Chapter One

Introduction

1.1 Overview.
1.2 Feature of the project.
1.3 Objective.
1.4 Methodology

1.1 Overview

The objective is to study Sa'ir Medium Voltage network using new distribution methods. Numerical calculations using E-TAP are used to investigate the power flow in the network. The study aims to reduce loses to the grid, improve power factor and study the load growth.

1.2 Feature of project

1. Reduce the losses, voltage drop, and time outage of electricity.
2. Study the load growth, reconstruct, and reinforce the network.

1.3 The objective of project

1- Analyze the network.
2- Make required load calculation.
3- Present scenarios to get an optimum network.
4- Find a solution for interruption during the peak demands.
5- Redistribute the loads to satisfy demands.

1.4 Methodology

According to the status of Sa'ir network, the following procedure is going to be conducted:

1. Collect the need and appropriate data using statistics methods.
2. Visiting the network substations.
3. Analyzing the network by using related software packages such as E-TAP.
4. Analysis the results and suggest the solutions.
5. Improve the operation by reconstruct and reinforce network.

Chapter Two

Sa'ir Medium Voltage Network

2.1 Introduction.
2.2 Medium Voltage Network Components.
2.3 Distribution Configuration.

2.1 Introduction:

Sa'ir lies 8 km to the north-East of Hebron between Halhul to the west, Bani Na'im to the south, Beit Fajar , camp'Arroub to the north ,and Dead Sea to the East, Sa'ir total population is 26216 in 2016 census.

The total area of Sa'ir is 6921 acres which a medium range of mountain and hills that height about(870 – 1019) m above sea level. The electric power system was built in 1973 by Sa'ir village council, but now the system is under responsibility of Sa'ir municipality which serve the area and founded in 1997.

In these days Sa'ir consume the electricity from IEC. The network configuration is radial with medium voltage level of 33KV.

The main transmission line passes through Kiryat Arba settlement until Sa'ir - transmission line feeds the domestic and the industrial sector in Sa'ir.

In this project we started by building a scheme for our network in order to determine the sites of transformers, transmission lines and cables lengths, and interconnection point site, then we can build single line diagram and analyze the network.

Figure 2.1: Sa'ir Aerial Photograph MAPS

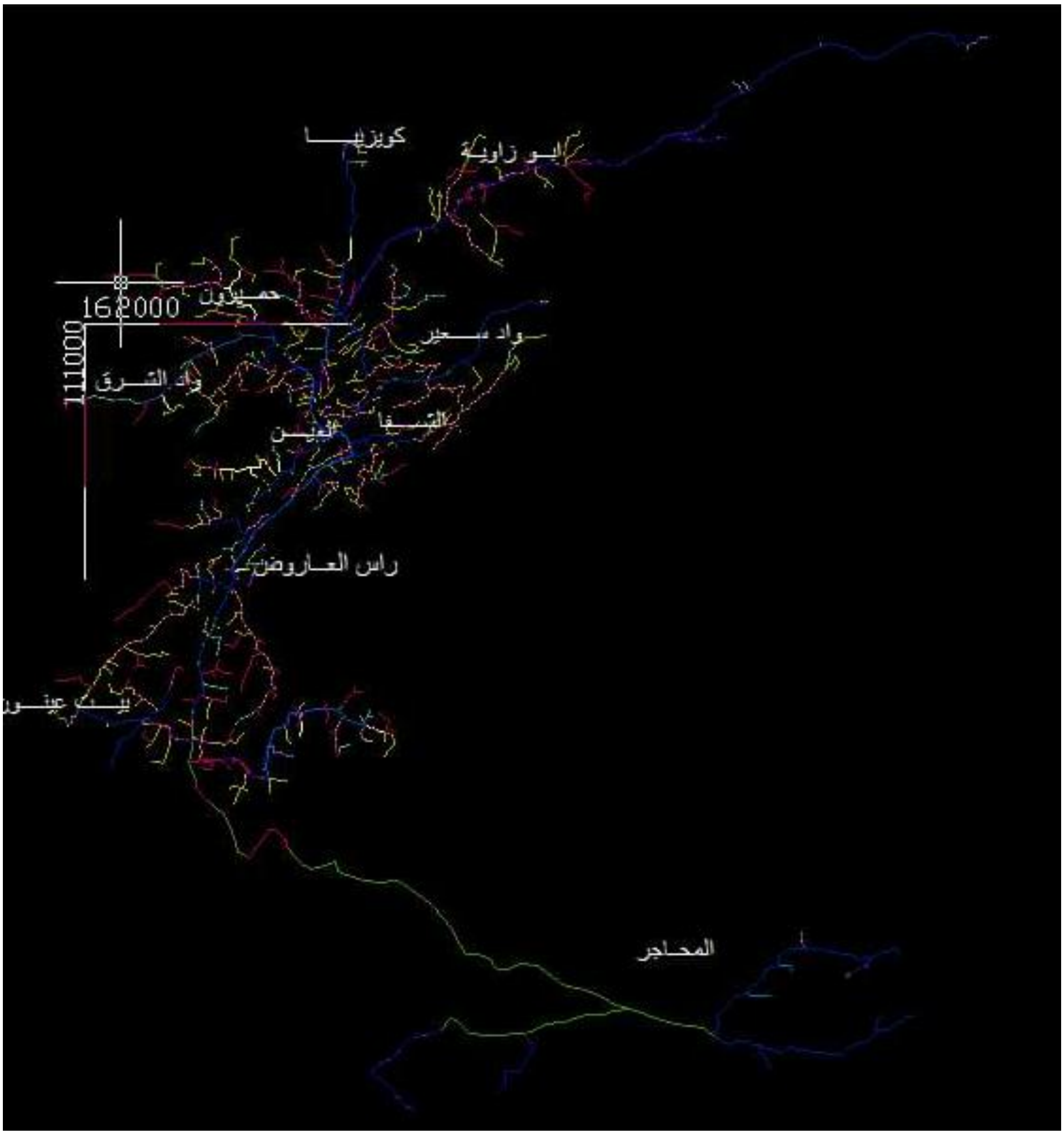

Figure 2.2: Sa'ir Aerial Photograph AutoCAD MAPS

2.2 Medium voltage network components

2.2.1 Medium voltage fed:

Sa'ir electrical network is provided by Israel electrical company(IEC) through an overhead transmission line of 33 KV. The main circuit breaker is rated above (200 A). the max demand is reached (7 MVA) Distributed to approximately 2800 domestic load and 89 industrial load.

The main supply for electrical distribution network in main substation which located on Kiryat Arba settlement. And the voltage of the existing distribution networks are 33 KV. IEC supplies electricity to the electrified communities by 33 KV by overhead lines. Electricity is purchased from IEC and then distributed to the consumers. The existing network is local low voltage distributions networks connected to Israeli electrical corporation (IEC) ,and the main protective device is the Auto-Recloser which interconnect Sa'ir network with ICE. The types of transmission lines that used are overhead lines and underground cables.

2.2.2 Transmission line

2.2.2.1 Introduction `

The important considerations in the design and operation of a transmission line are the determination of voltage drop. Line losses and efficiency of transmission. These values are greatly influenced by the line constants R, L and C of the transmission line.[1]. For instance. The voltage drop in the line depends upon the values of above three line constants. Similarly. The resistance of transmission line conductors is the most important cause of power loss in the line and determines the transmission efficiency.

2.2.2.2 Aluminum Conductors is uses in Sa'ir network

In Sa'ir network the total available HV transmission lines are about 17.46 Km (95mm^2 A.C.S.R.) distributed in all network.

Aluminum Conductor Steel Reinforced (A.C.S.R.)

A.C.S.R conductors are widely used for electrical power transmission- over long distances, since they are ideal for long overhead lines spans. They are- also used as a messenger for supporting overhead electrical cables. The tables 2.1, 2.2 and 2.3 shows standards, the sag tension and the resistance and reactance of the ACSR conductor respectively.

Figure2.3: ACSR Conductor, Aluminum Conductors Steel Reinforced

Table 2.1 The ACSR Conductor shall also conform to the following standards

ALL ALUMINIUM CONDUCTOR - GALVANISED STEEL REINFORCED (ACSR/GZ) ALL ALUMINIUM CONDUCTOR - ALUMINISED STEEL REINFORCED (ACSR/AZ) (Metric)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Equiv Alum Area	Stranding and Wire Diameter mm		UTS	Resistance at 20°C	Total Diameter	Cross Sectional Area (A)	Mass	Conductor Load N/m			Modulus of Elasticity (E)	Coefficient of Expansion (a)	Constants	
mm^2	Alum	Steel	kN	Ohms/km	mm	mm^2	kg/m	W	W_{100}	W_{500}	kPa	per °C x 10^{-6}	C1	C2
35.2	6/2.75	1/2.75	12.5	.8050	8.25	41.6	0.144	1.413	1.636	4.360	79 x 10^6	19.3	370.0	63.4
65.2	6/3.75	1/3.75	21.5	.4330	11.3	77.3	0.268	2.629	2.861	6.232	79 x 10^6	19.3	504.4	117.9
105.0	6/4.75	7/1.6	31.9	.2710	14.3	120.4	0.404	3.963	4.213	8.175	76 x 10^6	19.9	617.5	182.1
144.0	30/2.5	7/2.5	61.6	.1960	17.5	181.6	0.675	6.622	6.849	10.973	80 x 10^6	18.4	778.0	267.3
244.0	30/3.25	7/3.25	104.0	.1160	22.75	306.9	1.141	11.193	11.421	15.959	80 x 10^6	18.4	1011.4	451.8
373.0	54/3.0	7/3.0	115.0	.0758	27.0	431.2	1.440	14.126	14.381	19.540	68 x 10^6	19.9	1105.3	583.5
508.0	54/3.5	7/3.5	153.0	.0557	31.5	586.9	1.960	19.228	19.484	24.855	68 x 10^6	19.9	1289.5	794.2

Table 2.2 Sag tension for conductor (ASCR)

Temperature variation C		0		32		75
Wind variation %	0	0. 36	0	0.75	1.0	0
Tension= F x A (kg)	4060	4879	3322	5763	6804	2687
Sag $\frac{wL^2}{8T}$ (m)	6.114	5.088	7.471	4.307	3.648	9.239

Table 2.3 the resistance and reactance of the ACSR conductor

ACSR CABLE	R(Ohms/Km)	X(Ohms/Km)
120mm2	0.219	0.269
95mm2	0.301	0.322
50mm2	0.543	0.333

2.2.2.3 Tolerance

1. The tolerances on standard diameter of Aluminum and Steel wires shall be as detailed in specific technical requirements.

2. The cross-section of any wire shall not depart from circularity by more than an amount corresponding to the tolerance on the standard diameter. Central Electricity Supply Utility of Orissa.

3. The details of diameters, lay ratios of Aluminum and steel wires shall be in accordance with the standard specification. Table 2.4 shows some standards of A.C.S.R transmission line.

Table 2.4 some standards of (ASCR)

Name	Nominal area	Nominal cross sec. area	No of strands & diameter		Resistance at 20 C °	Overall diameter	Weight	Strength
UNITS	(mm^2)	(mm^2)	Al No × φ (mm)	St No × φ (mm)	Ω / Km	(mm)	Kg / Km	KN
Raccoon *	80	92.0	6 × 4.09	1 × 4.09	0 .36365	12.7	338.8	28.8
Wolf *	150	194.9	30 × 2.59	7 × 2.59	0.1829	18.1	725.3	68.91
Lynx *	175	226.2	30 × 2.79	7 × 2.79	0.1576	19.5	841.6	79.97
Zebra *	400	484.5	54 × 3.18	7 × 3.18	0.0676	28.6	1620.8	131.92

2.2.3 Cable

2.2.3.1 Cable specification

A cable is defined as a single conductor or an assembly- of conductors covered by solid electrical insulation. Cable specifications generally start with the conductor and progress radially through the insulation and coverings. The following is a typical list of specifications:

1. Number of conductors in cable.
2. Conductor size (American Wire Gage (AWG), circular mil) and material.
3. Insulation type.

4. Voltage rating.
5. Shielding system.
6. Outer finishes (or sheath).
7. Installation.

An alternate method of specifying cable is to furnish the amp city of the circuit (amperes (A)), the voltage (phase to phase, phase to ground, grounded, or ungrounded), and the frequency, along with any other pertinent system data.[2]

2.2.3.2 Cable Insulation

A very important parameter in cable selection is the insulation type. Insulation selection should be based on service life, dielectric characteristics, resistance to flame, mechanical strength and flexibility, temperature capability, moisture resistance, and the type of location where the cable is to be installed. Common insulation types applicable to medium-voltage cables are:

- Ethylene propylene rubber (EPR).
- Cross-linked polyethylene (XLPE).
- Tree-retardant cross-linked polyethylene (TR-XLPE).

These insulation materials have replaced the impregnated-paper designs that may still be found in some older installations. Tables 2.5 and 2.6 illustrate the maximum conductor temperature and the resistance and reactance of XLPE cable.

Sa'ir network has 3776 meter of (95 mm^2 XLPE) high voltage cable.

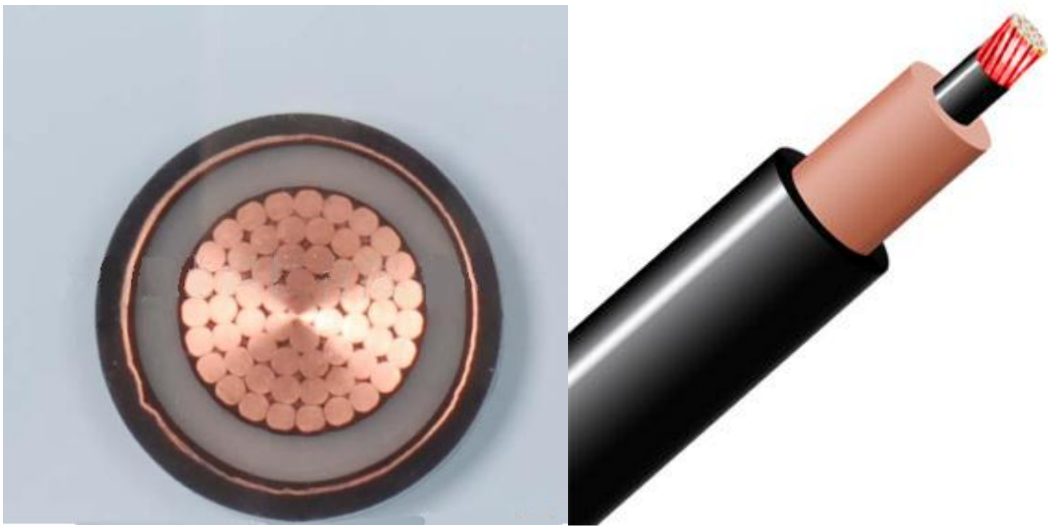

Figure2.4: high voltage cable

Table 2.5: Maximum Conductor Temperature, C

Thermosetting Circuit	Operating	Overload	Short
XLPE	90	130	250

Table 2.6: The resistance and reactance of XLPE

XLPE CABLE	R(Ohms/Km)	**X(Ohms/Km)**
95mm2	0.41	0.121
120mm2	0.196	0.117

2.2.4 Towers

The main supporting unit of overhead transmission line is transmission tower. Transmission towers have to carry the heavy transmission conductor at a sufficient safe height from ground. In addition to that all towers have to sustain all kinds of natural calamities. So transmission tower designing is an important engineering job where all three basic engineering concepts, civil, mechanical and electrical engineering concepts are equally applicable.

Sa'ir network has 80 medium voltage tower and 96 medium voltage ladder tower**.**

Figure2.5: high voltage towers

The table 2.7 below illustrate the safety distance between conductor and ground.

Table 2.7: safety Distance between conductor and ground

Up to 33 KV	5.8 m
33 KV to 66 KV	6 m
66 KV to 132 KV	6.7 m
132 KV to 273 KV	7 m
275 KV to 400 KV	7.3 m

2.2.5 Transformers

2.2.5.1 Transformer Models

The transformer model used in Sa'ir network is Delta Grounded Wye connection model.

Figure2.6: Three-phase transformer

2.2.5.2 The Delta Grounded Wye Step-Down Connection

The delta grounded wye step-down connection is a popular connection that is typically used in a distribution substation serving a four-wire wye feeder system. Another application of the connection is to provide service to a load that is primarily single-phase. Because of the wye connection, three single phase circuits are available, thereby making it possible to balance the single phase loading on the transformer bank.Three single-phase transformers can be connected to a delta grounded wye in a standard thirty-degree step-down connection as shown in Figure 2.7.

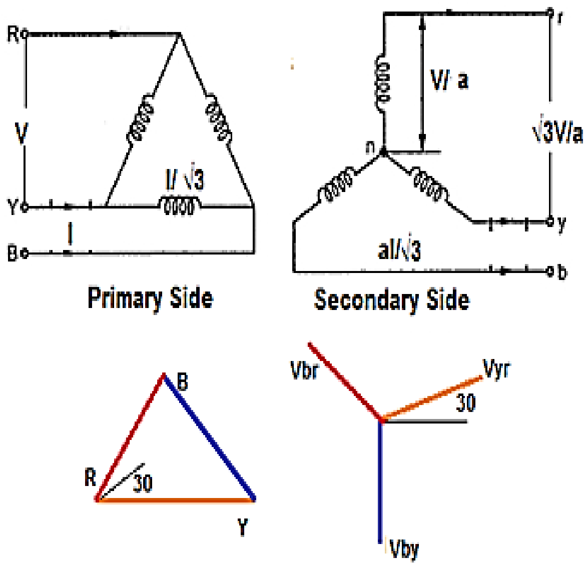

Figure 2.7: Delta grounded wye connection with voltages

2.2.5.3 Sa'ir Existing Transformer

Sa'ir electrical network have 50 transformer and this transformers have arrange of (160-630) KVA and the same rating voltage ratio of (33/0.4) KV, 13 of them for domestic loads and 13 for industrial loads.

The rated for each transformer Illustrated in table 2.8 and table 2.9 shown below.

Table 2.8: Transformers rating of domestic load

Transformer number	**Name of transformer**	**Rating (KVA)**	**Rating voltage ratio (KV)**
1	AL-DOARA	250	33/0.4
2	KHALET AL-FOOL	250	33/0.4
3	RAS AL-TAWEL	250	33/0.4
4	BET ENON	250	33/0.4
5	GRGAES	250	33/0.4
6	RAS AL-AROD	630	33/0.4
7	AL-SHFA	400	33/0.4

Transformer number	Name of transformer	Rating (KVA)	Rating voltage ratio (KV)
8	WAD AL-SHARQ	400	33/0.4
9	AL-AEN	630	33/0.4
10	WAD SA'IR	160	33/0.4
11	AHMARON	400	33/0.4
12	ABU ZAWEH	400	33/0.4
13	RBAEA	160	33/0.4

Table 2.9: Transformers rating of industrial load

Transformer number	Name of transformer	Rating (KVA)	Rating voltage ratio(KV)	Number of customer on the transformer
T1	Naser Mousa Shaker	400	33/0.4	4
T2	Hassan Edrees	160	33/0.4	1
T3	Jawdat Alshanteer	160	33/0.4	2
T4	Jamal Shhda Salah	160	33/0.4	2
T5	Yasser Mtoor	400	33/0.4	4
T6	Mohammad Ibrahim Jaradat	400	33/0.4	4
T7	Abu Adel Alrajbe	250	33/0.4	1
T8	Nihad Alrajbe	160	33/0.4	1
T9	Anwar Abu Alzulfe	630	33/0.4	7
T10	Abu Alzulfe Company	630	33/0.4	3
T11	Murad Nassar	250	33/0.4	1
T12	Khader Nassar	250	33/0.4	1
T13	Mousa Ali Mtoor	160	33/0.4	1
T14	Iyad Mohammad Mtoor	250	33/0.4	3

T15	Jihad Shaker Jabareen	160	33/0.4	2
T16	Rasme Abu Isnenih	400	33/0.4	3
T17	Shaher Gaeth	400	33/0.4	3
T18	Abd Almonaem Ez Aldeen	400	33/0.4	5
T19	Esaa Mohammad jaradat	250	33/0.4	1
T20	Saade Abd Allah Jaradat	160	33/0.4	1
T21	Abd Alrahim Mohammad Jaradat	160	33/0.4	1
T22	Galeb Hussein Thalje	250	33/0.4	2
T23	Saber Mousa Thalje	400	33/0.4	2
T24	Sulaiman Ezaat Jaradat	250	33/0.4	2
T25	Ibrahim Abd Alrhman Jaradat	630	33/0.4	3
T26	Asad Sade Jaradat	250	33/0.4	1
T27	Mousa Edrees	250	33/0.4	1
T28	Aodeh Edaes Jaradat	630	33/0.4	4
T29	Nader Rajbe	250	33/0.4	1
T30	Hassan Abd Alqader Joher	250	33/0.4	1
T31	Alatroon Company	1000	33/0.4	3
T32	Rebhe Mousa Jaradat	1000	33/0.4	7
T33	Akram Salem Jaradat	400	33/0.4	2
T34	Khaled Khalel Jaradat	630	33/0.4	5
T35	Badran Edrees	400	33/0.4	2
T36	Hamde Mtoor	400	33/0.4	2
T37	Zahran Saqel Jaradat	400	33/0.4	2

2.2.5.4 Transformer Protection

A typical protection scheme, commonly used in industrial power systems for a medium or high voltage oil immersed power transformer, is shown in fig. 3.8.

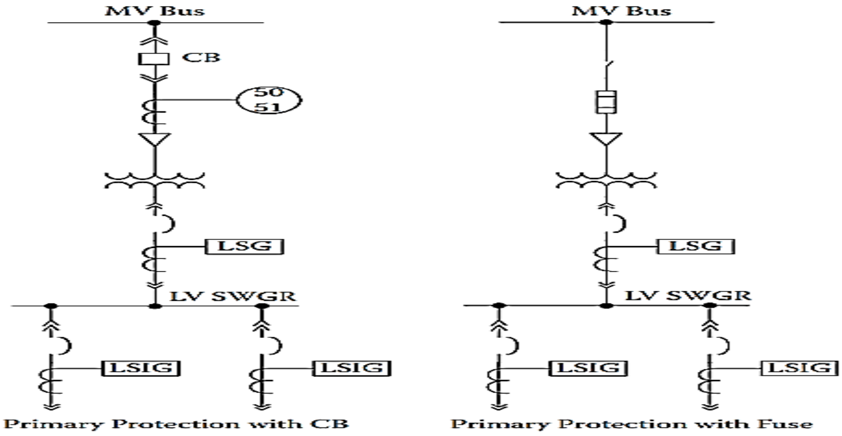

Figure 2.8: Transformer protection with primary CB and Fuse

Figure 3.8 descriptions some of the protection elements and Devices are provided in the following subsections:

1- Transformer Protection with a Primary Fuse

A typical transformer-protection scheme with primary fuse, commonly used with effectively grounded power systems.

Most fuse suppliers provide recommendations for the sizes and types of transformers their fuses can protect. However, the guidelines are:

- Power fuse: 140% of the transformer self-cooled rating
- Current-limiting fuse: 150% of the transformer self-cooled rating
- Fuse time current: below the transformer short-circuit withstand curve (SCW) and above the magnetizing inrush current
- Magnetizing inrush current: points for coordination are 10 to 12 P.U.at 0.1 s and 25 P.U. at 0.01 s

Limitation of Fuse for Transformer Protection

Industrial power systems are resistance grounded, and the limited ground fault current will not melt the fuse and clear the fault within a short time. A fused load-interrupter switch equipped with a shunt trip and a ground-fault relay, and capable of interrupting a ground fault current, can provide protection against line-to-ground, phase-to-phase, and three phase faults.

A phase-to-phase fault on the secondary of a Delta-Wye transformer will melt only one fuse on the primary, thus causing single phasing on the secondary system. This condition requires a switch fuse that will trip if one fuse blows, and if voltage or current are unbalanced, providing protection for downstream three-phase motors.

2- HV Circuit Breaker

HV Circuit Breaker don’t use in Sa'ir medium voltage network but used a disconnecter switch instead of it where the disconnecter switch can operate only with no load.

Figure 2.9: disconnecter switch

3- LV circuit breaker

The specification for circuit breakers is often the poor relation in comparison to other building service disciplines when it comes to the written detail. Several pages, indeed chapters may be written on other electrical disciplines of lighting, lift systems, Heating Ventilation and Air Conditioning (HVAC), Uninterruptible Power Supplies (UPS), Building Management Systems (BMS) and the switchboard itself. However the specification for the MCCB is often limited, outdated and usually a hybrid of other circuit breakers such as Miniature Circuit Breakers (MCB) and Air Circuit Breakers (ACB)[3].

Figure 2.10: Typical low voltage system

MCCB is a mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and breaking currents under specified abnormal circuit condition such as those of short circuits.

The MCCB rated on Sa'ir medium voltage network based on rated of transformer But values are calibrated according to subscribe to the consumer.

2.2.6 Isolators

Isolator (disconnecting switch) operates under no load condition. It does not have any current breaking capacity or current making capacity. Isolator is not even used for breaking load currents.
Isolators are used in addition to circuit breakers, and are provided on each side of every circuit breaker to provide isolation and enable maintenance.
Sequence of operation.

While opening –Open circuit breaker first and then isolators
While closing –Close isolators first and then close circuit breakers

Figure 2.11: Isolator (disconnecting switch)

2.2.7 Fuses

Fuse is a device used in circuit for protecting electrical equipments against overloads and /or short circuits.

Fuse element or fuse wire is that part of the fuse device which melts when an excessive current flows in the circuit and thus isolates the faulty device from the supply circuit.

Desirable qualities of fuse elements.
1. Low melting point.

2. Low Ohmic losses.
3. High conductivity.
4. Free from deterioration due to oxidation.
5. Low cost**.**

The rated of fuses in Sa'ir medium voltage network based on transformer rating and load of this transformer illustrate in table 2.10.

Table 2.10 : rated fuse used in Sa'ir network

Transformer rated (KVA)	**Fuse rated (A)**
160	4
250	6
400	10
630	16

Figure 2.12: 33KV fuses

2.2.8 Surge arrester

Surge arresters are devices that help prevent damage to apparatus due to high voltages. The arrester provides a low-impedance path to ground for the current from a lightning strike or transient voltage and then restores to a normal operating conditions. It will release high pressure until a normal operating condition is reached. When the pressure is returned to normal, the safety valve is ready for the next operation. When a high voltage (greater than the normal line voltage) exists on the line, the arrester immediately furnishes a path to ground and thus limits and drains of the excess voltage. The arrester has two functions, it must provide a point in the circuit at which an over-voltage pulse can pass to ground and second, to prevent any follow-up current from owing to ground.

Duty cycle rating: Duty cycle testing of an arrester is performed by subjecting an arrester to an AC rms voltage equal to its rating for 24 minutes. During which the arrester must be able to withstand lightning surges at 1-minute intervals. For station class arresters, the magnitude of this surge is 10kA (10,000 Amperes). For intermediate and distribution class arresters, this surge is 5 kA (5000 Amperes). Maximum continuous operating voltage rating is usually 80 to 90% of the duty cycle rating. [4].

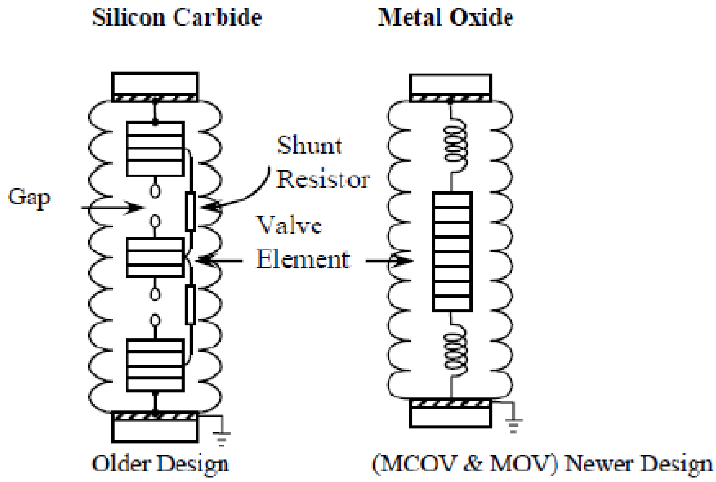

Figure 2.13: Surge arrester

2.2.9 Earthling System

2.2.9.1 Introduction

The topic of system grounding is extremely important, as it affects the susceptibility of the system to voltage transients, determines the types of loads the system can accommodate, and helps to determine the system protection requirements. The system grounding arrangement is determined by the grounding of the power source.

2.2.9.2 TT Earthling System

The type of earthing system used in Sa'ir network is TT system. In this system, the supply source has a direct connection to earth. All exposed conductive parts of an installation also are connected to an earth electrode that is electrically independent of the source earth. The structure of TT system is shown in Figure 2.14[5].

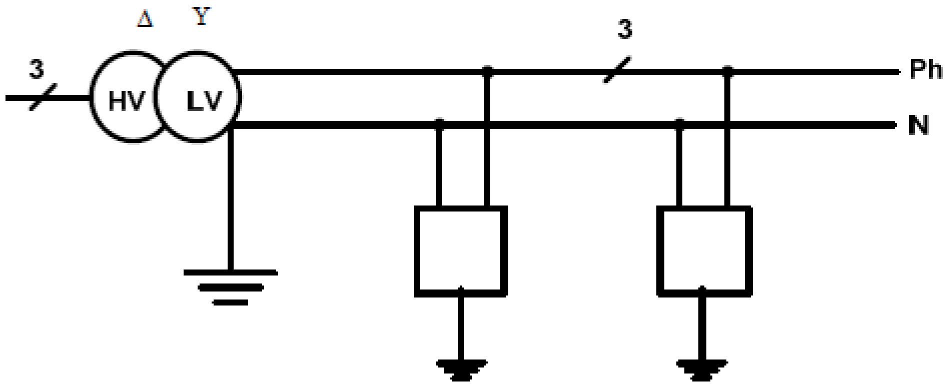

Figure 2.14: TT earthing system configuration

Fault Behavior in the TT Earthing System

Figure 2.15 explain fault occurs in TT earthing system. When an insulation fault occurs, the fault current **Id** is mainly limited by the earth resistances (*Ra* and *Rb*). At least one residual current device (RCD) must be fitted at the supply end of the installation. In order to increase availability of electrical power, use of several RCDs ensures time and current discrimination on tripping [6].

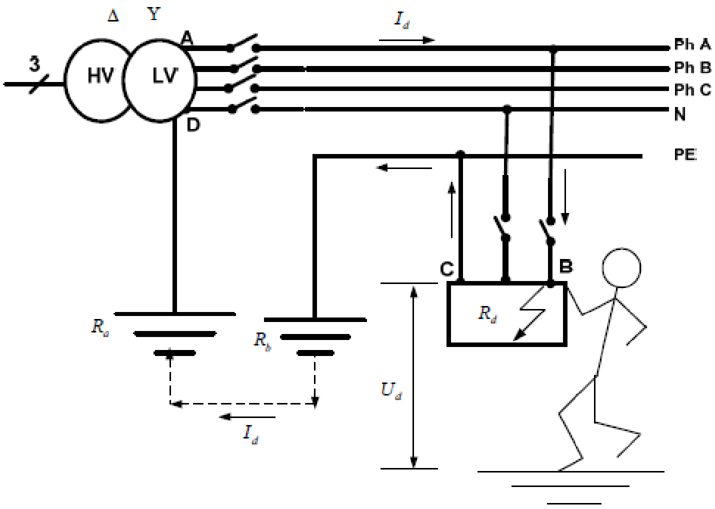

Figure 2.15: The fault behavior in the TT earthing system

Advantages of the TT Earthing System

1) The most commonly found earthing system.
2) Faults in the LV and MV grid do not migrate to other customers in the LV grid.
3) Good security condition, as the potential rise of the grounded conductive part must be limited at 50 V for a fault inside the installation and at 0V for a fault on the network.
4) Simple earthing of the installation and the easiest to implement.

5) No influence of extending the network.

Disadvantages of the TT Earthing System

1) Each customer needs to install and maintain its own ground electrode. Safety and protection depends on the customer, thus complete reliability is not assured.
2) High over voltages may occur between all live parts and between live parts and PE conductor.
3) Possible overvoltage stress on equipment insulation of the installation.

2.3 Distribution configuration

2.3.1 Introduction

The primary purpose of an electricity distribution system is to meet the customer's demands for energy after receiving the bulk electrical energy from transmission or sub transmission substation. There are basically two major types of distribution substations: primary substation and customer substation. The primary substation senres as a load center and the customer substation interfaces to the low voltage (LV) network. Customer substation is referred to a distribution room normally provided by the customer. The distribution room can accommodate a number of I-IV switchgear panel and the transformer to enable LV connection to the customer incoming switchboard. [7]

Depending on the geographical location, the distribution network can be in the form of overhead lines or underground cables. Cables are commonly used in urban areas and overhead lines are adopted for rural areas. Different network configurations are possible in order to meet the required supply reliability. Protection, control and monitoring equipment are provided to enable effective operation of the distribution network [7].

Planning of the distribution network is essential to enable the required demand can be met based on various forecast loading figures and supply security/reliability? There are three categories of planning, namely the long-term planning, the network planning and construction planning. Long-term planning is to determine the most optimum network arrangements and the associated investment with consideration on future .

2.3.2 Configuration of distribution power system.

Developments. Stage-by-stage development must be in line with the forecasted load growth so that electricity demands can be timely met. The construction planning or design is the actual design and engineering work when the required circuits and substations have been planned and adopted. Design, installation, operation and maintenance are the basic engineering considerations for a typical power system, including distribution.

Theirs two configuration in distribution power system.

1. Radial Electrical Power Distribution System.

2. Ring Main Electrical Power Distribution System.

2.3.3 Existing distribution configuration in Sa'ir network

The distribution configuration used in Sa'ir is radial system so that the main high voltage feeder feeds industrial and domestic transformers threw medium voltage transmission line and underground cable, also every transformer feeds some ABC .distribution cable deliver 0.4 KV to the customers in domestic sector.

That mean In case of transformer failure, the power interrupted. In other words the consumer would be in darkness until the feeder or transformer was fixed again.

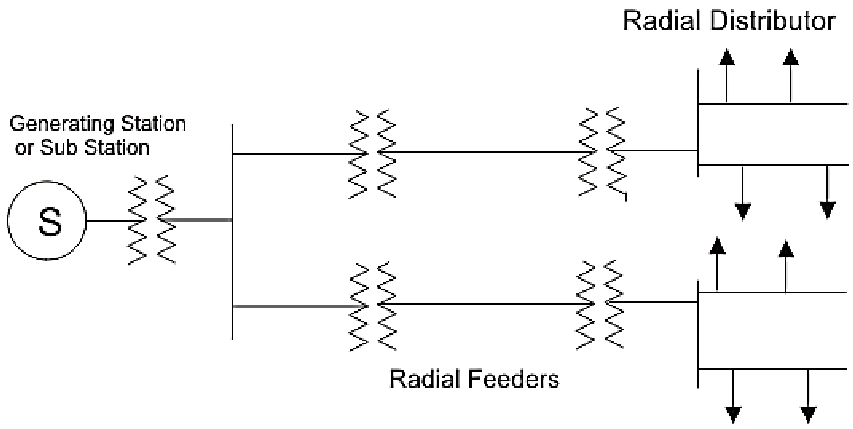

Figure 2.16:Radial electrical power distribution system**.**

Chapter Three

Collected Data And Analyses

3.1 Introduction

The electrical load of Sa'ir has been measured and analyzed threw a hardware device and software program.

For measuring the load, we use a device called “Vega 78 power analyzer , this device measures a wide range of power component and evaluate the power quality. In our project, we use it for taking a sample from domestic and industrial transformers for two hour reading then enter the maximum value of them to ETAP software for data analysis.

The main software used in the project is ETAP program witch a PowerStation with fully graphical electrical transient analyzer program that can run under the Microsoft Windows. ETAP provide the highest performance level for demanding applications, such as large network analysis requiring intensive computation and online monitoring and control applications.

To learn more about VEGA78 Power Analyzer and ETA-P Program see **App(A).**

3.2 Individual Transformers Load

3.2.1 Overview

Sa'ir consist 50 transformers feeding the area with requirement power for domestic and industrial sectors.

3.2.2 Data from Vega 78 power quality analyzer

Based on data from Sa'ir municipality it was divided loads into two categories :

1. Domestic loads.
2. Industrial loads.

1. Domestic loads

Based on data from Sa'ir municipality about number of customers on each transformer and loads it was divided in three categories :

1. Transformer with low load.
2. Transformer with medium load.
3. Transformer with high load.

We have been reading some transformers and appreciation of each other based on the relative transformers, including the load and the number of subscribers as follows:

Table3.1: Measurements of domestic transformers

Transformer number	**Name of transformer**	**Rating KVA**	**Measurements**	**Maximum Load KVA**
1	AL-DOARA	250	Two hour reading at evening	16
2	KHALET AL-FOOL	250	relative to GRGAES transformer	76
3	RAS AL-TAWEL	250	Two hour reading at morning and Two hour reading at evening	61
4	BET ENON	250	relative to GRGAES transformer	76
5	GRGAES	250	Two hour reading at morning and Two hour reading at evening	76
6	RAS AL-AROD	630	Two hour reading at morning and Two hour reading at evening	271
7	AL-SHFA	400	Two hour reading at morning and Two hour reading at evening	138
8	WAD AL-SHARQ	400	Two hour reading at morning and Two hour reading at evening	246
9	AL-AEN	630	Two hour reading at morning and Two hour reading at evening	277
10	WAD SA'IR	160	Two hour reading at morning	38
11	AHMARON	400	Two hour reading at morning and Two hour reading at evening	189.5
12	ABU ZAWEH	400	relative to AHMARON transformer	189.5
13	RBAEA	160	relative to WAD SA'IR transformer	38

2. Industrial loads

Based on data from Sa'ir municipality about number of customers on each transformer and rated power transformer it was divided into three categories:

1. Transformer with single customer.
2. Transformer with two customers.
3. Transformer with multi customers.

Table 3.2 shows number of transformers for each categories.

Table3.2: Number of transformers on each categories

Rating transformer	Number of transformers for single customer	Number of transformers for two customer	Number of transformers for multi customer
160KVA	10	4	0
250KVA	4	6	1
400KVA	0	0	8
630KVA	0	0	4

one transformers from each category measuring and estimating the rest of the transformers of the same rate it .

Transformers that have been measured are shown in Table3.3

Table3.3: Industrial transformers measures

Transformer number	Name of transformer	Rating KVA	Category	Maximum load KVA
1	Hassan Edrees	160	Single customer	73
2	Jamal Shhda Salah	160	Two customers	99
3	Murad Nassar	250	Single customer	101
4	Saber Mousa Thalje	250	Two customers	113
5	Iyad Mtoor	250	Multi customers	133
6	Naser Mousa Shaker	400	Multi customers	181
7	Anwar Abu Alzulfe	630	Multi customers	387

3.3 Load Consumer Category

3.3.1 Residential Electrical Loads (Dwelling Loads).

Residential load is a term which is used to describe the amount of electricity entering a residence at any given time. The amount of electricity a residence can access is typically limited by the amount of its service drop. When homes are constructed or electrical systems are renovated, an electrician must perform a number of calculations to estimate maximum residential load to determine how the system should be laid out, with the goal of preventing electrical problems caused by overloading the system.

In some regions of the world, utilities have promoted load management programs which are designed to compensate for aging electricity grids by managing the use of power at peak times. These programs also generate savings for utility customers, helping them spend less on electricity. Load management programs control high-load electrical devices like water heaters and fridges, deferring electricity use during peak periods to free up power resources.

Residential load calculations determine the amount of service drop appropriate to a residence, the type of wiring which should be used, and how circuits should be arranged. Electricians also perform calculations to determine the heating and cooling needs of a structure so that the best system can be installed. A system which is too small will not be sufficient, while a system which is too large will be inefficient. Installing the right system will cut energy costs and keep the temperature more comfortable.

3.3.2 Commercial Electrical Loads.

The electrical load requirements for commercial installations result in a great deal of diversity in usage. In other words, while some types of equipment and electrical loads are in use for extended periods, others are only used occasionally or for short periods of time.

Common commercial occupancies include banks, stores, restaurants, and office buildings. Some other locations with their own special requirements include marinas and mobile home parks. The NEC also provides specific requirements for calculating the loads for restaurant equipment, show-window lighting, sign lighting, multi-outlet assemblies, and electric welders.

When doing commercial load calculations, you have to know when the Code allows the application of a demand factor and when. On the other hand, it's necessary to consider a load as "continuous duty."

3.3.3 Industrial Electrical Loads.

Industrial load consists of load demand by industries. The magnitude of industrial load depends upon the type of industry. Thus small scale industry requires load up to 25 kW, medium scale industry between 25kW and 100 kW and large-scale industry requires load above 500 kW. Industrial loads are generally not weather dependent.

3.3.4 Municipal load

Municipal load consists of street lighting, power required for water supply and drainage purposes. Street lighting load is practically constant throughout the hours of the night. For water supply, water is pumped to overhead tanks by pumps driven by electric motors. Pumping is carried out during the off-peak period, usually occurring during the night. This helps to improve the load factor of the power system.

3.3.5 Irrigation load.

This type of load is the electric power needed for pumps driven by motors to supply water to fields. Generally this type of load is supplied for 12 hours during night.

3.3.6 Traction load.

This type of load includes tram cars, trolley buses, railways etc. This class of load has wide variation. During the morning hour, it reaches peak value because people have to go to their work place. After morning hours, the load starts decreasing and again rises during evening since the people start coming to their homes.

3.4 E-TAP simulation and result

3.4.1 E-TAP Simulation

In this part we take a sample of all transformers in the network then entered the power parameter reading for them to fill the needed data using Vega 78 power analyzer. The simulation data of the sample is cleared in figure 3.1 for the present network before reconstruction.

3.4.2 One-Line diagram

The main source of data for the system is the One-Line diagram; this data includes the series impedance and shunt admittances of the transmission line, other essential information includes transformer tap setting, data about the nominal voltages and the load power and the generated power.

3.4.3 E-TAP data and result

3.4.3.1 Data

The main source of data for the system is the One-Line diagram; this data includes the series impedance and shunt admittances of the transmission line tabel3.4, other essential information includes transformer tap setting, data about the nominal voltages and the load power and the generated power table 3.5 **.**

Table 3.4: Branches data from ETAP

ID	Type	From	ToSec	R	X	Z	Y
Line5	Line	Bus8	Bus10	5.897362	1.157514	6.009884	0.00187177
Cable3	Cable	Bus99	Bus100	0.145527	0.0937631	0.173118	0.00481556
Line58	Line	Bus100	Bus101	9.481444	0.9911672	9.533111	0.00137613
Cable4	Cable	Bus101	Bus102	0.336668	0.2169146	0.400496	0.01114047
Line59	Line	Bus102	Bus103	13.29688	2.609867	13.55059	0.00422031
RAS ALTAWEL	2W XFMR	Bus103	Bus104	887.5203	1331.281	1600	0
Line60	Line	Bus99	Bus105	2.651958	0.5205173	2.702558	0.00084171
Line61	Line	Bus105	Bus106	5.837595	0.610248	5.869405	0.00084726
Cable5	Cable	Bus106	Bus107	0.460475	0.2966832	0.547775	0.01523729
BET ENON	2W XFMR	Bus107	Bus108	887.5203	1331.281	1600	0
GARJAES	2W XFMR	Bus102	Bus109	887.5203	1331.281	1600	0
Line6	Line	Bus10	Bus11	2.781774	0.5459973	2.834851	0.00088291
Line62	Line	Bus105	Bus110	23.81199	4.673737	24.26633	0.00755771
RAS ALAROD	2W XFMR	Bus110	Bus111	352.1906	528.2859	634.9207	0
KHALET AL-FOOL	2W XFMR	Bus105	Bus112	887.5203	1331.281	1600	0
Line63	Line	Bus110	Bus113	23.18145	4.549977	23.62376	0.00735758
AL SHAFA	2W XFMR	Bus113	Bus114	554.7002	832.0503	1000	0
Cable6	Cable	Bus113	Bus115	0.293227	0.1889256	0.348819	0.00970299

AL AEN	2W XFMR	Bus115	Bus116	352.1906	528.2859	634.9207	0
Line65	Line	Bus115	Bus117	18.63789	3.658182	18.9935	0.0059155
WAD ALSHARQ	2W XFMR	Bus117	Bus118	554.7002	832.0503	1000	0
Line66	Line	Bus115	Bus119	3.875939	0.7607562	3.949893	0.00123019
T4	2W XFMR	Bus11	Bus12	1386.75	2080.126	2500	0
Line67	Line	Bus119	Bus120	9.402397	1.845471	9.581797	0.00298424
WAD SA'IR	2W XFMR	Bus120	Bus121	1386.75	2080.126	2500	0
Line69	Line	Bus124	Bus122	6.8988	1.354073	7.03043	0.00218962
AHMARON	2W XFMR	Bus122	Bus123	554.7002	832.0503	1000	0
Line68	Line	Bus115	Bus124	13.18561	2.588027	13.43719	0.00418499
Line70	Line	Bus124	Bus125	29.37554	5.765731	29.93603	0.00932353
ABU ZAWEH	2W XFMR	Bus125	Bus126	554.7002	832.0503	1000	0
Line71	Line	Bus125	Bus127	29.84554	5.857983	30.415	0.00947271
RBAEA	2W XFMR	Bus127	Bus128	1386.75	2080.126	2500	0
Line7	Line	Bus10	Bus13	2.077058	0.4076779	2.116689	0.00065924
T34	2W XFMR	Bus86	Bus130	554.7002	832.0503	1000	0
Line8	Line	Bus13	Bus14	9.27258	1.819991	9.449504	0.00294303
T5	2W XFMR	Bus14	Bus15	554.7002	832.0503	1000	0
Line9	Line	Bus13	Bus16	2.355235	0.4622777	2.400174	0.00074753
Line10	Line	Bus16	Bus17	1.891606	0.3712781	1.927699	0.00060038
T6	2W XFMR	Bus17	Bus18	554.7002	832.0503	1000	0
Line11	Line	Bus16	Bus19	1.854516	0.3639982	1.889901	0.00058861
Cable1	Cable	Bus1	Bus2	1.025207	0.66054	1.219575	0.03392453
T7	2W XFMR	Bus19	Bus20	887.5203	1331.281	1600	0
Line12	Line	Bus16	Bus21	1.854516	0.3639982	1.889901	0.00058861
T8	2W XFMR	Bus21	Bus22	1386.75	2080.126	2500	0
Line13	Line	Bus16	Bus23	6.546442	1.284914	6.67135	0.00207778
Line14	Line	Bus23	Bus24	2.781774	0.5459973	2.834851	0.00088291
T9	2W XFMR	Bus24	Bus25	352.1906	528.2859	634.9207	0
Line15	Line	Bus23	Bus26	2.781774	0.5459973	2.834851	0.00088291
T10	2W XFMR	Bus26	Bus27	352.1906	528.2859	634.9207	0
Line16	Line	Bus23	Bus28	2.559232	0.5023175	2.608063	0.00081228
Line17	Line	Bus28	Bus29	0.927258	0.1819991	0.94495	0.0002943
Line1	Line	Bus2	Bus3	2.559232	0.5023175	2.608063	0.00081228
T11	2W XFMR	Bus29	Bus30	887.5203	1331.281	1600	0
Line18	Line	Bus28	Bus31	2.763229	0.5423573	2.815952	0.00087702
Line19	Line	Bus31	Bus32	2.781774	0.5459973	2.834851	0.00088291

T12	2W XFMR	Bus32	Bus33	887.5203	1331.281	1600	0
Line20	Line	Bus31	Bus34	5.563548	1.091995	5.669702	0.00176582
Line21	Line	Bus34	Bus35	2.781774	0.5459973	2.834851	0.00088291
Line22	Line	Bus35	Bus36	5.563548	1.091995	5.669702	0.00176582
T13	2W XFMR	Bus36	Bus37	1386.75	2080.126	2500	0
T14	2W XFMR	Bus35	Bus38	887.5203	1331.281	1600	0
Line23	Line	Bus34	Bus39	1.854516	0.3639982	1.889901	0.00058861
Line2	Line	Bus3	Bus4	1.854516	0.3639982	1.889901	0.00058861
T15	2W XFMR	Bus39	Bus40	1386.75	2080.126	2500	0
Line24	Line	Bus34	Bus41	4.617745	0.9063554	4.705853	0.00146563
Line25	Line	Bus41	Bus42	2.781774	0.5459973	2.834851	0.00088291
T16	2W XFMR	Bus42	Bus43	554.7002	832.0503	1000	0
Line26	Line	Bus31	Bus44	3.282494	0.6442768	3.345124	0.00104183
Line27	Line	Bus44	Bus45	0.927258	0.1819991	0.94495	0.0002943
T17	2W XFMR	Bus45	Bus46	554.7002	832.0503	1000	0
Line28	Line	Bus44	Bus47	0.927258	0.1819991	0.94495	0.0002943
T18	2W XFMR	Bus47	Bus48	554.7002	832.0503	1000	0
Line29	Line	Bus44	Bus49	1.298161	0.2547987	1.322931	0.00041202
T1	2W XFMR	Bus4	Bus5	554.7002	832.0503	1000	0
T19	2W XFMR	Bus49	Bus50	887.5203	1331.281	1600	0
Line30	Line	Bus13	Bus51	4.562109	0.8954355	4.649156	0.00144797
Line31	Line	Bus51	Bus52	4.63629	0.9099954	4.724752	0.00147152
T20	2W XFMR	Bus52	Bus53	1386.75	2080.126	2500	0
Line32	Line	Bus51	Bus54	2.077058	0.4076779	2.116689	0.00065924
T21	2W XFMR	Bus54	Bus55	1386.75	2080.126	2500	0
Line33	Line	Bus51	Bus56	5.656274	1.110194	5.764197	0.00179525
Line34	Line	Bus56	Bus57	2.781774	0.5459973	2.834851	0.00088291
T22	2W XFMR	Bus57	Bus58	887.5203	1331.281	1600	0
Line35	Line	Bus56	Bus59	2.039968	0.400398	2.078891	0.00064747
Line3	Line	Bus3	Bus6	1.854516	0.3639982	1.889901	0.00058861
Line36	Line	Bus59	Bus60	1.854516	0.3639982	1.889901	0.00058861
T23	2W XFMR	Bus60	Bus61	887.5203	1331.281	1600	0
Line37	Line	Bus60	Bus62	1.854516	0.3639982	1.889901	0.00058861
T24	2W XFMR	Bus62	Bus63	1386.75	2080.126	2500	0
Line38	Line	Bus62	Bus64	1.854516	0.3639982	1.889901	0.00058861
T25	2W XFMR	Bus64	Bus65	554.7002	832.0503	1000	0
Line39	Line	Bus59	Bus66	2.22542	0.4367978	2.267881	0.00070633
T26	2W XFMR	Bus66	Bus67	1386.75	2080.126	2500	0

Line40	Line	Bus59	Bus68	2.22542	0.4367978	2.267881	0.00070633
T27	2W XFMR	Bus68	Bus69	1386.75	2080.126	2500	0
T2	2W XFMR	Bus6	Bus7	1386.75	2080.126	2500	0
Line41	Line	Bus59	Bus70	2.447961	0.4804776	2.494669	0.00077696
T28	2W XFMR	Bus70	Bus71	554.7002	832.0503	1000	0
Line42	Line	Bus3	Bus72	2.818865	0.5532773	2.872649	0.00089468
Line43	Line	Bus72	Bus73	4.461856	0.4664316	4.48617	0.00064759
T29	2W XFMR	Bus73	Bus74	1386.75	2080.126	2500	0
Line44	Line	Bus31	Bus75	4.395204	0.8626757	4.479065	0.001395
Line45	Line	Bus75	Bus76	1.001439	0.196559	1.020546	0.00031785
T30	2W XFMR	Bus76	Bus77	1386.75	2080.126	2500	0
Line46	Line	Bus75	Bus78	2.26251	0.4440778	2.305679	0.0007181
Line47	Line	Bus78	Bus79	1.11271	0.2183989	1.13394	0.00035316
Line4	Line	Bus72	Bus8	10.01439	1.96559	10.20546	0.00317848
T31	2W XFMR	Bus79	Bus80	352.1906	528.2859	634.9207	0
Line48	Line	Bus78	Bus81	1.11271	0.2183989	1.13394	0.00035316
T32	2W XFMR	Bus81	Bus82	352.1906	528.2859	634.9207	0
Line49	Line	Bus78	Bus83	1.11271	0.2183989	1.13394	0.00035316
Line50	Line	Bus83	Bus84	1.520703	0.2984785	1.549719	0.00048266
T33	2W XFMR	Bus84	Bus85	887.5203	1331.281	1600	0
Line51	Line	Bus83	Bus86	0.982894	0.192919	1.001647	0.00031196
Line52	Line	Bus83	Bus88	1.76179	0.3457983	1.795406	0.00055918
T35	2W XFMR	Bus88	Bus89	887.5203	1331.281	1600	0
T3	2W XFMR	Bus8	Bus9	1386.75	2080.126	2500	0
Line53	Line	Bus88	Bus90	1.835971	0.3603582	1.871002	0.00058272
T36	2W XFMR	Bus90	Bus91	887.5203	1331.281	1600	0
Line54	Line	Bus90	Bus92	5.062829	0.993715	5.159429	0.0016069
T37	2W XFMR	Bus92	Bus93	887.5203	1331.281	1600	0
Line55	Line	Bus2	Bus94	22.19773	2.320497	22.31869	0.00322175
AL-DOARA	2W XFMR	Bus94	Bus95	887.5203	1331.281	1600	0
Line56	Line	Bus2	Bus97	10.08857	1.98015	10.28106	0.00320202
Cable2	Cable	Bus97	Bus98	0.453958	0.2924849	0.540024	0.01502167
Line57	Line	Bus98	Bus99	3.004316	0.5896771	3.061639	0.00095354

Table 3.5: Transformers data

ID	FromBus	ToBus	PrimkV	SeckV	Sec%Tap	Conn	SecGrdType	MVA	MaxMVA	PosZ	PosX/R	ZeroZ	ZeroX/R
RAS ALTAWEL	Bus103	Bus104	33	0.4	0	D/Y	Solid	0.3	0.25	4	1.5	4	1.5
BET ENON	Bus107	Bus108	33	0.4	0	D/Y	Solid	0.3	0.25	4	1.5	4	1.5
GARJAES	Bus102	Bus109	33	0.4	0	D/Y	Solid	0.3	0.25	4	1.5	4	1.5
RAS ALAROD	Bus110	Bus111	33	0.4	0	D/Y	Solid	0.6	0.63	4	1.5	4	1.5
KHALET AL-FOOL	Bus105	Bus112	33	0.4	0	D/Y	Solid	0.3	0.25	4	1.5	4	1.5
AL SHAFA	Bus113	Bus114	33	0.4	0	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
AL AEN	Bus115	Bus116	33	0.4	0	D/Y	Solid	0.6	0.63	4	1.5	4	1.5
WAD ALSHARQ	Bus117	Bus118	33	0.4	0	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T4	Bus11	Bus12	33	0.4	0	D/Y	Solid	0.2	0.16	4	1.5	4	1.5
WAD SA'IR	Bus120	Bus121	33	0.4	0	D/Y	Solid	0.2	0.16	4	1.5	4	1.5
AHMARON	Bus122	Bus123	33	0.4	0	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
ABU ZAWEH	Bus125	Bus126	33	0.4	0	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
RBAEA	Bus127	Bus128	33	0.4	0	D/Y	Solid	0.2	0.16	4	1.5	4	1.5
T34	Bus86	Bus130	33	0.4	0	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T5	Bus14	Bus15	33	0.4	0	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T6	Bus17	Bus18	33	0.4	0	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T7	Bus19	Bus20	33	0.4	0	D/Y	Solid	0.3	0.25	4	1.5	4	1.5
T8	Bus21	Bus22	33	0.4	0	D/Y	Solid	0.2	0.16	4	1.5	4	1.5
T9	Bus24	Bus25	33	0.4	0	D/Y	Solid	0.6	0.63	4	1.5	4	1.5
T10	Bus26	Bus27	33	0.4	0	D/Y	Solid	0.6	0.63	4	1.5	4	1.5
T11	Bus29	Bus30	33	0.4	0	D/Y	Solid	0.3	0.25	4	1.5	4	1.5
T12	Bus32	Bus33	33	0.4	0	D/Y	Solid	0.3	0.25	4	1.5	4	1.5
T13	Bus36	Bus37	33	0.4	0	D/Y	Solid	0.2	0.16	4	1.5	4	1.5
T14	Bus35	Bus38	33	0.4	0	D/Y	Solid	0.3	0.25	4	1.5	4	1.5
T15	Bus39	Bus40	33	0.4	0	D/Y	Solid	0.2	0.16	4	1.5	4	1.5
T16	Bus42	Bus43	33	0.4	0	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T17	Bus45	Bus46	33	0.4	0	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T18	Bus47	Bus48	33	0.4	0	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T1	Bus4	Bus5	33	0.4	0	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T19	Bus49	Bus50	33	0.4	0	D/Y	Solid	0.3	0.25	4	1.5	4	1.5
T20	Bus52	Bus53	33	0.4	0	D/Y	Solid	0.2	0.16	4	1.5	4	1.5
T21	Bus54	Bus55	33	0.4	0	D/Y	Solid	0.2	0.16	4	1.5	4	1.5
T22	Bus57	Bus58	33	0.4	0	D/Y	Solid	0.3	0.25	4	1.5	4	1.5
T23	Bus60	Bus61	33	0.4	0	D/Y	Solid	0.3	0.25	4	1.5	4	1.5
T24	Bus62	Bus63	33	0.4	0	D/Y	Solid	0.2	0.16	4	1.5	4	1.5
T25	Bus64	Bus65	33	0.4	0	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T26	Bus66	Bus67	33	0.4	0	D/Y	Solid	0.2	0.16	4	1.5	4	1.5
T27	Bus68	Bus69	33	0.4	0	D/Y	Solid	0.2	0.16	4	1.5	4	1.5
T2	Bus6	Bus7	33	0.4	0	D/Y	Solid	0.2	0.16	4	1.5	4	1.5
T28	Bus70	Bus71	33	0.4	0	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T29	Bus73	Bus74	33	0.4	0	D/Y	Solid	0.2	0.16	4	1.5	4	1.5
T30	Bus76	Bus77	33	0.4	0	D/Y	Solid	0.2	0.16	4	1.5	4	1.5

T31	Bus79	Bus80	33	0.4	0	D/Y	Solid	0.6	0.63	4	1.5	4	1.5
T32	Bus81	Bus82	33	0.4	0	D/Y	Solid	0.6	0.63	4	1.5	4	1.5
T33	Bus84	Bus85	33	0.4	0	D/Y	Solid	0.3	0.25	4	1.5	4	1.5
T35	Bus88	Bus89	33	0.4	0	D/Y	Solid	0.3	0.25	4	1.5	4	1.5
T3	Bus8	Bus9	33	0.4	0	D/Y	Solid	0.2	0.16	4	1.5	4	1.5
T36	Bus90	Bus91	33	0.4	0	D/Y	Solid	0.3	0.25	4	1.5	4	1.5
T37	Bus92	Bus93	33	0.4	0	D/Y	Solid	0.3	0.25	4	1.5	4	1.5
AL-DOARA	Bus94	Bus95	33	0.4	0	D/Y	Solid	0.3	0.25	4	1.5	4	1.5

3.4.3.2 Summary

1. **Load flow result**

Introduction

The load flow study is very important in evaluating the operation of power systems. Controlling them and planning for the future expansion, the relating to a real power system can be carried out only with a digital computer.

Because of the complexity of the calculation we use a computer program in our case we use the ETAP, this program uses a number of methods of calculation such as Newton-Raphson and Gauss-Seidal methods and others in or case we are going to use Newton-Raphson method.

Data for load flow

We apply load flow test on the grid with balance load then record the result of our simulation for the existing 50 transformers. Tables 3.6, 3.7 and 3.8 shows the load flow result.

Table 3.6 : bus loading summary

ID	Type	kV	MW	Mvar	MVA	PF	LoadAmp
Bus1	SWNG	33	5.572409	4.187085	6.970181	0.799464	121.9465
Bus2	Load	33	5.567414	4.217762	6.98467	0.79709	122.3039
Bus3	Load	33	4.020119	3.611322	5.40398	0.743918	94.74049
Bus4	Load	33	0.1474355	0.108187	0.1828706	0.806229	3.206117
Bus5	Load	0	0.1455727	0.1053928	0.1797194	0.81	264.5047
Bus6	Load	33	0.0636359	0.03676608	0.0734934	0.865873	1.288474
Bus7	Load	0	0.0628838	0.03563787	0.0722802	0.87	106.2991
Bus8	Load	33	3.711959	3.428896	5.053312	0.73456	89.10137
Bus9	Load	0	0.0636384	0.07440156	0.0979053	0.65	146.1202
Bus10	Load	33	3.632197	3.351315	4.942081	0.734953	87.3653
Bus11	Load	33	0.0649991	0.07646423	0.1003577	0.647675	1.774147

Bus12	Load	0	0.0635731	0.07432519	0.0978048	0.65	146.3671
Bus13	Load	33	3.562221	3.275384	4.839169	0.736122	85.62246
Bus14	Load	33	0.1469212	0.1078319	0.1822459	0.80617	3.225104
Bus15	Load	0	0.1450363	0.1050045	0.1790572	0.81	266.0711
Bus16	Load	33	2.703556	2.589058	3.743319	0.722235	66.28423
Bus17	Load	33	0.1468859	0.1078075	0.182203	0.806166	3.226435
Bus18	Load	0	0.1449994	0.1049778	0.1790116	0.81	266.1809
Bus19	Load	33	0.0718227	0.06971485	0.1000933	0.717558	1.772414
Bus20	Load	0	0.0709118	0.06834854	0.0984886	0.72	146.2242
Bus21	Load	33	0.0633978	0.03664006	0.0732242	0.865805	1.296622
Bus22	Load	0	0.0626361	0.03549753	0.0719956	0.87	106.9713
Bus23	Load	33	2.413718	2.377138	3.387745	0.712485	60.10432
Bus24	Load	33	0.2492696	0.3009256	0.3907577	0.637914	6.933312
Bus25	Load	0	0.2437386	0.292629	0.3808415	0.64	571.9982
Bus26	Load	33	0.2492696	0.3009256	0.3907577	0.637914	6.933312
Bus27	Load	0	0.2437386	0.292629	0.3808415	0.64	571.9982
Bus28	Load	33	1.913294	1.777423	2.611499	0.732642	46.36002
Bus29	Load	33	0.0717555	0.06965167	0.100001	0.717548	1.775259
Bus30	Load	0	0.0708417	0.06828097	0.0983913	0.72	146.4589
Bus31	Load	33	1.839743	1.708556	2.510741	0.732749	44.59894
Bus32	Load	33	0.0717387	0.06963582	0.0999779	0.717545	1.775977
Bus33	Load	0	0.0708241	0.06826402	0.0983668	0.72	146.5181
Bus34	Load	33	0.3411623	0.3337666	0.4772755	0.714812	8.479948
Bus35	Load	33	0.1295441	0.1534542	0.2008229	0.645066	3.568266
Bus36	Load	33	0.0648719	0.0375143	0.0749379	0.865676	1.331568
Bus37	Load	0	0.0640686	0.03630936	0.0736421	0.87	109.8544
Bus38	Load	0	0.063019	0.1151763	0.1312897	0.48	196.7986
Bus39	Load	33	0.0648829	0.07633144	0.1001812	0.647655	1.779988
Bus40	Load	0	0.0634475	0.07417829	0.0976115	0.65	146.849
Bus41	Load	33	0.1467063	0.1068231	0.181477	0.808402	3.224633
Bus42	Load	33	0.1466968	0.1076771	0.1819734	0.806144	3.233609
Bus43	Load	0	0.144802	0.1048348	0.1787678	0.81	266.7728
Bus44	Load	33	0.3651585	0.2840331	0.4626181	0.78933	8.218778
Bus45	Load	33	0.1467078	0.1076847	0.1819867	0.806146	3.233191
Bus46	Load	0	0.1448134	0.1048431	0.178782	0.81	266.7383
Bus47	Load	33	0.1467078	0.1076847	0.1819867	0.806146	3.233191
Bus48	Load	0	0.1448134	0.1048431	0.178782	0.81	266.7383
Bus49	Load	33	0.0717352	0.0696326	0.0999732	0.717545	1.776124
Bus50	Load	0	0.0708205	0.06826057	0.0983619	0.72	146.5302
Bus51	Load	33	0.7079398	0.5827697	0.9169511	0.772058	16.23042
Bus52	Load	33	0.0634066	0.03664469	0.0732341	0.865807	1.296317
Bus53	Load	0	0.0626453	0.0355027	0.072006	0.87	106.9462
Bus54	Load	33	0.0649646	0.03756316	0.0750426	0.865703	1.328306
Bus55	Load	0	0.0641652	0.03636412	0.0737532	0.87	109.5852
Bus56	Load	33	0.5792189	0.5123281	0.7732882	0.749034	13.69292
Bus57	Load	33	0.0880697	0.0714728	0.1134224	0.776476	2.008473
Bus58	Load	0	0.0869001	0.06971832	0.1114103	0.78	165.699

Bus59	Load	33	0.4910543	0.4423305	0.6609014	0.743007	11.70425
Bus60	Load	33	0.2173531	0.263956	0.3419286	0.635668	6.055704
Bus61	Load	0	0.0868952	0.0697144	0.1114041	0.78	165.7141
Bus62	Load	33	0.1292778	0.1930592	0.2323458	0.556402	4.115077
Bus63	Load	0	0.0635269	0.07427112	0.0977336	0.65	146.5434
Bus64	Load	33	0.0643181	0.1172176	0.1337041	0.481048	2.368072
Bus65	Load	0	0.0633019	0.1156932	0.1318789	0.48	195.3659
Bus66	Load	33	0.0633948	0.03663848	0.0732208	0.865804	1.296727
Bus67	Load	0	0.062633	0.03549577	0.071992	0.87	106.9799
Bus68	Load	33	0.0633948	0.03663848	0.0732208	0.865804	1.296727
Bus69	Load	0	0.062633	0.03549577	0.071992	0.87	106.9799
Bus70	Load	33	0.1468786	0.1078025	0.1821941	0.806166	3.226708
Bus71	Load	0	0.1449918	0.1049723	0.1790022	0.81	266.2035
Bus72	Load	33	3.801529	3.466955	5.145037	0.738873	90.31554
Bus73	Load	33	0.0636049	0.03674963	0.0734583	0.865864	1.289519
Bus74	Load	0	0.0628515	0.03561959	0.0722431	0.87	106.3853
Bus75	Load	33	1.060491	1.025819	1.475447	0.718759	26.22376
Bus76	Load	33	0.0633104	0.03659386	0.0731253	0.865779	1.299697
Bus77	Load	0	0.0625451	0.03544591	0.0718909	0.87	107.225
Bus78	Load	33	0.9967189	0.9901379	1.404928	0.709445	24.97733
Bus79	Load	33	0.2490926	0.3007174	0.3904845	0.637907	6.942426
Bus80	Load	0	0.243547	0.292399	0.3805421	0.64	572.7501
Bus81	Load	33	0.2490926	0.3007174	0.3904845	0.637907	6.942426
Bus82	Load	0	0.243547	0.292399	0.3805421	0.64	572.7501
Bus83	Load	33	0.4984528	0.3897132	0.6327175	0.787797	11.24943
Bus84	Load	33	0.0879381	0.07137144	0.1132563	0.776452	2.013679
Bus85	Load	0	0.0867624	0.06960785	0.1112338	0.78	166.1285
Bus86	Load	33	0.1466659	0.1076558	0.1819359	0.806141	3.234793
Bus88	Load	33	0.2638226	0.2119916	0.3384417	0.779521	6.017676
Bus89	Load	0	0.086761	0.06960678	0.1112321	0.78	166.1327
Bus90	Load	33	0.1758761	0.1411834	0.225533	0.779824	4.010253
Bus91	Load	0	0.0867597	0.06960573	0.1112304	0.78	166.1368
Bus92	Load	33	0.0879339	0.07136818	0.113251	0.776451	2.013848
Bus93	Load	0	0.0867579	0.06960429	0.1112281	0.78	166.1425
Bus94	Load	33	0.0124765	0.00742012	0.0145163	0.859486	0.2541921
Bus95	Load	0	0.0124578	0.00739202	0.0144858	0.86	20.97085
Bus96	Load	0	0.0124578	0.00739202	0.0144858	0.86	20.97085
Bus97	Load	33	1.524589	0.60423	1.639959	0.929651	28.76406
Bus98	Load	33	1.524466	0.6190957	1.64538	0.926513	28.86167
Bus99	Load	33	1.523648	0.6198834	1.644919	0.926275	28.86794
Bus100	Load	33	0.1261595	0.04030793	0.1324422	0.952562	2.324334
Bus101	Load	33	0.1261427	0.04167362	0.1328483	0.949524	2.33175
Bus102	Load	33	0.1261421	0.052742	0.1367243	0.922602	2.399795
Bus103	Load	33	0.0575628	0.02127511	0.0613687	0.937985	1.077235
Bus104	Load	0	0.0572264	0.0207704	0.0608791	0.94	88.87193
Bus105	Load	33	1.396876	0.585077	1.514457	0.922361	26.58907
Bus106	Load	33	0.0685248	0.02050336	0.0715265	0.958034	1.255832

Bus107	Load	33	0.0685246	0.03563282	0.0772355	0.887217	1.356072
Bus108	Load	0	0.0679914	0.03483301	0.0763948	0.89	111.876
Bus109	Load	0	0.0680407	0.03485826	0.0764502	0.89	111.9217
Bus110	Load	33	1.255375	0.5364025	1.365172	0.919573	24.04679
Bus111	Load	0	0.2346609	0.1202203	0.2636639	0.89	389.0203
Bus112	Load	0	0.0679519	0.03481279	0.0763504	0.89	111.8051
Bus113	Load	33	1.015313	0.4190264	1.098383	0.924371	19.39756
Bus114	Load	0	0.125806	0.04972173	0.1352753	0.93	199.3813
Bus115	Load	33	0.8884212	0.3772217	0.9651883	0.920464	17.04591
Bus116	Load	0	0.2536558	0.1080569	0.2757128	0.92	407.916
Bus117	Load	33	0.2156374	0.1196932	0.2466292	0.874339	4.357621
Bus118	Load	0	0.2121962	0.1145314	0.2411321	0.88	359.5037
Bus119	Load	33	0.0351215	0.01117582	0.0368568	0.95292	0.6509261
Bus120	Load	33	0.0351202	0.01410402	0.0378464	0.927966	0.6684284
Bus121	Load	0	0.0349178	0.01380039	0.037546	0.93	55.14534
Bus122	Load	33	0.1728059	0.07577933	0.1886912	0.915813	3.334694
Bus123	Load	0	0.1707907	0.07275652	0.1856421	0.92	275.1123
Bus124	Load	33	0.380856	0.1451249	0.4075691	0.934458	7.201918
Bus125	Load	33	0.2078782	0.08059177	0.2229538	0.932383	3.942321
Bus126	Load	0	0.1707547	0.07274117	0.1856029	0.92	275.2058
Bus127	Load	33	0.0351029	0.01409755	0.037828	0.927962	0.6689587
Bus128	Load	0	0.0349002	0.01379343	0.0375271	0.93	55.18909
Bus129	Load	0	0.0626453	0.0355027	0.072006	0.87	106.9462
Bus130	Load	0	0.1447696	0.1048114	0.1787279	0.81	266.8704

Table 3.7: Load flow source result from ETAP

ID	IDTermBus	RatedkV	KVAHP	AmpRating	PF	OperatingKW	OperatingKvar	OperatingAmp
al-doara	Bus1	33	600000	0	0	5572.409	4187.085	121.9465
Lump2	Bus104	0.4	61.1529	88.26925	94	57.22637	20.7704	88.87193
Lump3	Bus108	0.4	76.8338	110.9033	89	67.99136	34.83301	111.876
Lump4	Bus109	0.4	76.88	110.9699	89	68.04065	34.85826	111.9217
Lump5	Bus111	0.4	265.951	383.878	89	234.6609	120.2204	389.0202
Lump6	Bus112	0.4	76.7876	110.8366	89	67.9519	34.81279	111.8051
Lump7	Bus114	0.4	136.393	196.8725	93	125.806	49.72173	199.3813
Lump8	Bus116	0.4	278.398	401.8452	92	253.6558	108.0569	407.916
Lump9	Bus118	0.4	244.196	352.477	88	212.1962	114.5314	359.5037
Lump20	Bus12	0.4	99.1888	143.1709	65	63.5731	74.32519	146.3671
Lump10	Bus121	0.4	37.8049	54.56826	93	34.91777	13.80039	55.14534
Lump11	Bus123	0.4	187.57	270.7413	92	170.7907	72.75652	275.1123
Lump12	Bus126	0.4	187.57	270.7413	92	170.7546	72.74117	275.2057
Lump13	Bus128	0.4	37.8049	54.56826	93	34.90018	13.79343	55.18909
Lump36	Bus129	0.4	72.8154	105.1031	87	62.64525	35.5027	106.9462
Lump49	Bus130	0.4	181.103	261.4077	81	144.7696	104.8114	266.8704
Lump21	Bus15	0.4	181.103	261.4077	81	145.0363	105.0045	266.0711

Lump35	Bus18	0.4	181.103	261.4077	81	144.9994	104.9778	266.1808
Lump34	Bus20	0.4	99.5814	143.7376	72	70.91181	68.34854	146.2242
Lump33	Bus22	0.4	72.8154	105.1031	87	62.63614	35.49753	106.9714
Lump22	Bus25	0.4	386.755	558.2497	64	243.7386	292.6291	571.9983
Lump23	Bus27	0.4	386.755	558.2497	64	243.7386	292.6291	571.9983
Lump24	Bus30	0.4	99.5814	143.7376	72	70.84171	68.28097	146.4589
Lump25	Bus33	0.4	99.5814	143.7376	72	70.82411	68.26402	146.5181
Lump26	Bus37	0.4	74.5937	107.6698	87	64.06862	36.30936	109.8544
Lump27	Bus38	0.4	133.229	192.3056	48	63.01905	115.1763	196.7986
Lump28	Bus40	0.4	99.1888	143.1709	65	63.44744	74.17829	146.849
Lump29	Bus43	0.4	181.103	261.4077	81	144.802	104.8348	266.7728
Lump30	Bus46	0.4	181.103	261.4077	81	144.8134	104.8431	266.7383
Lump31	Bus48	0.4	181.103	261.4077	81	144.8134	104.8431	266.7383
Lump16	Bus5	0.4	181.103	261.4077	81	145.5727	105.3928	264.5047
Lump32	Bus50	0.4	99.5814	143.7376	72	70.82053	68.26057	146.5302
Lump37	Bus55	0.4	74.5937	107.6698	87	64.16524	36.36411	109.5852
Lump38	Bus58	0.4	112.722	162.7048	78	86.90006	69.71832	165.699
Lump39	Bus61	0.4	112.722	162.7048	78	86.89519	69.7144	165.7141
Lump40	Bus63	0.4	99.1888	143.1709	65	63.52685	74.27112	146.5434
Lump41	Bus65	0.4	133.229	192.3056	48	63.30187	115.6932	195.3659
Lump42	Bus67	0.4	72.8154	105.1031	87	62.63303	35.49577	106.9799
Lump43	Bus69	0.4	72.8154	105.1031	87	62.63303	35.49577	106.9799
Lump17	Bus7	0.4	72.8154	105.1031	87	62.88377	35.63787	106.2991
Lump44	Bus71	0.4	181.103	261.4077	81	144.9918	104.9723	266.2035
Lump18	Bus74	0.4	72.8154	105.1031	87	62.8515	35.61959	106.3853
Lump45	Bus77	0.4	72.8154	105.1031	87	62.54504	35.44591	107.225
Lump46	Bus80	0.4	386.755	558.2497	64	243.547	292.399	572.7501
Lump47	Bus82	0.4	386.755	558.2497	64	243.547	292.399	572.7501
Lump48	Bus85	0.4	112.722	162.7048	78	86.76237	69.60785	166.1285
Lump50	Bus89	0.4	112.722	162.7048	78	86.76103	69.60677	166.1327
Lump19	Bus9	0.4	99.1888	143.1709	65	63.63841	74.40155	146.1202
Lump51	Bus91	0.4	112.722	162.7048	78	86.75974	69.60573	166.1368
Lump52	Bus93	0.4	112.722	162.7048	78	86.75793	69.60429	166.1425
Lump1	Bus96	0.4	14.503	20.93395	86	12.4578	7.392022	20.97085

Table 3.8 : Transformer percentage loading

ID	Type	From	To	CapMVA	LDGIMVA	LDGI%	LDGOMVA	LDGO%
ABU ZAWEH	Transformer	Bus125	Bus126	0.4	0.1886542	47.1635	0.1856029	46.4007
AHMARON	Transformer	Bus122	Bus123	0.4	0.1886912	47.1728	0.1856421	46.4105
AL AEN	Transformer	Bus115	Bus116	0.63	0.2799682	44.4394	0.2757128	43.7639
AL SHAFA	Transformer	Bus113	Bus114	0.4	0.1368476	34.2119	0.1352753	33.8188
AL-DOARA	Transformer	Bus94	Bus95	0.25	0.01451627	5.80651	0.01448581	5.79432
BET ENON	Transformer	Bus107	Bus108	0.25	0.07723545	30.8942	0.07639479	30.5579
GARJAES	Transformer	Bus102	Bus109	0.25	0.0772915	30.9166	0.07645016	30.5801
KHALET AL-FOOL	Transformer	Bus105	Bus112	0.25	0.07719003	30.876	0.07635045	30.5402
RAS ALAROD	Transformer	Bus110	Bus111	0.63	0.2677001	42.4921	0.2636639	41.8514
RAS ALTAWEL	Transformer	Bus103	Bus104	0.25	0.06136865	24.5475	0.06087912	24.3517
RBAEA	Transformer	Bus127	Bus128	0.16	0.03782798	23.6425	0.03752708	23.4544
T1	Transformer	Bus4	Bus5	0.4	0.1828706	45.7177	0.1797194	44.9299
T2	Transformer	Bus6	Bus7	0.16	0.07349336	45.9334	0.0722802	45.1751
T3	Transformer	Bus8	Bus9	0.16	0.1004496	62.781	0.09790526	61.1908
T4	Transformer	Bus11	Bus12	0.16	0.1003577	62.7236	0.09780477	61.128
T5	Transformer	Bus14	Bus15	0.4	0.1822459	45.5615	0.1790572	44.7643
T6	Transformer	Bus17	Bus18	0.4	0.182203	45.5507	0.1790116	44.7529
T7	Transformer	Bus19	Bus20	0.25	0.1000932	40.0373	0.09848862	39.3955
T8	Transformer	Bus21	Bus22	0.16	0.07322416	45.7651	0.07199556	44.9972
T9	Transformer	Bus24	Bus25	0.63	0.3907577	62.025	0.3808415	60.451
T10	Transformer	Bus26	Bus27	0.63	0.3907577	62.025	0.3808415	60.451
T11	Transformer	Bus29	Bus30	0.25	0.100001	40.0004	0.09839125	39.3565
T12	Transformer	Bus32	Bus33	0.25	0.09997791	39.9912	0.09836682	39.3467
T13	Transformer	Bus36	Bus37	0.16	0.07493789	46.8362	0.0736421	46.0263
T14	Transformer	Bus35	Bus38	0.25	0.134253	53.7012	0.1312897	52.5159
T15	Transformer	Bus39	Bus40	0.16	0.1001812	62.6133	0.09761146	61.0072
T16	Transformer	Bus42	Bus43	0.4	0.1819734	45.4934	0.1787678	44.692
T17	Transformer	Bus45	Bus46	0.4	0.1819867	45.4967	0.178782	44.6955
T18	Transformer	Bus47	Bus48	0.4	0.1819867	45.4967	0.178782	44.6955
T19	Transformer	Bus49	Bus50	0.25	0.0999732	39.9893	0.09836185	39.3447
T20	Transformer	Bus52	Bus53	0.16	0.07323405	45.7713	0.07200603	45.0038
T21	Transformer	Bus54	Bus55	0.16	0.07504259	46.9016	0.07375315	46.0957
T22	Transformer	Bus57	Bus58	0.25	0.1134224	45.369	0.1114103	44.5641
T23	Transformer	Bus60	Bus61	0.25	0.1134165	45.3666	0.1114041	44.5616
T24	Transformer	Bus62	Bus63	0.16	0.1002927	62.6829	0.09773362	61.0835
T25	Transformer	Bus64	Bus65	0.4	0.1337041	33.426	0.1318789	32.9697
T26	Transformer	Bus66	Bus67	0.16	0.07322078	45.763	0.07199199	44.995
T27	Transformer	Bus68	Bus69	0.16	0.07322078	45.763	0.07199199	44.995
T28	Transformer	Bus70	Bus71	0.4	0.1821941	45.5485	0.1790022	44.7506
T29	Transformer	Bus73	Bus74	0.16	0.07345825	45.9114	0.0722431	45.1519
T30	Transformer	Bus76	Bus77	0.16	0.0731253	45.7033	0.07189085	44.9318
T31	Transformer	Bus79	Bus80	0.63	0.3904844	61.9817	0.3805421	60.4035

T32	Transformer	Bus81	Bus82	0.63	0.3904844	61.9817	0.3805421	60.4035
T33	Transformer	Bus84	Bus85	0.25	0.1132563	45.3025	0.1112338	44.4935
T34	Transformer	Bus86	Bus130	0.4	0.1819359	45.484	0.1787279	44.682
T35	Transformer	Bus88	Bus89	0.25	0.1132547	45.3019	0.1112321	44.4928
T36	Transformer	Bus90	Bus91	0.25	0.1132531	45.3013	0.1112304	44.4922
T37	Transformer	Bus92	Bus93	0.25	0.113251	45.3004	0.1112281	44.4913
WAD ALSHARQ	Transformer	Bus117	Bus118	0.4	0.2466292	61.6573	0.2411321	60.283
WAD SA'IR	Transformer	Bus120	Bus121	0.16	0.03784642	23.654	0.03754599	23.4662

Total demand

Table 3.9 show the total demand for Sa'ir medium voltage network.

Table 3.9: Total demand

TotalD MW	TotalD Mvar	TotalD MVA	Total PF	Total PFLag	MTR Load MW	MTR Load Mvar	MTR Load MVA	MTR Load PF	MTR Load PFLag	Stat Load MW
5.572409	4.187085	6.970181	79.946	Lagging	4.369691	3.442235	5.562659	78.55399	Lagging	1.027832

2. Alert Summary

The table 3.10 and 3.11 describe the alert summary reports.

Table 3.10: alert summary loading

	% Alert Settings	
Loading	**Critical**	**Marginal**
Bus	100	95
Cable	100	95
Reactor	100	95
Line	100	95
Transformer	100	95
Panel	100	95
Protective Device	100	95
Generator	100	95
Inverter/Charger	100	95

Table 3.11 :alert summary of bus voltage

	% Alert Settings	
Bus Voltage	**Critical**	**Marginal**
OverVoltage	105	102
UnderVoltage	95	98

The table 3.12 indicate voltage drop in the network with the specific location of all buses.

Table 12: Alert result from ETAP

DeviceID	DeviceType	Unit	Rated	Calculated	Deviation	Condition	AlertType	Remarks
Bus9	Bus	kV	0.4	0.3868434	96.71085	Under Voltage	Marginal	3-Phase
Bus12	Bus	kV	0.4	0.3857944	96.44861	Under Voltage	Marginal	3-Phase
Bus15	Bus	kV	0.4	0.3885379	97.13448	Under Voltage	Marginal	3-Phase
Bus18	Bus	kV	0.4	0.3882788	97.06971	Under Voltage	Marginal	3-Phase
Bus20	Bus	kV	0.4	0.3888717	97.21792	Under Voltage	Marginal	3-Phase
Bus22	Bus	kV	0.4	0.3885775	97.14436	Under Voltage	Marginal	3-Phase
Bus25	Bus	kV	0.4	0.3844049	96.10123	Under Voltage	Marginal	3-Phase
Bus27	Bus	kV	0.4	0.3844049	96.10123	Under Voltage	Marginal	3-Phase
Bus30	Bus	kV	0.4	0.3878646	96.96615	Under Voltage	Marginal	3-Phase
Bus33	Bus	kV	0.4	0.3876115	96.90287	Under Voltage	Marginal	3-Phase
Bus37	Bus	kV	0.4	0.3870332	96.75829	Under Voltage	Marginal	3-Phase
Bus38	Bus	kV	0.4	0.385166	96.29151	Under Voltage	Marginal	3-Phase
Bus40	Bus	kV	0.4	0.3837685	95.94212	Under Voltage	Marginal	3-Phase
Bus43	Bus	kV	0.4	0.3868898	96.72245	Under Voltage	Marginal	3-Phase
Bus46	Bus	kV	0.4	0.3869705	96.74263	Under Voltage	Marginal	3-Phase
Bus48	Bus	kV	0.4	0.3869705	96.74263	Under Voltage	Marginal	3-Phase
Bus50	Bus	kV	0.4	0.38756	96.89	Under Voltage	Marginal	3-Phase

Bus53	Bus	kV	0.4	0.3887255	97.18139	Under Voltage	Marginal	3-Phase
Bus55	Bus	kV	0.4	0.3885688	97.14219	Under Voltage	Marginal	3-Phase
Bus58	Bus	kV	0.4	0.3881905	97.04763	Under Voltage	Marginal	3-Phase
Bus61	Bus	kV	0.4	0.3881334	97.03336	Under Voltage	Marginal	3-Phase
Bus63	Bus	kV	0.4	0.38505	96.2625	Under Voltage	Marginal	3-Phase
Bus65	Bus	kV	0.4	0.3897318	97.43295	Under Voltage	Marginal	3-Phase
Bus67	Bus	kV	0.4	0.388527	97.13174	Under Voltage	Marginal	3-Phase
Bus69	Bus	kV	0.4	0.388527	97.13174	Under Voltage	Marginal	3-Phase
Bus71	Bus	kV	0.4	0.3882256	97.0564	Under Voltage	Marginal	3-Phase
Bus77	Bus	kV	0.4	0.3870945	96.77362	Under Voltage	Marginal	3-Phase
Bus80	Bus	kV	0.4	0.3835986	95.89964	Under Voltage	Marginal	3-Phase
Bus82	Bus	kV	0.4	0.3835986	95.89964	Under Voltage	Marginal	3-Phase
Bus85	Bus	kV	0.4	0.3865735	96.64338	Under Voltage	Marginal	3-Phase
Bus89	Bus	kV	0.4	0.3865578	96.63944	Under Voltage	Marginal	3-Phase
Bus91	Bus	kV	0.4	0.3865424	96.6356	Under Voltage	Marginal	3-Phase
Bus93	Bus	kV	0.4	0.3865212	96.6303	Under Voltage	Marginal	3-Phase
Bus111	Bus	kV	0.4	0.3913073	97.82681	Under Voltage	Marginal	3-Phase
Bus114	Bus	kV	0.4	0.391718	97.92949	Under Voltage	Marginal	3-Phase
Bus116	Bus	kV	0.4	0.3902344	97.55861	Under Voltage	Marginal	3-Phase
Bus118	Bus	kV	0.4	0.3872496	96.8124	Under Voltage	Marginal	3-Phase
Bus123	Bus	kV	0.4	0.3895882	97.39705	Under Voltage	Marginal	3-Phase
Bus126	Bus	kV	0.4	0.3893737	97.34341	Under Voltage	Marginal	3-Phase
Bus129	Bus	kV	0.4	0.3887255	97.18139	Under Voltage	Marginal	3-Phase
Bus130	Bus	kV	0.4	0.3866619	96.66547	Under Voltage	Marginal	3-Phase

3. Branch Losses

The table 3.13 indicate power losses and the voltage drop in the network with the specific location of the losses. And table 3.14 shows the total losses in the network.

Table 3.13: Branch Losses

IDBranch	From	To	FromToMW	FromToMVar	ToFromMW	ToFromMvar	LosskW	Losskvar	VFrom	VTo	VDrop
Cable1	Bus1	Bus2	5.572815	1.710555	-5.569325	-1.742208	3.489866	-31.65277	100	99.9315	0.06854203
Line1	Bus2	Bus3	4.017716	1.130789	-4.013252	-1.130723	4.464722	0.06603748	99.9315	99.8229	0.1085789
Line55	Bus2	Bus94	0.01247776	0.004203405	-0.0124773	-0.0074206	0.00042117	-3.217198	99.9315	99.9286	0.00290664
Line56	Bus2	Bus97	1.539131	0.607215	-1.536364	-0.6098641	2.767636	-2.649056	99.9315	99.764	0.1674417
Line2	Bus3	Bus4	0.1472216	0.04871253	-0.1472172	-0.04929816	0.00448075	-0.5856268	99.8229	99.82	0.00291379
Line3	Bus3	Bus6	0.06364395	0.03618349	-0.0636429	-0.03676981	0.00100148	-0.5863191	99.8229	99.8216	0.00131539
Line42	Bus3	Bus72	3.802386	1.045827	-3.797986	-1.045854	4.399703	-0.0269465	99.8229	99.7097	0.113173
T1	Bus4	Bus5	0.1472172	0.04929816	-0.1458753	-0.04728541	1.341832	2.012748	99.82	98.5956	1.224404
T2	Bus6	Bus7	0.06364294	0.03676981	-0.0628911	-0.03564202	0.7518649	1.127797	99.8216	98.1746	1.646986
Line4	Bus8	Bus72	-3.719291	-1.009931	3.734369	1.009743	15.07723	-0.1882477	99.3147	99.7097	0.3949953
Line5	Bus8	Bus10	3.654048	0.9940811	-3.645473	-0.9942399	8.575181	-0.1588512	99.3147	99.0861	0.2285748
T3	Bus8	Bus9	0.06524365	0.01584985	-0.0646099	-0.01489915	0.6337972	0.9506958	99.3147	100.53	1.215665
Line6	Bus10	Bus11	0.0651848	0.01520693	-0.0651835	-0.01607351	0.00127321	-0.8665798	99.0861	99.0842	0.0019162
Line7	Bus10	Bus13	3.580288	0.979033	-3.577373	-0.9791076	2.914717	-0.0746381	99.0861	99.0071	0.07907979
T4	Bus11	Bus12	0.06518353	0.01607351	-0.0645469	-0.01511853	0.6366504	0.9549755	99.0842	100.287	1.202985
Line8	Bus13	Bus14	0.1482118	0.04522517	-0.148189	-0.04810514	0.0228396	-2.879966	99.0071	98.9923	0.01473874
Line9	Bus13	Bus16	2.715503	0.6926421	-2.713616	-0.693004	1.887143	-0.361855	99.0071	98.9392	0.06783359
Line30	Bus13	Bus51	0.7136585	0.2412404	-0.7133942	-0.2426073	0.2642809	-1.366985	99.0071	98.972	0.03507253
T5	Bus14	Bus15	0.148189	0.04810514	-0.1468149	-0.04604408	1.374036	2.061054	98.9923	100.207	1.214229
Line10	Bus16	Bus17	0.1481606	0.04756564	-0.1481559	-0.04815241	0.00468451	-0.5867716	98.9392	98.9362	0.00301226
Line11	Bus16	Bus19	0.07236118	0.008677986	-0.0723602	-0.00925397	0.00100721	-0.5759795	98.9392	98.9378	0.00138932
Line12	Bus16	Bus21	0.06404909	0.03644531	-0.0640481	-0.03702128	0.00103281	-0.5759748	98.9392	98.9379	0.00133568
Line13	Bus16	Bus23	2.429045	0.600315	-2.424857	-0.6015236	4.187662	-1.208532	98.9392	98.7707	0.16853
T6	Bus17	Bus18	0.1481559	0.04815241	-0.1467806	-0.04608947	1.375297	2.062945	98.9362	100.148	1.211894
T7	Bus19	Bus20	0.07236017	0.009253966	-0.0718777	-0.00853021	0.482501	0.7237515	98.9378	100.623	1.684622
T8	Bus21	Bus22	0.06404805	0.03702128	-0.0632727	-0.03585831	0.7753128	1.162969	98.9379	99.697	0.7590771
Line14	Bus23	Bus24	0.249923	0.0599259	-0.2499042	-0.06078347	0.01884934	-0.857572	98.7707	98.7633	0.00737247
Line15	Bus23	Bus26	0.249923	0.0599259	-0.2499042	-0.06078347	0.01884934	-0.857572	98.7707	98.7633	0.00737247
Line16	Bus23	Bus28	1.925011	0.4816718	-1.923978	-0.482261	1.033084	-0.5892392	98.7707	98.7184	0.05233029
T9	Bus24	Bus25	0.2499042	0.06078347	-0.2475158	-0.05720097	2.388332	3.582498	98.7633	99.9923	1.228975
T10	Bus26	Bus27	0.2499042	0.06078347	-0.2475158	-0.05720097	2.388332	3.582498	98.7633	99.9923	1.228975
Line17	Bus28	Bus29	0.07229611	0.009183106	-0.0722956	-0.00946981	0.00050559	-0.2867066	98.7184	98.7177	0.00069627
Line18	Bus28	Bus31	1.851682	0.4730779	-1.850646	-0.4737288	1.035769	-0.6509191	98.7184	98.6639	0.05443188
T11	Bus29	Bus30	0.0722956	0.009469813	-0.0718114	-0.00874355	0.484173	0.7262595	98.7177	100.393	1.674962
Line19	Bus31	Bus32	0.07228076	0.008665311	-0.0722793	-0.00952447	0.00151661	-0.8591591	98.6639	98.6618	0.00208825
Line20	Bus31	Bus34	0.3431176	0.1127437	-0.3430429	-0.1144476	0.07466135	-1.703937	98.6639	98.6433	0.02060532
Line26	Bus31	Bus44	0.3683048	0.1043462	-0.3682554	-0.1053506	0.04944785	-1.004342	98.6639	98.651	0.01293798

Line44	Bus31	Bus75	1.066943	0.2479736	-1.066401	-0.2492245	0.5418937	-1.250926	98.6639	98.6142	0.04970344
T12	Bus32	Bus33	0.07227925	0.00952447	-0.0717947	-0.00879757	0.4846002	0.7269003	98.6618	100.334	1.672511
Line21	Bus34	Bus35	0.1299784	0.05239153	-0.1299728	-0.0532495	0.00562743	-0.857977	98.6433	98.6394	0.0039578
Line23	Bus34	Bus39	0.06506957	0.01592874	-0.0650687	-0.01650131	0.00085707	-0.5725683	98.6433	98.642	0.00128316
Line24	Bus34	Bus41	0.1479949	0.04612738	-0.1479835	-0.04755116	0.01143534	-1.423782	98.6433	98.636	0.0073584
Line22	Bus35	Bus36	0.06554639	0.03619026	-0.0655431	-0.03790765	0.00324158	-1.717386	98.6394	98.6353	0.00410716
T14	Bus35	Bus38	0.06442644	0.01705925	-0.0640213	-0.01645149	0.405168	0.607752	98.6394	100.278	1.638498
T13	Bus36	Bus37	0.06554314	0.03790765	-0.064726	-0.0366819	0.8171613	1.225742	98.6353	99.341	0.7057396
T15	Bus39	Bus40	0.06506871	0.01650131	-0.0644265	-0.01553797	0.6422256	0.9633385	98.642	99.8206	1.178588
Line25	Bus41	Bus42	0.1479835	0.04755116	-0.1479766	-0.04840875	0.00691973	-0.857591	98.636	98.6315	0.00443909
T16	Bus42	Bus43	0.1479766	0.04840875	-0.1465944	-0.04633547	1.38219	2.073286	98.6315	99.8307	1.199198
Line27	Bus44	Bus45	0.1479895	0.04810768	-0.1479871	-0.04839364	0.00230852	-0.2859591	98.651	98.6495	0.00148003
Line28	Bus44	Bus47	0.1479895	0.04810768	-0.1479871	-0.04839364	0.00230852	-0.2859591	98.651	98.6495	0.00148003
Line29	Bus44	Bus49	0.0722765	0.009135204	-0.0722758	-0.00953605	0.00070845	-0.4008401	98.651	98.65	0.00097521
T17	Bus45	Bus46	0.1479871	0.04839364	-0.1466054	-0.04632097	1.381781	2.072672	98.6495	99.8495	1.199948
T18	Bus47	Bus48	0.1479871	0.04839364	-0.1466054	-0.04632097	1.381781	2.072672	98.6495	99.8495	1.199948
T19	Bus49	Bus50	0.07227579	0.009536045	-0.0717911	-0.00880901	0.4846909	0.7270363	98.65	100.322	1.671992
Line31	Bus51	Bus52	0.06405837	0.03558453	-0.0640558	-0.0370254	0.00256607	-1.440865	98.972	98.9687	0.00333458
Line32	Bus51	Bus54	0.06563064	0.03730783	-0.0656294	-0.03795334	0.00121362	-0.6455067	98.972	98.9705	0.00153235
Line33	Bus51	Bus56	0.5837052	0.169715	-0.5834916	-0.171431	0.213545	-1.715989	98.972	98.9367	0.03527245
T20	Bus52	Bus53	0.06405581	0.0370254	-0.0632808	-0.03586288	0.7750147	1.162522	98.9687	99.7288	0.7601777
T21	Bus54	Bus55	0.06562942	0.03795334	-0.0648157	-0.03673275	0.8137286	1.220593	98.9705	99.6883	0.7178414
Line34	Bus56	Bus57	0.08880779	0.01035809	-0.0888055	-0.01122185	0.00227444	-0.8637652	98.9367	98.9342	0.00255653
Line35	Bus56	Bus59	0.4946838	0.1610729	-0.4946274	-0.1616955	0.05642751	-0.6226267	98.9367	98.9259	0.01085298
T22	Bus57	Bus58	0.08880552	0.01122185	-0.088079	-0.01013208	0.7265169	1.089775	98.9342	100.442	1.508264
Line36	Bus59	Bus60	0.2183821	0.04163327	-0.2183728	-0.04220744	0.00937046	-0.5741656	98.9259	98.9216	0.00424816
Line39	Bus59	Bus66	0.06404586	0.03632848	-0.0640446	-0.03701946	0.00123862	-0.6909812	98.9259	98.9243	0.00160269
Line40	Bus59	Bus68	0.06404586	0.03632848	-0.0640446	-0.03701946	0.00123862	-0.6909812	98.9259	98.9243	0.00160269
Line41	Bus59	Bus70	0.1481535	0.04740528	-0.1481475	-0.04816442	0.00606165	-0.7591394	98.9259	98.922	0.00389821
Line37	Bus60	Bus62	0.1295717	0.0309733	-0.1295684	-0.0315486	0.00336698	-0.5753044	98.9216	98.9191	0.00254416
T23	Bus60	Bus61	0.08880103	0.01123414	-0.0880744	-0.01014416	0.7266538	1.089981	98.9216	100.429	1.507699
Line38	Bus62	Bus64	0.0644278	0.01531511	-0.064427	-0.01589089	0.00083286	-0.5757797	98.9191	98.9178	0.0012653
T24	Bus62	Bus63	0.06514057	0.01623349	-0.0645019	-0.01527541	0.638717	0.9580755	98.9191	100.113	1.193883
T25	Bus64	Bus65	0.06442697	0.01589089	-0.0641773	-0.01551645	0.2496279	0.3744418	98.9178	100.885	1.966686
T26	Bus66	Bus67	0.06404462	0.03701946	-0.0632692	-0.03585629	0.775445	1.163168	98.9243	99.6829	0.7585893
T27	Bus68	Bus69	0.06404462	0.03701946	-0.0632692	-0.03585629	0.775445	1.163168	98.9243	99.6829	0.7585893
T28	Bus70	Bus71	0.1481475	0.04816442	-0.1467719	-0.04610099	1.375618	2.063426	98.922	100.133	1.211301
Line43	Bus72	Bus73	0.06361759	0.03611153	-0.0636152	-0.03675509	0.00241205	-0.6435621	99.7097	99.7067	0.00301721
T29	Bus73	Bus74	0.06361517	0.03675509	-0.0628622	-0.03562566	0.7529544	1.129432	99.7067	98.0585	1.648185
Line45	Bus75	Bus76	0.06396703	0.03666902	-0.0639665	-0.036978	0.000561	-0.308987	98.6142	98.6135	0.00072299
Line46	Bus75	Bus78	1.002434	0.2125555	-1.00219	-0.2132057	0.2443342	-0.6502088	98.6142	98.5903	0.02395763
T30	Bus76	Bus77	0.06396648	0.036978	-0.063188	-0.03581029	0.778476	1.167714	98.6135	99.361	0.7474543
Line47	Bus78	Bus79	0.2497364	0.06112437	-0.2497288	-0.06146615	0.00756977	-0.3417808	98.5903	98.5873	0.00295436
Line48	Bus78	Bus81	0.2497364	0.06112437	-0.2497288	-0.06146615	0.00756977	-0.3417808	98.5903	98.5873	0.00295436
Line49	Bus78	Bus83	0.5027169	0.09095696	-0.502687	-0.09129435	0.02988148	-0.3373914	98.5903	98.5844	0.00587563
T31	Bus79	Bus80	0.2497288	0.06146615	-0.2473321	-0.05787107	2.396717	3.595076	98.5873	99.8066	1.219237
T32	Bus81	Bus82	0.2497288	0.06146615	-0.2473321	-0.05787107	2.396717	3.595076	98.5873	99.8066	1.219237

Line50	Bus83	Bus84	0.08868124	0.01109652	-0.08868	-0.01156536	0.00125062	-0.468837	98.5844	98.583	0.00140225
Line51	Bus83	Bus86	0.1479504	0.04814696	-0.147948	-0.04844967	0.00244964	-0.3027061	98.5844	98.5828	0.00156959
Line52	Bus83	Bus88	0.2660554	0.03205086	-0.2660424	-0.03259174	0.01302102	-0.5408743	98.5844	98.5795	0.00486802
T33	Bus84	Bus85	0.08867998	0.01156536	-0.0879496	-0.01046979	0.7303821	1.095573	98.583	100.075	1.492441
T34	Bus86	Bus130	0.147948	0.04844967	-0.1465647	-0.04637472	1.3833	2.07495	98.5828	99.78	1.197166
Line53	Bus88	Bus90	0.1773636	0.02102299	-0.1773576	-0.02158807	0.00602898	-0.5650806	98.5795	98.5761	0.00338115
T35	Bus88	Bus89	0.08867875	0.01156874	-0.0879483	-0.01047311	0.7304206	1.095631	98.5795	100.072	1.492285
Line54	Bus90	Bus92	0.08868004	0.01001603	-0.0886759	-0.0115766	0.00415807	-1.560572	98.5761	98.5715	0.00466341
T36	Bus90	Bus91	0.08867754	0.01157205	-0.0879471	-0.01047636	0.7304581	1.095687	98.5761	100.068	1.492132
T37	Bus92	Bus93	0.08867588	0.0115766	-0.0879454	-0.01048084	0.7305099	1.095765	98.5715	100.063	1.491922
AL-DOARA	Bus94	Bus95	0.01247734	0.007420603	-0.0124586	-0.00739251	0.0187312	0.0280968	99.9286	99.7189	0.2096273
Cable2	Bus97	Bus98	1.536364	0.6098641	-1.536239	-0.624733	0.1250431	-14.86897	99.764	99.7552	0.00880083
Line57	Bus98	Bus99	1.536239	0.624733	-1.535408	-0.6255184	0.8305223	-0.785393	99.7552	99.7053	0.04996199
Cable3	Bus99	Bus100	0.1261669	0.03551902	-0.1261666	-0.04030606	0.00025406	-4.787038	99.7053	99.705	0.0002198
Line60	Bus99	Bus105	1.409241	0.5899994	-1.408618	-0.5907136	0.6227797	-0.7141755	99.7053	99.6647	0.04056492
Line58	Bus100	Bus101	0.1261666	0.04030606	-0.1261498	-0.04167215	0.01678451	-1.366094	99.705	99.6926	0.01240525
Cable4	Bus101	Bus102	0.1261498	0.04167215	-0.1261492	-0.05274379	0.00061457	-11.07164	99.6926	99.6921	0.00052873
Line59	Bus102	Bus103	0.05757105	0.01708318	-0.0575661	-0.02127623	0.00492662	-4.19305	99.6921	99.6839	0.00818092
GARJAES	Bus102	Bus109	0.06857816	0.03566061	-0.0680446	-0.03486029	0.5335422	0.8003134	99.6921	98.6072	1.084919
RAS ALTAWEL	Bus103	Bus104	0.05756612	0.02127623	-0.0572297	-0.02077161	0.3364111	0.5046166	99.6839	98.8889	0.7949783
Line61	Bus105	Bus106	0.0685316	0.01965963	-0.0685286	-0.02050087	0.00299713	-0.8412404	99.6647	99.6606	0.00413701
Line62	Bus105	Bus110	1.271599	0.5354405	-1.267025	-0.5420253	4.573214	-6.58475	99.6647	99.3356	0.3290728
KHALET AL-FOOL	Bus105	Bus112	0.06848821	0.03561343	-0.0679558	-0.03481478	0.5324336	0.7986505	99.6647	98.5809	1.08379
Cable5	Bus106	Bus107	0.06852861	0.02050087	-0.0685284	-0.03563466	0.00025425	-15.13379	99.6606	99.6602	0.00040019
BET ENON	Bus107	Bus108	0.06852835	0.03563466	-0.0679952	-0.034835	0.5331088	0.7996632	99.6602	98.5757	1.084478
Line63	Bus110	Bus113	1.027465	0.4167185	-1.02457	-0.4233915	2.895174	-6.672981	99.3356	99.0766	0.259015
RAS ALAROD	Bus110	Bus111	0.2395598	0.1253067	-0.2369511	-0.1213936	2.608734	3.913101	99.3356	100.269	0.9333482
Cable6	Bus113	Bus115	0.8964545	0.3715645	-0.8964263	-0.3810706	0.02823639	-9.506106	99.0766	99.0732	0.00337075
AL SHAFA	Bus113	Bus114	0.1281158	0.05182701	-0.1270365	-0.05020805	1.079302	1.618953	99.0766	100.375	1.298805
Line65	Bus115	Bus117	0.2178489	0.1151074	-0.2177324	-0.1208883	0.1165585	-5.780824	99.0732	99.0279	0.04533866
Line66	Bus115	Bus119	0.03512327	0.00996838	-0.0351227	-0.01117575	0.00053128	-1.207369	99.0732	99.0718	0.00145527
Line68	Bus115	Bus124	0.384468	0.1425868	-0.3842414	-0.1466479	0.2266715	-4.061014	99.0732	99.0183	0.05494661
AL AEN	Bus115	Bus116	0.258986	0.1134079	-0.2561178	-0.1091057	2.868155	4.302233	99.0732	99.9916	0.9183404
WAD ALSHARQ	Bus117	Bus118	0.2177324	0.1208883	-0.2142242	-0.115626	3.508201	5.262302	99.0279	99.2194	0.1915006
Line67	Bus119	Bus120	0.03512274	0.01117575	-0.0351214	-0.01410447	0.00133478	-2.928725	99.0718	99.0682	0.00356878
WAD SA'IR	Bus120	Bus121	0.03512141	0.01410447	-0.034919	-0.01380087	0.2023993	0.303599	99.0682	98.2819	0.786294
Line69	Bus122	Bus124	-0.1744976	-0.07654241	0.1745231	0.07440086	0.02543942	-2.141557	99.0051	99.0183	0.01319144
AHMARON	Bus122	Bus123	0.1744976	0.07654241	-0.1724429	-0.07346037	2.054696	3.082044	99.0051	99.8244	0.8193333
Line70	Bus124	Bus125	0.2097183	0.072247	-0.2095689	-0.08135288	0.1494532	-9.105878	99.0183	98.9516	0.06668912
Line71	Bus125	Bus127	0.03510803	0.004824664	-0.035104	-0.01409795	0.00402996	-9.273286	98.9516	98.9404	0.01114936

ABU ZAWEH	Bus125	Bus126	0.1744608	0.07652821	-0.1724048	-0.07344411	2.056068	3.084102	98.9516	99.769	0.8174381
RBAEA	Bus127	Bus128	0.035104	0.01409795	-0.0349013	-0.01379387	0.2027231	0.3040846	98.9404	98.1535	0.7869258

Table 3.14: Total Losses

	KW	KVar
Total loss	174.9	-61.4

3.4.3.3 Protection analysis

ETAP program can make protection and flute analyses for network show in fig 3.2.

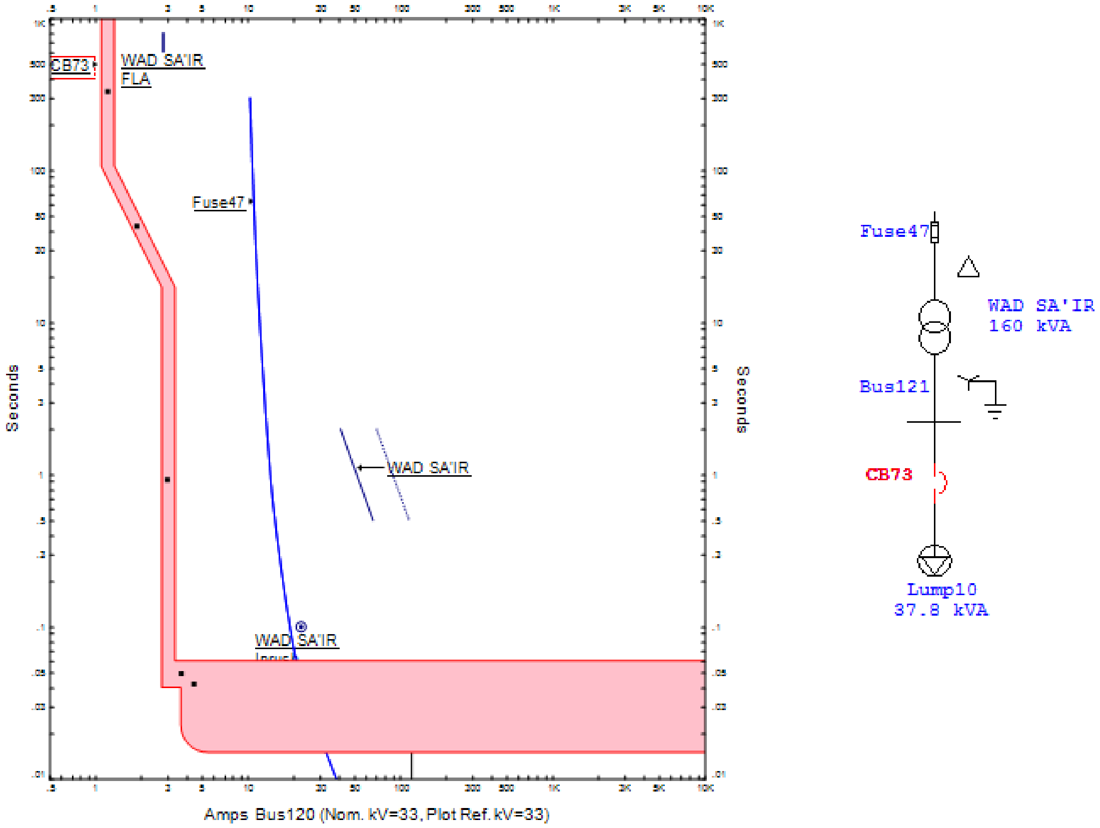

Figure 3.2: Simulation diagram for protection analysis

3.5 Problems

The project conclusion can be summarized network problems as follow.

1 – Sa'ir network has high losses.

The branch losses table for our sample show that Sa'ir has losses of 174.9 KW and 185 KVA.

2 –Sa'ir network has very low power factor range (0.48 – 0.87).

Which very low in industrial region and in range in demostic region.

3- Sa'ir network has voltage drop.

The E-TAP simulation show that a high average voltage drops in the sample we take where the voltage on some branch is under nominal voltage.

4- Problem in equipment

Many equipment must be replaced because some of them are old and the other is fluty like law voltage circuit barker and some transformer silica gel was black.

Chapter Four

Problems and Solution

4.1 Introduction

4.2 Problems and solutions

Chapter Four

4.1 Introduction

This chapter discusses the result from data analysis chapter and detects the problem in the network to give Possible solutions to increase the network efficiency. first part describes the problem and the other one contain a E-TAP data after reconstruction to improve the solution. The detected problem as the following, this chapter discusses the following problem.

1. High losses problem.
2. Low power factor range (0.48 – 0.91).
3. Voltage drop.

4.2 Problems and solutions

4.2.1 power factor correction

Introduction

Various inductive loads used in all industries deals with the problem of power factor improvement. Capacitor bank connected in shunt helps in maintaining the power factor closer to unity. They improve the electrical supply quality and increase the efficiency of the system. Also the line losses are also reduced. Shunt capacitor banks
are less costly and can be installed anywhere. This paper deals with shunt capacitor bank designing for power factor improvement considering overvoltage's for substation installation

Most ac electric machines draw apparent power in terms of kilovolt amperes (KVA) which is in excess of the useful power, measured in kilowatts (KW), required by the machine. The ratio of these quantities (KW/KVA) is called the power factor cos ϕ and is dependent on the type of machine in use.

$$power\ factor\ (\cos\phi) = \frac{usfule\ power\ (KW)}{appernt\ power\ (KVA)} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots.eq4.1$$

A large proportion of the electric machinery used in industry has an inherently low pf, which means that the supply authorities have to generate much more current than is theoretically required. In addition, the transformers and cables have to carry this high current. When the overall pf of a generating station’s load is low, the system is inefficient and the cost of electricity corresponding high [8]. To overcome this, and at the same time ensure that the generators and cables are not loaded with the wattles current, the supply authorities often impulse penalties for low pf [9][10].

Some of the machinery or equipment with low pf are listed below:

1. Induction motors of all types

2. Power thyristor installations

3. Welding machines

4. Electric arc and induction furnaces

5. Choke coils and induction furnaces

6. Neon signs and fluorescent lighting

The method employed to improve the **pf** involves introducing reactive (kvar) into the system in phase opposition to the watt less or reactive current.

Power Factor Improvement

The apparent power (KVA) in ac circuit can be resolved into two components, the in-phase component which supplies the useful power (KW), and the watt less component (kvar) which does no useful work. The phasor sum of the two is the KVA drawn from the supply. The cosine of the phase angle between the KVA and the KW represents the power factor of the load. This is shown by the phasor diagram in Fig4.1(a). To improve the power factor, equipment drawing kvar of approximately the same magnitude as the load kvar but in phase opposition (leading), is connected in parallel with the load. The resultant KVA is now smaller and the new power factor (cos $\phi 2$) is increased (Figs.4.1(a) and (b)). Cos $\phi 2$ is controlled by the magnitude of the kvar added. Thus any desired power factor can be obtained by varying the leading kvar. A typical arrangement of shunt capacitor connected in parallel with a load is shown in Fig. 4.2.

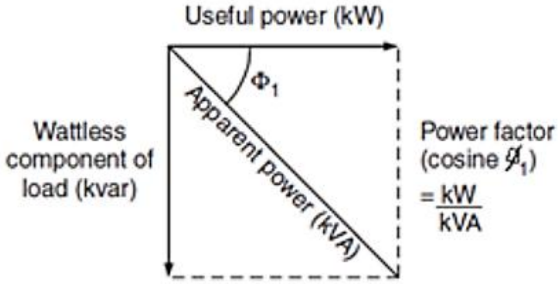

Figure 4.1: (a) Phasor Diagram of a plant operation at lagging power factor

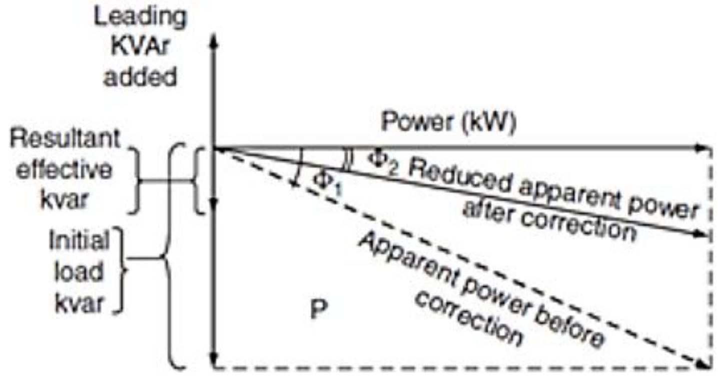

Figure 4.1 :(b) Power factor correction by adding leading kVAR

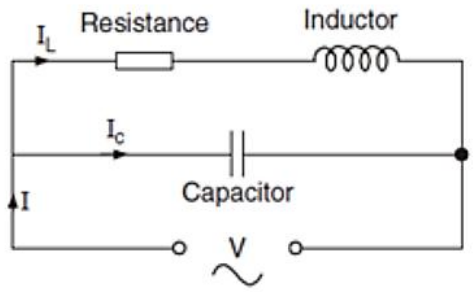

Figure 4.2: Capacitor connected in parallel with load

The network has a low power factor in many transformers at low voltage side so the capacitor bank is solved this problem by add it at load have low pf as shown in table4.1

Tabel4.1: capacitor bank correction

Location	Capacitor banck (KVAR)	Selected (KVAR)	Number of unit	Number of bus
Load of T1	60	60	1	Bus 5
Load of T3	60	60	1	Bus 9
Load of T4	60	60	1	Bus 12
Load of T5	60	60	1	Bus 15
Load of T6	60	60	1	Bus 18
Load of T7	60	60	1	Bus 20
Load of T9	240	240	1	Bus 25

Load of 10	240	240	1	Bus 27
Load of T11	60	60	1	Bus 30
Load of T12	60	60	1	Bus 33
Load of T14	100	100	1	Bus 38
Load of T15	60	60	1	Bus 40
Load of T16	60	60	1	Bus 34
Load of T17	60	60	1	Bus 46
Load of T18	60	60	1	Bus 48
Load of T19	60	60	1	Bus 50
Load of T22	60	60	1	Bus 58
Load of T23	60	60	1	Bus 61
Load of 24	60	60	1	Bus 63
Load of 25	100	100	1	Bus 65
Load of T28	60	60	1	Bus 71
Load of 31	240	240	1	Bus 80
Load of 32	240	240	1	Bus 82
Load of T33	60	60	1	Bus 85
Load of T34	60	60	1	Bus 130
Load of T35	60	60	1	Bus 89
Load of T36	60	60	1	Bus 91
Load of 37	60	60	1	Bus 93

Figure 4.3 shows the one line digram simulation for Sa'ir network after power factor correction.

Advantages of Power Factor Improvement

The benefits that can be achieved by applying the correct power factor correction are:

a) Reduction of power consumption due to improved energy efficiency. Reduced power consumption means less greenhouse gas emissions and fossil fuel depletion by power stations.

b) Reduction of electricity bills

c) Extra kVA available from the existing supply

d) Reduction of I2R losses in transformers and distribution equipment

e) Reduction of voltage drops in long cables.

f) Reduced electrical burden on cables and electrical components.

after makes power factor correction the network be more stable as show in table 4.2

Table 4.2: result after power factor correction

ID	Type	kV	MW	Mvar	MVA	PF	LoadAmp
Bus1	SWNG	33	5.572815	1.710555	5.829431	0.955979	101.9886
Bus2	Load	33	5.569325	1.742208	5.835467	0.954392	102.1642
Bus3	Load	33	4.013252	1.130723	4.169499	0.962526	73.07676
Bus4	Load	33	0.1472172	0.04929816	0.1552521	0.948246	2.721106
Bus5	Load	0	0.1458753	0.1056119	0.180093	0.81	263.6446
Bus6	Load	33	0.0636429	0.03676981	0.0735013	0.865875	1.288238
Bus7	Load	0	0.0628911	0.03564202	0.0722886	0.87	106.2797
Bus8	Load	33	3.719291	1.009931	3.853971	0.965055	67.89226
Bus9	Load	0	0.0646099	0.07553729	0.0993998	0.65	142.7143
Bus10	Load	33	3.645473	0.9942399	3.778622	0.964762	66.71846
Bus11	Load	33	0.0651835	0.01607351	0.0671361	0.970917	1.185432
Bus12	Load	0	0.0645469	0.07546367	0.0993029	0.65	142.9209
Bus13	Load	33	3.577373	0.9791076	3.708942	0.964527	65.54044
Bus14	Load	33	0.148189	0.04810514	0.1558014	0.95114	2.753565
Bus15	Load	0	0.1468149	0.1062922	0.181253	0.81	261.077
Bus16	Load	33	2.713616	0.693004	2.800708	0.968904	49.52503
Bus17	Load	33	0.1481559	0.04815241	0.1557845	0.951031	2.754828
Bus18	Load	0	0.1467806	0.1062673	0.1812106	0.81	261.1682
Bus19	Load	33	0.0723602	0.00925397	0.0729495	0.991921	1.289987
Bus20	Load	0	0.0718777	0.06927948	0.0998301	0.72	143.201
Bus21	Load	33	0.0640481	0.03702128	0.0739779	0.865773	1.308172
Bus22	Load	0	0.0632727	0.03585831	0.0727273	0.87	105.2919
Bus23	Load	33	2.424857	0.6015236	2.498352	0.970583	44.25384
Bus24	Load	33	0.2499042	0.06078347	0.25719	0.971671	4.556002
Bus25	Load	0	0.2475158	0.297164	0.3867435	0.64	558.2592
Bus26	Load	33	0.2499042	0.06078347	0.25719	0.971671	4.556002
Bus27	Load	0	0.2475158	0.297164	0.3867435	0.64	558.2592

Bus28	Load	33	1.923978	0.482261	1.983499	0.969992	35.15276
Bus29	Load	33	0.0722956	0.00946981	0.0729132	0.99153	1.29222
Bus30	Load	0	0.0718114	0.06921563	0.0997381	0.72	143.3965
Bus31	Load	33	1.850646	0.4737288	1.910317	0.968764	33.87446
Bus32	Load	33	0.0722793	0.00952447	0.0729041	0.991429	1.29279
Bus33	Load	0	0.0717947	0.06919947	0.0997148	0.72	143.4463
Bus34	Load	33	0.3430429	0.1144476	0.3616306	0.9486	6.413912
Bus35	Load	33	0.1299728	0.0532495	0.140458	0.92535	2.491274
Bus36	Load	33	0.0655431	0.03790765	0.0757159	0.865646	1.343013
Bus37	Load	0	0.064726	0.0366819	0.0743977	0.87	108.0961
Bus38	Load	0	0.0640213	0.117008	0.1333776	0.48	191.9806
Bus39	Load	33	0.0650687	0.01650131	0.0671285	0.969316	1.190611
Bus40	Load	0	0.0644265	0.07532292	0.0991177	0.65	143.3211
Bus41	Load	33	0.1479835	0.04755116	0.1554356	0.952057	2.757025
Bus42	Load	33	0.1479766	0.04840875	0.1556935	0.950435	2.761724
Bus43	Load	0	0.1465944	0.1061325	0.1809807	0.81	261.6661
Bus44	Load	33	0.3682554	0.1053506	0.3830284	0.961431	6.792896
Bus45	Load	33	0.1479871	0.04839364	0.1556989	0.95047	2.761315
Bus46	Load	0	0.1466054	0.1061405	0.1809943	0.81	261.6366
Bus47	Load	33	0.1479871	0.04839364	0.1556989	0.95047	2.761315
Bus48	Load	0	0.1466054	0.1061405	0.1809943	0.81	261.6366
Bus49	Load	33	0.0722758	0.00953605	0.0729022	0.991408	1.292911
Bus50	Load	0	0.0717911	0.06919604	0.0997099	0.72	143.4568
Bus51	Load	33	0.7133942	0.2426073	0.7535181	0.946751	13.32008
Bus52	Load	33	0.0640558	0.0370254	0.0739867	0.865775	1.30792
Bus53	Load	0	0.0632808	0.03586288	0.0727366	0.87	105.2716
Bus54	Load	33	0.0656294	0.03795334	0.0758134	0.86567	1.340189
Bus55	Load	0	0.0648157	0.03673275	0.0745008	0.87	107.8689
Bus56	Load	33	0.5834916	0.171431	0.6081538	0.959447	10.75428
Bus57	Load	33	0.0888055	0.01122185	0.0895117	0.99211	1.582921
Bus58	Load	0	0.088079	0.07066415	0.1129218	0.78	162.2707
Bus59	Load	33	0.4946274	0.1616955	0.5203861	0.950501	9.203252
Bus60	Load	33	0.2183728	0.04220744	0.2224143	0.981829	3.933662
Bus61	Load	0	0.0880744	0.07066043	0.1129159	0.78	162.2833
Bus62	Load	33	0.1295684	0.0315486	0.1333539	0.971613	2.358584
Bus63	Load	0	0.0645019	0.07541102	0.0992336	0.65	143.0698
Bus64	Load	33	0.064427	0.01589089	0.0663578	0.970903	1.173661
Bus65	Load	0	0.0641773	0.1172933	0.1337028	0.48	191.2915
Bus66	Load	33	0.0640446	0.03701946	0.073974	0.865772	1.308283
Bus67	Load	0	0.0632692	0.03585629	0.0727232	0.87	105.3008
Bus68	Load	33	0.0640446	0.03701946	0.073974	0.865772	1.308283
Bus69	Load	0	0.0632692	0.03585629	0.0727232	0.87	105.3008
Bus70	Load	33	0.1481475	0.04816442	0.1557803	0.951003	2.75515
Bus71	Load	0	0.1467719	0.106261	0.1811998	0.81	261.1914
Bus72	Load	33	3.797986	1.045854	3.939354	0.964114	69.12148
Bus73	Load	33	0.0636152	0.03675509	0.0734699	0.865867	1.289171
Bus74	Load	0	0.0628622	0.03562566	0.0722554	0.87	106.3566

Bus75	Load	33	1.066401	0.2492245	1.095137	0.973761	19.42917
Bus76	Load	33	0.0639665	0.036978	0.0738856	0.86575	1.310838
Bus77	Load	0	0.063188	0.03581029	0.0726299	0.87	105.5064
Bus78	Load	33	1.00219	0.2132057	1.024617	0.978111	18.18248
Bus79	Load	33	0.2497288	0.06146615	0.257182	0.97102	4.563993
Bus80	Load	0	0.2473321	0.2969434	0.3864564	0.64	558.883
Bus81	Load	33	0.2497288	0.06146615	0.257182	0.97102	4.563993
Bus82	Load	0	0.2473321	0.2969434	0.3864564	0.64	558.883
Bus83	Load	33	0.502687	0.09129435	0.5109099	0.983905	9.066957
Bus84	Load	33	0.08868	0.01156536	0.089431	0.991603	1.587126
Bus85	Load	0	0.0879496	0.07056034	0.1127559	0.78	162.6265
Bus86	Load	33	0.147948	0.04844967	0.1556791	0.95034	2.762831
Bus88	Load	33	0.2660424	0.03259174	0.2680313	0.99258	4.756901
Bus89	Load	0	0.0879483	0.07055932	0.1127543	0.78	162.63
Bus90	Load	33	0.1773576	0.02158807	0.1786666	0.992673	3.171006
Bus91	Load	0	0.0879471	0.07055832	0.1127527	0.78	162.6334
Bus92	Load	33	0.0886759	0.0115766	0.0894283	0.991586	1.587265
Bus93	Load	0	0.0879454	0.07055694	0.1127505	0.78	162.6382
Bus94	Load	33	0.0124773	0.0074206	0.0145172	0.859486	0.2541669
Bus95	Load	0	0.0124586	0.00739251	0.0144868	0.86	20.96877
Bus96	Load	0	0.0124586	0.00739251	0.0144868	0.86	20.96877
Bus97	Load	33	1.536364	0.6098641	1.652981	0.92945	28.98808
Bus98	Load	33	1.536239	0.624733	1.658409	0.926333	29.08583
Bus99	Load	33	1.535408	0.6255184	1.657936	0.926096	29.0921
Bus100	Load	33	0.1261666	0.04030606	0.1324484	0.952572	2.324102
Bus101	Load	33	0.1261498	0.04167215	0.1328546	0.949533	2.331519
Bus102	Load	33	0.1261492	0.05274379	0.1367316	0.922605	2.399571
Bus103	Load	33	0.0575661	0.02127623	0.0613721	0.937985	1.077138
Bus104	Load	0	0.0572297	0.02077161	0.0608827	0.94	88.86391
Bus105	Load	33	1.408618	0.5907136	1.527465	0.922194	26.81361
Bus106	Load	33	0.0685286	0.02050087	0.0715294	0.958048	1.255702
Bus107	Load	33	0.0685284	0.03563466	0.0772397	0.887217	1.355952
Bus108	Load	0	0.0679952	0.034835	0.0763992	0.89	111.866
Bus109	Load	0	0.0680446	0.03486029	0.0764546	0.89	111.9115
Bus110	Load	33	1.267025	0.5420253	1.378095	0.919404	24.27166
Bus111	Load	0	0.2369511	0.1213936	0.2662372	0.89	383.2495
Bus112	Load	0	0.0679558	0.03481478	0.0763548	0.89	111.7952
Bus113	Load	33	1.02457	0.4233915	1.108605	0.924198	19.57632
Bus114	Load	0	0.1270365	0.05020805	0.1365984	0.93	196.4255
Bus115	Load	33	0.8964263	0.3810706	0.974061	0.920298	17.20106
Bus116	Load	0	0.2561178	0.1091057	0.2783889	0.92	401.8537
Bus117	Load	33	0.2177324	0.1208883	0.2490409	0.874284	4.399857
Bus118	Load	0	0.2142242	0.115626	0.2434366	0.88	354.1348
Bus119	Load	33	0.0351227	0.01117575	0.0368579	0.952923	0.6508875
Bus120	Load	33	0.0351214	0.01410447	0.0378477	0.927966	0.6683913
Bus121	Load	0	0.034919	0.01380087	0.0375473	0.93	55.14228
Bus122	Load	33	0.1744976	0.07654241	0.190547	0.915772	3.367209

Bus123	Load	0	0.1724429	0.07346037	0.187438	0.92	271.0192
Bus124	Load	33	0.3842414	0.1466479	0.4112749	0.934269	7.266784
Bus125	Load	33	0.2095689	0.08135288	0.2248053	0.932224	3.974743
Bus126	Load	0	0.1724048	0.07344411	0.1873965	0.92	271.1097
Bus127	Load	33	0.035104	0.01409795	0.0378291	0.927962	0.6689256
Bus128	Load	0	0.0349013	0.01379387	0.0375283	0.93	55.18637
Bus129	Load	0	0.0632808	0.03586288	0.0727366	0.87	105.2716
Bus130	Load	0	0.1465647	0.106111	0.1809441	0.81	261.7461

4.2.2 Voltage drop

Introduction

Voltage drop Is defined as the amount of voltage loss that occur through all or part of a network due to impedance

Voltage drop becomes important when the length of power conductor becomes very long because increasing of its impedance. Voltage drop can also occur when over load or short circuit cases. Excessive voltage drop can cause loss of efficiency in operation of light, motors and other load for different applications.

Voltage drop is caused by resistance in the conductor or connections leading to the electrical load. There are many causes of resistance in the conductor path. There are four fundamental causes of voltage drop:

1-Material - Copper is a better conductor than aluminum and will have less voltage drop than aluminum for a given length and wire size.

2- Wire Size - Larger wire sizes (diameter) will have less voltage drop than smaller wire sizes (diameters) of the same length.

3- Wire Length - Shorter wires will have less voltage drop than longer wires for the same wire size (diameter).

4- Current Being Carried - Voltage drop increases on a wire with an increase in the current flowing through the wire.

We solve the under voltage on transformers by changing the tap changer at transformers as shown in table 4.3

Table 4.3: Transformers data with fixed tap changer

ID	FromBus	ToBus	PrimkV	SeckV	Sec%Tap	Conn	SecGrdType	MVA	MaxMVA	PosZ	PosX/R	ZeroZ	ZeroX/R
RAS ALTAWEL	Bus103	Bus104	33	0.4	0	D/Y	Solid	0.25	0.25	4	1.5	4	1.5
BET ENON	Bus107	Bus108	33	0.4	0	D/Y	Solid	0.25	0.25	4	1.5	4	1.5
GARJAES	Bus102	Bus109	33	0.4	0	D/Y	Solid	0.25	0.25	4	1.5	4	1.5
RAS ALAROD	Bus110	Bus111	33	0.4	2.5	D/Y	Solid	0.63	0.63	4	1.5	4	1.5
KHALET AL-FOOL	Bus105	Bus112	33	0.4	0	D/Y	Solid	0.25	0.25	4	1.5	4	1.5
AL SHAFA	Bus113	Bus114	33	0.4	2.5	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
AL AEN	Bus115	Bus116	33	0.4	2.5	D/Y	Solid	0.63	0.63	4	1.5	4	1.5
WAD ALSHARQ	Bus117	Bus118	33	0.4	2.5	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T4	Bus11	Bus12	33	0.4	2.5	D/Y	Solid	0.16	0.16	4	1.5	4	1.5
WAD SA'IR	Bus120	Bus121	33	0.4	0	D/Y	Solid	0.16	0.16	4	1.5	4	1.5
AHMARON	Bus122	Bus123	33	0.4	2.5	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
ABU ZAWEH	Bus125	Bus126	33	0.4	2.5	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
RBAEA	Bus127	Bus128	33	0.4	0	D/Y	Solid	0.16	0.16	4	1.5	4	1.5
T34	Bus86	Bus130	33	0.4	2.5	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T5	Bus14	Bus15	33	0.4	2.5	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T6	Bus17	Bus18	33	0.4	2.5	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T7	Bus19	Bus20	33	0.4	2.5	D/Y	Solid	0.25	0.25	4	1.5	4	1.5
T8	Bus21	Bus22	33	0.4	2.5	D/Y	Solid	0.16	0.16	4	1.5	4	1.5
T9	Bus24	Bus25	33	0.4	2.5	D/Y	Solid	0.63	0.63	4	1.5	4	1.5
T10	Bus26	Bus27	33	0.4	2.5	D/Y	Solid	0.63	0.63	4	1.5	4	1.5
T11	Bus29	Bus30	33	0.4	2.5	D/Y	Solid	0.25	0.25	4	1.5	4	1.5
T12	Bus32	Bus33	33	0.4	2.5	D/Y	Solid	0.25	0.25	4	1.5	4	1.5
T13	Bus36	Bus37	33	0.4	2.5	D/Y	Solid	0.16	0.16	4	1.5	4	1.5
T14	Bus35	Bus38	33	0.4	2.5	D/Y	Solid	0.25	0.25	4	1.5	4	1.5
T15	Bus39	Bus40	33	0.4	2.5	D/Y	Solid	0.16	0.16	4	1.5	4	1.5
T16	Bus42	Bus43	33	0.4	2.5	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T17	Bus45	Bus46	33	0.4	2.5	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T18	Bus47	Bus48	33	0.4	2.5	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T1	Bus4	Bus5	33	0.4	0	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T19	Bus49	Bus50	33	0.4	2.5	D/Y	Solid	0.25	0.25	4	1.5	4	1.5
T20	Bus52	Bus53	33	0.4	2.5	D/Y	Solid	0.16	0.16	4	1.5	4	1.5
T21	Bus54	Bus55	33	0.4	2.5	D/Y	Solid	0.16	0.16	4	1.5	4	1.5
T22	Bus57	Bus58	33	0.4	2.5	D/Y	Solid	0.25	0.25	4	1.5	4	1.5
T23	Bus60	Bus61	33	0.4	2.5	D/Y	Solid	0.25	0.25	4	1.5	4	1.5
T24	Bus62	Bus63	33	0.4	2.5	D/Y	Solid	0.16	0.16	4	1.5	4	1.5
T25	Bus64	Bus65	33	0.4	2.5	D/Y	Solid	0.4	0.4	4	1.5	4	1.5
T26	Bus66	Bus67	33	0.4	2.5	D/Y	Solid	0.16	0.16	4	1.5	4	1.5
T27	Bus68	Bus69	33	0.4	2.5	D/Y	Solid	0.16	0.16	4	1.5	4	1.5
T2	Bus6	Bus7	33	0.4	0	D/Y	Solid	0.16	0.16	4	1.5	4	1.5
T28	Bus70	Bus71	33	0.4	2.5	D/Y	Solid	0.4	0.4	4	1.5	4	1.5

T29	Bus73	Bus74	33	0.4	0	D/Y	Solid	0.16	0.16	4	1.5	4	1.5
T30	Bus76	Bus77	33	0.4	2.5	D/Y	Solid	0.16	0.16	4	1.5	4	1.5
T31	Bus79	Bus80	33	0.4	2.5	D/Y	Solid	0.63	0.63	4	1.5	4	1.5
T32	Bus81	Bus82	33	0.4	2.5	D/Y	Solid	0.63	0.63	4	1.5	4	1.5
T33	Bus84	Bus85	33	0.4	2.5	D/Y	Solid	0.25	0.25	4	1.5	4	1.5
T35	Bus88	Bus89	33	0.4	2.5	D/Y	Solid	0.25	0.25	4	1.5	4	1.5
T3	Bus8	Bus9	33	0.4	2.5	D/Y	Solid	0.16	0.16	4	1.5	4	1.5
T36	Bus90	Bus91	33	0.4	2.5	D/Y	Solid	0.25	0.25	4	1.5	4	1.5
T37	Bus92	Bus93	33	0.4	2.5	D/Y	Solid	0.25	0.25	4	1.5	4	1.5
AL-DOARA	Bus94	Bus95	33	0.4	0	D/Y	Solid	0.25	0.25	4	1.5	4	1.5

4.2.3 losses and solution

4.2.3.1 Introduction

Power distribution systems have tie and sectionalizing switches. The states of those switches determine the configuration of the network. Reconfiguration of distribution network is achieved through switching operation on switches of distribution network branches [11].

Power companies are interested in finding the most efficient configuration for minimization of real power losses and load balancing among distribution feeders. This will help to save energy and enhance the operation performance of distribution system.

To manage a loss reduction program in a transmission and distribution system, it is necessary to use efficient and effective computational tools like MATLAB that allow quantifying the loss in each different network element for system losses reduction.

4.2.3.2 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.

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

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.

The unexpected load increase was reflected in the increase of technical losses above the normal level

Losses are inherent to the distribution of electricity and cannot be eliminated.

4.2.3.3 Types of Technical Losses.

1- Lengthy Distribution lines

In practically 11 KV and 415 volts' lines, in rural areas are extended over long distances to feed loads scattered over large areas. Thus the primary and secondary distributions lines in rural areas are largely radial laid usually extend over long distances.

This results in high line resistance and therefore high (I^2) *R losses in the line.

* Haphazard growths of sub-transmission and distribution system in to new areas.

* Large scale rural electrification through long 33kV and LT lines.

2- Inadequate Size of Conductors of Distribution lines

The size of the conductors should be selected on the basis of KVA x KM capacity of standard conductor for a required voltage regulation, but rural loads are usually scattered and generally fed by radial feeders. The conductor size of these feeders should be adequate.

3- Installation of Distribution transformers away from load centers

Distribution Transformers are not located at Load center on the Secondary Distribution System.

In most of case Distribution Transformers are not located centrally with respect to consumers. Consequently, the farthest consumers obtain an extremity low voltage even though a good voltage levels maintained at the transformers secondary.

This again leads to higher line losses. (The reason for the line losses increasing as a result of decreased voltage at the consumer's end therefore in order to reduce the voltage drop in the line to the farthest consumers, the distribution transformer should be located at the load center to keep voltage drop within permissible limits.)

4- Low Power Factor of Primary and secondary distribution system

In most LT distribution circuits normally the Power Factor ranges from 0.65 to 0.75. A low Power Factor contributes towards high distribution losses.

For a given load, if the Power Factor is low, the current drawn in high and the losses proportional to square of the current will be more. Thus, line losses owing to the poor PF can be reduced by improving the Power Factor.

This can be done by application of shunt capacitors.

Shunt capacitors can be connected either in secondary side (11 KV side) of the 33/11 KV power transformers or at various point of Distribution Line.

The optimum rating of capacitor banks for a distribution system is 2/3rd of the average KVAR requirement of that distribution system.

The vantage point is at 2/3rd the length of the main distributor from the transformer.

A more appropriate manner of improving this PF of the distribution system and thereby reduce the line losses is to connect capacitors across the terminals of the consumers having inductive loads.

By connecting the capacitors across individual loads, the line loss is reduced from 4 to 9% depending upon the extent of PF improvement.

5- Bad Workmanship

Bad Workmanship contributes significantly role towards increasing distribution losses.

Joints are a source of power loss. Therefore, the number of joints should be kept to a minimum. Proper jointing techniques should be used to ensure firm connections.

Replacement of deteriorated wires and services should also be made timely to avoid any cause of leaking and loss of power.

6- Feeder Phase Current and Load Balancing

One of the easiest loss savings of the distribution system is balancing current along three-phase circuits.

Feeder phase balancing also tends to balance voltage drop among phases giving three-phase customers less voltage unbalance. Amperage magnitude at the substation doesn’t guarantee load is balanced throughout the feeder length.

Feeder phase unbalance may vary during the day and with different seasons. Feeders are usually considered “balanced” when phase current magnitudes are within 10. Similarly, balancing load among distribution feeders will also lower losses assuming similar conductor resistance. This may require installing additional switches between feeders to allow for appropriate load transfer.

Bifurcation of feeders according to Voltage regulation and Load.

7- Load Factor Effect on Losses

Power consumption of customer varies throughout the day and over seasons.

Residential customers generally draw their highest power demand in the evening hours. Same commercial customer load generally peaks in the early afternoon. Because current level (hence, load) is the primary driver in distribution power losses, keeping power consumption more level throughout the day will lower peak power loss and overall energy losses.

Lower power and energy losses are reduced by raising the load factor, which, evens out feeder demand variation throughout the feeder.

The load factor has been increase by offering customers “time-of-use” rates. Companies use pricing power to influence consumers to shift electric-intensive activities during off-peak times (such as, electric water and space heating, air conditioning, irrigating, and pool filter pumping).

8- Transformer Sizing and Selection

Distribution transformers use copper conductor windings to induce a magnetic field into a grain-oriented silicon steel core. Therefore, transformers have both load losses and no-load core losses.

Transformer copper losses vary with load based on the resistive power loss equation (P loss = I^2*R). For some utilities, economic transformer loading means loading distribution transformers to capacity-or slightly above capacity for a short time-in an effort to minimize capital costs and still maintain long transformer life.

However, since peak generation is usually the most expensive, total cost of ownership (TCO) studies should take into account the cost of peak transformer losses. Increasing distribution transformer capacity during peak by one size will often result in lower total peak power dissipation-more so if it is overloaded.

Transformer no-load excitation loss (iron loss) occurs from a changing magnetic field in the transformer core whenever it is energized. Core loss varies slightly with voltage but is essentially considered constant. Fixed iron loss depends on transformer core design and steel lamination molecular structure. Improved manufacturing of steel cores and introducing amorphous metals (such as metallic glass) have reduced core losses.

9- Balancing 3 phase loads

Balancing 3-phase loads periodically throughout a network can reduce losses significantly. It can be done relatively easily on overhead networks and consequently offers considerable scope for cost effective loss reduction, given suitable incentives.

10- Switching off transformers

One method of reducing fixed losses is to switch off transformers in periods of low demand. If two transformers of a certain size are required at a substation during peak periods, only one might be required during times of low demand so that the other transformer might be switched off in order to reduce fixed losses.

This will produce some offsetting increase in variable losses and might affect security and quality of supply as well as the operational condition of the transformer itself. However, these trade-offs will not be explored and optimized unless the cost of losses are taken into account.

11- Other Reasons for Technical Losses

- Unequal load distribution among three phases in L.T system causing high neutral currents.
- leaking and loss of power
- Over loading of lines.
- Abnormal operating conditions at which power and distribution transformers are operated
- Low voltages at consumer terminals causing higher drawl of currents by inductive loads.
- Poor quality of equipment used in agricultural pumping in rural areas, cooler air-conditioners and industrial loads in urban areas.

In the table4.4 we show the result of network after fixed the loses parameter's ,and table 4.5 show the total losses.

Table 4.4: branch losses after fixed losses parameters

IDBranch	From	To	FromToMW	FromToMVar	ToFromMW	ToFromMvar	LosskW	Losskvar	VFrom	VTo	VDrop
Cable1	Bus1	Bus2	5.572815	1.710555	-5.56933	-1.74221	3.489866	-31.6528	100	99.93146	0.068542
Line1	Bus2	Bus3	4.017716	1.130789	-4.01325	-1.13072	4.464722	0.066037	99.93146	99.82288	0.108579
Line55	Bus2	Bus94	0.012478	0.004203	-0.01248	-0.00742	0.000421	-3.2172	99.93146	99.92855	0.002907
Line56	Bus2	Bus97	1.539131	0.607215	-1.53636	-0.60986	2.767636	-2.64906	99.93146	99.76402	0.167442
Line2	Bus3	Bus4	0.147222	0.048713	-0.14722	-0.0493	0.004481	-0.58563	99.82288	99.81996	0.002914
Line3	Bus3	Bus6	0.063644	0.036183	-0.06364	-0.03677	0.001001	-0.58632	99.82288	99.82156	0.001315
Line42	Bus3	Bus72	3.802386	1.045827	-3.79799	-1.04585	4.399703	-0.02695	99.82288	99.70971	0.113173
T1	Bus4	Bus5	0.147217	0.049298	-0.14588	-0.04729	1.341832	2.012748	99.81996	98.59556	1.224404
T2	Bus6	Bus7	0.063643	0.03677	-0.06289	-0.03564	0.751865	1.127797	99.82156	98.17458	1.646986
Line4	Bus8	Bus72	-3.71929	-1.00993	3.734369	1.009743	15.07723	-0.18825	99.31471	99.70971	0.394995
Line5	Bus8	Bus10	3.654048	0.994081	-3.64547	-0.99424	8.575181	-0.15885	99.31471	99.08614	0.228575
T3	Bus8	Bus9	0.065244	0.01585	-0.06461	-0.0149	0.633797	0.950696	99.31471	100.5304	1.215665
Line6	Bus10	Bus11	0.065185	0.015207	-0.06518	-0.01607	0.001273	-0.86658	99.08614	99.08422	0.001916
Line7	Bus10	Bus13	3.580288	0.979033	-3.57737	-0.97911	2.914717	-0.07464	99.08614	99.00706	0.07908
T4	Bus11	Bus12	0.065184	0.016074	-0.06455	-0.01512	0.63665	0.954976	99.08422	100.2872	1.202985
Line8	Bus13	Bus14	0.148212	0.045225	-0.14819	-0.04811	0.02284	-2.87997	99.00706	98.99232	0.014739
Line9	Bus13	Bus16	2.715503	0.692642	-2.71362	-0.693	1.887143	-0.36186	99.00706	98.93922	0.067834
Line30	Bus13	Bus51	0.713659	0.24124	-0.71339	-0.24261	0.264281	-1.36699	99.00706	98.97198	0.035073
T5	Bus14	Bus15	0.148189	0.048105	-0.14681	-0.04604	1.374036	2.061054	98.99232	100.2065	1.214229
Line10	Bus16	Bus17	0.148161	0.047566	-0.14816	-0.04815	0.004685	-0.58677	98.93922	98.93621	0.003012
Line11	Bus16	Bus19	0.072361	0.008678	-0.07236	-0.00925	0.001007	-0.57598	98.93922	98.93784	0.001389
Line12	Bus16	Bus21	0.064049	0.036445	-0.06405	-0.03702	0.001033	-0.57597	98.93922	98.93789	0.001336
Line13	Bus16	Bus23	2.429045	0.600315	-2.42486	-0.60152	4.187662	-1.20853	98.93922	98.77069	0.16853
T6	Bus17	Bus18	0.148156	0.048152	-0.14678	-0.04609	1.375297	2.062945	98.93621	100.1481	1.211894
T7	Bus19	Bus20	0.07236	0.009254	-0.07188	-0.00853	0.482501	0.723752	98.93784	100.6225	1.684622
T8	Bus21	Bus22	0.064048	0.037021	-0.06327	-0.03586	0.775313	1.162969	98.93789	99.69696	0.759077
Line14	Bus23	Bus24	0.249923	0.059926	-0.2499	-0.06078	0.018849	-0.85757	98.77069	98.76332	0.007372
Line15	Bus23	Bus26	0.249923	0.059926	-0.2499	-0.06078	0.018849	-0.85757	98.77069	98.76332	0.007372

Line16	Bus23	Bus28	1.925011	0.481672	-1.92398	-0.48226	1.033084	-0.58924	98.77069	98.71836	0.05233
T9	Bus24	Bus25	0.249904	0.060783	-0.24752	-0.0572	2.388332	3.582498	98.76332	99.99229	1.228975
T10	Bus26	Bus27	0.249904	0.060783	-0.24752	-0.0572	2.388332	3.582498	98.76332	99.99229	1.228975
Line17	Bus28	Bus29	0.072296	0.009183	-0.0723	-0.00947	0.000506	-0.28671	98.71836	98.71767	0.000696
Line18	Bus28	Bus31	1.851682	0.473078	-1.85065	-0.47373	1.035769	-0.65092	98.71836	98.66393	0.054432
T11	Bus29	Bus30	0.072296	0.00947	-0.07181	-0.00874	0.484173	0.72626	98.71767	100.3926	1.674962
Line19	Bus31	Bus32	0.072281	0.008665	-0.07228	-0.00952	0.001517	-0.85916	98.66393	98.66184	0.002088
Line20	Bus31	Bus34	0.343118	0.112744	-0.34304	-0.11445	0.074661	-1.70394	98.66393	98.64333	0.020605
Line26	Bus31	Bus44	0.368305	0.104346	-0.36826	-0.10535	0.049448	-1.00434	98.66393	98.65099	0.012938
Line44	Bus31	Bus75	1.066943	0.247974	-1.0664	-0.24922	0.541894	-1.25093	98.66393	98.61423	0.049703
T12	Bus32	Bus33	0.072279	0.009524	-0.07179	-0.0088	0.4846	0.7269	98.66184	100.3344	1.672511
Line21	Bus34	Bus35	0.129978	0.052392	-0.12997	-0.05325	0.005627	-0.85798	98.64333	98.63937	0.003958
Line23	Bus34	Bus39	0.06507	0.015929	-0.06507	-0.0165	0.000857	-0.57257	98.64333	98.64204	0.001283
Line24	Bus34	Bus41	0.147995	0.046127	-0.14798	-0.04755	0.011435	-1.42378	98.64333	98.63596	0.007358
Line22	Bus35	Bus36	0.065546	0.03619	-0.06554	-0.03791	0.003242	-1.71739	98.63937	98.63526	0.004107
T14	Bus35	Bus38	0.064426	0.017059	-0.06402	-0.01645	0.405168	0.607752	98.63937	100.2779	1.638498
T13	Bus36	Bus37	0.065543	0.037908	-0.06473	-0.03668	0.817161	1.225742	98.63526	99.341	0.70574
T15	Bus39	Bus40	0.065069	0.016501	-0.06443	-0.01554	0.642226	0.963339	98.64204	99.82063	1.178588
Line25	Bus41	Bus42	0.147984	0.047551	-0.14798	-0.04841	0.00692	-0.85759	98.63596	98.63153	0.004439
T16	Bus42	Bus43	0.147977	0.048409	-0.14659	-0.04634	1.38219	2.073286	98.63153	99.83073	1.199198
Line27	Bus44	Bus45	0.14799	0.048108	-0.14799	-0.04839	0.002309	-0.28596	98.65099	98.64951	0.00148
Line28	Bus44	Bus47	0.14799	0.048108	-0.14799	-0.04839	0.002309	-0.28596	98.65099	98.64951	0.00148
Line29	Bus44	Bus49	0.072277	0.009135	-0.07228	-0.00954	0.000708	-0.40084	98.65099	98.65002	0.000975
T17	Bus45	Bus46	0.147987	0.048394	-0.14661	-0.04632	1.381781	2.072672	98.64951	99.84946	1.199948
T18	Bus47	Bus48	0.147987	0.048394	-0.14661	-0.04632	1.381781	2.072672	98.64951	99.84946	1.199948
T19	Bus49	Bus50	0.072276	0.009536	-0.07179	-0.00881	0.484691	0.727036	98.65002	100.322	1.671992
Line31	Bus51	Bus52	0.064058	0.035585	-0.06406	-0.03703	0.002566	-1.44087	98.97198	98.96865	0.003335
Line32	Bus51	Bus54	0.065631	0.037308	-0.06563	-0.03795	0.001214	-0.64551	98.97198	98.97045	0.001532
Line33	Bus51	Bus56	0.583705	0.169715	-0.58349	-0.17143	0.213545	-1.71599	98.97198	98.93671	0.035272
T20	Bus52	Bus53	0.064056	0.037025	-0.06328	-0.03586	0.775015	1.162522	98.96865	99.72883	0.760178
T21	Bus54	Bus55	0.065629	0.037953	-0.06482	-0.03673	0.813729	1.220593	98.97045	99.68829	0.717841
Line34	Bus56	Bus57	0.088808	0.010358	-0.08881	-0.01122	0.002274	-0.86377	98.93671	98.93416	0.002557
Line35	Bus56	Bus59	0.494684	0.161073	-0.49463	-0.1617	0.056428	-0.62263	98.93671	98.92586	0.010853
T22	Bus57	Bus58	0.088806	0.011222	-0.08808	-0.01013	0.726517	1.089775	98.93416	100.4424	1.508264
Line36	Bus59	Bus60	0.218382	0.041633	-0.21837	-0.04221	0.00937	-0.57417	98.92586	98.92161	0.004248
Line39	Bus59	Bus66	0.064046	0.036328	-0.06404	-0.03702	0.001239	-0.69098	98.92586	98.92426	0.001603
Line40	Bus59	Bus68	0.064046	0.036328	-0.06404	-0.03702	0.001239	-0.69098	98.92586	98.92426	0.001603
Line41	Bus59	Bus70	0.148154	0.047405	-0.14815	-0.04816	0.006062	-0.75914	98.92586	98.92196	0.003898
Line37	Bus60	Bus62	0.129572	0.030973	-0.12957	-0.03155	0.003367	-0.5753	98.92161	98.91907	0.002544
T23	Bus60	Bus61	0.088801	0.011234	-0.08807	-0.01014	0.726654	1.089981	98.92161	100.4293	1.507699
Line38	Bus62	Bus64	0.064428	0.015315	-0.06443	-0.01589	0.000833	-0.57578	98.91907	98.9178	0.001265
T24	Bus62	Bus63	0.065141	0.016233	-0.0645	-0.01528	0.638717	0.958076	98.91907	100.1129	1.193883
T25	Bus64	Bus65	0.064427	0.015891	-0.06418	-0.01552	0.249628	0.374442	98.9178	100.8845	1.966686
T26	Bus66	Bus67	0.064045	0.037019	-0.06327	-0.03586	0.775445	1.163168	98.92426	99.68285	0.758589
T27	Bus68	Bus69	0.064045	0.037019	-0.06327	-0.03586	0.775445	1.163168	98.92426	99.68285	0.758589
T28	Bus70	Bus71	0.148148	0.048164	-0.14677	-0.0461	1.375618	2.063426	98.92196	100.1333	1.211301
Line43	Bus72	Bus73	0.063618	0.036112	-0.06362	-0.03676	0.002412	-0.64356	99.70971	99.70669	0.003017

T29	Bus73	Bus74	0.063615	0.036755	-0.06286	-0.03563	0.752954	1.129432	99.70669	98.0585	1.648185
Line45	Bus75	Bus76	0.063967	0.036669	-0.06397	-0.03698	0.000561	-0.30899	98.61423	98.6135	0.000723
Line46	Bus75	Bus78	1.002434	0.212556	-1.00219	-0.21321	0.244334	-0.65021	98.61423	98.59027	0.023958
T30	Bus76	Bus77	0.063966	0.036978	-0.06319	-0.03581	0.778476	1.167714	98.6135	99.36096	0.747454
Line47	Bus78	Bus79	0.249736	0.061124	-0.24973	-0.06147	0.00757	-0.34178	98.59027	98.58732	0.002954
Line48	Bus78	Bus81	0.249736	0.061124	-0.24973	-0.06147	0.00757	-0.34178	98.59027	98.58732	0.002954
Line49	Bus78	Bus83	0.502717	0.090957	-0.50269	-0.09129	0.029881	-0.33739	98.59027	98.5844	0.005876
T31	Bus79	Bus80	0.249729	0.061466	-0.24733	-0.05787	2.396717	3.595076	98.58732	99.80655	1.219237
T32	Bus81	Bus82	0.249729	0.061466	-0.24733	-0.05787	2.396717	3.595076	98.58732	99.80655	1.219237
Line50	Bus83	Bus84	0.088681	0.011097	-0.08868	-0.01157	0.001251	-0.46884	98.5844	98.58299	0.001402
Line51	Bus83	Bus86	0.14795	0.048147	-0.14795	-0.04845	0.00245	-0.30271	98.5844	98.58282	0.00157
Line52	Bus83	Bus88	0.266055	0.032051	-0.26604	-0.03259	0.013021	-0.54087	98.5844	98.57953	0.004868
T33	Bus84	Bus85	0.08868	0.011565	-0.08795	-0.01047	0.730382	1.095573	98.58299	100.0754	1.492441
T34	Bus86	Bus130	0.147948	0.04845	-0.14656	-0.04637	1.3833	2.07495	98.58282	99.77999	1.197166
Line53	Bus88	Bus90	0.177364	0.021023	-0.17736	-0.02159	0.006029	-0.56508	98.57953	98.57614	0.003381
T35	Bus88	Bus89	0.088679	0.011569	-0.08795	-0.01047	0.730421	1.095631	98.57953	100.0718	1.492285
Line54	Bus90	Bus92	0.08868	0.010016	-0.08868	-0.01158	0.004158	-1.56057	98.57614	98.57148	0.004663
T36	Bus90	Bus91	0.088678	0.011572	-0.08795	-0.01048	0.730458	1.095687	98.57614	100.0683	1.492132
T37	Bus92	Bus93	0.088676	0.011577	-0.08795	-0.01048	0.73051	1.095765	98.57148	100.0634	1.491922
AL-DOARA	Bus94	Bus95	0.012477	0.007421	-0.01246	-0.00739	0.018731	0.028097	99.92855	99.71893	0.209627
Cable2	Bus97	Bus98	1.536364	0.609864	-1.53624	-0.62473	0.125043	-14.869	99.76402	99.75522	0.008801
Line57	Bus98	Bus99	1.536239	0.624733	-1.53541	-0.62552	0.830522	-0.78539	99.75522	99.70525	0.049962
Cable3	Bus99	Bus100	0.126167	0.035519	-0.12617	-0.04031	0.000254	-4.78704	99.70525	99.70503	0.00022
Line60	Bus99	Bus105	1.409241	0.589999	-1.40862	-0.59071	0.62278	-0.71418	99.70525	99.66469	0.040565
Line58	Bus100	Bus101	0.126167	0.040306	-0.12615	-0.04167	0.016785	-1.36609	99.70503	99.69263	0.012405
Cable4	Bus101	Bus102	0.12615	0.041672	-0.12615	-0.05274	0.000615	-11.0716	99.69263	99.6921	0.000529
Line59	Bus102	Bus103	0.057571	0.017083	-0.05757	-0.02128	0.004927	-4.19305	99.6921	99.68392	0.008181
GARJAES	Bus102	Bus109	0.068578	0.035661	-0.06804	-0.03486	0.533542	0.800313	99.6921	98.60718	1.084919
RAS ALTAWEL	Bus103	Bus104	0.057566	0.021276	-0.05723	-0.02077	0.336411	0.504617	99.68392	98.88894	0.794978
Line61	Bus105	Bus106	0.068532	0.01966	-0.06853	-0.0205	0.002997	-0.84124	99.66469	99.66055	0.004137
Line62	Bus105	Bus110	1.271599	0.535441	-1.26703	-0.54203	4.573214	-6.58475	99.66469	99.33562	0.329073
KHALET AL-FOOL	Bus105	Bus112	0.068488	0.035613	-0.06796	-0.03481	0.532434	0.798651	99.66469	98.5809	1.08379
Cable5	Bus106	Bus107	0.068529	0.020501	-0.06853	-0.03563	0.000254	-15.1338	99.66055	99.66015	0.0004
BET ENON	Bus107	Bus108	0.068528	0.035635	-0.068	-0.03484	0.533109	0.799663	99.66015	98.57568	1.084478
Line63	Bus110	Bus113	1.027465	0.416719	-1.02457	-0.42339	2.895174	-6.67298	99.33562	99.0766	0.259015
RAS ALAROD	Bus110	Bus111	0.23956	0.125307	-0.23695	-0.12139	2.608734	3.913101	99.33562	100.269	0.933348
Cable6	Bus113	Bus115	0.896455	0.371565	-0.89643	-0.38107	0.028236	-9.50611	99.0766	99.07323	0.003371
AL SHAFA	Bus113	Bus114	0.128116	0.051827	-0.12704	-0.05021	1.079302	1.618953	99.0766	100.3754	1.298805
Line65	Bus115	Bus117	0.217849	0.115107	-0.21773	-0.12089	0.116559	-5.78082	99.07323	99.02789	0.045339
Line66	Bus115	Bus119	0.035123	0.009968	-0.03512	-0.01118	0.000531	-1.20737	99.07323	99.07178	0.001455
Line68	Bus115	Bus124	0.384468	0.142587	-0.38424	-0.14665	0.226672	-4.06101	99.07323	99.01828	0.054947
AL AEN	Bus115	Bus116	0.258986	0.113408	-0.25612	-0.10911	2.868155	4.302233	99.07323	99.99157	0.91834
WAD ALSHARQ	Bus117	Bus118	0.217732	0.120888	-0.21422	-0.11563	3.508201	5.262302	99.02789	99.21939	0.191501
Line67	Bus119	Bus120	0.035123	0.011176	-0.03512	-0.0141	0.001335	-2.92873	99.07178	99.06821	0.003569

WAD SA'IR	Bus120	Bus121	0.035121	0.014104	-0.03492	-0.0138	0.202399	0.303599	99.06821	98.28191	0.786294
Line69	Bus122	Bus124	-0.1745	-0.07654	0.174523	0.074401	0.025439	-2.14156	99.00509	99.01828	0.013191
AHMARON	Bus122	Bus123	0.174498	0.076542	-0.17244	-0.07346	2.054696	3.082044	99.00509	99.82442	0.819333
Line70	Bus124	Bus125	0.209718	0.072247	-0.20957	-0.08135	0.149453	-9.10588	99.01828	98.95159	0.066689
Line71	Bus125	Bus127	0.035108	0.004825	-0.0351	-0.0141	0.00403	-9.27329	98.95159	98.94044	0.011149
ABU ZAWEH	Bus125	Bus126	0.174461	0.076528	-0.1724	-0.07344	2.056068	3.084102	98.95159	99.76904	0.817438
RBAEA	Bus127	Bus128	0.035104	0.014098	-0.0349	-0.01379	0.202723	0.304085	98.94044	98.15352	0.786926

Table 4.5: total losses

	KW	KVAR
Total loss	114.7	-107.8

Chapter Five
Load Growth

5.1 Introduction

5.2 Load growth

Chapter Five

Load Growth

5.1 Introduction

This chapter talks about the Sa'ir load growth and the future expected data for the maximum remaining year to reach the maximum load at domestic transformer or reach the available age, in both conditions the transformer who reach its full capacity or maximum age must be replaced

In the other hand chapter 5 contain an economic study for reconstruction to calculate the total money needed for problem solution.

5.2 Load growth

This section talks about the future of electrical load that’s occurred due to natural expansion witch increases by average (8.5%_14.5%) every year at domestic's side. the data needed is taken from Sa'ir municipality from (2008 to December 2015) to decide which areas have a high demand for new electricity participation, build a scientific expectation time for transformer to reach a full load, and study the time needed for replace a transformer due its load and presumptive age at 30 year for each.

The table 5.1 below clears the time needed for domestic's transformers to reach full load and decide if possible to complete its presumptive age or not. The expansion almost uniforms in all areas in the town. so the 6% growth equally included all domestics transformer with average load of 0.7 KWh or 0.77 KVA for each customer at 0.9 power factor.

Table 5.1: Sa'ir expected load growth

Transformer	transformer KVA	used KVA	excess KVA	Number of allowable participation	Transformer Old(year)	Remaining year	Percent of increase of participation	Expect year to reach full load	Number of year for replace
AL-DOARA	250	15	235	305	3	27	8.5%	35	27
KHALET AL-FOOL	250	77	173	244	10	20	11.2%	21	20
RAS AL-TAWEL	250	62	188	244	8	22	12.3%	15	15

BET ENON	250	77	173	244	12	18	11.6%	14	14
GRGAES	250	77	173	244	11	19	12.55%	13	13
RAS AL-AROD	630	266	364	472	24	6	13.8%	26	6
AL-SHFA	400	136	264	342	15	15	12.5%	21	15
WAD AL-SHARQ	400	244	156	202	18	12	13%	12	12
AL-AEN	630	278	352	457	24	6	14.4%	24	6
WAD SA'IR	160	38	122	158	4	26	8.5%	14	14
AHMARON	400	188	212	275	14	16	12%	17	16
ABU ZAWEH	400	188	212	275	16	14	12.5%	17	14
RBAEA	160	38	122	158	**7**	23	10%	12	12

Chapter Six
Conclusion and recommendation

6.1 Introduction.

6.2 problems.

6.3 solution of the problems.

6.4 Recommendation.

Chapter Six

Conclusion and recommendation

6.1 Introduction

This chapter divided in to two main part, the first part summering main problem and solution for Sa'ir medium voltage electric network. it's also contain the expected results after applying the project.

The other part is our recommendation for Sa'ir municipality, Palestine polytechnic university and student of electric power engineering.

6.2 problems

1. the network has a Losses evaluated from the load flow results of Sa'ir electric power network using ETAP show that it has a level of power losses nearly of 174.9 KW .
2. the network has an acceptable power factor value between (0.48-0.87) measured by Vega 78 power analyzer.
3. the network has a voltage drop of 1.8% or 600 volt in industrial, that's drop affects the low voltage side with voltage drop about 7 %.
4. Some protection and isolating equipment is very old with law readability and selectivity.

6.3 solution of the problem.

1. Losses is decreased after the previous scenarios to reach 113.7 KW.
2. Low Power Factor problem solved by Power Factor improvement using capacitor bank.
3. Voltage drop at medium voltage side is acceptable so its needn't to change conductor or redistribute load for a voltage drop of 1.8% at worst case. but the voltage drop at distribution side solved be changing the tap of transformer that's have an under voltage at the load.
4. the protection equipment is solved by calibration of circuit breakers and fuses by evaluate the maximum current using ETAP to satisfy a good selectivity.

The project describes the existing Sa'ir medium voltage network and put a solution for existing problems. the project practically applying will solve those problem and get the following advantages for the network.

1. Power factor will be rise to reach nearly unity power factor.

2. Voltage drop problem will be solved to reach acceptable range in low voltage side.

3. Network losses will be minimized as possible to get acceptable value.

4. Over load and under voltage problem will be solved.

5. Increasing the medium voltage network efficiency.

6.4 Recommendation

A. Recommendation for Sa'ir Municipality

1) Hiring a new electric engineer in the Municipality.

2) Use Vega 78 power analyzer for maintenance and check object.
3) Use power measuring devices for each transformer
4) Use E-TAP program for study the network.

B. Recommendation for our university

1. Build a new relationship between the university and the governmental or private power sector.
2. Change the Field Training system in the university to insure that power student can deal with medium voltage in training sits.
3. help interested student in E-TAP to learn more about the program.

C. Recommendation for power engineering student

1) Tray to learn more about E-TAP program and use it for developing the power engineering in the university.
2) Decide your graduation project in distribution sector for medium and also for low voltage network in other region.
3) Make research's about SCADA system for applying it and applying new power method in all cities in Palestine.

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