**Palestine Polytechnic University**

**College of Engineering**

# Minimization the Power Losses in Wad Shaheen Substation Network of JDECo

**Project Team**

**Omar Alkhatib** **Bilal ALhassis**

**Supervisor**

**Dr. Fouad Zaro**

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# الاهداء

الحمد لله اللذي بنعمته تتم الصالحات

نهدي تخرجنا الى معلم البشريه محمد ﷺ

الى امهاتنا اللواتي تحت اقدامهن الجنه

الى كل الاصدقاء وزملائنا في الدراسه

الى اساتذتنا اللذين لا تكفي لوصفهم الكلمات

مقدمين ثمره سنواتنا الدراسيه

سائلين المولى عز وجل التوفيق بكل خطوه

# شكر وتقدير

بعد شكرنا لله عز وجل ان اعاننا على انجاز هذا البحث المتواضع نقدم بجزيل الشكر والامتنان للدكتور الفاضل فؤاد الزرو على تفضله بقبول الاشراف على بحثنا،وعل كل النصائح والتوجيهات اللتي كانت بمثابه نبراس منير في كل خطوه.

وكذلك نود شكر كل من ساعدنا على اتمام هذا البحث وقدم لنا العون والمساعده بتزويدنا بالمعلومات اللازمه لاتمام هذا البحث ونخص بالذكر المهندس امجد كمال مدير قسم السكادا

في شركه كهرباء القدس اللذي لم يبخل علينا باعطائنا المعلومات اللازمه لاتمام البحث.

# Abstract


**This project studies the distribution network of the Wad Shaheen substation by using Electrical Transient Analyzer Program (ETAP) and it aims to make the critical developments and improvements on the network to minimize the power losses.**

**The network of the Wad Shaheen substation has high losses, during the average load, the power loss is 6.33% of demanded power this loss cost 4 ,299,408 NIS/Year.**

**There are several techniques to reduce power losses in the distribution network, We chose two techniques to test their effectiveness on the network, as follows: -**

**1. Network reconfiguration.**

**2. Network reconductoring.**

**After tested these techniques on the network, We found total power losses could be reduced from (1.636) MW to (1.382, 0.941 or 1.105)MW, depending on the soluition.**

## الملخص

يدرس هذا المشروع شبكه توزيع محطه واد شاهين باستخدام برنامج تحليل انظمه القوى(ETAP ) ، ويهدف لاجراء التطويرات ذات الاهميه الكبرى على الشبكه من اجل تقليل خسائر الطاقه.

تعاني شبكه واد شاهين من خسائر عاليه تصل الى 6.33% خلال الحمل المتوسط من الطاقه المطلوبه وتبلغ تكاليف هذه الخسائر حوالي 4,299,408 شيكل/سنه.

هنالك العديد من الحلول اللتي يمكن استخدامها لتقليل الخسائر،وقمنا باختيار افضل حلين من ناحيه تاثيرهما على الشبكه:-

1. إعادة تشكيل الشبكة.

2. إعادة توصيل الشبكة.

بعد اختبار هذين الحلين وجدنا انه يمكن تقليل فقد الطاقه من (ميجا واط1.636) الى(1.382,0.941 او1.105)ميجا واط وذلك بالاعتماد على الحل المناسب.

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# List of abbreviations

JDECo: The Jerusalem District Electricity Company

ETAP: Electrical Transient Analyzer Program

LVDS: Low Voltage Distribution System

HVDS: High Voltage Distribution System

ACCC: Aluminum Conductor Composite Core

IEC: Israeli Electric Company

MV: Medium Voltage

kV: kilo Volt

kVA: Kilovolt Volt Ampere

MVA: Megavolt- Ampere

km: kilometer

kWh: kilowatt-hour

kW: kilo Watt

PF: Power Factor

FACT:Flexible Alternating Current Transmission System

IEEE:  Institute of Electrical and Electronics Engineers

# Chapter 1

## Introduction

### 1.1Overview

### 1.2 Motivation

### 1.3 Objectives

### 1.4 Methodology

### 1.5 Literature Review

### 1.6 Time Plane

## 1.1Overview

This project studies sub distribution network of Jerusalem District Electric Co (JDECo), this network for Wad Shaheen substation, determine the power losses in the distribution networks components such as losses in the cables and transformers and do the simulation for the distribution of Wad Shaheen substation network by using ETAP to estimate the real power losses and propose scenarios to reduce it.

## 1.2 Motivation

The motivation behind this study is to get the best economical solution which helps in reducing the money lost that can be used to improve the distribution network of Wad Shaheen substation or in another benefit for the company which also may give the customer some advantages, estimate the power losses in the distribution network for Wad Shaheen substation network by using ETAP, and start the essential steps to minimize the power losses.

## 1.3 Objectives

1. Analysing the power flow using ETAP to obtain useful and detailed readings and information about the power losses in the distribution network.
2. Proposing sensible scenarios for power loss minimization.

## 1.4 Methodology

The procedures followed to accomplish this project are summarized as follow:

1. Data collection: the collected data involves the single line diagram (SLD) of the Wad Shaheen substation electrical network of the electrical MV network, the electrical specifications of the wires, cables, and transformers used by JDECo and the transformers loading measurements for both summer and winter seasons.
2. Load flow analysis: the single-line diagram of the Wad Shaheen substation is provided to ETAP software. The electrical specifications of the lines and transformers were entered into customized libraries in ETAP. Then, A simulation process will be performed to evaluate the status of the distribution networks completely.

## 1.5 Literature Review

Nassim A. Iqteit", Aysen Basa Arsoy" and „Bekir Cakir" illustrated a simple approximated formulas which explain the way to estimate the active and reactive power losses in the distribution networks, taking load profiles into account. Also, a detailed simulation and discussion were presented with an applied example, the idea of the formulas is easy to apply and has a small error when using an appropriate number of time intervals [1].

Another paper discusses the types of the losses in the DC and AC generator, the effect of these losses and how may reduce these losses to the minimum magnitude. In addition, he discussed the major electrical transmission line losses and the best solutions to minimize it, this article was made for a specific part of Jordan, the author used ETAP for simulation and presented a detailed comparison before and after each case [2].

The authors in focused on developing and improving the medium voltage electrical network and they presented the modelling approach used to restructure electrical network configuration, reduce drop voltage, reduce power losses and add new distribution transformer to enhance reliability of power systems distribution. Restructure electrical network was aimed to analyze and investigate electric loads of a distribution transformer. Measurement of real voltage and real current were finished two times for each consumer, that were morning period and night period or when peak load. Design and simulation were conduct by using ETAP[2].

This paper presents the estimation of Technical loss in a distribution system which plays an important role in planning and hence economics of any distribution utility. In a system there are two types of losses: fixed i.e.no load losses and variable i.e. load losses which are a function of load. This paper focuses on how load curve parameters like load factor, loss factor, coefficient of variation and loss coefficient can be useful for the loss estimation process. A simple approach is proposed to estimate technical loss in HT feeder and Distribution Transformer with nonfunctional energy meters with average demand using data available with local distribution company. Also, the paper discusses the use of average demand and loss coefficient in making economic cable choices and energy losses analysis [7].

## 1.5 Time Plan

**Table 1.1:** Time Plan for First semester

| Week / Work | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Selection Project** | | | | | | | | | | | | | | | | |
| **Data Collection** | | | | | | | | | | | | | | | | |
| **Data Analyses** | | | | | | | | | | | | | | | | |
| **Preparing the final report** | | | | | | | | | | | | | | | | |
| **Prepare the Presentation** | | | | | | | | | | | | | | | | |

**Table 1.2:** Time Plan for Second semester

| Week / Work | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Collecting data** | | | | | | | | | | | | | | | | |
| **Analysis in Etap** | | | | | | | | | | | | | | | | |
| **Select the solution** | | | | | | | | | | | | | | | | |
| **Preparing the final report** | | | | | | | | | | | | | | | | |
| **Prepare the presentation** | | | | | | | | | | | | | | | | |

# Chapter 2

# Case Study  Wad Shaheen Substation for JDECo

## 2.1 Introduction

## 2.2 The Existing System

## 2.3 Wad Shaheen power losses

## 2.4 Maximum and Minimum Power

## 2.1 Introduction

The municipality Wad Shaheen is located in the center of Bethlehem, 2 km from the city center, and has an estimated population of 10 thousand people, Its area 2 $km^2$ , and height is 750m From the sea.

Jerusalem District Electricity company (JDECO) is the biggest electricity distribution company in the Jerusalem & the West Bank serving more than "300,000" customers through a huge medium voltage grid. The peak load for the grid reaches about "550 MW" in winter time where almost all the feeding points loading at that period exceeds the "98 %" limit.

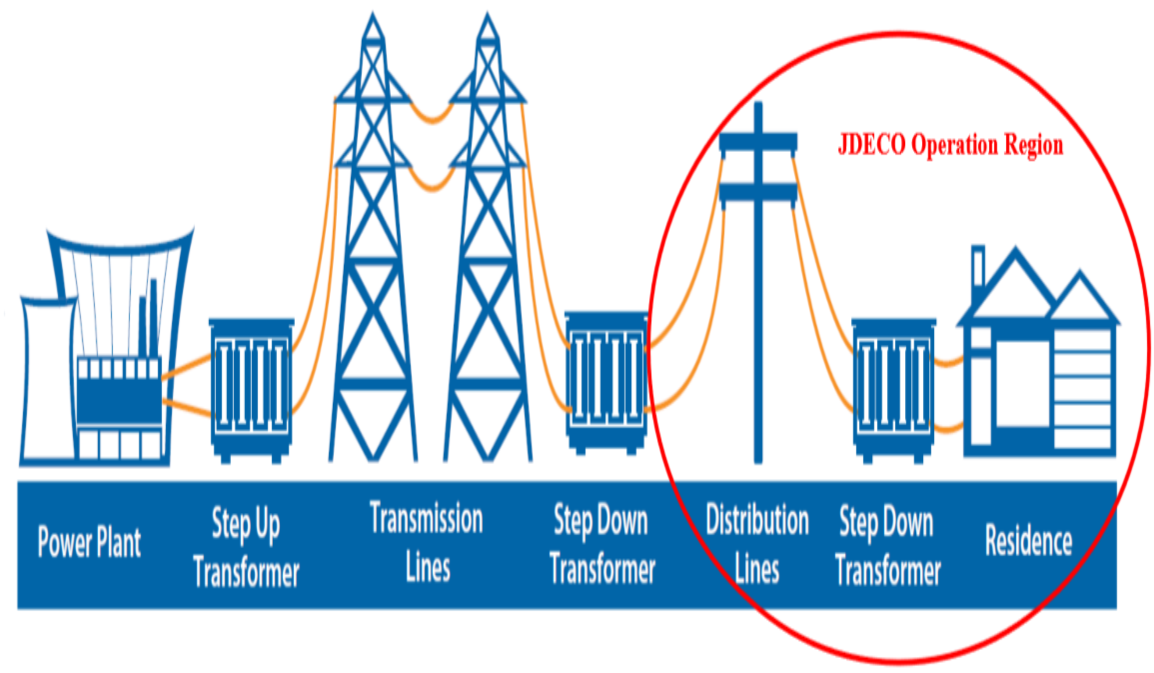



**Figure 2.1** : Electrical Distribution System

The Wad Shaheen substation is supplied from Israel Electric Corporation (IEC) with 33 kV and two transformer converts it to 11 kV however, most loads are connected by distribution transformers 33/0.4 kV. as shown in figure (2.2) [3]:

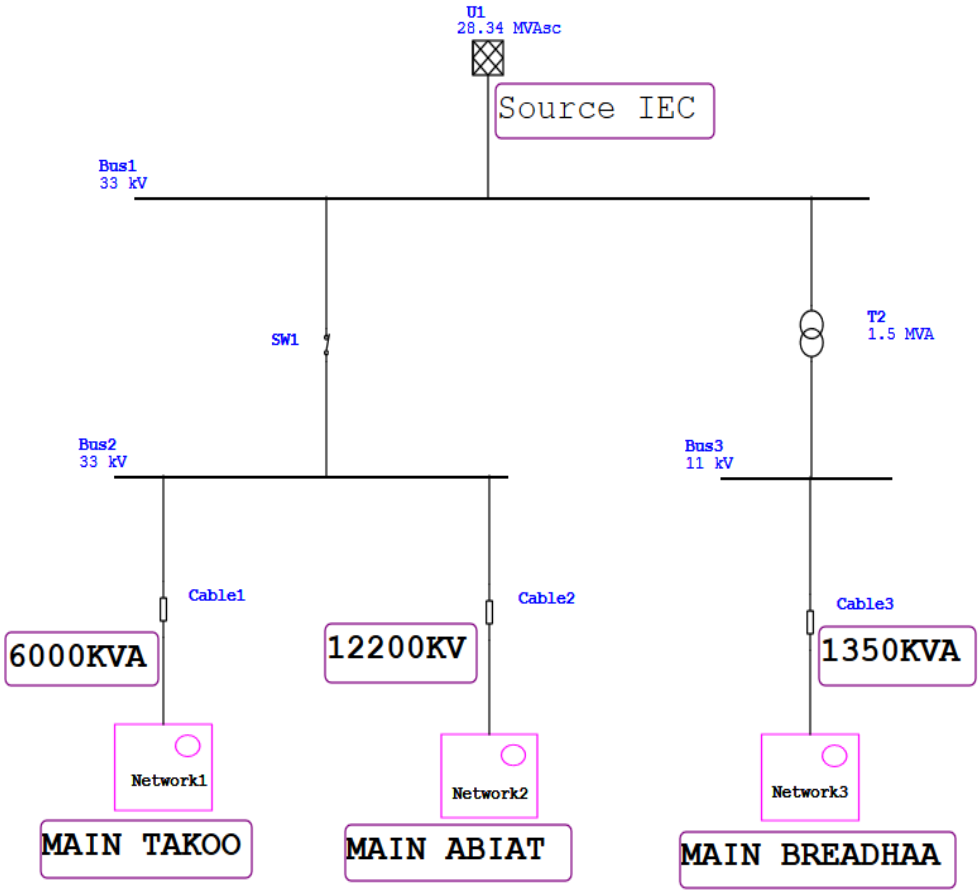



**Figure 2.2** : Single Line Diagram of Wad Shaheen Substation

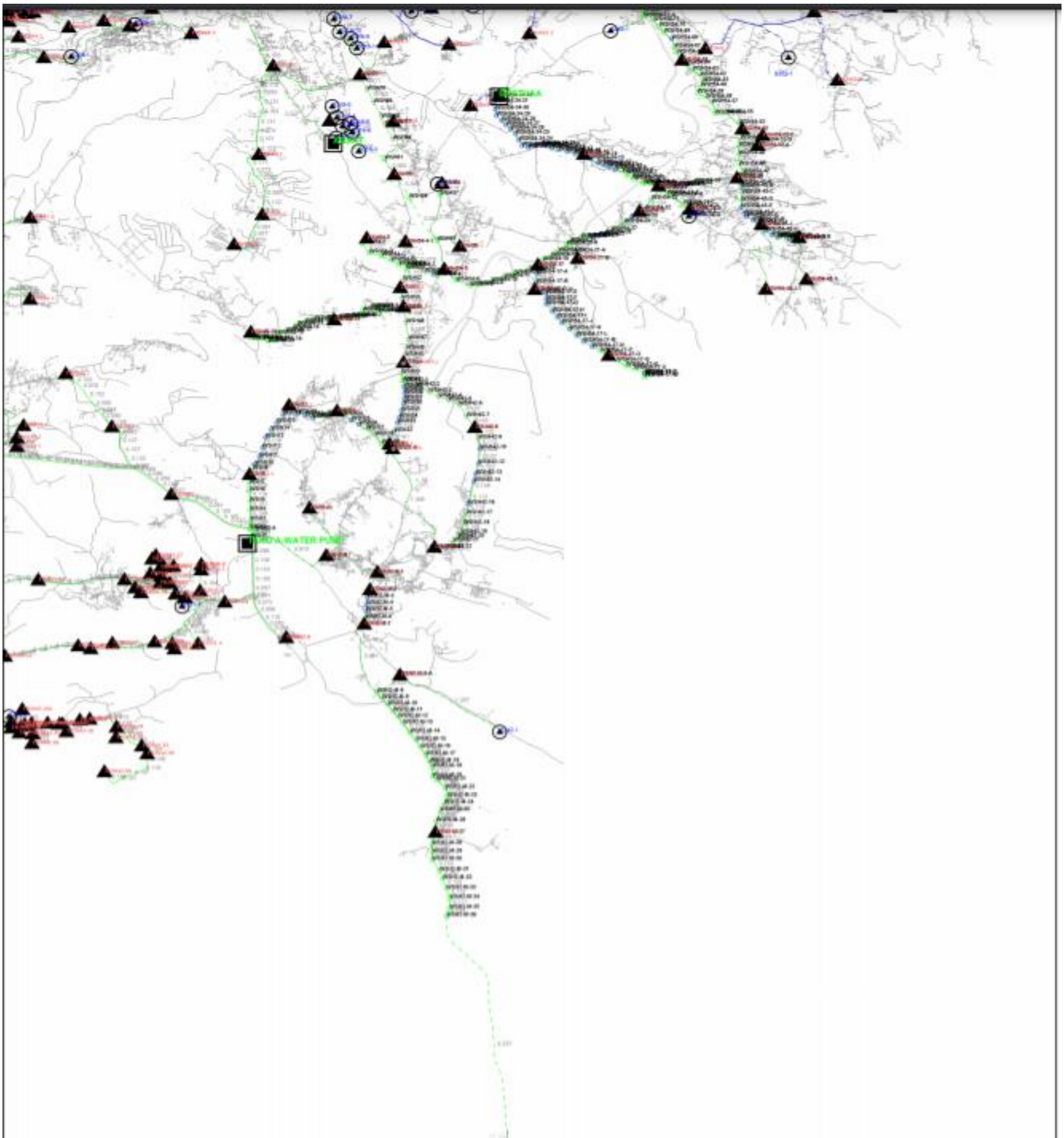


**Figure 2.3** : Distribution substation for Wad Shaheen

## 2.2 The Existing System

### 2.2.1 Substations

It is found in the WAD Shaheen three substation network These transformers are distributed to the stations through the table (2.1) [3]:

**Table 2.1 :** Main substations transformers

| Substation | No.Of transformers | Capacity(MW) |
|---|---|---|
| TAKOO | 25 | 9.3 |
| BREADHAA | 20 | 9.18 |
| ABIAT | 18 | 9.95 |
| total | 63 | 28.43 |

### 2.2.2 Distribution Transformers

Wad Shaheen grid contain 63 transformer ,these transformer have a wide range of (KVA) from (100-1600)KVA represented in following table (2.2) and figure (2.4) show the percentage range of the distribution transformer in MW network[3]:

**Figure 2.4 :** Transformer

**Table 2.2 :** Distribution Transformers.

| Transformer Rating(KVA) | Number of Transformer | % | MVA |
|---|---|---|---|
| 100 | 3 | 4.761904762 | 0.3 |
| 160 | 8 | 12.69844127 | 1.28 |
| 250 | 23 | 36.50793651 | 5.75 |
| 400 | 12 | 19.04761905 | 4.8 |
| 630 | 10 | 15.87301587 | 6.3 |
| 1000 | 2 | 3.174603175 | 2 |
| 1600 | 5 | 7.936507937 | 8 |
| Total | 63 | 100 | 28.43 |

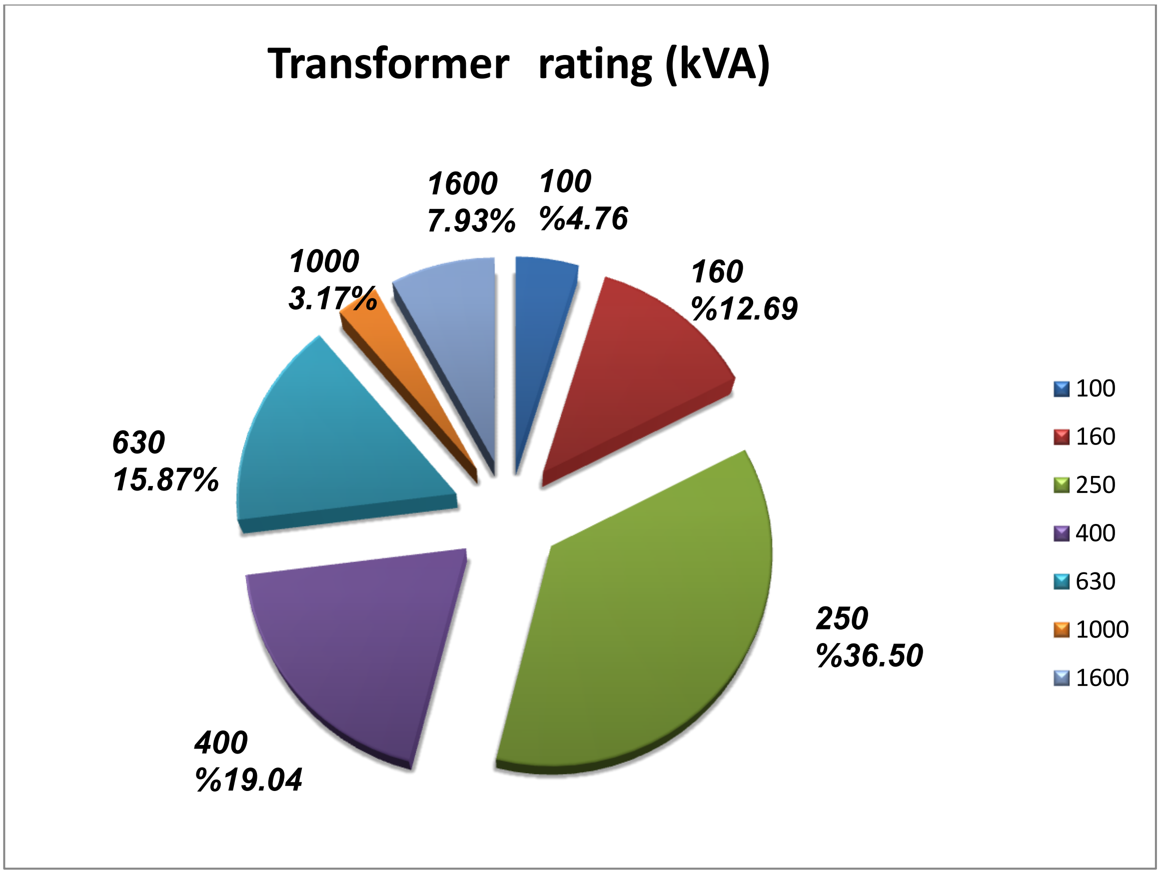



**Figure 2.5 :** Distribution Transformers in (KVA)

### 2.2.3 Overhead Lines

Overhead lines of Wad Shaheen substation medium voltage network is 33 kV network JDECo , The network contains overhead lines as shown in table (2.2):

**Table 2.3 :**Conductor Data

| Conductor Type | Quantity(Km) |
|---|---|
| Overhead  33KV TSLE 3X1X240 CU | 0.859 |
| Overhead 33KV FEAL 1X95 | 21.968 |
| Overhead  33KV 3X1X150 CU | 13.126 |
| Overhead 33KV TSLE 3X1X240 AL | 5.09 |
| Overhead 33KV EX 1X3X150 | 0.136 |
| Overhead 33KV DKBA 1X3X120 CU | 0.061 |
| Over head 33KV FEAL 1X50 | 3.242 |
| Total | 44.482 |

## 2.2.4 Isolation :

What is isolation?

Galvanic isolation is a circuit design technique that allows two circuits to communicate and eliminates any unwanted direct current that flows between them.

Isolation is used most commonly to:

- Protect human operators and low-voltage circuitry from high voltages.
- Prevent ground potential differences between communicating subsystems.
- Improve noise immunity.

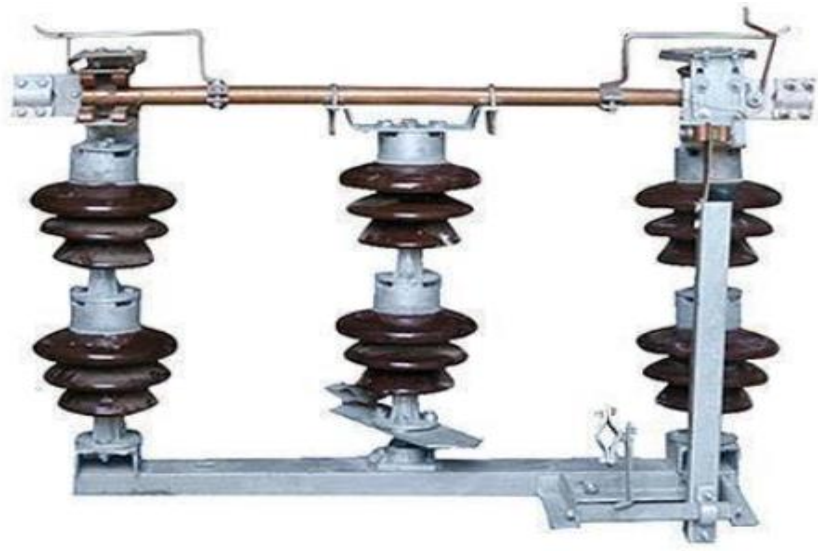


Figure 2.6 : Isolator

## 2.3 Wad Shaheen power losses

- The following figure(2.7) show the real power in transformer and cable in wad shaheen substation.

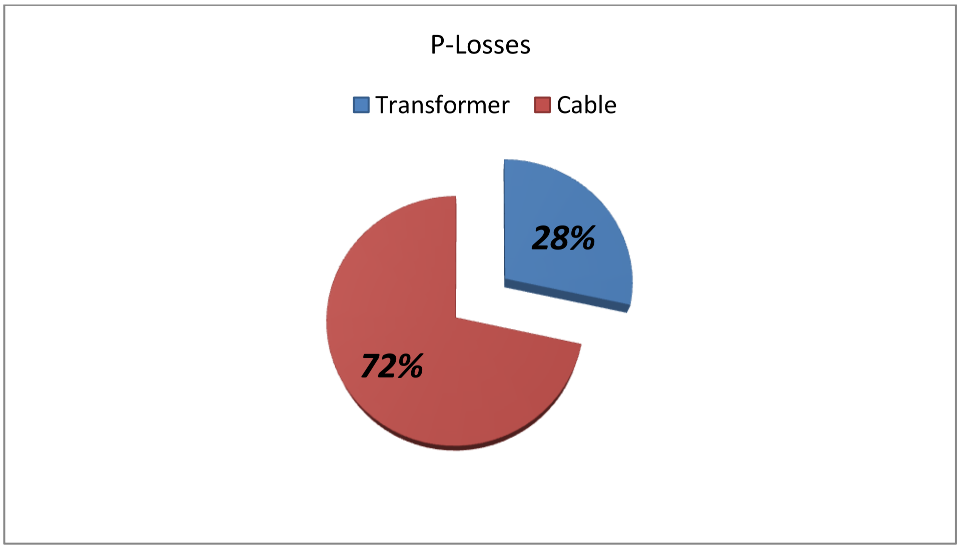



**Figure2.7**:Contribution of Grid Elements in P-Losses

- The following figure(2.8) show the real reactive power  in transformer and cable in wad shaheen substation.

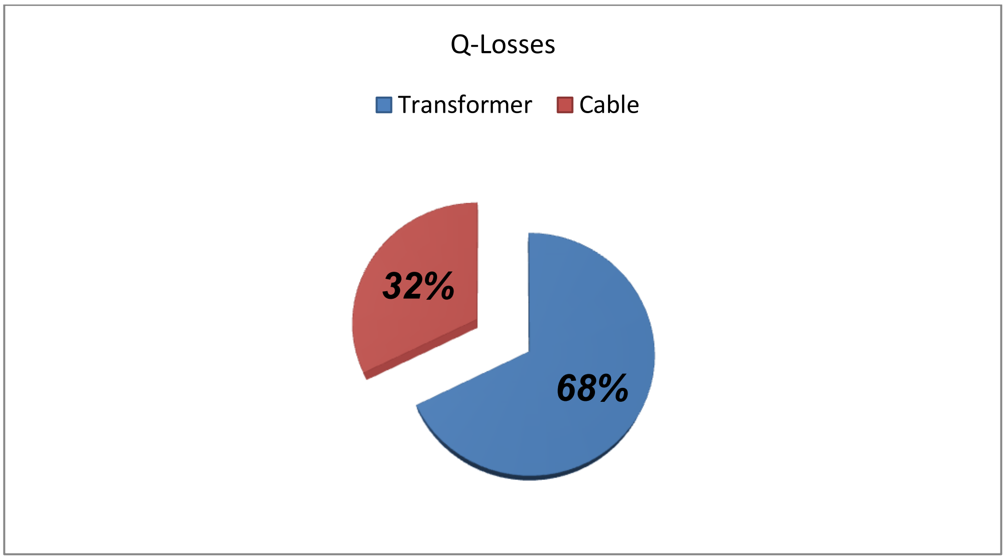



**Figure 2.8**:Contribution of Grid Elements in Q-Losses

- The following figure(2.9) show the Power losses percentage in 2017 and 2018 and 2019.

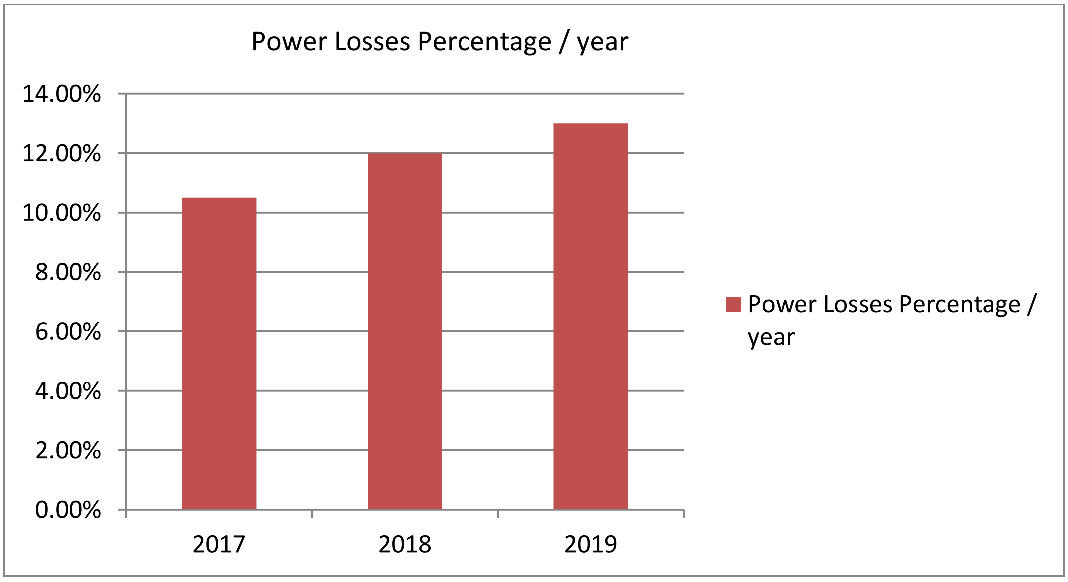



**Figure 2.9:** Power losses percentage / year

## 2.5 Maximum and Minimum Power

-In 2018 The Peak Load for network Wad Shaheeh substation was (246.3707) KVA As shown in figure (2.10) (2.11).

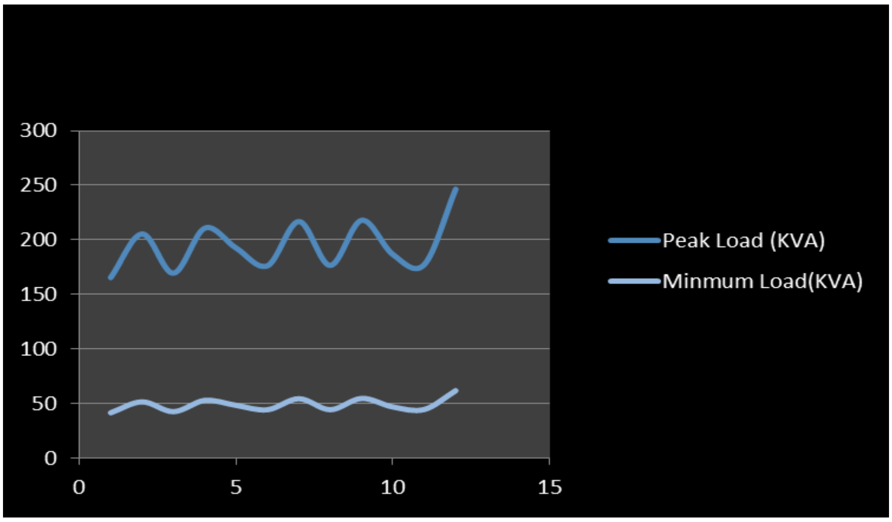



**Figure 2.10 :** The Minimum and Maximum Load for the Wad Shaheen substation in 2018

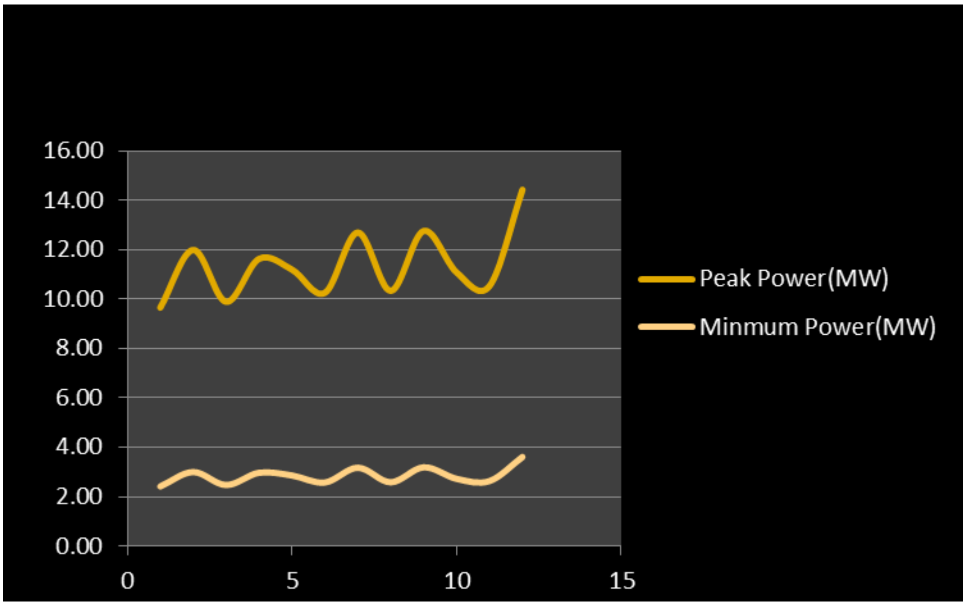



**Figure 2.11 :** The Minimum and Maximum power for the Wad Shaheen substation in 2018

-In 2019 The Peak Power for network Wad Saleh substation was (298.52) KVA As shown in figure (2.12) (2.13).

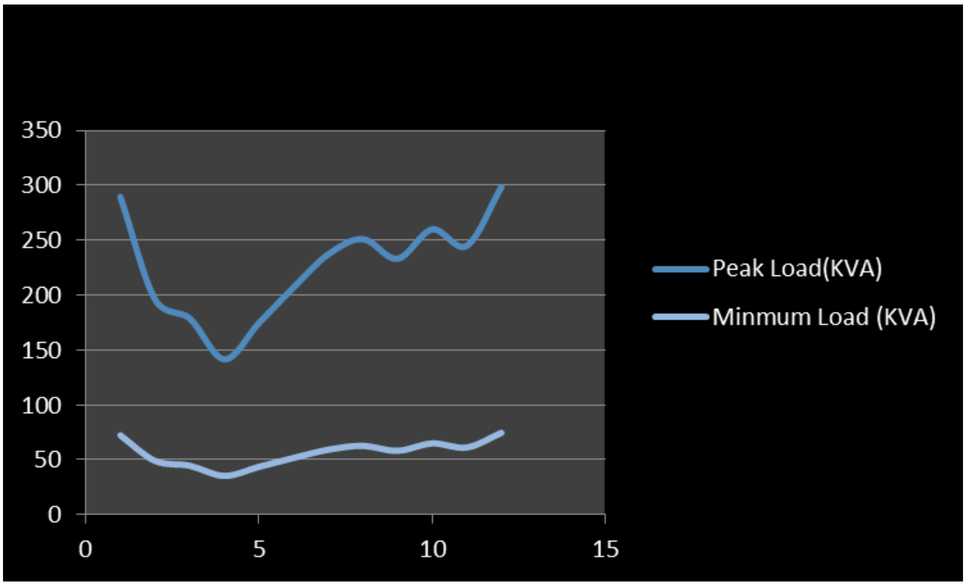



**Figure 2.12 :** The Minimum and Maximum Load for the Wad Shaheen substation in 2019

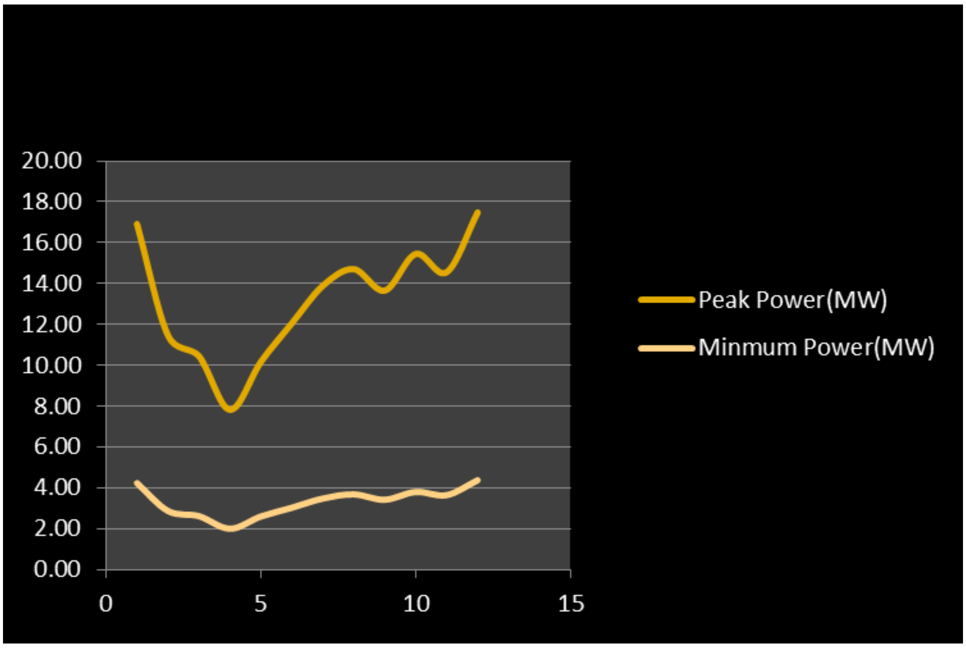



**Figure 2.13 :** The Minimum and Maximum power for the Wad Shaheen substation in 2019

-In 2020 The Peak Power for network Wad Saleh substation was (291.5173) KVA As shown in figure (2.14) (2.15).

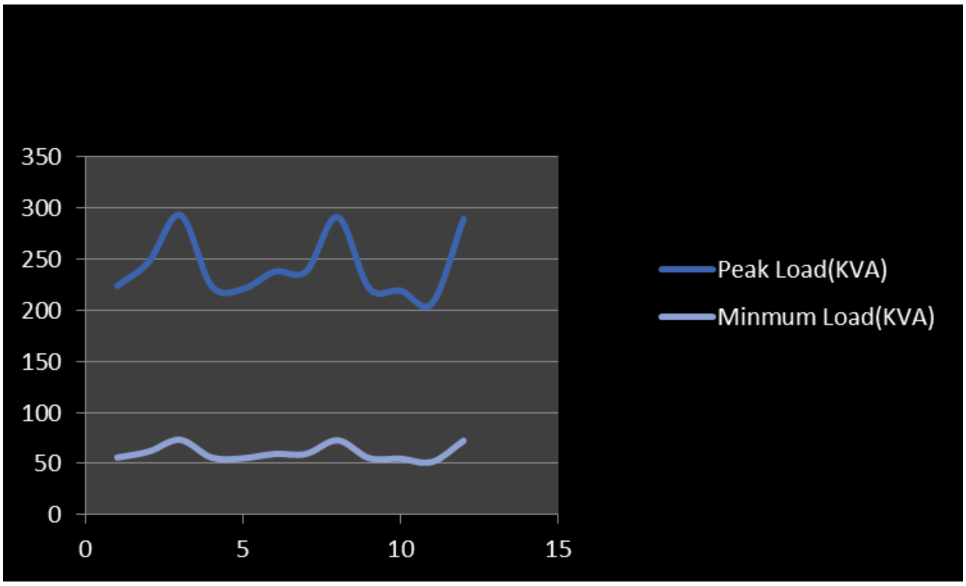



**Figure 2.14 :** The Minimum and Maximum Load for the Wad Shaheen substation in 2020

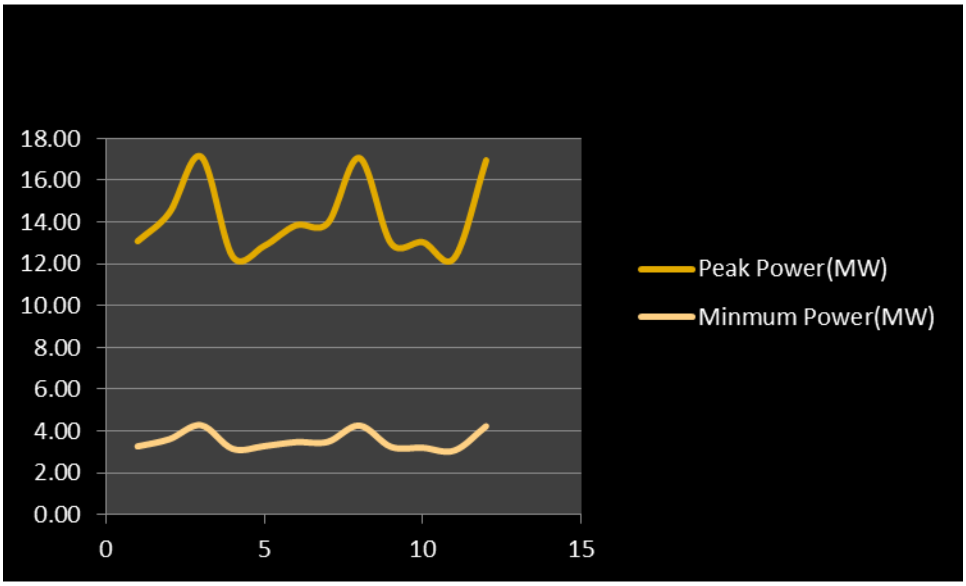



**Figure 2.15 :** The Minimum and Maximum power for the Wad Shaheen substation in 2020

The network of Wad Shaheen substation supplies an average of 10590.20183 KWh in the year 2019. as shown in figure (2.4) [3]

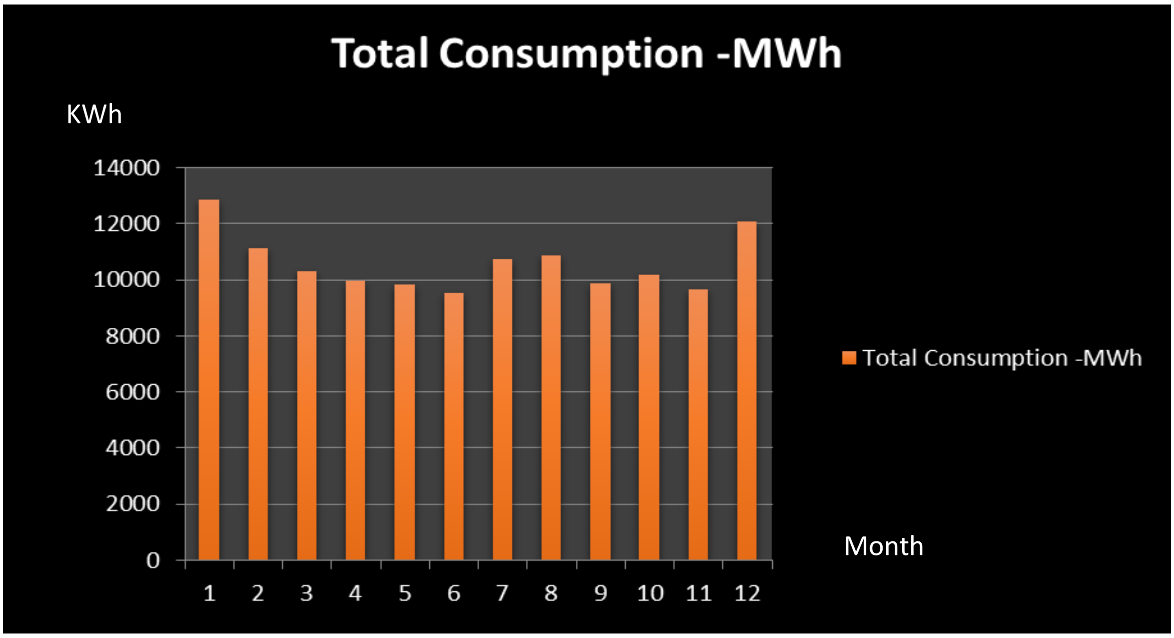



**Figure 2.16 :** Power Consumption 2019

# CHAPTER 3

# POWER LOSSES

## 3.1 Introduction

## 3.2 Types of Power Losses

## 3.3 Drawbacks of Losses

## 3.4 Advantages of Minimizing Losses

## 3.5 Power flow Analysis

## 3.6 Efficient Electrical Energy Transmission and Distribution

## 3.1 Introduction

Electric power transmission and distribution losses include losses in transmission between sources of supply and points of distribution and in the distribution to consumers, including pilferage[3].

In simple terms, Network Losses refer to the difference between the energy entering our electricity distribution network and the energy leaving it. Electricity enters our network in one of two ways; either from the Transmission System or from generators connected directly to our Distribution Network[3].

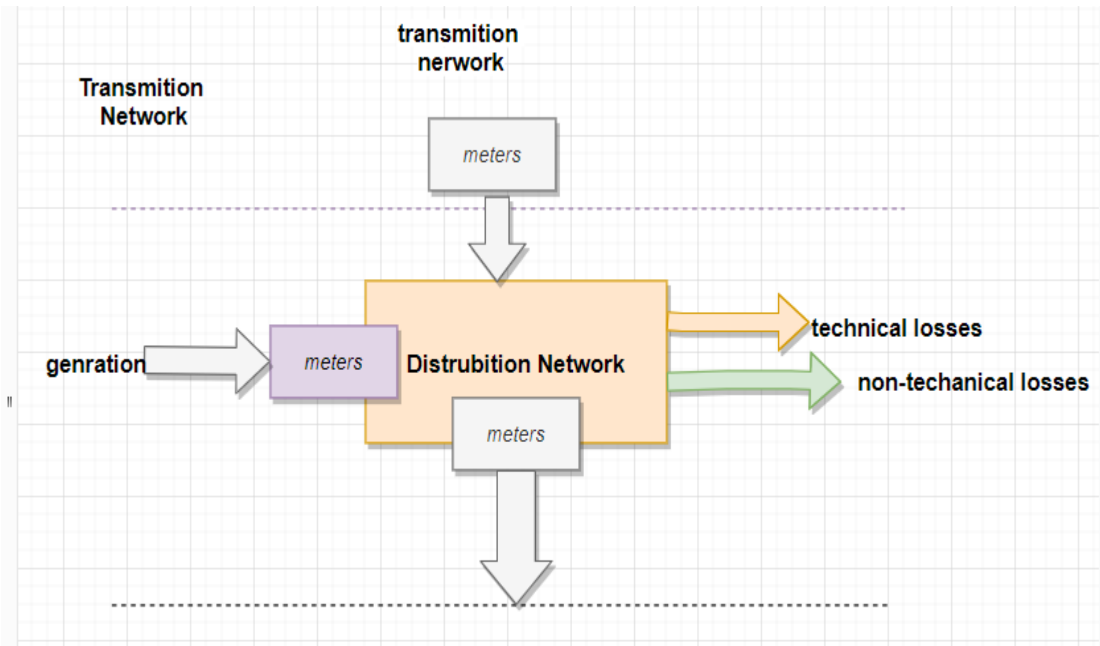



**Figure 3.1:** Losses type in distribution network[4]

## 3.2 Types of  Power Losses

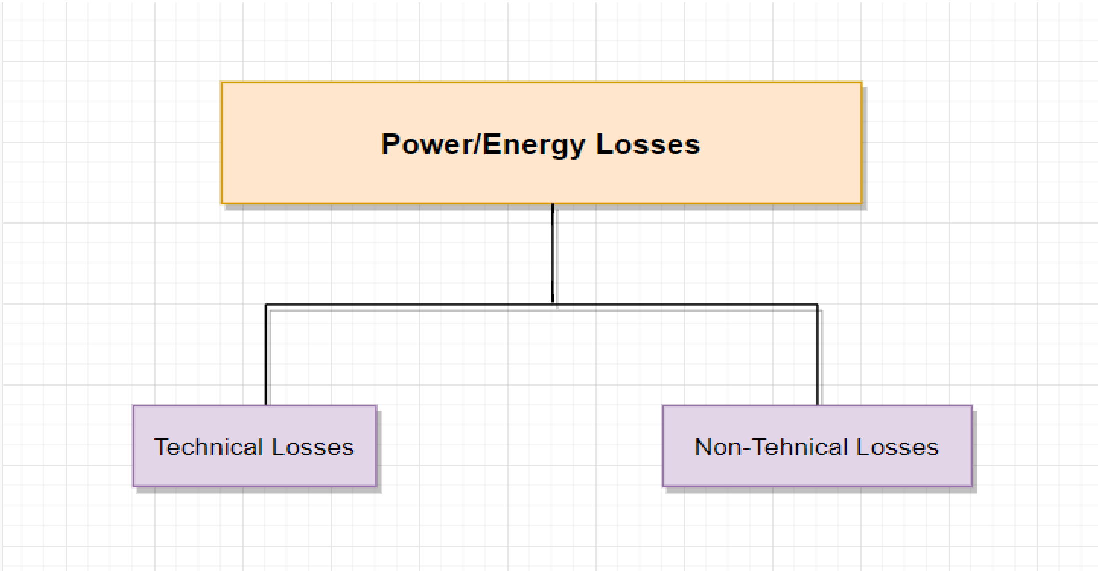



**Figure3.2:** Type of power Losses[4]

### 3.2.1 Technical losses

The technical losses are due to energy dissipated in the conductors, equipment used for transmission line, transformer, sub transmission line and distribution line and magnetic losses in transformers[4].

Technical losses are normally 22.5%, and directly depend on the network characteristics and the mode of operation[4].

The major amount of losses in a power system is in primary and secondary distribution lines. While transmission and sub-transmission lines account for only about 30% of the total losses. Therefore the primary and secondary distribution systems must be properly planned to ensure within limits[4].

- The unexpected load increase was reflected in the increase of technical losses above the normal level[4].

- Losses are inherent to the distribution of electricity and cannot be eliminated[4].

There are two Type of Technical Losses :

1. Fixed Technical losses.

2. Variable Technical losses.

### 3.2.1.1 Fixed Technical losses:

Fixed losses do not vary according to current. These losses take the form of heat and noise and occur as long as a transformer is energized[4].

- Between 1/4 and 1/3 of technical losses on distribution networks are fixed losses. Fixed losses on a network can be influenced in the ways set out below[4].
- Corona Losses.
- Leakage Current Losses.
- Dielectric Losses.
- Open-circuit Losses.
- Losses caused by continuous load of measuring elements.
- Losses caused by continuous load of control elements.

### 3.2.1.2 Variable Technical losses:

Variable losses vary with the amount of electricity distributed and are, more precisely, proportional to the square of the current. Consequently, a 1% increase in current leads to an increase in losses of more than 1%[4].

- Between 2/3 and 3/4 of technical (or physical) losses on distribution networks are variable Losses[4].
- By increasing the cross sectional area of lines and cables for a given load, losses will fall. This leads to a direct trade-off between cost of losses and cost of capital expenditure. It has been suggested that optimal average utilization rate on a distribution network that considers the cost of losses in its design could be as low as 30 per cent.
- Joule losses in lines in each voltage level
- Impedance losses

### 3.2.1.3 Technical Losses in Transformers

Transformers are thought of the main component in the distribution grid, and therefore it counts for a significant part of the total losses in the network , in this section it will be stated in detail what are these losses and how they are calculated[5].

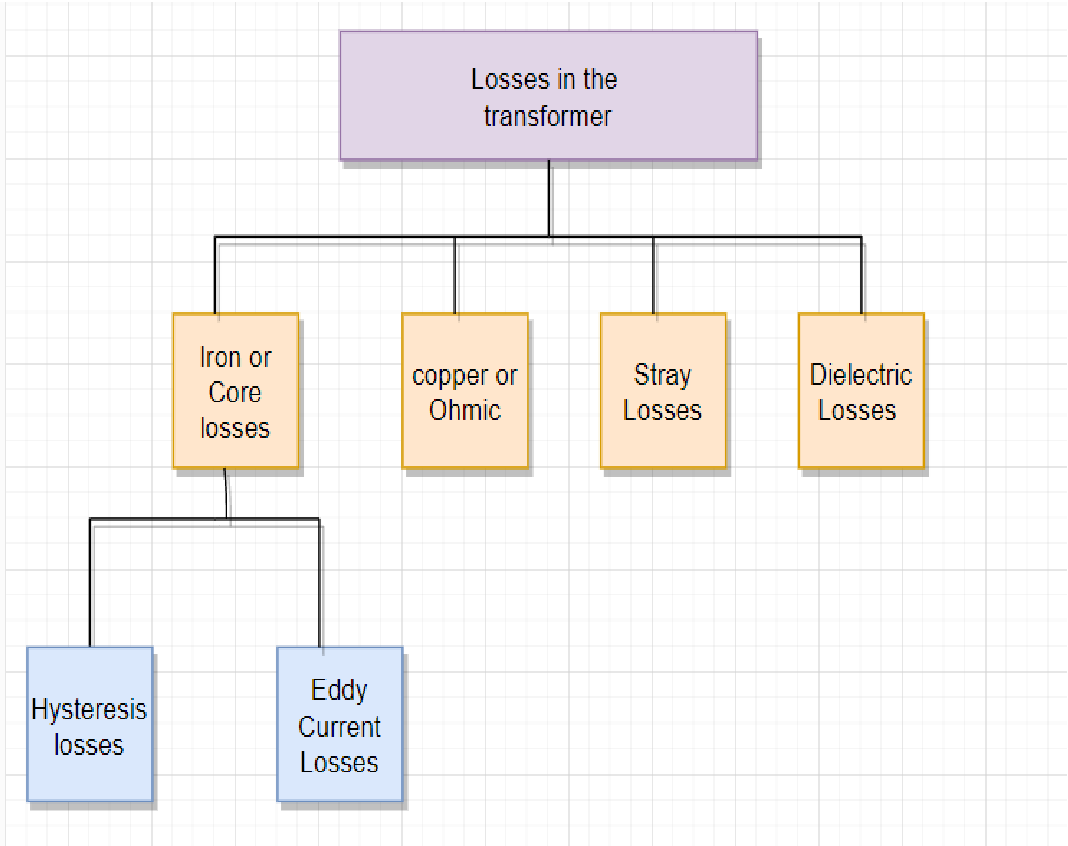



**Figure 3.3:** Types of Technical Losses in Transformers[5]

### 3.2.1.3.1 Iron Losses:-

Iron losses are caused by the alternating flux in the core of the transformer as this loss occurs in the core it is also known as Core loss. Iron loss is further divided into hysteresis and eddy current loss[5].

### 3.2.1.3.1.1 Hysteresis Loss:-

that stands for the power dissipated in the form of heat as a result of alternating magnetizing force the is implied on the core, and it is given by the equation(3.1)[5]:

$$P_h = K\eta B_{max}^{1.6} f v \qquad 3.1$$

Where:-

$P_h$: Hysteresis Loss (watts)

Kŋ: proportionality constant which depends upon the volume and quality of the material of the core used in the transformer.

$B_{max}$: the maximum or peak value of the flux density in ($wb/m^2$)

f: supply frequency

### 3.2.1.3.1.2 Eddy Current Losses:

The results from the flux that links with a closed circuit, where an emf is induced in the circuit and the current flows, the value of the current depends upon the amount of emf around the circuit and the resistance of the circuit. The eddy current losses are given by the equation(3.2)[5]:

$$P_e = K_e B_m^2 t^2 f^2 V \qquad 3.2$$

Pe: Eddy Current Loss (watts)

Ke: co-efficient of eddy current. Its value depends upon the nature of magnetic material like volume and resistivity of core material, thickness of laminations

Bm: maximum value of flux density in (wb/m2)

f: supply frequency (Hz)

t: thickness of lamination (m)

V: volume of magnetic material (m3)

### 3.2.1.3.2 copper losses:-

These losses occur due to ohmic resistance of the transformer windings and are related directly to the resistance of the primary and secondary winding of the transformer and the current flowing in each of them. It is given by the equation(3.3) [5]:

$$\mathbf{P_C = I_1^2 R_1 + I_2^2 R_2} \qquad \mathbf{3.3}$$

Where:

Pc: Copper Losses (watts)

$I_1$: current in the primary winding

$R_2$: resistance of the primary winding

$I_2$: current in the secondary winding

$R_2$: resistance of the secondary winding

### 3.2.1.3.3 Stray losses:-

They occur due to the presence of leakage field. The percentage of these losses are very small as compared to the iron and copper losses, so they can be neglected[5].

### 3.2.1.3.4 Dielectric Losses:-

it occurs in the insulating material of the transformer (oil or solid insulations) and are related to the quality of the insulation[5].

### 3.2.2 Non- Technical losses

Are caused by actions external to the power system are caused by loads and conditions that the technical losses computation failed to take into account. Non- technical losses are more difficult to measure because these losses are often unaccounted for by the system operators and thus have no recorded information. 'Non-technical losses, on the other hand, occur as a result of theft, metering inaccuracies, and unmetered energy. It is related mainly to power theft in one form or another. Theft of power is energy delivered to customers that are not measured by the energy meter for the customer. This can happen as a result of meter tampering or bypassing the meter. Losses due to metering inaccuracies are defined as the difference between the amount of energy delivered through the meters and the amount registered by the meters[6] .

main types of non-technical losses are[7]:

1. Energy theft.
2. Errors in Unmetered Supplies
3. Conveyance errors

#### 3.2.2.1 Energy theft:-

it is the energy that has been illegally taken from the network through tampering with meters or other network assets. This is taken without the knowledge of an energy company and leads to differences between estimated

and actual electricity consumption. Energy theft increases everybody’s energy bills and creates serious electrical hazards for both those stealing the power and those working on the network [7].

### 3.2.2.2 Errors in Unmetered Supplies:-

An unmetered supply is a supply of electricity to a particular item of equipment that is connected to the Distribution Network without a meter, e.g. street lights, traffic signals, pedestrian crossings[7].

### 3.2.2.3 Conveyance errors:-

These are losses that a rise when electricity is consumed but not correctly recorded. Situations a rise where energy is legally consumed but is not properly recorded in the national electricity settlement system. This can occur due to inaccuracies in meter readings, unregistered meter points, errors in registration, or faulty meters. These errors result in a discrepancy between actual and measured consumption, meaning energy is lost in the system[7] .

## 3.3 Drawbacks of Losses:-

1. Poor quality of service offered to customers.
2. The high cost of Network operation.

## 3.4 Advantages of Minimizing Losses:-

1. Good voltage profile and Improve reliability.

2. Solve some power quality problems.

4. Financial benefits.

## 3.5 Power flow Analysis:-

Load flow (power flow) analysis is a basic analysis of the study of power systems. It is used for normal, steady-state operation. It provides you with info on what is happening in a system. Load flow analysis is an important requirement for whatever you do in power systems, whether you do fault studies, stability studies, economic operation[8].

The objective of load flow calculations is to determine the steady-state operating characteristics of the power system for a given load and generator real power and voltage conditions[8].

Once I have this information, I can calculate easily real and reactive power flow in all branches together with power losses[8] .

The principles of a power flow analysis are direct, and accurate study relating to a power system can be passed out only with the digital computer.

Two of the frequently used mathematical methods are the Gauss-Seidel method and the Newton Raphson method, in addition to the Fast-decoupled method[8].

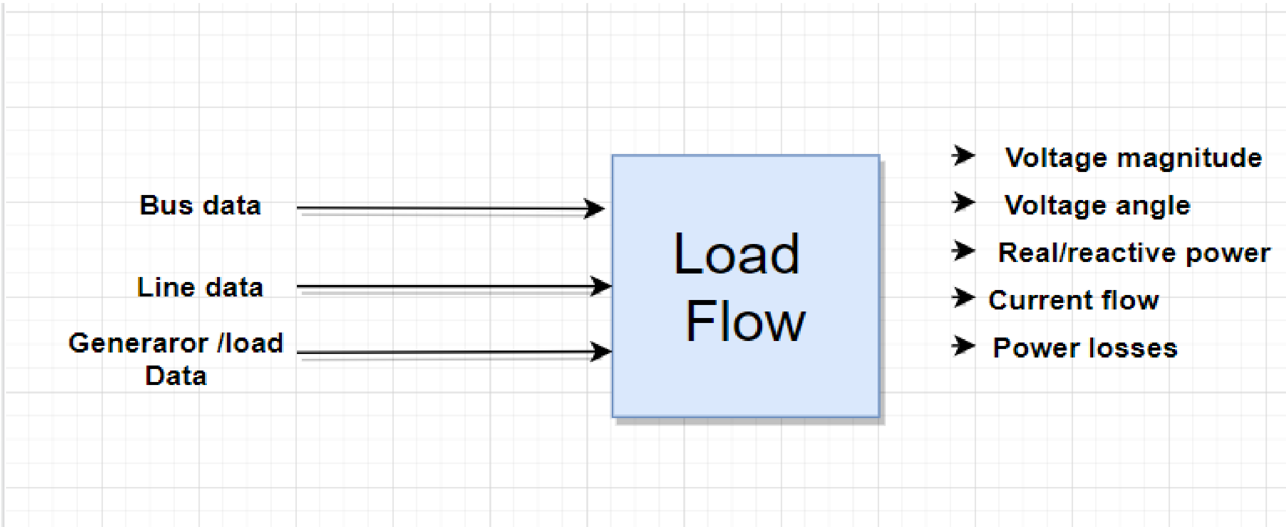



**Figure3.4**: Load Flow[8]

## 3.6 Efficient Electrical Energy Transmission and Distribution:-

Growing populations and industrializing countries create huge needs for electrical energy. Unfortunately, electricity is not always used in the same place that it is produced, meaning long-distance transmission lines and distribution systems are necessary. But transmitting electricity over distance and via networks involves energy loss[9] .

So, with growing demand comes the need to minimize this loss to achieve two main goals: reduce resource consumption while delivering more power to users. Reducing consumption can be done in at least two ways: deliver electrical energy more efficiently and change consumer habits[9].

Transmission and distribution of electrical energy require cables and power transformers, which create three types of energy loss [9].

1. The Joule effect, where energy is lost as heat in the conductor ( a copper wire, for example).
2. Magnetic losses, where energy dissipates into a magnetic field.
3. The dielectric effect, where energy is absorbed in the insulating material.

The Joule effect in transmission cables accounts for losses of about 2.5 % while the losses in transformers range between 1 % and 2 % (depending on the type and ratings of the transformer). So, saving just 1 % on the electrical energy produced by a power plant of 1000 megawatts means transmitting 10 MW more to consumers, which is far from negligible, with the same energy we can supply 1000 - 2000 more homes[9].

We can estimate the power losses on the conductors by applying the following equation[9]:

$$\boldsymbol{P_{Losses} = I^2 \times R} \qquad 3.4$$

multiplying the result by the length of the conductor

Considering the main parts of a typical Transmission & Distribution network, here are the average values of power losses at the different steps [9]:

- **1-2%** - Step-up transformer from generator to Transmission line .
- **2-4%** - Transmission line.
- **1-2%** - Step-down transformer from Transmission line to Distribution network.
- **4-6%** - Distribution network transformers and cables .

The overall losses between the power plant and consumers is then in the range between 8 and 15%.

# CHAPTER 4

## Power loss minimization methods

### 4.1 Introduction

### 4.2 Network reconfiguration.

### 4.3 Network reconductoring

### 4.4 Distribution transformer locating and sizing

### 4.5 High voltage distribution system.

### 4.6 Flexible Alternating Current Transmission System (FACTS).

### 4.7 Adding a New Sub-Station

## 4.1 Introduction

In general, there are many ways to reduce the power losses in the distribution network. In this chapter we introduce the effective methods and techniques to minimize the power losses that will be used and applied in the graduation project.

the methods of reducing power losses can be minimize as follow:

1. Network reconfiguration.

2. Network reconductoring.

3. Distribution transformer locating and sizing.

4. High voltage distribution system.

5. Flexible Alternating Current Transmission System (FACTS).

6. Adding a New Sub-Station.

## 4.2 Network reconfiguration

Distribution network reconfiguration is an important means to optimize the operation of distribution network. The reconfiguration of distribution network can change the opening and closing state of segmentation switch and tie switch in the distribution network without increasing investment. It can achieve the purpose of reducing network loss, balancing load to eliminate overload and light load, improving power supply reliability and improving power supply voltage quality. Therefore, it has important practical significance to accelerate the problem of distribution network reconfiguration[10].

## 4.3 Network reconductoring

Network reconductoring is the technique in which replaces the existing conductor on the feeder by a conductor of optimal size for optimal length of the feeder. This technique is used when the existing conductor is no more optimal because of rapid growth of load. This technique is good for the developing countries, where annual growth rates are high and the conductor are chosen to minimize the initial capital investment [6].

This method is very successful for minimizing the losses and developing the voltage profile. But it leads to an extra investment that increases the original investment of the feeders.

## 4.4 Distribution transformer locating and sizing

Generally, distribution transformers are not located centrally with respect to customers. The farthest customers take an extremely low voltage even though a reasonably good voltage level is maintained at the secondary of transformer. This leads to more losses in distribution system. In this technique, distribution transformers should be located close to the load center as possible and replace large transformers by the transformers of small rating so that it serves small number of customers so that optimum voltage level is maintained [6].

This technique calls for less investment than reconductoring the network. It helps in reducing the peak load and electrical losses in the distribution system. In addition, it improves the voltage that customers take. Moreover, it avoids overloading on conductors and transformers.

## 4.5 High voltage distribution system

in high voltage distribution system (HVDS), the electricity is distributed to the consumers at higher voltage level (11kV) instead of low voltage (415V). Adoption of HVDS by converting existing low voltage distribution system (LVDS) to HVDS reduces the technical losses appreciably.

Advantage of HVDS:-

1-Reduction of electrical losses.

2-Increaze in transition efficiency.

3-Improvement of voltage Regulation.

4- Reduction in conductor material.

5-Flexibility for future system growth.

6- Increase in transition capacity.

## 4.6 Flexible Alternating Current Transmission System (FACTS)

### 4.6.1 FACTS definition, necessity and types

A flexible alternating current transmission system (FACTS) is a system composed of static equipment used for the AC transmission of electrical energy. It is meant to enhance controllability and increase the power transfer capability of the network. It is generally a power electronics-based system[11].

FACTS is defined by the IEEE as "a power electronic based system and other static equipment that provide control of one or more AC transmission system parameters to enhance controllability and increase power transfer capability[12]."

According to Siemens "FACTS Increase the reliability of AC grids and reduce power delivery costs. They improve transmission quality and the efficiency of power transmission by supplying inductive or reactive power to the grid.

FACTS controllers can be categorized as follow:

1. Shunt connected controllers.
2. Series connected controllers.
3. Combined series-series controllers.
4. Combined shunt-series controllers.

#### 4.6.1.1 Shunt connected controllers:

Shunt controllers consist of variable impedance devices like capacitors or reactors which introduce current in series with the line. Their major task is to reduce the capacitivity of the transmission line. The injected current is in phase with the line voltage[11].

#### 4.6.1.2 Series connected controllers:

Series Controllers consists of capacitors or reactors which introduce voltage in series with the line. They are basically variable impedance devices. Their major task is to reduce the inductivity of the transmission line. They supply or consume variable reactive power [11].

#### 4.6.1.3 Combined series-series controllers:

These controllers consist of a combination of series controllers with each controller providing series compensation and also the transfer real power along the line.

#### 4.6.1.4 Combined shunt-series controllers:

These controllers introduce current in series using the series controllers and voltage in shunt using the shunt controllers [14].

### 4.6.2 FACTS benefits:

1. Facts is economical technology.

2. All the FACTS controllers can be uses with an existing AC transmission system.

3. Facts technology allows greater throughput over existing routes.

4. Facts can be uses on an existing transmission routes without construction of new transmission lines.

5. Reducing power loss and increasing power transfer capability.

6. Increase the security by raising transient stability limit.

7. Limit short circuit current and overloads.

8. Provide secure tie line connections to neighboring utilities.

9. Voltage regulating speed is fast.

10. Reduce reactive power flow with increasing active power flow.

## 4.7 Adding a new sub-station

Adding a new sub-station to the medium voltage network is highly effective way to decrease the power losses and improving the voltage drop, if the distance between the sub-station and the load was far away, the power losses will be increased through the cables in addition to the distribution transformers. As a result, when the sub-station feeders are close enough or at least not far away from the loads, the power losses will be less compared to a far sub-station or a feeder.

# CHAPTER 5

# Simulation analysis

## 5.1 Case study

## 5.2 Case 1 results

## 5.3 Case 2 results

## 5.4 Comparison between two case

## 5.5 Conclusion

## 5.1 Case study

In order to run the simulation in the MV network, we assumed that the Power Factor (PF) equal 92 % according to wad shaheen, and two cases were applied:

1. In the first case, we assumed the transformers loading to be 80% of the rated kVA for each transformer in order to reach the total peak value for wad shaheen network which is 25.779MWh.

2. In the second case, we set the input data for loading distribution transformers depending on the instantaneous readings in different days and times for each transformer in the network from the company.

## 5.2 Case 1 results

ETAP has many different solution methods, Newton- Raphson (NR) has been chosen to run the load flow, because it is most reliable and powerful technique for solving load flow problems at very accurate solution, fast in convergence, independent size of system and not effected by choosing of slack bus.

The data used in this analysis is obtained from JDECo, the simulation was made taking into consideration the transformers, cables and overhead transmission lines values as mentioned and explained in chapter two, after that we assumed the transformers to be loaded with 80% of its capacities. All results details are attached in Appendix.

### 5.2.1 Sub-Stations Results

**Table 5.1 :** Loading on each sub-station.

| Substation | Rated kV | KW | A | PF% |
|---|---|---|---|---|
| Takoo | 33 | 9300 | 176.86 | 92.5 |
| BREADHAA | 33 | 9180 | 174.5 | 91.1 |
| ABIAT | 33 | 9950 | 189.21 | 90.7 |
| Total | | 28430 | | |

Number of loads = 67

Number of buses = 154 bus

Power imported from Power Grid = 25.799 MW

Total power losses = 1.632 MW= 6.325%

PTotal = PDemand + PLosses

PTotal = 25.799 + 6.325 = 32.124

The following figure (5.1) represents the contribution of each sub – station in loading

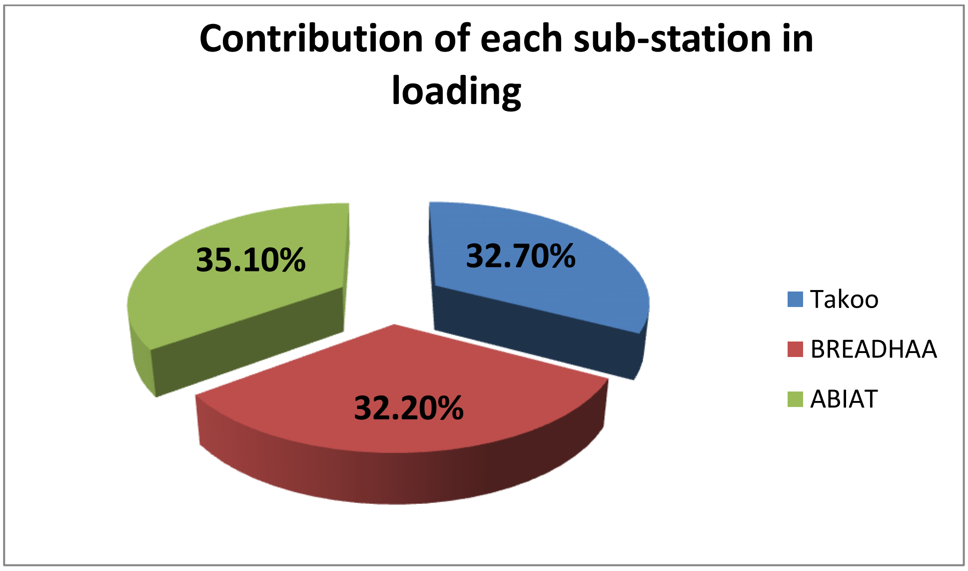



**Figure5.1**: the loading percentage on sub-station

Table (5.2) shows the result of every transformer in the sub-stations, results contain the loading power on transformers and power losses on each one of them:-\

**Table (5.2)** : loading and power losses on sub-stations transformers

| ID | Rating kVA | kW Flow | A | %Loading | kW Losses | %Losses |
|---|---|---|---|---|---|---|
| T1 ZATARAA | 1600 | 1196 | 38 | 92.02 | 14.8 | 1.241 |
| T2 ZATARAA | 1600 | 1172 | 32 | 90.79 | 14.6 | 1.248 |
| T3 RSHAYDEH | 1600 | 809 | 36 | 96 | 13.1 | 1.617 |
| T4 BREADHAA | 1500 | 1097 | 20 | 94 | 13.7 | 1.249 |
| Total | | 4274 | | | 56.2 | |

### 5.2.2 Transmission Line and Transformers

The transmission lines and cables gathered with the step down transformers (33-0.4) kV resulted in 508.431 kW of the total power losses contributed as shown in figure (5.2):

The follwing table (5.3) show the value & percentage of the total losses in distribution & substation transformer , and cables with transmission line

**Table5.3**:losses in distribution &substation Tr-r with transmission lines

| Type | kW Losses | %losses |
|---|---|---|
| LV Tr-r losses | 508.431 | 31.53 |
| Cable % line losses | 1127.569 | 68.57 |
| Total | 1636 | 100 |

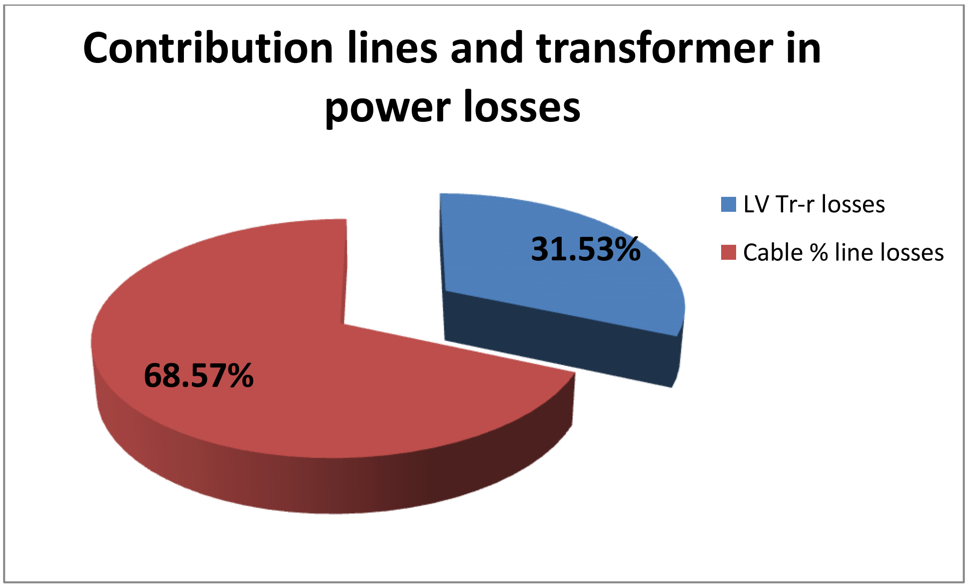



**Figure5.2**:-losses in distribution & Substation Tr-r with transmission line

The following figure(5.3) show the terminal voltage percentage on 33 kV buses and the buses that are less than 95 % of the nominal voltage at 33 kV.

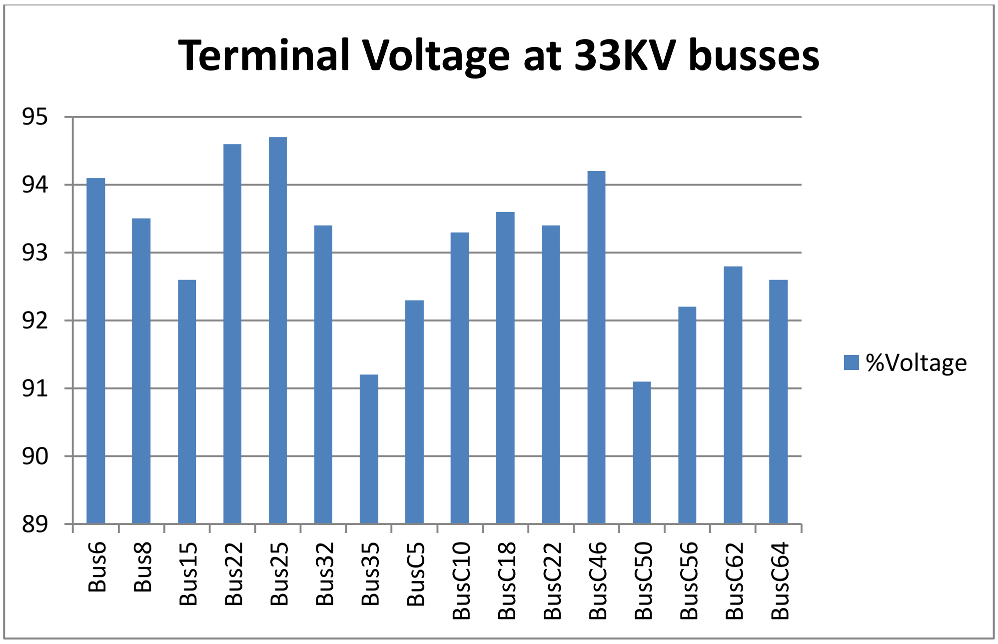



**Figure5.3**:-The terminal voltage percentage on 11KV busses

**Table5.4**:The busses less Than 95%of the nominal Voltage at 33KV

| No | Bus ID | Nominal kV | % Voltage |
|---|---|---|---|
| 1 | Bus6 | 33 | 94.1 |
| 2 | Bus8 | 33 | 93.5 |
| 3 | Bus15 | 33 | 92.6 |
| 4 | Bus22 | 33 | 94.6 |
| 5 | Bus25 | 33 | 94.7 |
| 6 | Bus32 | 33 | 93.4 |
| 7 | Bus35 | 33 | 91.2 |
| 8 | BusC5 | 33 | 92.3 |
| 9 | BusC10 | 33 | 93.3 |
| 10 | BusC18 | 33 | 93.6 |
| 11 | BusC22 | 33 | 93.4 |
| 12 | BusC46 | 33 | 94.2 |
| 13 | BusC50 | 33 | 91.1 |
| 14 | BusC56 | 33 | 92.2 |
| 15 | BusC62 | 33 | 92.8 |
| 16 | BusC64 | 33 | 92.6 |

The following figure(5.4) show the percentage terminal voltage in 0.4 KV buses and the buses that less than 92 % of the nominal voltage at 0.4 KV in table (5.4)

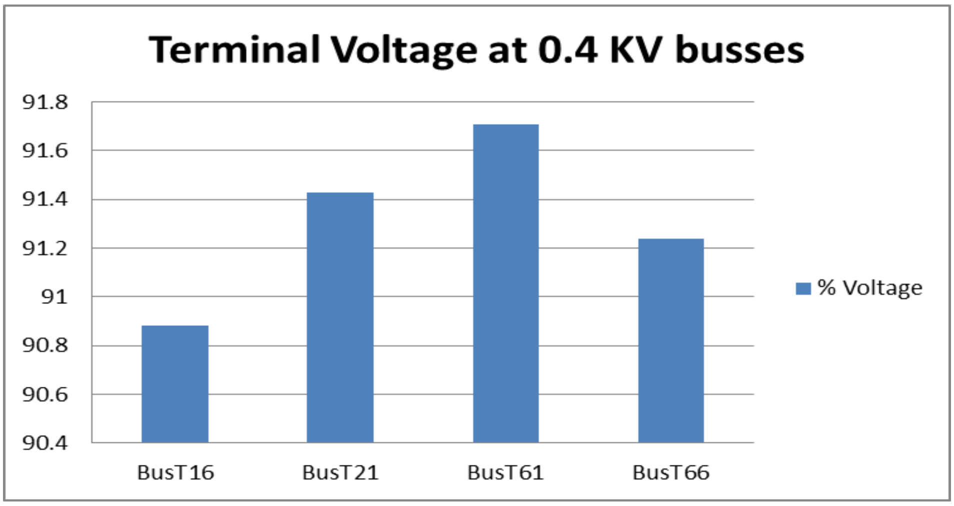



**Figure 5.4**: The terminal voltage percentage on 0.4 KV busses

**Table5.5**:The bus that is less Than 92%of the nominal Voltage at 0.4KV busses

| No | Bus ID | Nominal kV | % Voltage |
|---|---|---|---|
| 1 | BusT16 | 0.4 | 90.88 |
| 2 | BusT21 | 0.4 | 91.43 |
| 3 | BusT61 | 0.4 | 91.71 |
| 4 | BusT66 | 0.4 | 91.24 |

## 5.2.3 Cost of the technical power losses

Total technical of losses in MW=1.636MW

Cost for losses during 1 hour= =1636*0.3=490.8NIS / h

Annual cost for losses = 1636 kW*0.3 * 8760 h   = 4,299,408 NIS /Y

## 5.3 Case 2 results

In this case, we set the input data for transformers depending on the instantaneous readings for each transformer in the network from the company, noticing that the values of transformers loading were taken in a different times, the transformers loading information is attahed  in appendix. All results details are attached in Appendix.

### 5.3.1 Sub – Stations Result

In the following table, the results of the power demand in (MW), the power percentage of each sub-station, and the power factor are explained as follow:-

**Table 5.6** : Loading on each sub-station

| substation | Rated kV | KW | A | PF% |
|---|---|---|---|---|
| Takoo | 33 | 3880 | 59.134 | 93.5 |
| BREADHAA | 33 | 1490 | 26.068 | 94.2 |
| ABIAT | 33 | 5459 | 95.5 | 92.6 |
| Total | | 10829 | | |

Number of loads =67 load.

Number of buses =154bus.

Power imported from Power Grid  =10.829 MW.

Total power losses = 0.269MW = 2.48%.

PTotal = PDemand + Plosses

PTotal = 10.829MW + 0.269MW

=11.098MW.

The following figure (5.5)represents the contribution of each sub-station in loading:-

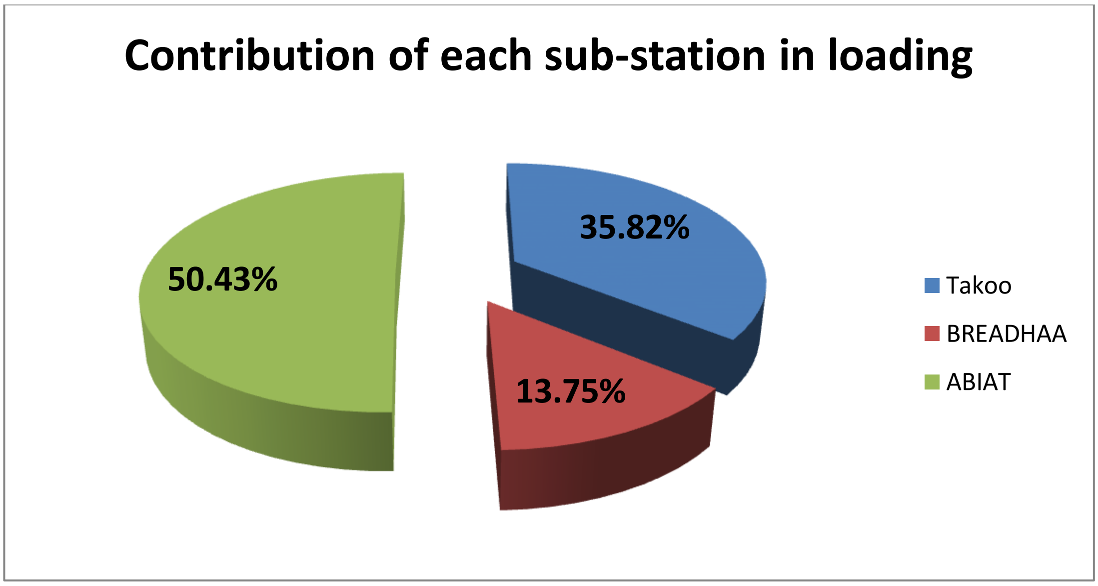



**Figure5.5**:-the loading percentage on sub-station

Table( 5.7) shows the result of every transformer in the sub-stations, results contains the loading power on transformers and power losses on each one of them:-

**Table 5.7:-**loading and power losses on sub-station transformer

| ID | Rating kVA | kW Flow | A | %PF | kW Losses |
|---|---|---|---|---|---|
| T1 Zataraa | 1600 | 720 | 12.5 | 97.6 | 2.5 |
| T2 Zatraa | 1600 | 665 | 11.6 | 92.7 | 3.1 |
| T3 Rshaydeh | 1600 | 405 | 7.08 | 94.5 | 2.1 |
| T4 Breadhaa | 1500 | 680 | 11.89 | 94.3 | 2.4 |
| Total | | 2470 | | | 10.1 |

### 5.3.2 Transmission Lines and Transformers

The transmission lines and cables gathered with the step down transformers (33-0.4) kV resulted in 296 kW of the total power losses contributed as shown in figure (5.6).

The following table (5.8) show the value & percentage of the total losses in distribution transformer, and cables with transmission line.

**table (5.8):-**losses in distribution transformer, and cables with transmission lines

| Type | kW Losses | %Losses |
|---|---|---|
| LV Tr-r losses | 108 | 36.49 |
| Cable line losses | 188 | 63.51 |
| Total | 296 | 100 |

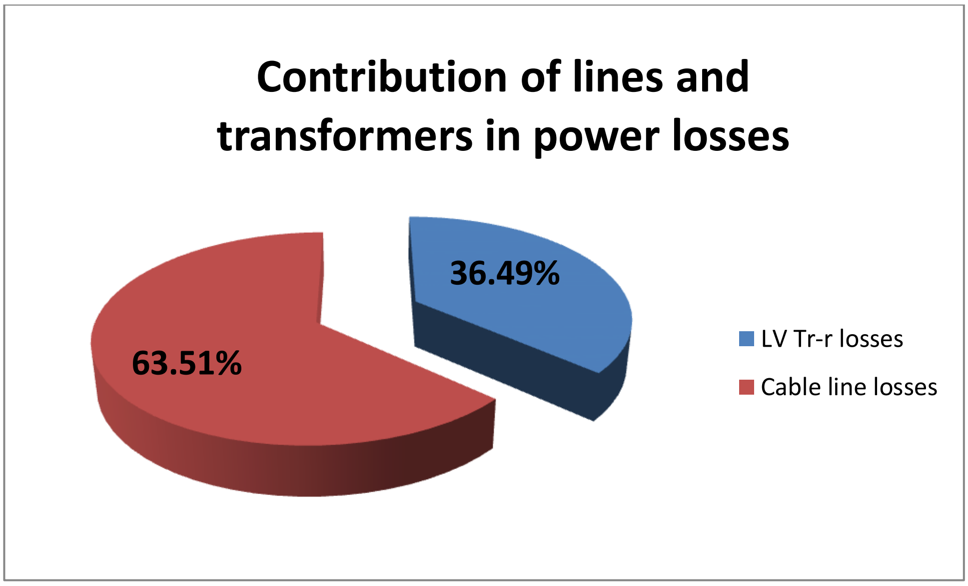



**Figure 5.6:-** losses in distribution transformer, and cables with transmission lines

The following figure (5.7) show the terminal voltage percentage on 33 kV buses and the buses that are less than 97 % of the nominal voltage at 33 kV.

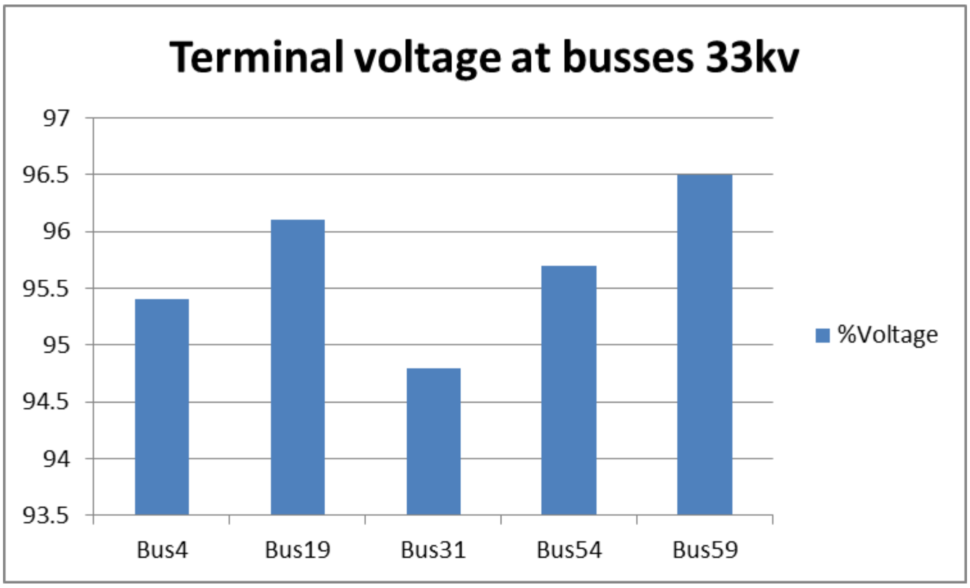



**Figure5.7:-**the Terminal voltage percentage on33kv busses

**Table 5.9:** The buses that are less than 97 % of the nominal voltage at 33 kV.

| NO | Bus ID | Nominal kV | %Voltage |
|---|---|---|---|
| 1 | Bus4 | 33 | 95.4 |
| 2 | Bus19 | 33 | 96.1 |
| 3 | Bus31 | 33 | 94.8 |
| 4 | Bus54 | 33 | 95.7 |
| 5 | Bus59 | 33 | 96.5 |

The following figure (5.8) show the terminal voltage percentage on 0.4 kV buses and the buses that are less than 90 % of the nominal voltage at 0.4 kV.

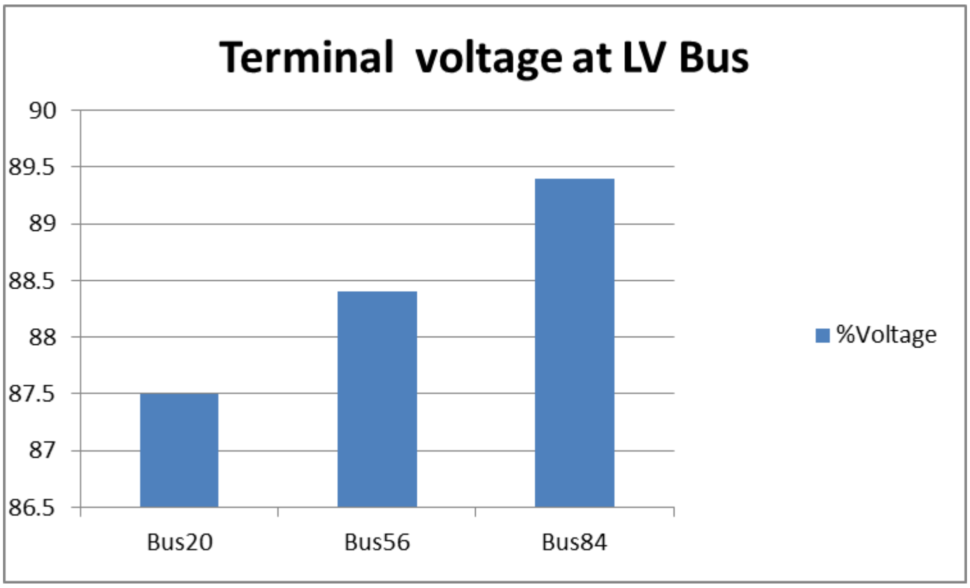



**Figure5.8:-**Terminal Voltage at LV Bus

**Table 5.10:-** The buses that are less than 90 % of the nominal voltage at 0.4 KV

| NO | Bus ID | Nominal kV | %Voltage |
|---|---|---|---|
| 1 | Bus20 | 0.4 | 87.5 |
| 2 | Bus56 | 0.4 | 88.4 |
| 3 | Bus84 | 0.4 | 89.4 |

## 5.3.3 Cost of the technical power losses

Total technical of losses in MW=0.269MW

Cost for losses during 1 hour= =0.269*0.3=80.7NIS / h

Annual cost for losses = 296 kW*0.3 * 8760 h = 706932 NIS /Y

## 5.4 Comparison between two case

Table (5.11) represents the Comparison between two case, and the difference between the values of the total power losses and the losses in both cables and transformers in three substation (Takoo ,Abiat ,Breaada).

**Table5.11:-** Comparison between two case

| | | | | |
|---|---|---|---|---|
| case1 | Loading(KW) | 9300 | 9180 | 9950 |
| | Cable and line losses (KW ) | 1127.569 | | |
| | Distrubition transformer losses(KW) | 508.431 | 508.431 | 508.431 |
| | Total losses(KW) | 1636 | | |
| | | | | |
| case2 | Loading (KW) | 3880 | 1490 | 5459 |
| | Cable and line losses (KW ) | 188 | | |
| | Distrubition transformer losses(KW) | 108 | | |
| | Total losses(KW) | 296 | | |

The following figure (5.9) and figure (5.10) represent the values of power losses in two case:-

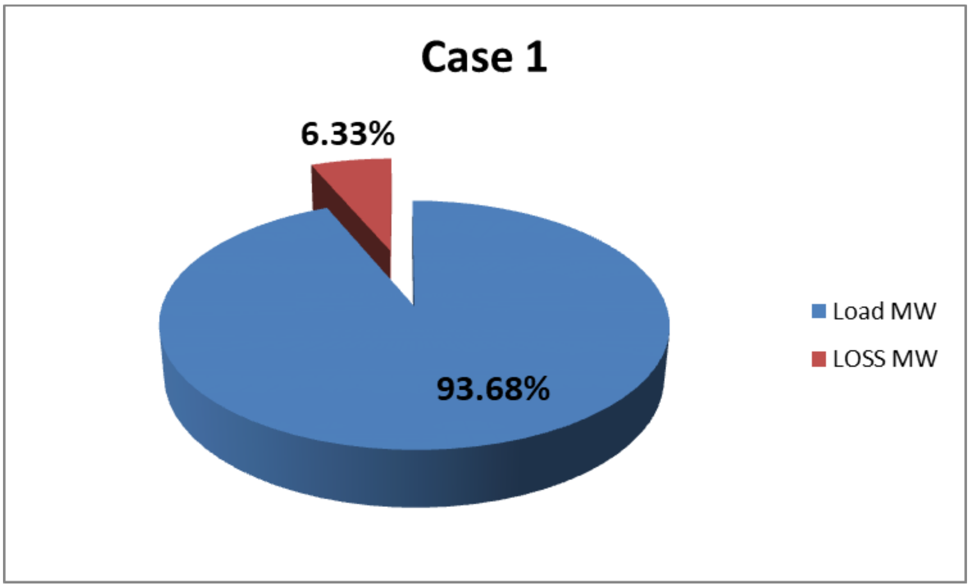



**Figure5.9:-**The percentage of the power losses in case1

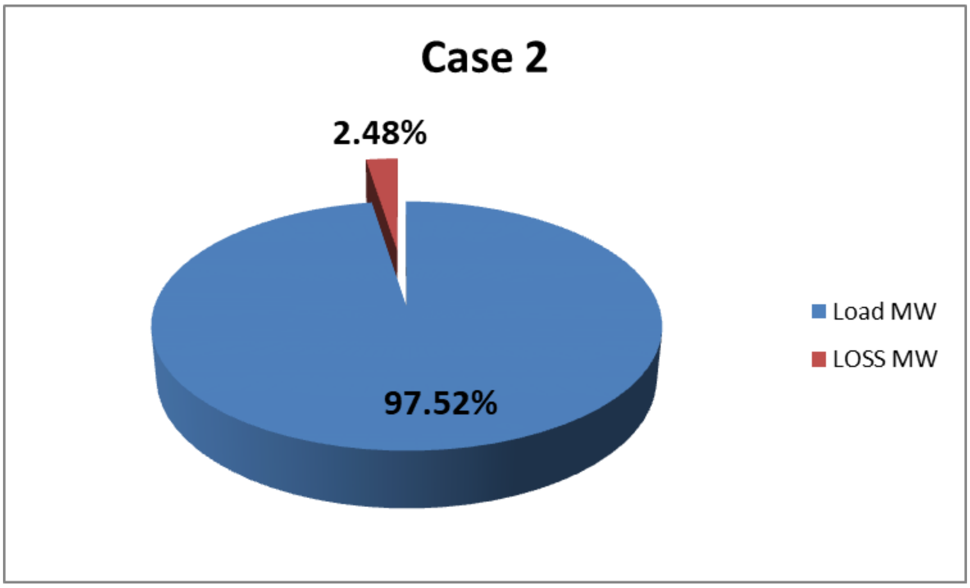



**Figure5.10:-**The percentage of the power losses in case2

## 5.5 Conclusion

In this chapter we applied load flow test in wad shaheen network with balance load, then, we recorded the result of our two simulation by ETP, and the percentage of the power losses in each case.

And after discussing the result with JIDCO , we decided to study the effect of Network Reconfiguration and Network Reconductring to Wad shaheen substation.

# Chapter 6

# The solution to minimizing power losses

## 6.1 Introduction

## 6.2 First solution network reconductring

## 6.3 Second solution network reconfiguration

## 6.4 Conclusion

## 6.1 Introduction

In this chapter, we present the solutions that applied to minimize the power losses in the First scenario “Peak load”, and show the effect of the solution on the losses.

## 6.2 First solution network reconductring

### 6.2.1 Introduction

After analyzing the Wad Shaheen Network, we concluded that the bulk of the losses were actually in cables and to solve this problem, we changed the cable trains that contained the greatest losses in the network to suit the load in the network, which in turn effectively contributes to reducing electrical losses in the network.

Table (6.1) represent cable cross-section area before and after network reconductring.

**Table (6.1)** :cable cross-section area before and after network reconductring

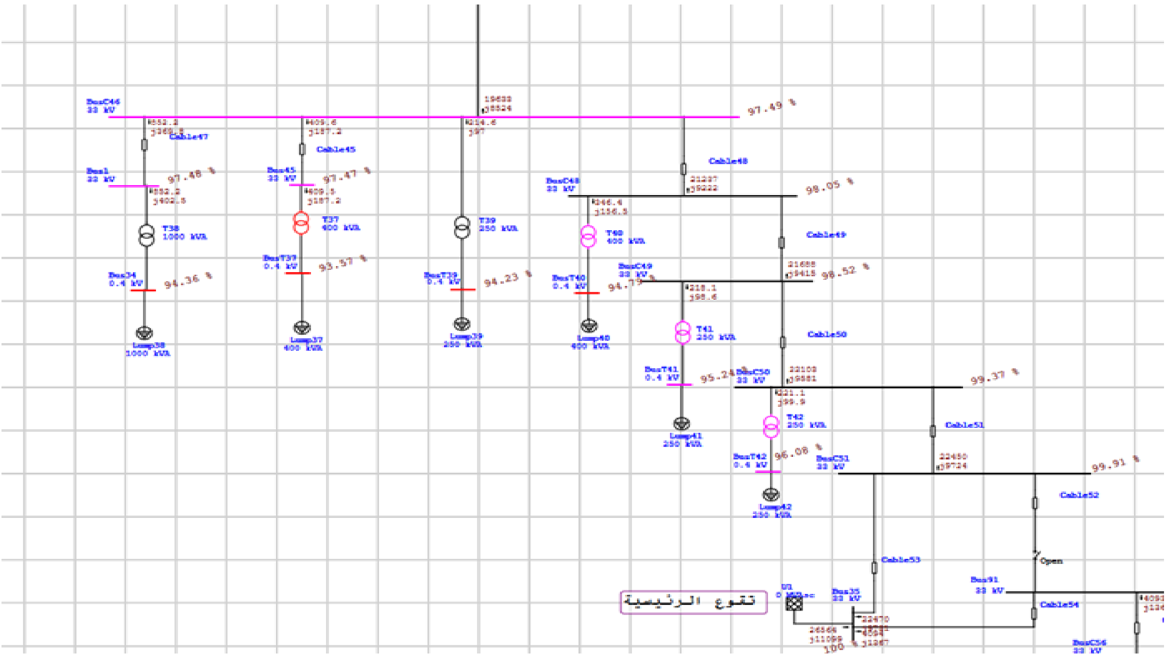
| ID | cable cross-section area before network reconductoring(mm2) | cable cross-section area after network reconductoring(mm2) |
|---|---|---|
| C24 | 95 | 150 |
| C36 | 95 | 150 |
| C38 | 95 | 150 |
| C42 | 95 | 150 |
| C46 | 95 | 150 |
| C48 | 95 | 150 |
| C49 | 95 | 150 |
| C50 | 95 | 150 |
| C51 | 95 | 120 |

Table (6.2) represent the losses in cable before and after network reconductring.

table (6.2):- the losses in cable before and after network reconductring

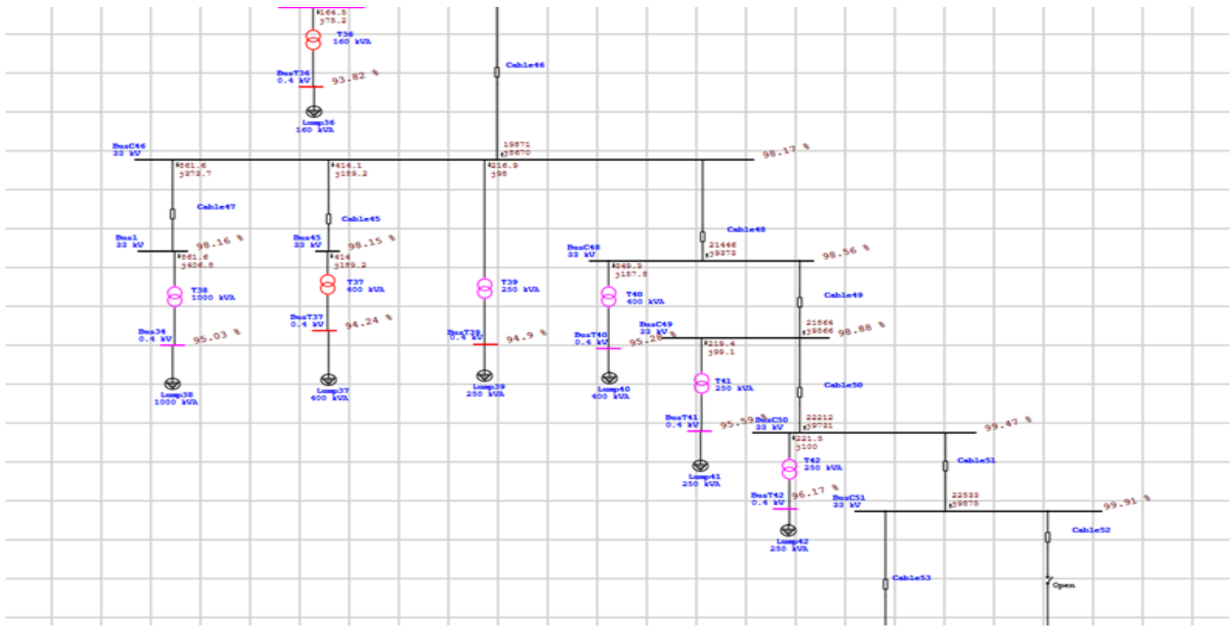
| ID | Losses in cable befor network reconductoring(KW) | Losses in cable after network reconductoring(KW) |
|---|---|---|
| C24 | 35.3 | 23.2 |
| C36 | 45.7 | 30.3 |
| C38 | 38 | 25.1 |
| C42 | 97.9 | 66.1 |
| C46 | 125.6 | 84 |
| C48 | 123.6 | 84.6 |
| C49 | 101 | 68.3 |
| C50 | 190.44 | 127 |
| C51 | 121.4 | 99.7 |

The following figure (6.1) shows the result before  network reconductoring



Figure(6.1): The overload before change the cable.

The following figure (6.2) shows the result after  network reconductoring



Figure(6.2): The overload decreasing after change the cable

### 6.2.2 Cost of technical losses after Network reconductring

Total technical of losses in MW=1.382MW

Cost for losses during 1 hour= 1.382*0.3=414.6NIS / h

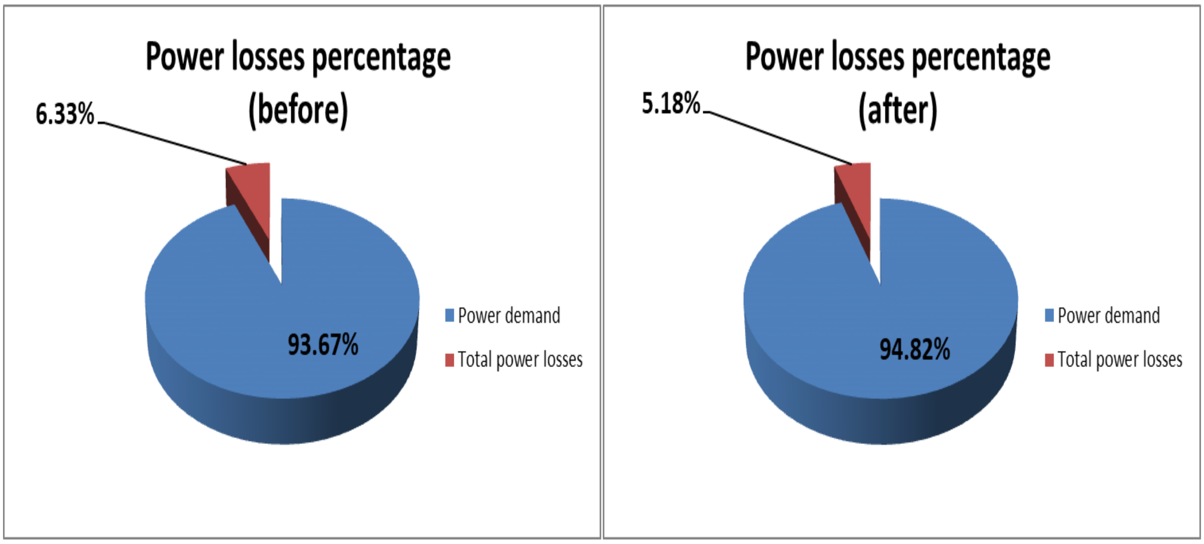
Annual cost for losses = 1.382 kW*0.3 * 8760 h = 3,631,896 NIS /Y

### 6.2.3 comparison before and after network reconductring

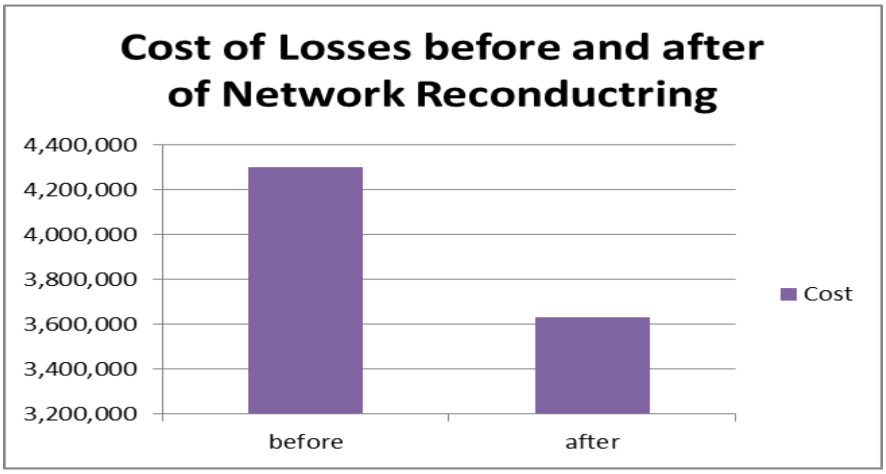
Table (6.3) represent the result of the analysis of the existing network done in the first case in chapter 5,and it also compare these result with result after network reconductring .

**Table (6.3)**:-comparison before and after network reconductring

| | Before | After |
|---|---|---|
| Power Demand MW | 26.31 | 26.648 |
| Total Power Losses MW | 1.636 | 1.382 |
| distribution transformer losses kW | 508.431 | 426 |
| Line & cable losses kW | 1127.569 | 956 |
| Percentage of Losses(%) | 6.33 | 5.18 |
| Cost of losses NIS /Y | 4,299,408 | 3,631,896 |




Figure(6.3): Power losses percentage before and after network reconductoring




Figure(6.4): Difference of Cost before and after of Network Reconductring

## 6.3 Second solution network reconfiguration

### 6.3.1 First Case

#### 6.3.1.1 Introduction

The second solution we applied to the network is network reconfiguration, to apply these solutions we added a new line “RL its length 3km and cable cross-section area 150 mm2” between power grid(Takoo) and Bus C7 and delete line “ RL its length 0.5km and cable cross-section area 50 mm2” line between Bus C34 and C36 .

This method help to reduce losses in the region ,especially because is an industrial area, thus it leads to balance the load in the network and thus to reduce losses .

Figure (6.5) present the cable location in the network:-

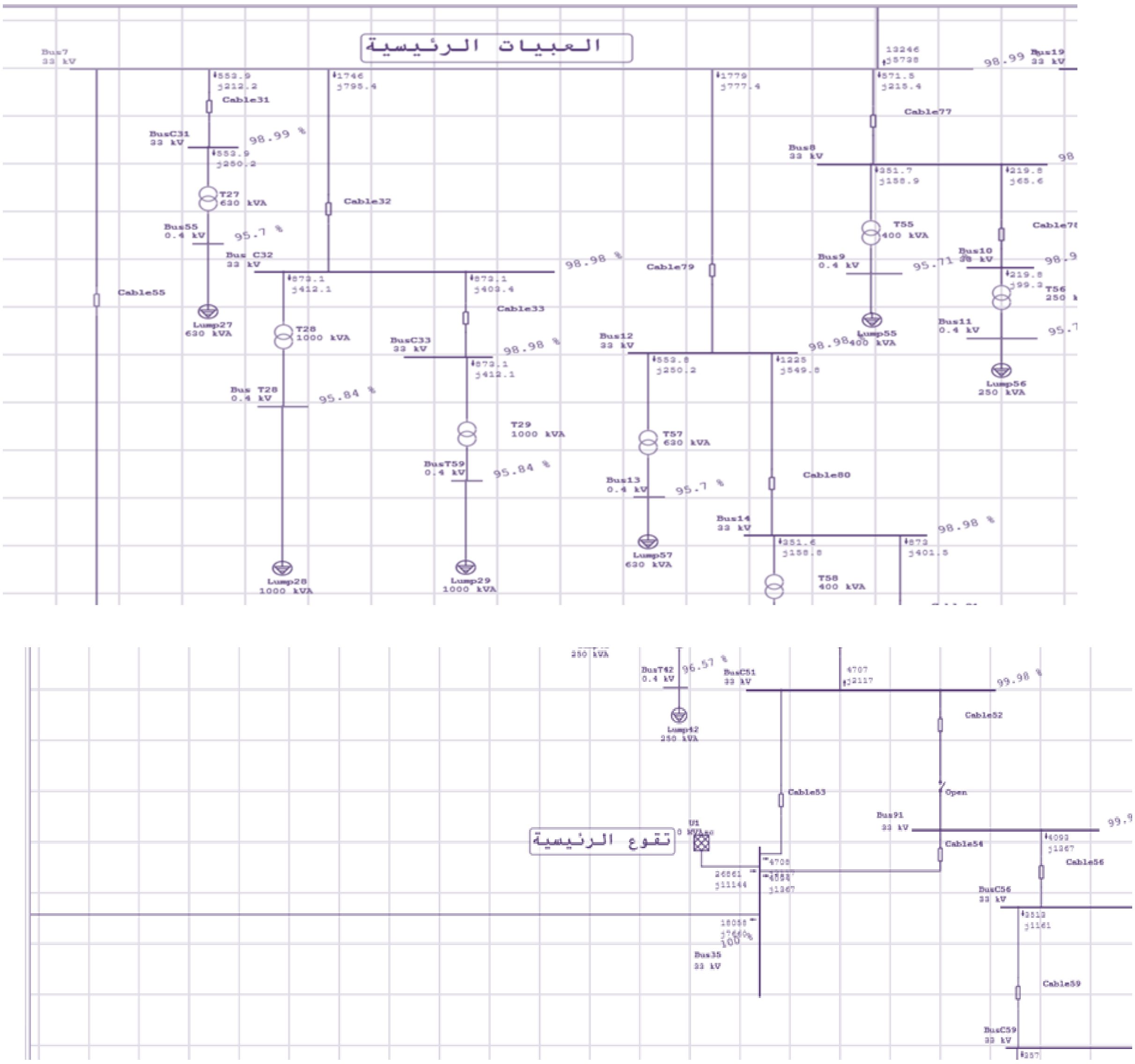



Figure (6.5):- location of new cable

### 6.3.1.2 Cost of technical losses after First Case

Total technical of losses in MW= 0.941MW

Cost for losses during 1 hour= 0.941*0.3=414.6NIS / h

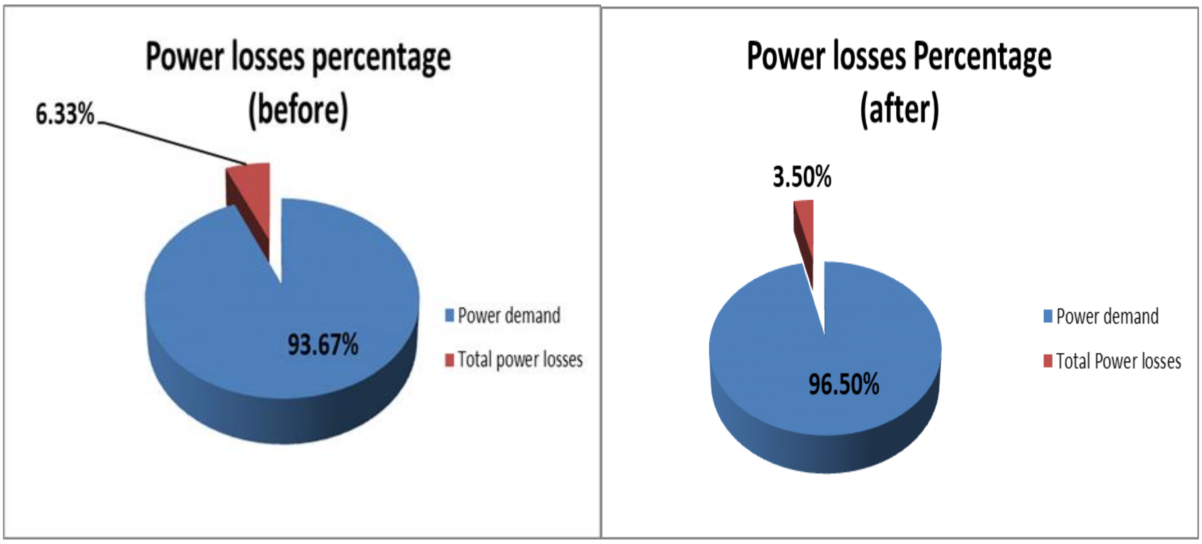
Annual cost for losses = 0.941 kW*0.3 * 8760 h = 2,472,948 NIS /Y

### 6.3.1.3 comparison before and after First Case

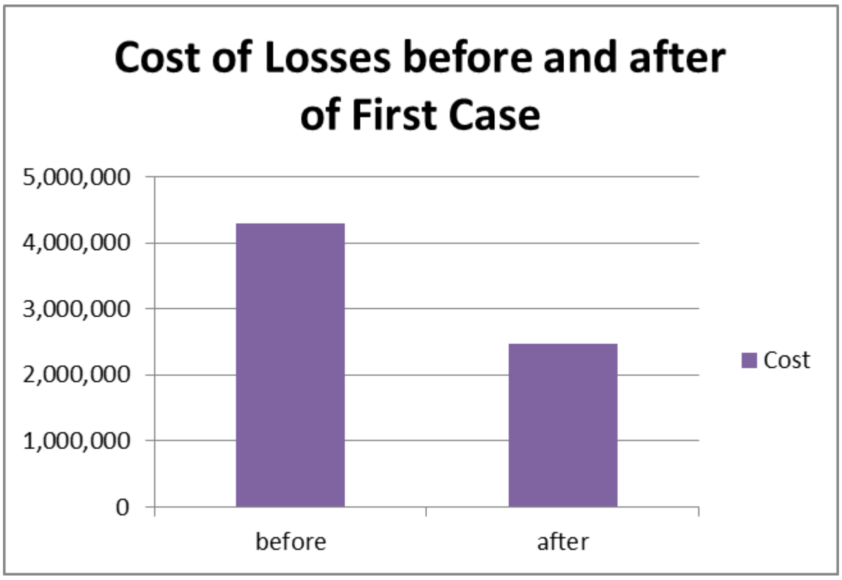
Table (6.4) represent the result of the analysis of the existing network done in the first case in chapter 5,and it also compare these result with result after network reconfiguration (First case):-

Table (6.4) comparison before and after First Case

| | | |
|---|---|---|
| **Power Demand (MW)** | 26.31 | 26.861 |
| **Total Power Losses( MW)** | 1.636 | 0.941 |
| **Load Demand (KW)** | 24.9 | 25.1 |
| **Distribution transformer losses (KW)** | 508.431 | 260 |
| **Line & cable losses (kW)** | 1127.569 | 681 |
| **Percentage of losses(%)** | 6.33 | 3.5 |
| **Cost for losses NIS /Y** | 4,299,408 NIS /Y | 2,472,948 NIS /Y |




Figure(6.6): Power losses percentage before and after case 1



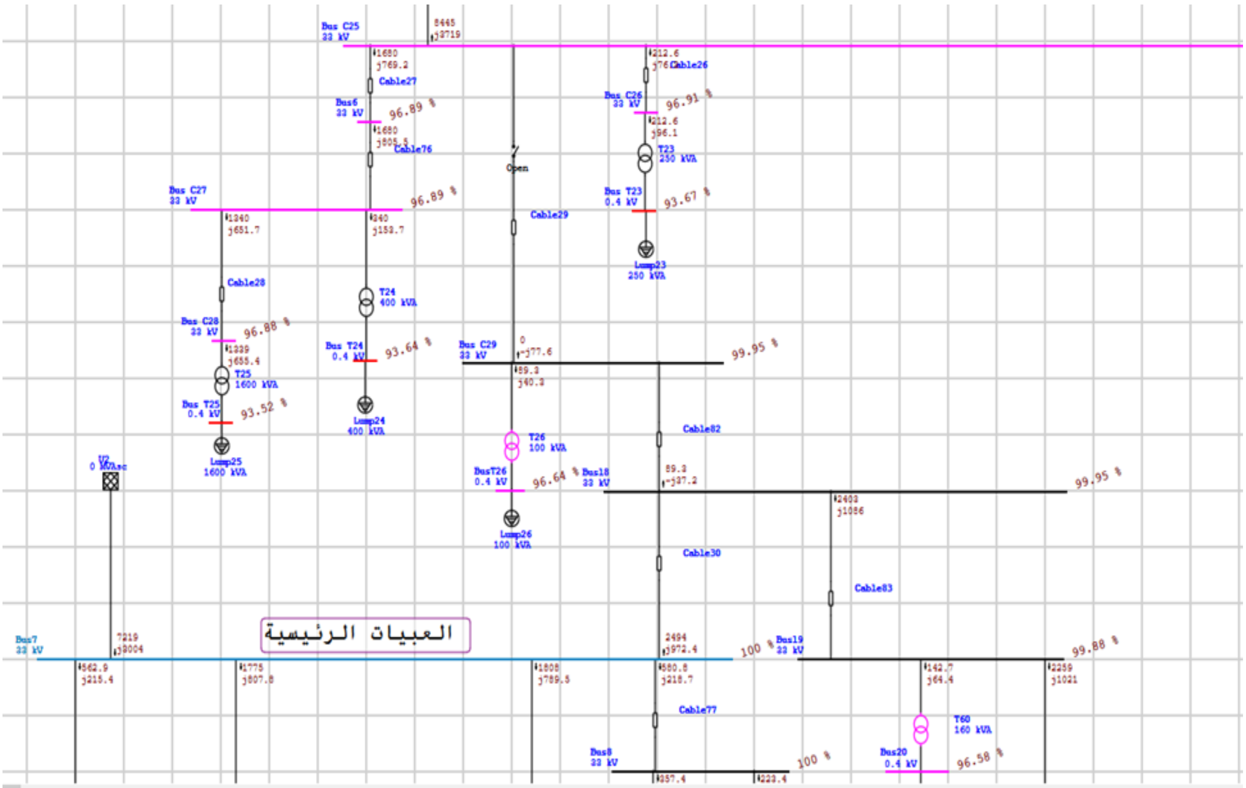

Figure(6.7): Difference of Cost before and after of First case

### 6.3.2 Second Case

#### 6.3.2.1 Introduction

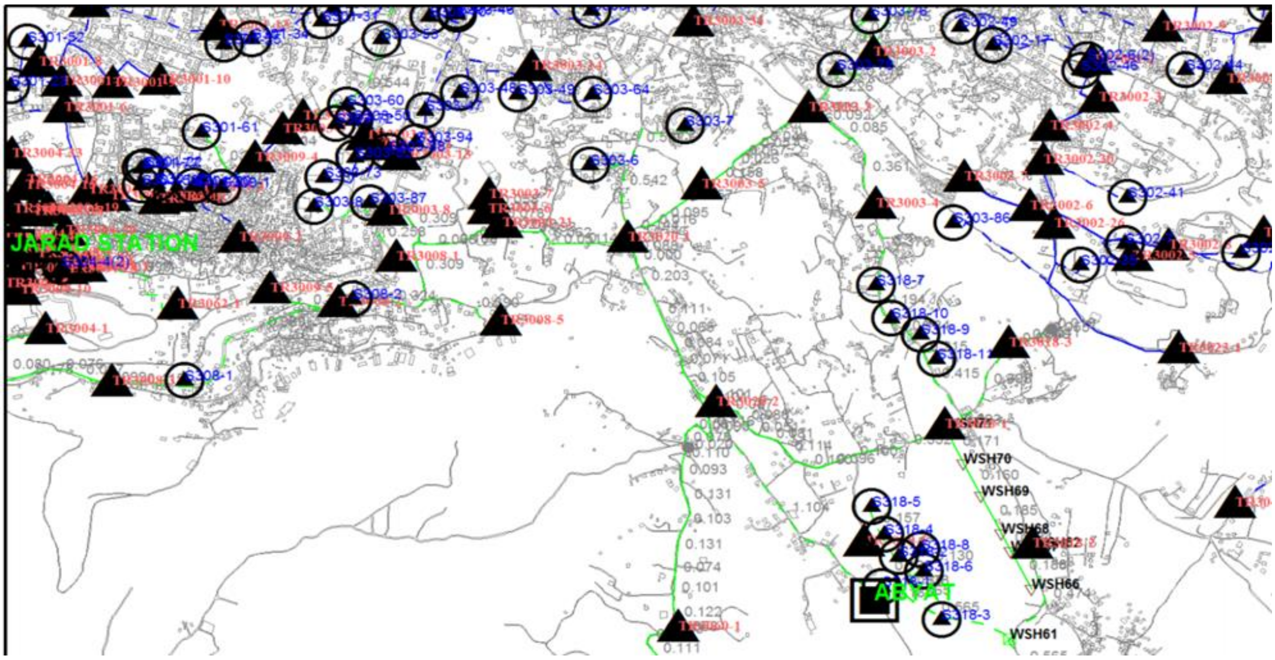
In this case, we separated the network in two parts in order to reduce the load on the loss network (ABIAT) which contain a large part of the losses and the other part network TAKOO and BREADHAA so we took a new link point on the ABIAT network from the GARADA station for a few losses.

Figure(6.8) present result after adding new power grid:-



Figure(6.8) :- The overload decreasing after adding new power grid

Figure(6.9) present the location of GARADA station:-




Figure(6.9) :- GARADA station

### 6.3.2.2 Cost of technical losses after Second Case:-

Total technical of losses in MW= 1.105MW

Cost for losses during 1 hour= 1.105*0.3=331.5NIS / h

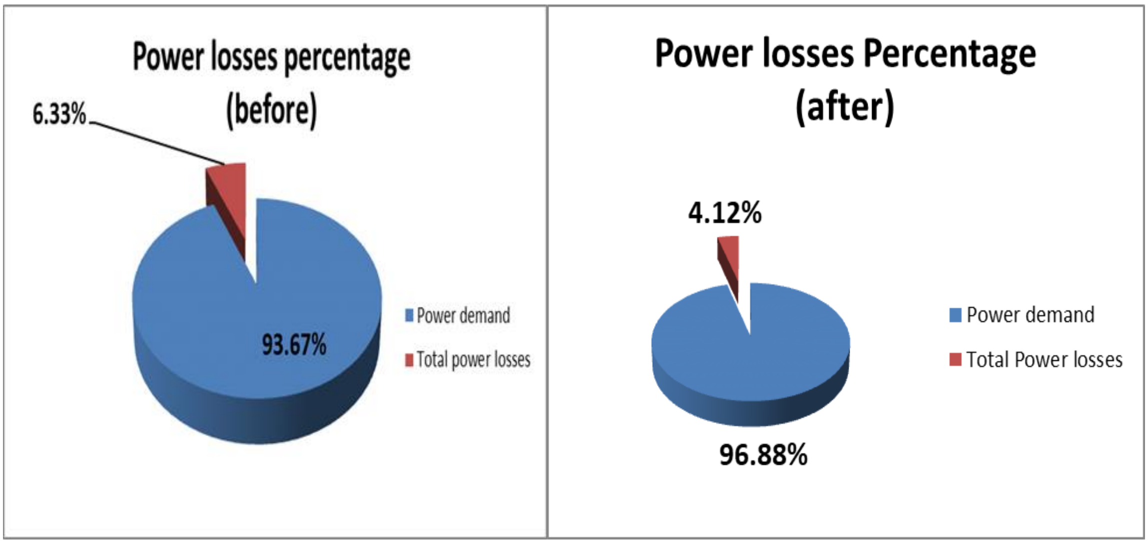
Annual cost for losses = 0.941 kW*0.3 * 8760 h =2,903,940 /Y

### 6.3.2.3 comparison before and after Second Case:-

Table (6.5) represent the result of the analysis of the existing network done in the first case in chapter 5,and it also compare these result with result after network reconfiguration (second t case):-

Table (6.5) comparison before and after second case

| | Before | After |
|---|---|---|
| **Power Demand MW** | 26.31 | 26.8 |
| **Total Power Losses MW** | 1.636 | 1.105 |
| **Load Demand MW** | 24.9 | 26.803 |
| **Distribution transformer losses KW** | 508.431 | 406 |
| **Line & cable losses kW** | 1127.569 | 699 |
| **percentage of losses (%)** | 6.33 | 4.12 |
| **cost of Losses NIS/Y** | 4,299,408 | 2,903,940 |




Figure(6.10): Power losses percentage before and after case 2


Figure(6.11): Difference of Cost before and after of second case

## 6.4 Conclusion

After studying the maximum load on the Wade Shaheen Network Section 5 we studied losses on the net and after observing that the bulk of the losses in cables we studied in this section several ways to reduce these losses in the first way we changed the countries of cables where the largest part of the cables and this method contributed to reducing the loss rate by 1.15% .

In the second way we applied two solutions and the first solution is to add a new cable between the power adapter in the area of TAKOO and the area where the value of high losses in area ABIAT as described earlier and this method contributed to reducing losses by 2.83% .

the second solution lies in pulling a cable from a nearby link point on the network which is GARADA station and this method contributed to reducing losses by 2.21% and the material return was calculated in each way as described earlier.

# Chapter 7

# Recommendation and conclusion

## 7.1 Conclusions

## 7.2 Recommendations

## 7.1 Conclusions

1. Technical losses are directly related to elements or components in the grid.

2. Conductors with a small cross-section and high resistance will have a bad effect on the grid from the loss aspect side, especially if the loads are relatively high.

3. A proper structural rework of the network can effectively reduce network losses.

## 7.2 Recommendations

1. We recommend that Jerusalem Al Electricity Company should use the A-program to analyze their networks and their ability to keep up with the network realistically.

2. We recommend that the Jerusalem Electricity Network reconsider and examine the cable trains in certain parts of the Wad Shaheen network as it is disproportionate to the existing load.

3. We recommend Jerusalem electricity company to add smart meters to certain sections of the network

# References

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# Appendix

# Appendix A

# Summary of Power Flow for Each Case of Scenarios and Solutions

| | | | |
|---|---|---|---|
| Project: minimizing the power losses in | | ETAP | Page:1 |
| Location: | wad Shaheen substation | | |
| Contract: | peak load | SN: | 4359168 |
| Engineer: | Revision:omar&bilal | Base | |
| | Study Case: LF | | |
| Filename: | wad Shaheen | Config.: | Normal |

## Peak Load

### SUMMARY OF TOTAL GENERATION, LOADING & DEMAND

| | MW | Mvar | MVA | % PF |
|---|---|---|---|---|
| Source (Swing Buses): | 26.564 | 11.099 | 28.790 | 92.27 Lagging |
| Source (Non-Swing Buses): | 0.000 | 0.000 | 0.000 | |
| Total Demand: | 26.564 | 11.099 | 28.790 | 92.27 Lagging |
| Total Motor Load: | 6.386 | 2.720 | 6.941 | 92.00 Lagging |
| Total Static Load: | 18.508 | 7.884 | 20.117 | 92.00 Lagging |
| Total Constant I Load: | 0.000 | 0.000 | 0.000 | |
| Total Generic Load: | 0.000 | 0.000 | 0.000 | |
| Apparent Losses: | 1.671 | 0.494 | | |
| System Mismatch: | 0.000 | 0.000 | | |

Number of Iterations: 3

Minimum Load

| | MW | Mvar | MVA | % PF |
|---|---|---|---|---|
| Source (Swing Buses): | 10.829 | 3.637 | 11.424 | 94.80 Lagging |
| Source (Non-Swing Buses): | 0.000 | 0.000 | 0.000 | |
| Total Demand: | 10.829 | 3.637 | 11.424 | 94.80 Lagging |
| Total Motor Load: | 2.528 | 1.077 | 2.748 | 92.00 Lagging |
| Total Static Load: | 8.032 | 3.422 | 8.730 | 92.00 Lagging |
| Total Constant I Load: | 0.000 | 0.000 | 0.000 | |
| Total Generic Load: | 0.000 | 0.000 | 0.000 | |
| Apparent Losses: | 0.269 | -0.862 | | |
| System Mismatch: | 0.000 | 0.000 | | |

Number of Iterations: 3

## Network Reconductoring

| | MW | Mvar | MVA | % PF |
|---|---|---|---|---|
| Source (Swing Buses): | 26.648 | 11.250 | 28.926 | 92.13 Lagging |
| Source (Non-Swing Buses): | 0.000 | 0.000 | 0.000 | |
| Total Demand: | 26.648 | 11.250 | 28.926 | 92.13 Lagging |
| Total Motor Load: | 6.386 | 2.720 | 6.941 | 92.00 Lagging |
| Total Static Load: | 18.881 | 8.043 | 20.523 | 92.00 Lagging |
| Total Constant I Load: | 0.000 | 0.000 | 0.000 | |
| Total Generic Load: | 0.000 | 0.000 | 0.000 | |
| Apparent Losses: | 1.382 | 0.486 | | |
| System Mismatch: | 0.000 | 0.000 | | |

Number of Iterations: 3

# Network Reconfiguration Case 1

| | MW | Mvar | MVA | % PF |
|---|---|---|---|---|
| Source (Swing Buses): | 26.861 | 11.144 | 29.081 | 92.37 Lagging |
| Source (Non-Swing Buses): | 0.000 | 0.000 | 0.000 | |
| Total Demand: | 26.861 | 11.144 | 29.081 | 92.37 Lagging |
| Total Motor Load: | 6.386 | 2.720 | 6.941 | 92.00 Lagging |
| Total Static Load: | 19.534 | 8.322 | 21.233 | 92.00 Lagging |
| Total Constant I Load: | 0.000 | 0.000 | 0.000 | |
| Total Generic Load: | 0.000 | 0.000 | 0.000 | |
| Apparent Losses: | 0.941 | 0.103 | | |
| System Mismatch: | 0.000 | 0.000 | | |

Number of Iterations: 3

| | | | |
|---|---|---|---|
| Project: | minimizing the power losses in | **ETAP** | Page :5 |
| Location: | wad Shaheen substation | | |
| Contract: | Third Scenario Case Analysis 1 | SN: | 4359168 |
| Engineer: | omar&bilal | Revision: | Base |
| Study Case: | LF | | |
| Filename: | wad Shaheen | Config.: | Normal |

## Network Reconfiguration Case 2

| | MW | Mvar | MVA | % PF |
|---|---|---|---|---|
| Source (Swing Buses): | 26.803 | 11.214 | 29.054 | 92.25 Lagging |
| Source (Non-Swing Buses): | 0.000 | 0.000 | 0.000 | |
| Total Demand: | 26.803 | 11.214 | 29.054 | 92.25 Lagging |
| Total Motor Load: | 6.386 | 2.720 | 6.941 | 92.00 Lagging |
| Total Static Load: | 19.312 | 8.227 | 20.992 | 92.00 Lagging |
| Total Constant I Load: | 0.000 | 0.000 | 0.000 | |
| Total Generic Load: | 0.000 | 0.000 | 0.000 | |
| Apparent Losses: | 1.105 | 0.267 | | |
| System Mismatch: | 0.000 | 0.000 | | |

Number of Iterations: 3

# Appendix B

# Summary of Power Losses for Each Case of Scenarios and Solutions

## Losses Summary for Cables and Distribution Transformers in peak Load

**Branch Losses Summary Report**

| Branch ID | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd % Drop |
|---|---|---|---|---|---|---|---|---|---|
| | MW | Mvar | MW | Mvar | kW | kvar | From | To | in Vmag |
| Cable1 | -0.591 | -0.267 | 0.591 | 0.267 | 0.1 | 0.0 | 93.9 | 93.9 | 0.01 |
| T1 | 0.510 | 0.231 | -0.497 | -0.212 | 12.5 | 18.8 | 93.9 | 90.7 | 3.19 |
| T2 | 0.081 | 0.037 | -0.079 | -0.034 | 2.0 | 3.0 | 93.9 | 90.7 | 3.19 |
| Cable2 | -0.324 | -0.117 | 0.324 | 0.117 | 0.0 | 0.0 | 93.9 | 93.9 | 0.00 |
| Cable70 | 0.324 | 0.117 | -0.324 | -0.146 | 0.0 | -29.2 | 93.9 | 93.9 | 0.00 |
| Cable3 | -0.915 | -0.385 | 0.915 | 0.385 | 0.0 | 0.0 | 93.9 | 93.9 | 0.00 |
| Cable4 | -1.044 | -0.443 | 1.045 | 0.443 | 0.6 | 0.2 | 93.9 | 93.9 | 0.05 |
| T4 | 0.130 | 0.059 | -0.126 | -0.054 | 3.2 | 4.8 | 93.9 | 90.7 | 3.19 |
| Cable5 | -1.007 | -0.464 | 1.007 | 0.446 | 0.1 | -18.0 | 93.9 | 93.9 | 0.01 |
| Cable6 | 0.804 | 0.372 | -0.804 | -0.380 | 0.0 | -8.2 | 93.9 | 93.9 | 0.00 |
| T6 | 0.203 | 0.092 | -0.198 | -0.084 | 5.0 | 7.5 | 93.9 | 90.8 | 3.19 |
| T7 | 0.804 | 0.380 | -0.792 | -0.337 | 12.3 | 43.1 | 93.9 | 90.9 | 3.05 |
| Cable7 | -2.254 | -0.981 | 2.255 | 0.981 | 1.5 | 0.5 | 93.9 | 94.0 | 0.06 |
| T5 | 0.203 | 0.092 | -0.198 | -0.084 | 5.0 | 7.5 | 93.9 | 90.8 | 3.19 |
| Cable8 | -0.811 | -0.269 | 0.811 | 0.269 | 0.2 | 0.1 | 94.0 | 94.0 | 0.02 |
| Cable9 | 0.203 | 0.024 | -0.203 | -0.092 | 0.0 | -67.6 | 94.0 | 94.0 | 0.00 |
| Cable10 | 0.405 | 0.153 | -0.405 | -0.153 | 0.0 | 0.0 | 94.0 | 94.0 | 0.01 |
| T9 | 0.203 | 0.092 | -0.198 | -0.084 | 5.0 | 7.5 | 94.0 | 90.8 | 3.19 |
| T10 | 0.203 | 0.092 | -0.198 | -0.084 | 5.0 | 7.5 | 94.0 | 90.8 | 3.19 |
| Cable11 | 0.203 | 0.061 | -0.203 | -0.092 | 0.0 | -30.3 | 94.0 | 94.0 | 0.00 |
| T11 | 0.203 | 0.092 | -0.198 | -0.084 | 5.0 | 7.5 | 94.0 | 90.8 | 3.19 |
| T12 | 0.203 | 0.092 | -0.198 | -0.084 | 5.0 | 7.5 | 94.0 | 90.8 | 3.19 |
| Cable12 | -3.577 | -1.481 | 3.578 | 1.450 | 0.7 | -31.6 | 94.0 | 94.0 | 0.02 |
| T8 | 0.511 | 0.231 | -0.498 | -0.212 | 12.5 | 18.8 | 94.0 | 90.8 | 3.19 |
| Cable13 | -1.482 | -0.709 | 1.482 | 0.710 | 0.4 | 0.1 | 94.1 | 94.1 | 0.02 |
| Cable72 | 1.279 | 0.618 | -1.279 | -0.627 | 0.0 | -9.1 | 94.1 | 94.1 | 0.00 |
| T13 | 0.203 | 0.092 | -0.198 | -0.084 | 5.0 | 7.5 | 94.1 | 90.9 | 3.19 |
| Cable15 | 1.726 | 0.819 | -1.726 | -0.819 | 0.0 | 0.0 | 94.1 | 94.1 | 0.00 |
| Cable18 | -6.788 | -2.979 | 6.796 | 2.982 | 7.8 | 2.7 | 94.1 | 94.2 | 0.10 |
| Cable71 | 3.580 | 1.450 | -3.578 | -1.450 | 2.3 | 0.8 | 94.1 | 94.0 | 0.06 |
| Cable16 | 1.523 | 0.727 | -1.523 | -0.727 | 0.2 | 0.1 | 94.1 | 94.1 | 0.01 |
| T15 | 0.203 | 0.092 | -0.198 | -0.084 | 5.0 | 7.5 | 94.1 | 90.9 | 3.19 |
| Cable17 | 1.198 | 0.587 | -1.197 | -0.587 | 1.0 | 0.3 | 94.0 | 94.0 | 0.07 |
| Cable74 | -1.522 | -0.734 | 1.523 | 0.734 | 0.7 | 0.2 | 94.0 | 94.1 | 0.04 |
| T16 | 0.324 | 0.147 | -0.317 | -0.135 | 8.0 | 11.9 | 94.0 | 90.8 | 3.19 |

| Branch ID | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd % Drop |
|---|---|---|---|---|---|---|---|---|---|
| | MW | Mvar | MW | Mvar | kW | kvar | From | To | in Vmag |
| Cable19 | -7.000 | -3.074 | 7.019 | 3.081 | 19.4 | 6.7 | 94.2 | 94.4 | 0.25 |
| T17 | 0.203 | 0.092 | -0.198 | -0.084 | 5.0 | 7.5 | 94.2 | 91.0 | 3.19 |
| Cable20 | 0.515 | 0.233 | -0.515 | -0.233 | 0.0 | 0.0 | 94.4 | 94.4 | 0.00 |
| Cable21 | -7.534 | -3.313 | 7.546 | 3.318 | 12.7 | 4.4 | 94.4 | 94.6 | 0.15 |
| T18 | 0.515 | 0.233 | -0.502 | -0.214 | 12.6 | 18.9 | 94.4 | 91.2 | 3.20 |
| Cable22 | 0.287 | 0.130 | -0.287 | -0.130 | 0.0 | 0.0 | 94.6 | 94.6 | 0.00 |
| Cable24 | -8.038 | -3.540 | 8.073 | 3.552 | 35.5 | 12.2 | 94.6 | 95.0 | 0.40 |
| T19 | 0.205 | 0.093 | -0.200 | -0.085 | 5.0 | 7.5 | 94.6 | 91.4 | 3.20 |
| Cable23 | 0.082 | 0.037 | -0.082 | -0.037 | 0.0 | 0.0 | 94.6 | 94.6 | 0.00 |
| T20 | 0.205 | 0.093 | -0.200 | -0.085 | 5.0 | 7.5 | 94.6 | 91.4 | 3.20 |
| T21 | 0.082 | 0.037 | -0.080 | -0.034 | 2.0 | 3.0 | 94.6 | 91.4 | 3.20 |
| Cable25 | -8.223 | -3.623 | 8.233 | 3.629 | 9.3 | 5.9 | 95.2 | 95.3 | 0.12 |
| Cable75 | 8.091 | 3.564 | -8.073 | -3.552 | 18.0 | 11.4 | 95.2 | 95.0 | 0.23 |
| T22 | 0.132 | 0.060 | -0.129 | -0.055 | 3.2 | 4.8 | 95.2 | 92.0 | 3.21 |
| Cable26 | 0.207 | 0.075 | -0.207 | -0.094 | 0.0 | -19.1 | 95.3 | 95.3 | 0.00 |
| Cable27 | 1.637 | 0.751 | -1.637 | -0.786 | 0.3 | -35.1 | 95.3 | 95.3 | 0.02 |
| Cable29 | 6.761 | 2.833 | -6.752 | -2.896 | 9.3 | -63.2 | 95.3 | 95.2 | 0.15 |
| Cable34 | -16.838 | -7.287 | 16.877 | 7.312 | 38.6 | 24.4 | 95.3 | 95.6 | 0.23 |
| T23 | 0.207 | 0.094 | -0.202 | -0.086 | 5.0 | 7.6 | 95.3 | 92.1 | 3.22 |
| Cable28 | 1.306 | 0.636 | -1.306 | -0.639 | 0.0 | -3.6 | 95.3 | 95.3 | 0.00 |
| Cable76 | -1.637 | -0.786 | 1.637 | 0.786 | 0.1 | 0.1 | 95.3 | 95.3 | 0.01 |
| T24 | 0.331 | 0.150 | -0.323 | -0.138 | 8.1 | 12.1 | 95.3 | 92.1 | 3.21 |
| T25 | 1.306 | 0.639 | -1.291 | -0.550 | 14.9 | 89.6 | 95.3 | 92.0 | 3.34 |
| Cable82 | 6.669 | 2.859 | -6.657 | -2.855 | 11.8 | 4.1 | 95.2 | 95.0 | 0.16 |
| T26 | 0.083 | 0.037 | -0.081 | -0.034 | 2.0 | 3.0 | 95.2 | 92.0 | 3.21 |
| Cable32 | -1.635 | -0.765 | 1.635 | 0.747 | 0.2 | -18.5 | 94.9 | 94.9 | 0.01 |
| Cable33 | 0.817 | 0.378 | -0.817 | -0.387 | 0.0 | -8.0 | 94.9 | 94.9 | 0.00 |
| T28 | 0.817 | 0.387 | -0.805 | -0.343 | 12.5 | 43.6 | 94.9 | 91.9 | 3.07 |
| T3 | -0.316 | -0.135 | 0.324 | 0.146 | 7.9 | 11.9 | 90.7 | 93.9 | 3.19 |
| T14 | -1.264 | -0.539 | 1.279 | 0.627 | 14.7 | 88.3 | 90.7 | 94.1 | 3.31 |
| Cable47 | -0.852 | -0.402 | 0.852 | 0.370 | 0.1 | -32.7 | 97.5 | 97.5 | 0.01 |
| T38 | 0.852 | 0.402 | -0.839 | -0.358 | 12.8 | 44.9 | 97.5 | 94.4 | 3.12 |
| Cable73 | 1.523 | 0.727 | -1.523 | -0.734 | 0.0 | -6.7 | 94.1 | 94.1 | 0.00 |
| Cable30 | -4.354 | -1.879 | 4.358 | 1.812 | 3.9 | -67.0 | 94.9 | 95.0 | 0.10 |
| Cable31 | 0.519 | 0.200 | -0.519 | -0.235 | 0.0 | -35.0 | 94.9 | 94.9 | 0.01 |
| Cable77 | 0.535 | 0.203 | -0.535 | -0.211 | 0.0 | -8.4 | 94.9 | 94.9 | 0.00 |
| Cable79 | 1.665 | 0.730 | -1.665 | -0.751 | 0.2 | -20.8 | 94.9 | 94.9 | 0.01 |

| Branch ID | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd % Drop |
|---|---|---|---|---|---|---|---|---|---|
| | MW | Mvar | MW | Mvar | kW | kvar | From | To | in Vmag |
| Cable78 | 0.206 | 0.062 | -0.206 | -0.093 | 0.0 | -31.0 | 94.9 | 94.9 | 0.00 |
| T55 | 0.329 | 0.149 | -0.321 | -0.137 | 8.0 | 12.1 | 94.9 | 91.7 | 3.21 |
| T56 | 0.206 | 0.093 | -0.201 | -0.086 | 5.0 | 7.5 | 94.9 | 91.7 | 3.21 |
| Cable80 | 1.147 | 0.516 | -1.147 | -0.526 | 0.0 | -9.7 | 94.9 | 94.9 | 0.00 |
| T57 | 0.519 | 0.235 | -0.506 | -0.216 | 12.7 | 19.0 | 94.9 | 91.7 | 3.21 |
| Cable81 | 0.817 | 0.377 | -0.817 | -0.386 | 0.0 | -9.7 | 94.9 | 94.9 | 0.00 |
| T58 | 0.329 | 0.149 | -0.321 | -0.137 | 8.0 | 12.1 | 94.9 | 91.7 | 3.21 |
| T59 | 0.817 | 0.386 | -0.805 | -0.343 | 12.5 | 43.6 | 94.9 | 91.8 | 3.07 |
| Cable83 | 2.299 | 1.043 | -2.297 | -1.042 | 1.7 | 0.6 | 95.0 | 95.0 | 0.07 |
| Cable84 | 2.166 | 0.983 | -2.163 | -0.982 | 2.2 | 0.8 | 95.0 | 94.9 | 0.09 |
| T60 | 0.132 | 0.060 | -0.129 | -0.055 | 3.2 | 4.8 | 95.0 | 91.8 | 3.21 |
| Cable85 | 1.958 | 0.889 | -1.958 | -0.889 | 0.2 | 0.1 | 94.9 | 94.9 | 0.01 |
| T61 | 0.206 | 0.093 | -0.201 | -0.085 | 5.0 | 7.5 | 94.9 | 91.7 | 3.21 |
| Cable86 | 1.958 | 0.889 | -1.957 | -0.889 | 0.7 | 0.3 | 94.9 | 94.8 | 0.03 |
| Cable87 | 1.825 | 0.829 | -1.825 | -0.829 | 0.7 | 0.2 | 94.8 | 94.8 | 0.03 |
| T62 | 0.132 | 0.059 | -0.128 | -0.055 | 3.2 | 4.8 | 94.8 | 91.6 | 3.21 |
| Cable88 | 1.459 | 0.663 | -1.459 | -0.663 | 0.2 | 0.1 | 94.8 | 94.8 | 0.01 |
| T63 | 0.366 | 0.166 | -0.356 | -0.152 | 10.0 | 14.9 | 94.8 | 91.2 | 3.57 |
| Cable89 | 0.941 | 0.429 | -0.941 | -0.429 | 0.1 | 0.0 | 94.8 | 94.8 | 0.01 |
| T64 | 0.517 | 0.234 | -0.505 | -0.215 | 12.6 | 19.0 | 94.8 | 91.6 | 3.20 |
| Cable90 | 0.576 | 0.262 | -0.576 | -0.262 | 0.0 | 0.0 | 94.8 | 94.8 | 0.00 |
| T65 | 0.366 | 0.166 | -0.356 | -0.151 | 10.0 | 14.9 | 94.8 | 91.2 | 3.57 |
| T66 | 0.576 | 0.262 | -0.560 | -0.239 | 15.7 | 23.5 | 94.8 | 91.2 | 3.57 |
| Cable53 | 22.470 | 9.731 | -22.450 | -9.724 | 20.9 | 7.2 | 100.0 | 99.9 | 0.09 |
| Cable54 | 4.094 | 1.367 | -4.093 | -1.367 | 0.6 | 0.2 | 100.0 | 100.0 | 0.01 |
| c77 | 1.855 | 0.579 | -1.853 | -0.798 | 1.8 | -219.0 | 99.6 | 99.5 | 0.11 |
| Cable66 | -1.855 | -0.579 | 1.856 | 0.579 | 1.3 | 0.5 | 99.6 | 99.7 | 0.07 |
| T67 | 1.197 | 0.587 | -1.183 | -0.504 | 13.8 | 82.7 | 94.0 | 90.6 | 3.31 |
| Cable45 | -0.409 | -0.187 | 0.410 | 0.187 | 0.1 | 0.0 | 97.5 | 97.5 | 0.01 |
| T37 | 0.409 | 0.187 | -0.398 | -0.169 | 11.8 | 17.8 | 97.5 | 93.6 | 3.90 |
| T27 | -0.506 | -0.216 | 0.519 | 0.235 | 12.7 | 19.0 | 91.7 | 94.9 | 3.21 |
| Cable56 | 4.093 | 1.367 | -4.093 | -1.367 | 0.0 | -0.1 | 100.0 | 100.0 | 0.00 |
| T29 | 0.817 | 0.387 | -0.805 | -0.343 | 12.5 | 43.6 | 94.9 | 91.8 | 3.07 |
| Cable35 | 0.133 | 0.060 | -0.133 | -0.060 | 0.0 | 0.0 | 95.6 | 95.6 | 0.00 |
| Cable36 | -17.010 | -7.372 | 17.056 | 7.388 | 46.4 | 16.0 | 95.6 | 95.8 | 0.25 |
| T30 | 0.133 | 0.060 | -0.130 | -0.055 | 3.2 | 4.9 | 95.6 | 92.4 | 3.22 |
| Cable37 | 0.334 | 0.151 | -0.334 | -0.151 | 0.0 | 0.0 | 95.8 | 95.8 | 0.01 |

| Branch ID | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd % Drop |
|---|---|---|---|---|---|---|---|---|---|
| | MW | Mvar | MW | Mvar | kW | kvar | From | To | in Vmag |
| Cable38 | -17.391 | -7.539 | 17.429 | 7.552 | 38.6 | 13.3 | 95.8 | 96.0 | 0.21 |
| T31 | 0.334 | 0.151 | -0.326 | -0.139 | 8.1 | 12.2 | 95.8 | 92.6 | 3.22 |
| Cable39 | -17.589 | -7.626 | 17.620 | 7.636 | 30.8 | 10.8 | 96.0 | 96.2 | 0.16 |
| T32 | 0.160 | 0.073 | -0.155 | -0.066 | 4.7 | 7.0 | 96.0 | 92.2 | 3.86 |
| Cable40 | 0.802 | 0.367 | -0.802 | -0.367 | 0.2 | 0.1 | 96.2 | 96.2 | 0.03 |
| Cable42 | -18.673 | -8.118 | 18.774 | 8.153 | 101.5 | 35.0 | 96.2 | 96.7 | 0.51 |
| T33 | 0.251 | 0.115 | -0.243 | -0.104 | 7.3 | 10.9 | 96.2 | 92.3 | 3.87 |
| Cable41 | 0.401 | 0.183 | -0.401 | -0.183 | 0.1 | 0.0 | 96.2 | 96.1 | 0.02 |
| T34 | 0.401 | 0.183 | -0.389 | -0.166 | 11.7 | 17.5 | 96.2 | 92.3 | 3.87 |
| T35 | 0.401 | 0.183 | -0.389 | -0.166 | 11.7 | 17.5 | 96.1 | 92.3 | 3.87 |
| Cable43 | -19.308 | -8.394 | 19.341 | 8.405 | 32.6 | 11.2 | 96.7 | 96.9 | 0.16 |
| T54 | 0.534 | 0.241 | -0.521 | -0.222 | 12.9 | 19.4 | 96.7 | 93.5 | 3.24 |
| Cable44 | 0.162 | 0.074 | -0.162 | -0.074 | 0.0 | 0.0 | 96.9 | 96.9 | 0.01 |
| Cable46 | -19.503 | -8.479 | 19.633 | 8.524 | 130.4 | 44.9 | 96.9 | 97.5 | 0.63 |
| T36 | 0.162 | 0.074 | -0.157 | -0.067 | 4.7 | 7.1 | 96.9 | 93.0 | 3.88 |
| Cable48 | -21.110 | -9.178 | 21.237 | 9.222 | 127.3 | 43.9 | 97.5 | 98.1 | 0.57 |
| T39 | 0.215 | 0.097 | -0.209 | -0.089 | 5.2 | 7.8 | 97.5 | 94.2 | 3.26 |
| Cable49 | -21.583 | -9.379 | 21.688 | 9.415 | 105.0 | 36.2 | 98.1 | 98.5 | 0.46 |
| T40 | 0.346 | 0.157 | -0.338 | -0.144 | 8.3 | 12.5 | 98.1 | 94.8 | 3.27 |
| Cable50 | -21.907 | -9.513 | 22.103 | 9.581 | 196.6 | 67.8 | 98.5 | 99.4 | 0.86 |
| T41 | 0.218 | 0.099 | -0.213 | -0.091 | 5.2 | 7.9 | 98.5 | 95.2 | 3.27 |
| Cable51 | -22.324 | -9.681 | 22.450 | 9.724 | 125.3 | 43.2 | 99.4 | 99.9 | 0.54 |
| T42 | 0.221 | 0.100 | -0.216 | -0.092 | 5.3 | 7.9 | 99.4 | 96.1 | 3.29 |
| Cable58 | 0.357 | 0.106 | -0.357 | -0.161 | 0.0 | -55.5 | 100.0 | 100.0 | 0.01 |
| Cable59 | 3.513 | 1.161 | -3.511 | -1.160 | 1.7 | 1.0 | 100.0 | 99.9 | 0.05 |
| T43 | 0.223 | 0.101 | -0.218 | -0.093 | 5.3 | 8.0 | 100.0 | 96.7 | 3.30 |
| T44 | 0.357 | 0.161 | -0.349 | -0.149 | 8.5 | 12.8 | 100.0 | 96.7 | 3.30 |
| Cable60 | 3.154 | 0.998 | -3.154 | -0.998 | 0.4 | 0.3 | 99.9 | 99.9 | 0.01 |
| T45 | 0.357 | 0.161 | -0.349 | -0.148 | 8.5 | 12.8 | 99.9 | 96.6 | 3.30 |
| Cable61 | 2.931 | 0.897 | -2.929 | -0.897 | 1.3 | 0.5 | 99.9 | 99.9 | 0.05 |
| T46 | 0.223 | 0.101 | -0.218 | -0.093 | 5.3 | 8.0 | 99.9 | 96.6 | 3.30 |
| Cable62 | 2.787 | 0.832 | -2.786 | -0.890 | 1.0 | -57.5 | 99.9 | 99.8 | 0.04 |
| T47 | 0.143 | 0.064 | -0.139 | -0.059 | 3.4 | 5.1 | 99.9 | 96.6 | 3.30 |
| Cable63 | 0.704 | 0.209 | -0.704 | -0.231 | 0.0 | -22.0 | 99.8 | 99.8 | 0.00 |
| Cable65 | 2.082 | 0.681 | -2.078 | -0.680 | 3.2 | 1.1 | 99.8 | 99.7 | 0.16 |
| Cable64 | 0.561 | 0.167 | -0.561 | -0.253 | 0.1 | -86.7 | 99.8 | 99.8 | 0.01 |
| T48 | 0.143 | 0.064 | -0.139 | -0.059 | 3.4 | 5.1 | 99.8 | 96.5 | 3.30 |

| Branch ID | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd % Drop |
|---|---|---|---|---|---|---|---|---|---|
| | MW | Mvar | MW | Mvar | kW | kvar | From | To | in Vmag |
| T49 | 0.561 | 0.253 | -0.548 | -0.233 | 13.4 | 20.1 | 99.8 | 96.5 | 3.30 |
| T50 | 0.222 | 0.100 | -0.217 | -0.092 | 5.3 | 8.0 | 99.7 | 96.4 | 3.30 |
| Cable67 | 1.410 | 0.670 | -1.410 | -0.671 | 0.0 | -1.4 | 99.5 | 99.5 | 0.00 |
| Cable68 | 0.222 | 0.028 | -0.222 | -0.100 | 0.0 | -72.2 | 99.5 | 99.5 | 0.00 |
| T52 | 0.222 | 0.100 | -0.216 | -0.092 | 5.3 | 8.0 | 99.5 | 96.2 | 3.29 |
| T51 | 1.410 | 0.671 | -1.397 | -0.595 | 12.7 | 75.9 | 99.5 | 96.8 | 2.72 |
| T53 | 0.222 | 0.100 | -0.216 | -0.092 | 5.3 | 8.0 | 99.5 | 96.2 | 3.29 |
| | | | | | 1670.8 | 494.3 | | | |

# Losses Summary Report for Cables and Distribution Transformers in Network reconductoring

## Branch Losses Summary Report

| Branch ID | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd % Drop |
|---|---|---|---|---|---|---|---|---|---|
| | MW | Mvar | MW | Mvar | kW | kvar | From | To | in Vmag |
| Cable1 | -0.603 | -0.273 | 0.603 | 0.273 | 0.1 | 0.0 | 95.2 | 95.2 | 0.01 |
| T1 | 0.521 | 0.235 | -0.508 | -0.216 | 12.7 | 19.0 | 95.2 | 92.0 | 3.21 |
| T2 | 0.083 | 0.037 | -0.081 | -0.034 | 2.0 | 3.0 | 95.2 | 92.0 | 3.21 |
| Cable2 | -0.331 | -0.120 | 0.331 | 0.120 | 0.0 | 0.0 | 95.2 | 95.2 | 0.00 |
| Cable70 | 0.331 | 0.120 | -0.331 | -0.150 | 0.0 | -30.0 | 95.2 | 95.2 | 0.00 |
| Cable3 | -0.934 | -0.392 | 0.934 | 0.392 | 0.0 | 0.0 | 95.2 | 95.2 | 0.00 |
| Cable4 | -1.066 | -0.452 | 1.067 | 0.452 | 0.6 | 0.2 | 95.2 | 95.2 | 0.05 |
| T4 | 0.132 | 0.060 | -0.129 | -0.055 | 3.2 | 4.8 | 95.2 | 92.0 | 3.21 |
| Cable5 | -1.028 | -0.473 | 1.028 | 0.455 | 0.1 | -18.5 | 95.2 | 95.2 | 0.01 |
| Cable6 | 0.821 | 0.380 | -0.821 | -0.388 | 0.0 | -8.5 | 95.2 | 95.2 | 0.00 |
| T6 | 0.207 | 0.094 | -0.202 | -0.086 | 5.0 | 7.6 | 95.2 | 92.0 | 3.21 |
| T7 | 0.821 | 0.388 | -0.809 | -0.345 | 12.5 | 43.8 | 95.2 | 92.1 | 3.08 |
| Cable7 | -2.302 | -1.001 | 2.304 | 1.001 | 1.5 | 0.5 | 95.2 | 95.3 | 0.06 |
| T5 | 0.207 | 0.094 | -0.202 | -0.086 | 5.0 | 7.6 | 95.2 | 92.0 | 3.21 |
| Cable8 | -0.828 | -0.274 | 0.828 | 0.274 | 0.2 | 0.1 | 95.3 | 95.3 | 0.02 |
| Cable9 | 0.207 | 0.024 | -0.207 | -0.094 | 0.0 | -69.5 | 95.3 | 95.3 | 0.00 |
| Cable10 | 0.414 | 0.156 | -0.414 | -0.156 | 0.0 | 0.0 | 95.3 | 95.3 | 0.01 |
| T9 | 0.207 | 0.094 | -0.202 | -0.086 | 5.0 | 7.6 | 95.3 | 92.1 | 3.21 |
| T10 | 0.207 | 0.094 | -0.202 | -0.086 | 5.0 | 7.6 | 95.3 | 92.1 | 3.21 |
| Cable11 | 0.207 | 0.062 | -0.207 | -0.094 | 0.0 | -31.1 | 95.3 | 95.3 | 0.00 |
| T11 | 0.207 | 0.094 | -0.202 | -0.086 | 5.0 | 7.6 | 95.3 | 92.0 | 3.21 |
| T12 | 0.207 | 0.094 | -0.202 | -0.086 | 5.0 | 7.6 | 95.3 | 92.0 | 3.21 |
| Cable12 | -3.653 | -1.511 | 3.654 | 1.479 | 0.7 | -32.5 | 95.3 | 95.3 | 0.02 |
| T8 | 0.522 | 0.236 | -0.509 | -0.217 | 12.7 | 19.1 | 95.3 | 92.1 | 3.21 |
| Cable13 | -1.514 | -0.724 | 1.514 | 0.724 | 0.4 | 0.1 | 95.3 | 95.4 | 0.02 |
| Cable72 | 1.306 | 0.630 | -1.306 | -0.640 | 0.0 | -9.4 | 95.3 | 95.3 | 0.00 |
| T13 | 0.207 | 0.094 | -0.202 | -0.086 | 5.0 | 7.6 | 95.3 | 92.1 | 3.22 |
| Cable15 | 1.763 | 0.836 | -1.763 | -0.836 | 0.0 | 0.0 | 95.4 | 95.4 | 0.00 |
| Cable18 | -6.933 | -3.040 | 6.941 | 3.043 | 7.9 | 2.7 | 95.4 | 95.5 | 0.11 |
| Cable71 | 3.656 | 1.480 | -3.654 | -1.479 | 2.3 | 0.8 | 95.4 | 95.3 | 0.06 |
| Cable16 | 1.556 | 0.742 | -1.556 | -0.742 | 0.2 | 0.1 | 95.4 | 95.4 | 0.01 |
| T15 | 0.207 | 0.094 | -0.202 | -0.086 | 5.1 | 7.6 | 95.4 | 92.2 | 3.22 |
| Cable17 | 1.223 | 0.599 | -1.223 | -0.599 | 1.0 | 0.3 | 95.3 | 95.2 | 0.07 |
| Cable74 | -1.555 | -0.749 | 1.556 | 0.749 | 0.7 | 0.2 | 95.3 | 95.4 | 0.04 |
| T16 | 0.331 | 0.150 | -0.323 | -0.138 | 8.1 | 12.1 | 95.3 | 92.1 | 3.21 |

| Branch ID | From-To Bus Flow MW | From-To Bus Flow Mvar | To-From Bus Flow MW | To-From Bus Flow Mvar | Losses kW | Losses kvar | % Bus Voltage From | % Bus Voltage To | Vd % Drop in Vmag |
|---|---|---|---|---|---|---|---|---|---|
| Cable19 | -7.149 | -3.137 | 7.169 | 3.143 | 19.7 | 6.8 | 95.5 | 95.7 | 0.25 |
| T17 | 0.208 | 0.094 | -0.203 | -0.086 | 5.1 | 7.6 | 95.5 | 92.3 | 3.22 |
| Cable20 | 0.526 | 0.238 | -0.525 | -0.238 | 0.0 | 0.0 | 95.7 | 95.7 | 0.00 |
| Cable21 | -7.694 | -3.381 | 7.707 | 3.385 | 12.9 | 4.4 | 95.7 | 95.9 | 0.15 |
| T18 | 0.525 | 0.238 | -0.513 | -0.218 | 12.8 | 19.2 | 95.7 | 92.5 | 3.22 |
| Cable22 | 0.293 | 0.132 | -0.293 | -0.132 | 0.0 | 0.0 | 95.9 | 95.9 | 0.00 |
| Cable24 | -8.209 | -3.612 | 8.232 | 3.624 | 23.2 | 12.0 | 95.9 | 96.2 | 0.28 |
| T19 | 0.209 | 0.095 | -0.204 | -0.087 | 5.1 | 7.6 | 95.9 | 92.7 | 3.23 |
| Cable23 | 0.084 | 0.038 | -0.084 | -0.038 | 0.0 | 0.0 | 95.9 | 95.9 | 0.00 |
| T20 | 0.209 | 0.095 | -0.204 | -0.087 | 5.1 | 7.6 | 95.9 | 92.7 | 3.23 |
| T21 | 0.084 | 0.038 | -0.082 | -0.035 | 2.0 | 3.0 | 95.9 | 92.7 | 3.23 |
| Cable25 | -8.385 | -3.697 | 8.395 | 3.703 | 9.4 | 6.0 | 96.4 | 96.5 | 0.12 |
| Cable75 | 8.250 | 3.636 | -8.232 | -3.624 | 18.3 | 11.5 | 96.4 | 96.2 | 0.23 |
| T22 | 0.135 | 0.061 | -0.132 | -0.056 | 3.3 | 4.9 | 96.4 | 93.2 | 3.23 |
| Cable26 | 0.211 | 0.076 | -0.211 | -0.095 | 0.0 | -19.6 | 96.5 | 96.5 | 0.00 |
| Cable27 | 1.669 | 0.764 | -1.669 | -0.800 | 0.3 | -35.9 | 96.5 | 96.5 | 0.02 |
| Cable29 | 6.871 | 2.875 | -6.861 | -2.940 | 9.4 | -64.9 | 96.5 | 96.4 | 0.15 |
| Cable34 | -17.146 | -7.418 | 17.185 | 7.442 | 39.1 | 24.7 | 96.5 | 96.7 | 0.24 |
| T23 | 0.211 | 0.095 | -0.206 | -0.088 | 5.1 | 7.7 | 96.5 | 93.3 | 3.24 |
| Cable28 | 1.331 | 0.648 | -1.331 | -0.651 | 0.0 | -3.7 | 96.5 | 96.5 | 0.00 |
| Cable76 | -1.669 | -0.800 | 1.669 | 0.800 | 0.2 | 0.1 | 96.5 | 96.5 | 0.01 |
| T24 | 0.338 | 0.153 | -0.330 | -0.140 | 8.2 | 12.3 | 96.5 | 93.2 | 3.24 |
| T25 | 1.331 | 0.651 | -1.316 | -0.560 | 15.1 | 90.9 | 96.5 | 93.1 | 3.36 |
| Cable82 | 6.777 | 2.901 | -6.765 | -2.897 | 11.9 | 4.1 | 96.4 | 96.2 | 0.16 |
| T26 | 0.084 | 0.038 | -0.082 | -0.035 | 2.0 | 3.1 | 96.4 | 93.1 | 3.23 |
| Cable32 | -1.666 | -0.779 | 1.666 | 0.760 | 0.2 | -18.9 | 96.1 | 96.1 | 0.01 |
| Cable33 | 0.833 | 0.386 | -0.833 | -0.394 | 0.0 | -8.2 | 96.1 | 96.1 | 0.00 |
| T28 | 0.833 | 0.394 | -0.821 | -0.350 | 12.6 | 44.2 | 96.1 | 93.0 | 3.09 |
| T3 | -0.323 | -0.137 | 0.331 | 0.150 | 8.1 | 12.1 | 92.0 | 95.2 | 3.21 |
| T14 | -1.291 | -0.550 | 1.306 | 0.640 | 14.9 | 89.7 | 92.0 | 95.3 | 3.34 |
| Cable47 | -0.862 | -0.407 | 0.862 | 0.374 | 0.1 | -33.1 | 98.2 | 98.2 | 0.01 |
| T38 | 0.862 | 0.407 | -0.849 | -0.362 | 12.9 | 45.3 | 98.2 | 95.0 | 3.13 |
| Cable73 | 1.556 | 0.742 | -1.556 | -0.749 | 0.1 | -6.8 | 95.4 | 95.4 | 0.00 |
| Cable30 | -4.438 | -1.913 | 4.442 | 1.844 | 4.0 | -68.7 | 96.1 | 96.2 | 0.10 |
| Cable31 | 0.529 | 0.203 | -0.529 | -0.239 | 0.0 | -35.8 | 96.1 | 96.1 | 0.01 |
| Cable77 | 0.545 | 0.206 | -0.545 | -0.215 | 0.0 | -8.6 | 96.1 | 96.1 | 0.00 |
| Cable79 | 1.697 | 0.743 | -1.697 | -0.765 | 0.2 | -21.3 | 96.1 | 96.1 | 0.01 |

| Branch ID | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd % Drop |
|---|---|---|---|---|---|---|---|---|---|
| | MW | Mvar | MW | Mvar | kW | kvar | From | To | in Vmag |
| Cable78 | 0.210 | 0.063 | -0.210 | -0.095 | 0.0 | -31.7 | 96.1 | 96.1 | 0.00 |
| T55 | 0.336 | 0.152 | -0.328 | -0.140 | 8.2 | 12.2 | 96.1 | 92.9 | 3.23 |
| T56 | 0.210 | 0.095 | -0.205 | -0.087 | 5.1 | 7.6 | 96.1 | 92.9 | 3.23 |
| Cable80 | 1.169 | 0.526 | -1.169 | -0.535 | 0.0 | -9.9 | 96.1 | 96.1 | 0.00 |
| T57 | 0.529 | 0.239 | -0.516 | -0.220 | 12.8 | 19.3 | 96.1 | 92.9 | 3.23 |
| Cable81 | 0.833 | 0.384 | -0.833 | -0.394 | 0.0 | -9.9 | 96.1 | 96.1 | 0.00 |
| T58 | 0.336 | 0.152 | -0.327 | -0.139 | 8.1 | 12.2 | 96.1 | 92.9 | 3.23 |
| T59 | 0.833 | 0.394 | -0.820 | -0.350 | 12.6 | 44.2 | 96.1 | 93.0 | 3.09 |
| Cable83 | 2.323 | 1.053 | -2.322 | -1.052 | 1.7 | 0.6 | 96.2 | 96.1 | 0.07 |
| Cable84 | 2.187 | 0.992 | -2.185 | -0.991 | 2.2 | 0.8 | 96.1 | 96.0 | 0.09 |
| T60 | 0.134 | 0.061 | -0.131 | -0.056 | 3.3 | 4.9 | 96.1 | 92.9 | 3.23 |
| Cable85 | 1.975 | 0.896 | -1.975 | -0.896 | 0.2 | 0.1 | 96.0 | 96.0 | 0.01 |
| T61 | 0.210 | 0.095 | -0.204 | -0.087 | 5.1 | 7.6 | 96.0 | 92.8 | 3.23 |
| Cable86 | 1.975 | 0.896 | -1.975 | -0.896 | 0.7 | 0.3 | 96.0 | 96.0 | 0.03 |
| Cable87 | 1.841 | 0.835 | -1.840 | -0.835 | 0.7 | 0.2 | 96.0 | 96.0 | 0.03 |
| T62 | 0.134 | 0.061 | -0.131 | -0.056 | 3.3 | 4.9 | 96.0 | 92.8 | 3.23 |
| Cable88 | 1.473 | 0.668 | -1.473 | -0.668 | 0.2 | 0.1 | 96.0 | 95.9 | 0.01 |
| T63 | 0.367 | 0.167 | -0.357 | -0.152 | 9.8 | 14.7 | 96.0 | 92.4 | 3.54 |
| Cable89 | 0.945 | 0.430 | -0.945 | -0.430 | 0.1 | 0.0 | 95.9 | 95.9 | 0.01 |
| T64 | 0.527 | 0.238 | -0.515 | -0.219 | 12.8 | 19.2 | 95.9 | 92.7 | 3.23 |
| Cable90 | 0.578 | 0.263 | -0.578 | -0.263 | 0.0 | 0.0 | 95.9 | 95.9 | 0.00 |
| T65 | 0.367 | 0.167 | -0.357 | -0.152 | 9.8 | 14.7 | 95.9 | 92.4 | 3.54 |
| T66 | 0.578 | 0.263 | -0.563 | -0.240 | 15.4 | 23.1 | 95.9 | 92.4 | 3.54 |
| Cable53 | 22.554 | 9.882 | -22.533 | -9.875 | 21.2 | 7.3 | 100.0 | 99.9 | 0.09 |
| Cable54 | 4.094 | 1.367 | -4.093 | -1.367 | 0.6 | 0.2 | 100.0 | 100.0 | 0.01 |
| c77 | 1.855 | 0.579 | -1.853 | -0.798 | 1.8 | -219.0 | 99.6 | 99.5 | 0.11 |
| Cable66 | -1.855 | -0.579 | 1.856 | 0.579 | 1.3 | 0.5 | 99.6 | 99.7 | 0.07 |
| T67 | 1.223 | 0.599 | -1.209 | -0.515 | 14.0 | 84.0 | 95.2 | 91.9 | 3.34 |
| Cable45 | -0.414 | -0.189 | 0.414 | 0.189 | 0.1 | 0.0 | 98.2 | 98.2 | 0.01 |
| T37 | 0.414 | 0.189 | -0.402 | -0.171 | 11.9 | 17.9 | 98.2 | 94.2 | 3.91 |
| T27 | -0.516 | -0.220 | 0.529 | 0.239 | 12.8 | 19.3 | 92.9 | 96.1 | 3.23 |
| Cable56 | 4.093 | 1.367 | -4.093 | -1.367 | 0.0 | -0.1 | 100.0 | 100.0 | 0.00 |
| T29 | 0.833 | 0.394 | -0.821 | -0.350 | 12.6 | 44.2 | 96.1 | 93.0 | 3.09 |
| Cable35 | 0.136 | 0.061 | -0.136 | -0.061 | 0.0 | 0.0 | 96.7 | 96.7 | 0.00 |
| Cable36 | -17.321 | -7.504 | 17.351 | 7.519 | 30.3 | 15.6 | 96.7 | 96.9 | 0.17 |
| T30 | 0.136 | 0.061 | -0.132 | -0.056 | 3.3 | 4.9 | 96.7 | 93.5 | 3.24 |
| Cable37 | 0.340 | 0.154 | -0.340 | -0.154 | 0.0 | 0.0 | 96.9 | 96.9 | 0.01 |

| | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd |
|---|---|---|---|---|---|---|---|---|---|
| Branch ID | MW | Mvar | MW | Mvar | kW | kvar | From | To | % Drop in Vmag |
| Cable38 | -17.691 | -7.673 | 17.716 | 7.686 | 25.1 | 12.9 | 96.9 | 97.1 | 0.14 |
| T31 | 0.340 | 0.154 | -0.332 | -0.141 | 8.2 | 12.3 | 96.9 | 93.7 | 3.24 |
| Cable39 | -17.879 | -7.760 | 17.910 | 7.771 | 31.2 | 10.9 | 97.1 | 97.2 | 0.16 |
| T32 | 0.163 | 0.074 | -0.158 | -0.067 | 4.7 | 7.1 | 97.1 | 93.2 | 3.89 |
| Cable40 | 0.816 | 0.373 | -0.815 | -0.373 | 0.3 | 0.1 | 97.2 | 97.2 | 0.03 |
| Cable42 | -18.980 | -8.260 | 19.047 | 8.295 | 66.2 | 34.1 | 97.2 | 97.6 | 0.35 |
| T33 | 0.255 | 0.117 | -0.248 | -0.105 | 7.4 | 11.1 | 97.2 | 93.3 | 3.89 |
| Cable41 | 0.408 | 0.186 | -0.408 | -0.186 | 0.1 | 0.0 | 97.2 | 97.2 | 0.02 |
| T34 | 0.408 | 0.186 | -0.396 | -0.169 | 11.8 | 17.7 | 97.2 | 93.3 | 3.89 |
| T35 | 0.408 | 0.186 | -0.396 | -0.169 | 11.8 | 17.7 | 97.2 | 93.3 | 3.89 |
| Cable43 | -19.588 | -8.539 | 19.621 | 8.551 | 32.9 | 11.4 | 97.6 | 97.7 | 0.16 |
| T54 | 0.541 | 0.245 | -0.528 | -0.225 | 13.1 | 19.6 | 97.6 | 94.3 | 3.26 |
| Cable44 | 0.164 | 0.075 | -0.164 | -0.075 | 0.0 | 0.0 | 97.7 | 97.7 | 0.01 |
| Cable46 | -19.786 | -8.626 | 19.871 | 8.670 | 85.0 | 43.8 | 97.7 | 98.2 | 0.43 |
| T36 | 0.164 | 0.075 | -0.160 | -0.068 | 4.7 | 7.1 | 97.7 | 93.8 | 3.90 |
| Cable48 | -21.363 | -9.331 | 21.446 | 9.373 | 83.0 | 42.7 | 98.2 | 98.6 | 0.39 |
| T39 | 0.217 | 0.098 | -0.212 | -0.090 | 5.2 | 7.8 | 98.2 | 94.9 | 3.27 |
| Cable49 | -21.796 | -9.531 | 21.864 | 9.566 | 68.5 | 35.3 | 98.6 | 98.9 | 0.32 |
| T40 | 0.349 | 0.158 | -0.341 | -0.145 | 8.4 | 12.6 | 98.6 | 95.3 | 3.28 |
| Cable50 | -22.083 | -9.665 | 22.212 | 9.731 | 128.2 | 66.0 | 98.9 | 99.5 | 0.59 |
| T41 | 0.219 | 0.099 | -0.214 | -0.091 | 5.3 | 7.9 | 98.9 | 95.6 | 3.28 |
| Cable51 | -22.433 | -9.831 | 22.533 | 9.875 | 100.2 | 43.3 | 99.5 | 99.9 | 0.44 |
| T42 | 0.221 | 0.100 | -0.216 | -0.092 | 5.3 | 7.9 | 99.5 | 96.2 | 3.29 |
| Cable58 | 0.357 | 0.106 | -0.357 | -0.161 | 0.0 | -55.5 | 100.0 | 100.0 | 0.01 |
| Cable59 | 3.513 | 1.161 | -3.511 | -1.160 | 1.7 | 1.0 | 100.0 | 99.9 | 0.05 |
| T43 | 0.223 | 0.101 | -0.218 | -0.093 | 5.3 | 8.0 | 100.0 | 96.7 | 3.30 |
| T44 | 0.357 | 0.161 | -0.349 | -0.149 | 8.5 | 12.8 | 100.0 | 96.7 | 3.30 |
| Cable60 | 3.154 | 0.998 | -3.154 | -0.998 | 0.4 | 0.3 | 99.9 | 99.9 | 0.01 |
| T45 | 0.357 | 0.161 | -0.349 | -0.148 | 8.5 | 12.8 | 99.9 | 96.6 | 3.30 |
| Cable61 | 2.931 | 0.897 | -2.929 | -0.897 | 1.3 | 0.5 | 99.9 | 99.9 | 0.05 |
| T46 | 0.223 | 0.101 | -0.218 | -0.093 | 5.3 | 8.0 | 99.9 | 96.6 | 3.30 |
| Cable62 | 2.787 | 0.832 | -2.786 | -0.890 | 1.0 | -57.5 | 99.9 | 99.8 | 0.04 |
| T47 | 0.143 | 0.064 | -0.139 | -0.059 | 3.4 | 5.1 | 99.9 | 96.6 | 3.30 |
| Cable63 | 0.704 | 0.209 | -0.704 | -0.231 | 0.0 | -22.0 | 99.8 | 99.8 | 0.00 |
| Cable65 | 2.082 | 0.681 | -2.078 | -0.680 | 3.2 | 1.1 | 99.8 | 99.7 | 0.16 |
| Cable64 | 0.561 | 0.167 | -0.561 | -0.253 | 0.1 | -86.7 | 99.8 | 99.8 | 0.01 |
| T48 | 0.143 | 0.064 | -0.139 | -0.059 | 3.4 | 5.1 | 99.8 | 96.5 | 3.30 |

| Branch ID | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd % Drop |
|---|---|---|---|---|---|---|---|---|---|
| | MW | Mvar | MW | Mvar | kW | kvar | From | To | in Vmag |
| T49 | 0.561 | 0.253 | -0.548 | -0.233 | 13.4 | 20.1 | 99.8 | 96.5 | 3.30 |
| T50 | 0.222 | 0.100 | -0.217 | -0.092 | 5.3 | 8.0 | 99.7 | 96.4 | 3.30 |
| Cable67 | 1.410 | 0.670 | -1.410 | -0.671 | 0.0 | -1.4 | 99.5 | 99.5 | 0.00 |
| Cable68 | 0.222 | 0.028 | -0.222 | -0.100 | 0.0 | -72.2 | 99.5 | 99.5 | 0.00 |
| T52 | 0.222 | 0.100 | -0.216 | -0.092 | 5.3 | 8.0 | 99.5 | 96.2 | 3.29 |
| T51 | 1.410 | 0.671 | -1.397 | -0.595 | 12.7 | 75.9 | 99.5 | 96.8 | 2.72 |
| T53 | 0.222 | 0.100 | -0.216 | -0.092 | 5.3 | 8.0 | 99.5 | 96.2 | 3.29 |
| | | | | | 1381.6 | 485.9 | | | |

## Losses Summary Report for Cables and Distribution Transformers in Network reconfiguration case 1

**Branch Losses Summary Report**

| Branch ID | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd % Drop |
|---|---|---|---|---|---|---|---|---|---|
| | MW | Mvar | MW | Mvar | kW | kvar | From | To | in Vmag |
| Cable1 | -0.619 | -0.280 | 0.619 | 0.280 | 0.1 | 0.0 | 96.7 | 96.8 | 0.01 |
| T1 | 0.534 | 0.241 | -0.521 | -0.222 | 12.9 | 19.4 | 96.7 | 93.5 | 3.24 |
| T2 | 0.085 | 0.038 | -0.083 | -0.035 | 2.1 | 3.1 | 96.7 | 93.5 | 3.24 |
| Cable2 | -0.339 | -0.122 | 0.339 | 0.122 | 0.0 | 0.0 | 96.8 | 96.8 | 0.00 |
| Cable70 | 0.339 | 0.122 | -0.339 | -0.153 | 0.0 | -31.0 | 96.8 | 96.8 | 0.00 |
| Cable3 | -0.958 | -0.402 | 0.958 | 0.402 | 0.0 | 0.0 | 96.8 | 96.8 | 0.00 |
| Cable4 | -1.094 | -0.464 | 1.095 | 0.464 | 0.6 | 0.2 | 96.8 | 96.8 | 0.05 |
| T4 | 0.136 | 0.061 | -0.132 | -0.056 | 3.3 | 4.9 | 96.8 | 93.5 | 3.24 |
| Cable5 | -1.055 | -0.485 | 1.055 | 0.466 | 0.1 | -19.1 | 96.8 | 96.8 | 0.01 |
| Cable6 | 0.843 | 0.389 | -0.843 | -0.398 | 0.0 | -8.7 | 96.8 | 96.8 | 0.00 |
| T6 | 0.212 | 0.096 | -0.207 | -0.088 | 5.1 | 7.7 | 96.8 | 93.6 | 3.24 |
| T7 | 0.843 | 0.398 | -0.830 | -0.354 | 12.7 | 44.6 | 96.8 | 93.7 | 3.10 |
| Cable7 | -2.362 | -1.026 | 2.364 | 1.026 | 1.5 | 0.5 | 96.8 | 96.9 | 0.06 |
| T5 | 0.212 | 0.096 | -0.207 | -0.088 | 5.1 | 7.7 | 96.8 | 93.6 | 3.24 |
| Cable8 | -0.849 | -0.280 | 0.850 | 0.280 | 0.2 | 0.1 | 96.8 | 96.9 | 0.02 |
| Cable9 | 0.212 | 0.024 | -0.212 | -0.096 | 0.0 | -71.8 | 96.8 | 96.8 | 0.00 |
| Cable10 | 0.425 | 0.160 | -0.425 | -0.160 | 0.0 | 0.0 | 96.8 | 96.8 | 0.01 |
| T9 | 0.212 | 0.096 | -0.207 | -0.088 | 5.1 | 7.7 | 96.8 | 93.6 | 3.24 |
| T10 | 0.212 | 0.096 | -0.207 | -0.088 | 5.1 | 7.7 | 96.8 | 93.6 | 3.24 |
| Cable11 | 0.212 | 0.064 | -0.212 | -0.096 | 0.0 | -32.2 | 96.8 | 96.8 | 0.00 |
| T11 | 0.212 | 0.096 | -0.207 | -0.088 | 5.1 | 7.7 | 96.8 | 93.6 | 3.24 |
| T12 | 0.212 | 0.096 | -0.207 | -0.088 | 5.1 | 7.7 | 96.8 | 93.6 | 3.24 |
| Cable12 | -3.748 | -1.548 | 3.749 | 1.515 | 0.7 | -33.6 | 96.9 | 96.9 | 0.02 |
| T8 | 0.535 | 0.242 | -0.522 | -0.223 | 13.0 | 19.4 | 96.9 | 93.6 | 3.24 |
| Cable13 | -1.553 | -0.742 | 1.553 | 0.742 | 0.4 | 0.1 | 96.9 | 96.9 | 0.02 |
| Cable72 | 1.340 | 0.646 | -1.340 | -0.656 | 0.0 | -9.7 | 96.9 | 96.9 | 0.00 |
| T13 | 0.213 | 0.096 | -0.207 | -0.088 | 5.1 | 7.7 | 96.9 | 93.7 | 3.24 |
| Cable15 | 1.809 | 0.857 | -1.809 | -0.857 | 0.0 | 0.0 | 96.9 | 96.9 | 0.00 |
| Cable18 | -7.114 | -3.115 | 7.122 | 3.118 | 8.1 | 2.8 | 96.9 | 97.1 | 0.11 |
| Cable71 | 3.751 | 1.516 | -3.749 | -1.515 | 2.3 | 0.8 | 96.9 | 96.9 | 0.06 |
| Cable16 | 1.596 | 0.761 | -1.596 | -0.761 | 0.2 | 0.1 | 96.9 | 96.9 | 0.01 |
| T15 | 0.213 | 0.096 | -0.208 | -0.088 | 5.1 | 7.7 | 96.9 | 93.7 | 3.25 |
| Cable17 | 1.255 | 0.614 | -1.254 | -0.614 | 1.0 | 0.3 | 96.9 | 96.8 | 0.07 |
| Cable74 | -1.595 | -0.768 | 1.596 | 0.768 | 0.7 | 0.3 | 96.9 | 96.9 | 0.04 |
| T16 | 0.340 | 0.154 | -0.332 | -0.141 | 8.2 | 12.3 | 96.9 | 93.6 | 3.24 |

| Branch ID | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd % Drop |
|---|---|---|---|---|---|---|---|---|---|
| | MW | Mvar | MW | Mvar | kW | kvar | From | To | in Vmag |
| Cable19 | -7.335 | -3.214 | 7.355 | 3.221 | 20.1 | 6.9 | 97.1 | 97.3 | 0.26 |
| T17 | 0.213 | 0.096 | -0.208 | -0.089 | 5.2 | 7.7 | 97.1 | 93.8 | 3.25 |
| Cable20 | 0.539 | 0.244 | -0.539 | -0.244 | 0.0 | 0.0 | 97.3 | 97.3 | 0.00 |
| Cable21 | -7.894 | -3.465 | 7.907 | 3.469 | 13.1 | 4.5 | 97.3 | 97.5 | 0.16 |
| T18 | 0.539 | 0.244 | -0.526 | -0.224 | 13.0 | 19.5 | 97.3 | 94.1 | 3.25 |
| Cable22 | 0.300 | 0.136 | -0.300 | -0.136 | 0.0 | 0.0 | 97.5 | 97.5 | 0.00 |
| Cable24 | -8.422 | -3.702 | 8.459 | 3.715 | 36.7 | 12.7 | 97.5 | 97.9 | 0.41 |
| T19 | 0.214 | 0.097 | -0.209 | -0.089 | 5.2 | 7.8 | 97.5 | 94.2 | 3.25 |
| Cable23 | 0.086 | 0.039 | -0.086 | -0.039 | 0.0 | 0.0 | 97.5 | 97.5 | 0.00 |
| T20 | 0.214 | 0.097 | -0.209 | -0.089 | 5.2 | 7.8 | 97.5 | 94.2 | 3.25 |
| T21 | 0.086 | 0.039 | -0.084 | -0.036 | 2.1 | 3.1 | 97.5 | 94.2 | 3.25 |
| Cable25 | -8.616 | -3.789 | 8.626 | 3.795 | 9.6 | 6.1 | 98.1 | 98.2 | 0.12 |
| Cable75 | 8.478 | 3.727 | -8.459 | -3.715 | 18.6 | 11.7 | 98.1 | 97.9 | 0.23 |
| T22 | 0.139 | 0.063 | -0.135 | -0.058 | 3.3 | 5.0 | 98.1 | 94.8 | 3.27 |
| Cable26 | 0.217 | 0.078 | -0.217 | -0.098 | 0.0 | -20.3 | 98.2 | 98.2 | 0.00 |
| Cable27 | 1.716 | 0.785 | -1.716 | -0.822 | 0.3 | -37.2 | 98.2 | 98.2 | 0.02 |
| Cable29 | -10.698 | -4.721 | 10.720 | 4.663 | 22.2 | -57.8 | 98.2 | 98.5 | 0.23 |
| Cable34 | 0.139 | 0.063 | -0.139 | -0.063 | 0.0 | 0.0 | 98.2 | 98.2 | 0.00 |
| T23 | 0.217 | 0.098 | -0.212 | -0.090 | 5.2 | 7.8 | 98.2 | 95.0 | 3.27 |
| Cable28 | 1.368 | 0.665 | -1.368 | -0.669 | 0.0 | -3.8 | 98.2 | 98.2 | 0.00 |
| Cable76 | -1.716 | -0.822 | 1.716 | 0.822 | 0.2 | 0.1 | 98.2 | 98.2 | 0.01 |
| T24 | 0.347 | 0.157 | -0.339 | -0.144 | 8.4 | 12.5 | 98.2 | 94.9 | 3.27 |
| T25 | 1.368 | 0.669 | -1.353 | -0.576 | 15.4 | 92.7 | 98.2 | 94.8 | 3.39 |
| Cable82 | -10.807 | -4.702 | 10.836 | 4.712 | 29.1 | 10.0 | 98.5 | 98.7 | 0.26 |
| T26 | 0.087 | 0.039 | -0.085 | -0.036 | 2.1 | 3.1 | 98.5 | 95.2 | 3.27 |
| Cable32 | -1.746 | -0.815 | 1.746 | 0.795 | 0.2 | -20.1 | 99.0 | 99.0 | 0.01 |
| Cable33 | 0.873 | 0.403 | -0.873 | -0.412 | 0.0 | -8.7 | 99.0 | 99.0 | 0.00 |
| T28 | 0.873 | 0.412 | -0.860 | -0.366 | 13.1 | 45.7 | 99.0 | 95.8 | 3.14 |
| T3 | -0.331 | -0.141 | 0.339 | 0.153 | 8.2 | 12.3 | 93.5 | 96.8 | 3.24 |
| T14 | -1.325 | -0.564 | 1.340 | 0.656 | 15.2 | 91.3 | 93.6 | 96.9 | 3.37 |
| Cable47 | -0.880 | -0.415 | 0.880 | 0.381 | 0.1 | -34.0 | 99.5 | 99.5 | 0.01 |
| T38 | 0.880 | 0.415 | -0.867 | -0.369 | 13.1 | 46.0 | 99.5 | 96.3 | 3.15 |
| Cable73 | 1.596 | 0.761 | -1.596 | -0.768 | 0.1 | -7.1 | 96.9 | 96.9 | 0.00 |
| Cable30 | 13.246 | 5.738 | -13.213 | -5.788 | 33.5 | -49.8 | 99.0 | 98.7 | 0.28 |
| Cable31 | 0.554 | 0.212 | -0.554 | -0.250 | 0.0 | -38.0 | 99.0 | 99.0 | 0.01 |
| Cable55 | -17.897 | -7.738 | 18.058 | 7.660 | 161.4 | -78.5 | 99.0 | 100.0 | 1.01 |
| Cable77 | 0.572 | 0.215 | -0.572 | -0.225 | 0.0 | -9.1 | 99.0 | 99.0 | 0.00 |

| Branch ID | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd % Drop |
|---|---|---|---|---|---|---|---|---|---|
| | MW | Mvar | MW | Mvar | kW | kvar | From | To | in Vmag |
| Cable79 | 1.779 | 0.777 | -1.779 | -0.800 | 0.2 | -22.6 | 99.0 | 99.0 | 0.01 |
| Cable78 | 0.220 | 0.066 | -0.220 | -0.099 | 0.0 | -33.7 | 99.0 | 99.0 | 0.00 |
| T55 | 0.352 | 0.159 | -0.343 | -0.146 | 8.4 | 12.6 | 99.0 | 95.7 | 3.28 |
| T56 | 0.220 | 0.099 | -0.215 | -0.091 | 5.3 | 7.9 | 99.0 | 95.7 | 3.28 |
| Cable80 | 1.225 | 0.550 | -1.225 | -0.560 | 0.0 | -10.5 | 99.0 | 99.0 | 0.00 |
| T57 | 0.554 | 0.250 | -0.541 | -0.230 | 13.3 | 19.9 | 99.0 | 95.7 | 3.28 |
| Cable81 | 0.873 | 0.402 | -0.873 | -0.412 | 0.0 | -10.6 | 99.0 | 99.0 | 0.00 |
| T58 | 0.352 | 0.159 | -0.343 | -0.146 | 8.4 | 12.6 | 99.0 | 95.7 | 3.28 |
| T59 | 0.873 | 0.412 | -0.860 | -0.366 | 13.1 | 45.7 | 99.0 | 95.8 | 3.14 |
| Cable83 | 2.376 | 1.075 | -2.375 | -1.075 | 1.7 | 0.6 | 98.7 | 98.6 | 0.07 |
| Cable84 | 2.235 | 1.011 | -2.233 | -1.011 | 2.2 | 0.7 | 98.6 | 98.6 | 0.09 |
| T60 | 0.140 | 0.063 | -0.137 | -0.058 | 3.4 | 5.0 | 98.6 | 95.4 | 3.28 |
| Cable85 | 2.014 | 0.912 | -2.014 | -0.912 | 0.2 | 0.1 | 98.6 | 98.5 | 0.01 |
| T61 | 0.218 | 0.099 | -0.213 | -0.091 | 5.2 | 7.9 | 98.6 | 95.3 | 3.28 |
| Cable86 | 2.014 | 0.912 | -2.014 | -0.912 | 0.7 | 0.2 | 98.5 | 98.5 | 0.03 |
| Cable87 | 1.874 | 0.849 | -1.873 | -0.848 | 0.7 | 0.2 | 98.5 | 98.5 | 0.03 |
| T62 | 0.140 | 0.063 | -0.136 | -0.058 | 3.4 | 5.0 | 98.5 | 95.2 | 3.27 |
| Cable88 | 1.503 | 0.681 | -1.503 | -0.680 | 0.2 | 0.1 | 98.5 | 98.5 | 0.01 |
| T63 | 0.370 | 0.168 | -0.361 | -0.154 | 9.5 | 14.2 | 98.5 | 95.0 | 3.48 |
| Cable89 | 0.953 | 0.432 | -0.953 | -0.432 | 0.1 | 0.0 | 98.5 | 98.5 | 0.01 |
| T64 | 0.549 | 0.248 | -0.536 | -0.228 | 13.2 | 19.8 | 98.5 | 95.2 | 3.27 |
| Cable90 | 0.583 | 0.264 | -0.583 | -0.264 | 0.0 | 0.0 | 98.5 | 98.5 | 0.00 |
| T65 | 0.370 | 0.168 | -0.361 | -0.154 | 9.5 | 14.2 | 98.5 | 95.0 | 3.48 |
| T66 | 0.583 | 0.264 | -0.568 | -0.242 | 14.9 | 22.3 | 98.5 | 95.0 | 3.48 |
| Cable53 | 4.708 | 2.117 | -4.707 | -2.117 | 0.9 | 0.3 | 100.0 | 100.0 | 0.02 |
| Cable54 | 4.094 | 1.367 | -4.093 | -1.367 | 0.6 | 0.2 | 100.0 | 100.0 | 0.01 |
| c77 | 1.855 | 0.579 | -1.853 | -0.798 | 1.8 | -219.0 | 99.6 | 99.5 | 0.11 |
| Cable66 | -1.855 | -0.579 | 1.856 | 0.579 | 1.3 | 0.5 | 99.6 | 99.7 | 0.07 |
| T67 | 1.254 | 0.614 | -1.240 | -0.528 | 14.3 | 85.5 | 96.8 | 93.5 | 3.37 |
| Cable45 | -0.423 | -0.193 | 0.423 | 0.193 | 0.1 | 0.0 | 99.5 | 99.5 | 0.01 |
| T37 | 0.423 | 0.193 | -0.411 | -0.175 | 12.1 | 18.2 | 99.5 | 95.5 | 3.94 |
| T27 | -0.541 | -0.230 | 0.554 | 0.250 | 13.3 | 19.9 | 95.7 | 99.0 | 3.28 |
| Cable56 | 4.093 | 1.367 | -4.093 | -1.367 | 0.0 | -0.1 | 100.0 | 100.0 | 0.00 |
| T29 | 0.873 | 0.412 | -0.860 | -0.366 | 13.1 | 45.7 | 99.0 | 95.8 | 3.14 |
| Cable35 | 0.139 | 0.063 | -0.139 | -0.063 | 0.0 | 0.0 | 98.2 | 98.2 | 0.00 |
| T30 | 0.139 | 0.063 | -0.136 | -0.058 | 3.3 | 5.0 | 98.2 | 95.0 | 3.27 |
| Cable37 | 0.354 | 0.160 | -0.354 | -0.160 | 0.0 | 0.0 | 99.4 | 99.3 | 0.01 |

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| Branch ID | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd % Drop |
|---|---|---|---|---|---|---|---|---|---|
| | MW | Mvar | MW | Mvar | kW | kvar | From | To | in Vmag |
| Cable38 | -0.354 | -0.160 | 0.354 | 0.160 | 0.0 | 0.0 | 99.4 | 99.4 | 0.00 |
| T31 | 0.354 | 0.160 | -0.345 | -0.147 | 8.5 | 12.7 | 99.3 | 96.1 | 3.29 |
| Cable39 | -0.523 | -0.237 | 0.523 | 0.237 | 0.0 | 0.0 | 99.4 | 99.4 | 0.00 |
| T32 | 0.169 | 0.077 | -0.164 | -0.070 | 4.8 | 7.3 | 99.4 | 95.4 | 3.94 |
| Cable40 | 0.844 | 0.386 | -0.844 | -0.385 | 0.3 | 0.1 | 99.4 | 99.3 | 0.03 |
| Cable42 | -1.631 | -0.743 | 1.631 | 0.743 | 0.7 | 0.3 | 99.4 | 99.4 | 0.04 |
| T33 | 0.264 | 0.121 | -0.256 | -0.109 | 7.6 | 11.3 | 99.4 | 95.4 | 3.94 |
| Cable41 | 0.422 | 0.193 | -0.422 | -0.193 | 0.1 | 0.0 | 99.3 | 99.3 | 0.02 |
| T34 | 0.422 | 0.193 | -0.410 | -0.175 | 12.1 | 18.1 | 99.3 | 95.4 | 3.94 |
| T35 | 0.422 | 0.193 | -0.410 | -0.175 | 12.1 | 18.1 | 99.3 | 95.4 | 3.94 |
| Cable43 | -2.189 | -0.995 | 2.189 | 0.995 | 0.4 | 0.1 | 99.4 | 99.4 | 0.02 |
| T54 | 0.558 | 0.252 | -0.544 | -0.232 | 13.3 | 20.0 | 99.4 | 96.1 | 3.29 |
| Cable44 | 0.169 | 0.077 | -0.169 | -0.077 | 0.0 | 0.0 | 99.4 | 99.4 | 0.01 |
| Cable46 | -2.358 | -1.072 | 2.360 | 1.073 | 1.8 | 0.6 | 99.4 | 99.5 | 0.07 |
| T36 | 0.169 | 0.077 | -0.164 | -0.070 | 4.8 | 7.3 | 99.4 | 95.5 | 3.94 |
| Cable48 | -3.885 | -1.748 | 3.889 | 1.749 | 4.2 | 1.4 | 99.5 | 99.6 | 0.10 |
| T39 | 0.222 | 0.100 | -0.216 | -0.092 | 5.3 | 8.0 | 99.5 | 96.2 | 3.29 |
| Cable49 | -4.244 | -1.910 | 4.248 | 1.911 | 4.0 | 1.4 | 99.6 | 99.7 | 0.09 |
| T40 | 0.355 | 0.160 | -0.347 | -0.148 | 8.5 | 12.7 | 99.6 | 96.3 | 3.30 |
| Cable50 | -4.471 | -2.011 | 4.479 | 2.014 | 8.1 | 2.8 | 99.7 | 99.9 | 0.17 |
| T41 | 0.222 | 0.100 | -0.217 | -0.092 | 5.3 | 8.0 | 99.7 | 96.4 | 3.30 |
| Cable51 | -4.702 | -2.115 | 4.707 | 2.117 | 5.6 | 1.9 | 99.9 | 100.0 | 0.11 |
| T42 | 0.223 | 0.101 | -0.218 | -0.093 | 5.3 | 8.0 | 99.9 | 96.6 | 3.30 |
| Cable58 | 0.357 | 0.106 | -0.357 | -0.161 | 0.0 | -55.5 | 100.0 | 100.0 | 0.01 |
| Cable59 | 3.513 | 1.161 | -3.511 | -1.160 | 1.7 | 1.0 | 100.0 | 99.9 | 0.05 |
| T43 | 0.223 | 0.101 | -0.218 | -0.093 | 5.3 | 8.0 | 100.0 | 96.7 | 3.30 |
| T44 | 0.357 | 0.161 | -0.349 | -0.149 | 8.5 | 12.8 | 100.0 | 96.7 | 3.30 |
| Cable60 | 3.154 | 0.998 | -3.154 | -0.998 | 0.4 | 0.3 | 99.9 | 99.9 | 0.01 |
| T45 | 0.357 | 0.161 | -0.349 | -0.148 | 8.5 | 12.8 | 99.9 | 96.6 | 3.30 |
| Cable61 | 2.931 | 0.897 | -2.929 | -0.897 | 1.3 | 0.5 | 99.9 | 99.9 | 0.05 |
| T46 | 0.223 | 0.101 | -0.218 | -0.093 | 5.3 | 8.0 | 99.9 | 96.6 | 3.30 |
| Cable62 | 2.787 | 0.832 | -2.786 | -0.890 | 1.0 | -57.5 | 99.9 | 99.8 | 0.04 |
| T47 | 0.143 | 0.064 | -0.139 | -0.059 | 3.4 | 5.1 | 99.9 | 96.6 | 3.30 |
| Cable63 | 0.704 | 0.209 | -0.704 | -0.231 | 0.0 | -22.0 | 99.8 | 99.8 | 0.00 |
| Cable65 | 2.082 | 0.681 | -2.078 | -0.680 | 3.2 | 1.1 | 99.8 | 99.7 | 0.16 |
| Cable64 | 0.561 | 0.167 | -0.561 | -0.253 | 0.1 | -86.7 | 99.8 | 99.8 | 0.01 |
| T48 | 0.143 | 0.064 | -0.139 | -0.059 | 3.4 | 5.1 | 99.8 | 96.5 | 3.30 |

| Branch ID | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd % Drop |
|---|---|---|---|---|---|---|---|---|---|
| | MW | Mvar | MW | Mvar | kW | kvar | From | To | in Vmag |
| T49 | 0.561 | 0.253 | -0.548 | -0.233 | 13.4 | 20.1 | 99.8 | 96.5 | 3.30 |
| T50 | 0.222 | 0.100 | -0.217 | -0.092 | 5.3 | 8.0 | 99.7 | 96.4 | 3.30 |
| Cable67 | 1.410 | 0.670 | -1.410 | -0.671 | 0.0 | -1.4 | 99.5 | 99.5 | 0.00 |
| Cable68 | 0.222 | 0.028 | -0.222 | -0.100 | 0.0 | -72.2 | 99.5 | 99.5 | 0.00 |
| T52 | 0.222 | 0.100 | -0.216 | -0.092 | 5.3 | 8.0 | 99.5 | 96.2 | 3.29 |
| T51 | 1.410 | 0.671 | -1.397 | -0.595 | 12.7 | 75.9 | 99.5 | 96.8 | 2.72 |
| T53 | 0.222 | 0.100 | -0.216 | -0.092 | 5.3 | 8.0 | 99.5 | 96.2 | 3.29 |
| | | | | | 940.6 | 102.5 | | | |

## Losses Summary Report for Cables and Distribution Transformers in Network reconfiguration case 2

**Branch Losses Summary Report**

| Branch ID | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd % Drop |
|---|---|---|---|---|---|---|---|---|---|
| | MW | Mvar | MW | Mvar | kW | kvar | From | To | in Vmag |
| Cable1 | -0.606 | -0.274 | 0.606 | 0.274 | 0.1 | 0.0 | 95.4 | 95.5 | 0.01 |
| T1 | 0.523 | 0.236 | -0.510 | -0.217 | 12.7 | 19.1 | 95.4 | 92.2 | 3.22 |
| T2 | 0.083 | 0.038 | -0.081 | -0.035 | 2.0 | 3.0 | 95.4 | 92.2 | 3.22 |
| Cable2 | -0.332 | -0.120 | 0.332 | 0.120 | 0.0 | 0.0 | 95.5 | 95.5 | 0.00 |
| Cable70 | 0.332 | 0.120 | -0.332 | -0.150 | 0.0 | -30.2 | 95.5 | 95.4 | 0.00 |
| Cable3 | -0.938 | -0.394 | 0.938 | 0.394 | 0.0 | 0.0 | 95.5 | 95.5 | 0.00 |
| Cable4 | -1.071 | -0.454 | 1.072 | 0.454 | 0.6 | 0.2 | 95.5 | 95.5 | 0.05 |
| T4 | 0.133 | 0.060 | -0.130 | -0.055 | 3.2 | 4.9 | 95.5 | 92.2 | 3.22 |
| Cable5 | -1.033 | -0.476 | 1.033 | 0.457 | 0.1 | -18.6 | 95.5 | 95.5 | 0.01 |
| Cable6 | 0.825 | 0.382 | -0.825 | -0.390 | 0.0 | -8.5 | 95.5 | 95.5 | 0.00 |
| T6 | 0.208 | 0.094 | -0.203 | -0.086 | 5.1 | 7.6 | 95.5 | 92.3 | 3.22 |
| T7 | 0.825 | 0.390 | -0.813 | -0.346 | 12.5 | 43.9 | 95.5 | 92.4 | 3.08 |
| Cable7 | -2.312 | -1.005 | 2.314 | 1.006 | 1.5 | 0.5 | 95.5 | 95.6 | 0.06 |
| T5 | 0.208 | 0.094 | -0.203 | -0.086 | 5.1 | 7.6 | 95.5 | 92.3 | 3.22 |
| Cable8 | -0.832 | -0.275 | 0.832 | 0.275 | 0.2 | 0.1 | 95.5 | 95.6 | 0.02 |
| Cable9 | 0.208 | 0.024 | -0.208 | -0.094 | 0.0 | -69.9 | 95.5 | 95.5 | 0.00 |
| Cable10 | 0.416 | 0.157 | -0.416 | -0.157 | 0.0 | 0.0 | 95.5 | 95.5 | 0.01 |
| T9 | 0.208 | 0.094 | -0.203 | -0.086 | 5.1 | 7.6 | 95.5 | 92.3 | 3.22 |
| T10 | 0.208 | 0.094 | -0.203 | -0.086 | 5.1 | 7.6 | 95.5 | 92.3 | 3.22 |
| Cable11 | 0.208 | 0.063 | -0.208 | -0.094 | 0.0 | -31.3 | 95.5 | 95.5 | 0.00 |
| T11 | 0.208 | 0.094 | -0.203 | -0.086 | 5.1 | 7.6 | 95.5 | 92.3 | 3.22 |
| T12 | 0.208 | 0.094 | -0.203 | -0.086 | 5.1 | 7.6 | 95.5 | 92.3 | 3.22 |
| Cable12 | -3.670 | -1.518 | 3.671 | 1.485 | 0.7 | -32.6 | 95.6 | 95.6 | 0.02 |
| T8 | 0.524 | 0.237 | -0.511 | -0.218 | 12.8 | 19.1 | 95.6 | 92.3 | 3.22 |
| Cable13 | -1.520 | -0.727 | 1.521 | 0.727 | 0.4 | 0.1 | 95.6 | 95.6 | 0.02 |
| Cable72 | 1.312 | 0.633 | -1.312 | -0.643 | 0.0 | -9.4 | 95.6 | 95.6 | 0.00 |
| T13 | 0.208 | 0.094 | -0.203 | -0.087 | 5.1 | 7.6 | 95.6 | 92.4 | 3.22 |
| Cable15 | 1.771 | 0.840 | -1.771 | -0.840 | 0.0 | 0.0 | 95.6 | 95.6 | 0.00 |
| Cable18 | -6.965 | -3.053 | 6.973 | 3.056 | 7.9 | 2.7 | 95.6 | 95.8 | 0.11 |
| Cable71 | 3.673 | 1.486 | -3.671 | -1.485 | 2.3 | 0.8 | 95.6 | 95.6 | 0.06 |
| Cable16 | 1.563 | 0.746 | -1.563 | -0.746 | 0.2 | 0.1 | 95.6 | 95.6 | 0.01 |
| T15 | 0.208 | 0.094 | -0.203 | -0.087 | 5.1 | 7.6 | 95.6 | 92.4 | 3.22 |
| Cable17 | 1.229 | 0.602 | -1.228 | -0.601 | 1.0 | 0.3 | 95.6 | 95.5 | 0.07 |
| Cable74 | -1.562 | -0.752 | 1.563 | 0.752 | 0.7 | 0.2 | 95.6 | 95.6 | 0.04 |
| T16 | 0.333 | 0.151 | -0.325 | -0.138 | 8.1 | 12.2 | 95.6 | 92.4 | 3.22 |

| Branch ID | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd % Drop |
|---|---|---|---|---|---|---|---|---|---|
| | MW | Mvar | MW | Mvar | kW | kvar | From | To | in Vmag |
| Cable19 | -7.181 | -3.150 | 7.201 | 3.157 | 19.8 | 6.8 | 95.8 | 96.0 | 0.25 |
| T17 | 0.209 | 0.094 | -0.204 | -0.087 | 5.1 | 7.6 | 95.8 | 92.5 | 3.22 |
| Cable20 | 0.528 | 0.239 | -0.528 | -0.239 | 0.0 | 0.0 | 96.0 | 96.0 | 0.00 |
| Cable21 | -7.729 | -3.395 | 7.742 | 3.400 | 12.9 | 4.4 | 96.0 | 96.2 | 0.15 |
| T18 | 0.528 | 0.239 | -0.515 | -0.219 | 12.8 | 19.2 | 96.0 | 92.8 | 3.23 |
| Cable22 | 0.294 | 0.133 | -0.294 | -0.133 | 0.0 | 0.0 | 96.2 | 96.2 | 0.00 |
| Cable24 | -8.246 | -3.628 | 8.282 | 3.640 | 36.2 | 12.5 | 96.2 | 96.6 | 0.41 |
| T19 | 0.210 | 0.095 | -0.205 | -0.087 | 5.1 | 7.6 | 96.2 | 92.9 | 3.23 |
| Cable23 | 0.084 | 0.038 | -0.084 | -0.038 | 0.0 | 0.0 | 96.2 | 96.2 | 0.00 |
| T20 | 0.210 | 0.095 | -0.205 | -0.087 | 5.1 | 7.6 | 96.2 | 92.9 | 3.23 |
| T21 | 0.084 | 0.038 | -0.082 | -0.035 | 2.0 | 3.1 | 96.2 | 92.9 | 3.23 |
| Cable25 | -8.436 | -3.713 | 8.445 | 3.719 | 9.5 | 6.0 | 96.8 | 96.9 | 0.12 |
| Cable75 | 8.300 | 3.652 | -8.282 | -3.640 | 18.3 | 11.6 | 96.8 | 96.6 | 0.23 |
| T22 | 0.136 | 0.061 | -0.133 | -0.056 | 3.3 | 4.9 | 96.8 | 93.6 | 3.24 |
| Cable26 | 0.213 | 0.076 | -0.213 | -0.096 | 0.0 | -19.7 | 96.9 | 96.9 | 0.00 |
| Cable27 | 1.680 | 0.769 | -1.680 | -0.805 | 0.3 | -36.2 | 96.9 | 96.9 | 0.02 |
| Cable34 | -10.338 | -4.565 | 10.352 | 4.574 | 14.2 | 9.0 | 96.9 | 97.1 | 0.14 |
| T23 | 0.213 | 0.096 | -0.207 | -0.088 | 5.1 | 7.7 | 96.9 | 93.7 | 3.24 |
| Cable28 | 1.340 | 0.652 | -1.339 | -0.655 | 0.0 | -3.7 | 96.9 | 96.9 | 0.00 |
| Cable76 | -1.679 | -0.805 | 1.680 | 0.805 | 0.2 | 0.1 | 96.9 | 96.9 | 0.01 |
| T24 | 0.340 | 0.154 | -0.332 | -0.141 | 8.2 | 12.3 | 96.9 | 93.6 | 3.24 |
| T25 | 1.339 | 0.655 | -1.324 | -0.564 | 15.2 | 91.3 | 96.9 | 93.5 | 3.37 |
| Cable82 | -0.089 | 0.037 | 0.089 | -0.037 | 0.0 | 0.0 | 99.9 | 99.9 | 0.00 |
| Cable29 | 0.000 | -0.078 | 0.000 | 0.000 | 0.0 | -77.6 | 99.9 | 99.9 | 0.00 |
| T26 | 0.089 | 0.040 | -0.087 | -0.037 | 2.1 | 3.2 | 99.9 | 96.6 | 3.30 |
| Cable32 | -1.775 | -0.828 | 1.775 | 0.808 | 0.2 | -20.5 | 100.0 | 100.0 | 0.01 |
| Cable33 | 0.887 | 0.410 | -0.887 | -0.419 | 0.0 | -8.9 | 100.0 | 100.0 | 0.00 |
| T28 | 0.887 | 0.419 | -0.874 | -0.372 | 13.2 | 46.3 | 100.0 | 96.8 | 3.16 |
| T3 | -0.324 | -0.138 | 0.332 | 0.150 | 8.1 | 12.1 | 92.2 | 95.4 | 3.22 |
| T14 | -1.297 | -0.553 | 1.312 | 0.643 | 15.0 | 90.0 | 92.3 | 95.6 | 3.34 |
| Cable47 | -0.863 | -0.408 | 0.863 | 0.374 | 0.1 | -33.2 | 98.3 | 98.3 | 0.01 |
| T38 | 0.863 | 0.408 | -0.850 | -0.362 | 13.0 | 45.4 | 98.3 | 95.1 | 3.13 |
| Cable73 | 1.563 | 0.746 | -1.563 | -0.752 | 0.1 | -6.9 | 95.6 | 95.6 | 0.00 |
| Cable30 | 2.494 | 0.972 | -2.492 | -1.049 | 1.1 | -76.7 | 100.0 | 99.9 | 0.05 |
| Cable31 | 0.563 | 0.215 | -0.563 | -0.254 | 0.0 | -38.8 | 100.0 | 100.0 | 0.01 |
| Cable77 | 0.581 | 0.219 | -0.581 | -0.228 | 0.0 | -9.3 | 100.0 | 100.0 | 0.00 |
| Cable79 | 1.808 | 0.790 | -1.807 | -0.813 | 0.2 | -23.1 | 100.0 | 100.0 | 0.01 |

| Branch ID | From-To Bus Flow MW | From-To Bus Flow Mvar | To-From Bus Flow MW | To-From Bus Flow Mvar | Losses kW | Losses kvar | % Bus Voltage From | % Bus Voltage To | Vd % Drop in Vmag |
|---|---|---|---|---|---|---|---|---|---|
| Cable78 | 0.223 | 0.067 | -0.223 | -0.101 | 0.0 | -34.4 | 100.0 | 100.0 | 0.00 |
| T55 | 0.357 | 0.161 | -0.349 | -0.149 | 8.5 | 12.8 | 100.0 | 96.7 | 3.30 |
| T56 | 0.223 | 0.101 | -0.218 | -0.093 | 5.3 | 8.0 | 100.0 | 96.7 | 3.30 |
| Cable80 | 1.245 | 0.558 | -1.245 | -0.569 | 0.0 | -10.8 | 100.0 | 100.0 | 0.00 |
| T57 | 0.563 | 0.254 | -0.549 | -0.234 | 13.4 | 20.2 | 100.0 | 96.7 | 3.30 |
| Cable81 | 0.887 | 0.408 | -0.887 | -0.419 | 0.0 | -10.8 | 100.0 | 100.0 | 0.00 |
| T58 | 0.357 | 0.161 | -0.349 | -0.149 | 8.5 | 12.8 | 100.0 | 96.7 | 3.30 |
| T59 | 0.887 | 0.419 | -0.874 | -0.372 | 13.2 | 46.3 | 100.0 | 96.8 | 3.16 |
| Cable83 | 2.403 | 1.086 | -2.401 | -1.086 | 1.7 | 0.6 | 99.9 | 99.9 | 0.07 |
| Cable84 | 2.259 | 1.021 | -2.257 | -1.021 | 2.2 | 0.7 | 99.9 | 99.8 | 0.09 |
| T60 | 0.143 | 0.064 | -0.139 | -0.059 | 3.4 | 5.1 | 99.9 | 96.6 | 3.30 |
| Cable85 | 2.034 | 0.920 | -2.034 | -0.920 | 0.2 | 0.1 | 99.8 | 99.8 | 0.01 |
| T61 | 0.223 | 0.101 | -0.217 | -0.093 | 5.3 | 8.0 | 99.8 | 96.5 | 3.30 |
| Cable86 | 2.034 | 0.920 | -2.033 | -0.920 | 0.7 | 0.2 | 99.8 | 99.7 | 0.03 |
| Cable87 | 1.891 | 0.855 | -1.890 | -0.855 | 0.6 | 0.2 | 99.7 | 99.7 | 0.03 |
| T62 | 0.142 | 0.064 | -0.139 | -0.059 | 3.4 | 5.1 | 99.7 | 96.5 | 3.30 |
| Cable88 | 1.518 | 0.687 | -1.518 | -0.687 | 0.2 | 0.1 | 99.7 | 99.7 | 0.01 |
| T63 | 0.372 | 0.168 | -0.363 | -0.154 | 9.3 | 13.9 | 99.7 | 96.3 | 3.45 |
| Cable89 | 0.958 | 0.434 | -0.958 | -0.434 | 0.1 | 0.0 | 99.7 | 99.7 | 0.01 |
| T64 | 0.560 | 0.253 | -0.547 | -0.233 | 13.4 | 20.1 | 99.7 | 96.4 | 3.30 |
| Cable90 | 0.586 | 0.265 | -0.586 | -0.265 | 0.0 | 0.0 | 99.7 | 99.7 | 0.00 |
| T65 | 0.372 | 0.168 | -0.363 | -0.154 | 9.3 | 14.0 | 99.7 | 96.2 | 3.45 |
| T66 | 0.586 | 0.265 | -0.571 | -0.243 | 14.6 | 22.0 | 99.7 | 96.2 | 3.45 |
| Cable53 | 15.489 | 6.843 | -15.479 | -6.839 | 10.0 | 3.4 | 100.0 | 99.9 | 0.06 |
| Cable54 | 4.094 | 1.367 | -4.093 | -1.367 | 0.6 | 0.2 | 100.0 | 100.0 | 0.01 |
| c77 | 1.855 | 0.579 | -1.853 | -0.798 | 1.8 | -219.0 | 99.6 | 99.5 | 0.11 |
| Cable66 | -1.855 | -0.579 | 1.856 | 0.579 | 1.3 | 0.5 | 99.6 | 99.7 | 0.07 |
| T67 | 1.228 | 0.601 | -1.214 | -0.517 | 14.0 | 84.2 | 95.5 | 92.2 | 3.34 |
| Cable45 | -0.415 | -0.190 | 0.415 | 0.190 | 0.1 | 0.0 | 98.3 | 98.3 | 0.01 |
| T37 | 0.415 | 0.190 | -0.403 | -0.172 | 11.9 | 17.9 | 98.3 | 94.3 | 3.91 |
| T27 | -0.549 | -0.234 | 0.563 | 0.254 | 13.4 | 20.2 | 96.7 | 100.0 | 3.30 |
| Cable56 | 4.093 | 1.367 | -4.093 | -1.367 | 0.0 | -0.1 | 100.0 | 100.0 | 0.00 |
| T29 | 0.887 | 0.419 | -0.874 | -0.372 | 13.2 | 46.3 | 100.0 | 96.8 | 3.16 |
| Cable35 | 0.136 | 0.062 | -0.136 | -0.062 | 0.0 | 0.0 | 97.1 | 97.1 | 0.00 |
| Cable36 | -10.489 | -4.635 | 10.506 | 4.641 | 17.2 | 5.9 | 97.1 | 97.2 | 0.15 |
| T30 | 0.136 | 0.062 | -0.133 | -0.057 | 3.3 | 4.9 | 97.1 | 93.8 | 3.25 |
| Cable37 | 0.342 | 0.154 | -0.342 | -0.154 | 0.0 | 0.0 | 97.2 | 97.2 | 0.01 |

| Branch ID | From-To Bus Flow MW | From-To Bus Flow Mvar | To-From Bus Flow MW | To-From Bus Flow Mvar | Losses kW | Losses kvar | % Bus Voltage From | % Bus Voltage To | Vd % Drop in Vmag |
|---|---|---|---|---|---|---|---|---|---|
| Cable38 | -10.848 | -4.796 | 10.862 | 4.801 | 14.7 | 5.1 | 97.2 | 97.3 | 0.13 |
| T31 | 0.342 | 0.154 | -0.333 | -0.142 | 8.3 | 12.4 | 97.2 | 93.9 | 3.25 |
| Cable39 | -11.026 | -4.875 | 11.037 | 4.880 | 11.9 | 4.1 | 97.3 | 97.4 | 0.10 |
| T32 | 0.163 | 0.075 | -0.159 | -0.068 | 4.7 | 7.1 | 97.3 | 93.4 | 3.89 |
| Cable40 | 0.818 | 0.374 | -0.818 | -0.374 | 0.3 | 0.1 | 97.4 | 97.4 | 0.03 |
| Cable42 | -12.112 | -5.370 | 12.154 | 5.385 | 41.9 | 14.4 | 97.4 | 97.8 | 0.32 |
| T33 | 0.256 | 0.117 | -0.248 | -0.106 | 7.4 | 11.1 | 97.4 | 93.5 | 3.90 |
| Cable41 | 0.409 | 0.187 | -0.409 | -0.187 | 0.1 | 0.0 | 97.4 | 97.4 | 0.02 |
| T34 | 0.409 | 0.187 | -0.397 | -0.169 | 11.8 | 17.7 | 97.4 | 93.5 | 3.90 |
| T35 | 0.409 | 0.187 | -0.397 | -0.169 | 11.8 | 17.7 | 97.4 | 93.5 | 3.89 |
| Cable43 | -12.697 | -5.630 | 12.710 | 5.635 | 13.9 | 4.8 | 97.8 | 97.9 | 0.10 |
| T54 | 0.543 | 0.245 | -0.530 | -0.226 | 13.1 | 19.6 | 97.8 | 94.5 | 3.26 |
| Cable44 | 0.165 | 0.075 | -0.165 | -0.075 | 0.0 | 0.0 | 97.9 | 97.9 | 0.01 |
| Cable46 | -12.875 | -5.710 | 12.931 | 5.730 | 56.0 | 19.3 | 97.9 | 98.3 | 0.41 |
| T36 | 0.165 | 0.075 | -0.160 | -0.068 | 4.8 | 7.1 | 97.9 | 94.0 | 3.91 |
| Cable48 | -14.427 | -6.392 | 14.485 | 6.412 | 58.9 | 20.3 | 98.3 | 98.7 | 0.39 |
| T39 | 0.217 | 0.098 | -0.212 | -0.090 | 5.2 | 7.8 | 98.3 | 95.0 | 3.27 |
| Cable49 | -14.835 | -6.570 | 14.885 | 6.587 | 49.3 | 17.0 | 98.7 | 99.0 | 0.32 |
| T40 | 0.350 | 0.158 | -0.341 | -0.145 | 8.4 | 12.6 | 98.7 | 95.4 | 3.28 |
| Cable50 | -15.104 | -6.686 | 15.197 | 6.718 | 93.1 | 32.1 | 99.0 | 99.6 | 0.59 |
| T41 | 0.220 | 0.099 | -0.214 | -0.091 | 5.3 | 7.9 | 99.0 | 95.7 | 3.28 |
| Cable51 | -15.419 | -6.819 | 15.479 | 6.839 | 59.9 | 20.7 | 99.6 | 99.9 | 0.37 |
| T42 | 0.222 | 0.100 | -0.217 | -0.092 | 5.3 | 8.0 | 99.6 | 96.3 | 3.29 |
| Cable58 | 0.357 | 0.106 | -0.357 | -0.161 | 0.0 | -55.5 | 100.0 | 100.0 | 0.01 |
| Cable59 | 3.513 | 1.161 | -3.511 | -1.160 | 1.7 | 1.0 | 100.0 | 99.9 | 0.05 |
| T43 | 0.223 | 0.101 | -0.218 | -0.093 | 5.3 | 8.0 | 100.0 | 96.7 | 3.30 |
| T44 | 0.357 | 0.161 | -0.349 | -0.149 | 8.5 | 12.8 | 100.0 | 96.7 | 3.30 |
| Cable60 | 3.154 | 0.998 | -3.154 | -0.998 | 0.4 | 0.3 | 99.9 | 99.9 | 0.01 |
| T45 | 0.357 | 0.161 | -0.349 | -0.148 | 8.5 | 12.8 | 99.9 | 96.6 | 3.30 |
| Cable61 | 2.931 | 0.897 | -2.929 | -0.897 | 1.3 | 0.5 | 99.9 | 99.9 | 0.05 |
| T46 | 0.223 | 0.101 | -0.218 | -0.093 | 5.3 | 8.0 | 99.9 | 96.6 | 3.30 |
| Cable62 | 2.787 | 0.832 | -2.786 | -0.890 | 1.0 | -57.5 | 99.9 | 99.8 | 0.04 |
| T47 | 0.143 | 0.064 | -0.139 | -0.059 | 3.4 | 5.1 | 99.9 | 96.6 | 3.30 |
| Cable63 | 0.704 | 0.209 | -0.704 | -0.231 | 0.0 | -22.0 | 99.8 | 99.8 | 0.00 |
| Cable65 | 2.082 | 0.681 | -2.078 | -0.680 | 3.2 | 1.1 | 99.8 | 99.7 | 0.16 |
| Cable64 | 0.561 | 0.167 | -0.561 | -0.253 | 0.1 | -86.7 | 99.8 | 99.8 | 0.01 |
| T48 | 0.143 | 0.064 | -0.139 | -0.059 | 3.4 | 5.1 | 99.8 | 96.5 | 3.30 |

| Branch ID | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd % Drop |
|---|---|---|---|---|---|---|---|---|---|
| | MW | Mvar | MW | Mvar | kW | kvar | From | To | in Vmag |
| T49 | 0.561 | 0.253 | -0.548 | -0.233 | 13.4 | 20.1 | 99.8 | 96.5 | 3.30 |
| T50 | 0.222 | 0.100 | -0.217 | -0.092 | 5.3 | 8.0 | 99.7 | 96.4 | 3.30 |
| Cable67 | 1.410 | 0.670 | -1.410 | -0.671 | 0.0 | -1.4 | 99.5 | 99.5 | 0.00 |
| Cable68 | 0.222 | 0.028 | -0.222 | -0.100 | 0.0 | -72.2 | 99.5 | 99.5 | 0.00 |
| T52 | 0.222 | 0.100 | -0.216 | -0.092 | 5.3 | 8.0 | 99.5 | 96.2 | 3.29 |
| T51 | 1.410 | 0.671 | -1.397 | -0.595 | 12.7 | 75.9 | 99.5 | 96.8 | 2.72 |
| T53 | 0.222 | 0.100 | -0.216 | -0.092 | 5.3 | 8.0 | 99.5 | 96.2 | 3.29 |
| | | | | | 1104.8 | 266.9 | | | |

# Appendix C

# Substation Load Data

## Jerusalem District Elecricity Company

**SCADA Department**

**High Voltage Lines Consumption**

**From 1/1/2019 To 31/12/2019**

| Line Name | Shufat (Bet) | Efrat | Taqoaa | Husan |
|---|---|---|---|---|
| 1 | 9,277,571 | 6,165,960 | 1,256,160 | 8,995,440 |
| 2 | 7,796,404 | 4,919,640 | 1,102,560 | 8,412,720 |
| 3 | 8,170,755 | 3,407,880 | 1,577,760 | 7,451,760 |
| 4 | 6,220,618 | 5,863,200 | 1,074,480 | 6,781,920 |
| 5 | 6,430,917 | 5,286,360 | 1,165,200 | 6,788,400 |
| 6 | 6,257,752 | 4,512,360 | 1,154,160 | 7,173,840 |
| 7 | 7,694,497 | 6,166,320 | 1,129,440 | 6,495,360 |
| 8 | 6,353,688 | 6,144,600 | 930,240 | 8,326,560 |
| 9 | 7,626,812 | 5,025,840 | 1,036,560 | 6,083,280 |
| 10 | 7,070,904 | 5,329,440 | 1,057,200 | 6,954,960 |
| 11 | 6,436,967 | 4,620,840 | 1,090,800 | 7,170,240 |
| 12 | 8,624,839 | 5,415,720 | 1,097,760 | 9,038,160 |
| Total | 87,961,724 | 62,858,160 | 13,672,320 | 89,672,640 |