the installed capacity of transformer per customer is 2.76 kVA per customer.

7. Analysis of Existing 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 was assessed, and accordingly, the augmentation and reinforcement works are proposed which shall be an 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 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 assessment had been carried out bifurcating HV and MV substations as detailed below.

7.1.1 HV Substation (220/132/66/33/11 kV)

Dewathang substation is the primary power source to Samdrupjongkhar Dzongkhag. To assess the capacity of the substation, the peak power consumed has been compiled based on the historical data. The details on the installed capacity of substations, existing peak load, and anticipated load in the future are tabulated in **Table 3.**

Table 3: Peak load of HV Substation

Sl. No.	Name of Source	Installed Capacity		Peak Load (MW)	Forecasted Load (MW)	
		MVA	MW	2019	2025	2030
Dewathang (Existing)						
1	132/33 kV	2x5	8.5	6.39	8.73	10.57
	33/11kV	2x5	8.5	2.63	3.55	4.41
Upcoming Substations						
2	Motanga (132/33 kV)	1x15	12.75	2.95	11.66	14.75
3	Phuntshothang (132/33 kV)	2x10	17.00	-	-	-

Note: Considering the power factor of 0.85

As shown in **Table 3,** the substation recorded a peak load of 6.39 MW (equivalent to 7.52 MVA @0.85 pf) at 33 kV voltage level, which is 75.2 % loaded against the installed capacity. The commissioning of the Phuntshothang substation can off-load the load of the Bangtar feeder which caters to the power requirement of seven (7) Gewogs (Martshala, Pemathang, Phuntshothang, Samrang, Langchenphu, Serthi, and Lauri) thereby reducing the burden to Dewathang substation.

Similarly, the 33/11kV substation experienced a peak load of 2.63 MW in 2019 is forecasted to reach 4.41MW by 2030 against the installed capacity of 8.5 MW. Therefore, the substation has adequate capacity to cater to the present and forecasted load.

However, it is pertinent to mention that the Motanga (Phuentsho Rabtenling) under Samdrupjongkhar is identified as an Industrial Park (IP) by the Department of Industry, Ministry of Economic Affairs. The IP has a total of 4 zones namely, Mineral/Chemical-based, Forest-based, Food and agro-based, and other industries. Table 4 exhibits the projected load at Motanga IP.

Table 4: Load forecast of Motanga IP

Category	Forecasted Load (MW)		
	2019	**2025**	**2030**
HV Industries	12.20	61.0	61.0
MV Industries	2.66	10.53	13.32
LV industries	0.29	1.13	1.43
	2.95	**11.66**	**14.75**

The power requirement to Motanga IP should be catered by 1x15 MVA, 132/33kV Motanga substation. The total MV and LV load of 14.75 MW is anticipated by 2030 against its installed capacity of 12.75 MW (@0.85 pf). Hence, it is imperative that the Motanga substation needs to be upgraded. The Up-gradation will not only cater to the future load growth of the Motanga IP but can serve as source redundancy to 33/11 kV Samdrupjongkhar substation.

7.1.2 MV Substation (33/11 kV)

The power imported from the Dewathang substation is further distributed to various parts of the Dzongkhag through the following 33/11kV substations. The detail of the installed capacity, existing peak load, and the anticipated load in the future are exhibited in **Table 5.**

Table 5: Peak load of MV Substation

Sl. No.	Name of Source	Available Installed Capacity		Peak Load (MW)	Forecasted Load (MW)	
		MVA	**MW**	**2019**	**2025**	**2030**
1	S/Jongkhar	2x2.5	4.25	1.49	2.22	2.53
2	Langchenphu	1x1.5	1.275	0.5	-	-

Note: C*onsidering the power factor of 0.85*

As seen from **Table 5,** the Langchenphu substation has adequate capacity to cater to the existing as well as future load growth. However, an additional transformer is recommended at Langchenphu substation for redundancy purposes.

Similarly, the Samdrupjongkhar substation has an adequate capacity to cater to the forested load. However, it is crucial to mention that seven LAPs are identified in and around Samdrupjongkhar Throm which should be catered from the substation. An additional load of around 3.912 MW is forecasted by 2030. Therefore, it is recommended to upgrade 2x2.5 MVA to a 2x5 MVA substation. The detailed power requirement for the LAPs is outlined in **Section 7.4.**

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 a 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 the identification of feeders that require reinforcement and reconfiguration works.

The behavior of the MV feeders is 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 the next 30 years. Therefore, it is equally important to consider the asset life of the system in addition to the assessment of the system at different time horizons.

7.2.1 Assessment of MV Feeder Capacity

The load profile of MV feeders emanating from the Dewathang substation had been 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 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: Historical Feeder wise peak power demand of ESD Samdrupjongkhar

Sl. No.	Name of Feeder	Peak Consumption Pattern(MW)						
		2013	2014	2015	2016	2017	2018	2019
1	33kV Samdrupjongkhar feeder	1.67	1.28	1.36	1.96	1.83	1.66	1.49
2	33kV Bangtar feeder	1.17	0.98	1.32	1.50	1.50	1.66	1.55
3	33kV Gomdar feeder	1.17	0.43	0.41	0.43	0.49	0.45	0.72
4	11kV Dewathang	1.10	1.65	1.77	1.66	1.58	2.02	1.96
5	11kV Orong feeder	0.20	0.32	0.30	0.36	0.57	0.36	0.52
6	11kV Station feeder	0.02	0.02	0.03	0.03	0.03	0.02	0.10
7	11kV Colony feeder	0.02	0.25	0.03	0.03	0.02	0.03	0.05

Source: Monthly substation Data of TD, BPC

Note: The load of 33/11kV substations is included in their respective source feeders.

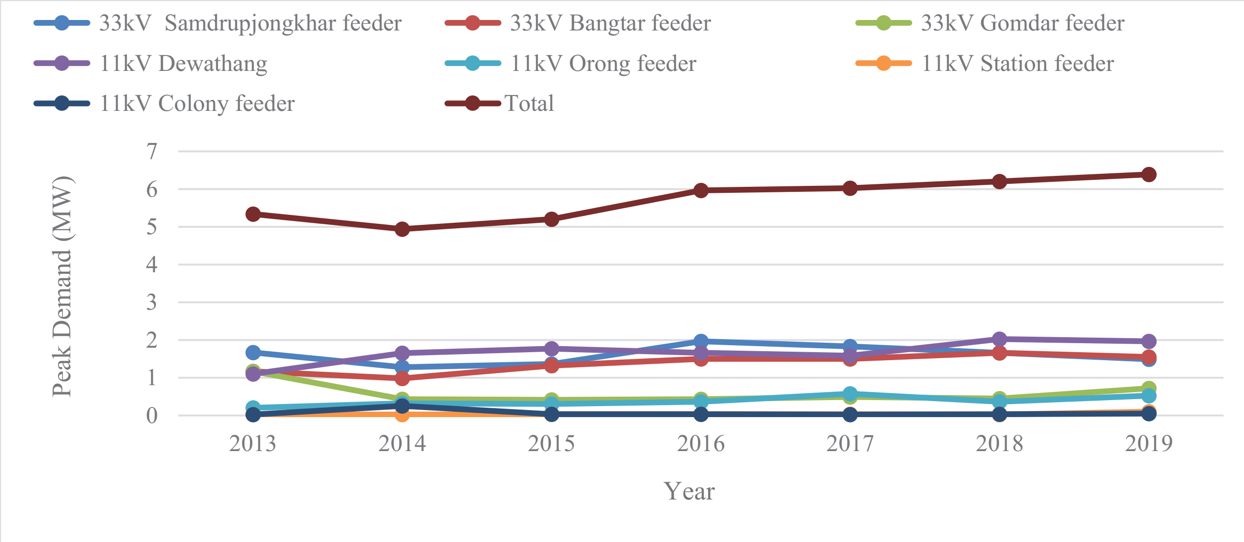


Figure 3: Feeder wise peak power demand of ESD Samdrupjongkhar

As can be seen in **Figure 3**, besides anomaly in the year 2013-2014 the graph shows a gradual increase in the growth of peak load over the last seven years.

The load carrying capacity of a feeder is determined by the line length and degree of load connected in addition to other parameters like ampacity capability. The majority of power distribution in the Dzongkhag is through the 33kV and 11kV system and the type of conductors used are mostly ACSR-Rabbit and Dog. **Table 7** exhibits the ampacity capability of the conductors at different voltage levels. Ampacity capability (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.

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

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

The distribution network is developed using the ETAP software based on the existing and the forecasted load for the assessment. The assessment is then carried out for the following case scenarios. The upcoming LAPs, bulk load/industrial load sanctioned by DCSD, BPC is also being considered. These power demands are added to the peak load forecast of that year when the load is anticipated to come online and to the subsequent years.

a) System Study with Existing System
b) System Study with future load: 2025 scenario
c) System Study with future load: 2030 scenario

a) System Study with Existing Load

A load flow analysis of the existing system was carried out considering the 2019 peak load. From the simulation result, it shows that all the feeders would experience an optimal voltage drop (within ±10%) at the substation bus as well as at the end of feeders. Hence, it is evident that the distribution network has adequate capacity to deliver the power to the customers without any additional investment.

b) Assessment of MV Feeder Capacities with Forecasted Load

The peak power demand presented in **Table 6** has been considered to forecast the power demand for the next 10 years (2020-2030). Linear Regression Method (LRM) in conjunction with Time Series Analysis (TSA) is adopted to forecast the load as detailed in **Annexure- 3**. The summary of the forecasted load for the feeders is tabulated in Table 8.

Table 8: Feeder wise load forecast of ESD Samdrupjongkhar

Sl. No.	Name of Feeder	Total Forecasted Load Growth (MW)							
		2020	2021	2022	2023	2025	2026	2028	2030
1	33kV Samdrupjongkhar feeder	1.91	1.97	2.03	2.09	2.22	2.28	2.41	2.53
2	33kV Bangtar feeder	1.81	1.93	2.05	2.17	2.41	2.53	2.77	3.01
3	33kV Gomdar feeder	0.49	0.51	0.52	0.53	0.56	0.57	0.59	0.62
4	11kV Dewathang	2.10	2.22	2.35	2.47	2.71	2.84	3.08	3.33
5	11kV Orong feeder	0.53	0.58	0.63	0.67	0.77	0.81	0.91	1.00
6	11kV Station feeder	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04
7	11kV Colony feeder	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04
	Total	**6.90**	**7.27**	**7.63**	**8.00**	**8.73**	**9.10**	**9.83**	**10.57**

Note: The load of 33/11kV substations is included in their respective source feeders

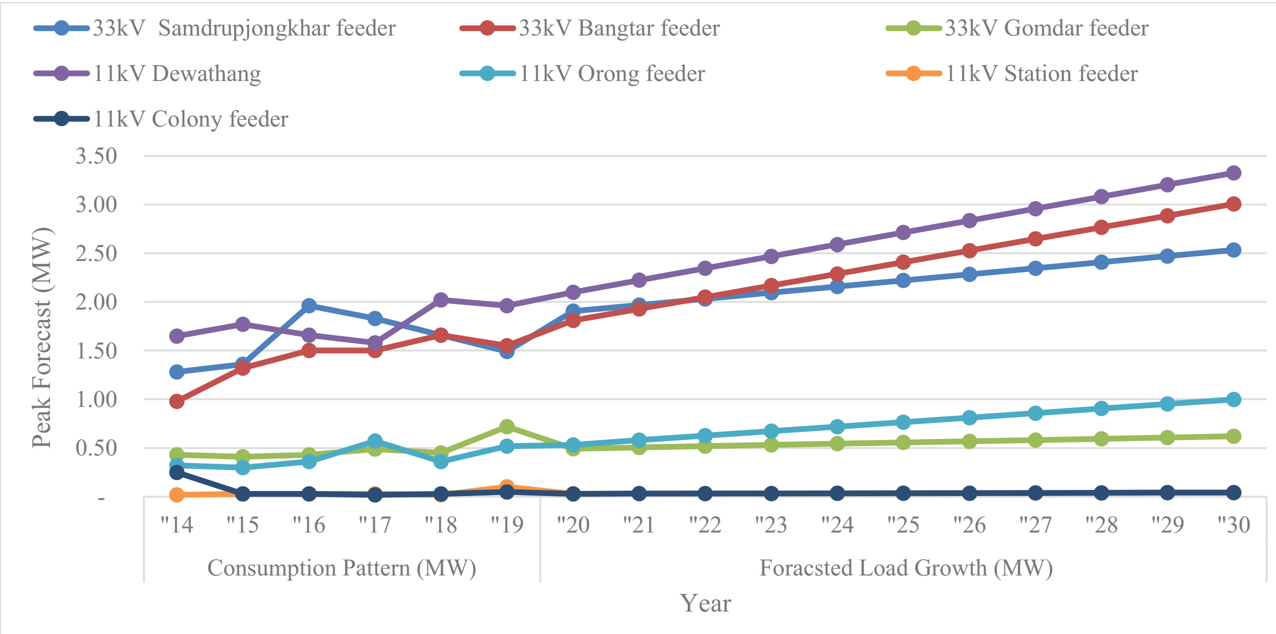


Figure 4: Feeder wise peak power demand forecast of ESD Samdrupjongkhar

From the power flow analysis of the 2025 and 2030 loading scenarios, the simulation results show that there will be a significant drop in bus voltage and marginal and critical voltage drops in respective feeders as presented in **Table 9.**

Table 9: Bus Voltage profile of Problematic Feeders

Sl. No.	Name of Feeder	Voltage Profile (% drop)		Remarks
		2025	2030	
1	33 kV Bus at Dewathang S/S	10.33 %	19.45 %	**As per DDCS Standard**
2	11 kV Bus Dewathang S/S	12.88 %	21.42 %	
3	33 kV Bus at S/Jongkhar S/S	12.04 %	33.06 %	
4	11kV Bus at S/Jongkhar S/S	16.04 %	34.00 %	

The feeders reflected in **Table 9** will be experiencing a low voltage profile which will be beyond the permissible range. The improvement measures and strategies to improve the low voltage profile is detailed as follows.

BPC is constructing two additional 132/33 kV substations at Motanga (15 MVA) and Phuntshothang (2x10 MVA). The substations are targeted to be commissioned by the end of 2019. With the inclusion of these two substations, the voltage profile is anticipated to improve significantly except for 33kV Gomdar Feeder. There is a voltage drop of 10.42% while the limits of medium voltage variation are ±10%. **Table 10** exhibits the improved voltage profile of the buses when two additional sources are considered.

Table 10: Improved Voltage profile

Sl. No.	Name of Feeder	Voltage Profile (Before)	Voltage Profile (After)	Corrective Actions
1	33 kV Bus at Dewathang S/S	19.45 %	6.50 %	With the connection of Motanga and Phuntshothang substations
2	11 kV Bus Dewathang S/S	21.42 %	8.59 %	
3	33 kV Bus at S/Jongkhar S/S	33.06 %	6.46 %	
4	11kV Bus at S/Jongkhar S/S	34.00 %	9.00 %	

The analysis was done to improve the voltage profile of the 33kV Gomdar feeder. The interconnection of the feeder with that of the 33kV Martshala feeder would improve the voltage profile to a greater extent since the Marstshala feeder is drawn-out from a different source (Phuntshothang substation). The simulation result shows that the voltage profile would increase from 89.58% to 97.1%. However, additional investment will be incurred for constructing 33kV line (approximately 1.5 km) and converting 11.3 km of single phase (2 wire) to 3-phase from Wangphu to Kaeptang. This arrangement will not only improve the voltage profile of the Gomdar feeder but will also act as a contingency feeder. Detailed simulation results for all the case studies are attached as **Annexure- 4.**

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 transformer and line loss. 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. **Table 11** below shows the energy sales, purchase, and loss profile of the Dzongkhag.

Table 11: Energy Sales-Purchase-Loss Trend

Sl. No.	Energy requirement, sales and loss (MU)	2014	2015	2016	2017	2018	Average
1	**Energy Requirement in kWh**						
i)	Purchase from GenCos as per TD bill	192.9	210.3	229.0	227.0	145.0	
ii)	Export to Zhemgang	0.0	-0.9	-0.7	-0.5	0.0	
iii)	Import from ASEB	0.7	0.2	0.1	0.1	0.1	
iv)	HV Purchase	175.5	190.5	207.5	205.4	127.5	
	Total	**193.6**	**209.6**	**228.4**	**226.6**	**145.1**	
% growth over previous year		**59.54 %**	**8.27%**	**8.96%**	**-0.79%**	**-35.98%**	**8.00%**
2	**Energy Sales in kWh (Category Wise)**						
i)	Total (LV)	11.5	12.3	13.3	14.5	12.5	
ii)	LV Bulk	4	4	4	4	3	
iii)	MV Industries	0.0	0	0	1	0	
iii)	HV Industries	177	191	207	205	128	
3	**Total Energy Sales**	**192.0**	**207.0**	**225.0**	**224.8**	**143.3**	
% growth over previous year		**61.19 %**	**7.80%**	**8.72%**	**-0.08%**	**-36.28%**	**8.27%**

Sl. No.	Energy requirement, sales and loss (MU)	2014	2015	2016	2017	2018	Average
4	**Loss (%)**	**0.83%**	**1.26%**	**1.48%**	**0.77%**	**1.24%**	**1.12 %**
	Losses excluding industries (%)	16.9%	16.21 %	14.31 %	6.09%	11.02%	12.91%
Number of the customer (Category Wise)							
i)	Total LV	8526	9487	10477	10933	8592	
ii)	LV Bulk	216	215	208	181	116	
iii)	MV Industries	0	0	1	1	1	
iv)	HV Industries	2	2	2	2	1	
5	**Total Customers**	**8744**	**9704**	**10688**	**11117**	**8710**	

Source: Adapted from BPC Power Data Book 2018

Note: LV Customer: Domestic (Rural & Urban), Rural Cooperatives, Rural Micro-Trades, Rural Community Lhakhangs, Religious Institutions, Commercial, Industrial, Agriculture, Institutions, Street Lighting, Power house auxiliaries, and Temporary connections.

As seen the energy requirement of the Dzongkhag has reduced drastically from the year 2017. The drop-in energy is because the entire distribution network of Nganglam Drungkhag was under the administration of Samdrupjongkhar Dzongkhag. Therefore, as evident from **Figure 5**, the energy requirement has decreased over the past two years. However, the energy requirement may increase once the Industrial Park at Motanga is fully operational.

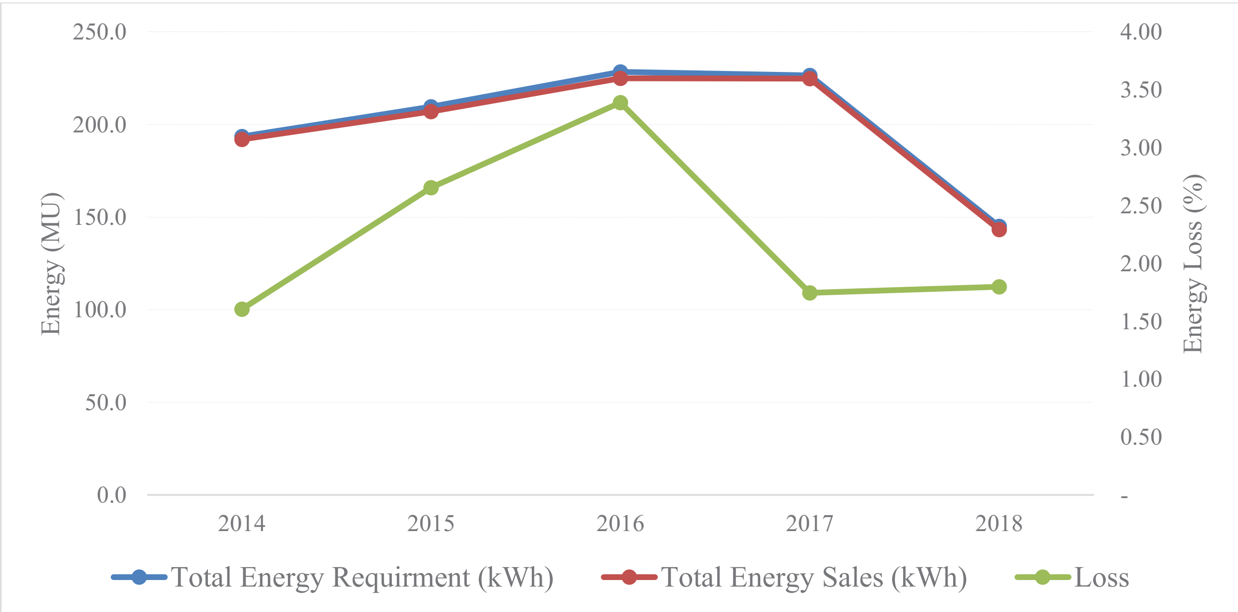


Figure 5: Energy requirement trend

Similarly, the energy loss of the Dzongkhag has reduced from 2017 onwards. This may be attributed to a decrease in the distribution network (i.e., Network of Nganglam Dungkhag was handed over to Pemagatshel).

Generally, the technical loss is 8.9% for the distribution network and any loss more than this range is due to commercial loss. An independent study carried out by 19 ESDs for 38 feeders in 2017 (two feeders each in ESD with more loss) showed that an average of 6.84% is due to technical loss. The study also showed that the loss pattern was never consistent because of variant characteristics of a distribution network and loading pattern. The average loss index of Samdrupjongkhar (2014-2018) is 1.12 % (2.24 million units on average) which is exceptionally good. The low energy loss is because of the presence of HV industries in the Dzongkhag. The energy loss excluding HV industries is as high as 12.91 % (on average) which is quite high. Therefore, there is a need to focus more on reducing non-technical loss.

The feeder wise energy loss was exhibited in **Table 12**. In the absence of recorded feeder-wise energy detail, the energy loss was derived by prorating the overall loss of the Dzongkhag by considering the line length of the feeder and the number of customers connected to it. However, it is relatable to mention that the feeder losses may not be precise and valid. Therefore, for the accurate analysis of the individual feeder loss, an energy meter for every feeder at 33/11kV substation is recommended.

Table 12: Feeder wise energy loss (in MU) of ESD Samdrupjongkhar

Sl. No.	Name of Feeder	Trunk line length	Total customer	Energy Loss (MU)				
				2014	2015	2016	2017	2018
1	33kV Samdrupjongkhar	15.61	1,815	0.62	0.64	0.62	0.26	0.38
2	33kV Bangtar	247	4,290	1.48	1.52	1.48	0.62	0.90
3	33kV Gomdar	79	1,380	0.47	0.49	0.47	0.20	0.29
4	11kV Dewathang	14.21	747	0.26	0.27	0.26	0.11	0.16
5	11kV Orong	44	738	0.25	0.26	0.25	0.11	0.16
6	11kV Station	0	1	0.00	0.00	0.00	0.00	0.00
7	11kV Colony	0	39	0.01	0.01	0.01	0.01	0.01
	Total		**9010**	**3.1**	**3.2**	**3.1**	**1.3**	**1.9**

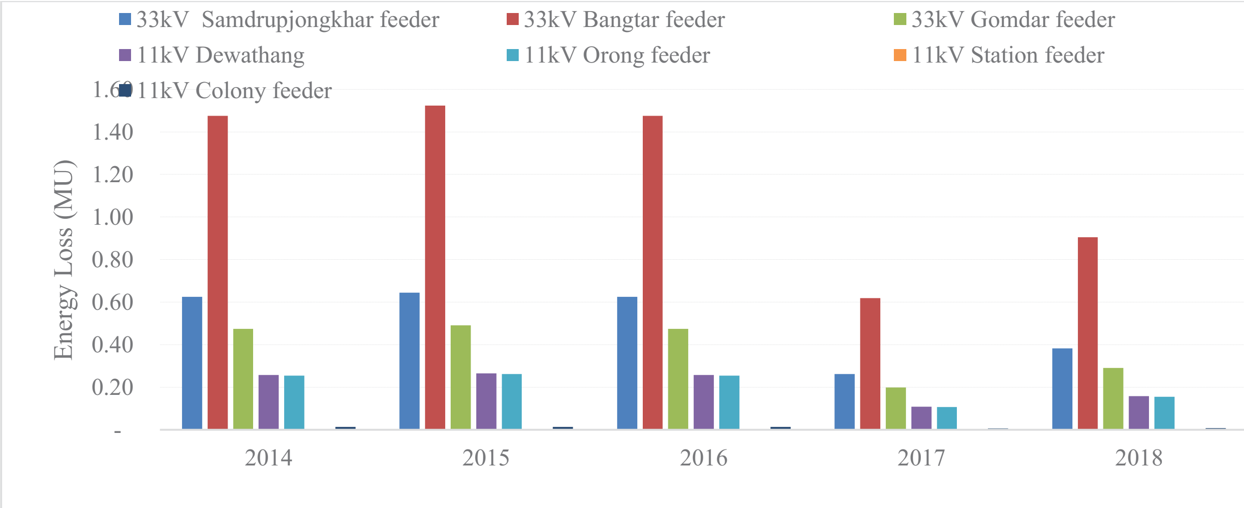


Figure 6: Feeder wise energy losses (MU) of ESD

The energy loss profile as shown in **Figure 6** indicates that the 33kV Bangtar feeder contributed the highest energy loss. The high loss is because of long distances resulting in high line resistance and therefore high I^2R losses in the line. The feeder has a total circuit line length of around 247 km.

7.2.3 Reliability Assessment of 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. The yearly average feeder reliability assessment (2016-2019) is summarized in **Table 13.** The individual feeder reliability details used to derive the 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 to compute the actual representation of the reliability indices. The average reliability indices viz a viz SAIFI & SAIDI compiled from 2016-2019 are 367.68 & 855.21 respectively which indicates that the power supply to the customers of Samdrupjongkhar Dzongkhag is not reliable.

Table 13: Feeder wise Reliability indices of ESD Samdrupjongkhar

Sl. No.	Year	Reliability Indices	11kV Dewathang	11kV Orong	33kV SJ	33kV Gomdar	33kV Bangtar	Total
1	2016	SAIFI	4.91	15.96	21.00	81.03	46.12	169.03
		SAIDI	472.75	59.26	59.26	325.85	83.24	1000.36
2	2017	SAIFI	75.99	61.03	15.63	95.30	229.50	477.44
		SAIDI	80.01	491.28	158.33	158.33	101.38	989.33
3	2018	SAIFI	75.01	43.96	7.16	94.01	286.02	506.16
		SAIDI	128.59	114.03	157.87	87.47	418.45	906.41
4	2019	SAIFI	14.92	47.79	8.29	86.01	161.09	318.10
		SAIDI	11.01	114.36	30.94	0.64	367.79	524.74
Average (Feeder wise)		**SAIFI**	**41.48**	**38.19**	**7.77**	**68.83**	**169.15**	
		SAIDI	**54.90**	**179.92**	**86.79**	**61.61**	**221.91**	
Average (Overall)		**SAIFI**	**367.68**					
		SAIDI	**855.21**					

Source: System Performance Report of DCSD, BPC

Notes:

(a) ***SAIFI*** *(System Average Interruption Frequency Index) = (Total no. of customer interruption per year)/ (Total no. of customers served)*
(b) ***SAIDI*** *(System Average Interruption Duration Index) = Σ (Total interruption duration per year)/(Total no. number of customers served)*

(c) The momentary outages less than five minutes and outages due to failure of the grid are not taken into account.

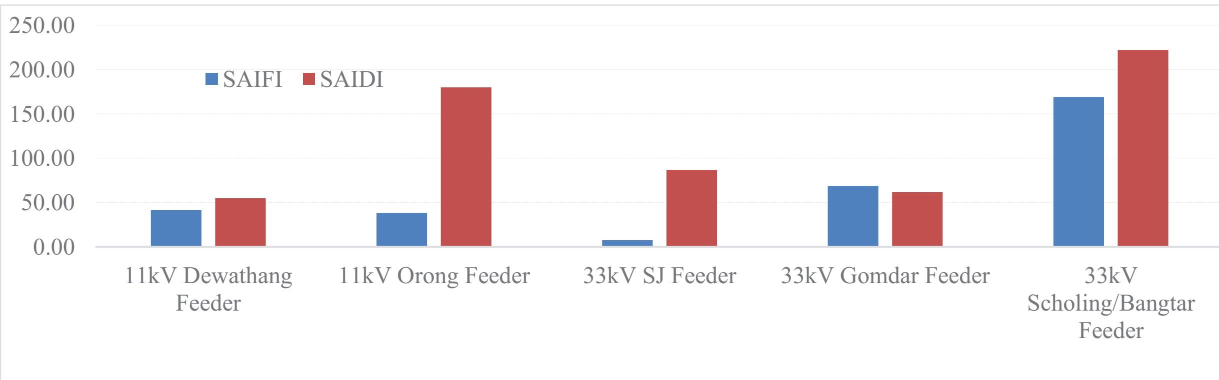


Figure 7: Graphical Representation of Reliability Indices

As seen, the frequency of outages and outage duration time is much higher for the 33kV Bangtar feeder, 33kV Gomdar feeder, and 11 kV Orong feeder. The measures and recommendations to curve the reliability issue and other problems are outlined as follows:

a) 33kV Bangtar feeder

The reliability indices of the feeder for the year 2017 and 2018 are tabulated in the following **Table 14** and details to arrive is attached as **Annexure-5**

Table 14: SAIDI and SAIFI for the year 2017

Month	2017		2018		Average	
	SAIFI	SAIDI	SAIFI	SAIDI	SAIFI	SAIDI
Jan	9	9.19	10.98	10.31	9.99	9.75
Feb	21	72.83	12.98	12.18	16.99	42.505
Mar	23.99	44.01	35.8	73.06	29.895	58.535
Apr	20	55.32	29	67.93	24.5	61.625
May	7	1.22	23	16.15	15	8.685
Jun	27	51.23	10	4.46	18.5	27.845
Jul	25.58	28.72	51	62.26	38.29	45.49
Aug	29	28.07	15.86	16.66	22.43	22.365
Sep	26	74.1	41	75.99	33.5	75.045
Oct	18	7.41	21	37.23	19.5	22.32
Nov	14.64	59.98	20	27.56	17.32	43.77
Dec	11.4	15.24	10	14.33	10.7	14.785
Total					**256.615**	**432.72**

Table 14 clearly shows that reliability indices for the Dzongkhag is due to the contribution of most susceptible 33kV Bangtar Feeder. To get a better view of the reliability index, the past tripping records of 2017 and 2018 have also been captured in **Table 15**.

The outage duration and the frequency shown above are the sums of both planned and tripping due to faults (unplanned). While analyzing the outage details of the feeder, it has been noted that most of the tripping is due to transient faults, trees falling on the power lines, destruction of structures by wild animals, and landslides.

Table 15: Tripping Data for 2017 and 2018

Tripping Record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2017													
Outage (hours)	9.2	72.8	44	55.3	10.7	51.2	29.2	28.1	74.1	7.4	23.8	11.8	**417.7**
Frequency	9	21	24	20	7	27	26	30	26	18	19	11	**238**
2018													
Outage (hours)	10.1	12.2	73.1	67.9	16.2	4.5	62.3	16.7	76	37.2	27.6	14.3	**417.9**
Frequency	10	12	39	29	23	11	52	16	41	21	20	10	**284**

With the commissioning of the Phuentshothang substation, the Jomotsangkha Drungkhag can be fed from the Samrang feeder which would improve the power quality to a certain extent. However, Jomotsangkha would still face reliability issues. The 29km line from Samrang to Agurithang (Langchenphug gewog) passes through a dense forest infested with wild elephants which impedes the restoration works. Further, the swollen rivers during monsoon season worsen the condition whereby the faulted line sections are inaccessible and prevent maintenance team from the quick restoration of power supply.

A detailed study was carried out by the Research and Development Department, BPC for the improvement of power supply to Jomotsangkha. The study explored the following long term solutions;

a) Construction of 33 kV line on the newly designed tower from Phuentshothang to Jomotsangkha;
b) Construction of 33 kV line on 132kV Tower from Phuentshothang to Jomotsangkha; and
c) Installation of 1500 kVA Diesel Generator at Jomotsangkha.

Until any of the aforementioned plans are approved and implemented, it is recommended to increase the frequency of RoW clearing, non-working ARCBs should be made functional and to install FPIs to locate the faults easily.

b) 11 kV Orong feeder

Similarly, the 11kV Orong line is susceptible to power interruptions next to 33kV Bangtar Feeder. The section of line (around 6.0km) is along the Deori river whereby it is very difficult to access during the monsoon season and takes a longer period to restore the power supply. This problematic section of the 11kV Orong line could be avoided by interconnecting the 11kV Orong line with the existing 33kV Gomdar feeder which would be charged at 11 kV voltage as depicted in **Figure 8.** The customers of Gomdar feeder can be catered by Martshala feeder. However, the two 33/0.240 kV, distribution transformers which cater to a load of Athraise and Dengzor village needs to be replaced with 11/0.24 kV transformer of equivalent rating (i.e. 2x16 kVA). With this arrangement, the reliability of the feeder(s) is expected to improve.

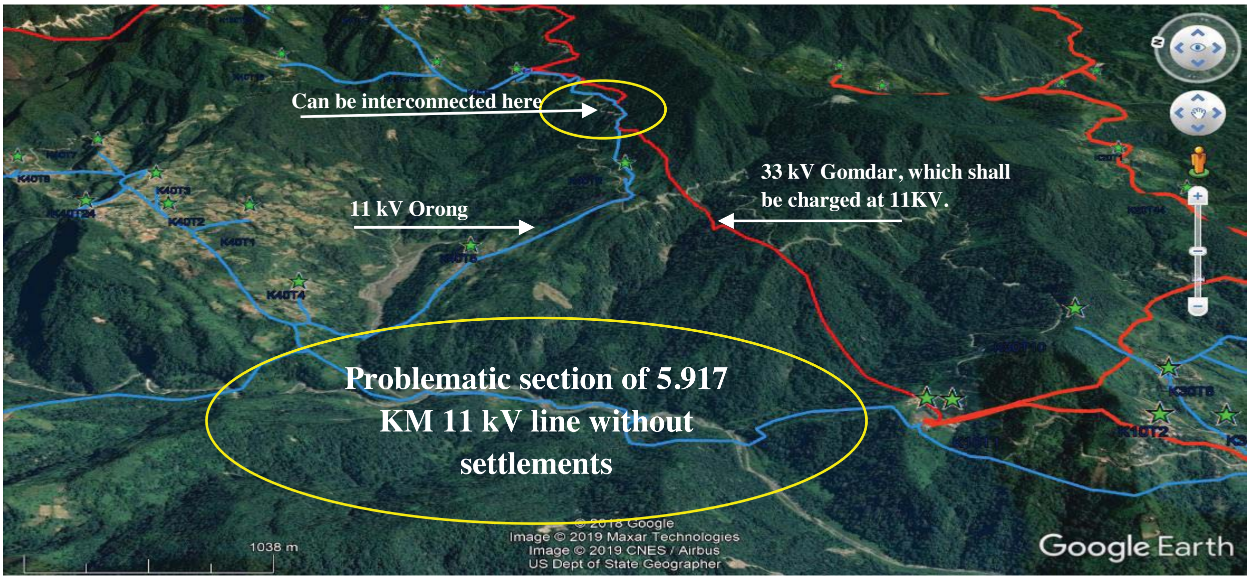


Figure 8: Problematic section of 11 kV Orong Feeder

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 to these loads is gaining 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 phases by constructing a third conductor on existing pole structures. The transformer can be upgraded from single phase to three phases as and when the demand for a 3-phase supply comes. The line up-gradation across the country would amount to Nu. 97.00 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 in the Dzongkhag is 93.673 km (33kV). The estimated cost for the conversion of such is Nu. 11.23 million.

As the single phase to three network conversions is a demand driven planning, conversion 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

7.3.1 Distribution Transformer Loading

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

Some of the existing transformer capacities would not be adequate to cater to the forecasted load growth for the next ten (10) years. Accordingly, the capacities of the transformers need to be up-graded and such a proposal is tabulated in **Table 16**. The individual DT loading details used to derive the summary is attached as **Annexure-7**.

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. 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 15 transformers as tabulated in **Table 16.** However, cross-swapping of the existing transformers before procurement of new transformer would mean that only 5 transformers have to be procured.

Table 16: List of Overloaded Distribution Transformers

Name	Capacity (kVA)	Load (kVA)	2019	2025		2030		
			% loading	kVA	% loading	kVA	% loading	Remarks
11kV Orong Feeder								
Melum	63	36.46	57.88%	139	221%	181.22	288%	New 250kVA
Menchuri	25	5.38	21.52%	20.51	82%	26.74	107%	New 125kVA
Metangkhar	16	13.47	84.21%	51.36	321%	66.96	419%	Replace with 63kVA Melum
Lower Pheluma	25	7.81	31.25%	29.78	119%	38.83	155%	add 25kVA from Wooling
Wooling Bachung	25	8.36	33.46%	31.88	128%	41.57	166%	Add 25kVA from Menchuri
Wooling near Lhakhang	63	18.58	29.50%	70.84	112%	92.36	147%	Load growth not expected

Name	Capacity (kVA)	Load (kVA)	2019	2025		2030		
			% loading	kVA	% loading	kVA	% loading	Remarks
Nagla	16	4.17	26.06%	15.89	99%	20.72	130%	Load growth not expected
Mandhar	63	14.11	22.39%	53.77	85%	70.1	111%	
11kV Dewathang Feeder								
Old JNEC S/s	125	82.37	65.90%	139.87	112%	171.45	137%	New 250 kVA
Reshore	63	36.79	58.40%	62.47	99%	76.58	122%	Replace with 125kVA from old S/S JNEC
10 Kilo(TPO Colony)	16	8	50.00%	13.58	85%	16.65	104%	Replace with 63kVA 12Kilo
33kV Bangtar Feeder								
Upper Khamaythang	63	43.27	68.69%	64.69	102.69%	80.75	128.18%	Replace with 125kVA Samdrupcholing SS
Serjung School	25	15	60.00%	22.43	89.70%	27.99	111.97%	Replace 63kVA from Upper Khamaythang
Samdrupcholing (Dungkhag Office)	125	87.05	69.64%	130.14	104.11%	162.43	129.95%	New 315 kVA
Lama Zimchung	16	15.77	98.59%	23.58	147.39%	29.44	183.98%	Load growth not expected

7.3.2 Asset life of Distribution Transformers

The assessment of the existing loading pattern together with the remaining asset life is crucial to ascertain its capabilities to transmit the projected load growth. The life cycle of the transformer and its mapping provides clear information for its optimal utilization and development of an asset replacement framework.

Although, as listed in **Table 17**, the DTs had already outlived the asset life, proper evaluation and testing should be required to find out the actual performance of the DTs and informed decisions can be made on the continuous use of the transformers. The life of the asset has been calculated from the year transformer is put to use.

Table 17: List of Outlived Distribution Transformers

SL. No.	Substation Name/Location	Capacity (kVA)	Sl. No.	Cap.Date	2019
1	Petrol Pump	125	94CD-003/01	1994	25
2	Old Polytechnic	315	188.04	1990	29
3	Kapoor	100	14324	1978	41
4	Rekhey	100	224140/3	1976	43
5	Melum	63	184-24	1990	29
6	Kezang Sawmill	160	186.11	1990	29
7	Borbila (9km)	63	94AD-140/23	1993	26
8	Gypsum Dump Yard	315	188.01	1990	29
9	Telecom	160	186.05	1990	29
10	Stone crusher	160	94DD-083/01	1994	25
11	Dawathang	100	1159	1971	48

7.3.3 Replacement of Single Phase Transformer

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 a need basis. The cost of Nu. 186 million is estimated for replacing all the single transformer including the distribution board across the county. The detailed work out is produced as **Annexure-8.**

There are around 117 single phase transformers in the Dzongkhag. The estimated cost for the conversion of such is Nu. 15.5 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

Samdrupjongkhar Thromde stretches down from Dewathang to the India-Bhutan gateway in the south, sharing its border with the Indian state of Assam. The Samdrupjongkhar Thromde has a population of 10,545 with an area of 4.47 sq. km (1067.873 acres of land) divided into 7 Local Area Plans (LAP-I to LAP-IV at S/Jongkhar, and Dewathang LAPs) The formal development of Samdrupjongkhar Thromde commenced only in 2011, having approved Samdrupjongkhar Thromde as one of the four Class-A Thromdes by the Parliament in August 2010. The Thromde was then formally delinked from the Dzongkhag Administration on 14th March 2011. The office of the Census Commissioner’s preliminary report places approximately 35,079 (4.8%) of the total population is in Samdrupjongkhar Dzongkhag.

The areas under the LAP -I are Samdrupjongkhar Core Town area, RBP Colony area, GREF area near India-Bhutan Gate, Vegetable Market area, and FCB Auction Yard.

Similarly, LAP II consists of all Government Institutions including the Dzongkhag Administration, Royal Court of Justice, Dratshang, Middle Secondary School, Hospital, and NPPF & NHDCL Residential Colony area.

As informed, the planning for LAP IV, Bangtsho & Kipse LAPs at Dewathang has been completed and the plot allocation would start by December 2019. The areas under LAP-IV are the Penchinang Checkpost area, Tashi Gatshel area, NPPF area and a total of 84 plots would be allocated. Therefore, it is anticipated that there will be a construction boom due to the presence of Motanga Industrial Estate or IP increasing the power demand in addition to normal growth.

The Samdrupjongkhar Throm network is as shown in **Figures 9, 10, 11, 12 & 13**.

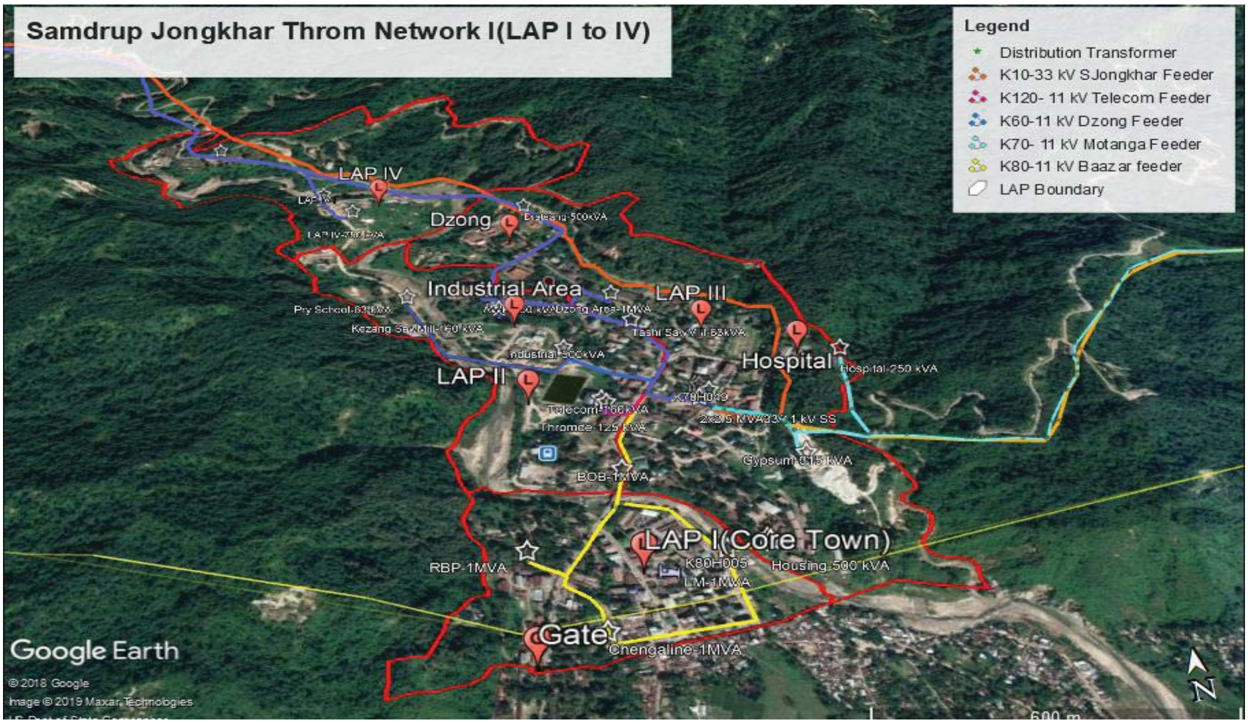


Figure 9: Existing 11 kV Network of LAP I to IV-Overall

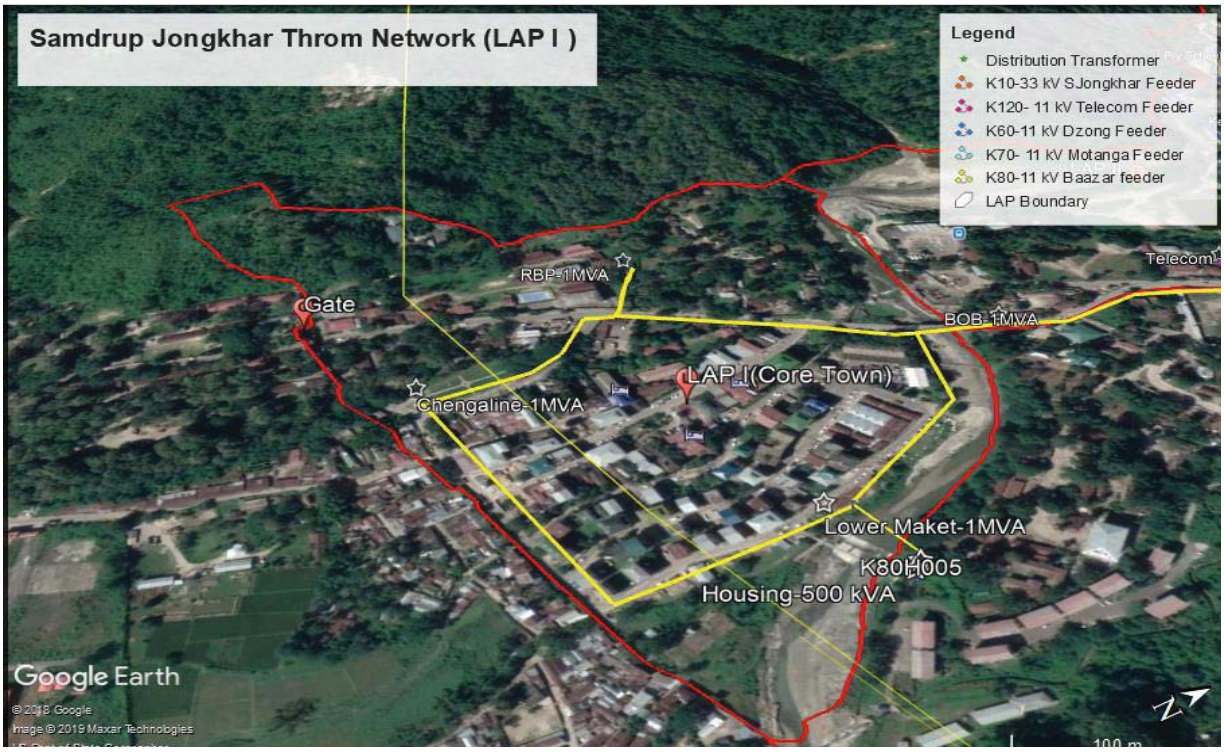


Figure 10: Existing 11 kV Network of - LAP I

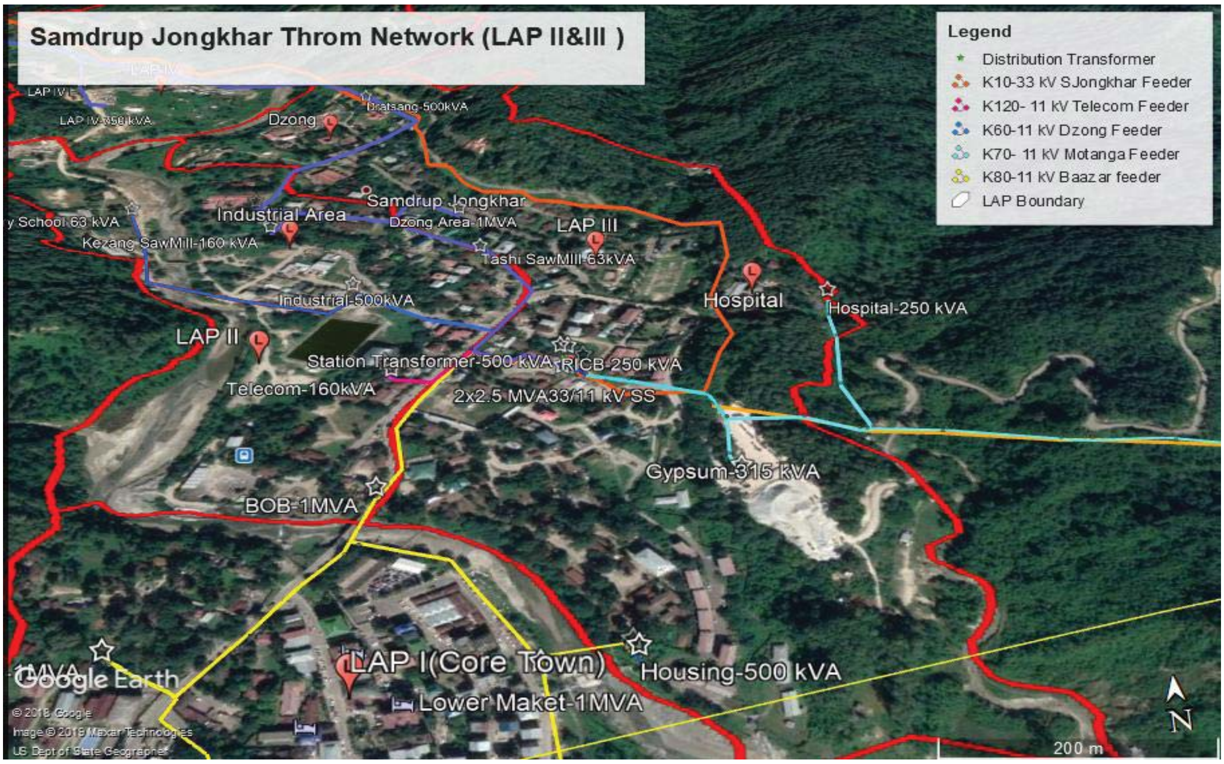


Figure 11: Existing 11 kV Network of Samdrup Jongkhar Throm - LAP II & III

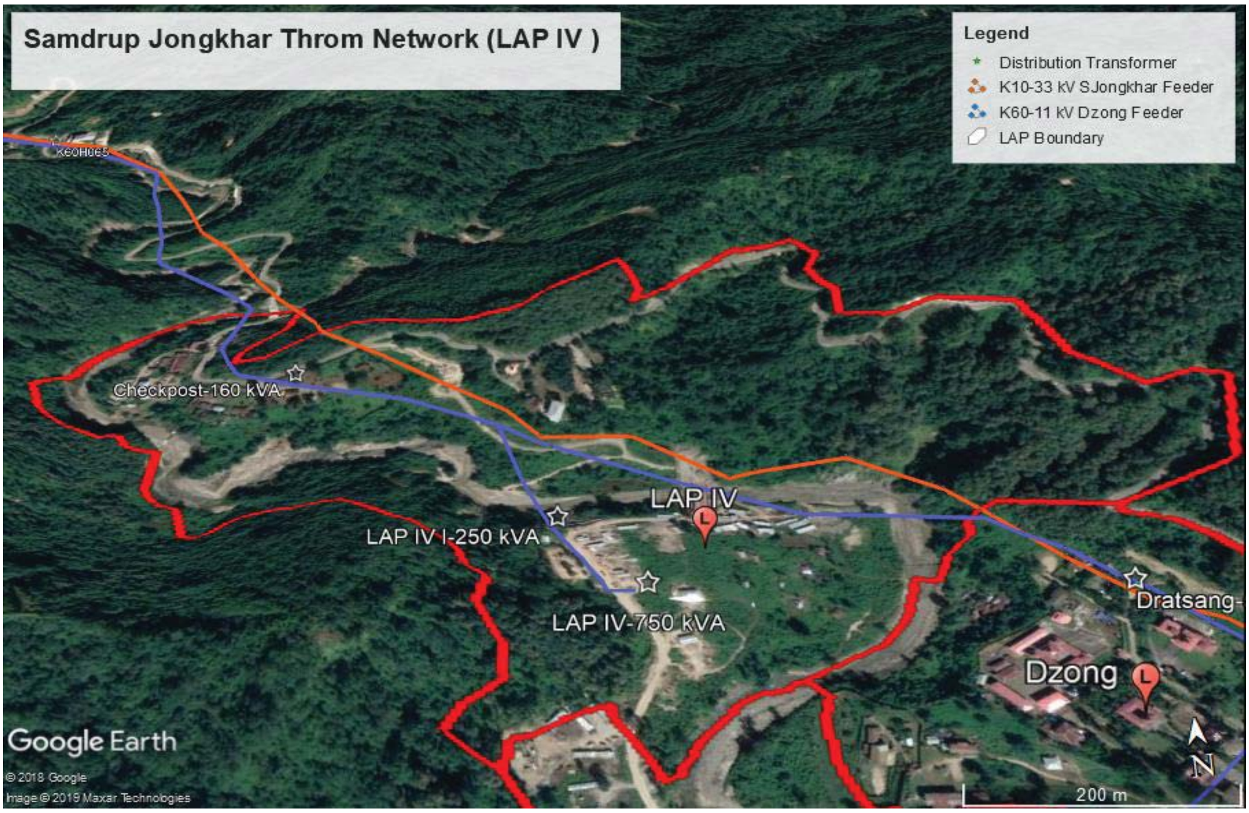


Figure 12: Existng 11 kV Network of Samdrup Jongkhar Throm - LAP IV

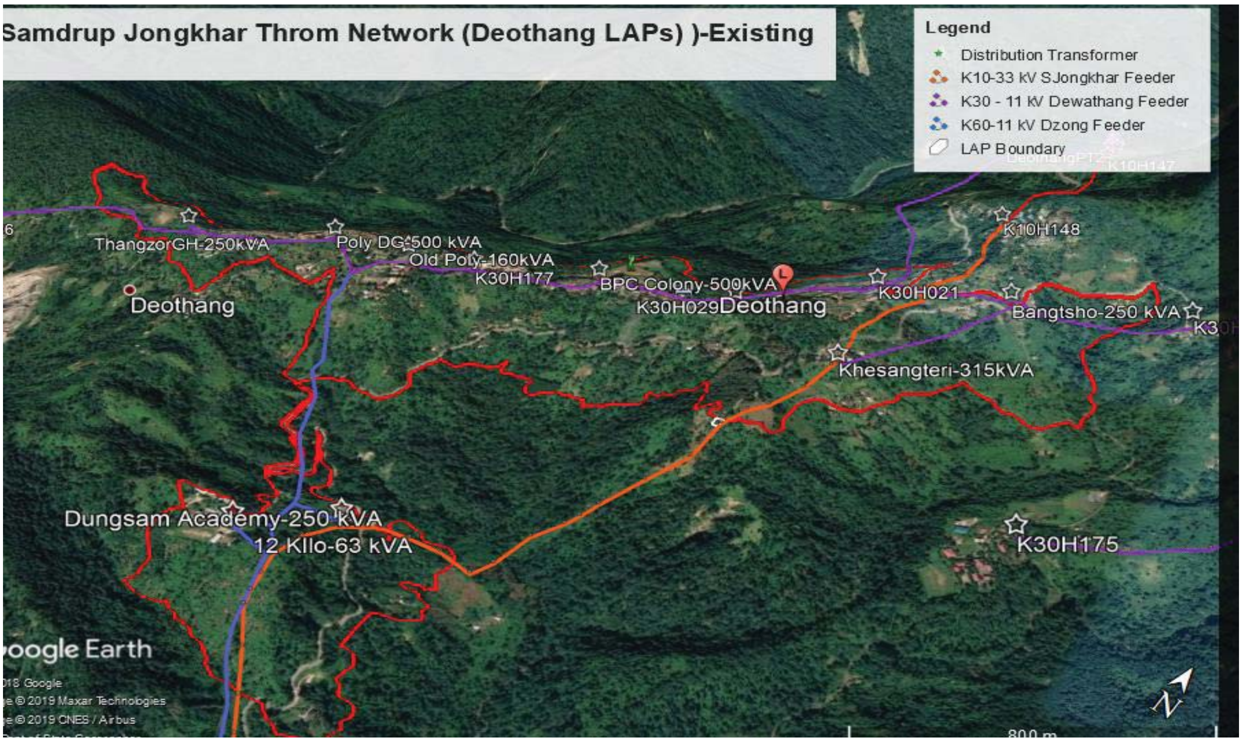


Figure 13: Existing 11 kV Network of Dewathang LAPs

The LAPs administrative boundaries for Samdrupjongkhar Thromde are as shown in **Figures 14 & 15**.

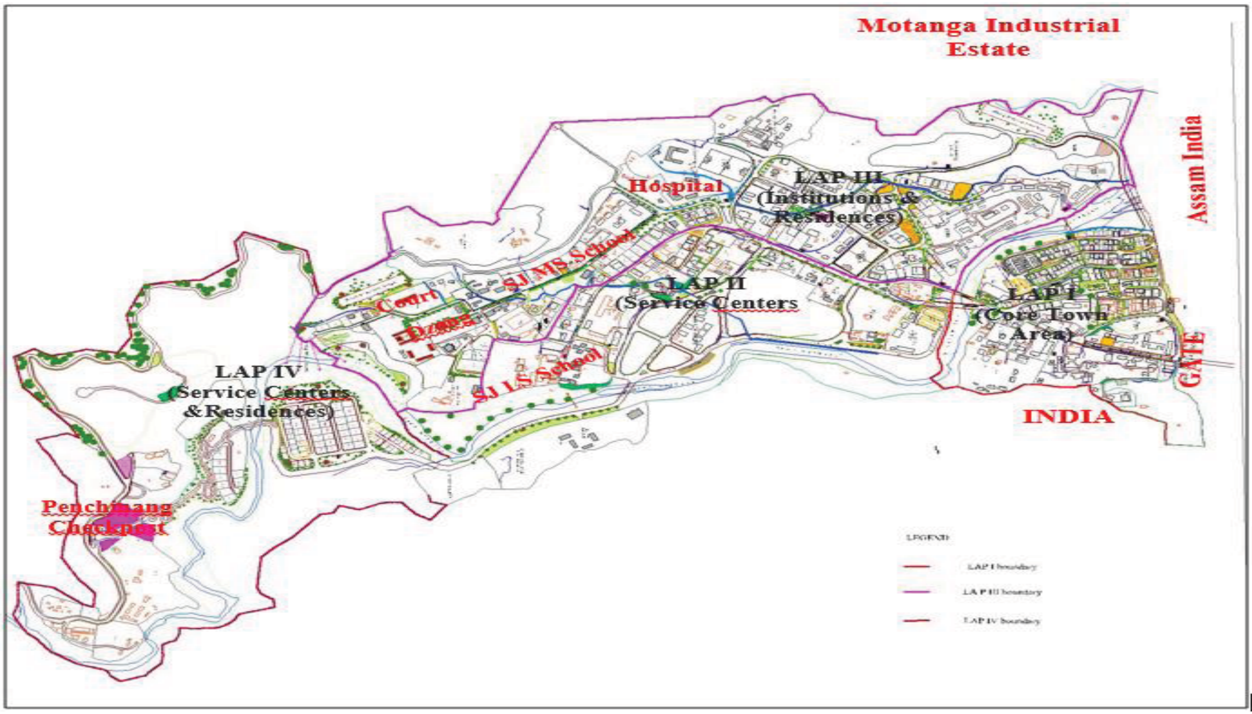


Figure 14: Administrative boundary map & Location of LAPs at Samdrupjongkhar.

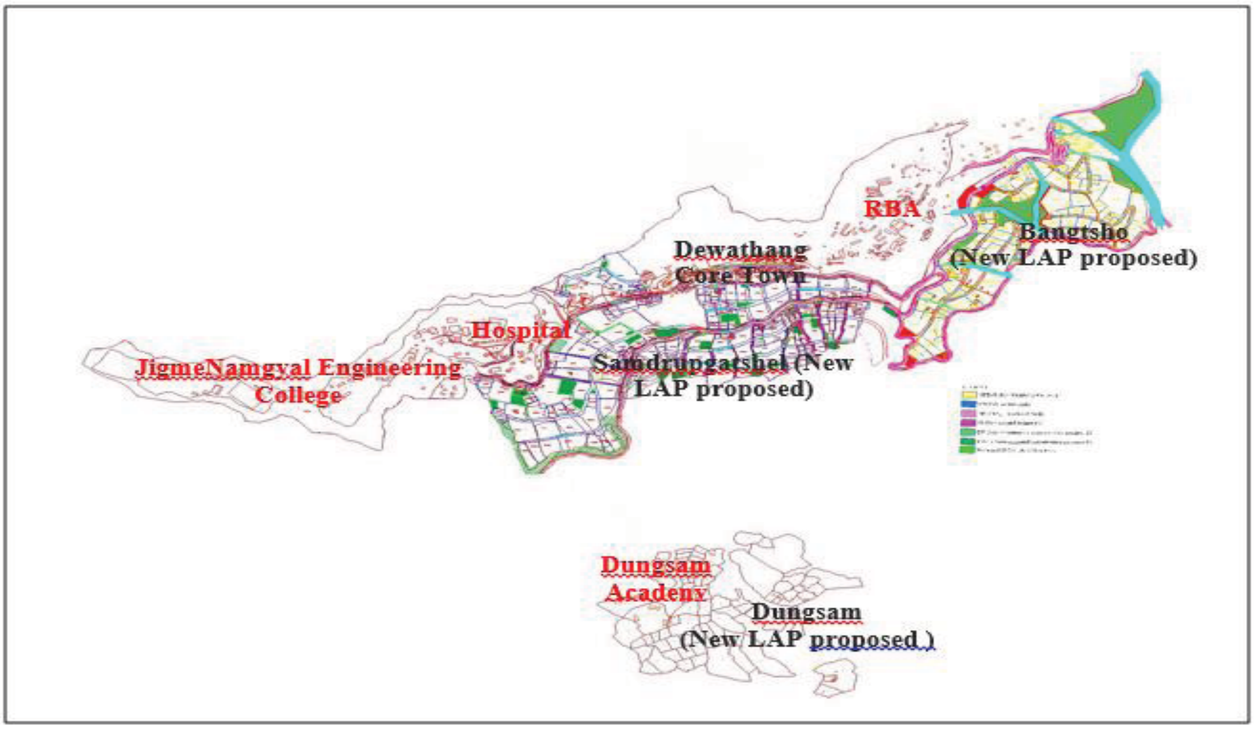


Figure 15: Administrative boundary map & Location of LAPs at Dewathang

i. Existing Distribution Network and Scenario

a) Existing Infrastructure

Besides the existing building infrastructures, 14 new buildings construction works specifically in the LAP II, III & IV are under full swing and power clearances for construction of 15 new buildings have been issued so far. Out of 85 plots allocated under LAP-IV, one building has been completed and 5 buildings are under construction. The basic amenities such as access road, drainage, and sewerage system, and footpath have also initiated in LAP IV and Dewathang LAPs.

b) Existing Distribution Network

Currently, the Samdrupjongkhar Thromde (S/Jongkhar Area) is fed from outgoing 11kV Baazar, 11kV BoB, 11 kV Dzong, 11 kV RICB feeders originating from 33/11kV, 2x2.5MVA Samdrupjongkhar substation. The feeders are constructed with UG 3x300sqmm Aluminum Cable for LAP I, 11 kV Rabbit & Dog for LAP II, III, IV, and Dewathang LAPs. The power supply to Samdrupjongkhar Throm consisting of 7(Seven) LAPs (Samdrupjongkhar- 4 LAPs and Deothang-3 LAPs) are interconnected through 11 kV Dzong & 11 kV Dewathang. The trunk line was Up-graded to ACSR Dog conductor in 2016. There are twenty-five transformers with an installed capacity of 8,803 kVA for 1,851 customers as shown in **Table 18**.

Table 18: Distribution Transformers under LAP I to IV and Dewathang LAPs

Sl. No.	Name of Transformer Location	Installed Capacity (kVA)	Location	Customer
DT Under LAP I to LAP IV				
1	Industrial area	500	Industrial Area	
2	Pry. School	63	Samdrupjongkhar LSS	
3	Tashi Sawmill	63	Tashi Sawmill	
4	Dzong Area	1000	Government Workshop, FCB Office, Jail, Dzong	
5	Kezang Sawmill	160	Kezang Sawmill	
6	AWP	250	AWP area	
7	Dratshang	500	Dzong area	
8	LAP IV	750	LAP IV	
9	Check post	250	RBP Colony and Checkpost	

Sl. No.	Name of Transformer Location	Installed Capacity (kVA)	Location	Customer
11	Telecom	160	Telecom Office	1811
12	Thromde SJ	125	Thromde Office	
13	Gypsum yard	315	Housing Colony, Gypsum Weigh Bridge, RBP Colony	
14	Hospital	250	Samdrup Jongkhar Hospital	
19	RICBL	250	NPPF Colony	
20	BPC Colony	500	BPC Colony	
21	BOB	1000	BOB	
22	Lower Market	1000	Lower Market	
23	NHDCL colony	500	NHDCL Colony	
24	Chenga Line	1000	Upper Market	
25	RBP Colony	1000	RBP Colony	
	Total	**9636**		**1811**
DTs Under Dewathnag LAPs				
1	Petrol Pump	125	RBA Dewathang	500
2	RBA DG	250	RBA Dewathang	
3	Khesangteri	315	Khesangteri area	
4	Bangtsho	250	Bangtsho LAP	
5	Old Poly	125	JNEC	
6	Poly DG	500	JNEC	
7	Poly Guest House	125	JNEC	
8	BPC colony	500	Dewathang Baazar	
9	Hospital	1000	Dewathang Hospital	
10	Dungsum Academy	250	Dungsam Academy	
12	12Kilo	63	Gayzor	
	Sub-total	**3753**		**500**

The peak load of the Samdrup Jongkhar town recorded as of October 2019 is 1.77 MW (2.082 MVA) which is 21.61% loaded against the installed capacity. The total forecasted load for LAP I to IV based on Distribution Transformer loading is 3.191 MVA for 2025 and 3.912 MVA for 2030.

The installed capacity of 33/11 kV Samdrup Jongkhar Substation works out to be 4.25MW (5MVA @0.85 pf) each and would be adequate to meet the power requirement when both are operating. However, under single out condition, one feeder/transformer won't be able to meet the forecasted load of 3.912 MW in 2030 for the circuit length of 4.45km. Further, when the power supply from the 11 kV Dewathang Feeder is interrupted, 33/11 kV Substation should be able to cater the additional forecasted load of 1.413 MVA in 2025 and 1.713 MVA in 2030 for Dewathang LAPs.

Therefore, it is recommended to upgrade the 2x2.5 MVA substation to 2x5MVA to meet the increasing power demand.

The improvement & up-gradation work for the power distribution network under LAP I which falls under Core town were carried out during the year 2013 to 2014. However, distribution network for LAP II, III, and IV under Samdrup Jongkhar thromde is still with an overhead distribution line constructed with ACSR Dog and Rabbit conductor and passes through LAP III and IV. These require overhead to UG conversion which is being planned under the second phase improvement and up-gradation project for the upper Thromde area during the year 2021-2023 to solve RoW issues, public safety, and aesthetic point of view. Similarly, 11 kV Dewathang Feeder passes through the center of the core area requiring it to be converted to a UG system. Further, to meet the load demand of the new LAPs and existing LAPs, we have proposed to construct an additional distribution substation as shown in **Figures 16, 17 & 18.**

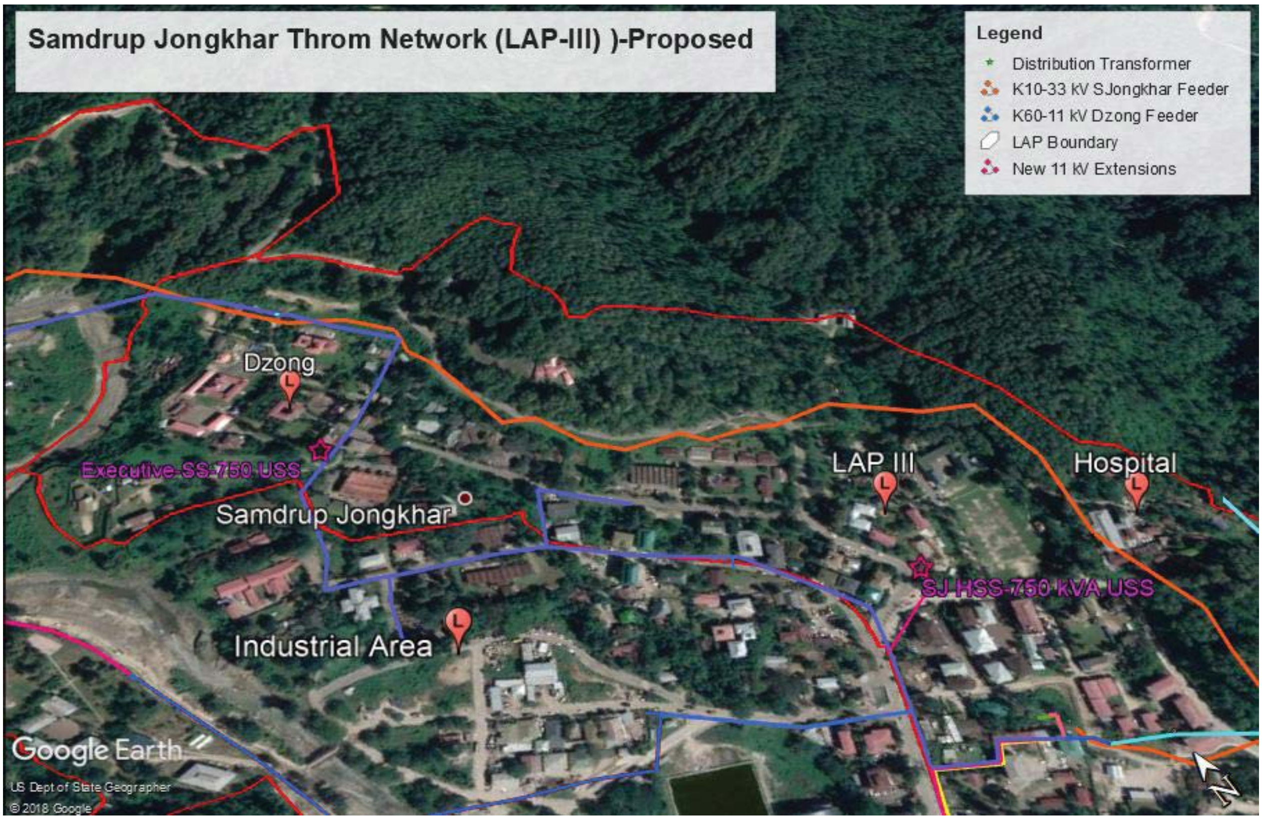


Figure 16: Proposed new substation for LAP II & III

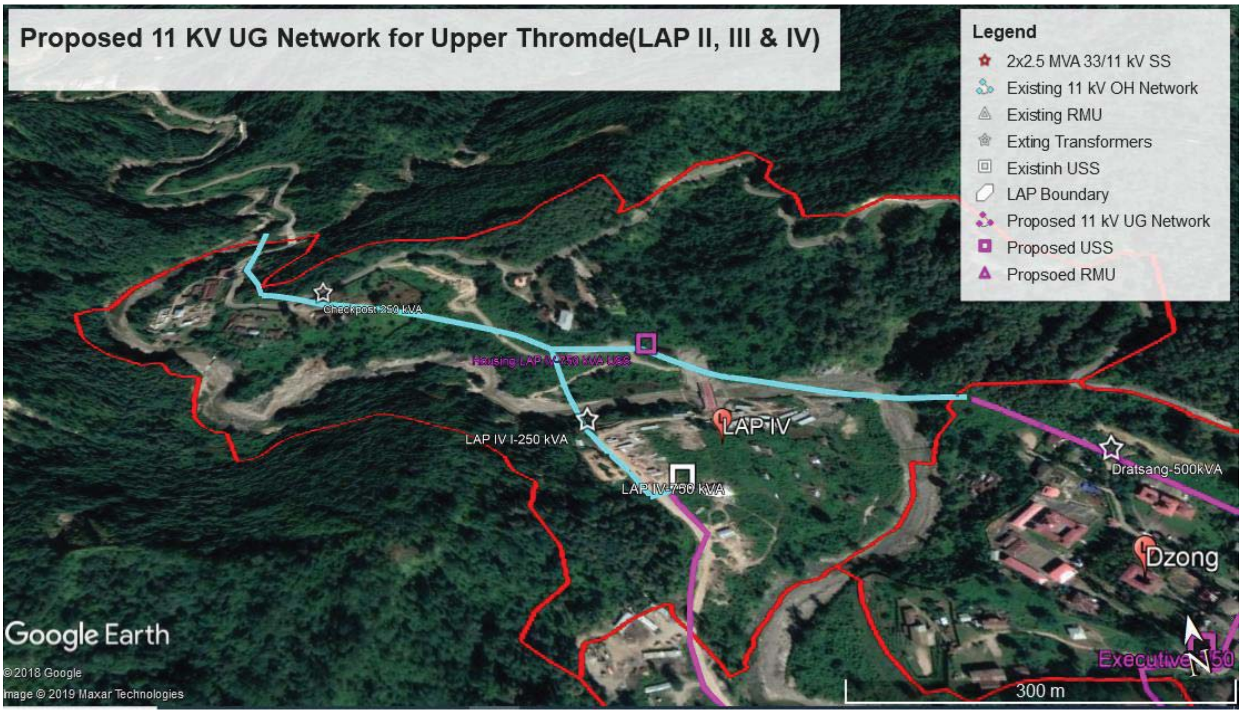


Figure 17: Proposed new substation for LAP IV

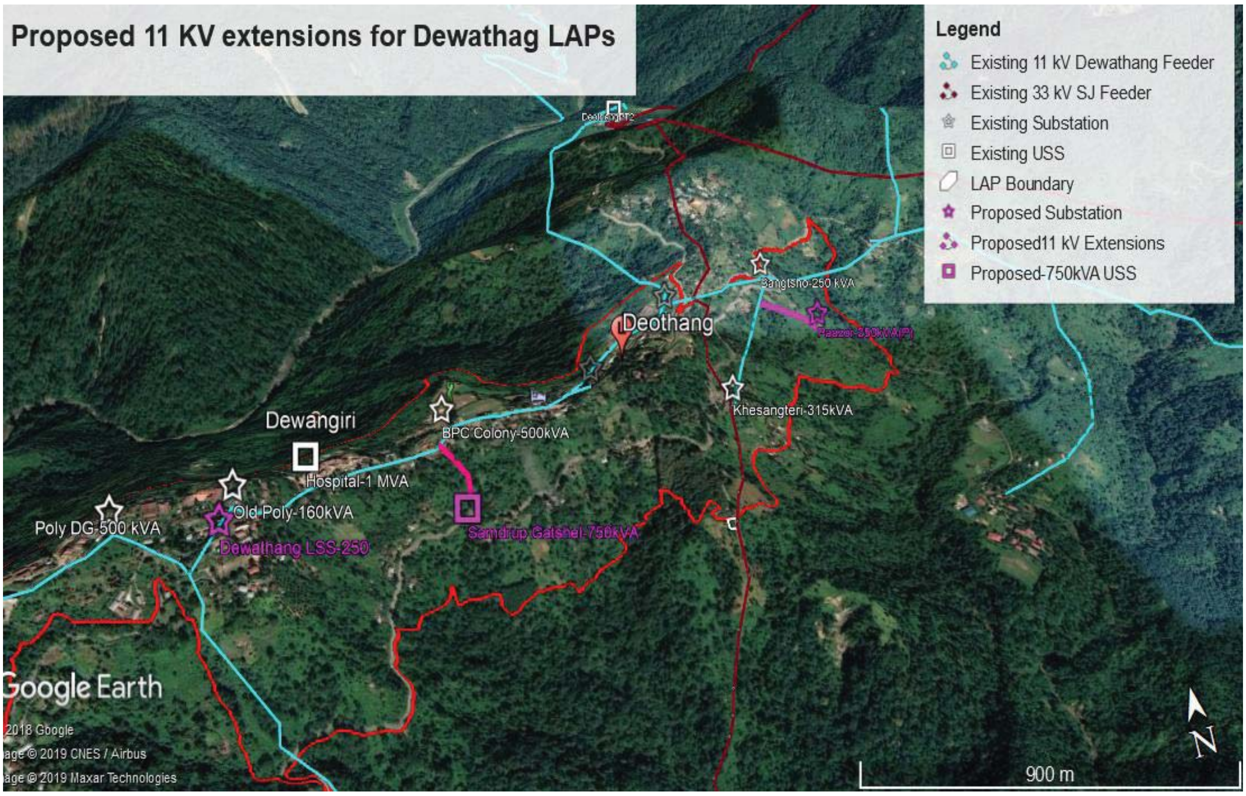


Figure 18: Proposed new substation for Dewathang LAPs

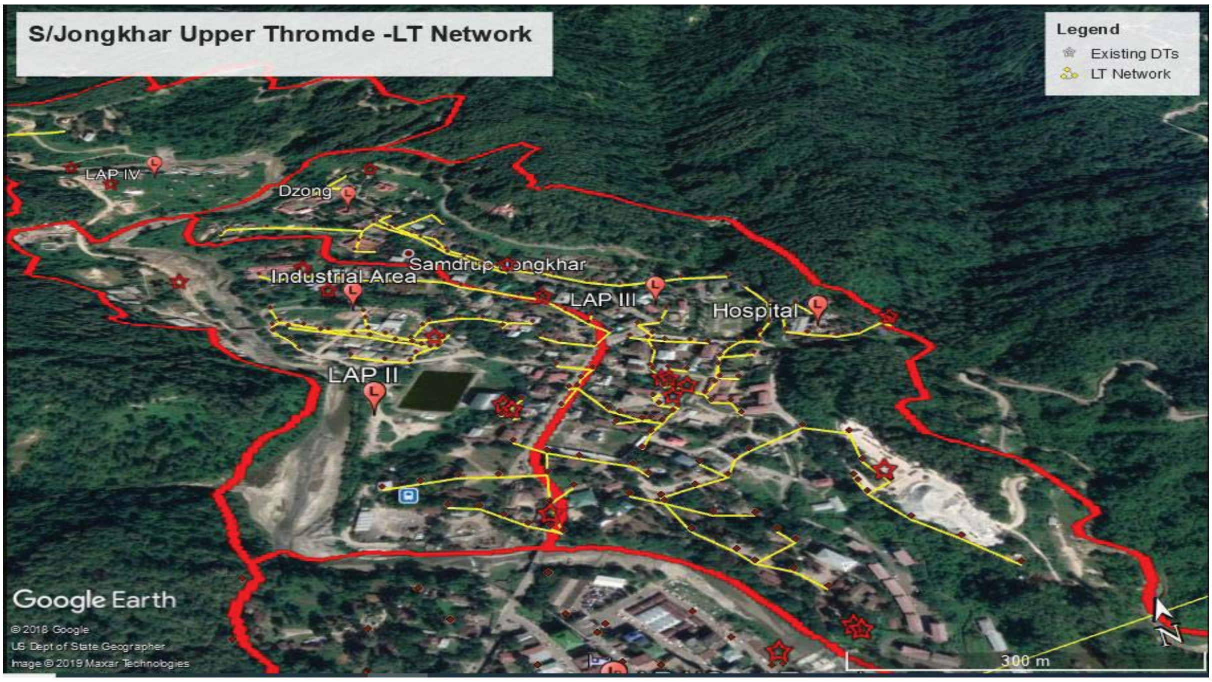


Figure 19: LT distribution network in Samdrup Jongkhar town LAP II & III.

As shown in **Figure 19,** the LT network is represented by a yellow line distributed under LAP-II & III. The LV lines for Upper Thromde are overhead with old RCC pole which have deteriorated due to age and on the verge of collapsing anytime, possess a high risk to the safety of the public, aesthetically looks bad and have limitations for up-gradation to meet the increased load demand. Further, as a maximum of the LV lines passes through private plots, frequent shifting is required to facilitate developmental works like the construction of new buildings and other public amenities. Therefore, it is felt necessary to convert the existing LT overhead lines to UG due to RoW issues, for the general safety of the general public and more importantly from an aesthetic point of view.

ii. Augmentation of Transformer Capacities

As per the load forecast, the peak load of the Samdrupjongkhar area will be 3.191 MVA and 3.912 MVA for 2025 and 2030 respectively and the Dewathang area will be 1.413 MVA and 1.713 MVA. The total capacity requirement is calculated as 6.0 MVA only. However, some of the distribution Transformers are overloading due to increased load demand of the particular area and some areas need to have new installation due to the expansion of new LAPs. Therefore, upgrading of existing substations to higher capacity would be required and need to be planned phase-wise manner in tandem with improvement & development works for Thromde areas to meet the increasing power demand and the details are as shown below:

a) Upgrade 11/0.415kV, 500 kVA to 750 kVA USS at Industrial Area
b) Upgrade 11/0.415kV, 250 kVA to 750 kVA USS at Gypsum Yard
c) Upgrade 11/0.415kV, 160 kVA to 250 kVA at Kezang Saw Mill
d) Upgrade 11/0.415kV, 315 kVA to 750 kVA USS at AWP
e) Upgrade 11/0.415kV, 63 kVA to 250 kVA at S/Jongkhar Pry School
f) Upgrade 11/0.415 kV, 250 kVA to 750 kVA USS at RBA-Dewathang
g) Upgrade 11/0.415 kV, 63 kVA to 250 kVA at 12 KM-Dewathang
h) Construction of 11/0.415 kV, 750 kVA Package substation for Executive Residence
i) Construction of 11/0.415kV, 750 kVA Package substation at S/Jongkhar HSS
j) Construction of 11/0.415kV, 750 kVA Package substation at LAP IV Housing
k) Construction of 11/0.415 kV, 750 kVA Package substation at Samdrupgatshel LAP, Dewathang
l) Construction of 11/0.415 kV, 250 kVA at Bangtsho LAP(Pazor), Dewathang
m) Construction of 11/0.415 kV, 250 kVA at Dewathang LSS

iii. Augmentation of conductor size and Conversion

a) UG network for Samdrup Jongkhar LAP II & III and Dewathang Core Area

For customers in LAP II & III of Upper Samdrup Jongkhar Throm, the power supply will be fed from 750 kVA Industrial substations, 1000 kVA Dzong Area, 750 kVA AWP, 500 kVA Dratshang, and new 750 kVA substation of Executive Residential area. Similarly, for the customer under LAP IV, the power supply will be fed from LAP IV-750 kVA USS, LAP IV-250 kVA Substation, 250 kVA RBP-4KM Substations. For LAPs at Dewathang, the power supply will be made from 750 kVA RBA, 500 kVA Baazar, 315 kVA Khesangteri, new 250 kVA Dewathang LSS, 250 kVA Bangtsho I & II Substations, and 750 kVA Samdrupgatshel USS.

There shall be provision for LT interconnection arrangement to have an adequate contingency plan, should any of the transformer fails.

b) HT overhead bare conductor to UG cable for a line passing through the town area

11kV Dzong feeder is constructed with ACSR Dog conductor which passes through the town area and also through the private and service plots in the AWP area. Further, 11 kV Dewathang Feeder & 33 kV S/Jongkhar Feeder passes right through the street of Dewathang Core Town area, private plots, and along the proposed Dewathang-Nganglam highway which impedes developmental activities. Therefore, to solve the RoW issues, for the safety of the general public and from an aesthetic point of view, it is proposed to replace the overhead bare conductor with UG cable.

The proposed network for improvement & up-gradation of an existing OH distribution system for LAP II, III, and IV & Dewathang Core town area with UG Distribution system is as shown in **Figure 20 & 21:**

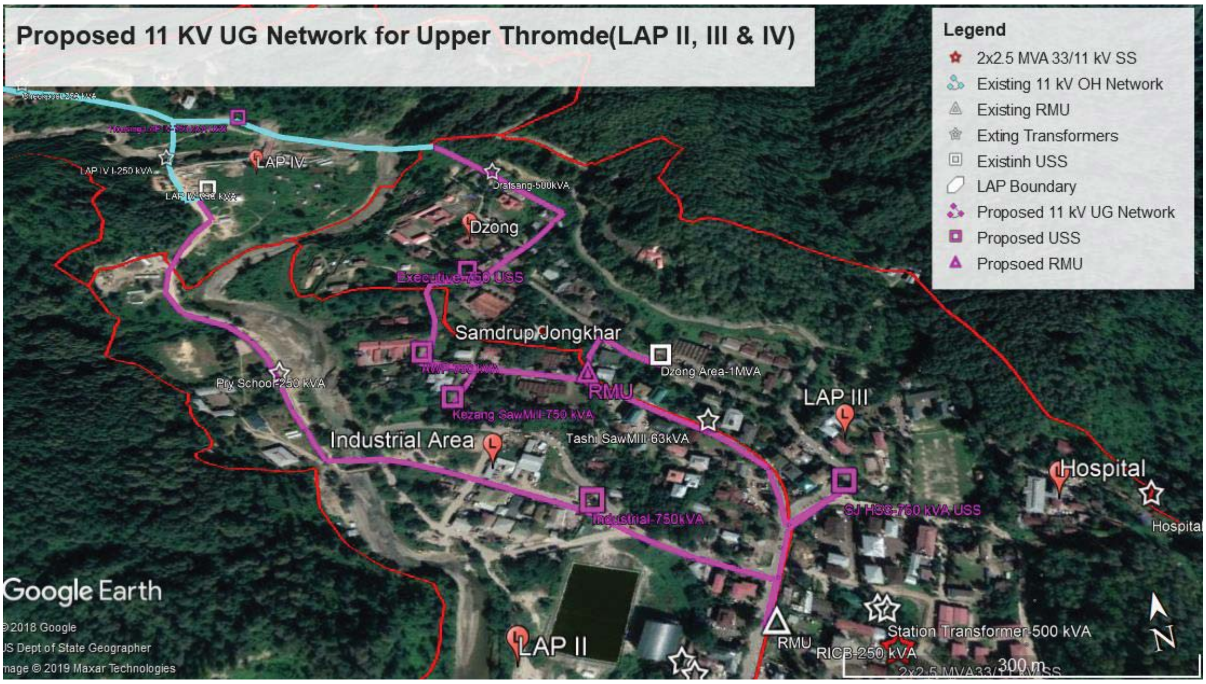


Figure 20: Proposed Distribution Network for LAP I-IV.

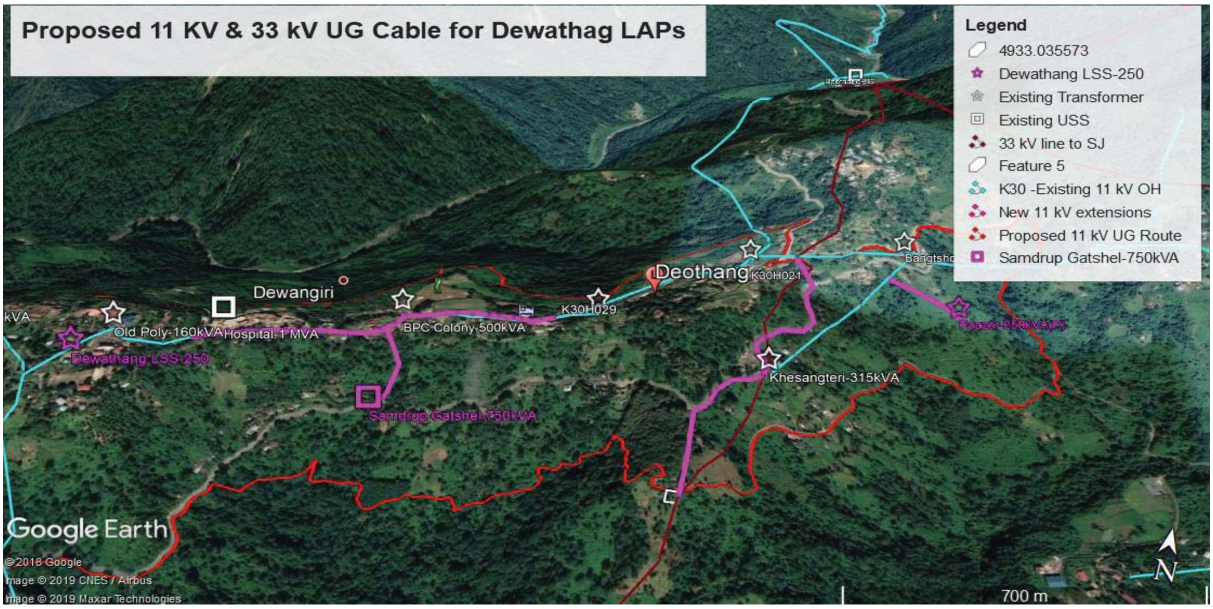


Figure 21: Proposed Distribution Network for Dewathang

8. Distribution System Panning till 2030

The distribution network of Samdrupjongkhar Dzongkhag has a radial topology with a 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. To have a 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 an 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 is detailed from **Section 8.1** through **Section 8.4.**

8.1 Power Supply Source

8.1.1 HV substation

As per the power source assessment made in **section 7.1**, it is recommended to up-grade the 1x15 MVA Motanga substation to 2x15 MVA to cater to a load of Motanga IP. The load of 14.75 MW is anticipated by 2030 at Motanga IP. Up-gradation will also serve as source contingency to the 33/11 kV Samdrupjongkhar substation.

8.1.2 MV Substations

As per secondary power source assessment made in **section 7.2.2**, the detailed action plan to address the issue of overloading and power supply arrangement for future load growth are as follows:

b) Installation of additional 1.5 MVA transformer at 33/11kV Langchenphu Substation for redundancy purpose. ESD Samdrupjongkhar may install the old 1.5 MVA transformer of Samdrupjongkhar substation. However, there will be an additional cost for the procurement of the control system (ARCB) and line extension.

c) Upgrade 2x2.5 MVA, 33/11kV Samdrupjongkhar substation to 2x5 MVA to cater to the load growth of Samdrupjongkhar Throm. Samdrupjongkhar Throm consists of seven LAPs out of which four LAPs (LAP I to LAP IV) should be catered from the Samdrupjongkhar substation during normal operation. The substation recorded a peak load of 1.77 MW as of 2019. An additional load of around 2.71 MW is anticipated based on DT loading. The installed capacity of 33/11 kV Samdrup Jongkhar Substation works out to be 4.25 MW (@ 0.85 pf) which is just adequate to meet the power demand when both the transformers are in operation. However, under single out condition, one feeder/transformer won't be able to cater to the forecasted load. Further, during the failure of 11 kV Dewathang Feeder, 33/11 kV Substation should be able to cater the additional load of Dewathang LAPs. Therefore, it is appropriate to upgrade the 2x2.5 MVA substation to 2x5MVA to meet the increasing power demand.

8.2 MV and LV Lines

As per the detailed MV line assessment made in **section 7.2,** this section outlines the list of MV works that needs to be executed as a measure to meet the future power demand, improve the voltage profile, curve the reliability issue, and other associated problems.

a) Power Supply improvement to Jomotsangkha Dungkhag
    1) Construction of 33 kV line on the new designed tower from Phuentshothang to Jomotsangkha.

2) Rerouting of 33 kV line Agurthang-Tokaphug to Serthi-Lauri via Langchenphug
3) Upgradation of 525m section of trunk line at Gairitor from Rabbit to Dog

b) Interconnection of 33 kV Martshala Feeder with Gomdar Feeder (1.5 KM-new, upgrade from 11.275 KM 2 phase-3 phase from Wangphu-Kaeptang) - To improve the voltage profile of the Gomdar Feeder

c) Realignment of 33 kV Gomdar Feeder line from Shekpashing-Drupthozor (1.66 km)

d) Arrangement of Gomdar feeder to charge at 11 kV till Dengzor to bypass 6 km problematic section of Orong Feeder across Deori River valley - To improve the reliability of Orong feeder.

e) Power Supply arrangement to LAPs
   - UG Cable trenching and laying
   - Improvement and Up-gradation of the distribution system at upper Throm (LAP II, III & IV)
   - Construction of distribution substations at Dewathang
     (a) 250kVA at Dewathang LSS
     (b) 1x250 kVA, 11/0.415 kV at Pazor (Bangtsho-Demkhong)
   - Up-gradation of 11/0.415 kV Transformer
     (a) 63 kVA to 250 kVA at S/Jongkhar LSS,
     (b) 160 kVA to 250 kVA at Kezang Sawmill
     (c) 63 kVA to 250 kVA at 12 KM -Dewathang
     (d) 250 kVA Substation with Chain link fencing at Dewathang Shedra.

f) Power Supply arrangement to Motanga IP.
g) Power Supply to Samdrupcholing Township
h) Replacement of LV ACSR Rabbit conductors by LV ABC 4x95sqmm at Wooling
i) Replacement of 3.25 KM ACSR rabbit with 4x95sqmm ABC at Langchenphug

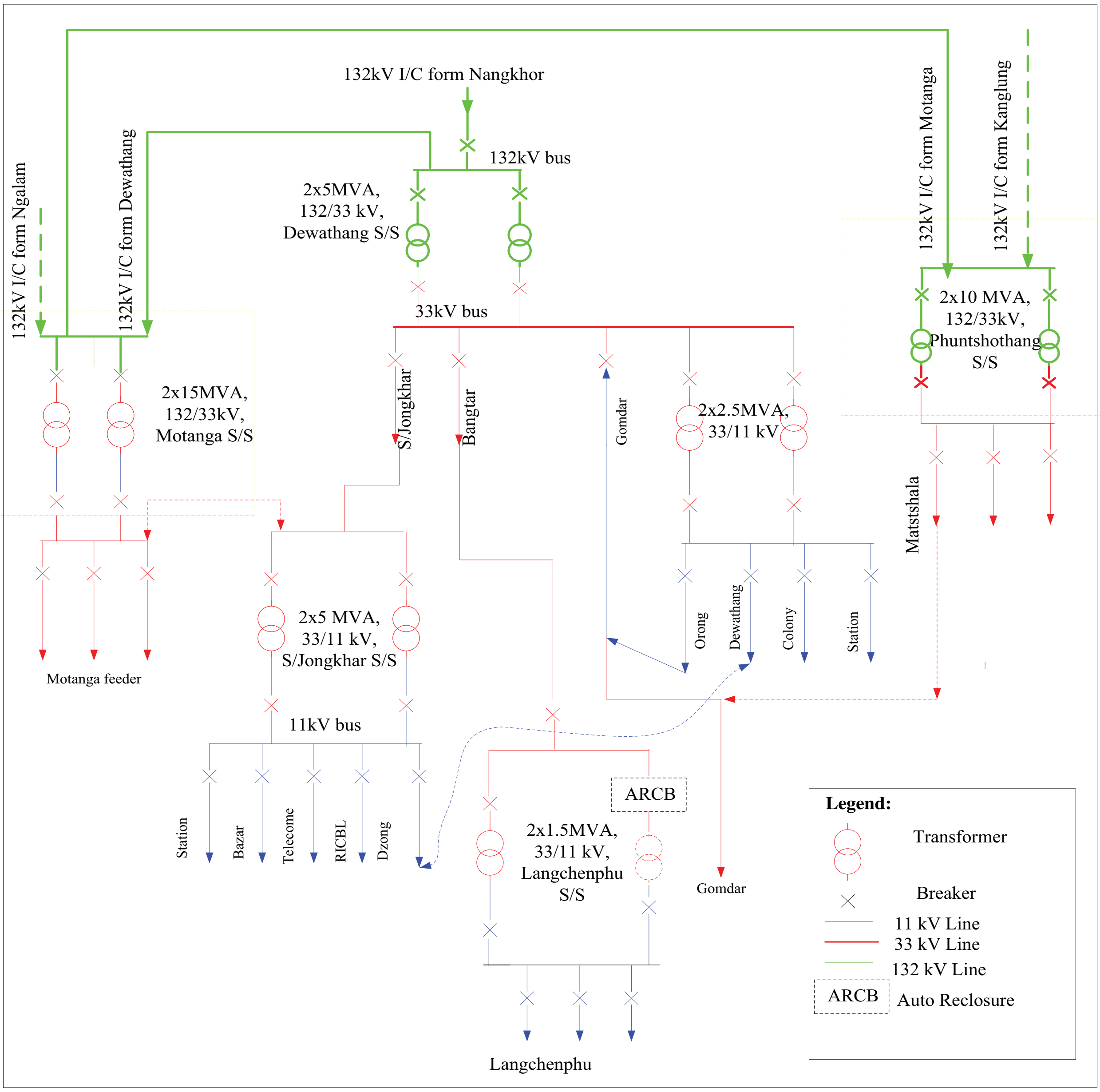


Figure 22: Proposed Distribution Network of ESD Samdrupjongkhar by 2030.

8.3 Distribution Transformers

The list of overloaded distribution transformers is presented in the earlier section of this report. As stated, while the load growth of the rural homes may not be as projected, the DTs of urban areas might get overloaded as forecasted. By disregarding the rural DTs and cross-swapping the expected overloaded urban DTs, four new DTs are needed to be procured.

a) Upgrade 125 kVA, 11/0.415 kV JNEC transformer to 250 kVA.
b) Upgrade 63 kVA, 11/0.415 kV Melum transformer to 250 kVA.
c) Upgrade 63kVA, 11/0.415 kV Menchuri transformer to 125 kVA.
d) Upgrade 125 kVA, 33/0.415 kV Samdrupcholing (Dungkhag office) transformer to 315 kVA.
e) Construction of 250 kVA substation at Chukharpo Industrial Service Center, Langchenphu
f) Constrcution of 500 kVA Substation for Samdrupcholing Town

Similarly, two 33/0.240 kV, distribution transformers that cater to a load of Athraise and Dengzor village needs to be replaced with 11/0.24 kV transformer of equivalent rating (i.e. 2x16 kVA) as the 33 kV Gomdar feeder shall be charged at 11 kV voltage.

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, optimize resource usage, and more importantly, the revenue generation will be enhanced. Similarly, to capture real-time data and information, it is inevitable to have an automated and smart distribution system. The feeders which are more susceptible to faults are identified with proposed restorative measures through the studies. Except for the tripping of breakers in the sending end substations, the existing distribution network is neither automated nor smart to detect the faults and respond in a real-time manner. Therefore, the automation and smart grid components are detailed in the BPC Smart Grid Master Plan 2019.

8.4.1 Intelligent Switching Devices

As per the detailed reliability assessment of individual feeders in **Section 7.2.3**, the 33 kV Bangtar and 11 kV Orong feeders are more susceptible to power interruptions. Therefore, additional preventive and corrective measures for these feeders need to be put in place. To improve the reliability and power quality of these feeders, it is proposed to have technology in place to respond to a fault and clear it accordingly rather than through an ex post facto approach. Therefore, it is proposed to enhance the existing switching and control system by having the 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.

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

Table 19 and 20 represent the list of switching equipment under ESD Samdrupjongkhar and **Figure 23** shows the list of FPIs to be installed at strategic locations.

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 to the customers.

Table 19: List of ARCBs under ESD Samdrupjongkhar

Sl.No.	Make	Rated voltage	Place & Year of installation	Name of feeder installed	Operational status
1	Noja, 630A	33kV	Tokorong in 2014	Gomdar Feeder	Out of service. PT failure. Can be revived after replacent of PT of extension of LV supply
2	Noja, 630A	33kV	Augutar in 2014	Langchenphu feeder	In service
3	Noja, 630A	11kV	Jomotshangkha town in 2014	India Feeder	Out of service. PSM Module not functioning
4	Jin Kwang, 800A	33kV	Samrang in 2014	Jomotsanngkha	In service
5	Allen Cooper	33 kV	Martang in 2014	Samdrupcholing	Bypassed due to PT failure. To revive soon with LT supply extension or PT replacement
6	Entec, 630A	11kV	Orong in 2014	Wooling-T-off	In service
7	Entec, 630A	33kV	Phuntshothang in 2014	Martshalla T-off	In service

Table 20: List of FPIs to be installed

Sl.No.	Location	Name of section	Qty	Unit	Voltage level	Name of Feeder
1	Samrang	Samrang-Nunai	1	set	33 kV	33 kV Jomotsangkha
2	Nunai	Nuai-Rayzor	1	set		
3	Rayor	Rayzor-Kherkheri	1	set		
4	Kherkheri	Kherkheri-Khowrong	1	set		

Sl.No.	Location	Name of section	Qty	Unit	Voltage level	Name of Feeder
5	Khowrong	Khowrong-Agurathang	1	set		
6	Agurthang	Agurthang-Tokaphu	1	set		
7	Tokaphu	Tokaphu-Phokcheri	1	set		
8	Phokcheri	Phokcheri-Lauri	1	set		
9	Kaptang	Kaptang-Serjung	1	set		33 kV Martshala
10	Denchi	Denchizor-Barzor	1	set		33 kV Gomdar
11	Gayree	Gayree-Wangphu	1	set		
12	Wangphu	Wangphu-Haila	1	set		
13	Wooling School	Wooling School-Thungshing	1	set	11 kV	11 kV Orong Feeder
14	Tersheri	Tersheri-Philuma	1	set		

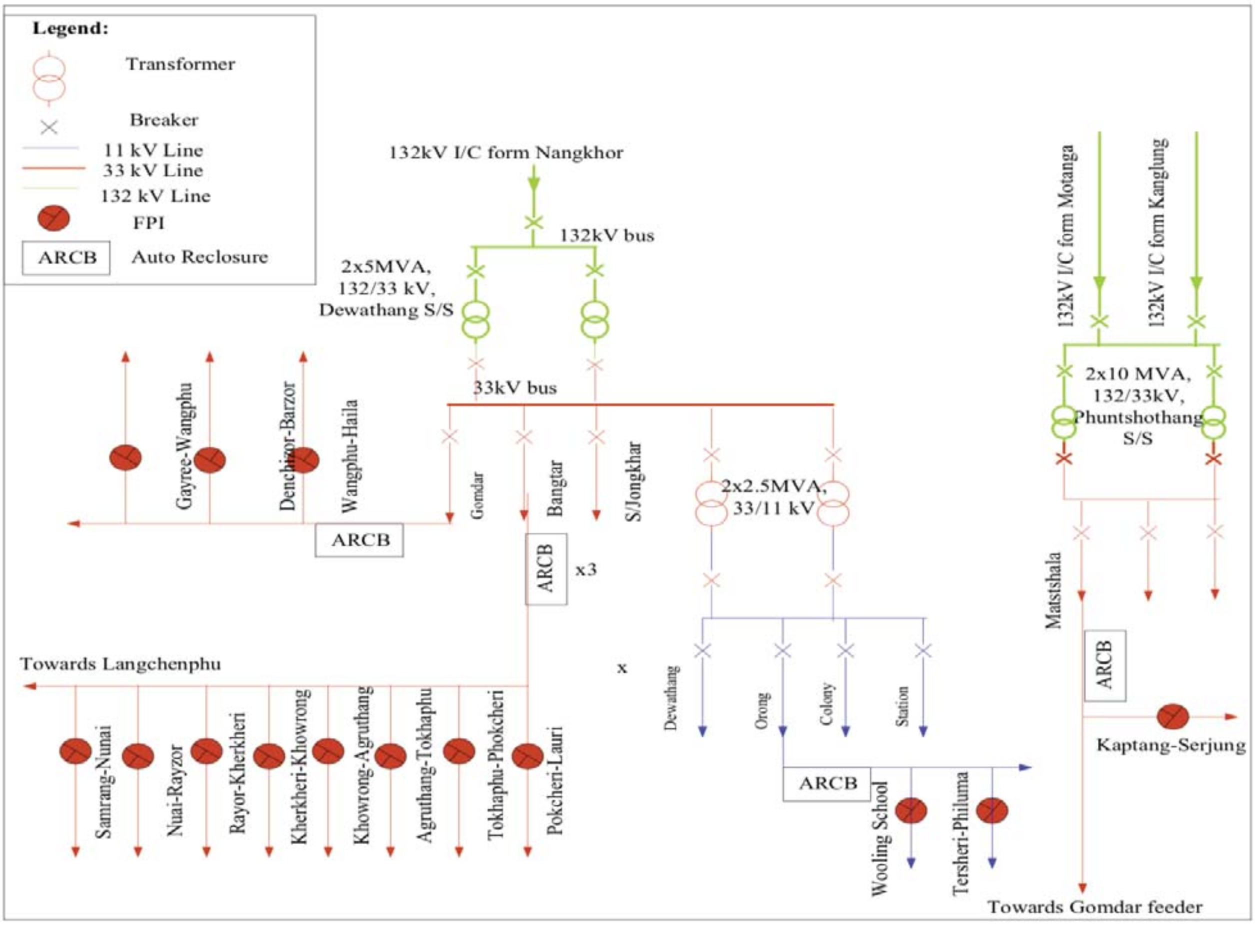


Figure 23: Proposed switching equipment for distribution network

8.4.2 Distribution System Smart Grid

The distribution grid modernization is outlined in Smart Grid Master Plan 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 that would require system augmentation and reinforcement as per the existing and projected load.

9. Investment Plan

Following the above-mentioned contingency plans targeted to improve the power quality, reduce losses, and improve reliability indices of the Dzongkhag, an 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 (2019-2023) 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 24.**

How important is the task?			
	Highly Important	Action: Do First **I**	Action: Do Next **II**
	Important	**Action: Do Later** **III**	No Action: Don't Do **IV**
		More Urgent	**Urgent**

How urgent is the task?

Figure 24: 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 switchgear 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 a 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 at the actual investment cost for the following years.

In the span of the next 10 years (2020-2030), the total projected investment required to adequately deliver the power to the customers of Samdrupjongkhar Dzongkhag is Nu. 511.749 million.

Table 21: Investment Plan until 2030

Sl.No.	Activities	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total (Million)
1	**Power Supply Sources**	-	-	-	-	-	-	-	-	-	-	-	-
1.1	Uprate 2x2.5 MVA Samdrupjongkhar SS to 2x5 MVA	-	-	-	-	-	2.00	10.00	-	-	-	-	**12.00**
1.2	Installation of 1.5 MVA transformer with control system at Langchenphu SS	-	-	2.00	2.60	-	-	-	-	-	-	-	**4.60**
2	**MV Lines**	-	-	-	-	-	-	-	-	-	-	-	-
2.1	Power Supply arrangement to Motanga IP.	3.12	10.00	50.00	16.00	-	-	-	-	-	-	-	**79.12**
2.2	Power Supply to Samdrupcholing Town	-	-	2.00	2.779	-	-	-	-	-	-	-	**4.779**
2.3	Power Supply arrangement to LAPs	-	-	-	-	-	-	-	-	-	-	-	-
2.3.1	Improvement and up-gradation of distribution network upper Throm (LAP II, III , IV) and Dewathang LAP	4.56	10.00	10.00	10.00	10.00							**44.56**
2.3.2	Construction of Distribution substation at Dewathang a) 250kVA at Dewathang LSS b)1x250 kVA, 11/0.415 kV at Pazor (Bangtsho-Demkhong)	-	-	1.00	2.61	-	-	-	-	-	-	-	**3.61**
2.3.3	Upgradation of 11/0.415 kV Transformer (a) 63 kVA to 250 kVA at S/Jongkhar LSS, (b) 160 kVA to 250 kVA at Kezang Sawmill & (c) 63 kVA to 250 kVA at 12 KM -Dewathang d) 250 kVA Substation with Chain link fencing at Deothang Shedra.	-	-	1.40		-	-	0.86			0.86		**3.12**
2.4	Power Supply Improvement to Jomotsangkha	-	-	-	-	-	-	-	-	-	-	-	-
2.4.1	Upgradation of 525m section of trunk line at Gairitor from Rabbit to Dog	-	-	-	0.18	-	-	-	-	-	-	-	**0.18**
2.4.2	Rerouting of 33 kV line Agurthang-Tokaphug to Serthi-Lauri via Langchenphug	-	-	-	8.28	-	-	-	-	-	-	-	**8.28**
2.4.3	Construction of 33 kV line on the new designed tower from Phuentshothang to Jomotsangkha.	-	-	30.00	200.00	70.00	-	-	-	-	-	-	**300.00**

Sl.No.	Activities	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total (Million)
2.5	Improvement of 33 kV Gomdar Feeder												
2.5.1	1 phase to 3 phase conversion under Gomdar & Martshala Gewog (a) 18KM 33 kV ACSR Rabbit line, (b)14x 1phase Transformers- 3phase , (c)14 KM LV ABC 1phase-3 phase	-	4.16	2.00	3.00	-	-	-	-	-	-	-	**9.16**
2.5.2	Interconnection of 33 kV Martshala Feeder with Gomdar Feeder (1.5 KM-new, upgrade from 11.275 KM 2 phase-3 phase from Wangphu-Kaeptang) - To improve the voltage profile of Gomdar Feeder	-	3.23	-	-	-	-	-	-	-	-	-	**3.23**
2.6	Arrangement of Gomdar feeder to charge at 11 kV till Dengzor to bypass 6 KM problematic section of Orong Feeder across Deori River valley - To improve the reliability of Orong feeder	-	-	0.65	-	-	-	-	-	-	-	-	**0.65**
2.7	Realignment of 33 kV Gomdar Feeder line from Shekpashing-Drupthozor (1.66KM)	1.18		-	-	-	-	-	-	-	-	-	**1.18**
2.8	Electrification of Rehabilitation Project Site under Samdrupcholing Dungkhag 1) Samrang, Samrang Gewog 2) Satpokhari, Samrang Gewog 3) Pueli-Deklai , Pemathang Gewog 5) Jakartala, Phuntshothang Gewog	-	4.76	-	-	-	-	-	-	-	-	-	**4.76**
3	**Distribution Transformers**	-	-	-	-	-	-	-	-	-	-	-	-
3.1	Construction of 250 kVA substation at Chukharpo Industrial service center	1.89	-	-	-	-	-	-	-	-	-	-	**1.89**
3.2	Construction of 63 kVA substation at Domphu village	0.52											
3.3	Uprate 125 kVA, 11/0.415 kV JNEC transformer to 250 kVA.	-	-	-	0.50	-	-	-	-	-	-	-	**0.50**
3.4	Uprate 63kVA, 11/0.415 kV Menchuri transformer to 125 kVA.	-	-	-	-	-	0.32	-	-	-	-	-	**0.32**
3.5	Uprate 63 kVA, 11/0.415 kV Melum transformer to 250 kVA.	-	-	-	0.50	-	-	-	-	-	-	-	**0.50**

Sl.No.	Activities	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total (Million)
3.6	Uprate 125 kVA, 33/0.415 kV Dungkhag office transformer to 315 kVA.	-	-	-		0.63	-	-	-	-	-	-	**0.63**
3.7	Conversion of 2 DTs from 33kV to 11kV (16 kVA)	-	-	0.65	-	-	-	-	-	-	-	-	**0.65**
4	**Switching & Control**	-		-	-	-	-	-	-	-	-	-	**-**
4.2	Installation of LBS	-	1.30	-	-	-	-	-	-	-	-	-	**1.30**
5	**Conversion Works**												**-**
5.1	Single Phase to Three Phase Line conversion	-	-	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	**11.23**
5.2	Single Phase Transformer to Three Phase conversion	-	-	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	**15.50**
	Total	**11.27**	**33.45**	**102.67**	**249.419**	**83.6**	**5.29**	**13.83**	**2.97**	**2.97**	**3.83**	**2.97**	**511.749**

10. Conclusion

Based on the inputs from the division 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 and 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 implemented.

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

The proportion of LV is higher in comparison to MV line length, accordingly the independent study carried out by BPC in 2017 showed that a large portion of the loss is due to LV and DT. Therefore, a similar system beyond DT (including DT) has to be carried out to capture the entire network and strategize to develop the blueprint.

11. Recommendation

Sl. No.	Parameters	Recommendations
A. Power Supply Sources		
1	HV Substations	**Substations 66/33kV 15 MVA Motanga Substation** To meet the industrial power demand of Motanga, it is recommended to Upgrade the substation to 2x15 MVA. The up-rating will not only cater to the load growth but will act as a source redundancy to the 33/11kV Samdrupjongkhar substation.
2	MV Substations	Up-rating/construction of new 33/11 kV substation should be implemented as described in section 5.1.2.
B. MV and LV Lines		
1	MV Lines	The MV line plans as discussed in section 8.2 are recommended.
2	LV Lines	Assessment of LV infrastructure is not in the scope of this study. Actual requirements must be studied according to the prevailing circumstances and proposed separately.
3	Conversion Works	**1) HT overhead to UG cable** Convert OH conductor to UG cable in and around already developed LAPs and construction of UG network in new LAPs to enhance safety, to ease the RoW issues, and for aesthetic view. **2) LT overhead to UG cable** The LV network of LAPs has to be converted to a UG system due to RoW issues, the safety of the general public, and the aesthetic point of view.
C. Distribution Transformers		
1	Distribution Transformer	As reflected in **Section 7.3.1** of this report, it is proposed to regularly monitor the loading pattern especially of the urban transformers. It is desired to load the transformers less than 85% to ensure that transformer is operated at maximum efficiency. As the system study is restricted to DTs, the loads need to be uniformly distributed amongst the LV feeders to balance the load and to procure the service plot.

Sl. No.	Parameters	Recommendations
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 a 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 in locating the fault and power restoration time thereby improving the reliability.
E. others		
1	Investment Plan	As reflected in Section 9 of this report, the overall investment plan as proposed is recommended.
2	Review of the DSMP	Recommended to review the DSMP in 2025 (after five years) and if need be every after two years. It is also proposed to be sync with the DSMP studies with that of the five year investment plan.
3	System Studies beyond DT	It is observed that the distribution of electricity is more through LV than through MV & HV and the scope of DSMP terminates at DT. Therefore, it is equally important to carry out similar system studies for LV networks till meter point. Due to time constraints and the non-available of required LV data, ESD S/Jongkhar should carry out the studies. Nevertheless, with the entire distribution network captured in the GIS and ISU, the system studies should be carried out including the LV network in near future.
4	Customer Mapping	One of the important parameters required especially for reaffirming the capability of the DTs is through customer growth pattern. Therefore, it is recommended to consistently up-date customer mapping annually.
5	Right of Way	Since RoW constraints are already formidable and can only get worse in the future, ESD S/Jongkhar should initiate the acquirement of the required plots for substations, DTs, RMU station, and line RoW urgently. RoW to be maintained as per the DDCS 2016 and if need be to increase the frequency of RoW clearing in the problematic sections of the line.

Sl. No.	Parameters	Recommendations
6	Asset life of DTs	The asset life of DTs needs to be gathered to enable the development of an asset replacement framework. However, it is recommended to regularly monitor the health of the transformers which have already outlived their lives.
7	Overloading of DTs	As per the load forecast, some of the rural DTs might overload. While the probability of realizing such an event is quite low. It is, however, recommended that the DTs that have already exhausted its statutory life (25 years and above) be regularly monitored.
8	New extension through 33kV network	The power carrying capacity of the 33kV system is almost 3-fold compared to that of the 11kV system. Therefore, any new extension of lines may be done through a 33kV system (based on fund availability and practical convenience).
9	Reliability	To improve the reliability of the feeder/network, it is recommended either that fault should be located within a short period of time thereby 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 the construction of feeders with customized 11kV & 33kV towers; and 3) To increase the frequency of Row clearing in a year.
10	Lightning Protection	The top root cause of power interruption is due to lightning and storm. Therefore, more focus should be on how to control and safeguard the equipment from lightning and storm.
11	Power supply to LAPs	The power supply infrastructure plans for the urban areas as discussed in section 7.4 are recommended.

12. Annexure

1. Annexure-1: MV Line Details and Single Line Diagram
2. Annexure-2: IS 2026, IEC 60076 (Technical parameters for Distribution Lines and Transformers)
3. Annexure-3: The details on the load forecast methodology.

4. Annexure-4: Detailed Simulation Results
5. Annexure-5: Feeder Wise Reliability Indices
6. Annexure-6: Material Cost of Upgrading single phase (11 kV and 33 kV) Lines to three-phase
7. Annexure-7: Distribution Transformer Loading
8. 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, a ratio of 80% (static load) to 20% (industrial feeders) were assumed;
3. The voltage level of ±10% is given as a critical value which is indicated by red color while simulating and a voltage level of ±5% is given as a marginal value which is indicated by pink color while simulating.
4. The typical inbuilt value of X/R ratio of the 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;

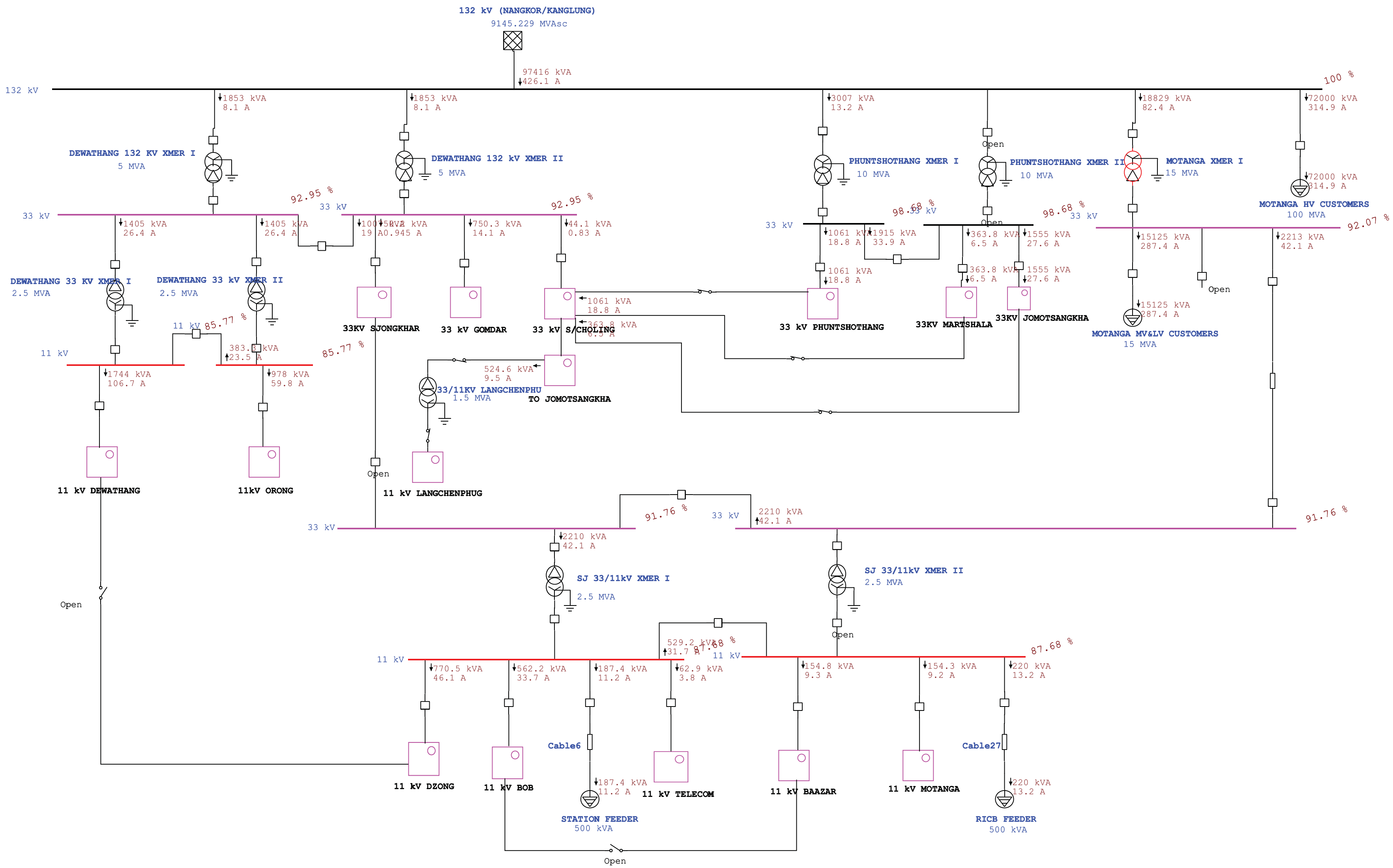
6. The technical parameters which are required for analysis of the distribution network have been considered as per the set standard of DDCS.

15. Challenges

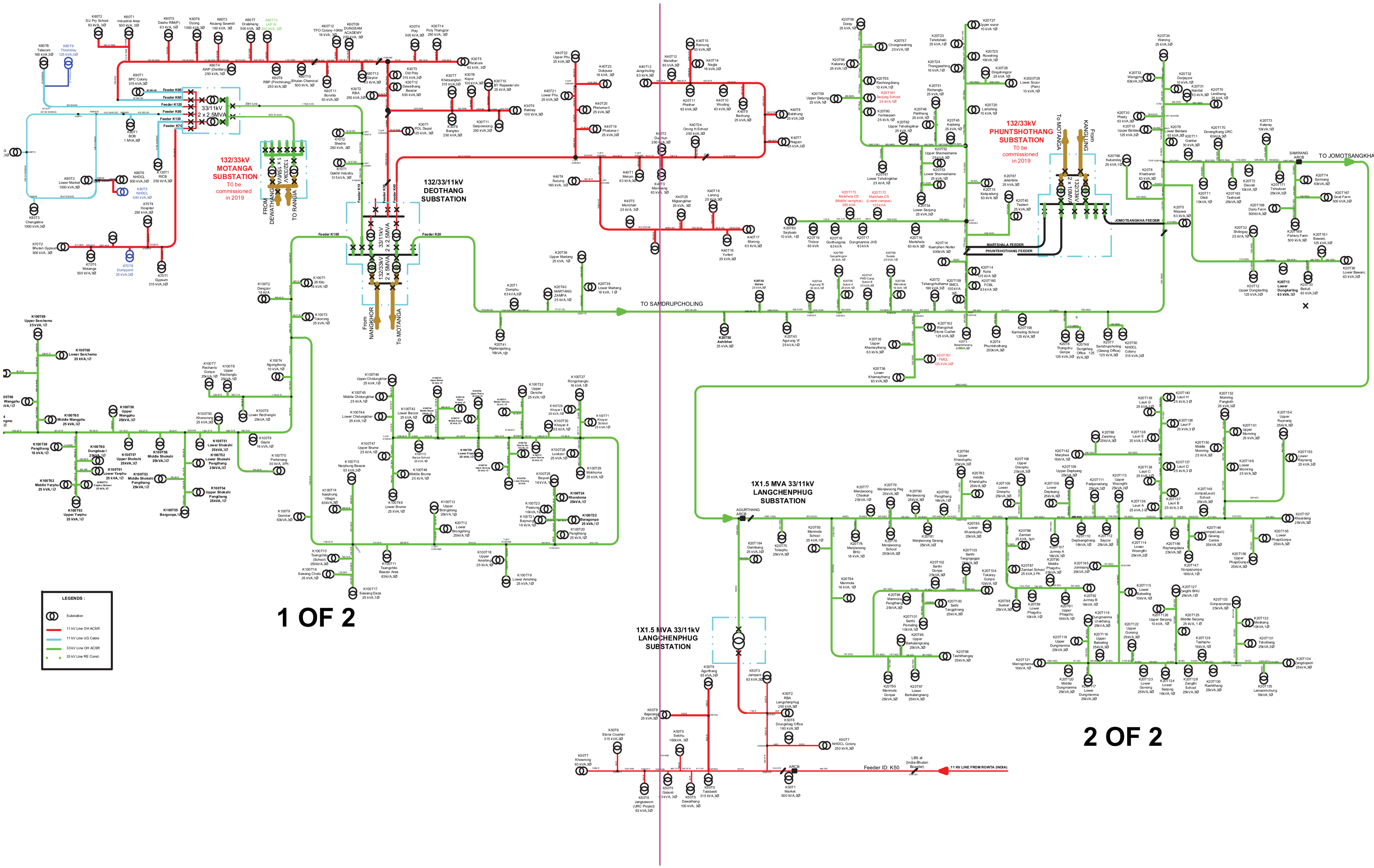
Sl. No.	Parameters	Challenges	Opportunities/Proposals
1	Software Tool (ETAP)	a) Only one key & offline Key b) Balanced Load Flow c) Limitations of No. of buses (1000)	a) Can opt for on line key with fewer more modules especially to carry out the technical evaluation of an unbalanced load flow system. This would be more applicable and accrue good results for LV networks.
2	Data	a) No recorded data (reliability & energy) on the out-going feeders of MV SS	a) Feeder Meters could be installed for outgoing feeders of MV substations to record actual data (reliability & energy)
		b) Peak Load data of DTs which were recorded manually may be inaccurate due to timing and number of DTs.	b) 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 us to have a proper TLM and replacement framework.
3	Manpower	a) Resource gap in terms of trained (ETAP) and adequate engineers (numbers)	a) Due to the lesser number of trained engineers in the relevant fields (software), engineers from other areas were involved.

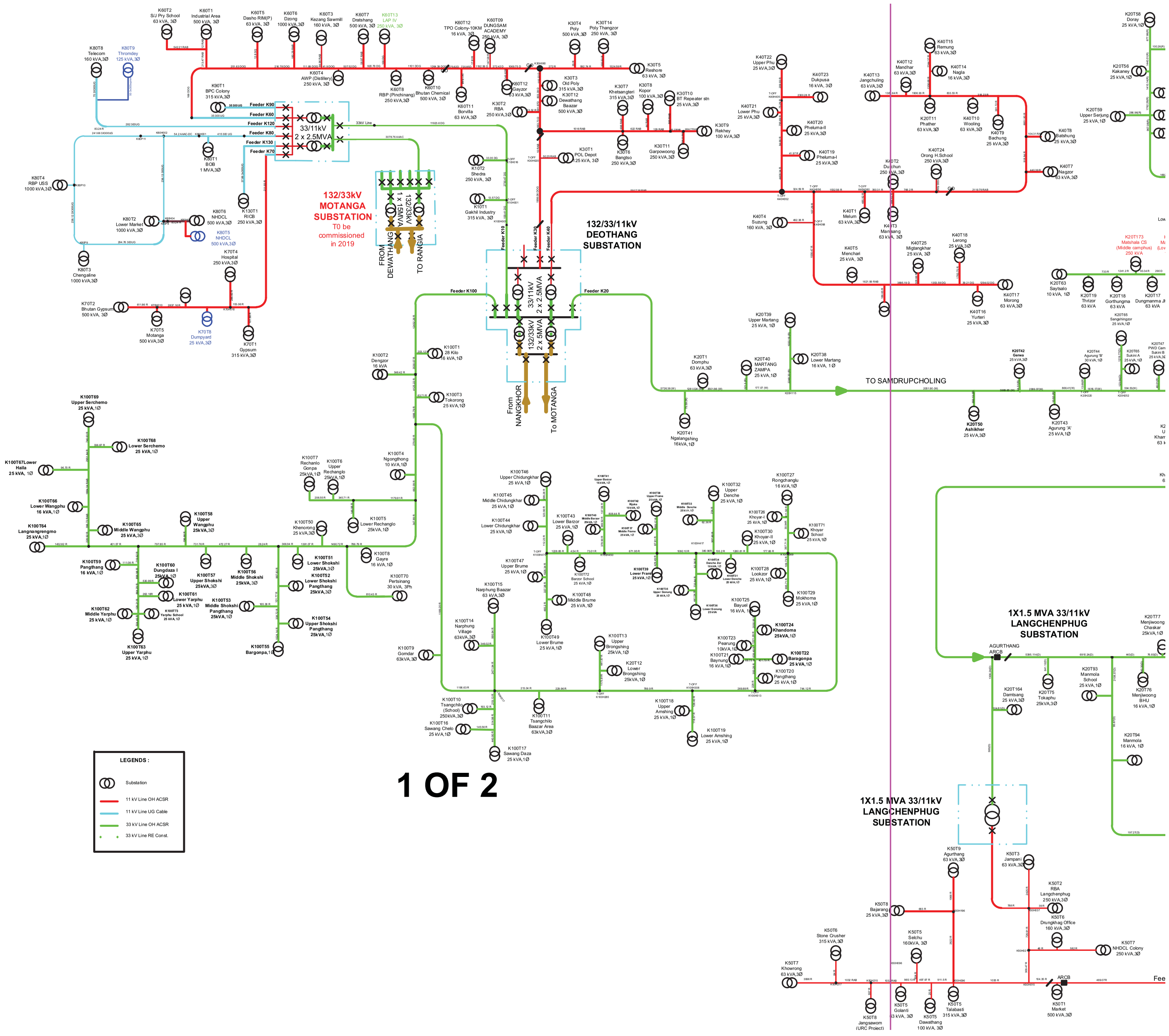
Annexure 1- SLD and MV Line Details

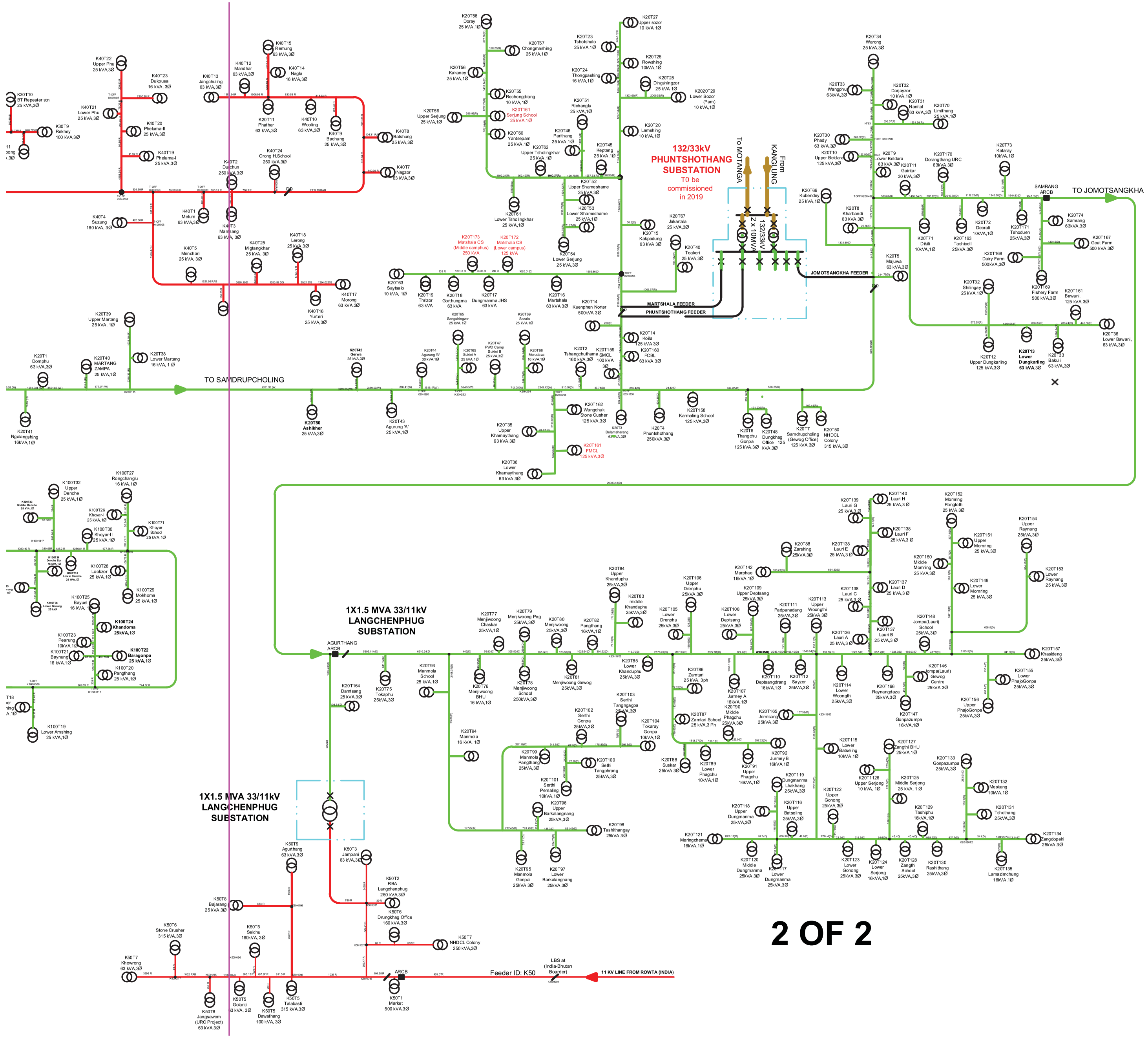
One-Line Diagram - ESD SAMDRUP JONGKHAR (Load Flow Analysis)



DISTRIBUTION NETWORK OF ESD SAMDRUP JONGKHAR




132/33/11kV
DEOTHANG
SUBSTATION
132/33kV
MOTANGA
SUBSTATION
T0 be
commissioned
in 2019
33/11kV
2 x 2.5MVA
132/33kV
1 x 15MVA
132/33kV
2 x 5MVA
FROM
DEWATHANG
TO RANGIA
From
NANGKHOR
To MOTANGA
Feeder K90
Feeder K60
Feeder K120
Feeder K80
Feeder K130
Feeder K70
Feeder K100
Feeder K20
Feeder K10
Feeder K30
Feeder K40
TO SAMDRUPCHOLING
1X1.5 MVA 33/11kV
LANGCHENPHUG
SUBSTATION
1X1.5 MVA 33/11kV
LANGCHENPHUG
SUESTATION
AGURTHANG
ARCB
LEGENDS :
Substation
11 kV Line OH ACSR
11 kV Line UG Cable
33 kV Line OH ACSR
33 kV Line RE Const.
1 OF 2


132/33kV
PHUNTSHOTHANG
SUBSTATION
T0 be
commissioned
in 2019
To MOTANGA
From KANGLUNG
132/33kV
2 x 10MVA
JOMOTSANGKHA FEEDER
MARTSHALA FEEDER
PHUNTSHOTHANG FEEDER
TO JOMOTSANGKHA
TO SAMDRUPCHOLING
1X1.5 MVA 33/11kV
LANGCHENPHUG
SUBSTATION
1X1.5 MVA 33/11kV
LANGCHENPHUG
SUESTATION
Feeder ID: K50
11 KV LINE FROM ROWTA (INDIA)

2 OF 2

Source	Feeder details: Name	Feeder details: ID	Voltage (kV)	Section	CONDUCTOR	Conductor type & Line Length: 300 UG	WOLF	DOG	RABBIT	Section Length (km)	Cumulative Length (km)	3-Phase / 1-Phase	Distribution Transformer: Capacity (kVA)	3-Phase/ 1-Phase	ID	Remarks
				33 kV SJ Feeder												
Deothang Substation (132/33/11 kV), 2x5 MVA, 2x2.5 MVA	Samdrupjongkhar Feeder	K10	33	K10H000	WOLF		0			0.000	0.000	3				
				K10H001 to K10H002	DG			159.41		0.159	0.159	3				
				K10H002 to K10H003	DG			84.97		0.085	0.244	3				
				K10H002 to K10H016	DG			2730.47		2.730	2.975	3				
				K10H016 to K10H146	DG			11923.6		11.924	14.898					
				K10H002 to K10H147(Gakil Industry SS)	RAB				13.570	0.014	14.912	3	315	3	K10T1	PVT.
				K10H016 to K10H148(Shedra SS)	RAB				33.350	0.033	14.945	3	250	3	K10T2	BPC
				K10H146 to 33KV IC Penal SJ	UG	16				0.016	14.961	3				
				33KVC/Penal to SjongkharPT3(33/11KV Powrer Transformer)	UG	28				0.028	14.989	3	2500	3	K10T3	BPC
				SjongkharPT3(33/11 Power Trafo- 11KVC/penal	UG	21				0.021	15.011	3				
				TOTAL		15.8	0	14898.45	46.92	15.011	15.011		3			
				33 kV Samdrupcholing Feeder												
Deothang Substation (132/33/11 kV), 2x5 MVA, 2x2.5 MVA	Samdrupcholing /Jomotsangkha Feeder	K20	33	DeothangPT1- K20H000	WLF	0	0			0.000	15.011	3				
				K20H000	WLF		0			0.000	0.000	3				
				K20H0000 to K20H053(Toff Neglangshing)	WLF		5873.65			5.874	5.874	3				
				K20H0053 to K20H1252Ngelangshing SS)	RAB				83.15	0.083	5.957	3			K20T44	BPC
				K20H0053 to K20H071(Domphu SS)	WLF		1336.38			1.336	7.293	3	63	3	K20T1	BPC
				K20H0071 to K20H112	WLF		3543.1			3.543	10.836	3				
				K20H0112 to K20H115	WLF		181.57			0.182	11.018	3				
				KK20H0112 to 20H1010(Marstang Zampa SS)	RAB				122.430	0.122	11.140	1	25	1	K20T43	BPC
				K20H0115 to K20H1001(Lower Martang)	RAB				2278.110	2.278	13.418	1	16	1	K20T41	BPC
				K20H1001-K20H1009(Upper Martang)	RAB				1180.860	1.181	14.599	1	25	1	K20T42	BPC
				K20H0115 to K20H139	WLF		2143.2			2.143	16.742	3				
				K20H0139 to K20H183	WLF		4043.42			4.043	20.786	3				
				K20H0139 to K20H1268(Ashikhar SS)	RAB				357.310	0.357	21.143	3	25	3	K20T21	BPC
				K20H0183 to K20H211	WLF		**2450.26**			2.450	23.593	**3**				
				K20H0183 to K20H1253(Gerwa SS)	RAB		877.79		44.490	0.922	24.516	3	25	3	K20T22	BPC
				K20H0211 to K20H1254(Agurung ASS)	RAB		2326.02		28.050	2.354	26.870	3	10	1	K20T20	BPC
				K20H0211 to K20H220	WLF		877.79			0.878	27.748	3				
				K20H0220 to K20H252	WLF		2326.02			2.326	30.074	3				
				K20H0220 to K20H1255(Agurung B SS)	RAB		912.94		18.18	0.931	31.005	3	25	1	K20T47	BPC
				K20H0243 to K20H1188	DG			127.61		0.128	31.132	3	25	1	K20T65	BPC
				K20H0252 to K20H1256	RAB				47.53	0.048	31.180	3	25	3	K20T48	PRIVATE
				K20H0252 to K20H264	WLF		750.3786306			0.750	31.930	3				

Source	Feeder details		Voltage (kV)	Section	CONDUCTOR	Conductor type & Line Length							Distribution Transformer			Remarks
	Name	ID				300 UG	WOLF	DOG	RABBIT	Section Length (km)	Cumulative Length (km)	3-Phase / 1-Phase	Capacity (kVA)	3-Phase/ 1-Phase	ID	
Deothang Substation (132/33/11 kV), 2x5 MVA, 2x2.5 MVA	Samdrupcholing /Jomotsangkha Feeder	K20	33	K20H0264 to K20H1229(merudaza SS)	DG			615.86		0.616	32.546	3	16	1	K20T68	BPC
				K20H1229(Merudaza) to K20H1239(Sazala)	RAB				1594.35	1.594	34.140	3	25	1	K20T69	BPC
				K20H0264 to K20H294	WLF		2446.325305			2.446	36.587	3				
				K20H0294 to K20H307(Tsangchuthama SS)	WLF		912.94			0.913	37.500	3	160	3	K20T2	BPC
				K20H0294 to K20H949	RAB				2237.49	2.237	39.737	3				
				K20H0924 to K20H2235(Wangchuk Stone Crusher SS)	RAB				143.0607966	0.143	39.880	3	125	3	K20T162	PRIVATE
				K20H0949 to K20H951(Upper Khamithang)	RAB				93.87	0.094	39.974	3	16	3	K20T38	BPC
				K20H0949 to K20H968	RAB				1328.5	1.329	41.303	3	25	3	K20T39	BPC
				K20H0307(Tsangchutham SS) to K20H308	WLF		37.72			0.038	41.340	3				
				K20H0308 to K20H322(Belamsharang)	RAB				790.08	0.790	42.130	3	63	3	K20T3	BPC
				K20H0308 to K20H331(Phuntshothang SS)	DG			635.63		0.636	42.766	3	250	3	K20T4	BPC
				K20H0308 to K20H519(Koila)	DG			2376.28		2.376	45.142	3		3	K20T14	BPC
				K20H0331 to K20H335	DG			414.8404511		0.415	45.557	3				
				K20H0335 to K20H2230(Karmaling HSS)	RAB				24.42	0.024	45.582	3	125	3	K20T158	PRIVATE
				K20H0335 to K20H342						0.000	45.582					
				K20H0342 to K20H351	DG			560.11		0.560	46.142	3				
				K20H0342 to K20H371Phuntshothang Gewog office)	DG			526.35		0.526	46.668	3	125	3	K20T7	BPC
				K20H0371-Goffice to K20H1263(NHDCL Colony)	RAB				**195.57**	0.196	46.864	**3**	315	**3**	K20T50	PRIVATE
				K20H0342 to K20H362(Thangchgonpa SS)	RAB				562.73	0.563	47.426	3	125	3	K20T6	BPC
				K20H0362 to K20H1259SCholing Dungkhag)	RAB				179.48	0.179	47.606	3	125	3	K20T49	BPC
				K20H0351 to K20H353(Majua)	DG			214.81		0.215	47.821	3	63	3	K20T5	BPC
				K20H0351 to K20H399	DG			1903.05		1.903	49.724	3				
				K20H0388 to K20H1212(Kubeney SS)	DG			1379.2		1.379	51.103	1	25	1	K20T66	BPC
				K20H0399 to K20H400(Kharbandi)	DG			22.93		0.023	51.126	3	63	3	K20T8	BPC
				K20H0399 to K20H464	RAB				599.05	0.599	51.725	3				
				K20H0400(kharbandi) to K20H422	DG			1272.72		1.273	52.998	3				
				K20H0422 to K20H423(Lower Beldara)	DG			54.96		0.055	53.053	3	63	3	K20T9	BPC
				K20H0422 to K20H455(Gairitar)	RAB				551.8	0.552	53.604	3	30	3	K20T11	BPC
				K20H0423 to K20H445(Upper Beldara)Toff	DG			1411.79		1.412	55.016	3				
				K20H0445 to K20H447(Upper Beldara)	DG			123.19		0.123	55.139	3	125	3	K20T10	BPC
				K21H0445(Gairitar) to K20H769	RAB				882.76	0.883	56.022	3				
				K20H0464 to K20H465(Upper Dungkarling)	RAB				28.05	0.028	56.050	3	125	3	K20T12	BPC
				K20H0464 to K20H485(Lower Dungkarling)	RAB				1449.04	1.449	57.499	3	63	3	K20T13	BPC
				K20H0464 to K20H886(Silingye Village)	RAB				1325.53	1.326	58.825	1	25	1	K20T35	BPC

Source	Feeder details		Voltage (kV)	Section	CONDUCTOR	Conductor type & Line Length							Distribution Transformer			Remarks
	Name	ID				300 UG	WOLF	DOG	RABBIT	Section Length (km)	Cumulative Length (km)	3-Phase / 1-Phase	Capacity (kVA)	3-Phase/ 1-Phase	ID	
Deothang Substation (132/33/11 kV), 2x5 MVA, 2x2.5 MVA	Samdrupcholing /Jomotsangkha Feeder	K20	33	K20H0485 to K20H897	RAB				637.44	0.637	59.462	3				
				K20H0503 to K20H2231(SMCL SS)	RAB				83.31	0.083	59.545	3	100	3	K20T159	PRIVATE
				K20H0504 to K20H2232(FCB SS)	RAB				11.28	0.011	59.557	3	63	3	K20T160	PRIVATE
				K20H0519 to K20H539	DG			1547.28		1.547	61.104	3				
				K20H0539 to K20H559	DG			1629.32		1.629	62.733	3				
				K20H0539 to K20H982(Teakiri SS)	RAB				1044.28	1.044	63.778	3	25	3	K20T40	BPC
				K20H0559 to K20H560(Kakpadung SS)	DG			58.5		0.059	63.836	3	63	3	K20T15	BPC
				K20H0559 to K20H578(Martshala SS)	DG			1607.54		1.608	65.444	3	63	3	K20T16	BPC
				K20H0559 to K20H659(Lamshing)	RAB				5397.43	5.397	70.841	3	10	1	K20T23	BPC
				K20H0578 to K20H588(Dungmanma)	DG			1027.55		1.028	71.869	3	63	3	K20T17	BPC
				Dungmanma to K20H589(Martshala CSS-Middle)	RAB				93.34959153	0.093	71.962		250	3		
				Marsthala CSS to K20H600(Gordungma)	RAB				1241.217477	1.241	73.110	3	63	3	K20T18	BPC
				K20H600(Gordungma) to K20H609(Thrizor)	RAB				619.52	0.620	73.729	3	63	3	K20T19	BPC
				K20H609(Thrizor) to K20H1224(Saytsalo)	DG			1662.95		1.663	75.392	3	10	1	K20T63	BPC
				K20H0647 to K20H1012(Kaptang SS)	RAB				277.74	0.278	75.670	1	25	1	K20T45	BPC
				K20H0659 to K20H671	RAB				1225.68	1.226	76.896	1				
				K20H0671 to K20H740(Dengsingzor)	RAB				1330.76	1.331	78.227	1	25	1	K20T28	BPC
				K20H0671 to K20H687(Thongpashing)	RAB				1506.73	1.507	79.733	1	16	1	K20T24	BPC
				K20H687(Thongpashing) to K20H699(Rawshing)	RAB				1133.15	1.133	80.866	1	10	1	K20T25	BPC
				K20H699(Rawshing) to K20H714(Tshotsalo)	RAB				1295.01	1.295	82.161	1	25	1	K20T26	BPC
				K20H714(Tshotsalo) to K20H725(Upper Sozor)	RAB				912.17	0.912	83.074	3	10	1	K20T27	BPC
				K20H0740 to K20H758(Lower Sozor)	RAB				2122.73	2.123	85.196	1	10	1	K20T29	BPC
				K20H0769 to K20H779(Phaydy SS)	RAB				570.61	0.571	85.767	3	63	3	K20T30	BPC
				K20H0769 to K20H793	RAB				949.86	0.950	86.717	1				
				K20H0793 to K20H799(Nainital SS)	RAB				409.76	0.410	87.127	3	63	3	K20T31	BPC
				K20H799(Nainital SS) to K20H1250(Limithang SS)	RAB				1709.18	1.709	88.836	1	25	1	K20T70	BPC
				K20H0793 to K20H820(Darjeyzor SS)	RAB				1680.83	1.681	90.517	1	10	1	K20T32	BPC
				K20H820(Darjeyzor SS) to K20H846(Wangphu SS)	RAB				1905.45	1.905	92.422	3	63	3	K20T33	BPC
				K20H846(Wangphu SS) to K20H865(Warong)	RAB				1337.55	1.338	93.760	3	25	3	K20T34	BPC
				K20H0897 to K20H907(Lower Bawani)	RAB				728.49	0.728	94.488	3	63	3	K20T36	BPC
				K20H0897 to K20H923(Bakuli village)	RAB				1087.12	1.087	95.575	3	63	3	K20T37	BPC
				K20H0899 to K20H2233(FMCL SS)	RAB				17.23	0.017	95.592	3	125	3	K20T161	PRIVATE
				K20H0924 to K20H2234	RAB				77.13	0.077	95.670	3				
				K20H0982 to K20H1186(Jakartala)	DG			1081.88		1.082	96.751	1	25	1	K20T67	BPC

Source	Feeder details		Voltage (kV)	Section	CONDUCTOR	Conductor type & Line Length							Distribution Transformer			Remarks
	Name	ID				300 UG	WOLF	DOG	RABBIT	Section Length (km)	Cumulative Length (km)	3-Phase / 1-Phase	Capacity (kVA)	3-Phase/ 1-Phase	ID	
Deothang Substation (132/33/11 kV), 2x5 MVA, 2x2.5 MVA	Samdrupcholing /Jomotsangkha Feeder	K20	33	K20H1012 to K20H1280(Toff to Deekley Ss)	DG			1516.94		1.517	98.268	3				
				K20H1023 to K20H1027(Parithang SS)	RAB				368.07	0.368	98.636	1	25	1	K20T46	BPC
				K20H1023 to K20H1043	RAB				420.75	0.421	99.057	3				
				K20H1027 to K20H1040(Rechanglo SS)	RAB				1434.43	1.434	100.492	1	25	1	K20T51	BPC
				K20H1043 to K20H1055(Upper shameshame SS)	RAB				1423.16	1.423	101.915	1	25	1	K20T52	BPC
				K20H1043 to K20H1094(Upper Tsholingkhar)	RAB				1407.41	1.407	103.322	1	25	1	K20T62	BPC
				K20H1055 to K20H1066	RAB				1270.09	1.270	104.592	3				
				K20H1066 to K20H1067(Lower Shameshame)	RAB				171.92	0.172	104.764	1	25	1	K20T53	BPC
				K20H1066 to K20H1080(Lower Serjung substation)	RAB				1626.23	1.626	106.390	1	25	1	K20T54	BPC
				K20H1094 to K20H1100	RAB				1200.45	1.200	107.591	3				
				K20H1100 to K20H1105(Lower Tsholingkhar)	RAB				543.31	0.543	108.134	1	25	1	K20T61	BPC
				K20H1100 to K20H1118(Yangtse Pam)	RAB				1707.54	1.708	109.842	1	25	1	K20T60	BPC
				K20H1118 to K20H1127	RAB				986.01	0.986	110.828	3				
				K20H1127 to K20H1130(Upper Serjung)	RAB				319.7	0.320	111.147	1	25	1	K20T59	BPC
				K20H1127 to K20H1143(Richongdrang)	RAB				1903.49	1.903	113.051	1	10	1	K20T55	BPC
				K20H1143 to K20H1157(Kakanay)	RAB				1508.02	1.508	114.559	1	25	1	K20T56	BPC
				K20H1157 to K20H1167	RAB				1477.95	1.478	116.037	3				
				K20H1167 to K20H1169(Chongmashing SS)	RAB				101.72	0.102	116.139	1	25	1	K20T57	BPC
				K20H1167 to K20H1178(Doray Substation)	RAB				686.58	0.687	116.825	1	10	1	K20T58	BPC
				K20H1188 to K20H1203(Sangshingzor)	DG			1299.44		1.299	118.125	1	25	1	K20T64	BPC
				K20H1269 to K20H1023(Toff to parithang)	RAB				1589.6	1.590	119.714	3				
				K20H1280 to K20H1305 Toff to Tashi Cell)	DG			2915.78		2.916	122.630	3				
				K20H1280 to K20H2218(Dekiley SS)	RAB				**580**	0.580	123.210	3	10		K20T71	BPC
				K20H1287 to K20H2286(Dorangthang SS)	RAB				**710**	0.710	123.920	3	63	3	K20T170	BPC
				K20H1305 to K20H1315(Deorali SS)	DG			1112.23		1.112	125.032	3	10	1	K20T72	BPC
				K20H1305 to K20H2236(Tashi cell SS)	RAB				12.06	0.012	125.044	1	25	1	K20T163	PRIVATE
				K20H1315 to K20H1322(T-OFF to Kattery Village)	DG			1246.56		1.247	126.291	3				
				K20H1322 to K20H1335(T-OFF to Tshoduen)	DG			1549.832699		1.550	127.840					
				K20H1335 to K20H2287(Tshoduen SS)	RAB				20.9	0.021	127.861	3	25	3	K20T171	BPC
				K20H1322 to K20H1343(T-OFF to Samrang)	DG			1041.662744		1.042	128.903	3				
				K20H1322 to K20H2225(Kataray Substation)	RAB				1113.14	1.113	130.016	1	10	1	K20T73	BPC
				K20H1565 to K20H2191(Toff Damtsang)	DG			1319.25		1.319	131.335	3				
				K20H2191 to K20H2192(Damtshang SS)	DG			107.91		0.108	131.443	3	25	3	K20T164	BPC
				K20H2192 to K20H2210	DG			2959.21		2.959	134.403	3				

Source	Feeder details		Voltage (kV)	Section	CONDUCTOR	Conductor type & Line Length							Distribution Transformer			Remarks
	Name	ID				300 UG	WOLF	DOG	RABBIT	Section Length (km)	Cumulative Length (km)	3-Phase / 1-Phase	Capacity (kVA)	3-Phase/ 1-Phase	ID	
Deothang Substation (132/33/11 kV), 2x5 MVA, 2x2.5 MVA	Samdrupcholing /Jomotsangkha Feeder	K20	33	K20H2210 to Talabusti PT4	AAAC			3.85		0.004	134.406	3	1500			BPC
				K20H1343 to K20H2229(Samrang Substation)	RAB				375	0.375	134.781	3	25	3	K20T74	BPC
				K20H2229 to K20H2247(T-OFF towards Dairy farm)	DG			415.43		0.415	135.197	3				
				K20H2247 to K20H2259(Goat farm SS)	DG			971.5		0.972	136.168	3	500	3	K20T167	PRIVATE
				K20H2247 to K20H2261(Dairy Farm SS)	DG			130.11		0.130	136.298	3	500	3	K20T168	PRIVATE
				K20H2261(Dairy Farm SS) to K20H2275(Fishery Farm SS)	DG			853.046219		0.853	137.151	3	500	3	K20T169	PRIVATE
				K20H1343(Samrang T-off to K20H1565(Langchenphug 33/11 kV SS T-off)	DG			29996.87		29.997	167.148	3				
				K20H1565 K20H1608(Tokaphu T-off)	DG			5580.61		5.581	172.729	3				
				K20H1608 to K20H1678(Tokaphu SS)	DG			664.484567		0.664	173.393	1	25	1	K20T75	BPC
				K20H1608 to K20H1668(	DG			7702.39		7.702	181.096	3				
				K20H1668 to K20H1788(Monmola School SS)	DG			**2217**		2.217	183.313	1	25	1	K20T93	BPC
				K20H1668 to K20H1671						0.000	183.313					
				K20H1671 to K20H1680	DG			138.45		0.138	183.451	3				
				K20H1680 to K20H1683(Minjiwoong BHU Ss)	DG			245.82		0.246	183.697	1	16	1	K20T76	BPC
				K20H1680 to K20H1684(Minjiwoong Chaskhar Ss)	DG			86.57		0.087	183.783	1	25	1	K20T77	BPC
				K20H1684 to K20H1687	DG			339.81		0.340	184.123	3				
				K20H1687 to K20H1688(Minjiwoong School Ss)	DG			169.64		0.170	184.293	3	250	3	K20T78	PRIVATE
				K20H1687 to K20H1691(Minjiwoong Peg Ss)	DG			272.67		0.273	184.565	1	25	3	K20T79	BPC
				K20H1687 to K20H1693(Minjiwoong Ss)	DG			255.82		0.256	184.821	3	25	3	K20T80	BPC
				K20H1693(Minjiwoong Ss) to K20H1695(Minjiwoong Gewog Ss)	DG			124.52		0.125	184.946	3	25	3	K20T81	BPC
				K20H1695(Minjiwoong Gewog Ss) to K20H1705(Pangthang Ss)	DG			1081.92		1.082	186.028	1	16	1	K20T82	BPC
				K20H1705(Pangthang Ss) to K20H1708	DG			452.74		0.453	186.480	3				
				K20H1708 to K20H1709 (Middle Khanduphu Ss)	DG			80.23		0.080	186.561	3	25	3	K20T83	BPC
				K20H1708 to K20H1714(Lower Khanduphu Ss)	DG			113.98		0.114	186.675	3	25	3	K20T85	BPC
				K20H1709 (Middle Khanduphu Ss) to K20H1712(Upper Khanduphu Ss)	DG			171.31		0.171	186.846	3	25	3	K20T84	BPC
				K20H1714(Lower Khanduphu Ss) to K20H1734(Lingshingzor)	DG			2536.43		2.536	189.382	3				
				K20H1734 to K20H1735	DG			113.25		0.113	189.496	3				
				K20H1735 to K20H1736	DG			242.53		0.243	189.738	3				
				K20H1735 to K20H1738(Zamtari Village Ss)	DG			163.24		0.163	189.901	3	25	3	K20T86	BPC
				K20H1736 to K20H1860(Lower Denphu ss)	DG			2114.81		2.115	192.016	3	25	3	K20T105	BPC
				K20H1737 to K20H1739(Zamtari School Ss)	DG			165.47		0.165	192.182	3	25	3	K20T87	BPC
				K20H1739(Zamtari School Ss) to K20H1747(Thekari TP)	DG			786.69		0.787	192.968	3				
				K20H1747 to K20H1752(Suskar Ss)	DG			544.01		0.544	193.512	3	25	3	K20T88	BPC
				K20H1747 to K20H1765(Lower Phagchu Ss)	DG			1726.74		1.727	195.239	1	10	1	K20T89	BPC

Source	Feeder details		Voltage (kV)	Section	CONDUCTOR	Conductor type & Line Length							Distribution Transformer			Remarks
	Name	ID				300 UG	WOLF	DOG	RABBIT	Section Length (km)	Cumulative Length (km)	3-Phase / 1-Phase	Capacity (kVA)	3-Phase/ 1-Phase	ID	
Deothang Substation (132/33/11 kV), 2x5 MVA, 2x2.5 MVA	Samdrupcholing /Jomotsangkha Feeder	K20	33	K20H1765(Lower Phagchu Ss) to K20H1767(Middle Phagchu Ss)	DG			138.710		0.139	195.378	3	25	3	K20T90	BPC
				K20H1767(Middle Phagchu Ss) to K20H1769(Upper Phagchu Ss)	DG			226.9		0.227	195.605	3	25	1	K20T91	BPC
				K20H1769(Upper Phagchu Ss) to K20H1772(Jurmey-B Ss)	DG			599.48		0.599	196.204	3	16	1	K20T92	BPC
				K20H1788 to K20H1789(Monmola Ss)	DG			98.75		0.099	196.303	3	16	1	K20T94	BPC
				K20H1789 to K20H1791(Monla TP structure)	DG			212.48		0.212	196.515	3				
				K20H1791(Monla TP structure) to K20H1792(Monmola Gonpa Ss)	DG			38.15		0.038	196.554	3	25	3	K20T95	BPC
				K20H1791(Monla TP structure) to K20H1813(Monmola Pangthang Ss)	DG			258.02		0.258	196.812	3	25	3	K20T99	BPC
				K20H1792(Monmola Gonpa Ss) to K20H1800(Upper Barkalangnang Ss)	DG			814.54		0.815	197.626	3	25	3	K20T96	BPC
				K20H1800 to K20H1802	DG			138.93		0.139	197.765	3				
				K20H1802 to K20H1804(Lower Barkalangnang Ss)	DG			204.65		0.205	197.970	3	25	3	K20T97	BPC
				K20H1802 to K20H1811(Tashithangay Ss)	DG			889.53		0.890	198.859	3	25	3	K20T98	BPC
				K20H1813 to K20H1819(T-off Serthi Gonpa)	DG			777.84		0.778	199.637	3				
				K20H1819 to K20H1823(T-off Pemaling)	DG			260.2		0.260	199.897	3				
				K20H1819 to K20H1827(Serthi Gonpa Ss)	DG			72.3		0.072	199.970	3	25	3	K20T102	BPC
				K20H1823(T-off Pemaling) to K20H1824(Serthi Tangfrang Ss)	DG			82.83		0.083	200.052	3	25	3	K20T100	BPC
				K20H1823 to K20H1826(Serthi Pemaling Ss)	DG			209.36		0.209	200.262	3	10	1	K20T101	BPC
				K20H1827 to K20H1830(Toff Tokari)	DG			179.56		0.180	200.441	3				
				K20H1830 to K20H1831(Serthi Tangngagpa SS)	DG			72.12		0.072	200.514	3	25	3	K20T103	BPC
				K20H1830 to K20H1844(Tokari Gonpa Ss)	DG			1400.81		1.401	201.914	3	10	1	K20T104	BPC
				K20H1850 to K20H1885(Jurmy Toff)	DG			3362.13		3.362	205.276	3				
				K20H1860 to K20H1862(Upper Denphu Ss)	DG			124.96		0.125	205.401	3	25	3	K20T106	BPC
				K20H1885 to K20H1893(Jurmey-A Ss)	DG			1172.76		1.173	206.574	3	16	1	K20T107	BPC

Source	Feeder details		Voltage (kV)	Section	CONDUCTOR	Conductor type & Line Length							Distribution Transformer			Remarks
	Name	ID				300 UG	WOLF	DOG	RABBIT	Section Length (km)	Cumulative Length (km)	3-Phase / 1-Phase	Capacity (kVA)	3-Phase/ 1-Phase	ID	
Deothang Substation (132/33/11 kV), 2x5 MVA, 2x2.5 MVA	Samdrupcholing /Jomotsangkha Feeder	K20	33	K20H1885 to K20H1900	DG			848.86		0.849	207.423	3				
				K20H1900 to K20H1906(Lower Depchang Ss)	DG			878.93		0.879	208.302	3	25	3	K20T108	BPC
				K20H1900 to K20H1925(Depchang Drang Ss)	DG			2341.56		2.342	210.644	3	16	1	K20T110	BPC
				K20H1906(Lower Depchang Ss) to K20H1908(Upper Depchang Ss)	DG			209.58		0.210	210.853	3	25	3	K20T109	BPC
				K20H1925 to K20H1944	DG			2368.88		2.369	213.222	1				
				K20H1944 to K20H1945(Padpanathang SS)	DG			207.48		0.207	213.429	3	25	3	K20T111	BPC
				K20H1944 to K20H1969(Sayzor SS)	DG			3283.78		3.284	216.713	3	25	3	K20T112	BPC
				K20H1969(Sayzor SS) to K20H1978	DG			1617.73		1.618	218.331	1				
				K20H1978 to K20H1980(Upper Woongthi Ss)	DG			133.62		0.134	218.465	3	25	3	K20T113	BPC
				K20H1978 to K20H1981(Lower Woongthi Ss)	DG			106.45		0.106	218.571	3	25	3	K20T114	BPC
				K20H1978 to K20H1995(Toff to Jomtsang SS)	DG			1638.30		1.638	220.209	3				
				K20H1995 to K20H2002(Lower Batseling SS)	DG			1108.66		1.109	219.680	1	10	1	K20T115	BPC
				K20H1981 to K20H2090	DG			1057.57		1.058	220.737	3				
				K20H1995 to K20H2237(Jomtsang SS)	DG			107.32		0.107	220.845	3	63	3	K20T165	BPC
				K20H2002 to K20H2004(Toff to Batseling)	DG			209.3		0.209	221.054	3				
				K20H2004 to K20H2005(Upper Batseling)	DG			85.5		0.086	221.139	3	25	3	K20T116	BPC
				K20H2004 to K20H2047	DG			2766.15		2.766	223.906	3				
				K20H2005(Upper Batseling) to K20H2011	DG			661.77		0.662	224.567	3				
				K20H2011 to K20H2014(Lower Dungmanma)	DG			241.43		0.241	224.809	3	25	3	K20T117	BPC
				K20H2011 to K20H2016(Upper Dungmanma)	DG			158.22		0.158	224.967	3	25	3	K20T118	BPC
				K20H2011 to K20H2021(Middle Dungmanma)	DG			58.11		0.058	225.025	3	25	3	K20T120	BPC
				K20H2016(Upper Dungmanma) to K20H2020*(Dungmanma Lhakhang)	DG			419.75		0.420	225.445	3	25	3	K20T119	BPC
				K20H2021(Middle Dungmanma) to K20H2030(Meringchema SS)	DG			2000.29		2.000	227.445	1	16	1	K20T121	BPC
				K20H2047 to K20H2048(Upper Gonong)	DG			165.44		0.165	227.611	3	25	3	K20T122	BPC
				K20H2047 to K20H2049(Lower Gonong)	DG			23.87		0.024	227.634	3	25	3	K20T123	BPC
				K20H2049(Lower Gonong) to K20H2051(Lower Serjong)	DG			225.63		0.226	227.860	1	16	1	K20T124	BPC
				K20H2051(Lower Serjong) to K20H2053(Middle Serjong)	DG			221.61		0.222	228.082	1	25	1	K20T125	BPC
				K20H2053(Middle Serjong) to K20H2054(Upper Serjong)	DG			124.55		0.125	228.206	1	10	1	K20T126	BPC
				K20H2052 to K20H2057(Zangthi School)	DG			45.63		0.046	228.252	3	25	3	K20T128	BPC
				K20H2054 to K20H2056(Zangthi BHU)	DG			207.13		0.207	228.459	1	25	1	K20T127	BPC
				K20H2057(Zangthi School) to K20H2058(Tashiphu SS)	DG			40.36		0.040	228.499	1	16	1	K20T129	BPC
				K20H2058(Tashiphu SS) to K20H2069(Rashithang)	DG			2010.52		2.011	230.510	3	25	3	K20T130	BPC
				K20H2069 to K20H2072	DG			445.39		0.445	230.955	3				

Source	Feeder details		Voltage (kV)	Section	CONDUCTOR	Conductor type & Line Length							Distribution Transformer			Remarks
	Name	ID				300 UG	WOLF	DOG	RABBIT	Section Length (km)	Cumulative Length (km)	3-Phase / 1-Phase	Capacity (kVA)	3-Phase/ 1-Phase	ID	
Deothang Substation (132/33/11 kV), 2x5 MVA, 2x2.5 MVA	Samdrupcholing /Jomotsangkha Feeder	K20	33	K20H2072 to K20H2073(Tshothang SS)	DG			132.06		0.132	231.087	3	25	3	K20T131	BPC
				K20H2072 to K20H2080	DG			341.04		0.341	231.428	3				
				K20H2073(Tshothang SS) to K20H2076(Meskang SS)	DG			186.14		0.186	231.615	1	10	1	K20T132	BPC
				K20H2076(Meskang SS) to K20H2078(Gongpazumpa SS)	DG			263.02		0.263	231.878	3	25	3	K20T133	BPC
				K20H2080 to K20H2081(Zangthopelri SS)	DG			112.42		0.112	231.990	3	25	3	K20T134	BPC
				K20H2080 to K20H2082(Lam Zimchung SS)	DG			325.13		0.325	232.315	1	16	1	K20T135	BPC
				K20H2090 to K20H2094(Lauri A)	DG			668.61		0.669	232.984	3	25	3	K20T136	BPC
				K20H2090 to K20H2127	DG			2497.02		2.497	235.481	3				
				K20H2094(Lauri A) to K20H2095(Lauri B)	DG			59.59		0.060	235.540	3	25	3	K20T137	BPC
				K20H2095(Lauri B) to K20H2096(Lauri C)	DG			149.73		0.150	235.690	3	25	3	K20T138	BPC
				K20H2096(Lauri C) to K20H2097(Lauri D)	DG			125.81		0.126	235.816	3	25	3	K20T139	BPC
				K20H2097(Lauri D) to K20H2098	DG			97.47		0.097	235.913	3				
				K20H2098 to K20H2099(Lauri E)	DG			59.01		0.059	235.972	3	25	3	K20T140	BPC
				K20H2099(Lauri E) to K20H2100(Lauri F)	DG			109.72		0.110	236.082	3	25	3	K20T141	BPC
				K20H2100(Lauri F) to K20H2101(Lauri G)	DG			144.88		0.145	236.227	3	25	3	K20T142	BPC
				K20H2101(Lauri G) to K20H2102(Lauri H)	DG			109.03		0.109	236.336	3	25	3	K20T143	BPC
				K20H2102(Lauri H) to K20H2106(Zarshing SS)	DG			903.72		0.904	237.240	3	25	3	K20T144	BPC
				K20H2106(Zarshing SS) to K20H2111(Marphae SS)	DG			640.68		0.641	237.880	1	16	1	K20T145	BPC
				K20H2115 to K20H2240(Raynangdaza SS)	DG			520.63		0.521	238.401	3	25	3	K20T166	BPC
				K20H2127 to K20H2128(Lauri-Jompa Gewog Center)	DG			59.97		0.060	238.461	3	25	3	K20T146	BPC
				K20H2127 to K20H2134(Jompa School SS)	DG			186.27		0.186	238.647	3	25	3	K20T148	BPC
				K20H2128 to K20H2132(Ramjar Gonpa SS)	DG			577.64		0.578	239.225	1	16	1	K20T147	BPC
				K20H2134(Jompa School SS) to K20H2137	DG			478.03		0.478	239.703	1				
				K20H2137 to K20H2139	DG			296.92		0.297	240.000	3				
				K20H2137 to K20H2173	DG			3130.03		3.130	243.130	3				
				K20H2139 to K20H2141(Lower Momring))	DG			264.22		0.264	243.394	3	25	3	K20T149	BPC
				K20H2141(Lower Momring)) to K20H2142(Middle Momring SS)	DG			137.43		0.137	243.531	3	25	3	K20T150	BPC
				K20H2139 to K20H2151(Lower Raynang SS)	DG			652.06		0.652	244.184	3	25	3	K20T153	BPC
				K20H2142(Middle Momring SS) to K20H2143(Upper Momring SS)	DG			96.78		0.097	244.280	3	25	3	K20T151	BPC
				K20H2143(Upper Momring SS) to K20H2146(Momring Pangtoth SS)	DG			355.62		0.356	244.636	3	25	3	K20T152	BPC
				K20H2151 to K20H2156(Upper Raynang SS)	DG			548.55		0.549	245.184	3	25	3	K20T154	BPC
				K20H2173 to K20H2175(Lower Phajo Gonpa SS)	DG			142.69		0.143	245.327	3	25	3	K20T155	BPC
Deothang Substation (132/33/11 kV),	Samdrupcholing /Jomotsangkha	K20	33	K20H2175(Lower Phajo Gonpa SS) to K20H2176(Upper Phajo Gonpa)	DG			102.41		0.102	245.430	3	25	3	K20T156	BPC

Source	Feeder details		Voltage (kV)	Section	CONDUCTOR	Conductor type & Line Length							Distribution Transformer			Remarks
	Name	ID				300 UG	WOLF	DOG	RABBIT	Section Length (km)	Cumulative Length (km)	3-Phase / 1-Phase	Capacity (kVA)	3-Phase/ 1-Phase	ID	
2x5 MVA, 2x2.5 MVA	Feeder			K20H2173 to K20H2179(Khashideng SS)	DG			351.71		0.352	245.781	3	25		K20T157	BPC
				TOTAL		**0.000**	**31039.504**	**147965.222**	**68508.228**	**247.513**	**247.513**		**166**			
				11 kV Deothang Feeder												
Deothang Substation (132/33/11 kV), 2x5 MVA, 2x2.5 MVA	Dewathang Feeder	K30	11	K30H000- K30H001	DG			67.95		0.068	15.079	3				
				K30H000 to K30H020	DG			1956.06		1.956	17.035	3				
				K30H020 to K30H021(Petrol Pump SS)	DG			50.25		0.050	17.085	3	125	3	K30T1	BPC
				From K30H020 to K30H027	DG			663.73		0.664	17.749	3				
				K30H020 to K30H090(Bangtsho SS)	RAB				435.08	0.435	18.184	3	250	3	K30T6	BPC
				K30H090-K30H099(Khesangteri SS)	RAB				726.49	0.726	18.910	3	315	3	K30T7	BPC
				K30H090 to K30H107	RAB				671.76	0.672	19.582	3				
				K30H107 to K30H108(Kopor SS)	RAB				46.94	0.047	19.629	3	100	3	K30T8	BPC
				K30H107 to K30H109(Toff to Teleom Tower SS)	RAB				95.23	0.095	19.724	3				
				K30H109 to K30H157(Telecom Tower ss)	RAB				656.16	0.656	20.380	3	25	3	K30T10	BPC
				K30H109 to K30H118(T-off to Garpowoong School)	RAB				607.26	0.607	20.987	3				
				K30H118 to K30H175(Garpowoong)	RAB				1211.3	1.211	22.199	3	250	3	K30T11	BPC
				K30H118- K30H147(RekhaySS)	RAB				2331.35	2.331	24.530	3	100	3	K30T9	BPC
				From Pole No. K30H027- K30H029(Central Military)	DG			117.87		0.118	24.648	3	250	3	K30T2	BPC
				K30H027 to K30H041(T-off to Dewathang Baazar SS)	DG			440.38		0.440	25.088	3				
				K30H41- K30H176(Dewathang Baazar SS)	RAB				13.65	0.014	25.102	3	500	3	K30T12	BPC
				K30H041 to K30H055(Old Polytechnic)	DG			732.51		0.733	25.835	3	315	3	K30T3	BPC
				K30H055(Old P0lytechnic) to K30H056 (Interconection point to K60)	DG			110.22		0.110	25.945	3				
				K30H056 (Interconnect point to K60) to K30H060(T-off to Poly DG)	RAB				230.33	0.230	26.175	3				
				K30H060 to K30H061(Polytechnic-DG)	RAB				11.16	0.011	26.186	3	500	3	K30T4	BPC
				K30H060to K30H067(T-off to GayzorSS)	RAB				492.06	0.492	26.678	3				
				K30H067 to K30H068 (Polytechnic-Guest house)	RAB				100.68	0.101	26.779	3	125	3	K30T14	PRIVATE
				K30H067 to K30H071(Gayzor SS)	RAB				222.3942436	0.222	27.001	3				
				K30H071 to K30H086(Reshore SS)	RAB				1102.194016	1.102	28.104	3	63	3	K30T5	BPC
				K30H071 to Gayzor SS)	RAB				1103.194016	1.103	29.207	3	63			BOC
				TOTAL		**0**	**0**	**4138.97**	**10057.23228**	**14.196**	**14.19620228**		**14**			

Source	Feeder details		Voltage (kV)	Section	CONDUCTOR	Conductor type & Line Length							Distribution Transformer			Remarks
	Name	ID				300 UG	WOLF	DOG	RABBIT	Section Length (km)	Cumulative Length (km)	3-Phase / 1-Phase	Capacity (kVA)	3-Phase/ 1-Phase	ID	
				11 kV orong Feeder												
Deothang Substation (132/33/11 kV), 2x5 MVA, 2x2.5 MVA	Orong	K40	11	11kV C/room -K40H000	UG	44				0.044	**0.044**	3				
				K40H000- K40H052(Phhilima Toff)	RAB				5917.39	5.917	**5.962**	3				
				K40H52 to K40H396	RAB				4408.35	4.408	**10.370**	3				
				K40H396 to K40H397(Lower Philuma SS)	RAB				41.97	0.042	**10.412**	3	25	3	K40T19	BPC
				K40H398(Lower Philuma to Upper Pheilum SS)	RAB				94.66	0.095	**10.507**	3	25	3	K40T20	BPC
				K40H398 to K40H404(Lower Phu SS)	RAB				795.7	0.796	**11.302**	3	25	3	K40T21	BPC
				K40H404 to K40H405	RAB				75.29	0.075	**11.378**	3				
				K40H404(Lower Phu SS) to K40H406(Upper Phu)	RAB				209.93	0.210	**11.587**	3	25	3	K40T22	BPC
				K40H405 to K40H427(Dukposa)	RAB				2300.28	2.300	**13.888**	3	16	3	K40T23	BPC
				K40H052 to K40H056	RAB				324.59	0.325	**14.212**	3				
				K40H056 to K40H080(Milum Toff)	RAB				1532.56	1.533	**15.745**	3				
				K40H080 to K40H086(Melum SS)	RAB				485.92	0.486	**16.231**	3	63	3	K40T1	BPC
				K40H080 to K40H089(Durtsun SS)	RAB				350.31	0.350	**16.581**	3	250	3	K40T2	BPC
				K40H089 to K40H097(Mantsang SS)	RAB				588.63	0.589	**17.170**	3	63	3	K40T3	BPC
				K40H089 to K40 H150	RAB				766.2	0.766	**17.936**	3				
				K40H150 to K40H441(Orong HS)	RAB				863.57	0.864	**18.800**	3	250	3	K40T24	BPC
				K40H150 to K40H165 (Nagzor Toff)	RAB				2119.79	2.120	**20.919**	3				
				K40H165 to K40H169(Nagzor SS)	RAB				440.39	0.440	**21.360**	3	63	3	K40T7	BPC
				K40H165 to K40H178	RAB				918.84	0.919	**22.279**	3				
				K40H178 to K40H179(Batshung SS)	RAB				104.31	0.104	**22.383**	3	25	3	K40T8	BPC
				K40H178 to K40H189	RAB				851.8	0.852	**23.235**	3				
				K40H189 to K40H195(Bachung SS)	RAB				391.72	0.392	**23.626**	3	25	3	K40T9	BPC
				K40H189 to K40H200(woling SS)	RAB				318.23	0.318	**23.945**	3	63	3	K40T10	BPC
				K40H200 to K40H210(pathar SS)	RAB				833.53	0.834	**24.778**	3	63	3	K40T11	BPC
				K40H210 to K40H234(Mandar SS)	RAB				1906.96	1.907	**26.685**	3	63	3	K40T12	BPC
				K40H234 to K40H247(Jangchuling SS)	RAB				1387.64	1.388	**28.073**	3	63	3	K40T13	BPC
				K40H210 to K40H260(Nagla SS)	RAB				1315.56	1.316	**29.388**	3	16	3	K40T14	BPC
				K40H260 to K40H279(Remung SS)	RAB				2244.37	2.244	**31.633**	3	63	3	K40T15	BPC
				K40H056 to K40H098	RAB				107.29	0.107	**31.740**	3				
				K40H098 to K40H102(Suzung SS)	RAB				402.38	0.402	**32.142**	3	63	3	K40T4	BPC
				K40H098 to K40H122(Menchari SS)	RAB				1556.47	1.556	**33.699**	3	25	3	K40T5	BPC
				K40H122(Menchari SS) to K40H143(Arong Toff)	RAB				1621.99	1.622	**35.321**	3				
				K40H143 to K40H145(Arong SS)	RAB				186.65	0.187	**35.507**	3	63	3	K40T6	BPC
				K40H143 to K40H319	DG			3895.19		3.895	**39.403**	3				

Source	Feeder details		Voltage (kV)	Section	CONDUCTOR	Conductor type & Line Length							Distribution Transformer			Remarks
	Name	ID				300 UG	WOLF	DOG	RABBIT	Section Length (km)	Cumulative Length (km)	3-Phase / 1-Phase	Capacity (kVA)	3-Phase/ 1-Phase	ID	
Deothang Substation (132/33/11 kV), 2x5 MVA, 2x2.5 MVA	Orong	K40	11	40H319 to K40H444(Migtangkhar SS)	RAB				328.66	0.329	**39.731**	3	25	33	K40T25	BPC
				K40H319 to K40H335	DG			1359.53		1.360	**41.091**	3				
				K40H335 to K40H336(Yurteri SS)	DG			39.21		0.039	**41.130**	3	16	3	KH40T16	BPC
				K40H336 to K40H357(Morong SS)	DG			1294.02		1.294	**42.424**	3	63	3	K40T17	BPC
				K40H335 to K40H372(Lerong SS)	RAB				1783.75	1.784	**44.208**	3	25	3	K40T18	BPC
				TOTAL				**6587.95**	**37575.68**	**44.208**	**44.208**		**25**			
				11 kV Langchenphug Feeder												
				K50H001-K50H012	RAB				452.16	0.452	**0.452**	3				
Deothang Substation (132/33/11 kV), 2x5 MVA, 2x2.5 MVA	Dlangchenphu Feeder	K50	11	K50H012 to K50H013(Daifam Baazar SS)	RAB				**16.91**	0.017	**0.469**	3	**500**	**3**	**K50T1**	**BPC**
				K50H013-K50H015	RAB				104.35	0.104	**0.573**	3				
				K50H015 to K50H021	RAB				309.47	0.309	**0.883**	3				
				K50H021 to K50H037	RAB				726.91	0.727	**1.610**	3				
				K50H037 to K50H038(RBA SS)	RAB				38.83	0.039	**1.649**	3	250	3	K50T2	BPC
				K50H037- K50H084(Jampani Ss)	RAB				2424.93	2.425	**4.074**	3	63	3	K50T3	BPC
				K50H037- K50H205(33/11 Ss)	RAB				787.8	0.788	**4.861**	3				
				K50H205 to (33/11 Ss)	UG	**14**				0.014	**4.876**	3				
				K50H015-K50H096(Talabasty SS)	RAB				1034.83	1.035	**5.910**	3	315	3	K50T4	BPC
				K50H096 to K50H106(Dawathang SS TOFF)	RAB				911.50	0.911	**6.822**	3				
				K50H112 to K50H106(Selchu SS TOFF)	RAB				497.97	0.498	**7.320**	3				
				K50H106 to K50H124(Golanty SS)	RAB				965.13	0.965	**6.876**	3	63	3	K50T5	BPC
				K50H128	RAB				33.06	0.033	**6.909**	3				
				K50H21 to -K50H129(Dungkhag Office SS)	RAB				45.61	0.046	**6.954**	3	160	3	K50T6	BPC
				K50H129 to K50H137(NHDC Colony)	RAB				581.72	0.582	**7.536**	3	250	3	K50T7	BPC
				K50H96 to K50H169	RAB				2621.73	2.622	**10.158**	3				
				K50H169 to K50H177(Bajrang SS)	RAB				682.66	0.683	**10.840**	3	25	3	K50T8	BPC
				K50H169 to K50H199(Agurator SS)	RAB				1977.45	1.977	**12.818**	3	63	3	K50T9	BPC
				K50H124 to K50H215	RAB				747	0.747	**13.565**	3				
				K50H215 to K50H217(Khowrong Toff)	RAB				430	0.430	**13.995**	3				
				K50H218 to K50H260(Khowrong SS)	RAB				3995.97	3.996	**17.991**	3	63	3	K50T12	BPC
				K50H217 to K50H261(Golanti stone Crasher)	RAB				84.25	0.084	**18.075**	3	160	3	K50T10	PRIVATE

Source	Feeder details		Voltage (kV)	Section	CONDUCTOR	Conductor type & Line Length							Distribution Transformer			Remarks
	Name	ID				300 UG	WOLF	DOG	RABBIT	Section Length (km)	Cumulative Length (km)	3-Phase / 1-Phase	Capacity (kVA)	3-Phase/ 1-Phase	ID	
				K50H215 to K50H267(Jangsa Woong)	RAB				557.02	0.557	**18.632**	3	63	3	K50T13	BPC
				K50H106 to K50H268(Dawathang)	RAB				20	0.020	**18.652**	3	100	3		BPC
				K50H1112 toSElchu SS	RAB				604	0.604	**19.256**	3	160	3		PRIVATE
	TOTAL							6587.95	15789.89222	20.665	20.665		14			
11 kV Dzong feeder as well as backup feed from deothang feeder Ring system																
Samdrup Jongkhar Substation (33/11 kV), 2x2.5 MVA	Dzong Feeder	K60	11	11 kV Panel to K60P4	UG	**125**				0.125	0.125	3				
				K60P4-K606001	UG	**9**				0.009	0.134	3				
				K60H001-K60H002	DG			50.48		0.050	0.185	3				
				K60H002 to K60H005	RAB				**202**	0.202	0.387	3				
				K60H005 to K60H006(Industrial Area SS)	RAB				**12**	0.012	0.399	3	500	3	K60T1	BPC
				K60H005 to K60H015(SJ Pry School SS)	RAB				**554**	0.554	0.953	3	250	3	K60T2	BPC
				K60H002 to K60H021	DG			316.47		0.316	1.270	3				
				K60H021 to K60H029	DG			328.52		0.329	1.598	3				
				K60H021 to K60H122(Tashi Sawmill)	SQ				13.14	0.013	1.611	3	63	3	K60T5	PRIVATE
				K60H026 to K60H127(Kezang Sawmill)	RAB				90.98	0.091	1.702	3	160	3	K60T8	PRIVATE
				K60H021 to K60H030(AWP SS)	DG			41.93		0.042	1.744	3	250	3	K60T3	BPC
				K60H030 to K60H040	DG			510.58		0.511	2.255	3				
				K60H040 to K60H128(Dratsang SS)	RAB				58.68	0.059	2.313	3	160	3	K60T7	BPC
				K60H040 to K60H046(Toff lap IV)	DG			628.35		0.628	2.942	3				
				K60H046 to lap IV SS)	DG			150.00		0.150	3.092	3	250	3		BPC
				K60H046 to K60H050(RBP Colony-4KM)	DG			298.61		0.299	2.612	3	25	3	K60T4	BPC
				K60H050 to K60H065(Druk Presidency-6 KM)	DG			1106.42		1.106	3.718	3	500	3	K60T10	PRIVATE
				K60H065 to K60H073(7KM)	DG			621.4		0.621	4.340	3				
				K60H073 to K60H084((KM-LBS)	DG			1264.39		1.264	5.604	3				
				K60H084 to K60H091(Toff to Borbila ss)	DG			575.62		0.576	6.180	3				
				K60H091(Toff to Borbila ss) to Borbilla SS	RAB			241		0.241	6.421	3	63	3	K60T13	BPC
				K60H091 to K60H098(Toff to TPO Coony SS)	DG			720.85		0.721	7.142	3				
				K60H097 to K60H129(10KM)	RAB				17.81	0.018	7.159	3	16	3	K60T12	BPC
				K60H098 to K60H108(Toff Dunsam Academy)	DG			1192.56		1.193	8.352	3				
				K60H108 to K60H131(Dungsam Academy SS)	RAB				147.99	0.148	8.500	3	250	3	K60T9	BPC
				K60H108 to K60H111(Toff to 12KM)	DG			278.98		0.279	8.779	3				
				K60H111 to K60H133(12 KM SS)	RAB				151.18	0.151	8.930	3	63	3	K60T11	BPC
				K60H111 to K60H121(interconnects with K30)	DG			1083.93		1.084	10.014	3				
	TOTAL					**134**	**0**	**9410**	**1248**	**10.79**	**10.79**		12			

Source	Feeder details		Voltage (kV)	Section	CONDUCTOR	Conductor type & Line Length							Distribution Transformer			Remarks
	Name	ID				300 UG	WOLF	DOG	RABBIT	Section Length (km)	Cumulative Length (km)	3-Phase / 1-Phase	Capacity (kVA)	3-Phase/ 1-Phase	ID	
				11 KV Motanga feeder												
Samdrup Jongkhar Substation (33/11 kV), 2x2.5 MVA	Dzong Feeder	K60	11	11KVC/Room to K70H001	UG	**21**				0.021	**0.021**	3				
				K70H001 to K70H005	RAB				211.93	0.212	**0.233**	3				
				K70H005 to K70H007(Gypsum yard SS)	RAB				101.88	0.102	**0.335**	3	315	3	K70T1	BPC
				K70H005 to K70H010(Hosptital T-off)	RAB				153.36	0.153	**0.489**	3				
				K70H010 to K70H053(Hospital SS)	RAB				286.6	0.287	**0.775**	3	250	3	K70T4	BPC
				K70H009 to K70H048(Motanga SS)	RAB				2837.16	2.837	**3.326**	3	500	3	K70T2	BPC
				K70H048 to K70H058(Bhutan Gypsum)	RAB				611.86	0.612	**1.387**	3	500	3	K70T5	PRIVATE
	TOTAL					**21**			**4202.79**	**4.224**	**4.224**		**4**			
Samdrup Jongkhar Substation (33/11 kV), 2x2.5 MVA	Bazaar Feeder	K80	11	**11 kV Samdrupjongkhar Bazar feeder**												
				11KVC/penal - K80P1	UG	**52**				0.052	**0.052**	3				
				11KVC/penal - K80P7(BOB USS)	UG	**415**				0.415	**0.467**	3				
				K80P7 to K80H001	UG	**21**				0.021	**0.489**	3				
				K80H001 to K80H002	AAAC			54.2		0.054	**0.543**	3				
				K80H002 to K80P8(Lower Market USS)	UG	**236**				0.236	**0.779**	3	1000	3	K80T2	BPC
				K80P8 to K80H003	UG	**23**				0.023	**0.802**	3				
				K80H004 to K80H005(NHDCL Conlony 1)	RAB				83.24	0.083	**0.885**	3	500	3	K80T6	BPC
				K80H005 to K80H006(NHDCL Conlony 2	RAB				91.6	0.092	**0.977**	3	500	3	K80T7	BPC
				K80P8 to K80P9(Chenga Line USS)	UG	**295**				0.295	**1.272**	3	1000	3	K80T3	BPC
				K80P9 to K80P10(RBP USS)	UG	**238**				0.238	**1.510**	3	1000	3	K80T4	BPC
				K80P10 to K80P11(Behind FCB)	UG	**220**				0.220	**1.730**	3	1000	3	K80T5	BPC
				K80P11 to K80H002	UG	**22**				0.022	**1.752**	3				
	TOTAL					**1,523**	**-**	**54**	**174.840**	**1.752**	**1.752**		**6**			
				11 kV Station Feeder												
	Station Feeder	K90	11	11KVC/penal to K90H001(Station Transformer)	UG	**36**				0.036	0.036	3	500	3	K90T1	BPC
	TOTAL									**0.036**	**0.036**		**1**			

Source	Feeder details: Name	Feeder details: ID	Voltage (kV)	Section	CONDUCTOR	Conductor type & Line Length: 300 UG	WOLF	DOG	RABBIT	Section Length (km)	Cumulative Length (km)	3-Phase / 1-Phase	Distribution Transformer: Capacity (kVA)	3-Phase/ 1-Phase	ID	Remarks
				33 kV Gomdar Feeder												
Deothang Substation (132/33/11 kV), 2x5 MVA, 2x2.5 MVA	Gomdar Feeder	K100	33	K100H000 to K100H113	RAB				12432.26	12.432	12.432	3				
				K100H113 to K100H115(28 Kilo-Athraise SS)	RAB				203.12	0.203	12.635	1	16	1	K100T01	BPC
				K100H113 to K100H142(Dengzor Toff)	RAB				3530.07	3.530	16.165	3				
				K100H142 to K100H147(Dengzor SS)	RAB				548.42	0.548	16.714	3	16	1	K100T02	BPC
				K100H142 to K100H175	RAB				4125.22	4.125	20.839	1				
				K100H175 to K100H176(Tokorong SS)	RAB				63.71	0.064	20.903	1	25	1	K100T03	BPC
				K100H175 to K100H195(Gomdar Toff)	RAB				1686.89	1.687	22.590	3				
				K100H195 to K100H206(Gomdar SS)	RAB				1189.2	1.189	23.779	3	63	3	K100T09	BPC
				K100H206 to K100H217	RAB				1196.63	1.197	24.976	3				
				K100H217 to K100H261(Narpung Toff)	RAB				2471.94	2.472	27.447	3				
				K100H261 to K100H267(Narphung village SS)	RAB				346.02	0.346	27.793	3	63	3	K100T14	BPC
				K100H261 to K100H279(Narphung Baazar SS)	RAB				995.94	0.996	28.789	3	63	3	K100T15	BPC
				K100H217 to K100H281(Tsangchilo SS)	RAB				213.04	0.213	29.002	3	63	3	K100T11	BPC
				K100H281 to K100H285(Amshing Toff)	RAB				229.96	0.230	29.232	3				
				K100H285 to K100H296(Lower Brongshing SS)	RAB				1175.81	1.176	30.408	1	25	1	K100T12	BPC
				K100H296 to K100H302(Upper Brongshing SS)	RAB				441.87	0.442	30.850	1	25	1	K100T13	BPC
				K100H285 to K100H308(Upper&Lower Amshing Toff)	RAB				862.37	0.862	31.712	1				
				K100H308 to K100H309(Upper Amshing)	RAB				126.4	0.126	31.839	1	25	1	K100T18	BPC
				Upper Amshing to K100H311(Lower amshing)	RAB				118.37	0.118	31.957	1	25	1	K100T19	BPC
				K100H308 to K100H313(Bayyul SS)	RAB				269.89	0.270	32.227	1				
				K100H313 to K100H317(Pangthang SS)	RAB				228.07	0.228	32.455	1	25	1	K100T20	BPC
				K100H321 to K100H322(Baynung Toff)	RAB				350.28	0.350	32.805	1				
				K100H322 to K100H323(Bannung SS)	RAB				68.75	0.069	32.874	1	16	1	K100T21	BPC
				K100H322 to K100H328(Bargonpa SS)	RAB				401.79	0.402	33.276	1	25	1	K100T22	BPC
				K100H322 to K100H334(Pearung SS)	RAB				639.49	0.639	33.916	1	10	1	K100T23	BPC
				K100H334 to K100H347(Khandoma SS)	RAB				1221.28	1.221	35.137	1	25	1	K100T24	BPC
				K100H347 to K100H364(Bayuel SS)	RAB				2030.95	2.031	37.168	1	16	1	K100T25	BPC
				K100H313 to K100H369	RAB				744.12	0.744	37.912	1				
				K100H369 to K100H372(Lookzor SS)	RAB				109.73	0.110	38.022	1	25	1	K100T28	BPC
				K100H372 to K100H379(Mokhoma SS)	RAB				695.71	0.696	38.717	1	25	1	K100T29	BPC
				K100H369 to K100H384(Khoyar I SS)	RAB				397.71	0.398	39.115	1	25	1	K100T26	BPC
				K100H383 to K100H788(Khoyar School SS)	RAB				30.94	0.031	39.146		25	1	K100T71	BPC
				K100H384 to K100H389(Ronghanglu Ss)	RAB				511.5	0.512	39.657	1	16	1	K100T27	BPC

Source	Feeder details		Voltage (kV)	Section	CONDUCTOR	Conductor type & Line Length							Distribution Transformer			Remarks
	Name	ID				300 UG	WOLF	DOG	RABBIT	Section Length (km)	Cumulative Length (km)	3-Phase / 1-Phase	Capacity (kVA)	3-Phase/ 1-Phase	ID	
Deothang Substation (132/33/11 kV), 2x5 MVA, 2x2.5 MVA	Gomdar Feeder	K100	33	K100H369 to K100H391(Khoyar II SS)	RAB				177.66	0.178	39.835	1	25	1	K100T30	BPC
				K100H391 to K100H404(Lower Denchi)	RAB				1280.81	1.281	41.116	1	25	1	K100T31	BPC
				K100H404 to K100H406	RAB				135.12	0.135	41.251	1				
				K100H406 to K100H408	RAB				307.9	0.308	41.559	1				
				K100H408 to K100H409(Upper Denchi)	RAB				62.36	0.062	41.621	1	25	1	K100T32	BPC
				Upper Dechi to K100H413(Middle Denchi)	RAB				234	0.234	41.855	1	25	1	K100T33	BPC
				K100H406 to K100H417(Gonung Toff)	RAB				380.96	0.381	42.236	1				
				K100H417 to K100H424(Upper Gonong)	RAB				733.84	0.734	42.970	1	25	1	K100T35	BPC
				K100H424 to K100H428(Lower Gonong)	RAB				441.54	0.442	43.412	1	25	1	K100T36	BPC
				K100H417 to K100H437(Frami Toff)	RAB				1080.1	1.080	44.492	1				
				K100H437 to K100H438(Middle Frami)	RAB				87.21	0.087	44.579	1	25	1	K100T37	BPC
				Midle Frami to Upper Frami	RAB				269.17	0.269	44.848	1	25	1	K100T38	BPC
				Midle Frami to Lower Frami	RAB				429.49	0.429	45.278	1	25	1	K100T39	BPC
				K100H437 to K100H450(Lower BarzorToff)	RAB				671.95	0.672	45.950	1				
				K100H450 to K100H789(Barzor Schoool SS)	RAB				73.01	0.073	46.023	1	25	1	K100T72	BPC
				K100H450 to K100H454(Middle Barzor)	RAB				378.9	0.379	46.401	1	25	1	K100T40	BPC
				K100H454 to K100H457(Upper Barzor Toff)	RAB				369.92	0.370	46.771	1				
				K100H457 to K100H458(Upper Barzor SS)	RAB				137.06	0.137	46.908	1	25	1	K100T41	BPC
				K100H457 to K100H464(Rejoke SS)	RAB				806.44	0.806	47.715	1	10	1	K100T42	BPC
				K100H789 to K100H465(Lower Bazor)	RAB				4.54	0.005	47.719	1	25	1	K100T43	BPC
				K100H465 to K100H475	RAB				1228.85	1.229	48.948	1				
				K100H475 to K100H477(Lower Chidungkhar)	RAB				112.23	0.112	49.061	1	25	1	K100T44	BPC
				Lower Chidungkhar to K100H480(Middle Chdungkhar)	RAB				323.9	0.324	49.384	1	25	1	K100T45	BPC
				K100H480 to K100H483(Upper Chidungkhar)	RAB				299.28	0.299	49.684	1	25	1	K100T46	BPC
				K100H475 to K100H494(Upper Brume)	RAB				1926.34	1.926	51.610	1	25	1	K100T47	BPC
				Upper Burme to Middle Brume	RAB				337.38	0.337	51.947	1	25	1	K100T48	BPC
				Middle Brume to Lower Brume	RAB				465.2	0.465	52.413	1	25	1	K100T49	BPC
				K100H217 to K100H218	RAB				219.13	0.219	52.632	3				
				K100H218 to K100H220(Gomdar School SS)	RAB				163.3	0.163	52.795	3	250	3	K100T10	BPC

Source	Feeder details		Voltage (kV)	Section	CONDUCTOR	Conductor type & Line Length							Distribution Transformer			Remarks
	Name	ID				300 UG	WOLF	DOG	RABBIT	Section Length (km)	Cumulative Length (km)	3-Phase / 1-Phase	Capacity (kVA)	3-Phase/ 1-Phase	ID	
Deothang Substation (132/33/11 kV), 2x5 MVA, 2x2.5 MVA	Gomdar Feeder	K100	33	K100H218 to K100H225	RAB				514.98	0.515	53.310	1				
				K100H225 to K100H227(Sawangchilo SS)	RAB				145.56	0.146	53.456	1	25	1	K100T16	BPC
				K100H225 to K100H234(Sawang Daza SS)	RAB				440.9	0.441	53.896	1	25	1	K100T17	BPC
				K100H195 to K100H504(Ngongthong SS)	RAB				279.6	0.280	54.176	3	10	1	K100T04	BPC
				K100H504 to K100H513	RAB				662.09	0.662	54.838	3				
				K100H513 to K100H528	RAB				1179.91	1.180	56.018	1				
				K100H528 to K100H530(Lower Rechanglu)	RAB				146.98	0.147	56.165	1	25	1	K100T5	BPC
				K100H528 to K100H533(Middle Rechanglu)	RAB				345.71	0.346	56.511	1	25	1	K100T6	BPC
				Middle Rechanglu to K100H536(Upper Rechanglu)	RAB				206.55	0.207	56.717	1	25		K100T7	BPC
				K100H513 to K100H540(Gayree Village SS)	RAB				347.89	0.348	57.065	3	16	1	K100T8	BPC
				K100H540 to K100H550(Pertsinang Toff)					786.79	0.787	57.852	3				
				K100H550 to K100H787(Pertsinang SS)	RAB				810.43	0.810	58.662	3	30	3	K100T70	BPC
				K100H550 to K100H568(Khenorong SS)	RAB				1490.72	1.491	60.153	3	25		K100T50	BPC
				Khenrong to K100H586(Lower Shokshi SS)	RAB				1391.07	1.391	61.544	3	25	1	K100T51	BPC
				Lower Shokshi to K100H590	RAB				366.94	0.367	61.911	3				
				K100H590 to K100H602(Lower Shokshi Pangthang)	RAB				997.83	0.998	62.909	1	25	1	K100T52	BPC
				K100H602 to K100H604	RAB				101.77	0.102	63.011	1				
				K100H604 to K100H607(Middle Shokshi Pangthang)	RAB				165.38	0.165	63.176	1	25	1	K100T53	BPC
				K100H604 to K100H611(Upper shokshi pangthang)	RAB				338.72	0.339	63.515	1	25	1	K100T54	BPC
				K100H611 to K100H624(Bargonpa SS)	RAB				1024.14	1.024	64.539	1	25	1	K100T55	BPC
				K100H590 to K100H625(Middle Shokshi SS)	RAB				28.24	0.028	64.567	3	25	1	K100T56	BPC
				Middle shokshi to K100H631(Upper Shokshi)	RAB				472.27	0.472	65.040	3	25	1	K100T57	BPC
				Upper shokshi to K100H634(LBS-Upper shokshi)	RAB				153.32	0.153	65.193	3				
				K100H634 to K100H638	RAB				578.44	0.578	65.771	3				
				K100H638 to K100H640(Upper Wangphu)	RAB				196.66	0.197	65.968	3	25	3	K100T58	BPC
				K100H638 to K100H648	RAB				797.85	0.798	66.766	3				
				K100H648 to K100H658	RAB				719.62	0.720	67.485	1				
				K100H658 to K100H660(Pangthang)	RAB				111.08	0.111	67.596	1	16	1	K100T59	BPC
				K100H658 to K100H668(Yarphu Dungdaza Toff)	RAB				896.98	0.897	68.493	1				
				K100H668 to K100H676(Dungdaza I)	RAB				530.99	0.531	69.024	1	16	1	K100T60	BPC
				K100H668 to K100H686(Lower Yarphu Toff)	RAB				864.29	0.864	69.889	1				

Source	Feeder details		Voltage (kV)	Section	CONDUCTOR	Conductor type & Line Length							Distribution Transformer			Remarks
	Name	ID				300 UG	WOLF	DOG	RABBIT	Section Length (km)	Cumulative Length (km)	3-Phase / 1-Phase	Capacity (kVA)	3-Phase/ 1-Phase	ID	
Deothang Substation (132/33/11 kV), 2x5 MVA, 2x2.5 MVA	Gomdar Feeder	K100	33	K100H686 to K100H689(Lower Yarphu)	RAB				262.16	0.262	70.151	1	25	1	K100T61	BPC
				K100H790 to K100H692(Middle Yarphu)	RAB				126.21	0.126	70.277	1	25	1	K100T62	BPC
				K100H692 to K100H790(Yarphu School SS)	RAB				21	0.021	70.298	1	25	1	K100T73	BPC
				Middle Yraphu to K100H698(Upper Yarphu)	RAB				504.45	0.504	70.803	1	25	1	K100T63	BPC
				K100H648 to K100H702(Haila Toff)	RAB				401.57	0.402	71.204	3				
				K100H702 to K100H718(Langnangringmo)	RAB				1432.82	1.433	72.637	1	25	1	K100T64	BPC
				K100H702 to K100H722(Middle Wangphu)	RAB				228.92	0.229	72.866	1	25	1	K100T65	BPC
				Middle Wangphu to K100H725(Lower Wangphu)	RAB				396.72	0.397	73.263	1	16	1	K100T66	BPC
				K100H725 to K100H745	RAB				1884.04	1.884	75.147	1				
				K100H745 to K100H747(Haila SS)	RAB				96.7	0.097	75.243	1	25	1	K100T67	BPC
				K100H745 to K100H769	RAB				2951.84	2.952	78.195	1				
				K100H769 to K100H773(Lower Serchenmo)	RAB				336.67	0.337	78.532	1	25	1	K100T68	BPC
				K100H769 to K100H779(Upper Sercheno SS)	RAB				746.63	0.747	79.278	1	25	1	K100T69	BPC
	TOTAL					0.000	0.000	0.000	79278.470	79.278	79.278		72			
Motanga Substation (132/33kV), 1x15 MVA,	Motanga to SJ Feeder	K110	33	**33 kV Motanga to SJ Feeer**												
				K110H045	AAAC			3078.76		3.079	**3.079**					
				TOTAL		0.000	0.000	3078.760	0.000	3.079	3.079		0			
Samdrup Jongkhar Substation (33/11 kV), 2x2.5 MVA				**11 kV Telecom Feeder**												
	Telecom Feeder	K120		11KVC/penal to K120H001(Telecom SS)	UG	**247**				0.247	**0.247**		160	3	K120T1	BPC
				Telecom Ss to K120H002(Thromde SS)	UG	**17**				0.017	**0.265**		63	3	K120T2	PRIVATE
				TOTAL		**264.67**	**0.00**	**0.00**	**0.00**	**0.265**	0.265		2			
				11 kV RICB Feeder												
				11KVC/penal to K130H001(RICB SS)	UG	**43**				0.043	**0.043**		250	3	K130T1	BPC
				TOTAL		43	-	-	-	0.043	0.043		1			

Annexure 2- IS 2026, IEC 60076

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

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.**

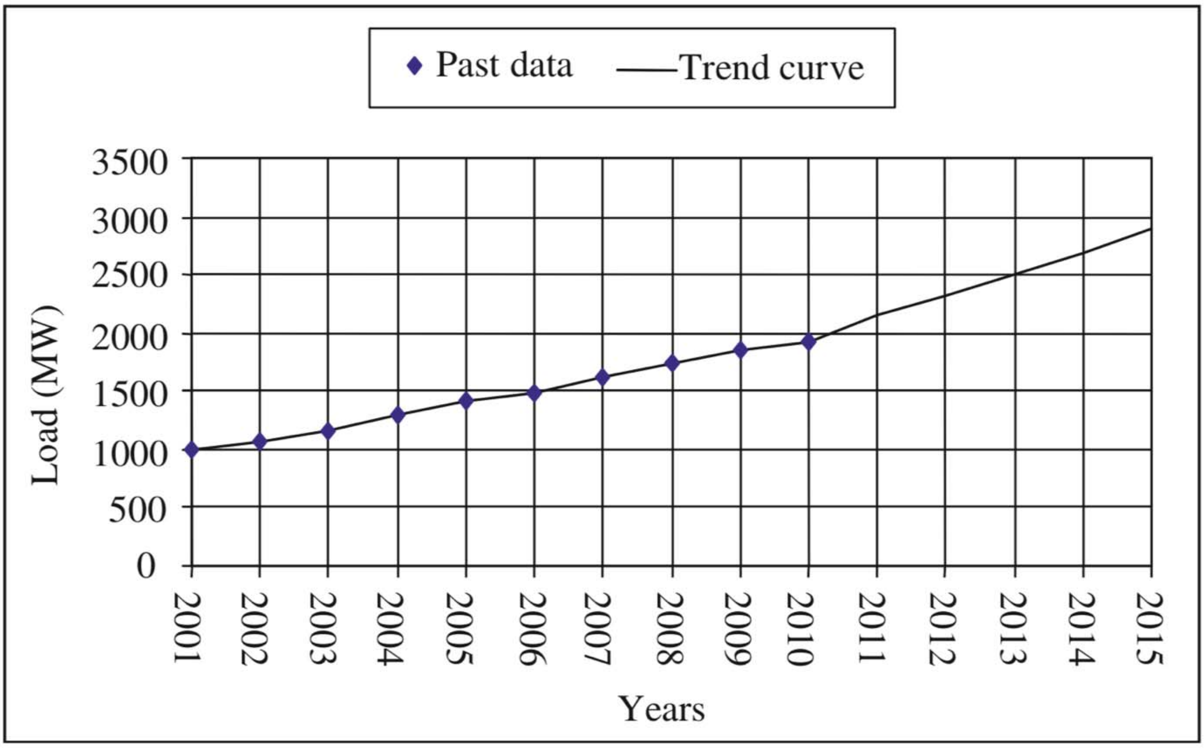


Figure 1: Typical trend curve[1]

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.

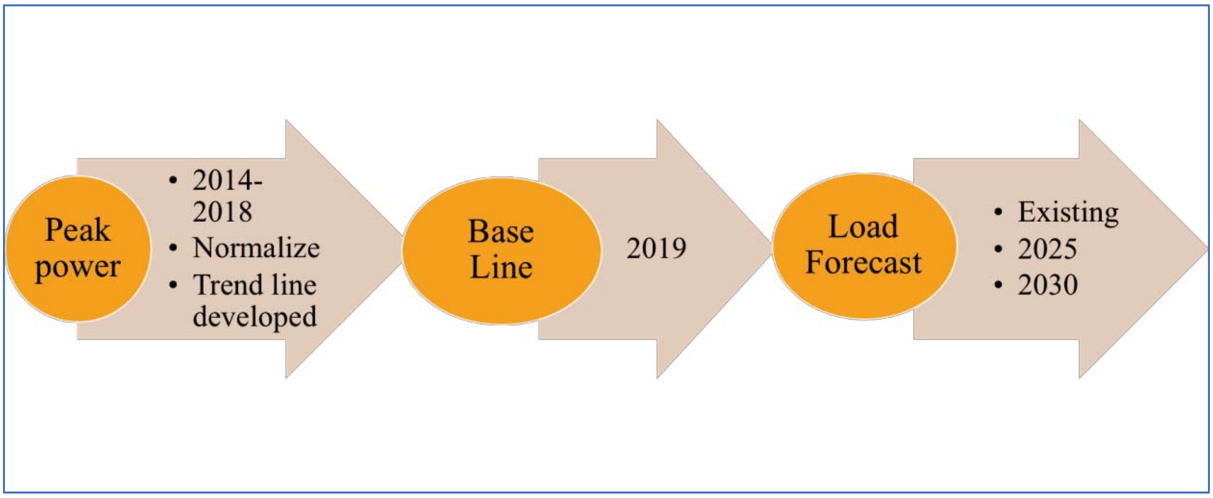


Figure 2: Flow diagram for load forecast

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**

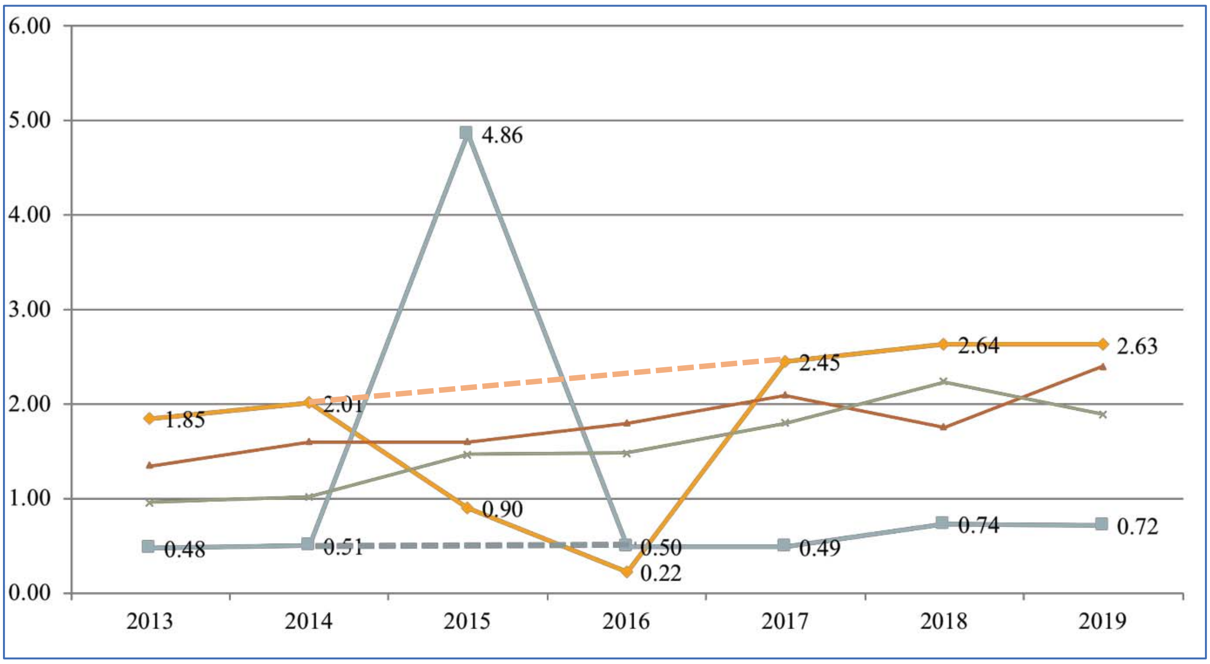


Figure 3: Actual data of Punakha Dzongkhag

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

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

$x_1 and\ x_2\ are\ the\ data\ for\ two\ years$

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.**

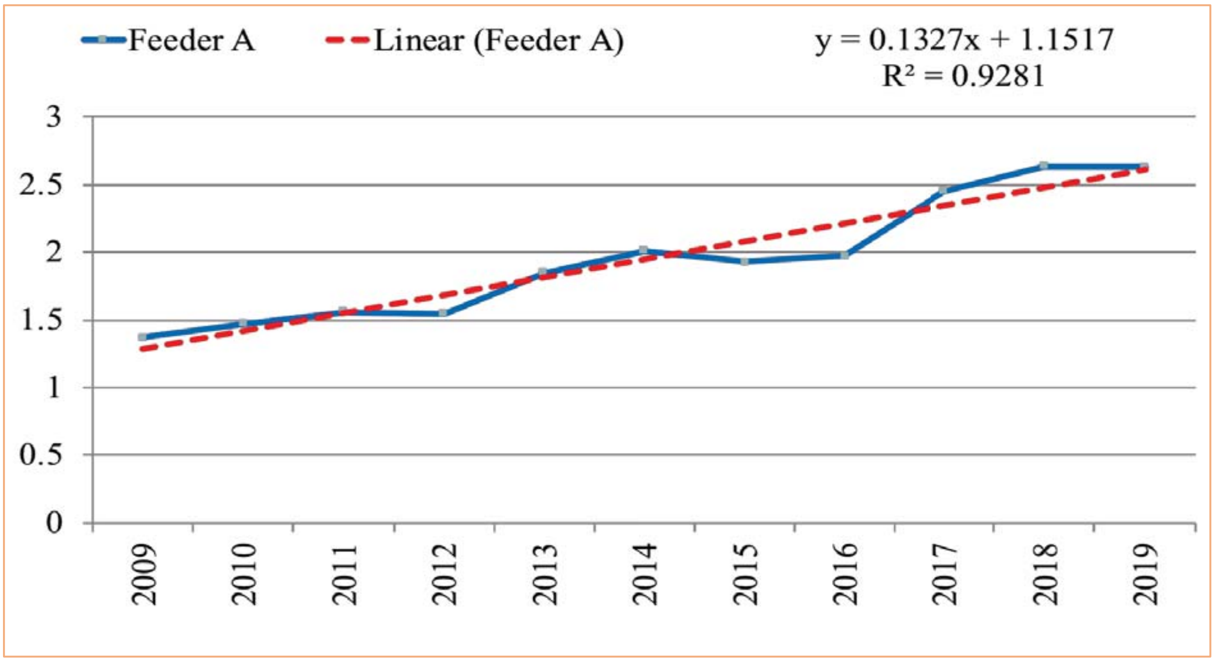


Figure 4: Trend line and load forecast for Punakha Dzongkhag

The trend line equation is given by[2]:

$y = ax + b$

$Where:$

$y -\ Dependent\ variable\ or\ forecasted\ load$

$a - Slope\ which\ is\ the\ average\ change\ in\ y\ for\ every\ increment\ of\ x\ (increase\ in\ year)$

$It\ also\ gives\ how\ dependent\ variable\ changes\ when\ indepemended\ variable\ increases.$

$x - is\ the\ independent\ variable\ or\ time\ in\ year$

$b - is\ the\ intercept\ which\ is\ the\ predicted\ value\ of\ y\ when\ x\ is\ zero\ (time\ is\ zero)$

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.

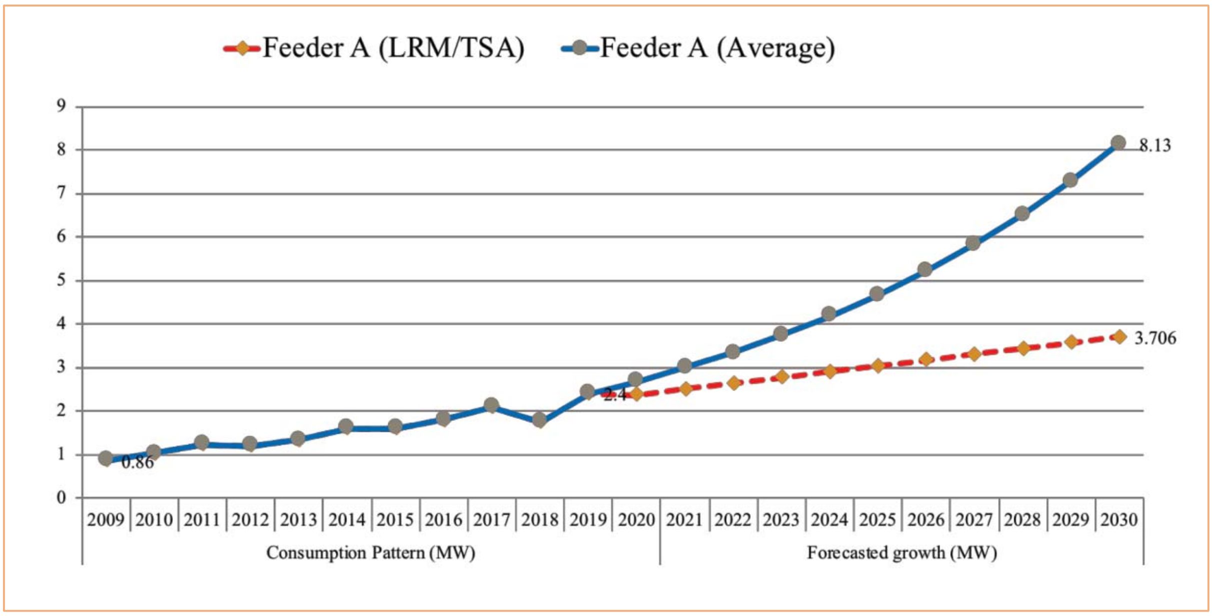


Figure 5: Forecasted load (trend line with red shows the linear regression and one with blue shows the forecast with average method)

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 assigned 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.

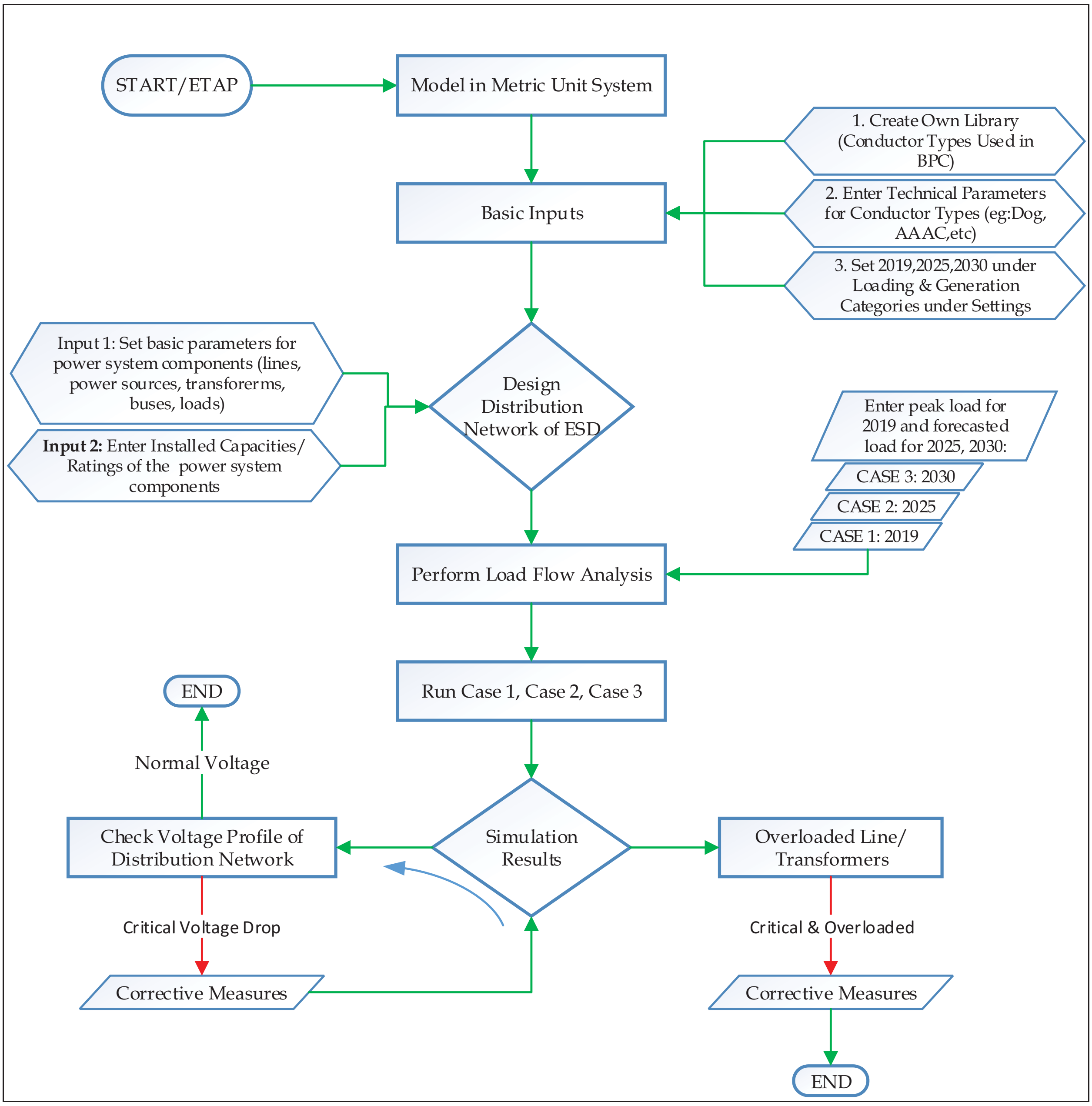


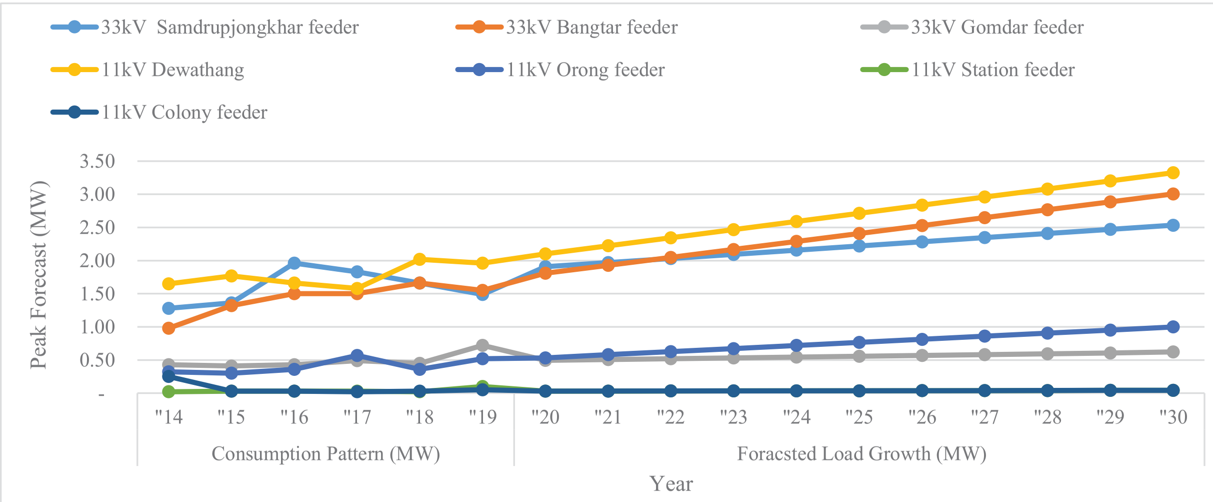
Figure 6: Flow Chart for Network Modelling & Load Flow Analysis (ETAP)

[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

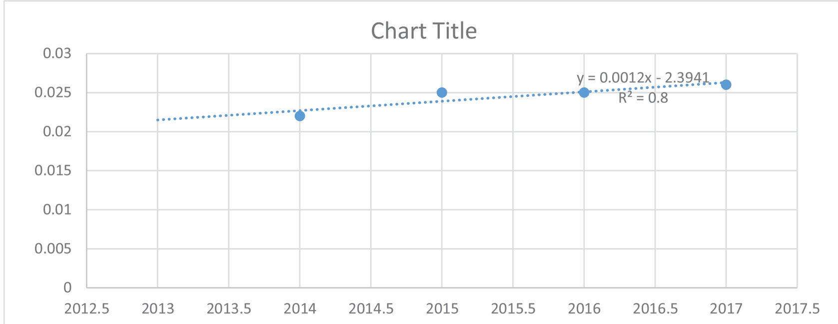
[3]http://www.powerqualityworld.com/2011/05/etap-tutorials-load-flow-analysis.html dated September 30, 2020

Sl. No.	Name of Feeder	Consumption Pattern (MW)						Foracsted Load Growth (MW)										
		"14	"15	"16	"17	"18	"19	"20	"21	"22	"23	"24	"25	"26	"27	"28	"29	"30
1	33kV Samdrupjongkhar feeder	1.28	1.36	1.96	1.83	1.66	1.49	1.91	1.97	2.03	2.09	2.16	2.22	2.28	2.35	2.41	2.47	2.53
2	33kV Bangtar feeder	0.98	1.32	1.50	1.50	1.66	1.55	1.81	1.93	2.05	2.17	2.29	2.41	2.53	2.65	2.77	2.89	3.00
3	33kV Gomdar feeder	0.43	0.41	0.43	0.49	0.45	0.72	0.49	0.51	0.52	0.53	0.54	0.56	0.57	0.58	0.59	0.61	0.62
4	11kV Dewathang	1.65	1.77	1.66	1.58	2.02	1.96	2.10	2.22	2.35	2.47	2.59	2.71	2.84	2.96	3.08	3.20	3.32
5	11kV Orong feeder	0.32	0.30	0.36	0.57	0.36	0.52	0.53	0.58	0.63	0.67	0.72	0.77	0.81	0.86	0.90	0.95	1.00
6	11kV Station feeder	0.02	0.03	0.03	0.03	0.02	0.10	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04
7	11kV Colony feeder	0.25	0.03	0.03	0.02	0.03	0.05	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04
	Total	**4.94**	**5.21**	**5.97**	**6.03**	**6.20**	**6.39**	**6.90**	**7.27**	**7.63**	**8.00**	**8.37**	**8.73**	**9.10**	**9.47**	**9.83**	**10.20**	**10.57**
		2.24	2.13	2.08	2.20	2.43	2.63	2.69	2.86	3.04	3.21	3.38	3.55	3.72	3.89	4.06	4.24	4.41



11 kV Station Feeder

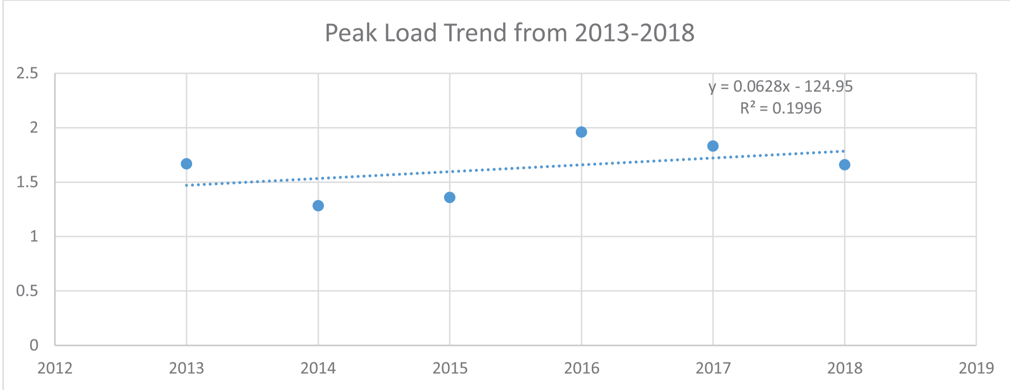
	2,013.00	2,014.00	2,015.00	2,016.00	2,017.00	2,018.00	2,019.00
Jan	0.02	0.01	0.01	0.01	0.02	0.01	0.10
Feb	0.01	0.01	0.03	0.01	0.02	0.02	0.01
Mar	0.01	0.01	0.01	0.02	0.03	0.02	0.00
Apr	0.01	0.02	0.01	0.01	0.01	0.01	0.01
May	0.02	0.01	0.01	0.01	0.03	0.01	0.01
Jun	0.01	0.01	0.01	0.01	0.01	0.02	0.02
Jul	0.01	0.00	0.01	0.01	0.01	0.02	0.01
Aug	0.02	0.01	0.01	0.02	0.02	0.01	
Sep	0.01	0.01	0.01	0.01	0.01	0.01	
Oct	0.02	0.02	0.01	0.02	0.01	0.02	
Nov	0.01	0.01	0.01	0.00	0.02	0.02	
Dec	0.01	0.02	0.01	0.03	0.02	0.01	
Peak Load	0.0152	0.022	0.025	0.025	0.026	0.02	0.1



	DATA FOR ANALYSIS						Forecasted Peak Load Year Wise from 2019-2030 with derived equation y = 0.0012x - 2.3941											
Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load		0.022	0.025	0.025	0.026	0.02	0.024	0.030	0.031	0.032	0.034	0.035	0.036	0.037	0.038	0.039	0.041	0.042
Load Growth in kW							0.0063	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	

33kV Samdrupjongkhar Feeder

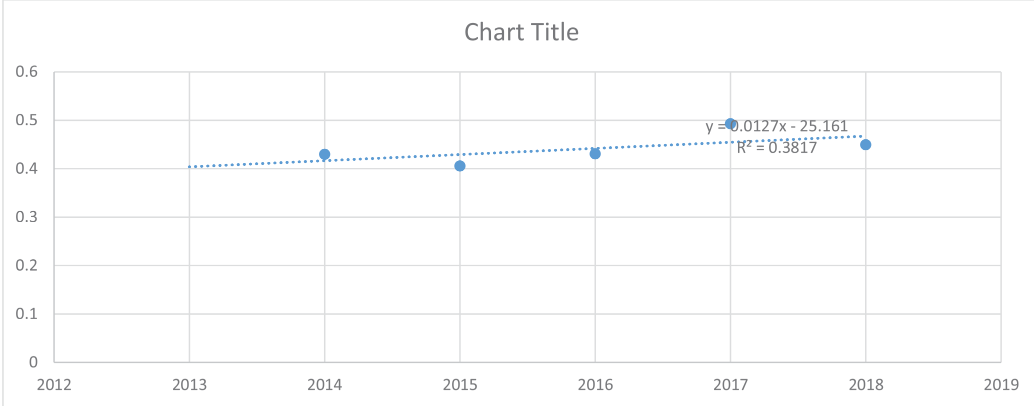
month	2013	2014	2015	2016	2017	2018	2019
Jan	1.021	1.064	1.038	1.302	1.23	1.44	1.28
Feb	1.276	1.024	1.08	1.26	1.215	1.01	1.33
Mar	1.67	1.065	1.014	1.188	1.398	1.3	1.27
Apr	1.070	1.115	1.038	1.179	1.029	1.13	1.17
May	1.18	1.041	1.287	1.086	1.134	1.66	1.16
Jun	1.159	1.284	1.329	1.413	1.329	1.31	1.45
Jul	1.18	1.16	1.203	1.191	1.593	1.57	1.49
Aug	1.19	1.209	1.299	1.4	1.833	1.44	
Sep	1.248	1.173	1.317	1.42	1.194	1.38	
Oct	1.126	1.101	1.359	1.497	1.317	1.34	
Nov	0.99	1.02	1.318	1.473	1.071	1.03	
Dec	1.04	1.02	0.981	1.96	1.11	1.66	
Peak Load	1.67	1.284	1.359	1.96	1.833	1.66	1.49



	DATA FOR ANALYSIS						Forecasted Peak Load Year Wise from 2019-2030 with derived equation (y = 0.0628x - 124.95)											
Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load	1.67	1.284	1.359	1.96	1.833	1.66	1.8432	1.906	1.9688	2.0316	2.0944	2.1572	2.22	2.2828	2.3456	2.4084	2.4712	2.534
Load Growth in kW							0.0628	0.0628	0.0628	0.0628	0.0628	0.0628	0.0628	0.0628	0.0628	0.0628	0.0628	

33 kV Gomdar Feeder

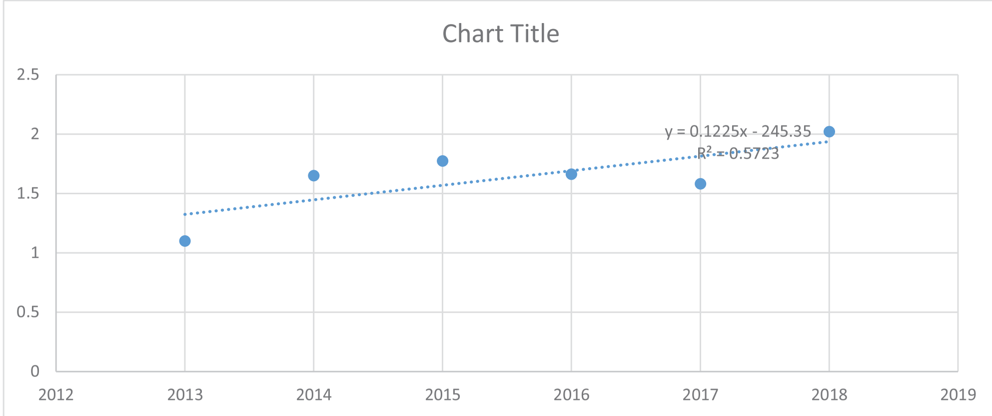
month	2013	2014	2015	2016	2017	2018	2019
Jan	0.38	0.43	0.328	0.392	0.391	0.4	0.71
Feb	0.37	0.36	0.3	0.38	0.382	0.38	0.57
Mar	0.35	0.04	0.32	0.384	0.398	0.42	0.41
Apr	0.40	0.292	0.356	0.354	0.399	0.4	0.54
May	0.39	0.285	0.367	0.351	0.372	0.39	0.72
Jun	0.34	0.287	0.313	0.337	0.376	0.35	0.36
Jul	0.35	0.264	0.307	0.328	0.361	0.37	0.38
Aug	1.17	0.346	0.365	0.397	0.42	0.41	
Sep	0.43	0.351	0.356	0.425	0.441	0.41	
Oct	0.45	0.365	0.387	0.39	0.412	0.42	
Nov	0.53	0.319	0.375	0.397	0.432	0.43	
Dec	0.44	0.4	0.406	0.431	0.493	0.45	
Peak Load	1.169	0.43	0.406	0.431	0.493	0.45	0.72



	DATA FOR ANALYSIS						Forecasted Peak Load Year Wise from 2019-2030 with derived equation y = 0.0127x - 25.161											
Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load		0.43	0.406	0.431	0.493	0.45	0.480	0.493	0.506	0.518	0.531	0.544	0.556	0.569	0.582	0.595	0.607	0.620
Load Growth in kW							0.0127	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127	

11 kV Dewathang Feeder

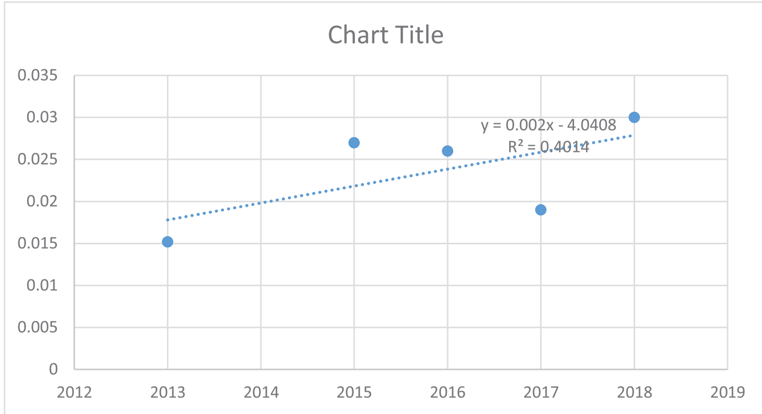
month	2013	2014	2015	2016	2017	2018	2019
Jan	0.65	0.36	0.702	0.897	1.58	0.6	0.72
Feb	0.590	0.67	0.733	0.694	0.833	1.47	1.09
Mar	0.58	1.007	1.39	1.293	0.723	0.83	0.98
Apr	0.520	1.65	0.858	0.948	0.574	1.14	1.96
May	0.43	0.961	0.927	0.975	0.52	1.76	1.36
Jun	1.098	0.839	1.549	1.032	0.5	1.55	1.59
Jul	1.02	0.666	1.198	1.661	0.964	2.02	1.78
Aug	0.39	0.81	0.922	1	1.086	2.02	
Sep	0.64	0.846	1.772	1.116	1.342	1.6	
Oct	0.64	0.726	1.237	1.312	0.472	1.69	
Nov	0.38	0.685	1.705	0.734	1.126	1.67	
Dec	0.36	0.738	1.195	1.1	1.083	0.85	
Peak Load	1.098	1.65	1.772	1.661	1.58	2.02	1.96



	DATA FOR ANALYSIS						Forecasted Peak Load Year Wise from 2019-2030 with derived equation y = 0.1225x - 245.35											
Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load	1.098	1.65	1.772	1.661	1.58	2.02	1.977	2.100	2.223	2.345	2.468	2.590	2.713	2.835	2.958	3.080	3.203	3.325
Load Growth in kW							0.1225	0.1225	0.1225	0.1225	0.1225	0.1225	0.1225	0.1225	0.1225	0.1225	0.1225	

11 kV Colony Feeder

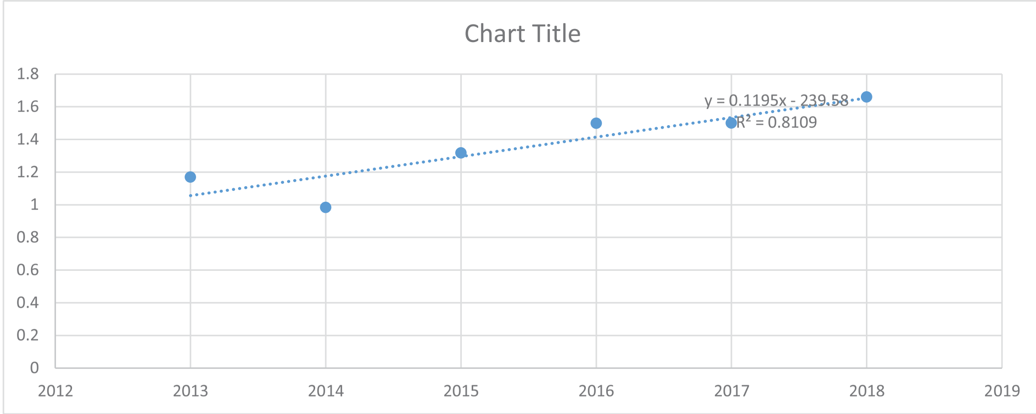
month	2013	2,014.00	2015	2016	2017	2018	2019
Jan	0.006	0.02	0.024	0.026	0.007	0.02	0.03
Feb	0.012	0.01	0.009	0.025	0.007	0.01	0.05
Mar	0.010	0.00	0.021	0.007	0.009	0.03	0.004
Apr	0.0152	0.01	0.018	0.018	0.019	0.02	0.02
May	0.0063	0.02	0.018	0.019	0.001	0.02	0.02
Jun	0.0152	0.00	0.017	0.02	0.013	0.01	0.02
Jul	0.02	0.01	0.019	0.016	0.014	0.02	0.02
Aug	0.01	0.02	0.017	0.009	0.013	0.01	
Sep	0.0152	0.25	0.015	0.018	0.014	0.02	
Oct	0.0063	0.01	0.016	0.006	0.015	0.02	
Nov	0.0063	0.02	0.018	0.006	0.008	0.02	
Dec	0.0063	0.02	0.027	0.007	0.009	0.03	
Peak Load	0.0152	0.249	0.027	0.026	0.019	0.03	0.05



	DATA FOR ANALYSIS						Forecasted Peak Load Year Wise from 2019-2030 with derived equationy = 0.002x - 4.0408											
Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load	0.0152		0.027	0.026	0.019	0.03	0.003	0.030	0.031	0.032	0.034	0.035	0.036	0.037	0.038	0.039	0.041	0.042
Load Growth in kW							0.0271	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	

33 kV Bangter Feeder

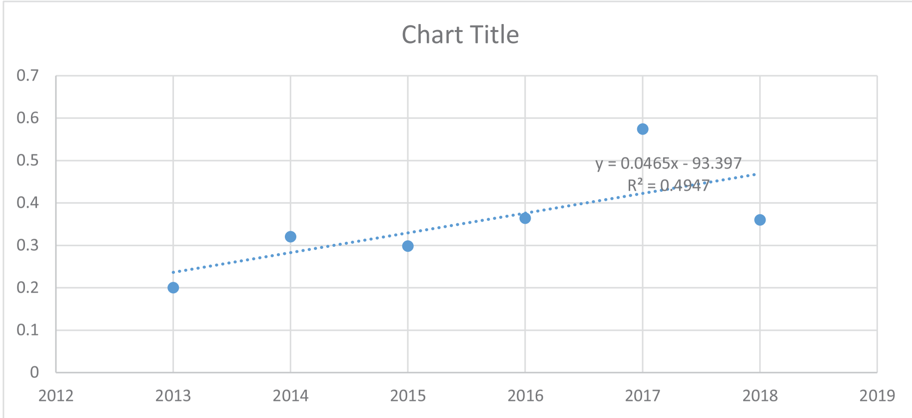
	2013	2014	2015	2016	2017	2018	2019
Jan	0.77	0.75	1.014	1.235	1.32	1.39	1.46
Feb	0.790	0.73	0.966	1.327	1.43	1.32	1.55
Mar	0.68	0.76	1.079	1.364	1.365	1.33	1.5
Apr	0.680	0.743	1.168	1.302	1.387	1.46	1.54
May	0.71	0.725	1.062	1.23	1.314	1.44	1.43
Jun	0.78	0.697	1.085	1.236	1.257	1.34	1.54
Jul	0.70	0.633	1.126	1.253	1.326	1.52	1.47
Aug	1.17	0.867	1.266	1.41	1.489	1.5	
Sep	0.82	0.81	0.828	1.499	1.395	1.5	
Oct	0.85	0.801	1.282	1.408	1.458	1.49	
Nov	0.8	0.984	1.318	1.38	1.5	1.66	
Dec	0.84	0.818	1.314	1.46	1.422	1.47	
Peak Load	1.169	0.984	1.318	1.499	1.5	1.66	1.55



	DATA FOR ANALYSIS						Forecasted Peak Load Year Wise from 2019-2030 with derived equation (y = 0.1195x - 239.58)											
Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load	1.169	0.984	1.318	1.499	1.5	1.66	1.6905	1.81	1.9295	2.049	2.1685	2.288	2.4075	2.527	2.6465	2.766	2.8855	3.005
Load Growth in kW							0.1195	0.1195	0.1195	0.1195	0.1195	0.1195	0.1195	0.1195	0.1195	0.1195	0.1195	

11 kV Orong Feeder

month	2013	2014	2015	2016	2017	2018	2019
Jan	0.18	0.2	0.235	0.264	0.328	0.26	0.31
Feb	0.160	0.32	0.24	0.24	0.021	0.27	0.52
Mar	0.16	0.241	0.246	0.26	0.277	0.28	0.32
Apr	0.190	0.266	0.252	0.292	0.574	0.36	0.33
May	0.17	0.242	0.248	0.251	0.23	0.25	0.13
Jun	0.18	0.238	0.24	0.237	0.246	0.23	0.26
Jul	0.18	0.256	0.298	0.239	0.211	0.22	0.25
Aug	0.20	0.265	0.263	0.364	0.333	0.25	
Sep	0.18	0.253	0.255	0.261	0.227	0.26	
Oct	0.19	0.308	0.27	0.271	0.293	0.33	
Nov	0.18	0.275	0.261	0.303	0.276	0.27	
Dec	0.2	0.259	0.277	0.295	0.285	0.29	
Peak Load	0.2	0.32	0.298	0.364	0.574	0.36	0.52



	DATA FOR ANALYSIS						Forecasted Peak Load Year Wise from 2019-2030 with derived equation y = 0.0465x - 93.397											
Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load	0.2	0.32	0.298	0.364	0.574	0.36	0.486	0.533	0.579	0.626	0.672	0.719	0.765	0.812	0.858	0.905	0.951	0.998
Load Growth in kW							0.0465	0.0465	0.0465	0.0465	0.0465	0.0465	0.0465	0.0465	0.0465	0.0465	0.0465	

Annexure-4: Detailed Simulation Results

Bus Loading Summary Report

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus494	11.000													
11 KV BUS	11.000	2500.0									1.660	84.9	105.1	4.2
33 KV BUS	33.000	2500.0									4.047	86.8	78.7	3.1
132 KV BUS	132.000	2500.0									80.565	84.8	352.4	14.1
Bus1	11.000		0.004	0.002	0.010	0.006					0.016	85.0	1.1	
Bus2	33.000		0.010	0.006	0.033	0.021					0.051	85.0	1.0	
Bus3	33.000													
Bus6	11.000	2500.0									1.296	85.3	82.0	3.3
Bus7	33.000	2500.0									2.084	82.3	41.3	1.7
Bus8	11.000										1.989	85.0	124.0	
Bus9	11.000		0.016	0.010	0.043	0.027					1.643	85.0	105.1	
Bus10	11.000		0.016	0.010	0.042	0.026					0.233	85.3	15.0	
Bus11	11.000										0.041	85.9	2.6	
Bus12	11.000										0.068	85.7	4.4	
Bus13	11.000										1.332	85.0	85.7	
Bus14	11.000										0.048	85.9	3.1	
Bus15	11.000		0.005	0.003	0.013	0.008					0.021	85.0	1.3	
Bus16	11.000										1.214	85.0	78.4	
Bus17	33.000	2500.0									5.428	88.6	105.6	4.2
Bus18	11.000										0.498	85.1	31.1	
Bus19	11.000		0.002	0.001	0.004	0.003					0.007	85.0	0.4	
Bus21	11.000		0.008	0.005	0.022	0.013					0.035	85.0	2.3	
Bus22	11.000		0.022	0.014	0.060	0.037					0.097	85.0	6.2	
Bus24	11.000		0.023	0.014	0.061	0.038					0.098	85.0	6.4	
Bus25	11.000										0.148	85.2	9.6	
Bus26	11.000		0.136	0.084	0.357	0.221					1.112	85.1	72.0	
Bus27	11.000										0.020	86.0	1.3	
Bus28	11.000										0.008	85.3	0.5	
Bus29	11.000		0.029	0.018	0.076	0.047					0.531	85.1	34.4	
Bus30	11.000										0.649	85.1	40.6	
Bus31	11.000										0.408	85.2	26.5	
Bus32	11.000		0.026	0.016	0.067	0.041					0.109	85.0	7.0	
Bus33	11.000		0.010	0.006	0.029	0.018					0.075	85.0	4.7	
Bus34	11.000										0.256	85.1	16.6	
Bus35	11.000										0.726	85.0	45.3	
Bus36	11.000										0.148	85.1	9.6	
Bus37	11.000		0.018	0.011	0.047	0.029					0.076	85.0	4.9	
Bus38	11.000		0.043	0.026	0.119	0.074					0.191	85.0	11.9	
Bus40	11.000		0.013	0.008	0.034	0.021					0.055	85.0	3.6	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					Percent
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Loading
Bus41	11.000										0.726	85.1	45.3	
Bus42	11.000										0.152	85.3	9.8	
Bus43	11.000		0.001	0.001	0.003	0.002					0.004	85.0	0.3	
Bus46	11.000		0.003	0.002	0.007	0.005					0.012	85.0	0.8	
Bus47	11.000		0.002	0.001	0.005	0.003					0.008	85.0	0.5	
Bus48	11.000		0.007	0.004	0.018	0.011					0.029	85.0	1.8	
Bus49	11.000		0.000	0.000	0.001	-					0.001	85.0	0.1	
Bus50	11.000										0.457	85.1	28.6	
Bus51	11.000										0.647	85.1	40.5	
Bus53	11.000		0.011	0.007	0.002	0.001					0.015	85.0	0.9	
Bus54	11.000		0.007	0.004	0.019	0.011					0.059	85.0	3.7	
Bus55	11.000		0.028	0.017	0.078	0.048					0.442	85.1	27.6	
Bus57	11.000		0.014	0.008	0.039	0.024					0.529	85.0	33.0	
Bus58	11.000										0.317	85.1	19.9	
Bus59	11.000		0.010	0.006	0.027	0.017					0.165	85.1	10.4	
Bus60	11.000		0.020	0.012	0.055	0.034					0.088	85.0	5.5	
Bus62	11.000		0.099	0.061	0.279	0.173					0.468	85.0	29.2	
Bus63	11.000												-	
Bus64	11.000		0.027	0.017	0.076	0.047					0.121	85.0	7.6	
Bus65	11.000										0.146	85.0	9.1	
Bus66	11.000		0.007	0.004	0.019	0.012					0.030	85.0	1.9	
Bus67	11.000										0.082	85.5	5.1	
Bus68	11.000		0.039	0.024	0.111	0.069					0.176	85.0	11.0	
Bus69	11.000		0.032	0.020	0.092	0.057					0.146	85.0	9.1	
Bus70	11.000										0.146	85.0	9.1	
Bus71	11.000		0.000	0.000	0.000	-					0.031	85.3	1.9	
Bus72	11.000										0.146	85.0	9.1	
Bus73	11.000										0.145	85.3	9.1	
Bus75	11.000		0.005	0.003	0.014	0.009					0.023	85.0	1.4	
Bus76	11.000		0.014	0.009	0.039	0.024					0.063	85.0	3.9	
Bus77	11.000		0.000	0.000	0.001	0.001					0.033	85.5	2.1	
Bus78	11.000		0.011	0.007	0.031	0.019					0.050	85.0	3.1	
Bus79	11.000										0.020	86.3	1.3	
Bus80	11.000		0.003	0.002	0.007	0.004					0.031	85.2	1.9	
Bus81	11.000		0.003	0.002	0.008	0.005					0.033	85.8	2.2	
Bus82	11.000										0.072	85.5	4.9	
Bus83	11.000		0.004	0.003	0.012	0.007					0.019	85.0	1.2	
Bus84	11.000										0.878	85.5	59.0	
Bus85	11.000										0.804	85.5	54.2	
Bus86	11.000		0.003	0.002	0.008	0.005					0.045	85.7	3.1	
Bus87	11.000		0.007	0.004	0.016	0.010					0.027	85.0	1.8	
Bus88	11.000		0.003	0.002	0.008	0.005					0.013	85.0	0.9	

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
Bus89	11.000		0.006	0.004	0.015	0.009					0.024	85.0	1.7	
Bus90	11.000		0.002	0.001	0.004	0.003					0.007	85.0	0.5	
Bus91	11.000										0.169	85.5	11.6	
Bus92	11.000										0.214	85.8	14.4	
Bus93	11.000		0.002	0.001	0.005	0.003					0.021	85.8	1.4	
Bus94	11.000										0.195	85.7	13.2	
Bus95	11.000		0.005	0.003	0.011	0.007					0.019	85.0	1.3	
Bus96	11.000		0.012	0.007	0.028	0.017					0.072	85.2	4.9	
Bus97	11.000										0.043	85.8	2.9	
Bus99	11.000										0.194	85.6	13.2	
Bus100	11.000		0.006	0.003	0.013	0.008					0.022	85.0	1.5	
Bus101	11.000		0.032	0.020	0.075	0.047					0.127	85.0	8.7	
Bus102	11.000		0.007	0.004	0.017	0.010					0.028	85.0	1.9	
Bus103	11.000		0.003	0.002	0.008	0.005					0.013	85.0	0.9	
Bus104	11.000		0.003	0.002	0.008	0.005					0.013	85.0	0.9	
Bus105	11.000										0.237	85.4	16.2	
Bus106	11.000		0.007	0.004	0.015	0.009					0.026	85.0	1.8	
Bus107	11.000										0.253	85.5	17.3	
Bus108	11.000										0.589	85.3	39.8	
Bus109	11.000		0.031	0.019	0.074	0.046					0.124	85.0	8.4	
Bus111	11.000		0.007	0.004	0.016	0.010					0.133	85.5	9.2	
Bus112	11.000		0.016	0.010	0.037	0.023					0.195	85.4	13.4	
Bus113	11.000		0.004	0.002	0.009	0.006					0.016	85.0	1.1	
Bus114	11.000		0.009	0.006	0.022	0.014					0.036	85.0	2.5	
Bus115	11.000		0.016	0.010	0.039	0.024					0.464	85.4	31.4	
Bus116	11.000		0.004	0.002	0.008	0.005					0.035	85.6	2.4	
Bus117	11.000										0.362	85.4	24.6	
Bus118	11.000		0.027	0.017	0.065	0.040					0.108	85.0	7.4	
Bus119	33.000		0.000	0.000	0.000	-					0.722	89.1	14.2	
Bus120	11.000										0.223	85.4	15.3	
Bus121	11.000		0.006	0.003	0.013	0.008					0.022	85.0	1.5	
Bus122	33.000		0.000	0.000	0.000	-					0.000	85.0	-	
Bus123	33.000		0.002	0.001	0.005	0.003					0.068	88.8	1.3	
Bus124	33.000		0.002	0.001	0.005	0.003					0.726	87.9	14.3	
Bus125	33.000		0.000	0.000	0.001	-					0.724	88.5	14.2	
Bus126	33.000										0.719	87.7	14.2	
Bus127	33.000		0.004	0.003	0.013	0.008					0.336	85.1	6.6	
Bus131	33.000		0.031	0.019	0.096	0.060					0.575	86.2	11.4	
Bus133	33.000										0.427	86.2	8.4	
Bus134	33.000		0.065	0.040	0.204	0.126					0.316	85.0	6.3	
Bus135	33.000										0.033	89.4	0.7	
Bus136	33.000		0.002	0.001	0.007	0.004					0.011	85.0	0.2	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus137	33.000		0.005	0.003	0.015	0.010					0.024	85.0	0.5	
Bus158	33.000										0.112	92.1	2.2	
Bus162	33.000		0.001	0.001	0.004	0.002					1.297	94.9	26.0	
Bus164	33.000		0.005	0.003	0.017	0.010					0.140	91.6	2.8	
Bus183	33.000		0.002	0.001	0.005	0.003					2.525	91.8	49.7	
Bus187	33.000		0.003	0.002	0.009	0.006					0.014	85.0	0.3	
Bus193	33.000		0.001	0.001	0.003	0.002					0.096	91.1	1.9	
Bus195	33.000		0.003	0.002	0.009	0.006					0.062	85.3	1.2	
Bus196	33.000		0.001	0.001	0.003	0.002					0.115	92.6	2.3	
Bus198	33.000		0.001	0.001	0.004	0.003					0.146	91.8	2.9	
Bus200	33.000		0.010	0.006	0.031	0.019					0.047	85.0	0.9	
Bus207	33.000		0.016	0.010	0.050	0.031					1.582	93.6	31.7	
Bus211	33.000		0.002	0.001	0.005	0.003					0.092	89.9	1.8	
Bus212	33.000										0.013	92.9	0.3	
Bus213	33.000		0.004	0.002	0.012	0.007					0.018	85.0	0.4	
Bus214	33.000		0.001	0.001	0.004	0.002					0.073	89.2	1.4	
Bus219	33.000		0.004	0.002	0.012	0.008					0.019	85.0	0.4	
Bus220	33.000										0.061	88.0	1.2	
Bus221	33.000		0.003	0.002	0.008	0.005					0.013	85.0	0.3	
Bus222	33.000		0.000	0.000	0.001	0.001					0.021	86.2	0.4	
Bus223	33.000		0.006	0.004	0.018	0.011					0.049	86.5	1.0	
Bus232	33.000		0.006	0.003	0.018	0.011					2.563	91.8	50.2	
Bus237	33.000										2.572	91.8	50.3	
Bus238	33.000		0.001	0.001	0.003	0.002					2.530	91.8	49.8	
Bus239	33.000										2.509	91.7	49.7	
Bus241	33.000		0.000	0.000	0.000	-					2.503	91.7	49.7	
Bus243	33.000										0.059	95.1	1.2	
Bus245	33.000		0.000	0.000	0.001	0.001					2.493	91.6	49.7	
Bus246	33.000		0.002	0.001	0.005	0.003					0.008	85.0	0.2	
Bus247	33.000										2.494	91.7	49.6	
Bus248	33.000		0.000	0.000	0.000	-					2.515	91.8	49.6	
Bus252	33.000		0.001	0.000	0.002	0.001					0.002	85.0	-	
Bus253	33.000		0.001	0.000	0.002	0.001					2.498	91.7	49.7	
Bus255	33.000		0.000	0.000	0.001	-					2.501	91.7	49.7	
Bus259	33.000										0.129	86.3	2.6	
Bus260	33.000										2.487	91.6	49.7	
Bus261	33.000		0.006	0.004	0.020	0.012					0.064	86.4	1.3	
Bus262	33.000		0.018	0.011	0.055	0.034					0.213	86.2	4.3	
Bus264	33.000		0.014	0.008	0.042	0.026					0.066	85.0	1.3	
Bus265	33.000		0.007	0.005	0.022	0.014					0.035	85.0	0.7	
Bus266	33.000										2.209	92.2	44.2	
Bus267	33.000		0.014	0.009	0.042	0.026					2.274	92.0	45.5	

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
Bus268	33.000		0.005	0.003	0.014	0.009					0.243	86.8	4.9	
Bus269	33.000										1.621	93.5	32.4	
Bus270	33.000		0.009	0.005	0.026	0.016					0.041	85.0	0.8	
Bus271	33.000		0.014	0.009	0.043	0.027					0.068	85.0	1.4	
Bus272	33.000		0.014	0.008	0.042	0.026					0.196	85.1	3.9	
Bus273	33.000										1.505	93.9	30.1	
Bus274	33.000		0.028	0.017	0.084	0.052					0.132	85.0	2.6	
Bus275	33.000										0.452	88.2	9.0	
Bus276	33.000		0.001	0.001	0.003	0.002					1.314	94.9	26.3	
Bus277	33.000		0.002	0.001	0.005	0.003					1.285	94.9	25.8	
Bus278	33.000		0.000	0.000	0.000	-					0.517	88.1	10.3	
Bus279	33.000		0.023	0.014	0.071	0.044					0.111	85.0	2.2	
Bus280	33.000		0.003	0.002	0.008	0.005					0.013	85.0	0.3	
Bus281	33.000		0.001	0.001	0.004	0.002					1.291	94.9	25.9	
Bus282	33.000		0.002	0.001	0.005	0.003					0.525	88.1	10.5	
Bus283	33.000		0.003	0.002	0.008	0.005					0.070	95.3	1.4	
Bus284	33.000		0.014	0.009	0.042	0.026					0.517	87.8	10.4	
Bus285	33.000		0.001	0.000	0.002	0.001					0.004	85.0	0.1	
Bus286	33.000		0.031	0.019	0.096	0.060					0.150	85.0	3.0	
Bus287	33.000		0.000	0.000	0.000	-					0.005	96.1	0.1	
Bus288	33.000										0.302	89.5	6.1	
Bus289	11.000		0.001	0.001	0.004	0.002					0.006	85.0	0.4	
Bus290	11.000		0.026	0.016	0.070	0.043					0.113	85.0	7.3	
Bus291	11.000		0.030	0.019	0.079	0.049					0.128	85.0	8.3	
Bus294	33.000		0.003	0.002	0.010	0.006					0.046	86.1	0.9	
Bus295	33.000		0.012	0.008	0.038	0.023					0.111	87.4	2.2	
Bus296	33.000		0.002	0.002	0.008	0.005					0.305	88.9	6.1	
Bus297	33.000										0.053	88.6	1.1	
Bus298	33.000		0.001	0.001	0.004	0.002					0.006	85.0	0.1	
Bus299	33.000		0.002	0.001	0.006	0.004					0.009	85.0	0.2	
Bus300	33.000										0.293	88.3	5.9	
Bus301	33.000		0.022	0.014	0.067	0.042					0.113	87.0	2.3	
Bus302	33.000		0.000	0.000	0.001	0.001					0.002	85.0	-	
Bus303	33.000		0.006	0.004	0.019	0.012					0.030	85.0	0.6	
Bus304	33.000		0.004	0.002	0.012	0.007					0.130	87.7	2.6	
Bus305	33.000										0.035	92.7	0.7	
Bus306	33.000		0.006	0.004	0.018	0.011					0.028	85.0	0.6	
Bus307	33.000		0.006	0.004	0.020	0.012					0.203	88.0	4.1	
Bus308	33.000		0.006	0.003	0.017	0.010					0.026	85.0	0.5	
Bus309	33.000		0.010	0.006	0.029	0.018					0.174	87.8	3.5	
Bus310	33.000		0.001	0.000	0.002	0.001					0.011	92.2	0.2	
Bus314	33.000		0.001	0.001	0.004	0.002					0.008	93.6	0.2	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus316	33.000		0.019	0.011	0.057	0.035					0.094	85.1	1.9	
Bus317	33.000										0.009	99.8	0.2	
Bus319	33.000		0.001	0.001	0.003	0.002					0.009	91.7	0.2	
Bus321	33.000		0.001	0.001	0.004	0.002					0.006	85.0	0.1	
Bus344	33.000		0.001	0.001	0.003	0.002					0.972	96.1	19.6	
Bus347	33.000		0.000	0.000	0.001	0.001					0.961	95.8	19.4	
Bus349	33.000		0.005	0.003	0.014	0.009					0.393	85.9	7.9	
Bus351	33.000										0.371	85.9	7.5	
Bus352	33.000		0.038	0.024	0.114	0.071					0.373	85.6	7.5	
Bus354	33.000										0.200	97.8	4.1	
Bus355	33.000										1.042	96.2	20.9	
Bus356	33.000										0.434	84.9	8.9	
Bus357	33.000										0.972	96.1	19.5	
Bus358	33.000										0.206	96.1	4.2	
Bus359	33.000										0.436	84.5	8.9	
Bus360	33.000		0.000	0.000	0.001	0.001					0.001	85.0	-	
Bus361	33.000		0.001	0.001	0.004	0.002					0.006	85.0	0.1	
Bus362	33.000		0.000	0.000	0.001	-					0.968	96.1	19.5	
Bus363	33.000		0.000	0.000	0.001	-					0.035	97.4	0.7	
Bus364	33.000										0.967	96.0	19.5	
Bus367	33.000										0.609	93.0	12.4	
Bus368	33.000		0.001	0.000	0.002	0.001					0.959	95.7	19.4	
Bus369	33.000										0.018	93.7	0.4	
Bus371	33.000										0.956	95.6	19.3	
Bus373	33.000		0.001	0.000	0.002	0.001					0.003	85.0	0.1	
Bus374	33.000		0.001	0.001	0.004	0.002					0.006	85.0	0.1	
Bus375	33.000		0.000	0.000	0.001	-					0.166	96.9	3.4	
Bus376	33.000		0.000	0.000	0.001	0.001					0.963	95.8	19.4	
Bus377	33.000		0.000	0.000	0.001	-					0.034	97.5	0.7	
Bus378	33.000										0.951	95.6	19.2	
Bus381	33.000										0.033	97.3	0.7	
Bus382	33.000		0.042	0.026	0.125	0.077					0.195	85.0	4.0	
Bus385	33.000										0.065	98.0	1.3	
Bus386	33.000		0.000	0.000	0.000	-					0.000	85.0	-	
Bus387	33.000		0.001	0.000	0.002	0.001					0.003	85.0	0.1	
Bus388	33.000										0.019	97.5	0.4	
Bus389	33.000		0.002	0.001	0.005	0.003					0.008	85.0	0.2	
Bus390	33.000		0.002	0.001	0.005	0.003					0.008	85.0	0.2	
Bus391	33.000										0.013	94.5	0.3	
Bus392	33.000										0.003	91.4	0.1	
Bus393	33.000										0.014	89.5	0.3	
Bus394	33.000		0.000	0.000	0.001	0.001					0.015	95.0	0.3	

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
Bus395	33.000		0.000	0.000	0.001	-					0.001	85.0	-	
Bus396	33.000		0.001	0.001	0.004	0.002					0.006	85.0	0.1	
Bus397	33.000		0.000	0.000	0.001	-					0.007	86.1	0.1	
Bus398	33.000		0.000	0.000	0.000	-					0.006	85.6	0.1	
Bus399	33.000										0.144	95.9	2.9	
Bus400	33.000		0.000	0.000	0.001	-					0.001	85.0	-	
Bus401	33.000		0.000	0.000	0.001	0.001					0.008	88.3	0.2	
Bus402	33.000		0.001	0.001	0.004	0.002					0.006	85.0	0.1	
Bus403	33.000		0.000	0.000	0.000	-					0.001	85.0	-	
Bus404	33.000		0.002	0.001	0.006	0.004					0.017	86.2	0.4	
Bus405	33.000		0.001	0.001	0.004	0.003					0.166	96.4	3.4	
Bus406	33.000										0.160	96.3	3.3	
Bus407	33.000		0.000	0.000	0.001	0.001					0.147	94.6	3.0	
Bus408	33.000		0.002	0.001	0.006	0.004					0.161	95.4	3.3	
Bus409	33.000		0.000	0.000	0.001	-					0.002	93.7	-	
Bus410	33.000		0.001	0.001	0.003	0.002					0.153	94.5	3.1	
Bus411	33.000										0.146	94.6	3.0	
Bus412	33.000										0.135	96.4	2.8	
Bus413	33.000			0.000	0.000	-					0.149	94.8	3.0	
Bus414	33.000										0.065	99.4	1.3	
Bus415	33.000										0.011	75.1	0.2	
Bus416	33.000		0.000	0.000	0.001	0.001					0.125	97.4	2.6	
Bus417	33.000		0.000	0.000	0.001	-					0.010	70.9	0.2	
Bus418	33.000		0.001	0.001	0.003	0.002					0.009	86.5	0.2	
Bus419	33.000										0.008	76.9	0.2	
Bus420	33.000										0.125	96.1	2.6	
Bus421	33.000		0.000	0.000	0.000	-					0.006	99.6	0.1	
Bus422	33.000		0.000	0.000	0.000	-					0.001	85.0	-	
Bus423	33.000		0.000	0.000	0.000	-					0.106	98.6	2.2	
Bus424	33.000		0.001	0.001	0.004	0.003					0.007	85.0	0.1	
Bus425	33.000		0.000	0.000	0.000	-					0.109	96.4	2.2	
Bus426	33.000										0.107	97.7	2.2	
Bus430	33.000		0.001	0.001	0.003	0.002					0.005	85.0	0.1	
Bus431	33.000										0.032	87.4	0.7	
Bus432	33.000		0.002	0.001	0.005	0.003					0.009	85.0	0.2	
Bus434	33.000		0.000	0.000	0.000	-					0.000	85.0	-	
Bus435	33.000		0.002	0.001	0.005	0.003					0.014	95.7	0.3	
Bus436	33.000		0.000	0.000	0.001	0.001					0.001	85.0	-	
Bus437	33.000		0.000	0.000	0.000	-					0.000	85.0	-	
Bus438	33.000										0.064	96.9	1.3	
Bus439	33.000		0.000	0.000	0.001	0.001					0.065	97.0	1.3	
Bus442	33.000		0.000	0.000	0.000	-					0.055	91.6	1.1	

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
Bus443	33.000		0.001	0.000	0.001	0.001					0.009	99.0	0.2	
Bus444	33.000		0.002	0.001	0.004	0.003					0.055	91.5	1.1	
Bus445	33.000										0.007	99.1	0.1	
Bus447	33.000		0.002	0.002	0.007	0.005					0.043	88.6	0.9	
Bus448	33.000		0.000	0.000	0.001	-					0.042	93.0	0.9	
Bus449	33.000										0.042	93.7	0.9	
Bus450	33.000		0.001	0.000	0.002	0.001					0.003	85.0	0.1	
Bus451	33.000		0.000	0.000	0.000	-					0.043	91.6	0.9	
Bus452	33.000		0.000	0.000	0.000	-					0.001	85.9	-	
Bus453	33.000		0.000	0.000	0.000	-					0.000	85.0	-	
Bus454	33.000		0.000	0.000	0.001	0.001					0.002	85.0	-	
Bus455	33.000		0.000	0.000	0.000	-					0.002	98.5	-	
Bus456	33.000		0.005	0.003	0.015	0.009					0.032	85.4	0.7	
Bus457	33.000		0.001	0.000	0.002	0.001					0.003	85.0	0.1	
Bus460	33.000		0.001	0.001	0.004	0.003					0.048	92.2	1.0	
Bus461	33.000										0.058	92.0	1.2	
Bus462	33.000		0.000	0.000	0.000	-					0.001	85.0	-	
Bus463	33.000		0.000	0.000	0.001	0.001					0.002	85.0	-	
Bus464	33.000		0.000	0.000	0.000	-					0.008	88.4	0.2	
Bus465	33.000		0.000	0.000	0.001	0.001					0.057	91.8	1.2	
Bus466	33.000		0.002	0.001	0.006	0.003					0.009	85.0	0.2	
Bus467	33.000		0.001	0.000	0.002	0.001					0.004	86.4	0.1	
Bus471	33.000		0.000	0.000	0.000	-					0.001	85.3	-	
Bus472	33.000		0.000	0.000	0.000	-					0.001	19.8	-	
Bus473	11.000										0.072	85.2	4.7	
Bus474	33.000		0.000	0.000	0.001	0.001					0.029	89.1	0.6	
Bus475	33.000		0.000	0.000	0.001	0.001					0.008	84.6	0.2	
Bus476	33.000										0.008	89.5	0.2	
Bus477	33.000										0.005	100.0	0.1	
Bus478	33.000		0.000	0.000	0.000	-					0.007	89.7	0.2	
Bus479	33.000		0.000	0.000	0.000	-					0.001	45.2	-	
Bus480	33.000		0.000	0.000	0.001	-					0.005	93.6	0.1	
Bus481	33.000		0.000	0.000	0.000	-					0.004	94.4	0.1	
Bus483	33.000		0.001	0.001	0.003	0.002					0.005	87.5	0.1	
Bus484	33.000		0.000	0.000	0.000	-					0.003	93.4	0.1	
Bus485	33.000										0.017	94.1	0.3	
Bus486	33.000		0.000	0.000	0.000	-					0.003	89.7	0.1	
Bus487	33.000										0.005	88.5	0.1	
Bus488	33.000		0.001	0.000	0.002	0.001					0.003	85.0	0.1	
Bus489	33.000										0.025	94.8	0.5	
Bus491	33.000										0.025	97.7	0.5	
Bus492	33.000		0.001	0.001	0.003	0.002					0.021	94.2	0.4	

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
Bus495	33.000		0.000	0.000	0.001	-					0.004	95.7	0.1	
Bus496	33.000		0.000	0.000	0.000	-					0.000	85.0	-	
Bus497	33.000		0.000	0.000	0.000	-					0.000	85.0	-	
Bus498	11.000		0.026	0.016	0.074	0.046					0.118	85.0	7.4	
Bus499	33.000										0.013	89.7	0.3	
Bus500	33.000		0.003	0.002	0.008	0.005					0.013	85.0	0.3	
Bus501	33.000		0.000	0.000	0.000	-					0.000	85.0	-	
Bus502	11.000										0.429	85.5	26.7	
Bus504	11.000										0.428	85.5	26.7	
Bus505	11.000										0.118	85.1	7.4	
Bus507	11.000		0.010	0.006	0.028	0.018					0.238	85.6	14.9	
Bus508	11.000		0.003	0.002	0.008	0.005					0.013	85.0	0.8	
Bus509	11.000										0.006	87.4	0.4	
Bus510	11.000		0.009	0.005	0.024	0.015					0.038	85.0	2.4	
Bus511	11.000										0.377	85.5	23.6	
Bus513	11.000		0.002	0.002	0.007	0.004					0.020	85.3	1.3	
Bus514	11.000										0.104	85.4	6.5	
Bus516	11.000		0.002	0.001	0.006	0.004					0.010	85.0	0.6	
Bus517	11.000		0.001	0.000	0.002	0.001					0.003	85.0	0.2	
Bus518	132.000		48.960	30.343	12.240	7.586					72.000	85.0	314.9	
Bus519	11.000		0.001	0.000	0.002	0.001					0.003	85.0	0.2	
Bus520	33.000		0.000	0.000	0.001	0.001					0.001	85.0	-	
Bus521	11.000		0.002	0.001	0.005	0.003					0.009	85.0	0.5	
Bus522	11.000		0.005	0.003	0.014	0.009					0.134	85.4	8.5	
Bus523	11.000		0.023	0.014	0.062	0.039					0.100	85.0	6.3	
Bus525	11.000		0.001	0.001	0.003	0.002					0.004	85.0	0.3	
Bus526	33.000										2.149	83.0	42.0	
Bus527	11.000										0.186	85.5	11.7	
Bus528	11.000		0.008	0.005	0.022	0.014					0.036	85.0	2.3	
Bus529	11.000		0.004	0.002	0.010	0.006					0.016	85.0	1.0	
Bus530	33.000										2.154	83.1	41.9	
Bus531	11.000										0.170	85.5	10.7	
Bus532	11.000		0.014	0.009	0.040	0.025					0.230	85.1	14.4	
Bus534	11.000		0.046	0.028	0.130	0.081					0.207	85.0	12.9	

* 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	45.27	13.39					
Cable2	Cable	338.03	3.69	1.09					
Cable3	Cable	338.03	9.09	2.69					
Cable4	Cable	338.03	1.85	0.55					
Cable6	Cable	338.03	11.00	3.25					
Cable7	Cable	338.03	9.09	2.69					
Cable8	Cable	338.03	9.09	2.69					
Cable9	Cable	338.03	32.99	9.76					
Cable27	Cable	338.03	12.91	3.82					
33/11KV LANGCHENPHU	Transformer				1.500	0.436	29.1	0.429	28.6
DEWATHANG 33 KV XMER I	Transformer				2.500	1.338	53.5	1.296	51.8
DEWATHANG 33 kV XMER II	Transformer				2.500	1.338	53.5	1.296	51.8
DEWATHANG 132 KV XMER I	Transformer				5.000	4.286	85.7	4.047	80.9
DEWATHANG 132 kV XMER II	Transformer				5.000	4.286	85.7	4.047	80.9
SJ 33/11kV XMER I	Transformer				2.500	2.084	83.4	1.989	79.6

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

Branch Losses Summary Report

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
Line2	1.410	0.876	-1.397	-0.865	13.4	11.5	82.9	82.1	0.88
DEWATHANG 33 KV XMER I	-1.105	-0.676	1.112	0.744	6.8	68.0	82.9	89.9	7.00
DEWATHANG 33 kV XMER II	1.112	0.744	-1.105	-0.676	6.8	68.0	89.9	82.9	7.00
DEWATHANG 132 KV XMER I	-3.512	-2.010	3.541	2.414	28.9	404.0	89.9	100.0	10.07
DEWATHANG 132 kV XMER II	3.554	2.395	-3.523	-1.991	31.1	403.8	100.0	89.9	10.07
Line497	-0.014	-0.009	0.014	0.009	0.0	0.0	80.8	80.8	0.00
Line498	-0.044	-0.027	0.044	0.027	0.0	-0.1	89.6	89.6	0.00
Line61	0.801	0.477	-0.751	-0.455	49.5	21.9	82.9	78.1	4.84
Line490	-1.715	-1.184	1.739	1.172	24.6	-12.0	88.2	89.6	1.38
SJ 33/11kV XMER I	1.715	1.184	-1.692	-1.047	22.9	137.6	88.2	84.2	4.00
Cable1	0.618	0.382	-0.618	-0.382	0.1	0.1	84.2	84.2	0.02
Cable2	0.050	0.031	-0.050	-0.031	0.0	0.0	84.2	84.2	0.00
Cable6	0.150	0.093	-0.150	-0.093	0.0	0.0	84.2	84.2	0.00
Cable9	0.450	0.279	-0.450	-0.279	0.2	0.1	84.2	84.2	0.03
Line1	0.200	0.122	-0.199	-0.122	0.8	0.0	82.1	81.7	0.31
Line14	1.138	0.706	-1.132	-0.701	5.9	5.0	82.1	81.6	0.48
Line3	0.083	0.051	-0.083	-0.051	0.1	-0.1	81.7	81.7	0.06
Line5	0.059	0.035	-0.059	-0.035	0.0	-0.1	81.7	81.7	0.04
Line4	0.005	0.003	-0.005	-0.003	0.0	-0.2	81.7	81.7	0.00
Line6	-0.035	-0.021	0.035	0.021	0.0	0.0	81.7	81.7	0.00
Line12	0.030	0.018	-0.030	-0.019	0.0	-0.6	81.7	81.6	0.08
Line7	0.041	0.025	-0.041	-0.025	0.0	0.0	81.7	81.7	0.01
Line9	0.017	0.011	-0.017	-0.011	0.0	0.0	81.7	81.7	0.00
Line16	0.096	0.060	-0.096	-0.060	0.0	0.0	81.6	81.6	0.01
Line18	1.036	0.641	-1.033	-0.639	2.9	2.5	81.6	81.3	0.26
Line8	0.006	0.004	-0.006	-0.004	0.0	-0.1	81.7	81.7	0.00
Line20	0.084	0.052	-0.084	-0.052	0.0	0.0	81.3	81.3	0.00
Line22	0.949	0.587	-0.946	-0.585	2.9	2.4	81.3	81.0	0.27
Line95	0.649	0.298	-0.643	-0.328	5.9	-30.5	89.9	89.1	0.81
Line212	2.372	1.017	-2.362	-1.019	10.3	-2.4	89.9	89.4	0.53
Line486	1.790	1.197	-1.790	-1.197	0.3	-0.2	89.9	89.9	0.02
Cable3	0.124	0.077	-0.124	-0.077	0.0	0.0	84.2	84.2	0.01
Cable27	0.176	0.109	-0.176	-0.109	0.0	0.0	84.2	84.2	0.00
Line54	0.124	0.076	-0.124	-0.076	0.0	0.0	84.2	84.2	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
Line13	0.109	0.068	-0.109	-0.068	0.0	0.0	80.8	80.8	0.02
Line19	-0.126	-0.077	0.126	0.077	0.0	0.0	80.8	80.9	0.02
Line21	0.017	0.010	-0.017	-0.010	0.0	-0.3	80.8	80.8	0.01
Line24	0.453	0.279	-0.452	-0.279	0.4	0.3	81.0	81.0	0.07
Line23	0.007	0.004	-0.007	-0.004	0.0	-0.2	80.8	80.8	0.00
Line41	0.010	0.006	-0.010	-0.006	0.0	0.0	80.8	80.8	0.00
Line25	0.007	0.004	-0.007	-0.004	0.0	-0.1	80.8	80.8	0.00
Line11	0.000	0.000	0.000	0.000	0.0	-0.1	80.8	80.8	0.00
Line26	0.348	0.214	-0.348	-0.214	0.1	0.1	81.0	80.9	0.02
Line33	-0.552	-0.341	0.553	0.342	1.1	0.8	83.9	84.1	0.18
Line36	0.001	0.001	-0.001	-0.001	0.0	0.0	83.9	83.9	0.00
Line42	0.551	0.341	-0.551	-0.340	0.4	0.3	83.9	83.9	0.07
Line30	0.218	0.135	-0.218	-0.135	0.1	0.0	80.9	80.9	0.05
Line39	0.129	0.079	-0.129	-0.079	0.1	-0.2	80.9	80.9	0.09
Line28	-0.092	-0.057	0.092	0.057	0.0	0.0	80.9	80.9	0.00
Line29	-0.064	-0.040	0.064	0.040	0.0	-0.1	84.1	84.1	0.01
Line38	0.025	0.015	-0.025	-0.016	0.0	-0.1	84.1	84.1	0.01
Line32	0.126	0.077	-0.126	-0.077	0.1	-0.1	80.9	80.8	0.08
Line17	0.618	0.382	-0.617	-0.382	0.4	0.3	84.2	84.1	0.06
Line34	0.064	0.040	-0.064	-0.040	0.0	0.0	80.8	80.8	0.01
Line337	0.061	0.038	-0.061	-0.038	0.0	0.0	80.8	80.8	0.01
Line35	-0.162	-0.100	0.162	0.100	0.1	0.0	83.8	83.9	0.03
Line37	-0.047	-0.029	0.047	0.029	0.0	-0.3	80.7	80.8	0.05
Line15	0.003	0.002	-0.003	-0.002	0.0	0.0	80.9	80.9	0.00
Line44	-0.388	-0.240	0.389	0.240	0.1	0.1	83.8	83.9	0.03
Line46	0.013	0.008	-0.013	-0.008	0.0	0.0	83.8	83.8	0.00
Line48	0.376	0.232	-0.376	-0.232	0.0	0.0	83.8	83.8	0.01
Cable4	0.025	0.016	-0.025	-0.016	0.0	0.0	84.2	84.2	0.00
Line50	0.270	0.167	-0.270	-0.167	0.2	0.1	83.8	83.7	0.08
Line47	0.398	0.246	-0.398	-0.246	0.0	0.0	84.2	84.2	0.01
Line27	0.075	0.046	-0.075	-0.046	0.0	0.0	83.7	83.7	0.00
Line52	0.196	0.121	-0.195	-0.121	0.1	0.0	83.7	83.7	0.06
Line51	0.103	0.064	-0.103	-0.064	0.0	-0.1	83.6	83.6	0.03
Line500	-0.140	-0.087	0.141	0.087	0.1	-0.1	83.6	83.7	0.04
Line31	0.020	0.012	-0.020	-0.012	0.0	0.0	84.2	84.2	0.00
Line40	0.000	0.000	0.000	0.000	0.0	-0.3	83.6	83.6	0.00
Line53	0.124	0.077	-0.124	-0.077	0.0	0.0	84.2	84.2	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
Line45	-0.071	-0.043	0.071	0.043	0.0	0.0	84.2	84.2	0.01
Line57	0.042	0.026	-0.042	-0.026	0.0	-0.1	84.2	84.2	0.01
Line62	0.028	0.017	-0.028	-0.017	0.0	-0.5	84.2	84.1	0.05
Cable7	-0.124	-0.077	0.124	0.077	0.0	0.0	84.2	84.2	0.01
Cable8	0.124	0.077	-0.124	-0.077	0.0	0.0	84.2	84.2	0.01
Line43	0.026	0.016	-0.026	-0.016	0.0	-0.1	84.1	84.1	0.00
Line56	-0.027	-0.016	0.027	0.016	0.0	-0.2	84.1	84.1	0.02
Line55	0.053	0.033	-0.053	-0.033	0.0	-0.1	84.2	84.2	0.01
Line49	0.011	0.007	-0.011	-0.007	0.0	0.0	77.8	77.8	0.00
Line67	-0.017	-0.010	0.017	0.010	0.0	0.0	77.8	77.8	0.00
Line69	0.006	0.003	-0.006	-0.004	0.0	-0.5	77.8	77.7	0.01
Line58	0.016	0.010	-0.016	-0.010	0.0	-0.2	84.1	84.1	0.01
Line59	-0.028	-0.017	0.028	0.017	0.0	-0.2	77.8	77.8	0.02
Line60	-0.062	-0.037	0.062	0.036	0.2	-0.9	77.8	78.1	0.30
Line63	0.023	0.014	-0.023	-0.014	0.0	0.0	77.8	77.8	0.00
Line65	0.039	0.023	-0.039	-0.023	0.0	0.0	77.8	77.8	0.00
Line64	0.689	0.419	-0.687	-0.418	2.3	1.0	78.1	77.8	0.24
Line71	0.183	0.110	-0.183	-0.110	0.1	0.0	77.8	77.8	0.02
Line74	0.504	0.308	-0.502	-0.307	1.2	0.5	77.8	77.7	0.18
Line68	-0.021	-0.013	0.021	0.013	0.0	0.0	77.2	77.2	0.00
Line70	-0.144	-0.088	0.145	0.087	1.2	-0.3	76.6	77.2	0.62
Line76	0.037	0.021	-0.037	-0.022	0.0	-0.9	76.6	76.5	0.09
Line79	0.108	0.067	-0.108	-0.067	0.0	0.0	76.6	76.6	0.02
Line73	0.167	0.100	-0.167	-0.100	0.6	0.0	77.8	77.5	0.28
Line75	0.016	0.010	-0.016	-0.010	0.0	-0.1	77.8	77.8	0.01
Line72	-0.018	-0.011	0.018	0.011	0.0	0.0	76.5	76.5	0.00
Line81	0.011	0.006	-0.011	-0.007	0.0	-0.4	76.5	76.5	0.02
Line77	0.167	0.100	-0.166	-0.100	0.7	0.0	77.5	77.2	0.30
Line84	0.022	0.013	-0.022	-0.013	0.0	-0.4	76.2	76.2	0.04
Line88	-0.061	-0.038	0.061	0.037	0.1	-0.4	76.2	76.4	0.13
Line78	0.019	0.011	-0.019	-0.012	0.0	-0.4	76.5	76.5	0.04
Line80	-0.024	-0.015	0.024	0.015	0.0	-0.1	76.5	76.5	0.01
Line83	-0.011	-0.007	0.011	0.007	0.0	0.0	76.7	76.7	0.00
Line82	-0.202	-0.123	0.203	0.123	0.6	0.1	76.7	76.9	0.21
Line96	0.191	0.116	-0.191	-0.116	0.5	0.0	76.7	76.5	0.18
1412.65	-0.216	-0.131	0.217	0.131	1.0	0.2	76.9	77.3	0.34
Line91	0.013	0.008	-0.013	-0.008	0.0	-0.1	76.9	76.9	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
Line87	0.105	0.065	-0.105	-0.065	0.1	-0.1	77.7	77.6	0.06
Line93	0.397	0.242	-0.396	-0.242	0.8	0.3	77.7	77.5	0.15
Line66	0.030	0.018	-0.030	-0.018	0.0	-0.3	76.4	76.3	0.04
Line89	-0.114	-0.069	0.114	0.069	0.2	-0.1	76.4	76.5	0.11
Line90	-0.167	-0.102	0.167	0.102	0.1	0.0	76.5	76.5	0.06
Line92	-0.031	-0.019	0.031	0.019	0.0	-0.1	77.5	77.5	0.02
Line85	0.310	0.189	-0.309	-0.188	1.1	0.4	77.5	77.3	0.26
Line94	0.019	0.011	-0.019	-0.011	0.0	-0.5	76.3	76.3	0.05
Line86	0.092	0.057	-0.092	-0.057	0.1	-0.1	77.3	77.2	0.09
Line100	0.643	0.328	-0.641	-0.336	1.7	-8.5	89.1	88.9	0.23
Line97	0.000	0.000	0.000	0.000	0.0	-0.1	87.9	87.9	0.00
Line185	0.053	0.027	-0.053	-0.029	0.0	-1.9	88.4	88.4	0.00
Line196	-0.060	-0.031	0.060	0.030	0.0	-1.2	88.4	88.4	0.00
Line99	-0.638	-0.346	0.640	0.336	2.0	-9.9	88.6	88.9	0.27
Line104	0.631	0.341	-0.630	-0.345	0.8	-4.0	88.6	88.5	0.11
Line106	0.496	0.289	-0.496	-0.292	0.4	-2.9	88.5	88.4	0.06
Line165	0.134	0.056	-0.134	-0.058	0.0	-1.7	88.5	88.5	0.01
Line109	0.269	0.166	-0.269	-0.167	0.0	-0.6	88.4	88.4	0.01
Line115	-0.286	-0.176	0.286	0.176	0.0	-0.5	88.4	88.4	0.01
Line108	0.368	0.213	-0.368	-0.216	0.2	-3.0	88.4	88.4	0.05
Line110	0.030	0.008	-0.030	-0.015	0.0	-6.4	88.4	88.4	0.01
Line128	0.053	0.032	-0.053	-0.032	0.0	-0.6	88.4	88.4	0.00
Line112	0.009	0.005	-0.009	-0.006	0.0	-0.9	88.4	88.4	0.00
Line113	0.020	0.010	-0.020	-0.013	0.0	-2.6	88.4	88.4	0.00
Line169	-0.103	-0.043	0.103	0.041	0.0	-2.1	88.5	88.5	0.01
Line171	0.016	0.008	-0.016	-0.010	0.0	-1.9	88.5	88.5	0.00
Line181	0.088	0.036	-0.088	-0.040	0.0	-3.9	88.5	88.5	0.01
Line239	-1.231	-0.408	1.232	0.406	0.7	-1.7	87.3	87.3	0.06
Line247	1.226	0.405	-1.225	-0.407	0.9	-2.3	87.3	87.2	0.08
Line139	0.107	0.043	-0.107	-0.044	0.0	-0.9	88.5	88.5	0.00
Line167	-0.128	-0.056	0.128	0.054	0.0	-1.7	88.5	88.5	0.01
Line216	-2.319	-1.000	2.319	1.000	0.3	-0.1	88.9	89.0	0.02
Line218	2.312	0.996	-2.309	-0.997	3.6	-0.9	88.9	88.8	0.19
Line184	-0.012	-0.007	0.012	0.005	0.0	-2.6	88.4	88.4	0.00
Line158	0.083	0.037	-0.083	-0.040	0.0	-3.6	88.5	88.4	0.01
Line170	0.040	0.025	-0.040	-0.025	0.0	-0.4	88.4	88.4	0.00
Line246	-1.481	-0.556	1.481	0.556	0.0	0.0	87.4	87.4	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
Line248	1.415	0.515	-1.414	-0.516	0.6	-1.0	87.4	87.4	0.05
Line107	0.012	0.004	-0.012	-0.005	0.0	-1.0	88.4	88.4	0.00
Line188	0.065	0.033	-0.065	-0.033	0.0	-0.1	88.4	88.4	0.00
Line195	-0.016	-0.010	0.016	0.009	0.0	-0.6	88.4	88.4	0.00
Line183	0.011	0.006	-0.011	-0.007	0.0	-0.5	88.4	88.4	0.00
Line187	0.042	0.023	-0.042	-0.025	0.0	-2.1	88.4	88.4	0.00
Line193	-0.018	-0.011	0.018	0.010	0.0	-1.0	88.4	88.4	0.00
Line213	2.329	1.001	-2.323	-1.003	6.2	-1.5	89.3	89.0	0.32
Line214	-2.353	-1.016	2.355	1.015	2.3	-0.5	89.3	89.4	0.12
Line210	0.007	0.004	-0.007	-0.004	0.0	-0.2	89.4	89.4	0.00
Line197	0.002	0.001	-0.002	-0.001	0.0	-0.1	88.4	88.4	0.00
Line215	2.299	0.998	-2.295	-0.999	4.2	-0.9	88.4	88.2	0.22
Line224	-2.301	-0.999	2.308	0.997	7.0	-1.7	88.4	88.8	0.37
Line217	2.295	0.998	-2.293	-0.999	1.5	-0.3	88.2	88.1	0.08
Line211	0.024	0.014	-0.024	-0.015	0.0	-0.3	87.1	87.1	0.00
Line270	-0.056	-0.018	0.056	0.015	0.0	-3.6	87.1	87.1	0.01
Line272	0.032	0.004	-0.032	-0.006	0.0	-2.2	87.1	87.1	0.00
Line223	2.283	0.997	-2.278	-0.997	4.1	-0.8	87.8	87.6	0.22
Line233	-2.284	-0.998	2.286	0.997	1.2	-0.3	87.8	87.9	0.07
Line231	-2.286	-0.997	2.287	0.997	1.0	-0.2	87.9	87.9	0.05
Line229	-2.290	-0.999	2.293	0.998	2.8	-0.6	87.9	88.1	0.15
Line221	0.056	0.034	-0.056	-0.035	0.0	-0.3	87.6	87.6	0.00
Line237	-0.111	-0.065	0.111	0.063	0.0	-2.2	87.6	87.6	0.01
Line240	0.056	0.031	-0.056	-0.032	0.0	-1.3	87.6	87.6	0.00
Line205	0.184	0.106	-0.184	-0.108	0.0	-2.2	87.6	87.6	0.02
Line227	2.095	0.891	-2.092	-0.892	2.3	-0.5	87.6	87.5	0.11
Line242	0.030	0.016	-0.030	-0.018	0.0	-2.1	87.6	87.6	0.00
Line177	0.057	0.034	-0.057	-0.036	0.0	-2.0	87.5	87.5	0.00
Line228	-2.036	-0.857	2.036	0.857	0.1	0.0	87.5	87.5	0.00
Line244	1.516	0.575	-1.516	-0.576	0.8	-1.0	87.5	87.4	0.05
Line250	0.462	0.248	-0.462	-0.249	0.0	-0.2	87.5	87.5	0.00
Line243	-0.210	-0.121	0.210	0.119	0.0	-1.4	87.1	87.2	0.01
Line251	0.094	0.058	-0.094	-0.058	0.0	-0.1	87.1	87.1	0.00
Line262	0.097	0.050	-0.097	-0.054	0.0	-3.7	87.1	87.1	0.01
Line209	0.034	0.020	-0.034	-0.021	0.0	-1.1	87.4	87.4	0.00
Line230	-0.167	-0.103	0.167	0.102	0.0	-1.4	87.4	87.4	0.01
Line232	0.112	0.069	-0.112	-0.069	0.0	-0.4	87.4	87.4	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
Line236	1.247	0.414	-1.246	-0.415	0.4	-1.0	87.4	87.3	0.04
Line256	-0.398	-0.213	0.398	0.213	0.0	-0.8	87.4	87.4	0.01
Line258	0.128	0.079	-0.128	-0.079	0.0	-0.4	87.4	87.4	0.00
Line252	0.011	0.006	-0.011	-0.007	0.0	-0.4	87.3	87.3	0.00
Line245	-1.220	-0.406	1.220	0.404	0.6	-1.5	87.2	87.2	0.05
Line326	1.003	0.283	-1.002	-0.285	0.7	-2.8	87.2	87.1	0.07
Line241	0.455	0.244	-0.455	-0.247	0.2	-3.1	87.5	87.4	0.03
Line254	-0.455	-0.245	0.455	0.244	0.0	-0.1	87.5	87.5	0.00
Line249	-0.066	-0.021	0.066	0.021	0.0	-0.1	87.1	87.1	0.00
Line257	-0.003	-0.002	0.003	-0.002	0.0	-4.2	87.1	87.1	0.00
Line448	0.004	0.001	-0.004	-0.001	0.0	-0.1	85.5	85.5	0.00
Line460	-0.004	-0.001	0.004	0.001	0.0	-0.6	85.5	85.5	0.00
Line269	0.271	0.135	-0.271	-0.138	0.1	-3.3	87.4	87.4	0.02
Line261	-0.039	-0.023	0.039	0.022	0.0	-0.7	87.1	87.1	0.00
Line268	0.026	0.015	-0.026	-0.016	0.0	-1.1	87.1	87.1	0.00
Line264	0.047	0.023	-0.047	-0.025	0.0	-1.5	87.1	87.1	0.00
Line267	0.002	-0.002	-0.002	-0.001	0.0	-2.7	87.4	87.4	0.00
Line271	0.259	0.134	-0.259	-0.138	0.1	-4.1	87.4	87.4	0.02
Line266	0.008	0.002	-0.008	-0.005	0.0	-2.8	87.1	87.1	0.00
Line265	-0.005	-0.003	0.005	0.003	0.0	-0.1	87.4	87.4	0.00
Line273	0.179	0.093	-0.179	-0.097	0.0	-4.2	87.4	87.4	0.02
Line290	0.080	0.045	-0.080	-0.049	0.0	-4.4	87.4	87.4	0.01
Line282	-0.098	-0.053	0.098	0.053	0.0	-0.2	87.4	87.4	0.00
Line284	0.008	-0.003	-0.008	-0.001	0.0	-3.2	87.4	87.4	0.00
Line255	-0.114	-0.063	0.114	0.059	0.0	-3.2	87.4	87.4	0.01
Line263	0.010	-0.007	-0.010	0.003	0.0	-4.2	87.1	87.1	0.00
Line274	0.022	0.013	-0.022	-0.014	0.0	-0.8	87.1	87.1	0.00
Line278	0.153	0.081	-0.153	-0.083	0.0	-2.8	87.4	87.4	0.01
Line253	0.008	-0.004	-0.008	-0.001	0.0	-4.8	87.1	87.1	0.00
Line286	0.008	0.001	-0.008	-0.004	0.0	-3.2	87.4	87.4	0.00
Line288	0.005	0.002	-0.005	-0.003	0.0	-1.6	87.4	87.4	0.00
Line308	-0.934	-0.268	0.935	0.267	0.5	-1.1	87.0	87.0	0.05
Line330	0.930	0.266	-0.930	-0.269	0.7	-3.2	87.0	86.9	0.07
Line312	0.919	0.276	-0.918	-0.279	0.6	-2.8	86.7	86.6	0.06
Line346	-0.920	-0.277	0.921	0.274	0.5	-2.5	86.7	86.7	0.06
Line315	-0.337	-0.201	0.337	0.200	0.0	-1.0	86.5	86.5	0.01
Line350	0.319	0.189	-0.319	-0.190	0.0	-1.1	86.5	86.5	0.01

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line317	0.319	0.190	-0.319	-0.193	0.1	-2.5	86.5	86.5	0.02
Line319	0.166	0.098	-0.166	-0.103	0.0	-4.6	86.5	86.5	0.02
Line325	-0.195	0.039	0.195	-0.057	0.1	-17.9	85.6	85.6	0.05
Line333	0.161	-0.042	-0.161	0.040	0.0	-1.1	85.6	85.6	0.00
Line335	0.034	0.002	-0.034	-0.008	0.0	-5.5	85.6	85.6	0.00
Line328	0.936	0.264	-0.935	-0.267	0.6	-2.9	87.1	87.0	0.06
Line295	0.000	-0.002	0.000	0.000	0.0	-2.6	85.6	85.6	0.00
Line327	0.369	0.230	-0.368	-0.233	0.1	-3.2	85.6	85.6	0.03
Line329	-0.369	-0.227	0.369	0.224	0.2	-3.1	85.6	85.7	0.05
Line323	-0.198	0.057	0.198	-0.071	0.1	-14.0	85.6	85.7	0.03
Line343	0.002	0.000	-0.002	-0.001	0.0	-1.7	85.6	85.6	0.00
33/11KV LANGCHENPHU	0.368	0.233	-0.367	-0.222	1.8	10.7	85.6	84.2	1.40
Line331	-0.001	-0.001	0.001	0.001	0.0	-0.1	85.6	85.6	0.00
Line332	-0.005	-0.003	0.005	0.001	0.0	-1.8	86.9	86.9	0.00
Line334	0.929	0.269	-0.929	-0.270	0.3	-1.3	86.9	86.9	0.03
Line345	0.033	0.007	-0.033	-0.008	0.0	-0.2	85.6	85.6	0.00
Line336	0.924	0.269	-0.922	-0.275	1.3	-6.6	86.9	86.7	0.15
Line321	-0.567	-0.153	0.572	0.081	4.9	-72.2	85.7	86.5	0.84
Line342	0.915	0.277	-0.915	-0.280	0.6	-2.8	86.6	86.6	0.06
Line349	-0.017	-0.006	0.017	0.004	0.0	-2.1	85.6	85.6	0.00
Line358	0.007	0.002	-0.007	-0.004	0.0	-2.1	85.6	85.6	0.00
Line359	0.007	0.004	-0.007	-0.004	0.0	-0.3	85.6	85.6	0.00
Line361	0.003	-0.001	-0.003	-0.001	0.0	-2.1	85.6	85.6	0.00
Line314	0.909	0.278	-0.909	-0.280	0.4	-2.2	86.6	86.5	0.05
Line344	0.005	0.001	-0.005	-0.003	0.0	-1.8	86.6	86.6	0.00
Line364	0.160	-0.041	-0.160	0.041	0.0	-0.2	85.6	85.6	0.00
Line355	0.032	0.007	-0.032	-0.008	0.0	-0.5	85.6	85.6	0.00
Line341	0.014	0.004	-0.014	-0.005	0.0	-0.7	85.6	85.6	0.00
Line357	0.018	0.004	-0.018	-0.004	0.0	-0.6	85.6	85.6	0.00
Line390	-0.063	-0.011	0.063	0.007	0.0	-4.3	85.5	85.5	0.01
Line406	0.000	-0.002	0.000	0.000	0.0	-2.1	85.5	85.5	0.00
Line408	0.063	0.013	-0.063	-0.016	0.0	-2.9	85.5	85.5	0.00
Line354	-0.003	-0.002	0.003	0.001	0.0	-0.5	85.6	85.6	0.00
Line356	-0.013	-0.004	0.013	0.004	0.0	-0.7	85.6	85.6	0.00
Line360	0.013	0.004	-0.013	-0.006	0.0	-1.9	85.6	85.6	0.00
Line365	0.005	0.003	-0.005	-0.003	0.0	-0.6	85.6	85.6	0.00
Line367	0.007	0.004	-0.007	-0.004	0.0	-0.2	85.6	85.6	0.00

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Line362	-0.001	-0.001	0.001	0.000	0.0	-0.7	85.6	85.6	0.00
Line363	-0.005	-0.003	0.005	0.003	0.0	-0.1	85.6	85.6	0.00
Line369	0.005	0.003	-0.005	-0.003	0.0	-0.2	85.6	85.6	0.00
Line373	-0.006	-0.003	0.006	0.003	0.0	-0.5	85.6	85.6	0.00
Line380	-0.138	0.041	0.138	-0.047	0.0	-6.7	85.6	85.6	0.01
Line381	0.008	-0.007	-0.008	0.007	0.0	-0.2	85.6	85.6	0.00
Line384	0.130	-0.034	-0.130	0.032	0.0	-2.1	85.6	85.6	0.00
Line368	-0.001	0.000	0.001	0.000	0.0	-0.1	85.6	85.6	0.00
Line370	-0.001	0.000	0.001	0.000	0.0	-0.4	85.6	85.6	0.00
Line371	-0.015	-0.009	0.015	0.007	0.0	-2.1	85.5	85.5	0.00
Line402	0.007	0.004	-0.007	-0.005	0.0	-0.5	85.5	85.5	0.00
Line353	0.154	-0.044	-0.154	0.043	0.0	-0.9	85.6	85.6	0.00
Line366	0.153	-0.043	-0.153	0.043	0.0	-0.7	85.6	85.6	0.00
Line376	-0.139	0.047	0.139	-0.047	0.0	-0.3	85.6	85.6	0.00
Line378	0.138	-0.048	-0.138	0.047	0.0	-0.3	85.6	85.6	0.00
Line375	0.145	-0.048	-0.145	0.048	0.0	-0.3	85.6	85.6	0.00
Line374	-0.002	-0.001	0.002	0.000	0.0	-1.0	85.6	85.6	0.00
Line372	0.141	-0.050	-0.141	0.048	0.0	-2.7	85.6	85.6	0.00
Line392	0.122	-0.036	-0.122	0.027	0.0	-8.6	85.6	85.5	0.01
Line399	0.008	0.004	-0.008	-0.005	0.0	-0.4	85.6	85.6	0.00
Line377	-0.064	-0.007	0.064	0.003	0.0	-4.0	85.5	85.5	0.00
Line404	0.001	0.000	-0.001	-0.001	0.0	-0.3	85.5	85.5	0.00
Line385	0.007	-0.007	-0.007	0.007	0.0	-0.4	85.6	85.6	0.00
Line398	0.120	-0.028	-0.120	0.028	0.0	-0.6	85.5	85.5	0.00
Line387	0.006	-0.007	-0.006	0.005	0.0	-2.0	85.6	85.6	0.00
Line382	0.004	0.002	-0.004	-0.003	0.0	-0.3	85.6	85.6	0.00
Line383	0.001	-0.001	-0.001	0.000	0.0	-1.3	85.6	85.6	0.00
Line389	0.006	-0.004	-0.006	0.000	0.0	-3.9	85.6	85.6	0.00
Line386	0.105	-0.034	-0.105	0.029	0.0	-5.9	85.5	85.5	0.01
Line391	0.006	0.000	-0.006	-0.003	0.0	-3.9	85.6	85.6	0.00
Line388	-0.104	0.014	0.104	-0.023	0.0	-8.3	85.5	85.5	0.01
Line421	0.040	-0.017	-0.040	0.017	0.0	-0.3	85.5	85.5	0.00
Line393	0.104	-0.029	-0.104	0.023	0.0	-5.8	85.5	85.5	0.01
Line379	0.000	0.000	0.000	0.000	0.0	-0.5	85.5	85.5	0.00
Line401	-0.028	-0.015	0.028	0.014	0.0	-1.1	85.5	85.5	0.00
Line424	0.027	0.016	-0.027	-0.017	0.0	-0.9	85.5	85.5	0.00
Line432	0.001	-0.001	-0.001	0.000	0.0	-0.3	85.5	85.5	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
Line443	-0.014	0.000	0.014	-0.001	0.0	-1.6	85.5	85.5	0.00
Line445	0.007	-0.004	-0.007	0.004	0.0	-0.1	85.5	85.5	0.00
Line412	-0.062	-0.016	0.062	0.015	0.0	-0.5	85.5	85.5	0.00
Line414	0.009	0.000	-0.009	0.000	0.0	-0.1	85.5	85.5	0.00
Line416	0.053	0.016	-0.053	-0.023	0.0	-7.1	85.5	85.5	0.01
Line405	0.051	0.022	-0.051	-0.022	0.0	-0.2	85.5	85.5	0.00
Line417	-0.051	-0.022	0.051	0.022	0.0	-0.6	85.5	85.5	0.00
Line418	0.007	-0.001	-0.007	0.000	0.0	-1.7	85.5	85.5	0.00
Line411	0.045	0.019	-0.045	-0.019	0.0	-0.1	85.5	85.5	0.00
Line420	0.003	0.000	-0.003	-0.002	0.0	-2.1	85.5	85.5	0.00
Line423	0.002	0.000	-0.002	0.000	0.0	-0.4	85.5	85.5	0.00
Line427	0.002	0.001	-0.002	-0.001	0.0	-0.1	85.5	85.5	0.00
Line413	-0.038	-0.020	0.038	0.015	0.0	-5.1	85.5	85.5	0.00
Line407	-0.039	-0.015	0.039	0.015	0.0	-0.1	85.5	85.5	0.00
Line419	-0.039	0.015	0.039	-0.017	0.0	-2.7	85.5	85.5	0.00
Line441	0.026	-0.014	-0.026	0.012	0.0	-1.4	85.5	85.5	0.00
Line422	0.000	0.000	0.000	0.000	0.0	-0.7	85.5	85.5	0.00
Line426	-0.001	0.000	0.001	-0.001	0.0	-0.4	85.5	85.5	0.00
Line425	0.002	0.000	-0.002	-0.001	0.0	-1.0	85.5	85.5	0.00
Line434	0.008	0.004	-0.008	-0.005	0.0	-0.3	85.5	85.5	0.00
Line431	0.001	0.000	-0.001	-0.001	0.0	-0.4	85.5	85.5	0.00
Line433	0.052	0.022	-0.052	-0.022	0.0	-0.1	85.5	85.5	0.00
Line430	-0.001	0.000	0.001	-0.001	0.0	-1.3	85.5	85.5	0.00
Line447	0.007	-0.004	-0.007	0.003	0.0	-0.4	85.5	85.5	0.00
90.7	-0.003	-0.001	0.003	0.001	0.0	-0.4	85.5	85.5	0.00
Line456	0.000	-0.001	0.000	0.000	0.0	-0.9	85.5	85.5	0.00
Line452	0.000	-0.001	0.000	0.000	0.0	-0.9	85.5	85.5	0.00
Line458	0.000	0.001	0.000	-0.002	0.0	-1.6	85.5	85.5	0.00
Line465	0.024	-0.013	-0.024	0.008	0.0	-5.0	85.5	85.5	0.00
Line440	-0.007	0.003	0.007	-0.003	0.0	-0.3	85.5	85.5	0.00
Line451	0.005	-0.004	-0.005	0.000	0.0	-4.3	85.5	85.5	0.00
Line449	0.007	-0.003	-0.007	0.003	0.0	-0.1	85.5	85.5	0.00
Line453	0.005	0.000	-0.005	-0.002	0.0	-1.6	85.5	85.5	0.00
Line397	0.000	-0.001	0.000	0.000	0.0	-0.6	85.5	85.5	0.00
Line464	0.000	0.000	0.000	-0.001	0.0	-0.3	85.5	85.5	0.00
Line457	0.004	0.001	-0.004	-0.001	0.0	-0.1	85.5	85.5	0.00
Line459	0.003	0.001	-0.003	-0.001	0.0	-0.3	85.5	85.5	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
Line442	-0.005	-0.002	0.005	0.001	0.0	-0.2	85.5	85.5	0.00
Line461	0.003	0.001	-0.003	-0.001	0.0	-0.4	85.5	85.5	0.00
Line438	0.011	-0.003	-0.011	-0.005	0.0	-8.1	85.5	85.5	0.00
Line446	0.005	-0.003	-0.005	0.002	0.0	-0.7	85.5	85.5	0.00
Line462	-0.016	0.006	0.016	-0.007	0.0	-1.2	85.5	85.5	0.00
Line463	0.002	0.001	-0.002	-0.001	0.0	-0.4	85.5	85.5	0.00
Line450	0.024	-0.008	-0.024	0.004	0.0	-4.3	85.5	85.5	0.00
Line444	0.020	-0.005	-0.020	0.005	0.0	-0.5	85.5	85.5	0.00
Line470	-0.100	-0.062	0.100	0.062	0.0	0.0	83.7	83.7	0.02
Line471	0.000	0.000	0.000	0.000	0.0	-0.1	83.7	83.7	0.00
Line455	0.011	0.006	-0.011	-0.007	0.0	-1.3	85.5	85.5	0.00
Line466	0.367	0.222	-0.366	-0.222	0.7	0.4	84.2	84.0	0.18
Line469	0.323	0.196	-0.322	-0.195	1.0	0.3	84.0	83.8	0.24
Line472	0.011	0.006	-0.011	-0.007	0.0	-0.6	84.0	84.0	0.03
Line474	0.032	0.020	-0.032	-0.020	0.0	0.0	84.0	84.0	0.00
Line479	-0.100	-0.062	0.100	0.062	0.0	-0.1	83.7	83.8	0.03
Line473	0.006	0.002	-0.006	-0.003	0.0	-0.7	83.6	83.5	0.01
Line481	-0.204	-0.123	0.204	0.123	0.6	0.0	83.6	83.8	0.21
Line493	0.159	0.097	-0.159	-0.097	0.3	-0.1	83.6	83.4	0.15
Line483	0.003	0.002	-0.003	-0.002	0.0	-0.2	83.5	83.5	0.00
Line485	0.003	0.002	-0.003	-0.002	0.0	-0.2	83.5	83.5	0.00
Line476	0.017	0.011	-0.017	-0.011	0.0	0.0	83.8	83.8	0.00
Line478	0.008	0.005	-0.008	-0.005	0.0	-0.2	83.8	83.8	0.00
Line480	-0.088	-0.054	0.089	0.054	0.0	-0.1	83.2	83.2	0.04
Line482	0.085	0.053	-0.085	-0.053	0.0	0.0	83.2	83.2	0.01
Line491	0.004	0.001	-0.004	-0.002	0.0	-1.0	83.2	83.2	0.01
Line488	-0.001	-0.001	0.001	0.001	0.0	0.0	89.9	89.9	0.00
Line489	-0.007	-0.005	0.007	0.004	0.0	-0.1	83.2	83.2	0.00
Line487	-0.115	-0.070	0.115	0.070	0.2	-0.2	83.2	83.3	0.11
Line484	-1.783	-1.199	1.789	1.197	5.8	-2.7	89.6	89.9	0.32
Line492	0.146	0.088	-0.145	-0.088	0.1	-0.1	83.4	83.3	0.07
Line495	0.014	0.008	-0.014	-0.008	0.0	0.0	83.4	83.4	0.00
Line494	-0.030	-0.019	0.031	0.019	0.0	-0.2	83.3	83.3	0.02
					297.6	595.5			

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	108.0
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
11 KV BUS	Bus	Under Voltage	11.000	kV	9.123	82.9	3-Phase
33 KV BUS	Bus	Under Voltage	33.000	kV	29.68	89.9	3-Phase
Bus1	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus10	Bus	Under Voltage	11.000	kV	8.99	81.7	3-Phase
Bus100	Bus	Under Voltage	11.000	kV	8.41	76.5	3-Phase
Bus101	Bus	Under Voltage	11.000	kV	8.43	76.6	3-Phase
Bus102	Bus	Under Voltage	11.000	kV	8.42	76.5	3-Phase
Bus103	Bus	Under Voltage	11.000	kV	8.42	76.5	3-Phase
Bus104	Bus	Under Voltage	11.000	kV	8.44	76.7	3-Phase
Bus105	Bus	Under Voltage	11.000	kV	8.44	76.7	3-Phase
Bus106	Bus	Under Voltage	11.000	kV	8.38	76.2	3-Phase
Bus107	Bus	Under Voltage	11.000	kV	8.46	76.9	3-Phase
Bus108	Bus	Under Voltage	11.000	kV	8.54	77.7	3-Phase
Bus109	Bus	Under Voltage	11.000	kV	8.54	77.6	3-Phase
Bus11	Bus	Under Voltage	11.000	kV	8.99	81.7	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus111	Bus	Under Voltage	11.000	kV	8.400	76.4	3-Phase
Bus112	Bus	Under Voltage	11.000	kV	8.41	76.5	3-Phase
Bus113	Bus	Under Voltage	11.000	kV	8.46	76.9	3-Phase
Bus114	Bus	Under Voltage	11.000	kV	8.52	77.5	3-Phase
Bus115	Bus	Under Voltage	11.000	kV	8.53	77.5	3-Phase
Bus116	Bus	Under Voltage	11.000	kV	8.39	76.3	3-Phase
Bus117	Bus	Under Voltage	11.000	kV	8.50	77.3	3-Phase
Bus118	Bus	Under Voltage	11.000	kV	8.49	77.2	3-Phase
Bus119	Bus	Under Voltage	33.000	kV	29.41	89.1	3-Phase
Bus12	Bus	Under Voltage	11.000	kV	8.99	81.7	3-Phase
Bus120	Bus	Under Voltage	11.000	kV	8.42	76.5	3-Phase
Bus121	Bus	Under Voltage	11.000	kV	8.39	76.3	3-Phase
Bus122	Bus	Under Voltage	33.000	kV	29.00	87.9	3-Phase
Bus123	Bus	Under Voltage	33.000	kV	29.19	88.4	3-Phase
Bus124	Bus	Under Voltage	33.000	kV	29.24	88.6	3-Phase
Bus125	Bus	Under Voltage	33.000	kV	29.33	88.9	3-Phase
Bus126	Bus	Under Voltage	33.000	kV	29.21	88.5	3-Phase
Bus127	Bus	Under Voltage	33.000	kV	29.17	88.4	3-Phase
Bus13	Bus	Under Voltage	11.000	kV	8.97	81.6	3-Phase
Bus131	Bus	Under Voltage	33.000	kV	29.18	88.4	3-Phase
Bus133	Bus	Under Voltage	33.000	kV	29.17	88.4	3-Phase
Bus134	Bus	Under Voltage	33.000	kV	29.16	88.4	3-Phase
Bus135	Bus	Under Voltage	33.000	kV	29.17	88.4	3-Phase
Bus136	Bus	Under Voltage	33.000	kV	29.17	88.4	3-Phase
Bus137	Bus	Under Voltage	33.000	kV	29.17	88.4	3-Phase
Bus14	Bus	Under Voltage	11.000	kV	8.99	81.7	3-Phase
Bus15	Bus	Under Voltage	11.000	kV	8.99	81.7	3-Phase
Bus158	Bus	Under Voltage	33.000	kV	29.20	88.5	3-Phase
Bus16	Bus	Under Voltage	11.000	kV	8.95	81.3	3-Phase
Bus162	Bus	Under Voltage	33.000	kV	28.81	87.3	3-Phase
Bus164	Bus	Under Voltage	33.000	kV	29.20	88.5	3-Phase
Bus17	Bus	Under Voltage	33.000	kV	29.68	89.9	3-Phase
Bus18	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus183	Bus	Under Voltage	33.000	kV	29.35	88.9	3-Phase
Bus187	Bus	Under Voltage	33.000	kV	29.19	88.4	3-Phase
Bus19	Bus	Under Voltage	11.000	kV	8.99	81.7	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus193	Bus	Under Voltage	33.000	kV	29.191	88.5	3-Phase
Bus195	Bus	Under Voltage	33.000	kV	29.17	88.4	3-Phase
Bus196	Bus	Under Voltage	33.000	kV	29.20	88.5	3-Phase
Bus198	Bus	Under Voltage	33.000	kV	29.20	88.5	3-Phase
Bus2	Bus	Under Voltage	33.000	kV	29.56	89.6	3-Phase
Bus200	Bus	Under Voltage	33.000	kV	29.17	88.4	3-Phase
Bus207	Bus	Under Voltage	33.000	kV	28.85	87.4	3-Phase
Bus21	Bus	Under Voltage	11.000	kV	8.98	81.6	3-Phase
Bus211	Bus	Under Voltage	33.000	kV	29.19	88.4	3-Phase
Bus212	Bus	Under Voltage	33.000	kV	29.19	88.4	3-Phase
Bus213	Bus	Under Voltage	33.000	kV	29.20	88.5	3-Phase
Bus214	Bus	Under Voltage	33.000	kV	29.19	88.4	3-Phase
Bus219	Bus	Under Voltage	33.000	kV	29.18	88.4	3-Phase
Bus22	Bus	Under Voltage	11.000	kV	8.98	81.7	3-Phase
Bus220	Bus	Under Voltage	33.000	kV	29.19	88.4	3-Phase
Bus221	Bus	Under Voltage	33.000	kV	29.19	88.4	3-Phase
Bus222	Bus	Under Voltage	33.000	kV	29.18	88.4	3-Phase
Bus223	Bus	Under Voltage	33.000	kV	29.18	88.4	3-Phase
Bus232	Bus	Under Voltage	33.000	kV	29.46	89.3	3-Phase
Bus237	Bus	Under Voltage	33.000	kV	29.50	89.4	3-Phase
Bus238	Bus	Under Voltage	33.000	kV	29.36	89.0	3-Phase
Bus239	Bus	Under Voltage	33.000	kV	29.17	88.4	3-Phase
Bus24	Bus	Under Voltage	11.000	kV	8.94	81.3	3-Phase
Bus241	Bus	Under Voltage	33.000	kV	29.09	88.2	3-Phase
Bus243	Bus	Under Voltage	33.000	kV	28.74	87.1	3-Phase
Bus245	Bus	Under Voltage	33.000	kV	28.98	87.8	3-Phase
Bus246	Bus	Under Voltage	33.000	kV	29.50	89.4	3-Phase
Bus247	Bus	Under Voltage	33.000	kV	29.00	87.9	3-Phase
Bus248	Bus	Under Voltage	33.000	kV	29.29	88.8	3-Phase
Bus25	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus252	Bus	Under Voltage	33.000	kV	29.17	88.4	3-Phase
Bus253	Bus	Under Voltage	33.000	kV	29.02	87.9	3-Phase
Bus255	Bus	Under Voltage	33.000	kV	29.07	88.1	3-Phase
Bus259	Bus	Under Voltage	33.000	kV	28.90	87.6	3-Phase
Bus26	Bus	Under Voltage	11.000	kV	8.91	81.0	3-Phase
Bus260	Bus	Under Voltage	33.000	kV	28.91	87.6	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus261	Bus	Under Voltage	33.000	kV	28.899	87.6	3-Phase
Bus262	Bus	Under Voltage	33.000	kV	28.90	87.6	3-Phase
Bus264	Bus	Under Voltage	33.000	kV	28.90	87.6	3-Phase
Bus265	Bus	Under Voltage	33.000	kV	28.90	87.6	3-Phase
Bus266	Bus	Under Voltage	33.000	kV	28.87	87.5	3-Phase
Bus267	Bus	Under Voltage	33.000	kV	28.87	87.5	3-Phase
Bus268	Bus	Under Voltage	33.000	kV	28.76	87.1	3-Phase
Bus269	Bus	Under Voltage	33.000	kV	28.85	87.4	3-Phase
Bus27	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus270	Bus	Under Voltage	33.000	kV	28.85	87.4	3-Phase
Bus271	Bus	Under Voltage	33.000	kV	28.87	87.5	3-Phase
Bus272	Bus	Under Voltage	33.000	kV	28.83	87.4	3-Phase
Bus273	Bus	Under Voltage	33.000	kV	28.84	87.4	3-Phase
Bus274	Bus	Under Voltage	33.000	kV	28.83	87.4	3-Phase
Bus275	Bus	Under Voltage	33.000	kV	28.86	87.4	3-Phase
Bus276	Bus	Under Voltage	33.000	kV	28.82	87.3	3-Phase
Bus277	Bus	Under Voltage	33.000	kV	28.76	87.2	3-Phase
Bus278	Bus	Under Voltage	33.000	kV	28.87	87.5	3-Phase
Bus279	Bus	Under Voltage	33.000	kV	28.76	87.1	3-Phase
Bus28	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus280	Bus	Under Voltage	33.000	kV	28.82	87.3	3-Phase
Bus281	Bus	Under Voltage	33.000	kV	28.78	87.2	3-Phase
Bus282	Bus	Under Voltage	33.000	kV	28.87	87.5	3-Phase
Bus283	Bus	Under Voltage	33.000	kV	28.74	87.1	3-Phase
Bus284	Bus	Under Voltage	33.000	kV	28.86	87.4	3-Phase
Bus285	Bus	Under Voltage	33.000	kV	28.74	87.1	3-Phase
Bus286	Bus	Under Voltage	33.000	kV	28.85	87.4	3-Phase
Bus287	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus288	Bus	Under Voltage	33.000	kV	28.86	87.4	3-Phase
Bus289	Bus	Under Voltage	11.000	kV	8.99	81.7	3-Phase
Bus29	Bus	Under Voltage	11.000	kV	8.91	81.0	3-Phase
Bus290	Bus	Under Voltage	11.000	kV	8.97	81.6	3-Phase
Bus291	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus294	Bus	Under Voltage	33.000	kV	28.75	87.1	3-Phase
Bus295	Bus	Under Voltage	33.000	kV	28.75	87.1	3-Phase
Bus296	Bus	Under Voltage	33.000	kV	28.85	87.4	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus297	Bus	Under Voltage	33.000	kV	28.753	87.1	3-Phase
Bus298	Bus	Under Voltage	33.000	kV	28.84	87.4	3-Phase
Bus299	Bus	Under Voltage	33.000	kV	28.75	87.1	3-Phase
Bus3	Bus	Under Voltage	33.000	kV	29.11	88.2	3-Phase
Bus30	Bus	Under Voltage	11.000	kV	9.23	83.9	3-Phase
Bus300	Bus	Under Voltage	33.000	kV	28.84	87.4	3-Phase
Bus301	Bus	Under Voltage	33.000	kV	28.83	87.4	3-Phase
Bus302	Bus	Under Voltage	33.000	kV	28.85	87.4	3-Phase
Bus303	Bus	Under Voltage	33.000	kV	28.75	87.1	3-Phase
Bus304	Bus	Under Voltage	33.000	kV	28.83	87.4	3-Phase
Bus305	Bus	Under Voltage	33.000	kV	28.74	87.1	3-Phase
Bus306	Bus	Under Voltage	33.000	kV	28.74	87.1	3-Phase
Bus307	Bus	Under Voltage	33.000	kV	28.83	87.4	3-Phase
Bus308	Bus	Under Voltage	33.000	kV	28.74	87.1	3-Phase
Bus309	Bus	Under Voltage	33.000	kV	28.83	87.4	3-Phase
Bus31	Bus	Under Voltage	11.000	kV	8.90	80.9	3-Phase
Bus310	Bus	Under Voltage	33.000	kV	28.74	87.1	3-Phase
Bus314	Bus	Under Voltage	33.000	kV	28.74	87.1	3-Phase
Bus316	Bus	Under Voltage	33.000	kV	28.84	87.4	3-Phase
Bus317	Bus	Under Voltage	33.000	kV	28.83	87.4	3-Phase
Bus319	Bus	Under Voltage	33.000	kV	28.83	87.4	3-Phase
Bus32	Bus	Under Voltage	11.000	kV	8.90	80.9	3-Phase
Bus321	Bus	Under Voltage	33.000	kV	28.83	87.4	3-Phase
Bus33	Bus	Under Voltage	11.000	kV	9.25	84.1	3-Phase
Bus34	Bus	Under Voltage	11.000	kV	8.90	80.9	3-Phase
Bus344	Bus	Under Voltage	33.000	kV	28.70	87.0	3-Phase
Bus347	Bus	Under Voltage	33.000	kV	28.61	86.7	3-Phase
Bus349	Bus	Under Voltage	33.000	kV	28.55	86.5	3-Phase
Bus35	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus351	Bus	Under Voltage	33.000	kV	28.54	86.5	3-Phase
Bus352	Bus	Under Voltage	33.000	kV	28.54	86.5	3-Phase
Bus354	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus355	Bus	Under Voltage	33.000	kV	28.74	87.1	3-Phase
Bus356	Bus	Under Voltage	33.000	kV	28.25	85.6	3-Phase
Bus357	Bus	Under Voltage	33.000	kV	28.72	87.0	3-Phase
Bus358	Bus	Under Voltage	33.000	kV	28.26	85.6	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus359	Bus	Under Voltage	33.000	kV	28.242	85.6	3-Phase
Bus36	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus360	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus361	Bus	Under Voltage	33.000	kV	28.67	86.9	3-Phase
Bus362	Bus	Under Voltage	33.000	kV	28.68	86.9	3-Phase
Bus363	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus364	Bus	Under Voltage	33.000	kV	28.67	86.9	3-Phase
Bus367	Bus	Under Voltage	33.000	kV	28.27	85.7	3-Phase
Bus368	Bus	Under Voltage	33.000	kV	28.58	86.6	3-Phase
Bus369	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus37	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus371	Bus	Under Voltage	33.000	kV	28.56	86.6	3-Phase
Bus373	Bus	Under Voltage	33.000	kV	28.26	85.6	3-Phase
Bus374	Bus	Under Voltage	33.000	kV	28.56	86.6	3-Phase
Bus375	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus376	Bus	Under Voltage	33.000	kV	28.62	86.7	3-Phase
Bus377	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus378	Bus	Under Voltage	33.000	kV	28.55	86.5	3-Phase
Bus38	Bus	Under Voltage	11.000	kV	9.22	83.8	3-Phase
Bus381	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus382	Bus	Under Voltage	33.000	kV	28.53	86.5	3-Phase
Bus385	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus386	Bus	Under Voltage	33.000	kV	28.25	85.6	3-Phase
Bus387	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus388	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus389	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus390	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus391	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus392	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus393	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus394	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus395	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus396	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus397	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus398	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus399	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus40	Bus	Under Voltage	11.000	kV	8.882	80.7	3-Phase
Bus400	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus401	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus402	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus403	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus404	Bus	Under Voltage	33.000	kV	28.23	85.5	3-Phase
Bus405	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus406	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus407	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus408	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus409	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus41	Bus	Under Voltage	11.000	kV	9.25	84.1	3-Phase
Bus410	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus411	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus412	Bus	Under Voltage	33.000	kV	28.23	85.6	3-Phase
Bus413	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus414	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus415	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus416	Bus	Under Voltage	33.000	kV	28.23	85.5	3-Phase
Bus417	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus418	Bus	Under Voltage	33.000	kV	28.23	85.6	3-Phase
Bus419	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus42	Bus	Under Voltage	11.000	kV	8.89	80.9	3-Phase
Bus420	Bus	Under Voltage	33.000	kV	28.23	85.5	3-Phase
Bus421	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus422	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus423	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus424	Bus	Under Voltage	33.000	kV	28.24	85.6	3-Phase
Bus425	Bus	Under Voltage	33.000	kV	28.23	85.5	3-Phase
Bus426	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus43	Bus	Under Voltage	11.000	kV	8.89	80.9	3-Phase
Bus430	Bus	Under Voltage	33.000	kV	28.23	85.6	3-Phase
Bus431	Bus	Under Voltage	33.000	kV	28.21	85.5	3-Phase
Bus432	Bus	Under Voltage	33.000	kV	28.23	85.5	3-Phase
Bus434	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus435	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus436	Bus	Under Voltage	33.000	kV	28.219	85.5	3-Phase
Bus437	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus438	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus439	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus442	Bus	Under Voltage	33.000	kV	28.21	85.5	3-Phase
Bus443	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus444	Bus	Under Voltage	33.000	kV	28.21	85.5	3-Phase
Bus445	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus447	Bus	Under Voltage	33.000	kV	28.21	85.5	3-Phase
Bus448	Bus	Under Voltage	33.000	kV	28.21	85.5	3-Phase
Bus449	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus450	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus451	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus452	Bus	Under Voltage	33.000	kV	28.21	85.5	3-Phase
Bus453	Bus	Under Voltage	33.000	kV	28.21	85.5	3-Phase
Bus454	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus455	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus456	Bus	Under Voltage	33.000	kV	28.21	85.5	3-Phase
Bus457	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus46	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus460	Bus	Under Voltage	33.000	kV	28.21	85.5	3-Phase
Bus461	Bus	Under Voltage	33.000	kV	28.21	85.5	3-Phase
Bus462	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus463	Bus	Under Voltage	33.000	kV	28.21	85.5	3-Phase
Bus464	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus465	Bus	Under Voltage	33.000	kV	28.21	85.5	3-Phase
Bus466	Bus	Under Voltage	33.000	kV	28.21	85.5	3-Phase
Bus467	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus47	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus471	Bus	Under Voltage	33.000	kV	28.21	85.5	3-Phase
Bus472	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus473	Bus	Under Voltage	11.000	kV	8.89	80.8	3-Phase
Bus474	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus475	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus476	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus477	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus478	Bus	Under Voltage	33.000	kV	28.220	85.5	3-Phase
Bus479	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus48	Bus	Under Voltage	11.000	kV	9.25	84.1	3-Phase
Bus480	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus481	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus483	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus484	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus485	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus486	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus487	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus488	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus489	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus49	Bus	Under Voltage	11.000	kV	9.23	83.9	3-Phase
Bus491	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus492	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus495	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus496	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus497	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus498	Bus	Under Voltage	11.000	kV	9.21	83.7	3-Phase
Bus499	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus50	Bus	Under Voltage	11.000	kV	9.22	83.8	3-Phase
Bus500	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus501	Bus	Under Voltage	33.000	kV	28.22	85.5	3-Phase
Bus502	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus504	Bus	Under Voltage	11.000	kV	9.24	84.0	3-Phase
Bus505	Bus	Under Voltage	11.000	kV	9.21	83.7	3-Phase
Bus507	Bus	Under Voltage	11.000	kV	9.19	83.6	3-Phase
Bus508	Bus	Under Voltage	11.000	kV	9.24	84.0	3-Phase
Bus509	Bus	Under Voltage	11.000	kV	9.19	83.5	3-Phase
Bus51	Bus	Under Voltage	11.000	kV	9.23	83.9	3-Phase
Bus510	Bus	Under Voltage	11.000	kV	9.24	84.0	3-Phase
Bus511	Bus	Under Voltage	11.000	kV	9.21	83.8	3-Phase
Bus513	Bus	Under Voltage	11.000	kV	9.21	83.8	3-Phase
Bus514	Bus	Under Voltage	11.000	kV	9.15	83.2	3-Phase
Bus516	Bus	Under Voltage	11.000	kV	9.21	83.8	3-Phase
Bus517	Bus	Under Voltage	11.000	kV	9.19	83.5	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus519	Bus	Under Voltage	11.000	kV	9.189	83.5	3-Phase
Bus520	Bus	Under Voltage	33.000	kV	29.67	89.9	3-Phase
Bus521	Bus	Under Voltage	11.000	kV	9.15	83.2	3-Phase
Bus522	Bus	Under Voltage	11.000	kV	9.15	83.2	3-Phase
Bus523	Bus	Under Voltage	11.000	kV	9.15	83.2	3-Phase
Bus525	Bus	Under Voltage	11.000	kV	9.15	83.2	3-Phase
Bus526	Bus	Under Voltage	33.000	kV	29.56	89.6	3-Phase
Bus527	Bus	Under Voltage	11.000	kV	9.17	83.4	3-Phase
Bus528	Bus	Under Voltage	11.000	kV	9.16	83.3	3-Phase
Bus529	Bus	Under Voltage	11.000	kV	9.17	83.4	3-Phase
Bus53	Bus	Under Voltage	11.000	kV	9.22	83.8	3-Phase
Bus530	Bus	Under Voltage	33.000	kV	29.67	89.9	3-Phase
Bus531	Bus	Under Voltage	11.000	kV	9.17	83.3	3-Phase
Bus532	Bus	Under Voltage	11.000	kV	9.21	83.7	3-Phase
Bus534	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus54	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus55	Bus	Under Voltage	11.000	kV	9.22	83.8	3-Phase
Bus57	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus58	Bus	Under Voltage	11.000	kV	9.21	83.7	3-Phase
Bus59	Bus	Under Voltage	11.000	kV	9.20	83.6	3-Phase
Bus6	Bus	Under Voltage	11.000	kV	9.12	82.9	3-Phase
Bus60	Bus	Under Voltage	11.000	kV	9.21	83.7	3-Phase
Bus62	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus63	Bus	Under Voltage	11.000	kV	9.20	83.6	3-Phase
Bus64	Bus	Under Voltage	11.000	kV	9.20	83.6	3-Phase
Bus65	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus66	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus67	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus68	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus69	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus7	Bus	Under Voltage	33.000	kV	29.11	88.2	3-Phase
Bus70	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus71	Bus	Under Voltage	11.000	kV	9.25	84.1	3-Phase
Bus72	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus73	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus75	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus76	Bus	Under Voltage	11.000	kV	9.261	84.2	3-Phase
Bus77	Bus	Under Voltage	11.000	kV	9.26	84.1	3-Phase
Bus78	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus79	Bus	Under Voltage	11.000	kV	8.55	77.8	3-Phase
Bus8	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus80	Bus	Under Voltage	11.000	kV	9.25	84.1	3-Phase
Bus81	Bus	Under Voltage	11.000	kV	8.55	77.8	3-Phase
Bus82	Bus	Under Voltage	11.000	kV	8.56	77.8	3-Phase
Bus83	Bus	Under Voltage	11.000	kV	9.25	84.1	3-Phase
Bus84	Bus	Under Voltage	11.000	kV	8.59	78.1	3-Phase
Bus85	Bus	Under Voltage	11.000	kV	8.56	77.8	3-Phase
Bus86	Bus	Under Voltage	11.000	kV	8.56	77.8	3-Phase
Bus87	Bus	Under Voltage	11.000	kV	8.56	77.8	3-Phase
Bus88	Bus	Under Voltage	11.000	kV	8.55	77.8	3-Phase
Bus89	Bus	Under Voltage	11.000	kV	8.50	77.2	3-Phase
Bus9	Bus	Under Voltage	11.000	kV	9.03	82.1	3-Phase
Bus90	Bus	Under Voltage	11.000	kV	8.55	77.7	3-Phase
Bus91	Bus	Under Voltage	11.000	kV	8.43	76.6	3-Phase
Bus92	Bus	Under Voltage	11.000	kV	8.56	77.8	3-Phase
Bus93	Bus	Under Voltage	11.000	kV	8.42	76.5	3-Phase
Bus94	Bus	Under Voltage	11.000	kV	8.53	77.5	3-Phase
Bus95	Bus	Under Voltage	11.000	kV	8.56	77.8	3-Phase
Bus96	Bus	Under Voltage	11.000	kV	8.39	76.2	3-Phase
Bus97	Bus	Under Voltage	11.000	kV	8.42	76.5	3-Phase
Bus99	Bus	Under Voltage	11.000	kV	8.50	77.2	3-Phase

SUMMARY OF TOTAL GENERATION , LOADING & DEMAND

	MW	Mvar	MVA	% PF
Source (Swing Buses):	68.296	42.737	80.565	84.77 Lagging
Source (Non-Swing Buses):	0.000	0.000	0.000	
Total Demand:	68.296	42.737	80.565	84.77 Lagging
Total Motor Load:	50.751	31.453	59.707	85.00 Lagging
Total Static Load:	17.247	10.689	20.290	85.00 Lagging
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	0.298	0.595		
System Mismatch:	0.000	0.000		

Number of Iterations: 4

Annexure-5: Feeder Wise Reliability Indices

Annexure 6- Material Cost of Upgrading single phase 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.

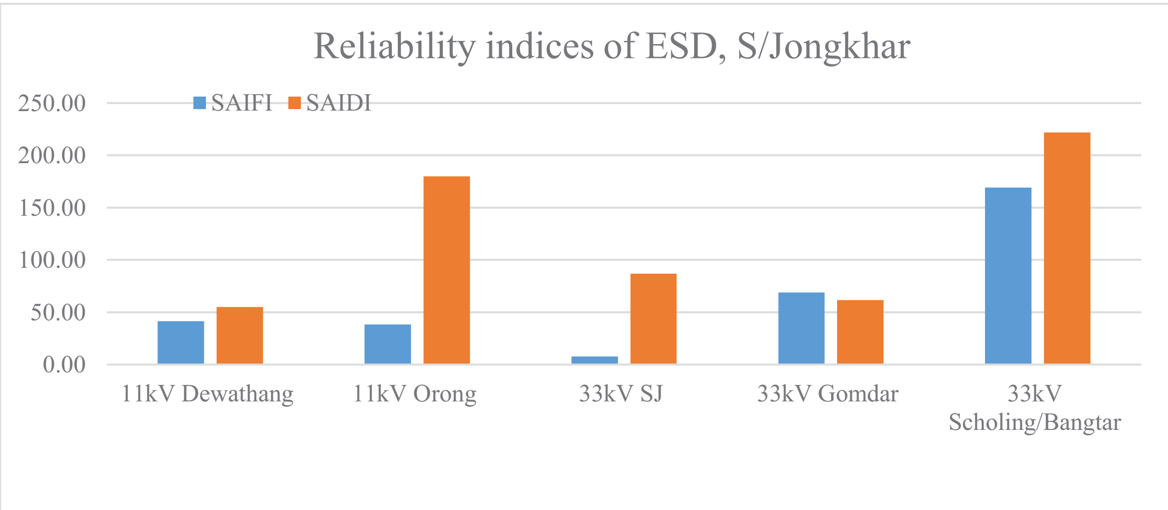
The total cost including material cost (Nu. 65 million), transportation cost (Nu. 3.47 million) and labor cost (Nu. 28 million) will amount to Nu. 97 million.

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
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	Year	Reliability Indices	11kV Dewathang	11kV Orong	33kV SJ	33kV Gomdar	33kV Scholing/Bangtar	Total
1	2016	SAIFI	4.91	15.96	21.00	81.03	46.12	169.03
		SAIDI	472.75	59.26	59.26	325.85	83.24	1000.36
2	2017	SAIFI	75.99	61.03	15.63	95.30	229.50	477.44
		SAIDI	80.01	491.28	158.33	158.33	101.38	989.33
3	2018	SAIFI	75.01	43.96	7.16	94.01	286.02	506.16
		SAIDI	128.59	114.03	157.87	87.47	418.45	906.41
4	2019	SAIFI	14.92	47.79	8.29	86.01	161.09	318.10
		SAIDI	11.01	114.36	30.94	0.64	367.79	524.74
Average (Feeder wise)		**SAIFI**	**41.48**	**38.19**	**7.77**	**68.83**	**169.15**	
		SAIDI	**54.90**	**179.92**	**86.79**	**61.61**	**221.91**	
Average (Overall)		**SAIFI**						367.68
		SAIDI						855.21



3phase Transformer under ESSD Samdrupcholing. (Bangter Feeder)

% Loading of a Distribution Transformer measured during peak hours

Sl				Voltage Ratio		Current		Secondary phase voltage			Load per phase			Load in kVA/Phase				%		2025		2030	
No	Name	Tfrs rating	Serial No	HV	LV	Ip	Is	Vrn	Vyn	Vbn	Ir	Iy	Ib	R	Y	B	3ph load (kVA)	Loading	Time (hrs)	kVA	%loading	kVA	%loading
																				2.4075		3.005	
																				0.50		0.87	
																				1.50		1.87	
1	Nganglangshing	30	5482	33	0.415	0.52	41.74	226	228	229	7.6	9.7	5.2	1.72	2.21	1.19	5.12	17%	1845hrs	7.65	26%	9.55	32%
2	Domphu	63	7555	33	0.415	1.10	87.65	226	226	225	33.4	7.5	36.6	7.55	1.70	8.24	17.48	28%	1917hrs	26.13	41%	32.62	52%
3	Dungkharcholing	25	9112299	33	0.240	0.76	104.17	227			16			3.63	-	-	3.63	15%	1815hrs	5.43	22%	6.78	27%
4	Martang Zampa	25		33	0.240	0.76	104.17										5.00	20%		7.48	30%	9.33	37%
5	Lower Martang	16	9112220	33	0.240	0.48	66.67	229			11.2			2.56	-	-	2.56	16%	1825hrs	3.83	24%	4.79	30%
6	Upper Martang	25	9112300	33	0.240	0.76	104.17	229			10			2.29	-	-	2.29	9%	1919hrs	3.42	14%	4.27	17%
7	Ashikhar	25	10639	33	0.415	0.44	34.78	232.5	237.1	233.7	0.5	0.2	0.4	0.12	0.05	0.09	0.26	1%	5.30pm	0.38	2%	0.48	2%
8	Gerwa	25	10484	33	0.415	0.44	34.78	230	231.9	230.1	5.2	0.6	0.9	1.20	0.14	0.21	1.54	6%	5.40pm	2.31	9%	2.88	12%
9	Augurung A	25	10485	33	0.415	0.44	34.78	234.1	234.6	233.1	0.3	0.1	0.1	0.07	0.02	0.02	0.12	0%	6.00pm	0.17	1%	0.22	1%
10	Agurung B	25	12301	33	0.415	0.44	34.78	232	231.9	230.8	0.9	0.6	0.8	0.21	0.14	0.18	0.53	2%	6.30pm	0.80	3%	0.99	4%
11	Sukuni A	25	9112890	33	0.240	0.76	104.17	231.8			6.9			1.60			1.60	6%	7.00pm	2.39	10%	2.98	12%
12	sangshingzor	25	13557	33	0.415	0.44	34.78	231.1	230	231.1	0.6	1.1	0.9	0.14	0.25	0.21	0.60	2%	7.45pm	89.7%	3.6%	111.9%	4.5%
13	Sukuni B	25	12299	33	0.415	0.44	34.78	229.1	233.6	232	0.5	0.1	0	0.11	0.02	-	0.14	1%	6.12pm	20.6%	0.8%	25.7%	1.0%
14	Sazala	25	9112856	33	0.240	0.76	104.17	231.6			4.1			0.95	-	-	0.95	4%	6.30pm	1.42	6%	1.77	7%
15	Merudaza	16	13405	33	0.240	0.48	66.67	232			2			0.46			0.46	3%	6.45pm	0.69	4%	0.87	5%
16	JTCP	125	125/521	33	0.415	2.19	173.91	234.3	235.1	234.1	76	83	80	17.81	19.51	18.73	56.05	45%	8.00pm	83.79	67%	104.59	84%
17	Upper Khamaythang	63		33	0.415	1.10	87.65	243	244	244	32.7	17.3	15.9	12.92	11.10	19.26	43.27	69%	6.16pm	64.69	103%	80.75	128%
18	FMCL	125		33	0.415	2.19	173.91										20.00	16%		29.90	24%	37.32	30%
19	Lower Khamaythang	63		33	0.415	1.10	87.65	229	230	232	29.6	19.3	42.6	10.76	7.87	4.48	23.11	37%	6.20pm	34.55	55%	43.12	68%
20	Belamsharang	63	7077	33	0.415	1.10	87.65	229.6	231.9	231	34.8	20.9	21.1	7.99	4.85	4.87	17.71	28%	7.00pm	26.48	42%	33.05	52%
21	SMCL	100	3944	33	0.415	1.75	139.12	243.5	239.8	241.9	4.3	8.9	10.1	1.05	2.13	2.44	5.62	6%	7.45pm	8.41	8%	10.50	10%
22	FCB Rice Mill khateythang	63	2810	33	0.415	1.10	87.65	220.3	224	226.6	0.35	0.78	0.32	0.08	0.17	0.07	0.32	1%	7.30pm	48.5%	0.8%	60.5%	1.0%
23	Koila	125		33	0.415	2.19	173.91	223	224	223	84.6	52.2	57.1	18.87	11.69	12.73	43.29	35%	5.45pm	64.72	52%	80.79	65%
24	Kuenphen Norter	500		33	0.415	8.75	695.62										100.00	20%		149.50	30%	186.61	37%
25	Teakiri	63		33	0.415	1.10	87.65	232	331	232	7.6	10.9	10.1	1.76	3.61	2.34	7.71	12%	6.00pm	11.53	18%	14.40	23%
26	Jakartala	25	13490	33	0.415	0.44	34.78	230	230	230	1.9	1.8	2.1	0.44	0.41	0.48	1.33	5%	6.00pm	1.99	8%	2.49	10%
27	Martshala	63	7546	33	0.415	1.10	87.65	235	235.5	232.8	13.3	9.16	28.53	3.13	2.16	6.64	11.92	19%	8.00pm	17.83	28%	22.25	35%
28	Martshala CS (Lower campus)	125		33	0.415	2.19	173.91										30.00	24%		44.85	36%	55.98	45%
29	Dungmana	63	7562	33	0.415	1.10	87.65	227.4	231.4	230.4	23.08	15.09	16.89	5.25	3.49	3.89	12.63	20%	6.25pm	18.88	30%	23.57	37%
30	Martshala CS (Uppercampus)	250		33	0.415	4.37	347.81										70.00	28%		104.65	42%	130.63	52%
31	Gorthongma	63	7532	33	0.415	1.10	87.65	234.3	230.9	232.6	5.26	2.01	3.6	1.23	0.46	0.84	2.53	4%	6.30pm	3.79	6%	4.73	8%
32	Thrizor	63	7550	33	0.415	1.10	87.65	233.7	234.8	231.8	2.13	5.52	1.66	0.50	1.30	0.38	2.18	3%	6.00pm	3.26	5%	4.07	6%
33	Saytshalo	25	13341	33	0.240	0.76	104.17	232.1			6.1			1.90			1.90	8%	5.12pm	2.85	11%	3.55	14%
34	Kagpadung	63	7565	33	0.415	1.10	87.65	235.6	231.9	234.4	6.2	3.2	6	1.46	0.74	1.41	3.61	6%	8.30pm	5.40	9%	6.74	11%
35	kaptang	25	9112933	33	0.240	0.76	104.17	228.3			10			2.28			2.28	9%	7.24pm	3.41	14%	4.26	17%
36	pairithang	25	9112887	33	0.240	0.76	104.17	230.5			6			1.38			1.38	6%	7.35pm	2.07	8%	2.58	10%
37	Richanglo	25	9112918	33	0.240	0.76	104.17	232.6			5			1.16			1.16	5%	8.15pm	1.74	7%	2.17	9%
38	Upper shame shame	25	9112888	33	0.240	0.76	104.17	232.44			8			1.86			1.86	7%	5.30pm	2.78	11%	3.47	14%
39	Yangtsepam	25	9112942	33	0.240	0.76	104.17	230.1			13			2.99			2.99	12%	5.15pm	4.47	18%	5.58	22%
40	lower tsholingkhar	25	9112830	33	0.240	0.76	104.17	229.1			17			3.89			3.89	16%	5.00pm	5.82	23%	7.27	29%
41	upper tsholingkhar	25	9112943	33	0.240	0.76	104.17	228.5			22			5.03			5.03	20%	5.30pm	7.52	30%	9.38	38%
42	lower shame shame	25		33	0.240	0.76	104.17	234			6			1.40			1.40	6%	5.45pm	2.10	8%	2.62	10%
43	Lower Serjung	25		33	0.240	0.76	104.17	235			8			1.88			1.88	8%	5.45pm	2.81	11%	3.51	14%
44	upper serjung	25		33	0.240	0.76	104.17	233			6			1.40			1.40	6%	5.30pm	2.09	8%	2.61	10%
45	Serjung School	25		33	0.240	0.76	104.17	233			36.00			15.00			15.00	60%		22.43	90%	27.99	112%
46	Richangdrang	10		33	0.240	0.30	41.67	228			6			1.37			1.37	14%	6.00pm	2.05	20%	2.55	26%
47	Kakanay	25		33	0.240	0.76	104.17	231			13.6			3.14			3.14	13%	5.30pm	4.70	19%	5.86	23%
48	chongmashing	25		33	0.240	0.76	104.17	232			15.7			3.64			3.64	15%	6.00pm	5.45	22%	6.80	27%
49	Doray	10		33	0.240	0.30	41.67	229			8			1.83			1.83	18%	6.00pm	2.74	27%	3.42	34%
50	Lhemshing	10	9112154	33	0.240	0.30	41.67	230.4			6			1.38			1.38	14%	7.25pm	2.07	21%	2.58	26%
51	Dingshingzor	25	9112738	33	0.240	0.76	104.17	228.3			11.3			2.58			2.58	10%	6.35pm	3.86	15%	4.81	19%
52	Lower sowzor	10	9112154	33	0.240	0.30	41.67	227.8			5.4			1.23			1.23	12%	7.00pm	1.84	18%	2.30	23%
53	Thongpashing	16	9112207	33	0.240	0.48	66.67	230.4			10.5			2.42			2.42	15%	7.30pm	3.62	23%	4.51	28%
54	Rawshing	10	9112159	33	0.240	0.30	41.67	228.6			5.8			1.33			1.33	13%	7.45pm	1.98	20%	2.47	25%
55	Tshatshalo	25	9112304	33	0.240	0.76	104.17	229.5			8.2			1.88			1.88	8%	8.00pm	2.81	11%	3.51	14%
56	Upper Sowzor	10	9112144	33	0.240	0.30	41.67	233.6			6.1			1.42			1.42	14%	6.55pm	2.13	21%	2.66	27%
57	Tshangchuthama	160	33-7082	33	0.415	230.3	231.1	231.9	228.1	223.9	71.3	60.1	58.9	16.53	13.71	13.19	43.43	27%	6.57pm	64.93	41%	81.05	51%
58	Phuntshongthang	250	33/1112	33	0.415	4.37	347.81	228.6	229.1	223	31.4	29.9	56.6	7.18	6.85	12.62	26.65	11%	6.50pm	39.84	16%	49.73	20%
59	Karmaling HSS	125		33	0.415	2.19	173.91	218	220	221	75.2	80.3	79.2	16.39	17.67	17.50	51.56	41%	9.00pm	77.09	62%	96.22	77%
60	Thangchu Gonpa	125		33	0.415	2.19	173.91	227	238	239	39.3	53.1	88.2	8.92	12.64	21.08	42.64	34%	6.00pm	63.75	51%	79.57	64%
61	Samdrupcholing (Dungkhag Offic	125	7613	33	0.415	2.19	173.91	230	230	231	145	128	105	33.35	29.44	24.26	87.05	70%	7.30pm	130.14	104%	162.43	130%
62	Samdrupcholing(GewogOffice)	125	9559	33	0.415	2.19	173.91	230.1	230.6	230.5	4.3	2.9	3.1	0.99	0.67	0.71	2.37	2%	6.25pm	3.55	3%	4.43	4%
63	NHDCL	315	55434	33	0.415	5.51	438.24	230	229	229	10	18	11	2.30	4.12	2.52	8.94	3%	8.00pm	13.37	4%	16.68	5%
64	Majowa	63		33	0.415	1.10	87.65	232	231	232	4.3	5.2	7.3	1.00	1.20	1.69	3.89	6%	5.50pm	5.82	9%	7.26	12%
65	Upper Dungkharling	125		33	0.415	2.19	173.91	227	226	225	56.9	49.1	85.6	12.92	11.10	19.26	43.27	35%	7.00pm	64.69	52%	80.75	65%
66	Shillinggay	25	9112692	33	0.240	0.76	104.17	234.4			37.04			8.68			8.68	35%	7.15pm	12.98	52%	16.20	65%
67	lower Dungkharling	63		33	0.415	1.10	87.65	231	230	232	46.6	34.2	19.3	10.76	7.87	4.48	23.11	37%	8.35pm	34.55	55%	43.12	68%
68	Bakuli(Lower P/tshothang)	63	9122372	33	0.415	1.10	87.65	231.1	233.6	235.1	6.2	4.1	4.9	1.43	0.96	1.15	3.54	6%	7.00pm	5.30	8%	6.61	10%
69	Bawani	125		33	0.415	2.19	173.91	231	232	231	16.7	12.3	18.2	3.86	2.85	4.20	10.92	9%	9.00pm	16.32	13%	20.37	16%
70	Lower Bawani	63		33	0.415	1.10	87.65										20.00	32%		29.90	47%	37.32	59%
71	Kubenday	25	9112854	33	0.240	0.76	104.17	227.4			16.99			3.86			3.86	15%	7.15pm	5.78	23%	7.21	29%
72	Kharbandi	63		33	0.415	1.10	87.65	237.1	233.1	234.4	0.33	8.54	12.57	0.08	1.99	2.95	5.02	8%	8.00pm	7.50	12%	9.36	15%
73	upper Beldara	125	7610	33	0.415	2.19	173.91	223.3	217.3	219.2	52.58	64.76	50.61	11.74	14.07	11.09	36.91	30%	6.00pm	55.18	44%	68.87	55%

3phase Transformer under ESSD Samdrupcholing. (Bangter Feeder)

% Loading of a Distribution Transformer measured during peak hours

Sl				Voltage Ratio		Current		Secondary phase voltage			Load per phase			Load in kVA/Phase				%		2025		2030	
No	Name	Tfrs rating	Serial No	HV	LV	Ip	Is	Vrn	Vyn	Vbn	Ir	Iy	Ib	R	Y	B	3ph load (kVA)	Loading	Time (hrs)	kVA	%loading	kVA	%loading
74	Lower Beldara	63	7548	33	0.415	1.10	87.65	233.3	235.1	234.5	4.04	17.01	13.02	0.94	4.00	3.05	7.99	13%	6.30pm	11.95	19%	14.92	24%
75	Phedey	63	9132359	33	0.415	1.10	87.65	222.5	225.3	223.9	18.44	13.49	71.88	4.10	3.04	16.09	23.24	37%	6.00pm	34.74	55%	43.36	69%
76	Nainetal	63	9132357	33	0.415	1.10	87.65	225.4	224.8	227.4	15.58	16.14	30.45	3.51	3.63	6.92	14.06	22%	7.45pm	21.03	33%	26.25	42%
77	Lingmaythang	25	9112907	33	0.240	0.76	104.17	228.3			14.46			3.30			3.30	13%	8.00pm	4.94	20%	6.16	25%
78	Darjayzor	10	9112181	33	0.240	0.30	41.67	230.4			6.9			1.59			1.59	16%	7.15pm	2.38	24%	2.97	30%
79	Wangphu	63	9132361	33	0.415	1.10	87.65	234.5	236.1	232.9	6.8	6.3	3.1	1.59	1.49	0.72	3.80	6%	6.45pm	5.69	9%	7.10	11%
80	Warong	63	9112178	33	0.415	1.10	87.65	227.3	223.61	226.1	3.4	2.6	20.35	0.77	0.58	4.60	5.96	9%	7.14pm	8.90	14%	11.11	18%
81	Gairitar	30	7513	33	0.415	0.52	41.74	223	206.1	225.4	5.45	7.22	2.89	1.22	1.49	0.65	3.35	11%	8.25pm	5.02	17%	6.26	21%
82	Dekilla	10	9132325	33	0.240	0.30	41.67	219.4			2.6			0.57			0.57	6%	7.45pm	0.85	9%	1.06	11%
83	Dorangthang URC	63		33	0.415	1.10	87.65	227.3	223.61	226.1	6.8	6.3	3.1	1.55	1.41	0.70	3.66	6%		5.46	9%	6.82	11%
84	Durali	10	9112163	33	0.240	0.30	41.67	221			6			1.33			1.33	13%	5.45pm	1.98	20%	2.47	25%
85	Katari	10	911291	33	0.240	0.30	41.67	223			10			2.23			2.23	22%	6.25pm	3.33	33%	4.16	42%
86	Tshoduen	25		33	0.415	0.44	34.78	227.3	223.61	226.1	6.8	6.3	5	1.55	1.41	1.13	4.08	16%		6.11	24%	7.62	30%
87	Samrang	63	7560	33	0.415	1.10	87.65	225	225.8	225	21	20	24	4.73	4.52	5.40	14.64	23%	5.30pm	21.89	35%	27.32	43%
88	Dairy Farm	500		33	0.415	8.75	695.62										120.00	24%		179.41	36%	223.93	45%
89	Goat Farm	500		33	0.415	8.75	695.62										120.00	24%		179.41	36%	223.93	45%
90	Fishery	500		33	0.415	8.75	695.62										130	26%		194.36	39%	242.59	49%
91	Damtshang	25	TCB-09-0543	33	0.415	0.44	34.78	230	227	226	0.2	0.1	0	0.05	0.02	-	0.07	0.27%	1915hrs	0.10	0.41%	0.13	1%
92	Tokaphung SS	25	9132312	33	0.415	0.44	34.78	226.6	227	227.5	4.24	1.94	1.86	0.96	0.44	0.42	1.82	7.30%	1855hrs	2.73	11%	3.40	14%
93	Monmola (School) S/s	25	13569	33	0.415	0.44	34.78	231.8	229.9	220.3	1.21	0.99	1.12	0.28	0.23	0.25	0.75	3.02%	1931hrs	1.13	5%	1.41	6%
94	Middle Monmola S/s	16	13398	33	0.240	0.48	66.67	228.1			2.47			0.56		-	0.56	3.52%	1908hrs	0.84	5%	1.05	7%
95	Monmola Gonpa S/s	25	13496	33	0.415	0.44	34.78	212.12	224.7	225.5	1.43	1.61	0.94	0.30	0.36	0.21	0.88	3.51%	1858hrs	1.31	5%	1.64	7%
96	Upper Barkalangnang S/s	25	13551	33	0.415	0.44	34.78	356.6	341	348.9	9.69	4.17	2.49	3.46	1.42	0.87	5.75	22.98%	1943hrs	8.59	34%	10.72	43%
97	Lower Barkalangnang S/s	25	13472	33	0.415	0.44	34.78	229.4	251.6	221.4	5.69	2.31	2.04	1.31	0.58	0.45	2.34	9.35%	1927hrs	3.50	14%	4.36	17%
98	Tashithangay S/s	25	13532	33	0.415	0.44	34.78	222.9	224.2	223.1	11.5	6.3	7.6	2.56	1.41	1.70	5.67	23%	1847hrs	8.48	34%	10.58	42%
99	Monmola Pangthang S/s	25	13501	33	0.415	0.44	34.78	230.1	225.7	227.3	2.08	1.34	2.71	0.48	0.30	0.62	1.40	5.59%	1928hrs	2.09	8%	2.61	10%
100	Serthi Lhakhang S/s	25	13539	33	0.415	0.44	34.78	236.2	230	232.1	1.66	1.21	1.46	0.39	0.28	0.34	1.01	4.04%	1930hrs	1.51	6%	1.88	8%
101	Serthi Tangngagpa S/s	25	13516	33	0.415	0.44	34.78	234.7	231.2	230.1	3.83	3.11	9.7	0.90	0.72	2.23	3.85	15.40%	1935hrs	5.76	23%	7.18	29%
102	Serthi Tangfrang S/s	25	13583	33	0.415	0.44	34.78	228.6	225.9	225.3	8.52	0.95	8.11	1.95	0.21	1.83	3.99	15.96%	1854hrs	5.96	24%	7.44	30%
103	Serthi Pemaling S/s	10	13352	33	0.240	0.30	41.67	156.4			2.01			0.31		-	0.31	3.14%	1845hrs	0.47	5%	0.59	6%
104	Tokari Gonpa S/s	10	13342	33	0.240	0.30	41.67	232.8			3.13			0.73		-	0.73	7.29%	1809hrs	1.09	11%	1.36	14%
105	Minjung BHU S/s	16	13413	33	0.240	0.48	66.67	228.9			2.62			0.60		-	0.60	3.75%	1905hrs	0.90	6%	1.12	7%
106	Chaskhar S/s	16	13376	33	0.240	0.48	66.67	226.2			20.49			4.63		-	4.63	28.97%	1917hrs	6.93	43%	8.65	54%
107	Menjung Guest House S/s	25	13538	33	0.415	0.44	34.78	227.3	221.9	219.8	3.08	4.25	23.91	0.70	0.94	5.26	6.90	27.59%	1915hrs	10.31	41%	12.87	51%
108	Minjung School S/s	250		33	0.415	4.37	347.81	234.6	233.6	232.6	7.2	7.82	6.03	1.69	1.83	1.40	4.92	1.97%	1905hrs	7.35	3%	9.18	4%
109	Menjung Peg S/s	25	13526	33	0.415	0.44	34.78	228.7	225.5	225.3	2.72	0.42	0.5	0.62	0.09	0.11	0.83	3.32%	1855hrs	1.24	5%	1.55	6%
110	Menjung/RNR/BT/Gewog S/s	25	13541	33	0.415	0.44	34.78	236.5	234.6	234.8	5.08	2.91	0.15	1.20	0.68	0.04	1.92	7.68%	1827hrs	2.87	11%	3.58	14%
111	Pangthang S/s	16	13363	33	0.240	0.48	66.67	232.2			0.1			0.02		-	0.02	0.15%	1815hrs	0.03	0.22%	4.33%	0.27%
112	Middle Khanduphu S/s	25	13549	33	0.415	0.44	34.78	228.3	227.1	226.7	2.7	0.25	0.39	0.62	0.06	0.09	0.76	3.05%	1845hrs	1.14	5%	1.42	6%
113	Upper Khanduphu S/s	25	13585	33	0.415	0.44	34.78	229	228	229	1.2	0.5	0.4	0.27	0.11	0.09	0.48	1.92%	1845hrs	0.72	3%	0.90	4%
114	Lower Khanduphu S/s	25	13494	33	0.415	0.44	34.78	229.7	227.5	227.6	2.29	0.7	0.93	0.53	0.16	0.21	0.90	3.59%	1856hrs	1.34	5%	1.67	7%
115	Zamtari Village S/s	25	13511	33	0.415	0.44	34.78	233	230	229	0.88	0.68	1	0.21	0.16	0.23	0.59	2.36%	1815hrs	0.88	3.53%	110.18%	4.41%
116	Zamtari School S/s	25	13571	33	0.415	0.44	34.78	247.6	246.8	246.4	0.98	0.87	1.63	0.24	0.21	0.40	0.86	3.44%	1815hrs	1.28	5%	1.60	6%
117	Suskhar S/s	25	13586	33	0.415	0.44	34.78	233.3	233	231	0.91	0.46	0.59	0.21	0.11	0.14	0.46	1.82%	1730hrs	0.68	2.73%	85.05%	3.40%
118	Lower Phakchu	10	13353	33	0.240	0.30	41.67	229.1			0.71			0.16		-	0.16	1.63%	1915hrs	0.24	2.43%	30.35%	3.04%
119	Middle Phagchu S/s	25	13474	33	0.415	0.44	34.78	232.2	231.4	229.9	0.17	0.15	1.14	0.04	0.03	0.26	0.34	1.35%	1857hrs	0.50	2.01%	62.75%	2.51%
120	Upper Phagchu S/s	16	13396	33	0.240	0.48	66.67	230			14.7			3.38		-	3.38	21.13%	1858hrs	5.05	32%	6.31	39%
121	Jurmey-B S/s	16	10119849	33	0.240	0.48	66.67	230.6			3.24			0.75		-	0.75	4.67%	1840hrs	1.12	7%	1.39	9%
122	Lower Drenphu	25	13581	33	0.415	0.44	34.78	230	231.8	234.9	3.76	8.94	0.51	0.86	2.07	0.12	3.06	12.23%	1700hrs	4.57	18%	5.70	23%
123	Upper Drenphu	25	13582	33	0.415	0.44	34.78	236.6	233.3	234.3	8.06	6.18	0.18	1.91	1.44	0.04	3.39	13.56%	1817hrs	5.07	20%	6.33	25%
124	Jurmey-A	16	13406	33	0.240	0.48	66.67	227.9			4			0.91		-	0.91	5.70%	1905hrs	1.36	9%	1.70	11%
125	Lower Depchang	25	13553	33	0.415	0.44	34.78	235.7	231.7	234.4	8.01	18.09	0.27	1.89	4.19	0.06	6.14	24.57%	1855hrs	9.18	37%	11.46	46%
126	Upper Depchang	25	13572	33	0.415	0.44	34.78	234.6	236.6	234.2	21.32	3.46	0.06	5.00	0.82	0.01	5.83	23.34%	1900hrs	8.72	35%	10.89	44%
127	Deptsangdrang	16	10119840	33	0.240	0.48	66.67	222.9			1.09			0.24		-	0.24	1.52%	1853hrs	0.36	2%	0.45	3%

3phase Transformer under ESSD Samdrupcholing. (Bangter Feeder)

% Loading of a Distribution Transformer measured during peak hours

Sl No	Name	Tfrs rating	Serial No	Voltage Ratio HV	Voltage Ratio LV	Current Ip	Current Is	Secondary phase voltage Vrn	Secondary phase voltage Vyn	Secondary phase voltage Vbn	Ir	Load per phase Iy	Load per phase Ib	Load in kVA/Phase R	Load in kVA/Phase Y	Load in kVA/Phase B	3ph load (kVA)	% Loading	Time (hrs)	2025 kVA	2025 %loading	2030 kVA	2030 %loading
128	Padpanathang	25	13495	33	0.415	0.44	34.78	229.6	226.8	228.9	0.2	0.19	0.26	0.05	0.04	0.06	0.15	0.59%	1858hrs	0.22	0.89%	27.72%	1.11%
129	Sayzor	25	13527	33	0.415	0.44	34.78	230.2	229.8	230.4	0.08	0.06	0.06	0.02	0.01	0.01	0.05	0.18%	1914hrs	0.07	0.3%	0.09	0.3%
130	Jomtshang	25		33	0.415	0.44	34.78	230	231	230	0.2	0.1	0.1	0.05	0.02	0.02	0.09	0.37%	1845hrs	0.14	0.6%	17.2%	0.7%
131	Lower Batseling	10	13361	33	0.240	0.30	41.67	229.9			4.28			0.98		-	0.98	9.84%	1845hrs	1.47	14.7%	183.6%	18.4%
132	Lower Gonong	25	13528	33	0.415	0.44	34.78	224.4	227.1	224.3	4.03	0.38	0.08	0.90	0.09	0.02	1.01	4.03%	1845hrs	1.51	6.0%	188.2%	7.5%
133	Upper Gonong	25	13512	33	0.415	0.44	34.78	230.6	227.9	229.6	4.45	0.16	0.12	1.03	0.04	0.03	1.09	4.36%	1858hrs	1.63	6.5%	203.4%	8.1%
134	Zangthi School	25	13491	33	0.415	0.44	34.78	229.9	230.2	232.5	18.4	0.6	0.8	4.23	0.14	0.19	4.55	18.22%	1800hrs	6.81	27.2%	849.9%	34.0%
135	Rashithang	25	13486	33	0.415	0.44	34.78	224.4	227.8	226.8	9.91	14.92	9.95	2.22	3.40	2.26	7.88	31.52%	1850hrs	11.78	47.1%	1470.3%	58.8%
136	Lower Serjong	16	13364	33	0.240	0.48	66.67	228.9			0.36			0.08		-	0.08	0.52%	1855hrs	0.12	0.8%	15.4%	1.0%
137	MiddleSerjong	25	09112862	33	0.240	0.76	104.17	227.8			0.31			0.07		-	0.07	0.28%	1914hrs	0.11	0.4%	13.2%	0.5%
138	Upper Serjong	10	13340	33	0.240	0.30	41.67	230.1			0.28			0.06		-	0.06	0.64%	1915hrs	0.10	1.0%	12.0%	1.2%
139	Zangthi BHU	25	09112936	33	0.240	0.76	104.17	231.3			20.1			4.65		-	4.65	18.60%	1800hrs	6.95	27.8%	867.6%	34.7%
140	Tashiphu	16	13391	33	0.240	0.48	66.67	238			2.19			0.52		-	0.52	3.26%	1913hrs	0.78	4.9%	97.3%	6.1%
141	Tshothang	25	13514	33	0.415	0.44	34.78	229.7	230.7	230.8	0.1	0.13	0.26	0.02	0.03	0.06	0.11	0.45%	1855hrs	0.17	0.7%	21.1%	0.8%
142	Meskang	10	13356	33	0.240	0.30	41.67	234.1			1.6			0.37		-	0.37	3.75%	1845hrs	0.56	5.6%	69.9%	7.0%
143	Lama Zimchung	16	13408	33	0.240	0.48	66.67	222.8			70.8			15.77		-	15.77	98.59%	1912hrs	23.58	147%	29.44	184%
144	Dzangdopelri	25	13534	33	0.415	0.44	34.78	231.3	231.8	233.6	7.42	18.52	0.19	1.72	4.29	0.04	6.05	24.21%	1810hrs	9.05	36%	11.30	45%
145	Upper Batseling	25	13559	33	0.415	0.44	34.78	234.6	233.1	234.4	3.1	2.43	1.31	0.73	0.57	0.31	1.60	6.40%	1800hrs	2.39	10%	2.99	12%
146	Upper Dungmanma	25	13462	33	0.415	0.44	34.78	225.9	228.1	230.6	0.09	0.07	0.12	0.02	0.02	0.03	0.06	0.26%	1915hrs	0.10	0.38%	0.12	0.5%
147	Dungmanma Lhakhang	25	13525	33	0.415	0.44	34.78	228.6	230.4	232.2	4.1	2.3	1.14	0.94	0.53	0.26	1.73	6.93%	1800hrs	2.59	10%	3.23	13%
148	Lower Dungmanma	25	13502	33	0.415	0.44	34.78	231.4	234.8	233.6	4.38	1.53	3.1	1.01	0.36	0.72	2.10	8.39%	1835hrs	3.14	13%	3.91	16%
149	Middle Dungmanma	25	13504	33	0.415	0.44	34.78	230.9	229.6	227.8	0.13	0.08	0.22	0.03	0.02	0.05	0.10	0.39%	19185hrs	0.15	0.6%	0.18	0.7%
150	Meringchima	16	13410	33	0.240	0.48	66.67	230.8			5.46			1.26		-	1.26	7.88%	1918hrs	1.88	12%	2.35	15%
151	Upper Woongthi	25	13565	33	0.415	0.44	34.78	237.6	236	234.3	0.33	0.39	3.16	0.08	0.09	0.74	0.91	3.64%	1805hrs	1.36	5%	1.70	7%
152	Lower Woongthi	25	13505	33	0.415	0.44	34.78	230.2	228.7	228.6	0.1	0.09	0.07	0.02	0.02	0.02	0.06	0.24%	1845hrs	0.09	0.4%	0.42	2%
153	Lauri A	25	13587	33	0.415	0.44	34.78	226.5	196.2	223.2	4.25	0.39	19.2	0.96	0.08	4.29	5.32	21.30%	1915hrs	7.96	32%	9.94	40%
154	Lauri B	25	13537	33	0.415	0.44	34.78	222.8	223	223.2	0.28	0.37	0.33	0.06	0.08	0.07	0.22	0.87%	1856hrs	0.33	1%	0.41	2%
155	Lauri C	25	13477	33	0.415	0.44	34.78	224.9	220.5	221.7	0.2	0.17	0.07	0.04	0.04	0.02	0.10	0.39%	1919hrs	0.15	1%	0.18	1%
156	Lauri D	25	13445	33	0.415	0.44	34.78	223.4	219.7	220.4	5.3	0.54	0.48	1.18	0.12	0.11	1.41	5.63%	1909hrs	2.11	8%	2.63	11%
157	Zarshing	25	13564	33	0.415	0.44	34.78	226.9	223.5	223.6	1.12	0.08	0.11	0.25	0.02	0.02	0.30	1.19%	1917hrs	0.44	1.77%	55.35%	2.21%
158	Marphae	16	10119832	33	0.240	0.48	66.67	226.8			2.1			0.48		-	0.48	2.98%	1851hrs	0.71	4%	0.89	6%
159	Lauri E	25	13545	33	0.415	0.44	34.78	222.2	218.9	218.4	0.2	0.42	1.52	0.04	0.09	0.33	0.47	1.87%	1911hrs	0.70	2.8%	87.4%	3.5%
160	Lauri F	25	13577	33	0.415	0.44	34.78	223.6	219.1	220.4	0.09	0.59	0.23	0.02	0.13	0.05	0.20	0.80%	1845hrs	0.30	1.2%	37.3%	1.5%
161	Lauri G	25	13529	33	0.415	0.44	34.78	224.2	219	219.2	0.89	0.13	0.89	0.20	0.03	0.20	0.42	1.69%	1857hrs	0.63	2.5%	79.0%	3.2%
162	Lauri H	25	13566	33	0.415	0.44	34.78	220.7	219.5	219.6	5.89	0.39	2.08	1.30	0.09	0.46	1.84	7.37%	1848hrs	2.75	11%	3.44	14%
163	Raynang Daza	25		33	0.415	0.44	34.78	233.2	232.4	233	2.64	1.23	1.11	0.62	0.29	0.26	1.16	4.64%	1805hrs	1.73	7%	2.16	9%
164	Ramjar Gonpa	16	10119836	33	0.240	0.48	66.67	226.9			1.09			0.25		-	0.25	1.55%	1859hrs	0.37	2%	0.46	3%
165	Jompa Geog Center	25	13482	33	0.415	0.44	34.78	233.3	232.8	232.8	8.5	2.53	3.31	1.98	0.59	0.77	3.34	13.37%	1852hrs	5.00	20%	6.24	25%
166	Gongpazumpa	25	13547	33	0.415	0.44	34.78	230.6	229.9	232.6	0.6	0.14	0.39	0.14	0.03	0.09	0.26	1.05%	1905hrs	0.39	1.6%	48.8%	2.0%
167	Jompa School	25	13530	33	0.415	0.44	34.78	230.6	228.9	230.1	3.86	7.66	0.84	0.89	1.75	0.19	2.84	11.35%	1830hrs	4.24	17%	5.29	21%
168	Lower Raynang	25	13500	33	0.415	0.44	34.78	236.9	234.5	234.8	0.07	0.09	0.11	0.02	0.02	0.03	0.06	0.25%	1859hrs	0.09	0.4%	11.9%	0.5%
169	Upper Raynang	25	13544	33	0.415	0.44	34.78	240.2	238.6	239.1	0.12	0.08	0.1	0.03	0.02	0.02	0.07	0.29%	1914hrs	0.11	0.4%	13.4%	0.5%
170	Lower Momring	25	13497	33	0.415	0.44	34.78	226.8	223.9	226.8	0.41	0.24	0.22	0.09	0.05	0.05	0.20	0.79%	1835hrs	0.29	1.2%	36.7%	1.5%
171	Middle Momring	25	13548	33	0.415	0.44	34.78	227.2	223.4	225.8	0.1	0.2	3.21	0.02	0.04	0.72	0.79	3.17%	1824hrs	1.18	4.7%	147.8%	5.9%
172	Upper Momring	25	13488	33	0.415	0.44	34.78	238.6	234.5	230.1	2.86	6.13	1.14	0.68	1.44	0.26	2.38	9.53%	1830hrs	3.56	14.2%	444.5%	17.8%
173	Momring Pangtoth	25	13500	33	0.415	0.44	34.78	220.8	225.1	223.9	0.09	0.3	0.25	0.02	0.07	0.06	0.14	0.57%	1825hrs	0.21	0.9%	26.8%	1.1%
174	Lower Phajo Gonpa	25	13509	33	0.415	0.44	34.78	233.7	231.3	231.4	0.29	0.18	0.16	0.07	0.04	0.04	0.15	0.59%	1859hrs	0.22	0.9%	27.3%	1.1%
175	Upper Phajo Gonpa	25	13551	33	0.415	0.44	34.78	233.6	231.6	231.7	0.08	0.1	0.11	0.02	0.02	0.03	0.07	0.27%	1849hrs	0.10	0.4%	12.6%	0.5%
176	Khashideng	25	13521	33	0.415	0.44	34.78	210.8	225.6	232.3	26.89	11.8	2.79	5.67	2.66	0.65	8.98	35.91%	1845hrs	13.42	54%	16.75	67%
177	Bazar	500	KT-500/301	11	0.415	26.24	695.62	225	228	227	154	101	109	34.65	23.03	24.74	82.42	16.48%	1936hrs	123.22	25%	153.80	31%
178	RBA	250	KT-500/250	11	0.415	13.12	347.81	221	223	223	55	30	36	12.16	6.69	8.03	26.87	10.75%	1915hrs	40.18	16%	50.15	20%
179	Jampani	63	2088	11	0.415	3.31	87.65	211	208	211	8.8	20.2	12.3	1.86	4.20	2.60	8.65	13.74%	1920hrs	12.94	21%	16.15	26%
180	Tala Basty	315	18810	11	0.415	16.53	438.24	224	220	223	33.2	41	69	7.44	9.02	15.39	31.84	10.11%	1915hrs	47.61	15%	59.42	19%
181	Golanty	63	40845	11	0.415	3.31	87.65	229	227	228	27	23.5	19.2	6.18	5.33	4.38	15.90	25.23%	1930hrs	23.76	38%	29.66	47%
182	Dungkhag Office compound	160	2463	11	0.415	8.40	222.60	224	221	225	4	15	14	0.90	3.32	3.15	7.36	4.60%	1930hrs	11.01	7%	13.74	9%
183	NHDC Colony	250	8546	11	0.415	13.12	347.81	223	205	222	15.6	6.8	5.3	3.48	1.39	1.18	6.05	2.42%	1940hrs	9.04	4%	11.29	5%
184	Bajarang	25		11	0.415	1.31	34.78	233	235	237	5.8	2.7	1.2	1.35	0.63	0.28	2.27	9.08%	1905hrs	3.39	14%	4.24	17%
185	Agurator	63	17641	11	0.415	3.31	87.65	215	216	218	5.9	3.3	2.5	1.27	0.71	0.55	2.53	4.01%	1900hrs	3.78	6%	4.71	7%
186	Khawrong	63	2026	11	0.415	3.31	87.65	220	219	217	6.1	4.2	3.8	1.34	0.92	0.82	3.09	4.90%	1915hrs	4.61	7%	5.76	9%
187	Dawathang	100	72239	11	0.415	5.25	139.12	239	237	235	3.2	8.25	16.8	0.76	1.96	3.95	6.67	6.67%	1900hrs	9.97	10%	12.44	12%
188	Stone Crushing Plant (Jangsa)	250	72243	11	0.415	13.122	347.81	239	238	233	97.3	93.1	112.1	23.25	22.16	26.12	71.53	28.61%	1015hrs	106.94	43%	133.48	53%
189	SELCHU	250		11	0.415	13.122	347.81	233	234	235	39.5	32.5	37	9.20	7.61	8.70	25.50	10.20%	1115hrs	38.13	15%	47.59	19%
190	Jangsawom	63		11	0.415	3.30674	87.65										6.17	9.80%	1115hrs	9.23	15%	11.52	18%
	Total																1,894.50	kVA		2823.12		3524.08	
																	1.61	MW		2.40		3.00	
													As per load flow			load flow	1.431	MW		1.87			
													Difference			Diffeence	(0.18)	MW					
													%				-0.01%						

% Loading of a Distribution Transformer measured during peak hours (gomdar)									
						2025		2030	
Sl No	Name	Tfrs rating	3ph load (kVA)	% Loading	Time (hrs)	kVA	%loading	kVA	%loading
						0.5565		0.62	
						0.43		0.59	
						1.43		1.59	
1	Athraise	16	0.30	1.88%	1813hrs	0.428689	3%	0.477606	3%
1	Dengzor	16	0.74	4.60%	1700hrs	1.050668	7%	1.170555	7%
1	Tokorong	25	5.93	23.71%	1700hrs	8.462442	34%	9.428057	38%
4	Gomdar	63	9.20	14.60%	1830hrs	13.12809	21%	14.62608	23%
5	Narphung village	63	8.10	12.85%	1700hrs	11.55888	18%	12.87782	20%
6	Narphung Bazar	63	17.78	28.22%	1830hrs	25.37682	40%	28.27247	45%
7	Tsangchilo school	250	35.45	14.18%	1825hrs	50.60794	20%	56.38261	23%
1	Sawangchilo	25	5.32	21.29%	1825hrs	7.599148	30%	8.466257	34%
1	sawangdaza	25	5.49	21.96%	1800hrs	7.836084	31%	8.730228	35%
10	Tshangchillo Bazar	63	14.73	23.37%	1815hrs	21.02072	33%	23.41931	37%
1	upper Brongshing	25	5.15	20.61%	1800hrs	7.353812	29%	8.192926	33%
1	lower Brongshing	25	5.17	20.67%	1815hrs	7.375352	30%	8.216924	33%
1	upper amshing	25	8.63	34.51%	1745hrs	12.31627	49%	13.72163	55%
1	lower amshing	25	6.36	25.43%	1755hrs	9.076695	36%	10.1124	40%
1	Bargongpa	25	5.19	20.78%	1720hrs	7.415143	30%	8.261256	33%
1	Pangthang	25	5.68	22.73%	1800hrs	8.110788	32%	9.036277	36%
1	Pearung	25	4.28	17.13%	1845hrs	6.111883	24%	6.809285	27%
1	Khandoma	25	5.92	23.68%	1850hrs	8.449388	34%	9.413514	38%
1	Bayuel	16	4.04	25.28%	1900hrs	5.773651	36%	6.432459	40%
1	lookzor	25	4.51	18.05%	1730hrs	6.442025	26%	7.177099	29%
1	mokhoma	25	8.00	32.00%	1830hrs	11.4193	46%	12.72231	51%
1	Khoyar School	25	10.00	40.00%		14.27537	57%	15.90428	64%
1	Upper khoyar	25	9.09	36.34%	1750hrs	12.96985	52%	14.44978	58%
1	Middle Khoyar	25	8.36	33.43%	1815hrs	11.92968	48%	13.29093	53%
1	Rongchanglo	16	4.84	30.22%	1900hrs	6.902573	43%	7.690198	48%
1	Lower denchi	25	11.28	45.12%	1832hrs	16.104	64%	17.94157	72%
1	Middle denchi	25	8.81	35.22%	1700hrs	12.57079	50%	14.0052	56%
1	Upper denchi	25	8.95	35.79%	1815hrs	12.77139	51%	14.22868	57%
1	Denchizor	16	7.38	46.11%	1840hrs	10.53212	66%	11.7339	73%
1	Upper Gonong	25	6.93	27.73%	1700hrs	9.898046	40%	11.02747	44%
1	lower Gonong	25	4.97	19.87%	1730hrs	7.089667	28%	7.898641	32%
1	lower frami	25	2.83	11.32%	1930hrs	4.038218	16%	4.499003	18%
1	middle frami	25	3.24	12.94%	1920hrs	4.618545	18%	5.145548	21%
1	upper frami	25	4.35	17.38%	1915hrs	6.20404	25%	6.911959	28%
1	middle bazor	25	6.94	27.77%	1800hrs	9.910287	40%	11.04111	44%
1	rejoke	10	8.60	85.98%	1845hrs	12.27406	123%	13.67461	137%
1	upper bazor	16	4.44	27.75%	1740hrs	6.338108	40%	7.061324	44%
1	Barzor School	25	12.00	48.00%		17.13045	69%	19.08514	76%
1	lower bazor	25	5.22	20.87%	1825hrs	7.449946	30%	8.30003	33%
1	Upper Brume	25	7.23	28.93%	1920hrs	10.32405	41%	11.50209	46%
1	middle brume	25	8.43	33.73%	1725hrs	12.03706	48%	13.41056	54%
1	Lower brume	25	5.56	22.26%	1700hrs	7.943912	32%	8.85036	35%
1	lower chidungkhar	25	7.20	28.80%	1900hrs	10.278	41%	11.45079	46%
1	middle chidundkhar	25	6.83	27.33%	1855hrs	9.75248	39%	10.8653	43%
1	upper chidungkhar	25	8.31	33.24%	1845hrs	11.86151	47%	13.21498	53%

% Loading of a Distribution Transformer measured during peak hours (gomdar)						2025		2030	
Sl No	Name	Tfrs rating	3ph load (kVA)	% Loading	Time (hrs)	kVA	%loading	kVA	%loading
1	Ngongthong	10	5.15	51.48%	1823hrs	7.349631	73%	8.188268	82%
1	lower rinchanglo	25	6.17	24.67%	1715hrs	8.803149	35%	9.807641	39%
1	Upper richanglo	25	7.12	28.49%	1700hrs	10.16879	41%	11.32911	45%
1	Richanglo Goenpa	25	5.59	22.35%	1900hrs	7.977276	32%	8.887531	36%
1	Gayre	16	2.98	18.63%	1830hrs	4.254818	27%	4.740318	30%
	Pertsinang	30	13.93	46.42%		19.87989	66%	22.1483	74%
1	Kheynong rong	25	3.92	15.67%	1815hrs	5.592663	22%	6.23082	25%
2	lower shokshi	25	5.79	23.14%	1825hrs	8.258447	33%	9.200785	37%
7	lower shokshi pangthang	25	4.12	16.49%	1700hrs	5.884595	24%	6.556062	26%
1	Middle shokshi pangthang	25	2.11	8.43%	1725hrs	3.007536	12%	3.350714	13%
1	Upper shokshi pangthang	25	1.41	5.65%	1730hrs	2.017967	8%	2.248229	9%
1	Bargoenpa	16	1.88	11.78%	1825hrs	2.689623	17%	2.996525	19%
3	middle shokshi	25	4.22	16.87%	1830hrs	6.021353	24%	6.708425	27%
4	Upper shokshi	25	6.03	24.13%	1845hrs	8.611619	34%	9.594257	38%
6	upper wangphu	25	9.94	39.76%	1950hrs	14.18915	57%	15.80822	63%
1	Pangthang Bainung	16	1.63	10.22%	1800hrs	2.333167	15%	2.599396	16%
1	lower Wangphu	16	2.36	14.73%	1850hrs	3.363564	21%	3.747366	23%
1	Yarphu Dungdaza	25	2.29	9.16%	1900hrs	3.269061	13%	3.64208	15%
1	lower yarphu	25	2.04	8.17%	1840hrs	2.916459	12%	3.249244	13%
1	Yarphu School	25	11.00	44.00%		15.70291	63%	17.49471	70%
1	middle yarphu(sch.area)	25	2.07	8.28%	1930hrs	2.955002	12%	3.292186	13%
1	Upper yarphu	25	2.71	10.85%	1700hrs	3.871481	15%	4.313241	17%
1	Langnangringmo	25	1.80	7.21%	1800hrs	2.572137	10%	2.865633	11%
5	middle wangphu	25	4.53	18.10%	1900hrs	6.460178	26%	7.197323	29%
1	Tshechula)	16	4.32	27.03%	1725hrs	6.173734	39%	6.878194	43%
1	haila	25	2.43	9.71%	1735hrs	3.465204	14%	3.860605	15%
1	lower Serchemo	25	1.12	4.47%	1600hrs	1.594845	6%	1.776826	7%
1	Upper Serchemo	25	2.24	8.98%	1630hrs	3.203679	13%	3.569239	14%
Total			**458.626**	**kVA**		**654.7059**		**729.4118**	
			0.390	**MW**		**0.556**		**0.620**	
		As per load flow	0.3957	MW					
		Difference	0.01	MW					
		%	0%						

% Loading of a Distribution Transformer measured during peak hours (33 kV Sj Feeder)

Sl		Tfrs		Voltage Ratio		Current		Secondary phase voltage			Load per phase			Load in kVA/Phase			3ph load	%		2025		2030	
No	Name	rating	Serial No	HV	LV	Ip	Is	Vrn	Vyn	Vbn	Ir	Iy	Ib	R	Y	B	(kVA)	Loading	Time (hrs)	kVA	%loading	kVA	%loading
							Projected load forcast for 2025(MW)													2.22		2.534	
																				0.93		1.20	
																				1.93		2.20	
1	Shedra	250	2808/2	33	0.415	4.37	347.81	231	231	232	28.6	30.6	47.6	6.61	7.07	11.04	24.72	9.9%	1937hrs	47.735106	19.09%	54.48682773	21.79%
2	Gakhil Industry, Deothang	315	44536	33	0.415	5.51	438.24	230	233	231.5	0.78	0.32	2	0.18	0.07	0.46	0.72	0.23%	1200hrs	1.3845622	0.44%	1.580396628	0.50%
3	33/11 kV Substation	2500		33	11.000												1,327.00	53.08%		2562.645	102.51%	2925.109246	117.00%
																	1,352.44	kVA		2,611.76		2,981.18	
															Total		1.1496	MW					
																		MW					
	Distribution Transformers fed from 2x2.5 MVA, 33/11 kV Samdrup Jongkhar Substation considered under Dewathang feeder for load forcasting purpose																						
1	Industrial area	500	KT-500/250	11	0.415	26.24	695.62	231	230	229	67.8	27.6	33.14	15.66	6.35	7.59	29.60	6%	1825hrs	57.160039	11.43%	65.24483728	13.05%
2	Pry.school	160	TCB-09-0543	11	0.415	8.40	222.60	229	232	229	20.2	9.3	21.4	11.83	13.23	21.5	46.56	29%	1801hrs	89.914659	56.20%	102.6323184	64.15%
3	Tashi Sawmil	63		11	0.415	3.3	87.6	220	222	220	1	0.5	1.3	0.220	0.111	0.286	0.617	1%	1130hrs	1.1915237	1.89%	1.360054563	2.16%
4	Dzong Area	1000	72243	11	0.415	52.49	1,391.25	226	226	224	140.3	200.45	189.4	31.71	45.30	42.43	119.44	12%	1150hrs	230.6479	23.06%	263.2710741	26.33%
5	Kezang Sawmil	160	186.11	11	0.415	8.40	222.60	231	229	223	13.07	11.3	10.71	3.02	2.59	2.39	8.00	5%	1130hrs	15.439985	9.65%	17.62383832	11.01%
6	AWP	250	2026	11	0.415	13.12	347.81	207	208	207	111.1	175.5	91.6	23.00	36.50	18.96	78.46	31%	1811hrs	151.52416	60.61%	172.9559565	69.18%
7	Dratshang	160		11	0.415	8.40	222.60	231	229	223	80	83	79	18.48	19.01	17.62	55.10	34%		106.41446	66.51%	121.4658778	75.92%
8	Check post	160		11	0.415	8.40	222.60	217	215	214	42.4	46.7	40.5	9.20	10.04	8.67	27.91	17%	1845hrs	53.895303	33.68%	61.51833186	38.45%
9	6kilo Druk Presidency	500		11	0.415	26.2	695.6	231	229	232	100	110	120	23.100	25.190	27.840	76.130	15%	1100hrs	147.01897	29.40%	167.8135395	33.56%
10	Thromde SJ	125		11	0.415	6.6	173.9	231	229	232	20.3	30.4	29.3	4.689	6.962	6.798	18.449	15%	1100hrs	35.626946	28.50%	40.66607229	32.53%
11	Gypsum yard	315	18810	11	0.415	16.53	438.24	223	224	223	75.8	13.5	89.2	16.90	3.02	19.89	39.82	13%	1921hrs	76.896732	24.41%	87.77311611	27.86%
12	Hospital	250	2088	11	0.415	13.12	347.81	210	211	212	42.2	54.2	49.9	8.86	11.44	10.58	30.88	12%	1919hrs	59.628328	23.85%	68.06224431	27.22%
13	Waste Dump Yard	25		11	0.415	1.31	34.78	229	228	228	0	0.1	5.2	-	0.02	1.19	1.21	5%	1845hrs	2.3336098	9.33%	2.663678985	10.65%
14	Tachicell & BT tower	16		11	0.415	0.84	22.26	230	229.5	230	1.5	0	0	0.35	-	-	0.35	2%	1030hrs	0.6662491	4.16%	0.760484318	4.75%
15	Motanga	250	72239	11	0.415	13.12	347.81	232	235	236	7.5	24.1	0.9	1.74	5.66	0.21	7.62	3%	1830hrs	14.707497	5.88%	16.78774643	6.72%
16	Bhutan chemical Motanga	500	500	11	0.415	26.24	695.62	229	226	223	19.17	17.65	17.3	4.39	3.99	3.86	12.24	2%	1100hrs	23.631044	4.73%	26.97345295	5.39%
17	RICBL	250	KM-717/B	11	0.415	13.12	347.81	212	213	211	75.4	125.4	104.6	15.98	26.71	22.07	64.77	26%	1835hrs	125.07253	50.03%	142.7629656	57.11%
18	BPC Colony	500	1006	11	0.415	26.24	695.62	220	221	218	152.3	132.1	130.1	33.51	29.19	28.36	91.06	18%	1824hrs	175.8548	35.17%	200.7279621	40.15%
19	BOB	1000	1.782.875	11	0.415	52.49	1,391.25	224	223	223	62.6	69.2	31.65	14.02	15.43	7.06	36.51	4%	1845hrs	70.5103	7.05%	80.48337795	8.05%
20	Lower market	1000		11	0.415	52.49	1,391.25	224	223	223	424.8	425.82	401.69	95.16	94.96	89.58	279.69	28%	1845hrs	540.1251	54.01%	616.5211758	61.65%
21	Housing colony 2	500	8546	11	0.415	26.24	695.62	221	219	218	27.1	21.7	21.1	5.99	4.75	4.60	15.34	3%	1840hrs	29.626262	5.93%	33.81664353	6.76%
22	Chenga Line	1000		11	0.415	52.49	1,391.25	224	223	223	104.07	145.7	163.68	23.31	32.49	36.50	92.30	9%	1845hrs	178.25237	17.83%	203.4646476	20.35%
23	RBP Colony	1000		11	0.415	52.49	1,391.25	224	223	223	45.617	100.06	80.14	10.22	22.31	17.87	50.40	5%	1845hrs	97.33558	9.73%	111.1028646	11.11%
																Total:	**3,888.46**	**kVA**		**7507.0038**		**8568.805202**	
																	3.31	**MW**					
	As per load flow																			6.3809532		7.283484422	

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**