The Islamic University Of Gaza
Faculty of Graduate Studies
Department of Control Systems Engineering

Master Thesis

A Proposed SCADA System to improve the conditions of the Electricity sector in Gaza Strip

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A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Electrical Engineering.

1433-2012

بسم الله الرحمن الرحيم

الجامعة الإسلامية – غزة
The Islamic University - Gaza

عمادة الدراسات العليا **هاتف داخلي:** 1150

ج س غ/35/
الرقم.......13/06/2012 Ref
التاريخ..................... Date

نتيجة الحكم على أطروحة ماجستير

بناءً على موافقة عمادة الدراسات العليا بالجامعة الإسلامية بغزة على تشكيل لجنة الحكم على أطروحة الباحث/ **حسن علي محمود أبو مطير** لنيل درجة الماجستير في **كلية *الهندسة*** **قسم الهندسة الكهربائية-أنظمة التحكم** وموضوعها:

A proposed SCADA System to improve the conditions of the Electricity sector in Gaza Strip

وبعد المناقشة العلنية التي تمت اليوم الأحد 18 شعبان 1433هـ، الموافق 2012/07/08م الساعة العاشرة صباحاً، بمبنى طيبة، اجتمعت لجنة الحكم على الأطروحة والمكونة من:

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وبعد المداولة أوصت اللجنة بمنح الباحث درجة الماجستير في **كلية *الهندسة*/ قسم <u>الهندسة الكهربائية-أنظمة التحكم</u>.**

واللجنة إذ تمنحه هذه الدرجة فإنها توصيه بتقوى الله ولزوم طاعته وأن يسخر علمه في خدمة دينه ووطنه.

والله ولي التوفيق ،،،

عميد الدراسات العليا

٢٠١٢/٧/٨

أ.د. فؤاد علي العاجز

صفحة الحكم

DEDICATION

To all my family members who have been a constant source of motivation, inspiration, and support.

ACKNOWLEDGEMENT

I thank Allah, the lord of the worlds, for His mercy and limitless help and guidance. May peace and blessings be upon Mohammed the last of the messengers.

I would like to express my deep appreciation to my advisor Dr. Hatem ELaydi for providing advice, support and excellent guidance. The warm discussions and regular meetings I had with him during this research and his spirit of youth, contributed greatly to the successful completion of this research.

Special thanks to all other Islamic University staff members that I may have called upon for assistance especially Dr. B. Hamed and Dr. I. Abuhadrous , as their suggestions have helped with the development of this thesis.

Finally, I would like to express my special thanks to family and my waif “Heba" for supporting.

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ABSTRACT

Gaza Strip consider is one of the poorest regions in the world, which suffers from the problem of electric power. Gaza Strip relies on three main sources feed into different areas , gets energy from the power plant in Gaza, and the electricity company in Israel, and the power plant in Egypt. This energy is distributed to consumers, depending on the available energy from these sources and distribution process is relying on primitive methods and handy despite the diligence of operators and their keenness on a fair distribution of power in parts of the Gaza Strip, causing problems in the distribution is the lack of distributive justice.

The aim of this study is to propose design a Supervisory Control And Data Acquisition (SCADA System) for the management of the electricity network in the Gaza Strip. Expected from this system work to transfer all the data necessary for the system operator, and provide specialists with the necessary information about the network and transformer substations in the sub-regions such as voltage and current and productive capacity in order to reduce losses on the network to help develop plans to manage power distribution in a fair. These data considered is essential when developing plans for development to keep up with the growing demand for electric power in the Gaza Strip because of the high population steadily.

Adopted the design process to use the method of Optimal Power Flow (OPF) to make sure incoming data to the control system supervisory and data acquisition mathematically by sensors deployed on the transformer substations in the areas of the Gaza Strip, which is working to compile energy from different sources and entered the system Supervisory Control and Data Acquisition, and take appropriate action as a case.

الملخص

يعتبر قطاع غزة من أكثر المناطق فقراً في العالم و التي تعاني من مشكلة الطاقة الكهربائية، فهو يعتمد على ثلاث مصادر أساسية تغذي المناطق المختلفة في قطاع غزة، و يحصل على الطاقة من محطة التوليد في غزة، و شركة الكهرباء في إسرائيل ، و محطة الطاقة في مصر . يتم توزيع هذه الطاقة على المستهلكين اعتماداً على الطاقة المتوفرة من هذه المصادر و تتم عملية التوزيع بالاعتماد على أساليب بدائية و يدوية بالرغم من اجتهاد المُشغلين و حرصهم على توزيع عادل للطاقة في مناطق قطاع غزة، مما يسبب مشاكل في التوزيع تتمثل في عدم عدالة التوزيع.

الهدف من هذه الدراسة هو اقتراح تصميم نظام تحكم إشرافي و اكتساب بيانات لإدارة شبكة الكهرباء في قطاع غزة. المُتوقع من هذا النظام العمل على نقل كافة البيانات اللازمة لمشغل النظام و تزويد المختصين بالمعلومات اللازمة عن الشبكة و المحولات الفرعية في المناطق الفرعية مثل الجهد و التيار و القدرة المُنتجة بهدف تقليل الفاقد على الشبكة للمساعدة في وضع الخطط اللازمة لإدارة توزيع الطاقة بشكل عادل، و تعتبر هذه المعلومات ضرورية عند وضع خطط التطوير لمواكبة الطلب المتزايد على الطاقة الكهربائية في قطاع غزة بسبب ارتفاع عدد السكان بشكل مطرد.

اعتمدت عملية التصميم على استخدام طريقة التوزيع المثالي للطاقة للتأكد من البيانات الواردة إلى نظام التحكم الإشرافي و اكتساب البيانات حسابيا من خلال المجسات المنتشرة على المحولات الفرعية في مناطق قطاع غزة و التي تعمل على تجميع الطاقة الواردة من المصادر المختلفة و إدخالها على نظام التحكم الإشرافي و جلب البيانات، و اتخاذ الإجراء المناسب حسب الحالة.

NOMENCLATURE

ACK	Acknowledgment
A/D	Analog to digital
GEDCO	Gaza Electricity Distribution Co.
IEC	Israeli Electricity Company
RTU	Remote Terminal Unit
MTU	Master Terminal Unit
SCADA	Supervisory Control and Data Acquisition
OPF	Optimal Power Flow
HMI	Human Machine Interface
IED	Intelligent Electronic Device
SOE	Stored sequence Of Events
TTD	Time Tagged Data
ISR	Information Storage and Retrieval
LAN	Local Area Network
WAN	Wide Area Network
IEEE	Institute of Electrical and Electronics Engineers.
PLC	Programmable Logic Control
RS	Recommended Standard
OPC	Ole for Process Control
SQL	Structured Query Language

Chapter 1

INTRODUCTION

1.1 Introduction

Gaza Strip is one of highest overpopulated regions in the world; there are 1.6 million people in 360 km^2. In addition, it is considered one of the poorest regions in the world of stable electricity [1]. Power networks in Gaza Strip are complex systems that cannot be efficiently and securely operated without an energy management system [2].

The electrical network in Gaza is considered radial [2]. A radial network leaves the station and passes through the network area with no normal connection to any other supply. This is typical of long rural lines with isolated load areas. An interconnected network is generally found in more urban areas and will have multiple connections to other points of supply. These points of connection are normally open but allow various configurations by the operating utility with closing and opening switches. Operation of these switches may be by remote control from a control center or by a lineman. The benefit of the interconnected model is that in the event of a fault or required maintenance a small area of network can be isolated and the remainder kept on supply [3].

The main sources of electricity in Gaza are: Gaza Power Station, the Israeli Electricity Company, and the limited power line that comes from Egypt, which feeds the southern part of Gaza Strip [4, 5].

1.2 Problem Statement

Lack of sufficient energy to cover all the growing needs in the Gaza Strip in different periods, result in a large deficit in the distribution of energy for consumers to meet their needs, and the presence of significant losses on the network, and the lack of system monitoring and control monitors the distribution of energy to different areas in the Gaza Strip equally.

1.3 Motivation

Due to the lack of sufficient energy to meet the needs at different times, and difficult to find an easy alternative to generate energy from other sources, the proposed solution, which can be applied to distribute the energy evenly and is just a control system and centralized control.

1.4 Literature Review

- ***Kang, and Yang, (2010)*** [6] **,** this work analysis of 30-bus IEEE stander, the approaches in this paper depended on a distribution and parallel computing framework; without any monitoring or controlling for the power system network. The main simulation result proved the efficiency and balancing load. However, the solution doesn't proposed any mentoring on the system.

- ***Bustami, (2008)*** [7] **,** *proposed* an optimum design and performance analysis of a Palestinian electrical network in the West Bank only, where he outlined an integrated electrical network with standard voltages, low power losses, high quality electrical energy, high reliability, source diversity, good voltage level, and low transmission cost. He's proposed integrated model allows for future connection to the seven Arab country grids, and eventually supplies end users with low cost electrical energy. However, his proposal did not present any approach to monitor or control this network.

- ***Mohammad, Tawalbeh, and Al-Aubidy (2007)*** [8] **,** implemented fast power loss computation and shunt capacitor insertion using fuzzy logic technique for fast power loss computation using supervisory control and data acquisition system (SCADA) with personal computer only. The main objective from this research was correction of power factor based on SCADA system.

- ***Momoh, Zheng, and D'Arnaud (2009)*** [9]**,** proposed an integrated strategy for maintaining voltage stability for online applications. The proposed strategy employed real time data in the computation of a voltage stability index for voltage stability monitoring and control. The chosen index allowed for fast evaluation of the voltage stability margin for real-time assessment. A fast control operation based on fuzzy logic control was used to determine the VAR compensation required for the mitigation of occurrences of voltage in stability.

1.5 Thesis Contribution

This study uses a SCADA system to improve the power quality and to coordinate between power supply by monitoring the current power supplies, balancing the three-phase lines, and controlling the quality of the supplies. The paper also conducts optimal power flow using Newton-Raphson and Gauss- Sidle and Powerword and Matlab with LabView software.

1.6 Methodology

1. Field Visits: Visits includes the Power and Natural Resources Authority, the Electricity Distribution Company, and the Gaza power Generation Plant. The purpose of these visits is to collect the necessary data from expert engineers such as the electric power problems, the current methods of connecting and disconnecting power, energy quality that reaches to the consumer, etc.
2. Analyze and classify of these problems and put clear description for the most important ones using the collected data.
3. Identify similar systems in other countries and identify their problems and how they were solved.
4. Choose the best way to build a SCADA system for electricity distribution in Gaza Strip.
5. Develop a model that simulates the distribution network to test and evaluate the System.
6. Test the developed model and collect the results and feedbacks.

1.7 Thesis Structure

The thesis is organized into 6 chapters. Each chapter begins with an introduction describing the topic reader will encounter. **Chapter 2** covers the main information about SCADA system and control theorem. **Chapter 3** covers characteristic of power system in general and in Gaza, also discusses the main step to control in power systems. **Chapter 4** analyses three buses system which represented Gaza Strip network by using optimal power flow methods and comparing between them. **Chapter 5** proposes a framework to design SCADA system in Gaza Strip with a hardware and software design through assumption of functional descriptions. **Chapter 6** concludes this study and the future work and recommendations.

Chapter 2

SCADA SYSTEM

2.1- Introduction

Control engineering theory studies systems performance stability that must certain specification. The ideal simple system consists of an input, plant, and output. This system may be an open loop which has no feedback signal as shown in Figure 1, or a closed loop, similar to open loop with added feedback signal as shown in Figure 2 [10].

SCADA system is considered a closed loop system. This chapter talks about SCADA systems its, definition, structure, functions, and most applications.

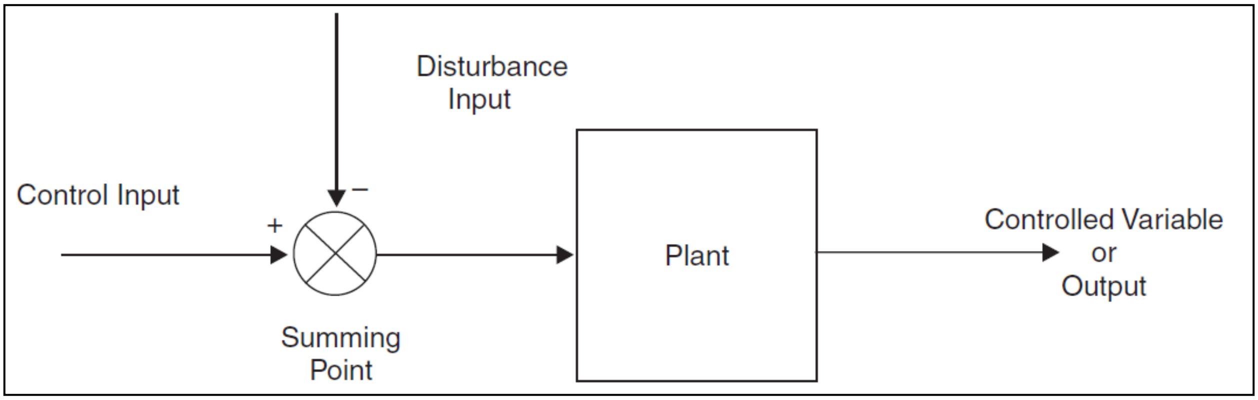

Figure 1: Open loop system

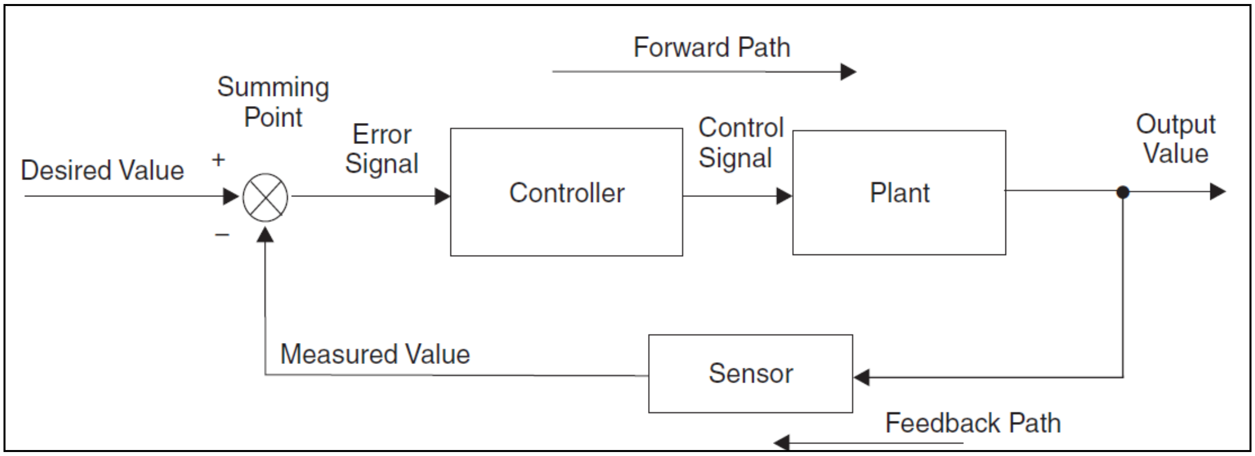

Figure 2: Closed loop system.

2.2 SCADA System

Supervisory control and data acquisition (SCADA) systems are vital components of most nations' critical infrastructures. Most popular SCADA system applications founded in water treatments, chimerical plant, and power networks [11]. SCADA Systems became popular in the 1960's and arose to more efficiently monitor and control the state of remote equipment [12].

SCADA provides management and monitoring with real-time data on production operations, implement more efficient control paradigms, improves plant and personnel safety, and reduces costs of operation. These benefits are made possible by the use of standard hardware and software in SCADA systems combined with improved communication protocols and increased connectivity to outside networks, including the Internet. However, these benefits are acquired at the price of increased vulnerability to attacks or erroneous actions from a variety of external and internal sources [13].

2.3 SCADA System Evolution, Definitions, and Basic Architecture

Supervisory control and data acquisition (SCADA) means different things to different people, depending on their backgrounds and perspectives. Therefore, it is important to review the evolution of SCADA and its definition as understood by professionals and practitioners in the field.

Listed here are two typical definitions of a SCADA system:

- SCADA is the technology that enables a user to collect data from one or more distant facilities and/or send limited control instructions to those facilities.

- SCADA is a system operating with coded signals over communication channels and provides control of RTU (Remote Terminal Unit) equipment.

Additional definitions associated with SCADA systems are given in Table 1. This list is not meant to be all-inclusive, but describes some important terms used in the application of SCADA systems [13].

Table 1: SCADA-Related Definitions

TERM	DEFINTION
Deterministic	Degree to which an activity can be performed within a predictable timeframe.
Proportional, Integral, Derivative (PID) control	Method used to calculate control parameters to maintain a predetermined set point. Mathematical techniques are used to calculate rates of change, time delays, and other functions necessary to determine the Corrections to be applied.
Real-time	An action that occurs at the same rate as actual time; no lag time, no processing time.
Real-time operating system (RTOS)	A computer operating system that implements process and services in a deterministic manner.
Hot stand-by system	A duplicate system that is kept in synchronism with the main system and that can assume control if the main system goes down.

The main process of SCADA system is described in three hierarchical processes first from the top: Supervisory process, the second Control process, and finally Data Acquisition process. Figure 3 illustrates these processes.

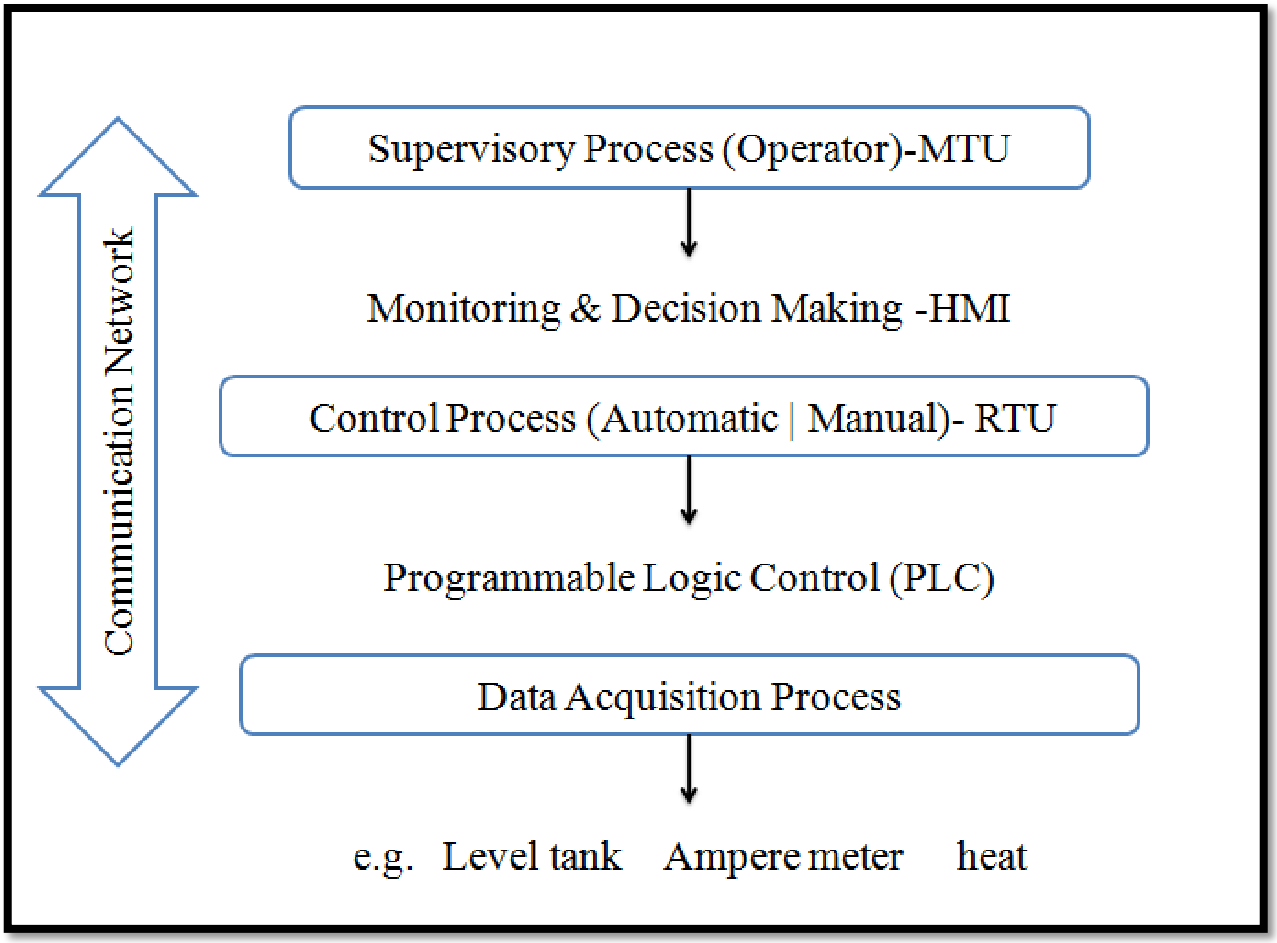

Figure 3: SCADA System Structure.

Operator: Human operator who monitors the SCADA system and performs supervisory control functions for the remote plant operation.

Human machine interface (HMI): Presents data to the operator and provides for control inputs in a variety of formats, including graphics, schematics, windows, pull down menus, touch-screens, and so on.

Master terminal unit (MTU): Equivalent to a master unit in a master/ slave architecture. The MTU presents data to the operator through the HMI, gathers data from the distant site, and transmits control signals to the remote site. The transmission rate of data between the MTU and the remote site is relatively low and the control method is usually open loop because of possible time delays or data flow interruptions

Communications means: Communication method between the MTU and remote controllers. Communication can be through the Internet, wireless or wired networks, or the switched public telephone network.

Remote terminal unit (RTU): Functions as a slave in the master/slave architecture. Sends control signals to the device under control, acquires data from these devices, and transmits the data to the MTU. An RTU may be a PLC. The data rate between the RTU and controlled device is relatively high and the control method is usually closed loop.

As discussed previously, SCADA architecture comprises two levels: a master or client level at the supervisory control center and a slave or data server level that interacts with the processes under control. In addition to the hardware, the software components of the SCADA architecture are important [13].

SCADA software components consist of two components including client (master) and data server (slave) these components connected between them by communication network. The main functions for these components illustrated below:

- **SCADA master/client :**
    - ✓ Human machine interface (HMI).
    - ✓ Alarm handling.
    - ✓ Event and log monitoring.
    - ✓ Special applications.
    - ✓ ActiveX controls.
- **SCADA slave/data server**
    - ✓ Real-time system manager.
    - ✓ Data processing applications.
    - ✓ Report generator.
    - ✓ Alarm handling.
    - ✓ Drivers and interfaces to control components.
    - ✓ Charting and trending.
    - ✓ Typical SCADA system architecture

- ✓ Spreadsheet.
    - ✓ Data logging [13].

2.4 Basis of a real-time control system (SCADA)

The basis of any real-time control is the SCADA system, acquires data from different sources, preprocesses, and stores the data in a database accessible to different users and applications [14, 15]. Modern SCADA systems are configured around the following standard base functions:

- Data acquisition.
- Monitoring and event processing.
- Control.
- Data storage archiving and analysis.
- Application-specific decision support.
- Reporting.

2.4.1 Data Acquisition

Basic information describing the operating state of the power network is passed to the SCADA system. This is collected automatically by equipment in various substations and devices, manually input by the operator to reflect the state of any manual operation of non-automated devices by field crews, or calculated. In all cases, the information is treated in the same way [14]. This information is categorized as:

- Status indications.
- Measured values.
- Energy values.

The status of switching devices and alarm signals are represented by status indications. These indications are contact closings connected to digital input boards of the remote communication device-such as RTU- and are normally either single or double indications [14]. Figure 4 represented by single status indications, whereas all switches and two-state devices have double indication.

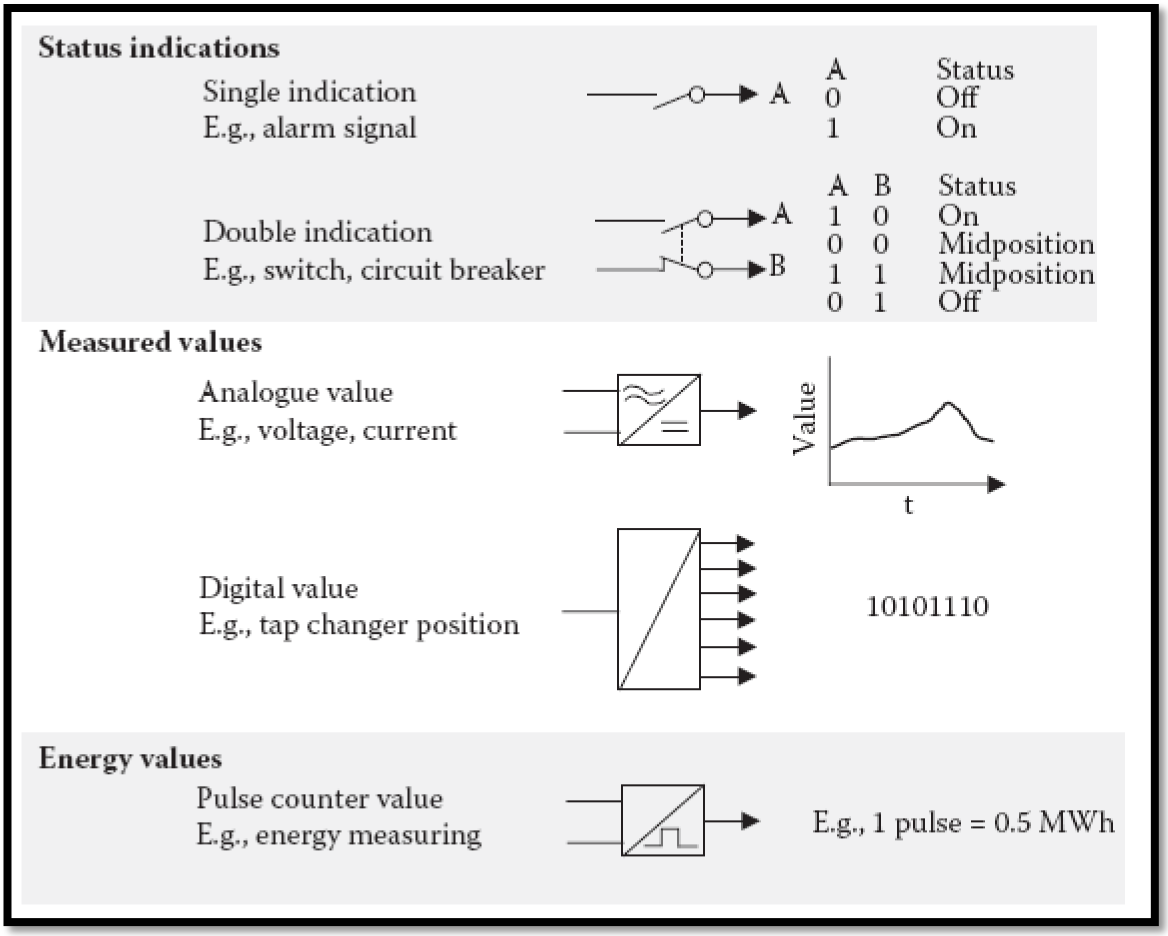

Figure 4: : Examples of acquired data types.

One bit represents the close contact, and the other bit the open contact. This permits the detection of false and intermediate values (00 or 11 state), which would be reflected by a stuck or incomplete switch operation, resulting in a mal operation alarm. Also, errors in the monitoring circuits will be detected. Measured values reflect different time varying quantities, such as voltage, current, temperature, and tap changer positions, which are collected from the power system. They fall into two basic types, analog and digital. All analog signals are transformed via an A/D converter to binary format; because they are treated as momentary values, they have to be normalized before storing in the SCADA database. The scanning (polling) of metered values is done cyclically or by only sending changed values respecting deadbands (report by exception) and recorded on a change-of-value philosophy. Digitally coded values are typical of different settings such as tap changer positions and health checks from (Intelligent Electronic Device) IEDs.

Energy values are usually obtained from pulse counters or IEDs. RTUs associated with pulse meters are instructed to send the pulse information at predefined demand intervals or, if required, intermediate points. At the prespecified time interval, the contents of the continuous counter for the time period is passed on and the process repeated for the next interval [14].

2.4.2 Monitoring and Event processing

The collection and storage of data by itself yields little information; thus, an important function established within all SCADA systems is the ability to monitor all data presented against normal values and limits. The purpose of data monitoring varies for the different types of data collected and the requirements of individual data points in the system. Particularly, if it is a status indication change or limit violation, it will require an event to be processed.

Status monitoring requires that each indication be compared with the previous value stored in the database. Any change generates an event that notifies the operator. To expand the information content, status indications are assigned a normal condition; thus, triggering a different alarm with an out of normal condition message. Status indication changes can be delayed to allow for the operating times of primary devices to avoid unnecessary alarm messaging.

The need to continually provide the operator with information among a multitude of collected data has resulted in the idea of applying quality attributes to data, which in turn invokes a method of flagging the data either in a particular color or symbol in the operator’s display console.

Event processing is required for all events generated by the monitoring function or caused by operator actions. This processing classifies and groups events so that the appropriate information can be sent to the various HMI functions to represent the criticality of the alarm to the operator. Event processing is a crucial function within the control system and significantly influences the real time performance, particularly during alarm bursts. The result of event processing is event and alarm lists in chronological order. In order to assist the operator, events are classified into a number of categories, the most significant being alarms, which generate an alarm list. The following categories are the most usual:

- Unacknowledged and persistent alarm categories determine a particular alert on the display such as flashing of the color presentation, and in some cases an audible signal is generated. The unacknowledged alarm remains until operator acknowledgment is made.

The persistent alarm category remains until the state disappears (usually through operator action) or is inhibited.

- An event associated with a particular device type in which an attribute is assigned for each data point such as a bus voltage or relay protection operation.
- Reason for the event occurring by assignment to the monitoring function (e.g., spontaneous tripping of a circuit breaker or recloser, a manual or control command). A priority assigned for ranking all events into different priority groups often determined by combining the device type and the reason for the event.

The whole purpose of these classifications is to filter important events from less important events, so in times of multiple activities, the operator is assisted in resolving the most important issues first [14].

2.4.3 Control Function

Control functions are initiated by the operators or automatically from software applications and directly affect power system operation. They can be grouped into four subclasses.

Individual device control, which represents the direct open/close command to an individual device.

Control messages to regulating equipment that requires the operation, once initiated by the control room, to automatically be conducted by local logic at the device to ensure operation remains within predetermined limits. Raising or lowering tap changer taps is a typical example or sending of new set points to power generators.

Sequential control covers the automatic completion of a linked set of control actions once the sequence start command has been initiated. A set of sequential switching steps to restore power through a predefined backup configuration typifies sequential control.

Automatic control is triggered by an event or specific time that invokes the control action. Automatic control of voltage through on load tap changing responding automatically to the voltage set point violation is a common example. Time switched capacitor banks are another. The first three control categories above are initiated manually except when sequential control is initiated automatically. Manually initiated control actions can be either always on a select confirm-before-operate basis or immediate command [14].

2.4.4 Data Storage, Archiving, and analysis

As stated earlier, data collected from the process are stored in the real-time database within the SCADA application server to create an up-to-date image of the supervised process. The data from RTUs are stored at the time received, and any data update overwrites old values with new ones.

Performance statistics captured by SCADA systems are extremely important in supplying customers and the regulator with actual figures on power quality of segments of the network as well as the network as a whole. The stored sequence of events (SOE) list provides the basis for developing these statistics.

This time tagged data (TTD) is stored in the historical database at cyclic intervals, e.g., scan rates, every 10 seconds or every hour. Normally, only changed data are stored to save disk space. Data can be extracted at a later date for many forms of analysis such as planning, numerical calculations, system loading and performance audits and report production [14].

This requirement for data mining is driving more sophisticated data archiving functions with adaptable ways to select data and events to be stored. These historians, utility data warehouses, or information storage and retrieval (ISR) systems with full redundancy and flexible retrieval facilities are now an integral part of any DMS. They are normally based on commercial relational databases like *Oracle* or *SQL server*.

2.4.5 SCADA Hardware

SCADA systems are implemented on hardware comprised of a multi-channeled communications front end that manages the data acquisition process from the RTUs. This traditionally has been achieved by repeated polling of RTUs at short intervals (typically, every 2 seconds). The data received are then passed to the SCADA server, over a local area network (LAN), for storage and access by operators and other applications. Control is invoked through operator consoles supporting the HMI command structure and graphic displays. The mission criticality of SCADA systems demands that redundancy is incorporated, thus hot standby front ends and application servers based on dual LAN configurations are standard. The general configuration of a typical SCADA system is shown in Figure 5 the front ends support efficient communications arrangements over a wide area network (WAN) to the RTUs, for the collection of process data and the transmission of control commands that can be optimized for both security and cost. Communication front ends support a variety of configurations. The most popular in use today are as follows:

- Multi-drop is a radial configuration where RTUs are polled in sequence over one communications channel. This results in a cheaper solution at the expense of response time.
- Point-to-point dedicates one communication channel to one RTU. It is commonly used for either major substations or data concentrators having RTUs with large I/O requirements. This configuration gives high response levels with the added expense of many communication channels. In applications requiring very high reliability, an additional communication path is added to form a redundant line point-to-point scheme.
- Loop operates in an open loop configuration supplied from two communication front ends, each channel being of the multi-drop type. The advantage is one of reliability, because the loss of any communication segment path can be overcome by switching the normally open point (*NOP*).
- Star configuration is a combination of point-to-point to data concentrator RTU, which controls data access to slave RTUs configured as point-to-point or multi-drop. Such configurations are used in distribution automation where a mixed response time can be economically engineered.

The central system comprising of everything above the communications front end is called the “master station.” In the industry, there exist many communications protocols and their variants in use between the master station and the RTUs [14].

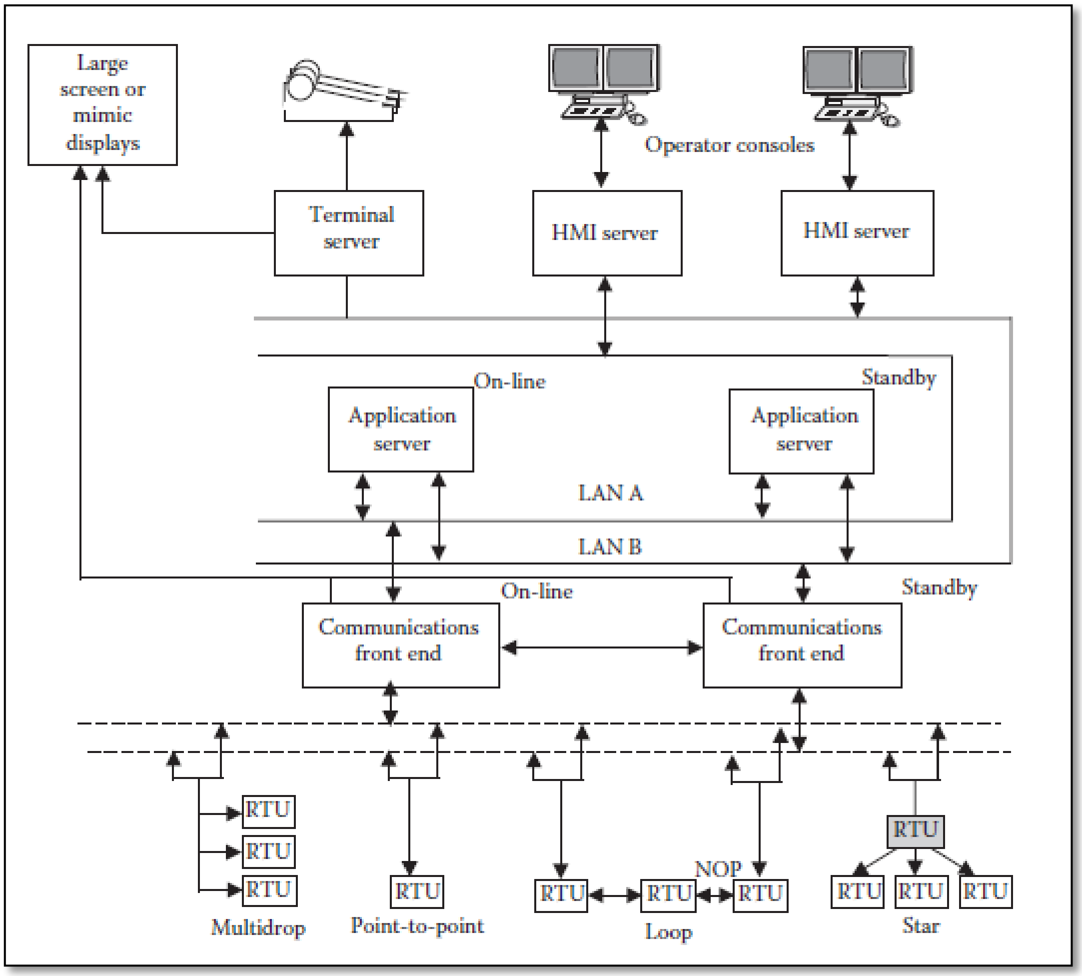

Figure 5: Configuration of a typical SCADA system

Chapter 3

GAZA POWER SYSTEMS CHARACTERISTICS

3.1 Introduction

This chapter covers the main power system characteristic in general, and then goes into details about the power system characteristic in Gaza Strip. Then, it will concentrate on power feeder resources, distribution network, and the main problem and obstacle to developing power system in Gaza Strip.

Electrical energy is the most popular form of energy, because it can be transported easily at reasonable cost [16]. A reliable, continuous supply of electric energy is essential for the functioning of today's complex societies. Due to a combination of increasing energy consumption and impediments of various kinds concerning the extension of existing electric transmission networks, these power systems are operated closer and closer to their limits [17].

3.2 Modern Power system

The ideal Power System operation under normal balanced three-phase steady-state conditions requires the following:

1. Generation supplies.
2. Transmission line networks.
3. Distribution networks.
4. Consumers or Load.

Figure 6 illustrates the ideal power system compensates [19].

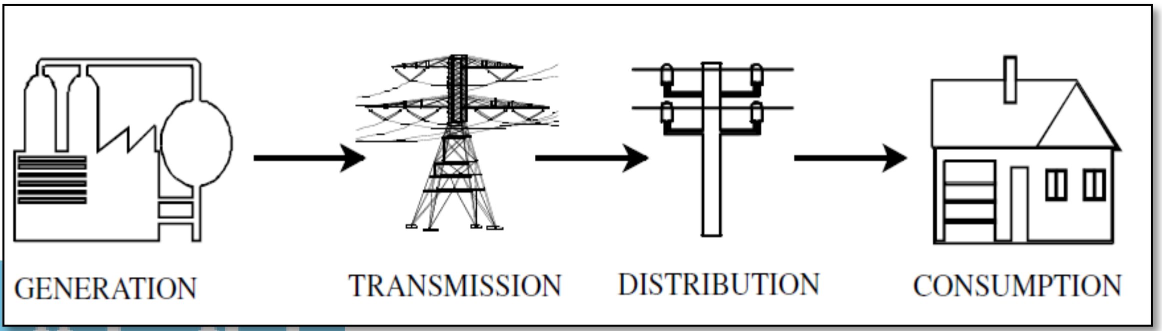

Figure 6: : the ideal power system compensates.

For more detail we can see the basic components of a power system as shown in Figure 7.

3.2.1 Generation

Generators are the essential components of power systems. The generator units responsibility into produce the power which will be transposing through transformer to far customer by transmissions line [19].

There are many types of generators which depend on Gas, Hydraulic, and Solar energy.

3.2.2 Transformers (Substations)

Another major component of a power system is the transformer. It transfers power with high efficiency from one level of voltage to another level. The power transferred to secondary is almost the same as primary, except for losses in the transformer, and the product VI on the secondary side is approximately the same as the primary side. Therefore, using a step-up transformer of turns ratio a will reduce the secondary current by a ratio of (1/a).

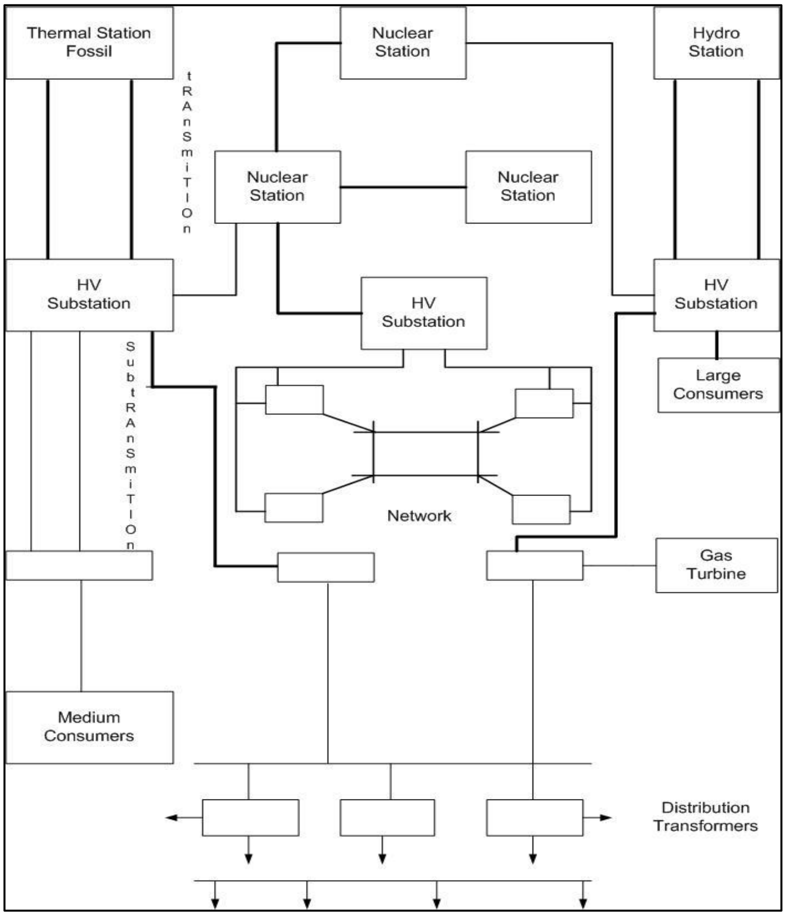

Figure 7: Basic components of a power system.

This will reduce losses in the line, which makes the transmission of power over long distances possible. At receiving end of the transmission lines step-down transformers are used to reduce the voltage to suitable value for distribution or utilization. In modern utilization system, the power may be undergo four or five transformations between generator and ultimate user [19].

3.2.3 Transmission and Sub transmission

The purpose of an overhead transmission network is to transfer electric energy from generation units at various locations to the distribution system which ultimately supplies the load. Transmission lines also interconnect neighboring utilities which permits not only economic dispatch of power within region during normal condition, but also the transfer of power between regions during emergencies. Figure 7 shown an elementary diagram of a transmission and distribution system. High voltage transmission lines are terminated in substations, which are called *high-voltage* substations, receiving substations, or primary substations. The function of some substation is switching circuit in and out of service; they are referred to as switching station. At the primary substation, the voltage is stepped down to a value more suitable for the nest part of the journey toward the load. Very large industrial customers may be served from the transmission system.

The portion of the transmission system that connects the high-voltage substations through step-down transformers to the distribution substations is called the substations network. There is no clear delineation between transmission and substation voltage levels. Capacitor banks and reactor banks are usually installed in the substations for maintaining the transmission line voltage [19].

3.2.4 Distribution

The distribution system is that part which connects the distribution substations to the consumers' service-entrance equipment. The primary distribution lines are usually in the range of 4 to 34.5 kV and supply the load in a well-defined geographical area. The secondary distribution network reduces the voltage for utilization by commercial and residential consumers. Lines and cable not exceeding a few hundred feet in length then deliverer power to the individual consumers. The secondary distribution serves most of the customers at level of 240/120 V, single- phase, tree-wire; 208Y/120V, tree-phase, four-wire; or 480Y/277V, three-phase, four wire. The power for a typical home is derived from a transformer that reduces the primary feeder voltage to 240/120V using a three-wire line.

Distribution systems are both *overload* and *underground*. The growth of underground distribution has been extremely repaid and as much as 70 percent of new residential construction is served underground [19].

3.2.5 Loads

Loads of power systems are divided into industrial, commercial, and residential. Very large industrial loads may be served from the transmission system. Large industrial loads are served directly from the subtransmission network. The industrial loads are served from the primary distribution network. The industrial loads are composite loads, and induction motors from a high protection of these load. These composite loads are function of voltage and frequency and form a major part of the system load Commercial and residential loads consist largely of lighting, heating, and cooling. These loads are independent of frequency and consume negligibly small reactive power.

The real power of loads is expressed in term of kilowatts or megawatts. The magnitude of load varies throughout the day, and power must be available to consumers on demand.

The daily-load curve of a utility is a composite of demand made by various classes of users. The greatest value of load during a 24-hr period is called the *peak* or *maximum demand*. Smaller peaking generators may be commissioned to meet the peak load that occurs for only a few hours. In order to assess the usefulness of the generating plant the *load factor* is defined. The load factor is ratio of average load over a designated period of time to the peak load occurring in that period. Load factors may be given for a day, a month, or a year. The yearly or annual load factor is most useful since a year represent a full cycle of times.

The daily load factor is

$$\frac{average\ load}{peak\ load} \qquad (3.1)$$

Multiplying the numerators and denominator of daily load factor by a time period of 24-hr, we have

$$\frac{energy\ consumed\ during\ 24\ hr}{peak\ load \times 24hr} \qquad (3.2)$$

The annual load factor is

$$\frac{total\ annual\ energy}{peak\ load \times 8760hr} \tag{3.3}$$

Generally there is diversity in the peak load between different classes of the loads, which improves the overall system load factor. In order for a power plant to operate economically, it must have a high system load factor. Today's typical system load factors are in the range of 55 to 70 percent.

There are a few other factors used by utilities. *Utilization factor* is the ratio of maximum demand to installed capacity, and *plant factor* is the ratio of annual energy generation to the plant capacity ×8760 hr. These factors indicate how well the system capacity is utilized and operated [19].

3.3 Power system control consists of 4 steps

- System parametric or state-space modeling based on physical components or assumed properties
- System parameter identification based on component data and measurements.
- System observation of inputs and outputs by filtering, prediction, state estimation etc.
- Design of an open-loop or closed-loop system control law such that the operating conditions are met [14].

IEEE stander power flow system divided into five categories 14, 30, 57,118, and 300 buses [20]. For example the information for 30 bus system is including 50 branches and 7 generators. The base case for active power and reactive power load is 2859 MW and 1773 MW, respectively, and the system power and voltage base are 100 MVA and 330-kv.The system illustrated in Figure 8[21].

Power system in Gaza is not similar to any IEEE standards, so the power system in Gaza needs a lot of development and improvement, so we can apply previous steps. The main problem in Gaza power system, there does not exist of a real distribution network to distributed efficient power [2].

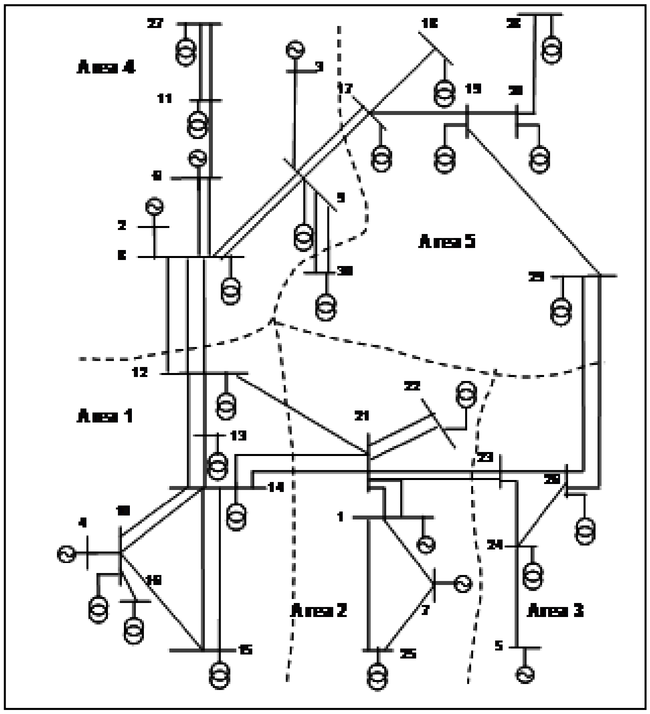

Figure 8: 30- bus 330KV HV systems

3.4 Power System in Gaza Strip

On the other hand, the situation in the Gaza Strip differs from the ideal one; since the Gaza Strip depends on three different sources of energy was detailed in pervious point. It also includes a distribution networks for these sources without the presence of a real transmission networks due to various factors currently prevent the existence such networks, and absence of any organized way between these sources based on need.

The needs varies from time to time and place most of the operations manually and results in many errors that adversely affect an efficient system and the energy that must be reach to consumers. From the viewpoint of system automation, Generating Unit Control is a complete closed-loop system and in the last decade a lot of effort has been dedicated to improve the performance of the controllers. The main problem for example with excitation control is that the control law is based on a linearized machine model and the control parameters are tuned to some nominal operating conditions.

In case of a large disturbance, the system conditions will change in a highly non-linear manner and the controller parameters are no longer valid. In this case the controller may even add a destabilizing effect to the disturbance by for example adding negative damping.

3.5 Power feeders of Gaza Strip:

Gaza Strip relies on three main sources of power: Gaza Power Station, the Israeli Electricity Company, and the limited power line that comes from Egypt, which feeds the southern part of Gaza Strip. Gaza is fed with electricity as follows:

- Ten Israeli lines, 12 MW for each line; a total of 120 megawatts divided as follows:
  - Gaza City: Dome line, Baghdad line, Sha'af line, and the sea line (shared between Gaza City and the north area).
  - North area: Jabalya line and Beit Lahiya line.
  - Central area: Line K7 and line 11 (shared between the Central area and Khan Younis).
  - Khan Younis: Line 8.
  - Rafah: Line 9 (joint between Khan Younis and Rafah).
- Two lines from Egypt 5 MW and 12 MW. It feeds Rafah area in the south.
- Gaza power plant and with nominal capacity of each generator is 140 MW. The generators transformers have been destroyed in 2006 as a result of the Zionist shelling. After a partial reform, the current production capacity of the generators is 78 MW each [4].

Figure 9 illustrates the sources that provide power to Gaza strip, the areas in which it is distributed, and the shortage in each distribution line [3].

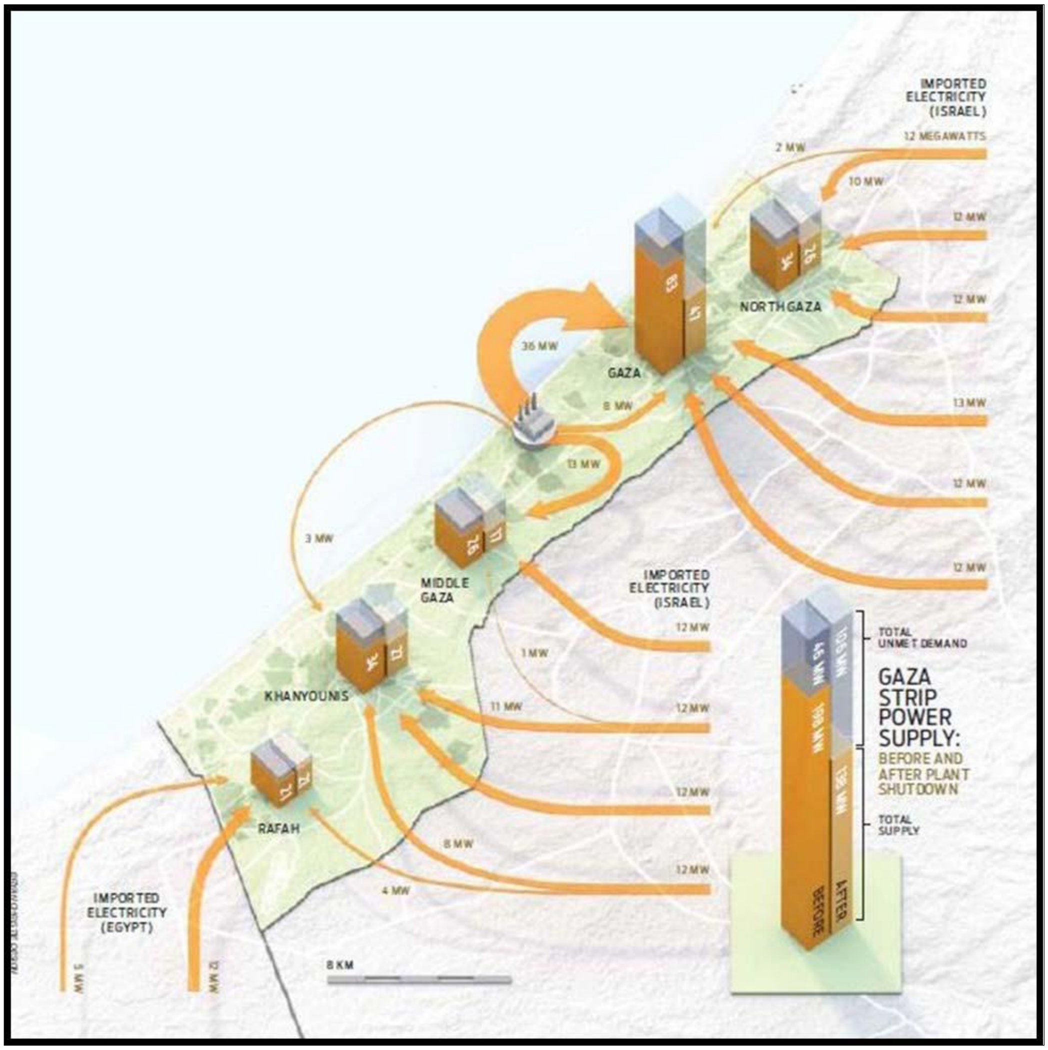

Figure 9: Power feeders of Gaza Strip, its demand.

Table 3.1 below shows a summary of the most important events from 1993 to 2011 in power sectors in Gaza Strip [3].

Table 2: Events Summery

#	Year	Event
1	**1993**	The Oslo According give Palestinians greater authority over municipal services likes the electricity grid.
2	**1994**	The Gaza power plant is commissioned as part of a larger blueprint to lessen dependence on Israel.
3	**1999**	Construction begins on the US $140 million project. Total demand to be met 244 WM.
4	**2000**	Al-Aqsa Intifada and the destruction of infrastructure and power grids.
5	**2002**	The plant begins initial operation; Enron, a major U.S.-based investor, collapses.
6	**2005**	Israel pulls military forces from Gaza in a strategy known as disengagement.
7	**2006**	Israel bombs the plant in retaliation for the kidnapping of an Israeli soldier.
8	**2007**	Israel begins rations fuel to 2.2 million liters per week. The plant needs 4.9 million liters per week to meet demand.
9	**2008**	Fuel cutoffs in the wake of Israel’s military strikes damage the plant’s transformers, and the plant shut down completely.
10	**2009-2011**	Even when the power plant is online, Gaza only gets at most 60 MW from the plant itself. The rest getting from Egypt (17 MW) and Israel (120 MW).

Chapter 4

OPTIMAL POWER FLOW (OPF) ANALYSIS

4.1 Introduction

This chapter explains the methods of an analysis of optimal power flow (OPF) for specific region which feeds from two sources GEDCO and (IEC), using MATLAB and PowerWord. The Middle region is used a case study.

The Power network is not integrated in Gaza Strip [2].The main three sources of power in Gaza Strip: Gaza Electrical Distribution Co (GEDCO) Israeli Electricity Co. (IEC) and Egypt powers. The power system in Gaza is not stable and robust [2,21], which effects the power flow on the network; so Gaza Strip power network can be classified as radial network.

In the early days, it was believed that the real-time data base provided by SCADA could provide an operator with an accurate system view [22]. But SCADA system needs tools to confirm from getting results, to mention a few: hard to assure availability of all measurements at all times, measurements prone to errors, etc. A more powerful tool was needed to process collected measurements and to filter bad ones. A central master station, located at the control center, gathers information through the SCADA system. The SCADA system collects measurement data in real time from remote terminal units (RTUs) installed in substations across the power system. Typical RTU measurements include power flows (both active and reactive), power injections, voltage magnitude, phase angles and current magnitude [23]. OPF analysis tools are considered important because they helps SCADA system to deal with different variable in Gaza network such as voltage (V), phase angle (θ), power factor ($p.f$), real power (MW), current (A), frequency (Hz) and reactive power ($MVAR$). This chapter will concentrate on some such as voltage (V), phase angle (θ), real power (MW), and reactive power ($MVAR$)

4.2 Optimal Power Flow Problem

The goal of the Optimal Power Flow (OPF), or load flow calculates a state of the power system and values of the control variables which minimize a given objective function (e.g. generation cost, network losses, etc.) and at the same time satisfy all constraints imposed on the problem.[17], the objective here deals with network losses. OPF analysis is an important part of power system design procedures (system planning). The OPF problem models the nonlinear relationships among bus power injections, power demands, and bus voltages and angles, with the network constants providing the circuit parameters [22]. It is the heart of most system-planning studies and also the starting point for transient and dynamic stability studies. This chapter provides a formulation of the OPF problem and its associated solution strategies. An understanding of the fundamentals of three-phase systems is assumed, including per-unit calculations, complex power relationships, and circuit-analysis techniques. [22]. Power flow is the name given to a network solution that shows currents, voltages, and real and reactive power flows at every bus in the system [22].

4.3 Problem formulation

Let real and reactive power generated at bus- i be denoted by P_{Gi} and Q_{Gi} respectively. Also let us denote the real and reactive power consumed at the i^{th} bus by P_{Li} and Q_{Li} respectively. Then the net real power injected in bus- i is:

$$P_{i,inj} = P_{Gi} - P_{Li} \tag{4.1}$$

Let the injected power calculated by the load flow program be $P_{i,\, calc}$. Then the mismatch between the actual injected and calculated values is given by

$$\Delta P_i = P_{i,inj} - P_{i,calc} = P_{Gi} - P_{Li} - P_{i,calc} \tag{4.2}$$

In a similar way the mismatch between the reactive power injected and calculated values is given by

$$\Delta Q_i = Q_{i,inj} - Q_{i,calc} = Q_{Gi} - Q_{Li} - Q_{i,calc} \tag{4.3}$$

The main purpose of the load flow is to minimize the above two mismatches. The OPF problem models the nonlinear relationships among bus power injections, power demands, and bus voltages and angles, with the network constants providing the circuit parameters, so an iterative procedure must be used to estimate the bus voltages and their angles in order to calculate the mismatches in each bus. The most common techniques used for the iterative solution of nonlinear algebraic equation are Guess-Seidel, and Newton Raphson methods.

4.3.1 Solving OPF using Guess-Seidel methods

Gauss-Seidel power flow, first denote the initial voltage of the i th bus by $V_i(0)$, i = 2, ... , n . This should read as the voltage of the ith bus at the 0th iteration, or initial guess. Similarly this voltage after the first iteration will be denoted by *Vi* (1). In this Gauss-Seidel load flow the load buses and voltage controlled buses are treated differently. The real and reactive power injected at any bus can be expressed as [18]:

$$P_{i,inj} - jQ_{i,inj} = V_i^* \sum_{k=1}^{n} Y_{ik} V_k = V_i^* [Y_{i1}V_1 + Y_{i2}V_2 \dots.] \qquad (4.4)$$

Gauss- Seidel Steps:

- **Step-1:** Make an initial guess for the solution vector [V].
- **Step-2:** All proper values are plugged into Equation (4.4). The new *v1* value that is calculated will replace the previous guess, *v1*, in the solution vector. [V] Will then be used to calculate v2. This will be done for each *vi* from v1 to *xn* until a new solution vector is complete. At this point, the first iteration is done.
- **Step-3:** The absolute relative approximate error is calculated by comparing each new guess *xi* with the previous guess. The maximum of these errors is the absolute relative approximate error at the end of the iteration.
- **Step-4:** The new solution vector becomes the old solution vector and Steps 2-3 are repeated until either the maximum number of iterations has been conducted or the pre-specified tolerance has been met.

4.3.2 Solving OPF using Newton-Raphson methods

The Newton-Raphson procedure is as follows:

- **Step-1:** Choose the initial values of the voltage magnitudes $|V|^{(0)}$ of all n_p load buses and $n-1$ angles $\delta^{(0)}$ of the voltages of all the buses except the slack bus.
- **Step-2:** Use the estimated $|V|^{(0)}$ and $\delta^{(0)}$ to calculate a total $n-1$ number of injected real power $P_{calc}^{(0)}$ and equal number of real power mismatch $\Delta P^{(0)}$.
- **Step-3:** Use the estimated $|V|^{(0)}$ and $\delta^{(0)}$ to calculate a total n_p number of injected reactive power $Q_{calc}^{(0)}$ and equal number of reactive power mismatch $\Delta Q^{(0)}$.
- **Step-4:** Use the estimated $|V|^{(0)}$ and $\delta^{(0)}$ to formulate the Jacobian matrix $J^{(0)}$.
- **Step-5: solve** $\begin{bmatrix} \boldsymbol{\Delta\delta_2} \\ \vdots \\ \boldsymbol{\Delta\delta_{2n}} \\ \frac{\Delta|\boldsymbol{v_2}|}{|\boldsymbol{v_2}|} \\ \vdots \\ \frac{\Delta|\boldsymbol{v_{1+n0}}|}{|\boldsymbol{v_{1+n0}}|} \end{bmatrix} = \begin{bmatrix} \boldsymbol{\Delta P_2} \\ \vdots \\ \boldsymbol{\Delta P_n} \\ \boldsymbol{\Delta Q_2} \\ \vdots \\ \boldsymbol{\Delta Q_{1+no}} \end{bmatrix}$ for $\delta^{(0)}$ and $\Delta\,|V|^{(0)}$ (4.5)
- **Step-6** : Obtain the updates from

$$\delta^1 = \delta^0 + \Delta\delta^0 \tag{4.5}$$

- **Step-6:** Check if all the mismatches are below a small number. Terminate the process if yes. Otherwise go back to step-1 to start the next iteration with the updates given by (4.5) and (4.6) [18].

$$|V|^1 = |V|^0 \left[1 + \frac{\Delta|V|^0}{|V|^0}\right] \tag{4.6}$$

4.4 Optimal Power Flow Analysis in Gaza Strip

This section uses the middle region in Gaza Strip as a case study, and utilizes several analysis methods to obtain Optimal Power Flow (OPF) solutions using MATLAB and PowerWord. The Middle region depends on two sources of power: the first source is from Gaza station: with a feeder around **16 MW** from lines *(J1,J2,J4,J5,and J10)* from Power Plant, and the second source is Israeli Electricity Co. (IEC) with a feeder around **32 MW** form line *(F7)***.** Figure 10 shows the Middle region with distributed power lines [24].

The next step will be obtaining a single line diagram to expected needs for each region and, which represents three bus systems to shows the distribution lines in the Middle region and need customers as shown in Figure 11 [24]. Buses are classified as

1- **Slack bus:** or ***swing bus***, is taken as reference where the magnitude and phase angle of the voltage are specified. This bus makes up the difference between the scheduled loads and generated power that are caused by the losses in the network.
2- **Load Bus: or *P-Q bus*** at is a bus where the active and reactive power is specified. The magnitude and phase angle of the bus voltage are unknown.
3- **Regulated Buses** or ***Generator Buses*** **(*Voltage-controlled buses*):** At these buses, the real power and voltage magnitude are specified. The phase angle of the voltage and the reactive power are to be detrained. The limits on value of the reactive power are also specified. These buses are called P-V buses [19].

4.5 Solving Optimal Power flow in Gaza Strip

Before beginning solve OPF in Middle region must be taken into account the mine constraints illustrated in this points:

- The capability limits of generation(s) units must be considered.
- The system frequency must not deviate beyond prescribed limits.
- The voltage levels at the system buses must lie within an acceptable margin.
- The capability limits of the transmission lines must not be exceeded.

For Power flow case study will used Guess-Seidel, and Newton-Raphon methods to applied on Middle region which assumed represented as three bus system, and comparison between two methods to investigated which method fastest to reach OPF with mismatch around zero.

Assumed Middle region system consist of a slack bus from Power Plant, Israeli P-V bus, and load bus in Middle region as shown in Figure 12.

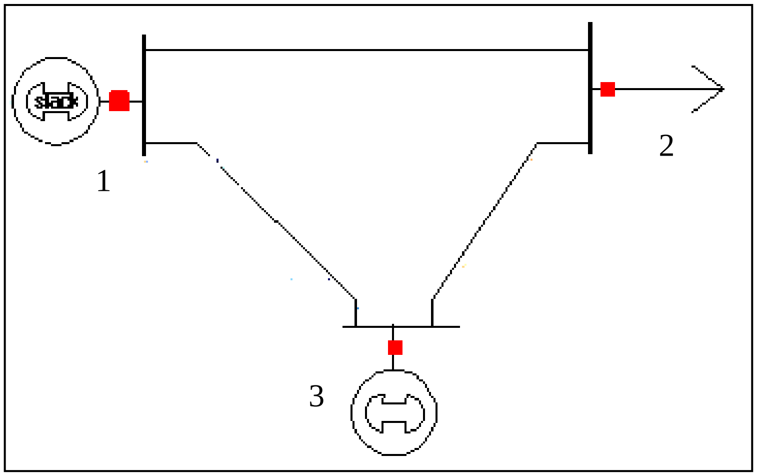

Figure 10: Three bus system in Middle region

The line impedances and the line charging admittances are given in Table 3. The bus voltage magnitudes, their angles, the power generated and consumed at each bus are given in Table 4

Table 3: Line impedance and line charging data.

Line (bus to bus)	Impedance	Line charging (*Y* /2)
1-2	0.02 + *j* 0.10	*j* 0.030
2-3	0.04 + *j* 0.20	*j* 0.025
3-1	0.05 + *j* 0.25	*j* 0.020

Table 4: Bus voltages, power generated and load - initial data

Bus #	Bus Voltage		Power Generated		Load	
	V(p.u)	ϴ(deg)	P(MW)	Q(MVAR)	P(MW)	Q(MVAR)
1	1.05	0	NA	NA	0	0
2	1	0	0	0	96	62
3	1	0	0	0	35	14

Using Gauss-Seidel and Newton-Raphson methods to calculate the bus parameters yielded the same result. However the Newton-Raphson method converged **faster than** the Gauss-Seidel method, where; when used the NR getting the result after **4** iterations, but when used GS getting the results after **10** iterations. The bus voltage magnitudes, angles of each bus along with power generated and consumed at each bus are given in Table 5.

Table 5: Bus voltages, power generated and load after load flow convergence.

Bus #	**Bus Voltage**		**Power Generated**		**Load**	
	V(p.u)	Ɵ(deg)	P(MW)	Q(MVAR)	P(MW)	Q(MVAR)
1	1	0	16	57.11	15	14
2	0.9826	-5.0124	0	0	26	45
3	0.9777	-7.1322	32	15.59	0	0

This show that OPF enables us to utilize numerical analysis tools to compute, estimate the bus parameters, using Matlab and PowerWord.

Chapter 5

DESIGN SCADA SYSTEM BASED ON OPF FOR GAZA STRIP

5.1- Introduction

The purpose of this chapter is to provide guidance to design framework for SCADA system based on OPF in Gaza Strip, which is considered the main contribution in this research. Before starting to design a SCADA system we must be known a functional description for a power system which we will be dealing requirements, and specifications. This chapter defines a functional description, requirements, specifications, and SCADA framework.

5.2 Functional Description

The power plant(s) supplies Gaza Strip with generated the power that is needed, and distributed through distribution networks to the customers. The main services and requirements that are needed for a SCADA system must be included[1]:

1- Reading magnitude voltage from generation(s).
2- Reading phase angle voltage from generation(s).
3- Reading real and reactive power generation(s)
4- Investigating occur of optimal power flow for customers.
5- Providing previous data in real-time to help manger or operator in decision making.
6- Providing graphical representation and Human Machine Interface (HMI) of the actual power network in Gaza Strip.
7- Supplying data archive for all process in the network and mage it from any control room(s).
8- Collecting data from distributed area in Gaza Strip.

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[1] These services and requirements assumption by author.

5.3 System Design

The design of a SCADA system that achieves the above requirements, with fulfills specifications while minimizing costs and insuring long term system robustness, will propose a hardware and software design to implement SCADA system.

5.3.1 Hardware Design

According to the previous functional discretion and the power system demand in Gaza Strip the proposed SCADA system consists of three subsystems distributed in Gaza Strip based on power feeder's sources. The distributed system is interconnected by communication network, Figure 13 provides general layout of the proposed SCADA system in Gaza Strip.

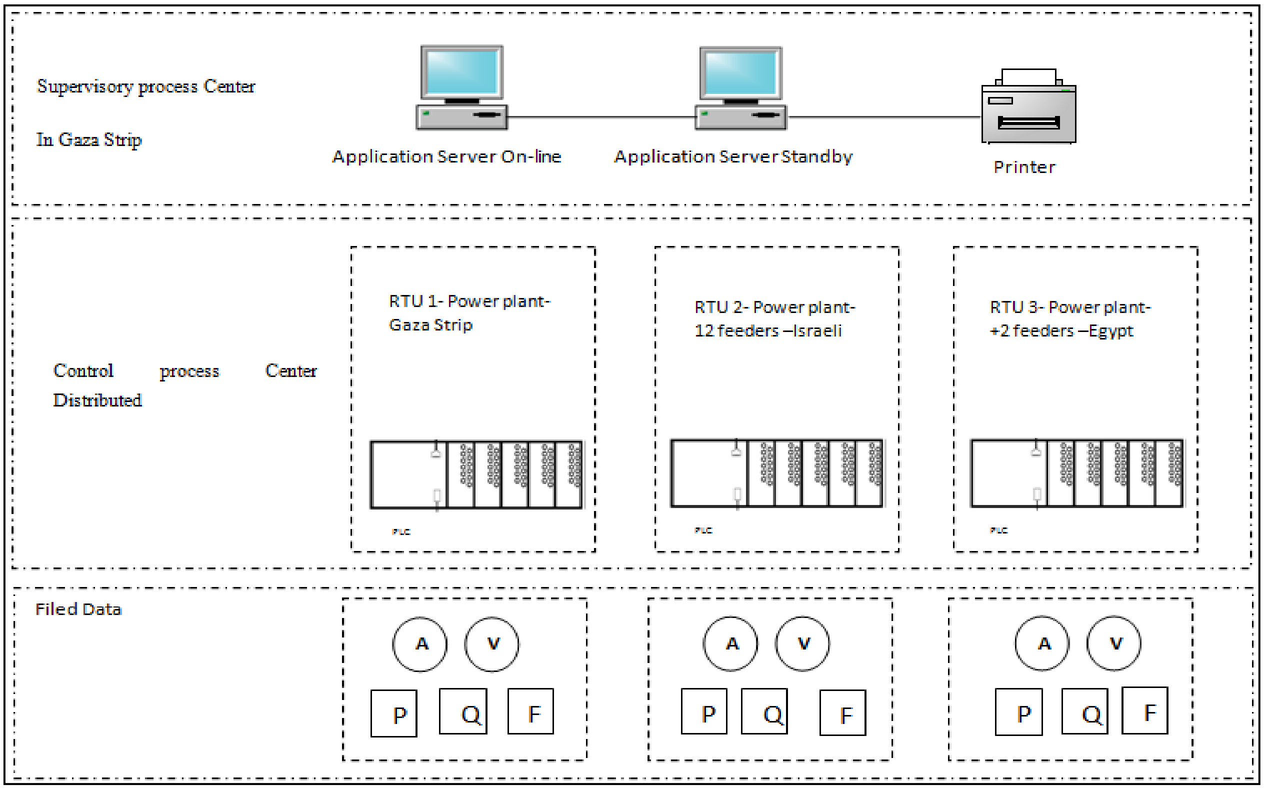

Figure 11: General layout of SCADA system in Gaza Strip

It is clear in figure 13 that three PLCs which control the three subsystems are interconnected to allow communication between the subsystems. For this purpose, PLCs in each subsystem must have modules deal with different signals (digital and analog). Also each PLC should have interface modules to the control network.

The proposed system design is based on constructing three subsystems in Middle of Gaza for power generation from Gaza Plant, South of Gaza for power generation from Egypt, and North of Gaza for power generation from Israeli to collecting data necessary through PLCs and travel it to SCADA center which proposed constructed in GEDCO by using fiber-optic communication because it has thousands of times the bandwidth of copper wire and can carry signals hundreds of times further before needing a repeater, also it give them greater reliability and the opportunity to offer new services [25].

These PLC's will reading the signals from filed through current transform and voltage transformer to read voltage and current signals. On the other hand will read the real and reactive power by using power meter to transfer to control room through Ethernet cable. Then transfer all of data to supervisory process through fiber-optic cable.

5.3.1.1 Communication Network

In filed data process collects the different measurements (analog and digital) by PLC through serial connection (RS232, RS422, or RS 485). RS232, RS422 and RS485 form the key element in transferring digital information between the RTUs or PLCs, and the modems. These data communications standards are examined in detail necessary for a complete understanding of the telemetry sections of the workshop. An interface standard defines the electrical and mechanical details that allow communications equipment from different manufacturers to be connected together and to function efficiently. These standards are designed primarily to transport digital data from one point to another. The RS-232 standard is initially designed to connect digital computer equipment to a modem where the data would then be converted into an analog form suitable for transmission over greater distances. The RS-422 and RS-485 standards can perform the same function but also have the ability of being able to transfer digital data over distances of over 1200 m [13, 26]. Thus, we chose RS485 because it is an upgrade of RS-4222 and allows the same distance and data speed but increases the number of transmitters and

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[2] Review Practical SCADA

receivers permitted on the line. RS-485 permits multidrop network connection on two wires and provides for reliable serial data communication for:

- Distances of up to 1200 m (same as RS-422)
- Data rates of up to 10 Mbps (same as RS-422)
- Up to 32 line drivers permitted on the same line.
- Up to 32 line receivers permitted on the same line.

The RS-485 interface standard is useful where distance and connection of multiple devices on the same pair of lines is desirable. Special care must be taken with the software to coordinate which devices on the network can become active. In most cases, a master terminal, such as a PLC or computer, controls which transmitter/receiver will be active at any one time [26]. To transfer data from control process to supervisory process by using fiber-optic communication because it has thousands of times the bandwidth of copper wire and can carry signals hundreds of times further before needing a repeater, also it give them greater reliability and the opportunity to offer new services [25].

In modern SCADA systems, there have the business process which upper supervisory process and connecting between them through web, as shown in Figure 14[**26**].

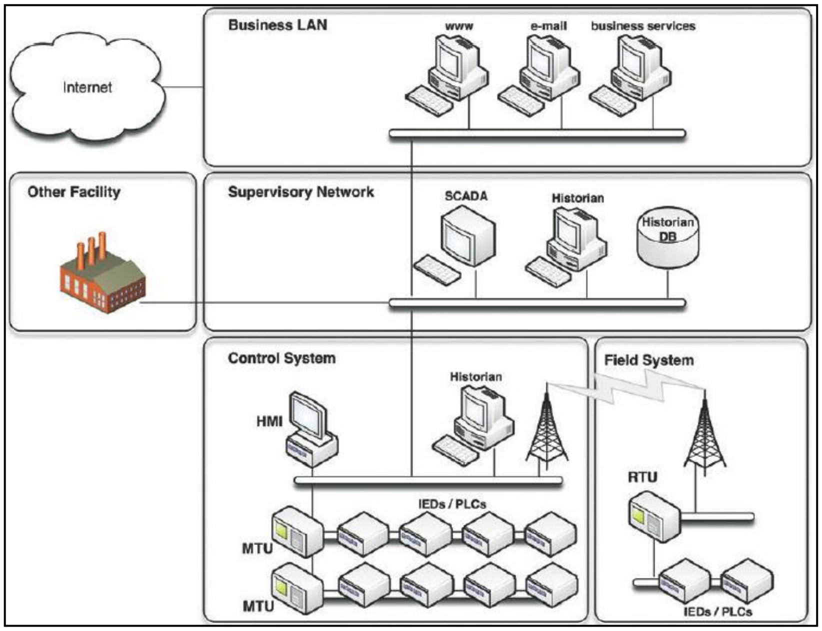


Figure 12: Sample Industrial Automated Control System Network.

Overall recommended Hardware design is illustrated in Figure 15.

5.3.2 Software Design

SCADA software application is considered important to be integrated with the hardware design to achieve a good security in SCADA system.

To implement application of a SCADA system, we can use any commercial packages which are specialized in SCADA system such as WinCC Filexble, Trace MODE, Industsoft, Wonderware, and Ifix [27]. These packages are designed by specialist companies to specific PLCs.

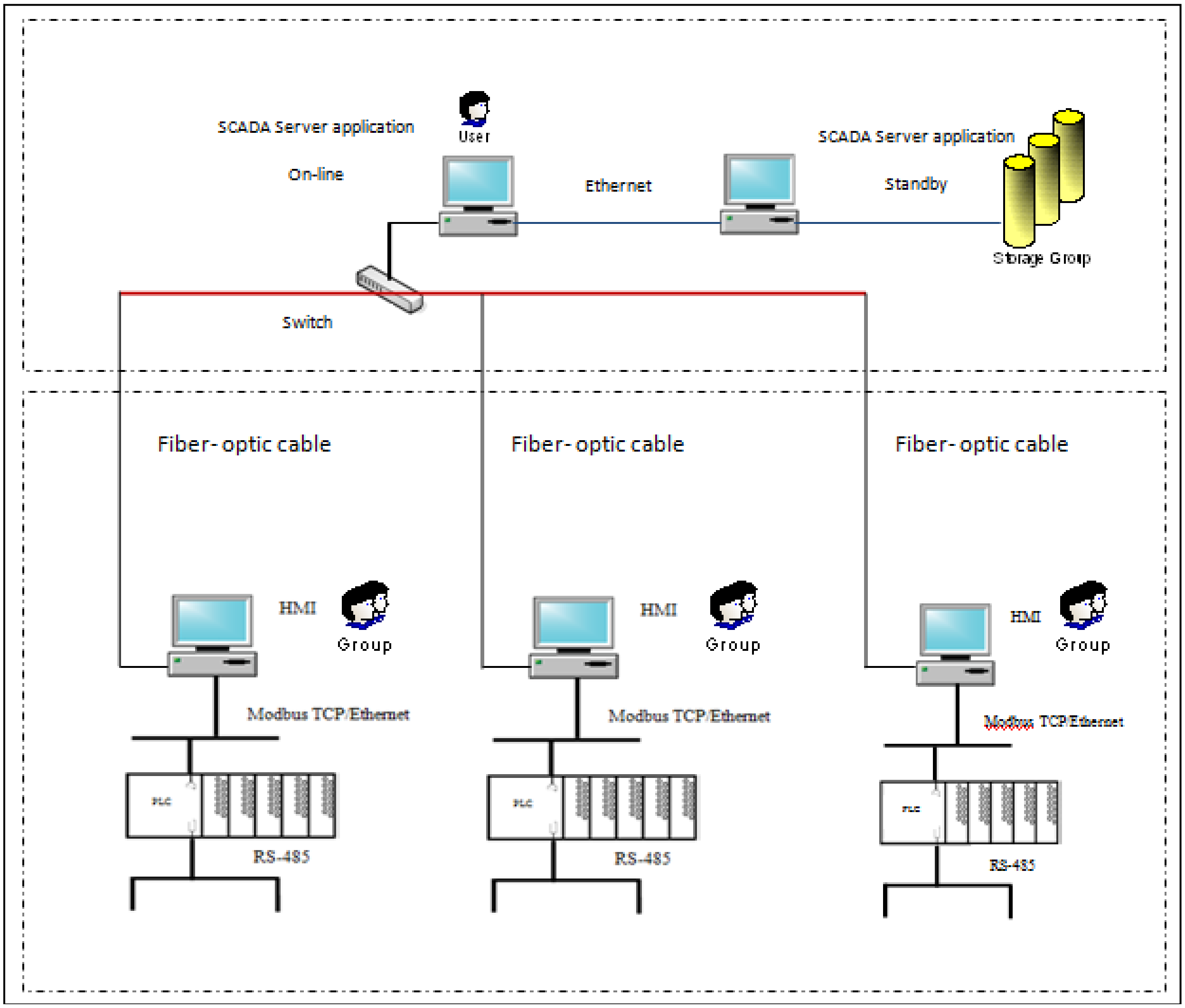


Figure 15: Proposed hardware designs.

The second solution involves designing SCADA application software by using basic programming language such as C#, JAVA, or Visual Basic. Table 6 makes comparison between the first solution and second solution.

Table 6: comparison between the first solution and second solution

Items	First Solution (Commercial)	Second Solution (High level languages)
Design time	Less	More
Cost	Applications	Programmer
Flexibility	Low	High
Device drivers	Available	need to install OPC to connect with other devices
Efficiency	High	Low

In our case recommended to use the first solution, because effort more facilities to integrated with a hardware devices other industrial networks, and more reliability.

The process in SCADA application is illustrated in flow chart as show in Figure 16, and uses LabVIEW for implementation.

When the operator or manger of the SCADA system runs SCADA application, it should select the bus number from overall system to read all data. Then, the manger sets the tolerance value ε to calculate the OPF according to this value. After that the SCADA application provides the manger in the network result to make a decision based on the result.

The proposed flow chart is expected to result in the previous requirements when integrating the SCADA application with a hardware design.

After collecting the necessary data of SCADA application, it can be stored in the database using SQL.

5.3.2.1 SQL Database

SQL stands for Structured Query Language. SQL is used to communicate with a database. SQL statements are used to perform tasks such as update data on a database, or retrieve data from a database. Although most database systems use SQL, most of them also have their own additional proprietary extensions that are usually only used on their system [28]. However, the standard SQL commands such as "Select", "Insert", "Update", "Delete", "Create", and "Drop" can be used to accomplish almost everything that one needs to do with a database, and to help the manger to query any data storage in DB in demand [28].

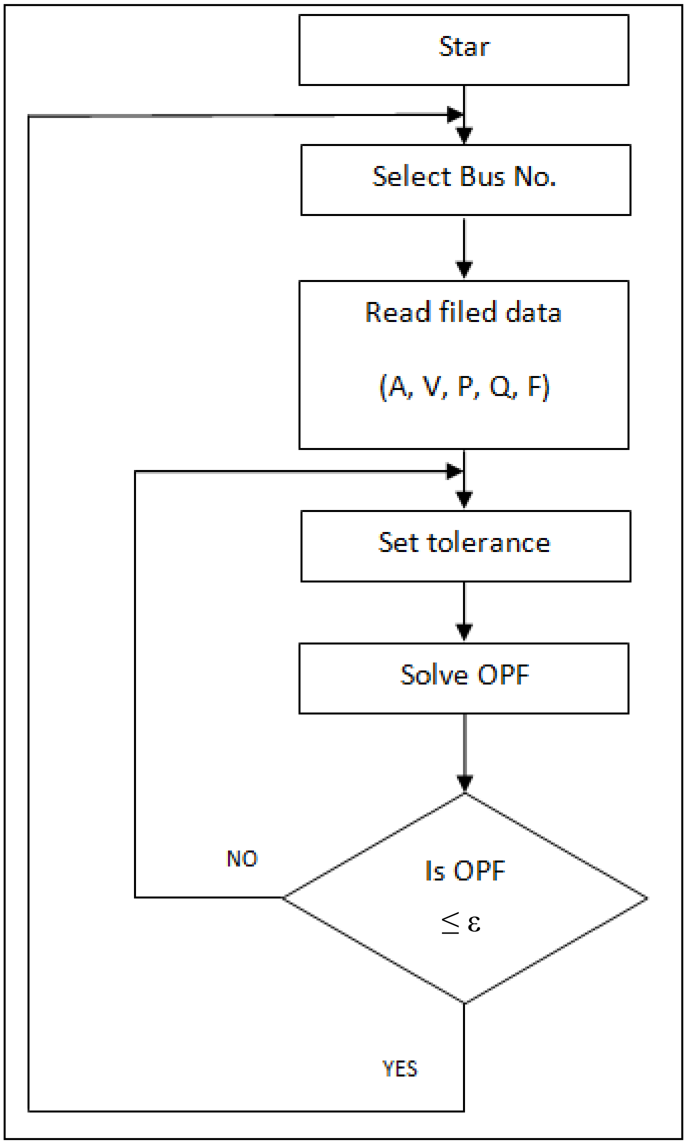


Figure 13: : Flow Chart of complete system.

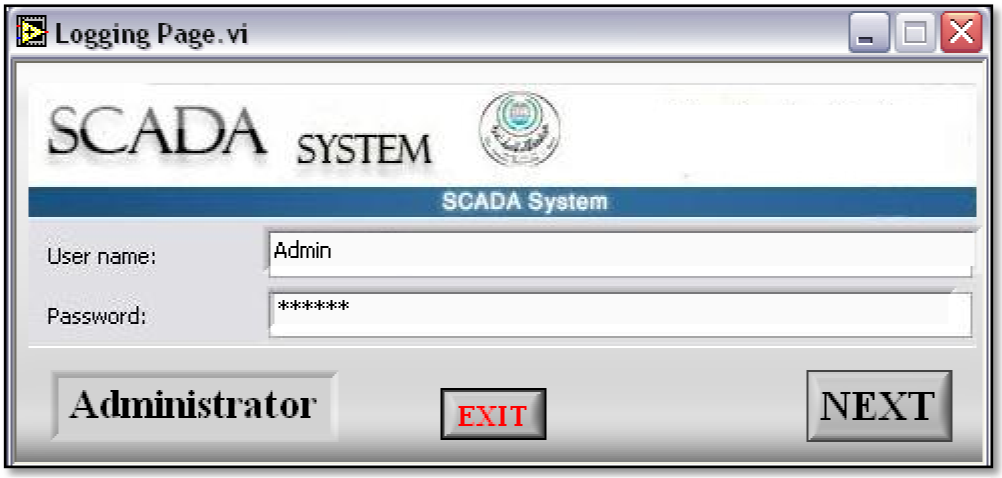
5.4 Requirements of SCADA application

To install SCADA application in the real filed must be keep in mind found the equipments:

1- Industrial Computer with platform windows (2000, or XP), and recommended install XP.
2- High capacity storage in industrial computer.
3- High speed processor: Pentium 4 or above.
4- Wide Screen monitors.

5.5 System Test

Administrator Account: or SCADA slave/data server. For example, the administrator account page is shown in Figure.17. After logging move to main page (Data server) as shown in Figure 18.

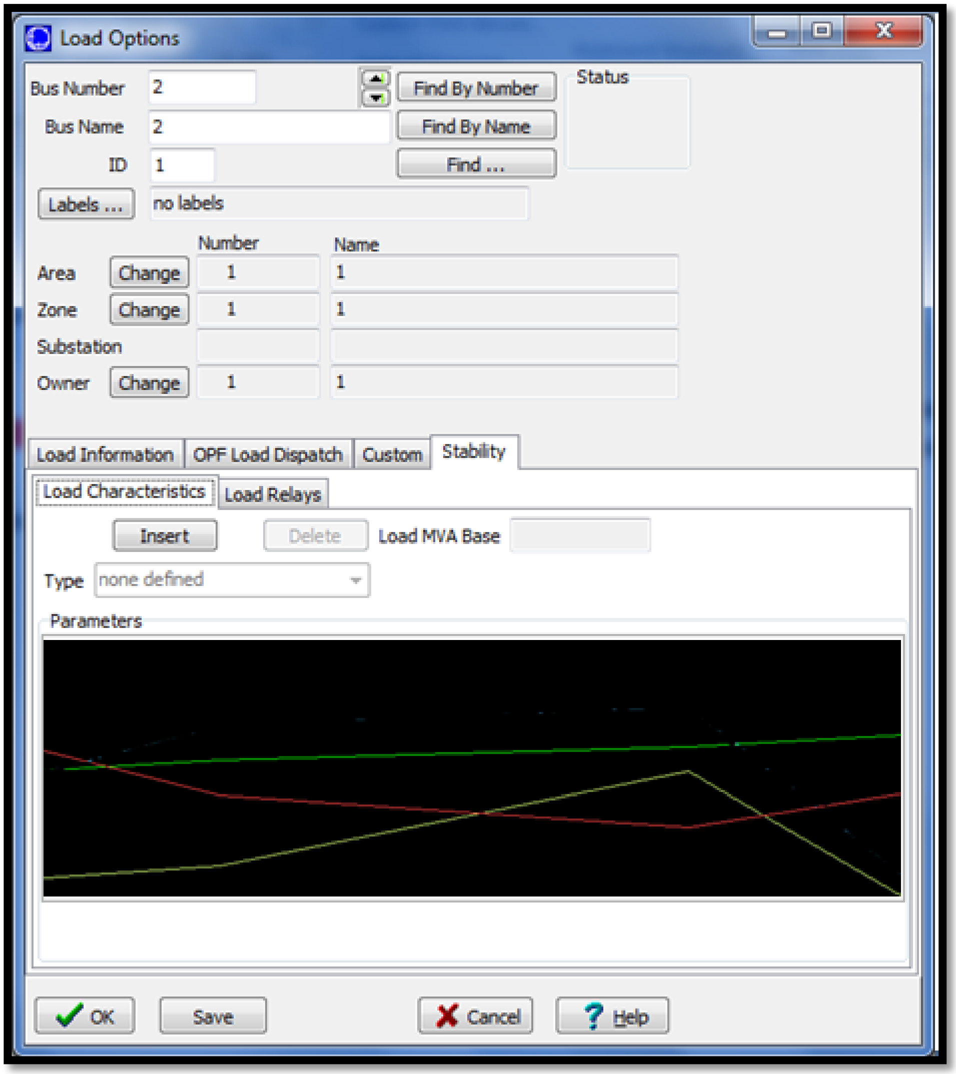


User name: Admin

Password: ******

Figure 14: Admin Account.

This is window appears all regions included in SCADA system, when pushing in any buses will appears all information about this bus. Figure 18 illustrated bus 2 information. Figure 19 appears the voltage stability in load regions.



Bus Number 2

Bus Name 2

ID 1

no labels

	Number	Name
Area	1	1
Zone	1	1
Substation		
Owner	1	1

Load MVA Base

Type none defined

Figure 15**: Voltage Stability**

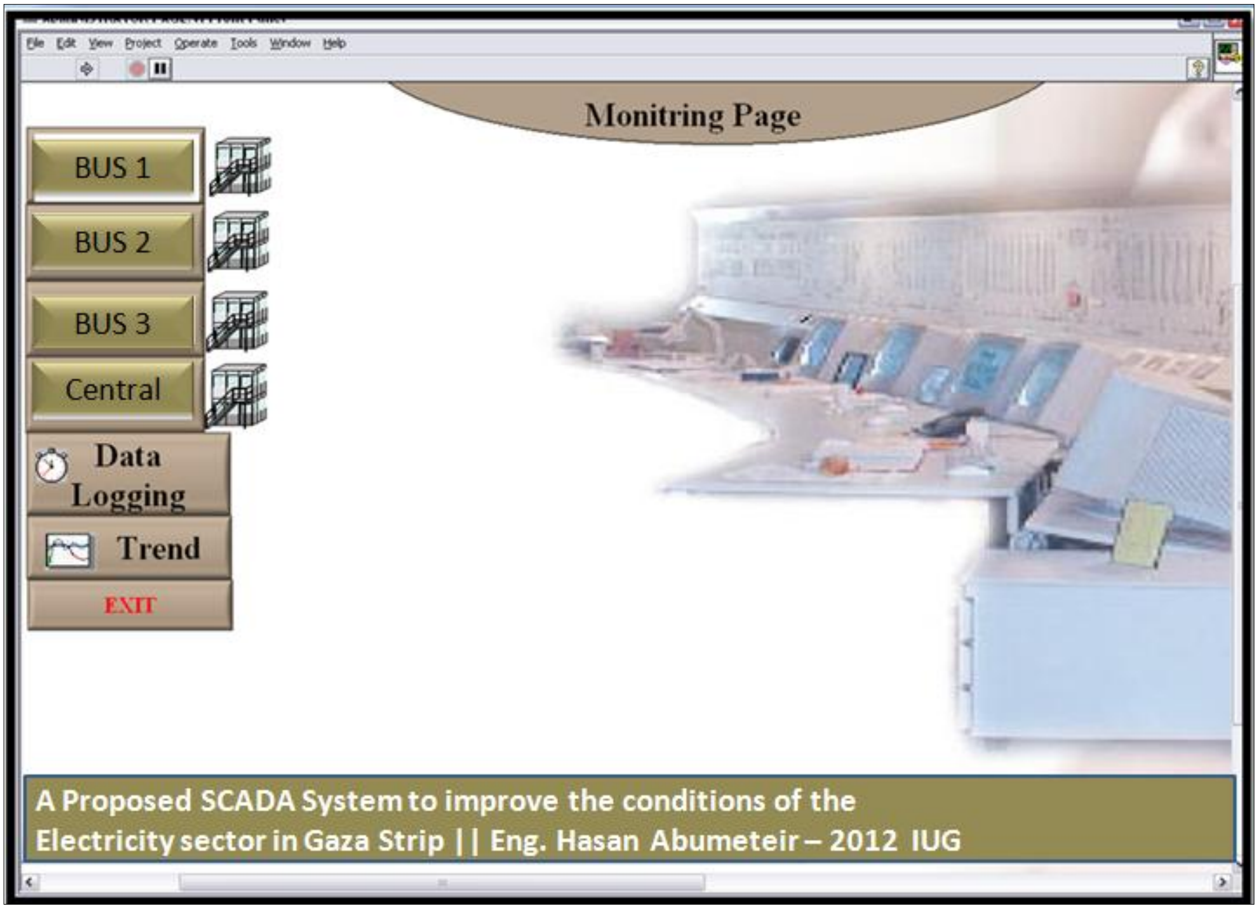


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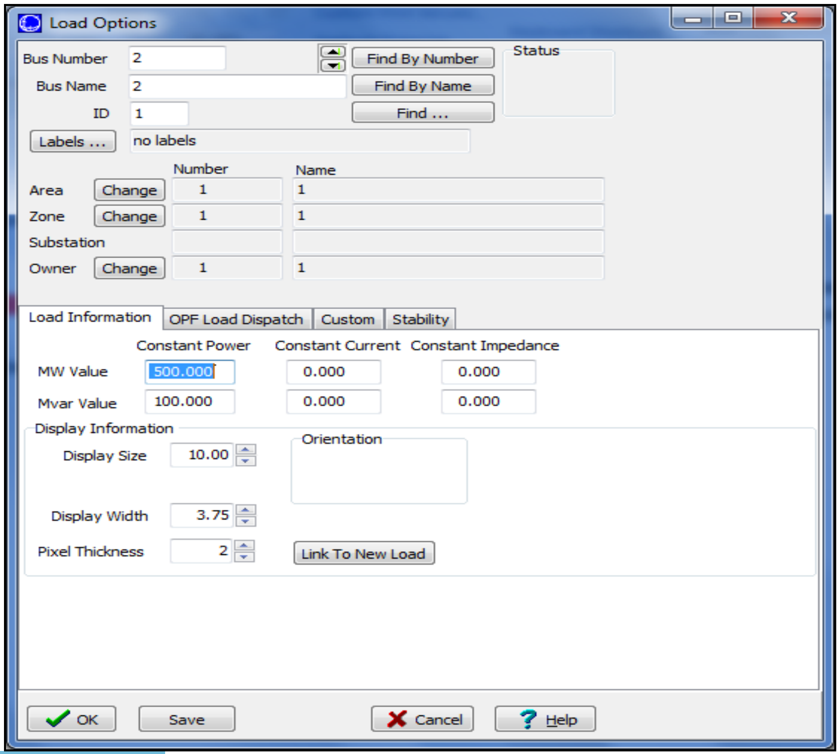
Figure 16: Main window



Bus Number 2
Bus Name 2
ID 1
no labels

		Number	Name
Area	Change	1	1
Zone	Change	1	1
Substation			
Owner	Change	1	1

	Constant Power	Constant Current	Constant Impedance
MW Value	500.000	0.000	0.000
Mvar Value	100.000	0.000	0.000

Display Information
Display Size 10.00
Display Width 3.75
Pixel Thickness 2

Figure 17: Bus 2 information

Chapter 6

CONCLUSIONS AND FUTURE WORK

6.1 Conclusions

Studying power flow and distribution is important to cut loses and waste. Finding an optimal power flow using the latest technology optimizes the available resources. This paper addressed the problem of the power distribution in Gaza Strip, which is fed with power from three different sources. This study provided a novel approach for optimal power distribution by monitoring sources of nutrition, the network and the energy up to the consumer for sporadic periods.

A SCADA technology was utilized to collect data, monitor performance, and conduct control. A power flow analysis was performed using the optimized methods of Newton- Raphson and Gauss- Sidle. Matlab with LABVIEW were used to perform the analysis and modeling of the system. Powerword was also used to perform the analysis.

A comparison was perform between the results of the optimizes OPF methods Newton- Raphson and Gauss- Sidle the results showed Newton- Raphson faster than Gauss- Sidle and more accurate. On the other hand, a comparison was performing between the results of the Powerword and Matlab with LabView. The comparison showed that similar results were obtained using both methods. An infrastructure for SCADA system for Power network in Gaza Strip based on OPF was proposed.

6.2 Recommendations and future work

- Labview consider a powerful tools to test and simulate the power network, but in real environments not effectively. The recommended tools and effectively is Totally Integrated Automation from SEMEINS.
- The Optimize OPF method help us to analysis system mathematically and depends on iterative calculation and the Newton- Raphson method consider a best way, because quick and accurate.
- The communication network in this study depends on fiber-optic and RS- 485.

As a future work the proposed thinking how connoting Gaza Power Network with EULLST

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