

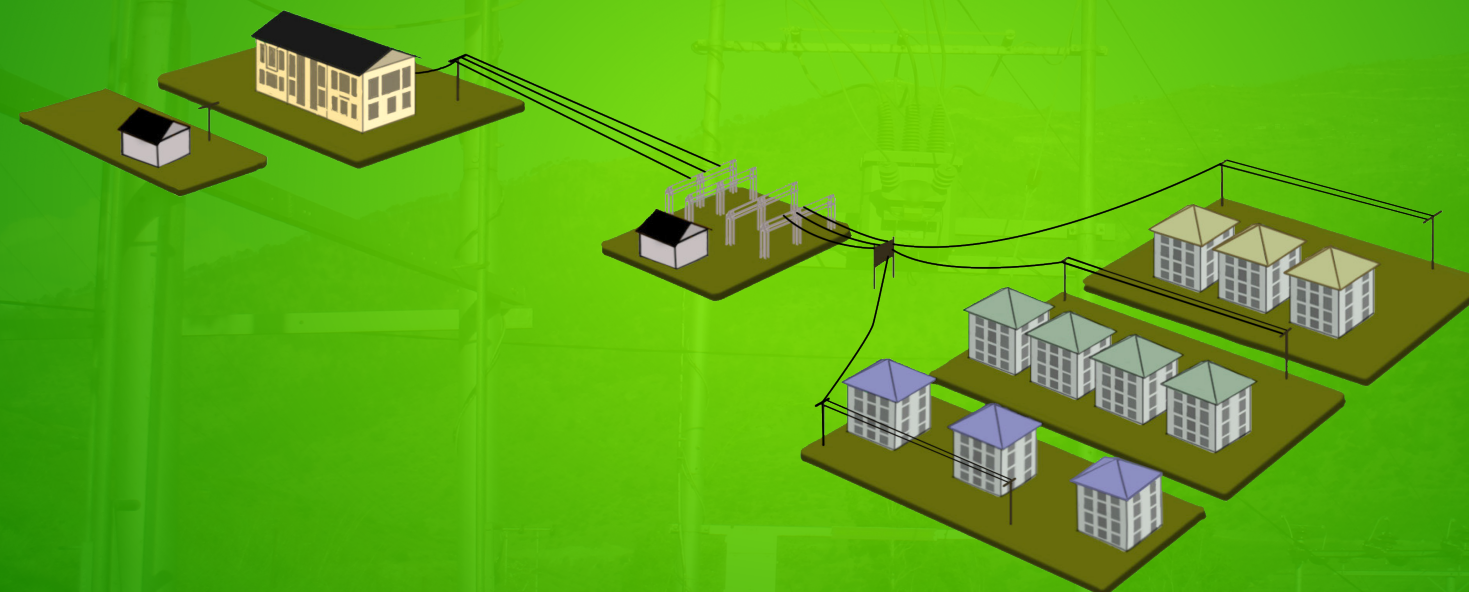
BHUTAN POWER CORPORATION LIMITED
(An ISO 9001:2015, ISO 14001:2015 & OHSAS 18001:2007 Certified Company)

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DISTRIBUTION SYSTEM MASTER PLAN (2020-2030)

THIMPHU DZONGKHAG



Distribution and Customer Services Department
Distribution Services
Bhutan Power Corporation Limited

2020



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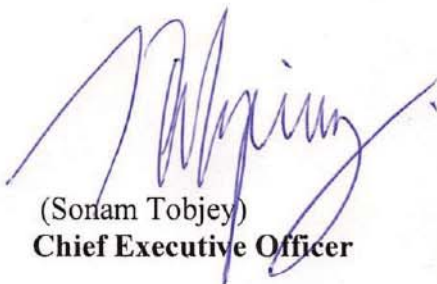
FOREWORD

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

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

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

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



(Sonam Tobjey)
Chief Executive Officer



Preparation, Review & Approval of the Document

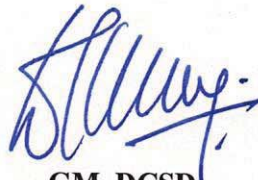
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Abbreviations

BPC: Bhutan Power Corporation Limited
ESD: Electricity Services Division
DSMP: Distribution System Master Plan
GIS: Geographic Information System
SLD: Single Line Diagram
ETAP: Electrical Transient and Analysis Program
IS: Indian Standard
IEC: International Electro-technical Commission
DT: Distribution Transformer
TSA: Time Series Analysis
LRM: Linear Regression Method
MV: Medium voltage (33kV, 11kV and 6.6 kV)
DDCS: Distribution Design and Construction Standards

kVA: Kilo Volt Ampere
W: Watt
kWh: Kilo Watt Hour
RMU: Ring Main Unit
FPI: Fault Passage Indicator
USS: Unitized Substation
DMS: Distribution Management System
ADMS: Advanced DMS
SCADA: Supervisory Control and Data Acquisition
DSCADA: Distribution SCAD
TMH: Thimphu Mini Hydel
GMH: Gidagom Mini Hydel
DPH: Diesel Power House
ARCB: Auto Recloser Circuit Breaker
ISD: Intelligent Switching Device
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 is 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 Plan 2019 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.

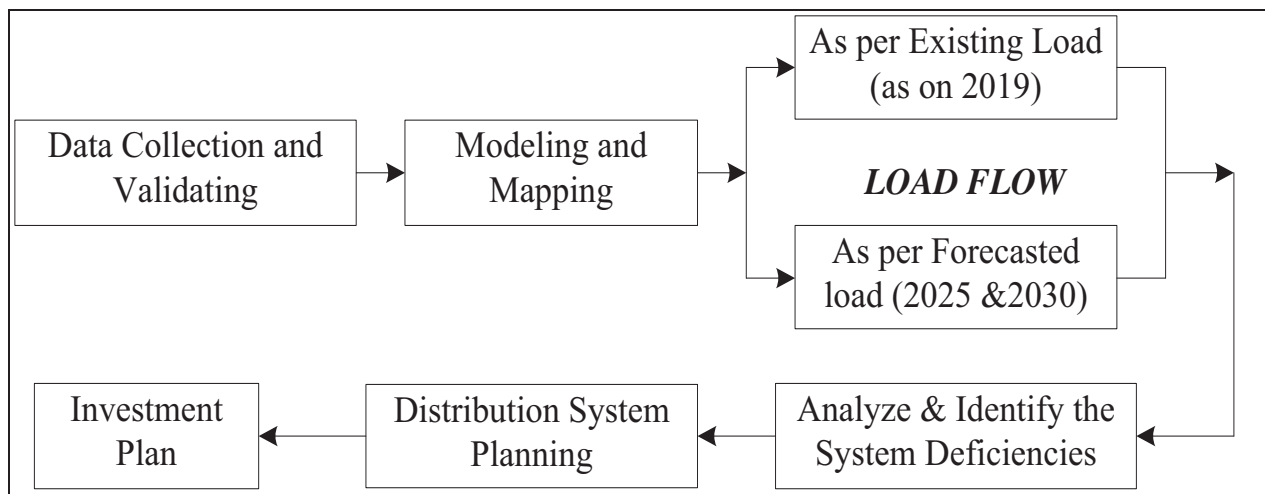


Figure 1: Block diagram for distribution system planning for thematic studies

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 Power supply sources

The history of electricity in Thimphu Dzongkhag started in 1967 with the commissioning of the 360 kW Thimphu Mini Hydro (TMH) power plant. Subsequently, a 1.25 MW hydropower plant at Gideon spun in 1975. These plants were crucial in facilitating Bhutan's modern development during that period. However, Thimphu was growing at a phenomenal rate and power source capacity constraints were alleviated only when the grid power from the 336 MW Chukha hydropower plant became accessible in 1987. Thimphu now has access to 64 MW Basochu hydropower plant via 220 kV and 66 kV transmission lines thus strengthening the energy security scenario of the capital (city). At present, the generation from both Gidagom and Thimphu MHPP is synchronized and injected into the national grid. In the last few decades, we have witnessed unprecedented growth in the capital city posing huge constraints on the limited power sources.

Currently, the power supply to eight (8) Gewogs (Chang, Dagala, Genekha, Kawang, Mewang, Lingshi, Naro and Soe) and Thimphu city are fed from four substations located at: (i) Olakha (2x20 MVA 66/33 kV, 2x5 MVA 33/11 kV), (ii) Semtokha (2x50 MVA 220/66 kV, 2x10 MVA 66/11 kV), (iii) Dechencholing (2x10 MVA 66/33 kV, 2x2.5 MVA, 33/11 kV) and (iv) Bjemina (1x10 MVA 66/33 kV, 1x5 MVA, 33/11kV). However, the distribution network of Lingshi Dungkhag is being operated and maintained by ESD Paro. The basic electricity distribution network model is illustrated in the schematic diagram shown in **Figure 2**.

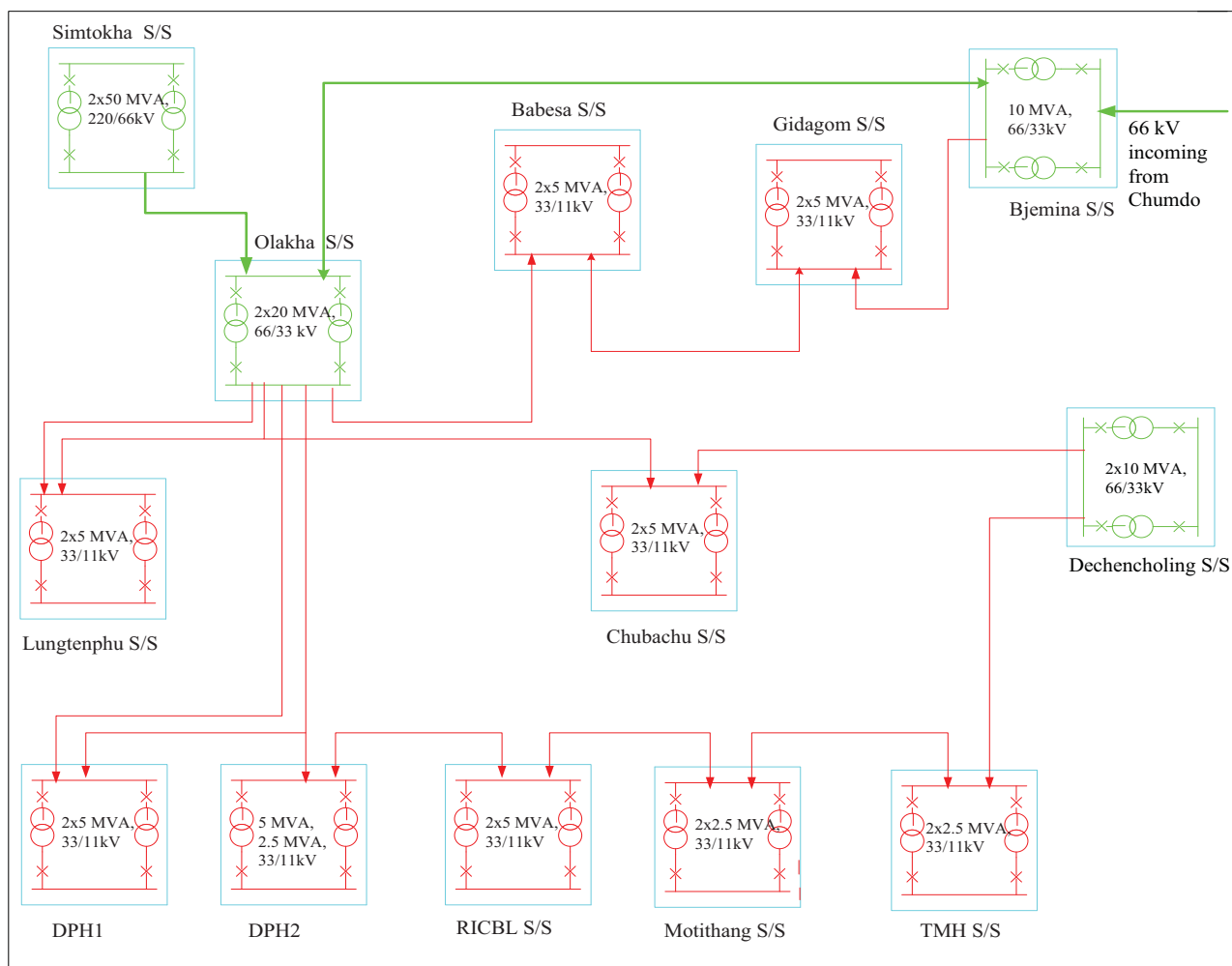


Figure 2: Electricity Distribution Schematic of Thimphu Dzongkhag

a) Semtokha 220/66/11 kV sub-station

The 220 kV substation at Semtokha has 2x50 MVA, 220/66 kV, and 2x10 MVA, 66/11 kV transformers. At 66 kV level, it has access to a 66 kV line from CHPC via Chumdo and Olakha HV stations. It also has access to Basochu hydropower plant through 220 kV and 66 kV lines via Lobesa substation. There are nine outgoing 11 kV feeder panels of which one is utilized as a station feeder. The peak load of 2x50 MVA, 220/66kV transformer was 68.22 MW, and the recorded peak load at 2x10 MVA; 66/11kV was 18.6 MW (as of 2019).

b) Olakha 66/33 kV sub-station

The 66/33kV, 2x20 MVA Olakha substation has six 33 kV outgoing feeders of which four of the 33kV feeders terminates at DPH1 (2x5MVA), DPH2 (1x2.5 & 1x5 MVA), 2x5 MVA Babesa,

and 2x5 MVA Chubachu 33/11kV step down substations. The 33kV Chubachu feeder is extended till the 2x5 MVA Lungtenphu step down substation through the LILO arrangement. The 33kV Babesa feeder is tapped at the Babesa substation and extends to the 2x5 MVA Gidagom substation.

Of the remaining two feeders, one is used as a station feeder and the other one is maintained as a spare (n-1 contingency feeder). The recorded peak load of the Olakha substation was 31.9 MW (as of 2019) against its installed capacity of 34 MW (@0.85 pf).

c) Dechencholing 66/33/11 kV sub-station

A 66 kV line has been constructed from Semtokha to Parizampa where a 66/33/11 kV substation has been installed. Transformation capacities of 2x10 MVA 66/33 kV and 2x2.5 MVA, 33/11 kV are available. There are six 33 kV feeders available from the substation which are further stepped down to 33/11kV TMH and Chubachu substations. The third feeder is meant for the customers of Kabesa and the remaining feeders are spare. Dechencholing substation experienced a peak load of 16.32 MW (as of 2019).

d) Bjemina 66/33/11 kV sub-station

The Bjemina substation is fed from the 66kV Chumdo switching station. The 1x10 MVA, 66/33 substation has two 33kV outgoing feeders. Each of the 33kV feeders terminates at the Gidagom step-down substation and the other feeder is extended to Paro Dzongkhag. The substation also has four 11kV feeders including one incomer and one station feeder. The recorded peak load of the substation was 8.73 MW (as of 2019).

6.2 Electricity Distribution Lines

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

Table 1: MV and LV Line Details

Sl. No.	Total Sub-transmission and Distribution Line Length (km)	OH ACSR	OH ABC	UG Cable	Total
1	33 kV	93.414	0.000	8.438	101.852
2	11 kV	177.966	21.455	61.025	260.446
3	6.6 kV	0.000	3.030	0.000	3.03
Total		271.380	24.485	69.463	365.328

Sl. No.	Total Sub-transmission and Distribution Line Length (km)	OH ACSR	OH ABC	UG Cable	Total
1	415 V	139.200	162.734	95.738	397.672
2	230 V	0.125	16.124	0.000	16.249
Total		139.325	178.858	95.738	413.921

As seen, the total MV line length is 365.382 km and the total LV line length is 413.921 km. The ratio of LV to MV line length is 1.13:1 which reflects almost equal proportion power distribution through the LV & MV network. While the ratio of LV to MV line length would vary according to the site conditions, as a general rule, the ratio of 1.2:1 should be maintained which would balance the initial capex and optimize the running and maintenance costs. Therefore, it is recommended that ESD Thimphu maintain a similar ratio while extending or constructing new infrastructure. The MV distribution network is mainly through 33 kV and 11 kV overhead lines.

6.3 Distribution Transformers

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

Table 2: Total Numbers of Transformers and Installed Capacity

Sl.No.	Transformer Capacities (kVA)	BPC		Private	
		No. of Transformer	Total KVA (kVA)	No. of Transformer	Total KVA (kVA)
1	16	5	80		
2	25	25	625	1	25
3	35	1	35		0
4	63	51	3213	3	189
5	100	5	500		0
6	125	5	625	5	625
7	160	19	3040	3	480
8	200	5	1000		0
9	250	57	14250	11	2750
10	315	4	1260	3	945
11	400	2	800		0
12	500	108	54000	18	9000
13	630	1	630	6	3780
14	750	19	14250	14	10500

Sl.No.	Transformer Capacities (kVA)	BPC		Private	
		No. of Transformer	Total KVA (kVA)	No. of Transformer	Total KVA (kVA)
15	1000	19	19000	4	4000
16	1250	22	27500	8	10000
17	1500			1	1500
18	1600	1	1600		0
Total		349	142,408.00	77	43,794.00

As of September 2019, there were 426 (349 BPC & 77Private) transformers with a total installed capacity of 186,202kVA. As evidenced by **Table 2**, the installed capacity of the transformer per customer is 4.68 kVA.

The installed transformers are generally large in capacity and few in number rather than vice-versa. Ideally, the distribution transformers need to be installed close to the customer premises. However, investment costs may offset the benefits if too many transformers are installed. The other constraints can be related to the availability of service plots for so many distribution transformer stations and RoW for lines.

While the number of distribution transformer stations required ideally would vary according to prevailing site conditions, as a general rule, space for one distribution transformer station is required at every 100 meter interval.

7. Analysis of the 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 (220/132/66/33/11kV)

The 220/66/11kV Semtokha substation is the primary power source catering entire load of Thimphu Dzongkhag. There are four 66/33/11kV substations in various locations that act as secondary sources to nine 33/11kV substations. To assess the capacity of the substations, 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: Details and peak load of source substation

Sl.No	Name of Source	Voltage Level	Installed Capacity		Peak Load(MW)	Forecasted Peak Load(MW)	
			MVA	MW	2019	2025	2030
1	Semtokha Substation	66/11	2*10	17	18.6	21.77	24.07
2	D/Choling Substation	66/33	2*10	17	16.69	21.43	25.19
		33/11	2*2.5	4.25	4.08	7.7	9.69
3	Olakha	66/33	2*20	34	32	38.11	43.49
4	Bjemina	66/33	10	8.5	5.97	12.13	15.28
		33/11	5	4.25	1.689	2.34	3.1
Upcoming Substation							
	Changedaphu	66/11	2*20	34	-	-	-

Note: Considering the power factor of 0.85

a) Semtokha 220/66/11 kV substation

The substation has a transformation capacity of 2x10 MVA at 11kV voltage level which caters to the load of Semtokha, Chamgang, Yusipang, Hongtsho, Babesa, Olakha, Lungtenphu, Changjiji, and Changzamtok (DPH). As evident from **Table 3**, the substation recorded a peak load of 18.6 MW as of 2019 against its installed capacity of 17 MW which indicates that the transformers are

already overloaded. Upgrading of a substation is a prerequisite to cater the existing load and future load. No additional load can be connected unless the transformers are upgraded. The loading of the substation can be alleviated by redistributing 11kV feeders from various 33/11kV substation as described below:

- a) 11kV Lungtenphu feeder can be connected to the 33/11kV Lungtenphu substation. The peak load of the feeder is around 0.67 MW.
- b) 11kV Changzamtok feeder can be connected to the 33/11kV DPH substation. The peak load of the feeder is around 2.7 MW.
- c) 11kV Lingkana Feeder can be connected to the 33/11 kV TMH substation. The peak load of the feeder is around 1.36 MW.

Redistributing the load to other substations can off-load the load in Sementokha by about 5 MW. However, the proposed solution is a temporary arrangement and would require up-gradation as a long term solution.

b) Olakha 66/33 kV sub-station

The 66/33kV, 2x20 MVA Olakha substation has six outgoing 33 kV feeders. The substation acts as a secondary source to six 33/11kV substations namely: DPH I, DPH II, RICBL, Babesa, Lungtenphu, and Chubachu substations. The recorded peak load of the Olakha substation is 32 MW (as of 2019) against its installed capacity of 34 MW indicating that the substation is 94 % loaded against its installed capacity. The time series forecast suggests that the capacity of the substation needs to be upgraded as the peak power has been projected to reach 43.49 MW by 2030.

c) Dechencholing 66/33/11 kV sub-station

The substation has a transformation capacity of 2x10 MVA at 33 kV voltage level and 2x2.5 MVA at 11kV voltage level. The peak load of 16.69 MW was recorded against its installed capacity of 17 MW. Similarly, there are ten 11kV feeders with a coincidental peak load of 4.08 MW. The time series forecast indicates that the capacity of the substation needs to be up-graded as the peak power has been projected to reach 25.19 MW and 9.69 MW at 33 kV and 11 kV substations respectively.

d) Bjemina 66/33/11 kV sub-station

The 1x10 MVA 66/33 substation recorded a peak load of 5.97 MW indicating that the substation is 70.2 % loaded against the installed capacity. The time series forecast suggests a load growth of 15.28 MW by 2030 against its installed capacity of 8.5 MW. Hence, the substation needs to be upgraded.

As evident from **Table 3**, the Olakha and Dechencholing substations are already more than 90 % loaded. However, with the commissioning of 2x20 MVA, 66/33 kV Changedaphu substation by the end of 2019, the overloading can be relieved as a load of DPH I & II, RICBL, and upcoming 33/11 kV hospital substations can be sourced from the new substation.

7.1.2 MV Substation (33/11 kV)

The power imported from the HV substations is further distributed to various MV substations. The detail of the installed capacity of substations, existing peak load, and the anticipated load in the future are exhibited in **Table 4**.

Table 4: Details and peak loads of 33/11kV substations

SL.No .	Name of Source	Voltage Level	Installed Capacity		Peak Load(MW)		Forecasted Peak Load(MW)		Remarks
			MVA	MW	2019	% Loading	2025	2030	
1	Lungtenphu	33/11	2*5	8.5	4.12	49%	5.99	7.54	
2	Babesa	33/11	2*5	8.5	3.71	44%	5.73	7.41	
3	RICB	33/11	2*5	8.5	9.89		15.27	17.37	DPH-II & RICBL substations is fed by one 33kV incomer from Olakha
4	DPH II	33/11	2*2.5	4.25					
5	DPHI	33/11	2*5	8.5	6.01	70.7%	7.84	9.38	
6	Chubachu	33/11	2*5	8.5	8.95	105.3%	13.40	16.87	
7	Motithang	33/11	2*2.5	4.25	3.00	71%	4.04	4.92	
8	TMH	33/11	2*2.5	4.25	4.53	107%	6.12	7.42	
9	GMH	33/11	1*1.6	1.36	0.10	7%	0.15	0.20	
10	Hospital	33/11	2*5	8.5	-	-	-	-	Upcoming

Note: Considering the Power Factor of 0.85

The MV substations located in the core areas of Thimphu are all loaded more than 90 % and in some cases, the transformers are already overloaded which necessitates immediate up-gradation. The time series forecast indicates that the entire substation needs to be upgraded by the year 2030. However, with the commissioning of the upcoming 2x5 MVA, 33/11 kV substation at a hospital, the loading from the DHP and RICB substations can be shared and relieved from overloading.

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 Feeders Capacity

The load profile of MV feeders emanating from the various substations 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 5**.

Table 5: Feeder wise peak power demand of ESD Thimphu

Feeder ID	Feeder Name	Peak load						
		2013	2014	2015	2016	2017	2018	2019
220 kV Semtokha Substation								
N10(11)	SAARC, Tashichoedzong, Changzamtok	4.44	4.83	5.10	5.30	5.35	5.52	5.77

Feeder ID	Feeder Name	Peak load						
		2013	2014	2015	2016	2017	2018	2019
220 kV Semtokha Substation								
N20(11)	Lungtenphu, RBA, YHSS, Changjiji	-	3.40	3.11	3.48	3.97	3.51	3.82
N30(11)	Babesa, RTC, BhuddhaProject, IT Park	4.19	4.44	4.99	4.00	4.80	4.56	4.79
N40(11)	Chamgang Feeder	-	0.74	0.88	0.99	0.96	0.82	0.95
N50(11)	Lingkana	3.67	3.05	3.41	4.51	4.67	5.57	5.75
N60(11)	Agro/Babesa feeder	4.06	4.15	4.23	4.83	4.02	4.83	4.78
N70(11)	VVIP	-	-	3.29	2.85	4.62	3.08	3.74
N80(11)	Hongtsho Feeder	-	-		0.49	0.49	0.66	0.72
N840(11)	Station Transformer 2	-	-	0.08	0.08	0.09	0.10	0.12
66kV Olakha Substation								
N110(33)	Chubachu Feeder	9.14	7.70	9.49	8.79	10.89	14.61	13.76
N240(33)	DPH 1 Feeder	4.22	4.78	3.51	3.87	8.79	3.89	6.00
N250(33)	DPH 2	11.6	11.25	10.89	11.95	14.06	9.82	12.76
N740(33)	Babesa Feeder	2.63	2.46	1.05	1.4	2.7	4.77	3.71
N850(33)	Station Transformer	-	-	-	-	0.027	0.04	0.05
66kV Dechencholing Substation								
N120(33)	Kabesa	0.71	0.61	0.76	0.668	0.86	0.83	0.80
N130(33)	Chubachu	4.96	3.76	7.4	5.2	7.86	8.52	8.95
N140(33)	Thimphu Minihydel	4.28	5.83	6.63	6.18	6.68	6.92	7.54
N150(11)	RBG-E	0.98	0.86	0.90	0.96	1.01	0.96	0.96
N160(11)	Begana		0.50	0.69	0.56	0.85	0.83	0.93
N170(11)	RBG-A	0.98	0.82	0.78	0.84	0.99	1.65	1.34
N330(11)	Taba/Dangrena	0.99	0.99	1.16	1.42	1.84	1.66	1.96
N340(11)	Yangphel R State	0.09	0.11	0.06	0.09	0.10	0.12	0.17
N880(11)	Station Transfomer	0.02	0.07	0.02	0.02	0.02	0.06	0.07
66kV Bjemina Substation								
N750(33)	Gidagom feeder	-	-	-	-	4.29	4.79	5.3
N180(11)	Tsaluna Feeder	0.13	0.12	0.20	0.23	0.23	0.23	0.25
N190(11)	Gidagom Feeder	0.13	0.12	0.20	0.23	0.23	0.23	0.25
N200(11)	Bjemina Industrial State	0.12	0.15	0.15	0.17	0.20	0.21	0.19
N870(11)	Station Transformer	0.03	0.01	0.11	0.01	0.01	0.19	0.10

Source: Monthly Substation Data of TD, BPC

Note: Some of the 11kV feeders are heavily loaded during the winter season and operating near their thermal limit. The heaving loading is due to the ring connection.

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 MV lines under ESD Thimphu consist of a 33kV and 11kV voltage level. The types of conductors used are mostly ACSR-Rabbit and Dog. **Table 6** 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 6: Thermal loading of ACSR conductor at different voltage levels

Sl. No.	ACSR Conductor Type	Ampacity of Conductor	MVA rating corresponding to the Ampacity
33 kV Voltage Level			
1	RABBIT	193	11.031
2	DOG	300	17.146
3	WOLF	398	22.748
11 kV Voltage Level			
1	RABBIT	193	3.677
2	DOG	300	5.715
3	WOLF	398	7.582

The distribution network was developed using the ETAP software based on the existing and the forecasted load for the assessment. The assessment was carried out for the following case studies. 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 the Existing Load

A load flow analysis of the existing system was carried out considering the 2019 peak load. The simulation results and proposed corrective measures are as detailed in the following sections.

➤ **11 kV Changzamtok Feeder (N10) at Semtokha Substation:**

The feeder comprises OH (Dog) and UG cables (150 and 300 sq. mm). The simulation result shows that the 150 sq. mm UG cable is already overloaded with a total peak load of 5.77 MW. There are 13 DTs with a total capacity of 8630 kVA connected to this feeder. Additionally, this particular feeder act as a source to 2x5 MVA, 33/11kV, DPH-I substation at 11kV voltage level and caters to the load of two additional feeders (RBA (N730) and Zamdolam (N440)). With this existing system, the N730 and N440 feeders will experience a marginal voltage drop due to the long circuit line length.

The above system deficiencies can be improved by isolating the load of three feeders. While the N10 feeder can be retained from the Semtokha substation, the load of N730 and N440 feeders should be transferred to the DPH-I substation. The new arrangement shall address both the overloading and under voltage issues.

➤ **33kV Chubachu Feeder (N110) at Olakha Substation:**

The N110 feeder supplying the power to the Chubachu substation is connected to the Lungtenphu substation (LILO arrangement). The feeder comprises a mixture of OH (Dog) and UG cables (185 sq. mm). The simulation result shows that the 185 sq. mm UG cable of the incoming feeder is overloaded.

The overloading can be addressed by segregating a load of Chubachu and Lungtenphu substations. The dedicated 33kV incoming source to Lungtenphu is recommended.

➤ **33kV DPH-II feeder (N250) at Olakha Substation:**

The N250 feeder is the source to the 33/11 kV, DPH-II, and RICB substations. The simulation results indicate that the feeder is overloaded. The feeder consists of UG cables (150 & 185 sq. mm), AAAC, and OH Dog Conductors.

The RICB substation is recommended to connect to the upcoming 66/33 kV Changedaphu substation to address the N250 feeder overloading issue.

➤ **11kV Bus Voltage at Dechencholing Substation:**

The simulation results show that all the 11kV feeders emanating from the Dechencholing substation would experience a marginal voltage drop (92.6 %). The voltage drop is due to the degree of loading in the source transformer which is 4.08 MW against its installed capacity of 4.22 MW (2x2.5 MVA).

The voltage profile of the feeders can be improved by up-grading the 2x2.5 MVA Dechencholing substation to 2x5 MVA. The Transmission department has a plan to upgrade the substation in the year 2020. While the plan is being implemented, the immediate solution to the voltage drop problem can be addressed by changing the tap of power transformers.

➤ **11kV Gidagom Feeder (N190) at Bjemina Substation**

The N190 feeder caters to a load of Bjemina and Gidagom customers. The same feeder connects the Gidagom substation and acts as a source to the Thimphu feeder which caters to a load of Ramtokto and Khatsarabchu areas. The simulation results indicate a critical voltage drop (86.88%).

Installation of 5 MVA transformer at Gidagom substation and segregating the load can improve the voltage profile. A load of Thimphu feeder should be catered from the Gidagom substation.

Similarly, the simulation results indicate that there is a marginal voltage drop in all the 11 kV feeders emanating from 33/11kV Chubachu, DPH –I, DPH-II, and TMH substations. The voltage drop is due to the overloading of transformers. The voltage profile can be improved by upgrading the substations (transformers). However, the immediate measure to improve the voltage profile could be to use the tap of the power and distribution transformers.

b) Assessment of MV Feeder Capacities with Forecasted Load

The peak power demand presented in **Table 5** 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 7**.

Table 7: Demand Forecast for ESD Thimphu

Feeder ID	Feeder Name	Forecasted Peak load (MW)		
		2020	2025	2030
220 kV Semtokha Substation				
N10(11)	SAARC, Tashichoedzong, Changzamtok	5.97	6.99	8.01
N20(11)	Luntenphu, RBA, Yhss, Changjiji	3.93	4.47	5.01
N30(11)	Babesa, RTC, Buddha Project, IT Park	4.87	5.27	5.67
N40(11)	Chamgang Feeder	0.97	1.09	1.21
N50(11)	Lingkana	6.2	8.41	10.61
N60(11)	Agro/Babesa feeder	4.9	5.47	6.05
N70(11)	VVIP	3.85	4.42	4.99
N80(11)	Hongtsho Feeder	0.8	1.22	1.64
N840 (11)	Station Transformer	0.12	0.15	0.17
66kV Olakha Substation				
N110 (33)	Chubachu Feeder	9.14	9.14	9.14
N240 (33)	DPH 1 Feeder	6.31	7.84	9.38
N250 (33)	DPH 2	13.18	15.27	17.37
N740 (33)	Babesa Feeder	4.05	5.73	7.41
N850 (33)	Station Transformer	0.07	0.13	0.2
66kV Dechencholing Substation				
N120(33)	Kabesa	0.84	1.01	1.19
N130(33)	Chubachu	9.74	13.73	17.71
N140(33)	Thimphu Minihydel	7.97	10.16	12.34
N150 (11)	RBG-E	0.97	1.02	1.08
N160 (11)	Begana	1.01	1.42	1.84
N170 (11)	RBG-A	1.45	2.01	2.57
N330 (11)	Taba/Dangrena	2.14	3.02	3.9
N340 (11)	Yangphel R State	0.17	0.2	0.22
N880 (11)	Station Transfomer	0.07	0.08	0.09
66kV Bjemina Substation				
N750(33)	Gidagom feeder	5.8	8.3	10.8
N180(11)	Tsaluna Feeder	0.27	0.39	0.52
N190(11)	Gidagom Feeder	0.27	0.39	0.52
N200(11)	Bjemina Industrial State	0.2	0.29	0.38

Feeder ID	Feeder Name	Forecasted Peak load (MW)		
		2020	2025	2030
N870 (11)	Station Transformer	0.12	0.22	0.32

The power demand for the 33/11 kV MV substation is exhibited in **Table 8**. In the absence of recorded feeder wise power demand, the peak power demand of incoming feeders had been considered and prorated to forecast the peak power demand of individual outgoing feeders for the next 10 years.

Table 8: Demand forecast for MV substations

Feeder ID	Feeder Name	Peak Load 2019(MW)	Forecasted Peak (MW)		Remarks
			2025	2030	
33/11kV, Lungtenphug SS					
N90	YHSS Feeder	4.12	5.99	7.54	
N830	Station Feeder	0.05	0.07	0.09	
N890	Changjiji/Olakha Feeder	0.00	0.00	0.00	
33/11kV, Babesa SS					
N780	TATA Showroom Feeder	1.03	1.59	2.06	
N790	IT Park Feeder	0.06	0.09	0.12	
N800	GREF Feeder	0.46	0.71	0.91	
N810	WangchuTaba	2.12	3.28	4.24	
N820	Station Transformer	0.04	0.06	0.08	
33/11kV, RICBL SS					
N500 (33Kv)	Motithang Feeder	0.00	0.00	0.00	
N510	Station Transformer	0.03	0.04	0.05	
N520	Upper Hospital Feeder	3.89	4.66	5.30	Added PL of N470
N530	YDF Feeder	0.43	0.51	0.58	
N540	Upper Changangkha Feeder	1.29	1.55	1.76	
N550	From P&T SS feeder	1.89	2.27	2.58	
N560	OAG Feeder	0.36	0.43	0.49	
33/11kV, DPH I SS					
N370	Station Transformer	0.09	0.12	0.15	Fed by N240 Olakha
N410	Essential Feeder	4.26	6.23	10.88	
N380	RBP II Feeder	1.02	1.49	1.78	
N390	Press Outgoing feeder	2.35	2.81	3.20	Fed by N250 Olakha
N480	Changjiji/Olakha Feeder	0.34	0.41	0.46	
N420	SAARC Feeder	1.00	1.46	1.85	Included in N50

Feeder ID	Feeder Name	Peak Load 2019(MW)	Forecasted Peak (MW)		Remarks
			2025	2030	
N440	RBP I Feeder	3.38	4.10	4.69	Included in N10
N730	Zamdo Lam Feeder	0.13	0.15	0.18	
N400	VVIP feeder	0.74	2.04	2.31	Included in N70
N900	Changlimithang feeder	0.61	1.68	1.90	
33/11kV, DPH II SS					
N430	Trade Feeder	0.06	0.15	0.18	
N490	FCB Feeder	1.93	2.32	2.63	
N450	Station Feeder	0.02	0.05	0.05	Included in N70
N460	Hospital Feeder	0.60	1.63	1.84	
N470	350 Bedded feeder	1.53	1.83	2.08	Included in N520
33/11kV, Chubachu SS					
N640	Station Transformer	0.05	0.07	0.08	
N650	Satellite Feeder	1.95	2.84	3.57	
N660	RAPA Feeder	0.37	0.54	0.68	
N670	Bhutan Hotel Feeder	1.57	2.27	2.86	
N680	BDBL Feeder	0.50	0.73	0.92	
N690	Lower ChubachuFeeder	2.31	3.35	4.22	
N700	BPC HQ Feeder	0.63	0.92	1.16	
N710	Taj Hotel Feeder	0.63	0.92	1.16	
N720	Sunday Market Feeder	1.22	1.77	2.22	
33/11kV, Motithang SS					
N570	Station Transformer	0.01	0.02	0.02	
N580	MoLHR/RUB Feeder	0.26	0.35	0.43	
N590	Phajoding Feeder	0.29	0.39	0.94	
N600	Ministers Enclave III Feeder	0.24	0.33	0.40	
N610	Survey Feeder	1.52	2.05	2.50	
N620	Motithang Complaint Centre Feeder	0.46	0.62	0.76	
N630	Ministers Enclave I Feeder	0.21	0.28	0.34	
33/11kV, TMH SS					
N300	Taba Feeder	1.13	1.53	1.86	
N310	Dechenchling Palace I	0.72	0.97	1.17	
N320	Indian House Feeder	0.43	0.58	0.70	
N280	HM Palace I Feeder	0.02	0.03	0.03	
N290	HM Palace II Feeder	0.00	0.00	0.00	
N230(33kV)	Motithanng Incomer	0.00	0.00	0.00	
N270	YHSS Feeder	1.57	2.11	2.57	

Feeder ID	Feeder Name	Peak Load 2019(MW)	Forecasted Peak (MW)		Remarks
			2025	2030	
N770	Hejo/Dzong Feeder	0.66	0.89	1.08	
N760	Zilukha Feeder	Included in N610			
33/11kV, GPH SS					
N100 (33kV)	Babesa Feeder	Included in Bjemina SS			
N210 (33kv)	Chumdo Substation				
N350	Thimphu Outgoing Feeder				
N360	Station Transformer	0.13	4.73	6.15	Fed from GPH

c) Simulation Result of 2025 Loading

The 2x5 MVA Chubachu substation needs to be up-graded to meet the forecasted load demand of 2025. The up-gradation of the Chubachu substation should be carried out simultaneously with the up-gradation of the incoming 33 kV feeder.

Similarly, with the upgrading of the TMH substation, the incoming 33kV feeder needs to be resized as the feeder has to cater to a load of TMH and Motithang substations.

It is also anticipated that the DPH-I substation would be overloaded by 2025. The issues can be addressed by transferring the load to the DHP-II substation (i.e. by interconnecting 11 kV VVIP feeder of DPH- II and 11kV essential feeder of DPH-I substation). However, the 95 and 150 sq. mm cable of both the feeders need to be resized to cater to the forecasted demand.

d) Simulation Result of 2030 Loading

From the load flow analysis, it is anticipated that with the projected load of 2030, most of the HV and MV substations and lines would get overloaded. The overloading is primarily due to the consideration of LAP development. The load of the LAPs has been projected based on the power clearances issued by ESD Thimphu from the year 2018-2019 as detailed in **Section 7.4** “Power requirement for urban areas by 2030”. Following corrective measures were considered for the analysis;

- Construction of 2x5 MVA, 33/11 kV substation at Taba to cater to the power demand of upper Taba.

- Construction of 33kV line from Olakha substation to Serbithang and construct 33/11 kV substation to cater to the power demand of Serbitahng LAP.
- Construction of 33kV line from Changedaphu substation to DHP substation and upgrade the capacity of DPH substation to cater the load of Changedaphu and Changbangdu.
- Resizing of the overloaded cables

With all these reinforcement and augmentation works, the reliability and quality of the power supply would be improved significantly. The detailed summary of the simulation result is 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 9** below shows the energy sales, purchase, and loss profile of Thimphu.

Table 9: Energy Sales-Purchase-Loss Trend

Sl. No.	Particulars	2014	2015	2016	2017	2018	Average
1	Energy Requirement in kWh						
i)	Purchase from GenCos as per TD bill	177.1	184.0	190.8	203.6	221.3	
ii)	Mini/Micro Hydropower Generation	4.8	5.9	6.0	4.4	5.3	
iii)	Diesel Generation	0.002	0.002	0.000	0.003	0.012	
iv)	Import	0.0	0.0	0.0	0.0	0.0	
	Total	181.9	189.9	196.8	208.0	226.6	
	% Growth	%	4.40%	3.66%	5.67%	8.96%	5.67%
2	Energy Sales in kWh (Category Wise)						
i)	Total (LV)	138.4	145.9	154.6	162.6	175.1	
ii)	LV Bulk	24.71	22.67	24.62	23.75	21.90	
iii)	MV Industries	-	-	-	1.35	4.95	
iv)	HV Industries	-	-	-	-	-	

Sl. No.	Particulars	2014	2015	2016	2017	2018	Average
	Total Energy Sales	163.1	168.6	179.2	187.7	201.9	
	% growth	%	3.38%	6.31%	4.73%	7.60%	
	Total loss (%)	%	11.23 %	8.96%	9.78%	10.90 %	10.22%

Source: Adapted from Power Data Book 2018, BPC

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.

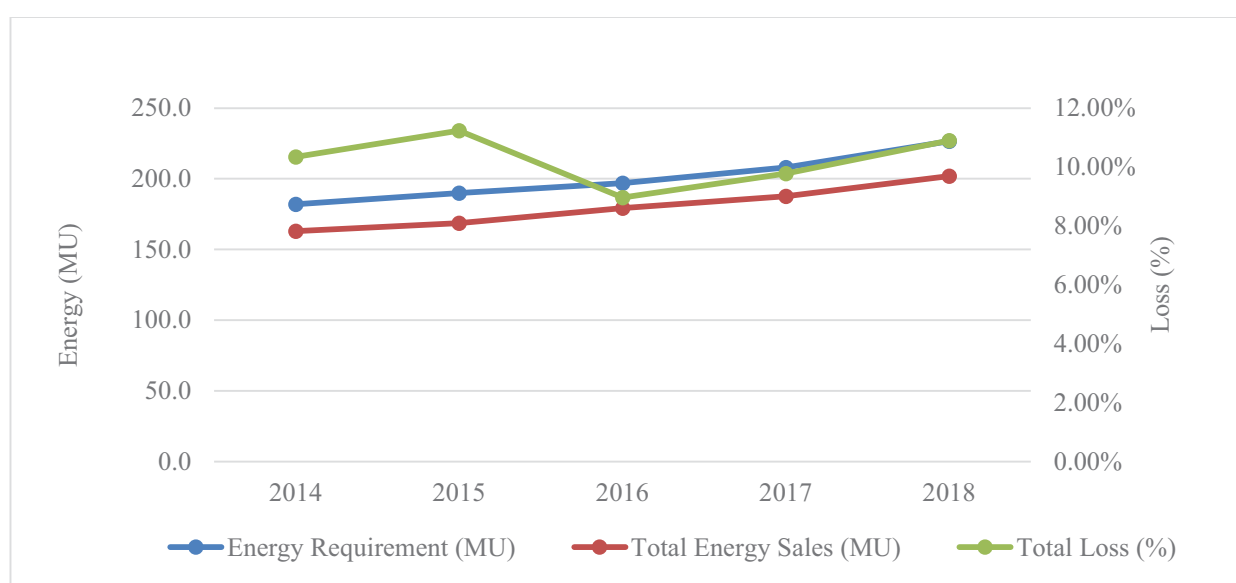


Figure 3: Energy Requirement Trend of ESD Thimphu

The energy consumption and energy requirement growth between the years 2014-2018 indicate a substantial increase in the energy requirement.

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 Thimphu (2014-2018) is 10.22% (20.6 million units on average) indicating that around 50 % of the energy loss is in the form of commercial loss. Therefore, there is a need to focus more on reducing non-technical loss. However, with the implementation of DMS, the actual energy

transaction at different levels in the distribution system can be recorded (i.e. segregate MV and LV loss) and accurate analysis can be done.

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 (2016-2018) is summarized in **Table 10**. 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 2016-2018 are 0.99 & 1.86 respectively which indicates that the power supply to the customers of Thimphu Dzongkhag is exceptionally reliable when compared to other Dzongkhags.

Table 10: Reliability indices of ESD, Thimphu

Sl. No.	Reliability Index	2016	2017	2018	Average
1	SAIFI	0.58	0.83	1.56	0.99
2	SAIDI	2.07	1.28	2.24	1.86

(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 interruption due to scheduled outages, momentary outages less than five minutes, and outages due to failure of the grid are excluded.

Figure 4 below represents, the reliability indices of the feeders originating from various substations. As stated, the power supply in the Dzongkhag is reliable and commendable. Most of the feeder outages are caused by the outages of the HV transmission system and planned outages to facilitate planned maintenance activities. The detailed root causes of outages are shown in **Figure 5**.

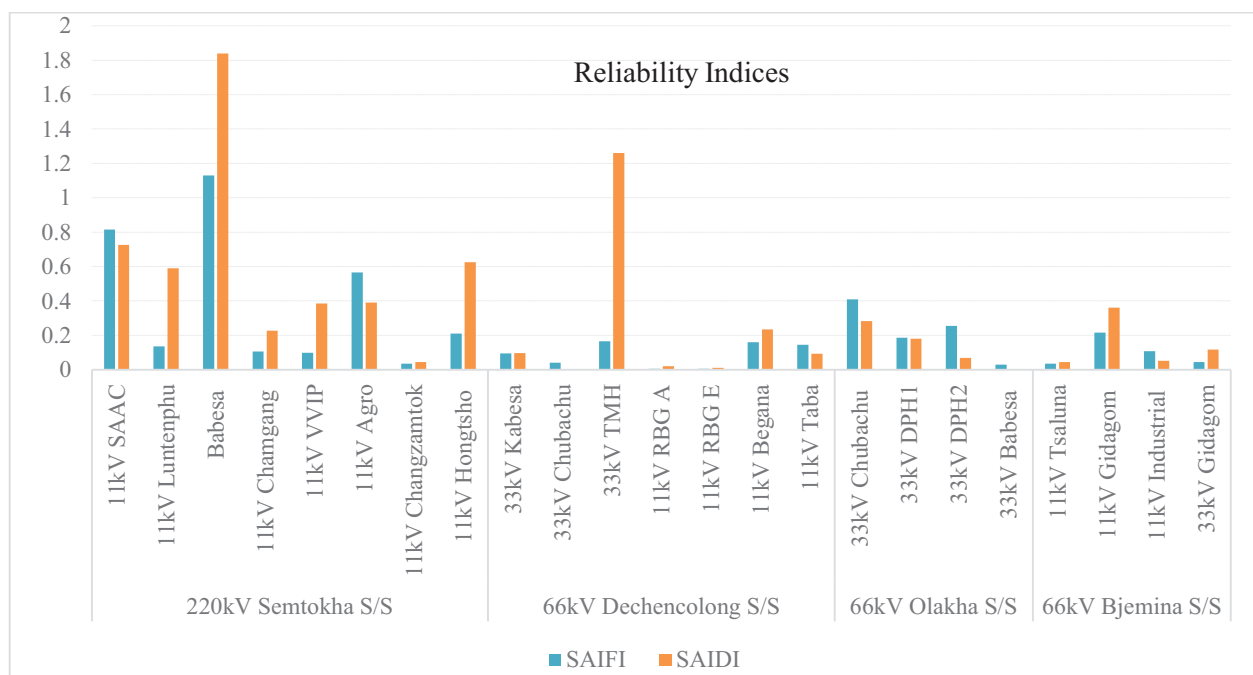


Figure 4: Feeder wise average reliability indices

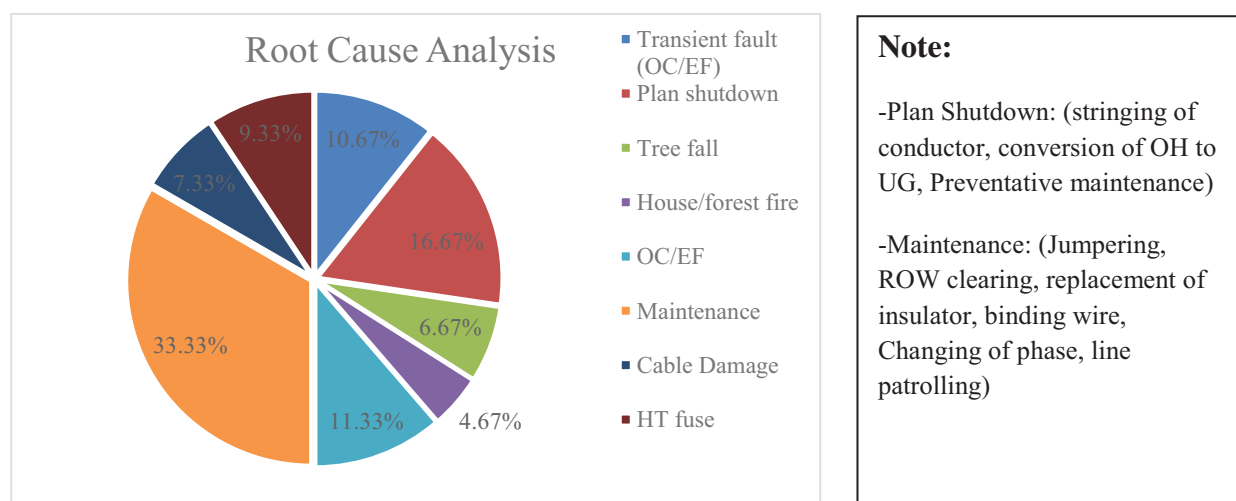


Figure 5: Root Cause Analysis of Outages

As evident from Figure 5, it is recommended to focus more on how to strategically plan to implement the maintenance schedule without interrupting the power supply.

Further, due to the lack of utility service trenches, power cables are not easily traceable and occasionally cables have been damaged during the frequent excavations carried out for various constructional purposes by the third party. The outages caused by faults on power distribution lines and substations were minimal.

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 5.93 km (11kV). The estimated cost for the conversion of such is Nu. 7.72 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 Existing 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 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 11**. The individual DT loading details used to derive the summary is attached as **Annexure-7**.

Table 11: Feeder Wise Overloaded Distribution Transformer under ESD Thimphu

Transformer Name	kVA Rating	% Loading	Peak Load 2019(kVA)	Peak Load 2025(kVA)	% Loading	Peak Load 2030 (kVA)	% Loading
N10 (SAARC, Tashichoedzong, Changzamtok)							
Tshatsho Baykha	500	60.00%	300.00	709.31	141.86%	985.12	197.02%
Olakha Lam	500	80.00%	400.00	945.75	189.15%	1313.49	262.70%
Langothangna	500	70.00%	350.00	827.53	165.51%	1149.30	229.86%
Jiji Lam 5	750	75.00%	562.50	1329.96	177.33%	1847.09	246.28%
L Changbangdu	1000	50.00%	500.00	1182.19	118.22%	1641.86	164.19%

Transformer Name	kVA Rating	% Loading	Peak Load 2019(kVA)	Peak Load 2025(kVA)	% Loading	Peak Load 2030 (kVA)	% Loading
Bangdu Lam2	750	65.00%	487.50	1152.63	153.68%	1600.82	213.44%
OlakhaLam C/White Tara	500	40.00%	200.00	472.87	94.57%	656.74	131.35%
Changzamtog	750	80.00%	600.00	1418.62	189.15%	1970.23	262.70%
N20							
Sama Lam 1	63	96%	60.76	71.11	112.87%	79.73	126.55%
N30 (Babesa)							
U Changbangdu	750	60%	450.00	754.09	100.55%	811.65	108.22%
Bangdu Lam 5	750	60%	450.00	754.09	100.55%	811.65	108.22%
Bangdu Lam 2	500	60%	300.00	502.73	100.55%	541.10	108.22%
Hindu Lhakhang	200	60%	120.00	201.09	100.55%	216.44	108.22%
Chuba Lam	500	60%	300.00	502.73	100.55%	541.10	108.22%
Chuba Lam1	630	60%	378.00	633.44	100.55%	681.78	108.22%
TshatshoBaykha	750	60%	450.00	754.09	100.55%	811.65	108.22%
N40 (Chamgang)							
Chamgang RBP1	500	80%	400.00	459.40	91.88%	508.90	101.78%
Chamgang RBP2	500	80%	400.00	459.40	91.88%	508.90	101.78%
N50 (Lingkana)							
Lubding Lam 6	500	55%	275.00	401.68	80.34%	507.26	101.45%
Mateygang	250	60%	150.00	219.10	87.64%	276.68	110.67%
N60 (Agro)							
Gepja Lam 2	750	90%	675.00	772.67	103.02%	854.07	113.88%
N70 (VVIP)							
Lungten Lam	500	60%	300.00	823.68	164.74%	929.57	185.91%
N80 (Hongtsho)							
Hongtshothang	250	60%	150.00	255.59	102.23%	343.58	137.43%
Hongtsho(Eucha)	250	60%	150.00	255.59	102.23%	343.58	137.43%
Ramthang	315	60%	189.00	322.04	102.23%	432.91	137.43%
TashigangGoe mba	63	80%	50.40	85.88	136.31%	115.44	183.24%
U Memelakha	500	50%	250.00	425.98	85.20%	572.63	114.53%
Dochula	250	50%	125.00	212.99	85.20%	286.31	114.53%
N120 (Kabesa)							
U Jozhi (soshi)	250	70%	175.00	220.71	88.28%	258.80	103.52%
L Dazhi	315	70%	220.50	278.09	88.28%	326.09	103.52%
U Dazhi (kabesa)	500	70%	350.00	441.42	88.28%	517.60	103.52%
L Jozhi	250	70%	175.00	220.71	88.28%	258.80	103.52%

Transformer Name	kVA Rating	% Loading	Peak Load 2019(kVA)	Peak Load 2025(kVA)	% Loading	Peak Load 2030 (kVA)	% Loading
Dagaling	63	80%	50.40	63.56	100.90%	74.53	118.31%
ChukorMenchu	63	70%	44.10	55.62	88.28%	65.22	103.52%
Lamgawog	63	70%	44.10	55.62	88.28%	65.22	103.52%
N170 (RGB-A)							
D/ling RGB A	1250	80.00%	1,000.00	1,313.73	105.10%	1,679.74	134.38%
D/ling RGB C	500	80.00%	400.00	525.49	105.10%	671.90	134.38%
D/ling RGB D	500	80.00%	400.00	525.49	105.10%	671.90	134.38%
N330 (Yangphel)							
D/Ling Nursery	250	60%	150.00	426.35	170.54%	550.59	220.24%
Dangrena 1	500	60%	300.00	852.71	170.54%	1,101.18	220.24%
Dangrena 2	1000	60%	600.00	1,705.41	170.54%	2,202.35	220.24%
D/ling Palace 01	250	50%	125.00	355.29	142.12%	458.82	183.53%
D/choling WTP	250	30%	75.00	213.18	85.27%	275.29	110.12%
N190 (Gidagom)							
Bjemina 2 - SHB	500	50%	250	536.83	107%	618.86	124%
Gidagom RSA	500	50%	250	536.83	107%	618.86	124%
Gidaphu TQ 1	500	50%	250	536.83	107%	618.86	124%
N200 (Bjemina industrial state)							
Bjemina 1 - BCB	250	50%	125	340.59	136%	442.35	177%
N540 (Upper Hospital)							
Kawang Damisa	750	80%	600	718.33	96%	816.94	109%
N380 (RBP II)							
RBP 2A	750	80%	600	876.74	117%	1048.28	140%
RBP 2B	750	80%	600	876.74	117%	1048.28	140%
N390							
Gongdzin Lam 1	1000	75%	750	897.91	90%	1021.17	102%
Gongdzin Lam	1250	75%	937.5	1122.39	90%	1276.46	102%
Changlam 1	750	80%	600	718.33	96%	816.94	109%
N410 (Essential)							
Changkhorlo 1	250	60%	150	219.18	88%	382.94	153%
Rabten Lam	1000	50%	500	730.61	73%	1276.48	128%
Samphel Lam	500	60%	300	438.37	88%	765.89	153%
DrimeyLamA	1250	60%	750	1095.92	88%	1914.72	153%
Drimey Lam	1000	40%	400	584.49	58%	1021.18	102%
Khachen Lam	500	60%	300	438.37	88%	765.89	153%
SaleyGom	500	90%	450	657.55	132%	1148.83	230%
Thegchen Lam	1000	70%	700	1022.86	102%	1787.07	179%
Thori lam7	500						

Transformer Name	kVA Rating	% Loading	Peak Load 2019(kVA)	Peak Load 2025(kVA)	% Loading	Peak Load 2030 (kVA)	% Loading
Darzho Lam 15	1250	70%	875	1278.57	102%	2233.84	179%
Kuenga Lam 8	500	60%	300	438.37	88%	765.89	153%
N400 (VVIP)							
Motithang III	500	40%	200	549.12	110%	619.71	124%
N440 (RBP)							
RBP 1A	500	80%	400	484.72	97%	555.33	111%
RBP 1B	500	80%	400	484.72	97%	555.33	111%
RBP 1C	500	80%	400	484.72	97%	555.33	111%
N480 (Changiji)							
Samar ZinkharRBA	250	80%	200	239.44	96%	272.31	109%
Samazinkha	250	80%	200	239.44	96%	272.31	109%
RBA D2	250	80%	200	239.44	96%	272.31	109%
JaluWom	1000	80%	800	957.77	96%	1089.25	109%
N650 (Satelite)							
Bhutan Telecom	500	60%	300	511.48	102%	644.02	129%
Doebum Lam A BBS3	500	60%	300	511.48	102%	644.02	129%
Kawajhangsa UNDP	500	50%	250	426.24	85%	536.68	107%
Bhutan Telecom 2	750	60%	450	767.23	102%	966.03	129%
KawangJangsa RMA	500	50%	250	426.24	85%	536.68	107%
Tashichhodzong2	1000	60%	600	1022.97	102%	1288.04	129%
KawangJangsa NITM A	600	60%	360	613.78	102%	772.82	129%
N660 (RAPA)							
Thagzo Lam	1000	50%	500	852.48	85%	1073.37	107%
N670 (Bhutan Hotel)							
Doebum Lam1	500	50%	250	426.24	85%	536.68	107%
Doebum Lam2	500	50%	250	426.24	85%	536.68	107%
Doebum Lam3	500	50%	250	426.24	85%	536.68	107%
Lodrey Lam	1250	60%	750	1278.72	102%	1610.05	129%
Chang Gumji	500	60%	300	511.49	102%	644.02	129%
Dashing Lam	1000	60%	600	1022.98	102%	1288.04	129%
N680 (BDBL)							
BDBL	750	50%	375	639.36	85%	805.02	107%
N690 (Lower Chubachu)							
Yarden Lam 1	500	60%	300	511.48	102%	644.02	129%
City Mall	500	50%	250	426.24	85%	536.69	107%

Transformer Name	kVA Rating	% Loading	Peak Load 2019(kVA)	Peak Load 2025(kVA)	% Loading	Peak Load 2030 (kVA)	% Loading
NorzinLamB	1000	70%	700	1193.47	119%	1502.72	150%
NorzinLamC	500	60%	300	511.48	102%	644.02	129%
NorzinLamD	500	60%	300	511.48	102%	644.02	129%
RICB HQ	1250	50%	625	1065.60	85%	1341.71	107%
NorzinLamA	1000	70%	700	1193.47	119%	1502.72	150%
Yarkay Plaza	750	50%	375	639.36	85%	805.03	107%
N700 (BPC HQ)							
BPC HQ	750	50%	375	639.36	85%	805.03	107%
NPPF HQ	1000	60%	600	1022.98	102%	1288.04	129%
N710 (Taj Hotel)							
Hotel Taj	1000	60%	600	1022.98	102%	1288.04	129%
Tashi commercial Complex	750	50%	375	639.36	85%	805.03	107%
N720 (Sunday market)							
Chhogyal Lam	1000	70%	700	1193.47	119%	1502.71	150%
Changlam 2A	1250	70%	875	1491.84	119%	1878.39	150%
Changlam 2B	500	60%	300	511.49	102%	644.02	129%
N610 (survey)							
ZilukhaDratsha ng	250	70%	175	235.91	94%	286.67	115%
N620 (Motithang complain)							
Kuenga Lam	750	70%	525	707.73	94%	860.01	115%
N270 (YHSS)							
Belpi Lam 7	1000	70%	700.00	943.64	94%	1,146.68	115%
N300 (Taba)							
T. Hanku Lam1	500	65%	325	438.12	88%	532.39	106%
T. Hanku Lam	500	65%	325	438.12	88%	532.39	106%
T. Hanku Lam 14	250	80%	200	269.61	108%	327.62	131%
N760 (Zilukha)							
Belpi Lam 16	500	70%	350.00	471.82	94%	573.34	115%
Babena	750	70%	525.00	707.73	94%	860.01	115%
Gaden Lam	750	70%	525.00	707.73	94%	860.01	115%
N320 (Mothithangincommer)							
TMH Station Transformer	250	80%	200.00	269.61	108%	327.62	131%
N770 (Hejo)							
Hejo	500	70%	350.00	471.82	94%	573.34	115%
Lhadrong Lam	750	70%	525.00	707.73	94%	860.01	115%
Lhudrong Lam 2	750	70%	525.00	707.73	94%	860.01	115%
N210 (chumdo)							

Transformer Name	kVA Rating	% Loading	Peak Load 2019(kVA)	Peak Load 2025(kVA)	% Loading	Peak Load 2030 (kVA)	% Loading
DenduLuma	63	80%	50.4	62.01	98%	80.69	128%
Kharisumtse	25	90%	22.5	27.69	111%	36.02	144%
N350 (Thimphu outgoing)							
K Shangrilla	200	70%	140	172.26	86%	224.15	112%
Termalingka	500	70%	350	430.66	86%	560.38	112%
U Jazam	500	70%	350	430.66	86%	560.38	112%

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. However, with the implementation of Distribution DMS, every DTs will be metered which will help ESD to monitor the loading, phase imbalance, condition of the transformers and accordingly make an informed decision. Hence, the proposed up-gradation works should be monitored and revisited.

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 12**, 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 into use.

Table 12: List of Outlived Distribution Transformers

Sl. No.	Substation Name/Transformer location	Voltage level	kVA Rating	Sl. No.	Put into use	2019
1	RBA B	11/0.433	160	86DD-069/9	1988	31
2	RBA E	11/0.433	250	86FD-082/3	1987	32
3	Langothangna	11/0.433	500	135389	1989	30
4	Samazinkha	11/0.433	250	86FD-082/8	1987	32
5	Kuenselphodrang	11/0.433	500	36459	1985	34
6	Hindu Lhakhang	11/0.415	200	VE 271/I/71	1987	32

Sl. No.	Substation Name/Transformer location	Voltage level	kVA Rating	Sl. No.	Put into use	2019
7	Thori Lam 13	11/0.415	63		1988	31
8	Sangga Lam I	11/0.433	500	36460	1985	34
9	Foreign Secretary	11/0.415	500	94ID-309/01	1994	25
10	Kunzang Lam	11/0.415	400	86HD-037/2	1987	32
11	Chhophel Lam	11/0.433	160	86DD-069/15	1988	31
12	Kawang Lam	11/0.433	250	187-03	1990	29
13	Doebum Lam A BBS	11/0.433	250	81FB-070/89	1986	33
14	Chang Khorlo D	11/0.433	500	81ID141/714	1994	25
15	Chang Khorlo	11/0.433	250	86FD-082/5	1987	32
16	Taba Lam 12	11/0.433	400	86HD-037/1	1987	32
17	Thimphu Mini Hydel	11/0.415	250	13037	1978	41
18	Dechenphodrang	11/0.433	100	86BD-160/14	1988	31
19	Belpi Lam 3	11/0.415	160	6768-069	1988	31
20	Samteling	11/0.415	160	86DD-068/1	1987	32
21	Norzin Lam	11/0.400	500	82ID-160/3	1983	36
22	Trade Office	11/0.433	500	37	1993	26
23	RBP 1	11/0.400	500	82ID-160/4	1983	36
24	Doebum Lam 1	11/0.400	250	82FD-075/2	1983	36
25	Y.R. Estate 1	11/0.433	160	866D-069/19	1988	31
26	Lower Gyentsawa	11/0.415	250		1988	31
27	CMTD Begana	11/0.433	500	36462	1985	34
28	Dekiling	11/0.400	16	1994-25	1993	26
29	Gasabarma	11/0.400	100	1016/1	1970	49
30	Changtagang	11/0.433	63	S/3318	1988	31
31	D/Ling POL Depot	11/0.433	125	18514	1990	29
32	Jagoma	11/0.433	100	86BD-160/16	1988	31
33	D/ling Palace 01	11/0.433	250	86FD-082/7	1987	32
34	D/ling Palace 02	11/0.433	160	86DD-069/51	1988	31
35	RIM II	11/0.433	500	2029307/1	1993	26
36	Yusipang RPBC I	11/0.433	315	18808	1989	30
37	Chhago Lam 1B	11/0.433	125	185-17	1990	29
38	Chhago Lam 1A	11/0.433	160	94DD/083/06	1994	25
39	Serbi Lam	11/0.433	160	86 DD-069/18	1988	31
40	Serbi Lam BAIL	11/0.400	750	M 1111/1	1993	26
41	Serbi Lam BAIL	11/0.400	750	M 1111/2	1993	26
42	S Dochu Lam C	11/0.433	160	86DD-	1988	31

Sl. No.	Substation Name/Transformer location	Voltage level	kVA Rating	Sl. No.	Put into use	2019
				069/16		
43	C Thagoma	11/0.400	500	82ID-165/5	1983	36
44	Chamgang RBP	11/0.433	500	132789	1989	30
45	C Chudzomsa	11/0.433	63	S/4077	1989	30
46	Serbithang A	11/0.433	160	86DD-069/21	1988	31
47	Nezergang	11/0.433	150		1986	33
48	Serbithang NCAH	11/0.415	250	36469	1985	34
49	GidaNamsay	11/0.433	125	185-02	1990	29
50	Gidagom SF1	11/0.433	500	17185	1980	39
51	Gidaphu TQ 2	11/0.433	250	50VE88	1988	31
52	Gidagom RSA 1	11/0.415	315	8707	1988	31
53	GPH	11/0.433	250	13036	1978	41
54	Namseling	11/0.433	250	36467	1985	34
55	Jazam	11/0.433	160	86DD-069/17	1988	31
56	SAARC	11/0.415	630	3649/2	1991	28
57	SAARC	11/0.433	630	3649/1	1991	28
58	Hotel Riverview	11/0.433	250	36466	1985	34
59	Yangchenphu	11/0.433	500	36461	1985	34
60	Samar Zinkhar	11/0.433	250	86FD-082/8	1987	32
61	Tshalu Lam 1B	11/0.433	250	14326	1979	40

7.3.3 Replacement of Single Phase Transformers

As discussed in the “Single Phase to Three Phase Conversion” of the distribution network it will be more economical and technically feasible to convert the single to three phase transformers on a need basis. The cost of Nu. 186 million is estimated for replacing all the single transformer including the distribution board across the country. The detailed work out is produced as **Annexure-8**.

There are around 7 single phase transformers in the Dzongkhag. The estimated cost for the conversion of such is Nu.1.18 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

The peak power demand projection of urban Thimphu was worked out by Druk Care Consultancy (2006) is reproduced in **Table 13** which indicates that urban Thimphu has space and capacity for around 36,000 residential units. Assuming that the available capacity development will be eventually realized by the year 2030, the coincidental peak power demand of urban Thimphu is likely to be in the order of 72 MW (@ 2kW per dwelling unit) excluding load requirements for organizations, industries, offices, public lighting, etc.

Table 13: Peak Power Demand Projection of Urban Thimphu (Based on Local Area Plans)

Locality	Precinct	Total Plot Area (ha)	Population Estimate by 2027	Estimated Dwelling Units	Peak Demand Projection (kW)	Reference
Dechencholing		60.00	7,713	1,543	3,085	Estimated from structure plan
Taba	UV1 (high density)	11.10	5,772	2,081	4,162	From Local Area Plan
	UV2 (medium density)	25.95	10,380	2,076	4,152	
Jungzhina	UV1 (high density)	4.62	2,402	480	961	From Local Area Plan
	UV2 (medium density)	22.65	9,060	1,812	3,624	
	E-4 (low density)	21.32	1,066	213	426	
Hejo-Samtenling	UV1 (high density)	1.38	897	179	359	From Local Area Plan
	UV2 (medium density)	37.00	20,350	4,070	8,140	
	E-4 (low density)	2.28	228	46	91	
Langjophakha	Area to the west of Dechen Lam towards Wang Chhu	8.20	3,895	1,538	3,076	From Local Area Plan
	Area to the east of Dechen Lam towards Wang Chhu	9.12	3,192	608	1,216	
Zilungkha		5.00	964	193	386	Estimated from structure plan
Lower & upper Motithang		45.00	6,942	2,150	4,300	
Changzamtog & Changidaphu		50.00	9,641	1,928	3,857	
Changbangdu	UV1 (high density)	0.47	271	94	188	From Local Area Plan
	UV2 (medium density)	6.64	3,320	664	1,328	

Locality	Precinct	Total Plot Area (ha)	Population Estimate by 2027	Estimated Dwelling Units	Peak Demand Projection (kW)	Reference
	UV2 (low density)	12.43	1,243	249	498	
Lungtenphu	UV1 (high density)	3.37	1,944	505	1,010	From Local Area Plan
	UV2 (medium density)	29.18	13,131	2,918	5,836	
	UV2 (low density)	22.52	2,252	450	900	
Semtokha	UV1 (high density)	7.67	9,588	1,533	3,066	From Local Area Plan
	UV2 (medium density)	9.68	4,840	968	1,936	
	UV2 (low density)	34.54	3,454	1,381	2,762	
Babesa	UV1 (high density)	2.74	2,737	547	1,095	From Local Area Plan
	UV2 (medium density)	21.28	10,640	2,128	4,256	
Serbithang	UV2 (medium density)	9.34	2,335	467	934	From Local Area Plan
	UV2 (low density)	6.22	622	125	250	
Kawajangsa&Chubachu		70.00	8,999	1,800	3,599	Estimated from structure plan
City core area		80.00	14,398	2,880	5,759	Estimated from structure plan
Total		620	162,277	35,626	71,252	

However, it is pertinent to mention that some of the LPAs had been already developed and realized, while some are underway. Therefore, the power requirement of urban Thimphu is re-workout based on power clearances issued by ESD Thimphu in the year 2018-2019. **Table 14** exhibits the growth potential and power demand of the various localities in Thimphu.

Table 14: Power Demand of various localities

Sl. No.	Area	Load (MW)		Total (MW)	Demand Factor (@60%)	Load to be Connected to
		2019	2018			
1	Babesa	6.78	9.61	16.39	9.83	Babesa SS
2	Changangkha	1.36	1.33	2.70	1.62	RICBL SS
3	Chang Gewog (flyover bridge)	5.26	4.60	9.86	5.92	DPH SS
4	Changbangdu	1.98	3.31	5.29	3.17	DPH SS
5	Changedaphu	1.98	1.26	3.24	1.94	RICB SS
6	Changjiji	0.27	0.70	0.98	0.59	DPH SS
7	Changzamtog	4.05	5.28	9.33	5.60	DPH SS
8	Core area	2.84	4.10	6.94	4.17	Chubachu SS

Sl. No.	Area	Load (MW)		Total (MW)	Demand Factor (@60%)	Load to be Connected to
		2019	2018			
9	Dechencholing	1.30	2.14	3.43	2.06	Dechencholing SS
10	HejoSamtenling	5.31	5.82	11.13	6.68	TMH SS
11	Jungshina	1.79	2.39	4.18	2.51	TMH SS
12	KawangGewog (kabesa)	0.75	0.69	1.43	0.86	Dechencholing SS
13	Kawangjangsa	0.06	0.52	0.58	0.35	Motithang SS
14	Langjophaka	3.14	3.42	6.56	3.94	TMH SS
15	Lungtenphu	2.85	3.43	6.28	3.77	Lungtenphu SS
16	Mewang Gewog (Debsi)	2.39	1.09	3.48	2.09	Babesa SS
17	Motithang	2.00	4.03	6.02	3.61	Motithang SS
18	Olakha	0.21	0.91	1.12	0.67	Lungtenphu SS
19	Pamtsho	0.75	0.07	0.82	0.49	TMH SS
20	Semtokha	4.28	9.25	13.52	8.11	Semtokha
21	Taba	5.32	7.24	12.56	7.54	Dechencholing SS
22	Zilukha	0.34	0.59	0.93	0.56	TMH SS
Total Load (MW)		55.01	71.78	126.79	76.08	

From the table above, the total power requirement of 76.08 MW (@ 60% load factor) is estimated within the next 10 years. The area-wise power planning as per the projected load is as described below:

a) Power supply infrastructure plans for Babesa and Mewang region

From **Table 14**, it is seen that the power requirement of Babesa and Mewang region is expected to grow over (to) 9.83 MW and 2.09 MW respectively. Currently, the power requirement to those areas is catered via (from) 2x5 MVA, 33/11 kV substation at Babesa. The substation recorded a peak load of 3.71 MW against its installed capacity of 8.5 MW. However, with the projected load of 11.92 MW, the substation capacity at Babesa will be exhausted. Moreover, the proposed Thimphu-Phuentsholing highway along the Debsi will aid in growing the precinct rapidly and so is the power requirements. It would therefore be necessary to construct a 2x5 MVA 33/11kV substation at Debsi (or) arrange a 33 kV distribution in the Debsi area to reduce the load on the Babesa substation. The substation plot and the RoW for the MV lines need to be prioritized and acquired.

b) Power supply infrastructure plans for Taba

As seen from the above table, the load of Taba is expected to grow over 7.54 MW. It would therefore be necessary to install 2x5 MVA, 33/11kV substation at Taba (i.e. in LILO arrangement on the 33 kV “ring” limb connecting Chubachu 33/11 kV substation). It should be on the Chubachu substation limb since the other 33 kV limb connects the 33/11 kV substations of TMH, Motithang, RICB, and DPH before connecting the Olakha substation. The substation plot and the RoW for the interconnecting MV lines need to be acquired. The substation will not only cater to the load of the Taba area but will ease the load of the Dechencholing substation.

c) Power supply infrastructure plans for Changjiji and Changzamtok

A total load of around 12.11 MW is expected over the next 10 years. The power supply to these areas can be arranged from DPH I (2x5 MVA) & DPH II (2x2.5 MVA) substation. However, the DPH II substation needs to be upgraded to 2x5 MVA to cater the future load growth.

d) Power supply infrastructure plans for Hejo, Jungzhina, Zilukha, Pamtsho, and Langjophakha

The power supplies to the above areas are catered from 2x2.5 MVA, 33/11 kV, TMH substation. The substation recorded a peak load of 4.53 MW against its installed capacity of 4.25 MW. The substation is overloaded (107% loaded) and requires immediate up-grading. Further with the projected load of around 14.12 MW in the future (by 2025), it is, therefore, necessary to up-grade the 2x2.5 MVA substation to 2x10 MVA to cater to the existing and future load growth. Moreover, the substation has to cater to the load of the Lingkana feeder which is currently connected to the Semtokha substation.

e) Power supply infrastructure plans for Semtokha

A load of around 8.11 MW at Semtokha LAP is projected. Assuming that the LAP development is eventually realized by the year 2030, it is necessary to up-grade 2x10 MVA, 66/11 Semtokha substation to 2x20 MVA since the capacity of the existing transformer is already exhausted. The substation recorded a peak load of 18.6 MW (as of 2019).

f) Power supply infrastructure plans for Motithang and Kawangjangsa

The power supply to Motithang and Kawangjangsa is catered by 2x2.5 MVA, 33/11 kV Motithang substation. The substation has a peak load of 3 MW against its capacity of 4.25 MW. With the projected additional load of around 3.96, it is, therefore, necessary to up-grade the 2x2.5 MVA substation to 2x5 MVA.

g) Power supply infrastructure plans for Serbithang

From **Table 14** above it is seen that the population of Serbithang is expected to grow to over 3,000 and the peak power demand of Serbithang is expected to reach 1.2 MW. It would therefore be necessary to construct a 33kV line from Olakha substation and construct a 33/11 kV substation to meet the power demand of the Serbithang area. The 11 kV feeders catering to the existing load are heavily loaded during winter peak load hours and are operating near their thermal limit. With the construction of a substation at Serbithang, the existing 11 kV feeders can also be rearranged from the new substation. However, The RoW for the construction of MV lines and substation plot needs to be acquired without delay.

h) Power supply infrastructure plans for Changedaphu and Changbangdu

From **Table 14** it is seen that the power demand of around 5.11 MW is projected in Chanbangdu and Changedaphu areas. At present, the power demand of these areas is met from the DPH substation. However, the substation is heavily loaded during winter peak hours and does not have enough capacity to cater to the additional load. Therefore, it is necessary to upgrade the capacity of the DPH 2 substation and construct an additional 11kV feeder to cater to future load growth. Further, the construction of a 33kV line from the Changedaphu substation to the DPH substation is recommended for source redundancy. The RoW for the construction of MV lines needs to be acquired without delay.

i) Power supply infrastructure plans for Lungtenphu

The power supply to Lungtenphu LAP can be catered from 2x5 MVA, 33/11 kV Lungtenphu substation. However, an additional 11 kV feeders need to be constructed. A total additional load of around 3.77 MW is projected for the LAP.

8. Distribution System Planning till 2030

The 33 kV “ring” forms the main power distribution backbone for urban Thimphu. However, in the future, the “ring” may not have sufficient capacity to meet the contingency requirements with the entire loads of urban Thimphu connected to it. The option of providing a double ring necessitates major reconfiguration for each of the 33/11kV substations and addressing the RoW issues. Proposing to invest at a time (one-time investment) may not be possible due to huge cost implications.

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 7.1.1**, the remedial measures to address the overloading issues are as described below:

- a) The 2x10 MVA, 66/11kV Semtokha substation experienced a peak load of 18.6 MW against its installed capacity of 17 MW (@ 0.85 pf). The overloading in a substation can be relieved by:
 - Connecting the 11kV Lungtenphu feeder to the 33/11kV Lungtenphu substation. The peak load of the feeder is around 0.67 MW.
 - Connecting the 11kV Changzamtok feeder to the 33/11kV DPH substation. The peak load of the feeder is around 2.7 MW.
 - Connecting the 11kV Lingkana Feeder to 33/11 kV TMH substation. The peak load of the feeder is around 1.36 MW.

About 5 MW of load can be relieved from the Semtokha substation. However, the proposed solution is temporary and a long-term solution must be sought to address which is upgrading of the substation. Further, with the development of Semtokha LAP, an additional load of around 8.11 MW is projected which should be catered from the Semtokha substation.

- b) The 2x2.5, 33/11 kV Dechencholing substation needs to be up-graded. The substation recorded a peak load of 4.08 MW which indicates that around 96 % of available capacity is being utilized whereby the substation cannot cater to the additional load. An additional load of around 2.92MW is expected.
- c) The 1x10 MVA, 66/11 kV Bjemina substation needs to be up-graded as a load of around 15.28 MW is projected by the year 2030.
- d) The 2x10 MVA, 66/33 kV Dechencholing Substation needs to be up-graded as the load flow analysis indicates marginal loading.

8.1.2 MV Substations

As detailed in **section 7.1.2**, the detailed action plan to address the issue of overloading and power supply arrangement for future load growth are outlined below:

- a) Construction of 2x5 MVA, 33/11kV substation at Debsi and connect to the 33kV Babesa line in LILO arrangement. **(OR)** Arrange a 33 kV distribution in Mewang and Debsi areas.
- b) Construction of 2x5 MVA, 33/11kV substation at upper Taba and connect to 33 kV “ring” limb connecting Chubachu substation.
- c) Construction of 2x5 MVA, 33/11 kV substation at Semtokha and connect to 33kV spare feeder at Olakha HV substation. However, this work may not require if the 66/11 kV Simtokha substation is upgraded. A total load of around 8.11 MW is projected in Semtokha LAP.
- d) Up-grade 2x2.5 MVA DPH II substation to 2x5 MVA to cater to the future load growth of Chang, Chanjiji, and Changzamtok. An additional load of 12.11 MW is projected.
- e) Up-grade 2x2.5 MVA TMH substation to 2x10 MVA to cater to a load of Hejo, Jungzhina, Pamtscho, and Langjophakha areas. An additional load of around 14.12 MW is expected.
- f) Up-grade 2x2.5 MVA Motithang substation to 2x5 MVA to cater to a load of Motithang and Kawangjangsa areas. An additional load of 3.96 MW is projected.
- g) Installation of 2x2.5 MVA transformer at Gidagom substation. The old transformer of TMH and DPH 2 substations can be used.

Although it may take some years to construct new 33/11 kV substations, the service plots for the proposed substations and RoW for the lines need to be acquired. **Figure 6** below depicts the power distribution model by 2030;

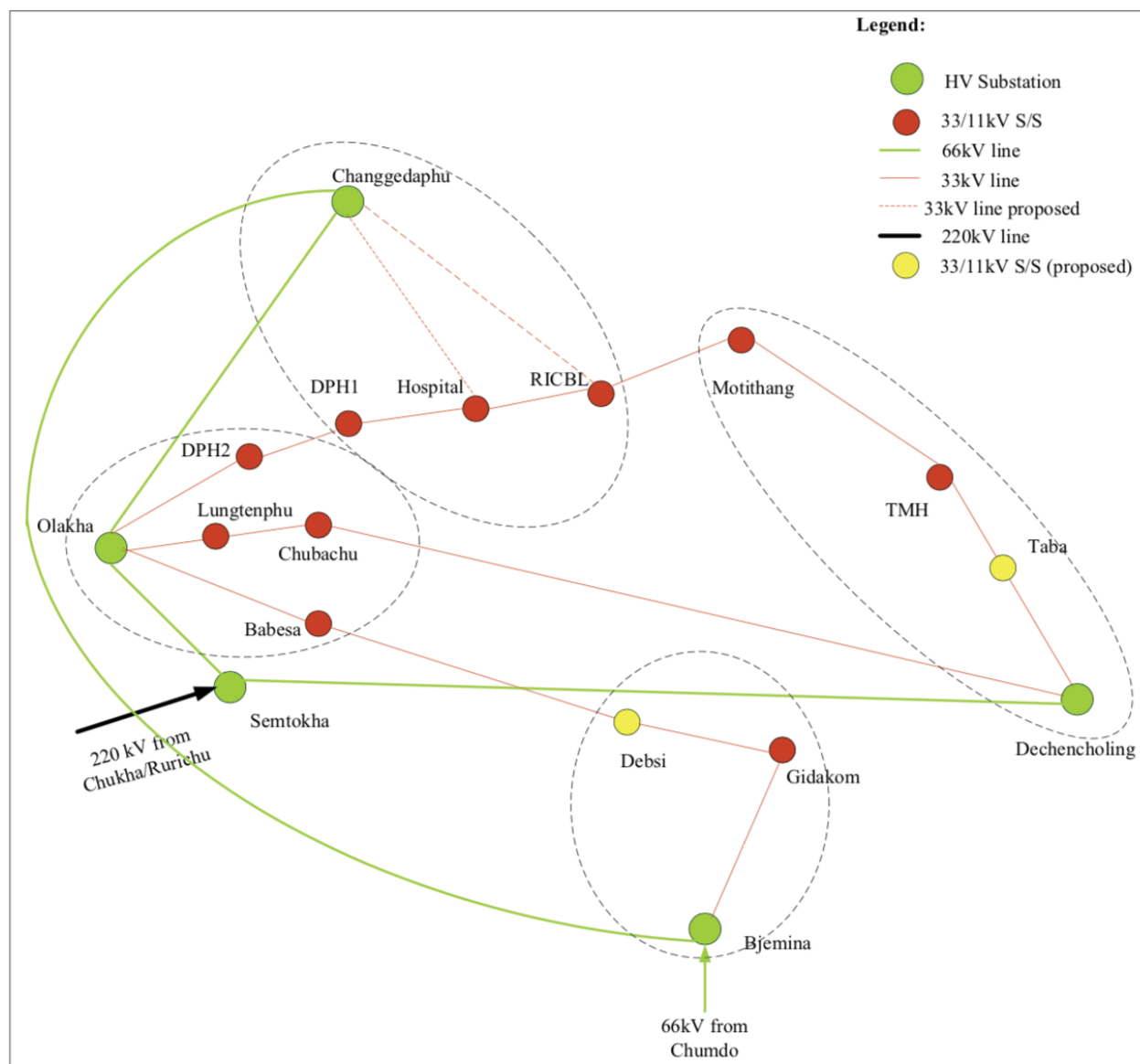


Figure 6: Power Distribution Model by 2030

8.2 MV Lines

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

- a) Construction of cable trench and laying of UG HV cables in and around upper Taba.
- b) Construction of cable trench and laying of UG HV cables in and around Semtokha.
- c) Construction of cable trench and laying of UG HV cables in around Changjalu and Lungtenphu LAP
- d) Construction of an additional 11 kV feeder from Lungtenphu substation to cater to the future load growth of Lungtenphu LAP.
- e) Construction of cable trench and laying of UG HV cables in and around Debsi.
- f) Extension of 33kV HV UG cable from Changedaphu substation to DPH substation.
- g) Construction of 33kV OH line with Dog conductor or equivalent UG from Olakha substation till Serbithang to cater to the future power demand of Serbithang LAP (4 km approx.)
- h) Up-rate 150 and 185 sq. mm UG cables of 33kV incoming feeder to Chubachu substation to Dog conductor or equivalent UG (1.0 km approx.)
- i) Up-rate 95 sq. mm UG cable of 11kV Essential feeder from DPH I substation to 300 sq. mm UG (0.34 km approx.)
- j) Up-rate 185 sq. mm 33kV incoming of TMH substation to 33kV Dog conductor or equivalent UG (0.3 km approx.) The feeder has to bear the load of TMH and Motithang substation.
- k) Up-rate 150 sq. mm 11kV outgoing VVIP (N400) feeder at DPH 1 substation to 300 sq. mm (6 km approx.)
- l) Up-rate 150 sq. mm 11kV outgoing Thimphu (N350) feeder at Gidagom substation to 300 sq. mm (0.42 km approx.)

Although it may take some years to develop the LPA, the RoW for the construction of Lines needs to be acquired.

Note: *For the power supply arrangement to the new LAPs, the cost-sharing method can be adopted. Civil works like the construction of cable trench can be taken up by Thromde and cable works by BPC.*

8.3 Distribution Transformers

The list of overloaded distribution transformers was presented in the earlier section of this report. There are around 119 DTs (rural and urban areas) that are expected to be overloaded by the year

2030. However, with the implementation of DMS, every DTs will be metered, and the actual loading of the DTs can be recorded. ESD Thimphu is, therefore, recommended to accordingly up-grade/install additional transformer based on the actual loading. However, construction of new substations for the under developing LAPs are recommended as follows:

- a) Construction of at least 7Nos. of 11/0.415 kV, 1000 kVA USS in and around Babesa to cater to the future power demands.
- b) Construction of at least 6 Nos. of 11/0.415 kV, 1000 kVA USS to cater to the power demands of Taba and Dechencholing area.
- c) Construction of at least 4 Nos. 11/0.415 kV, 750 kVA USS at Hejo-Samtenling LAP to cater to the power demands of Hejo/Samtenling/Pamtsho/Jungzhina/Langiophakha/Zilukha areas.
- d) Construction of at least 6 Nos. of 11/0.415 kV, 750 kVA USS Semtokha LAP to cater to the future power demands.
- e) Construction of 3 Nos. of 33/0.415 kV, 750 kVA USS to cater to the power demands of Debsi area.
- f) Construction of at least 3 Nos. 11/0.415 kV, 750 kVA USS at Lungtenphu LAP to cater to the future power demands.
- g) Construction of 4 Nos. of 11/0.415 kV, 750 kVA USS at Serbithang to cater to the future power demands.
- h) Construction of 3 Nos. of 11/0.415 kV, 750 kVA USS at Motithang to cater to the future power demands.
- i) Construction of 5 Nos. of 11/0.415 kV, 750 kVA USS in and around Chang Gewog to cater to the future power demands of Changedaphu and Changbangdu.

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 Distribution System Smart Grid

Distribution Management System (DMS) has already been introduced for managing the electricity distribution system in Thimphu. With the growing power system complexity, growing power demands, and increasing demand for quality power supply, the implementation of the DMS system is indeed timely for Thimphu's distribution system.

The DMS project has been contracted at a cost of around Nu.350 million. While DMS in principle offers the benefits of enhanced overall efficiency, lesser outages, better data, and information, etc., trained and competent human resources to operate and maintain the system are necessary for sustainable operations. It may therefore be prudent to start with the monitoring functions (and defer control functions) such as breaker status, feeder peak loads, feeder energy, online condition monitoring systems for transformers and generators, etc. Following benefits are expected from the DMS:

- a) Enhancement of power quality and reliability
- b) Reduction in the costs of providing electricity services
- c) Reduction in staff requirements
- d) Enhancement of system operational efficiency
- e) Improvement in the level of services
- f) Minimization of risks of outages and catastrophic failures
- g) Alleviation of health hazards
- h) Compliance with regulatory requirements

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 7**.

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 are 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 15** 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 is Nu. 596.78 million.

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 7: Priority Matrix

Table 15: Investment Plan until 2030

Sl. No.	Activities	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total (Million)
1	Power Supply Source												
1.1	Up-rating of 2x2.5 MVA DHP 2 SS to 2x5 MVA.	-	6.60	-	-	-	-	-	-	-	-	-	6.60
1.2	Up-rating of 2x2.5 MVA TMH SS to 2x10 MVA.	1.50	33.50	-	-	-	-	-	-	-	-	-	35.00
1.3	Up-rating of 2x5 MVA Chubachu SS to 2x10 MVA (GIS).		50.00	-	-	-	-	-	-	-	-	-	50.00
1.4	Up-rating of 2x2.5 MVA Motithang SS to 2x5 MVA	-	-	-	-	-	-	6.00	6.00	-	-	-	12.00
1.5	Installation of 2x2.5 MVA transformer at Gidagom SS	-	-		2.00	-	-	-	-	-	-	-	2.00
1.6	Construction of 2x5 MVA , 33/11 kV SS at Taba	-	-	-	-	10.00	62.00	-	-	-	-	-	72.00
1.7	Construction of 2x5 MVA , 33/11 kV SS at Serbithang	-	-	-	-	-	-	10.00	62.00	-	-	-	72.00
2	MV Lines	-	-	-	-	-	-	-	-	-	-	-	-
2.1	Construction of cable trench and laying of UG HV cables in around upper Taba LAP.	-	20.90	-	-	-	-	-	-	-	-	-	20.90
	Construction of cable trench and laying of UG HV cables in around Dechencholing LAP		6.33										6.33
2.2	Construction of cable trench and laying of UG HV cables in around upper Semtokha LAP.	-	-	-	-	10.00	5.00	-	-	-	-	-	15.00
2.3	Construction of cable trench and laying of UG HV cables in around upper Debsi area.	-	-	-	-	-	-	10.00	-	-	-	-	10.00
2.4	Extension of 33kV HV UG cable form Changedaphu substation to DPH substation	14.32		-	-	-	-	-	-	-	-	-	14.32
2.5	Construction of cable trench and laying of UG HV cables in around upper Lungtenphu and Changjalu LAP.		3.10										3.10

Sl. No.	Activities	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total (Million)
2.6	Construction of additional 11 kV feeder from Lungtenphu substation	-	1.93	-	-	-	-	-	-	-	-	-	1.93
2.7	Construction of 33kV OH line with Dog conductor or equivalent UG from Olakha substation till Serbithang	-	-	-	-	3.00	-	-	-	-	-	-	3.00
3	Distribution Transformer	-	-	-	-	-	-	-	-	-	-	-	-
3.1	Construction 7 Nos. of 11/0.415 kV, 1000 kVA USS in and around Babesa.	4.51	12.67	4.60	-	9.20	-	-	4.60	-	9.20	-	44.78
3.2	Construction of at 7 Nos. of 11/0.415 kV, 1000 kVA USS to cater the power demand of Taba and Dechencholing area.	-	5.82	-	-	9.20	-	-	9.20	-	4.60	-	28.82
3.3	Construction of at least 5 Nos. 11/0.415 kV, 750 kVA USS at Hejo-Santenling LAP to cater the power demand of Hejo/Santenling/Pamtsho/Lungzhina/Langjophakha/Zilukha areas.	4.59	12.21	-	9.20	-	-	-	-	9.20	-	-	35.20
3.4	Construction of at least 6 Nos. of 11/0.415 kV, 1000 kVA USS Sentsokha LAP to cater the future power demand.	-	-	8.80	-	-	4.40	-	8.80	-	4.40	-	26.40
3.5	Construction of 3 Nos. of 33/0.415 kV, 750 kVA USS to cater the power demand of Debsi area.	-	-	5.83	-	-	11.66	-	-	-	-	-	17.49
3.6	Construction of 3 Nos. 11/0.415 kV, 750 kVA USS at Lungtenphu LAP to cater the future power demand	-	-	8.80	-	-	-	4.40	-	-	-	-	13.20
3.7	Construction of 2 Nos. of 11/0.415 kV, 750 kVA USS at Motithang to cater the future power demand.	-	-	-	8.80	-	-	-	4.40	-	-	-	13.20
3.8	Construction of 5 Nos. of 11/0.415 kV, 750 kVA USS in and around Chang gewog to cater the future power demand of Chnagedaphu and Chang.	-	4.40	-	-	8.80	-	-	8.80	-	-	-	22.00
3.9	Construction of 2 Nos. of 11/0.415 kV, 750 kVA USS at Serbithang to cater the future power demand.	-	-	4.4	-	-	-	-	4.4	-	-	-	8.80

Sl. No.	Activities	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total (Million)
3.10	Up-rating of DTs in and around Thimphu	19.48	7.37	-	-	3.00					5.00		34.85
4	Conversion Works	-	-	-	-	-	-	-	-	-	-	-	-
4.1	Up-rate 150 and 185 sq. mm UG cables of 33kV incoming feeder to Chubachu substation to Dog conductor or equivalent UG (1.0 km approx.)	-	-	2.00	-	-	-	-	-	-	-	-	2.00
4.2	Up-rate 95 sq. mm UG cable of 11kV Essential feeder from DPH I substation to 300 sq. mm UG (0.34 km approx.)	-	-	-	-	-	0.50	-	-	-	-	-	0.50
4.3	Up-rate 185 sq. mm 33kV incoming of TMH substation to 33kV Dog conductor or equivalent UG (0.3 km approx.) The feeder has to bear the load of TMH and Moithang substation.	-	-	0.80	-	-	-	-	-	-	-	-	0.80
4.4	Up-rate 150 sq. mm 11kV outgoing VVIP (N400) feeder at DPH 1 substation to 300 sq. mm (6 km approx.)	-	-	-	-	-	-	-	-	7.20	-	-	7.20
4.5	Up-rate 150 sq. mm 11kV outgoing Thimphu (N350) feeder at Gidagom substation to 300 sq. mm (0.42 km approx.)	-	-	-	-	-	-	-	-	0.60	-	-	0.60
4.6	Replacement of VCB panels for DPH-I and DPH-II Substation	-	7.89	-	-	-	-	-	-	-	-	-	7.89
4.7	Single Phase to Three Phase Line conversion	-	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	7.70
4.8	Single Phase Transformer to Three Phase conversion	-	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	1.18
	Total	44.39	173.61	36.12	20.89	54.09	84.45	31.29	109.09	17.89	24.09	0.89	596.78

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	1) Substations 66/11 kV, 20 MVA Semtokha Substation To meet the existing and future power demand as per the time series forecast, the substation needs to be up-graded to 40 MVA. 2) 66/33 kV, 20MVA and 33/11 kV, 5 MVA Dechencholing Substation The 20 MVA, 66/33, and 5 MVA, 33/11 kV substation is recommended to up-rate to 30 MVA and 10 MVA respectively to meet the increasing power demand. 3) 66/33 kV, 10 MVA Bjemina Substation Installation of additional 10 MVA transformers to meet the future power demand.
2	MV Substations	Up-gradation/construction of new 33/11 kV substation should be implemented as described in section 8.1.2.
B. MV and LV Lines		
3	Conversion Works	1) HT overhead to UG cable It is proposed to convert OH (distribution network) to UG (distribution network) 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 more importantly from an aesthetic point of view.
C. Distribution Transformers		

Sl. No.	Parameters	Recommendations
1	Distribution Transformer	Although it would be better to have one distribution transformer station installed in each 100x100 sq. m area in urban Thimphu, given the space constraints the BPCL should obtain a plot to install at least one transformer station in every 200x200 sq.m area. However, in areas yet to be developed and where opportunities exist, a transformer station plot should be obtained in every 100x100 sq.m area.
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	DMS project shall cover this.
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 Trashigang 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 by examining customer growth patterns. Therefore, it is recommended to consistently update the customers via a customer mapping process carried out annually.

Sl. No.	Parameters	Recommendations
5	Right of Way	RoW should be maintained as per the DDCS 2016. However, an increased frequency of Row clearing in the problematic sections of the line and fast growth sub-tropical forest is recommended. Further, service plots for the substations and RoW for the lines need to be availed in tandem with the planning.
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 or 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. DMS would enhance reliability issues.
10	Conversion Works	As the joint survey for laying the UG had not been done, the investment has been worked based on assumptions of likely scenarios. Therefore, ESD Thimphu should incorporate the actual activities during the rolling out of the investment plans.
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 (3 Φ) 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. Thimphu City Development Strategy (2008).
11. Industrial Parks (Department of Industry).
12. 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 $\pm 10\%$ is given as a critical value which is indicated by red color while simulating and a voltage level of $\pm 5\%$ 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.

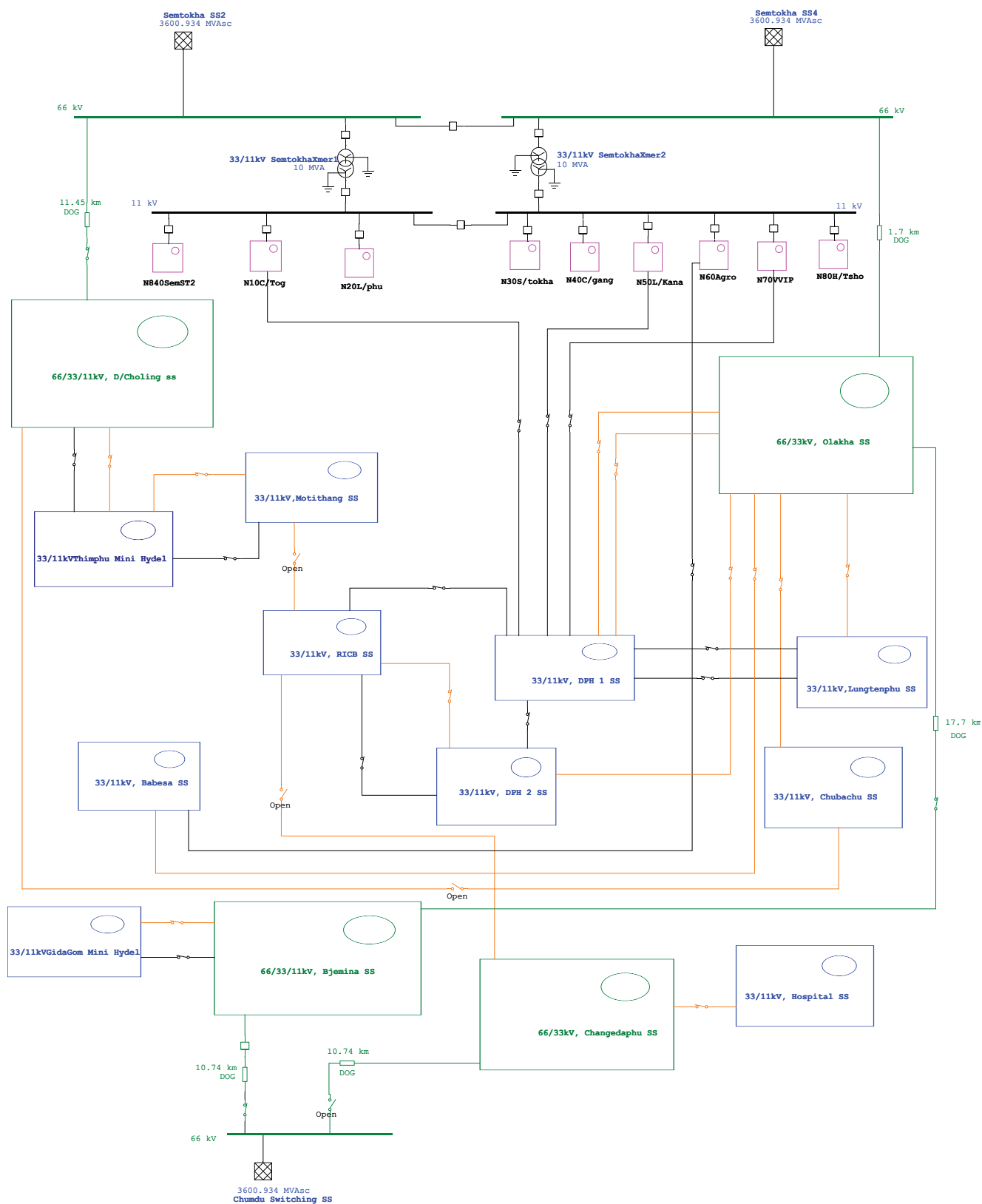
15. Challenges

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

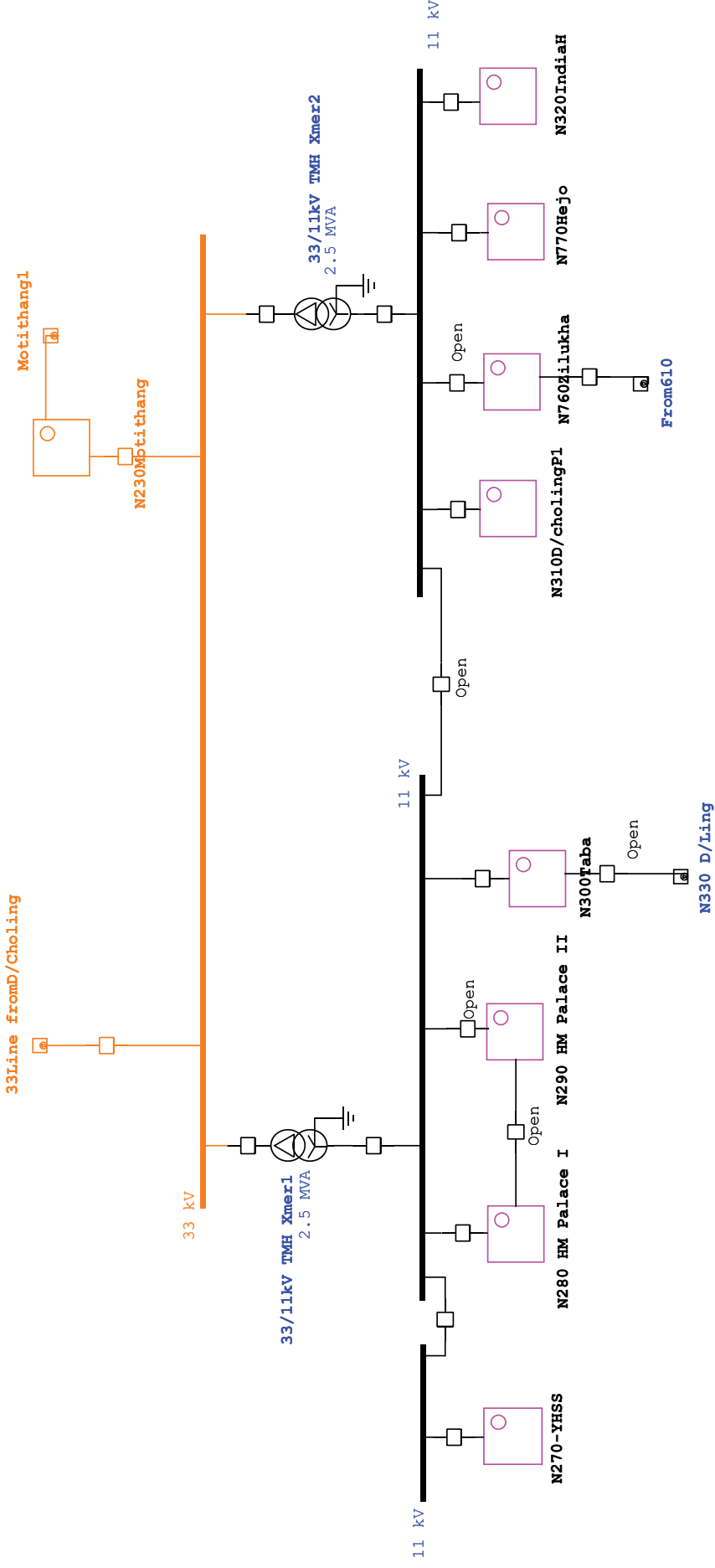
Sl. No.	Parameters	Challenges	Opportunities/Proposals
		c) No proper feeder and DT wise Customer Mapping recorded	c) Customer Information System (CIS) of the feeder/DT would enable us to have a proper TLM and replacement framework.
3	Manpower	a) Resource gap in terms of trained (ETAP) and adequate engineers (numbers)	a) Due to the lesser number of trained engineers in the relevant fields (software), engineers from other areas were involved

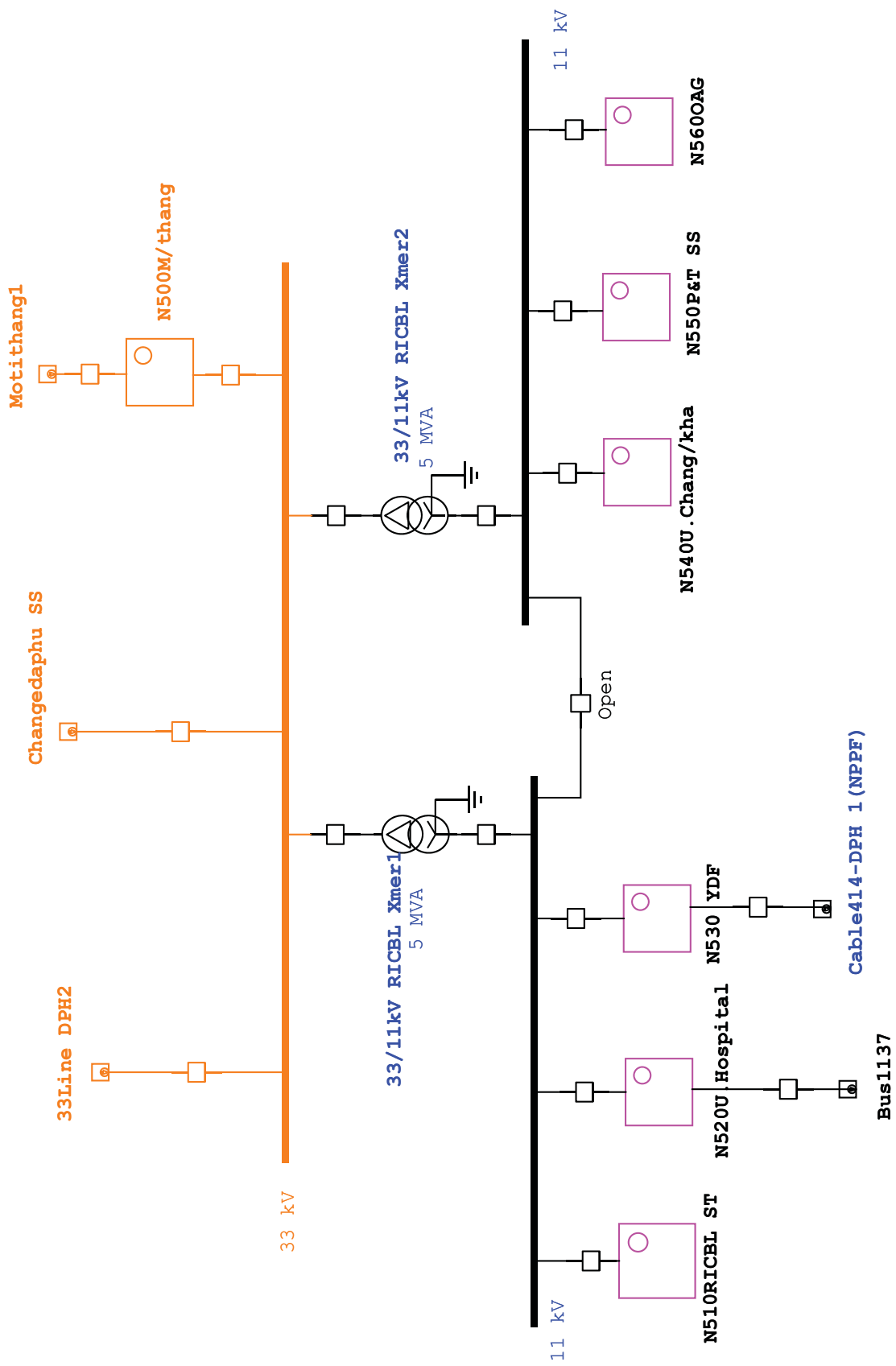
Annexure 1- SLD and MV Line Details

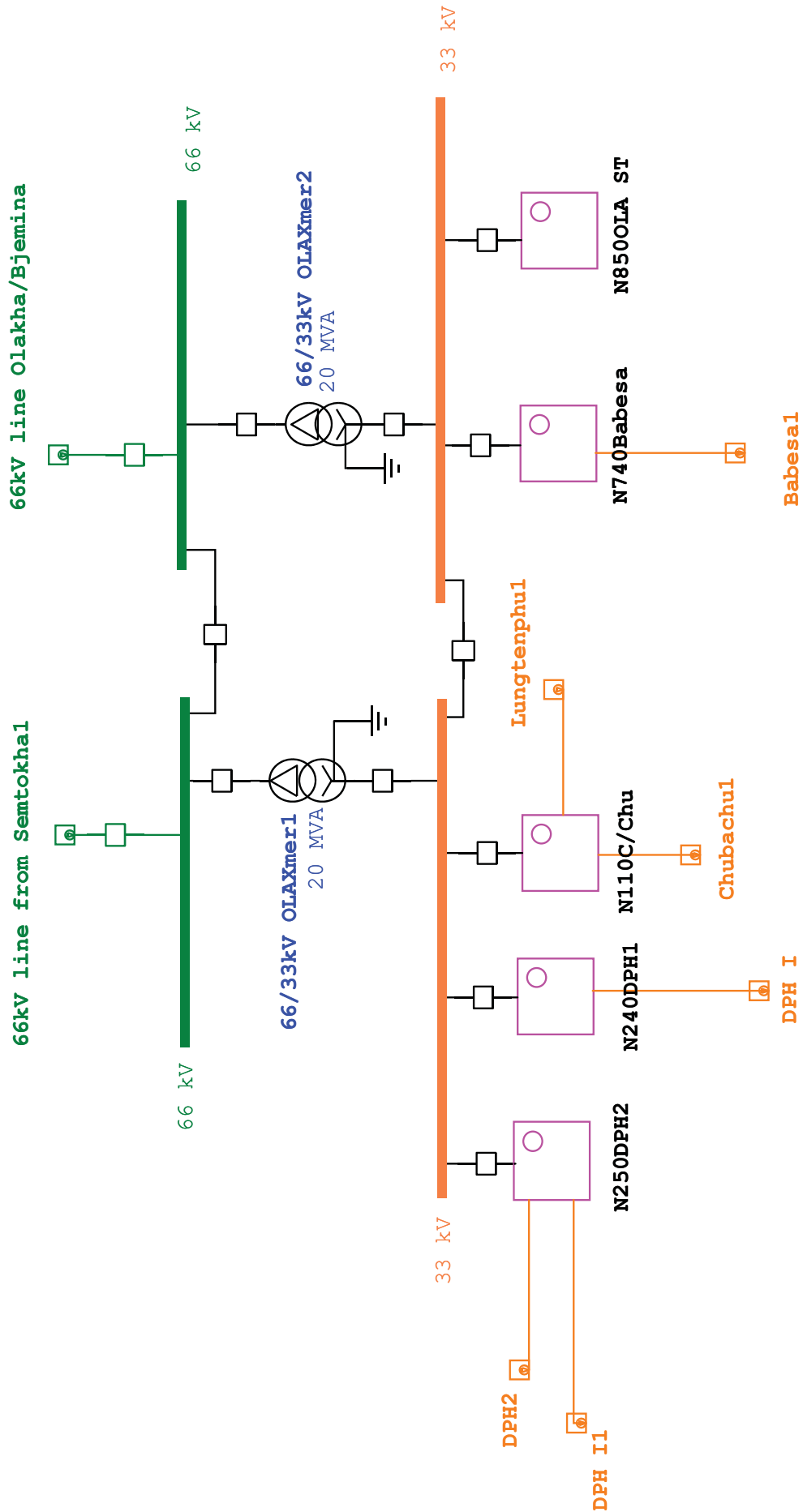
One-Line Diagram - Thimphu ESD Overall (Edit Mode)

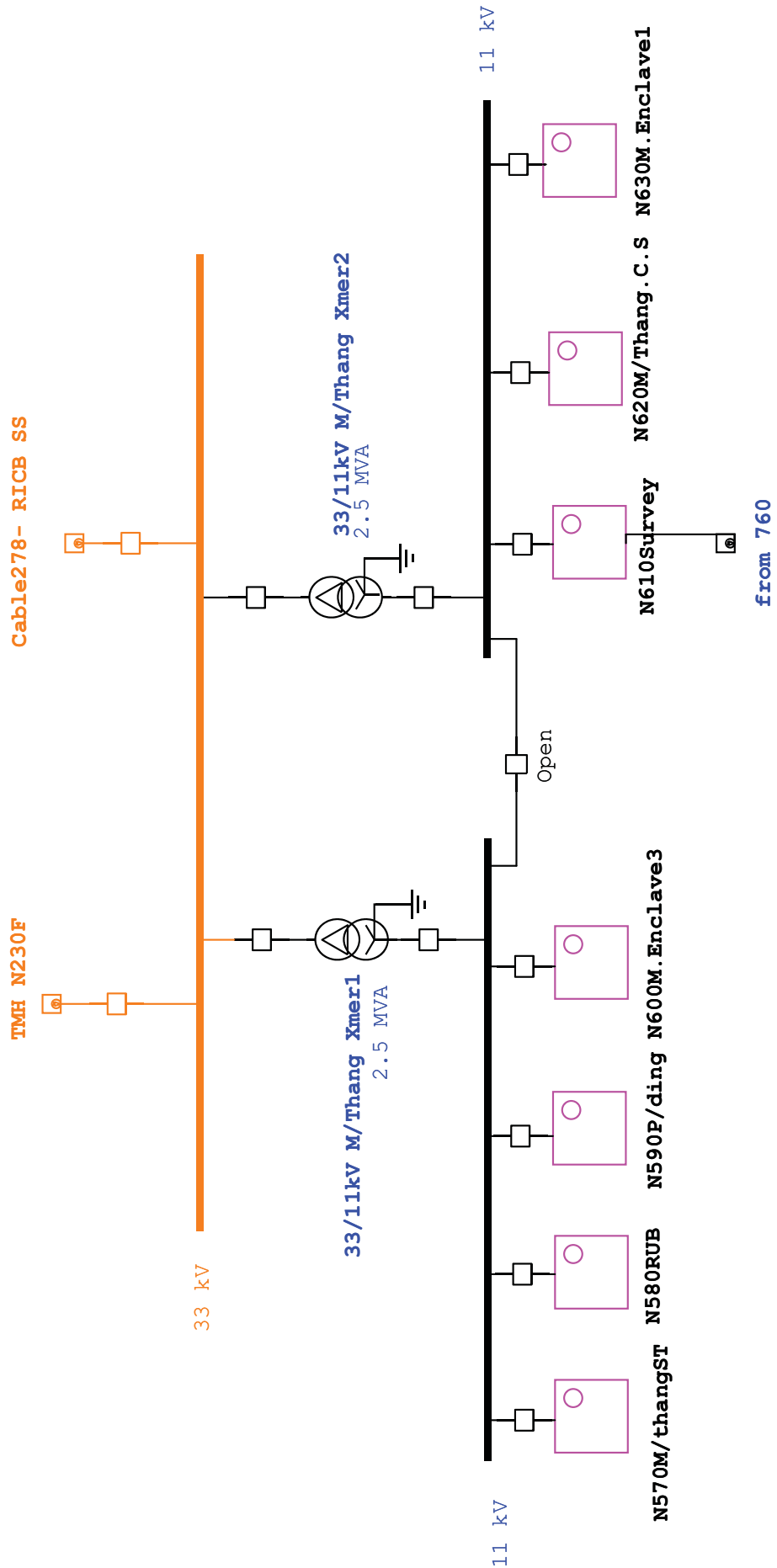


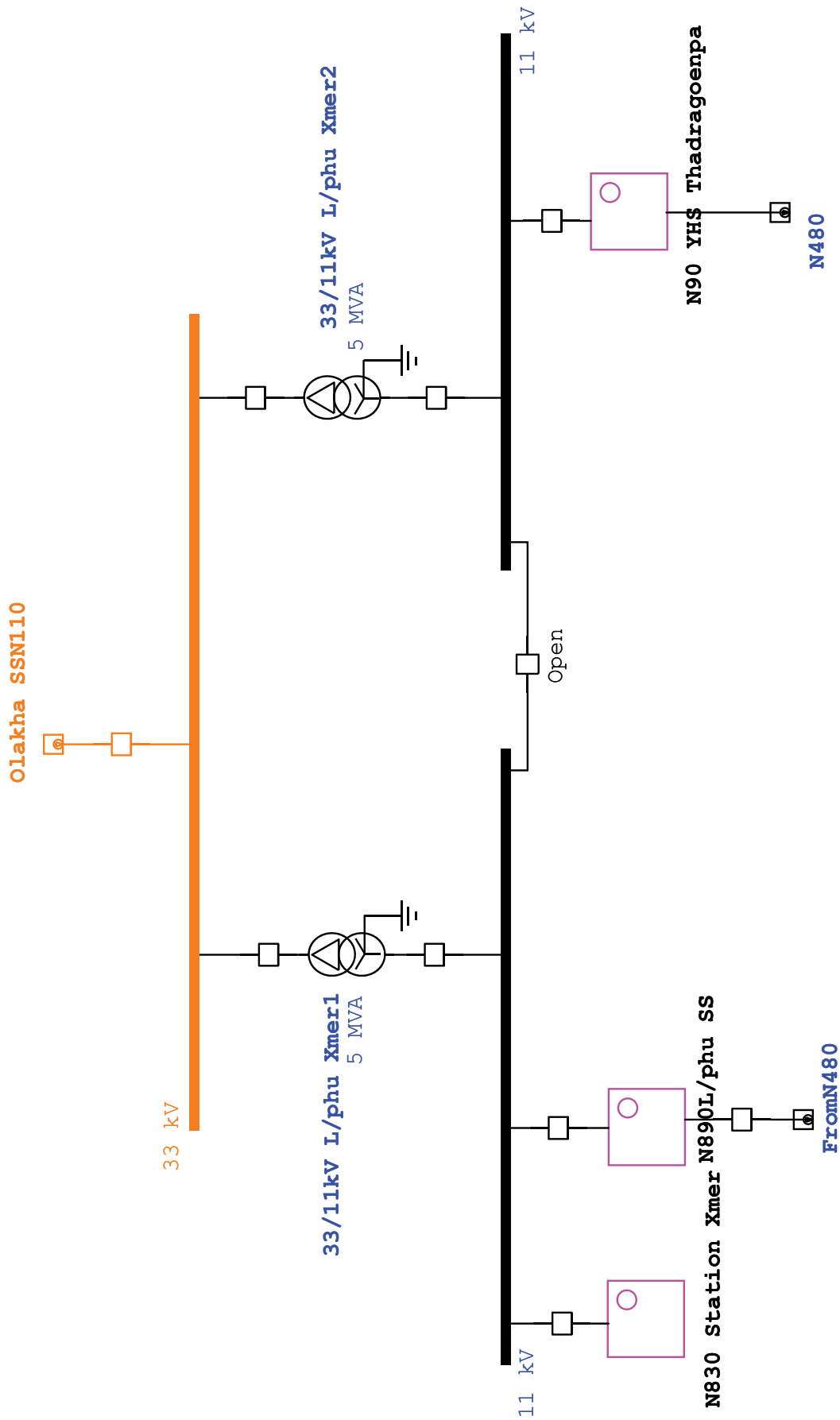
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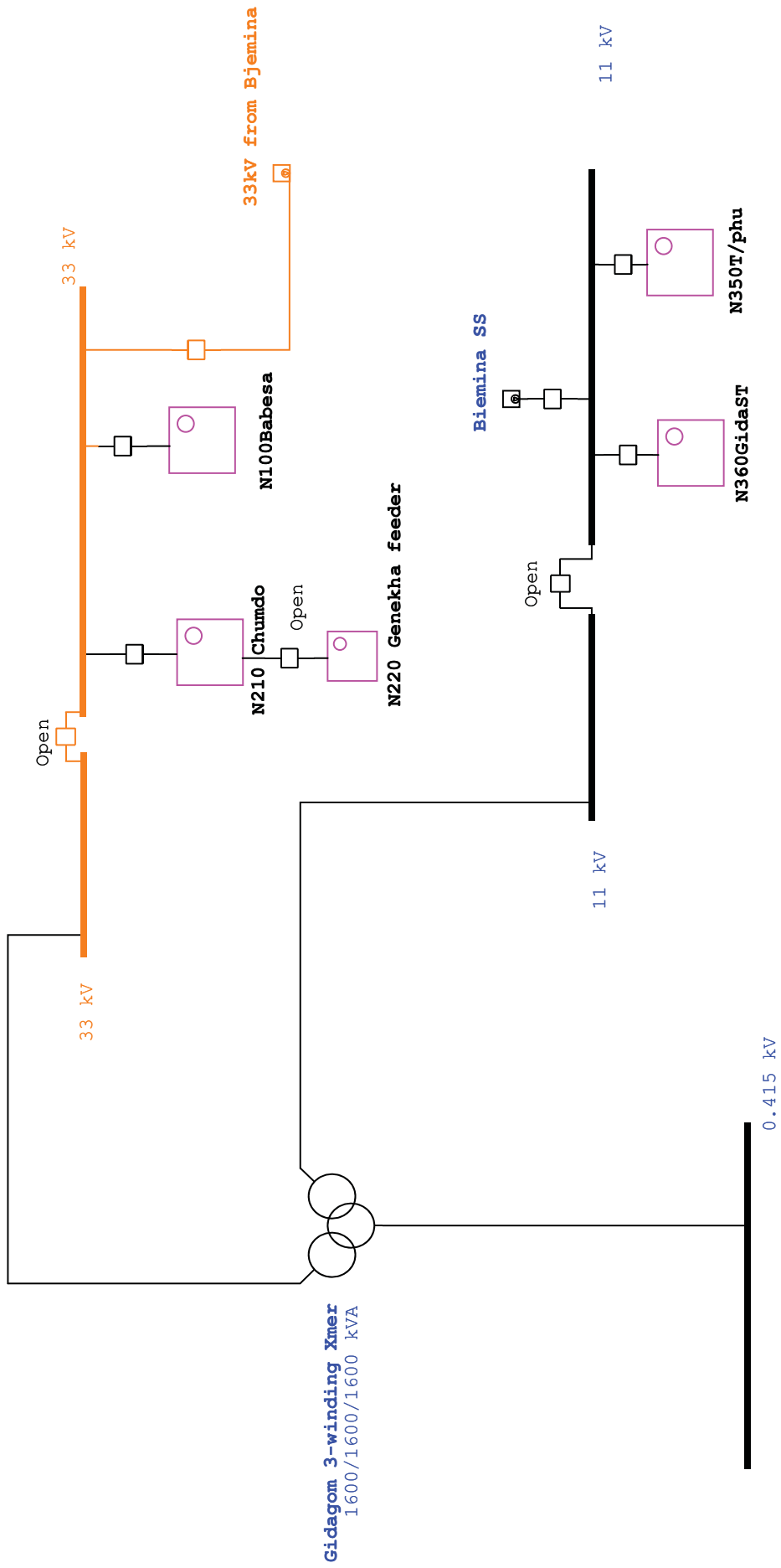






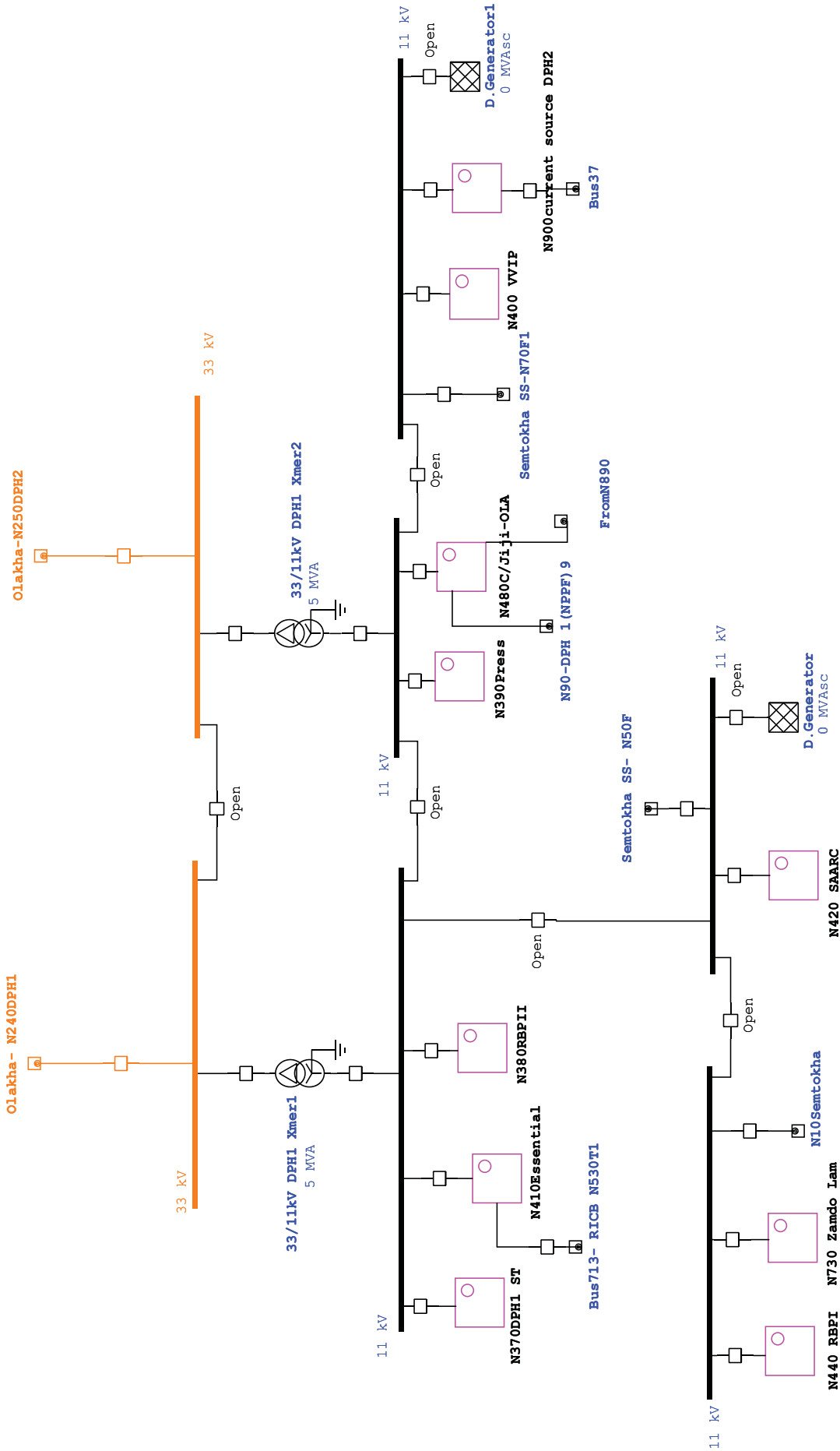


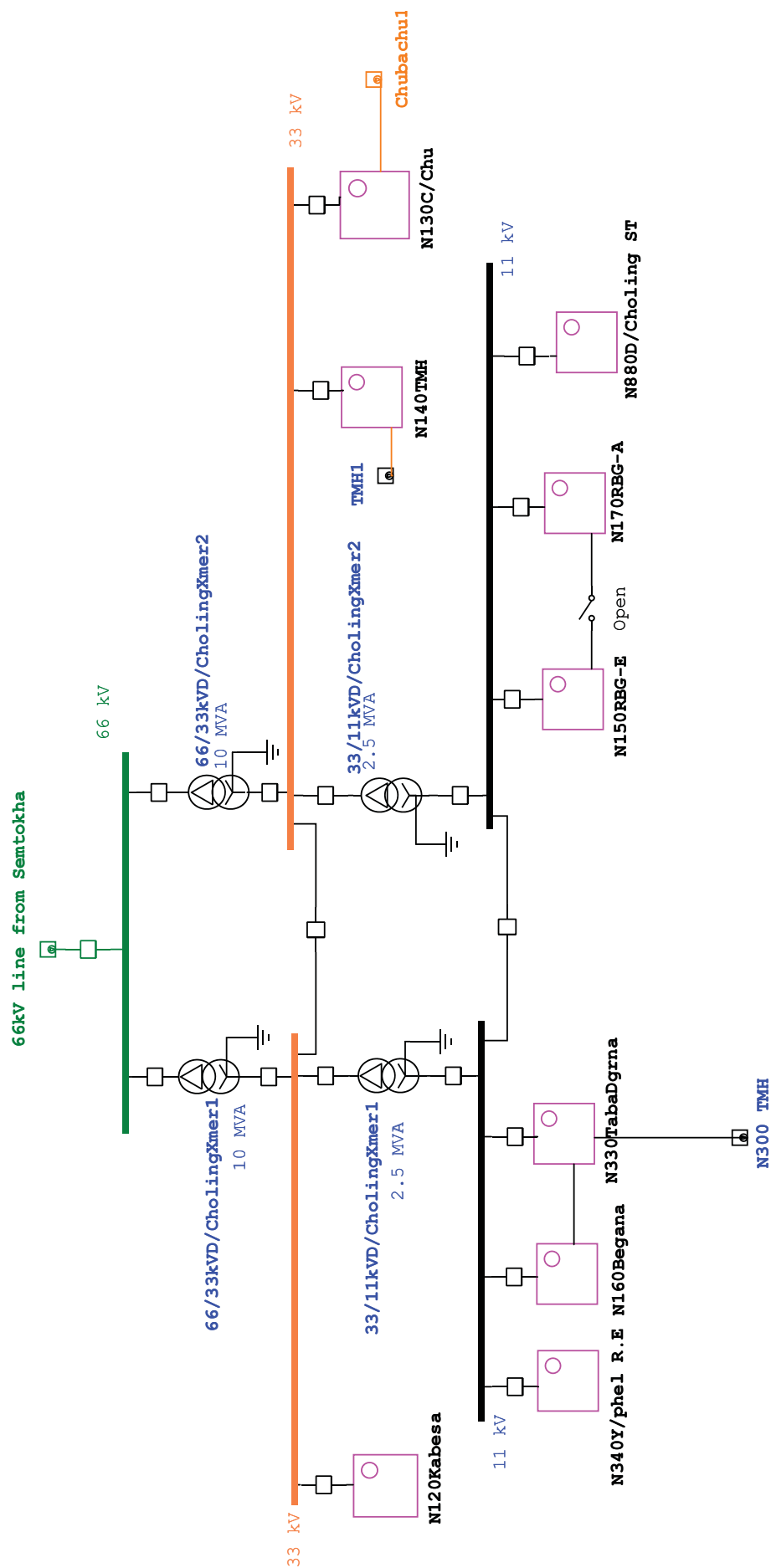


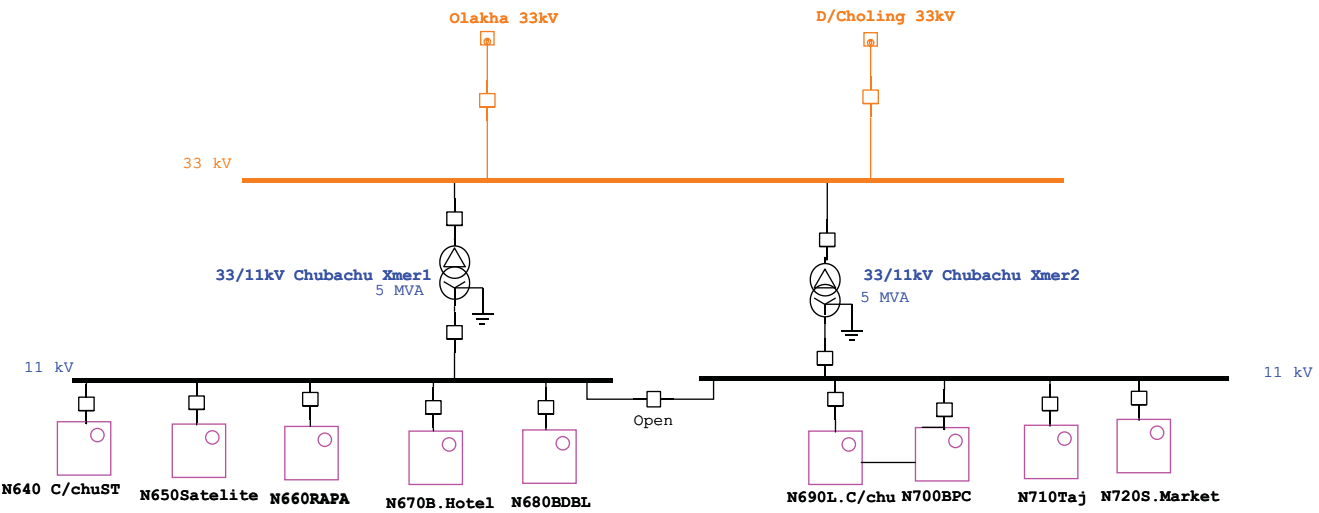


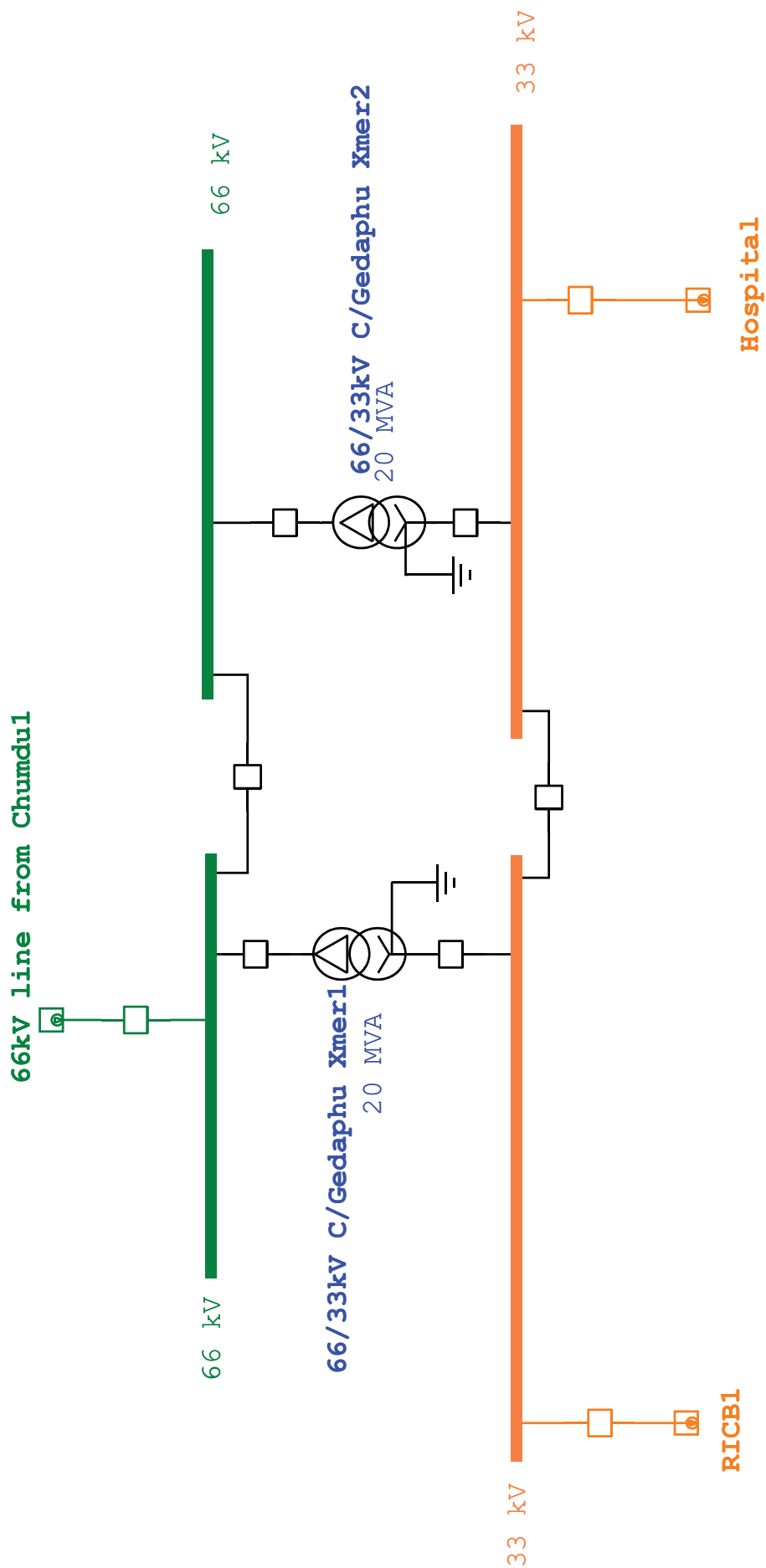


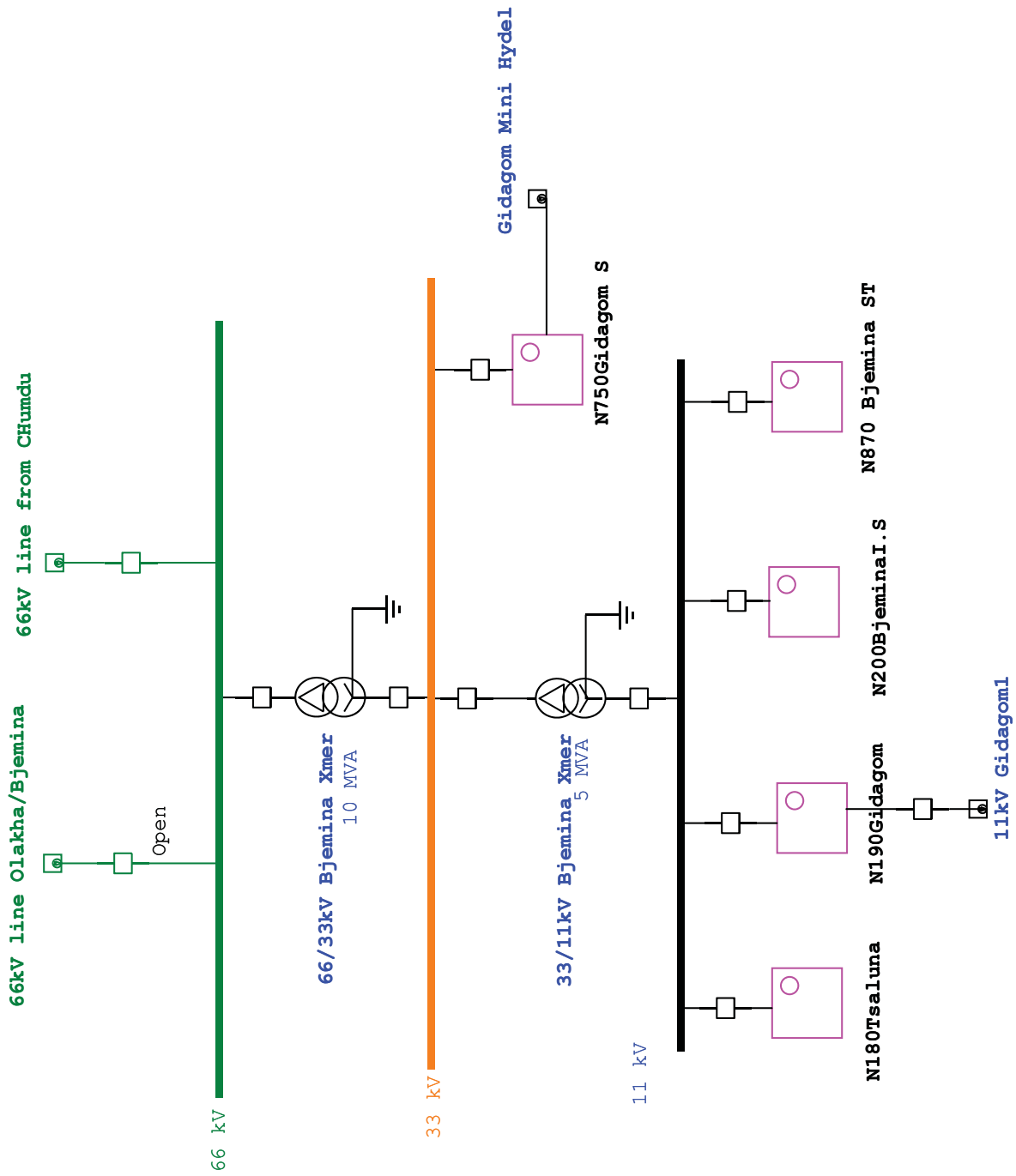
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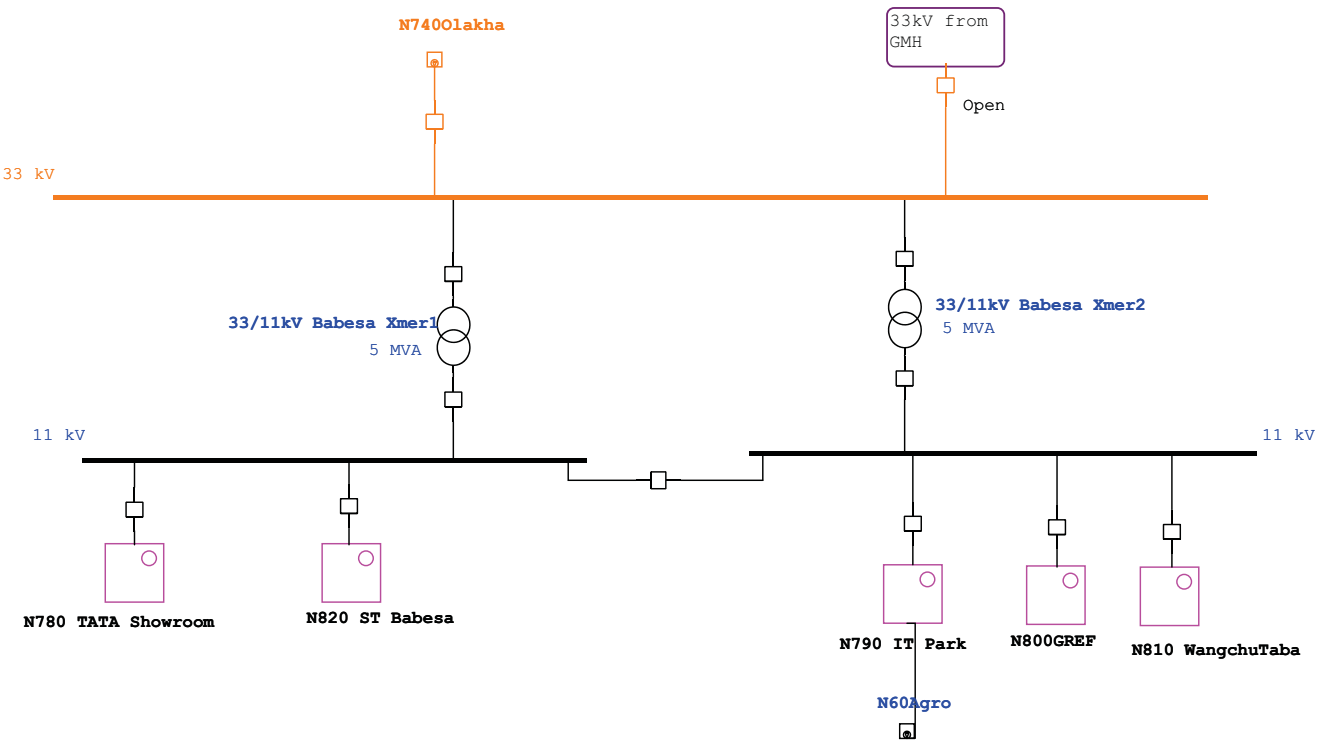




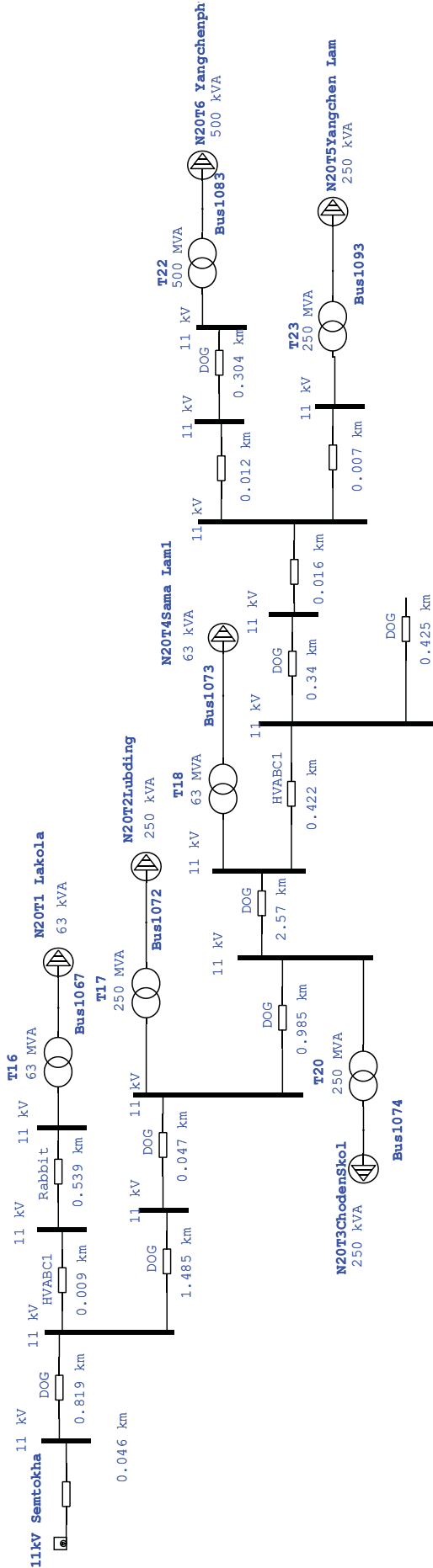




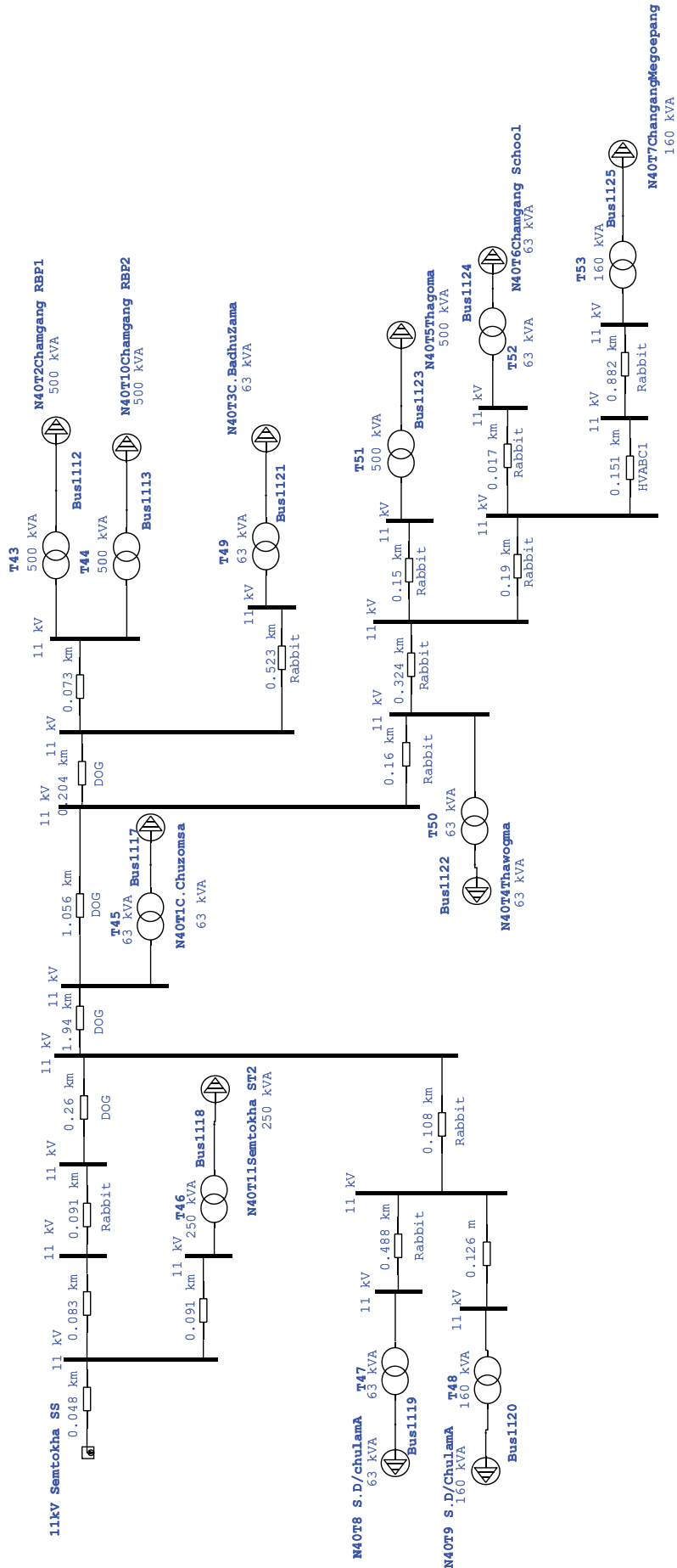




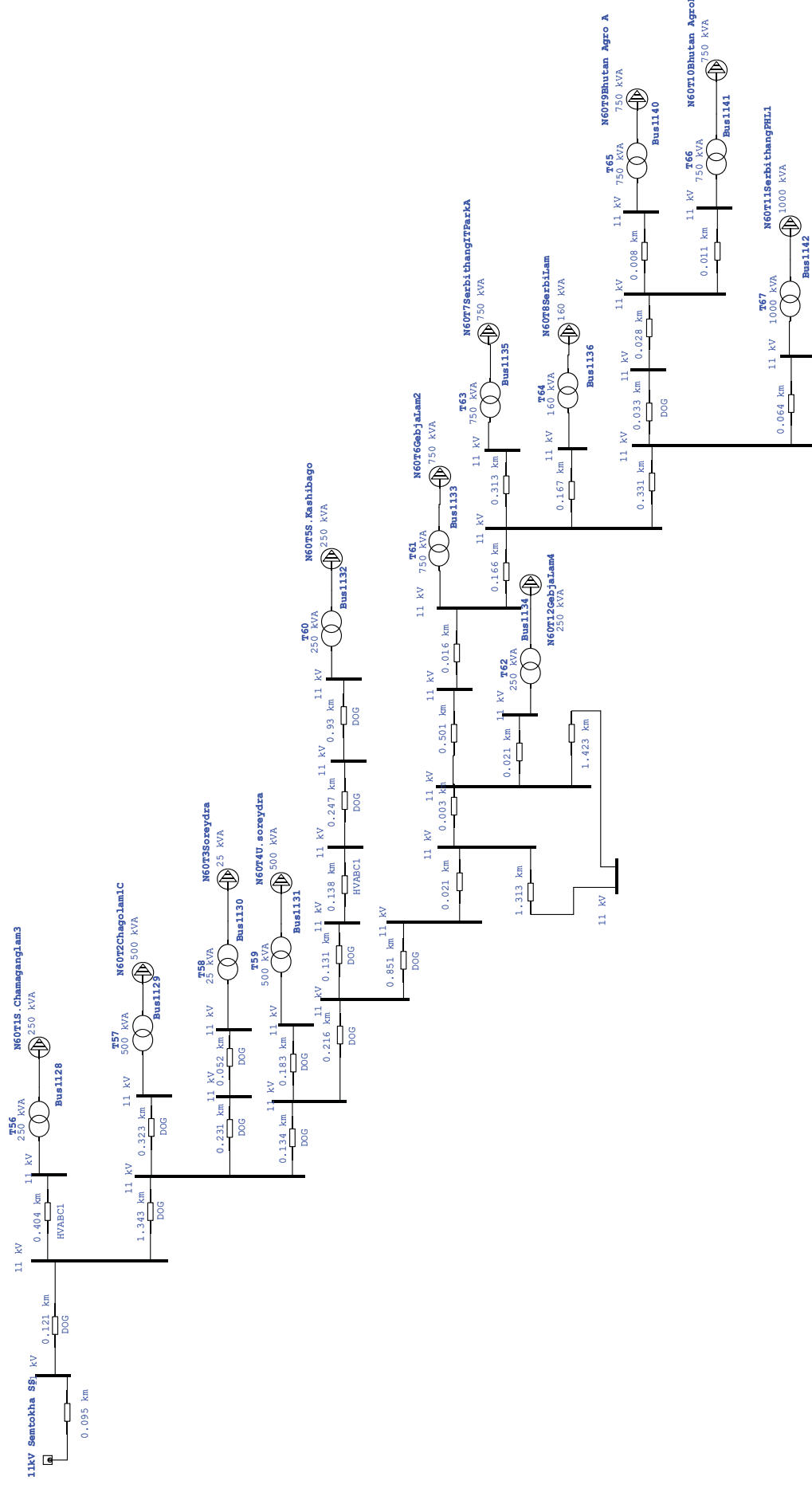
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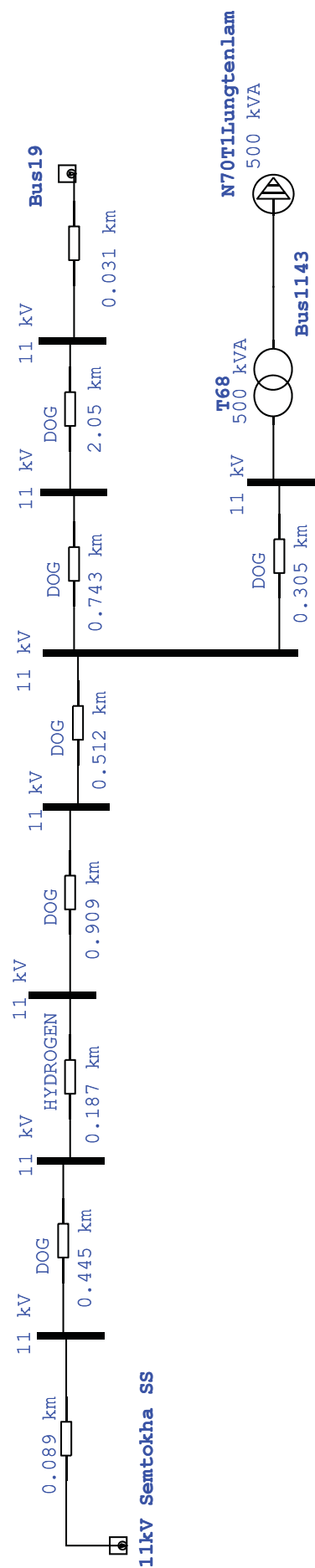


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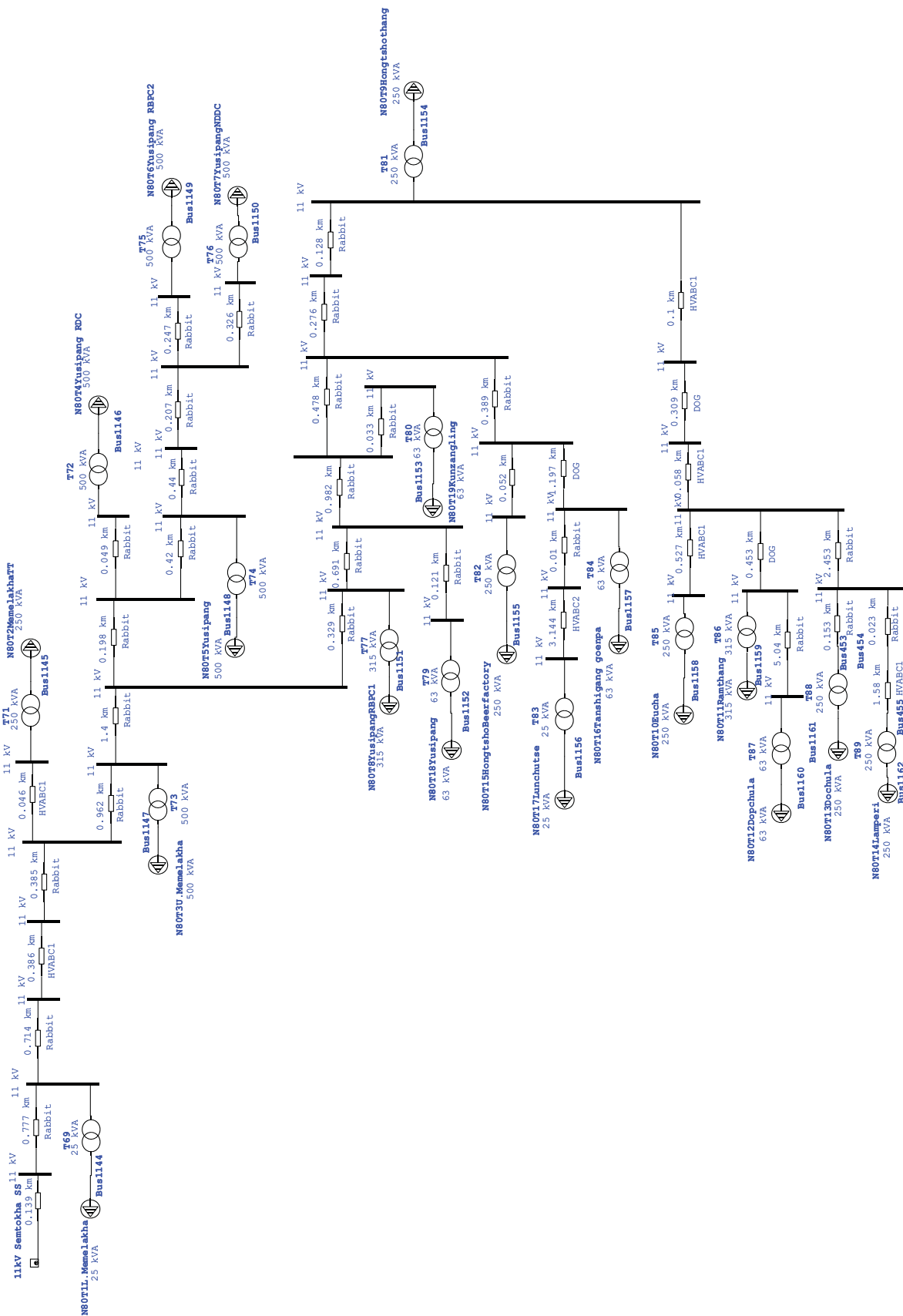


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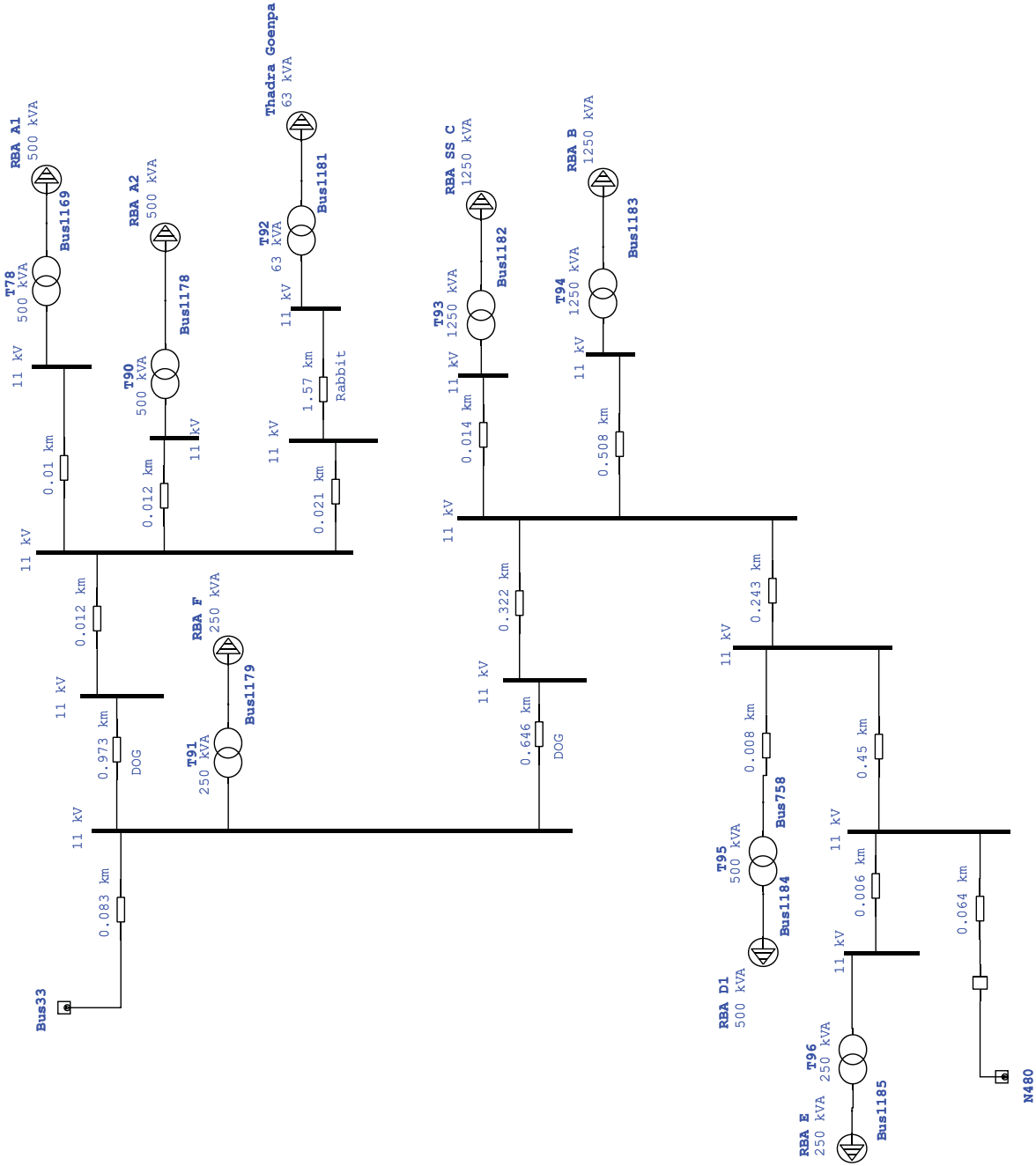


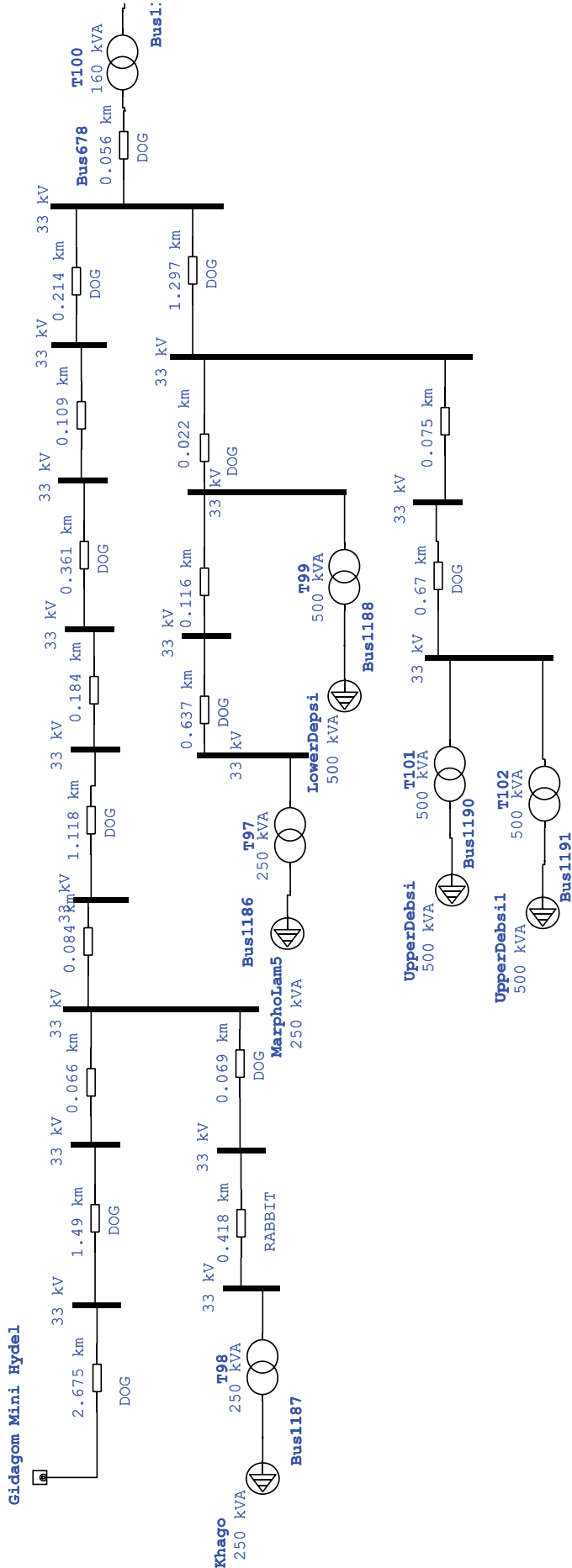


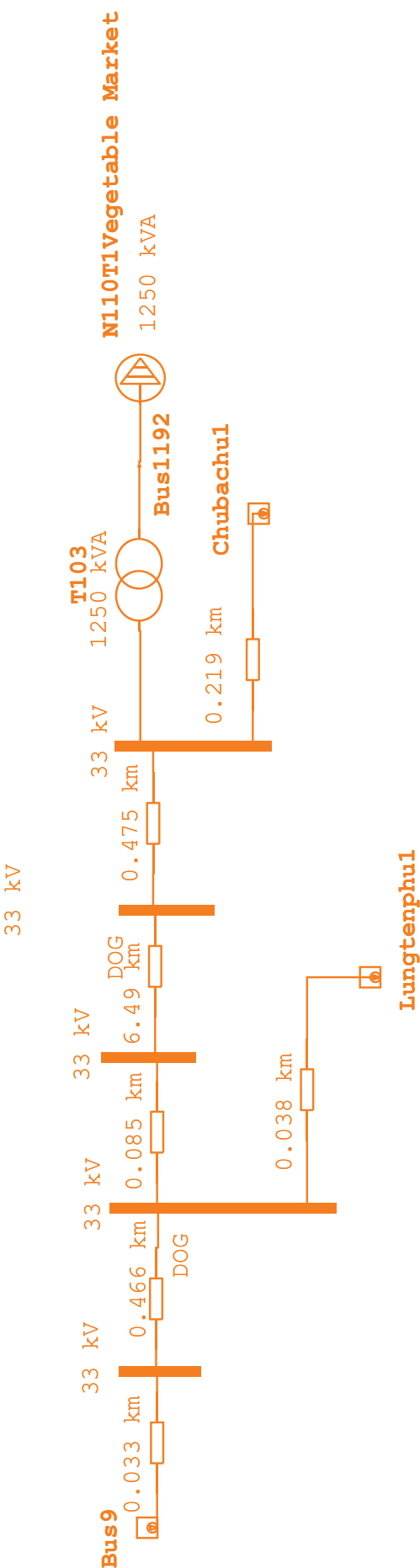
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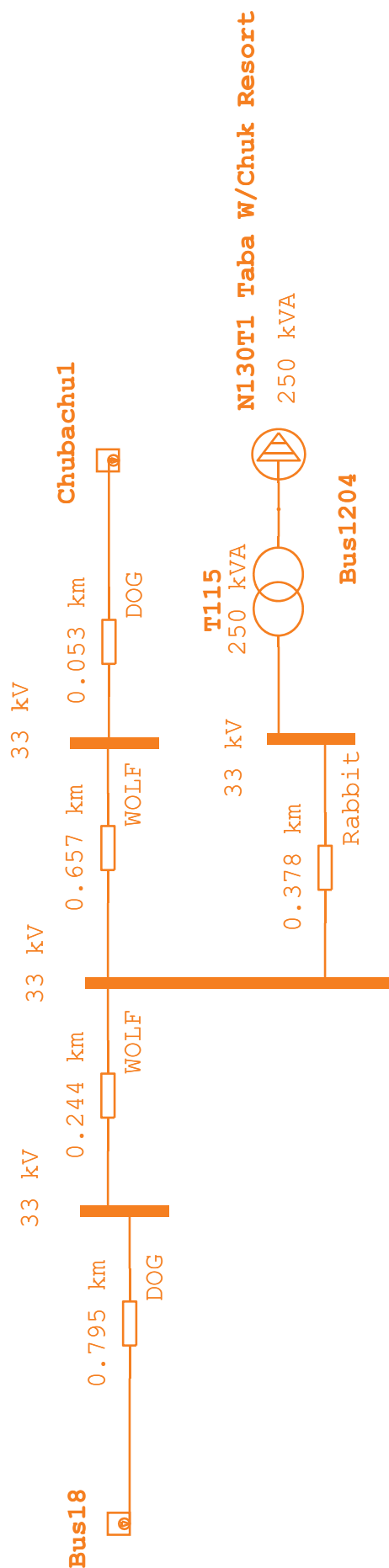


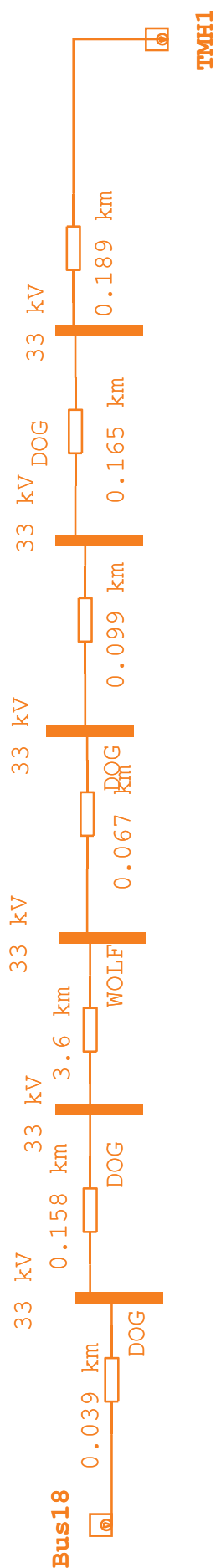
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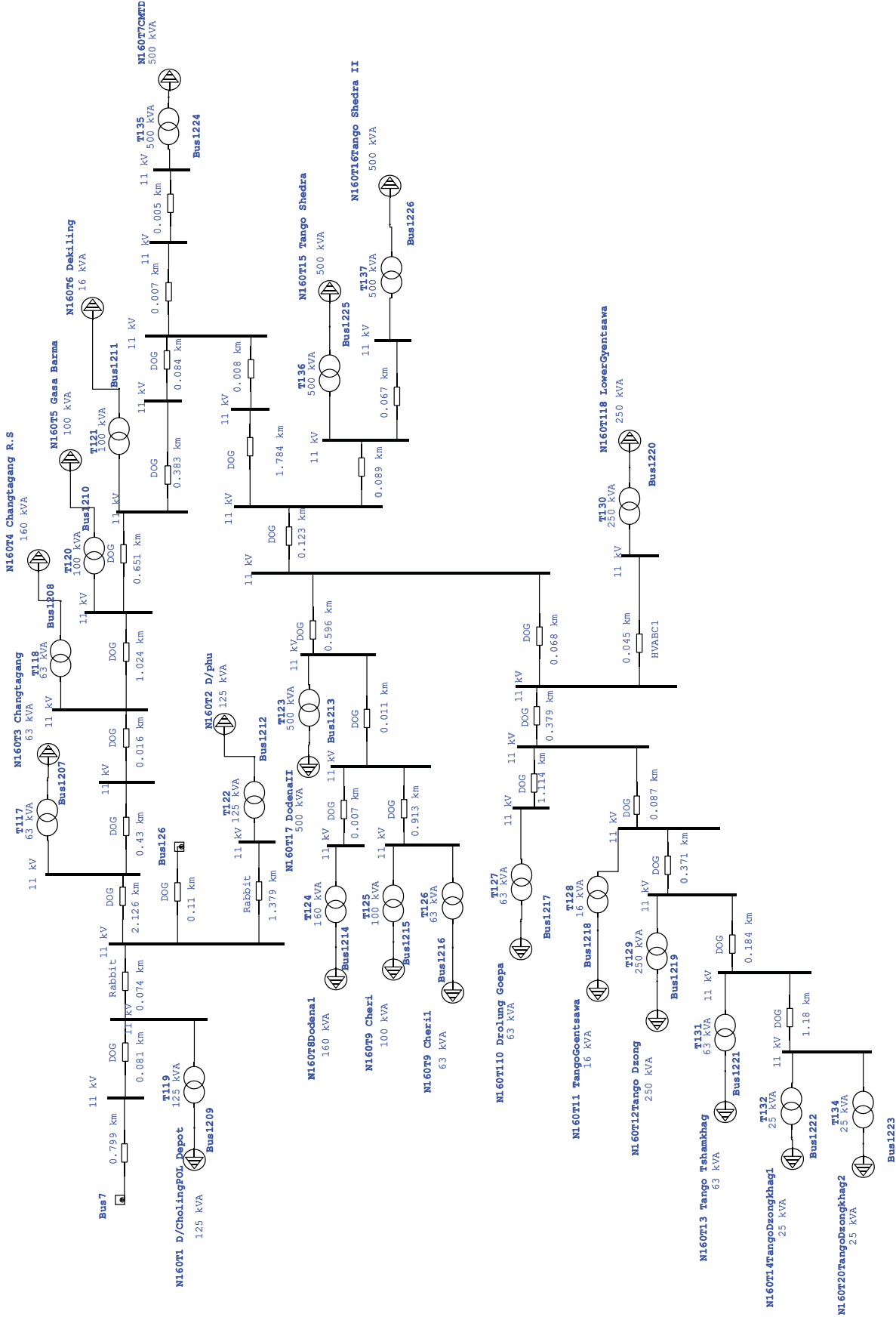


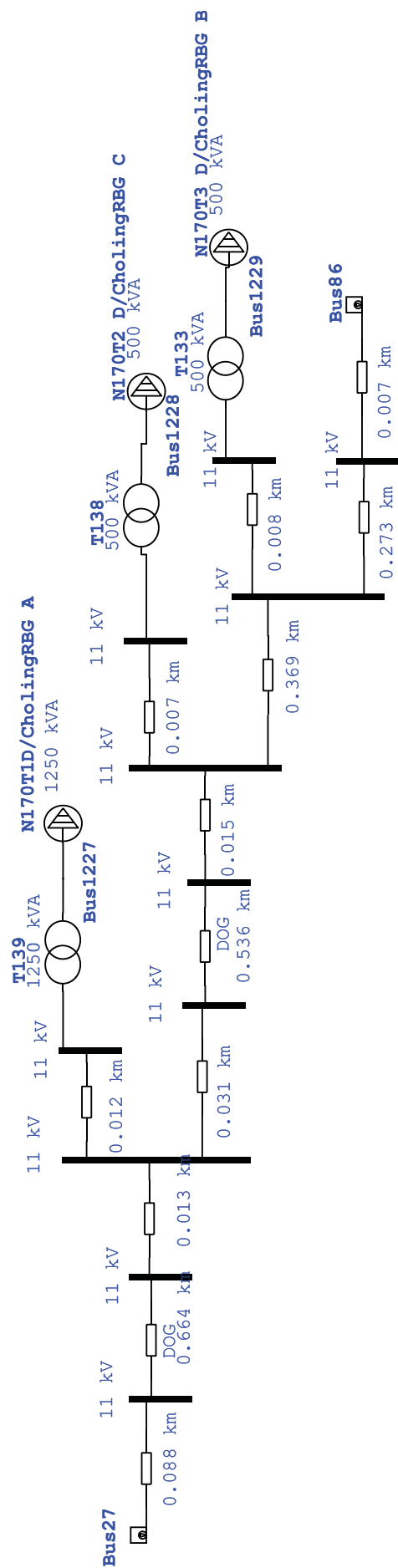




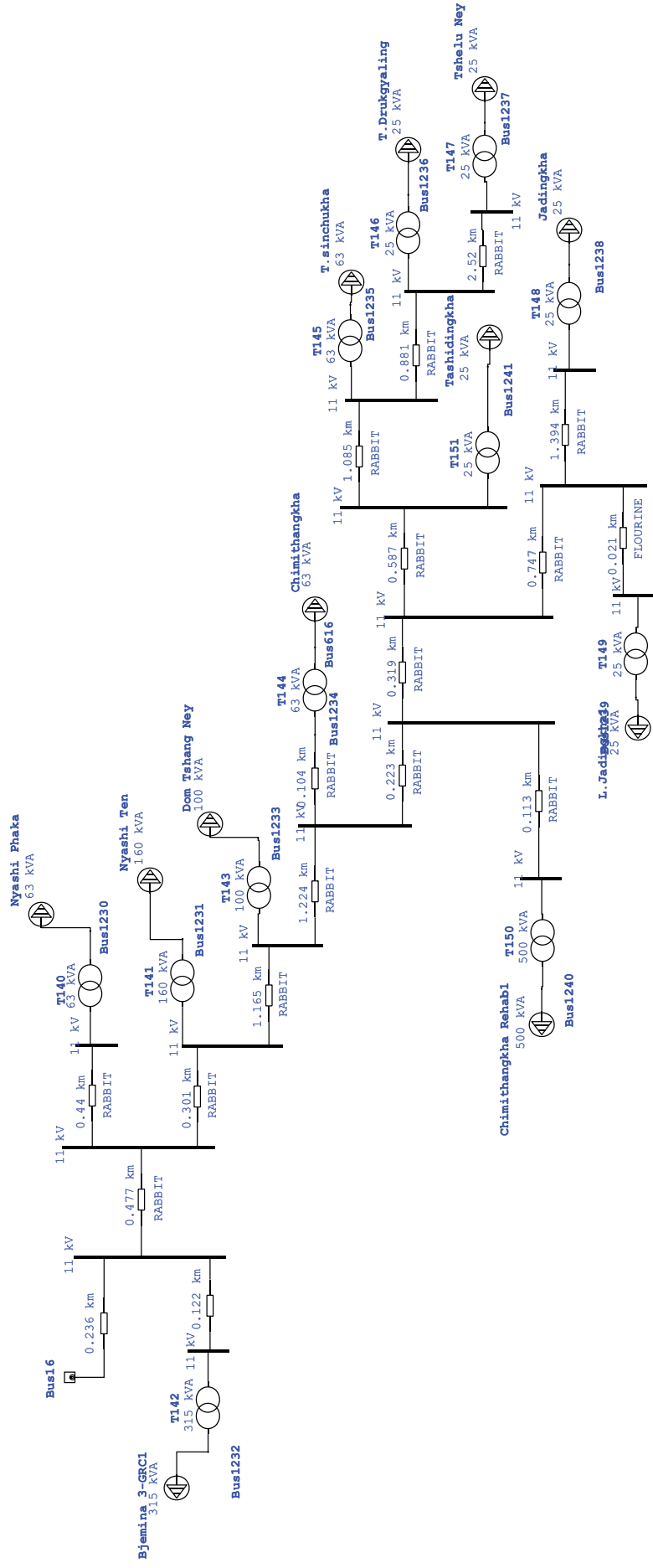


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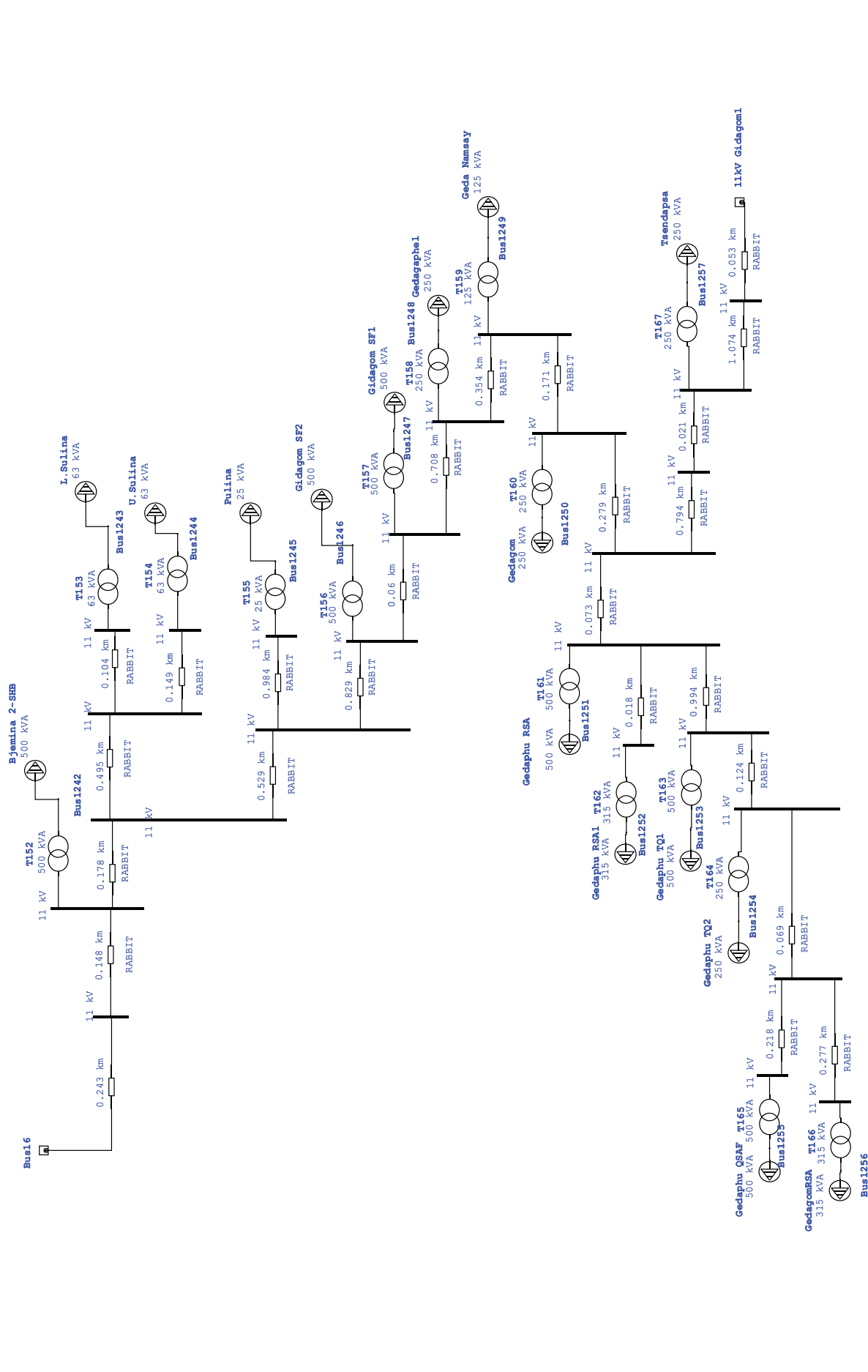


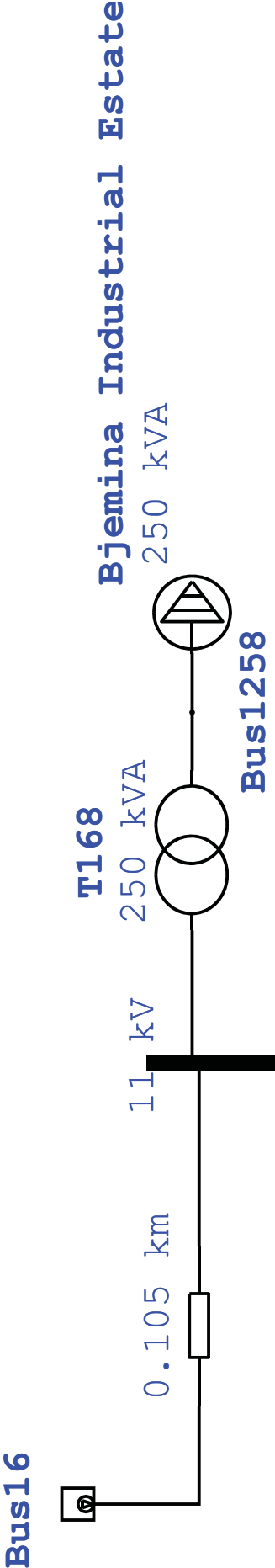


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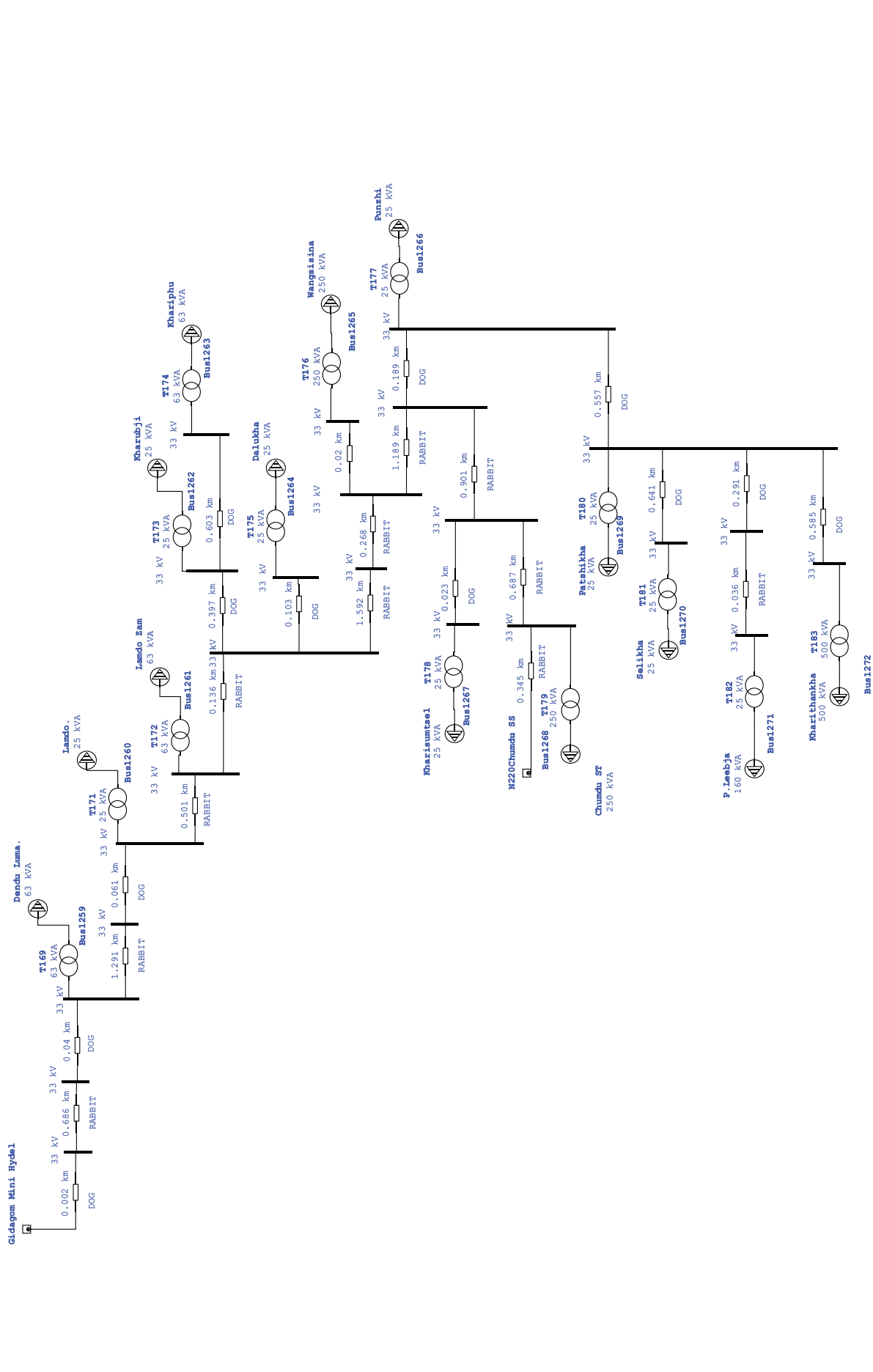


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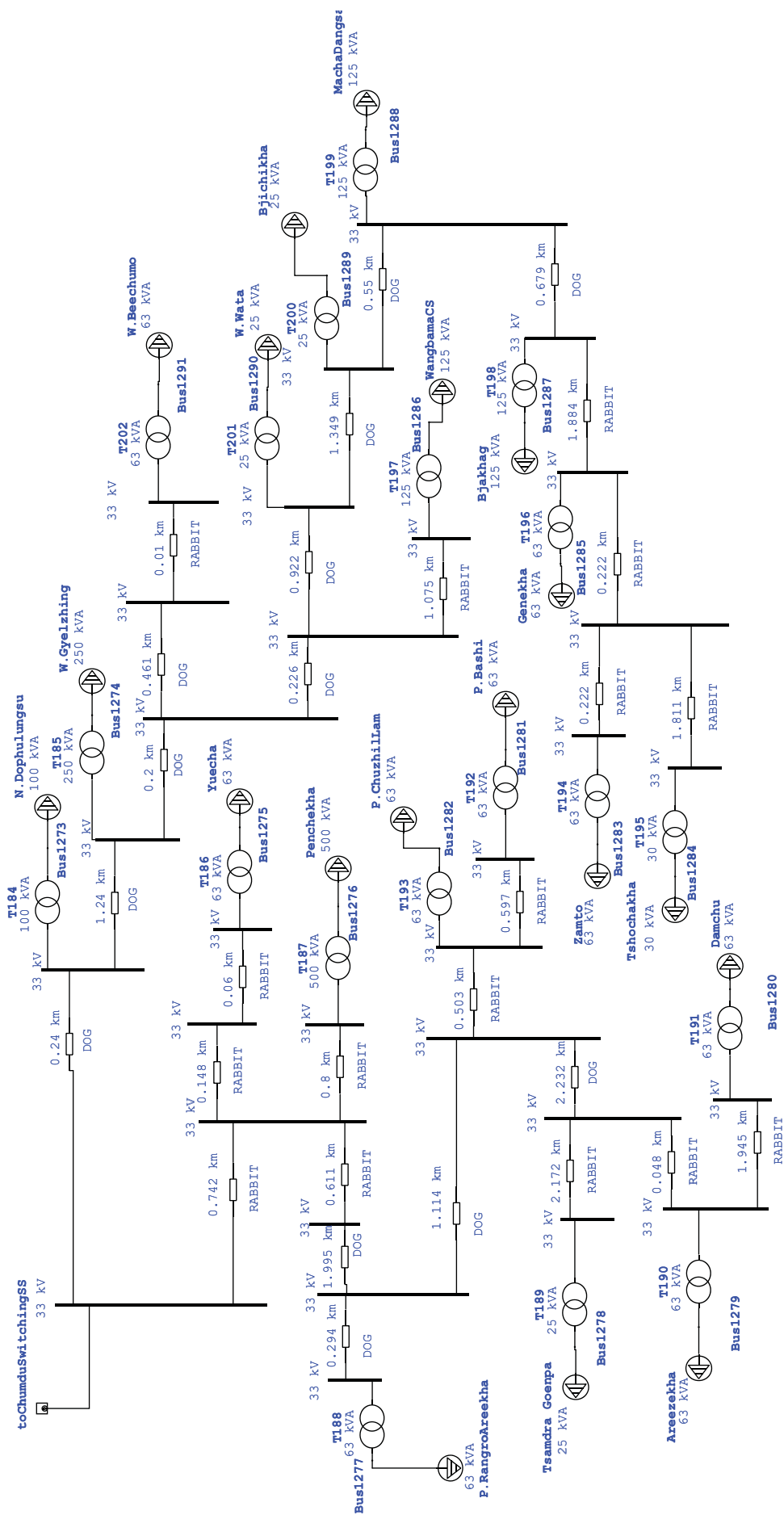


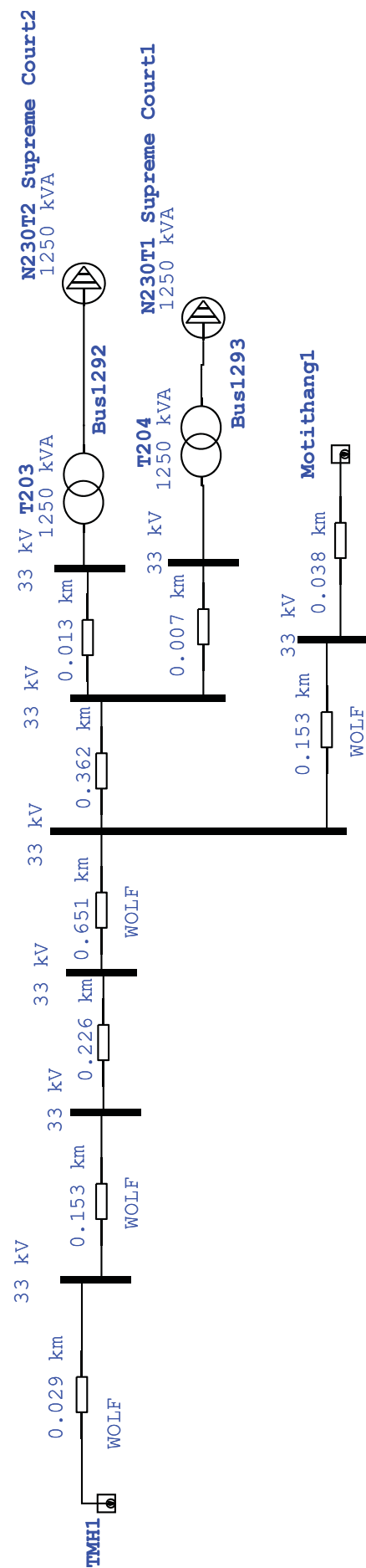


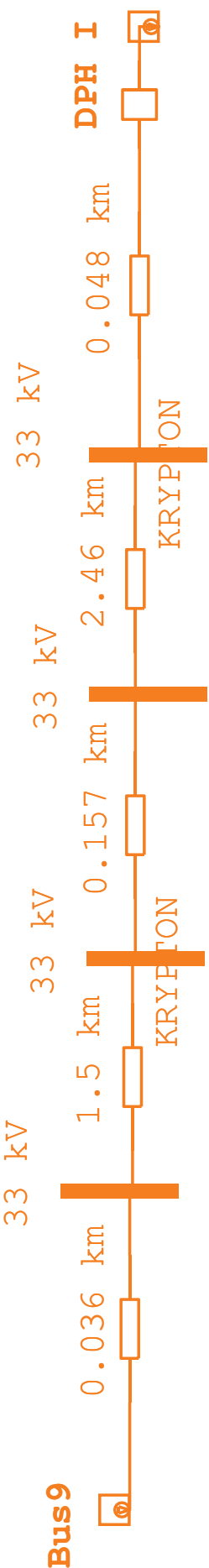
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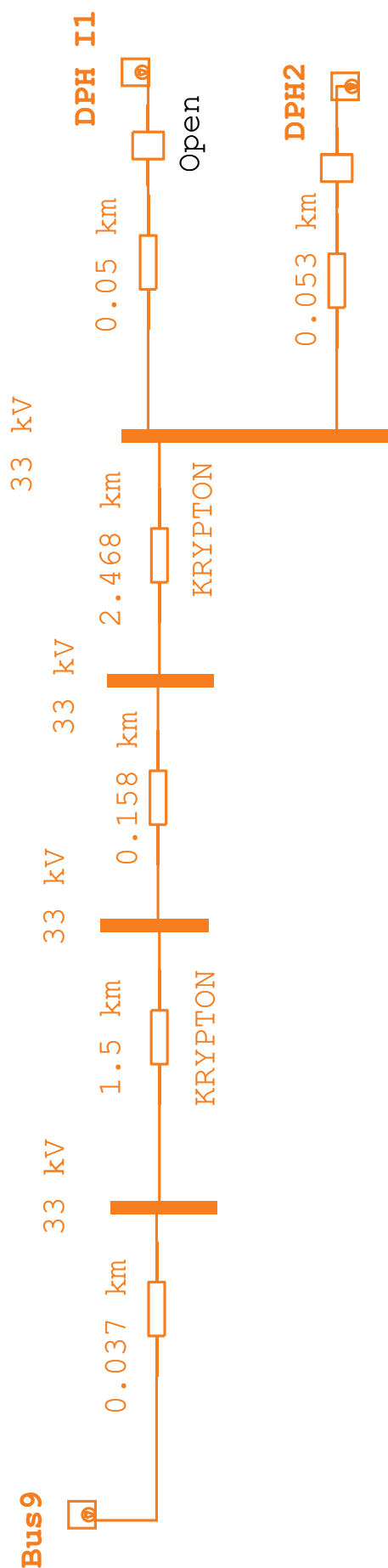
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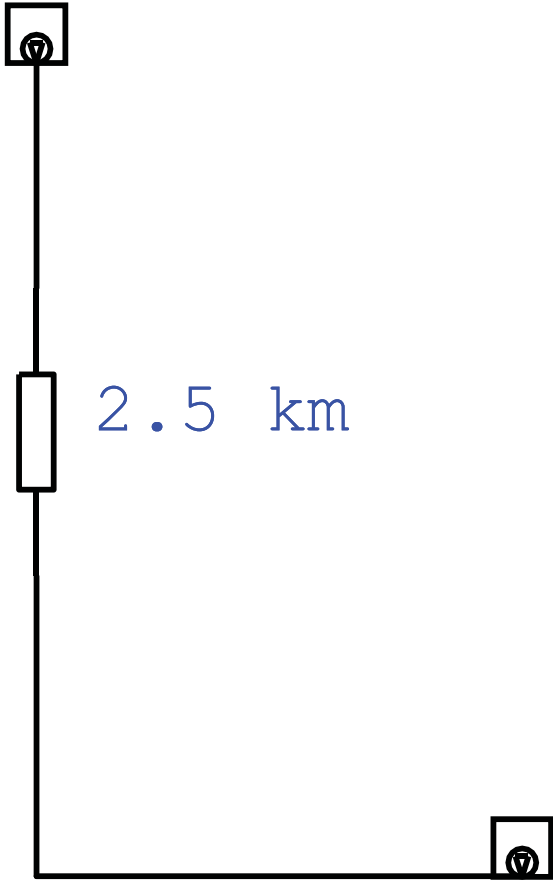




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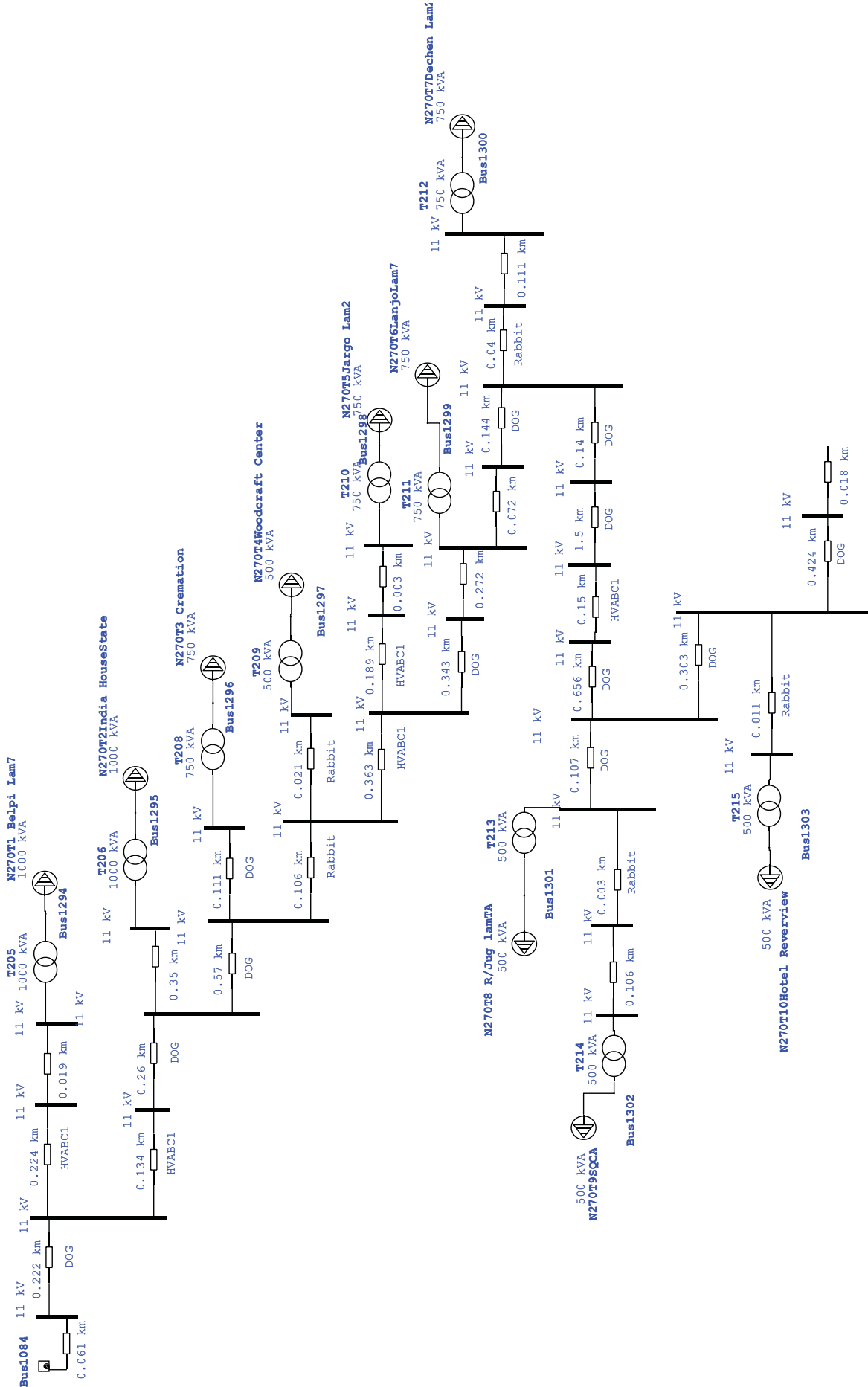


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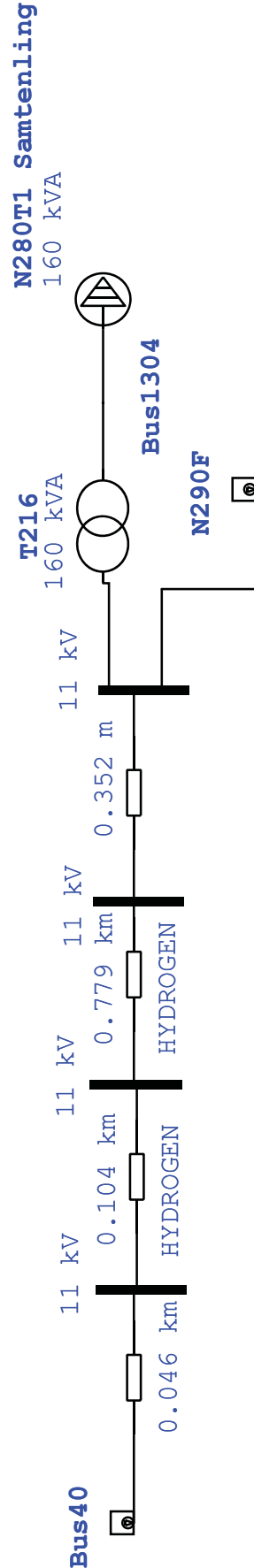


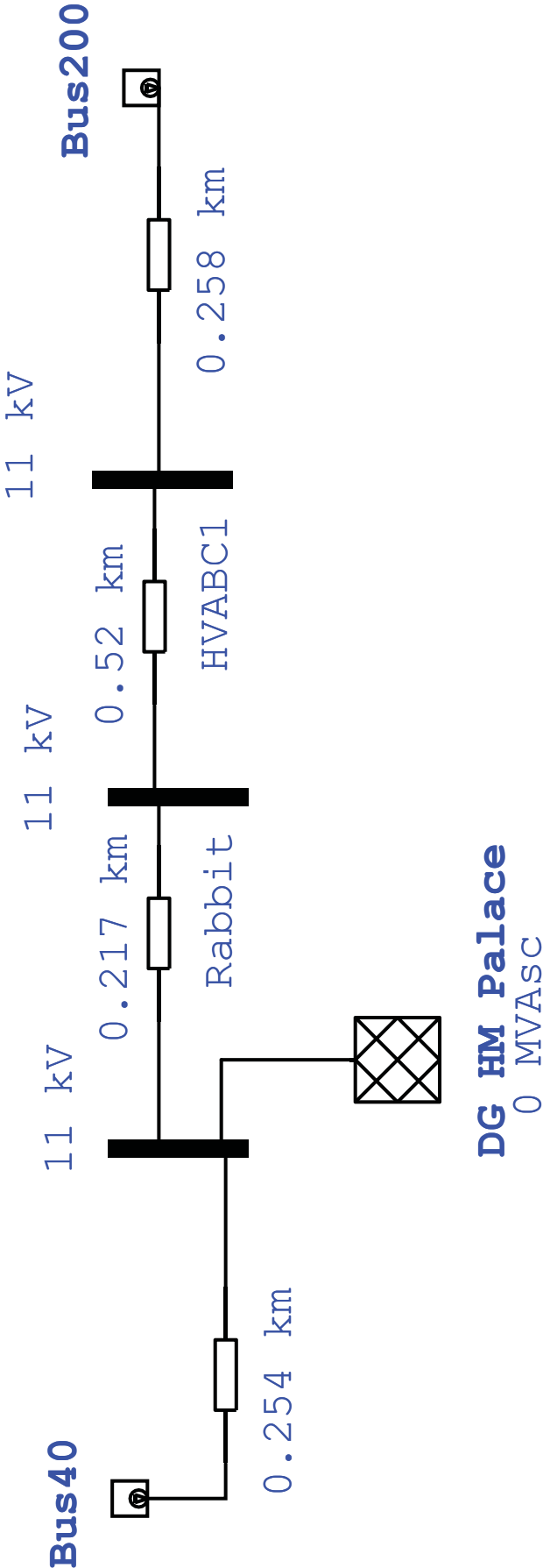
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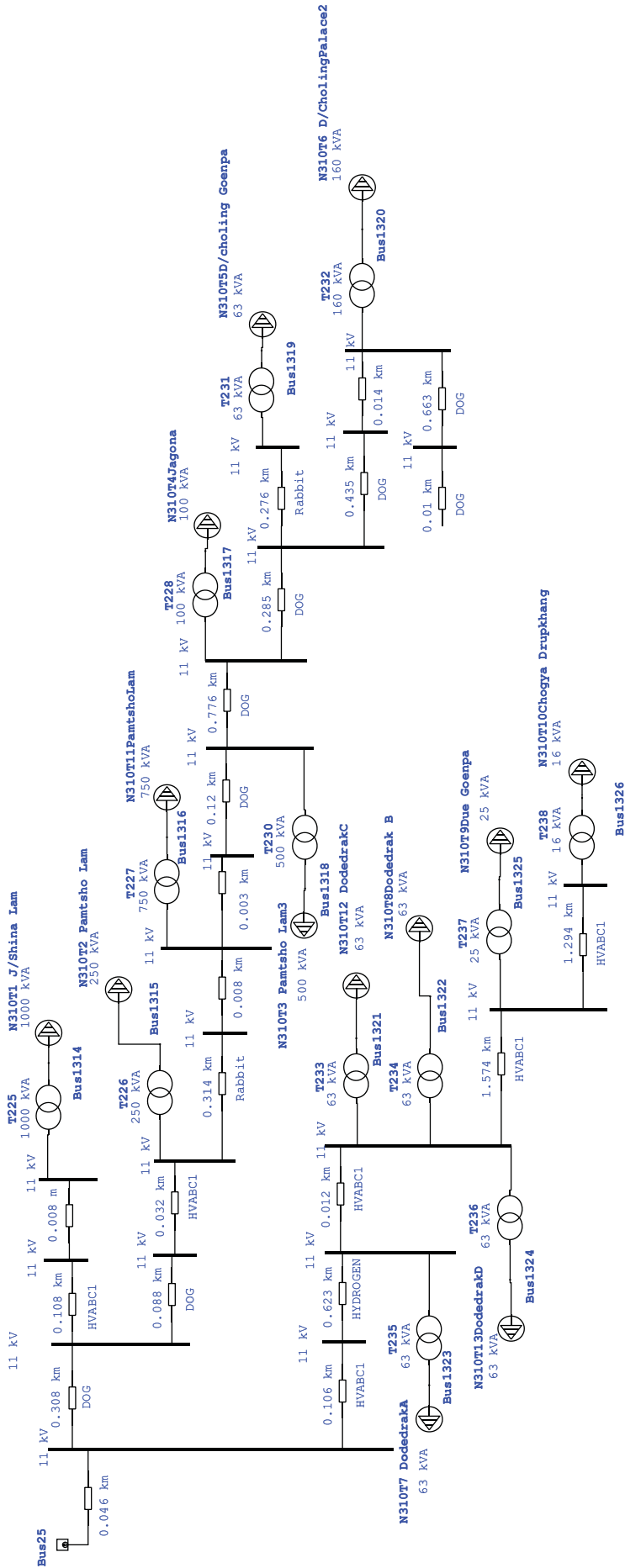


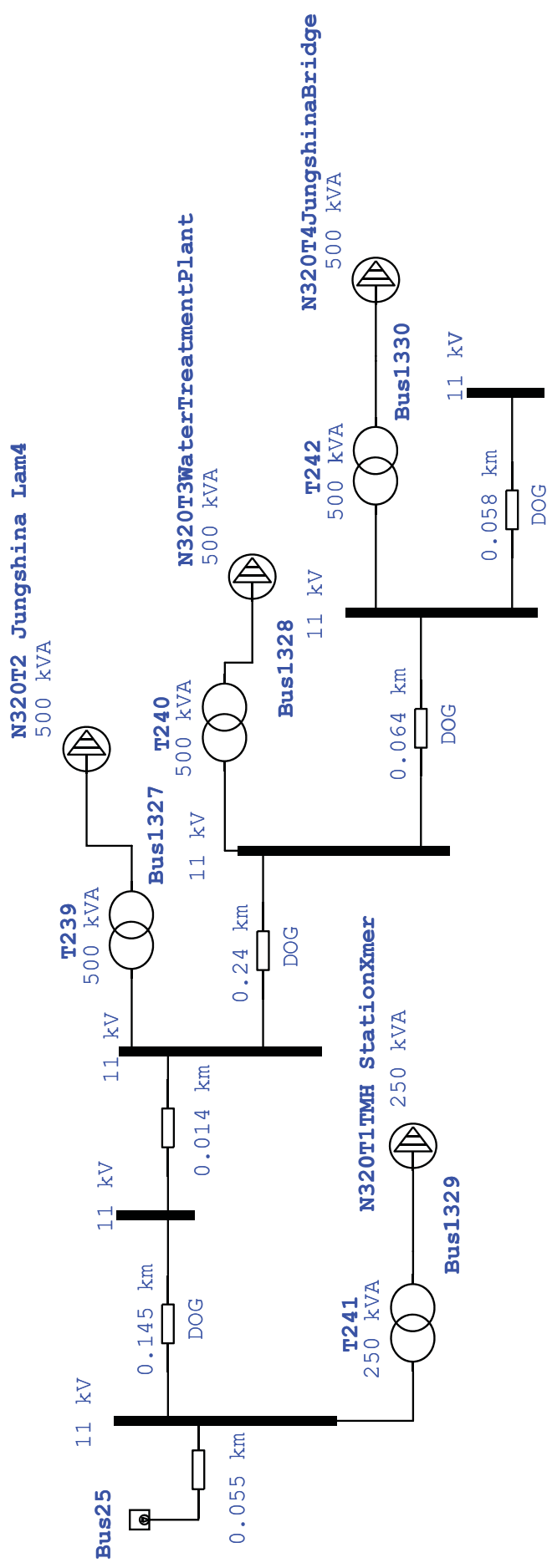
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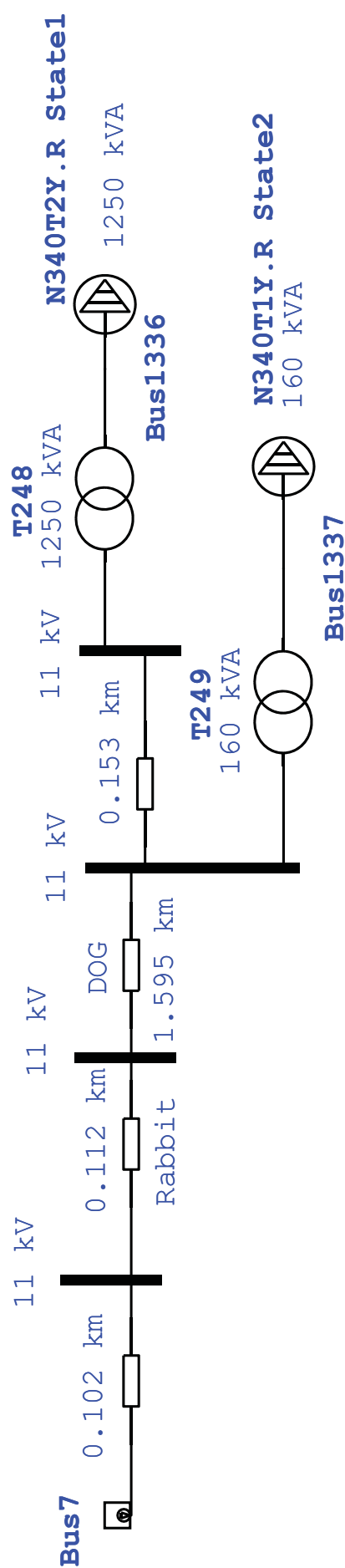




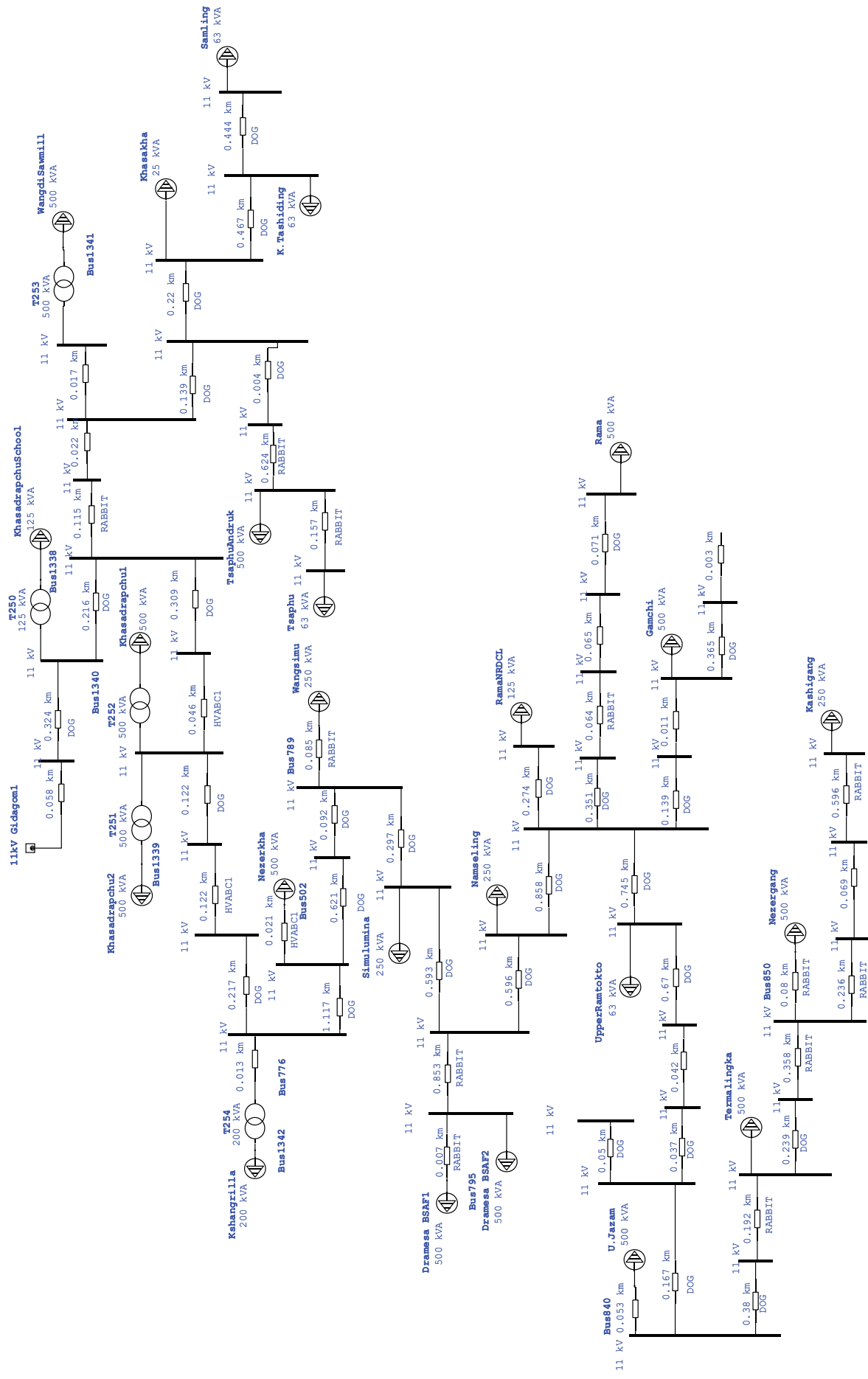
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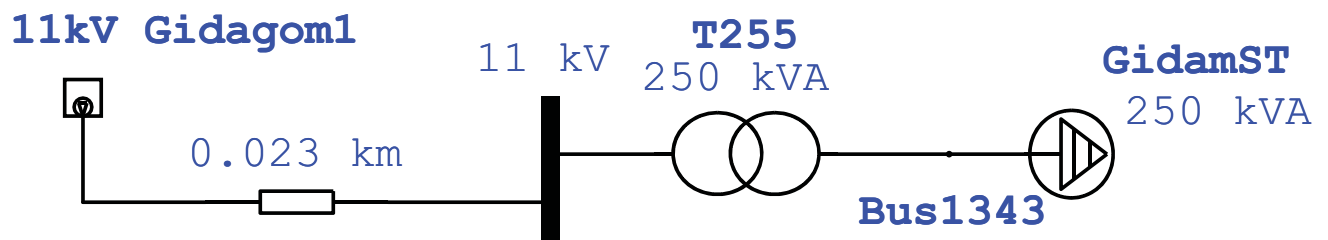




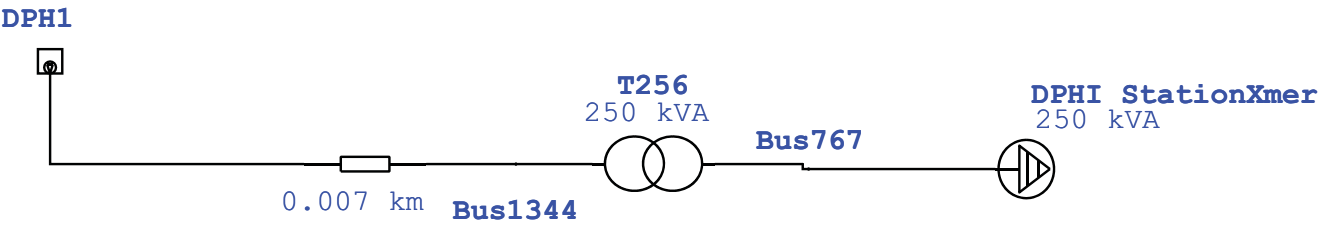


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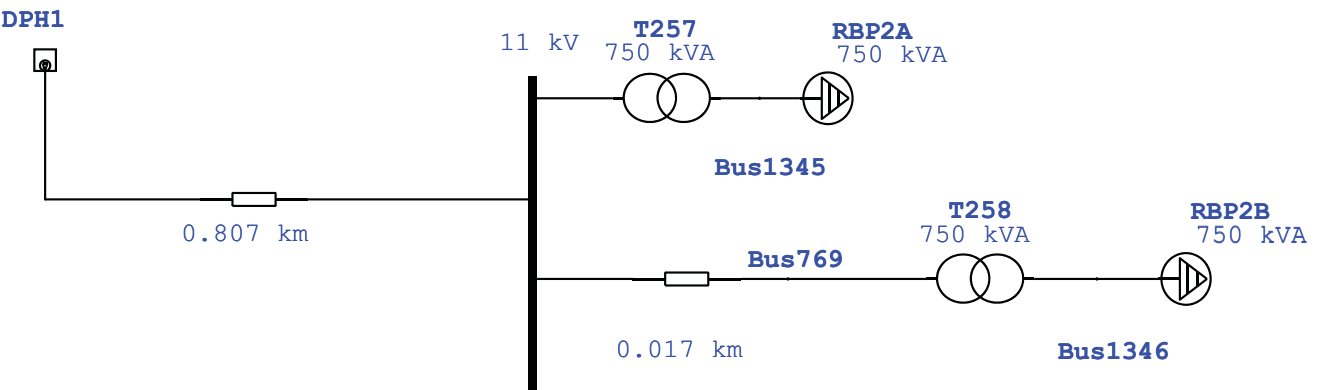


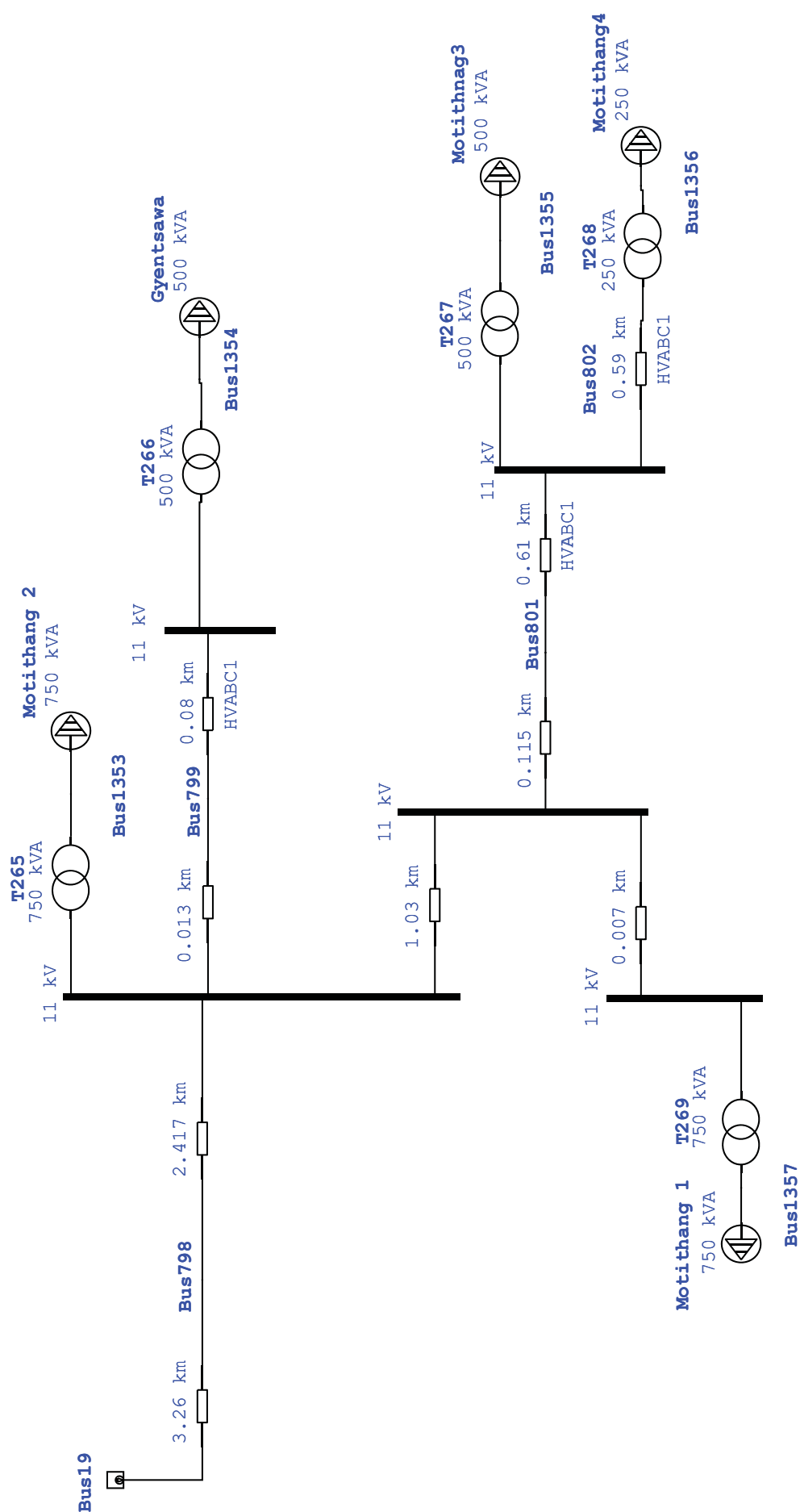


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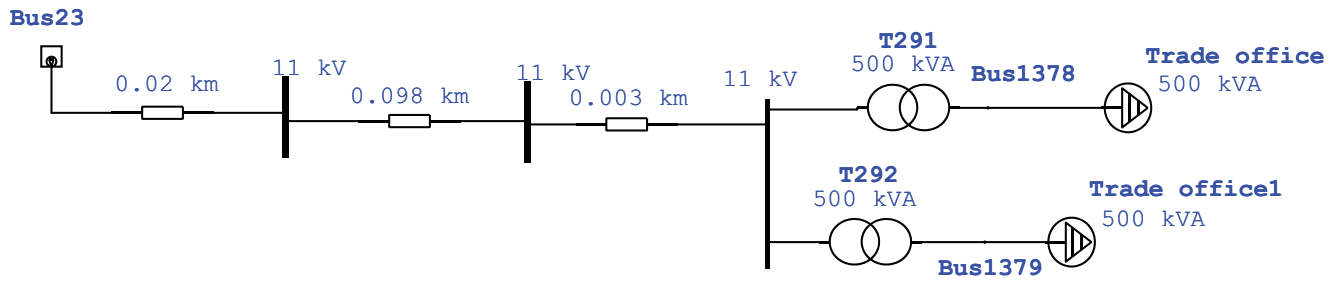


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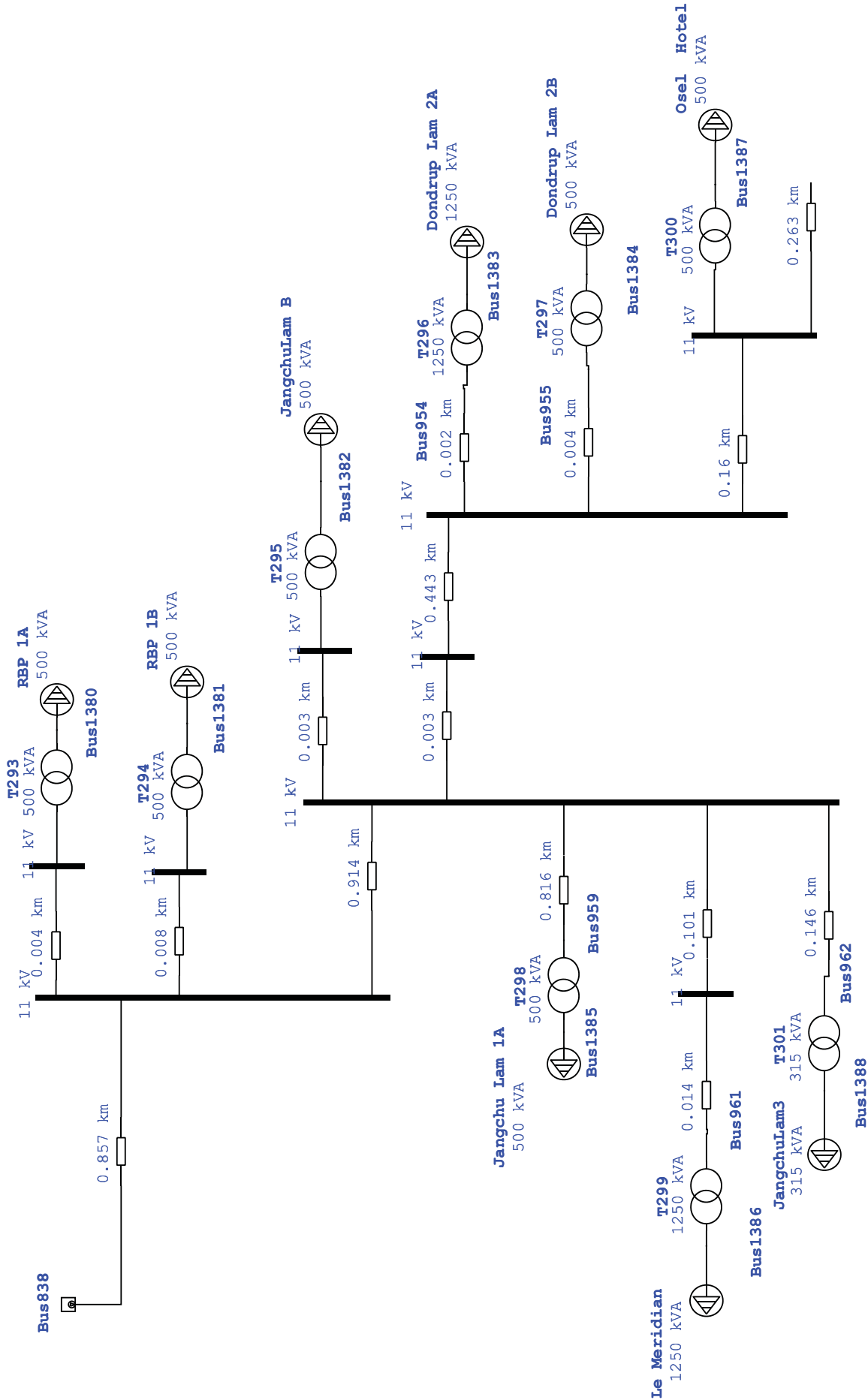




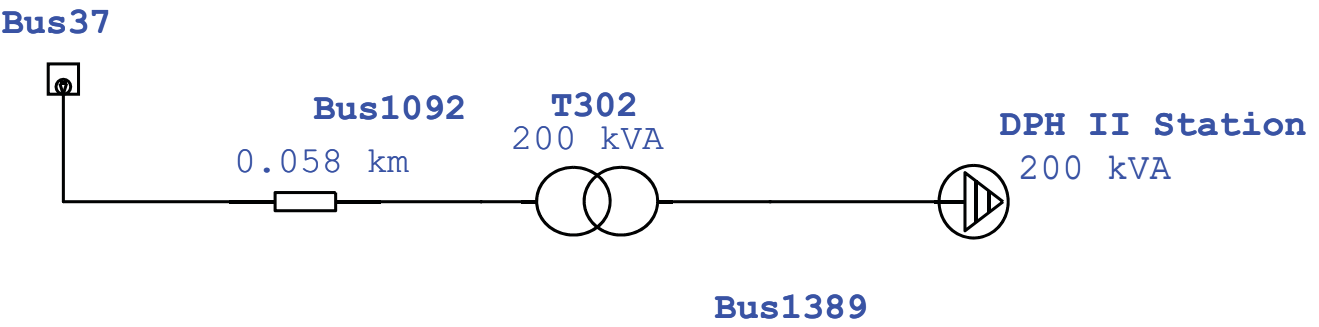
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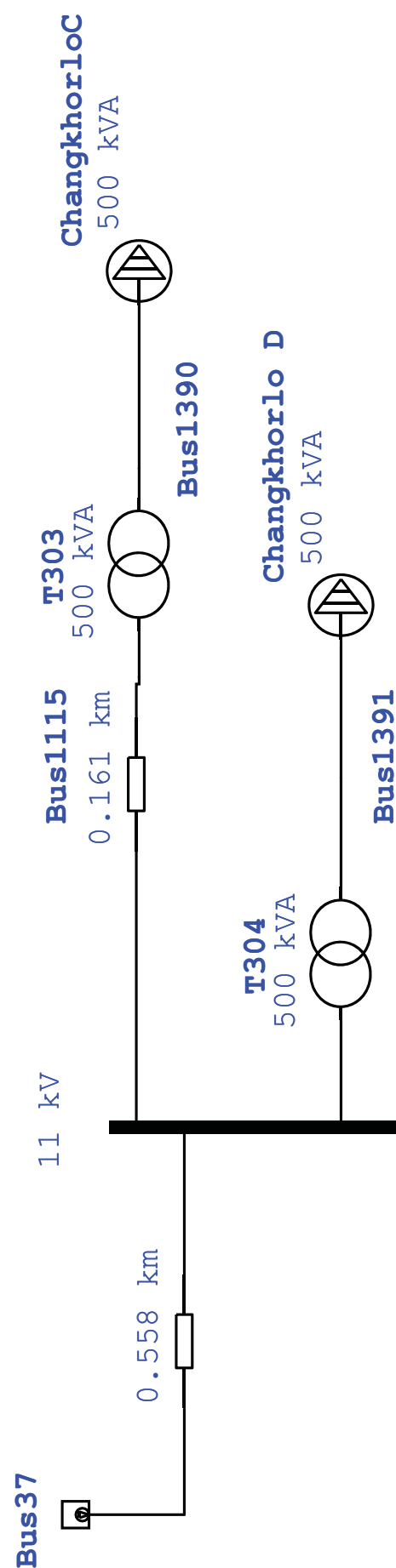


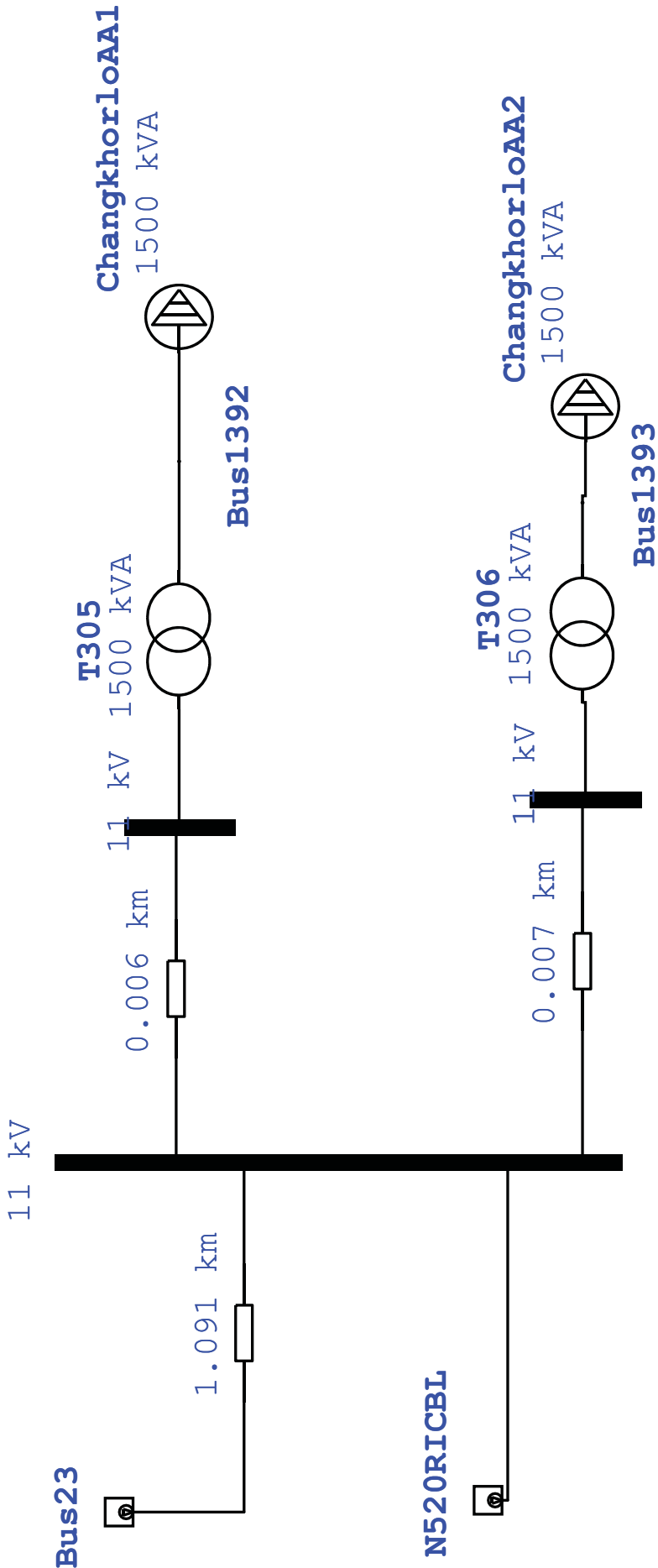
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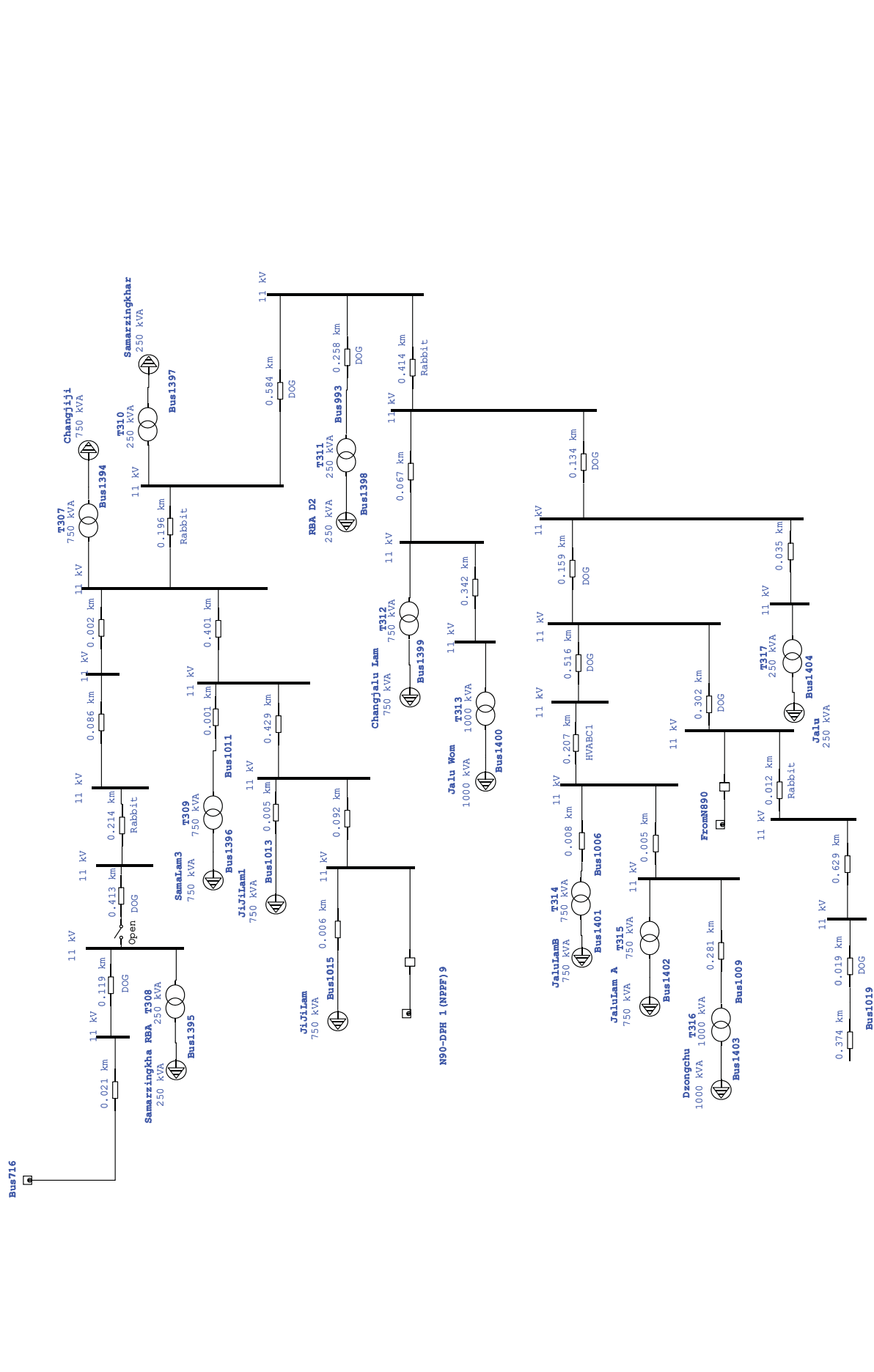
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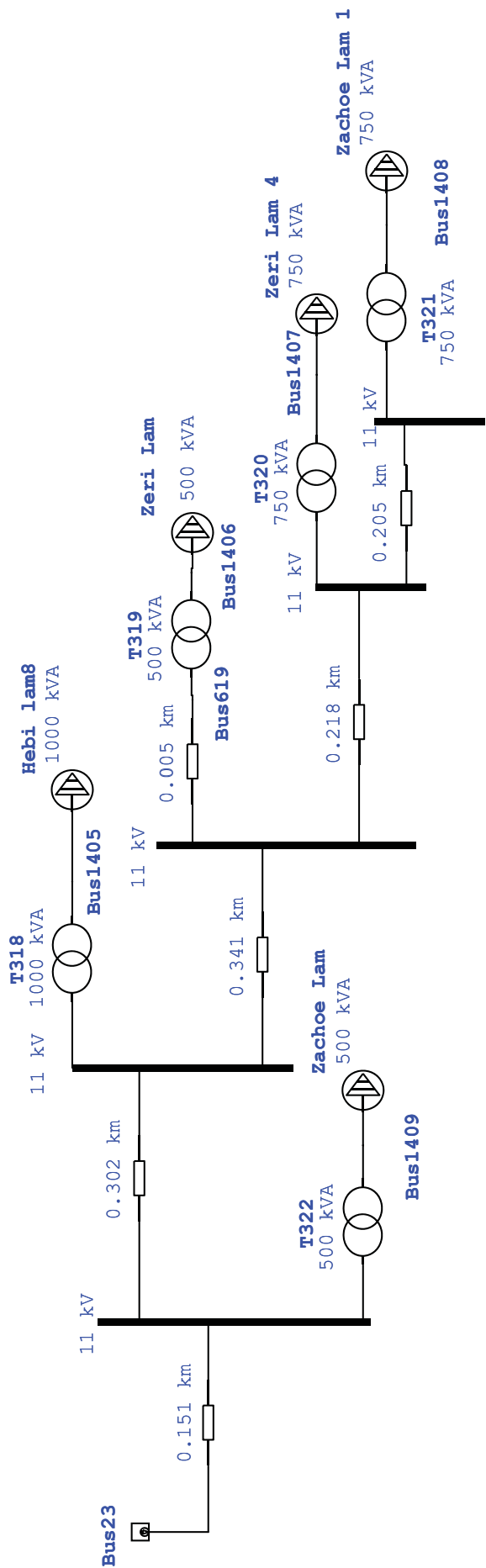


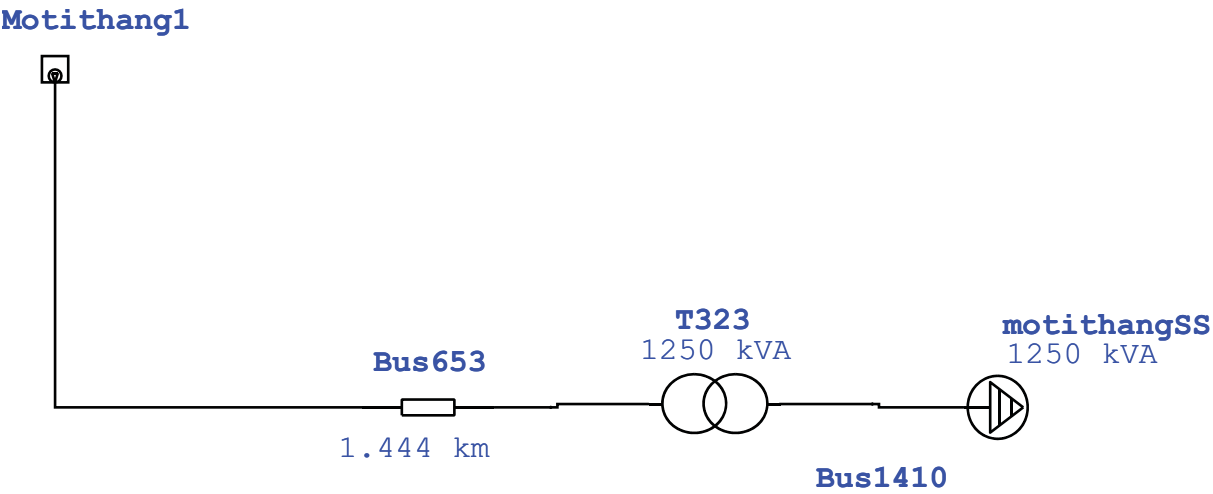


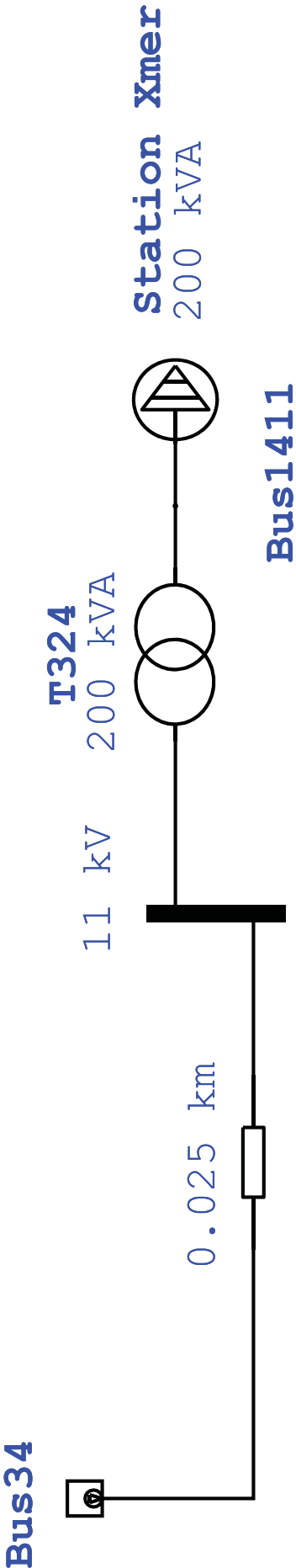


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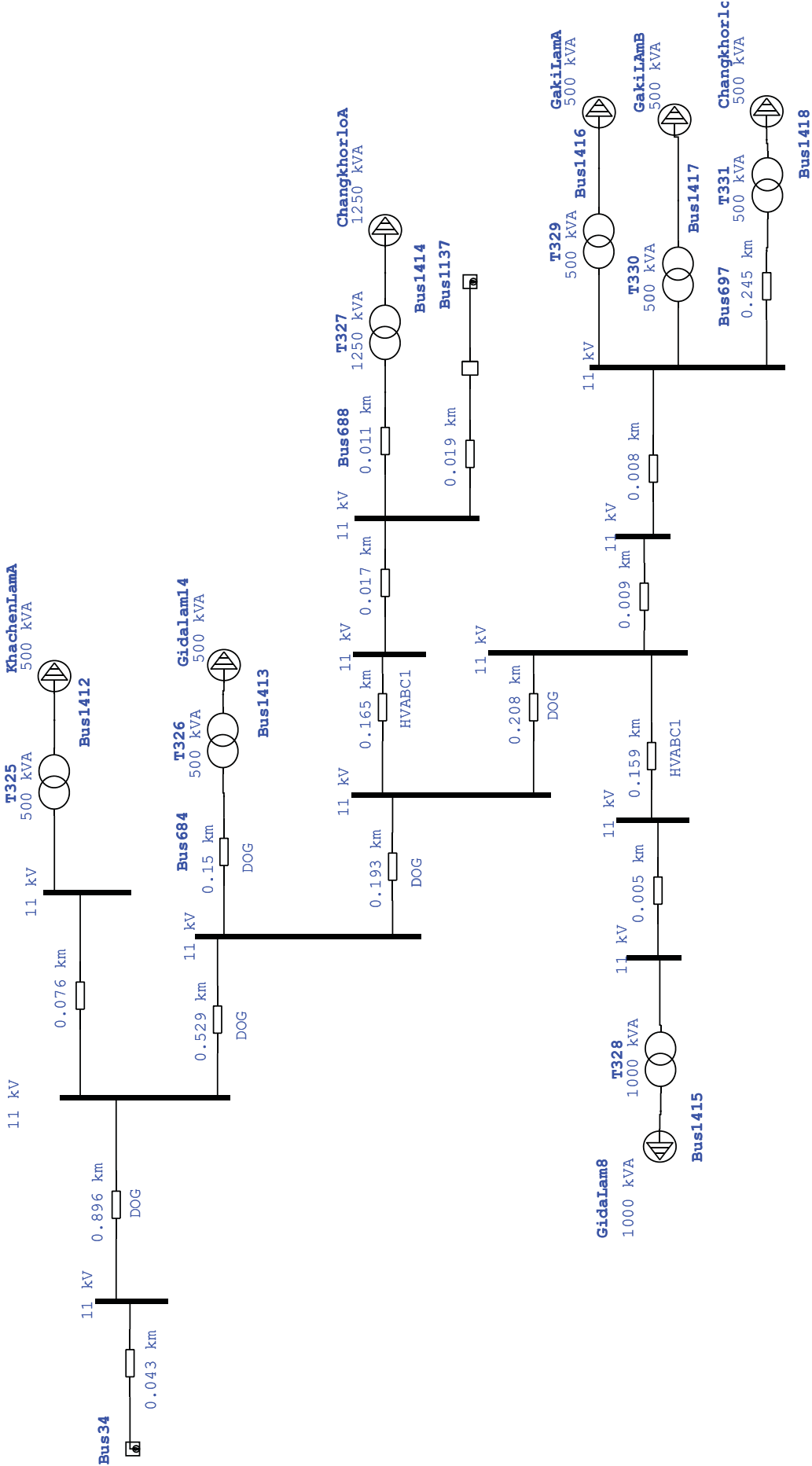


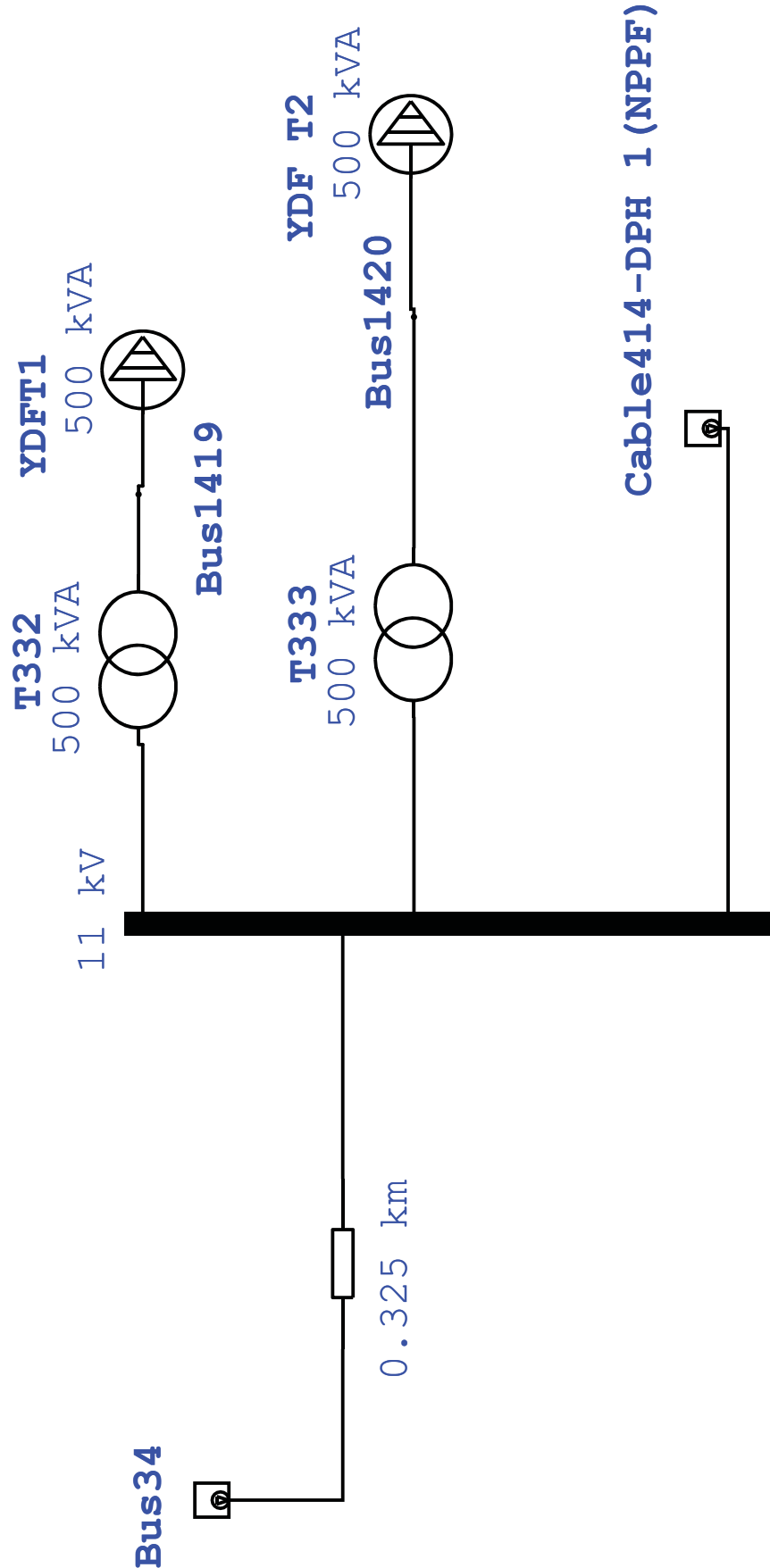




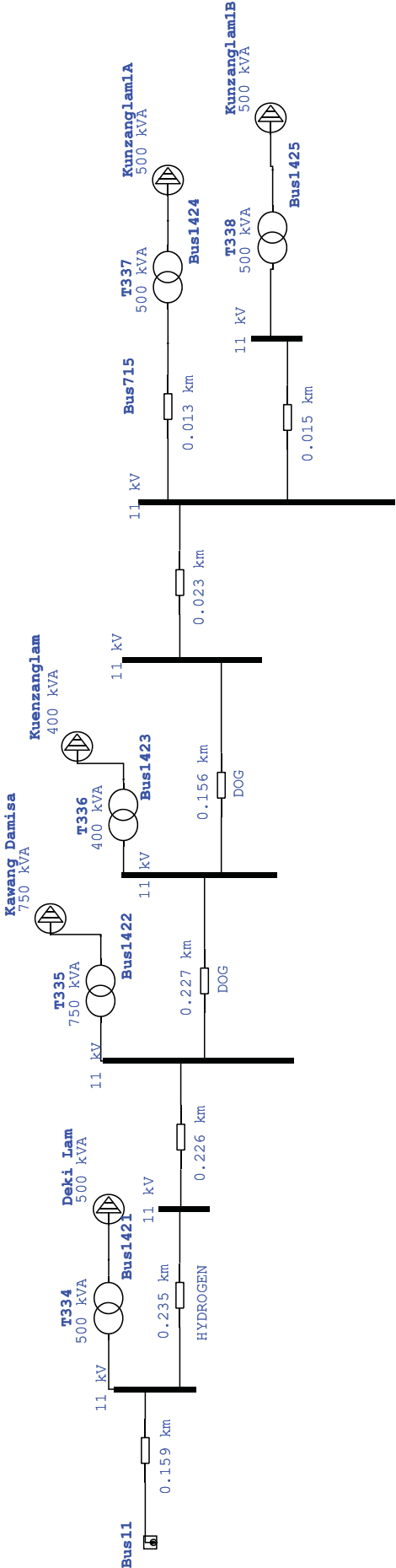


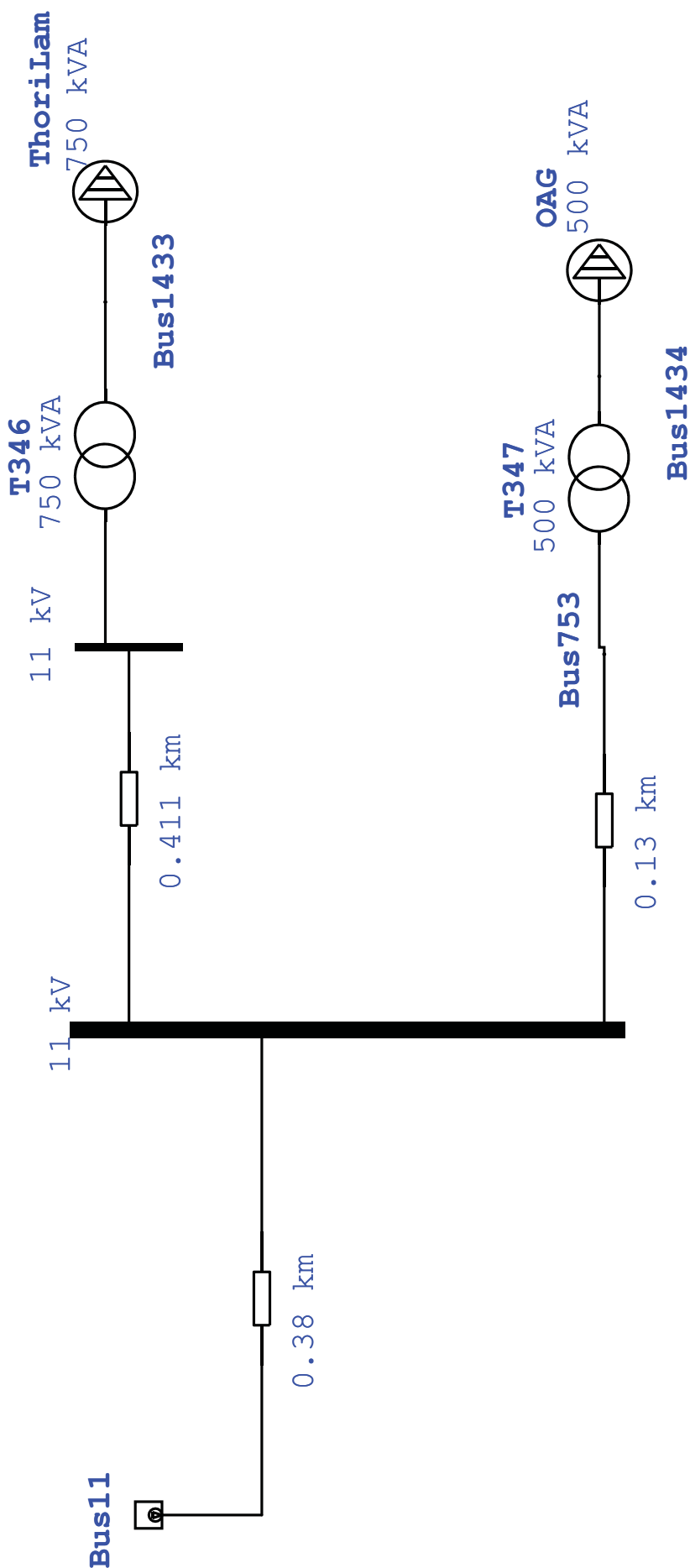
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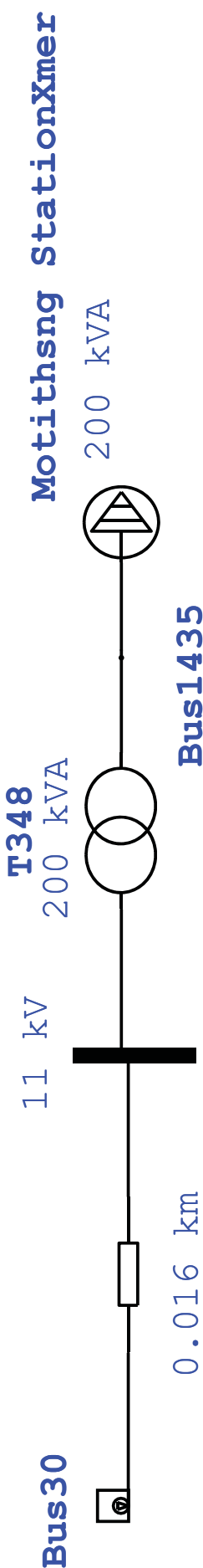


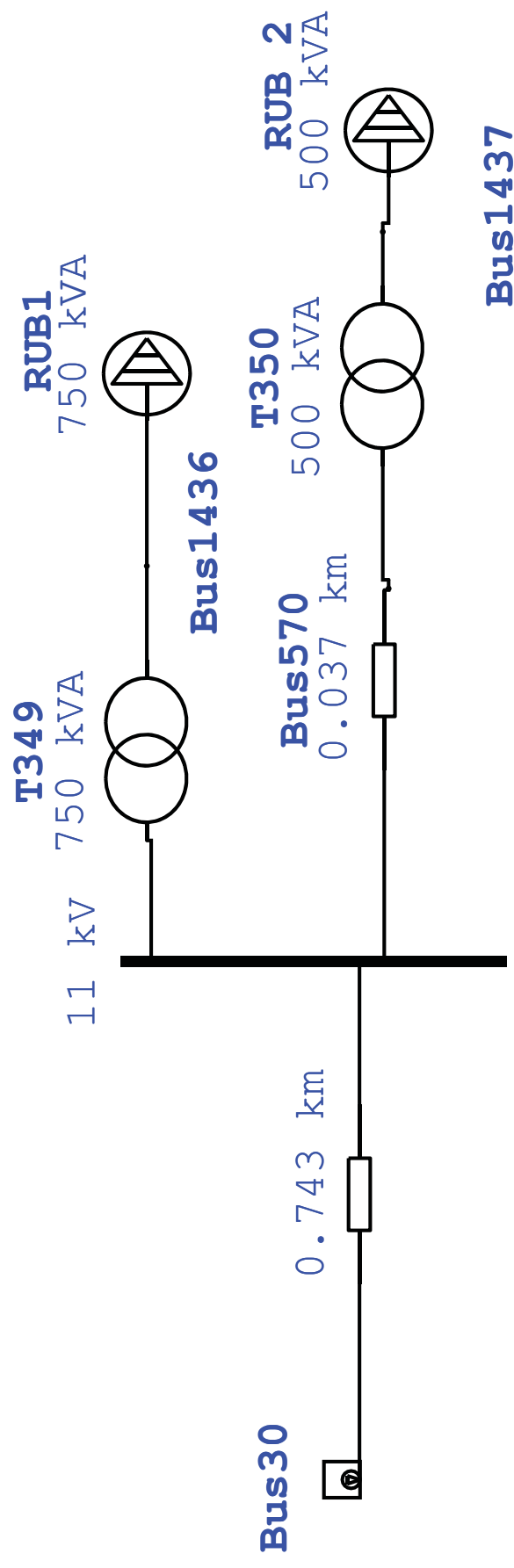


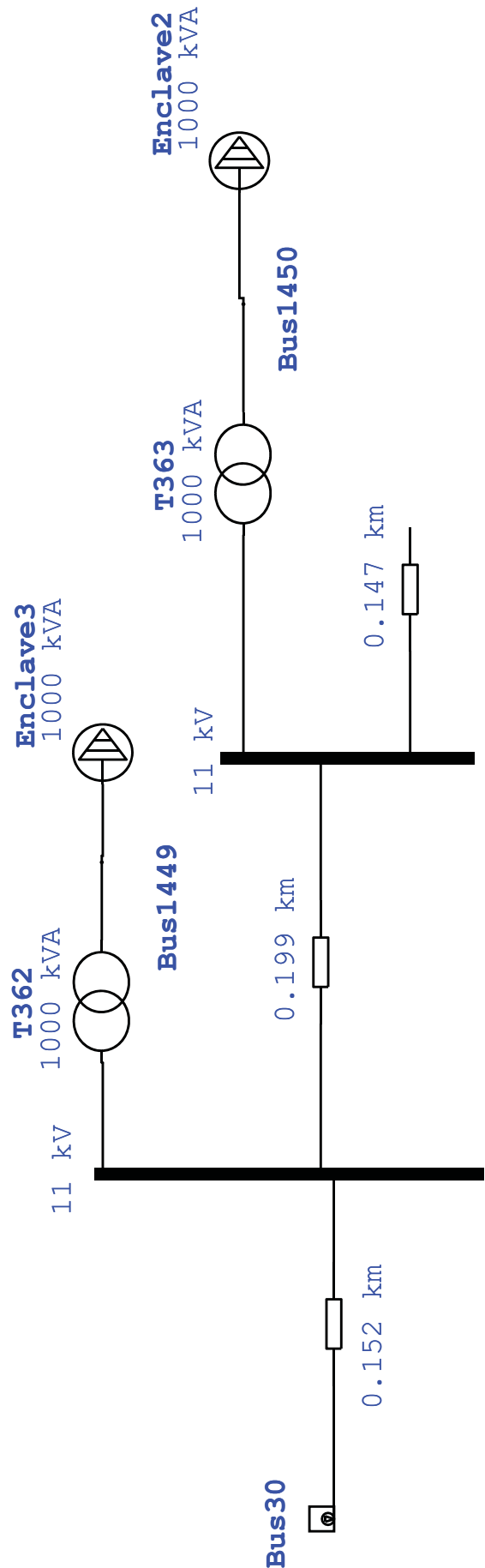
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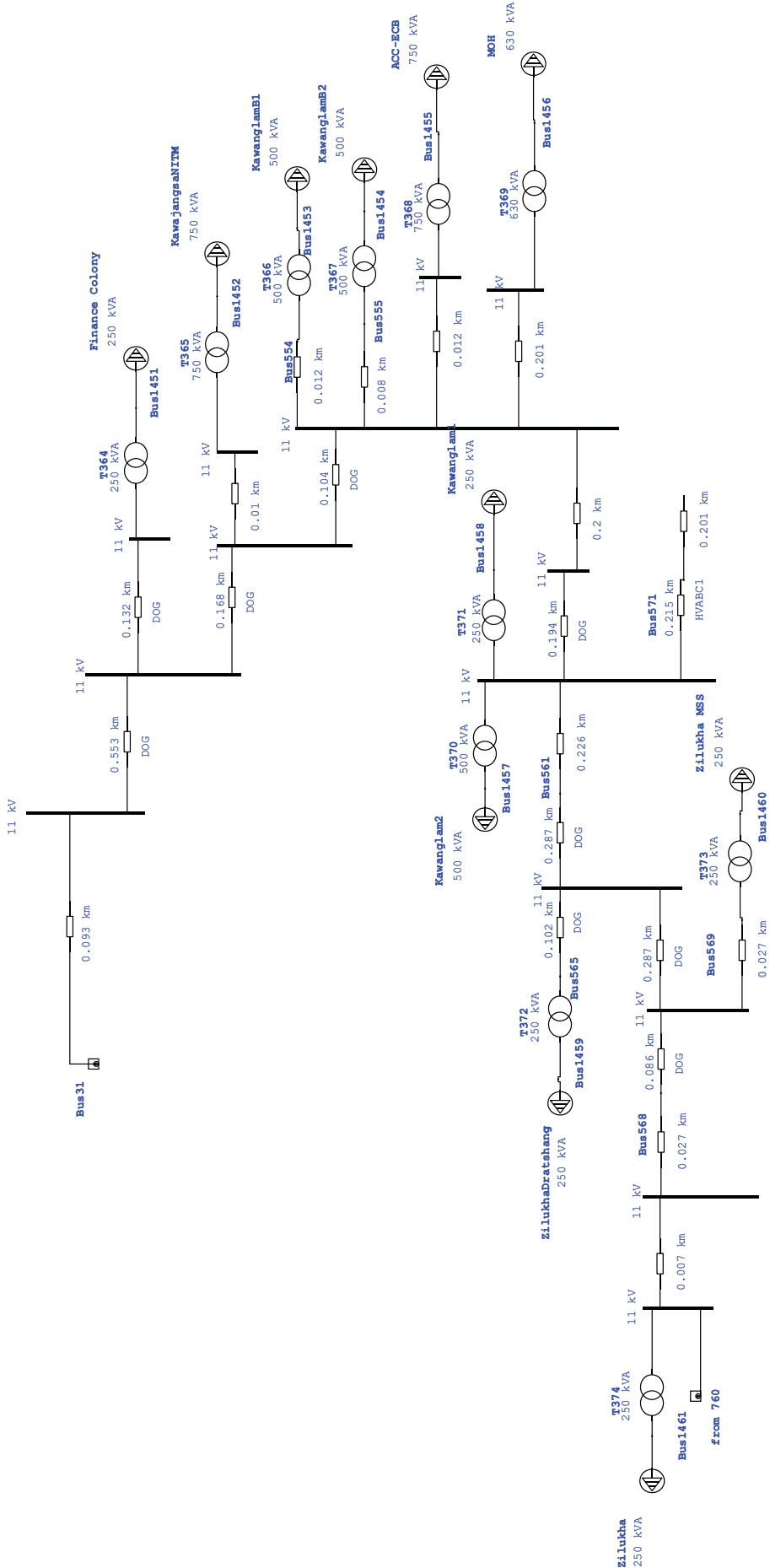


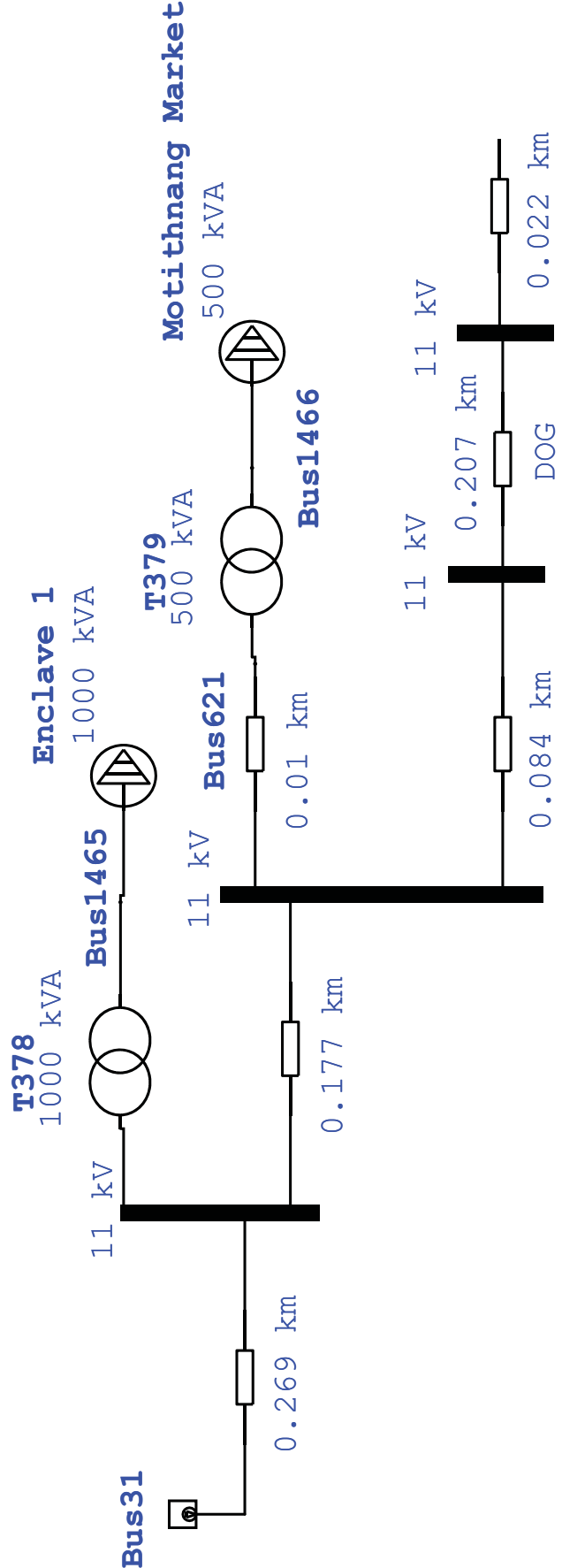


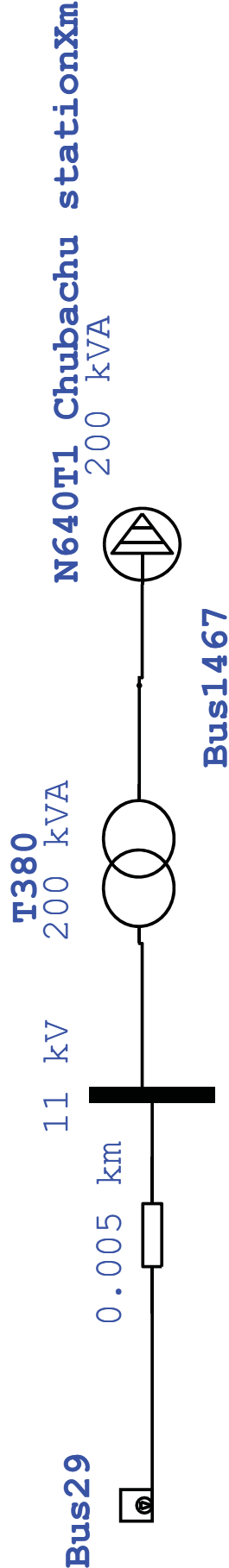




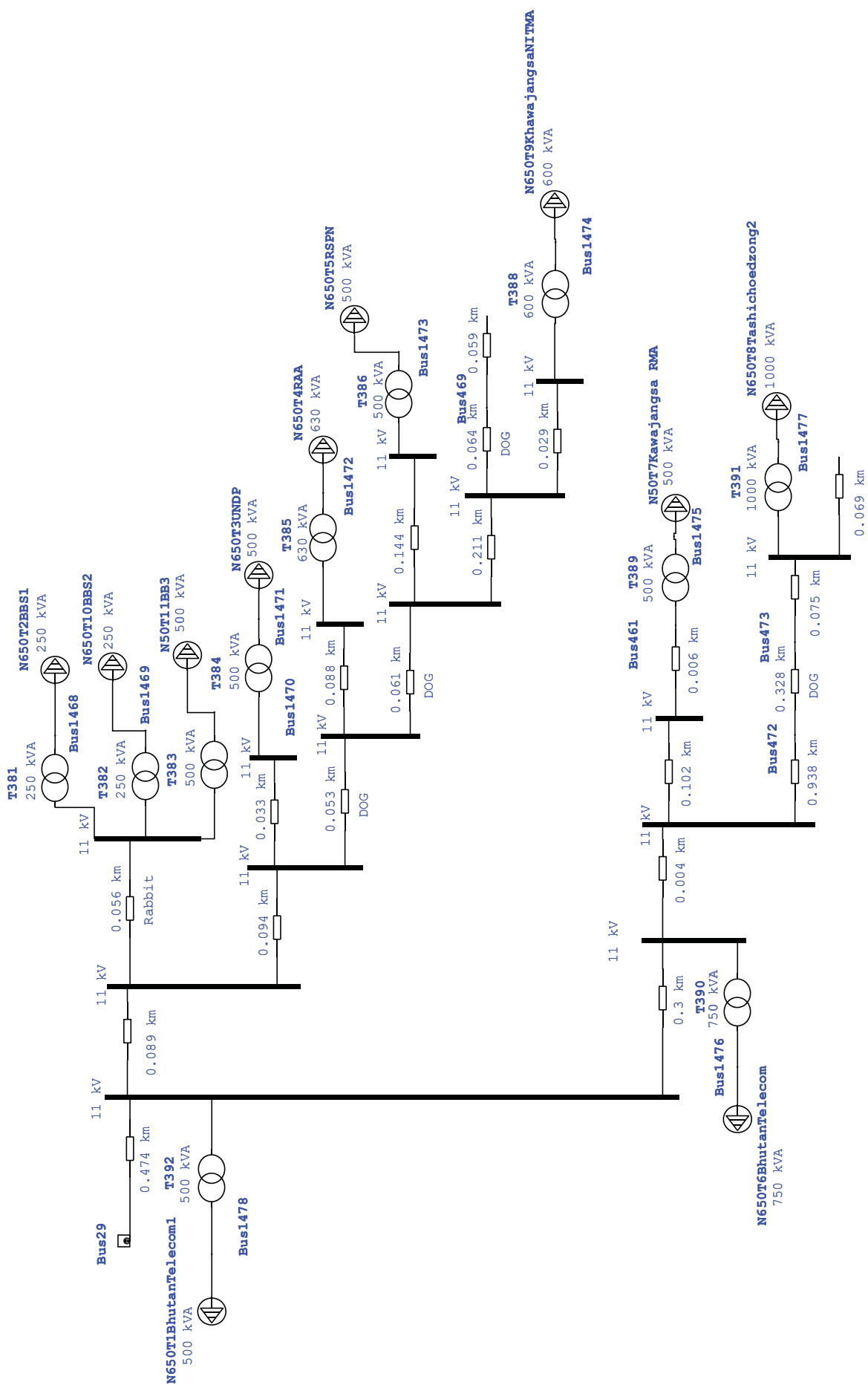
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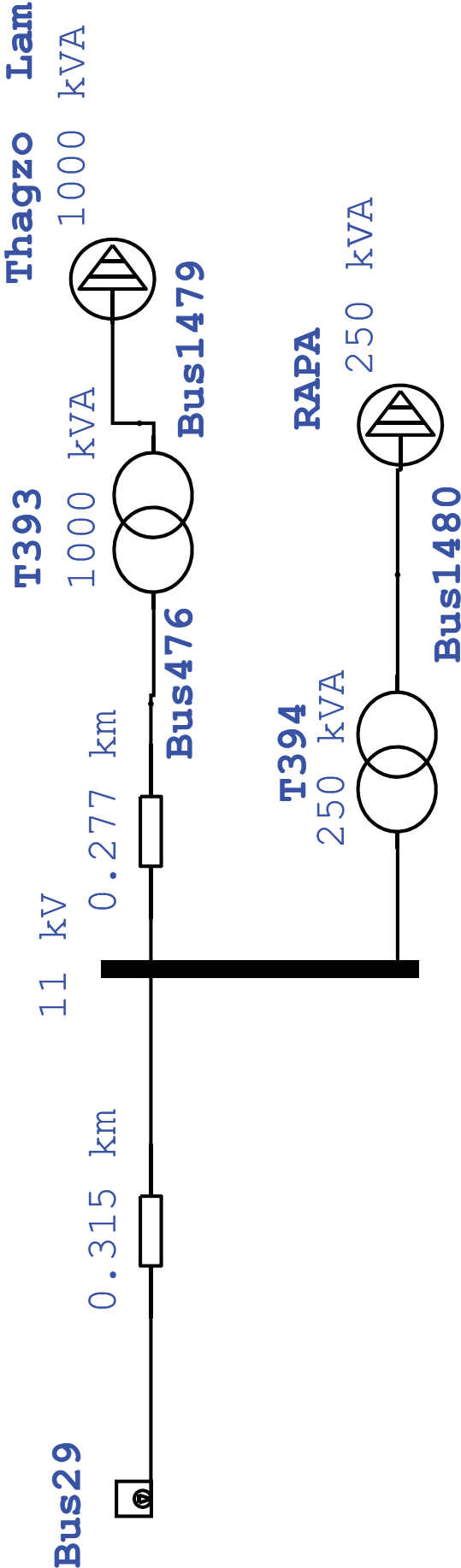


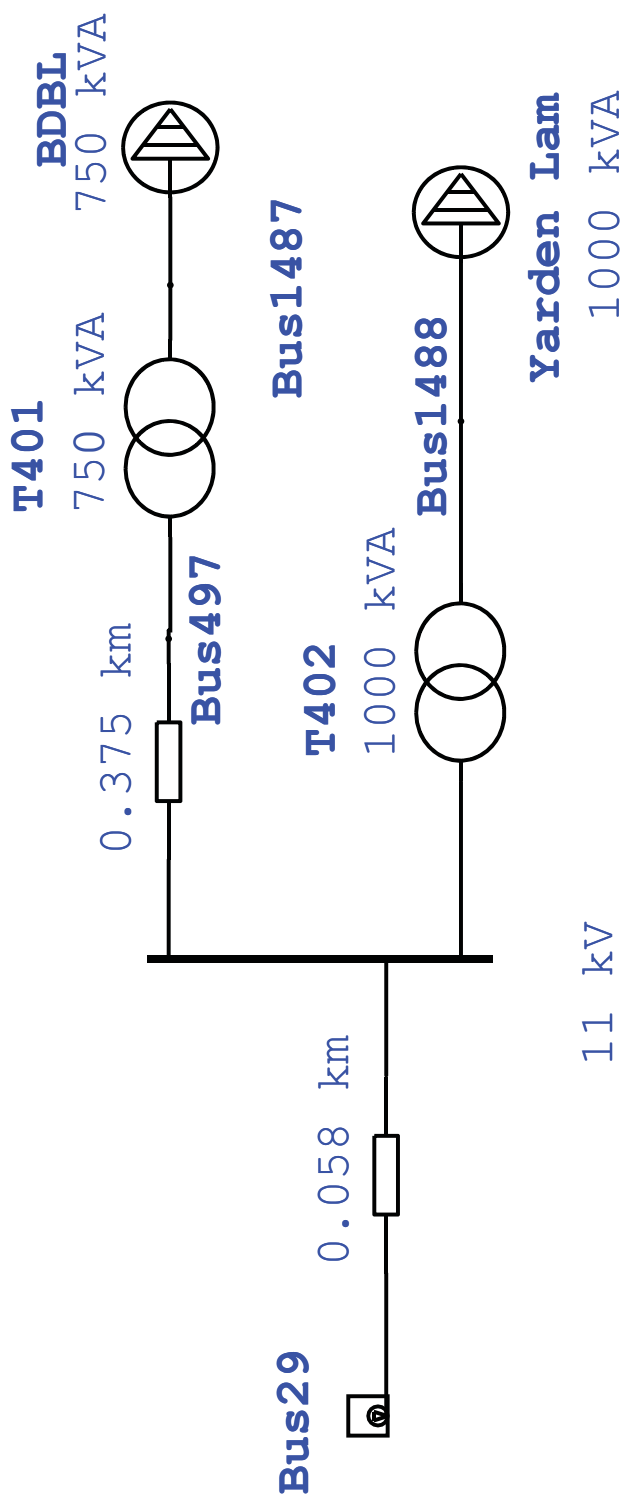




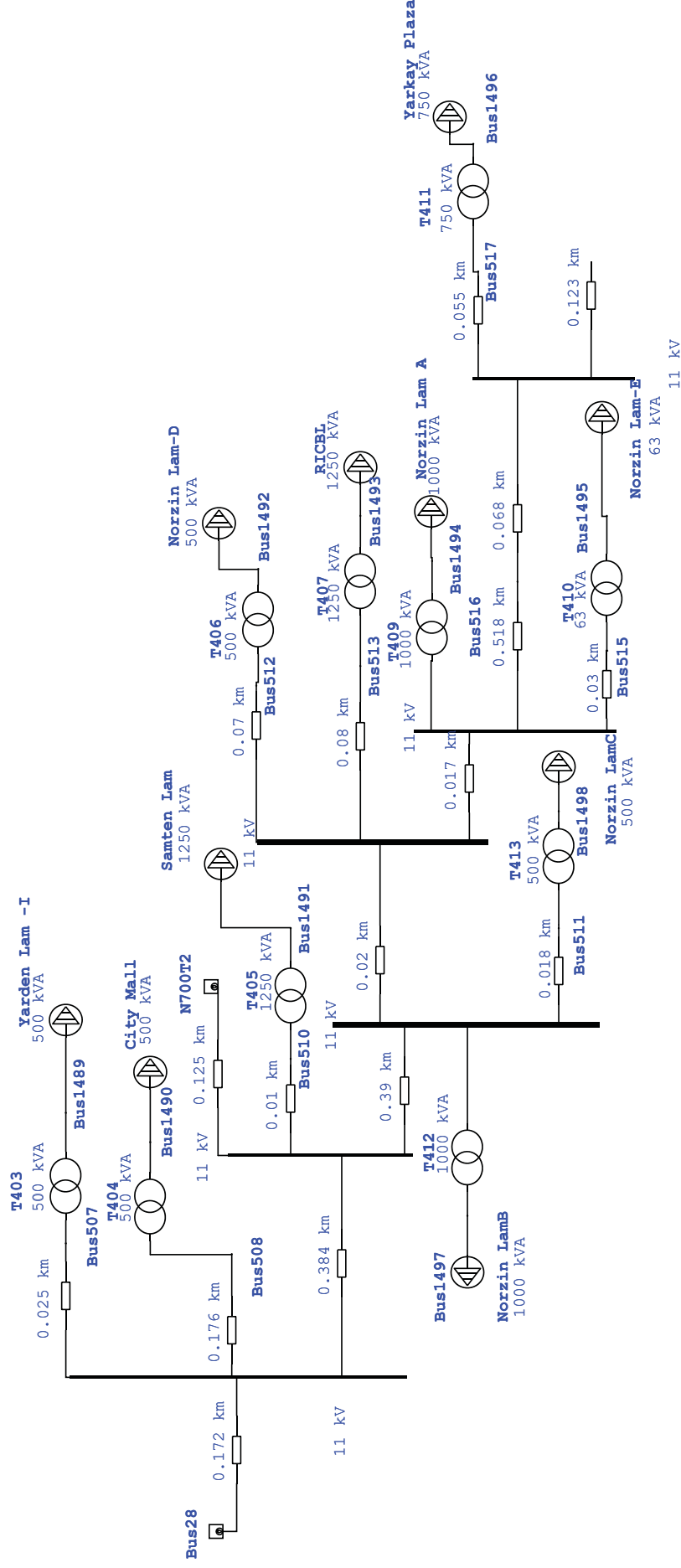
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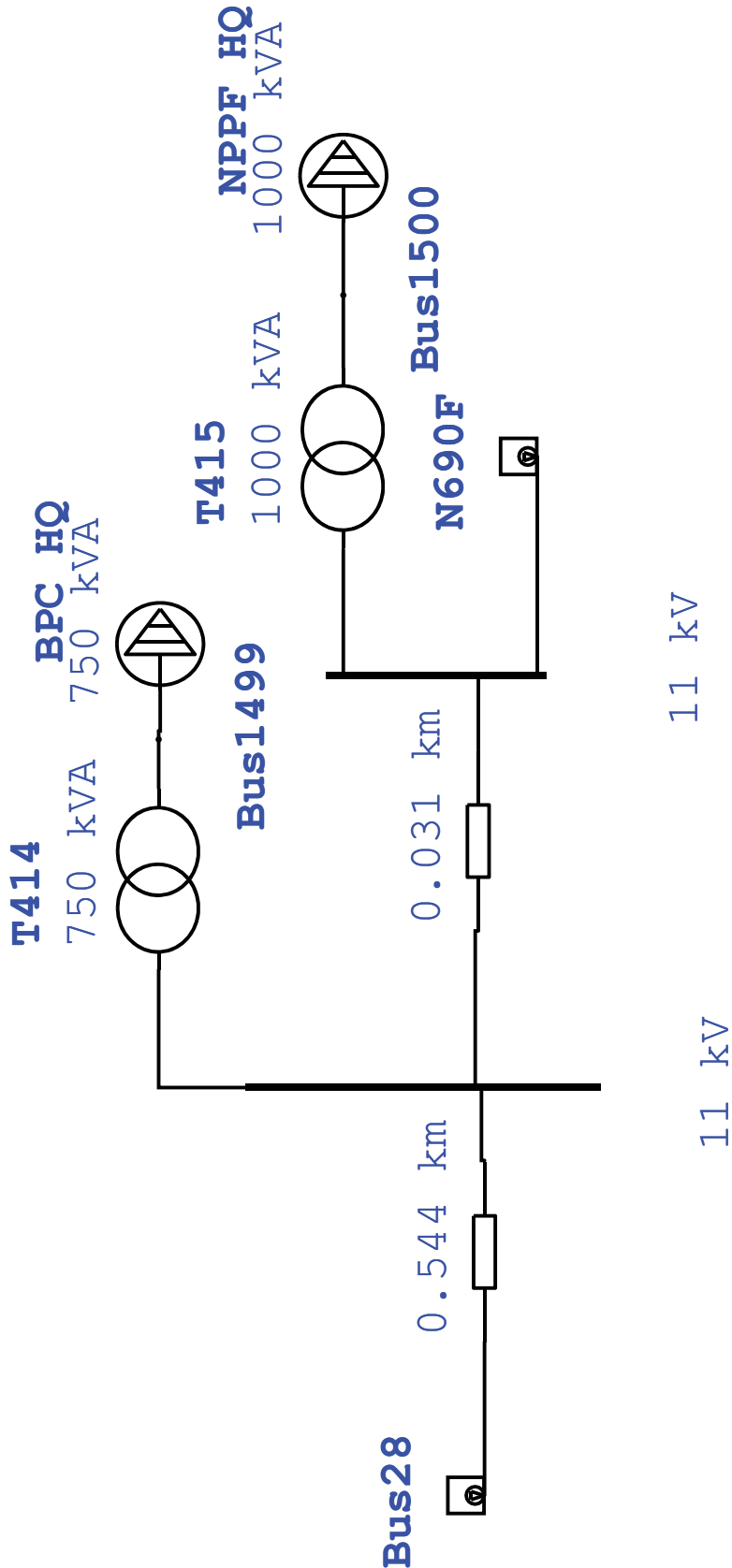




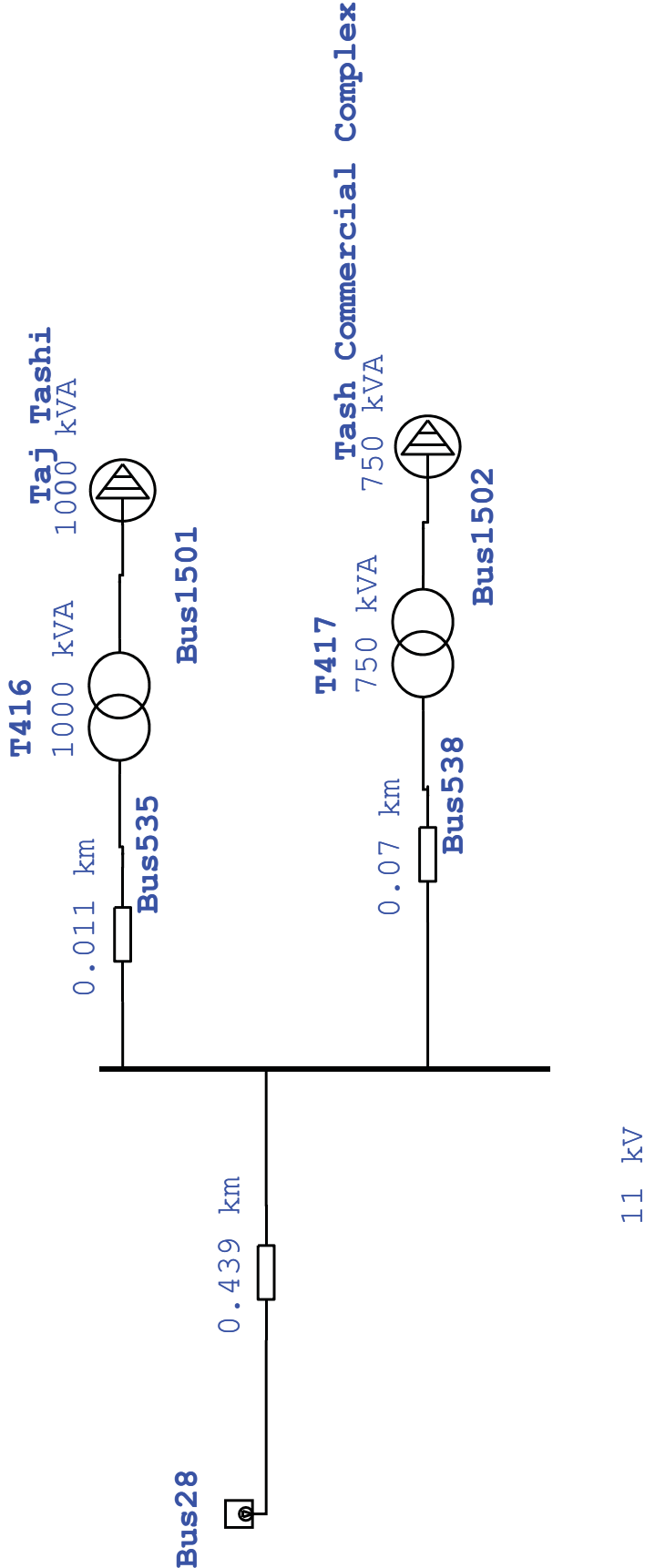


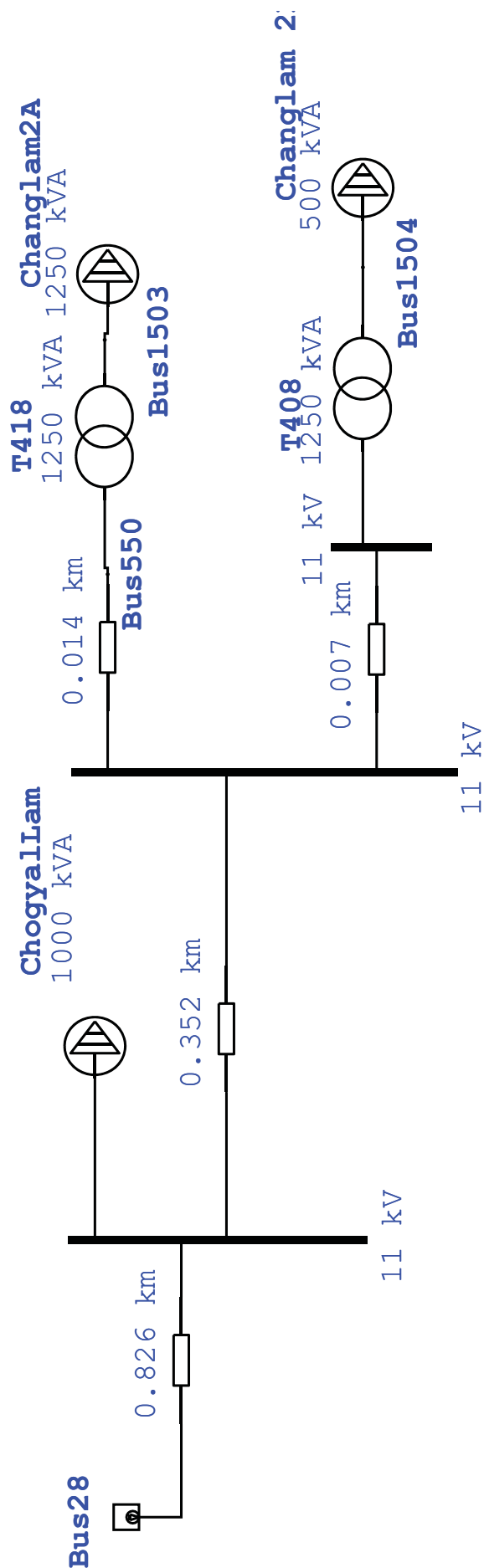
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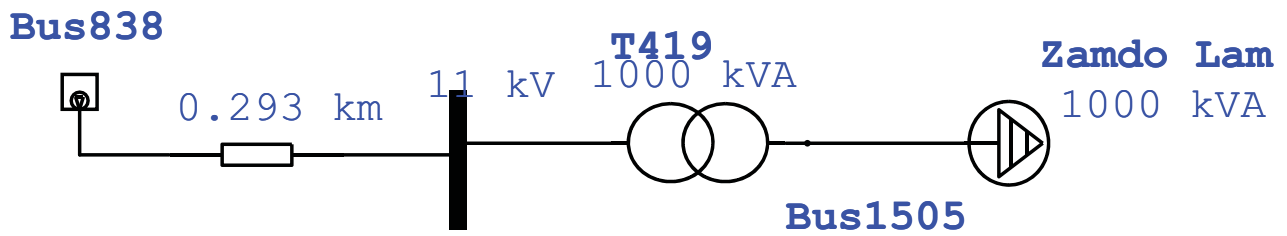


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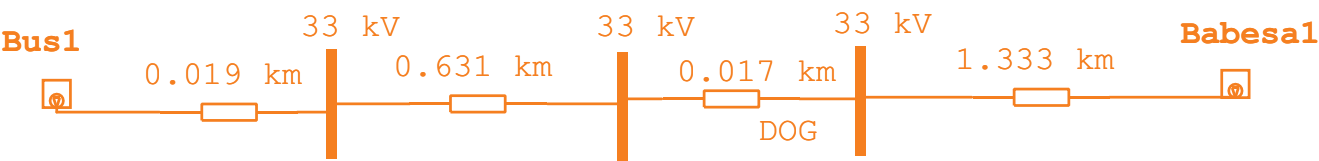


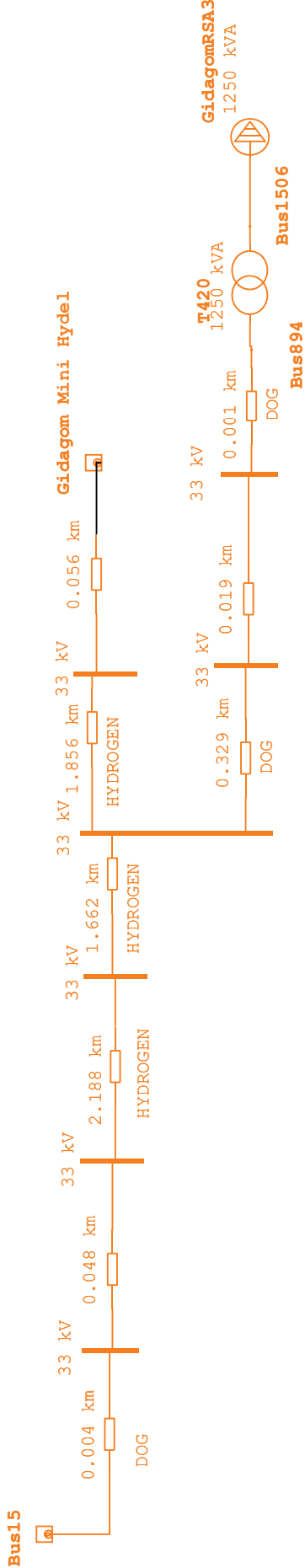


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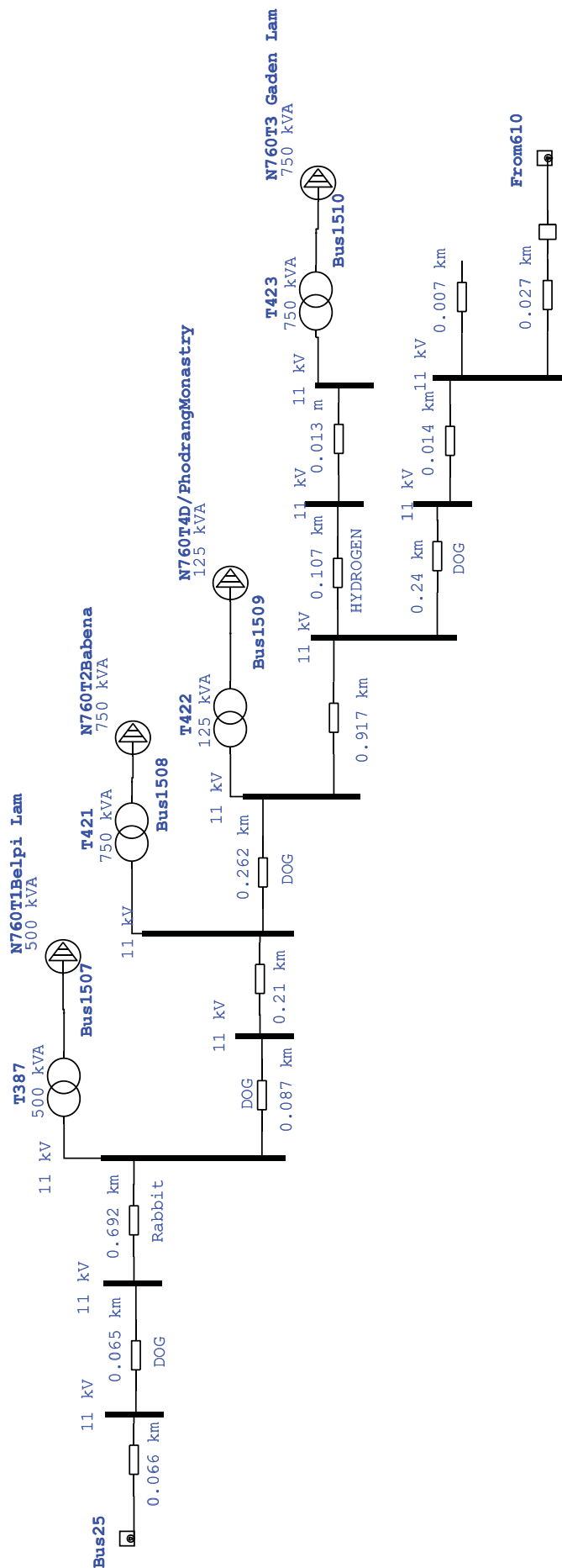


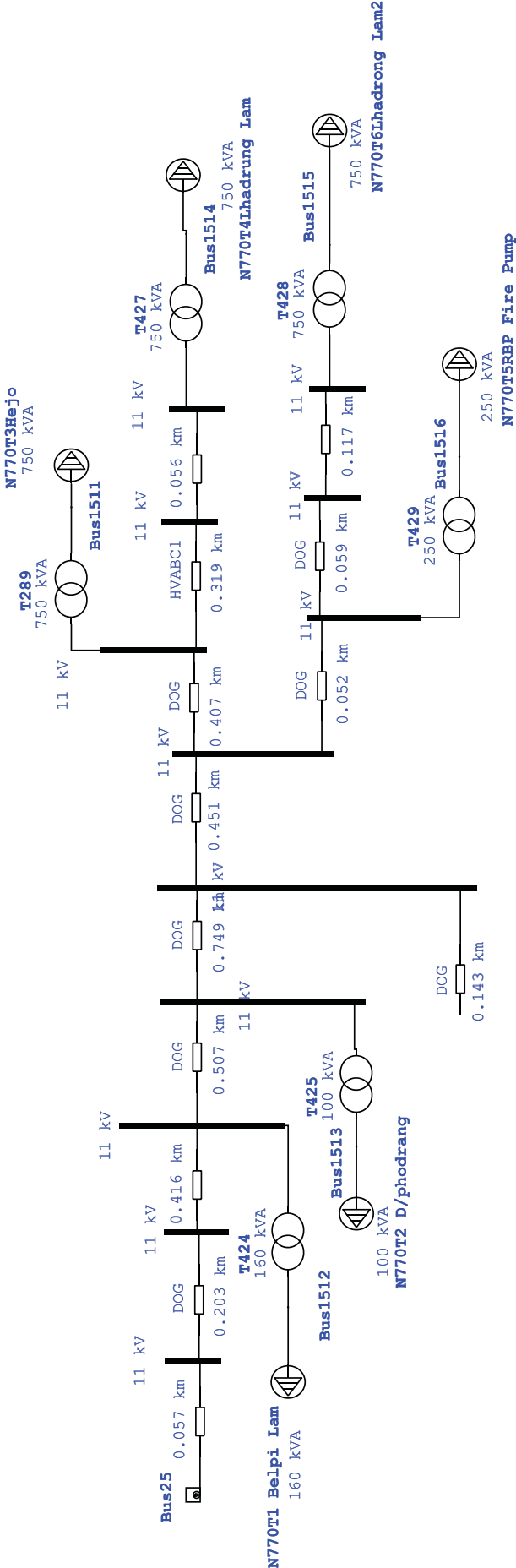
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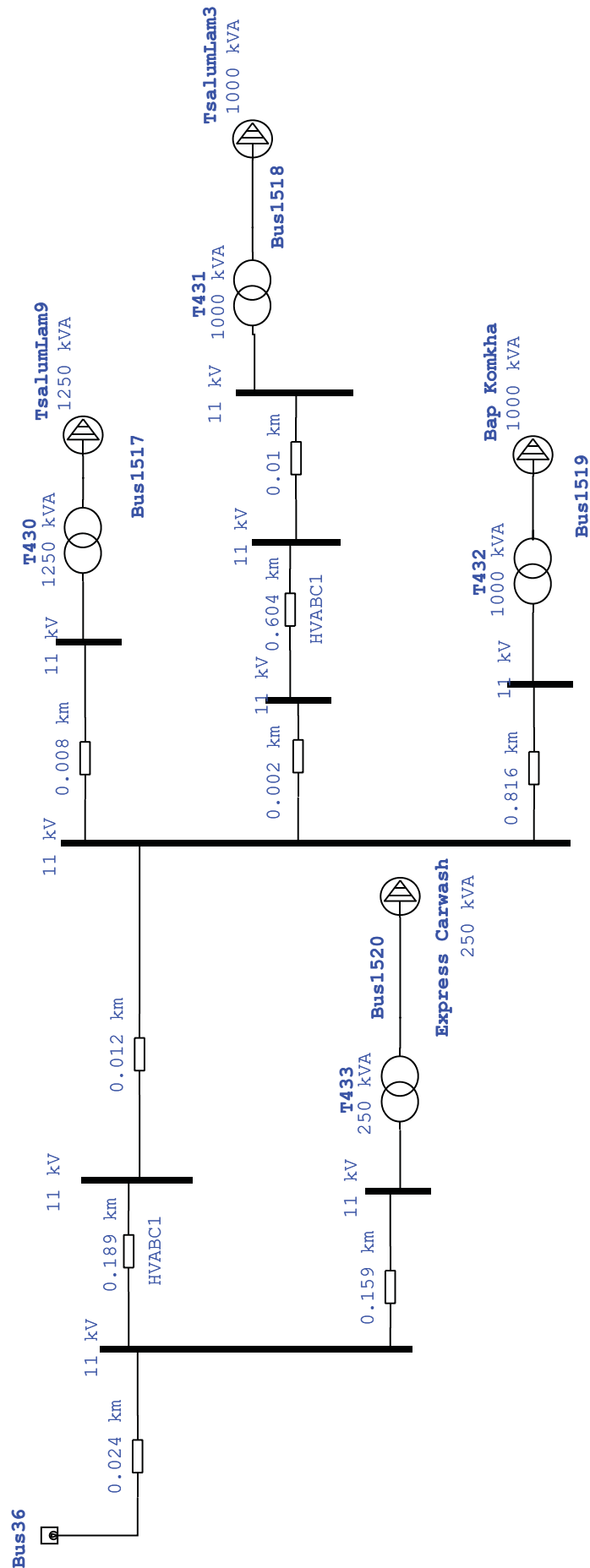


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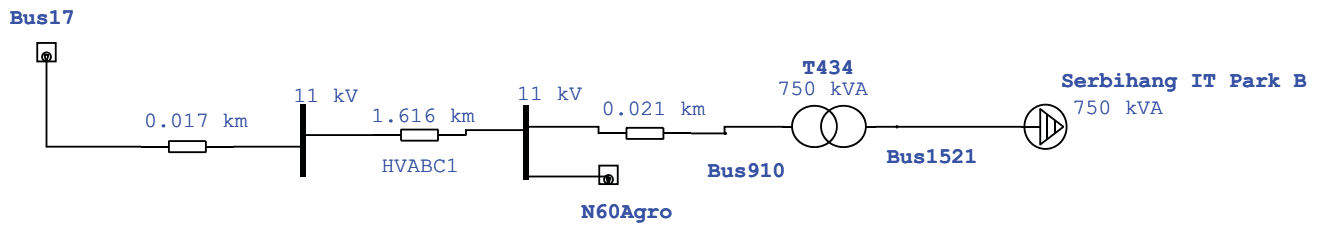




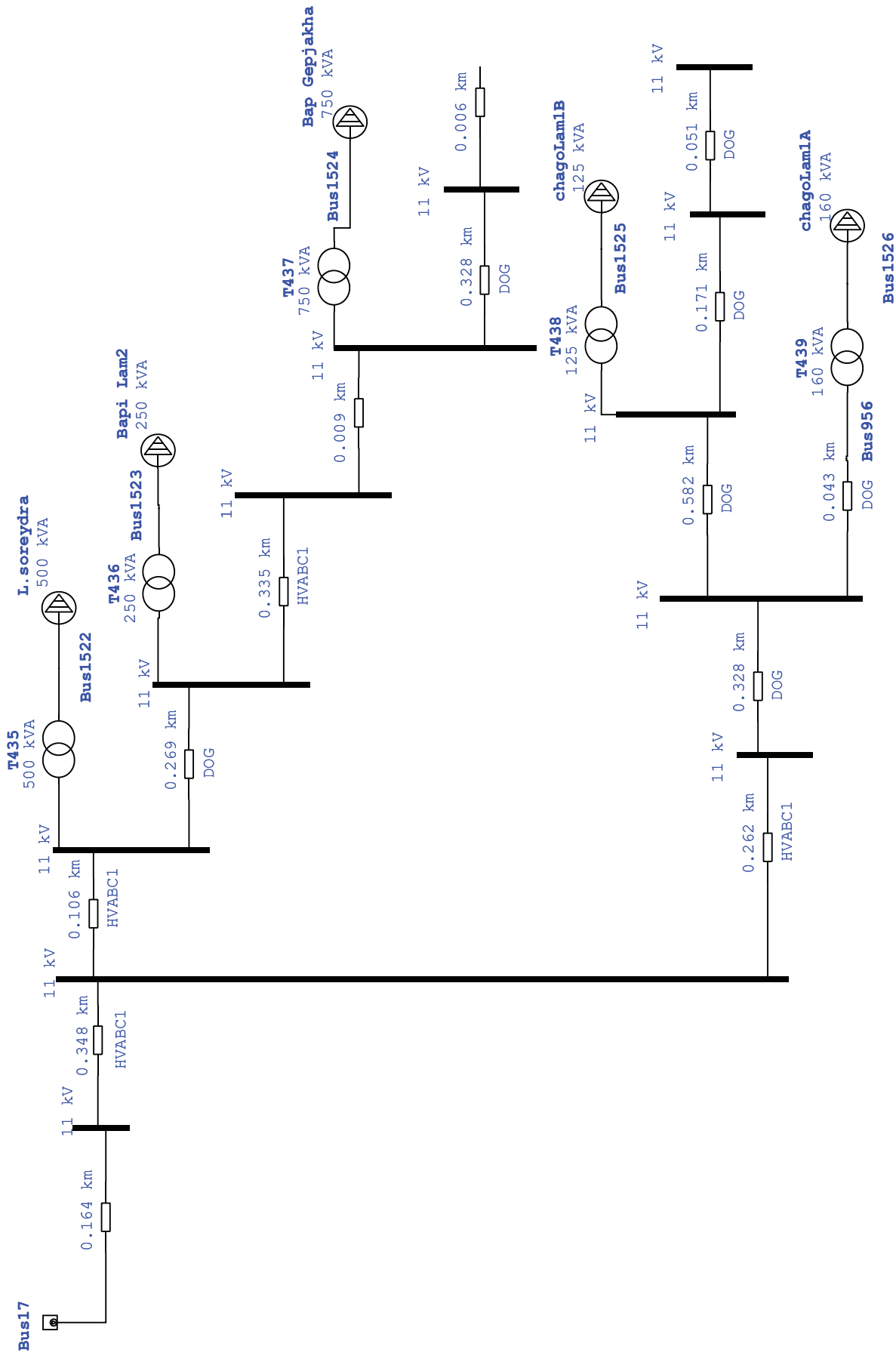
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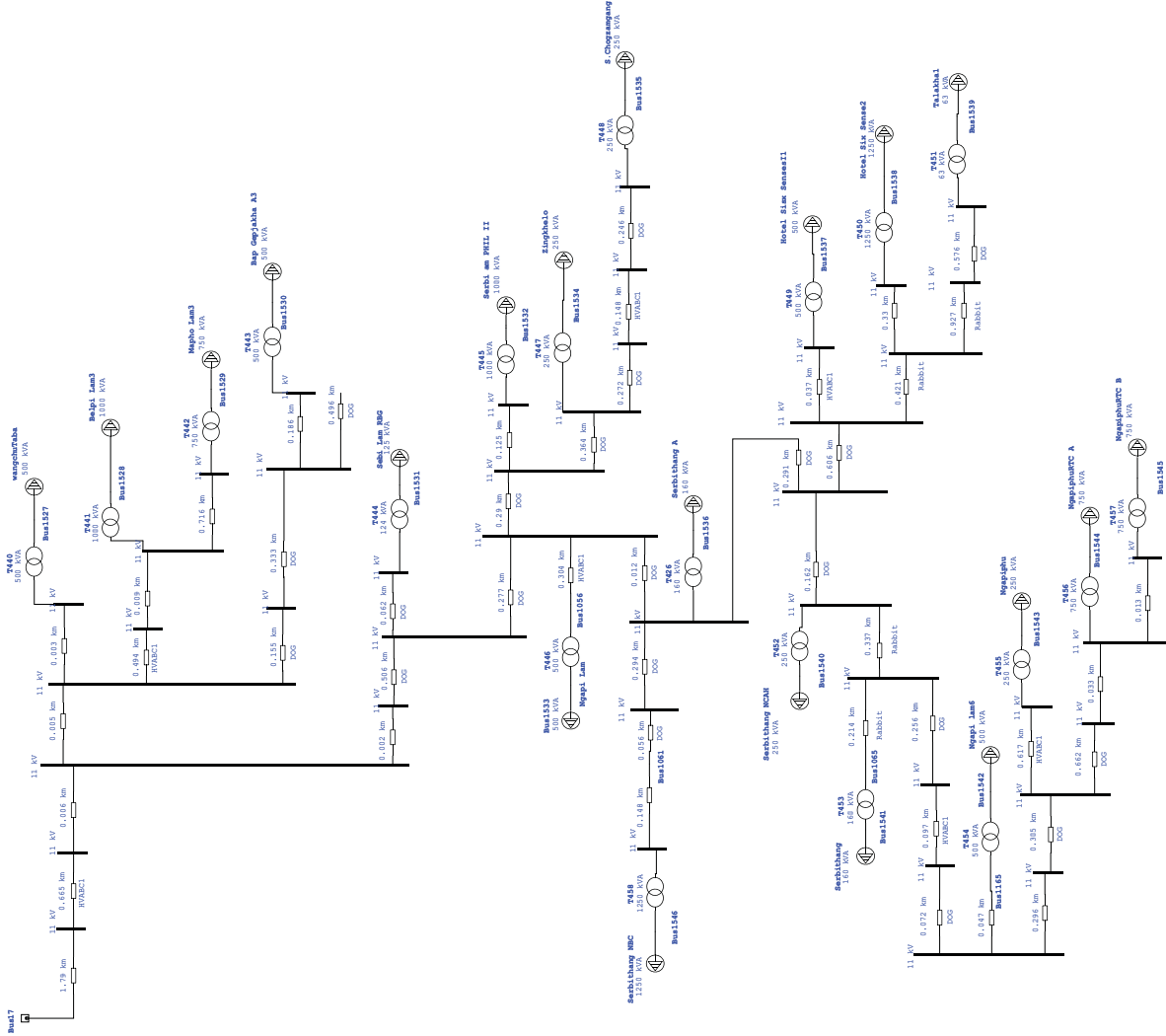
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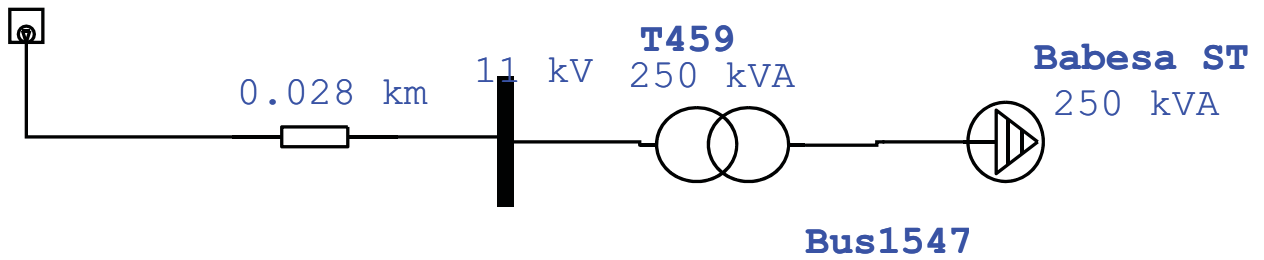


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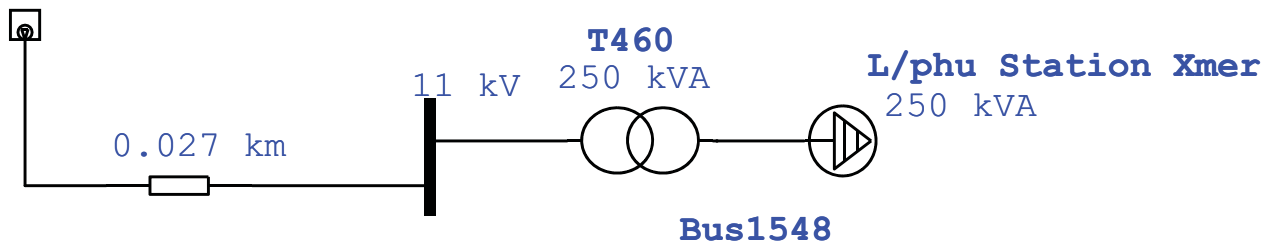
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Bus36

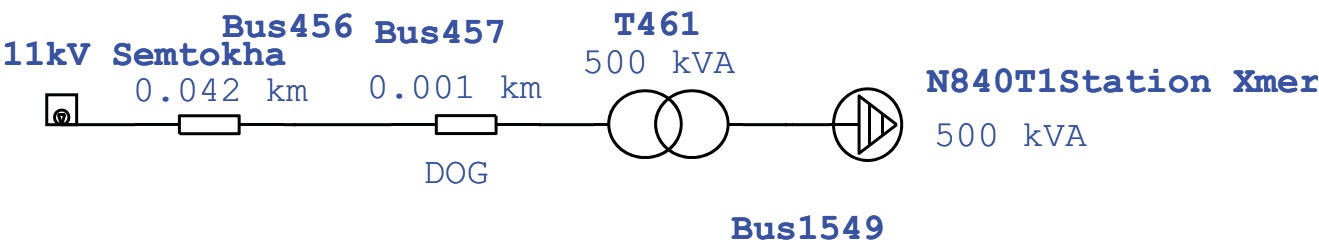


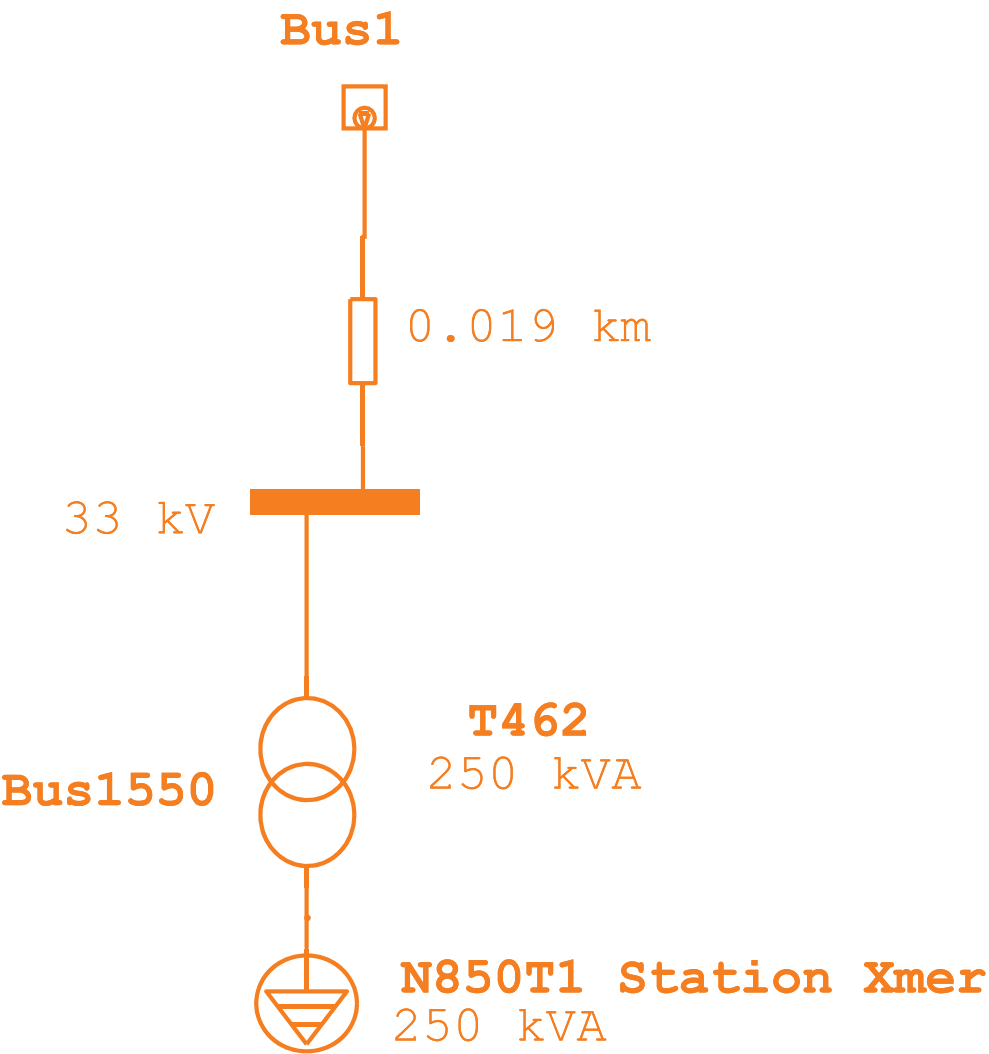
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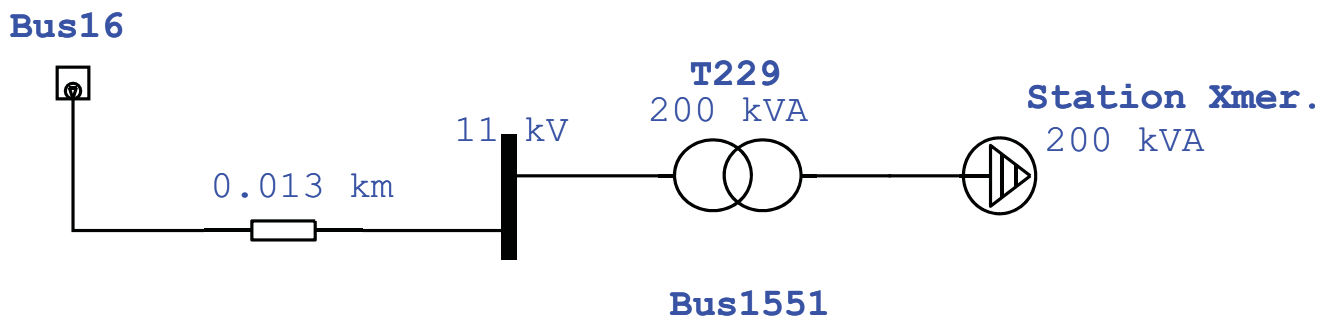


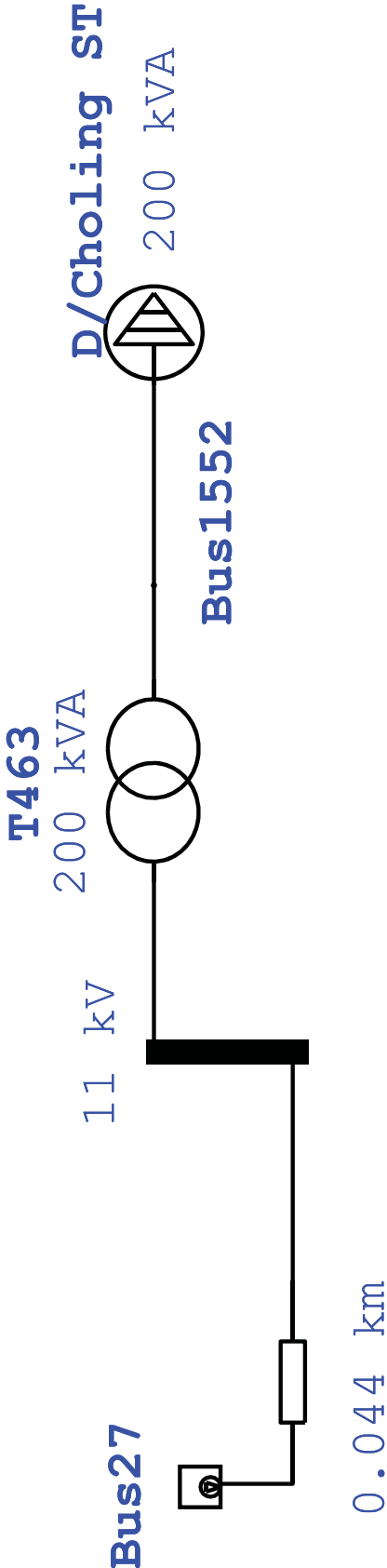
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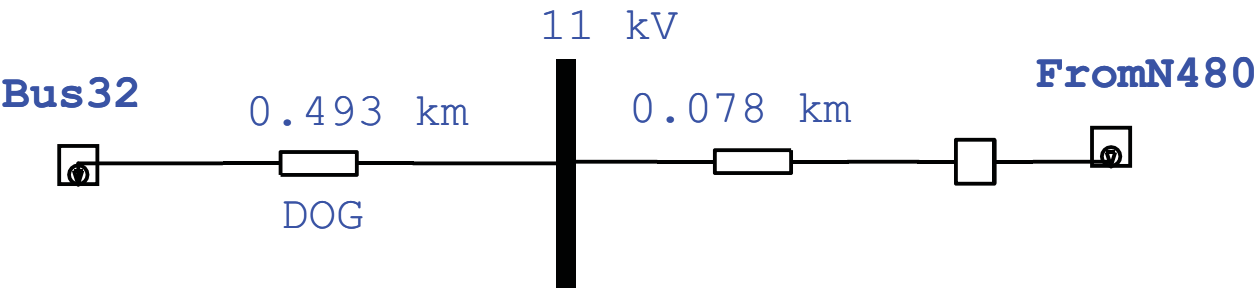


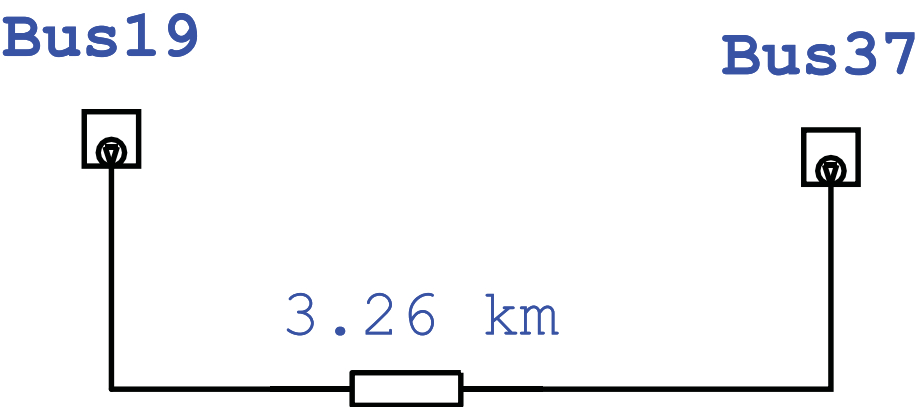


One-Line Diagram - Thimphu ESD Overall=>...=>N870 Bjemina ST (Edit Mode)









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	55°C
	· 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 proposed¹ 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 load¹.

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**.

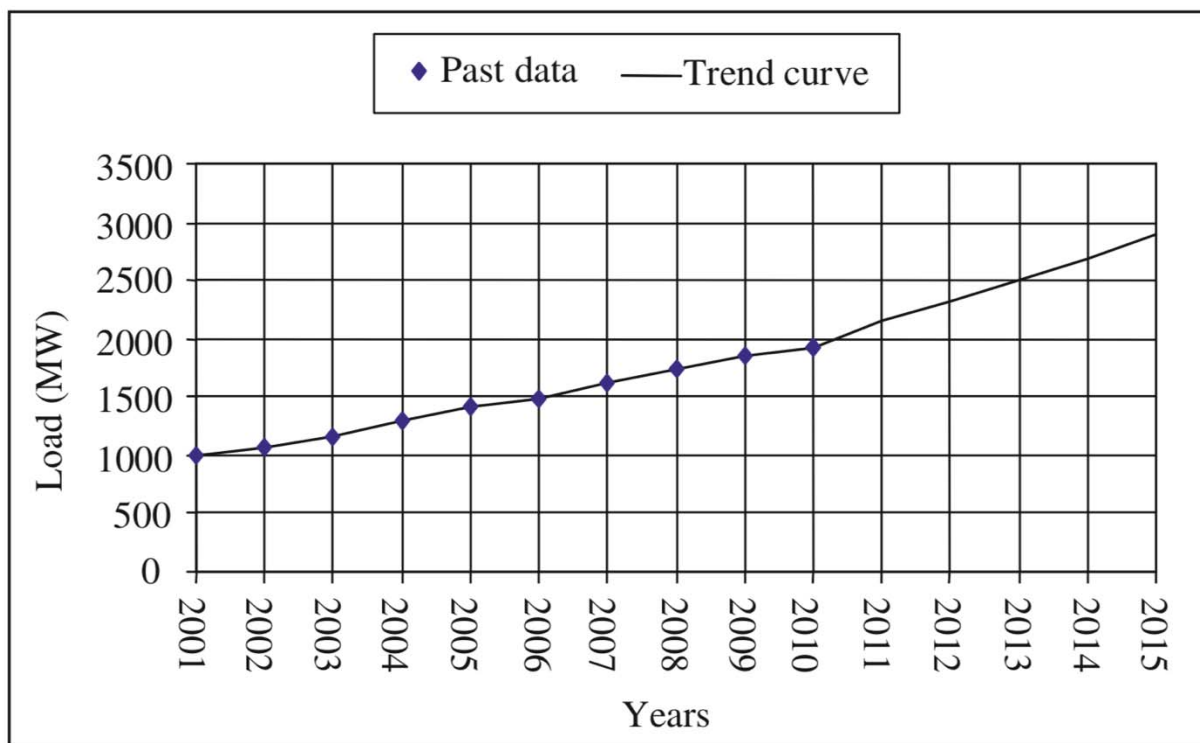


Figure 1: Typical trend curve¹

1.2.2 Economic Modelling

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

1.2.3 End-use Analysis

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

1.2.4 Hybrid Analysis

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

1.3 Trend Line Analysis

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

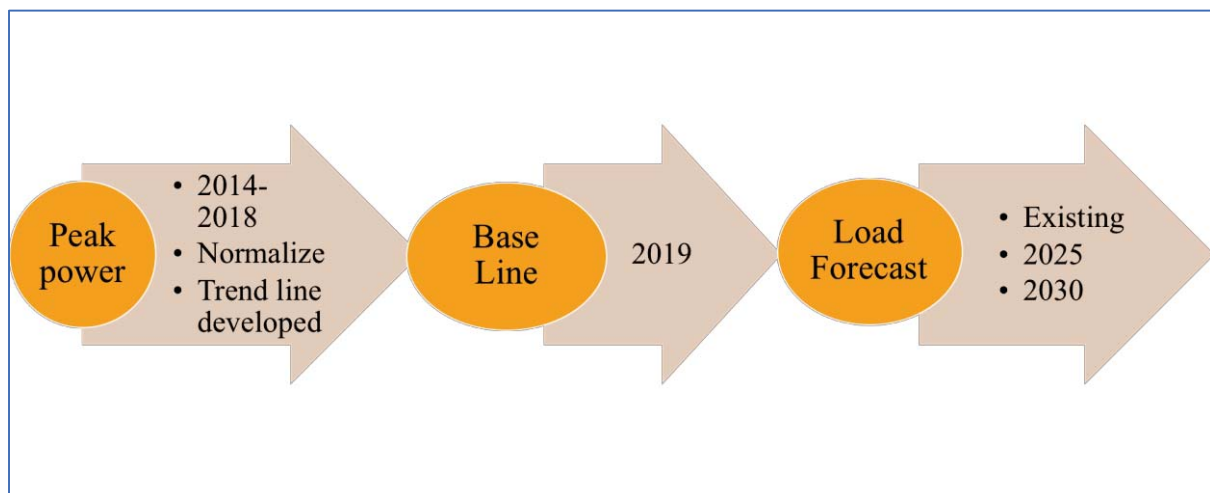


Figure 2: Flow diagram for load forecast

1.3.1 Normalizing the Data

Some of the distribution network do have ring feeders and multiple sources for better reliability and contingency. This in turn has resulted in abnormality in the power consumption data (recordings). Further, in the absence of meters or malfunctioning of the reading equipment or

recorded data, some of the feeders have unreliable data for some of the years. Therefore, data is normalized by omitting the outliers or by taking the average of the past data (or average of preceding and future load if a year's data is missing). Such exercise is carried out for all the feeders and substation loads.

Table 1: Actual power data of Punakha Dzongkhag

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

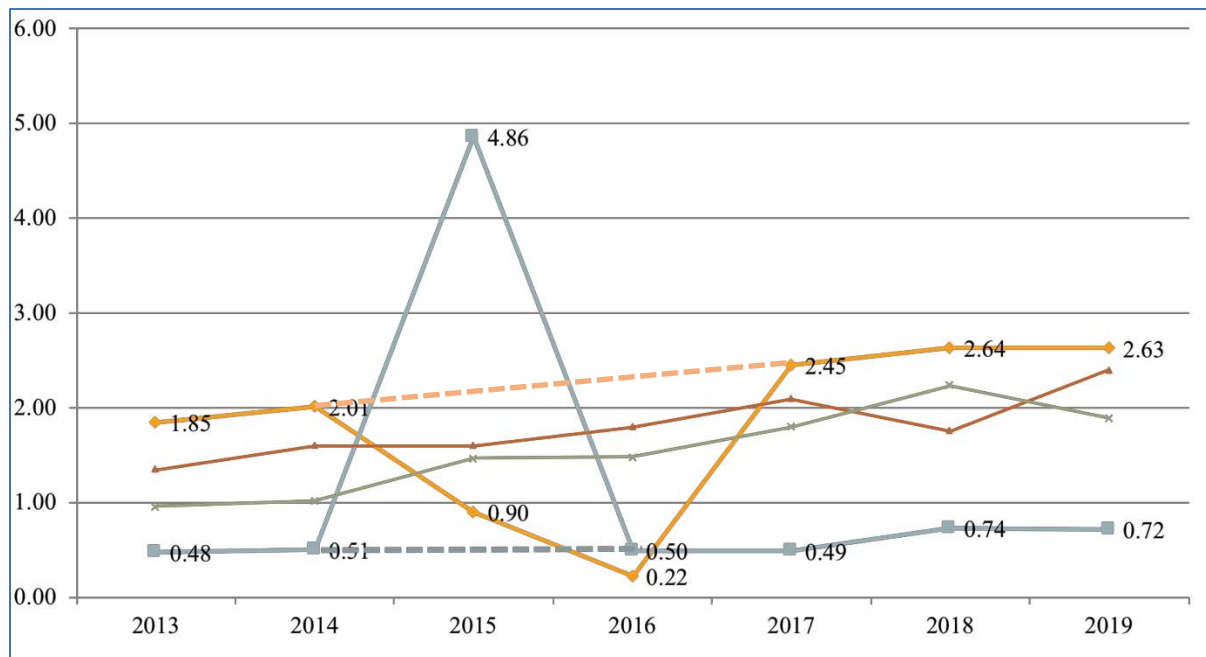


Figure 3: Actual data of Punakha Dzongkhag

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

Where:

x is the normalized data

x_1 and x_2 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 equation¹. The trend line added is then extrapolated to forecast the load for next ten years which is as shown in **Figure 4**.

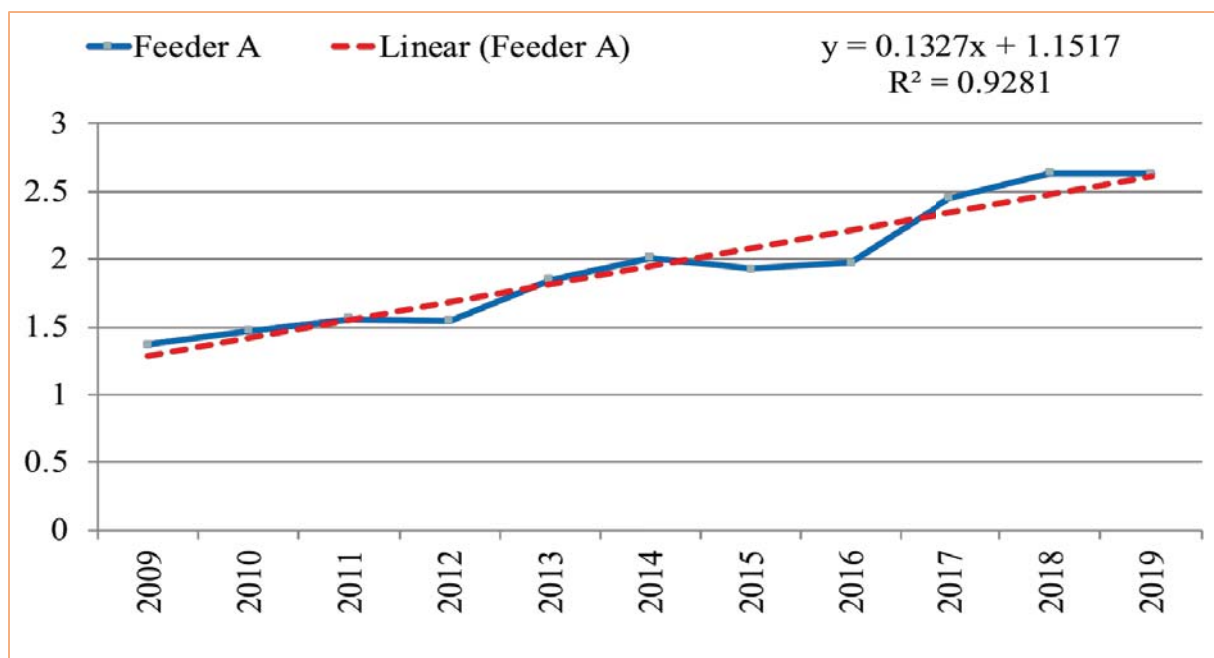


Figure 4: Trend line and load forecast for Punakha Dzongkhag

The trend line equation is given by²:

$$y = ax + b$$

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 independent 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.

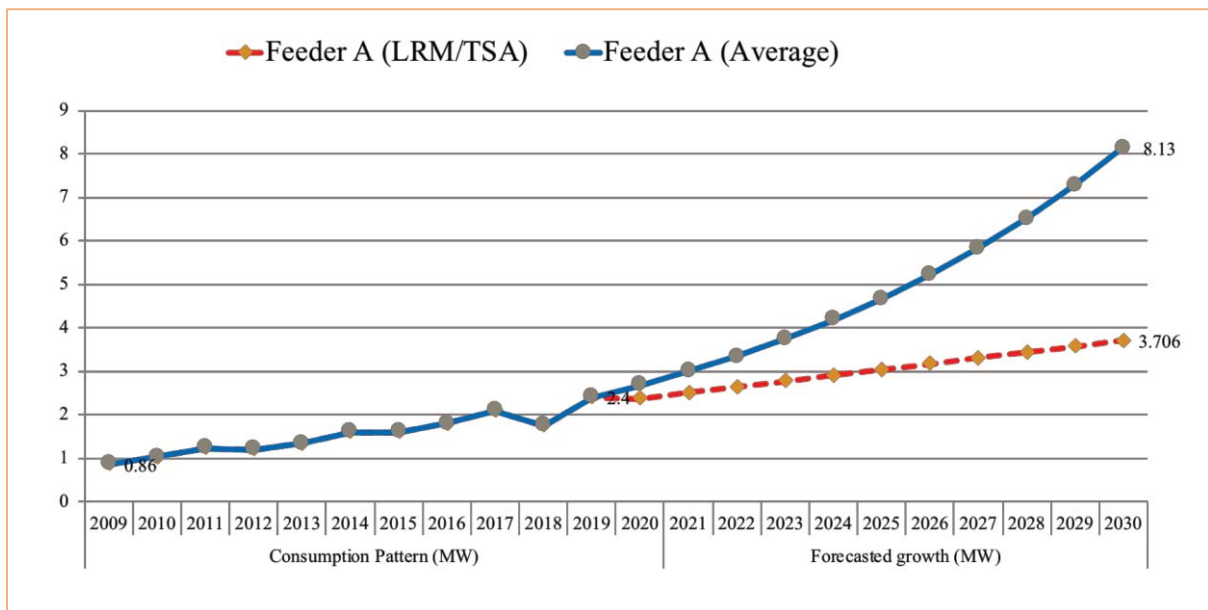


Figure 5: Forecasted load (trend line with red shows the linear regression and one with blue shows the forecast with average method)

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 systems³. 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 ($\pm 5\%$ for Over and Under Voltage Category)” and set “Critical ($\pm 10\%$ 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 $\pm 10\%$ is assigned as critical value which is indicated by red colour while simulating and voltage level of $\pm 5\%$ 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.

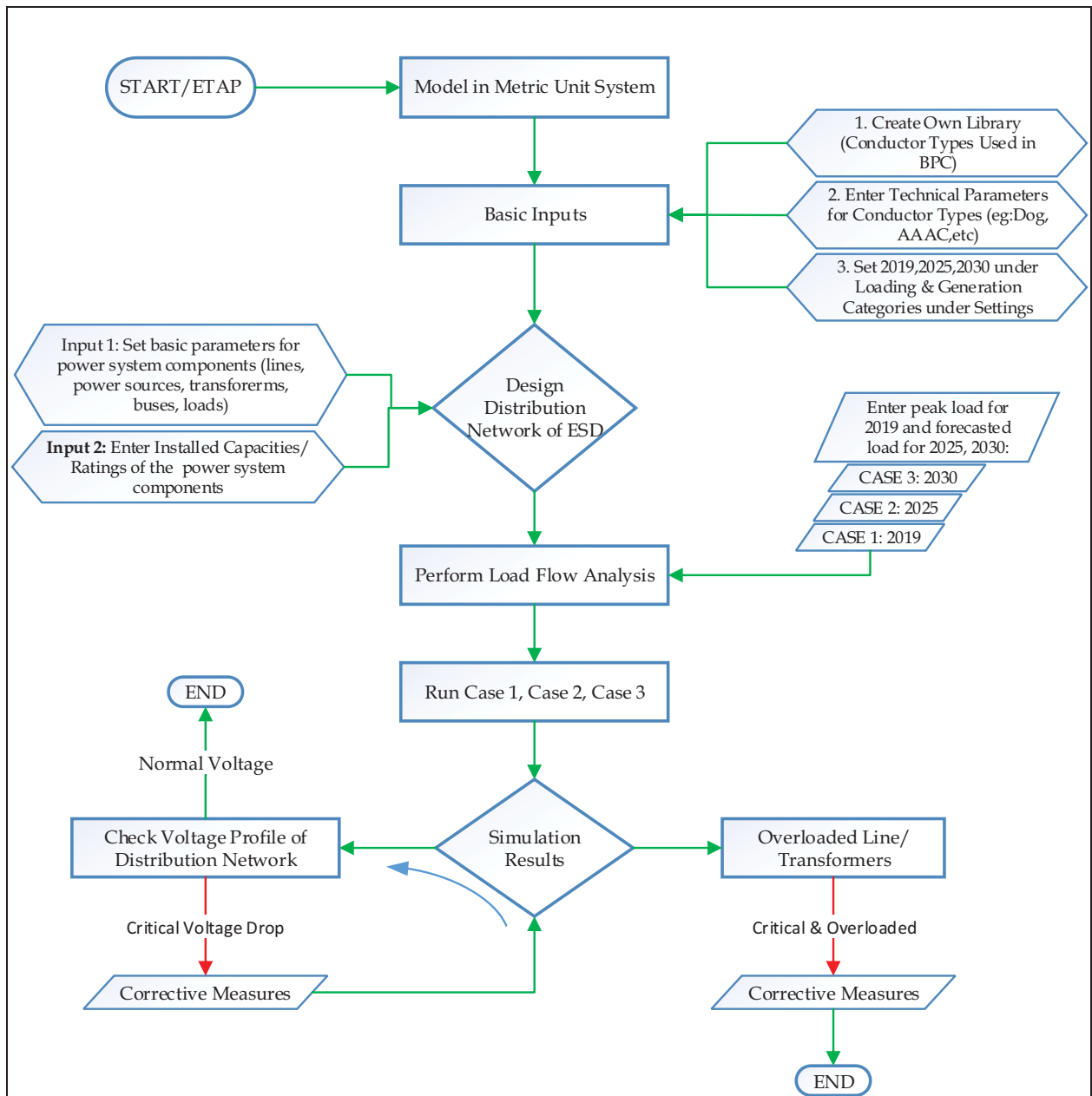


Figure 6: Flow Chart for Network Modelling & Load Flow Analysis (ETAP)

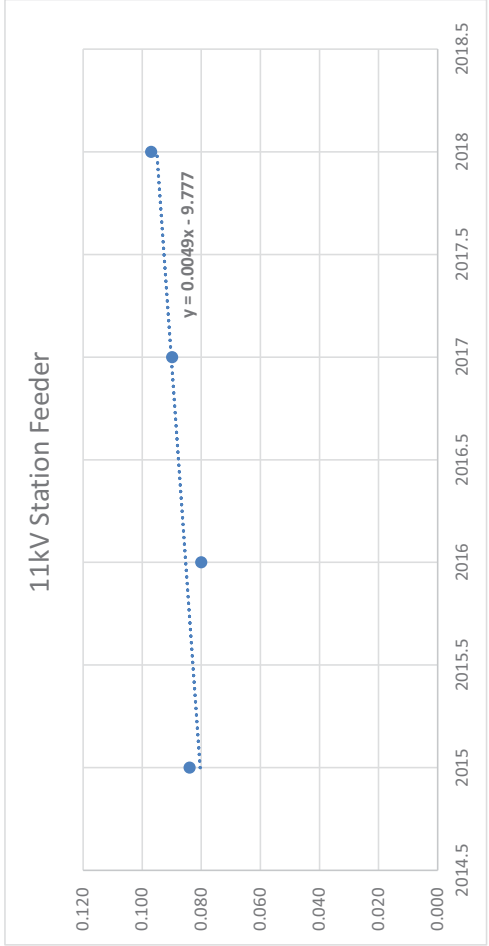
¹Electric Power System Planning Issues, Algorithms and Solutions by Hossein Seifi
 Mohammad Sadegh Sepasian

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

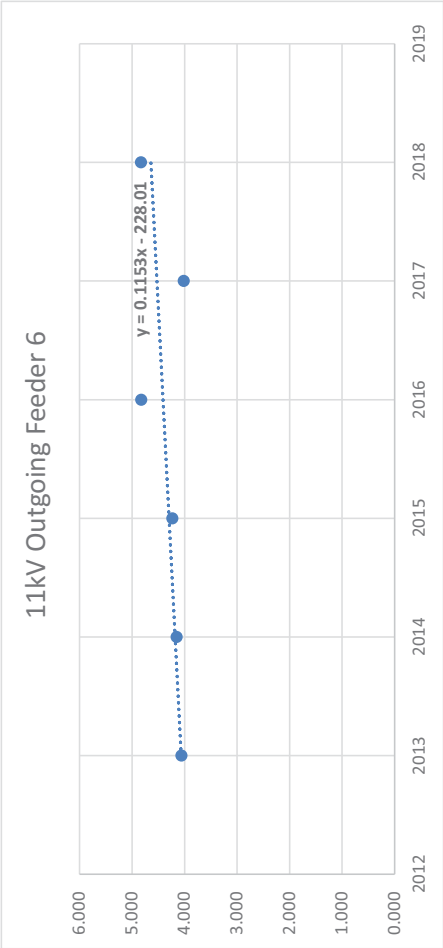
220 kV Simtokha Substation												
Feeder ID	Feeder Name	Peak load										
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
N10	SAARC, Tashichoedzong, Changzamtok	5.97	6.18	6.38	6.59	6.79	6.99	7.20	7.40	7.60	7.81	8.01
N20	Luntenphu, RBA, Yhss, Changji	3.93	4.04	4.14	4.25	4.36	4.47	4.58	4.69	4.80	4.90	5.01
N30	Babesa,RTC,Bhuddha Project,IT Park	4.87	4.95	5.03	5.11	5.19	5.27	5.35	5.43	5.51	5.59	5.67
N40	Chamgang Feeder	0.97	1.00	1.02	1.04	1.07	1.09	1.11	1.14	1.16	1.18	1.21
N50	Lingkhana	6.20	6.64	7.08	7.52	7.96	8.41	8.85	9.29	9.73	10.17	10.61
N60	Agro/Babesa feeder	4.90	5.01	5.13	5.24	5.36	5.47	5.59	5.70	5.82	5.93	6.05
N70	VVIP	3.85	3.97	4.08	4.20	4.31	4.42	4.54	4.65	4.76	4.88	4.99
N80	Hongtsho Feeder	0.80	0.88	0.97	1.05	1.14	1.22	1.30	1.39	1.47	1.56	1.64
N840	Station Transformer	0.12	0.13	0.13	0.14	0.14	0.15	0.15	0.16	0.16	0.17	0.17
	Total	31.61	32.78	33.96	35.13	36.31	37.49	38.66	39.84	41.01	42.19	43.36
66kV Olakha Substation												
N110	Chubachu Feeder	14.80	15.83	16.87	17.90	18.94	19.97	21.01	22.04	23.08	24.11	25.15
N240	DPH 1 Feeder	6.31	6.61	6.92	7.23	7.54	7.84	8.15	8.46	8.76	9.07	9.38
N250	DPH 2	13.18	13.60	14.01	14.43	14.85	15.27	15.69	16.11	16.53	16.95	17.37
N740	Babesa Feeder	4.05	4.38	4.72	5.05	5.39	5.73	6.06	6.40	6.74	7.07	7.41
N850	Station Transformer	0.07	0.08	0.09	0.11	0.12	0.13	0.14	0.16	0.17	0.18	0.20
	Total	32.74	33.81	34.89	35.96	37.04	38.11	39.19	40.26	41.34	42.42	43.49
66kV Dechencholing Substation												
N120(33)	Kabesa	0.84	0.87	0.91	0.94	0.98	1.01	1.05	1.08	1.12	1.15	1.19
N130(33)	Chubachu	9.74	10.54	11.34	12.13	12.93	13.73	14.52	15.32	16.12	16.92	17.71
N140(33)	Thimphu Minihydel	7.97	8.41	8.85	9.28	9.72	10.16	10.59	11.03	11.47	11.91	12.34
N150 (11)	RBG-E	0.97	0.98	0.99	1.00	1.01	1.02	1.03	1.05	1.06	1.07	1.08
N160 (11)	Begana	1.01	1.10	1.18	1.26	1.34	1.42	1.51	1.59	1.67	1.75	1.84
N170 (11)	RBG-A	1.45	1.56	1.67	1.79	1.90	2.01	2.12	2.23	2.35	2.46	2.57
N330 (11)	Taba/Dangrena	2.14	2.32	2.49	2.67	2.84	3.02	3.20	3.37	3.55	3.72	3.90
N340 (11)	Yangphel R State	0.17	0.18	0.18	0.19	0.19	0.20	0.20	0.21	0.21	0.22	0.22
N880 (11)	Station Transformer	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09
	Total	24.30	25.95	27.61	29.26	30.92	32.57	34.23	35.88	37.54	39.20	40.85
66kV Bjemina Substation												
N750(33)	Gidagom feeder	5.80	6.30	6.80	7.30	7.80	8.30	8.80	9.30	9.80	10.30	10.80
N180(11)	Tsaluna Feeder	0.27	0.29	0.32	0.34	0.37	0.39	0.42	0.44	0.47	0.49	0.52
N190(11)	Gidagom Feeder	0.27	0.29	0.32	0.34	0.37	0.39	0.42	0.44	0.47	0.49	0.52
N200(11)	Bjemina Industrial State	0.20	0.22	0.24	0.25	0.27	0.29	0.31	0.32	0.34	0.36	0.38
N870 (11)	Station Transformer	0.12	0.14	0.16	0.18	0.20	0.22	0.24	0.26	0.28	0.30	0.32
	Total	6.66	7.25	7.84	8.42	9.01	9.59	10.18	10.77	11.35	11.94	12.53
Total Peak load (MW)		95.30	99.80	104.29	108.78	113.27	117.77	122.26	126.75	131.25	135.74	140.23
% Growth		%	4.71%	4.50%	4.31%	4.13%	3.97%	3.82%	3.67%	3.54%	3.42%	3.31%

Monthly Peak Load (MW) - 11kV Station Feeder (Semtokha SS)						
	2015	2016	2017	2018		
Jan	0.071	0.069	0.090	0.082		
Feb	0.078	0.075	0.076	0.084		
Mar	0.074	0.068	0.081	0.097		
Apr	0.063	0.058	0.000	0.059		
May	0.054	0.050	0.000	0.049		
Jun	0.063	0.049	0.000	0.040		
Jul	0.058	0.043	0.086	0.038		
Aug	0.051	0.042	0.046	0.045		
Sep	0.056	0.049	0.052	0.041		
Oct	0.061	0.061	0.056	0.063		
Nov	0.069	0.078	0.079	0.075		
Dec	0.084	0.080	0.082	0.085		
Max. Peak Load in a Year (MW)	0.084	0.080	0.090	0.097		



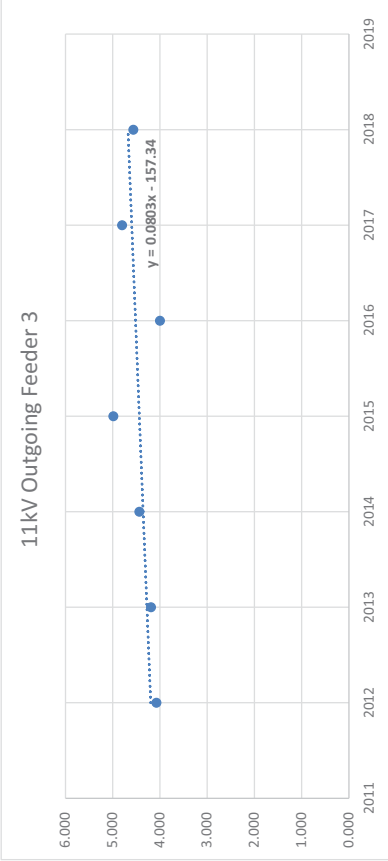
Forecasted Peak Load (MW)											
Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2030
Peak Load (MW)	0.116	0.121	0.126	0.131	0.136	0.141	0.146	0.150	0.155	0.160	0.170

Monthly Peak Load (MW) – 11kV Outgoing Feeder 6 (Semtokha SS)						
	2013	2014	2015	2016	2017	2018
Jan	0.000	3.933	4.234	3.340	3.559	2.817
Feb	0.000	3.960	4.230	3.006	3.411	4.279
Mar	0.000	4.042	4.175	4.825	4.017	3.493
Apr	0.000	3.106	3.542	2.732	2.953	2.968
May	0.000	2.693	1.014	2.501	3.012	2.713
Jun	0.000	2.637	1.054	2.119	2.626	2.403
Jul	0.000	2.374	0.842	1.911	2.198	2.920
Aug	3.500	2.465	1.045	2.080	3.103	3.005
Sep	2.147	1.940	0.743	2.240	2.720	3.331
Oct	2.975	2.931	2.589	2.770	3.685	4.300
Nov	3.888	3.797	3.363	3.574	3.810	4.829
Dec	4.058	4.154	3.230	3.850	3.402	4.514
Max. Peak Load in a Year (MW)	4.058	4.154	4.234	4.825	4.017	4.829



Forecasted Peak Load (MW)											
Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2030
Peak Load (MW)	4.781	4.896	5.011	5.127	5.242	5.357	5.473	5.588	5.703	5.818	6.049

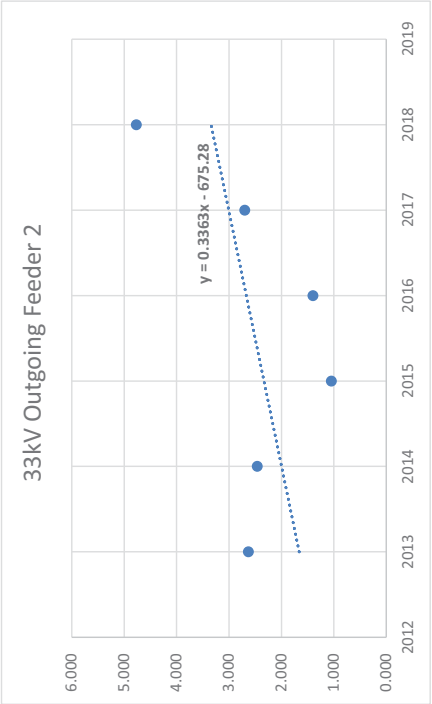
Monthly Peak Load (MW) - 11kV Outgoing Feeder 3 (Semtokha SS)							
	2012	2013	2014	2015	2016	2017	2018
Jan	3.678	4.092	4.06	4.47	3.27	1.66	4.51
Feb	3.699	4.056	4.10	3.86	3.08	1.50	4.23
Mar	4.077	3.307	3.80	4.66	4.00	1.59	4.05
Apr	3.196	3.219	3.34	4.99	3.48	2.40	3.64
May	1.983	1.575	2.80	3.58	2.59	2.40	3.09
Jun	1.515	1.365	2.37	4.63	2.44	1.81	3.68
Jul	1.396	1.248	2.21	4.18	2.71	2.03	3.66
Aug	1.452	3.24	2.32	3.41	2.43	2.01	1.89
Sep	1.581	3.59	2.49	3.65	2.37	2.97	1.95
Oct	3.348	4.162	4.21	2.75	3.28	4.80	2.99
Nov	3.822	5.186	5.04	2.86	3.46	4.09	4.47
Dec	0.00	4.191	4.44	3.40	2.44	4.11	4.56
Max. Peak Load in a Year (MW)	4.077	4.191	4.438	4.986	3.999	4.804	4.564



Forecasted Peak Load (MW)											
Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2030
Peak Load (MW)	4.786	4.866	4.946	5.027	5.107	5.187	5.267	5.348	5.428	5.508	5.669

Monthly Peak Load (MW) - 33kV Outgoing Feeder 2 (Olakha SS)

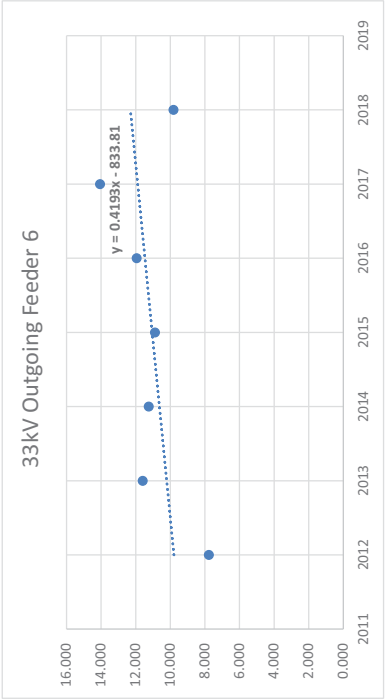
	2013	2014	2015	2016	2017	2018
Jan	0	1.75	0.00	1.05	2.10	1.64
Feb	0	2.46	0.00	1.40	1.05	1.94
Mar	0	1.05	0.00	1.05	1.40	1.93
Apr	0	1.93	0.70	0.00	1.40	1.64
May	0	1.95	0.70	0.00	0.90	1.18
Jun	0	2.45	0.52	0.00	0.85	0.88
Jul	0	0.87	0.00	0.00	0.80	0.89
Aug	0	0.87	0.00	0.00	0.82	0.97
Sep	0	0.00	0.00	0.00	0.80	0.99
Oct	0	0.00	0.79	0.00	1.40	1.48
Nov	1.05	0.00	0.70	0.00	1.60	1.96
Dec	2.63	0.00	1.05	1.40	2.70	4.77
Max. Peak Load in a Year (MW)	2.630	2.460	1.050	1.400	2.700	4.770



Year	Forecasted Peak Load (MW)																	
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load (MW)	2.630	2.460	1.050	1.400	2.700	4.770	3.710	4.046	4.382	4.719	5.055	5.391	5.727	6.064	6.400	6.736	7.073	7.409

Monthly Peak Load (MW) - 33kV Outgoing Feeder 6 (Olakha SS)

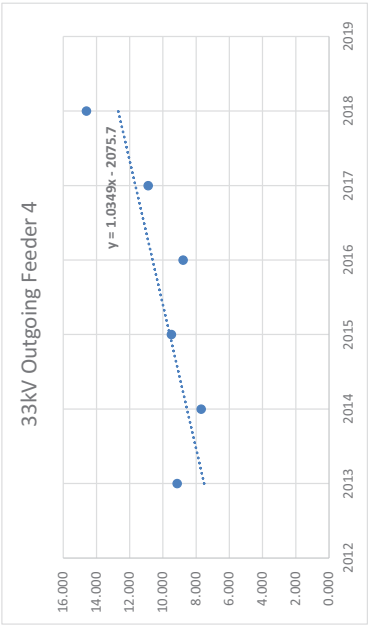
	2012	2013	2014	2015	2016	2017	2018
Jan		8.44	10.54	9.49	11.60	13.35	7.50
Feb		9.84	11.25	9.84	10.54	13.00	7.22
Mar	5.97	9.14	10.26	8.79	10.54	14.06	9.82
Apr	4.69	7.02	7.38	7.73	8.08	8.44	6.71
May	5.97	4.92	7.03	6.32	7.02	6.92	5.39
Jun	3.69	6.67	7.02	5.62	6.67	6.09	3.88
Jul	3.51	3.16	7.73	5.62	5.97	4.79	3.40
Aug	2.81	3.87	5.62	5.62	5.97	5.19	2.99
Sep	4.57	4.22	4.92	4.92	7.02	4.87	3.29
Oct	4.57	9.14	6.67	6.32	7.02	3.24	4.72
Nov	7.78	10.19	7.73	8.79	11.25	7.10	7.64
Dec		11.6	8.79	10.89	11.95	7.53	9.47
Max. Peak Load in a Year (MW)	7.780	11.600	11.250	10.890	11.950	14.060	9.820



Year	Forecasted Peak Load (MW)																		
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load (MW)	7.780	11.600	11.250	10.890	11.950	14.060	9.820	12.757	13.176	13.595	14.015	14.434	14.853	15.273	15.692	16.111	16.530	16.950	17.369

Monthly Peak Load (MW) - 33kV Outgoing Feeder 4 (Olakha SS)

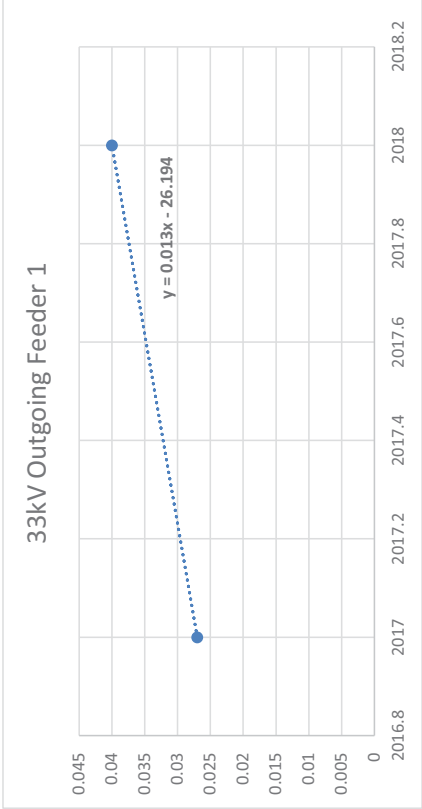
	2013	2014	2015	2016	2017	2018
Jan	8.79	7.70	7.38	8.79	8.44	6.91
Feb	8.9	6.32	0.00	8.79	9.84	8.85
Mar	6.32	6.56	0.00	6.32	10.89	11.74
Apr	4.92	4.57	7.38	4.92	3.16	13.88
May	0	5.27	4.22	3.75	5.06	10.47
Jun	4.22	4.57	4.92	3.75	1.96	7.04
Jul	3.16	4.57	4.22	6.35	1.69	4.40
Aug	7.73	3.87	4.22	0.35	1.92	3.79
Sep	4.57	3.51	4.22	0.35	1.67	11.45
Oct	5.62	5.27	5.62	4.57	2.78	9.91
Nov	9.14	6.32	7.38	6.32	6.39	12.57
Dec	8.08	7.38	9.49	7.38	8.49	14.61
Max. Peak Load in a Year (MW)	9.140	7.700	9.490	8.790	10.890	14.610



Year	Forecasted Peak Load (MW)																	
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load (MW)	9,140	7,700	9,490	8,790	10,890	14,610	13,763	14,798	15,833	16,868	17,903	18,938	19,972	21,007	22,042	23,077	24,112	25,147

Monthly Peak Load (MW) - 33kV Outgoing Feeder 1 (Olakha SS)

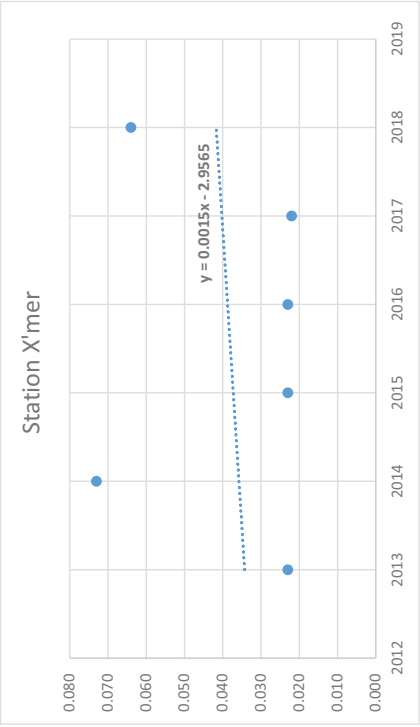
	2014	2015	2016	2017	2018
Jan	0.00	0.00	0.00	0.00	0.03
Feb	0.00	0.00	0.00	0.00	0.03
Mar	0.00	0.00	0.00	0.00	0.03
Apr	0.00	0.00	0.00	0.02	0.02
May	0.00	0.00	0.00	0.02	0.03
Jun	0.00	0.00	0.00	0.02	0.02
Jul	0.00	0.00	0.00	0.02	0.02
Aug	0.00	0.00	0.00	0.05	0.02
Sep	0.00	0.00	0.00	0.02	0.02
Oct	0.00	0.00	0.00	0.02	0.02
Nov	0.00	0.00	0.00	0.03	0.03
Dec	0.00	0.00	0.00	0.05	0.04
Max. Peak Load in a Year (MW)				0.027	0.040



Forecasted Peak Load (MW)														
Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load (MW)	0.027	0.040	0.053	0.066	0.079	0.092	0.105	0.118	0.131	0.144	0.157	0.17	0.183	0.196

Monthly Peak Load (MW) - Station X'mer

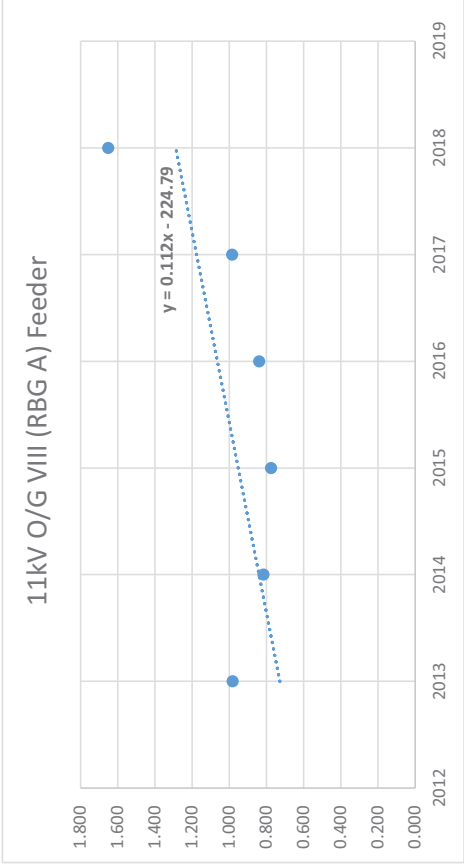
	2013	2014	2015	2016	2017	2018
Jan	0.02	0.02	0.02	0.02	0.02	0.02
Feb	0.02	0.02	0.02	0.02	0.02	0.02
Mar	0.02	0.02	0.02	0.02	0.02	0.02
Apr	0.02	0.02	0.02	0.02	0.02	0.02
May	0.02	0.02	0.02	0.02	0.02	0.02
Jun	0.01	0.02	0.01	0.01	0.01	0.02
Jul	0.01	0.01	0.01	0.01	0.01	0.01
Aug	0.01	0.01	0.01	0.01	0.02	0.01
Sep	0.01	0.02	0.01	0.01	0.02	0.02
Oct	0.02	0.07	0.02	0.02	0.02	0.06
Nov	0.02	0.06	0.02	0.02	0.02	0.02
Dec	0.02	0.02	0.02	0.02	0.02	0.02
Max. Peak Load in a Year (MW)	0.023	0.073	0.023	0.023	0.022	0.064



Forecasted Peak Load (MW)											
Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2030
Peak Load (MW)	0.072	0.074	0.075	0.076	0.078	0.079	0.081	0.083	0.084	0.086	0.088

Monthly Peak Load (MW) - 11kV O/G VIII (RBG A) Feeder

	2013	2014	2015	2016	2017	2018
Jan	0.77	0.82	0.68	0.74	0.72	0.82
Feb	0.70	0.74	0.69	0.77	0.99	0.84
Mar	0.98	0.67	0.73	0.78	0.93	0.87
Apr	0.71	0.68	0.686	0.69	0.72	0.81
May	0.55	0.45	0.58	0.58	0.60	0.71
Jun	0.38	0.35	0.38	0.47	0.41	0.47
Jul	0.34	0.47	0.38	0.37	0.35	0.36
Aug	0.37	0.61	0.40	0.39	0.38	0.45
Sep	0.34	0.39	0.42	0.47	0.44	0.45
Oct	0.71	0.70	0.70	0.74	0.73	0.89
Nov	0.79	0.73	0.76	0.84	0.84	1.65
Dec	0.80	0.69	0.78	0.76	0.84	0.94
Max. Peak Load in a Year (MW)	0.982	0.816	0.775	0.839	0.985	1.652

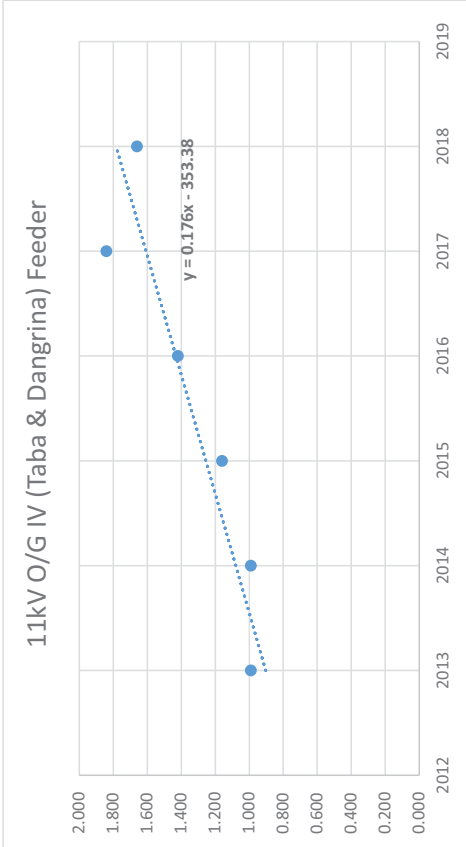


Forecasted Peak Load (MW)

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load (MW)	0.982	0.816	0.775	0.839	0.985	1.652	1.338	1.450	1.562	1.674	1.786	1.898	2.010	2.122	2.234	2.346	2.458	2.570

Monthly Peak Load (MW) - 11kV O/G IV (Taba & Dangrina) Feeder

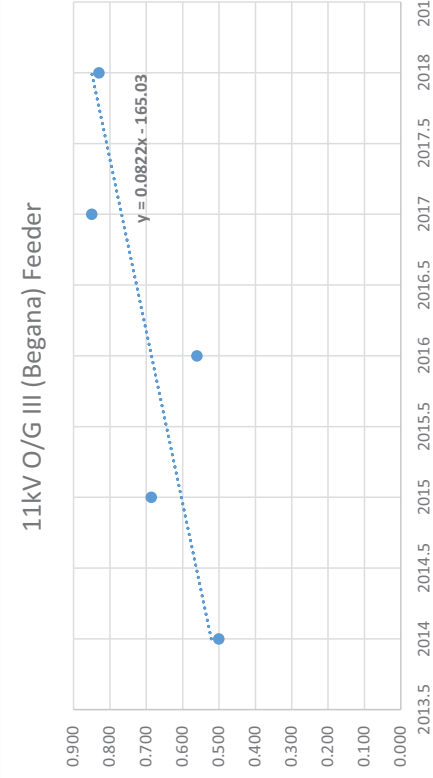
	2013	2014	2015	2016	2017	2018
Jan		0.96	1	1.42	1.22	1.63
Feb		0.96	1.01	1.13	1.26	1.66
Mar		0.94	0.99	1.07	1.62	1.58
Apr	0.752	0.82	0.88	0.89	1.1	1.51
May	0.602	0.67	0.77	0.85	0.86	1.25
Jun	0.514	0.726	0.67	0.66	0.71	0.83
Jul	0.49	0.59	0.63	0.68	0.7	0.73
Aug	0.476	0.57	0.69	0.69	0.71	0.82
Sep	0.467	0.681	0.69	0.75	1.14	0.86
Oct	0.63	0.81	0.847	0.89	1.79	1.24
Nov	0.765	0.93	1	2.24	1.84	1.39
Dec	0.99	0.99	1.16	1.15	1.65	1.52
Max. Peak Load in a Year (MW)	0.990	0.990	1.160	1.420	1.840	1.660



Forecasted Peak Load (MW)											
Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2030
Peak Load (MW)	1.964	2.140	2.316	2.492	2.668	2.844	3.020	3.196	3.372	3.548	3.900

Monthly Peak Load (MW) - 11kV O/G III (Begana) Feeder

	2018	2017	2016	2015	2014
Jan	0.605	0.634	0.472	0.406	0.501
Feb	0.499	0.517	0.554	0.365	0.38
Mar	0.695	0.547	0.561	0.423	0.448
Apr	0.51	0.46	0.496	0.47	0.475
May	0.83	0.85	0.437	0.686	0.404
Jun	0.342	0.358	0.335	0.35	0.326
Jul	0.384	0.304	0.387	0.329	0.325
Aug	0.381	0.333	0.355	0.362	0.34
Sep	0.422	0.381	0.382	0.39	0.402
Oct	0.551	0.419	0.501	0.402	0.429
Nov	0.631	0.518	0.527	0.482	0.498
Dec	0.642	0.656	0.546	0.519	0.434
Max. Peak Load in a Year (MW)	0.830	0.850	0.561	0.686	0.501

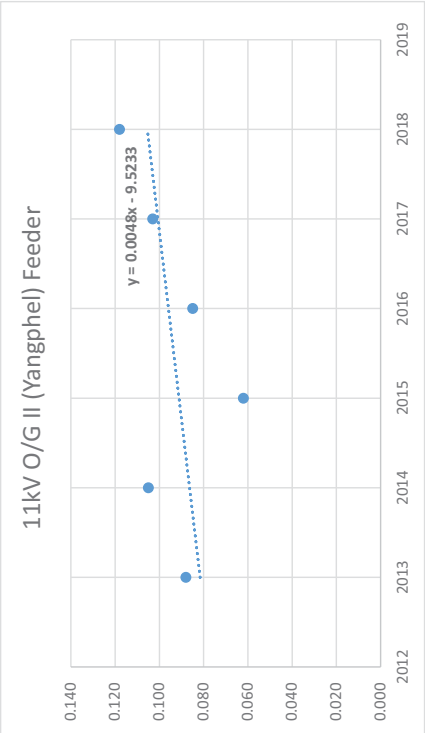


Forecasted Peak Load (MW)

Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load (MW)	0.932	1.014	1.096	1.178	1.261	1.343	1.425	1.507	1.589	1.672	1.754	1.836

Monthly Peak Load (MW) - 11kV O/G II (Yangphel) Feeder

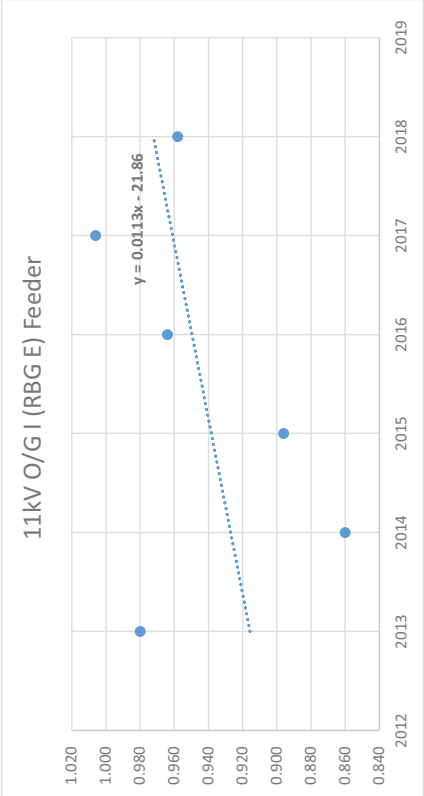
	2018	2017	2016	2015	2014	2013
Jan	0.118	0.086	0.03	0.05	0.1	
Feb	0.109	0.063	0.032	0.062	0.105	
Mar	0.114	0.086	0.035	0.022	0.94	
Apr	0.112	0.064	0.027	0.029	0.095	
May	0.107	0.058	0.043	0.026	0.084	
Jun	0.092	0.05	0.039	0.028	0.077	
Jul	0.084	0.051	0.036	0.039	0.057	0.058
Aug	0.072	0.059	0.085	0.027	0.051	0.079
Sep	0.082	0.058	0.036	0.024	0.069	0.052
Oct	0.11	0.076	0.043	0.021	0.038	0.088
Nov	0.105	0.08	0.048	0.022	0.05	0.082
Dec	0.118	0.103	0.056	0.026	0.0766	0.081
Max. Peak Load in a Year (MW)	0.118	0.103	0.085	0.062	0.105	0.088



Year	Forecasted Peak Load (MW)																	
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load (MW)	0.088	0.105	0.062	0.085	0.103	0.118	0.168	0.173	0.177	0.182	0.187	0.192	0.197	0.201	0.206	0.211	0.216	0.221

Monthly Peak Load (MW) - 11kV O/G I (RBG E) Feeder

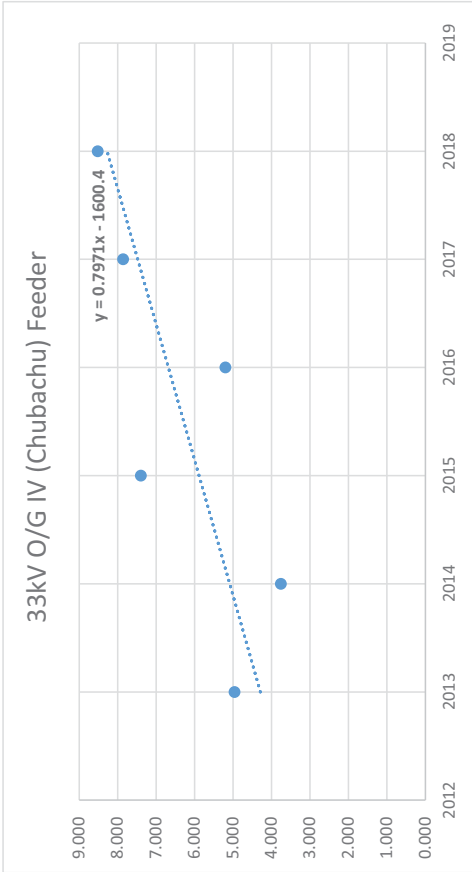
	2018	2017	2016	2015	2014	2013
Jan	0.827	0.937	0.82	0.801	0.86	0.92
Feb	0.883	0.927	0.874	0.806	0.818	0.871
Mar	0.838	1.006	0.874	0.896	0.754	0.939
Apr	0.808	0.832	0.753	0.767	0.645	0.77
May	0.709	0.682	0.638	0.62	0.533	0.98
Jun	0.478	0.459	0.485	0.437	0.413	0.45
Jul	0.379	0.42	0.462	0.436	0.38	0.41
Aug	0.453	0.497	0.464	0.442	0.418	0.438
Sep	0.507	0.547	0.528	0.464	0.505	0.441
Oct	0.939	0.818	0.798	0.772	0.772	0.81
Nov	0.958	0.991	0.964	0.865	0.81	0.906
Dec	0.942	0.855	0.894	0.849	0.786	0.961
Max. Peak Load in a Year (MW)	0.958	1.006	0.964	0.896	0.860	0.980



Year	Forecasted Peak Load (MW)																	
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load (MW)	0.980	0.860	0.896	0.964	1.006	0.958	0.955	0.966	0.977	0.989	1.000	1.011	1.023	1.034	1.045	1.056	1.068	1.079

Monthly Peak Load (MW) - 33kV O/G IV (Chubachu) Feeder

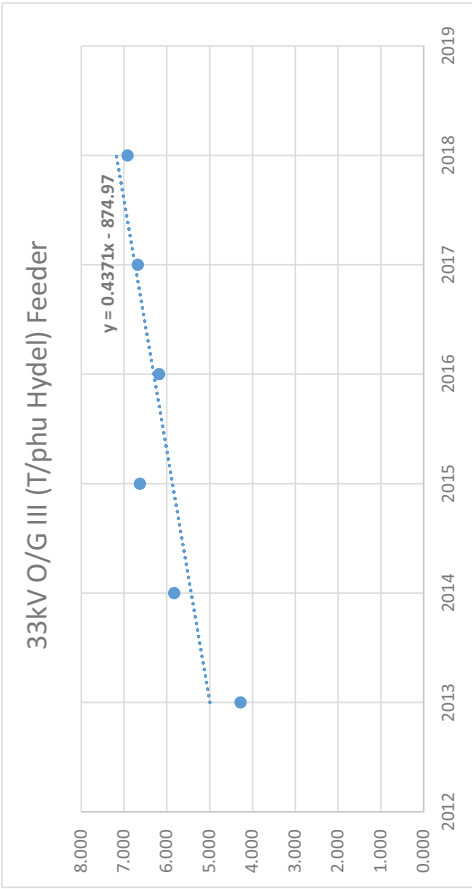
	2018	2017	2016	2015	2014	2013
Jan	8.52	7.68		6.82	0.54	
Feb	8.06	7.54		7.06	0.054	
Mar	7.48	6.74		7.4	0.054	
Apr	4.46	5.1	3.12	5.66	3.76	4.96
May	3.46	4.72			3.6	4.02
Jun	3.04	3.3	2.82		0	3.84
Jul	3.46	3.16	2.88		3.3	
Aug	3.38	3.32	2.92		3.72	
Sep	3.38	3.32	2.9		0	
Oct		5.2	3.94		0	4.5
Nov		7.66			0	
Dec		7.86	5.2		0	0.54
Max. Peak Load in a Year (MW)	8.520	7.860	5.200	7.400	3.760	4.960



Forecasted Peak Load (MW)

Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load (MW)	8.945	9.742	10.539	11.336	12.133	12.930	13.728	14.525	15.322	16.119	16.916	17.713

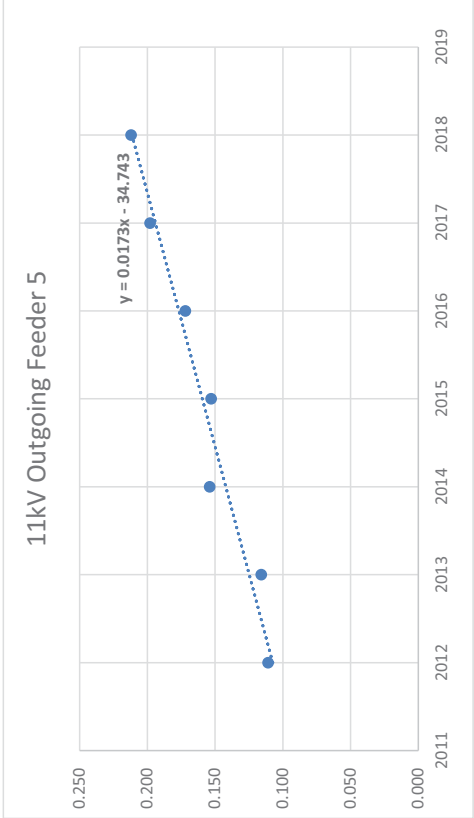
Monthly Peak Load (MW) - 33kV O/G II (T/phu Hydel) Feeder						
	2018	2017	2016	2015	2014	2013
Jan	4.34	6.05	6.07	5.65	3.99	4.09
Feb	4.13	5.91	5.85	5.39	4.21	4.22
Mar	4.04	5.96	5.6	5.25	3.79	3.87
Apr	3.75	5.138	4.47	4.34	3.62	3.49
May	3.15	3.96	4.46	3.1	2.95	3.28
Jun	4.18	3.44	3.76	2.8	2.51	3.19
Jul	3.83	3.4	3.2	3.08	2.23	3.08
Aug	3.94	4.47	2.98	3.8	2.17	3.31
Sep	4.02	4.83	3.14	3.99	5.49	2.86
Oct	6.68	5.42	4.68	5.42	4.96	3.94
Nov	6.92	6.68	6.18	5.78	5.02	4.22
Dec	6.56	5.58	6.04	6.63	5.83	4.28
Max. Peak Load in a Year (MW)	6.920	6.680	6.180	6.630	5.830	4.280



Forecasted Peak Load (MW)											
Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2030
Peak Load (MW)	7.535	7.972	8.409	8.846	9.283	9.720	10.157	10.595	11.032	11.469	12.343

Monthly Peak Load (MW) - 11kV Outgoing Feeder 5 (Bjemina SS)

	2012	2013	2014	2015	2016	2017	2018
Jan	0.071	0.097	0.11	0.11	0.13	0.20	0.18
Feb	0.094	0.105	0.15	0.10	0.10	0.13	0.17
Mar	0.079	0.116	0.15	0.11	0.14	0.15	0.18
Apr	0.11	0.084	0.08	0.10	0.15	0.16	0.17
May	0.095	0.088	0.10	0.14	0.14	0.16	0.17
Jun	0.111	0.099	0.11	0.13	0.11	0.15	0.17
Jul	0.089	0.089	0.10	0.14	0.13	0.15	0.17
Aug	0.107	0.096	0.11	0.15	0.15	0.17	0.20
Sep	0.08	0.096	0.10	0.14	0.15	0.15	0.17
Oct	0.104	0.095	0.10	0.14	0.15	0.14	0.17
Nov	0.082	0.11	0.09	0.13	0.15	0.16	0.21
Dec		0.098	0.11	0.14	0.17	0.18	1.27
Max. Peak Load in a Year (MW)	0.111	0.116	0.154	0.153	0.172	0.198	0.212

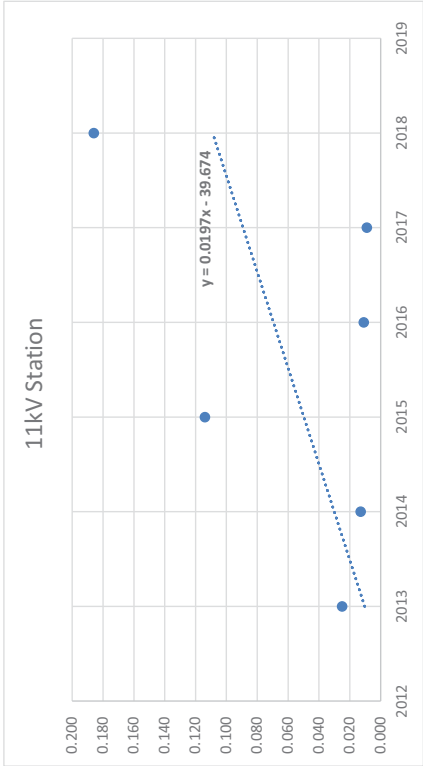


Forecasted Peak Load (MW)

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load (MW)	0.111	0.116	0.154	0.153	0.172	0.198	0.212	0.186	0.203	0.220	0.238	0.255	0.272	0.289	0.307	0.324	0.341	0.359	0.376

Monthly Peak Load (MW) - 11kV Station (Bjemina SS)

	2013	2014	2015	2016	2017	2018
Jan	0.009	0.01	0.01	0.01	0.01	0.01
Feb	0.009	0.01	0.01	0.01	0.01	0.01
Mar	0.009	0.01	0.01	0.01	0.01	0.01
Apr	0.007	0.01	0.11	0.01	0.01	0.01
May	0.009	0.01	0.01	0.01	0.01	0.01
Jun	0.009	0.01	0.01	0.01	0.01	0.01
Jul	0.006	0.01	0.01	0.01	0.01	0.01
Aug	0.008	0.01	0.01	0.01	0.01	0.01
Sep	0.007	0.01	0.01	0.01	0.01	0.01
Oct	0.007	0.01	0.01	0.01	0.01	0.01
Nov	0.009	0.01	0.01	0.01	0.01	0.01
Dec	0.025	0.01	0.01	0.01	0.01	0.19
Max. Peak Load in a Year (MW)	0.025	0.013	0.114	0.011	0.009	0.186

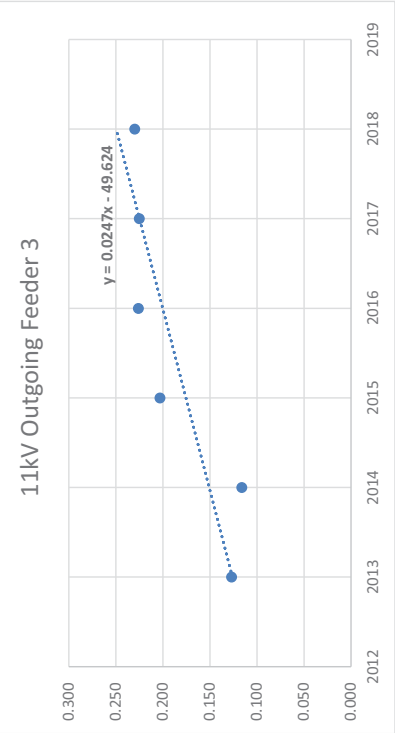


Forecasted Peak Load (MW)

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load (MW)	0.025	0.013	0.114	0.011	0.009	0.186	0.100	0.120	0.140	0.159	0.179	0.199	0.218	0.238	0.258	0.278	0.297	0.317

Monthly Peak Load (MW) - 11kV Outgoing Feeder 3 (Bjemina SS)

	2013	2014	2015	2016	2017	2018
Jan	0.117	0.12	0.10	0.15	0.21	0.22
Feb	0.114	0.11	0.12	0.17	0.21	0.18
Mar	0.127	0.09	0.16	0.17	0.23	0.20
Apr	0.114	0.10	0.17	0.19	0.21	0.20
May	0.101	0.09	0.15	0.20	0.19	0.20
Jun	0.112	0.11	0.14	0.19	0.18	0.19
Jul	0.1	0.10	0.14	0.19	0.17	0.16
Aug	0.125	0.11	0.17	0.19	0.18	0.16
Sep	0.119	0.11	0.17	0.19	0.19	0.18
Oct	0.112	0.11	0.15	0.22	0.19	0.23
Nov	0.121	0.11	0.18	0.23	0.21	0.21
Dec	0.12	0.11	0.20	0.22	0.21	0.00
Max. Peak Load in a Year (MW)	0.127	0.116	0.203	0.226	0.225	0.230



Year	Forecasted Peak Load (MW)																	
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Load (MW)	0.127	0.116	0.203	0.226	0.225	0.230	0.245	0.270	0.295	0.319	0.344	0.369	0.393	0.418	0.443	0.468	0.492	0.517

Annexure 4- ETAP Simulation Results

Bus Loading Summary Report

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
			MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
ID	kV	Rated Amp												
0	11.000										1.410	85.0	86.4	
11kV Gidagom	11.000										0.229	85.0	12.4	
11kV Gidagom1	11.000										0.229	85.0	12.4	
11kV Hospital	11.000										3.592	85.0	208.2	
11kV Hospital1	11.000										5.085	85.0	294.7	
B	11.000										1.171	85.0	71.9	
Babesa1	33.000										8.110	82.6	142.4	
Bjemina	66.000										15.318	84.8	136.9	
Bus00	11.000		0.070	0.043	0.213	0.132					0.332	85.0	20.0	
Bus000	11.000										2.075	85.0	125.1	
Bus1	33.000		0.936		0.234						16.350	83.3	286.2	
Bus 1	11.000		4.794	2.971	1.197	0.742					12.896	84.9	677.2	
Bus2	33.000										23.379	81.9	409.5	
Bus3	11.000										0.236	85.0	14.5	
Bus4	11.000										1.086	85.1	65.1	
Bus5	33.000										23.254	82.0	409.5	
Bus6	33.000										17.900	87.6	344.0	
Bus7	11.000										5.347	84.9	331.1	
Bus8	33.000										15.410	81.7	271.5	
Bus9	33.000										23.388	81.9	409.5	
Bus11	11.000										4.758	85.0	279.3	
Bus12	11.000		0.041	0.025	0.122	0.076					1.162	85.0	70.6	
Bus13	11.000		0.034	0.021	0.102	0.063					0.160	85.0	9.7	
Bus14	11.000										0.943	85.0	56.6	
Bus15	33.000										14.795	87.3	258.3	
Bus16	11.000										2.036	85.2	106.6	
Bus17	11.000										5.451	85.1	298.2	
Bus18	33.000										21.020	89.3	404.0	
Bus19	11.000										3.562	84.8	205.7	
Bus20	33.000										14.652	81.9	271.7	
Bus21	11.000										0.002	92.5	0.1	
Bus22	33.000		0.149	0.092	0.525	0.326					14.597	82.0	271.8	
Bus23	11.000										1.884	84.7	106.9	
Bus25	11.000										3.796	82.9	227.6	
Bus26	11.000		0.146	0.091	0.462	0.286					3.059	85.0	180.7	
Bus27	11.000										4.369	84.9	270.5	
Bus28	11.000										8.745	85.0	514.1	
Bus29	11.000										4.407	85.0	259.0	
Bus30	11.000										4.417	85.0	274.6	

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Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
Bus31	11.000										3.870	80.7	225.3	
Bus32	11.000										3.518	86.8	192.0	
Bus33	11.000										4.034	83.2	222.1	
Bus34	11.000										4.637	85.0	272.2	
Bus35	11.000		0.051	0.032	0.149	0.093					0.236	85.0	14.5	
Bus36	11.000										3.904	85.1	213.5	
Bus37	11.000										3.679	84.7	208.8	
Bus38	11.000												-	
Bus39	33.000										0.261	85.8	5.0	
Bus40	11.000										4.124	85.0	247.2	
Bus41	33.000										0.014	-	0.3	
Bus42	33.000										0.009	-	0.2	
Bus43	33.000										0.009	-	0.2	
Bus44	33.000												-	
Bus45	33.000										0.014	-	0.3	
Bus46	33.000										0.009	-	0.2	
Bus47	33.000										0.009	-	0.2	
Bus48	33.000										8.131	82.7	142.4	
Bus49	33.000												-	
Bus50	33.000										8.124	82.7	142.4	
Bus51	33.000										8.124	82.7	142.4	
Bus52	33.000		0.039	0.024	0.156	0.097					0.230	85.0	4.0	
Bus53	33.000										5.113	99.9	98.4	
Bus54	33.000										0.000	-	-	
Bus55	33.000										0.161	85.3	3.1	
Bus56	33.000		0.032	0.020	0.105	0.065					0.161	85.0	3.1	
Bus57	33.000										1.202	85.5	23.1	
Bus58	33.000										1.203	85.5	23.1	
Bus59	33.000										0.168	85.1	3.2	
Bus60	33.000										0.168	85.1	3.2	
Bus61	33.000		0.033	0.021	0.110	0.068					0.168	85.0	3.2	
Bus62	33.000		0.045	0.028	0.149	0.092					1.035	85.5	19.9	
Bus63	33.000										0.807	85.6	15.5	
Bus64	33.000		0.045	0.028	0.149	0.092					0.229	85.0	4.4	
Bus65	33.000										0.579	85.8	11.1	
Bus66	33.000		0.033	0.021	0.110	0.068					0.269	85.4	5.2	
Bus67	33.000		0.010	0.006	0.033	0.021					0.102	85.4	2.0	
Bus68	33.000		0.010	0.006	0.033	0.021					0.051	85.0	1.0	
Bus69	33.000										0.311	85.8	6.0	
Bus70	33.000										0.211	85.5	4.1	
Bus71	33.000		0.010	0.006	0.033	0.021					0.051	85.0	1.0	
Bus72	33.000		0.010	0.006	0.033	0.021					0.051	85.0	1.0	

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Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
			MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
ID	kV	Rated Amp												
Bus73	33.000										0.160	85.4	3.1	
Bus74	33.000		0.022	0.013	0.072	0.044					0.110	85.0	2.1	
Bus75	33.000		0.010	0.006	0.033	0.021					0.051	85.0	1.0	
Bus76	33.000										11.777	84.1	226.4	
Bus77	33.000										11.765	84.1	226.4	
Bus78	33.000										11.559	84.5	226.5	
Bus79	33.000										11.553	84.5	226.5	
Bus80	33.000										11.552	84.5	226.5	
Bus81	33.000										11.538	84.5	226.5	
Bus82	11.000										2.068	85.0	125.1	
Bus83	11.000										0.977	85.0	60.5	
Bus84	11.000		0.077	0.047	0.220	0.136					0.977	85.0	60.5	
Bus85	11.000										0.628	85.0	39.0	
Bus86	11.000		0.138	0.086	0.396	0.245					0.628	85.0	39.0	
Bus87	11.000										2.331	84.9	144.4	
Bus88	11.000										2.309	85.0	144.4	
Bus89	11.000										2.309	85.0	144.4	
Bus90	11.000		0.253	0.157	0.712	0.441					1.135	85.0	71.0	
Bus91	11.000										1.173	85.0	73.4	
Bus92	11.000										1.168	85.0	73.4	
Bus93	11.000										1.168	85.0	73.4	
Bus94	11.000		0.131	0.081	0.366	0.227					0.584	85.0	36.7	
Bus95	11.000												-	
Bus96	11.000		0.051	0.032	0.151	0.094					0.238	85.0	14.5	
Bus97	11.000										1.552	91.7	96.6	
Bus98	11.000		0.018	0.011	0.052	0.032					1.551	91.7	96.6	
Bus99	11.000										1.579	85.6	98.4	
Bus100	11.000		0.018	0.011	0.050	0.031					1.427	84.8	90.7	
Bus101	11.000										1.342	84.9	85.6	
Bus102	11.000		0.018	0.011	0.049	0.031					1.342	84.9	85.6	
Bus103	11.000		0.018	0.011	0.052	0.032					0.082	85.0	5.1	
Bus104	11.000		0.018	0.011	0.049	0.030					1.252	84.9	80.5	
Bus105	11.000		0.003	0.002	0.007	0.004					1.167	84.9	75.4	
Bus106	11.000										1.152	85.0	74.7	
Bus107	11.000										1.151	85.0	74.7	
Bus108	11.000										1.006	85.0	65.3	
Bus109	11.000										0.994	85.0	65.3	
Bus110	11.000		0.034	0.021	0.087	0.054					0.284	85.0	18.7	
Bus111	11.000		0.034	0.021	0.087	0.054					0.142	85.0	9.3	
Bus112	11.000										0.710	85.1	46.6	
Bus113	11.000		0.034	0.021	0.086	0.054					0.370	85.0	24.4	
Bus114	11.000										0.339	85.1	22.3	

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Directly Connected Load												Total Bus Load			
Bus			Constant kVA		Constant Z		Constant I		Generic		Rated Amp	MVA	% PF	Amp	Percent Loading
ID	kV		MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar					
Bus115	11.000											0.262	85.1	17.2	
Bus116	11.000		0.018	0.011	0.047	0.029						0.076	85.0	5.0	
Bus117	11.000		0.003	0.002	0.007	0.004						0.186	85.1	12.2	
Bus118	11.000		0.018	0.011	0.046	0.029						0.175	85.1	11.5	
Bus119	11.000		0.018	0.011	0.047	0.029						0.099	85.1	6.5	
Bus120	11.000		0.005	0.003	0.014	0.008						0.022	85.0	1.5	
Bus121	11.000		0.018	0.011	0.047	0.029						0.076	85.0	5.0	
Bus122	11.000											0.229	85.0	15.1	
Bus123	11.000		0.018	0.011	0.046	0.029						0.076	85.0	5.0	
Bus124	11.000		0.037	0.023	0.093	0.058						0.153	85.0	10.1	
Bus125	11.000											3.600	81.3	223.8	
Bus126	11.000											3.632	81.8	226.3	
Bus127	11.000		0.094	0.058	0.265	0.164						3.490	84.9	217.9	
Bus128	11.000											3.052	85.0	191.6	
Bus129	11.000		0.187	0.116	0.520	0.322						2.837	85.0	178.5	
Bus130	11.000											0.344	85.0	21.7	
Bus131	11.000											2.000	85.0	126.2	
Bus132	11.000											1.650	85.0	104.5	
Bus133	11.000		0.374	0.232	1.029	0.638						1.650	85.0	104.5	
Bus134	11.000											0.344	85.0	21.7	
Bus135	11.000											0.344	85.0	21.7	
Bus136	11.000											0.344	85.0	21.7	
Bus137	11.000											0.344	85.0	21.7	
Bus138	11.000											0.344	85.0	21.7	
Bus140	11.000											0.209	85.0	13.1	
Bus141	11.000		0.047	0.029	0.130	0.081						0.208	85.0	13.1	
Bus142	11.000											0.197	85.1	12.2	
Bus143	11.000											0.197	85.1	12.2	
Bus144	11.000		0.022	0.014	0.063	0.039						0.197	85.0	12.2	
Bus145	11.000		0.021	0.013	0.061	0.038						0.097	85.0	6.0	
Bus146	11.000											1.124	84.9	67.4	
Bus147	11.000											1.122	85.0	67.4	
Bus148	11.000		0.027	0.017	0.081	0.050						1.121	85.0	67.4	
Bus149	11.000		0.017	0.010	0.051	0.031						0.992	85.0	59.7	
Bus150	11.000											0.909	85.0	55.0	
Bus151	11.000											0.907	85.0	55.0	
Bus152	11.000		0.055	0.034	0.164	0.102						0.473	85.0	28.7	
Bus153	11.000											0.215	85.0	13.1	
Bus154	11.000		0.046	0.028	0.137	0.085						0.215	85.0	13.1	
Bus155	11.000		0.036	0.022	0.108	0.067						0.434	85.0	26.3	
Bus156	11.000											0.264	85.0	16.0	
Bus157	11.000		0.056	0.035	0.168	0.104						0.264	85.0	16.0	

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Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
Bus158	33.000										4.659	81.9	91.5	
Bus159	33.000										4.657	81.9	91.5	
Bus160	33.000										4.656	81.9	91.5	
Bus161	33.000										4.651	81.9	91.5	
Bus162	33.000													
Bus163	33.000													-
Bus164	33.000													-
Bus165	33.000										4.650	81.9	91.5	
Bus166	11.000										1.654	85.0	100.9	
Bus167	11.000										0.505	39.4	30.3	
Bus168	11.000										0.505	39.4	30.3	
Bus169	11.000		0.034	0.021	0.105	0.065					0.647	52.5	38.7	
Bus170	11.000										0.647	52.5	38.7	
Bus171	11.000		0.065	0.040	0.201	0.124					0.937	64.6	56.0	
Bus172	11.000		0.021	0.013	0.064	0.040					1.034	66.9	61.7	
Bus173	11.000										1.256	70.6	74.8	
Bus174	11.000										0.228	85.0	13.6	
Bus175	11.000		0.047	0.029	0.146	0.091					0.228	85.0	13.6	
Bus176	11.000										1.258	70.6	74.8	
Bus177	11.000										1.258	70.6	74.8	
Bus178	11.000										0.332	85.0	20.0	
Bus179	11.000										0.610	85.1	36.6	
Bus180	11.000		0.018	0.011	0.056	0.035					0.610	85.1	36.6	
Bus181	11.000										0.522	85.1	31.4	
Bus182	11.000		0.051	0.032	0.155	0.096					0.522	85.1	31.4	
Bus183	11.000										0.279	85.1	16.8	
Bus184	11.000		0.018	0.011	0.054	0.034					0.279	85.1	16.8	
Bus185	11.000		0.018	0.011	0.055	0.034					0.194	85.1	11.7	
Bus186	11.000										0.109	85.2	6.6	
Bus187	11.000		0.005	0.003	0.015	0.009					0.024	85.0	1.4	
Bus188	11.000										0.085	85.1	5.1	
Bus189	11.000		0.018	0.011	0.054	0.034					0.085	85.0	5.1	
Bus190	11.000										-	-	-	
Bus191	11.000										1.896	85.0	115.4	
Bus192	11.000										0.142	85.3	8.5	
Bus193	11.000		0.011	0.007	0.035	0.022					0.142	85.3	8.5	
Bus194	11.000		0.015	0.009	0.046	0.029					0.088	85.5	5.3	
Bus195	11.000		0.002	0.001	0.006	0.004					0.016	86.1	0.9	
Bus196	11.000		0.001	0.001	0.004	0.003					0.007	85.0	0.4	
Bus197	11.000										0.030	85.4	1.8	
Bus198	11.000										0.030	85.3	1.8	
Bus199	11.000										0.030	85.0	1.8	

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Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
			MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
Bus200	11.000		0.006	0.004	0.019	0.012					0.030	85.0	1.8	
Bus201	11.000										0.000	-	-	
Bus202	11.000										0.000	-	-	
Bus203	11.000													
Bus204	11.000										2.330	85.0	139.7	
Bus205	11.000										2.323	85.0	139.7	
Bus206	11.000										0.243	85.0	14.6	
Bus207	11.000		0.051	0.032	0.155	0.096					0.243	85.0	14.6	
Bus208	11.000		0.051	0.032	0.152	0.094					0.238	85.0	14.5	
Bus209	11.000		0.051	0.032	0.149	0.092					1.170	85.0	71.9	
Bus210	11.000										0.935	85.0	57.5	
Bus211	11.000										0.934	85.0	57.5	
Bus212	11.000										0.235	85.0	14.4	
Bus213	11.000		0.051	0.032	0.148	0.092					0.235	85.0	14.4	
Bus214	11.000										0.699	85.0	43.1	
Bus215	11.000										0.695	85.0	43.1	
Bus216	11.000										0.694	85.0	43.1	
Bus217	11.000										0.693	85.0	43.1	
Bus218	11.000		0.051	0.032	0.145	0.090					0.462	85.0	28.7	
Bus219	11.000										0.231	85.0	14.4	
Bus220	11.000		0.051	0.032	0.145	0.090					0.231	85.0	14.4	
Bus221	11.000										0.231	85.0	14.4	
Bus222	11.000		0.051	0.032	0.145	0.090					0.231	85.0	14.4	
Bus223	11.000													
Bus224	66.000										15.569	85.0	136.2	
Bus225	11.000										1.763	85.0	105.7	
Bus226	11.000										1.757	85.0	105.7	
Bus227	11.000										1.752	85.0	105.7	
Bus228	11.000										1.747	85.0	105.7	
Bus229	11.000										1.555	85.0	94.1	
Bus230	11.000										1.361	85.0	82.4	
Bus231	11.000										0.192	85.0	11.6	
Bus232	11.000		0.041	0.025	0.123	0.076					0.192	85.0	11.6	
Bus233	11.000										1.359	85.0	82.4	
Bus234	11.000		0.042	0.026	0.125	0.077					1.359	85.0	82.4	
Bus235	11.000										1.163	85.0	70.6	
Bus236	11.000										1.163	85.0	70.6	
Bus237	11.000										1.162	85.0	70.6	
Bus238	11.000		0.042	0.026	0.124	0.077					0.195	85.0	11.9	
Bus239	11.000										0.775	85.0	47.1	
Bus240	11.000										0.194	85.0	11.8	
Bus241	11.000		0.041	0.026	0.124	0.077					0.194	85.0	11.8	

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Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
			MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
ID	kV	Rated Amp												
Bus242	11.000										0.581	85.0	35.3	
Bus243	11.000										0.386	85.0	23.5	
Bus244	11.000		0.041	0.026	0.123	0.076					0.193	85.0	11.7	
Bus245	11.000		0.041	0.025	0.123	0.076					0.192	85.0	11.6	
Bus246	11.000		0.041	0.026	0.123	0.076					0.193	85.0	11.7	
Bus247	11.000		0.042	0.026	0.124	0.077					0.195	85.0	11.9	
Bus248	11.000													
Bus249	11.000		0.001	0.001	0.006	0.003					0.008	85.0	0.4	
Bus250	11.000		0.035	0.022	0.108	0.067					0.839	85.0	50.3	
Bus251	11.000										0.670	85.0	40.2	
Bus252	11.000		0.071	0.044	0.216	0.134					0.670	85.0	40.2	
Bus253	11.000		0.035	0.022	0.107	0.066					0.333	85.0	20.0	
Bus254	11.000		0.035	0.022	0.107	0.066					0.166	85.0	10.0	
Bus255	11.000													
Bus256	11.000										2.233	84.9	117.3	
Bus257	11.000										2.212	85.0	117.3	
Bus258	11.000		0.064	0.040	0.250	0.155					2.212	85.0	117.3	
Bus259	11.000										1.841	85.0	97.7	
Bus260	11.000										1.834	85.0	97.8	
Bus262	11.000										0.732	85.0	39.0	
Bus263	11.000		0.064	0.040	0.247	0.153					0.366	85.0	19.5	
Bus264	11.000		0.064	0.040	0.247	0.153					0.366	85.0	19.5	
Bus265	11.000										0.736	85.0	39.2	
Bus266	11.000										0.736	85.0	39.2	
Bus267	11.000		0.065	0.040	0.250	0.155					0.736	85.0	39.2	
Bus268	11.000		0.064	0.040	0.247	0.153					0.365	85.0	19.5	
Bus269	11.000										0.366	85.0	19.5	
Bus270	11.000		0.064	0.040	0.247	0.153					0.366	85.0	19.5	
Bus271	11.000												-	
Bus272	11.000		0.064	0.040	0.251	0.156					0.740	85.0	39.2	
Bus273	11.000										0.740	85.0	39.2	
Bus274	11.000										1.111	85.0	58.7	
Bus275	11.000		0.064	0.040	0.253	0.157					1.484	85.0	78.5	
Bus277	11.000		0.064	0.040	0.251	0.156					0.370	85.0	19.6	
Bus278	11.000										0.370	85.0	19.6	
Bus279	11.000		0.064	0.040	0.250	0.155					0.370	85.0	19.6	
Bus280	11.000													
Bus286	11.000										1.022	85.0	53.7	
Bus287	11.000										1.018	85.0	53.7	
Bus288	11.000										0.008	86.1	0.4	
Bus289	11.000										1.004	85.0	53.3	
Bus290	11.000		0.039	0.024	0.153	0.095					1.004	85.0	53.3	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
			MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
ID	kV	Rated Amp												
Bus291	11.000		0.038	0.024	0.149	0.092					0.775	85.1	41.3	
Bus292	11.000		0.014	0.008	0.052	0.032					0.552	85.0	29.6	
Bus293	11.000										0.474	85.0	25.5	
Bus294	11.000										0.474	85.0	25.5	
Bus295	11.000										0.474	85.0	25.5	
Bus296	11.000										0.316	85.0	17.0	
Bus297	11.000		0.056	0.035	0.213	0.132					0.316	85.0	17.0	
Bus298	11.000		0.028	0.017	0.106	0.066					0.158	85.0	8.5	
Bus299	11.000										5.648	84.5	296.8	
Bus300	11.000										5.422	84.8	296.8	
Bus301	11.000		0.036	0.022	0.128	0.079					4.604	84.9	255.8	
Bus302	11.000										4.397	85.0	245.0	
Bus303	11.000		0.036	0.022	0.132	0.082					0.395	85.0	21.6	
Bus304	11.000		0.036	0.022	0.132	0.082					0.197	85.0	10.8	
Bus305	11.000										0.355	85.0	19.5	
Bus306	11.000										0.355	85.0	19.5	
Bus308	11.000										3.352	85.0	187.0	
Bus309	11.000										3.352	85.0	187.0	
Bus310	11.000										3.344	85.0	187.0	
Bus311	11.000										3.342	85.0	187.0	
Bus312	11.000		0.086	0.053	0.306	0.189					1.041	85.0	58.1	
Bus313	11.000		0.109	0.067	0.385	0.239					0.581	85.0	32.4	
Bus314	11.000										3.348	85.0	187.0	
Bus315	11.000										0.000	-	-	
Bus316	11.000		0.029	0.018	0.101	0.062					3.256	85.0	182.7	
Bus317	11.000										3.073	85.0	174.2	
Bus318	11.000		0.017	0.010	0.053	0.033					0.082	85.0	4.8	
Bus319	11.000										3.047	85.0	174.2	
Bus320	11.000		0.129	0.080	0.436	0.270					0.665	85.0	38.0	
Bus321	11.000		0.012	0.007	0.039	0.024					0.060	85.0	3.4	
Bus322	11.000										0.076	85.1	4.3	
Bus323	11.000		0.014	0.009	0.051	0.031					0.076	85.0	4.3	
Bus324	11.000										2.318	85.0	132.8	
Bus325	11.000										2.316	85.0	132.8	
Bus326	11.000		0.129	0.080	0.433	0.269					2.316	85.0	132.8	
Bus327	11.000										1.655	85.0	94.9	
Bus328	11.000										1.654	85.0	94.9	
Bus329	11.000										1.650	85.0	94.9	
Bus330	11.000		0.086	0.053	0.287	0.178					0.439	85.0	25.2	
Bus331	11.000										1.209	85.0	69.6	
Bus332	11.000		0.034	0.021	0.114	0.071					0.482	85.0	27.8	
Bus333	11.000										0.724	85.0	41.8	

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Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
			MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
Bus334	11.000										0.483	85.0	27.8	
Bus335	11.000										0.307	85.0	17.7	
Bus336	11.000		0.030	0.019	0.100	0.062					0.307	85.0	17.7	
Bus337	11.000		0.030	0.019	0.100	0.062					0.153	85.0	8.9	
Bus338	11.000		0.072	0.044	0.236	0.146					0.723	85.0	41.8	
Bus339	11.000		0.071	0.044	0.235	0.146					0.360	85.0	20.9	
Bus340	11.000													
Bus341	11.000													
Bus342	11.000												-	
Bus343	11.000		0.071	0.044	0.200	0.124					1.700	85.0	106.7	
Bus344	11.000										2.916	85.0	153.2	
Bus345	11.000										2.786	85.0	146.4	
Bus346	11.000										2.781	85.0	146.4	
Bus347	11.000										2.772	85.0	146.4	
Bus348	11.000		0.003	0.002	0.010	0.006					1.096	85.0	58.4	
Bus349	11.000										1.663	85.0	87.9	
Bus350	11.000		0.009	0.005	0.034	0.021					0.050	85.0	2.7	
Bus352	11.000										1.076	85.0	57.7	
Bus353	11.000										0.590	85.0	31.6	
Bus354	11.000		0.003	0.002	0.010	0.006					0.486	85.1	26.1	
Bus355	11.000		0.101	0.063	0.388	0.240					0.575	85.0	30.8	
Bus356	11.000		0.003	0.002	0.010	0.006					0.015	85.0	0.8	
Bus357	11.000										0.471	85.1	25.3	
Bus358	11.000		0.057	0.035	0.218	0.135					0.323	85.0	17.3	
Bus359	11.000										0.148	85.1	7.9	
Bus360	11.000										0.111	85.1	6.0	
Bus361	11.000		0.020	0.012	0.075	0.046					0.111	85.0	6.0	
Bus362	11.000		0.007	0.004	0.025	0.015					0.037	85.0	2.0	
Bus363	11.000		0.022	0.014	0.088	0.055					0.130	85.0	6.8	
Bus364	11.000										0.527	85.1	27.7	
Bus365	11.000										0.527	85.1	27.7	
Bus366	11.000										0.527	85.1	27.7	
Bus367	11.000										0.526	85.1	27.7	
Bus368	11.000		0.043	0.027	0.171	0.106					0.252	85.0	13.3	
Bus369	11.000										0.274	85.2	14.4	
Bus370	11.000										0.274	85.2	14.4	
Bus371	11.000										0.274	85.0	14.5	
Bus372	11.000		0.047	0.029	0.186	0.115					0.274	85.0	14.5	
Bus373	11.000													
Bus374	11.000													
Bus375	11.000										2.072	85.0	130.0	
Bus376	11.000										3.407	84.8	179.0	

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Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
			MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
ID	kV	Rated Amp												
Bus377	11.000										3.401	84.8	179.0	
Bus378	11.000										3.151	84.9	169.1	
Bus379	11.000		0.032	0.020	0.128	0.079					0.189	85.0	9.9	
Bus380	11.000		0.043	0.027	0.165	0.102					0.244	85.0	13.1	
Bus381	11.000										0.003	85.3	0.2	
Bus382	11.000		0.001	0.000	0.002	0.001					0.003	85.0	0.2	
Bus383	11.000										2.899	84.9	155.8	
Bus384	11.000		0.075	0.047	0.287	0.178					0.426	85.0	22.9	
Bus385	11.000										2.466	84.9	132.9	
Bus386	11.000										0.060	85.4	3.3	
Bus387	11.000										0.060	85.3	3.3	
Bus388	11.000										0.060	85.3	3.3	
Bus389	11.000		0.011	0.007	0.041	0.025					0.061	85.0	3.3	
Bus390	11.000										2.383	85.0	129.6	
Bus391	11.000										2.383	85.0	129.6	
Bus392	11.000										2.383	85.0	129.6	
Bus393	11.000										2.171	85.0	118.3	
Bus394	11.000		0.145	0.090	0.539	0.334					2.171	85.0	118.3	
Bus395	11.000										1.365	85.0	74.4	
Bus396	11.000		0.032	0.020	0.120	0.074					0.179	85.0	9.7	
Bus397	11.000		0.021	0.013	0.077	0.047					0.114	85.0	6.2	
Bus398	11.000										1.072	85.0	58.4	
Bus399	11.000										0.893	85.0	48.7	
Bus400	11.000										0.893	85.0	48.7	
Bus401	11.000		0.081	0.050	0.299	0.185					0.446	85.0	24.3	
Bus402	11.000		0.081	0.050	0.299	0.185					0.446	85.0	24.3	
Bus403	11.000		0.032	0.020	0.120	0.074					0.179	85.0	9.7	
Bus404	11.000		0.038	0.023	0.140	0.087					0.209	85.0	11.4	
Bus406	11.000										0.922	85.0	48.4	
Bus407	11.000										0.921	85.0	48.4	
Bus408	11.000										0.920	85.0	48.4	
Bus409	11.000										0.917	85.0	48.5	
Bus410	11.000										0.916	85.0	48.5	
Bus411	11.000										0.001	-	-	
Bus412	11.000		0.158	0.098	0.619	0.384					0.915	85.0	48.5	
Bus413	11.000													
Bus414	11.000		0.107	0.066	0.299	0.185					1.380	85.0	86.7	
Bus415	11.000										1.862	85.6	97.8	
Bus416	11.000		0.007	0.004	0.026	0.016					1.842	85.6	97.8	
Bus417	11.000										1.787	85.5	95.8	
Bus418	11.000										1.769	85.4	95.8	
Bus419	11.000										1.778	85.5	95.8	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
			MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
ID	kV	Rated Amp												
Bus420	11.000		0.017	0.011	0.065	0.041					0.097	85.0	5.3	
Bus421	11.000		0.017	0.011	0.062	0.039					1.650	85.4	90.5	
Bus422	11.000										1.531	85.3	85.4	
Bus423	11.000										0.362	85.1	20.2	
Bus424	11.000		0.017	0.011	0.060	0.037					0.091	85.0	5.1	
Bus425	11.000		0.017	0.011	0.060	0.037					1.165	85.3	65.2	
Bus426	11.000		0.017	0.011	0.060	0.037					0.271	85.1	15.2	
Bus427	11.000										0.181	85.1	10.1	
Bus428	11.000										0.181	85.0	10.1	
Bus429	11.000		0.017	0.011	0.060	0.037					0.090	85.0	5.1	
Bus430	11.000		0.017	0.011	0.060	0.037					0.090	85.0	5.1	
Bus431	11.000										1.067	85.3	60.1	
Bus432	11.000										0.969	85.3	55.0	
Bus433	11.000		0.017	0.011	0.060	0.037					0.091	85.0	5.1	
Bus434	11.000										0.876	85.3	50.0	
Bus435	11.000										0.662	85.3	37.8	
Bus436	11.000		0.028	0.017	0.095	0.059					0.661	85.2	37.8	
Bus437	11.000		0.017	0.011	0.059	0.036					0.090	85.0	5.1	
Bus438	11.000										0.213	85.3	12.2	
Bus439	11.000		0.017	0.011	0.059	0.037					0.090	85.0	5.1	
Bus440	11.000		0.017	0.011	0.058	0.036					0.124	85.4	7.1	
Bus441	11.000										0.035	86.2	2.0	
Bus442	11.000		0.007	0.004	0.023	0.014					0.035	85.0	2.0	
Bus443	11.000										0.517	85.3	29.5	
Bus444	11.000										0.516	85.3	29.5	
Bus445	11.000										0.516	85.3	29.5	
Bus446	11.000		0.017	0.011	0.059	0.036					0.089	85.0	5.1	
Bus447	11.000										0.037	85.9	2.3	
Bus448	11.000		0.001	0.001	0.004	0.002					0.006	85.0	0.4	
Bus449	11.000		0.017	0.011	0.058	0.036					0.175	85.4	10.0	
Bus450	11.000		0.017	0.011	0.058	0.036					0.088	85.0	5.1	
Bus451	11.000										0.251	85.1	14.4	
Bus452	11.000										2.040	85.0	120.5	
Bus453	11.000		0.017	0.011	0.058	0.036					0.089	85.0	5.1	
Bus454	11.000										0.162	85.2	9.3	
Bus455	11.000		0.032	0.020	0.106	0.065					0.162	85.0	9.3	
Bus456	11.000										0.200	85.0	10.5	
Bus457	11.000		0.034	0.021	0.136	0.084					0.200	85.0	10.5	
Bus458	11.000										0.902	85.0	56.7	
Bus459	11.000		0.083	0.052	0.233	0.144					0.372	85.0	23.4	
Bus460	11.000										0.265	85.0	16.7	
Bus461	11.000		0.060	0.037	0.166	0.103					0.265	85.0	16.7	

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Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
Bus462	11.000										2.339	85.0	146.7	
Bus463	11.000		0.060	0.037	0.167	0.103					0.266	85.0	16.7	
Bus464	11.000										2.609	85.0	163.6	
Bus465	11.000		0.060	0.037	0.168	0.104					0.268	85.0	16.8	
Bus466	11.000										2.825	85.0	176.9	
Bus467	11.000		0.048	0.029	0.134	0.083					0.213	85.0	13.4	
Bus468	11.000										3.213	85.0	201.0	
Bus469	11.000										3.217	85.0	201.0	
Bus470	11.000		0.002	0.001	0.006	0.004					0.031	85.9	1.9	
Bus471	11.000		0.086	0.053	0.241	0.150					0.385	85.0	24.1	
Bus472	11.000										0.636	85.0	40.0	
Bus473	11.000										0.635	85.0	40.0	
Bus474	11.000		0.143	0.088	0.397	0.246					0.635	85.0	40.0	
Bus475	11.000		0.018	0.011	0.057	0.035					0.674	85.0	39.6	
Bus476	11.000		0.119	0.074	0.379	0.235					0.586	85.0	34.5	
Bus477	11.000		0.060	0.037	0.189	0.117					2.823	85.0	166.3	
Bus478	11.000		0.004	0.002	0.012	0.007					0.019	85.0	1.1	
Bus479	11.000		0.060	0.037	0.189	0.117					0.292	85.0	17.2	
Bus480	11.000		0.060	0.037	0.189	0.117					0.292	85.0	17.2	
Bus481	11.000										1.225	85.0	72.3	
Bus482	11.000		0.003	0.002	0.009	0.006					0.022	86.1	1.4	
Bus483	11.000		0.179	0.111	0.565	0.350					0.875	85.0	51.6	
Bus484	11.000										0.350	85.0	20.6	
Bus485	11.000		0.071	0.044	0.226	0.140					0.350	85.0	20.6	
Bus486	11.000		0.001	0.001	0.002	0.001					0.007	87.7	0.5	
Bus487	11.000		0.143	0.088	0.453	0.281					0.701	85.0	41.3	
Bus488	11.000		0.001	0.001	0.002	0.001					0.004	85.0	0.2	
Bus489	11.000		0.003	0.002	0.008	0.005					0.013	85.0	0.8	
Bus490	11.000		0.139	0.086	0.442	0.274					1.388	85.0	81.7	
Bus491	11.000		0.039	0.024	0.111	0.069					0.177	85.0	11.0	
Bus492	11.000		0.039	0.024	0.111	0.069					0.354	85.0	22.0	
Bus493	11.000										0.567	85.0	33.4	
Bus494	11.000		0.028	0.017	0.088	0.055					0.704	85.0	41.5	
Bus495	11.000													
Bus496	33.000		0.010	0.006	0.033	0.021					0.051	85.0	1.0	
Bus497	11.000		0.071	0.044	0.228	0.141					0.352	85.0	20.7	
Bus498	11.000										0.145	85.0	9.4	
Bus499	11.000		0.034	0.021	0.089	0.055					0.145	85.0	9.4	
Bus500	11.000										0.584	85.0	36.7	
Bus501	11.000		0.131	0.081	0.365	0.226					0.584	85.0	36.7	
Bus502	11.000		0.082	0.051	0.217	0.135					0.351	85.0	22.6	
Bus503	11.000		0.095	0.059	0.304	0.188					0.821	85.0	48.3	

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Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
			MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
ID	kV	Rated Amp												
Bus504	11.000		0.018	0.011	0.051	0.031					0.081	85.0	5.0	
Bus505	11.000		0.033	0.020	0.102	0.063					0.198	85.0	11.8	
Bus506	11.000										2.610	89.1	153.5	
Bus507	11.000		0.071	0.044	0.227	0.141					0.352	85.0	20.7	
Bus508	11.000		0.060	0.037	0.189	0.117					0.293	85.0	17.2	
Bus509	11.000										3.576	85.0	210.8	
Bus510	11.000		0.104	0.065	0.330	0.205					0.511	85.0	30.1	
Bus511	11.000		0.062	0.038	0.196	0.121					0.304	85.0	17.9	
Bus512	11.000		0.062	0.038	0.196	0.121					0.304	85.0	17.9	
Bus513	11.000		0.130	0.080	0.409	0.254					0.634	85.0	37.5	
Bus514	11.000		0.146	0.091	0.462	0.286					1.102	85.0	65.1	
Bus515	11.000		0.001	0.001	0.004	0.003					0.006	85.0	0.4	
Bus516	11.000										0.380	85.0	22.5	
Bus517	11.000		0.078	0.048	0.245	0.152					0.380	85.0	22.5	
Bus518	11.000										0.380	85.0	22.5	
Bus519	11.000		0.008	0.005	0.026	0.016					0.040	85.0	2.4	
Bus520	11.000										0.198	85.0	11.8	
Bus521	11.000										0.826	85.0	49.2	
Bus522	11.000		0.089	0.055	0.283	0.176					2.772	80.6	163.3	
Bus523	11.000		0.070	0.043	0.223	0.138					1.735	85.0	101.9	
Bus524	11.000										1.389	85.0	81.7	
Bus525	11.000										0.567	85.0	33.4	
Bus526	11.000		0.130	0.081	0.404	0.250					0.628	85.0	37.4	
Bus527	11.000										0.826	85.0	49.2	
Bus528	11.000										2.773	78.9	161.5	
Bus529	11.000		0.082	0.051	0.256	0.159					1.225	85.0	72.9	
Bus535	11.000		0.143	0.088	0.454	0.281					0.702	85.0	41.3	
Bus537	11.000										1.140	85.0	67.2	
Bus538	11.000		0.089	0.055	0.283	0.176					0.438	85.0	25.8	
Bus544	11.000		0.028	0.017	0.088	0.055					0.136	85.0	8.0	
Bus546	11.000										2.750	78.9	161.5	
Bus548	11.000		0.028	0.017	0.089	0.055					0.138	85.0	8.1	
Bus549	11.000										2.608	78.6	153.5	
Bus550	11.000		0.208	0.129	0.659	0.409					1.021	85.0	60.2	
Bus551	11.000		0.071	0.044	0.226	0.140					0.350	85.0	20.6	
Bus552	11.000										1.371	85.0	80.9	
Bus553	11.000										2.467	78.2	145.5	
Bus554	11.000		0.027	0.017	0.086	0.053					0.133	85.0	7.9	
Bus555	11.000		0.027	0.017	0.086	0.053					0.133	85.0	7.9	
Bus556	11.000		0.028	0.017	0.089	0.055					0.138	85.0	8.1	
Bus557	11.000		0.028	0.017	0.088	0.055					0.137	85.0	8.1	
Bus559	11.000										1.930	76.1	113.8	

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Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
			MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
ID	kV	Rated Amp												
Bus560	11.000		0.055	0.034	0.173	0.107					1.926	76.1	113.9	
Bus561	11.000										1.661	74.5	98.2	
Bus562	11.000		0.004	0.003	0.013	0.008					0.020	85.0	1.2	
Bus563	11.000		0.167	0.103	0.528	0.327					2.189	85.0	129.1	
Bus564	11.000										1.656	74.5	98.2	
Bus565	11.000		0.028	0.017	0.087	0.054					0.134	85.0	8.0	
Bus566	11.000										1.520	73.4	90.4	
Bus568	11.000										1.388	72.2	82.6	
Bus569	11.000		0.028	0.017	0.086	0.053					0.134	85.0	8.0	
Bus570	11.000		0.043	0.026	0.120	0.074					0.191	85.0	11.9	
Bus571	11.000												-	
Bus573	11.000										0.754	85.0	49.5	
Bus586	11.000		0.072	0.045	0.206	0.128					0.327	85.0	20.3	
Bus589	11.000										0.471	85.4	24.7	
Bus590	11.000										0.608	85.3	31.8	
Bus591	11.000										0.082	86.1	5.1	
Bus592	11.000										0.082	86.1	5.1	
Bus593	11.000		0.006	0.004	0.024	0.015					0.036	85.0	1.9	
Bus595	11.000										0.327	85.0	20.3	
Bus596	11.000										0.421	85.3	26.2	
Bus597	11.000										0.082	86.2	5.1	
Bus598	11.000		0.023	0.014	0.093	0.057					0.136	85.0	7.1	
Bus599	11.000										0.760	85.0	44.3	
Bus600	11.000		0.051	0.032	0.166	0.103					0.255	85.0	14.8	
Bus601	11.000										0.505	85.0	29.4	
Bus602	11.000										0.251	85.0	14.6	
Bus603	11.000										0.094	86.1	5.8	
Bus604	11.000										0.038	85.0	2.4	
Bus605	11.000		0.009	0.005	0.024	0.015					0.038	85.0	2.4	
Bus606	11.000										0.043	87.0	2.7	
Bus607	11.000		0.001	0.001	0.004	0.002					0.043	86.7	2.7	
Bus608	11.000		0.016	0.010	0.062	0.038					0.435	85.4	22.8	
Bus609	11.000		0.050	0.031	0.163	0.101					0.251	85.0	14.6	
Bus610	11.000										0.255	85.0	14.8	
Bus611	11.000		0.051	0.032	0.166	0.103					0.255	85.0	14.8	
Bus613	11.000		0.007	0.005	0.029	0.018					0.343	85.5	18.0	
Bus614	11.000		0.034	0.021	0.111	0.069					0.340	85.0	19.8	
Bus615	11.000										0.299	85.4	15.8	
Bus616	11.000		0.005	0.003	0.018	0.011					0.027	85.0	1.4	
Bus618	11.000													
Bus619	11.000													
Bus620	11.000										0.170	85.0	9.9	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
			MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus621	11.000		0.034	0.021	0.111	0.068					0.170	85.0	9.9	
Bus622	11.000										0.000	-	-	
Bus623	11.000												-	
Bus624	11.000													
Bus625	11.000													
Bus626	11.000										0.272	85.5	14.4	
Bus627	11.000										0.060	86.9	3.1	
Bus629	11.000										0.018	86.3	0.9	
Bus630	11.000		0.002	0.001	0.007	0.004					0.011	85.0	0.6	
Bus631	11.000		0.001	0.001	0.005	0.003					0.007	85.0	0.4	
Bus632	11.000		0.037	0.023	0.144	0.089					0.213	85.0	11.2	
Bus633	11.000		0.001	0.001	0.005	0.003					0.042	86.7	2.2	
Bus634	11.000		0.003	0.002	0.012	0.008					0.035	86.5	1.9	
Bus635	11.000		0.002	0.001	0.007	0.004					0.017	87.3	0.9	
Bus636	11.000		0.001	0.001	0.005	0.003					0.007	85.0	0.4	
Bus647	11.000										0.088	85.0	5.0	
Bus648	11.000										0.088	85.0	5.0	
Bus649	11.000		0.017	0.011	0.058	0.036					0.088	85.0	5.0	
Bus653	33.000										4.043	78.3	75.1	
Bus655	33.000										1.834	85.4	33.1	
Bus656	11.000										3.392	87.0	186.6	
Bus657	33.000										1.645	85.4	29.7	
Bus658	11.000		0.010	0.006	0.030	0.019					0.047	85.0	2.8	
Bus659	33.000										1.646	85.3	29.8	
Bus661	33.000										1.645	85.3	29.8	
Bus662	33.000										1.646	85.2	29.8	
Bus663	33.000										1.645	85.2	29.8	
Bus664	33.000										1.646	85.2	29.8	
Bus665	33.000										1.549	85.1	28.1	
Bus674	33.000		0.082	0.051	0.304	0.189					0.642	85.1	11.6	
Bus675	33.000										0.188	85.5	3.4	
Bus676	11.000		0.018	0.011	0.066	0.041					0.099	85.0	5.4	
Bus677	33.000		0.034	0.021	0.127	0.079					0.189	85.0	3.4	
Bus678	33.000		0.017	0.011	0.065	0.040					0.097	85.0	1.8	
Bus679	33.000		0.163	0.101	0.608	0.377					0.908	85.0	16.5	
Bus680	11.000													
Bus681	11.000										0.403	85.0	23.5	
Bus682	11.000		0.081	0.050	0.262	0.162					0.403	85.0	23.5	
Bus683	11.000										0.692	85.0	40.3	
Bus684	11.000		0.058	0.036	0.188	0.116					0.289	85.0	16.8	
Bus685	11.000										2.347	85.0	136.5	
Bus686	11.000										2.355	85.0	136.5	

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	Study Case: 2030 LFC		

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
Bus687	11.000										3.232	85.0	187.4	
Bus688	11.000		0.174	0.108	0.571	0.354					0.877	85.0	50.9	
Bus689	33.000										0.907	85.1	16.4	
Bus690	33.000										0.189	85.3	3.4	
Bus691	11.000										1.651	85.0	96.2	
Bus692	11.000										0.576	85.0	33.6	
Bus693	33.000		0.034	0.021	0.127	0.079					0.190	85.0	3.4	
Bus694	11.000										1.074	85.0	62.6	
Bus695	11.000		0.151	0.094	0.491	0.304					1.074	85.0	62.6	
Bus696	11.000		0.116	0.072	0.374	0.232					0.576	85.0	33.6	
Bus697	11.000		0.064	0.040	0.207	0.128					0.318	85.0	18.5	
Bus698	11.000		0.017	0.011	0.043	0.027					0.071	85.0	4.7	
Bus699	11.000												-	
Bus700	11.000		0.013	0.008	0.051	0.032					0.610	85.3	31.9	
Bus701	11.000										0.610	85.3	31.9	
Bus702	11.000										0.534	85.3	28.0	
Bus703	11.000										0.013	85.3	0.7	
Bus704	11.000		0.001	0.001	0.004	0.003					0.006	85.0	0.3	
Bus705	11.000		0.001	0.001	0.004	0.003					0.006	85.0	0.3	
Bus706	11.000										0.521	85.3	27.3	
Bus707	11.000		0.001	0.000	0.002	0.001					0.003	85.0	0.2	
Bus708	11.000		0.010	0.006	0.041	0.025					0.517	85.2	27.2	
Bus709	11.000		0.010	0.006	0.040	0.025					0.457	85.2	24.1	
Bus710	11.000		0.004	0.002	0.015	0.009					0.396	85.2	20.9	
Bus711	11.000		0.001	0.000	0.003	0.002					0.374	85.2	19.8	
Bus712	11.000		0.005	0.003	0.020	0.012					0.370	85.2	19.6	
Bus713	11.000										0.340	85.2	18.0	
Bus713- RICB N530T1	11.000		0.117	0.073	0.373	0.231					4.459	85.0	262.4	
Bus714	11.000		0.058	0.036	0.183	0.114					0.284	85.0	16.7	
Bus715	11.000		0.058	0.036	0.183	0.114					0.284	85.0	16.7	
Bus716	11.000										3.261	85.0	187.2	
Bus717	11.000		0.013	0.008	0.050	0.031					0.311	85.1	16.5	
Bus718	11.000		0.006	0.004	0.025	0.016					0.037	85.0	2.0	
Bus719	11.000		0.013	0.008	0.050	0.031					0.200	85.1	10.6	
Bus720	11.000										0.682	85.0	44.8	
Bus721	11.000		0.005	0.003	0.020	0.012					0.126	85.1	6.7	
Bus722	11.000										0.096	85.1	5.1	
Bus723	11.000										1.514	80.1	84.4	
Bus724	11.000										2.529	85.0	148.9	
Bus725	11.000		0.006	0.004	0.025	0.016					0.037	85.0	2.0	
Bus726	11.000										1.389	85.0	81.8	
Bus727	11.000		0.202	0.125	0.641	0.398					0.992	85.0	58.4	

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Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
			MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
ID	kV	Rated Amp												
Bus728	11.000		0.081	0.050	0.257	0.159					0.397	85.0	23.4	
Bus729	11.000										1.389	85.0	81.8	
Bus730	11.000		0.010	0.006	0.040	0.025					0.059	85.0	3.1	
Bus731	11.000										1.140	85.0	67.1	
Bus732	11.000		0.070	0.043	0.221	0.137					0.342	85.0	20.2	
Bus733	11.000										0.584	85.0	34.4	
Bus734	11.000		0.043	0.027	0.138	0.085					0.213	85.0	12.5	
Bus735	11.000		0.041	0.025	0.129	0.080					0.200	85.0	11.8	
Bus736	11.000		0.058	0.036	0.183	0.114					0.284	85.0	16.7	
Bus737	11.000		0.020	0.013	0.065	0.040					0.100	85.0	5.9	
Bus738	11.000										0.029	85.6	1.6	
Bus739	11.000		0.005	0.003	0.020	0.012					0.030	85.0	1.6	
Bus740	11.000										0.000	-	-	
Bus741	11.000										0.682	85.0	44.8	
Bus742	11.000		0.054	0.034	0.139	0.086					0.227	85.0	14.9	
Bus743	11.000										0.454	85.1	29.9	
Bus744	11.000		0.031	0.019	0.111	0.069					4.033	83.2	222.1	
Bus745	11.000										0.679	85.0	37.5	
Bus746	11.000										0.679	85.0	37.5	
Bus747	11.000		0.061	0.038	0.221	0.137					0.332	85.0	18.3	
Bus748	11.000		0.061	0.038	0.221	0.137					0.332	85.0	18.3	
Bus749	11.000										0.015	86.5	0.9	
Bus750	11.000		0.003	0.002	0.010	0.006					0.016	85.0	0.9	
Bus751	11.000										0.485	85.0	28.5	
Bus752	11.000		0.052	0.032	0.167	0.103					0.258	85.0	15.2	
Bus753	11.000		0.046	0.028	0.147	0.091					0.227	85.0	13.3	
Bus754	11.000										3.154	82.7	175.5	
Bus755	11.000										3.148	82.7	175.5	
Bus756	11.000		0.153	0.095	0.543	0.336					0.818	85.0	45.6	
Bus757	11.000		0.153	0.095	0.542	0.336					0.817	85.0	45.6	
Bus758	11.000		0.061	0.038	0.217	0.134					0.327	85.0	18.2	
Bus759	11.000										1.187	78.6	66.3	
Bus760	11.000		0.031	0.019	0.108	0.067					0.163	85.0	9.1	
Bus761	11.000		0.004	0.003	0.010	0.006					0.103	85.1	6.8	
Bus762	11.000		0.010	0.006	0.026	0.016					0.043	85.0	2.8	
Bus763	11.000		0.010	0.006	0.026	0.016					0.086	85.1	5.6	
Bus764	11.000										0.351	85.0	23.1	
Bus765	11.000		0.075	0.046	0.190	0.118					0.351	85.0	23.1	
Bus766	11.000		0.009	0.006	0.024	0.015					0.039	85.0	2.6	
Bus767	11.000		0.030	0.018	0.099	0.062					0.152	85.0	8.7	
Bus768	11.000		0.179	0.111	0.594	0.368					1.818	85.0	104.6	
Bus769	11.000		0.179	0.111	0.594	0.368					0.909	85.0	52.3	

Directly Connected Load												Total Bus Load			
Bus			Constant kVA		Constant Z		Constant I		Generic		Rated Amp	MVA	% PF	Amp	Percent Loading
ID	kV		MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar					
Bus770	11.000											0.755	85.0	49.5	
Bus771	11.000		0.163	0.101	0.419	0.260						1.440	85.0	94.3	
Bus772	11.000											1.442	85.0	94.3	
Bus774	11.000											1.609	85.0	104.8	
Bus775	11.000											1.445	85.0	94.3	
Bus776	11.000		0.038	0.024	0.099	0.061						0.161	85.0	10.5	
Bus777	11.000											1.980	84.9	127.4	
Bus778	11.000											1.996	84.9	127.4	
Bus779	11.000											3.255	85.0	187.2	
Bus780	11.000		0.024	0.015	0.079	0.049						0.121	85.0	7.0	
Bus781	11.000		0.070	0.043	0.231	0.143						3.126	85.0	180.2	
Bus782	11.000		0.139	0.086	0.460	0.285						0.705	85.0	40.7	
Bus783	11.000											2.065	85.0	119.1	
Bus784	11.000											1.973	85.0	114.0	
Bus785	11.000		0.173	0.107	0.572	0.355						1.973	85.0	114.0	
Bus786	11.000		0.217	0.134	0.715	0.443						1.096	85.0	63.3	
Bus787	11.000		0.017	0.011	0.058	0.036						0.088	85.0	5.1	
Bus788	11.000											2.176	84.9	138.8	
Bus789	11.000		0.041	0.025	0.111	0.069						0.178	85.0	11.4	
Bus790	11.000		0.041	0.025	0.112	0.069						2.365	84.8	150.2	
Bus791	11.000											3.110	84.8	195.7	
Bus792	11.000		0.082	0.051	0.224	0.139						0.719	85.0	45.6	
Bus793	11.000		0.105	0.065	0.326	0.202						0.697	85.0	41.6	
Bus794	11.000		0.079	0.049	0.248	0.154						0.385	85.0	22.8	
Bus795	11.000		0.082	0.051	0.224	0.139						0.360	85.0	22.8	
Bus796	11.000		0.119	0.073	0.372	0.230						3.470	85.0	205.7	
Bus797	11.000											2.500	85.0	148.7	
Bus798	11.000											3.509	84.9	205.7	
Bus799	11.000											0.385	85.0	22.8	
Bus800	11.000		0.119	0.073	0.369	0.229						1.800	85.0	107.1	
Bus801	11.000											0.700	85.1	41.6	
Bus802	11.000		0.040	0.024	0.122	0.075						0.190	85.0	11.3	
Bus803	11.000		0.041	0.025	0.116	0.072						3.331	84.8	207.2	
Bus804	11.000											4.227	84.7	258.3	
Bus805	11.000		0.017	0.011	0.050	0.031						0.079	85.0	4.8	
Bus806	11.000											0.379	85.0	23.2	
Bus807	11.000											0.379	85.0	23.2	
Bus808	11.000											0.379	85.0	23.2	
Bus809	11.000		0.082	0.051	0.240	0.149						0.378	85.0	23.2	
Bus810	11.000		0.009	0.005	0.026	0.016						4.347	84.5	260.8	
Bus811	11.000											4.419	84.4	260.8	
Bus812	11.000											0.332	85.0	19.1	

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Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
Bus813	11.000										0.332	85.0	19.1	
Bus814	11.000										0.332	85.0	19.1	
Bus815	11.000										0.332	85.0	19.1	
Bus816	11.000		0.065	0.040	0.217	0.134					0.332	85.0	19.1	
Bus817	11.000													
Bus818	11.000													
Bus819	11.000		0.218	0.135	0.686	0.425					1.063	85.0	62.9	
Bus820	11.000										3.017	85.0	178.2	
Bus821	11.000		0.075	0.046	0.236	0.146					0.366	85.0	21.6	
Bus822	11.000										3.023	85.0	178.2	
Bus823	11.000		0.173	0.107	0.550	0.341					3.877	85.0	228.4	
Bus824	11.000										1.588	85.0	93.8	
Bus825	11.000		0.130	0.081	0.408	0.253					1.582	85.0	93.8	
Bus826	11.000										4.421	84.4	260.8	
Bus827	11.000		0.196	0.121	0.608	0.377					0.946	85.0	56.3	
Bus829	11.000										4.425	84.4	260.8	
Bus830	11.000										0.949	85.0	56.3	
Bus831	11.000												-	
Bus836	11.000										4.913	84.4	288.4	
Bus837	11.000										0.198	85.0	11.8	
Bus840	11.000		0.095	0.059	0.304	0.189					0.470	85.0	27.6	
Bus841	11.000		0.095	0.059	0.316	0.196					5.964	84.5	343.6	
Bus842	11.000										4.964	84.3	288.4	
Bus843	11.000										0.474	85.0	27.3	
Bus844	11.000										0.473	85.0	27.3	
Bus845	11.000		0.075	0.047	0.303	0.188					0.445	85.0	23.3	
Bus846	11.000		0.063	0.039	0.254	0.158					0.374	85.0	19.6	
Bus847	33.000										12.725	87.8	222.2	
Bus848	11.000										2.270	85.0	124.2	
Bus849	11.000										2.176	85.0	119.4	
Bus850	11.000		0.082	0.051	0.270	0.167					0.413	85.0	23.9	
Bus851	11.000										2.176	85.0	119.4	
Bus852	11.000		0.016	0.010	0.058	0.036					0.087	85.0	4.7	
Bus853	11.000		0.159	0.099	0.583	0.361					0.873	85.0	47.9	
Bus854	11.000		0.111	0.068	0.404	0.250					0.605	85.0	33.2	
Bus855	11.000										0.695	85.0	38.3	
Bus856	11.000										0.060	85.1	3.5	
Bus857	11.000										0.697	85.0	38.3	
Bus858	11.000		0.128	0.079	0.463	0.287					0.695	85.0	38.3	
Bus859	11.000										0.060	85.1	3.5	
Bus860	11.000		0.012	0.007	0.039	0.024					0.060	85.0	3.5	
Bus861	11.000		0.082	0.051	0.241	0.149					0.379	85.0	23.2	

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Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
			MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
Bus862	11.000										0.379	85.0	23.2	
Bus865	11.000												-	
Bus886	11.000		0.016	0.010	0.058	0.036					0.087	85.0	4.7	
Bus888	33.000										12.726	87.8	222.2	
Bus889	33.000										12.580	88.0	222.3	
Bus890	33.000										12.470	88.1	222.3	
Bus892	33.000										0.970	85.0	17.3	
Bus893	33.000										0.970	85.0	17.3	
Bus894	33.000		0.170	0.105	0.655	0.406					0.970	85.0	17.3	
Bus895	33.000										11.398	88.5	205.1	
Bus908	11.000										0.133	85.2	7.3	
Bus909	11.000										0.133	85.0	7.3	
Bus910	11.000		0.024	0.015	0.089	0.055					0.133	85.0	7.3	
Bus930	11.000		0.041	0.025	0.154	0.095					0.229	85.0	12.4	
Bus932	11.000										1.007	85.0	55.2	
Bus933	11.000										1.009	85.1	55.2	
Bus934	11.000		0.060	0.037	0.217	0.135					0.881	85.0	48.4	
Bus935	11.000		0.024	0.015	0.087	0.054					0.555	85.0	30.5	
Bus945	11.000										0.425	85.0	23.4	
Bus946	11.000		0.078	0.048	0.283	0.176					0.425	85.0	23.4	
Bus947	11.000												-	
Bus948	11.000										0.125	85.1	6.8	
Bus949	11.000										0.125	85.1	6.8	
Bus956	11.000		0.013	0.008	0.047	0.029					0.070	85.0	3.8	
Bus957	11.000		0.010	0.006	0.037	0.023					0.055	85.0	3.0	
Bus963	11.000										0.000	-	-	
Bus964	11.000													
Bus971	11.000		0.016	0.010	0.054	0.034					0.082	85.0	4.7	
Bus981	33.000										1.834	85.5	33.1	
Bus982	33.000										1.834	85.4	33.1	
Bus984	11.000		0.047	0.029	0.165	0.102					0.249	85.0	13.9	
Bus985	11.000													
Bus986	11.000										0.249	85.0	13.9	
Bus987	11.000										0.249	85.0	13.9	
Bus988	11.000										0.249	85.0	13.9	
Bus989	11.000		0.069	0.043	0.243	0.151					0.740	89.9	41.4	
Bus990	11.000		0.031	0.019	0.108	0.067					0.875	92.0	48.8	
Bus992	11.000										1.039	91.1	57.9	
Bus993	11.000		0.031	0.019	0.109	0.067					0.164	85.0	9.1	
Bus994	11.000										2.069	88.2	114.8	
Bus995	11.000		0.069	0.043	0.246	0.153					1.030	85.0	57.2	
Bus996	11.000		0.122	0.076	0.438	0.271					0.659	85.0	36.6	

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Directly Connected Load														
Bus			Directly Connected Load								Total Bus Load			
ID	kV	Rated Amp	Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
			MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
Bus997	11.000										2.175	88.1	120.5	
Bus999	11.000		0.019	0.012	0.069	0.043					0.103	85.0	5.7	
Bus1000	11.000										3.374	87.0	186.6	
Bus1001	11.000										1.194	85.0	66.2	
Bus1003	11.000										4.263	85.2	235.7	
Bus1005	11.000										1.192	85.0	66.2	
Bus1006	11.000		0.080	0.050	0.286	0.177					0.431	85.0	24.0	
Bus1007	11.000		0.080	0.050	0.286	0.177					0.760	85.0	42.3	
Bus1008	11.000										4.166	85.0	235.7	
Bus1009	11.000		0.061	0.038	0.218	0.135					0.329	85.0	18.3	
Bus1010	11.000										0.407	76.6	22.7	
Bus1011	11.000		0.069	0.043	0.243	0.151					0.367	85.0	20.5	
Bus1012	11.000										0.663	72.7	37.0	
Bus1013	11.000		0.069	0.043	0.243	0.151					0.367	85.0	20.5	
Bus1015	11.000		0.069	0.043	0.243	0.151					0.367	85.0	20.5	
Bus1016	11.000										-	-	-	
Bus1017	11.000										-	-	-	
Bus1018	11.000										4.165	85.0	235.7	
Bus1019	11.000												-	
Bus1020	11.000										1.740	85.0	98.4	
Bus1021	11.000										2.426	84.9	137.2	
Bus1022	11.000										2.410	85.0	137.2	
Bus1026	11.000										6.137	84.3	343.6	
Bus1031	11.000										6.133	84.3	343.6	
Bus1032	33.000										0.922	86.7	16.6	
Bus1033	11.000										2.469	100.0	143.6	
Bus1034	33.000		0.014	0.008	0.052	0.032					0.923	86.6	16.6	
Bus1035	33.000										0.923	86.6	16.6	
Bus1036	33.000										0.847	86.5	15.3	
Bus1037	33.000		0.003	0.002	0.010	0.006					0.847	86.5	15.3	
Bus1038	33.000		0.009	0.005	0.032	0.020					0.832	86.5	15.0	
Bus1039	33.000										0.784	86.5	14.1	
Bus1040	33.000		0.003	0.002	0.010	0.006					0.062	86.4	1.1	
Bus1041	33.000										0.710	86.1	12.8	
Bus1042	11.000		0.096	0.059	0.325	0.202					0.495	85.0	28.2	
Bus1043	11.000		0.128	0.079	0.435	0.269					1.157	85.0	65.8	
Bus1044	11.000										1.157	85.0	65.8	
Bus1045	11.000		0.055	0.034	0.190	0.118					0.288	85.0	16.3	
Bus1046	11.000										0.288	85.0	16.3	
Bus1047	11.000										0.288	85.0	16.3	
Bus1048	11.000										2.320	85.0	132.5	
Bus1049	11.000		0.024	0.015	0.080	0.050					0.122	85.0	7.0	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
			MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
ID	kV	Rated Amp												
Bus1050	11.000										0.367	85.0	21.0	
Bus1051	33.000		0.009	0.005	0.032	0.020					0.048	85.0	0.9	
Bus1052	11.000		0.028	0.017	0.093	0.058					0.245	85.0	14.0	
Bus1053	11.000										0.103	85.1	5.9	
Bus1054	11.000										0.103	85.0	5.9	
Bus1055	11.000		0.020	0.012	0.067	0.042					0.103	85.0	5.9	
Bus1056	11.000													
Bus1057	11.000		0.020	0.013	0.069	0.043					1.953	85.0	111.6	
Bus1058	11.000										0.208	85.0	11.9	
Bus1059	33.000		0.003	0.002	0.010	0.006					0.015	85.0	0.3	
Bus1060	11.000		0.040	0.025	0.136	0.084					0.208	85.0	11.9	
Bus1061	11.000										0.208	85.0	11.9	
Bus1062	11.000										1.636	85.0	93.7	
Bus1063	11.000		0.024	0.015	0.080	0.049					1.013	85.0	58.1	
Bus1064	11.000										0.889	85.0	51.1	
Bus1065	11.000		0.013	0.008	0.043	0.026					0.065	85.0	3.7	
Bus1066	11.000										0.823	85.0	47.4	
Bus1068	33.000										0.710	86.1	12.8	
Bus1069	33.000		0.027	0.017	0.102	0.063					0.152	85.0	2.7	
Bus1070	33.000										0.559	86.1	10.1	
Bus1071	33.000		0.003	0.002	0.013	0.008					0.472	85.7	8.5	
Bus1075	33.000										0.090	86.6	1.6	
Bus1076	33.000		0.006	0.004	0.023	0.014					0.034	85.0	0.6	
Bus1077	33.000		0.010	0.006	0.038	0.024					0.057	85.0	1.0	
Bus1078	33.000		0.003	0.002	0.010	0.006					0.453	85.5	8.2	
Bus1079	33.000		0.003	0.002	0.010	0.006					0.015	85.0	0.3	
Bus1080	33.000										0.122	85.0	2.2	
Bus1081	33.000		0.022	0.013	0.082	0.051					0.122	85.0	2.2	
Bus1082	33.000		0.054	0.034	0.204	0.126					0.304	85.0	5.5	
Bus1084	11.000										2.330	85.0	139.7	
Bus1092	11.000		0.011	0.007	0.036	0.022					0.055	85.0	3.1	
Bus1115	11.000		0.184	0.114	0.598	0.371					0.921	85.0	53.7	
Bus1138	11.000		0.209	0.130	0.677	0.420					1.043	85.0	60.8	
Bus1139	11.000		0.209	0.130	0.677	0.420					1.043	85.0	60.8	
Bus1163	11.000										0.822	85.0	47.4	
Bus1164	11.000										0.822	85.0	47.4	
Bus1165	11.000		0.048	0.029	0.158	0.098					0.242	85.0	13.9	
Bus1166	11.000										0.580	85.0	33.4	
Bus1167	11.000										0.580	85.0	33.4	
Bus1168	11.000		0.020	0.012	0.066	0.041					0.101	85.0	5.8	
Bus1170	11.000										0.478	85.0	27.6	
Bus1171	11.000		0.047	0.029	0.156	0.097					0.478	85.0	27.6	

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Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
			MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
ID	kV	Rated Amp												
Bus1172	11.000		0.047	0.029	0.156	0.097					0.239	85.0	13.8	
Bus1173	11.000										0.621	85.1	35.6	
Bus1174	11.000		0.040	0.025	0.134	0.083					0.204	85.0	11.7	
Bus1175	11.000										0.416	85.1	23.9	
Bus1176	11.000		0.079	0.049	0.262	0.162					0.401	85.0	23.0	
Bus1177	11.000										0.015	85.6	0.9	
Bus1180	11.000		0.003	0.002	0.010	0.006					0.015	85.0	0.9	
Buss	11.000										15.289	84.8	802.9	
Changedaphu	66.000										36.376	77.9	318.2	
Changedaphu 1	66.000										18.188	77.9	159.1	
Changedaphu SS	33.000										23.378	81.7	434.2	
Changedaphu2	33.000		2.380	1.475	0.528	0.327					17.133	82.2	318.2	
Chubachu1	33.000										13.782	81.8	257.0	
Dechencholing	66.000										28.249	83.9	258.0	
Depsi	33.000										8.386	89.3	151.5	
Depsi1	11.000		1.160		3.778						4.938	100.0	287.2	
Depsi2	33.000										4.972	99.9	95.7	
Depsi1 1	11.000		1.840		0.404						4.059	91.3	227.2	
DPH I	33.000										5.735	83.0	106.5	
DPH I1	33.000										2.868	83.0	53.3	
DPH1	11.000										2.783	85.0	159.8	
DPH2	33.000										3.837	83.6	71.3	
From610	11.000		0.028	0.017	0.086	0.053					1.388	72.2	82.6	
FromN480	11.000										3.391	87.0	186.6	
Gidagom Mini Hydel	33.000										11.397	88.5	205.1	
Gidagom Mini Hydel1	33.000										0.229	84.9	4.1	
Hospital	33.000										7.472	82.4	138.8	
Lungtenphu 1	33.000										7.835	82.5	138.0	
Motithang1	33.000										4.650	81.9	91.5	
Motithang2	33.000										4.038	78.3	75.1	
N10 bus	11.000													
N10 Bus 2	11.000										1.485	85.0	78.5	
N30 Bus	11.000		0.065	0.040	0.237	0.147					0.355	85.0	19.5	
N40 Bus	11.000		0.022	0.014	0.087	0.054					1.613	85.0	85.3	
N330 D/Ling	11.000		0.078	0.048	0.215	0.133					0.344	85.0	21.7	
N460 DPH2	11.000		0.184	0.114	0.598	0.371					1.842	85.0	107.3	
N470 DPH2	11.000										2.085	85.0	121.6	
N480	11.000										1.025	77.4	57.2	
N580T2	11.000		0.043	0.027	0.122	0.076					3.604	85.0	225.1	
N610RMU1	11.000										1.388	72.2	82.6	
N700T2	11.000		0.143	0.088	0.453	0.281					2.335	79.8	137.6	
Olakha	66.000										34.391	79.7	303.1	

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Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar				
Olakha1	66.000										17.267	79.3	152.2	
RICB1	33.000										13.811	80.7	256.5	
semtokha	66.000										45.320	81.9	396.4	
semtokha2	66.000										47.942	80.5	419.4	
TMH1	33.000										11.535	84.5	226.5	
wanchuk Taba RMU	11.000		0.055	0.034	0.190	0.118					0.289	85.0	16.3	

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

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

Branch Loading Summary Report

CKT / Branch		Cable & Reactor			Transformer				
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	Loading (input)		Loading (output)	
						MVA	%	MVA	%
0.416	Cable	338.03	67.37	19.93					
33kV from Bjemina	Cable	338.03	205.10	60.68					
33Line fromD/Choling	Cable	274.79	226.51	82.43					
c	Cable	178.41	25.83	14.48					
cable	Cable	229.86	10.50	4.57					
Cable4	Cable	212.74	4.39	2.07					
Cable6	Cable	190.58	0.25	0.13					
Cable7	Cable	212.74	0.16	0.07					
Cable8	Cable	190.58	23.11	12.12					
Cable9	Cable	212.74	3.23	1.52					
Cable10	Cable	190.58	0.25	0.13					
Cable11	Cable	212.74	142.35	66.92					
Cable12	Cable	274.79	226.51	82.43					
Cable13	Cable	190.58	0.16	0.08					
Cable14	Cable	190.58	142.35	74.70					
Cable15	Cable	190.58	4.02	2.11					
Cable16	Cable	338.03	13.57	4.01					
Cable17	Cable	190.58	30.26	15.88					
Cable18	Cable	190.58	60.54	31.77					
Cable19	Cable	190.58	38.96	20.44					
Cable20	Cable	190.58	60.54	31.77					
Cable21	Cable	212.74	91.49	43.01					
Cable22	Cable	190.58	38.96	20.44					
Cable23	Cable	190.58	144.38	75.76					
Cable24	Cable	190.58	71.02	37.27					
Cable25	Cable	190.58	144.39	75.77					
Cable26	Cable	190.58	36.69	19.25					
Cable27	Cable	190.58	73.38	38.50					
Cable28	Cable	190.58	0.00	0.00					
Cable29	Cable	190.58	73.37	38.50					
Cable30	Cable	338.03	15.99	4.73					
Cable31	Cable	200.71	96.56	48.11					
Cable32	Cable	301.98	65.30	21.62					

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CKT / Branch		Cable & Reactor			Transformer				
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	Loading (input)		Loading (output)	
						MVA	%	MVA	%
Cable33	Cable	338.03	18.68	5.52					
Cable34	Cable	338.03	5.99	1.77					
Cable35	Cable	338.03	9.34	2.76					
Cable36	Cable	338.03	223.80	66.21					
Cable37	Cable	338.03	12.19	3.61					
Cable38	Cable	338.03	223.80	66.21					
Cable39	Cable	338.03	21.73	6.43					
Cable40	Cable	338.03	104.45	30.90					
Cable41	Cable	338.03	21.74	6.43					
Cable42	Cable	338.03	21.74	6.43					
Cable43	Cable	338.03	67.37	19.93					
Cable44	Cable	338.03	13.08	3.87					
Cable45	Cable	190.58	0.00	0.00					
Cable46	Cable	190.58	0.00	0.00					
Cable47	Cable	274.79	61.72	22.46					
Cable48	Cable	190.58	0.00	0.00					
Cable49	Cable	190.58	38.67	20.29					
Cable51	Cable	338.03	74.84	22.14					
Cable52	Cable	338.03	19.97	5.91					
Cable53	Cable	212.74	29.73	13.97					
Cable54	Cable	338.03	1.79	0.53					
Cable55	Cable	338.03	65.12	19.26					
Cable56	Cable	338.03	16.81	4.97					
Cable57	Cable	338.03	31.41	9.29					
Cable59	Cable	338.03	5.13	1.52					
Cable60	Cable	229.86	1.79	0.78					
Cable61	Cable	338.03	139.69	41.32					
Cable62	Cable	338.03	9.71	2.87					
Cable63	Cable	338.03	14.60	4.32					
Cable64	Cable	338.03	14.46	4.28					
Cable65	Cable	338.03	71.93	21.28					
Cable66	Cable	338.03	57.48	17.01					
Cable67	Cable	229.86	14.44	6.28					
Cable68	Cable	229.86	14.36	6.25					
Cable69	Cable	338.03	296.82	87.81					

CKT / Branch		Cable & Reactor			Transformer				
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	Loading (input)		Loading (output)	
						MVA	%	MVA	%
Cable70	Cable	274.79	11.64	4.24					
Cable71	Cable	338.03	105.72	31.27					
Cable72	Cable	338.03	82.44	24.39					
Cable73	Cable	338.03	70.57	20.88					
Cable74	Cable	338.03	70.57	20.88					
Cable75	Cable	338.03	11.87	3.51					
Cable76	Cable	338.03	47.08	13.93					
Cable77	Cable	229.86	11.78	5.12					
Cable78	Cable	274.79	11.65	4.24					
Cable79	Cable	229.86	11.74	5.11					
Cable81	Cable	338.03	50.32	14.88					
Cable82	Cable	229.86	25.46	11.08					
Cable83	Cable	229.86	40.20	17.49					
Cable84	Cable	338.03	117.30	34.70					
Cable85	Cable	261.41	117.31	44.87					
Cable86	Cable	338.03							
Cable87	Cable	338.03	39.01	11.54					
Cable88	Cable	338.03	19.50	5.77					
Cable89	Cable	338.03	19.50	5.77					
Cable90	Cable	338.03	39.24	11.61					
Cable91	Cable	338.03	19.49	5.77					
Cable92	Cable	229.86	19.50	8.48					
Cable93	Cable	229.86	19.50	8.48					
Cable94	Cable	229.86	0.00	0.00					
Cable96	Cable	338.03	39.15	11.58					
Cable97	Cable	338.03	58.74	17.38					
Cable98	Cable	378.60	78.49	20.73					
Cable99	Cable	338.03	19.59	5.80					
Cable100	Cable	229.86	19.57	8.52					
Cable102	Cable	229.86	4.83	2.10					
Cable103	Cable	338.03	53.67	15.88					
Cable104	Cable	338.03	16.97	5.02					
Cable105	Cable	229.86	8.49	3.69					
Cable106	Cable	229.86	10.81	4.70					
Cable107	Cable	338.03	19.46	5.76					

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CKT / Branch		Cable & Reactor			Transformer				
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	Loading (input)		Loading (output)	
						MVA	%	MVA	%
Cable108	Cable	338.03	186.99	55.32					
Cable109	Cable	338.03	186.99	55.32					
Cable110	Cable	338.03	187.00	55.32					
Cable111	Cable	229.86	58.06	25.26					
Cable112	Cable	229.86	32.37	14.08					
Cable113	Cable	338.03	187.00	55.32					
Cable114	Cable	229.86	0.00	0.00					
Cable115	Cable	338.03	182.73	54.06					
Cable116	Cable	338.03	132.80	39.29					
Cable117	Cable	338.03	94.86	28.06					
Cable118	Cable	229.86	17.72	7.71					
Cable119	Cable	229.86	8.86	3.86					
Cable120	Cable	229.86	20.87	9.08					
Cable121	Cable	229.86	9.39	4.08					
Cable122	Cable	229.86	9.39	4.08					
Cable123	Cable	378.60	153.17	40.46					
Cable124	Cable	378.60	146.35	38.66					
Cable125	Cable	338.03	85.27	25.22					
Cable126	Cable	229.86	30.84	13.41					
Cable127	Cable	338.03	6.82	2.02					
Cable128	Cable	338.03	27.68	8.19					
Cable129	Cable	338.03							
Cable131	Cable	338.03	178.98	52.95					
Cable132	Cable	338.03	129.65	38.35					
Cable133	Cable	338.03	129.55	38.32					
Cable134	Cable	338.03	118.27	34.99					
Cable135	Cable	338.03	118.27	34.99					
Cable136	Cable	338.03	74.41	22.01					
Cable137	Cable	338.03	0.10	0.03					
Cable138	Cable	338.03	9.74	2.88					
Cable139	Cable	338.03	6.24	1.84					
Cable140	Cable	338.03	58.43	17.29					
Cable141	Cable	229.86	0.10	0.04					
Cable142	Cable	229.86	48.69	21.18					
Cable143	Cable	229.86	24.35	10.59					

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CKT / Branch		Cable & Reactor			Transformer				
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	Loading (input)		Loading (output)	
						MVA	%	MVA	%
Cable144	Cable	229.86	24.35	10.59					
Cable145	Cable	338.03	9.74	2.88					
Cable146	Cable	229.86	11.38	4.95					
Cable147	Cable	338.03	48.44	14.33					
Cable148	Cable	338.03	97.81	28.93					
Cable149	Cable	229.86	5.13	2.23					
Cable150	Cable	338.03	10.49	3.10					
Cable151	Cable	338.03	106.69	31.56					
Cable152	Cable	338.03	86.67	25.64					
Cable153	Cable	338.03	56.65	16.76					
Cable154	Cable	338.03	16.68	4.93					
Cable155	Cable	338.03	16.68	4.93					
Cable156	Cable	338.03	130.04	38.47					
Cable157	Cable	229.86	16.69	7.26					
Cable158	Cable	229.86	16.83	7.32					
Cable159	Cable	229.86	13.36	5.81					
Cable160	Cable	338.03	176.92	52.34					
Cable161	Cable	212.74	29.76	13.99					
Cable162	Cable	338.03	24.06	7.12					
Cable163	Cable	338.03	39.97	11.83					
Cable164	Cable	338.03	39.98	11.83					
Cable165	Cable	212.74	29.77	13.99					
Cable166	Cable	229.86	39.63	17.24					
Cable167	Cable	229.86	34.46	14.99					
Cable168	Cable	338.03	166.32	49.20					
Cable169	Cable	338.03	1.10	0.33					
Cable170	Cable	229.86	17.21	7.49					
Cable171	Cable	229.86	17.21	7.49					
Cable172	Cable	338.03	22.03	6.52					
Cable173	Cable	338.03	72.27	21.38					
Cable174	Cable	190.58	4.99	2.62					
Cable175	Cable	338.03	51.62	15.27					
Cable176	Cable	338.03	20.65	6.11					
Cable177	Cable	338.03	20.65	6.11					
Cable178	Cable	212.74	3.41	1.60					

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CKT / Branch		Cable & Reactor			Transformer				
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	Loading (input)		Loading (output)	
						MVA	%	MVA	%
Cable179	Cable	338.03	41.31	12.22					
Cable180	Cable	229.86	81.72	35.55					
Cable181	Cable	338.03	0.00	0.00					
Cable182	Cable	338.03	11.01	3.26					
Cable183	Cable	190.58	36.68	19.25					
Cable184	Cable	190.58	36.68	19.25					
Cable185	Cable	229.86	11.79	5.13					
Cable186	Cable	338.03	161.48	47.77					
Cable187	Cable	229.86	2.37	1.03					
Cable188	Cable	338.03	11.79	3.49					
Cable189	Cable	338.03	11.79	3.49					
Cable190	Cable	338.03	20.68	6.12					
Cable191	Cable	338.03	48.26	14.28					
Cable192	Cable	338.03	8.12	2.40					
Cable193	Cable	229.86	7.87	3.42					
Cable194	Cable	229.86	7.87	3.42					
Cable195	Cable	338.03	8.11	2.40					
Cable196	Cable	178.41	8.05	4.51					
Cable197	Cable	338.03	113.85	33.68					
Cable198	Cable	338.03	98.22	29.06					
Cable199	Cable	338.03	82.60	24.44					
Cable200	Cable	338.03	153.53	45.42					
Cable201	Cable	229.86	20.68	9.00					
Cable202	Cable	338.03	17.23	5.10					
Cable203	Cable	229.86	115.79	50.38					
Cable204	Cable	229.86	30.12	13.10					
Cable205	Cable	338.03	180.66	53.45					
Cable206	Cable	229.86	17.93	7.80					
Cable207	Cable	338.03	120.48	35.64					
Cable208	Cable	229.86	17.93	7.80					
Cable209	Cable	338.03	37.46	11.08					
Cable210	Cable	338.03	65.09	19.26					
Cable211	Cable	229.86	0.37	0.16					
Cable212	Cable	338.03	7.96	2.35					
Cable213	Cable	338.03	22.47	6.65					

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CKT / Branch		Cable & Reactor			Transformer				
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	Loading (input)		Loading (output)	
						MVA	%	MVA	%
Cable214	Cable	261.41	22.47	8.60					
Cable215	Cable	338.03	22.47	6.65					
Cable216	Cable	190.58	16.43	8.62					
Cable217	Cable	229.86	82.60	35.94					
Cable219	Cable	338.03	163.33	48.32					
Cable220	Cable	338.03	137.60	40.71					
Cable221	Cable	229.86	37.41	16.28					
Cable222	Cable	338.03	44.29	13.10					
Cable223	Cable	338.03	49.20	14.55					
Cable224	Cable	338.03	49.20	14.55					
Cable226	Cable	229.86	44.79	19.49					
Cable227	Cable	229.86	14.94	6.50					
Cable228	Cable	229.86	23.16	10.08					
Cable229	Cable	338.03	260.77	77.14					
Cable230	Cable	229.86	27.60	12.01					
Cable231	Cable	229.86	3.47	1.51					
Cable232	Cable	229.86	23.17	10.08					
Cable233	Cable	229.86	14.85	6.46					
Cable234	Cable	338.03	29.44	8.71					
Cable235	Cable	178.41	41.33	23.16					
Cable236	Cable	178.41	67.15	37.64					
Cable239	Cable	338.03	14.60	4.32					
Cable240	Cable	338.03	14.84	4.39					
Cable243	Cable	338.03	19.80	5.86					
Cable244	Cable	338.03	9.90	2.93					
Cable245	Cable	338.03	0.00	0.00					
Cable250	Cable	338.03	80.86	23.92					
Cable251	Cable	229.86	60.22	26.20					
Cable252	Cable	338.03	129.05	38.18					
Cable253	Cable	229.86	20.65	8.98					
Cable255	Cable	229.86	9.90	4.31					
Cable261	Cable	338.03	225.10	66.59					
Cable262	Cable	338.03	11.94	3.53					
Cable264	Cable	190.58	1.25	0.65					
Cable269	Cable	229.86	31.81	13.84					

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CKT / Branch		Cable & Reactor			Transformer				
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	Loading (input)		Loading (output)	
						MVA	%	MVA	%
Cable271	Cable	229.86	7.12	3.10					
Cable275	Cable	338.03	0.00	0.00					
Cable276	Cable	338.03	0.00	0.00					
Cable277	Cable	229.86							
Cable278	Cable	338.03	0.00	0.00					
Cable278- RICB SS	Cable	261.41	75.10	28.73					
Cable279	Cable	229.86	2.76	1.20					
Cable280	Cable	338.03							
Cable285	Cable	229.86	23.50	10.22					
Cable286	Cable	229.86	136.51	59.39					
Cable287	Cable	338.03	26.18	7.75					
Cable288	Cable	229.86	20.35	8.85					
Cable289	Cable	229.86	50.85	22.12					
Cable290	Cable	229.86	5.08	2.21					
Cable291	Cable	229.86	2.39	1.04					
Cable294	Cable	229.86	33.63	14.63					
Cable295	Cable	338.03	62.58	18.51					
Cable296	Cable	229.86	62.58	27.22					
Cable297	Cable	229.86	18.55	8.07					
Cable307	Cable	338.03	262.38	77.62					
Cable309	Cable	338.03	31.94	9.45					
Cable311	Cable	229.86	5.02	2.18					
Cable312	Cable	338.03	101.92	30.15					
Cable313	Cable	338.03	33.44	9.89					
Cable314	Cable	338.03	16.72	4.95					
Cable315	Cable	229.86	16.72	7.27					
Cable316	Cable	338.03	148.94	44.06					
Cable317	Cable	229.86	5.02	2.18					
Cable318	Cable	229.86	5.02	2.18					
Cable321	Cable	338.03	81.80	24.20					
Cable322	Cable	229.86	58.43	25.42					
Cable323	Cable	338.03	23.37	6.91					
Cable324	Cable	338.03	81.80	24.20					
Cable326	Cable	338.03	67.14	19.86					
Cable327	Cable	338.03	20.17	5.97					

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CKT / Branch		Cable & Reactor			Transformer				
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	Loading (input)		Loading (output)	
						MVA	%	MVA	%
Cable328	Cable	338.03	34.43	10.19					
Cable329	Cable	338.03	12.54	3.71					
Cable330	Cable	338.03	11.80	3.49					
Cable331	Cable	338.03	16.73	4.95					
Cable332	Cable	229.86	5.90	2.57					
Cable348	Cable	338.03	28.45	8.42					
Cable349	Cable	338.03	13.30	3.94					
Cable350	Cable	338.03	15.15	4.48					
Cable354	Cable	229.86	5.39	2.34					
Cable365	Cable	178.41	8.73	4.89					
Cable367	Cable	338.03	104.60	30.94					
Cable368	Cable	338.03	52.30	15.47					
Cable370	Cable	338.03	23.27	6.88					
Cable371	Cable	229.86	19.56	8.51					
Cable372	Cable	338.03	222.19	65.73					
Cable373	Cable	261.41	17.30	6.62					
Cable378	Cable	229.86	12.37	5.38					
Cable379	Cable	338.03	187.18	55.37					
Cable380	Cable	338.03	6.97	2.06					
Cable381	Cable	338.03	180.21	53.31					
Cable382	Cable	338.03	40.67	12.03					
Cable384	Cable	338.03	119.13	35.24					
Cable385	Cable	338.03	114.04	33.74					
Cable387	Cable	338.03	63.35	18.74					
Cable388	Cable	338.03	5.10	1.51					
Cable389	Cable	212.74	33.14	15.58					
Cable391	Cable	378.60	205.69	54.33					
Cable393	Cable	338.03	2.75	0.81					
Cable394	Cable	378.60	205.69	54.33					
Cable395	Cable	229.86	41.62	18.11					
Cable396	Cable	338.03	22.80	6.74					
Cable397	Cable	378.60	148.69	39.27					
Cable398	Cable	378.60	107.07	28.28					
Cable399	Cable	338.03	19.06	5.64					
Cable403	Cable	338.03	222.14	65.72					

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CKT / Branch		Cable & Reactor			Transformer				
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	Loading (input)		Loading (output)	
						MVA	%	MVA	%
Cable404	Cable	301.98	37.52	12.43					
Cable405	Cable	229.86	18.34	7.98					
Cable406	Cable	338.03	19.06	5.64					
Cable407	Cable	338.03	19.06	5.64					
Cable408	Cable	338.03							
Cable409	Cable	229.86							
Cable410	Cable	338.03	62.86	18.59					
Cable411	Cable	229.86	21.61	9.40					
Cable412	Cable	229.86	178.25	77.55					
Cable413	Cable	338.03	178.25	52.73					
Cable414	Cable	229.86	18.34	7.98					
Cable414-DPH 1(NPPF)	Cable	338.03	228.42	67.57					
Cable415	Cable	338.03	93.78	27.74					
Cable416	Cable	229.86	0.85	0.37					
Cable422	Cable	301.98	175.49	58.11					
Cable423	Cable	229.86	45.62	19.85					
Cable424	Cable	229.86	45.59	19.83					
Cable425	Cable	229.86	84.44	36.74					
Cable426	Cable	229.86	18.24	7.93					
Cable427	Cable	229.86	66.30	28.84					
Cable428	Cable	229.86	9.11	3.96					
Cable467	Cable	338.03	124.16	36.73					
Cable468	Cable	338.03	119.42	35.33					
Cable469	Cable	229.86	47.93	20.85					
Cable470	Cable	338.03	38.27	11.32					
Cable471	Cable	338.03	33.22	9.83					
Cable472	Cable	147.19	4.74	3.22					
Cable473	Cable	338.03	38.27	11.32					
Cable491	Cable	229.86	4.74	2.06					
Cable528	Cable	338.03	7.28	2.15					
Cable529	Cable	338.03	7.29	2.16					
Cable545	Cable	338.03	13.90	4.11					
Cable546	Cable	338.03	13.90	4.11					
Cable547	Cable	338.03	57.16	16.91					
Cable548	Cable	338.03	36.58	10.82					

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CKT / Branch		Cable & Reactor			Transformer				
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	Loading (input)		Loading (output)	
						MVA	%	MVA	%
Cable550	Cable	338.03	5.72	1.69					
Cable552	Cable	229.86	23.98	10.43					
Cable553	Cable	338.03	42.26	12.50					
Cable554	Cable	338.03	18.27	5.41					
Cable555	Cable	338.03	8.81	2.61					
Cable557	Cable	229.86	20.50	8.92					
Cable558	Cable	338.03	17.42	5.15					
Cable559	Cable	229.86	20.50	8.92					
Cable561	Cable	338.03	37.02	10.95					
Cable562	Cable	229.86	20.50	8.92					
Cable563	Cable	338.03	55.23	16.34					
Cable564	Cable	338.03	0.00	0.00					
Cable565	Cable	338.03	23.36	6.91					
Cable585	Cable	338.03	235.66	69.72					
Cable586	Cable	338.03	3.11	0.92					
Cable586-DPH I N900	Cable	338.03	205.69	60.85					
Cable587	Cable	338.03	235.67	69.72					
Cable588	Cable	229.86	16.34	7.11					
Cable589	Cable	338.03	98.44	29.12					
Cable591	Cable	338.03	137.23	40.60					
Cable632	Cable	338.03	53.67	15.88					
Cable650	Cable	229.86	60.82	26.46					
Cable651	Cable	229.86	60.82	26.46					
Cable671	Cable	229.86	28.19	12.26					
Cable672	Cable	229.86	65.79	28.62					
Cable673	Cable	229.86	16.33	7.10					
Cable674	Cable	338.03	7.00	2.07					
Cable676	Cable	229.86	11.87	5.17					
Cable678	Cable	338.03	13.94	4.12					
Cable679	Cable	338.03	33.42	9.89					
Cable680	Cable	338.03	27.59	8.16					
Cable681	Cable	338.03	13.79	4.08					
Cable682	Cable	229.86	23.05	10.03					
Connected to N520T5	Cable	229.86							
connecttoN400T3	Cable	338.03	72.93	21.58					

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CKT / Branch		Cable & Reactor			Transformer				
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	Loading (input)		Loading (output)	
						MVA	%	MVA	%
ConnecttoN580T2	Cable	338.03	200.98	59.45					
from 760	Cable	338.03	74.84	22.14					
FromN890	Cable	338.03	186.64	55.21					
N90-DPH 1(NPPF)9	Cable	338.03	57.25	16.94					
N350T/phu feeder	Cable	378.60	343.55	90.74					
N460 DPH II	Cable	338.03	107.34	31.75					
N470 DPH II	Cable	338.03	121.64	35.99					
N520RICBL2	Cable	229.86	187.36	81.51					
N690F	Cable	338.03	96.53	28.56					
N740Olakha	Cable	212.74	142.35	66.92					
Olakha SSN110	Cable	274.79	137.96	50.21					
TMH N230F	Cable	212.74	91.52	43.02					
33/11kV Babesa Xmer1	Transformer				5.000	4.055	81.1	3.904	78.1
33/11kV Babesa Xmer2	Transformer				5.000	4.055	81.1	3.904	78.1
33/11kV Bjemina Xmer	Transformer				5.000	2.073	41.5	2.036	40.7
33/11kV Chubachu Xmer1	Transformer				5.000	4.594	91.9	4.373	87.5
33/11kV Chubachu Xmer2	Transformer				10.000	9.188	91.9	8.745	87.5
33/11kV DPH1 Xmer1	Transformer				5.000	2.868	57.4	2.783	55.7
33/11kV DPH1 Xmer2	Transformer				5.000	2.868	57.4	2.783	55.7
33/11kV DPH2 Xmer1	Transformer				5.000	1.919	38.4	1.884	37.7
33/11kV DPH2 Xmer2	Transformer				5.000	1.919	38.4	1.884	37.7
33/11kV DPH2 Xmer3	Transformer				5.000	4.193	83.9	4.059	81.2
33/11kV DPH2 Xmer4	Transformer				5.000	4.193	83.9	4.059	81.2
33/11kV GMH	Transformer				5.000	0.229	4.6	0.229	4.6
33/11kV Hospital Xmer1	Transformer				5.000	3.736	74.7	3.592	71.8
33/11kV Hospital Xmer2	Transformer				5.000	3.736	74.7	3.592	71.8
33/11kV L/phu Xmer1	Transformer				5.000	3.635	72.7	3.518	70.4
33/11kV L/phu Xmer2	Transformer				5.000	4.205	84.1	4.034	80.7
33/11kV M/Thang Xmer1	Transformer				5.000	4.650	93.0	4.417	88.3
33/11kV M/Thang Xmer2	Transformer				5.000	4.038	80.8	3.870	77.4
33/11kV RICBL Xmer1	Transformer				5.000	4.886	97.7	4.637	92.7
33/11kV RICBL Xmer2	Transformer				5.000	4.886	97.7	4.637	92.7
33/11kV Taba	Transformer				5.000	2.486	49.7	2.469	49.4
33/11kV Taba2	Transformer				5.000	2.486	49.7	2.469	49.4
33/11kV TMH Xmer1	Transformer				10.000	3.442	34.4	3.383	33.8

CKT / Branch		Cable & Reactor			Transformer				
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	Loading (input)		Loading (output)	
						MVA	%	MVA	%
33/11kV TMH Xmer2	Transformer				10.000	3.442	34.4	3.383	33.8
33/11kVD/CholingXmer1	Transformer				5.000	4.692	93.8	4.369	87.4
33/11kVD/CholingXmer2	Transformer				5.000	4.692	93.8	4.369	87.4
66/11kV SemtokhaXmer1	Transformer				20.000	13.320	66.6	12.896	64.5
66/11kV SemtokhaXmer2	Transformer				20.000	13.320	66.6	12.896	64.5
66/33kV Bjemina Xmer	Transformer				10.000	7.659	76.6	7.398	74.0
66/33kV Bjemina Xmer1	Transformer				10.000	7.659	76.6	7.398	74.0
66/33kV C/Gedaphu Xmer1	Transformer				20.000	18.188	90.9	17.133	85.7
66/33kV C/Gedaphu Xmer2	Transformer				20.000	18.188	90.9	17.133	85.7
66/33kV OLAXmer1	Transformer				20.000	17.267	86.3	16.350	81.7
66/33kV OLAXmer2	Transformer				20.000	17.267	86.3	16.350	81.7
66/33kVD/CholingXmer1	Transformer				20.000	18.833	94.2	17.900	89.5
66/33kVD/CholingXmer2	Transformer				10.000	9.416	94.2	8.950	89.5

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

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Branch Losses Summary Report

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Line123	-1.198	-0.743	1.204	0.746	6.7	2.7	85.6	86.1	0.43
Line126	0.201	0.124	-0.200	-0.124	0.1	0.0	85.6	85.6	0.04
Line127	0.997	0.619	-0.995	-0.617	2.2	1.8	85.6	85.4	0.21
33/11kV GMH	-0.194	-0.120	0.194	0.121	0.1	0.8	97.0	97.2	0.21
Cable378	0.194	0.120	-0.194	-0.120	0.0	0.0	97.0	97.0	0.00
N470 DPH II	1.784	1.106	-1.773	-1.099	11.0	7.8	90.6	90.0	0.58
33/11kV Hospital Xmer1	-3.053	-1.892	3.079	2.116	26.3	223.4	90.6	94.2	3.64
N460 DPH II	1.574	0.976	-1.565	-0.970	8.6	6.0	90.6	90.1	0.51
N520RICBL2	2.749	1.702	-2.748	-1.702	0.5	0.2	90.6	90.5	0.01
33/11kV Hospital Xmer2	-3.053	-1.892	3.079	2.116	26.3	223.4	90.6	94.2	3.64
Cable65	0.995	0.617	-0.994	-0.617	0.5	0.4	85.4	85.4	0.05
N740Olakha	-6.700	-4.570	6.717	4.570	17.0	0.0	99.7	99.8	0.17
33/11kV Babesa Xmer1	3.350	2.285	-3.322	-2.050	27.7	235.1	99.7	96.0	3.72
33/11kV Babesa Xmer2	3.350	2.285	-3.322	-2.050	27.7	235.1	99.7	96.0	3.72
66kV line from CHumdu	-12.983	-8.129	13.226	8.213	243.5	83.8	97.9	100.0	2.09
66/33kV Bjemina Xmer	6.491	4.064	-6.456	-3.611	34.9	453.7	97.9	100.2	2.30
66/33kV Bjemina Xmer1	6.491	4.064	-6.456	-3.611	34.9	453.7	97.9	100.2	2.30
Cable52	-0.283	-0.175	0.283	0.175	0.0	0.0	87.4	87.4	0.00
Line120	-1.762	-1.095	1.768	1.097	5.2	2.1	87.0	87.3	0.23
Line122	1.762	1.095	-1.757	-1.090	4.9	4.3	87.0	86.8	0.27
Cable14	6.725	4.570	-6.725	-4.570	0.3	0.0	99.9	99.9	0.00
Cable15	0.195	0.121	-0.195	-0.121	0.0	0.0	99.9	99.9	0.00
66/33kV OLAXmer2	-13.625	-9.038	13.698	10.512	73.7	1473.7	99.9	99.3	0.68
Cable84	1.896	1.180	-1.896	-1.180	0.2	0.2	99.9	99.9	0.01
Cable103	0.869	0.539	-0.869	-0.538	0.0	0.0	99.9	99.9	0.01
Cable150	0.170	0.105	-0.170	-0.105	0.0	0.0	99.9	99.9	0.00
66/11kV SemtokhaXmer1	-10.949	-6.815	11.002	7.508	53.3	693.1	99.9	100.0	0.05
Line14	19.152	13.408	-19.057	-13.326	95.0	81.6	99.9	99.4	0.54
Line519	-19.152	-13.408	19.159	13.414	6.7	5.8	99.9	99.9	0.04
Cable64	0.200	0.124	-0.200	-0.124	0.0	0.0	85.6	85.6	0.00
Cable55	-0.924	-0.571	0.924	0.571	0.1	0.1	87.6	87.6	0.01
Line98	0.803	0.497	-0.802	-0.496	1.2	1.0	87.6	87.4	0.15
Line110	0.121	0.074	-0.121	-0.074	0.0	0.0	87.6	87.5	0.01
Olakha SSN110	6.462	4.430	-6.462	-4.430	0.3	0.0	99.4	99.4	0.00

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Contract:		SN:	BHUTANPWR
Engineer:		Revision:	Base
Filename:	Thimphu ESD	Config.:	Normal
	Study Case: 2030 LFC		

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Line520	12.595	8.896	-12.587	-8.890	7.6	6.4	99.4	99.3	0.06
Cable8	1.028	0.623	-1.028	-0.623	0.0	0.0	91.0	91.0	0.00
33/11kVD/CholingXmer1	3.736	2.838	-3.710	-2.308	26.5	530.5	91.0	84.8	6.27
66/33kVD/CholingXmer1	-15.684	-8.627	15.808	10.237	123.8	1609.2	91.0	95.8	4.74
Cable31	1.431	0.621	-1.424	-0.619	6.9	2.2	84.8	84.4	0.39
Cable36	2.940	2.102	-2.928	-2.094	12.2	8.6	84.8	84.4	0.35
Cable37	0.167	0.103	-0.167	-0.103	0.0	0.0	84.8	84.8	0.00
Line16	12.587	8.890	-12.005	-8.401	582.4	488.9	99.3	94.3	4.96
Cable6	0.000	-0.014	0.000	0.014	0.0	0.0	99.9	99.9	0.00
Cable10	0.000	-0.014	0.000	0.014	0.0	0.0	99.9	99.9	0.00
66/33kV OLAXmer1	-13.625	-9.038	13.698	10.512	73.7	1473.7	99.9	99.3	0.68
Cable312	1.475	0.915	-1.475	-0.914	0.6	0.4	89.4	89.4	0.04
Cable316	2.156	1.337	-2.150	-1.332	6.3	4.4	89.4	89.1	0.27
Cable348	0.412	0.255	-0.412	-0.255	0.1	0.1	89.4	89.4	0.03
33/11kV RICBL Xmer2	-3.941	-2.443	3.986	2.825	44.9	382.1	89.4	94.2	4.80
Cable74	-0.988	-0.612	0.988	0.612	0.0	0.0	86.4	86.4	0.00
Cable75	0.166	0.103	-0.166	-0.103	0.0	0.0	86.4	86.4	0.00
Cable76	0.659	0.408	-0.659	-0.408	0.0	0.0	86.4	86.4	0.00
Cable62	-0.136	-0.085	0.136	0.085	0.0	0.0	86.8	86.8	0.01
Line95	0.519	0.321	-0.519	-0.321	0.1	0.1	87.4	87.4	0.03
Line97	0.283	0.175	-0.283	-0.175	0.1	0.0	87.4	87.4	0.03
Line489	11.171	6.096	-11.171	-6.096	0.2	0.2	100.2	100.2	0.00
33/11kV Bjemina Xmer	1.742	1.125	-1.735	-1.066	6.9	58.5	100.2	100.3	0.09
Cable269	0.519	0.317	-0.519	-0.317	0.2	0.1	100.3	100.3	0.03
Cable309	0.521	0.319	-0.520	-0.319	0.1	0.1	100.3	100.3	0.02
Cable370	0.378	0.234	-0.378	-0.234	0.0	0.0	100.3	100.3	0.01
Cable371	0.318	0.197	-0.318	-0.197	0.0	0.0	100.3	100.3	0.00
Cable528	0.113	0.070	-0.113	-0.070	0.0	0.0	96.0	96.0	0.00
Cable563	0.859	0.531	-0.859	-0.530	0.2	0.1	96.0	95.9	0.02
Cable585	3.668	2.259	-3.631	-2.233	36.9	26.1	96.0	94.9	1.00
Line9	9.910	6.370	-9.907	-6.368	2.4	2.0	91.0	91.0	0.02
Line24	5.116	0.272	-5.106	-0.266	9.4	5.9	91.0	90.9	0.17
33/11kVD/CholingXmer2	3.736	2.838	-3.710	-2.308	26.5	530.5	91.0	84.8	6.27
66/33kVD/CholingXmer2	-7.842	-4.314	7.904	5.118	61.9	804.6	91.0	95.8	4.74
Cable391	3.019	1.890	-2.979	-1.855	40.2	35.1	90.9	89.5	1.35
Cable586-DPH 1 N900	-3.019	-1.890	3.071	1.926	51.3	36.2	90.9	92.5	1.60
Line521	12.005	8.401	-11.962	-8.365	42.7	35.9	94.3	94.0	0.36

Project:	ETAP	Page:	40
Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:	Study Case: 2030 LFC	Revision:	Base
Filename: Thimphu ESD		Config.:	Normal

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Cable137	-0.002	-0.001	0.002	0.001	0.0	0.0	96.5	96.5	0.00
Cable141	0.002	0.001	-0.002	-0.001	0.0	0.0	96.5	96.5	0.00
Olakha SS	11.288	7.947	-11.271	-7.932	17.6	14.7	94.0	93.8	0.16
Cable181	0.000	0.000	0.000	0.000			92.5	92.5	0.00
Cable311	0.075	0.047	-0.075	-0.047	0.0	0.0	92.5	92.5	0.00
33/11kV DPH2 Xmer2	-1.596	-1.001	1.605	1.052	8.5	51.2	92.5	94.2	1.71
Cable17	-0.199	-0.464	0.199	0.464	0.0	0.0	87.6	87.6	0.00
Cable43	0.955	0.593	-0.955	-0.593	0.1	0.1	87.6	87.6	0.01
Cable81	0.714	0.442	-0.713	-0.442	0.1	0.0	87.6	87.6	0.01
33/11kV TMH Xmer2	-2.949	-1.658	2.964	1.750	15.3	92.0	87.6	89.1	1.53
Cable205	-2.600	-1.612	2.605	1.615	4.7	3.3	88.9	89.0	0.17
Cable206	0.258	0.160	-0.258	-0.160	0.0	0.0	88.9	88.9	0.00
Cable207	1.734	1.075	-1.734	-1.075	0.1	0.1	88.9	88.9	0.01
Cable18	0.831	0.515	-0.831	-0.515	1.0	0.0	84.8	84.7	0.07
Cable23	1.981	1.231	-1.979	-1.231	1.5	0.0	84.8	84.7	0.04
Cable174	0.069	0.042	-0.069	-0.042	0.0	0.0	84.8	84.8	0.00
Cable200	2.326	1.187	-2.325	-1.186	1.5	1.1	89.3	89.2	0.06
Cable219	2.241	1.643	-2.235	-1.639	5.4	3.8	89.3	89.1	0.21
Cable236	0.971	0.601	-0.969	-0.601	2.3	0.6	89.3	89.1	0.18
Cable252	1.866	1.157	-1.861	-1.153	5.1	3.6	89.3	89.0	0.25
33/11kV Chubachu Xmer2	-7.434	-4.607	7.514	5.288	80.1	681.1	89.3	93.8	4.52
Cable102	0.070	0.043	-0.070	-0.043	0.0	0.0	89.3	89.3	0.00
Cable166	0.573	0.355	-0.573	-0.355	0.4	0.1	89.3	89.2	0.05
Cable168	2.405	1.491	-2.399	-1.487	5.8	4.1	89.3	89.1	0.22
Cable191	0.698	0.433	-0.698	-0.432	0.1	0.0	89.3	89.3	0.01
33/11kV Chubachu Xmer1	-3.717	-2.304	3.757	2.644	40.1	340.6	89.3	93.8	4.52
Cable172	0.301	0.187	-0.301	-0.187	0.0	0.0	84.4	84.4	0.01
Cable261	3.077	1.910	-3.063	-1.900	14.0	9.9	84.4	84.0	0.40
Cable264	0.017	0.011	-0.017	-0.011	0.0	0.0	84.4	84.4	0.00
Cable287	0.359	0.220	-0.359	-0.220	0.0	0.0	84.4	84.4	0.01
33/11kV M/Thang Xmer1	-3.754	-2.327	3.810	2.665	56.2	337.4	84.4	88.9	4.45
Cable186	2.188	1.705	-2.188	-1.704	0.9	0.6	90.2	90.1	0.04
Cable222	0.647	0.401	-0.646	-0.401	0.3	0.2	90.2	90.1	0.04
Cable243	0.289	0.179	-0.289	-0.179	0.0	0.0	90.2	90.2	0.01
33/11kV M/Thang Xmer2	-3.124	-2.284	3.162	2.512	37.9	227.2	90.2	94.1	3.91
Cable354	0.084	0.052	-0.084	-0.052	0.0	0.0	96.2	96.2	0.00
Line356	2.971	1.693	-2.950	-1.675	20.9	18.1	96.2	95.4	0.77

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Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:	Study Case: 2030 LFC	Revision:	Base
Filename: Thimphu ESD		Config.:	Normal

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
33/11kV L/phu Xmer1	-3.054	-1.745	3.077	1.935	22.4	190.1	96.2	99.4	3.20
Cable403	3.355	2.240	-3.354	-2.239	1.5	1.1	95.3	95.3	0.04
33/11kV L/phu Xmer2	-3.355	-2.240	3.385	2.495	29.9	254.4	95.3	99.4	4.03
Cable279	0.040	0.025	-0.040	-0.025	0.0	0.0	89.4	89.4	0.00
Cable307	3.798	2.355	-3.790	-2.349	8.3	5.9	89.4	89.2	0.20
33/11kV RICBL Xmer1	-3.941	-2.443	3.986	2.825	44.9	382.1	89.4	94.2	4.80
Cable467	1.930	1.194	-1.930	-1.194	0.1	0.1	96.0	95.9	0.01
Cable491	0.074	0.046	-0.074	-0.046	0.0	0.0	96.0	96.0	0.00
Cable586	0.047	0.029	-0.047	-0.029	0.0	0.0	92.5	92.5	0.00
33/11kV DPH2 Xmer1	-1.596	-1.001	1.605	1.052	8.5	51.2	92.5	94.2	1.71
Cable275	0.000	0.000	0.000	0.000			92.5	92.5	0.00
Line35	0.180	0.108	-0.180	-0.109	0.0	-1.5	91.0	91.0	0.01
Line139	-0.224	-0.134	0.224	0.133	0.0	-0.6	91.0	91.0	0.00
Line184	0.043	0.026	-0.043	-0.027	0.0	-0.5	91.0	91.0	0.00
Cable54	0.025	0.016	-0.025	-0.016	0.0	0.0	87.6	87.6	0.00
Cable71	1.499	0.929	-1.499	-0.929	0.2	0.1	87.6	87.6	0.01
33/11kV TMH Xmer1	-2.949	-1.658	2.964	1.750	15.3	92.0	87.6	89.1	1.53
Line17	0.000	-0.014	0.000	0.009	0.0	-5.5	99.9	99.9	0.00
Cable7	0.000	-0.009	0.000	0.009	0.0	0.0	99.9	99.9	0.00
Line18	0.000	-0.009	0.000	0.000	0.0	-9.0	99.9	99.9	0.00
Line22	0.000	-0.014	0.000	0.009	0.0	-5.5	99.9	99.9	0.00
Cable13	0.000	0.009	0.000	-0.009	0.0	0.0	99.9	99.9	0.00
Line21	0.000	-0.009	0.000	0.000	0.0	-9.0	99.9	99.9	0.00
Cable11	6.725	4.570	-6.717	-4.570	8.1	0.0	99.9	99.8	0.08
Line23	6.717	4.570	-6.717	-4.570	0.4	0.6	99.8	99.8	0.01
D/Choling 33kV1	4.969	0.185	-4.969	-0.185	0.6	0.4	90.9	90.9	0.01
Line26	0.137	0.081	-0.137	-0.082	0.0	-0.7	90.9	90.9	0.00
Line28	0.000	0.000	0.000	-0.002	0.0	-2.0	90.9	90.9	0.00
D/Choling 33kV	0.000	0.000	0.000	0.000	0.0	-0.2	90.9	90.9	0.00
Line27	0.137	0.084	-0.137	-0.085	0.0	-1.0	90.9	90.9	0.01
Line15	1.028	0.623	-1.028	-0.624	0.4	-1.3	91.0	91.0	0.04
Line3	0.143	0.088	-0.143	-0.088	0.0	-0.6	91.0	91.0	0.00
Line29	0.885	0.536	-0.885	-0.537	0.0	-0.2	91.0	91.0	0.00
Cable9	0.143	0.088	-0.143	-0.088	0.0	0.0	91.0	91.0	0.00
Line13	0.143	0.088	-0.143	-0.089	0.0	-0.2	91.0	91.0	0.00
Line25	0.691	0.416	-0.691	-0.417	0.0	-0.4	91.0	91.0	0.01
Cable4	0.194	0.120	-0.194	-0.120	0.0	0.0	91.0	91.0	0.00

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Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:	Study Case: 2030 LFC	Revision:	Base
Filename: Thimphu ESD		Config.:	Normal

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Line12	0.497	0.296	-0.497	-0.297	0.1	-0.9	91.0	91.0	0.01
Line31	0.230	0.139	-0.230	-0.140	0.0	-0.8	91.0	91.0	0.00
Line32	0.267	0.158	-0.267	-0.160	0.0	-1.8	91.0	91.0	0.01
Line33	0.087	0.051	-0.087	-0.053	0.0	-1.3	91.0	91.0	0.00
Line30	0.043	0.026	-0.043	-0.027	0.0	-1.0	91.0	91.0	0.00
Line34	0.043	0.027	-0.043	-0.027	0.0	-0.4	91.0	91.0	0.00
Line37	0.043	0.027	-0.043	-0.027	0.0	-0.2	91.0	91.0	0.00
Line39	0.137	0.082	-0.137	-0.084	0.0	-1.1	91.0	91.0	0.00
Line38	0.093	0.057	-0.093	-0.058	0.0	-0.6	91.0	91.0	0.00
Line41	0.043	0.026	-0.043	-0.027	0.0	-0.6	91.0	91.0	0.00
Line43	9.907	6.368	-9.897	-6.360	9.8	8.2	91.0	90.9	0.10
Line42	9.897	6.360	-9.766	-6.183	131.3	177.3	90.9	89.3	1.64
Line40	9.766	6.183	-9.762	-6.179	4.2	3.5	89.3	89.2	0.04
Cable12	9.762	6.179	-9.760	-6.179	2.0	0.0	89.2	89.2	0.01
Line44	9.760	6.179	-9.750	-6.171	10.3	8.6	89.2	89.1	0.10
33Line fromD/Choling	9.750	6.171	-9.746	-6.171	3.8	0.0	89.1	89.1	0.02
Line119	1.621	1.006	-1.612	-0.998	9.2	7.9	86.8	86.2	0.55
Cable20	0.831	0.515	-0.831	-0.515	0.0	0.0	84.7	84.7	0.00
Cable19	0.534	0.331	-0.534	-0.331	0.3	0.0	84.7	84.7	0.03
Cable22	0.534	0.331	-0.534	-0.331	0.0	0.0	84.7	84.7	0.00
Line6	1.979	1.231	-1.962	-1.216	16.8	14.6	84.7	83.9	0.80
Cable25	1.962	1.216	-1.962	-1.216	0.2	0.0	83.9	83.9	0.01
Cable24	0.965	0.598	-0.965	-0.598	0.0	0.0	83.9	83.9	0.00
Cable29	0.997	0.618	-0.997	-0.618	0.1	0.0	83.9	83.9	0.01
Line47	0.997	0.618	-0.993	-0.615	3.5	2.9	83.9	83.6	0.33
Cable27	0.993	0.615	-0.993	-0.615	0.1	0.0	83.6	83.6	0.00
Cable26	0.497	0.308	-0.497	-0.308	0.0	0.0	83.6	83.6	0.00
Cable183	0.497	0.308	-0.496	-0.308	0.4	0.0	83.6	83.5	0.05
Cable28	0.000	0.000	0.000	0.000			83.5	83.5	
Line125	-0.202	-0.125	0.202	0.125	0.0	0.0	86.1	86.1	0.00
Line45	1.424	0.619	-1.423	-0.618	0.9	0.8	84.4	84.3	0.06
Line49	1.353	0.575	-1.351	-0.574	1.5	0.7	84.3	84.2	0.09
Line51	1.232	0.774	-1.211	-0.756	21.3	18.0	84.2	82.6	1.62
Line52	0.070	0.043	-0.070	-0.043	0.1	-0.3	84.2	84.1	0.10
N160F	0.049	-0.243	-0.049	0.243	0.0	0.0	84.2	84.2	0.01
Line50	1.142	0.713	-1.139	-0.710	3.8	3.2	82.6	82.3	0.31
Line48	1.139	0.710	-1.138	-0.710	0.1	0.1	82.3	82.3	0.01

Project:	ETAP	Page:	43
Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:	Study Case: 2030 LFC	Revision:	Base
Filename: Thimphu ESD		Config.:	Normal

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Line55	1.071	0.668	-1.063	-0.661	8.1	6.8	82.3	81.6	0.69
Line54	0.995	0.620	-0.991	-0.616	4.5	3.8	81.6	81.2	0.41
Line36	0.981	0.610	-0.979	-0.608	2.6	2.2	81.2	80.9	0.24
Line57	0.979	0.608	-0.978	-0.607	0.6	0.5	80.9	80.9	0.05
Cable32	0.855	0.531	-0.855	-0.531	0.0	0.0	80.9	80.9	0.00
Cable121	0.123	0.076	-0.123	-0.076	0.0	0.0	80.9	80.9	0.00
Line59	0.855	0.531	-0.846	-0.523	9.3	7.7	80.9	79.9	0.98
Cable33	0.242	0.150	-0.242	-0.150	0.0	0.0	79.9	79.9	0.00
Line61	0.604	0.373	-0.604	-0.373	0.3	0.3	79.9	79.9	0.05
Cable35	0.121	0.075	-0.121	-0.075	0.0	0.0	79.9	79.9	0.00
Line56	0.288	0.178	-0.288	-0.178	0.0	0.0	79.9	79.9	0.01
Line60	0.315	0.195	-0.315	-0.195	0.4	0.2	79.9	79.7	0.12
Line68	0.194	0.120	-0.194	-0.120	0.0	0.0	79.7	79.7	0.00
Line11	0.065	0.040	-0.065	-0.040	0.0	0.0	79.9	79.9	0.00
Line58	0.223	0.138	-0.223	-0.138	0.1	0.0	79.9	79.8	0.05
Line62	0.158	0.098	-0.158	-0.098	0.0	0.0	79.8	79.8	0.01
Line63	0.065	0.040	-0.065	-0.040	0.0	-0.2	79.8	79.8	0.05
Line65	0.149	0.092	-0.149	-0.092	0.1	0.0	79.8	79.8	0.04
Line67	0.084	0.052	-0.084	-0.052	0.0	0.0	79.8	79.7	0.01
Line66	0.019	0.011	-0.019	-0.012	0.0	-0.3	79.7	79.7	0.01
Line64	0.065	0.040	-0.065	-0.040	0.0	0.0	79.7	79.7	0.00
Line70	0.130	0.080	-0.130	-0.080	0.1	-0.1	79.7	79.7	0.08
Cable38	2.928	2.094	-2.921	-2.089	6.7	4.7	84.4	84.2	0.19
Line8	2.970	1.846	-2.965	-1.842	5.6	4.9	84.2	84.1	0.18
Line72	2.607	1.620	-2.594	-1.609	12.6	11.0	84.1	83.6	0.45
Line71	2.417	1.499	-2.411	-1.494	5.3	4.6	83.6	83.4	0.20
Line79	0.177	0.110	-0.177	-0.110	0.1	0.0	83.6	83.6	0.04
Line74	1.704	1.056	-1.700	-1.053	3.8	3.3	83.4	83.2	0.21
Line75	-0.293	-0.181	0.293	0.181	0.1	0.1	83.1	83.2	0.04
Line78	0.293	0.181	-0.293	-0.181	0.1	0.0	83.1	83.1	0.02
Line76	1.408	0.871	-1.403	-0.869	4.8	2.0	83.2	82.9	0.26
Cable40	1.403	0.869	-1.403	-0.869	0.0	0.0	82.9	82.9	0.00
Cable39	0.293	0.181	-0.293	-0.181	0.0	0.0	83.1	83.1	0.00
Line73	0.293	0.181	-0.292	-0.181	0.2	0.0	83.1	83.1	0.05
Line80	0.292	0.181	-0.292	-0.181	0.1	0.0	83.1	83.0	0.03
Cable41	0.292	0.181	-0.292	-0.181	0.0	0.0	83.0	83.0	0.00
Cable42	0.292	0.181	-0.292	-0.181	0.0	0.0	83.0	83.0	0.00

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Line81	0.177	0.110	-0.177	-0.110	0.1	0.0	83.6	83.5	0.05
Line77	0.167	0.103	-0.167	-0.103	0.0	0.0	84.8	84.8	0.02
Line69	0.167	0.103	-0.167	-0.104	0.3	-0.2	84.8	84.6	0.16
Cable34	0.082	0.051	-0.082	-0.051	0.0	0.0	84.6	84.6	0.00
Line10	0.955	0.593	-0.954	-0.592	1.1	0.9	87.6	87.4	0.11
0.416	0.954	0.592	-0.953	-0.591	0.7	0.5	87.4	87.4	0.07
Line84	0.845	0.525	-0.843	-0.523	2.2	1.8	87.4	87.1	0.25
Line53	0.775	0.481	-0.773	-0.479	2.8	2.2	87.1	86.8	0.34
Line83	0.773	0.479	-0.771	-0.478	1.7	1.3	86.8	86.6	0.21
connecttoN650nearDzong	0.000	0.000	0.000	0.000	0.0	0.0	86.8	86.8	0.00
Line86	0.402	0.249	-0.402	-0.249	0.4	0.2	86.6	86.5	0.10
Line88	0.369	0.228	-0.369	-0.228	0.0	0.0	86.6	86.6	0.01
Line85	0.183	0.113	-0.183	-0.113	0.1	0.0	86.5	86.4	0.06
Cable44	0.183	0.113	-0.183	-0.113	0.0	0.0	86.4	86.4	0.00
Line87	0.224	0.139	-0.224	-0.139	0.0	0.0	86.6	86.5	0.01
Cable30	0.224	0.139	-0.224	-0.139	0.0	0.0	86.5	86.5	0.00
Line7	-3.818	-2.670	3.818	2.670	0.2	0.2	89.1	89.1	0.01
Line90	3.818	2.670	-3.817	-2.669	0.9	0.9	89.1	89.1	0.03
Cable21	3.817	2.669	-3.815	-2.669	1.2	0.0	89.1	89.0	0.02
Line89	3.815	2.669	-3.812	-2.666	3.9	3.6	89.0	88.9	0.12
Cable46	0.000	0.000	0.000	0.000			88.9	88.9	0.00
Line92	3.812	2.666	-3.811	-2.665	0.9	0.9	88.9	88.9	0.03
Cable45	0.000	0.000	0.000	0.000			88.9	88.9	0.00
Cable48	0.000	0.000	0.000	0.000			88.9	88.9	0.00
TMH N230F	3.811	2.665	-3.810	-2.665	0.2	0.0	88.9	88.9	0.00
Line124	-1.407	-0.871	1.409	0.872	2.6	1.2	86.1	86.2	0.15
Line19	-0.199	-0.464	0.199	0.464	0.1	0.0	87.6	87.6	0.02
Line91	-0.199	-0.464	0.201	0.465	1.5	0.5	87.6	87.8	0.22
Line2	-0.340	-0.551	0.340	0.551	0.2	0.1	87.8	87.8	0.03
Cable49	-0.340	-0.551	0.340	0.551	0.2	0.0	87.8	87.8	0.02
Line94	-0.606	-0.715	0.607	0.716	1.0	0.8	87.8	88.0	0.12
Cable47	-0.692	-0.769	0.693	0.769	1.4	0.0	88.0	88.0	0.08
Line93	0.193	0.120	-0.193	-0.120	0.0	0.0	88.0	88.0	0.01
Line96	-0.887	-0.889	0.888	0.890	1.6	1.4	88.0	88.2	0.15
Cable16	0.193	0.120	-0.193	-0.120	0.0	0.0	88.0	88.0	0.00
Cable51	-0.888	-0.890	0.888	0.890	0.0	0.0	88.2	88.2	0.00
from 760	-0.888	-0.890	0.888	0.890	0.1	0.0	88.2	88.2	0.00

Project:	ETAP	Page:	45
Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:	Study Case: 2030 LFC	Revision:	Base
Filename: Thimphu ESD		Config.:	Normal

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Line100	0.519	0.321	-0.519	-0.321	0.1	0.0	87.4	87.4	0.02
Line99	0.445	0.275	-0.444	-0.274	0.7	0.3	87.4	87.2	0.14
Cable57	0.444	0.274	-0.444	-0.274	0.0	0.0	87.2	87.2	0.00
Cable56	0.238	0.147	-0.238	-0.147	0.0	0.0	87.2	87.2	0.00
Line104	0.238	0.147	-0.238	-0.147	0.0	0.0	87.2	87.2	0.02
Line103	0.166	0.102	-0.166	-0.102	0.1	-0.1	87.2	87.1	0.08
Line101	0.093	0.057	-0.093	-0.057	0.0	-0.1	87.1	87.1	0.02
Line102	0.020	0.013	-0.020	-0.013	0.0	-0.1	87.1	87.1	0.01
Line106	0.072	0.045	-0.072	-0.045	0.0	-0.1	87.1	87.1	0.02
Cable59	0.072	0.045	-0.072	-0.045	0.0	0.0	87.1	87.1	0.00
Line108	0.000	0.000	0.000	0.000	0.0	-0.2	87.1	87.1	0.00
ConnecttoN170 RBGC	0.000	0.000	0.000	0.000	0.0	0.0	87.1	87.1	0.00
Line121	0.203	0.126	-0.203	-0.126	0.0	0.0	86.2	86.2	0.01
Line112	0.121	0.074	-0.121	-0.074	0.0	-0.1	87.5	87.5	0.04
Line114	0.075	0.046	-0.075	-0.046	0.0	0.0	87.5	87.5	0.00
Line116	0.014	0.008	-0.014	-0.008	0.0	-0.5	87.5	87.5	0.02
Line113	0.006	0.003	-0.006	-0.003	0.0	-0.4	87.5	87.5	0.01
Line105	0.025	0.016	-0.025	-0.016	0.0	0.0	87.6	87.6	0.00
Line118	0.025	0.016	-0.025	-0.016	0.0	-0.2	87.6	87.5	0.01
Cable60	0.025	0.016	-0.025	-0.016	0.0	0.0	87.5	87.5	0.00
Line111	0.000	0.000	0.000	0.000	0.0	-0.1	100.0	100.0	0.00
Line115	0.000	0.000	0.000	0.000	0.0	-0.2	100.0	100.0	0.00
Cable61	-1.979	-1.229	1.980	1.229	0.4	0.3	87.5	87.6	0.02
Line117	1.979	1.229	-1.974	-1.224	5.3	4.6	87.5	87.3	0.26
Line109	0.206	0.128	-0.206	-0.128	0.1	0.0	87.3	87.2	0.05
Cable63	0.206	0.128	-0.206	-0.128	0.0	0.0	87.2	87.2	0.00
Cable66	0.795	0.493	-0.795	-0.493	0.1	0.1	85.4	85.4	0.01
Line128	0.795	0.493	-0.794	-0.492	0.6	0.5	85.4	85.3	0.07
Line129	0.199	0.124	-0.199	-0.124	0.0	0.0	85.3	85.3	0.01
Line130	0.595	0.369	-0.594	-0.369	0.3	0.2	85.3	85.3	0.05
Cable67	0.199	0.124	-0.199	-0.124	0.0	0.0	85.3	85.3	0.01
Line131	0.594	0.369	-0.591	-0.366	3.4	2.5	85.3	84.7	0.54
Line132	0.591	0.366	-0.590	-0.366	0.7	0.2	84.7	84.6	0.09
Line133	0.590	0.366	-0.589	-0.365	1.5	1.1	84.6	84.4	0.24
Line134	0.393	0.243	-0.392	-0.243	0.1	0.1	84.4	84.4	0.03
Line137	0.196	0.121	-0.196	-0.121	0.1	0.0	84.4	84.4	0.04
Line135	0.196	0.122	-0.196	-0.122	0.0	0.0	84.4	84.4	0.00

Project:	ETAP	Page:	46
Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:	Study Case: 2030 LFC	Revision:	Base
Filename: Thimphu ESD		Config.:	Normal

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Cable68	0.196	0.122	-0.196	-0.122	0.0	0.0	84.4	84.4	0.01
Line136	0.196	0.122	-0.196	-0.122	0.0	0.0	84.4	84.4	0.00
Line138	0.000	0.000	0.000	0.000	0.0	-0.1	84.4	84.4	0.00
Line46	1.499	0.929	-1.493	-0.925	5.2	4.5	87.6	87.2	0.34
Line140	1.493	0.925	-1.489	-0.923	4.5	1.8	87.2	87.0	0.24
Line141	1.489	0.923	-1.485	-0.920	3.5	3.0	87.0	86.7	0.23
Cable78	0.164	0.101	-0.164	-0.101	0.0	0.0	86.7	86.7	0.00
Line142	1.322	0.819	-1.322	-0.819	0.1	0.1	86.7	86.7	0.01
Line143	0.164	0.101	-0.163	-0.101	0.1	-0.1	86.7	86.7	0.06
Line144	1.158	0.717	-1.157	-0.717	1.4	0.5	86.7	86.6	0.09
Line145	1.157	0.717	-1.156	-0.716	1.3	1.1	86.6	86.5	0.10
Cable70	0.163	0.101	-0.163	-0.101	0.0	0.0	86.7	86.7	0.00
Cable72	1.156	0.716	-1.155	-0.716	0.3	0.2	86.5	86.5	0.02
Cable73	0.989	0.612	-0.989	-0.612	0.1	0.1	86.5	86.5	0.01
Line146	0.989	0.612	-0.989	-0.612	0.2	0.2	86.5	86.5	0.02
Line148	0.989	0.612	-0.988	-0.612	0.5	0.4	86.5	86.4	0.05
Line149	0.494	0.306	-0.494	-0.306	0.4	0.3	86.4	86.4	0.08
Line150	0.165	0.102	-0.165	-0.102	0.0	0.0	86.4	86.4	0.00
Cable77	0.165	0.102	-0.165	-0.102	0.0	0.0	86.4	86.4	0.01
Line151	0.328	0.203	-0.328	-0.203	0.3	0.1	86.4	86.3	0.08
Line153	0.166	0.102	-0.166	-0.102	0.1	-0.1	86.4	86.3	0.05
Cable79	0.164	0.102	-0.164	-0.102	0.0	0.0	86.3	86.3	0.00
Line152	0.164	0.101	-0.164	-0.102	0.1	-0.1	86.3	86.2	0.04
Line154	0.000	0.000	0.000	0.000	0.0	-0.3	86.3	86.3	0.00
Line167	-0.007	-0.004	0.007	0.004	0.0	-0.2	99.6	99.6	0.00
Line4	0.570	0.353	-0.570	-0.353	0.3	0.2	87.6	87.5	0.05
Cable83	0.570	0.353	-0.570	-0.353	0.0	0.0	87.5	87.5	0.00
Line155	0.283	0.175	-0.283	-0.175	0.1	0.0	87.5	87.5	0.04
Line156	0.141	0.088	-0.141	-0.088	0.0	0.0	87.5	87.5	0.01
Line157	0.000	0.000	0.000	0.000	0.0	0.0	87.5	87.5	0.00
Line20	1.896	1.180	-1.880	-1.166	16.4	14.0	99.9	99.0	0.96
Cable85	1.880	1.166	-1.879	-1.166	0.3	0.1	99.0	99.0	0.01
Line159	1.566	0.972	-1.564	-0.970	1.7	1.5	99.0	98.8	0.12
Cable86	0.000	0.000	0.000	0.000			98.8	98.8	
Line160	1.564	0.970	-1.559	-0.966	4.9	4.1	98.8	98.5	0.35
Cable87	0.622	0.386	-0.622	-0.386	0.0	0.0	98.5	98.5	0.00
Cable92	0.311	0.193	-0.311	-0.193	0.0	0.0	98.5	98.5	0.00

Project:	ETAP	Page:	47
Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:	Study Case: 2030 LFC	Revision:	Base
Filename: Thimphu ESD		Config.:	Normal

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Line161	0.626	0.388	-0.626	-0.388	0.2	0.1	98.5	98.5	0.03
Cable88	0.311	0.193	-0.311	-0.193	0.0	0.0	98.5	98.5	0.00
Cable89	0.311	0.193	-0.311	-0.193	0.0	0.0	98.5	98.5	0.00
Line158	0.626	0.388	-0.625	-0.388	0.5	0.1	98.5	98.4	0.07
Cable90	0.625	0.388	-0.625	-0.388	0.0	0.0	98.4	98.4	0.00
Cable91	0.311	0.192	-0.311	-0.192	0.1	0.0	98.4	98.4	0.02
Cable93	0.311	0.193	-0.311	-0.193	0.0	0.0	98.5	98.5	0.01
Cable94	0.000	0.000	0.000	0.000			98.5	98.5	0.00
Cable96	-0.629	-0.390	0.629	0.390	0.1	0.0	99.2	99.2	0.01
Line163	0.314	0.195	-0.314	-0.195	0.4	0.0	99.2	99.1	0.14
Line162	-0.629	-0.390	0.629	0.390	0.1	0.0	99.2	99.2	0.01
Cable97	-0.944	-0.585	0.944	0.585	0.1	0.1	99.2	99.2	0.01
Cable99	0.315	0.195	-0.315	-0.195	0.0	0.0	99.2	99.2	0.01
Cable98	-1.262	-0.782	1.262	0.782	0.3	0.2	99.2	99.3	0.02
Cable100	0.314	0.195	-0.314	-0.195	0.0	0.0	99.1	99.1	0.00
Line164	0.000	0.000	0.000	0.000	0.0	-0.1	99.1	99.1	0.00
Line165	0.869	0.538	-0.866	-0.536	2.9	2.2	99.9	99.6	0.37
Line166	0.007	0.004	-0.007	-0.004	0.0	0.0	99.6	99.6	0.00
Line168	0.859	0.532	-0.854	-0.528	5.1	3.9	99.6	98.9	0.66
Line169	0.854	0.528	-0.853	-0.528	0.2	0.1	98.9	98.9	0.02
Line170	0.661	0.409	-0.659	-0.408	2.0	1.4	98.9	98.5	0.34
Line171	0.472	0.292	-0.469	-0.290	2.7	1.4	98.5	97.9	0.64
Line172	0.404	0.250	-0.403	-0.250	0.7	0.1	97.9	97.8	0.15
Line173	0.403	0.250	-0.403	-0.250	0.3	0.1	97.8	97.7	0.07
N20F to DPH1 notconnected	0.000	0.000	0.000	0.000	0.0	-0.2	97.8	97.8	0.00
Cable82	0.403	0.250	-0.403	-0.250	0.0	0.0	97.7	97.7	0.00
Cable104	0.269	0.166	-0.269	-0.166	0.0	0.0	97.7	97.7	0.00
Cable105	0.134	0.083	-0.134	-0.083	0.0	0.0	97.7	97.7	0.00
Line174	0.269	0.166	-0.268	-0.166	0.1	0.0	97.7	97.6	0.04
Cable69	-4.773	-3.020	4.776	3.022	3.1	2.2	99.9	99.9	0.07
Line175	4.773	3.020	-4.600	-2.869	172.6	150.7	99.9	95.9	4.01
Line176	3.963	2.474	-3.911	-2.429	51.5	44.9	95.9	94.5	1.39
Line178	0.336	0.208	-0.335	-0.208	0.2	0.0	95.9	95.8	0.05
Line180	0.302	0.187	-0.302	-0.187	0.0	0.0	95.9	95.9	0.01
Line177	3.747	2.328	-3.736	-2.318	10.7	9.4	94.5	94.2	0.30
Cable108	2.851	1.770	-2.848	-1.768	2.8	2.0	94.2	94.1	0.10
Cable111	0.886	0.549	-0.885	-0.549	0.3	0.1	94.2	94.2	0.03

Project:	ETAP	Page:	48
Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:	Study Case: 2030 LFC	Revision:	Base
Filename: Thimphu ESD		Config.:	Normal

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Cable106	0.168	0.104	-0.168	-0.104	0.0	0.0	95.8	95.8	0.01
Line181	0.302	0.187	-0.302	-0.187	0.0	0.0	95.9	95.9	0.00
Cable107	0.302	0.187	-0.302	-0.187	0.1	0.0	95.9	95.8	0.02
Cable109	2.848	1.768	-2.848	-1.768	0.0	0.0	94.1	94.1	0.00
Cable113	2.848	1.768	-2.844	-1.765	3.6	2.5	94.1	94.0	0.12
Cable114	0.000	0.000	0.000	0.000	0.0	0.0	94.1	94.1	0.00
Cable110	2.841	1.764	-2.840	-1.763	1.4	1.0	93.9	93.8	0.05
Line183	-2.841	-1.764	2.844	1.765	3.4	1.4	93.9	94.0	0.10
Cable115	2.775	1.723	-2.767	-1.717	8.0	5.7	93.8	93.5	0.28
Line189	0.065	0.040	-0.065	-0.040	0.0	0.0	93.8	93.8	0.00
Cable112	0.494	0.306	-0.494	-0.306	0.0	0.0	94.2	94.2	0.00
connected to N780T2	0.000	0.000	0.000	0.000	0.0	-0.1	94.1	94.1	0.00
Line185	2.638	1.637	-2.614	-1.616	23.7	20.6	93.5	92.6	0.94
Line186	2.614	1.616	-2.589	-1.606	24.6	10.2	92.6	91.8	0.79
Line182	1.974	1.225	-1.970	-1.221	3.3	3.7	91.8	91.6	0.19
Line187	0.565	0.350	-0.565	-0.350	0.0	0.0	91.8	91.8	0.00
Line188	0.051	0.031	-0.051	-0.031	0.0	-0.1	91.8	91.8	0.02
Line190	0.065	0.040	-0.065	-0.040	0.0	-0.2	93.8	93.8	0.02
Line179	1.970	1.221	-1.969	-1.221	1.4	0.6	91.6	91.6	0.06
Cable116	1.969	1.221	-1.969	-1.221	0.1	0.0	91.6	91.5	0.00
Cable117	1.406	0.872	-1.406	-0.872	0.0	0.0	91.5	91.5	0.00
Line191	1.406	0.872	-1.405	-0.872	0.8	0.3	91.5	91.5	0.05
Line192	1.405	0.872	-1.402	-0.869	3.2	2.7	91.5	91.3	0.23
Line193	0.373	0.231	-0.373	-0.231	0.1	0.1	91.3	91.2	0.03
Line194	1.029	0.638	-1.028	-0.637	1.0	0.8	91.3	91.2	0.10
Line195	0.411	0.254	-0.410	-0.254	0.1	0.1	91.2	91.1	0.03
Line196	0.617	0.383	-0.615	-0.381	2.2	1.6	91.2	90.8	0.36
Line197	-0.410	-0.254	0.410	0.254	0.3	0.1	91.1	91.1	0.07
Line198	0.261	0.162	-0.261	-0.162	0.4	0.0	91.1	90.9	0.15
Line199	0.615	0.381	-0.614	-0.381	0.7	0.5	90.8	90.7	0.12
Line201	0.000	0.000	0.000	0.000	0.0	-0.1	90.8	90.8	0.00
Cable118	0.261	0.162	-0.261	-0.162	0.0	0.0	90.9	90.9	0.00
Cable119	0.130	0.081	-0.130	-0.081	0.0	0.0	90.9	90.9	0.00
Cable120	0.306	0.190	-0.306	-0.190	0.1	0.0	90.7	90.7	0.02
Line200	0.000	0.000	0.000	0.000	0.0	-0.1	90.7	90.7	0.00
Connected to N520T5	0.000	0.000	0.000	0.000			90.7	90.7	
Cable151	-1.445	-0.895	1.445	0.896	0.4	0.3	83.6	83.6	0.02

Project:	ETAP	Page:	49
Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:	Study Case: 2030 LFC	Revision:	Base
Filename: Thimphu ESD		Config.:	Normal

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Cable152	1.174	0.727	-1.173	-0.727	0.8	0.6	83.6	83.6	0.06
Cable123	-2.478	-1.537	2.479	1.537	0.3	0.3	99.9	99.9	0.01
Cable124	2.368	1.469	-2.367	-1.468	0.5	0.5	99.9	99.9	0.02
Cable127	0.110	0.068	-0.110	-0.068	0.0	0.0	99.9	99.9	0.00
Line202	2.367	1.468	-2.363	-1.466	4.7	2.2	99.9	99.7	0.18
Line204	2.363	1.466	-2.356	-1.460	6.8	5.8	99.7	99.4	0.32
Line203	0.940	0.584	-0.932	-0.577	8.1	6.3	99.4	98.5	0.95
Line205	1.416	0.877	-1.414	-0.876	2.0	0.9	99.4	99.3	0.13
Line207	0.920	0.570	-0.915	-0.566	4.3	3.3	98.5	97.9	0.51
Cable125	1.371	0.849	-1.371	-0.849	0.0	0.0	99.3	99.3	0.00
Line206	0.043	0.026	-0.043	-0.027	0.0	-0.2	99.3	99.3	0.02
Line208	0.502	0.311	-0.501	-0.310	0.2	0.1	97.9	97.9	0.05
Line210	0.414	0.256	-0.414	-0.256	0.3	0.1	97.9	97.9	0.06
Cable126	0.489	0.303	-0.489	-0.303	0.1	0.0	97.9	97.9	0.01
Line211	0.012	0.008	-0.012	-0.008	0.0	-0.2	97.9	97.9	0.01
Line212	0.401	0.248	-0.401	-0.248	0.5	0.1	97.9	97.8	0.11
Line213	0.275	0.170	-0.275	-0.170	0.1	0.0	97.8	97.7	0.04
Line214	0.126	0.078	-0.126	-0.078	0.0	-0.1	97.8	97.8	0.02
Line215	0.032	0.020	-0.032	-0.020	0.0	0.0	97.8	97.8	0.00
Line216	0.094	0.058	-0.094	-0.058	0.0	-0.1	97.8	97.7	0.01
Line217	0.094	0.058	-0.094	-0.058	0.1	-0.3	97.7	97.7	0.07
Cable128	-0.449	-0.276	0.449	0.276	0.0	0.0	99.9	99.9	0.01
Line218	0.449	0.276	-0.448	-0.276	0.4	0.2	99.9	99.8	0.10
Line220	0.448	0.276	-0.448	-0.276	0.1	0.1	99.8	99.8	0.04
Line219	0.448	0.276	-0.447	-0.276	0.8	0.4	99.8	99.6	0.21
Line221	0.214	0.133	-0.214	-0.133	0.0	0.0	99.6	99.6	0.01
Line222	0.233	0.143	-0.233	-0.143	0.1	-0.1	99.6	99.5	0.06
Line223	0.233	0.143	-0.233	-0.143	0.1	-0.1	99.5	99.5	0.06
Line224	0.233	0.143	-0.233	-0.143	0.2	-0.1	99.5	99.4	0.09
Line225	0.233	0.144	-0.233	-0.144	0.1	0.0	99.4	99.4	0.02
Line226	0.000	-0.001	0.000	0.000	0.0	-0.8	99.4	99.4	0.00
Cable129	0.000	0.000	0.000	0.000			99.4	99.4	
Cable156	-1.761	-1.092	1.762	1.092	0.6	0.4	83.6	83.7	0.03
Line209	0.316	0.196	-0.316	-0.196	0.1	0.0	83.6	83.6	0.02
Cable131	-2.888	-1.808	2.889	1.809	1.1	0.8	99.9	99.9	0.04
Line227	2.888	1.808	-2.883	-1.804	4.7	4.1	99.9	99.7	0.18
Line228	0.161	0.099	-0.160	-0.099	0.1	-0.1	99.7	99.7	0.06

Project:	ETAP	Page:	50
Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:	Study Case: 2030 LFC	Revision:	Base
Filename: Thimphu ESD		Config.:	Normal

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Line229	2.722	1.704	-2.676	-1.664	46.7	40.4	99.7	97.8	1.90
Line230	0.208	0.129	-0.208	-0.129	0.1	-0.1	97.8	97.8	0.04
Line231	0.003	0.002	-0.003	-0.002	0.0	-0.1	97.8	97.8	0.00
Line233	2.465	1.534	-2.462	-1.530	4.0	3.4	97.8	97.6	0.17
Line232	0.003	0.002	-0.003	-0.002	0.0	0.0	97.8	97.8	0.00
Line234	0.362	0.225	-0.362	-0.224	0.1	0.0	97.6	97.6	0.04
Line235	2.099	1.306	-2.095	-1.302	4.6	4.0	97.6	97.4	0.24
Line236	0.052	0.031	-0.052	-0.031	0.0	0.0	97.4	97.4	0.00
Line240	2.043	1.271	-2.026	-1.256	17.4	14.9	97.4	96.5	0.92
Line237	0.052	0.031	-0.052	-0.032	0.0	-0.1	97.4	97.4	0.01
Line238	0.052	0.032	-0.052	-0.032	0.0	-0.1	97.4	97.4	0.01
Line239	0.052	0.032	-0.052	-0.032	0.0	-0.3	97.4	97.4	0.03
Cable132	2.026	1.256	-2.025	-1.256	0.1	0.1	96.5	96.5	0.01
Cable133	2.024	1.255	-2.024	-1.255	0.0	0.0	96.5	96.5	0.00
Cable134	1.848	1.145	-1.845	-1.144	2.6	1.8	96.5	96.3	0.14
Cable146	0.178	0.110	-0.178	-0.110	0.0	0.0	96.5	96.5	0.00
Cable135	1.845	1.144	-1.845	-1.143	0.1	0.1	96.3	96.3	0.00
Cable136	1.161	0.719	-1.161	-0.719	0.3	0.2	96.3	96.3	0.03
Cable138	0.152	0.094	-0.152	-0.094	0.0	0.0	96.3	96.3	0.01
Cable139	0.097	0.060	-0.097	-0.060	0.0	0.0	96.3	96.3	0.00
Cable140	0.911	0.565	-0.911	-0.565	0.4	0.3	96.3	96.3	0.05
Cable145	0.152	0.094	-0.152	-0.094	0.0	0.0	96.3	96.3	0.00
Line241	0.759	0.470	-0.759	-0.470	0.1	0.1	96.3	96.2	0.01
Cable142	0.759	0.470	-0.759	-0.470	0.1	0.0	96.2	96.2	0.01
Cable143	0.379	0.235	-0.379	-0.235	0.0	0.0	96.2	96.2	0.00
Cable144	0.379	0.235	-0.379	-0.235	0.0	0.0	96.2	96.2	0.00
Cable147	-0.784	-0.486	0.784	0.486	0.1	0.1	99.9	99.9	0.01
Line242	0.784	0.486	-0.783	-0.485	1.3	0.9	99.9	99.8	0.18
Line243	0.783	0.485	-0.782	-0.484	0.4	0.4	99.8	99.7	0.07
Line244	0.782	0.484	-0.780	-0.482	2.6	1.9	99.7	99.3	0.37
Line245	0.780	0.482	-0.778	-0.481	1.5	1.1	99.3	99.1	0.21
Line246	0.000	-0.001	0.000	0.001	0.0	-0.3	99.1	99.1	0.00
Line247	0.778	0.482	-0.777	-0.482	0.9	0.6	99.1	99.0	0.12
Line248	0.000	-0.001	0.000	0.000	0.0	-0.8	99.1	99.1	0.00
Cable153	0.767	0.475	-0.766	-0.475	0.0	0.0	83.6	83.6	0.00
Cable148	-1.594	-0.962	1.595	0.962	0.5	0.3	99.9	99.9	0.03
Line249	1.594	0.962	-1.576	-0.954	17.9	8.1	99.9	98.9	1.05

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Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:	Study Case: 2030 LFC	Revision:	Base
Filename: Thimphu ESD		Config.:	Normal

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Line250	1.544	0.934	-1.528	-0.927	15.8	7.2	98.9	97.9	0.95
Line251	1.528	0.927	-1.520	-0.923	8.7	3.5	97.9	97.4	0.51
Line252	-1.511	-0.919	1.520	0.923	8.5	3.9	96.9	97.4	0.51
Line253	0.083	0.051	-0.083	-0.051	0.0	0.0	96.9	96.9	0.00
Line254	1.428	0.868	-1.409	-0.859	19.0	8.6	96.9	95.7	1.21
Line255	1.330	0.810	-1.305	-0.799	24.6	11.1	95.7	94.0	1.66
Line256	0.308	0.190	-0.308	-0.190	0.2	0.0	94.0	94.0	0.06
Line257	0.997	0.609	-0.994	-0.607	3.4	1.5	94.0	93.7	0.30
Line258	0.077	0.048	-0.077	-0.048	0.0	0.0	94.0	94.0	0.00
Line260	0.231	0.143	-0.231	-0.143	0.2	0.0	94.0	93.9	0.09
Line259	0.917	0.559	-0.911	-0.557	6.0	2.6	93.7	93.1	0.58
Line261	0.154	0.095	-0.154	-0.095	0.1	-0.1	93.9	93.8	0.06
Line262	0.154	0.095	-0.154	-0.095	0.1	0.0	93.8	93.8	0.03
Line263	0.077	0.047	-0.077	-0.048	0.0	-0.1	93.8	93.8	0.02
Line264	0.077	0.048	-0.077	-0.048	0.0	-0.1	93.8	93.8	0.02
Line267	0.833	0.509	-0.826	-0.506	7.2	3.0	93.1	92.4	0.75
Line268	0.077	0.048	-0.077	-0.048	0.0	0.0	93.1	93.1	0.01
Line269	0.750	0.459	-0.747	-0.458	2.9	1.2	92.4	92.1	0.33
Line272	0.076	0.047	-0.076	-0.047	0.0	0.0	92.4	92.4	0.00
Line270	0.565	0.346	-0.564	-0.346	0.9	0.4	92.1	91.9	0.14
Line273	0.182	0.111	-0.182	-0.111	0.1	-0.1	92.1	92.0	0.07
Line271	0.564	0.346	-0.564	-0.346	0.4	0.2	91.9	91.9	0.07
Line277	0.441	0.270	-0.441	-0.270	0.2	0.1	91.9	91.8	0.04
Cable149	0.076	0.047	-0.076	-0.047	0.0	0.0	92.0	92.0	0.00
Line274	0.106	0.064	-0.105	-0.064	0.1	-0.3	92.0	91.9	0.07
Line275	0.030	0.018	-0.030	-0.018	0.0	0.0	91.9	91.9	0.00
Line276	0.030	0.018	-0.030	-0.019	0.0	-1.0	91.9	91.9	0.02
Line278	0.441	0.270	-0.441	-0.269	0.3	0.2	91.8	91.7	0.08
Line279	0.441	0.269	-0.440	-0.269	0.1	0.0	91.7	91.7	0.02
Line280	0.076	0.047	-0.076	-0.047	0.0	-0.2	91.7	91.7	0.04
Line281	0.150	0.091	-0.150	-0.091	0.1	-0.1	91.7	91.7	0.04
Line283	0.214	0.131	-0.213	-0.132	1.2	-0.2	91.7	91.2	0.49
Line307	-0.032	-0.019	0.032	0.018	0.0	-0.9	84.2	84.3	0.11
Line309	0.005	0.003	-0.005	-0.003	0.0	-0.1	84.2	84.2	0.00
Line310	0.027	0.016	-0.027	-0.016	0.0	-0.1	84.2	84.2	0.00
Line282	0.075	0.045	-0.075	-0.046	0.3	-1.4	91.7	91.3	0.35
Line284	0.075	0.047	-0.075	-0.047	0.0	0.0	91.2	91.2	0.01

Project:	ETAP	Page:	52
Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:	Study Case: 2030 LFC	Revision:	Base
Filename: Thimphu ESD		Config.:	Normal

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Line285	0.138	0.085	-0.138	-0.085	0.0	0.0	91.2	91.2	0.00
Cable208	0.258	0.160	-0.258	-0.160	0.0	0.0	88.9	88.9	0.01
Cable209	0.539	0.334	-0.539	-0.334	0.0	0.0	88.9	88.9	0.01
Cable210	0.937	0.581	-0.937	-0.581	0.0	0.0	88.9	88.9	0.00
Line286	0.138	0.085	-0.137	-0.085	0.3	-0.4	91.2	91.0	0.20
Line287	0.170	0.105	-0.170	-0.105	0.0	0.0	99.9	99.9	0.00
Cable154	0.226	0.140	-0.226	-0.140	0.0	0.0	83.6	83.6	0.00
Cable163	0.541	0.335	-0.540	-0.335	0.6	0.4	83.6	83.5	0.09
Cable155	0.226	0.140	-0.226	-0.140	0.0	0.0	83.6	83.6	0.00
Cable157	0.226	0.140	-0.226	-0.140	0.0	0.0	83.7	83.7	0.00
Line265	-1.988	-1.232	1.989	1.234	1.4	1.2	83.7	83.7	0.07
Cable158	0.228	0.141	-0.228	-0.141	0.0	0.0	83.7	83.7	0.01
Line266	-2.218	-1.375	2.220	1.377	2.0	1.7	83.7	83.8	0.08
Cable159	0.181	0.112	-0.181	-0.112	0.0	0.0	83.8	83.8	0.01
Cable160	-2.401	-1.489	2.403	1.491	2.5	1.7	83.8	83.9	0.09
Cable162	0.327	0.203	-0.327	-0.203	0.0	0.0	83.9	83.9	0.00
Line288	-2.730	-1.693	2.734	1.696	3.1	2.7	83.9	84.0	0.11
ConnecttoN580T2	-2.734	-1.696	2.734	1.697	0.9	0.6	84.0	84.0	0.03
Line311	0.019	0.011	-0.019	-0.011	0.0	0.0	84.2	84.2	0.00
Line289	0.540	0.335	-0.540	-0.334	0.6	0.5	83.5	83.4	0.11
Cable164	0.540	0.334	-0.540	-0.334	0.0	0.0	83.4	83.3	0.01
Cable167	0.498	0.309	-0.498	-0.308	0.2	0.1	89.2	89.2	0.04
Cable169	0.016	0.010	-0.016	-0.010	0.0	0.0	89.1	89.1	0.00
Cable170	0.248	0.154	-0.248	-0.154	0.0	0.0	89.1	89.1	0.00
Cable171	0.248	0.154	-0.248	-0.154	0.0	0.0	89.1	89.1	0.00
Cable173	1.042	0.646	-1.042	-0.645	0.9	0.6	89.1	89.0	0.08
Cable179	0.596	0.369	-0.596	-0.369	0.1	0.1	89.1	89.0	0.02
Cable175	0.744	0.461	-0.744	-0.461	0.0	0.0	89.0	89.0	0.00
Cable176	0.298	0.184	-0.297	-0.184	0.1	0.0	89.0	89.0	0.02
Line312	0.007	0.003	-0.007	-0.004	0.0	-0.1	84.2	84.2	0.00
Cable177	0.297	0.184	-0.297	-0.184	0.0	0.0	89.0	89.0	0.00
Line314	0.003	0.002	-0.003	-0.002	0.0	-0.5	84.2	84.2	0.00
Line315	-0.011	-0.007	0.011	0.006	0.0	-0.2	84.4	84.4	0.01
Cable180	-1.180	-0.731	1.181	0.732	1.1	0.4	89.1	89.2	0.08
Line290	0.599	0.371	-0.599	-0.371	0.5	0.3	89.1	89.1	0.08
Cable182	-0.151	-0.093	0.151	0.093	0.0	0.0	84.4	84.4	0.01
Cable313	0.482	0.299	-0.482	-0.299	0.0	0.0	89.0	89.0	0.00

Project:

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Location:

16.1.1C

Date: 11-12-2019

Contract:

SN: BHUTANPWR

Engineer:

Study Case: 2030 LFC

Revision: Base

Filename: Thimphu ESD

Config.: Normal

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Line302	-0.482	-0.299	0.482	0.299	0.2	0.1	89.0	89.1	0.04
Cable276	0.000	0.000	0.000	0.000			92.5	92.5	0.00
Cable190	-0.299	-0.185	0.299	0.185	0.1	0.0	89.3	89.3	0.02
Cable122	0.123	0.076	-0.123	-0.076	0.0	0.0	80.9	80.9	0.00
Cable184	0.496	0.308	-0.496	-0.308	0.0	0.0	83.5	83.5	0.00
Line82	-0.299	-0.185	0.299	0.185	0.0	0.0	81.5	81.6	0.01
Cable185	-0.168	-0.104	0.168	0.104	0.0	0.0	88.1	88.1	0.00
Cable187	0.034	0.021	-0.034	-0.021	0.0	0.0	88.1	88.1	0.00
Cable201	0.299	0.185	-0.299	-0.185	0.0	0.0	89.2	89.2	0.00
Cable202	0.249	0.154	-0.249	-0.154	0.0	0.0	89.2	89.2	0.01
Cable203	1.777	0.847	-1.773	-0.845	3.9	1.5	89.2	89.0	0.19
Cable204	0.434	0.269	-0.434	-0.269	0.0	0.0	89.0	89.0	0.00
N690F	-1.266	-1.039	1.267	1.039	0.4	0.3	89.0	89.1	0.03
Cable211	0.005	0.003	-0.005	-0.003	0.0	0.0	88.9	88.9	0.00
Cable213	0.323	0.200	-0.323	-0.200	0.1	0.1	88.9	88.8	0.03
Cable214	0.323	0.200	-0.323	-0.200	0.0	0.0	88.8	88.8	0.01
Cable215	-0.323	-0.200	0.323	0.200	0.0	0.0	88.8	88.8	0.00
Cable188	-0.168	-0.104	0.168	0.104	0.1	0.0	88.1	88.1	0.04
Cable189	0.168	0.104	-0.168	-0.104	0.0	0.0	88.1	88.1	0.00
Cable221	0.534	0.331	-0.534	-0.331	0.0	0.0	88.1	88.1	0.00
Cable223	-0.702	-0.435	0.702	0.435	0.3	0.2	88.1	88.1	0.04
Cable220	1.863	1.409	-1.863	-1.408	0.2	0.2	89.1	89.1	0.01
Line301	1.182	0.733	-1.181	-0.732	1.5	1.6	89.4	89.2	0.14
Cable314	0.241	0.149	-0.241	-0.149	0.0	0.0	89.0	89.0	0.00
Cable315	0.241	0.149	-0.241	-0.149	0.0	0.0	89.0	89.0	0.00
Cable224	-0.702	-0.435	0.702	0.435	0.0	0.0	88.1	88.1	0.00
Line333	2.188	1.704	-2.170	-1.689	17.5	15.2	90.1	89.4	0.76
connecttoN400T3	-1.041	-0.645	1.042	0.646	1.1	0.8	88.1	88.2	0.10
Cable235	-0.596	-0.370	0.596	0.370	0.0	0.0	89.1	89.1	0.00
c	0.373	0.231	-0.373	-0.231	0.1	0.0	89.1	89.1	0.01
Line343	-0.116	-0.072	0.116	0.072	0.0	0.0	89.4	89.4	0.01
Line346	2.054	1.617	-2.049	-1.613	4.8	4.2	89.4	89.2	0.22
Cable192	-0.117	-0.073	0.117	0.073	0.0	0.0	89.2	89.2	0.00
Line347	1.932	1.540	-1.929	-1.538	2.7	2.3	89.2	89.0	0.13
Cable251	-0.868	-0.538	0.868	0.538	0.0	0.0	89.0	89.0	0.00
Cable253	-0.297	-0.184	0.297	0.184	0.0	0.0	89.0	89.0	0.00
Cable250	-1.165	-0.722	1.166	0.723	0.9	0.6	89.0	89.0	0.07

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Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:	Study Case: 2030 LFC	Revision:	Base
Filename: Thimphu ESD		Config.:	Normal

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Cable193	0.113	0.070	-0.113	-0.070	0.0	0.0	89.0	89.0	0.00
Cable194	0.113	0.070	-0.113	-0.070	0.0	0.0	89.0	89.0	0.00
Cable195	0.117	0.072	-0.117	-0.072	0.0	0.0	89.0	89.0	0.00
Cable196	0.116	0.072	-0.116	-0.072	0.0	0.0	89.0	89.0	0.01
Cable197	1.469	1.253	-1.469	-1.252	1.0	0.7	89.0	89.0	0.05
Line349	1.469	1.252	-1.465	-1.249	3.1	2.6	89.0	88.8	0.19
Cable198	1.238	1.108	-1.237	-1.108	0.8	0.6	88.8	88.7	0.05
Line355	0.000	0.000	0.000	0.000	0.0	-0.1	88.8	88.8	0.00
Line350	1.237	1.108	-1.234	-1.105	3.4	2.9	88.7	88.5	0.24
Line351	0.114	0.071	-0.114	-0.071	0.0	0.0	88.5	88.5	0.01
Line352	1.119	1.034	-1.117	-1.032	2.9	2.4	88.5	88.3	0.22
Cable212	0.114	0.070	-0.114	-0.070	0.0	0.0	88.3	88.3	0.00
Line354	1.003	0.961	-1.002	-0.961	0.7	0.6	88.3	88.2	0.06
Cable199	1.002	0.961	-1.002	-0.961	0.1	0.0	88.2	88.2	0.01
Cable262	-0.163	-0.101	0.163	0.101	0.0	0.0	84.0	84.0	0.00
Line494	0.581	0.359	-0.580	-0.359	0.6	0.2	80.0	79.9	0.07
Line495	0.061	0.037	-0.060	-0.037	0.0	0.0	80.0	80.0	0.01
Line506	-0.641	-0.396	0.642	0.397	0.9	0.7	80.0	80.1	0.13
Cable288	-0.278	-0.172	0.278	0.172	0.1	0.1	84.4	84.4	0.04
Line319	0.031	0.019	-0.031	-0.019	0.0	-0.2	100.1	100.1	0.01
Line322	-0.402	-0.245	0.403	0.245	0.7	0.2	100.1	100.3	0.16
Line323	0.372	0.226	-0.371	-0.226	0.4	0.1	100.1	100.0	0.10
Cable271	0.116	0.072	-0.116	-0.072	0.0	0.0	100.3	100.3	0.00
Cable290	-0.070	-0.041	0.070	0.041	0.0	0.0	84.4	84.4	0.00
Line304	0.038	0.021	-0.038	-0.021	0.0	0.0	84.4	84.4	0.00
Line305	0.033	0.020	-0.033	-0.020	0.0	0.0	84.4	84.4	0.00
Line294	-0.070	-0.041	0.070	0.041	0.0	-0.1	84.4	84.4	0.03
Line297	-0.278	-0.172	0.278	0.172	0.0	0.0	84.4	84.4	0.01
notconnected	0.000	0.000	0.000	0.000	0.0	0.0	84.4	84.4	0.00
Line303	0.081	0.048	-0.081	-0.048	0.0	-0.1	84.4	84.4	0.02
Line298	-0.070	-0.041	0.070	0.041	0.0	0.0	84.4	84.4	0.01
Cable233	0.217	0.134	-0.217	-0.134	0.0	0.0	90.1	90.1	0.00
Cable234	0.430	0.266	-0.430	-0.266	0.0	0.0	90.1	90.1	0.00
Line368	0.213	0.132	-0.213	-0.132	0.0	0.0	90.1	90.1	0.00
Line369	0.217	0.134	-0.217	-0.134	0.0	0.0	90.1	90.1	0.02
Cable239	0.213	0.132	-0.213	-0.132	0.0	0.0	90.1	90.1	0.02
Cable291	0.033	0.020	-0.033	-0.020	0.0	0.0	84.4	84.4	0.00

Project:	ETAP	Page:	55
Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:		Revision:	Base
Filename:	Thimphu ESD	Config.:	Normal
	Study Case: 2030 LFC		

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Line306	0.038	0.021	-0.038	-0.022	0.0	-0.3	84.4	84.3	0.05
Line324	0.294	0.178	-0.293	-0.178	0.9	0.0	100.0	99.7	0.29
Cable240	0.217	0.134	-0.217	-0.134	0.0	0.0	90.1	90.1	0.02
Line326	0.256	0.155	-0.256	-0.156	0.7	-0.1	99.7	99.4	0.27
Cable244	0.145	0.090	-0.145	-0.090	0.0	0.0	90.2	90.1	0.00
Line331	0.023	0.014	-0.023	-0.014	0.0	0.0	99.4	99.4	0.00
Line332	0.233	0.141	-0.233	-0.141	0.1	0.0	99.4	99.4	0.04
Cable277	0.000	0.000	0.000	0.000			92.5	92.5	
Cable278	0.000	0.000	0.000	0.000			92.5	92.5	0.00
Cable245	0.000	0.000	0.000	0.000	0.0	0.0	90.1	90.1	0.00
Cable255	0.145	0.090	-0.145	-0.090	0.0	0.0	90.1	90.1	0.00
Line372	0.000	0.000	0.000	0.000	0.0	-0.1	90.1	90.1	0.00
Cable280	0.000	0.000	0.000	0.000			92.5	92.5	
Line335	0.052	0.029	-0.052	-0.029	0.0	-0.1	99.4	99.4	0.01
Line340	0.181	0.112	-0.181	-0.112	0.0	0.0	99.4	99.4	0.02
Line336	0.015	0.009	-0.015	-0.009	0.0	-0.3	99.4	99.4	0.01
Line341	0.037	0.021	-0.037	-0.021	0.0	-0.2	99.4	99.4	0.02
Line338	0.009	0.006	-0.009	-0.006	0.0	0.0	99.4	99.4	0.00
Line339	0.006	0.003	-0.006	-0.004	0.0	-0.5	99.4	99.4	0.01
Line342	0.031	0.017	-0.031	-0.018	0.0	-0.4	99.4	99.3	0.03
Line344	0.015	0.008	-0.015	-0.008	0.0	-0.3	99.3	99.3	0.01
Line345	0.006	0.003	-0.006	-0.004	0.0	-0.9	99.3	99.3	0.01
Cable317	0.075	0.047	-0.075	-0.047	0.0	0.0	92.5	92.5	0.00
Cable318	0.075	0.047	-0.075	-0.047	0.0	0.0	92.5	92.5	0.00
Cable278- RICB SS	3.167	2.514	-3.162	-2.512	4.9	2.3	94.2	94.1	0.12
Cable389	1.566	0.955	-1.566	-0.955	0.0	0.0	96.8	96.8	0.00
Line436	-1.566	-0.955	1.568	0.952	2.0	-3.2	96.8	97.0	0.14
FromN890	2.950	1.675	-2.949	-1.674	1.0	0.7	95.4	95.4	0.03
Cable53	-1.405	-0.857	1.405	0.857	0.0	0.0	96.8	96.8	0.00
Line437	1.405	0.857	-1.403	-0.859	1.2	-2.7	96.8	96.7	0.09
Cable161	1.403	0.859	-1.403	-0.859	0.1	0.0	96.7	96.7	0.01
Line438	1.403	0.859	-1.403	-0.860	0.4	-0.9	96.7	96.7	0.03
Cable165	1.403	0.860	-1.403	-0.860	0.1	0.0	96.7	96.7	0.00
Line439	1.403	0.860	-1.403	-0.861	0.2	-0.5	96.7	96.7	0.02
Line440	1.320	0.810	-1.319	-0.813	1.2	-3.2	96.7	96.6	0.10
Line485	0.082	0.051	-0.082	-0.051	0.0	-0.2	96.7	96.7	0.00
Cable216	0.772	0.476	-0.772	-0.476	0.0	0.0	96.6	96.6	0.00

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Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:	Study Case: 2030 LFC	Revision:	Base
Filename: Thimphu ESD		Config.:	Normal

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Line441	0.547	0.337	-0.547	-0.337	0.0	-0.1	96.6	96.6	0.00
Cable178	0.161	0.098	-0.161	-0.098	0.0	0.0	96.6	96.6	0.00
Line483	0.161	0.098	-0.161	-0.100	0.0	-2.1	96.6	96.6	0.01
Line486	-0.772	-0.478	0.772	0.476	0.2	-2.0	96.5	96.6	0.03
Line412	0.000	0.000	0.000	0.000	0.0	-0.3	90.1	90.1	0.00
Cable285	0.343	0.212	-0.343	-0.212	0.0	0.0	90.1	90.0	0.01
Line413	-0.343	-0.212	0.343	0.212	0.4	0.1	90.1	90.2	0.10
Line414	0.246	0.152	-0.246	-0.152	0.1	0.0	90.2	90.1	0.02
Line415	-0.589	-0.364	0.589	0.365	0.4	0.3	90.2	90.2	0.07
Line416	-1.995	-1.236	2.002	1.239	7.6	3.1	90.2	90.5	0.31
Line417	1.405	0.871	-1.403	-0.869	2.3	2.0	90.2	90.1	0.17
Cable286	-2.002	-1.239	2.002	1.239	0.2	0.1	90.5	90.5	0.01
Cable289	0.746	0.462	-0.746	-0.462	0.0	0.0	90.5	90.5	0.00
Line488	-0.162	-0.099	0.162	0.099	0.0	-0.2	96.8	96.8	0.00
Line490	0.162	0.099	-0.161	-0.100	0.0	-1.3	96.8	96.8	0.01
Cable295	0.913	0.566	-0.913	-0.566	0.0	0.0	90.1	90.1	0.00
Line418	0.490	0.304	-0.490	-0.304	0.4	0.1	90.1	90.0	0.07
Cable294	0.490	0.304	-0.490	-0.304	0.0	0.0	90.0	90.0	0.00
Cable296	0.913	0.566	-0.913	-0.566	0.0	0.0	90.1	90.1	0.00
Cable297	0.271	0.168	-0.270	-0.168	0.1	0.0	90.1	90.0	0.02
Line493	0.000	0.000	0.000	0.000	0.0	-0.1	80.0	80.0	0.00
Line364	0.456	0.279	-0.456	-0.279	0.3	0.1	100.2	100.1	0.07
Line365	-0.520	-0.318	0.520	0.319	0.4	0.1	100.2	100.3	0.07
Line367	0.011	0.006	-0.011	-0.007	0.0	-0.2	100.1	100.1	0.00
Line373	0.445	0.272	-0.444	-0.272	1.0	0.3	100.1	99.9	0.20
Line366	0.005	0.003	-0.005	-0.003	0.0	0.0	100.1	100.1	0.00
Line370	0.005	0.003	-0.005	-0.003	0.0	-0.1	100.1	100.1	0.00
Line371	0.003	0.001	-0.003	-0.002	0.0	-0.4	99.9	99.9	0.00
Line382	0.442	0.271	-0.440	-0.270	1.5	0.4	99.9	99.6	0.31
Line383	0.389	0.239	-0.389	-0.239	0.1	0.0	99.6	99.6	0.02
Line384	0.339	0.208	-0.338	-0.208	0.7	0.1	99.6	99.4	0.21
Line385	0.319	0.196	-0.319	-0.196	0.3	0.0	99.4	99.3	0.10
Line386	0.315	0.194	-0.315	-0.194	0.2	0.0	99.3	99.3	0.05
Line388	0.290	0.178	-0.290	-0.178	0.2	0.0	99.3	99.2	0.07
Line390	0.265	0.163	-0.265	-0.163	0.0	0.0	99.2	99.2	0.02
Line397	0.025	0.015	-0.025	-0.015	0.0	-0.3	99.2	99.2	0.02
Cable414-DPH 1(NPPF)	3.300	2.045	-3.295	-2.042	4.1	2.9	89.2	89.1	0.12

Project:	ETAP	Page:	57
Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:	Study Case: 2030 LFC	Revision:	Base
Filename: Thimphu ESD		Config.:	Normal

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Cable379	2.771	1.718	-2.766	-1.714	4.9	3.5	91.4	91.3	0.17
33/11kV DPH1 Xmer2	-2.366	-1.466	2.381	1.598	15.5	131.6	91.4	94.2	2.77
Line391	0.032	0.020	-0.032	-0.020	0.0	0.0	99.2	99.2	0.00
Line392	0.170	0.105	-0.170	-0.105	0.3	-0.2	99.2	99.0	0.15
Line393	0.107	0.066	-0.107	-0.066	0.0	0.0	99.0	99.0	0.01
Cable226	0.580	0.359	-0.580	-0.359	0.0	0.0	79.9	79.9	0.00
Line394	0.082	0.051	-0.082	-0.051	0.0	0.0	99.0	99.0	0.00
Line395	0.032	0.019	-0.032	-0.020	0.0	-0.1	99.0	99.0	0.01
Line396	0.050	0.031	-0.050	-0.031	0.0	-0.1	99.0	99.0	0.01
Cable425	-1.212	-0.907	1.213	0.908	1.3	0.5	94.1	94.2	0.08
Cable426	0.278	0.172	-0.278	-0.172	0.0	0.0	94.1	94.1	0.00
Cable427	0.934	0.735	-0.932	-0.734	1.5	0.6	94.1	94.0	0.12
Cable321	1.181	0.732	-1.181	-0.732	0.0	0.0	89.1	89.1	0.00
Cable326	0.969	0.601	-0.969	-0.600	0.5	0.4	89.1	89.1	0.05
Cable322	0.843	0.523	-0.843	-0.523	0.0	0.0	89.1	89.1	0.00
Cable323	0.337	0.209	-0.337	-0.209	0.0	0.0	89.1	89.1	0.00
Cable324	-1.181	-0.732	1.181	0.732	0.0	0.0	89.1	89.1	0.00
Cable327	0.291	0.180	-0.291	-0.180	0.0	0.0	89.1	89.1	0.00
Cable328	0.497	0.308	-0.497	-0.308	0.2	0.1	89.1	89.0	0.04
Cable329	0.181	0.112	-0.181	-0.112	0.0	0.0	89.1	89.1	0.01
Cable330	0.170	0.105	-0.170	-0.105	0.0	0.0	89.0	89.0	0.00
Cable331	0.241	0.150	-0.241	-0.150	0.0	0.0	89.0	89.0	0.00
Cable332	0.085	0.053	-0.085	-0.053	0.0	0.0	89.0	89.0	0.00
Line398	0.025	0.015	-0.025	-0.015	0.0	0.0	99.2	99.2	0.00
Line401	0.000	0.000	0.000	0.000	0.0	-0.4	99.2	99.2	0.00
Biemina SS	0.000	0.000	0.000	0.000	0.0	0.0	99.2	99.2	0.00
Cable227	0.193	0.120	-0.193	-0.120	0.0	0.0	79.9	79.9	0.00
Line497	0.387	0.239	-0.386	-0.239	0.2	0.1	79.9	79.9	0.03
Line496	0.088	0.054	-0.088	-0.054	0.0	0.0	79.9	79.9	0.01
Line503	0.299	0.185	-0.299	-0.185	0.0	0.0	79.9	79.9	0.00
Line374	0.579	0.358	-0.577	-0.357	1.7	1.1	95.3	95.0	0.31
Line376	2.633	1.793	-2.609	-1.772	24.2	21.0	95.3	94.3	0.96
Cable404	0.577	0.357	-0.577	-0.357	0.0	0.0	95.0	95.0	0.00
Cable405	0.282	0.175	-0.282	-0.175	0.0	0.0	95.0	95.0	0.00
Cable414	0.282	0.175	-0.282	-0.175	0.0	0.0	95.0	95.0	0.00
Cable416	0.013	0.008	-0.013	-0.008	0.0	0.0	95.0	95.0	0.00
Line375	0.013	0.008	-0.013	-0.008	0.0	-0.5	95.0	95.0	0.02

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Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:	Study Case: 2030 LFC	Revision:	Base
Filename: Thimphu ESD		Config.:	Normal

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Cable349	0.193	0.119	-0.193	-0.119	0.0	0.0	89.4	89.4	0.00
Cable350	0.219	0.136	-0.219	-0.136	0.0	0.0	89.4	89.4	0.01
Cable422	2.609	1.772	-2.604	-1.769	4.6	2.7	94.3	94.2	0.16
Cable423	0.696	0.431	-0.696	-0.431	0.0	0.0	94.2	94.2	0.00
Cable424	0.695	0.431	-0.695	-0.430	0.8	0.3	94.2	94.1	0.10
Cable428	0.139	0.086	-0.139	-0.086	0.0	0.0	94.0	94.0	0.00
N90-DPH 1(NPPF)9	0.794	0.648	-0.794	-0.648	0.1	0.1	94.0	94.0	0.01
Line502	0.073	0.045	-0.073	-0.045	0.0	-0.1	79.9	79.8	0.02
Line500	-0.036	-0.023	0.036	0.023	0.0	-0.1	79.8	79.8	0.01
Line504	0.299	0.185	-0.298	-0.185	0.8	0.2	79.9	79.7	0.20
Line505	0.033	0.021	-0.033	-0.021	0.0	0.0	79.7	79.7	0.01
Cable365	-0.129	-0.080	0.129	0.080	0.0	0.0	91.4	91.4	0.00
Cable367	-1.545	-0.958	1.549	0.960	3.3	2.3	91.2	91.4	0.20
Cable368	0.773	0.479	-0.773	-0.479	0.0	0.0	91.2	91.2	0.00
Line507	-0.642	-0.397	0.642	0.397	0.3	0.1	80.1	80.1	0.03
Line517	-1.225	-0.758	1.226	0.759	1.3	1.1	80.1	80.2	0.10
Line510	-1.226	-0.759	1.229	0.760	2.7	1.1	80.2	80.4	0.16
cable	0.137	0.085	-0.137	-0.085	0.0	0.0	80.6	80.6	0.00
Line562	1.231	0.762	-1.229	-0.760	2.3	2.0	80.6	80.4	0.17
Line575	-1.368	-0.847	1.383	0.860	14.9	12.8	80.6	81.6	0.98
Line577	-1.682	-1.045	1.694	1.056	12.3	10.6	81.6	82.2	0.66
Line576	-1.694	-1.056	1.696	1.057	1.8	1.6	82.2	82.3	0.10
Cable380	0.103	0.064	-0.103	-0.064	0.0	0.0	91.3	91.3	0.00
Cable381	2.663	1.650	-2.658	-1.647	5.6	4.0	91.3	91.1	0.20
Cable382	0.600	0.372	-0.599	-0.372	0.3	0.2	91.1	91.0	0.04
Cable384	1.757	1.088	-1.756	-1.087	1.2	0.9	91.1	91.0	0.07
Cable388	0.075	0.047	-0.075	-0.047	0.0	0.0	91.0	91.0	0.00
Line318	1.681	1.041	-1.677	-1.039	3.5	1.4	91.0	90.8	0.17
Cable385	1.677	1.039	-1.677	-1.039	0.1	0.0	90.8	90.8	0.00
Cable387	0.932	0.577	-0.932	-0.577	0.2	0.1	90.8	90.8	0.02
Line578	0.151	0.094	-0.151	-0.094	0.0	0.0	82.3	82.3	0.01
Line581	-1.847	-1.151	1.854	1.157	7.0	6.0	82.3	82.7	0.35
Line588	-2.006	-1.252	2.023	1.266	16.3	14.1	82.7	83.4	0.75
Line589	0.616	0.381	-0.611	-0.379	4.3	1.8	83.4	82.9	0.54
Line591	-2.638	-1.646	2.666	1.671	27.8	24.2	83.4	84.4	0.98
Line590	0.306	0.189	-0.306	-0.189	0.0	0.0	82.9	82.9	0.00
Line320	-0.592	-0.367	0.595	0.368	2.6	0.9	87.9	88.2	0.35

Project:	ETAP	Page:	59
Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:	Study Case: 2030 LFC	Revision:	Base
Filename: Thimphu ESD		Config.:	Normal

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Line321	0.162	0.100	-0.161	-0.100	0.2	-0.1	87.9	87.8	0.09
Line411	-0.327	-0.203	0.327	0.203	0.1	0.0	88.5	88.5	0.03
Cable394	-2.949	-1.829	2.979	1.855	29.8	26.0	88.5	89.5	1.00
Cable396	0.327	0.203	-0.327	-0.203	0.0	0.0	88.5	88.5	0.00
Cable397	2.132	1.322	-2.125	-1.316	6.6	5.8	88.5	88.2	0.31
Cable395	0.595	0.368	-0.595	-0.368	0.2	0.1	88.2	88.2	0.02
Cable398	1.530	0.948	-1.530	-0.948	0.0	0.0	88.2	88.2	0.00
Line592	-2.823	-1.768	2.868	1.807	44.8	39.0	84.4	85.9	1.49
Line593	0.067	0.042	-0.067	-0.042	0.0	-0.1	85.9	85.9	0.01
Line595	0.322	0.200	-0.322	-0.199	0.2	0.1	85.9	85.8	0.07
Line597	-3.579	-2.248	3.640	2.300	60.5	52.8	85.9	87.5	1.61
Line609	0.322	0.200	-0.322	-0.200	0.1	0.0	85.9	85.8	0.03
Line594	0.322	0.199	-0.322	-0.199	0.1	0.0	85.8	85.8	0.02
Cable228	0.322	0.199	-0.322	-0.199	0.0	0.0	85.8	85.8	0.01
Line596	0.322	0.199	-0.322	-0.199	0.0	0.0	85.8	85.8	0.01
Line598	-3.675	-2.322	3.730	2.370	55.4	48.4	87.5	89.0	1.47
Cable229	-3.730	-2.370	3.731	2.371	1.1	0.7	89.0	89.0	0.03
Cable399	-0.282	-0.175	0.282	0.175	0.0	0.0	91.4	91.4	0.00
Line325	0.282	0.175	-0.282	-0.175	0.1	0.0	91.4	91.4	0.03
Line327	0.282	0.175	-0.282	-0.175	0.2	0.0	91.4	91.3	0.06
Cable406	0.282	0.175	-0.282	-0.175	0.1	0.0	91.3	91.3	0.02
Cable407	0.282	0.175	-0.282	-0.175	0.0	0.0	91.3	91.3	0.00
Cable408	0.000	0.000	0.000	0.000			91.3	91.3	
Cable409	0.000	0.000	0.000	0.000			91.3	91.3	
Cable410	-0.904	-0.560	0.904	0.561	0.5	0.3	88.8	88.8	0.05
Cable411	0.311	0.193	-0.311	-0.193	0.1	0.1	88.8	88.8	0.03
Cable412	-2.564	-1.590	2.570	1.592	5.6	2.1	88.8	89.0	0.17
Cable415	1.349	0.837	-1.349	-0.837	0.0	0.0	88.8	88.8	0.00
Cable413	-2.570	-1.592	2.572	1.594	1.7	1.2	89.0	89.1	0.06
Line328	1.349	0.837	-1.345	-0.834	3.9	3.3	88.8	88.6	0.28
Line329	0.807	0.500	-0.806	-0.500	0.9	0.3	88.6	88.5	0.09
Line599	-3.731	-2.371	3.734	2.374	3.1	2.7	89.0	89.1	0.08
Line330	-0.804	-0.498	0.806	0.500	2.2	1.8	88.2	88.5	0.27
Line600	0.000	0.000	0.000	0.000	0.0	0.0	89.1	89.1	0.00
Line601	-3.734	-2.374	3.748	2.386	13.8	12.1	89.1	89.4	0.37
Cable230	0.400	0.248	-0.400	-0.248	0.0	0.0	89.4	89.4	0.01
Line603	-4.148	-2.633	4.186	2.667	38.4	33.6	89.4	90.3	0.92

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Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:		Revision:	Base
Filename:	Thimphu ESD	Config.:	Normal
	Study Case: 2030 LFC		

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Line523	-5.039	-3.189	5.168	3.302	129.2	112.9	91.1	93.7	2.59
Line602	4.225	2.685	-4.186	-2.667	38.4	18.0	91.1	90.3	0.77
Line605	0.403	0.250	-0.403	-0.249	0.2	0.1	91.1	91.1	0.05
Line604	0.403	0.249	-0.403	-0.249	0.6	0.2	91.1	90.9	0.14
Line606	0.351	0.218	-0.351	-0.218	0.1	0.0	90.9	90.9	0.03
Line607	0.051	0.031	-0.051	-0.032	0.0	-0.1	90.9	90.9	0.01
Cable372	-11.170	-6.096	11.171	6.096	0.9	0.6	100.2	100.2	0.01
Line491	11.170	6.096	-11.065	-5.986	105.4	109.9	100.2	99.0	1.17
Cable472	0.074	0.046	-0.074	-0.046	0.0	0.0	95.9	95.9	0.01
Line387	1.856	1.148	-1.850	-1.146	6.6	2.7	95.9	95.6	0.31
Cable468	1.850	1.146	-1.850	-1.146	0.1	0.0	95.6	95.6	0.00
Cable469	0.742	0.460	-0.742	-0.460	0.0	0.0	95.6	95.6	0.00
Cable470	0.593	0.367	-0.593	-0.367	0.0	0.0	95.6	95.6	0.00
Cable471	0.514	0.319	-0.514	-0.319	0.3	0.2	95.6	95.6	0.06
Cable473	0.591	0.366	-0.591	-0.366	0.0	0.0	95.3	95.3	0.00
Line389	-0.591	-0.366	0.593	0.367	2.2	0.7	95.3	95.6	0.32
Cable231	0.051	0.032	-0.051	-0.032	0.0	0.0	90.9	90.9	0.00
Line608	0.051	0.032	-0.051	-0.032	0.0	-0.2	90.9	90.9	0.03
Cable232	-0.322	-0.200	0.322	0.200	0.0	0.0	85.8	85.8	0.00
Line610	0.000	0.000	0.000	0.000	0.0	-0.1	85.8	85.8	0.00
Line492	11.065	5.986	-10.985	-5.902	80.1	83.7	99.0	98.1	0.89
Line498	10.160	5.392	-10.084	-5.313	76.1	78.7	98.1	97.2	0.91
Line499	0.825	0.510	-0.825	-0.511	0.1	-1.0	98.1	98.1	0.02
Cable373	0.825	0.511	-0.825	-0.511	0.0	0.0	98.1	98.1	0.00
Line501	0.825	0.511	-0.825	-0.511	0.0	0.0	98.1	98.1	0.00
33kV from Bjemina	10.084	5.313	-10.083	-5.313	0.9	0.6	97.2	97.2	0.01
Line400	0.113	0.070	-0.113	-0.070	0.2	-0.5	96.0	95.8	0.16
Cable529	0.113	0.070	-0.113	-0.070	0.0	0.0	95.8	95.8	0.00
Line406	0.750	0.464	-0.749	-0.464	0.6	0.2	95.7	95.6	0.07
Line407	-0.856	-0.530	0.859	0.530	2.6	1.0	95.7	95.9	0.27
Line408	0.106	0.065	-0.106	-0.065	0.0	-0.1	95.7	95.6	0.02
Line409	0.472	0.292	-0.472	-0.292	0.3	0.2	95.6	95.5	0.07
Line419	0.361	0.224	-0.361	-0.224	0.5	0.1	95.5	95.4	0.11
Cable565	0.361	0.224	-0.361	-0.224	0.0	0.0	95.4	95.4	0.00
Line420	0.000	0.000	0.000	0.000	0.0	-0.1	95.4	95.4	0.00
Line421	0.106	0.065	-0.106	-0.065	0.0	-0.1	95.6	95.6	0.02
Line422	0.047	0.029	-0.047	-0.029	0.0	-0.2	95.6	95.6	0.01

Project:	ETAP	Page:	61
Location:	16.1.1C	Date:	11-12-2019
Contract:		SN:	BHUTANPWR
Engineer:		Revision:	Base
Filename:	Thimphu ESD	Config.:	Normal
	Study Case: 2030 LFC		

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Line423	0.060	0.037	-0.060	-0.037	0.0	0.0	95.6	95.6	0.00
Line425	0.000	0.000	0.000	0.000	0.0	-0.1	95.6	95.6	0.00
Line424	0.000	0.000	0.000	0.000	0.0	0.0	95.6	95.6	0.00
Line434	-0.070	-0.043	0.070	0.043	0.0	0.0	92.2	92.2	0.00
Line549	-1.568	-0.952	1.572	0.946	3.6	-5.8	97.0	97.2	0.25
Line453	0.000	0.000	0.000	0.000	0.0	0.0	93.8	93.8	0.00
Line455	-0.211	-0.131	0.212	0.131	0.1	-0.1	93.8	93.9	0.05
Line454	-0.212	-0.131	0.212	0.131	0.1	0.0	93.9	93.9	0.04
Cable545	0.212	0.131	-0.212	-0.131	0.0	0.0	93.9	93.9	0.00
Cable546	-0.212	-0.131	0.212	0.131	0.0	0.0	93.9	93.9	0.00
Cable555	0.142	-0.068	-0.142	0.068	0.0	0.0	93.9	93.9	0.00
Line457	-0.666	-0.256	0.666	0.256	0.7	0.3	93.9	94.0	0.11
Line458	-0.805	-0.342	0.807	0.343	1.7	1.3	94.0	94.3	0.23
Line459	0.139	0.086	-0.139	-0.086	0.0	-0.1	94.3	94.3	0.02
Line460	-0.946	-0.430	0.950	0.431	3.3	1.4	94.3	94.6	0.33
Cable547	0.876	0.543	-0.876	-0.543	0.1	0.1	94.6	94.6	0.01
Line461	-1.825	-0.974	1.827	0.976	2.1	1.8	94.6	94.7	0.13
Cable548	0.560	0.347	-0.560	-0.347	0.2	0.1	94.6	94.6	0.03
Cable550	0.088	0.054	-0.088	-0.054	0.0	0.0	94.7	94.7	0.00
Line462	-1.915	-1.030	1.918	1.033	2.8	2.4	94.7	94.9	0.16
Line463	1.018	0.631	-1.015	-0.629	2.8	2.2	94.9	94.6	0.29
Line465	-2.936	-1.663	2.949	1.675	12.8	11.1	94.9	95.4	0.47
Line464	1.015	0.629	-1.013	-0.628	2.2	0.9	94.6	94.4	0.19
Line431	3.631	2.233	-3.540	-2.195	91.1	37.9	94.9	92.8	2.17
Cable552	0.367	0.227	-0.367	-0.227	0.0	0.0	94.4	94.4	0.00
Cable553	0.646	0.400	-0.646	-0.400	0.0	0.0	94.4	94.4	0.00
Cable554	0.279	0.173	-0.279	-0.173	0.0	0.0	94.4	94.4	0.01
Cable587	3.540	2.195	-3.540	-2.195	0.1	0.1	92.8	92.8	0.00
Cable557	0.312	0.193	-0.312	-0.193	0.0	0.0	93.9	93.9	0.00
Cable558	-0.170	-0.262	0.170	0.262	0.0	0.0	93.9	93.9	0.02
Cable559	0.312	0.193	-0.312	-0.193	0.0	0.0	93.9	93.9	0.00
Cable561	-0.482	-0.455	0.482	0.455	0.0	0.0	93.9	94.0	0.01
Cable562	-0.312	-0.193	0.312	0.193	0.0	0.0	94.0	94.0	0.00
Cable564	0.000	0.000	0.000	0.000	0.0	0.0	95.4	95.4	0.00
Line467	0.000	0.000	0.000	0.000	0.0	0.0	95.4	95.4	0.00
Line466	0.000	0.000	0.000	0.000	0.0	0.0	95.4	95.4	0.00
Cable589	1.480	0.915	-1.480	-0.915	0.0	0.0	92.8	92.8	0.00

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Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Cable591	2.060	1.280	-2.060	-1.280	0.0	0.0	92.8	92.8	0.00
Cable588	0.245	0.152	-0.245	-0.152	0.0	0.0	92.8	92.8	0.00
Line447	0.989	0.612	-0.984	-0.609	5.3	2.0	92.8	92.3	0.45
Line450	0.245	0.152	-0.245	-0.152	0.1	0.0	92.8	92.7	0.02
Line433	2.060	1.280	-2.049	-1.270	11.6	10.0	92.8	92.2	0.58
Line451	1.979	1.226	-1.973	-1.221	5.9	5.1	92.2	91.9	0.31
N350T/phu feeder	5.171	3.304	-5.168	-3.302	2.4	2.1	93.8	93.7	0.05
33/11kV DPH2 Xmer3	-3.708	-1.652	3.746	1.883	38.5	231.1	93.8	96.8	3.09
Line560	-0.799	-0.460	0.799	0.460	0.0	0.0	97.2	97.2	0.00
Line561	0.799	0.460	-0.799	-0.461	0.5	-1.9	97.2	97.2	0.05
33/11kV Taba2	-2.469	0.000	2.484	0.092	15.4	92.3	90.2	90.9	0.62
Line563	-0.799	-0.462	0.799	0.461	0.0	-0.1	97.2	97.2	0.00
Line565	0.734	0.421	-0.733	-0.425	0.7	-3.7	97.2	97.1	0.09
Line564	0.733	0.425	-0.733	-0.425	0.0	-0.2	97.1	97.1	0.00
Line567	0.720	0.417	-0.720	-0.418	0.3	-1.4	97.1	97.0	0.03
Line566	0.679	0.393	-0.679	-0.393	0.1	-0.4	97.0	97.0	0.01
Line568	0.013	0.008	-0.013	-0.008	0.0	-0.3	97.0	97.0	0.00
Line570	0.054	0.030	-0.054	-0.031	0.0	-1.3	97.0	97.0	0.00
Line572	0.612	0.356	-0.611	-0.360	0.6	-4.7	97.0	96.9	0.09
Line569	0.041	0.023	-0.041	-0.025	0.0	-2.0	97.0	97.0	0.00
Line571	0.611	0.360	-0.611	-0.361	0.1	-0.8	96.9	96.9	0.02
Cable671	-0.421	-0.261	0.421	0.261	0.4	0.2	92.2	92.3	0.08
Cable672	-0.984	-0.609	0.984	0.609	0.0	0.0	92.3	92.3	0.00
Cable673	-0.245	-0.152	0.245	0.152	0.0	0.0	92.7	92.7	0.01
Line449	-0.245	-0.152	0.245	0.152	0.1	0.0	92.7	92.7	0.05
Not connected	0.000	0.000	0.000	0.000	0.0	-0.2	92.7	92.7	0.00
Line452	0.312	0.193	-0.312	-0.193	0.2	0.0	91.9	91.8	0.05
Line472	0.000	0.000	0.000	0.000	0.0	-0.1	91.9	91.9	0.00
Line473	1.660	1.028	-1.660	-1.028	0.2	0.2	91.9	91.9	0.01
Cable674	-0.104	-0.065	0.104	0.065	0.0	0.0	91.8	91.8	0.00
Line468	0.208	0.129	-0.208	-0.129	0.1	0.0	91.8	91.8	0.04
Line469	0.087	0.054	-0.087	-0.054	0.0	-0.1	91.8	91.8	0.01
Line470	0.087	0.054	-0.087	-0.054	0.0	0.0	91.8	91.8	0.01
Line471	0.087	0.054	-0.087	-0.054	0.0	-0.1	91.8	91.7	0.01
Line474	0.177	0.109	-0.177	-0.109	0.1	-0.1	91.9	91.8	0.03
Line476	1.394	0.863	-1.391	-0.861	3.1	2.6	91.9	91.6	0.23
Line475	0.177	0.109	-0.177	-0.109	0.0	0.0	91.8	91.8	0.01

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Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
Cable676	-0.177	-0.109	0.177	0.109	0.0	0.0	91.8	91.8	0.01
Line478	0.862	0.534	-0.862	-0.533	0.7	0.5	91.6	91.6	0.08
Line512	0.529	0.327	-0.528	-0.327	0.9	0.6	91.6	91.5	0.18
Line479	0.758	0.469	-0.756	-0.468	2.1	0.9	91.6	91.3	0.24
Line480	0.055	0.034	-0.055	-0.034	0.0	-0.1	91.3	91.3	0.01
Line481	0.700	0.434	-0.700	-0.433	0.7	0.5	91.3	91.2	0.10
Line482	0.700	0.433	-0.699	-0.433	0.5	0.2	91.2	91.2	0.06
Cable393	0.129	0.080	-0.129	-0.080	0.0	0.0	96.9	96.9	0.00
Line573	0.482	0.281	-0.481	-0.285	0.3	-3.6	96.9	96.9	0.06
Line574	0.404	0.243	-0.404	-0.243	0.0	-0.6	96.9	96.9	0.00
Line579	0.078	0.042	-0.078	-0.045	0.0	-2.8	96.9	96.9	0.01
Line583	0.388	0.233	-0.388	-0.235	0.0	-1.8	96.9	96.8	0.01
Line580	0.029	0.018	-0.029	-0.018	0.0	-0.1	96.9	96.9	0.00
Line582	0.048	0.027	-0.048	-0.029	0.0	-2.1	96.9	96.8	0.00
toChumduSwitchingSS	0.000	-0.001	0.000	0.000	0.0	-1.1	96.8	96.8	0.00
Line584	0.013	0.006	-0.013	-0.008	0.0	-2.1	96.8	96.8	0.00
Line586	0.103	0.063	-0.103	-0.064	0.0	-1.0	96.8	96.8	0.00
Line587	0.258	0.158	-0.258	-0.160	0.0	-1.9	96.8	96.8	0.01
Line585	0.103	0.064	-0.103	-0.064	0.0	-0.1	96.8	96.8	0.00
Cable632	-0.782	-0.485	0.783	0.485	0.2	0.1	90.0	90.1	0.02
Cable650	-0.886	-0.549	0.886	0.549	0.0	0.0	90.0	90.0	0.00
Cable651	-0.886	-0.549	0.886	0.549	0.0	0.0	90.0	90.0	0.00
Line487	0.699	0.433	-0.699	-0.433	0.2	0.1	91.2	91.1	0.03
Cable678	0.206	0.127	-0.206	-0.127	0.0	0.0	91.1	91.1	0.00
Cable679	0.493	0.305	-0.493	-0.305	0.1	0.1	91.1	91.1	0.02
Line508	0.493	0.305	-0.493	-0.305	0.4	0.3	91.1	91.0	0.09
Line509	0.086	0.053	-0.086	-0.053	0.1	-0.2	91.0	91.0	0.05
Line511	0.407	0.252	-0.406	-0.252	0.6	0.3	91.0	90.9	0.15
Cable680	0.406	0.252	-0.406	-0.252	0.0	0.0	90.9	90.9	0.00
Cable681	0.203	0.126	-0.203	-0.126	0.0	0.0	90.9	90.9	0.00
Line513	0.174	0.108	-0.174	-0.108	0.0	0.0	91.5	91.5	0.01
Line514	0.354	0.219	-0.354	-0.219	0.6	0.1	91.5	91.3	0.14
Cable682	0.341	0.211	-0.341	-0.211	0.1	0.1	91.3	91.3	0.03
Line515	0.013	0.008	-0.013	-0.008	0.0	-0.3	91.3	91.3	0.01
Line516	0.013	0.008	-0.013	-0.008	0.0	-0.2	91.3	91.3	0.00
66/11kV SemtokhaXmer2	-10.949	-6.815	11.002	7.508	53.3	693.1	99.9	100.0	0.05
66/33kV C/Gedaphu Xmer1	14.171	11.401	-14.089	-9.749	82.6	1652.0	100.0	94.2	5.80

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
66/33kV C/Gedaphu Xmer2	14.171	11.401	-14.089	-9.749	82.6	1652.0	100.0	94.2	5.80
66kV line from Semtokha	-23.712	-15.355	24.636	16.063	924.4	708.2	95.8	100.0	4.22
Line524	-7.492	-3.767	7.517	3.786	25.1	19.0	96.8	97.2	0.37
33/11kV DPH2 Xmer4	3.746	1.883	-3.708	-1.652	38.5	231.1	96.8	93.8	3.09
33/11kV Taba	-2.469	0.000	2.484	0.092	15.4	92.3	90.2	90.9	0.62
33/11kV DPH1 Xmer1	2.381	1.598	-2.366	-1.466	15.5	131.6	94.2	91.4	2.77
Cable217	-1.002	-0.961	1.002	0.961	0.0	0.0	88.2	88.2	0.00
66kV line from Semtokha1	-27.397	-20.788	27.587	20.941	189.9	153.1	99.3	100.0	0.74
66kV line Olakha/Bjemina	0.000	-0.235	0.000	0.000	0.0	-234.9	99.3	99.3	0.02
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Alert Summary Report

	% Alert Settings	
	<u>Critical</u>	<u>Marginal</u>
<u>Loading</u>		
Bus	100.0	95.0
Cable	100.0	95.0
Reactor	100.0	95.0
Line	100.0	95.0
Transformer	100.0	95.0
Panel	100.0	95.0
Protective Device	100.0	95.0
Generator	100.0	95.0
Inverter/Charger	100.0	95.0
<u>Bus Voltage</u>		
OverVoltage	110.0	105.0
UnderVoltage	90.0	95.0
<u>Generator Excitation</u>		
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
0	Bus	Under Voltage	11.000	kV	9.421	85.6	3-Phase
B	Bus	Under Voltage	11.000	kV	9.40	85.4	3-Phase
Bus00	Bus	Under Voltage	11.000	kV	9.61	87.4	3-Phase
Bus000	Bus	Under Voltage	11.000	kV	9.58	87.0	3-Phase
Bus100	Bus	Under Voltage	11.000	kV	9.09	82.6	3-Phase
Bus101	Bus	Under Voltage	11.000	kV	9.05	82.3	3-Phase
Bus102	Bus	Under Voltage	11.000	kV	9.05	82.3	3-Phase
Bus103	Bus	Under Voltage	11.000	kV	9.25	84.1	3-Phase
Bus104	Bus	Under Voltage	11.000	kV	8.98	81.6	3-Phase
Bus105	Bus	Under Voltage	11.000	kV	8.93	81.2	3-Phase
Bus106	Bus	Under Voltage	11.000	kV	8.90	80.9	3-Phase
Bus107	Bus	Under Voltage	11.000	kV	8.90	80.9	3-Phase
Bus108	Bus	Under Voltage	11.000	kV	8.90	80.9	3-Phase
Bus1084	Bus	Under Voltage	11.000	kV	9.63	87.6	3-Phase
Bus109	Bus	Under Voltage	11.000	kV	8.79	79.9	3-Phase

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus11	Bus	Under Voltage	11.000	kV	9.834	89.4	3-Phase
Bus110	Bus	Under Voltage	11.000	kV	8.79	79.9	3-Phase
Bus111	Bus	Under Voltage	11.000	kV	8.79	79.9	3-Phase
Bus112	Bus	Under Voltage	11.000	kV	8.79	79.9	3-Phase
Bus113	Bus	Under Voltage	11.000	kV	8.77	79.7	3-Phase
Bus1138	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus1139	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus114	Bus	Under Voltage	11.000	kV	8.78	79.9	3-Phase
Bus115	Bus	Under Voltage	11.000	kV	8.78	79.8	3-Phase
Bus116	Bus	Under Voltage	11.000	kV	8.77	79.8	3-Phase
Bus117	Bus	Under Voltage	11.000	kV	8.78	79.8	3-Phase
Bus118	Bus	Under Voltage	11.000	kV	8.77	79.8	3-Phase
Bus119	Bus	Under Voltage	11.000	kV	8.77	79.7	3-Phase
Bus12	Bus	Under Voltage	11.000	kV	9.51	86.4	3-Phase
Bus120	Bus	Under Voltage	11.000	kV	8.77	79.7	3-Phase
Bus121	Bus	Under Voltage	11.000	kV	8.78	79.9	3-Phase
Bus122	Bus	Under Voltage	11.000	kV	8.77	79.7	3-Phase
Bus123	Bus	Under Voltage	11.000	kV	8.77	79.7	3-Phase
Bus124	Bus	Under Voltage	11.000	kV	8.76	79.7	3-Phase
Bus125	Bus	Under Voltage	11.000	kV	9.29	84.4	3-Phase
Bus126	Bus	Under Voltage	11.000	kV	9.27	84.2	3-Phase
Bus127	Bus	Under Voltage	11.000	kV	9.25	84.1	3-Phase
Bus128	Bus	Under Voltage	11.000	kV	9.20	83.6	3-Phase
Bus129	Bus	Under Voltage	11.000	kV	9.17	83.4	3-Phase
Bus13	Bus	Under Voltage	11.000	kV	9.54	86.8	3-Phase
Bus130	Bus	Under Voltage	11.000	kV	9.15	83.1	3-Phase
Bus131	Bus	Under Voltage	11.000	kV	9.15	83.2	3-Phase
Bus132	Bus	Under Voltage	11.000	kV	9.12	82.9	3-Phase
Bus133	Bus	Under Voltage	11.000	kV	9.12	82.9	3-Phase
Bus134	Bus	Under Voltage	11.000	kV	9.14	83.1	3-Phase
Bus135	Bus	Under Voltage	11.000	kV	9.14	83.1	3-Phase
Bus136	Bus	Under Voltage	11.000	kV	9.14	83.1	3-Phase
Bus137	Bus	Under Voltage	11.000	kV	9.13	83.0	3-Phase
Bus138	Bus	Under Voltage	11.000	kV	9.13	83.0	3-Phase
Bus14	Bus	Under Voltage	11.000	kV	9.61	87.4	3-Phase
Bus140	Bus	Under Voltage	11.000	kV	9.19	83.6	3-Phase

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Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus141	Bus	Under Voltage	11.000	kV	9.186	83.5	3-Phase
Bus142	Bus	Under Voltage	11.000	kV	9.32	84.8	3-Phase
Bus143	Bus	Under Voltage	11.000	kV	9.32	84.8	3-Phase
Bus144	Bus	Under Voltage	11.000	kV	9.30	84.6	3-Phase
Bus145	Bus	Under Voltage	11.000	kV	9.30	84.6	3-Phase
Bus146	Bus	Under Voltage	11.000	kV	9.63	87.6	3-Phase
Bus147	Bus	Under Voltage	11.000	kV	9.62	87.4	3-Phase
Bus148	Bus	Under Voltage	11.000	kV	9.61	87.4	3-Phase
Bus149	Bus	Under Voltage	11.000	kV	9.58	87.1	3-Phase
Bus150	Bus	Under Voltage	11.000	kV	9.55	86.8	3-Phase
Bus151	Bus	Under Voltage	11.000	kV	9.52	86.6	3-Phase
Bus152	Bus	Under Voltage	11.000	kV	9.51	86.5	3-Phase
Bus153	Bus	Under Voltage	11.000	kV	9.51	86.4	3-Phase
Bus154	Bus	Under Voltage	11.000	kV	9.50	86.4	3-Phase
Bus155	Bus	Under Voltage	11.000	kV	9.52	86.6	3-Phase
Bus156	Bus	Under Voltage	11.000	kV	9.52	86.5	3-Phase
Bus157	Bus	Under Voltage	11.000	kV	9.52	86.5	3-Phase
Bus158	Bus	Under Voltage	33.000	kV	29.40	89.1	3-Phase
Bus159	Bus	Under Voltage	33.000	kV	29.39	89.1	3-Phase
Bus160	Bus	Under Voltage	33.000	kV	29.38	89.0	3-Phase
Bus161	Bus	Under Voltage	33.000	kV	29.34	88.9	3-Phase
Bus162	Bus	Under Voltage	33.000	kV	29.34	88.9	3-Phase
Bus163	Bus	Under Voltage	33.000	kV	29.34	88.9	3-Phase
Bus164	Bus	Under Voltage	33.000	kV	29.34	88.9	3-Phase
Bus165	Bus	Under Voltage	33.000	kV	29.33	88.9	3-Phase
Bus166	Bus	Under Voltage	11.000	kV	9.47	86.1	3-Phase
Bus167	Bus	Under Voltage	11.000	kV	9.63	87.6	3-Phase
Bus168	Bus	Under Voltage	11.000	kV	9.63	87.6	3-Phase
Bus169	Bus	Under Voltage	11.000	kV	9.66	87.8	3-Phase
Bus170	Bus	Under Voltage	11.000	kV	9.66	87.8	3-Phase
Bus171	Bus	Under Voltage	11.000	kV	9.66	87.8	3-Phase
Bus172	Bus	Under Voltage	11.000	kV	9.68	88.0	3-Phase
Bus173	Bus	Under Voltage	11.000	kV	9.68	88.0	3-Phase
Bus174	Bus	Under Voltage	11.000	kV	9.68	88.0	3-Phase
Bus175	Bus	Under Voltage	11.000	kV	9.68	88.0	3-Phase
Bus176	Bus	Under Voltage	11.000	kV	9.70	88.2	3-Phase

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Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus177	Bus	Under Voltage	11.000	kV	9.702	88.2	3-Phase
Bus178	Bus	Under Voltage	11.000	kV	9.61	87.4	3-Phase
Bus179	Bus	Under Voltage	11.000	kV	9.61	87.4	3-Phase
Bus180	Bus	Under Voltage	11.000	kV	9.61	87.4	3-Phase
Bus181	Bus	Under Voltage	11.000	kV	9.60	87.2	3-Phase
Bus182	Bus	Under Voltage	11.000	kV	9.60	87.2	3-Phase
Bus183	Bus	Under Voltage	11.000	kV	9.60	87.2	3-Phase
Bus184	Bus	Under Voltage	11.000	kV	9.59	87.2	3-Phase
Bus185	Bus	Under Voltage	11.000	kV	9.58	87.1	3-Phase
Bus186	Bus	Under Voltage	11.000	kV	9.58	87.1	3-Phase
Bus187	Bus	Under Voltage	11.000	kV	9.58	87.1	3-Phase
Bus188	Bus	Under Voltage	11.000	kV	9.58	87.1	3-Phase
Bus189	Bus	Under Voltage	11.000	kV	9.58	87.1	3-Phase
Bus190	Bus	Under Voltage	11.000	kV	9.58	87.1	3-Phase
Bus191	Bus	Under Voltage	11.000	kV	9.48	86.2	3-Phase
Bus192	Bus	Under Voltage	11.000	kV	9.63	87.5	3-Phase
Bus193	Bus	Under Voltage	11.000	kV	9.63	87.5	3-Phase
Bus194	Bus	Under Voltage	11.000	kV	9.63	87.5	3-Phase
Bus195	Bus	Under Voltage	11.000	kV	9.62	87.5	3-Phase
Bus196	Bus	Under Voltage	11.000	kV	9.62	87.5	3-Phase
Bus197	Bus	Under Voltage	11.000	kV	9.63	87.6	3-Phase
Bus198	Bus	Under Voltage	11.000	kV	9.63	87.6	3-Phase
Bus199	Bus	Under Voltage	11.000	kV	9.63	87.5	3-Phase
Bus200	Bus	Under Voltage	11.000	kV	9.63	87.5	3-Phase
Bus204	Bus	Under Voltage	11.000	kV	9.63	87.5	3-Phase
Bus205	Bus	Under Voltage	11.000	kV	9.60	87.3	3-Phase
Bus206	Bus	Under Voltage	11.000	kV	9.60	87.2	3-Phase
Bus207	Bus	Under Voltage	11.000	kV	9.60	87.2	3-Phase
Bus208	Bus	Under Voltage	11.000	kV	9.48	86.2	3-Phase
Bus209	Bus	Under Voltage	11.000	kV	9.39	85.4	3-Phase
Bus210	Bus	Under Voltage	11.000	kV	9.39	85.4	3-Phase
Bus211	Bus	Under Voltage	11.000	kV	9.38	85.3	3-Phase
Bus212	Bus	Under Voltage	11.000	kV	9.38	85.3	3-Phase
Bus213	Bus	Under Voltage	11.000	kV	9.38	85.3	3-Phase
Bus214	Bus	Under Voltage	11.000	kV	9.38	85.3	3-Phase
Bus215	Bus	Under Voltage	11.000	kV	9.32	84.7	3-Phase

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Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus216	Bus	Under Voltage	11.000	kV	9.309	84.6	3-Phase
Bus217	Bus	Under Voltage	11.000	kV	9.28	84.4	3-Phase
Bus218	Bus	Under Voltage	11.000	kV	9.28	84.4	3-Phase
Bus219	Bus	Under Voltage	11.000	kV	9.28	84.4	3-Phase
Bus220	Bus	Under Voltage	11.000	kV	9.28	84.4	3-Phase
Bus221	Bus	Under Voltage	11.000	kV	9.28	84.4	3-Phase
Bus222	Bus	Under Voltage	11.000	kV	9.28	84.4	3-Phase
Bus223	Bus	Under Voltage	11.000	kV	9.28	84.4	3-Phase
Bus225	Bus	Under Voltage	11.000	kV	9.63	87.6	3-Phase
Bus226	Bus	Under Voltage	11.000	kV	9.59	87.2	3-Phase
Bus227	Bus	Under Voltage	11.000	kV	9.57	87.0	3-Phase
Bus228	Bus	Under Voltage	11.000	kV	9.54	86.7	3-Phase
Bus229	Bus	Under Voltage	11.000	kV	9.54	86.7	3-Phase
Bus230	Bus	Under Voltage	11.000	kV	9.53	86.6	3-Phase
Bus231	Bus	Under Voltage	11.000	kV	9.53	86.7	3-Phase
Bus232	Bus	Under Voltage	11.000	kV	9.53	86.7	3-Phase
Bus233	Bus	Under Voltage	11.000	kV	9.52	86.5	3-Phase
Bus234	Bus	Under Voltage	11.000	kV	9.52	86.5	3-Phase
Bus235	Bus	Under Voltage	11.000	kV	9.52	86.5	3-Phase
Bus236	Bus	Under Voltage	11.000	kV	9.51	86.5	3-Phase
Bus237	Bus	Under Voltage	11.000	kV	9.51	86.4	3-Phase
Bus238	Bus	Under Voltage	11.000	kV	9.51	86.4	3-Phase
Bus239	Bus	Under Voltage	11.000	kV	9.51	86.4	3-Phase
Bus240	Bus	Under Voltage	11.000	kV	9.51	86.4	3-Phase
Bus241	Bus	Under Voltage	11.000	kV	9.51	86.4	3-Phase
Bus242	Bus	Under Voltage	11.000	kV	9.50	86.4	3-Phase
Bus243	Bus	Under Voltage	11.000	kV	9.49	86.3	3-Phase
Bus244	Bus	Under Voltage	11.000	kV	9.49	86.2	3-Phase
Bus245	Bus	Under Voltage	11.000	kV	9.54	86.7	3-Phase
Bus246	Bus	Under Voltage	11.000	kV	9.49	86.3	3-Phase
Bus247	Bus	Under Voltage	11.000	kV	9.49	86.3	3-Phase
Bus248	Bus	Under Voltage	11.000	kV	9.49	86.3	3-Phase
Bus25	Bus	Under Voltage	11.000	kV	9.63	87.6	3-Phase
Bus250	Bus	Under Voltage	11.000	kV	9.63	87.6	3-Phase
Bus251	Bus	Under Voltage	11.000	kV	9.63	87.5	3-Phase
Bus252	Bus	Under Voltage	11.000	kV	9.63	87.5	3-Phase

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Bus253	Bus	Under Voltage	11.000	kV	9.621	87.5	3-Phase
Bus254	Bus	Under Voltage	11.000	kV	9.62	87.5	3-Phase
Bus255	Bus	Under Voltage	11.000	kV	9.62	87.5	3-Phase
Bus26	Bus	Under Voltage	11.000	kV	9.78	88.9	3-Phase
Bus27	Bus	Under Voltage	11.000	kV	9.32	84.8	3-Phase
Bus28	Bus	Under Voltage	11.000	kV	9.82	89.3	3-Phase
Bus29	Bus	Under Voltage	11.000	kV	9.82	89.3	3-Phase
Bus3	Bus	Under Voltage	11.000	kV	9.42	85.6	3-Phase
Bus30	Bus	Under Voltage	11.000	kV	9.29	84.4	3-Phase
Bus318	Bus	Under Voltage	11.000	kV	9.82	89.3	3-Phase
Bus34	Bus	Under Voltage	11.000	kV	9.83	89.4	3-Phase
Bus343	Bus	Under Voltage	11.000	kV	9.20	83.6	3-Phase
Bus35	Bus	Under Voltage	11.000	kV	9.42	85.6	3-Phase
Bus375	Bus	Under Voltage	11.000	kV	9.20	83.6	3-Phase
Bus4	Bus	Under Voltage	11.000	kV	9.63	87.6	3-Phase
Bus40	Bus	Under Voltage	11.000	kV	9.63	87.6	3-Phase
Bus414	Bus	Under Voltage	11.000	kV	9.19	83.6	3-Phase
Bus447	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus448	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus452	Bus	Under Voltage	11.000	kV	9.78	88.9	3-Phase
Bus458	Bus	Under Voltage	11.000	kV	9.19	83.6	3-Phase
Bus459	Bus	Under Voltage	11.000	kV	9.20	83.6	3-Phase
Bus460	Bus	Under Voltage	11.000	kV	9.19	83.6	3-Phase
Bus461	Bus	Under Voltage	11.000	kV	9.19	83.6	3-Phase
Bus462	Bus	Under Voltage	11.000	kV	9.20	83.7	3-Phase
Bus463	Bus	Under Voltage	11.000	kV	9.20	83.7	3-Phase
Bus464	Bus	Under Voltage	11.000	kV	9.21	83.7	3-Phase
Bus465	Bus	Under Voltage	11.000	kV	9.21	83.7	3-Phase
Bus466	Bus	Under Voltage	11.000	kV	9.22	83.8	3-Phase
Bus467	Bus	Under Voltage	11.000	kV	9.22	83.8	3-Phase
Bus468	Bus	Under Voltage	11.000	kV	9.23	83.9	3-Phase
Bus469	Bus	Under Voltage	11.000	kV	9.24	84.0	3-Phase
Bus470	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus471	Bus	Under Voltage	11.000	kV	9.23	83.9	3-Phase
Bus472	Bus	Under Voltage	11.000	kV	9.18	83.5	3-Phase
Bus473	Bus	Under Voltage	11.000	kV	9.17	83.4	3-Phase

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Bus474	Bus	Under Voltage	11.000	kV	9.168	83.3	3-Phase
Bus475	Bus	Under Voltage	11.000	kV	9.82	89.2	3-Phase
Bus476	Bus	Under Voltage	11.000	kV	9.81	89.2	3-Phase
Bus477	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
Bus478	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
Bus479	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
Bus480	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
Bus481	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus482	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus483	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus484	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus485	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus486	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus487	Bus	Under Voltage	11.000	kV	9.80	89.0	3-Phase
Bus488	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
Bus489	Bus	Under Voltage	11.000	kV	9.28	84.4	3-Phase
Bus490	Bus	Under Voltage	11.000	kV	9.81	89.1	3-Phase
Bus491	Bus	Under Voltage	11.000	kV	9.29	84.4	3-Phase
Bus492	Bus	Under Voltage	11.000	kV	9.29	84.4	3-Phase
Bus493	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus494	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
Bus497	Bus	Under Voltage	11.000	kV	9.82	89.3	3-Phase
Bus498	Bus	Under Voltage	11.000	kV	8.90	80.9	3-Phase
Bus499	Bus	Under Voltage	11.000	kV	8.90	80.9	3-Phase
Bus500	Bus	Under Voltage	11.000	kV	9.19	83.5	3-Phase
Bus501	Bus	Under Voltage	11.000	kV	9.19	83.5	3-Phase
Bus502	Bus	Under Voltage	11.000	kV	8.97	81.5	3-Phase
Bus503	Bus	Under Voltage	11.000	kV	9.82	89.3	3-Phase
Bus504	Bus	Under Voltage	11.000	kV	9.32	84.8	3-Phase
Bus505	Bus	Under Voltage	11.000	kV	9.69	88.1	3-Phase
Bus506	Bus	Under Voltage	11.000	kV	9.82	89.2	3-Phase
Bus507	Bus	Under Voltage	11.000	kV	9.82	89.2	3-Phase
Bus508	Bus	Under Voltage	11.000	kV	9.81	89.2	3-Phase
Bus509	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus510	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus511	Bus	Under Voltage	11.000	kV	9.78	88.9	3-Phase

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Bus512	Bus	Under Voltage	11.000	kV	9.775	88.9	3-Phase
Bus513	Bus	Under Voltage	11.000	kV	9.77	88.9	3-Phase
Bus514	Bus	Under Voltage	11.000	kV	9.78	88.9	3-Phase
Bus515	Bus	Under Voltage	11.000	kV	9.78	88.9	3-Phase
Bus516	Bus	Under Voltage	11.000	kV	9.77	88.8	3-Phase
Bus517	Bus	Under Voltage	11.000	kV	9.77	88.8	3-Phase
Bus518	Bus	Under Voltage	11.000	kV	9.77	88.8	3-Phase
Bus519	Bus	Under Voltage	11.000	kV	9.69	88.1	3-Phase
Bus520	Bus	Under Voltage	11.000	kV	9.69	88.1	3-Phase
Bus521	Bus	Under Voltage	11.000	kV	9.69	88.1	3-Phase
Bus522	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
Bus523	Bus	Under Voltage	11.000	kV	9.83	89.4	3-Phase
Bus524	Bus	Under Voltage	11.000	kV	9.81	89.2	3-Phase
Bus525	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus526	Bus	Under Voltage	11.000	kV	9.69	88.1	3-Phase
Bus527	Bus	Under Voltage	11.000	kV	9.70	88.1	3-Phase
Bus529	Bus	Under Voltage	11.000	kV	9.70	88.1	3-Phase
Bus535	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
Bus537	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
Bus538	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
Bus544	Bus	Under Voltage	11.000	kV	9.83	89.4	3-Phase
Bus546	Bus	Under Voltage	11.000	kV	9.83	89.4	3-Phase
Bus548	Bus	Under Voltage	11.000	kV	9.81	89.2	3-Phase
Bus549	Bus	Under Voltage	11.000	kV	9.81	89.2	3-Phase
Bus550	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus551	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus552	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus553	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus554	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus555	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus556	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus557	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus559	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus560	Bus	Under Voltage	11.000	kV	9.77	88.8	3-Phase
Bus561	Bus	Under Voltage	11.000	kV	9.76	88.7	3-Phase
Bus562	Bus	Under Voltage	11.000	kV	9.29	84.4	3-Phase

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Bus563	Bus	Under Voltage	11.000	kV	9.794	89.0	3-Phase
Bus564	Bus	Under Voltage	11.000	kV	9.73	88.5	3-Phase
Bus565	Bus	Under Voltage	11.000	kV	9.73	88.5	3-Phase
Bus566	Bus	Under Voltage	11.000	kV	9.71	88.3	3-Phase
Bus568	Bus	Under Voltage	11.000	kV	9.70	88.2	3-Phase
Bus569	Bus	Under Voltage	11.000	kV	9.71	88.3	3-Phase
Bus570	Bus	Under Voltage	11.000	kV	9.24	84.0	3-Phase
Bus571	Bus	Under Voltage	11.000	kV	9.77	88.8	3-Phase
Bus573	Bus	Under Voltage	11.000	kV	8.80	80.0	3-Phase
Bus586	Bus	Under Voltage	11.000	kV	9.28	84.4	3-Phase
Bus591	Bus	Under Voltage	11.000	kV	9.28	84.4	3-Phase
Bus592	Bus	Under Voltage	11.000	kV	9.28	84.4	3-Phase
Bus595	Bus	Under Voltage	11.000	kV	9.29	84.4	3-Phase
Bus596	Bus	Under Voltage	11.000	kV	9.29	84.4	3-Phase
Bus597	Bus	Under Voltage	11.000	kV	9.28	84.4	3-Phase
Bus603	Bus	Under Voltage	11.000	kV	9.29	84.4	3-Phase
Bus604	Bus	Under Voltage	11.000	kV	9.28	84.4	3-Phase
Bus605	Bus	Under Voltage	11.000	kV	9.28	84.4	3-Phase
Bus606	Bus	Under Voltage	11.000	kV	9.28	84.4	3-Phase
Bus607	Bus	Under Voltage	11.000	kV	9.28	84.3	3-Phase
Bus658	Bus	Under Voltage	11.000	kV	9.83	89.4	3-Phase
Bus692	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus696	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus698	Bus	Under Voltage	11.000	kV	8.80	80.0	3-Phase
Bus699	Bus	Under Voltage	11.000	kV	8.80	80.0	3-Phase
Bus7	Bus	Under Voltage	11.000	kV	9.32	84.8	3-Phase
Bus713- RICB N530T1	Bus	Under Voltage	11.000	kV	9.81	89.2	3-Phase
Bus714	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus715	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus720	Bus	Under Voltage	11.000	kV	8.79	79.9	3-Phase
Bus724	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
Bus726	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
Bus727	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
Bus728	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
Bus729	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
Bus731	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase

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Bus732	Bus	Under Voltage	11.000	kV	9.799	89.1	3-Phase
Bus733	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus734	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
Bus735	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus736	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus737	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus741	Bus	Under Voltage	11.000	kV	8.79	79.9	3-Phase
Bus742	Bus	Under Voltage	11.000	kV	8.79	79.9	3-Phase
Bus743	Bus	Under Voltage	11.000	kV	8.79	79.9	3-Phase
Bus751	Bus	Under Voltage	11.000	kV	9.83	89.4	3-Phase
Bus752	Bus	Under Voltage	11.000	kV	9.83	89.4	3-Phase
Bus753	Bus	Under Voltage	11.000	kV	9.83	89.4	3-Phase
Bus761	Bus	Under Voltage	11.000	kV	8.79	79.9	3-Phase
Bus762	Bus	Under Voltage	11.000	kV	8.78	79.8	3-Phase
Bus763	Bus	Under Voltage	11.000	kV	8.78	79.8	3-Phase
Bus764	Bus	Under Voltage	11.000	kV	8.79	79.9	3-Phase
Bus765	Bus	Under Voltage	11.000	kV	8.76	79.7	3-Phase
Bus766	Bus	Under Voltage	11.000	kV	8.76	79.7	3-Phase
Bus770	Bus	Under Voltage	11.000	kV	8.81	80.1	3-Phase
Bus771	Bus	Under Voltage	11.000	kV	8.82	80.1	3-Phase
Bus772	Bus	Under Voltage	11.000	kV	8.83	80.2	3-Phase
Bus774	Bus	Under Voltage	11.000	kV	8.86	80.6	3-Phase
Bus775	Bus	Under Voltage	11.000	kV	8.84	80.4	3-Phase
Bus776	Bus	Under Voltage	11.000	kV	8.86	80.6	3-Phase
Bus777	Bus	Under Voltage	11.000	kV	8.97	81.6	3-Phase
Bus778	Bus	Under Voltage	11.000	kV	9.04	82.2	3-Phase
Bus78	Bus	Under Voltage	33.000	kV	29.46	89.3	3-Phase
Bus788	Bus	Under Voltage	11.000	kV	9.05	82.3	3-Phase
Bus789	Bus	Under Voltage	11.000	kV	9.05	82.3	3-Phase
Bus79	Bus	Under Voltage	33.000	kV	29.45	89.2	3-Phase
Bus790	Bus	Under Voltage	11.000	kV	9.09	82.7	3-Phase
Bus791	Bus	Under Voltage	11.000	kV	9.17	83.4	3-Phase
Bus792	Bus	Under Voltage	11.000	kV	9.12	82.9	3-Phase
Bus793	Bus	Under Voltage	11.000	kV	9.67	87.9	3-Phase
Bus794	Bus	Under Voltage	11.000	kV	9.74	88.5	3-Phase
Bus795	Bus	Under Voltage	11.000	kV	9.12	82.9	3-Phase

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Bus796	Bus	Under Voltage	11.000	kV	9.740	88.5	3-Phase
Bus797	Bus	Under Voltage	11.000	kV	9.71	88.2	3-Phase
Bus798	Bus	Under Voltage	11.000	kV	9.85	89.5	3-Phase
Bus799	Bus	Under Voltage	11.000	kV	9.74	88.5	3-Phase
Bus80	Bus	Under Voltage	33.000	kV	29.44	89.2	3-Phase
Bus800	Bus	Under Voltage	11.000	kV	9.71	88.2	3-Phase
Bus801	Bus	Under Voltage	11.000	kV	9.70	88.2	3-Phase
Bus802	Bus	Under Voltage	11.000	kV	9.66	87.8	3-Phase
Bus803	Bus	Under Voltage	11.000	kV	9.28	84.4	3-Phase
Bus804	Bus	Under Voltage	11.000	kV	9.45	85.9	3-Phase
Bus805	Bus	Under Voltage	11.000	kV	9.44	85.9	3-Phase
Bus806	Bus	Under Voltage	11.000	kV	9.44	85.8	3-Phase
Bus807	Bus	Under Voltage	11.000	kV	9.44	85.8	3-Phase
Bus808	Bus	Under Voltage	11.000	kV	9.44	85.8	3-Phase
Bus809	Bus	Under Voltage	11.000	kV	9.43	85.8	3-Phase
Bus81	Bus	Under Voltage	33.000	kV	29.41	89.1	3-Phase
Bus810	Bus	Under Voltage	11.000	kV	9.62	87.5	3-Phase
Bus811	Bus	Under Voltage	11.000	kV	9.78	89.0	3-Phase
Bus819	Bus	Under Voltage	11.000	kV	9.77	88.8	3-Phase
Bus82	Bus	Under Voltage	11.000	kV	9.55	86.8	3-Phase
Bus820	Bus	Under Voltage	11.000	kV	9.77	88.8	3-Phase
Bus821	Bus	Under Voltage	11.000	kV	9.77	88.8	3-Phase
Bus822	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus823	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
Bus824	Bus	Under Voltage	11.000	kV	9.77	88.8	3-Phase
Bus825	Bus	Under Voltage	11.000	kV	9.74	88.6	3-Phase
Bus826	Bus	Under Voltage	11.000	kV	9.79	89.0	3-Phase
Bus827	Bus	Under Voltage	11.000	kV	9.70	88.2	3-Phase
Bus829	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
Bus83	Bus	Under Voltage	11.000	kV	9.32	84.7	3-Phase
Bus830	Bus	Under Voltage	11.000	kV	9.73	88.5	3-Phase
Bus831	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
Bus836	Bus	Under Voltage	11.000	kV	9.84	89.4	3-Phase
Bus837	Bus	Under Voltage	11.000	kV	9.69	88.1	3-Phase
Bus84	Bus	Under Voltage	11.000	kV	9.32	84.7	3-Phase
Bus840	Bus	Under Voltage	11.000	kV	9.84	89.4	3-Phase

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Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus85	Bus	Under Voltage	11.000	kV	9.314	84.7	3-Phase
Bus86	Bus	Under Voltage	11.000	kV	9.31	84.7	3-Phase
Bus861	Bus	Under Voltage	11.000	kV	9.44	85.8	3-Phase
Bus862	Bus	Under Voltage	11.000	kV	9.44	85.8	3-Phase
Bus865	Bus	Under Voltage	11.000	kV	9.44	85.8	3-Phase
Bus87	Bus	Under Voltage	11.000	kV	9.32	84.7	3-Phase
Bus88	Bus	Under Voltage	11.000	kV	9.23	83.9	3-Phase
Bus89	Bus	Under Voltage	11.000	kV	9.23	83.9	3-Phase
Bus90	Bus	Under Voltage	11.000	kV	9.23	83.9	3-Phase
Bus91	Bus	Under Voltage	11.000	kV	9.23	83.9	3-Phase
Bus92	Bus	Under Voltage	11.000	kV	9.19	83.6	3-Phase
Bus93	Bus	Under Voltage	11.000	kV	9.19	83.6	3-Phase
Bus94	Bus	Under Voltage	11.000	kV	9.19	83.6	3-Phase
Bus95	Bus	Under Voltage	11.000	kV	9.19	83.5	3-Phase
Bus96	Bus	Under Voltage	11.000	kV	9.47	86.1	3-Phase
Bus97	Bus	Under Voltage	11.000	kV	9.28	84.4	3-Phase
Bus98	Bus	Under Voltage	11.000	kV	9.27	84.3	3-Phase
Bus99	Bus	Under Voltage	11.000	kV	9.26	84.2	3-Phase
From610	Bus	Under Voltage	11.000	kV	9.70	88.2	3-Phase
Motithang1	Bus	Under Voltage	33.000	kV	29.33	88.9	3-Phase
N330 D/Ling	Bus	Under Voltage	11.000	kV	9.13	83.0	3-Phase
N470 DPH2	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
N580T2	Bus	Under Voltage	11.000	kV	9.24	84.0	3-Phase
N610RMU1	Bus	Under Voltage	11.000	kV	9.70	88.2	3-Phase
N700T2	Bus	Under Voltage	11.000	kV	9.80	89.1	3-Phase
TMH1	Bus	Under Voltage	33.000	kV	29.40	89.1	3-Phase

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Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
11kV Hospital	Bus	Under Voltage	11.000	kV	9.962	90.6	3-Phase
11kV Hospital1	Bus	Under Voltage	11.000	kV	9.96	90.6	3-Phase
33/11kV RICBL Xmer1	Transformer	Overload	5.000	MVA	4.89	97.7	3-Phase
33/11kV RICBL Xmer2	Transformer	Overload	5.000	MVA	4.89	97.7	3-Phase
Bus1000	Bus	Under Voltage	11.000	kV	10.44	94.9	3-Phase
Bus1001	Bus	Under Voltage	11.000	kV	10.41	94.6	3-Phase
Bus1003	Bus	Under Voltage	11.000	kV	10.44	94.9	3-Phase

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Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus1005	Bus	Under Voltage	11.000	kV	10.386	94.4	3-Phase
Bus1006	Bus	Under Voltage	11.000	kV	10.39	94.4	3-Phase
Bus1007	Bus	Under Voltage	11.000	kV	10.39	94.4	3-Phase
Bus1008	Bus	Under Voltage	11.000	kV	10.21	92.8	3-Phase
Bus1009	Bus	Under Voltage	11.000	kV	10.38	94.4	3-Phase
Bus1010	Bus	Under Voltage	11.000	kV	10.33	93.9	3-Phase
Bus1011	Bus	Under Voltage	11.000	kV	10.33	93.9	3-Phase
Bus1012	Bus	Under Voltage	11.000	kV	10.33	93.9	3-Phase
Bus1013	Bus	Under Voltage	11.000	kV	10.33	93.9	3-Phase
Bus1015	Bus	Under Voltage	11.000	kV	10.33	94.0	3-Phase
Bus1018	Bus	Under Voltage	11.000	kV	10.20	92.8	3-Phase
Bus1020	Bus	Under Voltage	11.000	kV	10.20	92.8	3-Phase
Bus1021	Bus	Under Voltage	11.000	kV	10.20	92.8	3-Phase
Bus1022	Bus	Under Voltage	11.000	kV	10.14	92.2	3-Phase
Bus1026	Bus	Under Voltage	11.000	kV	10.31	93.8	3-Phase
Bus1031	Bus	Under Voltage	11.000	kV	10.31	93.7	3-Phase
Bus1033	Bus	Under Voltage	11.000	kV	9.93	90.2	3-Phase
Bus1042	Bus	Under Voltage	11.000	kV	10.15	92.2	3-Phase
Bus1043	Bus	Under Voltage	11.000	kV	10.15	92.3	3-Phase
Bus1044	Bus	Under Voltage	11.000	kV	10.16	92.3	3-Phase
Bus1045	Bus	Under Voltage	11.000	kV	10.20	92.7	3-Phase
Bus1046	Bus	Under Voltage	11.000	kV	10.20	92.7	3-Phase
Bus1047	Bus	Under Voltage	11.000	kV	10.20	92.7	3-Phase
Bus1048	Bus	Under Voltage	11.000	kV	10.11	91.9	3-Phase
Bus1049	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Bus1050	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Bus1052	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Bus1053	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Bus1054	Bus	Under Voltage	11.000	kV	10.09	91.8	3-Phase
Bus1055	Bus	Under Voltage	11.000	kV	10.09	91.7	3-Phase
Bus1056	Bus	Under Voltage	11.000	kV	10.11	91.9	3-Phase
Bus1057	Bus	Under Voltage	11.000	kV	10.11	91.9	3-Phase
Bus1058	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Bus1060	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Bus1061	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Bus1062	Bus	Under Voltage	11.000	kV	10.08	91.6	3-Phase

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Bus1063	Bus	Under Voltage	11.000	kV	10.072	91.6	3-Phase
Bus1064	Bus	Under Voltage	11.000	kV	10.05	91.3	3-Phase
Bus1065	Bus	Under Voltage	11.000	kV	10.04	91.3	3-Phase
Bus1066	Bus	Under Voltage	11.000	kV	10.03	91.2	3-Phase
Bus1092	Bus	Under Voltage	11.000	kV	10.17	92.5	3-Phase
Bus1115	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus1163	Bus	Under Voltage	11.000	kV	10.03	91.2	3-Phase
Bus1164	Bus	Under Voltage	11.000	kV	10.02	91.1	3-Phase
Bus1165	Bus	Under Voltage	11.000	kV	10.02	91.1	3-Phase
Bus1166	Bus	Under Voltage	11.000	kV	10.02	91.1	3-Phase
Bus1167	Bus	Under Voltage	11.000	kV	10.01	91.0	3-Phase
Bus1168	Bus	Under Voltage	11.000	kV	10.01	91.0	3-Phase
Bus1170	Bus	Under Voltage	11.000	kV	10.00	90.9	3-Phase
Bus1171	Bus	Under Voltage	11.000	kV	10.00	90.9	3-Phase
Bus1172	Bus	Under Voltage	11.000	kV	10.00	90.9	3-Phase
Bus1173	Bus	Under Voltage	11.000	kV	10.06	91.5	3-Phase
Bus1174	Bus	Under Voltage	11.000	kV	10.06	91.5	3-Phase
Bus1175	Bus	Under Voltage	11.000	kV	10.05	91.3	3-Phase
Bus1176	Bus	Under Voltage	11.000	kV	10.04	91.3	3-Phase
Bus1177	Bus	Under Voltage	11.000	kV	10.04	91.3	3-Phase
Bus1180	Bus	Under Voltage	11.000	kV	10.04	91.3	3-Phase
Bus18	Bus	Under Voltage	33.000	kV	30.04	91.0	3-Phase
Bus19	Bus	Under Voltage	11.000	kV	10.00	90.9	3-Phase
Bus20	Bus	Under Voltage	33.000	kV	31.13	94.3	3-Phase
Bus22	Bus	Under Voltage	33.000	kV	31.01	94.0	3-Phase
Bus23	Bus	Under Voltage	11.000	kV	10.17	92.5	3-Phase
Bus301	Bus	Under Voltage	11.000	kV	10.39	94.5	3-Phase
Bus302	Bus	Under Voltage	11.000	kV	10.36	94.2	3-Phase
Bus308	Bus	Under Voltage	11.000	kV	10.35	94.1	3-Phase
Bus309	Bus	Under Voltage	11.000	kV	10.35	94.1	3-Phase
Bus31	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus310	Bus	Under Voltage	11.000	kV	10.32	93.9	3-Phase
Bus311	Bus	Under Voltage	11.000	kV	10.32	93.8	3-Phase
Bus312	Bus	Under Voltage	11.000	kV	10.36	94.2	3-Phase
Bus313	Bus	Under Voltage	11.000	kV	10.36	94.2	3-Phase
Bus314	Bus	Under Voltage	11.000	kV	10.34	94.0	3-Phase

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Bus315	Bus	Under Voltage	11.000	kV	10.349	94.1	3-Phase
Bus316	Bus	Under Voltage	11.000	kV	10.29	93.5	3-Phase
Bus317	Bus	Under Voltage	11.000	kV	10.19	92.6	3-Phase
Bus319	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Bus320	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Bus321	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Bus322	Bus	Under Voltage	11.000	kV	10.32	93.8	3-Phase
Bus323	Bus	Under Voltage	11.000	kV	10.32	93.8	3-Phase
Bus324	Bus	Under Voltage	11.000	kV	10.08	91.6	3-Phase
Bus325	Bus	Under Voltage	11.000	kV	10.07	91.6	3-Phase
Bus326	Bus	Under Voltage	11.000	kV	10.07	91.5	3-Phase
Bus327	Bus	Under Voltage	11.000	kV	10.07	91.5	3-Phase
Bus328	Bus	Under Voltage	11.000	kV	10.06	91.5	3-Phase
Bus329	Bus	Under Voltage	11.000	kV	10.04	91.3	3-Phase
Bus330	Bus	Under Voltage	11.000	kV	10.04	91.2	3-Phase
Bus331	Bus	Under Voltage	11.000	kV	10.03	91.2	3-Phase
Bus332	Bus	Under Voltage	11.000	kV	10.02	91.1	3-Phase
Bus333	Bus	Under Voltage	11.000	kV	9.99	90.8	3-Phase
Bus334	Bus	Under Voltage	11.000	kV	10.02	91.1	3-Phase
Bus335	Bus	Under Voltage	11.000	kV	10.00	90.9	3-Phase
Bus336	Bus	Under Voltage	11.000	kV	10.00	90.9	3-Phase
Bus337	Bus	Under Voltage	11.000	kV	10.00	90.9	3-Phase
Bus338	Bus	Under Voltage	11.000	kV	9.98	90.7	3-Phase
Bus339	Bus	Under Voltage	11.000	kV	9.97	90.7	3-Phase
Bus340	Bus	Under Voltage	11.000	kV	9.97	90.7	3-Phase
Bus341	Bus	Under Voltage	11.000	kV	9.97	90.7	3-Phase
Bus342	Bus	Under Voltage	11.000	kV	9.99	90.8	3-Phase
Bus37	Bus	Under Voltage	11.000	kV	10.17	92.5	3-Phase
Bus38	Bus	Under Voltage	11.000	kV	10.17	92.5	3-Phase
Bus39	Bus	Under Voltage	33.000	kV	30.02	91.0	3-Phase
Bus422	Bus	Under Voltage	11.000	kV	10.34	94.0	3-Phase
Bus423	Bus	Under Voltage	11.000	kV	10.34	94.0	3-Phase
Bus424	Bus	Under Voltage	11.000	kV	10.34	94.0	3-Phase
Bus425	Bus	Under Voltage	11.000	kV	10.31	93.7	3-Phase
Bus426	Bus	Under Voltage	11.000	kV	10.33	93.9	3-Phase
Bus427	Bus	Under Voltage	11.000	kV	10.32	93.8	3-Phase

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Bus428	Bus	Under Voltage	11.000	kV	10.316	93.8	3-Phase
Bus429	Bus	Under Voltage	11.000	kV	10.31	93.8	3-Phase
Bus430	Bus	Under Voltage	11.000	kV	10.31	93.8	3-Phase
Bus431	Bus	Under Voltage	11.000	kV	10.25	93.1	3-Phase
Bus432	Bus	Under Voltage	11.000	kV	10.16	92.4	3-Phase
Bus433	Bus	Under Voltage	11.000	kV	10.25	93.1	3-Phase
Bus434	Bus	Under Voltage	11.000	kV	10.13	92.1	3-Phase
Bus435	Bus	Under Voltage	11.000	kV	10.11	91.9	3-Phase
Bus436	Bus	Under Voltage	11.000	kV	10.10	91.9	3-Phase
Bus437	Bus	Under Voltage	11.000	kV	10.16	92.4	3-Phase
Bus438	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus439	Bus	Under Voltage	11.000	kV	10.12	92.0	3-Phase
Bus440	Bus	Under Voltage	11.000	kV	10.11	91.9	3-Phase
Bus441	Bus	Under Voltage	11.000	kV	10.11	91.9	3-Phase
Bus442	Bus	Under Voltage	11.000	kV	10.11	91.9	3-Phase
Bus443	Bus	Under Voltage	11.000	kV	10.10	91.8	3-Phase
Bus444	Bus	Under Voltage	11.000	kV	10.09	91.7	3-Phase
Bus445	Bus	Under Voltage	11.000	kV	10.09	91.7	3-Phase
Bus446	Bus	Under Voltage	11.000	kV	10.08	91.7	3-Phase
Bus449	Bus	Under Voltage	11.000	kV	10.08	91.7	3-Phase
Bus450	Bus	Under Voltage	11.000	kV	10.05	91.3	3-Phase
Bus451	Bus	Under Voltage	11.000	kV	10.03	91.2	3-Phase
Bus453	Bus	Under Voltage	11.000	kV	10.03	91.2	3-Phase
Bus454	Bus	Under Voltage	11.000	kV	10.03	91.2	3-Phase
Bus455	Bus	Under Voltage	11.000	kV	10.01	91.0	3-Phase
Bus495	Bus	Under Voltage	11.000	kV	10.17	92.5	3-Phase
Bus496	Bus	Under Voltage	33.000	kV	30.02	91.0	3-Phase
Bus528	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
Bus53	Bus	Under Voltage	33.000	kV	29.99	90.9	3-Phase
Bus54	Bus	Under Voltage	33.000	kV	29.99	90.9	3-Phase
Bus55	Bus	Under Voltage	33.000	kV	29.99	90.9	3-Phase
Bus56	Bus	Under Voltage	33.000	kV	29.98	90.9	3-Phase
Bus57	Bus	Under Voltage	33.000	kV	30.04	91.0	3-Phase
Bus58	Bus	Under Voltage	33.000	kV	30.03	91.0	3-Phase
Bus59	Bus	Under Voltage	33.000	kV	30.03	91.0	3-Phase
Bus599	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase

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Bus6	Bus	Under Voltage	33.000	kV	30.044	91.0	3-Phase
Bus60	Bus	Under Voltage	33.000	kV	30.03	91.0	3-Phase
Bus600	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
Bus601	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
Bus602	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
Bus609	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
Bus61	Bus	Under Voltage	33.000	kV	30.03	91.0	3-Phase
Bus610	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
Bus611	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
Bus614	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus618	Bus	Under Voltage	11.000	kV	10.17	92.5	3-Phase
Bus619	Bus	Under Voltage	11.000	kV	10.17	92.5	3-Phase
Bus62	Bus	Under Voltage	33.000	kV	30.03	91.0	3-Phase
Bus620	Bus	Under Voltage	11.000	kV	9.92	90.1	3-Phase
Bus621	Bus	Under Voltage	11.000	kV	9.92	90.1	3-Phase
Bus622	Bus	Under Voltage	11.000	kV	9.92	90.1	3-Phase
Bus623	Bus	Under Voltage	11.000	kV	9.92	90.1	3-Phase
Bus624	Bus	Under Voltage	11.000	kV	10.17	92.5	3-Phase
Bus625	Bus	Under Voltage	11.000	kV	10.17	92.5	3-Phase
Bus63	Bus	Under Voltage	33.000	kV	30.03	91.0	3-Phase
Bus64	Bus	Under Voltage	33.000	kV	30.03	91.0	3-Phase
Bus647	Bus	Under Voltage	11.000	kV	10.17	92.5	3-Phase
Bus648	Bus	Under Voltage	11.000	kV	10.17	92.5	3-Phase
Bus649	Bus	Under Voltage	11.000	kV	10.17	92.5	3-Phase
Bus65	Bus	Under Voltage	33.000	kV	30.02	91.0	3-Phase
Bus653	Bus	Under Voltage	33.000	kV	31.09	94.2	3-Phase
Bus66	Bus	Under Voltage	33.000	kV	30.02	91.0	3-Phase
Bus67	Bus	Under Voltage	33.000	kV	30.02	91.0	3-Phase
Bus68	Bus	Under Voltage	33.000	kV	30.02	91.0	3-Phase
Bus680	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
Bus681	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
Bus682	Bus	Under Voltage	11.000	kV	9.91	90.0	3-Phase
Bus683	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus684	Bus	Under Voltage	11.000	kV	9.92	90.1	3-Phase
Bus685	Bus	Under Voltage	11.000	kV	9.92	90.2	3-Phase
Bus686	Bus	Under Voltage	11.000	kV	9.96	90.5	3-Phase

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Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus687	Bus	Under Voltage	11.000	kV	9.960	90.5	3-Phase
Bus688	Bus	Under Voltage	11.000	kV	9.96	90.5	3-Phase
Bus69	Bus	Under Voltage	33.000	kV	30.02	91.0	3-Phase
Bus691	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
Bus694	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
Bus695	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
Bus697	Bus	Under Voltage	11.000	kV	9.90	90.0	3-Phase
Bus70	Bus	Under Voltage	33.000	kV	30.02	91.0	3-Phase
Bus71	Bus	Under Voltage	33.000	kV	30.02	91.0	3-Phase
Bus716	Bus	Under Voltage	11.000	kV	10.06	91.4	3-Phase
Bus72	Bus	Under Voltage	33.000	kV	30.02	91.0	3-Phase
Bus723	Bus	Under Voltage	11.000	kV	10.35	94.1	3-Phase
Bus73	Bus	Under Voltage	33.000	kV	30.02	91.0	3-Phase
Bus74	Bus	Under Voltage	33.000	kV	30.02	91.0	3-Phase
Bus745	Bus	Under Voltage	11.000	kV	10.45	95.0	3-Phase
Bus746	Bus	Under Voltage	11.000	kV	10.45	95.0	3-Phase
Bus747	Bus	Under Voltage	11.000	kV	10.45	95.0	3-Phase
Bus748	Bus	Under Voltage	11.000	kV	10.45	95.0	3-Phase
Bus749	Bus	Under Voltage	11.000	kV	10.45	95.0	3-Phase
Bus75	Bus	Under Voltage	33.000	kV	30.02	91.0	3-Phase
Bus750	Bus	Under Voltage	11.000	kV	10.44	95.0	3-Phase
Bus754	Bus	Under Voltage	11.000	kV	10.38	94.3	3-Phase
Bus755	Bus	Under Voltage	11.000	kV	10.36	94.2	3-Phase
Bus756	Bus	Under Voltage	11.000	kV	10.36	94.2	3-Phase
Bus757	Bus	Under Voltage	11.000	kV	10.35	94.1	3-Phase
Bus758	Bus	Under Voltage	11.000	kV	10.35	94.1	3-Phase
Bus759	Bus	Under Voltage	11.000	kV	10.34	94.0	3-Phase
Bus76	Bus	Under Voltage	33.000	kV	30.04	91.0	3-Phase
Bus760	Bus	Under Voltage	11.000	kV	10.34	94.0	3-Phase
Bus767	Bus	Under Voltage	11.000	kV	10.06	91.4	3-Phase
Bus768	Bus	Under Voltage	11.000	kV	10.03	91.2	3-Phase
Bus769	Bus	Under Voltage	11.000	kV	10.03	91.2	3-Phase
Bus77	Bus	Under Voltage	33.000	kV	30.00	90.9	3-Phase
Bus779	Bus	Under Voltage	11.000	kV	10.04	91.3	3-Phase
Bus780	Bus	Under Voltage	11.000	kV	10.04	91.3	3-Phase
Bus781	Bus	Under Voltage	11.000	kV	10.02	91.1	3-Phase

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Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus782	Bus	Under Voltage	11.000	kV	10.012	91.0	3-Phase
Bus783	Bus	Under Voltage	11.000	kV	10.01	91.0	3-Phase
Bus784	Bus	Under Voltage	11.000	kV	9.99	90.8	3-Phase
Bus785	Bus	Under Voltage	11.000	kV	9.99	90.8	3-Phase
Bus786	Bus	Under Voltage	11.000	kV	9.99	90.8	3-Phase
Bus787	Bus	Under Voltage	11.000	kV	10.01	91.0	3-Phase
Bus812	Bus	Under Voltage	11.000	kV	10.06	91.4	3-Phase
Bus813	Bus	Under Voltage	11.000	kV	10.05	91.4	3-Phase
Bus814	Bus	Under Voltage	11.000	kV	10.05	91.3	3-Phase
Bus815	Bus	Under Voltage	11.000	kV	10.04	91.3	3-Phase
Bus816	Bus	Under Voltage	11.000	kV	10.04	91.3	3-Phase
Bus817	Bus	Under Voltage	11.000	kV	10.04	91.3	3-Phase
Bus818	Bus	Under Voltage	11.000	kV	10.04	91.3	3-Phase
Bus841	Bus	Under Voltage	11.000	kV	10.02	91.1	3-Phase
Bus842	Bus	Under Voltage	11.000	kV	9.94	90.3	3-Phase
Bus843	Bus	Under Voltage	11.000	kV	10.02	91.1	3-Phase
Bus844	Bus	Under Voltage	11.000	kV	10.00	90.9	3-Phase
Bus850	Bus	Under Voltage	11.000	kV	10.00	90.9	3-Phase
Bus856	Bus	Under Voltage	11.000	kV	10.00	90.9	3-Phase
Bus859	Bus	Under Voltage	11.000	kV	10.00	90.9	3-Phase
Bus860	Bus	Under Voltage	11.000	kV	10.00	90.9	3-Phase
Bus971	Bus	Under Voltage	11.000	kV	10.14	92.2	3-Phase
Bus984	Bus	Under Voltage	11.000	kV	10.32	93.8	3-Phase
Bus985	Bus	Under Voltage	11.000	kV	10.32	93.8	3-Phase
Bus986	Bus	Under Voltage	11.000	kV	10.33	93.9	3-Phase
Bus987	Bus	Under Voltage	11.000	kV	10.33	93.9	3-Phase
Bus988	Bus	Under Voltage	11.000	kV	10.33	93.9	3-Phase
Bus989	Bus	Under Voltage	11.000	kV	10.33	93.9	3-Phase
Bus990	Bus	Under Voltage	11.000	kV	10.34	94.0	3-Phase
Bus992	Bus	Under Voltage	11.000	kV	10.37	94.3	3-Phase
Bus993	Bus	Under Voltage	11.000	kV	10.37	94.3	3-Phase
Bus994	Bus	Under Voltage	11.000	kV	10.41	94.6	3-Phase
Bus995	Bus	Under Voltage	11.000	kV	10.41	94.6	3-Phase
Bus996	Bus	Under Voltage	11.000	kV	10.40	94.6	3-Phase
Bus997	Bus	Under Voltage	11.000	kV	10.42	94.7	3-Phase
Bus999	Bus	Under Voltage	11.000	kV	10.42	94.7	3-Phase

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Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Changedaphu SS	Bus	Under Voltage	33.000	kV	31.085	94.2	3-Phase
Changedaphu2	Bus	Under Voltage	33.000	kV	31.09	94.2	3-Phase
Chubachu1	Bus	Under Voltage	33.000	kV	30.96	93.8	3-Phase
Depsi1	Bus	Under Voltage	11.000	kV	9.93	90.2	3-Phase
Depsi11	Bus	Under Voltage	11.000	kV	10.31	93.8	3-Phase
Depsi2	Bus	Under Voltage	33.000	kV	29.98	90.9	3-Phase
DPH I	Bus	Under Voltage	33.000	kV	31.09	94.2	3-Phase
DPH I1	Bus	Under Voltage	33.000	kV	31.09	94.2	3-Phase
DPH1	Bus	Under Voltage	11.000	kV	10.06	91.4	3-Phase
DPH2	Bus	Under Voltage	33.000	kV	31.09	94.2	3-Phase
Hospital	Bus	Under Voltage	33.000	kV	31.09	94.2	3-Phase
Motithang2	Bus	Under Voltage	33.000	kV	31.04	94.1	3-Phase
N460 DPH2	Bus	Under Voltage	11.000	kV	9.91	90.1	3-Phase
N480	Bus	Under Voltage	11.000	kV	10.33	94.0	3-Phase
RICB1	Bus	Under Voltage	33.000	kV	31.09	94.2	3-Phase
wanchuk Taba RMU	Bus	Under Voltage	11.000	kV	10.20	92.8	3-Phase

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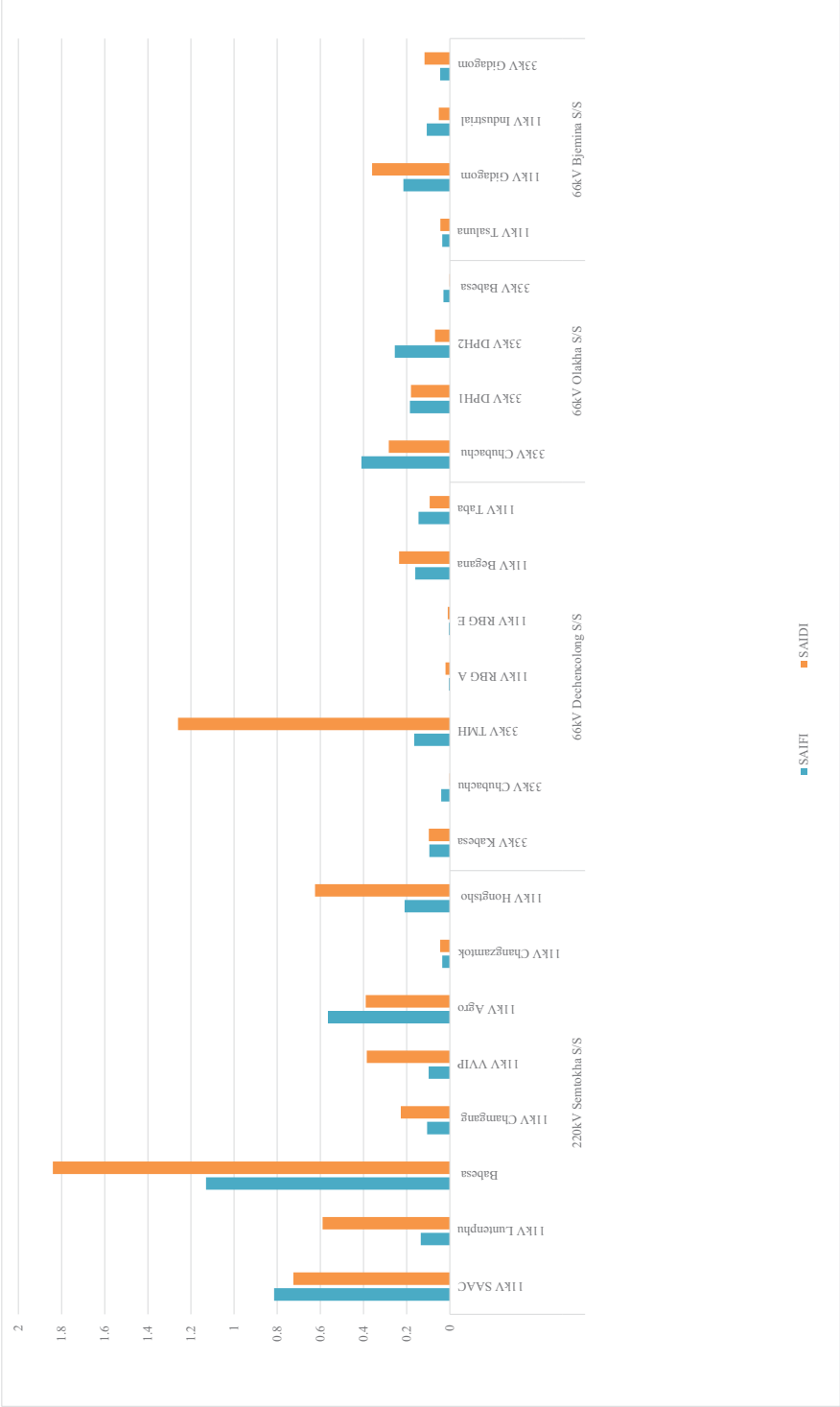
SUMMARY OF TOTAL GENERATION, LOADING & DEMAND

	MW	Mvar	MVA	% PF
Source (Swing Buses):	115.795	83.035	142.489	81.27 Lagging
Source (Non-Swing Buses):	0.000	0.000	0.000	
Total Demand:	115.795	83.035	142.489	81.27 Lagging
Total Motor Load:	32.867	17.930	37.440	87.79 Lagging
Total Static Load:	77.030	45.002	89.213	86.34 Lagging
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	5.897	20.102		
System Mismatch:	0.000	0.000		

Number of Iterations: 4

Annexure 5- Feeder Wise Reliability Indices

	220kV Sementokha S/S						66kV Dechencolong S/S						66kV Olakha S/S						66kV Bjemina S/S					
	11kV SAAC	11kV luntenu u	11kV Babesa	11kV Chamgang	11kV VVIP	11kV Agro tok	11kV Changzam	11kV Hongtsho	33kV Kabesa	33kV Chubachu	33kV TMH A	11kV RBG E	11kV RBG	11kV Begna	11kV Taba Chubachu	33kV Chubachu	33kV DPH1	33kV DPH2	33kV Babesa	11kV Tsaluna	11kV Gidagom	11kV Industrial	33kV Gidagom	
Average	0.815	0.135	1.13	0.105	0.098	0.565	0.035	0.21	0.095	0.04	0.165	0.005	0.005	0.16	0.145	0.41	0.185	0.255	0.03	0.035	0.215	0.107	0.045	
SAIFI																								
SAIDI	0.725	0.59	1.84	0.227	0.3851	0.39	0.045	0.625	0.0971	0.002	1.26	0.02	0.01	0.235	0.093	0.283	0.18	0.0685	0.0015	0.044	0.36	0.0515	0.117	



SL#	Month	2017										2018							
		Reliability	SAAC	Luntenphu	Babesa	Chamgang	VVIP	Agro	Lower Thimphu	Hongtsho	SAAC	Luntenphu	Babesa	Chamgang	VVIP	Agro	Lower Thimphu	Hongtsho	
1.000	January	SAIFI	0.600	-	-	-	-	-	-	-	0.150		0.070						
		SAIDI	0.110	-	-	-	-	-	-	-	0.130		0.040						
2.000	February	SAIFI	-	-	-	-	0.060	-	-										
		SAIDI	-	-	-	-	0.060	-	-										
3.000	March	SAIFI	0.130	-	-	-	-	-	-	-									
		SAIDI	0.090	-	-	-	-	-	-	-		0.840	0.110					0.110	
4.000	April	SAIFI	-	-	-	-	-	-	-	-	0.080		2.180	0.400				0.360	
		SAIDI	-	-	-	-	-	-	-	-	0.180		0.280			0.100			
5.000	May	SAIFI	0.090	-	-	-	-	-	-	-	0.060		0.060	0.040					
		SAIDI	0.170	-	-	-	-	-	-	-	0.110		0.360	0.020					
6.000	June	SAIFI	-	-	-	0.070	-	-	-	-								0.010	
		SAIDI	-	-	-	0.180	-	-	-	-								0.010	
7.000	July	SAIFI	0.160	-	-	0.070	0.030	-	-	-	0.060		0.270		0.050	0.050	0.060	0.110	
		SAIDI	0.240	-	-	0.060	0.020	-	-	-	0.030	1.180			0.540	0.030	0.070	0.130	
8.000	August	SAIFI	-	-	-	0.360	0.010	0.004	0.250	0.010	0.060								
		SAIDI	-	-	-	0.260	0.001	0.010	0.150	0.020	0.020								
9.000	September	SAIFI	0.080	-	-	0.220	0.010	-	0.300	-									
		SAIDI	0.270	-	-	0.140	0.010	-	0.120	-					0.090			0.110	
10.000	October	SAIFI	0.080	-	-	0.220		0.002	0.200	-									
		SAIDI	0.020	-	-	0.150		0.000	0.170	-									
11.000	November	SAIFI	-	-	-	-	0.010	-	0.100	-									
		SAIDI	-	-	-	-	0.003	-	0.020	-									
12.000	December	SAIFI	0.080	-	-	0.070			0.070	-					0.050				
		SAIDI	0.080	-	-	0.030			0.160	-					0.210				
	2017	SAIFI	1.2200	-	1.0100	0.0600	0.0060	0.9800	0.0100	11kV Hongtsho									
		SAIDI	0.9800	-	0.8200	0.0340	0.0102	0.6800	0.0200	11kV Changzamtok									
	2018	SAIFI	0.410	0.270	1.250	0.150	0.190	0.150	0.060	0.340									
		SAIDI	0.470	1.180	2.860	0.420	0.760	0.100	0.070	1.000									
	Average	SAIFI	0.815	0.135	1.130	0.105	0.098	0.565	0.035	0.210									
		SAIDI	0.725	0.590	1.840	0.227	0.385	0.390	0.045	0.625									



SL#	Month	Reliability	2017				2018			
			Chubachu	DPH1	DPH2	Babesa	Chubachu	DPH1	DPH2	Babesa
1.000	January	SAIFI	0.060							
		SAIDI	0.002							
		SAIFI	0.180							
2.000	February	SAIDI	0.120							
		SAIFI								
		SAIDI								
3.000	March	SAIFI								
		SAIDI								
		SAIFI								
4.000	April	SAIDI							0.060	
		SAIFI							0.003	
		SAIDI							0.100	
5.000	May	SAIDI					0.110		0.010	
		SAIFI					0.190			
		SAIDI				0.040				
6.000	June	SAIFI				0.002				
		SAIDI								
		SAIFI					0.060		0.050	
7.000	July	SAIDI					0.120		0.010	
		SAIFI	0.080							
		SAIDI	0.004							
9.000	September	SAIFI	0.080		0.240	0.020			0.050	
		SAIDI			0.090	0.070			0.004	
		SAIFI			0.120					
10.000	October	SAIDI			0.260					
		SAIFI								
		SAIDI								
11.000	November	SAIFI								
		SAIDI								
		SAIFI	0.250					0.010	0.050	
12.000	December	SAIDI	0.130					0.010	0.040	

Olakha HV S/S

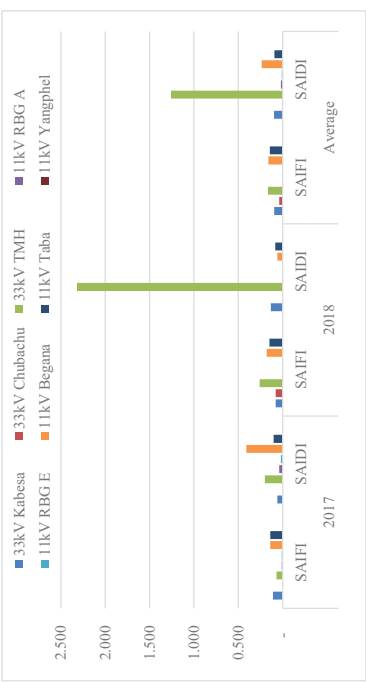


		33kV Chubachu	11kV DPH1	11kV DPH2	11kV Babesa
10.000	2017	SAIFI	0.650	0.360	0.060
		SAIDI	0.256	0.350	0.003
		SAIFI	0.170	0.010	-
11.000	2018	SAIDI	0.310	0.010	0.067
		SAIFI	0.410	0.185	0.030
		SAIDI	0.283	0.180	0.002
12.000	Average	SAIFI	0.410	0.185	0.030
		SAIDI	0.283	0.180	0.002

Dechencholing

SL#	Month	Reliability	2017							2018								
			Kabesa	Chubachu	TMH	RBG A	RBG E	Begana	Taba	Yangphel	Kabesa	Chubachu	TMH	RBG A	RBG E	Begana	Taba	Yangphel
1.000	January	SAIFI															0.010	
		SAIDI															0.020	
2.000	February	SAIFI																
		SAIDI																
3.000	March	SAIFI	0.060													0.160		
		SAIDI	0.000													0.050		
4.000	April	SAIFI			0.070							0.080						
		SAIDI			0.200							0.004						
5.000	May	SAIFI						0.040										
		SAIDI						0.280										
6.000	June	SAIFI						0.060										
		SAIDI						0.060										
7.000	July	SAIFI				0.010	0.010	0.040										
		SAIDI			0.040	0.020	0.070											
8.000	August	SAIFI	-														0.060	
		SAIDI	0.050														0.020	
9.000	September	SAIFI									0.020					0.020		
		SAIDI									0.002					0.010		
10.000	October	SAIFI	0.050															
		SAIDI	0.010															
11.000	November	SAIFI									0.020						0.060	
		SAIDI									0.002		0.130	2.090			0.040	
12.000	December	SAIFI									0.040		0.020	0.130			0.020	
		SAIDI									0.130		0.230				0.004	

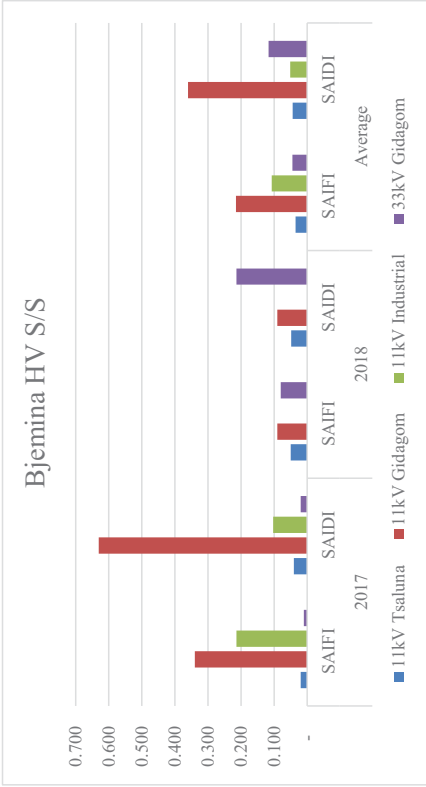
		33kV Kabesa	33kV Chubachu	33kV TMH	11kV RBG A	11kV RBG E	11kV Begana	11kV Taba	11kV Yangphel
2017	SAIFI	0.110	-	0.070	0.010	0.010	0.140	0.140	-
	SAIDI	0.060	-	0.200	0.040	0.020	0.410	0.102	-
2018	SAIFI	0.080	0.080	0.260	-	-	0.180	0.150	-
	SAIDI	0.134	0.004	2.320	-	-	0.060	0.084	-
Average	SAIFI	0.095	0.040	0.165	0.005	0.005	0.160	0.145	-
	SAIDI	0.097	0.002	1.260	0.020	0.010	0.235	0.093	-



Bjemina

SL#	Month	Reliability	2017				2018				
			Tsaluna	Gidagom (11)	industrial	Gidagom (33)	Tsaluna	Gidagom (11)	industrial	Gidagom (33)	
1.000	January	SAIFI							0.030		0.030
		SAIDI							0.060		0.010
2.000	February	SAIFI							0.020		0.010
		SAIDI							0.010		0.040
3.000	March	SAIFI							0.030		0.010
		SAIDI			0.090				0.010		0.040
4.000	April	SAIFI				0.060					
		SAIDI			0.030				0.010		0.040
5.000	May	SAIFI				0.060					
		SAIDI			0.040		0.008				0.050
6.000	June	SAIFI		0.060							0.020
		SAIDI		0.270							0.070
7.000	July	SAIFI		0.120	0.002						
		SAIDI		0.040	0.010						
8.000	August	SAIFI	0.010								
		SAIDI	0.030								
9.000	September	SAIFI		0.110							
		SAIDI		0.080							
10.000	October	SAIFI		0.020	0.002	0.010					
		SAIDI		0.120	0.003	0.020					
11.000	November	SAIFI	0.010				0.030				
		SAIDI	0.010				0.040				0.010
12.000	December	SAIFI		0.030				0.010			0.010
		SAIDI		0.120				0.010			0.004

		11kV	11kV Tsaluna	11kV Gidagom	11kV Industrial	33kV Gidagom
10.000	2017	SAIFI	0.020	0.340	0.214	0.010
		SAIDI	0.040	0.630	0.103	0.020
11.000	2018	SAIFI	0.050	0.090	-	0.080
		SAIDI	0.048	0.090	-	0.214
12.000	Average	SAIFI	0.035	0.215	0.107	0.045
		SAIDI	0.044	0.360	0.052	0.117



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	Trashigang	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 in case 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

Annexure 8- Material Cost of three phase (3 Φ) 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	Trashigang	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	1 Φ	3 Φ	1 Φ
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	Trashigang	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

