DESIGN OF A LARGE SCALE SOLAR PV SYSTEM AND IMPACT ANALYSIS OF ITS INTEGRATION INTO LIBYAN POWER GRID

A THESIS SUBMITTED TO THE GRADUATE SCHOOL OF APPLIED SCIENCES
OF
NEAR EAST UNIVERSITY

By
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In Partial Fulfilment of the Requirements for
The Degree of Master of Science
in
Electrical and Electronic
Engineering

NICOSIA, 2016

SAND MUSTAFA AL REFAI: Design of a Large Scale Sola~~.Y System and Impact Analysis of Its Integration into Libyan Powe ~:ij,d

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ACKNOWLEDGEMENTS

I would like to express my sincere appreciation and thanks to my supervisor, Assoc. Prof. Dr. M. Timur Aydemir , for his guidance and mentorship during my graduate studies. His impressive knowledge and creative thinking have been source of inspiration throughout this work.

My deepest gratitude goes to my parents, my wife, my brothers, sisters, and my son, to whom I am most indebted. I thank them for constant love, prayers, patience and support while I was studying abroad. I know I can never come close to returning their favor upon me.

A special thanks to my beloved Dad for his sacrifices, never-ending support and encouragement during my study. I would like to thank him for being a constant source of inspiration and motivation for me. Without him I would be no-where near what I have become today.

I will always be thankful to my friends and colleagues for their unlimited support. I extend my thanks to all the Libyan community that gave me a second family away from home.

To my parents and family....

ABSTRACT

Electrical energy is very important for sustainability and quality of life on this planet. Solar photovoltaic (PV) is one of the most adequate technologies used to convert the energy of the sun to electrical energy. Suitable exploitation of solar energy implies important diminution of the emissions of greenhouse gases.

In Libya, due to environmental, economic and development perspectives the Renewable Energy Authority of Libya (REA OL) is planning to implement a grid· connected 14 MW photovoltaic (PV) power plant near the Houn city in the Jufra District in Libya. The implementation of such large scale solar project may affect the normal parameters of the existing power station. These parameters are mainly voltage control, stability, protection equipment, and harmonic distortion levels. Therefore, this thesis develops a study of the design of PV system to be implemented in Houn substation 220 kV. The study aims to find the optimal parameters of the PV system such that it can function correctly. In addition, it investigates the impact of integrating PV directly with the existing grid. Different analysis tools will be used to perform load flow analysis to ascertain the effect on the PV to the grid. Analysis of the voltage variations and voltage stability after the integration of the PV system will also be assessed. Harmonic distortion analysis of the system is also going to be experimented after the connection of the PV plant to ensure the conformity of the resulting system with the international power quality standards.

In order to prove the design validity of the proposed system, models and simulations in MATLAB/SIMULINK and ETAP program will be established for a practical distribution grid. Real loads and solar energy data will be used in the simulation models for more realistic design. The results obtained from the analysis will be presented, tabulated, and discussed throughout this work.

Keywords: Solar energy; photovoltaic (PV); Houn city; Houn substation 220kV; MATLAB/Simulink; ETAP

ÖZET

Elektrik enerjisi gezegenimizdeki yaşamın sürdürülebilirliği ve kalitesi için çok önemlidir. Güneş enerjisini elektrik enerjisine dönüştürmek için kullanılan en uygun teknolojilerden biri fotovoltaik panellerdir: Güneş enerjisinden uygun biçimde yararlanarak sera etkisi yapan gazların yayımı azaltılabilir.

Libya Yenilenebilir Enerji Kurumu (REAOL) çevresel, ekonomik ve gelişim perspektifleri ile Jufra bölgesinin Haun şehri yakınlarında şebeke bağlantılı 14 MW gücünde fotovoltaik enerji tesisinin kurulumunu planlamaktadır. Bu ölçekte bir güneş enerjisi sisteminin kurulumu, mevcut enerji santralinin normal parametrelerini etkileyebilir. Bu parametrelerin başlıcaları gerilim kontrolü, kararlılık, koruma cihazları ve harmonik bozunum seviyeleridir. Bu tezde 220 kV gerilimli Haun şalt merkezinde kurulacak PV sistemin tasarımına yönelik bir çalışma gerçekleştirilmektedir. Çalışmanın amacı, PV sistemin işlevini doğru biçimde yerine getirebilmek için gerekli optimum parametrelerin bulunmasıdır. Ayrıca, PV sistemin mevcut şebekeye doğrudan bağlanmasının etkileri incelenmektedir; PV sistemin şebekeye etkisini değerlendirmek amacıyla yük akışı analizini yapmak için farklı analiz araçları kullanılmaktadır. PV sistemin entegrasyonunun bağlantısından sonra gerilimdeki değişimlerin ve gerilim kararlılığının analizi de gerçekleştirilmektedir. Sistemin uluslararası güç kalitesi standartlarına uygun davrandığını görmek için harmonik bozunum analizi de yapılmaktadır.

Önerilen sistemin tasarımının doğruluğunu göstermek için gerçek sistemin ve dağıtım şebekesinin MATLAB/SIMULINK ve ETAP programları ile modellemesi ve benzetimi gerçekleştirilmiştir. Daha gerçekçi bir tasarım için gerçek yük ve güneş enerjisi verileri kullanılmıştır. Çalışmada, analizlerden elde edilen veriler sunulmakta ve tartışılmaktadır.

Analıtar Kelimeler: Güneş enerjisi; Photovoltaik (PV) enerji; Haun şehri; Haun 220 kV şaltmerkezi; MATLAB/Simulink; ETAP

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LIST OF ABBREVIATIONS

AC	Alternative Current
CB	Circuit Breaker
CHP	Combined Heat and Power
CP	Cathodic Protection
CPV	Concentrated Photovoltaic
CSA	Cross Sectional Area
CSES	Center of Solar Energy Studies
DC	Direct Current
DG	Distributed Generation
EIA	Energy Information Administration
ETAP	Electrical Transient Analyzer Program
FACTS	Flexible Alternative Current Transmission Systems
FC	Fuel Cell
GECOL	General Electrical Company of Libya
MATLAB	Matrix Laboratory
MPPT	Maximum Power Point Tracking
PCC	Point of Common Coupling
PU	Per Unit
PV	Photovoltaic
REAOL	Renewable Energy Authority of Libya
SCADA	Supervisory Control and Data Acquisition
STC	Standard Test Conditions
THD	Total Harmonic Distortion
UPS	Uninterruptible Power Supplies
VTs	Voltage Transformers

CHAPTERl

INTRODUCTION

This work is an introduction of the Photovoltaic (PV) solar energy in the Libyan national electrical network. It represents a study of the implementation of 14 MW solar power station into Houn sub-station in Libya.

1.1 Introduction

Electrical energy is one of the most central human needs. Life without electrical energy is not imaginable. Nowadays Libya, similar to the other countries of the Middle East, uses oil and natural gas to produce its electrical energy needs. However, as these types of non-renewable energy sources will exhaust one day, it is very important to find alternative electrical energy sources like wind, sea waves, and solar energy. One of the great wealth that Libya has is the incredible distribution and amount of solar energy incident. Therefore, the significance of the investment in this source for the production of electrical energy by using the high efficiency photovoltaic generators becomes evident.

Normally power systems meet load growth demands through installation of centralized large generation plants, transmission lines and substations as well as distribution infrastructure. Figure 1.1 shows the traditional power delivery structure, from centralized generation to long distance transmission distribution. The generation station generates electricity at lower voltage level, generally 11 kV. This voltage is stepped up through a generation step up station. Stepped up voltage at the level of 220 kV or 400 kV is transmitted for long distances until the destination consumption areas. This power is then stepped down to different distribution levels according to consumers' needs. Solar generation is generally a small source of electric power generation ranging in size from less than a kW to tens of MW. PV sources are not generally part of the central power generation and are more suited to be installed near to the load, as shown, in the green distribution area in Figure 1.1.

Photovoltaic systems are widely used in different applications, from small cells in calculators·that consume small amount of power to large scale PV plants that produce power in the range of many MW. Although there is a broad variety of PV applications, the main applications for PV systems are in the power generation on-board craft and in standalone, systems in rurahareas. In the last decades an important revolution in the use of grid-connected solar: generators has been witnessed. The newly developed technologies encouraged consumers to start shifting toward the use of distributed energy resources like PV systems. Prices and initial installation costs of the PV systems have noticeably been decreased in the last 10 years especially with the exclusion of back-up batteries.

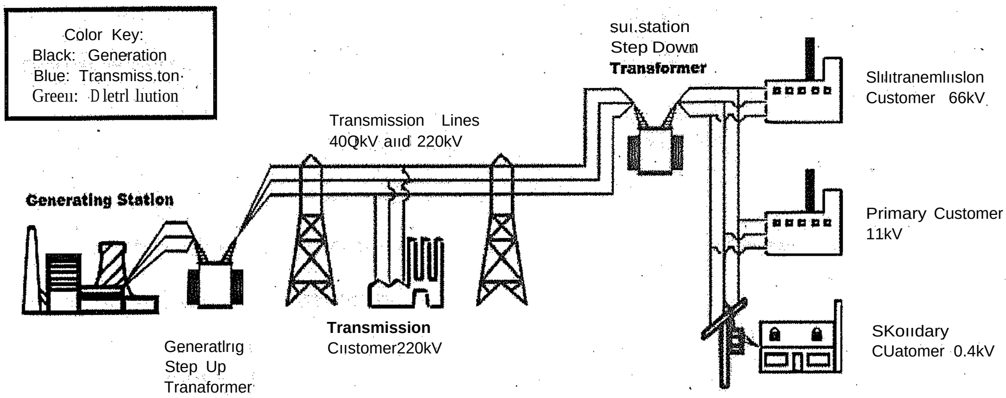


Figure 1.1: General power system topology (Condon, 2004)

Photovoltaic energy is one of the cleanest sources of renewable energy. The recent observations of the climatic alterations have encouraged the humanity for more investigation in the renewable resources of energy like solar. Although the technology was very costly in its beginnings, it has spread and has become very familiar and most used especially with the introduction of programs to encourage people to investigate in this technology. The use of distributed resources and especially PV systems in connection with power systems has many advantages such as (Steffel, et al., 2012):

- Voltage profile improvement.
- Voltage stability improvement for the whole system.
- Reactive power flow reduction.
- Power loss reduction.
- Pollution reduction.
- Maintenance cost reduction.

However, the use of individual solar applications or large scale PV generators can affect power systems and cause serious problems that need to be taken in consideration. For that reason, the penetratio11ofciisfüputed generation systems in the power systems has become one of the hottest topics of electrical power engineering. The variable nature of PV sources may cause serious pow~riqüı:ı.lity issues in the distribution systems. Such problems must be studied and mentioned füeliminary to the installation of distributed generation system to avoid the failure of the systems. These problems or disadvantages cıın be summarized in the next few points (Coster et al., 20 U; Steffel et al., 2012):

- Injection of harmonics due to the use of power inverters.
- The interruption of solar generation during night.
- The challenges of protection because of the bidirectional powerflow.
- Over voltage of the systems.

In this work, the use of solar energy power station with a total capacity of 14 MW in the Libyan distribution station ofllou.rris studied ..The study will iııclude the effect of the solar power station on the stability of the distribution station. It wilLinclude the analysis of load flow, short circuit faults, system stability, an.d)ıarrnonics of the system after the installation of the solar station. The projectwas proposed by the Renewable Energy Authority of Libya (REAOL) to bı.iild a photovoltaic (PV) power plant. The power rating of this first grid-connected plant of Libya which will be near the city of Haun in the Jufra District is 14 MW. The project is expected to produce an annual net electricity of approximately 23,140 MWh. High technology PV modules, power electronic systems, transformers and protection devices will be employed in this plant. Measurement and communication equipment will also be used to ensure reliability and surveillance of the system. The geographical location of the proposed project activity is as shown in Figure 1.2. The town of Haun situates at the latitude of 29° 08' 52" N, and longitude of 16° 00' 57" E, at a distance of about 250 km from the coastal line and 700 km from the capital city of Libya. The total available area for the project is approximately 10 hectare. The plant is planned to be connected to the distribution substation of 66/11 kV near Haun station of 220 kV as explained in Appendix 1. The specifications of the solar panels that must be used as sited by the REAOL are shown in Table 1.1. The substation has 2 step down transformers 66/11 kV of 20 MVA each. The connection between the solar field and the 11 kV bus bar will be established through 7 step-up transformers of 3 MVA each. The voltage rating of these transformers is 0.4/11 kY and situated 100 m away from the field (UNFCCC, 2012). Figure 1.3 presents the scijematic.diagram of the connection between.the solar system and the distribution grid through step-up transformers.

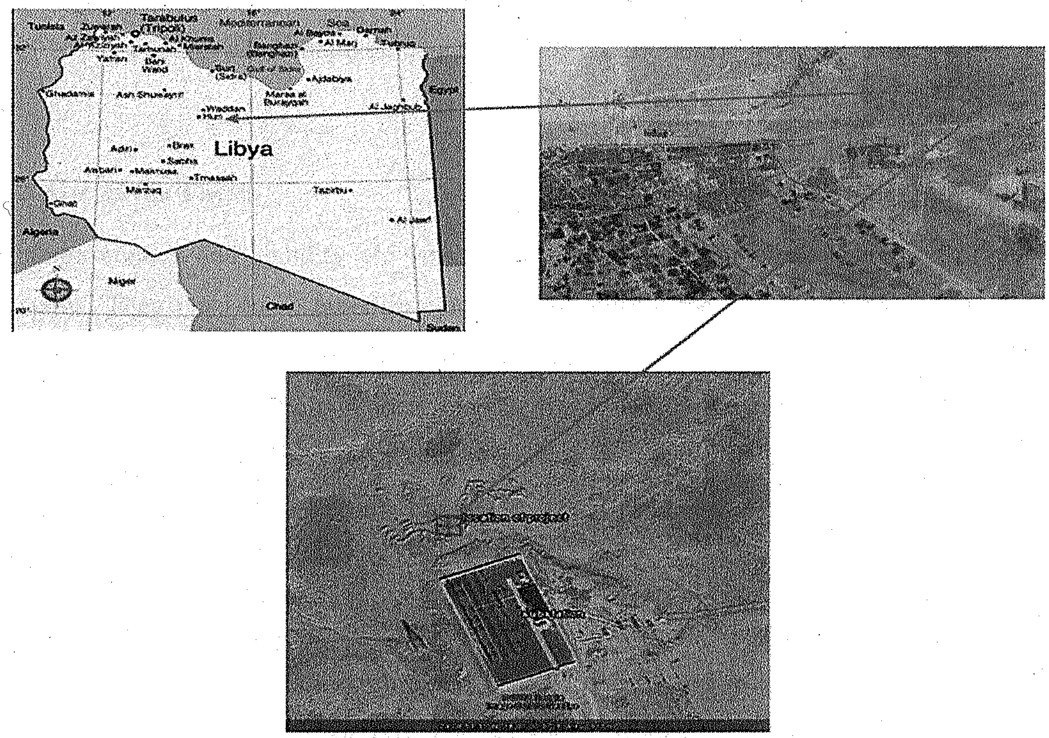


Figure 1.2: The location of the proposed project activity near the town of Houn, Jufra

Table 1.1: Technical specifications of PV modules to be used in Houn project

Parameter	Value
Cell type	Crystalline PV module
Power	Different power ratings: 230- 245 Wp
Number of modules	- 51;140 - 60,870
Module efficiency	14.1 - 15.1 %
Maximum rated current series	15 A
Power tolerance	+/-3 %
Maximum power voltage	29.4-30.7 V
Plant load factor	18.87 %

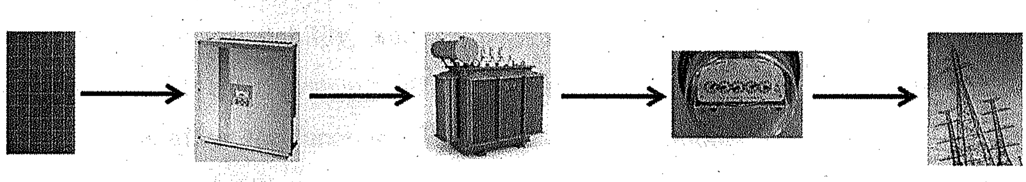


Figure 1.3: Schematic diagram of the connection of the solar station

1.2 Aim of the Thesis

Voltage control and stability are very critical for safe and reliable operation of power systems. They need to be taken in consideration during the generation, transmission and distribution levels of electric power. Voltage control for traditional power systems is well established. However, voltage control for distributed power systems is a rather new concept. Several researchers have been proposing new control algorithms to overcome the problems related to voltage regulation and stability so that renewable energy plants can be safely connected to national grids.

Libya is a country rich in solar energy and needs new power plants. Therefore it is expected that new solar energy projects will be carried out in near future, which means voltage stability and regulation problems should be studied before connecting these plants to existing networks.

The purpose of this work is to establish the analysis of the distributed solar generation that is planned in Houn in Libya. The analysis has the aim of determining the effect of installing 14 MW solar station connected to the distribution station of Houn. This analysis will focus on studying the voltage profile, voltage stability; short circuit faults, reactive power flow, and harmonic distortions due to the connection of the solar station to the distribution system at Houn. The study will discuss the general structure of the solar generation station and its components. The connection between the solar system and the power distribution station of Houn will also be discussed. A load flow and short circuit analysis of the studied systems will be performed in an attempt to obtain the optimal levels of voltage quality and stability of the system. In order to verify the feasibility and validity of the studied system, model of the distribution station combined and connected with the solar PV station will be built in ETAP software. Different analysis methods of load flow, short circuit, voltage stability, and harmonics are going to be analysed. Separately, modelling of the solar system will be discussed and studied to show the different parameters that affect the function of the solar cells. The model will be carried out using Matlab software and different operating conditions will be studied and discussed.

As a conclusion, the objectives of this study can be resumed in the next few points:

- To study the capability of solar generation systems in the load demand and power flow reduction at the distribution station level in Libya.
- To study the effect of connecting large scale commercial solar sources directly with the public grid. And to open the opportunity for future analysis of the techno-economic benefits of connecting large or small size solar projects to the Libyan National Grid.
- To inspect the consequences of grid connected solar systems on the voltage regulation levels in the public network in Libya and its participation in load reduction and stabilization of transmission systems.

1.3 Overview of the Thesis

In Chapter 2, a review of the existing literature on the topic is presented. In _Chapter3, discussion on the distributed generation systems is presented, the methodology followed in the thesis is described and the two simulation and analysis software programs are presented. In Chapter 4, the design and simulation of the grid connected plant are given. In Chapter 5, load flow, short circuit analysis, harmonic analysis and voltage profile studies are explained. In Chapter 6, results are discussed. In Chapter 7, the thesis is concluded and future work is discussed.

CHAPTER2

LITERATURE REVIEW

2.1 Introduction

The Energy is defined conventionally as the capability of work production. The origin of the word energy comes from the ancient Greek. It is a compound term from the two Greek word "en" and "ergon". The terms mean something that can work in the body. Scientists define the energy as the ability or capacity to perform work. The famous physician Max Planck has given a more accurate and scientific definition of the energy. He defined the energy as: "The ability of a system to produce outside activity" (Tzanakis, 2006).

Electrical energy has been the main source of energy for humanity during the last two hundred years. However, this energy is produced based on the burn of fossil fuels like gas and petrol oil. These fuels suffer from two disadvantages that pushed toward the investigation in new natural resources; these are the environment pollution and the non-renewable nature of these fuels. Scientists have focused on the investigation of renewable energy resource for electrical energy production. In the last decades, different technologies were developed to produce green energy. One of the main developed technologies was the solar energy technology. Throughout the course of its development, renewable solar energy has witnessed different revolutions in terms of power production, back-up and efficiency. Recently, solar or renewable energy systems became able to be connected directly to the electric grids. This allowed these systems to support the existing power generation systems directly with the minimum costs. They share now in a great amount of power production all around the world. However, these advantages were combined with some drawbacks concerning the effects of distributed generation systems which a term is describing all power sources that are connected to the main sources at any point- connected to the existing power systems. These drawbacks concern mainly the lack of stability, voltage regulation, and harmonic distortions caused by distributed generation systems.

2.2 Literature Review

Different researches were pointed toward the study and analysis of these drawbacks and different solutions to overcome their effects. (Coster, Myrzik, Kruimer, & Kling, 2011) Has discussed the effects of the Distributed Generation (DG) systems on the power grid stability as reported by Dutch distribution system operators. The authors discussed the different opportunities to handle network planning challenges in the existence of distributed sources. Paper demonstrated that voltage control issues and protection errors are rarely happening in compact power systems.A study of the issues combined with the use of distributed generation systems on the power grids was presented in (Therien, 201 O). The author discussed different issues like voltage regulation, protection system faults, harmonics, power flow, and intermittency of power systems with DG. A case study of a grid connected solar system was presented to address the different issues related to the DG. In (Nazari & Ilic, 2008) different problems related to the. use of distributed generation systems on power grids were discussed.

The effects of the location of DG and technology on the stability of the power system voltage were discussed in (Angelim & Affonso, 2016). In the paper, three distributed generation technologies were discussed and experimented. In addition, different DG locations were used and the effects on the stability of the power systems were discussed. An analysing method of the financial value of the DG systems was proposed and discussed in (Ault, McDonald, & Burt, 2003). The authors discussed different factors and issues concerning the DG systems. The developed function is helpful in determining the DG impact on the network, business, and the penetration of system. A case study of the United Kingdom distributed generation system was also discussed in this work. Line losses reduction due to the use of DG systems was discussed by (Dang, Yu, Dang, & Han, 2011). The work presented the study of radial feeder and distributed generator system under various load conditions, Results of losses reduction were presented and discussed. Impact of distributed generation on the dispatch of power systems was discussed in (Liu, Zhang, Zhou, & Zhong, 2012). Different renewable energy distributed generators were discussed and their impact was studied.

A study of the. investigation of hybrid distributed generation system of wind, PV, and hydro power sources was presented by (Liu, Zhang, Zhou, & Zhong, 2012). The dynamic impact of these DG systems was analysed and presented (Olulope, Folly, & Venayagamoorthy, 2013). Different issues related to the placement of distributed generators into power grid were discussed in (Yadav & Srivastava, 2014). Review of the riiost DG technologies also was presented in this paper work. The work in (Zhao, Li, & Liu, 2014) discussed the analysis of distributed generators and the optimal design techniques of these generators.

CHAPTER3

DISTRIBUTED GENERATION SYSTEMS

3.1 Introduction

Life cannot beimagined, to have the same quality it is having without electricity. It is so important for life and human civilization. It is the source of light that clear the darkness, it is the way how.we keep our foods in fridges, and it is the mean we use to operate our air conditioners, electricity is the invention that gives our life its .comfort, None of our basic needs for comfort life can be achieved without electricity. TV's, cameras,. personal computers, digital processors, phones, cellular phones, radio, modem cars, home appliances, and. many .othet electronic devices could not happen to work without electricity. Based on reports of the Energy Information Administration {EIA); until 2030, the electrical, energy is expected to remain the fastest developing form of energy worldwide (Dorian, Franssen; & Simbeck, 2006). The traditional. resources used for electrical energy production have dangerous consequences on the. environment especially under the actual and.predicted electrical consumption rates.

The nature and sources .of electricity is well known and understood. This knowledge allows various.uses of electrical energy to be useful. Nowadays, the integration of clean electrical energy sources into the actual infrastructures is growing quickly; governments as well as environment organizations are paying more attention for the subject. However, governments need to do more efforts to increase the chances of renewable resources to be more competitive.

New policies and technologies aim to decrease environment pollution due to energy production by finding new clean, renewable, and low cost resources. Renewable resources like solar, wind, sea waves, and many other energy sources are nowadays more and more investigated. The use and development of these renewable clean free energy sources has led to the use of Distributed Generation systems DG.

3.2 Electric Power Networks vs. Distributed Generation

An electrical grid is an interrelated network of electrical components distributing electrical power between producers and clients. Power systems in our days are very complex grids that can be essentially categorized into four main groups: generation system, transmission system, distribution system, and different loads (Paolone & Cherkaoui). Figure 3.1 shows a general structure of the electric .power grid. In the generation system, electricity is mostly produced by huge centrifuged alternators located in generation stations. The electrical power is usually generated under the level of 11 kV or 30 kV.

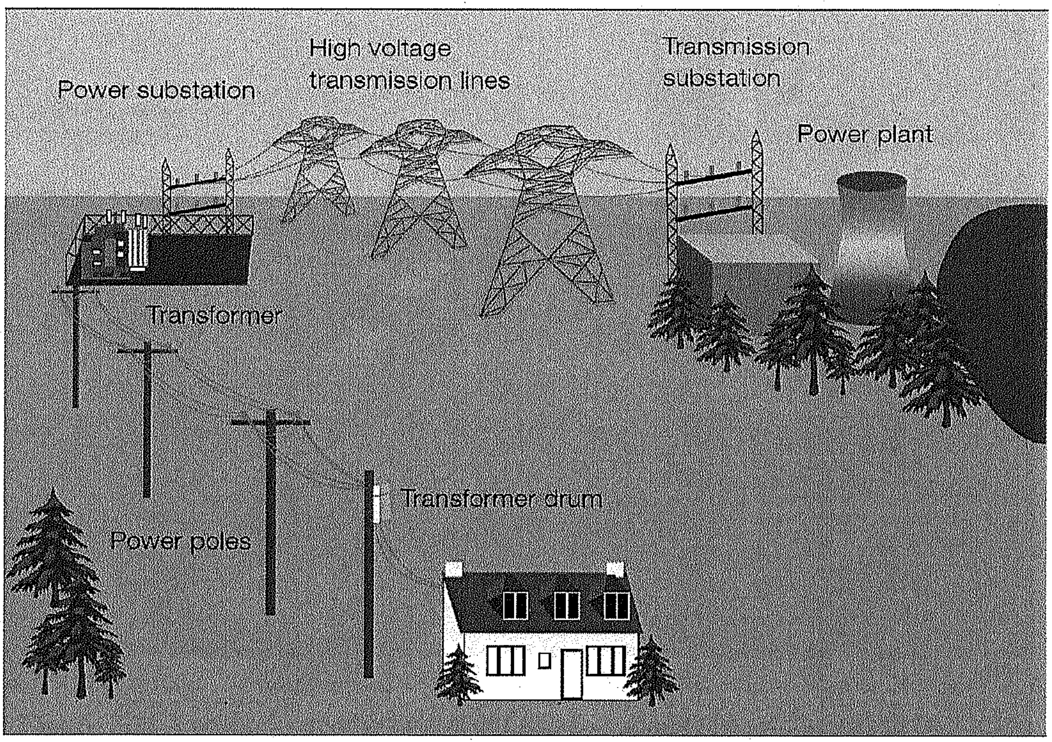


Figure 3.1: Structure of the electric power grid (Paolone & Cherkaoui)

Overhead transmission networks are responsible for the transmission of electrical power between different parts of the system. They transfer energy from main stations to distribution stations and between generation stations as well. The distribution grid can be either low or medium voltage distribution network. It uses transformers to step down high or extra high voltages to low level or medium level voltages. Transformers in the distribution unit feed electrical power to a number of secondary feeders whom consumer is connected to. Customers are connected to feeders either directly or through transformers to step down the voltage to a suitable level.

Distributed generation (DG) term is used to describe the use of group of interconnected small size power generators. These generators produce low voltage level electricity by usually using alternativefuel, The distributed generators are constructed such that they can be connected directly to the nearest available network and loads. A general description of a power system including distributod generation systems is present in Figure 3.2. Distributed generation is still used and>considered as spare or emergency endorsement source of power and restricted to a limited part of grid tied sources.

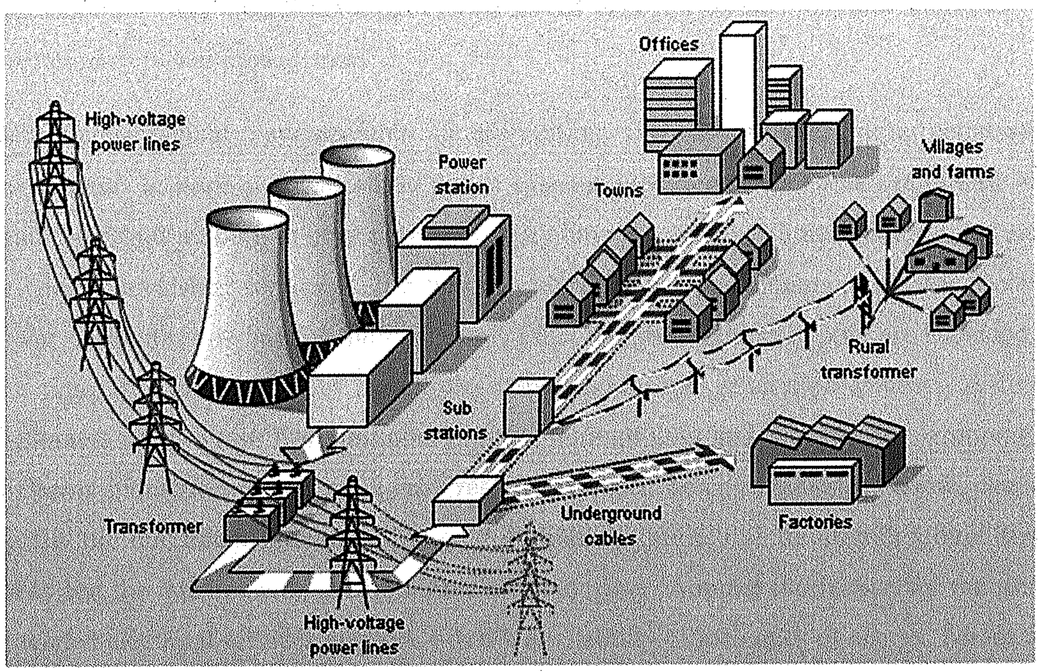


Figure 3.2: A power system with distributed generation (The grid as it is today, 2016)

DG systems are less used in many countries where prices of oil and natural gas are low, or where regulatory batteries are used. However, widespread of DG is being reconsidered due to the changes in relation between centralized and distributed power generation; in addition to the excessive use of natural gas and restrictions on the new transmission lines, and the new technologies that are implemented in the DG systems (The grid as it is today, 2016).

3.2.1 History of distributed generation

In 80s of the 19th century, the Pearl Street electric system that was created by Edison and served Wall Street and the near buildings can be considered as a distributed generation system. The same generation structure continued until the end of nineteenth century in the United State of America (USA) and around the world. Such systems served few small areas by direct current sources. Over more, individual factories were served individually by systems that supplied electric power with heating in Combined Heat and Power (CHP) systems (Hughes, 1993). Th~ main struggle of the distributed Direct Current (DC) system was the huge amount of losses under low voltages. The transmission of electricity under low voltages for long distance causes a lot of power losses. As a result, other competitors supported the use of alternating current based systems. In the Alternative Current (AC) systems larger and spread out areas can be served easily. This was possible thanks for the invention of power transformers.

With technological developments in alternating current systems, more economical investments in large and centralized power systems were required. These centralized high load systems were built in huge networks. They have the ability to spread out in wide areas providing consistent services. Unfortunately, storage of large amounts of electrical power is very difficult; this implies the requirement that that demand and supply are balanced all the time. For more efficient use of the transmission and generation systems, different customers need to stabilize their consumption through days and seasons. The grouping of different industrial, commercial, and residential loads helps achieving smooth demand profile the maximum possible. This goal implies the service to be extended over larger areas and the interconnection of multiple areas together. Another motivation for the use of extended electrical services network was the availability of resources of energy. Mines and water hydraulic energy resources are mostly located far from centres of industrial and residential zones. The two possible choices were to transport fuel to the distributed power stations or to transmit the electrical energy from the places of energy resources using high voltage systems. By the 1930s, industrial states had established huge electrical grids, joining together around the steam turbine generation system. Smaller generation systems were then naturally melted and shut down. An increase from 80 MW generation station in 1920 to 600 MW unit in 1960 and then to 1400 MW in 1980 have been witnessed. The idea to return back to the distributed generation in the 20th century came after the petrol shocks in the 1970s and the need to increase the systems efficiencies. The efficiency of large scale economic generation system was limited to 33 % of the used energy (Nishida, et al., 2003).

Evolution of small scale distributed generation has led to important reduction in cost, increased reliability, and less pollution emissions of different turbines, fuel cells, engines, and solar panels. On another side, particularly in the past two decades; a great evolution in the management, monitoring, surveillance, and control systems has happened (Hamlyn, Cheung, Lin, Cuiigang, & Cheung,2008) & (Lin, et al., 2009) ..

3.2.2 Types of distributed generation technologies

Actually, types of distributed generators extend to cover all types of power generation methods. These types include the traditional generators like oil and gas generators in addition to recently developed technologies like micro turbines, solar plants, wind farms and other sources of electrical energy.

3.2.2.1 Gas turbines

Gas turbines or power generation based on gas turbine technologies is common with very large generation capacities. Sizes of gas turbines vary from small gas turbines of 500 kW and reaching the capacity of huge gas stations of 50 MW. Gas turbines are very common due to low costs of their maintenance in addition to higher efficiency achieved due to the high ability for heat recovery. Gas turbines are the most favourite type for almost all distributed generation requirements (Davis, 2002).

3.2.2.2 Micro turbines

The same functional cycle of conventional turbines is implemented in micro turbines. However, micro turbines are commercially less developed compared to the mentioned conventional turbines. The development of micro turbine has started from the design of fast and small turbines. These turbines rotate at high speeds of up to 100000 cycles per minute. Their components like nozzles and burners are more and more compressed. Generally, the sizes of micro turbines range between 30 and 250 kW (Pilavachi, 2002). Micro turbines require less maintenance costs and use an air cooling system. However, micro turbines are a little bit less efficient than their conventional large sized gas turbines because.of low functional temperatures.

3.2.2.3 Engines

The technology of internal combustion engines is a well-known and conventional engines structure. These engines are fed by natural or diesel oil. Natural gas engines are using spark ignition while diesel oil engines implement a compression ignition technology to fire. The energy of combustion is divided into three main parts; the first part is the mechanical energy that is converted into electricity with the ratio of 26-39 %; the second part is a useful heat that can be used for different goals and represent 46-60 %; the last part represents different losses of the engine due to radiations and exhaust gas losses in addition to gear box losses.

Power production engines are of the size of 1 MW typically. They are more and more used in distributed generation systems. They are increasingly being used in combined heat power for peak load or standby needs in different applications (Daley, ASCO Power Technol., & Siciliano, 2003).

3.2.2.4 Fuel cells

Fuel cells (FC) produce electromechanical energy out of chemical energy without the need for any thermal energy phase. Fuel cells have very high efficiency compared to other engines. In the fuel cell the hydrogen and the oxygen are fed to the cell. Chemical reactions combining hydrogen and oxygen molecules producing water and energy take place in the fuel cell. The oxidation of hydrogen to produce water creates equilibrium where electrons flow through an external electric structure providing energy. Unlike normal batteries, fuel cells can provide continuous energy provided with the two main functional elements which axe oxygen and hydrogen. However, the direct oxidation of natural gas is still impossible which implies the conversion between different materials. This conversion is less efficient and still need more scientific researches and investigations.

Fuel cells have their own advantages including high power efficiency and performance under variable loading values. Their emissions are very small and they cause no noise. The main disadvantage of the use of fuel cells is as mentioned above the high initial costs.

3.2.2.5 Wind turbines

Wind power generation existed since long time and it can be considered as distributed generation sources if it is located near the demand source. Generally, areas with high and stable wind speed over the year can have wind turbine farms. The annual capacity factor of a good wind turbine area is 20-40 %. Typical wind turbine can provide its .services for more than 20 years with six month interval maintenance. Rotating axe of the wind turbine transfer the mechanical energy from the wind to a gear box connected to an electrical generator. Normal wind turbine sizes range from few hundreds of watts for residential needs to huge turbines with the power of over 5 MW (Spera, 2009). The main disadvantages of wind powersreside in the initial costs in addition to the intermittent nature of the energy source.

3.2.2.6 Photovoltaic solar cell

Solar cells have the ability to produce electricity directly from the sunlight by taking advantage of photovoltaic effect (Williams & Ogden, 1989). Solar cells are constructed totally of fixed parts; there are no rotating or moving parts within the solar cell. Typical photovoltaic cell can produce a maximum of 2 W and about 1.5 V. For commercial and technical reasons, multiple cells are normally grouped in series and parallel combinations to produce more power and higher voltage levels suitable to be used in different applications. The group of multiple series and parallel combined cells is called PV module.

3.3 Photovoltaic Systems

PV system is a system able to convert energy from the sun directly into electrical energy. The main part of the .solar system is the solar cell combined in groups to produce solar modules and arrays. Solar systems are used to produce energy to be used in feeding different electrical loads. Solar cells produce DC electrical energy that can be used directly in feeding some types of DC loads; or converted through different converter types to feed other DC and AC loads. Solar systems can be connected together to form larger systems or even can be combined with public grids to exchange their power with. The general structure of the solar system is composed of a DC-DC converter, DC-AC inverter, battery system, controllers, protection devices, in addition to some auxiliary power sources and the loads. Recently, batteries in solar systems became an optional part in the grid tied solar systems; these systems exchange the energy directly with the electric grid with the need to locally stock it. By consequence, costs of grid tied solar systems have reduced to half the initial costs.

Solar systems can be found in different forms and sizes from residential application size of Jess than 10 kW to medium size of 10-100 kW, and other large systems with production capacity of more than 100 kW. These systems are either used as standalone systems, hybrid systems in combination with other energy sources, or connected directly to the power grid to exchange energy interactively.

Commercial solar modules produce the energy from the sun with an approximate energy efficiency of 10-20 %. This means.that 10-20 % of the solar energy falling on the module is being captured and converted to electricity. Scientists and research laboratories are making huge efforts to increase these efficiency ratios and decrease the costs of solar applications. As a result for these efforts appeared the solar cells or Concentrated Photovoltaic Cells (CPV). These systems focus solar energy on multi-junction solar cell to increase cell's efficiency. In CPV. systems, the solar cells are fit in concentrating collectors. Concentrating collectors use mirrors or lens to concentrate the light of the sun on the solar cells. Some special tracking systems are used with CPV systems to ensure continuous tracking of the sunlight. The main advantage of CPV systems is the very high efficiency achieved. Some references concluded that CPV can produce an energy efficiency of up to 50 % (Luque, 2011). However, the need for special sophisticated tracking systems is one of CPV's costs.

3.3.1 Advantages and drawbacks of solar energy

Solar energy has its own advantages and disadvantages, the advantages of solar energy systems can be resumed by (Deendayal, 2012):

1- Solar energy is available mostly everywhere and solar systems are flexible; they can be used in different manners and can be easily implemented.
2- Solar energy is available when its need is maximum, the peak demand happens in midday when the solar energy produces its maximum energy.
3- Solar structures can work for long periods of time with the minimum maintenance and operating costs.
4- Solar energy is clean and environment friend, it is safe and cause minimal pollution.
5- Solar systems are modular; any extra power generation can be added easily with no extra needs or expenses.
6- Solar systems are the perfect choice to be implemented in remote areas as they are cheap and reliable compared to the creation of public grids infrastructures.
7- The main and most important advantage of solar systems is that their source of energy is infinite, charge free, and accessible all the time.

Although solar energy is clean and cheap source of power, it still presents some disadvantages. The main disadvantages of solar energy are:

1- Solar energy needs to be stocked in batteries especially in remote areas; that amplify the expenses and imply extra maintenance costs.
2- The most important drawback of solar energy resides in its initial costs if compared to other large scale electrical power sources. However, in the last 10 years the costs of the solar energy have decreased to about 50 % due to the use of new technologies in their production and development.
3- Another drawback of solar systems is the variable output power that is a function of the solar irradiation and temperature. Areas that have short day times or covered by clouds for long periods will produce very low amounts of energy. Over more, the efficiency of solar arrays is less than 20 %; this means more and more reduction in power generation.

3.4 Energy **Potentiatin** Libya

Libya is one Qf the main exporting countries in Africa and the world with 6 million populations spread ewer its area of 1.75 million square kilometres. Weather in Libya is Middle Eastern hot in summer and warm in winter. Like most of Middle East countries, Libya has high average solar irradiation that makes it a great solar energy potential. The daily average irradiation varies between 7.1 kWp and 8.1kWp(Mopfa1&Q¢11ich, 2009). Figure 3.3 presents the solar map of Libya showing the solar energy distribution in the Libyan territories. Until 2011, Libya had a large electric grid with big and well-arranged infrastructure. 12000 km of high voltage networks combined with 12500 km of medium voltage grid in addition to 7000 km of low voltage grid constructed the main nerves of the Libyan national grid (Hassan, Nafeh, H.Fahmy, & El-Sayed, 2010). However, after the war in 2011 the situation in Libya has changed and national electric grid became unable to feed the country with the required energy. Many high and medium voltage transmission lines were destroyed during and after the war and couldn't serve the distribution stations. Power consumption in Libya is in continuous growth. Load profile in Libya during the years 2003-2012 is presented in Figure 3.4. It shows a constant annual increase in the consumption during this period except for 2011 where political and civil was events have affected all the fields of the life including the energy consumption and production. Many generation and distribution station went off service during the war that has a great effect on the overall energy sector.(Fig;ure 35 .den1onstrates the. growth in Libyan electricity generation during.the. perioq/ext~11di11gfr9m2003 until the .year 2012..The figure shows that the energy productiopwas(gro\Ving .in a fixed rate of approximately 7.6 % between 2003 and 2Ql0. However, the energy production sector has faced some troubles during the year 2011 as a result of the political and security instability. However, during the year 2012 the energy production sector has recovered its. normal.growtl; rate and the annual production reached the value of 35000.GWh.

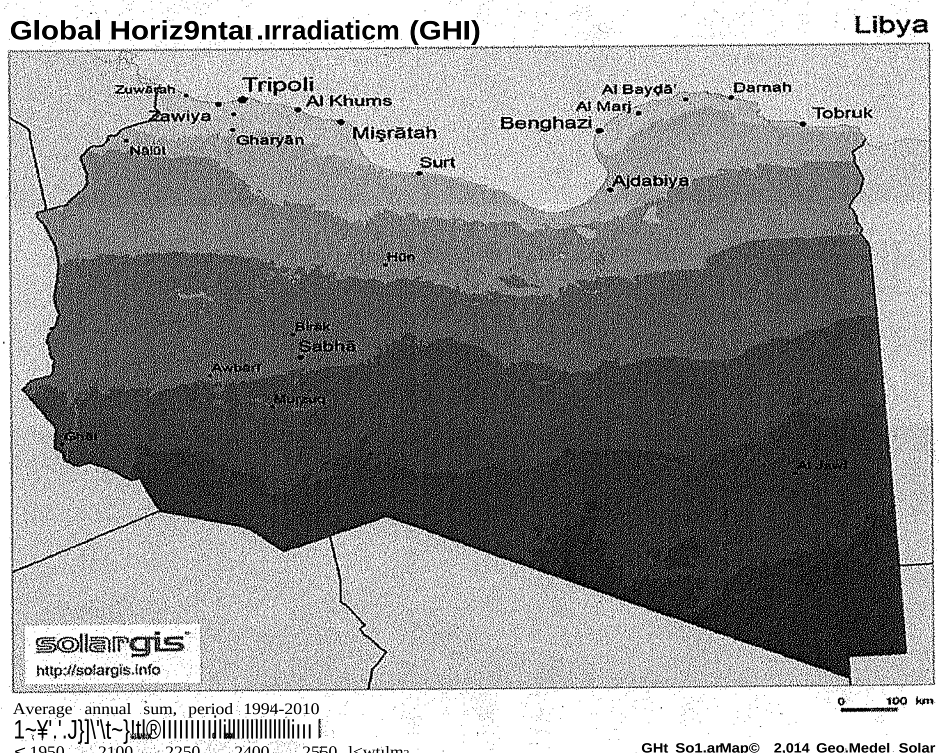


Figure 3.3:i§olar map inLibya (Solargis,.2016)

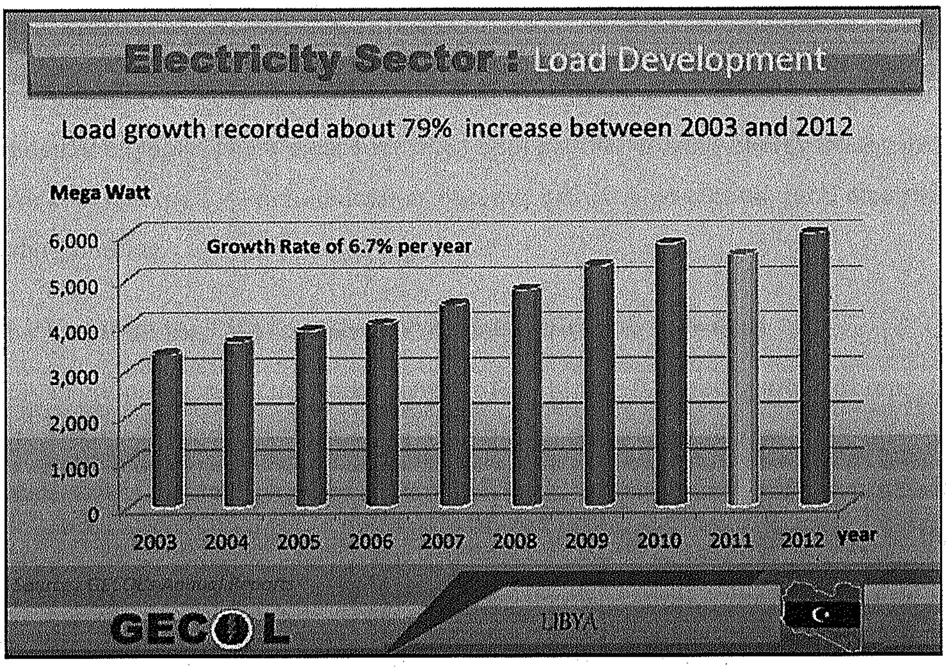


Figure 3.4: Load growth in Libya 2003-2012 (Ibrahim & Khalifa, 2003)

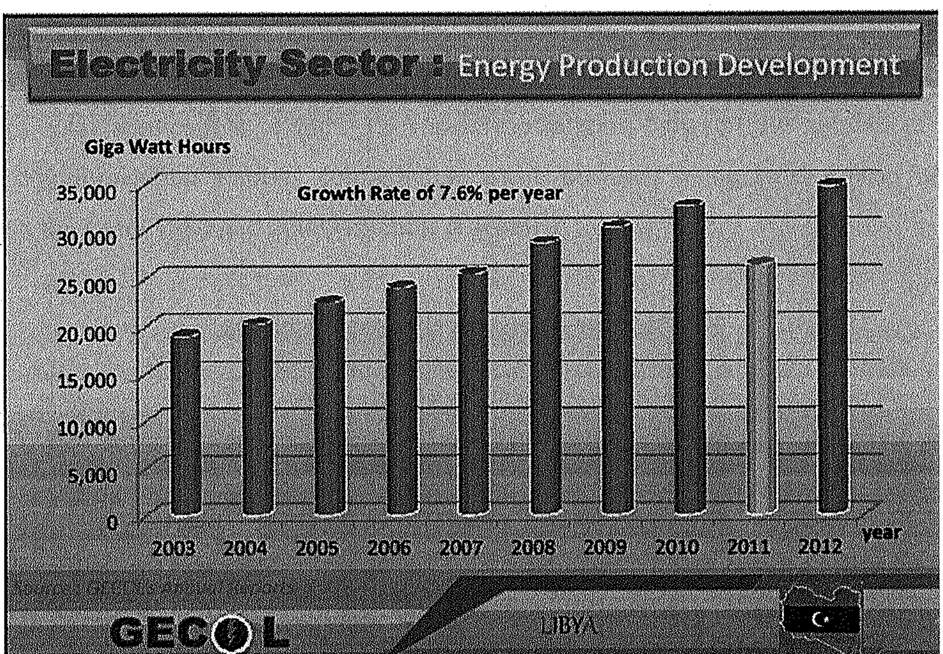


Figure 3.5: Electricity production growth **in** Libya between 2003 and 2012 (Ibrahim & Khalifa, 2003)

3.4.1 Photovoltaic applications in Libya

The investigation in solar potential in Libya is still weak and need more plans and governmental support. There exist four main applications of solar energy sector in Libya; these are solar energy for communication systems, cathodic protection, rural electrification and water pumping.

3.4.1.1 PV system for Libyan microwave communication networks

The Libyan communication networks consist of about five hundred stations of repeaters. In the end of the year 1997, 9 rural stations were driven using solar systems. The approximate total peak power demand was about 10.5 kW peak. Among the 9 solar energy powered communication stations, four stations solar systems are still working after more than 30 years of service. The batteries of the system were replaced many times with an average life time of 8 years. On the other hand, the other stations that use diesel generators have faced many struggles due to the lack of diesel and maintenance. Problems include continuous interruption in the communication services and stolen fuel and engine parts. One of the most famous cases was in Zalaf station that went of service for 17 days during the year 1997 (saleh, 2006). Nowadays, more than 80 communication stations in Libya are using solar energy to obtain their power needs. This increase in the number of solar energy powered stations is due to the success of solar energy applications and the reductions in the costs of solar applications. Figure 3.6 shows the relation between the number of diesel based communication stations compared to those powered using solar energy sources between the years 1980 and 2003 (Ibrahim & Khalifa, 2003).

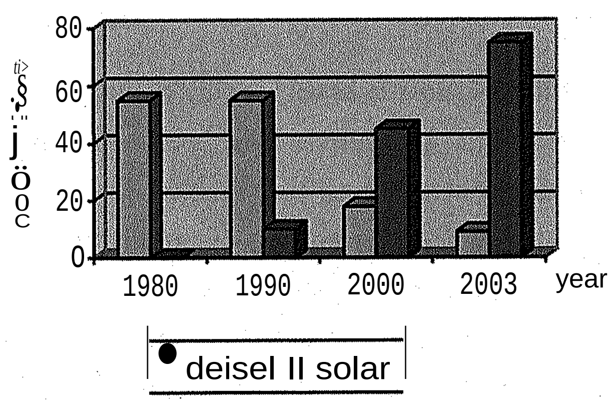


Figure 3.6: PV and diesel stations in the communication network
(Ibrahim & Khalifa, 2003)

3.4.1.2 Solar energy for cathodic protection

The Cathodic Protection (CP) stations are usually situated at large distances from public networks; this signifies that it's impossible practically to use the public grids in feeding these stations with their power requirements. A cathodic protection station requires up to 15 kWh daily. Solar systems offer a perfect and reliable source of energy for CP stations. Solar systems must be chosen to fit best the load profile of a CP station. Solar systems for CP stations can be set up in any place near to the station to convert directly the sun energy to the required type of energy need by the station. For reasons related to maintenance of diesel generators, the need for continuous supply of fuel. In addition to the lack of power grids that solar resources were chosen as the best alternative for CP station empowerment (Al-Jadi, EK.biat, & Krema, 2012). The first system used in CP stations in Libya was set up into service in 1976, CP stations comes the next in the total accumulated solar power in Libya after communication systems. By the year 2005 over than 300,CP stations were powered using solar energy systems in Libya. The total set up systems produced about 450kW peak (AI-Jadi, EK.hlat,& Krema, 2012).

3.4.1.3 Rural electrification with PV systems

The main problems that face the planners of power distribution systems in different countries can be concluded in low population, and distance from the existing networks. The extension of high voltage lines to cover rural areas through the desert is a very costly process and needs special budgets. In the less populated countries of the developing countries, just main cities are empowered through the public network. The electrification of rural areas is accomplished by the use of other resources available within the possibilities of the governments.

As an example, in a 200 citizen's village located at a distance of fifteen kilometres from the distribution station in Libya, and considering an average annual individual consumption of JOOO kWh, the village will need 200 MWh per year. A price of 0.75 $/kWh will be charged to be able to provide such a village with electricity from this station without loss which is 10 times the actual national tariff in Libya. For such reason, a rural area was accepted to be a place having 200 citizens and situated at a distance more than 5 km from the low voltage grid (AI-Jadi, EK.biat,& Krema, 2012).

The Libyan national plan to cover all the cover all the remote areas by electricity is to electrify all distributed houses and villages in addition to water pumping units. A project for the electrification of 10 villages was presented earlier to be established as a first step in this plan (Al-Jadi, EK.biat,& Krema, 2012). Some of these villages are:

a) Mrair Gabis village.
b) Swaihat village.
c) Intlat village.
d) Beer al-Merhan village.
e) Wadi Marsit village.
f) Intlat village.

The first works of installation of solar systems in this project was initiated in 2003. The total number of installed projects by the General Electrical Company of Libya (GECOL) was 340 with capacity of 220 kW peak. Projects that are installed by the Center of Solar Energy Studies (CSES) and the Saharian Center is about 125 kW peak divided on 150 individual projects. The applications were as following:

- 380 projects for isolated houses.
- 30 projects for police stations.
- 100 projects for street lighting.

3.4.1.4 PV systems for water pumping

Water pumping is one of the most suitable applications of solar energy systems. The variable nature of the-produced solar power is acceptable in water pumping applications. The project of water pumping included the installation of 35 individual solar projects. The total power generated by these projects is 96 kWp. Table 3.1 shows the total solar power generation for different applications in Libya until the year 2014 (Al-Jadi, EKhlat, & Krema, 2012).

Table 3.1: The total installed PV capacity in Libya

APPLICATIONS	NUMBER OF SYSTEMS	TOTAL POWER [KWP]
COMMUNICATION	100	420
CATHODIC PROTECTION	300	540
RURAL ELECTRIFICATION	510	345
WATER PUMPING	40	110
TOTAL	950	1415

3.5 Methodology of the Work

In this research, a large scale grid connected photovoltaic system is designed with 14 MW installed capacity. Details of the design include the total number of PV modules, inverter, cables and circuit breakers. In this study, the main system design is undertaken based on the amount of generated power. The generated output power from the PV system is at 0.4 kV voltage level. It is stepped up through 0.4 kV to 11 kV bus-bars by 7 step-up distribution transformers with 3 MVA rating each. The output of the power transformer is synchronized to the national grid at Houn substation less than 100 m of the supply point. To achieve the power ratings, 7 arrays with 2 MW for each array resulting at 14 MW generated power were adopted.

Results and objectives of this study presented in three main areas. Detailed design section, Matlab/Simulink PV Simulation, and power analysis studies using ETAP. Design section starts with considering the methods of connection of solar arrays and their connection with the inverter and power transformers, cables selection, inverter selection, and protective devices selection. Load flow, short circuit, harmonics and voltage stability studies were carried out. The results of power flow, busses voltages, busses angles and line losses were compared. Flow chart of the methodology is depicted below in Figure 3.7.

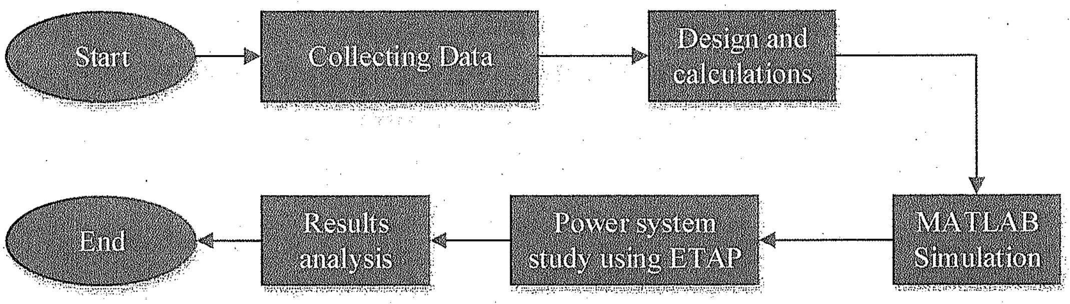


Figure 3.7: Flow chart of the station design and analysis process

3.6 Modelling and Analysis Software

In this work, two software packages have been used which are:

3.6.1 MATLAB / SIMULINK (version 7.8.0.347 (R2009a))

The Matlab is a high level powerful programming language dedicated for technical processing and .mathematics.purposes, it has an easy to use and manipulate.user interface. Matlab environment presents mathematical problems and solutions simple and familiar mathematical notation. Matlab has a very powerful graphical user interface called Simulink. Simulink is used to build easily models for different systems. The interactive graphical environment of Simulink simplified the process of modelling processes or systems, removing all necessity of writing differential equations in programming languages (MathWarks, 2016).

3.6.2 ETAP (version 12.6.0H)

ETAP is the most wide-ranging analysis software that is designed especially to design and apply tests of power systems. ETAP program can use real data obtained from normal operation of the systems to perform offline data analysis, simulation, energy management, and load control. The name ETAP stands for (Electrical Transient Analyzer Program). It is designed to be used by engineers to perform different tasks of power systems analysis for different areas of industries in a one package.

CHAPTER4

DESIGN AND SIMULATION OF GRID CONNECTED PV SYSTEM FOR LIBYAN NATIONAL GRID

4.1 Introduction

In this chapter, the details of the design and calculations of 14 MW PV integrated to the Libyan national grid at Haun city which is the capital of the Jufra District in Libya will be presented. Also, mathematical modelling of the PV panels used in the design will be discussed and presented; Matlab simulations of the panels will also be discussed and presented in this chapter.

4.2 Design Procedure of the PV Station

This section introduces the design procedure before the integration of solar PV power system into an existing grid with power generation of 14 MW. The main system design is undertaken based on the amount of generated power (14 MW). The generated voltage is 0.4 kV and it will be stepped up to 66 kV. It is stepped up through two stages:

- First stage: voltage step-up from 0.4 kV to 11 kV by seven step-up distribution transformers with 3 MVA rating each.

- Second stage: voltage step-up from 11 kV to 66 kV by two step-up power transformers with 12.5 MVA rating.

The output voltage of the power transformer is synchronized to the national grid at Haun main substation. To achieve the power ratings, 7 PV arrays with 2 MW for each array resulting at 14 MW generated power will be used.

PV modules must be selected. based on some criterions related to their efficiency, price, warranty, life period, and atmospheric conditions. The selection must take these considerations in account in order to guarantee the best performance, highest benefit, reliability, at suitable prices. The first decision is to choose between mono-crystalline and poly-crystalline modules. The choice must consider the price and efficiency as the first criterions as the other criterions are approximately the same. Generally, the prices of poly-crystalline are more expensive than the mono-crystalline panels. However, the efficiency in poly crystalline modules is a little better than mono crystalline panels. Due to the high costs of the project as the project .needs a huge number of PV panels to generate the required power of 14 MW. The Renewable Energy Authority of Libya "REAOL" decided to use mono crystalline panels. Suniva ART245-60 modules of 240 Wp solar panels are going to be used in the project. ART245-60 module is a well-known robust solar cell's type that is designed to be used in grid tied solar projects and power stations. The characteristics of the ART245-60 are taken under STC "Standard Test Conditions" in laboratory environment The standard conditions are 1000W/m2 irradiation, 25°C, and 1.5 solar spectrum air mass. Basic features of the used modules are presented in Table 4.1 while the detailed data sheet of the module is presented in Appendix 2 (Suniva, 201 O).

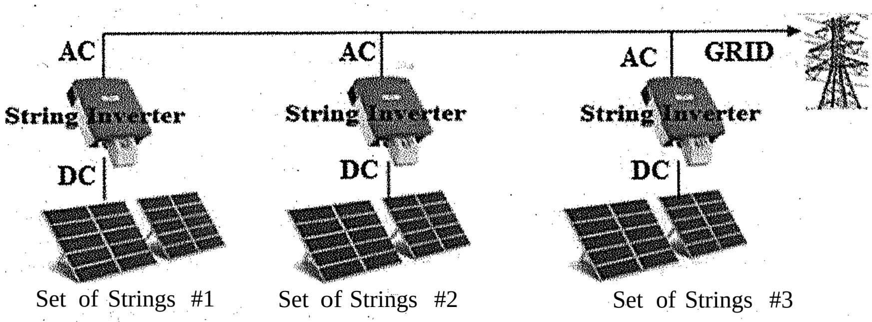
Table 4.1: Basic features of the discussed PV modules

Maximum power	240W
Voltage @ maximum power point	30.9V
Current @ maximum power point	7.95
Open circuit voltage	37.4
Short circuit current	8.44
Cells per module	60
P (Voltage de-rating factor (Voe% / oC))	-0.332
a (Current de-rating factor (ise % / oC))	0.035
y (Power de-rating factor (Pmax % /oC))	-0.465

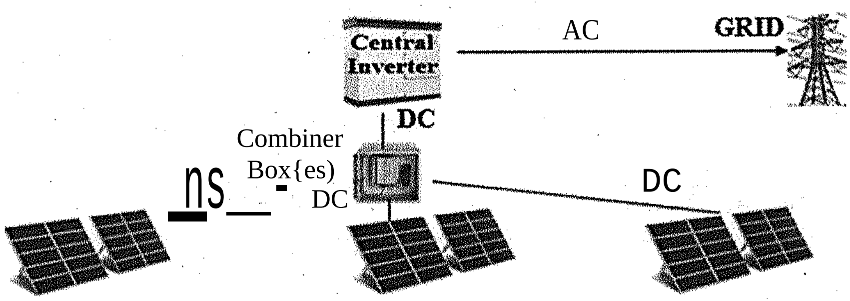
4.2.1 Design and selection of grid tied inverter

Inverter is a power electronic device used to invert/convert electrical energy from DC to AC. The inverter is actually bi-directional device; the power conversion is achieved from AC to DC or from DC to AC. However, it is mainly used as an AC generator (Rashid, 2001). The DC side of the inverter is fed from a battery or a group of batteries while the AC side can be connected directly or via a special transformer to increase the voltage level and improve the quality of the generated voltage. Inverters are used in UPS systems, static compensators, active filters, flexible alternative current transmission systems (FACTS), and many other applications (Rashid, 2001). The development of power electronic technologies has Jed to a great evolution in the voltage source inverters topologies and control schemes. Recently, synchronised or grid connected inverters are widely spread and used in renewable energy applications, Such inverters has the ability to synchronise there output voltage and current with the grid's voltage. They can be directly connected to existing powergridand interchange energy with theJatter. Grid connected inverters have greatly decreased the costs of solar and wind energy systems as they reduced the need for batteries to backup generated energy. Instead, generated energy is being fed directly to the grid that is considered as a huge battery for the power system.

Two types of inverters can be used in large scale projects; these are multiple string inverter and central inverter. Multi string inverter topology is presented in Figure 4.1-a. Each group of panels or strings are connected together and fed to a suitable DC-AC inverter. The group of inverters are then connected individually and separately to the grid. The main advantage of this topology is the use of small, size and rating inverters instead of using one large inverter.in central topology. It also requires less maintenance in general than the other topology. The failure of one inverter iri a string system causes the failure of a part of the system and not the whole system. Over more, the maintenance required will be considered for that one inverter and not for the whole system. However, the initial cost of string inverter based system is higher than the central inverter. String inverters are still new topologies and not used too much in large scale stations. One more advantage of the string inverter is that it can be connected with strings with different angles and different voltage levels. Central inverters are the most used in power stations. Figure 4.1-b shows the topology of the central inverter. Multiple PV strings are combined in a one DC box out of which one connection is fed to a high rated inverter. The DC connection of multiple strings implies that their tilt angle and generated power are exactly the same. Central inverter requires less space and less initial costs compared to string inverters. However, the failure of the inverter causes the failure of the whole system (Cenergypower, 2014).



{a) String inverter



{b) Central inverter

Figure 4.1: (a) - String inverter a vs. (b) - Central inverter (Cenergypower, 2014)

Due to the low initial costs and the familiarity of central inverter in similar applications as it is used widely all over the world in similar applications, central inverter has been chosen to be implemented in this work. Details of the design and sizing of the system are going to be discussed in the next sections of this chapter.

4.2.1.1 Design of the. central inverter

The aim of the present study is to design a large scale grid connected PV generator. The design must take different rating and power calculations in consideration to avoid future failures and problems as much as possible. The system is going to be connected to the Houn station in the Jufra district. The capacity of the solar system is decided to be 14 MW of mono crystalline solar panels. The design needs to consider the maximum input voltage for the inverter to find the maximum series strings or modules. Also, the maximum current rating of the inverter is used.to decide the parallel strings that are going to be fed. Cables sizes also must consider the current rating of the strings. Central inverters of 1 MW rating from ABB were chosen to be used in the project. Total of 14 inverters are going to be connected and used in the system. Central inverter PVS800-57-1000 kW-C model is used. Main features of this inverter's model are presented in Table 4.2 while the documentation is provided in Appendix 3 (ABB, 2014). To accomplish the design task of the project, the total power was divided on seven fields. Each field has a power capacity of 2 MW. The design considers the calculations for one field and then generalized for the rest of the fields of project. Given that the maximum power of each module is 240 Wp, the total number of modules to be used in each field can be found easily by:

$$\text{Number of modules per field}=\frac{2000\text{kW}}{240\text{W}}=8333 \text{ PV module}$$

Table 4.2: Features of the ABB 1 MW central inverter used

Model	PVS800-57-1000kW-C
Rated power	1000 kW
Maximum power	1200 kW
DC voltage range (MPPT)	600-850 V
Maximum DC voltage	1100V
Maximum DC current	1710 A
DC inputs	8-20
Nominal AC voltage (3-phase)	400V
Nominal AC current	1445 A

The total number of the PV modules in the project is then given by:

Total number of modules= 8333x7=58,331 PV module.

It is important to remember here that the power ratings given in the datasheet of the solar modules are measured under standard test conditions that are difficult to be achieved in real life. The real maximum power obtained from the module is mostly less than this value due to high temperature and low irradiation levels. The open circuit voltage values given in Table 4.1 were given at standard temperature of 25 degrees. However, the temperature is variable that can decrease to. less than zero or more than 60 at the cell's surface. For this reason, open circuit voltage values are going to be calculated at the highest and lowest temperature limits of the modules that are -40 and 90 degrees. The next relation can be used to give an approximation of the open circuit voltage.

$$V(T) = V_{@25^\circ C} \times (1 + \beta \times \Delta T) \qquad (4.1)$$

Where β is the temperature de-rating factor shown in table 4.1. The maximum and minimum voltages of the system can be given as:

$$(V_{oc})_{@-40^\circ C} = 37.4 \times [1 + (-0.332) \times (-40 - 25)/100) = 45.6\ V$$

$$(V_{oc})_{@90^\circ C} = 37.4 \times [1 + (-0.332) \times (90 - 25)/100) = 29.32\ V$$

$$(V_{MPP})_{@-40^\circ C} = 30.9 + (-0.332\ \%) \times \Delta T = 20.9 + (-0.00332) \times (-65) \times 29.8$$
$$= 36.2V$$

$$(V_{MPP})_{@+90^\circ C} = 30.90 - 0.00332 \times \Delta T \times 30.9 = 30.90 - 65 \times 0.00332 = 24.32V$$

From Table 4.2, the maximum permissible DC input voltage is 1100 V, and the maximum power point voltage ranges between 600 and 850 V. It is important to notice that both the open circuit and maximum power point voltages are maximal at the minimum temperature -40°C and minimum at 90°C. These values are important to find the number of series connected modules per each string that can be connected to the inverter. These values are going to be calculated at the minimum acceptable temperature that is -40°C.

$$Number\ of\ modules\ per\ string = \frac{V_{MPP\,inverter}}{V_{MPP@-40^\circ C}} = \frac{850}{36.2} = 23.4 \qquad (4.2)$$

The optimum number of modules per string is found to be 23 modules per string. Now it is important to find the maximum possible number of modules per string as follows:

$$modules\ per\ String_{max} = \frac{V_{max\,inverter}}{V_{oc@-40^\circ C}} = \frac{1100}{37.4} = 29.4 \qquad (4.3)$$

That means the maximum allowed number of series modules is 29 modules. The optimal design implies that the number of series module will be between 23 and 29 modules as maximum. In order to find the maximum number of parallel strings, it is important to consider the short circuit and maximum power point currents. The number of strings is found as follows:

$$String_{number\,max/inverter} = \frac{I_{max,inverter}}{I_{SC\,module}} = \frac{1710}{8.49} = 201.4\,strings \tag{4.4}$$

This means that a maximum of 201 parallel strings can be connected at the input of the inverter. For each inverter, taking in consideration the total number of modules per field found previously to be 8333 modules that will be distributed on two inverters. That means each inverter will be connected to a total of 4167 modules. If we accept that each string will contain 26 series modules for better performance and security, the number of parallel string is then given by:

$$String_{number/inverter} = \frac{Strings\ per\ inverter}{Modules\ per\ string} = \frac{4167}{26} = 160 < 201 \tag{4.5}$$

From the previous calculation it was found that the design must use 160 strings of 26 modules each respecting the inverter and modules specifications. Figure 4.2 shows the connection of the strings and modules as calculated previously.

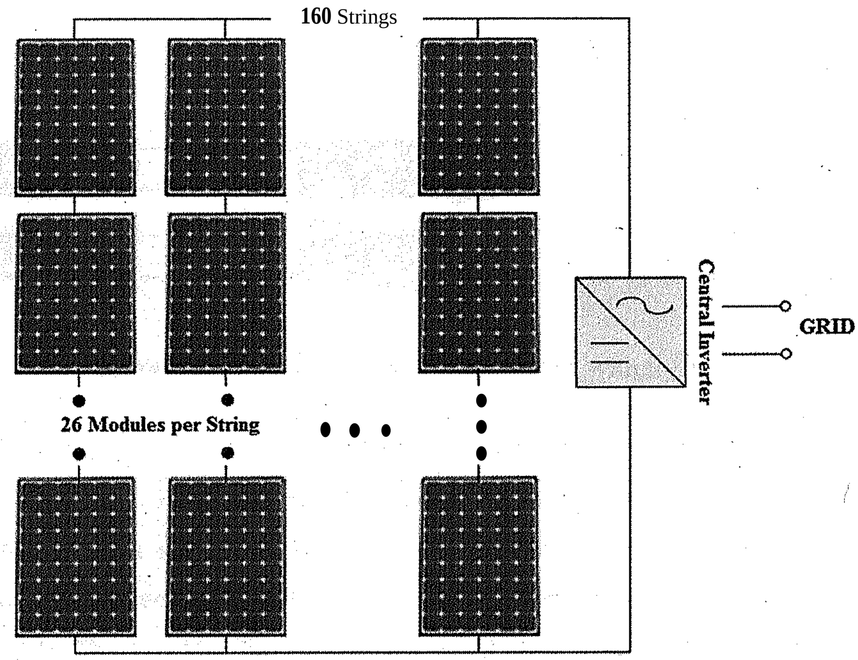


Figure 4.2: The array configuration of the central inverter

4.2.2 Layout of grid connected PV system with the central inverters

Since there exist 7 distribution transformers with 3 MVA rating each, the modules were distributed on 14 arrays. Each two arrays were connected to 1 transformer through two separate central inverters. The seven transformers primary sides are connected to the 11 kV grid bus bar. Inverters are connected to the panels such that each inverter is connected with 160 parallel strings, and 26 modules per string in series. Figure 4.3 below presents the connection scheme of the arrays, inverters, transformers and bus bars.

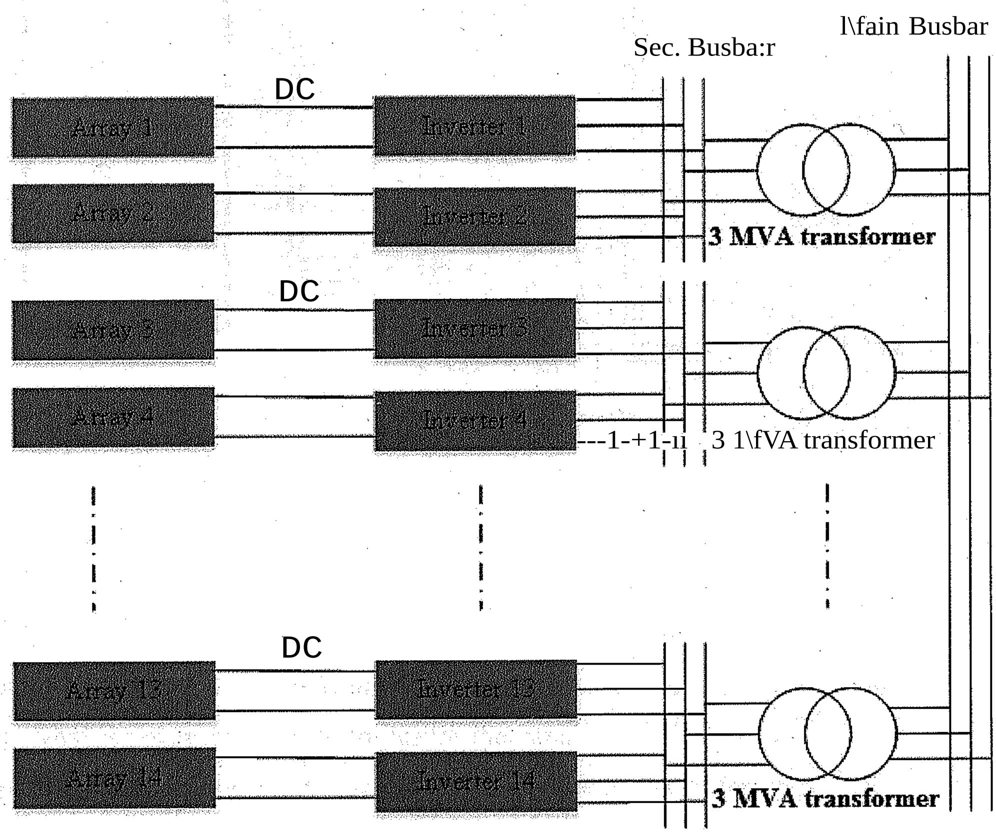


Figure 4.3: General structure of the arrays with the inverters

The wiring diagram connection of the inverters output to the main AC combiner box is shown in Figure 4.4. It must be mentioned here that the output of the main combiner box was connected to a step-down distribution transformer from the secondary side. This transformer is selected to be (11/0.4) kV, since it is connected to the inverter from the 0.4 kV level side. The 11 kV voltage level is selected because the Houn station has an 11 kV bus-bars. The connection between each two elements is done through special AC protection and disconnection circuits to ensure the total safety of equipments and persons against any faults or electric hazards as shown in Figure 4.4. These protection circuits in addition to the suitable cable sizing calculations are going to be discussed in the next parts of this work gradually.

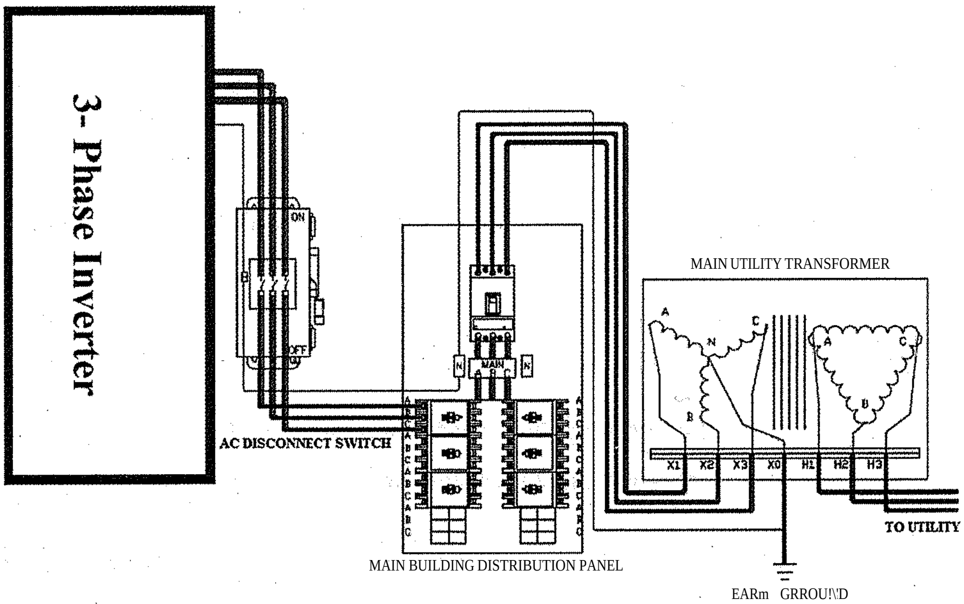


Figure 4.4: Wiring diagram of connection of inverters output to main combiner box

4.2.3 Cable sizing

Cable sizing is one of the most important issues in electrical works and installations. It is a very vital measure of security to ensure the capability of connection wires to handle all types of electrical and electromagnetic stresses under the different possible atmospheric conditions. In addition, the wiring must not affect the performance of the designed system due to extra losses caused by wrong sizing of cables. Cables must be sized to withstand the current flowing through it, to support short circuit fault levels for short periods until the tripping of protection circuits, to handl~ changes in temperature and moisture, to be able to withstand the voltage levels they are carrying, and to ensure the minimum possible voltage drop. The voltage drop in a wire can be given by:

$$V_d = \frac{\rho \times l}{A} \times 2 \times I \qquad (4.6)$$

Where,

ρ : is the resistivity of used wire which is normally taken to be 0.0183 $\Omega.mm^2/m$ for copper.

l = the length of cables in meters.

I = the current through the cables in amperes.

A is the cross sectional area (CSA) in mm^2.

The multiplication by 2 accounts for total circuit wire length. We can rearrange the above equation to obtain the following equation:

$$A = \frac{2 \times \rho \times l \times I}{V_{dmax}} \tag{4.7}$$

In the design of the system, a maximum cable voltage drop of 5 % was used and this is the maximum allowable voltage drop in the international standards.

4.2.3.1 Sizing cables between PV modules

The cable is sized based on the following information:

Length of cable is 1.5 m, while the maximum current that can flow through the wire is given by:

$$I_{c} = 1.25 \times I_{SC module} = 1.25 \times 8.44 = 10.55A \tag{4.8}$$

Where, the factor of 1.25 was considered for reason of security. The maximum allowable voltage drop is given by:

$$V_{MPP module} \times 5\% = 30.4 \times 5\% = 1.52V \tag{4.9}$$

The wires are considered copper wires that have resistivity of 0.0183 $\Omega.mm^2/m$, from which the cross sectional area is found as:

$$A = \frac{2 \times \rho \times l \times I}{V_{dmax}} = \frac{2 \times 0.0183 \times 1.5 \times 10.55}{1.52} = 0.38 mm^2 \tag{4.10}$$

This means that any cable of cross-sectional area above 0.38 mm^2 can be used for the wiring between PV modules. However, this value is suitable to ensure the minimum voltage drop, but it is not enough to ensure that the wires can handle the maximum current flowing through it. By referring to the NEC tables for cable sizing it is found that a wire of 15 mm^2 is needed to withstand a current of 9A while a wire of 2.5 mm^2 is needed to withstand 16A. In our application the maximum current with safety factor is 10.55, then the best choice is a 2.5 mm^2 wire. It is important to notice that special insulated DC wires with PVC cover are used. This insulation is suitable to be used under ultraviolet rays without need for any extra covering.

4.2.3.2 Sizing of cable from PV array bus-bar to inverter

The cable is sized based on the following information:

Length of cable is 20 m, the maximum current from array is 8.44 x 160 x 1.25 = 1688A. The maximum voltage drop is given by:

$$Vd = 5\% \times V_{max} = 5\% \times 600 = 30V \tag{4.11}$$

The minimum cross sectional area is found by:

$$A = \frac{2 \times \rho \times l \times I}{Vd} = \frac{2 \times 0.0183 \times 20 \times 1688}{30} = 41.2 mm^2 \tag{4.12}$$

That means the minimum cable cross sectional area needed to ensure acceptable voltage drop is 41.2 mm^2, however; the design must consider the cables' ampacity. As the wires need to handle an amount of current of 1688A, by referring to the cable tables it is found that the maximum cable size is 240 mm^2 and can handle a maximum of 400A. A good choice of cables was found to be 6 wires of 150 mm^2 that can handle a maximum of 1722A.

4.2.3.3 Sizing of cable from inverter to main junction (inverter / distribution panel)

The cable is sized based on the following information:

Maximum length of cable is 30 m; the maximum current from inverter at full load on each phase (line) is given by:

$$I_{p1ıase} = \frac{Inverter\ V_{\sim ax}}{V_{LL}\ xJj} = \frac{1200}{400x\text{-}Ji} = 1.73kA \tag{4.13}$$

The maximum allowable voltage drop is given by:

$$v_{dmax} = 5\% \times 400 / Ji = 11.SV \tag{4.14}$$

The minimum cross sectional area correspondent to voltage drop can be calculated by:

$$A = \frac{2xpxlxl}{v_{dmax}} = \frac{2x0.0183x30xl\ 730}{11.5} = l65.2mm2 \tag{4.15}$$

By considering the cable ampacity, 6 cables of 185 mm^2 should be used to connect each inverter to the bus bar.

4.2.4 Sizing of circuit breakers

Circuit breakers are installed in the system to protect against over current of the circuits and sized to not be below 125 % of the current flowing through the wiring. The circuit breakers used in this installation must be bi-directional. However, the sizing of circuit breakers should be less than the maximum ampacity of the protected cables in the circuit.

4.2.4.1 Sizing of circuit protection between PV array and inverter

There are generally two ways of undertaking the circuit protection between PV array and Inverter.

1- Each parallel string of modules can be fused before entering DC collection point.
2- The total output of the PV array is fused before being joined to the inverter.

In this study installation, the first option is used because that makes it easier to find suitable DC circuit breakers at suitable prices.

The maximum current is 1.25 x short circuit current of modules (8.44 amperes) = 1.25 x 8.44 = 1O.SSA

Therefore, the minimum rate of DC circuit protection is $\frac{125}{100}$ x $10.55 = 13.18\,A$ per parallel string.

4.2.4.2 Sizing of circuit protection on every phase output of inverter

The maximum current from inverter at full load on each phase (line) was found earlier in this chapter, the current was 1730A per phase. During the cable sizing calculations it was found that we need to use 6 cables of 185mm^2. The best circuit breaker value for this cable size is 300A circuit breaker. That means 6 circuit breakers with capacity of 300A are going to be used at the output of the inverter.

4.2.5 Synchronization with füe system

In a grid tied system, the synchronisation is a very important notion to take care of. The connection between two power sources needs to take in consideration that the two sources have the same variables. The variables that must be equal are the voltage, the phase, and the frequency. The connection between sources is done just when these three variables are equal in both sources. There are two connection points between the grid and the solar system; these are the 0.4 kV level bus-bar and the 11 kV level bus-bar. Synchronization must be achieved when there is a closed loop system; this is implemented by using Synchro-check relay. Two voltage transformers (VTs) on phase measure the voltages, one on the system circuit side and the other on the bus-bar. The Synchro-check relay compares the line voltage and the bus-voltage, and then a closing pulse command comes from the SCADA centre, and closes a normally open contactor if the synchronization conditions are achieved, then the circuit breaker closes. The synchronisation is very important to protect the systems from being short circuit connected to each other and it is used in all stations to connect multiple sources of power. Table 4.3 resumes the cable and circuit breaker sizing of the designed system as per calculation.

Table 4.3: Cable sizing for the PV system

Cable	Cable Length (m)	Cable size (mm^2)	CB rating
Sizing cables between PV modules	1.5	2.5	No
Cables from PV array to the inverter	20	6x150	No
Sizing of AC wires	30	6x185	300

4.3 PV Modelling Using SIMULINK

4.3.1 Electrical circuit models of PV modules

Models of photovoltaic cell provide a comprehensive description of the behaviour of photovoltaic cell for scientists to be able to study it. A well-known model commonly used in the electrical engineering is the so called single diode PV cell model. The ideal photovoltaic cells model consists of a single diode connected in parallel with a light generated current source (I_{sc}) as shown in Figure 4.5. The equation for the output current is given by:

$$I = I_{sc} - I_D \tag{4.16}$$

While the diode's current is given by:

$$I_D = I_s\left[e^{i.:.'r} - 1\right] \tag{4.17}$$

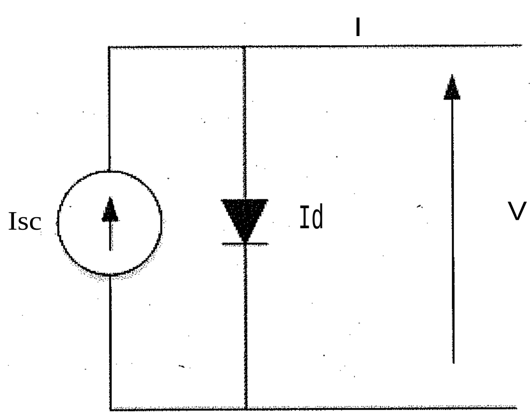


Figure 4.5: Solar cell's model using single diode

The light generated electric current depends on both temperature of the cell and irradiance. It is measured under laboratory special conditions. Thus:

$$I_{sc} = I_{scref} + k_i(T_k - T_{ref}) \times G / 1000 \tag{4.18}$$

Where:

lr·c: is the light generated current at the STC (25°C and 1OOOW/m2).

K;: is the short circuit current/temperature coefficient at Isc-r (0.0017 A/K).

Tl and Trer: are the actual and reference temperature in Kelvin.

a: is the irradiation on the device surface, and 1OOOW/m2 is the STC value.

The model presented in Figure 4.5 cannot describe the total behaviour of the cell under all environmental variations. Some extra losses need to be considered in a more practical model as shown in Figure 4.6; *Rs* and *Rp* are the series and parallel resistance losses.

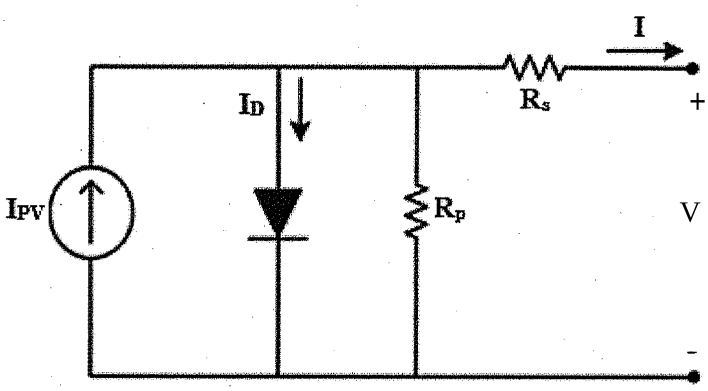


Figure 4.6: Solar cell model using single diode with *Rs* and *Rp*

In this model, a photo electric current source *lsc* depending on the solar radiation, cell temperature and voltage, a diode whose inverse saturation current is a function of temperature, and two series and shunt resistances to represent different losses in the cell are used. The formula that describes the *I-V* characteristic of the cell in Figure 4.6 is given by:

$$I = I_{sc} - I_D - \frac{V_D}{R_p} \tag{4.19}$$

The reverse saturation current *lrs* is given as:

$$I_{rs} = I_{sc\,ref}\left[\exp\left(\frac{qV_{oc}}{N_s\,K\,A\,T}\right)-1\right] \tag{4.20}$$

The module's saturation current *IQ* changes with the cell temperature and is given by:

IQ =1,.., [(T/ T,.ef).3 eqcYAK X(1/ T,·ef - Yr)] (4.21)

Where, *IQ* is the diode saturation current (A). The formula describing the output current of a PV cell or module of the single diode equivalent circuit is given by:

$$I_{pv} = N_p\,I_{sc} - N_s\,I_o\left\{\exp\left(\frac{q\left(V_{pv}+I_{pv}R_s\right)}{N_s\,A\,K\,T}\right)-1\right\} - V_{pv} + \left(\frac{I_{pv}R_s}{R_p}\right) \tag{4.22}$$

Where:

K: is Boltzmann's constant (1.38 x 10^{-23} J K^{-1}).

q: is the electronic charge (1.602 x 10^{-19} C).

T: is the cell temperature (K).

A: is the diode ideality factor.

Rs: the series resistance (Q).

Rp: is the shunt resistance (Q).

N§: is the number of cells connected in series = 26.

Np: is the number of cells connected in parallel = 160.

Vpv =N.«> 37.30 V.

The formula described by equation 4.22 depends on the solar irradiance, and the cell temperature (Abdulkadir, Samosir, & Yatim, 2012). Nameplate values of solar arrays are given under STC conditions. Real operation conditions differ from the STC. Theuse of the simple model of solar cell in our work simplifies the work without affecting the accuracy or generalization of the theory. It makes it easier for power electronic engineers to consider this model while working with power converters. The value of the shunt resistance *Rp* is typically high such that it can be neglected (Abdulkadir, Samosir, & Yatim, 2012) (Yusof, 2004).

4.3.2 Simulink modelling for PV module

Mono-crystalline 240W PV Module is taken as the reference module for simulation and the data sheet details are given in Table 4.1. In addition the simulation for one array of 2 MW is conducted and then the simulation is generalized to all arrays in a similar way. A block diagram of the model based upon the equations of PV model is represented in Simulink environment as given in Figures 4.7, 4.8 and 4.9.

These models are developed in moderate complexity to include the temperature dependence of the photo current source, the saturation current through the diode, and a series resistance is considered based upon the shackle diode equations described previously. Since the main objective is to develop a functional PV model for the Simulink environment, the system is modelled to supply power to the load.

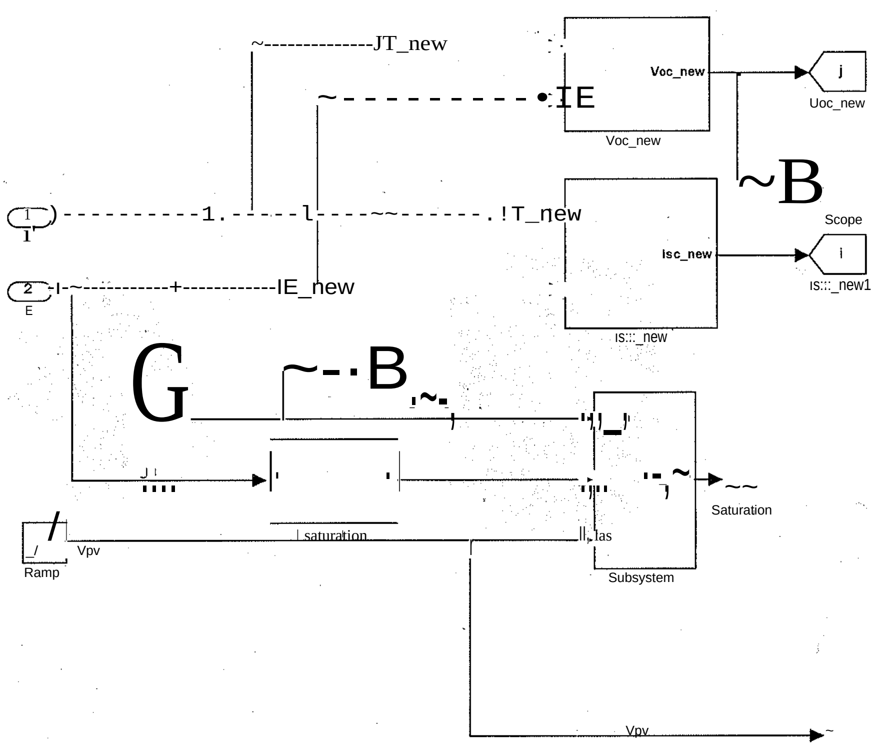


Figure 4.7: Block diagram of the model based upon the equations of PV model

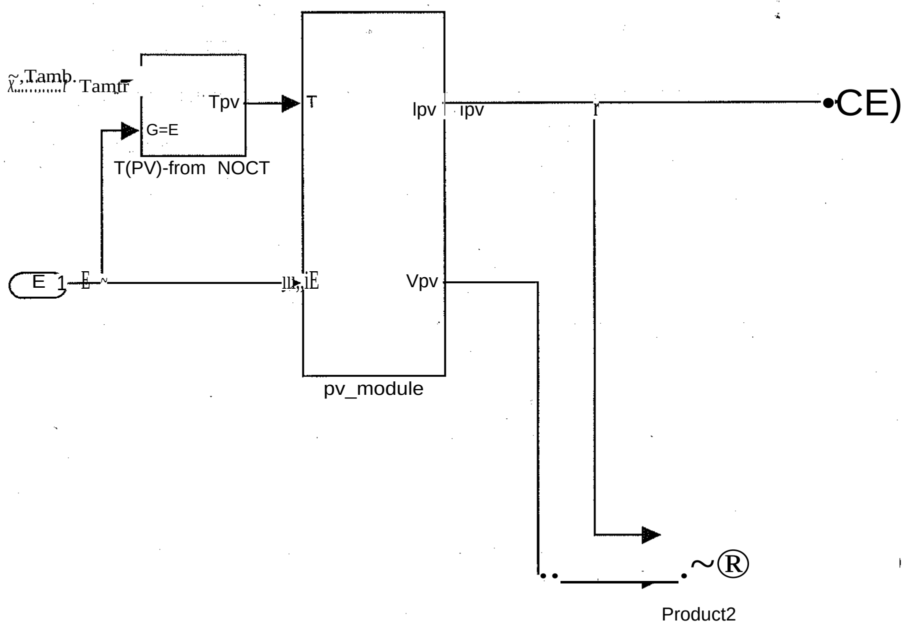


Figure 4.8: Masked PV module in Simulink

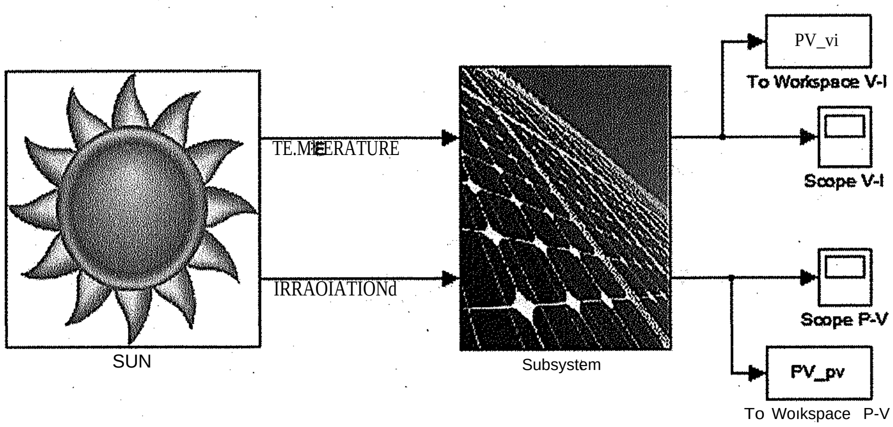


Figure 4.9: The final model of PV system

4.3.3 PV Simulation results and discussions

The mode1 discussed previously and shown in Figures 4.7, 4.8 and 4.9 was simulated under different conditions to evaluate the different characteristics of the PV modules. Figure 4.1 0 presents the V-1 curve of the system simulated in Matlab environment. The simulation has considered 160 strings of 26 series modules parallel connected. The curves show the variations in voltage and current under different irradiation levels and fixed temperature of 25°C. Figure 4.11 presents the P-V curve of the same system under same conditions of temperature and irradiation. These two figures show that the system has one peak at which the system can provide the maximum power.

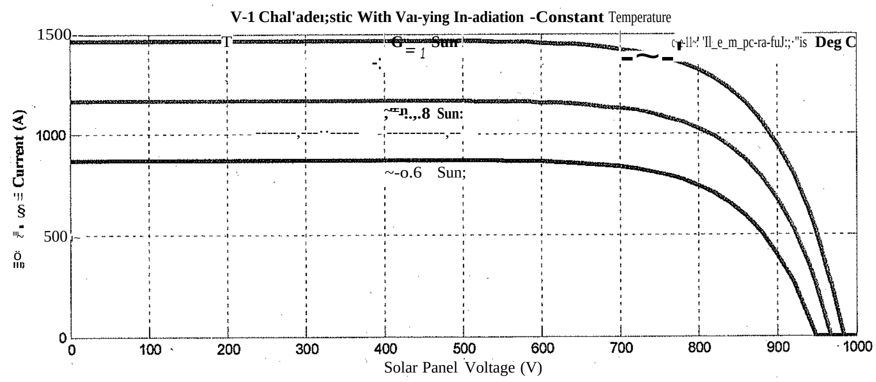


Figure 4.10: Simulink model of solar panel (160 strings) V-I characteristic curves

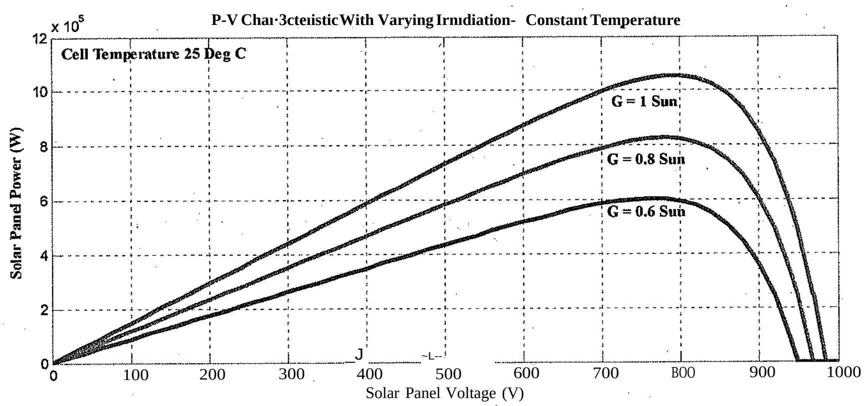


Figure 4.11: Simulink model of solar panel (160 strings) P-V characteristic curves

Figures 4.12 and 4.13 present the variations in the 1-V and P-V curves under variable temperature and a solar irradiation of 1000W/m2. The figures show that the higher the temperature the lower generated power becomes. Also, the figures show that the generated voltage decreases slightly with the increase in temperature of the cells.

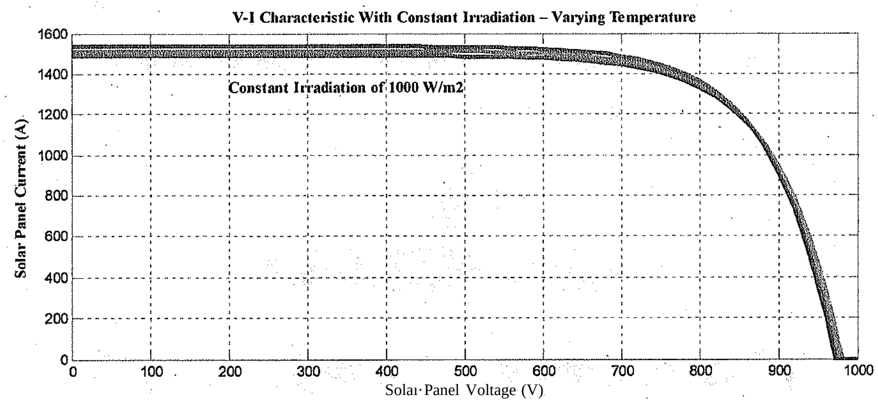


Figure 4.12: Simulink model of solar panel (160 strings) V-1 characteristic curves

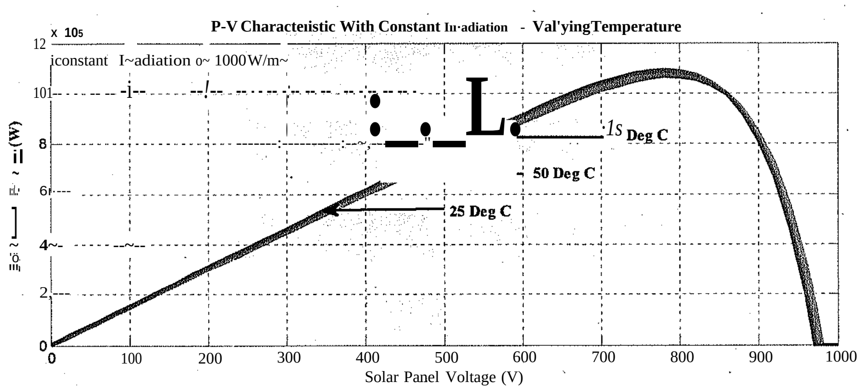


Figure 4.13: Simulink model of solar panel (160 strings) P-V characteristic curves

CHAPTERS

POWER SYSTEM STUDIES FOR PV INTEGRATION

5.1 Introduction

This chapter introduces the electrical power system studies for the project using ETAP software. The used methodology is as shown in the flow chart of Figure 5.1 below:

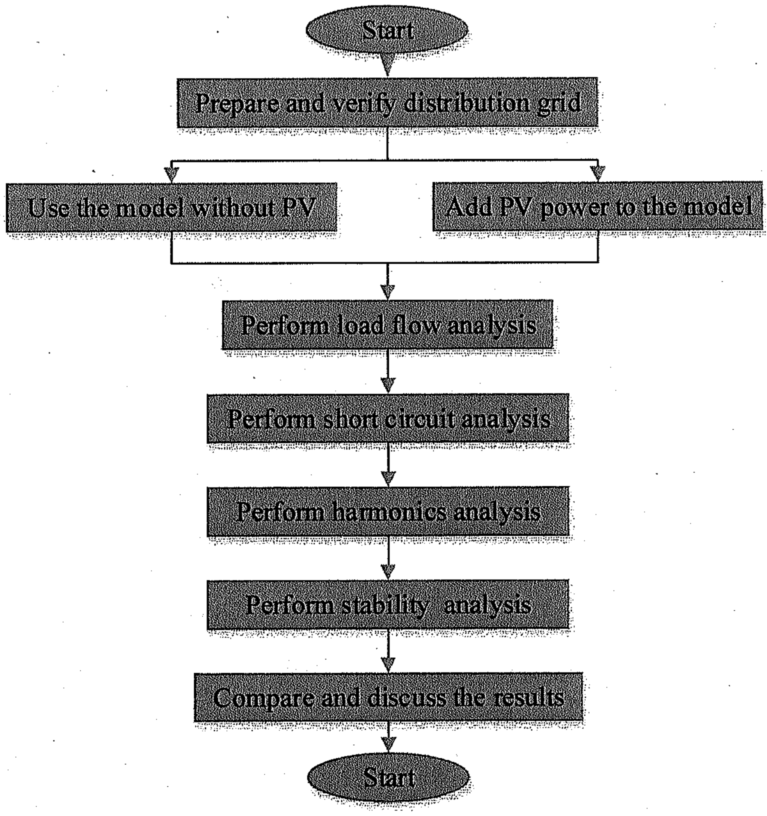


Figure 5.1: Electrical power system study methodology flow chart

5.2 Load Flow Study and Analysis Using ETAP

ETAP software uses the buses voltages, flow of current and power in the system, and branches power factor.to perform load flow analysis. It is a very powerful software that can analyse the load flow for loop or radial electrical systems. Furthermore, ETAP software is designed to be able to perform different types of load flow analysis based on the custom choices and purposes of the specific case.

The purpose of load flow analysis in ETAP is to build an extensive idea about the behaviour. of the power system under different supply and load conditions, It helps electrical power systems planners to design and test the performance of their systems prior to their installation and during their real time operation. It is also used to detect and forecast possible faults or power flow problems to propose the suitable solutions. The load flow Study is capable to define and adjust the parameters of the system for each case separately. ETAP has multiple choices to define the display options based on the user's needs and requirements from load flow analysis.

L.oad flow analysis in ETAP is hasedi mainly on numerical solutions of systems of g.ifferential equations.

Ş,2.1 Load flow simulation using ETAP

This section discusses the implementation of Haun substation project simulation with the 14 MW PV plant as presented in Figure 5.2. Figure 5.2 shows the components of the Haun substation in addition to the PV Plant model in ETAP. As discussed earlier in chapter 4, PV arrays are connected through 7 transformers to the 11 kV bus-bars. The latter are connected through 2 step-up transformers to buses 11 and 12 as shown in the figure. The figure shows the load flow results for each one of the buses and branches.

On the figure buses voltages can be seen in per unit (PU). It is important to mention that in Figure 5.2 the PV plant is disconnected. The voltage on the 66 kV bus 1 is 99.12 % while the power of the PV plant is zero. Figure 5.3 shows the system load flow after the connection of PV plant. The voltage at bus 1 has increased to 99.39 % while a total of 11641 kW is flowing from the PV plant to the system. Power factor of the PV plant is approximately I.

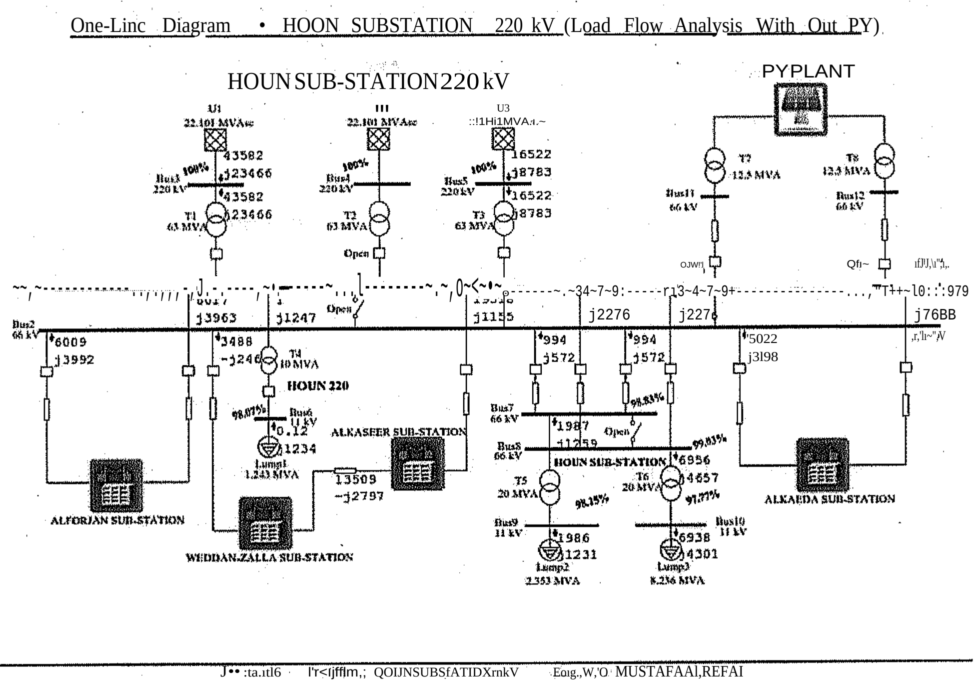


Figure 5.2: Load flow simulation with PV disconnected

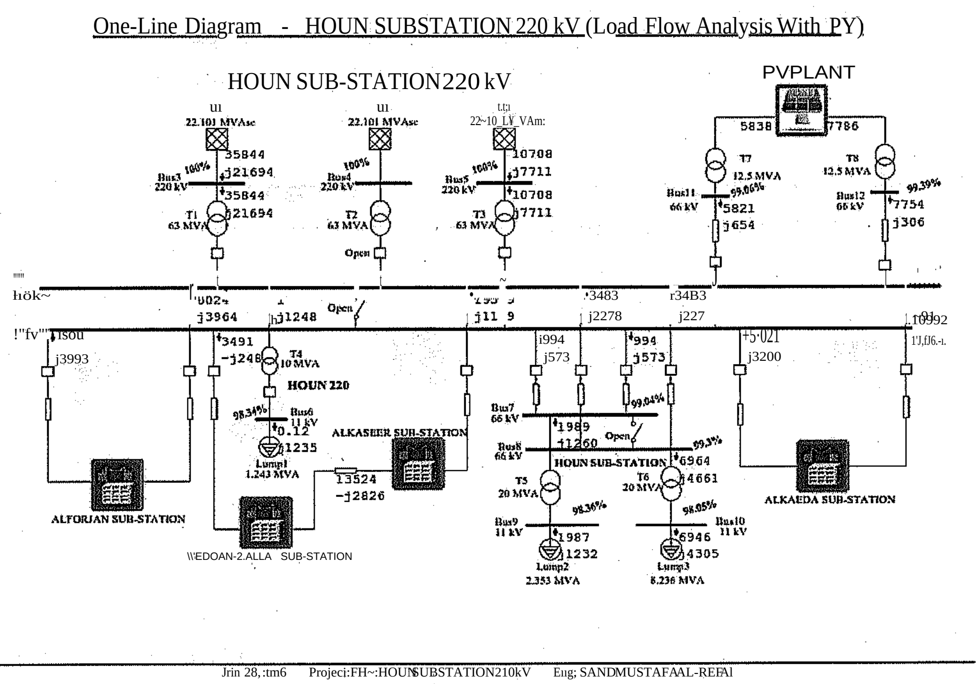


Figure 5.3: Load flow simulation with PV connected

5.3 Short Circuit Study and. Analysis Using ET AP

The ETAP has the functionality of ShortCircuit analysis in electrical distribution systems. It can find the short circuit currents and the contributions of each load in the short circuit. Fault duties are based on the new editions issued by IEC and ANSI/IEEE standards (ETAP, 2016). ETAP presents a very powerful short circuit detection and calculation ability. It is one of the main short circuit analysis software used in power systems by power engineers to estimate the effects of short circuit consequences in power systems.

5.3.1 Short circuit simulation using ETAP

Short circuit analysis was performed onthe substation of Haun without PV plant as shown in Figure 5.4 and with the PV plant connected as shown in Figure 5.5. The figures show the short circuit currents at all buses and branches. It is obvious that the existence of PV plant in Figure 5.5 has increased the short circuit currents slightly at most of buses. However, the increase in short circuit current levels is very small and doesn't introduce extra problems.

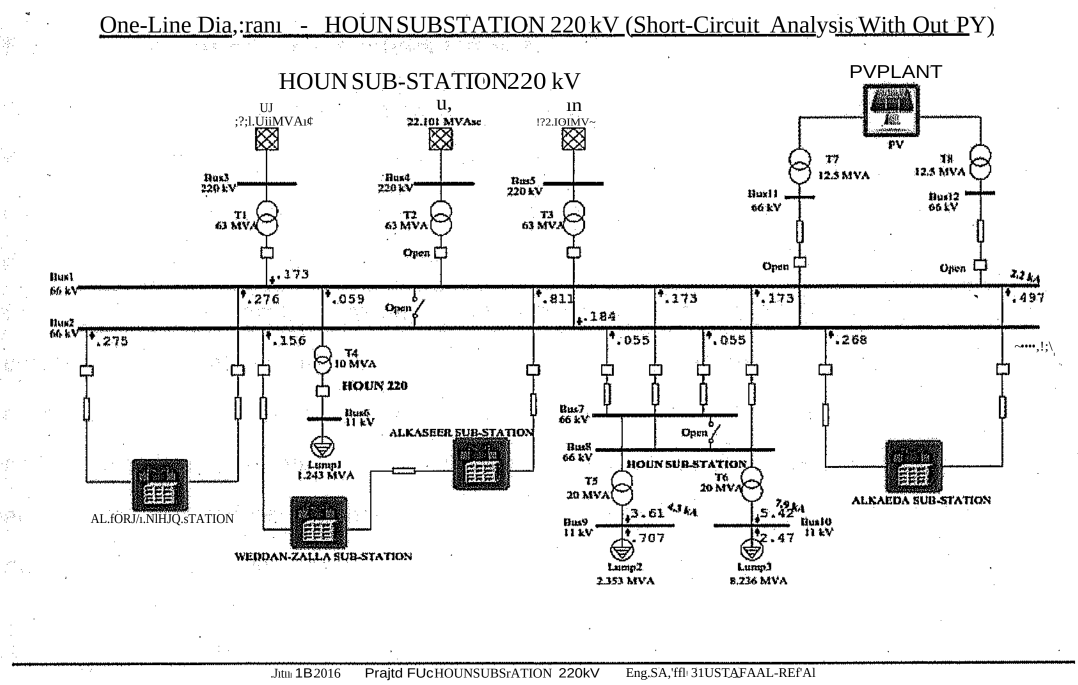


Figure 5.4: Short circuit simulation with PV disconnected

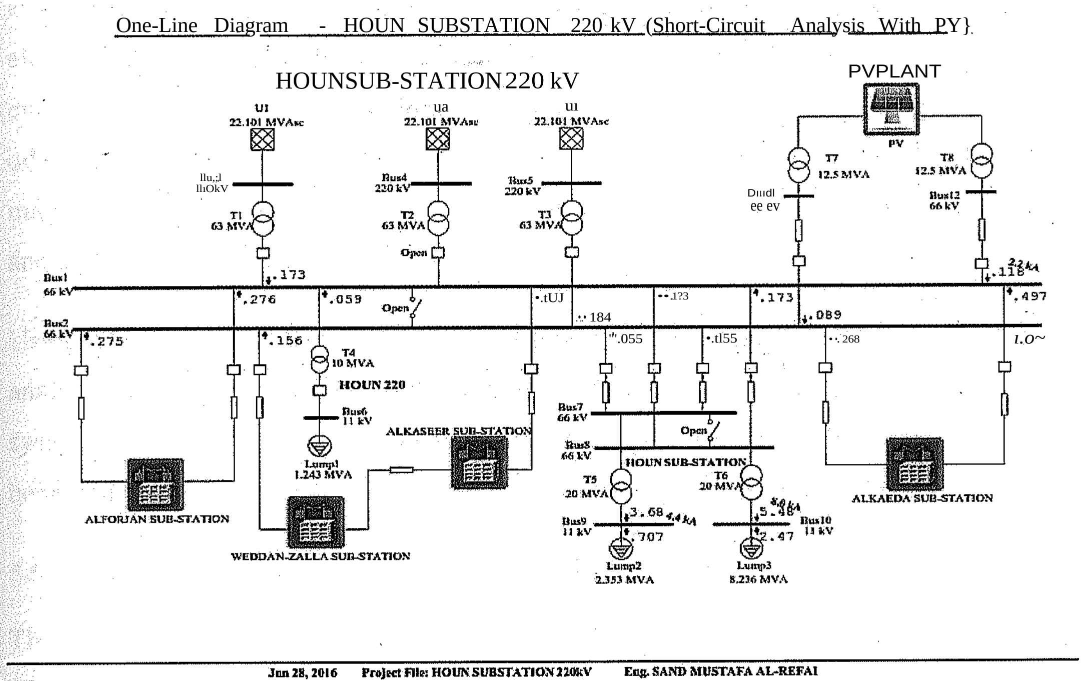


Figure 5.5: Short circuit simulation with PV connected

5.4 Harmonics Study and Analysis Using ETAP

As a result of the continuously increasing uses of power electronic equipment like variable speed motor drives, UPS systems, power converters, rectifiers, and different power electronic devices, power quality of system's voltage and current is strictly affected in different areas. Components of higher frequencies start to circulate in power systems causing the wave forms of voltage and current to be distorted. Such higher frequency components are integer multipliers of the fundamental frequency which are known by the term harmonics. The harmonic emitting devices are called nonlinear loads and include power electronic switching devices, transformers, motors, fluorescent lights, arc furnaces and many other different devices. Such devices cause very serious problems affecting the power quality of power systems.

The existence of harmonics in any power system causes different problems and effects that include but not limited to over temperature of equipment, low power factor of devices, low performance of electrical components, unexpected behaviours of protective devices, interferences with communication systems, resonance with other equipment that cause failure of these equipment, noise, vibration of electrical motors, and other effects. Over more, harmonic currents don't stay near to their source; instead, they penetrate the electrical distribution networks and start circulating throughout the electric systems. The circulation of harmonic currents in the electric systems distorts electric voltages fed to the other users and the harmonic problem is accumulated. This phenomenon has become a main hot topic for power quality as a result of the increasing spread of electronic devices and equipment in power systems,

Using computer simulation, the problem of power system harmonics can be modelled and analysed. The ETAP harmonic analysis module offers a great tool to model different power system elements and equipment accurately to study their frequency dependency, nonlinear behaviour, and other effects of the presence of harmonic currents and voltages.

5.5/Transient Stability Study and Analysis Using ETAP

The ETAP is constructed to study the system's dynamic behaviour and steady state limits of a power system. This study or analysis is implemented before, throughout, and following changes or disturbances in the electric systems. The program implements the events and activities defined by the user to analyse the system. It then determines the response of the system to these events. These analyses are important to determine the pfotective and design parameters of the system.

Voltage profile is the numerical description of the system voltages at a given point, generally a bus or a node of the electric system at some determined circumstances. Examples of voltage profile are: no load profile, light load profile, full load profile, and finally overload profile. In the most of power systems, voltage is limited to predefined values that shouldn't be exceeded. Some variations in the voltage profile parameters can lead the system to instability. Voltage stability is a description of the ability of the system tô preserve steady state parameters and voltages at their state values after different faults or occurrences (Cutsem & Vournas, 1998).

CHAPTER6

RESULTS ANALYSIS OF POWER SYSTEM STUDIES

6.1 Introduction

To simulate a real system, models of each element have to be built ~nd incorporated in the power system simulation software ETAP. This provides the ability to simulate load flow, short circuit, harmonics and stability analysis work in the same software environment. This chapter introduces the results and analysis for electrical power system studies for the project using ETAP software.

6.2 Load Flow Analysis

Load flow analysis is a great tool that produces essential computation practice in order to establish the characteristics of power system under steady state conditions. In this thesis load flow analysis for Haun substation which consists of 42 buses, 14 transmission lines and 26 transformers in addition to switches and circuit breakers as shown in the single line diagram Figure 5.2 and Figure 5.3. Modelling and simulation are carried out by using ETAP simulation software for two cases; first case without PV connection and the second case with PV connection. The results are tabulated as shown in Appendixes 4 and 5.

Tabulated reports show that integrating a PV system into Haun distribution network improves the system voltage profile as can be observed in most of the busses and particularly bus 10 which became normal after it was critical before connecting the PV system. The importance of the load flow analysis is to make sure that the distribution network is safe enough to be connected with PV generators. The results obtained from the load flow study of Haun substation show that the use of PV generators at Houn power station is safe, feasible, and advantageous. It can noticeably iinprove the voltage stability at each bus of the system, and increase the voltage profile.

6.3 Short Circuit Analysis

The short circuit of power system under consideration is performed to identify the strong and weak buses in the power system under disturbance. The possibilities for a short circuit in three phase system are as follows:

1- Symmetrical three phase fault.
2- Single Line to Ground fault.
3- Line to Line fault.
4- Double Line to Ground fault.

Short circuit analysis basically based on finding the steady state solution of the power system under study. This information is needed to determine the required interrupting capacity of the circuit breakers and to design proper relaying system (Saadat, 2010). To get enough information, differ~nt types of faults are· simulated at .different locations and the study is carried :outfor two cases; first case, without PV connection to Haun network, and the second case when the PV plant is connected to Houn network. In this thesis the ETAP report results of sho:rt circuit studies is tabulated as shown in Appendixes 6 and 7. The reports include the following inforrnation:

1- Short circuit contributions from all buses connected to the faulted buses or between any other two buses specified in the input, or both.
2-. Voltage at the remote buses where fault contributions are specified by (I).
3- System X/R ratio at the fault point for medium voltage circuit breaker interrupting duty with its associated multiplying factor.
4- Symmetrical and asymmetrical current for breaker momentary duty.
5- Local and remote fault contributions.

The report includes input data, total fault level at each faulted bus, and also contributions from all connecting buses. Short circuit studied diagrams for Haun network as depicted in Figure 5.4 and Figure 5.5 showing all system faulted busses results.

6.4 Harmonics Analysis

Harmonics were presented earlier in this work and they present one of the most important problems in power systems. PV systems can represent a source of harmonics to the grid under some conditions; produced harmonics can be the effect of the solar panels instable functionality due to variable irradiations or from the power electronic elements used as interface. However, it is important to notice here that modern power inverters provide high power quality factors. The injected harmonics by such inverters are mostly high order harmonics that can be filtered easily.

In this research work simulations were carried out for the system under consideration, to obtain the voltage and current waveforms at bus bars 1 and 2 which are the Point of Common Coupling (PCC), where the study were performed for two cases one without PV connection, and the other with PV connection. Figure 6.1 shows the waveforms of the bus 1 voltage before the connection of PV plant. Figure 6,2 presents the Total Harmonic Distortion (THD} amounts of all buses after connecting the. PV plant.

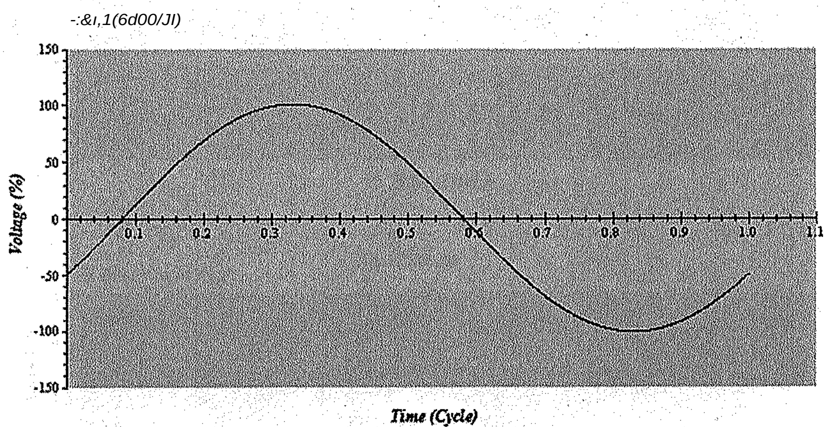


Figure 6.1:Voltage waveform at.bus 1 with PV disconnected

One-Line Diagram - HOUN SUBSTATION 220 kV (Harmonic Analysis with PV and No Filters)

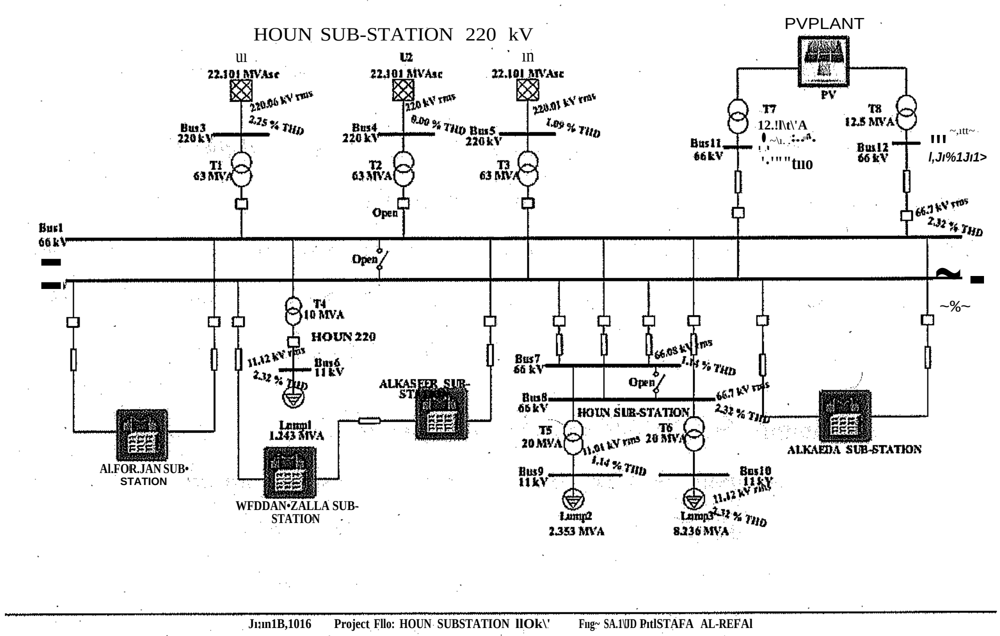


Figure 6.2: Analysis results of harmonic with PV connected

Figure 6.3 presents the waveform and spectrum of the bus 1 voltage after the connection of the PV plant.

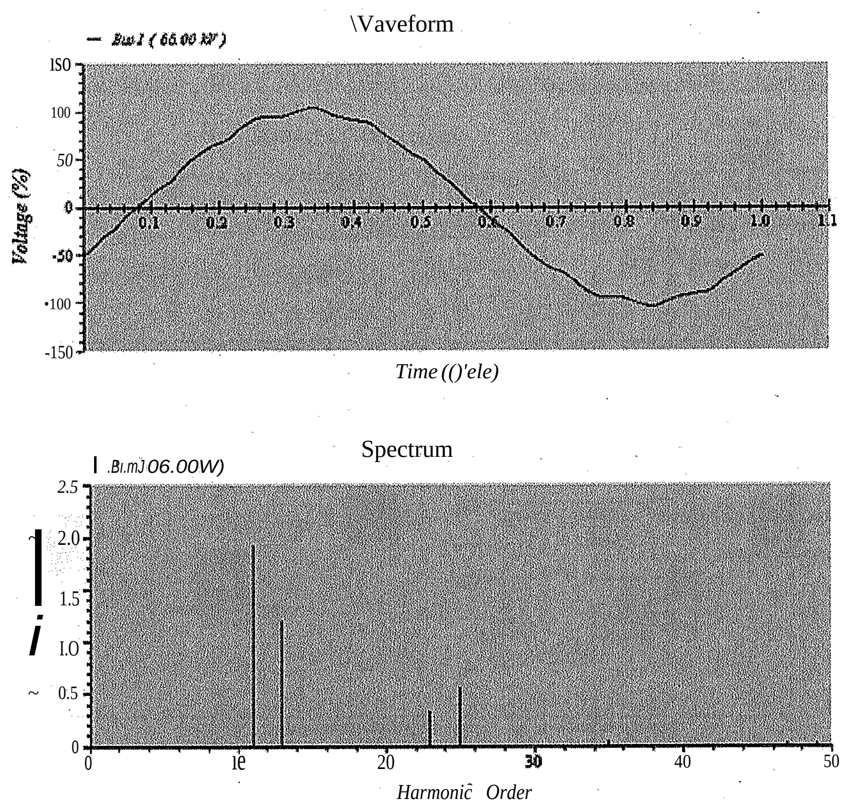


Figure 6.3: Waveform and spectrum of busl voltage after using PV plant

From Figure 6.2 it can be noticed thatTHD values of voltages at buses land 2 are 2.33 % and 1.15 % respectively . The. results 'show that the injection.of solar power through solar inverters causes the.jnjection: of voltage harmonics into the power system. However, the THD values after the use of PV plant are still less than 5 % and don't cause any problems according to different international standards like IEC.

To improve the stability condition such as reducing the 5th and higher orders harmonics and reduce the harmonic content.in the waveforms, passivy filters can be connected at the common coupling busses as shown in Figure 6.4. The figure/shows that the use of harmonic passive filters has reduced the THD value of voltage to 0.63 % at bus 1 and 0.41 % at bus 2. It is important to mention here that the filter was tuned specifically to cancel the 11th harmonic as it was the dominant harmonic as shown in Figure 6.3. It is important to notice that the 11th harmonic was cancelled as shown in Figure 6.5. Another filter tuned at the 13th harmonic could reduce more the THO and increase the power quality at bus 1 and bus 2.

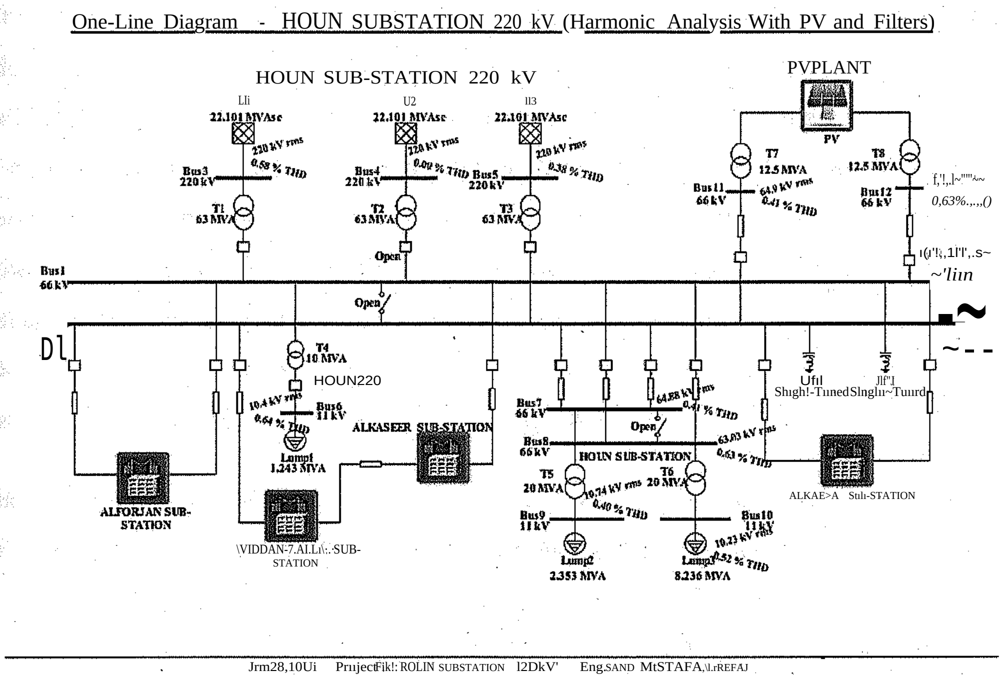


Figure 6.4: Harmonic study with filters and PV connection

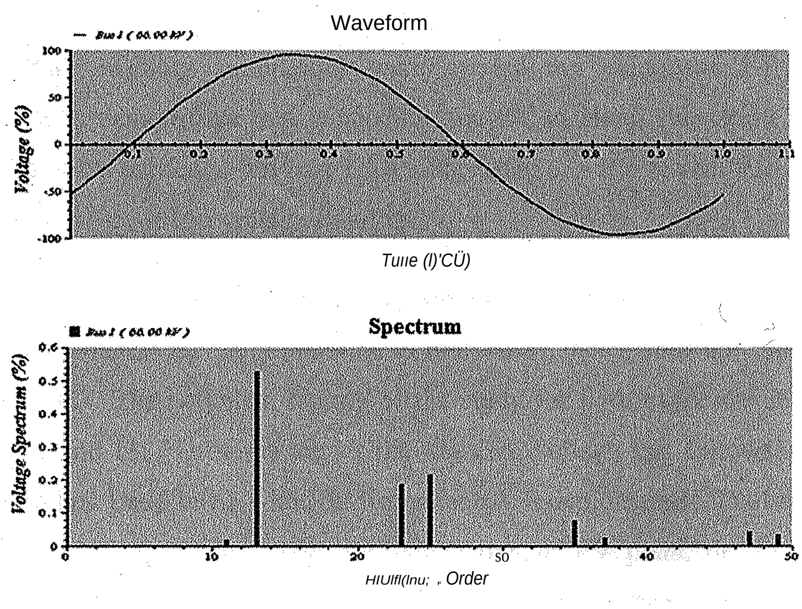


Figure 6.5: Bus 1 voltage waveform and spectrum with filters and PV connection

The complete reports of the study including THDV value with filters are depicted in the Appendixes 8, 9, 10 and 11.

6.5 Transient Stability Analysis

Stability of power system is the criterion that guarantees it to keep in equilibrium point under normal conditions; also to. return to its. initial stable conditions after the occurrence of different .disturbances. Unacceptable voltage profiles can be the main consequençe of the incapability of the system to feed the required reactive power to the load. Under normal operating conditions, the. magnitude of the bus voltage boosts proportional to the increase in the injected reactive power on the same bus. However, unstable system occurs w.hen the voltage of the bus decrease with the increase of reactive power injection; The voltage instability is a local problem; however, its effects can spread all over the system due to the relation between active power, reactive power, and bus voltage.

Solar systems are nonlinear configurations because of the discrete operation and existence of the sunlight, in addition to the switching scheme of the power electronic converters and DC-AC inverter devices. The output voltage in a solar system, the generated current, and the produced power are subject to dynamic variations at real time basis. The connection of such type of systems has its side effects on the other different components of the power system and its stability especially the power factor and voltage profile. In this thesis PV plant is integrated at bus 1 and bus 2 as shown previously.

Dynamic voltage stability .simulations were carried out using the ETAP software. Simulation results demonstrate that connecting the PV to Houn substation: increases the voltage profile at the particular bus bar. Thus, integrating of a PV system into a distribution network improves the system voltage stability.

In transient stability we studied about the behavior of the system under consideration during the disturbance for large interval in both cases. The results are shown in Figure 6.6 and Figure 6.7. The complete reports of the study for both cases are depicted in the Appendixes 12 and 13. Figure 6.6 shows the transient voltage that follows a three phase fault applied to bus 1 and bus 5 with PV disconnected. It demonstrates a voltage change of up to 200 % in bus 1 voltage. After the connection of PV plant, the same fault was executed and results were shown in Figure 6.7. The transient voltage has decreased to 140

% and the time of transient was also decreased. These two figures show that the connection of PV plant help stabilizing the power system and reducing the transient effects.

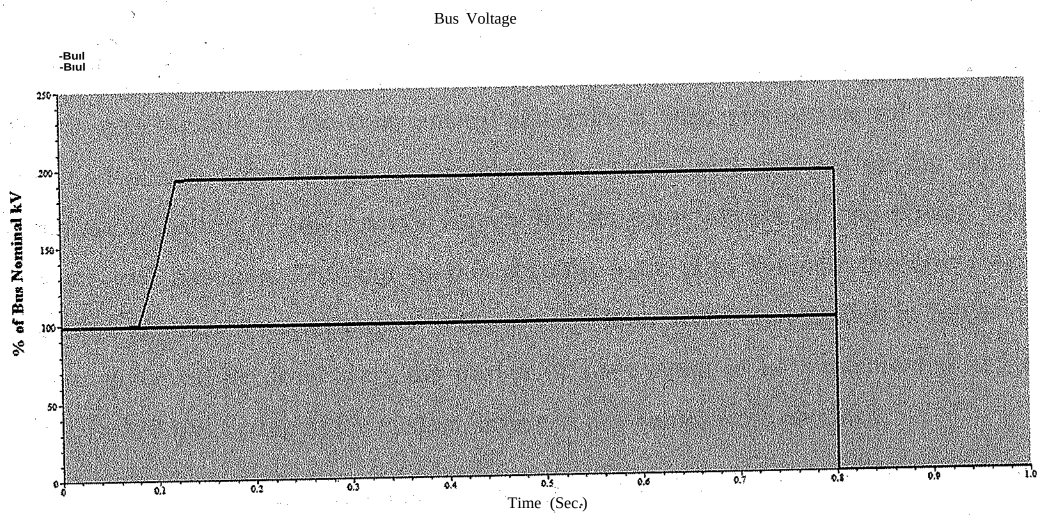


Figure 6.6: Percentage of bus nominal (kV) without PV connection

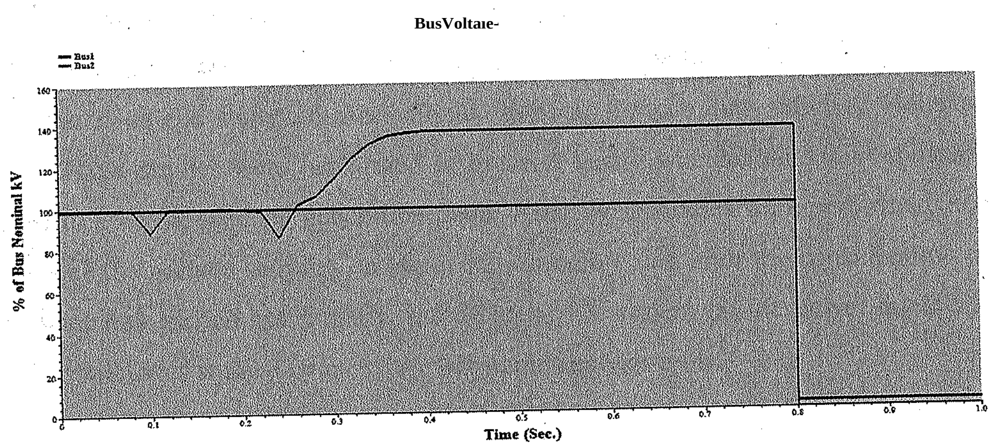


Figure 6.7: Percentage of bus nominal (kV) with PV connection

CHAPTER 7
CONCLUSION AND FUTURE WORK

7.1 Conclusion

Libya is very wealthy in the solar energy and gains a huge prospective for solar power generation plants. Solar energy is variable in the nature and depends on the site. The unpredictable nature of this energy source has its great impact on the power system operation and planning. The aim of this specific work is to evaluate the effect of the integration of solar power generator in the city of Houn distribution station in Libya. This aim was achieved by developing the design of PV system to be implemented in Houn substation 220 kV. Sizing of PV system, inverters and cables were obtained.

In order to verify the design validity, different simulation models using MATLAB and ETAP programs have been built and carried out. Real load and solar energy data were used in the simulation to achieve more realistic results that can help for future analysis and planning processes.

Investigation of the impact of 14 MW PV plant on Houn distribution power system in this thesis was carried out and some analyses were established. The first study was concerned by the slow variations in the corrimon coupling point's voltage. The second study was concentrated on the study of short circuit faults at the coupling point of Houn power station. These studies were performed in order to verify whether the Houn substation is capable to hold the planned generation plant. After those studies were performed, another analysis of the voltage stability on Houn station before and after the consideration of the solar plant was carried out. Finally, the effect of PV system on the power quality at the coupling point was studied by using the harmonic analysis tools.

The obtained results from the load flow analysis show that the implementation of PV solar generation station at Houn power distribution station develops the voltage profile and increase the stability of the system. Distribution lines' losses are found to be decreased as an effect of the implementation of the solar system. The applied analyses have shown that the power station of Houn is in good status and its voltage profile is healthy before and after the use of PV generation system.

The implementation of PV plant connected to the station of Houn has shown capability of decreasing the transient effects of buses faults. This means an increased stability compared with the high transient when the PV plant is not connected. The connection of the PV plant has caused the injection of some voltage harmonics that started to spread over the network. However, the amount of generated harmonics was within the international limits stated by different standards. Tuned filters for the dominant harmonics were installed on the connection buses to cancel these harmonics, Analyses have shown that. these filters were able to reduce the harmonics significantly.

From the work done in this thesis it can be concluded that the addition of support PV power generation of 14 MW increases the efficiency of the Houn power station and improves the voltage profile of all station buses. After applying a fault at 66 kV and 11 kV busses, it's found that the PV system is capable to develop the voltage steady and dynamic state stability of Houn power distribution station. The PV system responded to the faults by sharing in the voltage recovery during the fault and after it. No system tripping was detected throughout or after the disturbance.

7.2 Future Work

Any scientific research can't cover all aspects and investigates all important points at once; some points need to be reinvestigated and studied in future works. Separately from the studies applied in the course of this thesis work; that seems to be of the highest importance, further studies of the impact of the solar systems on the connected power systems and distribution stations needs to be penetrated. After the integration of DG stations, power flow becomes bi-directional. In this case, different protection and interruption systems need to be studied and introduced into the stations. Future works that are recommended in other stages of this work are:

1- The reliability analysis on the distribution station of the security and adequacy of the proposed system especially keeping in mind the intermittent function of PV stations.

2- Further studies on the protection profile after the injection of PV generators.

3- The frequency stability of the power station under the effects of PV systems.

REFERENCES

ABB. (2014, Jul). Central Inverters. Retrieved Mar 2016, from Central inverters: https://library.e.abb.com/public/e2508291cc16d124c1257d490049abe5/17237_PVS800_central%20inverters%20flyer%20EN_3AUA0000057380_RevL_lowres.pdf

Abdulkadir, M., Samosir, A. S., & Yatim, A. H. (2012). Modeling And Simulatio Based Approach of Photovoltaic System in Simulink Model. *ARPN Journal of Engineering and Applied Sciences,* 7(5), (pp. 616-623).

Al-Jadi, I. M., EK.hlat, M.A., & Krema, N. M. (2012). Photovoltaic in Libya applications and evaluation. *In the Proceedings of the International Conference on Renewable Energy for Developing Countries.* IEEE. Retrieved Feb 2016 from http://www.udc.edu/docs/cere/PHOTOVOLTAIC%20IN%20LIBYA.pdf

Angelim, J. H., & Affonso, C. M. (2016). Impact of distributed generation technology and location on power system voltage stability. *In the Proceedings of the IEEE Latin America Transactions* (pp. 1758 - 1765). IEEE. doi:10.1 109/TLA.2016.7483512

Ault, G. W., McDonald, J. R., & Burt, G. M. (2003). Strategic analysis framework for evaluating distributed generation and utility strategies. *In the roceedings of the Generation, Transmission and Distribution* (pp. 475-481). IET. doi:10.1049/ip-gtd:20030374

Cenergypower. (2014, Sep 1). *String vs. central inverter.* Retrieved Jun 2016, from http://cenergypower.com/blog/string-vs-central-inverters-choosing-right-inverter/

Condon, J. C. (2004). *Distributed Generation as a Potential Solution to United States Electricity Transmission Bottlenecks.* University of Arizona. Retrieved Apr 2016, from http://www.wise-intern.org/journal/2004/WISE2004.ClayCondon.Comp1eteDraft.pdf

Coster, E., Myrzik, J., Kruimer, B., & Kling, W. (2011). Integration Issues of Distributed Generation in Distribution Grids. *In the Proceedings of the IEEE 99(1),* (pp. 28-39). IEEE. doi:10.1109/JPROC.2010.2052776

Cutsem, T. V., & Vournas, C. (1998). *Voltage Stability of Electric Power Systems.* Kluwer A.cademicPublishers.

Daley, J. M., ASCO Power Technol., F. P., & Siciliano, R. L. (2003). Application of emergency and standby generation for distributed generation. I. Concepts and hypotheses. *IEEE Transactions on Industry Applications,* doi:10.1109/TIA.2003.813742

Dang, K., Yu, J., Dang, T., & Han, B. (2011). Benefit of distributed generation on line loss reduction. *In the Proceedilygs of the International Conference on Electrical and Control Engineering* (pp. 2042-2045). Yichang. doi:10.1109/ICECENG.2011.6057911

Davis, M. W. (2002). Mini gas turbines and high speed generators a preferred choice for serving large commercial. customers and micro grids Generating system. *In the Proceedings of the Power Engineering Society Summer Meeting* (pp. 669-676). IEEE.

Deendayal, U. P. (n.d.). *Advantages and Disadvantages of Photovoltaics.* Retrieved May 2016, from http://www.sse.pdpu.ac.in/aboutsolar.html

Dorian, J. P., Franssen, H. T., & Simbeck, D. R. (2006). Global challenges in energy. *Energy Policy,* (pp. 1984-1991).

ETAP. (2016). *Short Circuit Analysis.* Retrieved Apr 5, 2016, from http://etap.com/short-circuit-analysis/short-circuit-analysis-software.htm

Hamlyn, A., Cheung, H., Lin, W., Cungang, Y., & Cheung, R. (2008); Distributed monitoring and centralized forecasting network for DG-connected distribution systems. *In the Proceedings of the Conversion and Delivery of Electrical Energy in the 21st Century conference* (pp. 1-7). IEEE.

Hassan, A. A., Nafeh, A. E.-S., H.Fahmy, F., & El-Sayed, M. A. (2010). Stand-Alone Photovoltaic System for an Emergency Health Clinic. *The Paper Presented at the International Conference on Renewable Energies and Power Quality.* Granada, Spain: ICREPQ.

Hughes, T. P. (1993). *Networks of power: Electrification in Western Society, 1880-1930.* Baltimore: Johns Hopkins University Press.

Ibrahim, I. M., & Khalifa, B. (2003). The role of using PV system in changing the infra-structure of power generation in Libyan Communication network. *The paper Presented at the Second Engineering Conference, Benghazi.* Benghazi, Libya. Retreived May 6, 2016,from: http://www.udc.edu/docs/cere/PHOTOVOLTAIC%20IN%20LIBYA.pdf

Lin, W., Hamlyn, A., Cheung, H., Yasin, R., Li, C., & Cheung, R. (2009). Network-aided strategy and breaker impacts on voltage instability corrective actions for power systems with DGs. *In the Proceedings of the Power & Energy Society General Meeting* (pp. 1-7). IEEE.

Liu, J., Zhang, W., Zhou, R., & Zhong, J. (2012). Impacts of distributed renewable energy generations on smart grid operation and dispatch. *In the Proceedings of the IEEE Power and Energy Society General Meeting* (pp. 1-5). San Diego, CA: IEEE. doi:10.1109/PESGM.2012.6344997

Luque, 'A. (2011). WiH we exceed 50% efficiency in photovoltaic. *Journal of Applied Physics*, 31301-31319.

MathWorks. (2016). *SIMULINK*. Retrieved Aug 4, 2016, from MathWorks: http://uk.mathworks.com/products/simulink/

Mondal, A. H., & Denich, M. (2009). Hybrid systems for decentralized power generation in Bangladesh. *Energy/or Sustainable Development, 14(1)*. (pp. 48-55).

Nazari, M. H., & Ilic, M. (2008). Potential Problems and Solutions Associated with Distributed Generation. *Paper Presented at the 4th Carnegie Mellon Electricity Industry Conference*. Pittsburgh, US. Retrieved Apr 10, 2016, from: https://www.ece.cmu.edu/~electriconf/2008/PDFs/Nazari_Ilic_CEIC%20paper.pdf

Nishida, Y., Nakamura, S., Aikawa, N., Sumiyoshi, S., Yamashita, H., & Omori, H. (2003). A novel type of utility-interactive inverter for photovoltaic system. *In the Proceedings of the 29th Annual Conference in Industrial Electronic Society* (pp. 2338-2343). IEEE.

Olulope, P. K., Folly, K. A., & Venayagamoorthy, G. K. (2013). Modeling and simulation of hybrid distributed generation and its impact on transient stability of power system. *In the Proceedings of the IEEE International Coriference on Industrial Technology* (pp. 1757-1762). Cape Town.doi:10.1109/ICIT.2013.6505941

Paolone, M., & Cherkaoui, R. (n.d.). *Distributed electrical systems laboratory*. Retrieved Jun 2016, from http://desl-pwrs.epfl.ch/

Pilavachi, P. (2002). Mini- and micro-gas turbines for combined heat and power. *Applied Thermal Engineering*, :2003-2014.

Rashid, M. H. (2001). *Power Electronics Handbook*. Academic Press.

Saadat, H. (2010). *Power System Analysis*. NewYork, USA: PSA Publishing.

Saleh, I. M. (2006). Prospects of renewable energy in Libya. *In the Proceedings of the International Symposium on Solar Physics and Solar Eclipses*, (pp. 153-161).

Solargis. (2016). *Solar map in Libya*. Retrieved May 2016, from Solargis: http://solargis.com/products/maps-and-gis-data/free/overview/

Spera, D. A. (2009). *Wind Turbine Technology: Fundamental Concepts in Wind Turbine Engineering*. ASME.

Steffel, S. J., Caroselli, P. R., Dinkel, A. M., Liu, J. Q., Sackey, R. N., & Vadhar, N. R. (2012). Integrating Solar Generation on the Electric Distribution Grid. *In the Proceedings o/the IEEE Transactions on Smart Grid*. IEEE (pp. 878- 886).

Suniva. (2010, Jun). *ART245-60 datasheet.* Retrieved Aug 2, 2016, from Suniva: http://www.suniva.com/docu~nents/suniva ART245-60-3%2006091O.pdf

The grid as it is today. (2016, Mar). Retrieved May 2016, from altenergymag: http://www.altenergymag.com/stream/articles/

Therien, S. G. (2010). *Distributed Generation: Issues Concerning a Changing Power Grid Paradigm. Master Thesis.* San Luis Obispo: California Polytechnic State University.

Tzamalis, L. (2006). *Combining wind and solar energy to meet demands in the built environment. Master Thesis.* Glasgow, Scotland: Strathclyde University.

UNFCCC. (2012, Nov). *Hun 14 MW Photovoltaic Power Plant by REAOL, Libya.* Retrieved Mar 2016, from http://cdm.unfccc.int/Projects/DB/RWTUV1356073216.09/view

Williams, R. H., & Ogden, J. M. (1989). *Solar hydrogen: Moving beyond fossil fuels.* World Resources Institute.

Yadav, A., & Srivastava, L. (2014). Optimal placement of distributed generation: An overview and key issues. *In the Proceedings of the 2014 International Coriference on Power Signals Control and Computations* (pp. 1-6). Thrissur: IEEE. doi:10.1109/EPSCICON.2014.6887517

Yusof, Y. (2004). Modeling and Simulation of maximum power point tracker for Photovoltaic system. *In the Proceedings of the National Power and Energy Conference* (pp. 88-93). KualaLumpur, Malaysia.

Zhao, D., Li, Y., & Liu, Y. (2014). Optimal design and sensitive analysis of distributed generation system with renewable energy sources. *In the Proceedings of the China International Coriference on Electricity Distribution* (pp. 456-460). Shenzhen. doi:10.1109/CICED.2014.6991749

APPENDICES

APPENDIX 1

HOUN SUBSTATION LOADS

MEDIUM VOLTAGE t\'ETWORKMANAGEMENT CONSOLE

DETECTING LOADS TRANSFORMERS (66/30/11 kV)

	SUB STATION	NUMBER	VOLTAGE	CAPACITY MVA	MW	TOTAL
1	HOUN	1	66/11	20	7	9
		2	66/11	20	2	
2	ALKAEDA	1	66/11	20	5	16
		2	66/11	20	11	
3	WEDDAN	1	66/11	20	3.5	9
		2	66/11	20	5.5	
4	ALFORJAN	1	66/11	15	6	12
		2	66/11	15	6	
5	ALKASEER	1	66/11	20	3	3
		2	66/11	20	0	
6	ZALLA	1	66/11	10	5	7
		2	66/11	10	2	
7	ZALLA ROAD TRANSFORMER	1	66/11	10	6	6
8	HOUN 220	1	66/11	10	0	0

APPENQIX2

MODULE DATASHEET

Suniva® ART245-60 Monocrystalline Solar Modules

ELECTRICAL DATA (NOMINAL)

The electrical data apply to standard test conditions (STC): Irradiance of 1000 W/m² with AM 1.5 spectra at 25°C.

Power Classification (Max.)	Pmax (W)	235	240	245
Voltage at Max. Power Point	Vmp (V)	30.00	30.40	30.90
Current at Max. Power Point	Imp (A)	7.84	7.89	7.95
Open Circuit Voltage	Voc (V)	37.30	37.30	37.40
Short Circuit Current	Isc (A)	8.38	8.44	8.49

The rated power may only vary by -0/+4.99 Wp and all other electrical parameters by ± 5%

DIMENSIONS AND WEIGHTS

Cells / Module	60
Module Dimensions	1657 x 987 mm; 65.24 x 38.86 in.
rifotioui!;;t1fLc1inuuii.l(Depth)	42 mm; 1.65 in.
Approximate Weight	19 kg; 42 lbs.

CHARACTERISTIC DATA

Type of Solar Cell	High-efficiency Suniva® 3 busbar monocrystalline cells of 156 x 156 mm
Frame	Silver anodized aluminum alloy
Glass	Anti-reflective coating, tempered & low-iron
Junction Box	IP67 rated; IEC & UL listed; with internal bypass diodes
Cable & Connectors	4 mm² cable with MC4 connectors; cable length approximately 1 m

TEMPERATURE COEFFICIENTS

Voltage	ß, Voc (%/°C)	-0.332
Current	α, Isc (%/°C)	+0.036
Power	γ, Pmax (%/°C)	-0.460

LIMITS

Max. System Voltage	1000 VDC
Operating Module Temperature	-40°C to +90°C
Storm Resistance	Tested to IEC 61215 for wind loads of 5400 Pa (204 mph)

SUnlwf' reserves the right to ctinnge the dala at any time.

Suniva® The Brilliance of Solar Made Sensible

Mixed Sources

Pleaserecycle.

10/06/10

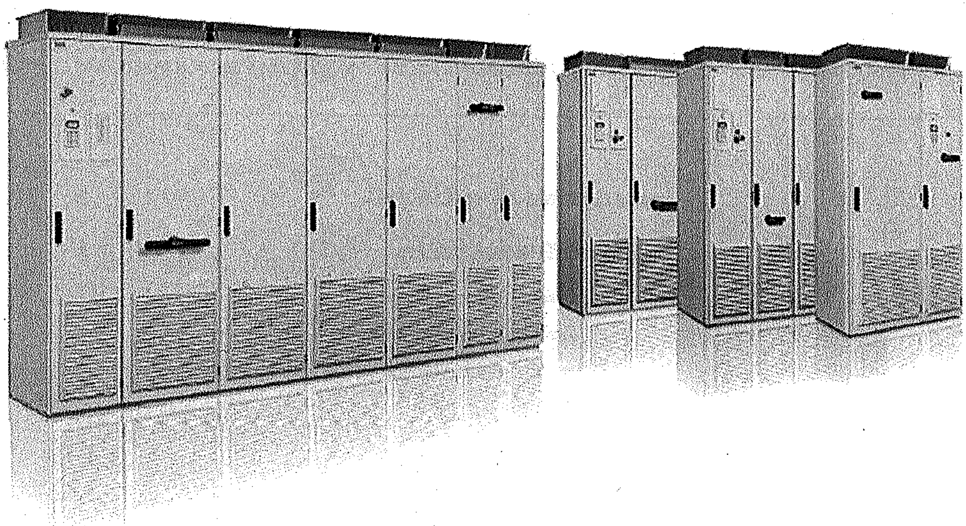
APPEND1X3

ABB CENTRAL INVERTER

ABB central inverters

PVS800

100 to 1000 kW



Technical data and types

Type designation PVS800-57	-0100kW-A 100 kW	-0250kW-A 250 kW	-0315kW-B 315 kW	-0500kW-A 500 kW	-0630kW-B 630 kW	-0875kW-B 875 kW	-1000kW-C 1000 kW
Input (DC)							
Maximum input power ($P_{PV,max}$) 1)	120 kWp	300 kWp	378 kWp	600 kWp	756 kWp	1050 kWp	1200 kWp
DC voltage range, mpp ($U_{DC,mpp}$)	450 to 825 V	450 to 825 V	525 to 825 V	450 to 825 V	525 to 825 V	525 to 825 V	600 to 850 V
Maximum DC voltage ($U_{max(DC)}$)	1000 V	1000 V	1000 V	1100 V	1100 V	1100 V	1100 V
Maximum DC current ($I_{max(DC)}$)	245 A	600 A	615 A	1145 A	1230 A	1710 A	1710 A
Number of protected DC inputs	1 (+/-) / 4 2)	2, 4, 8 (+/-)	2, 4, 8 (+/-)	4 to 15 (+/-)	4 to 15 (+/-)	8 to 20 (+/-)	8 to 20 (+/-)
Output (AC)							
Nominal power ($P_{N(AC)}$) 3)	100 kW	250 kW	315 kW	500 kW	630 kW	875 kW	1000 kW
Maximum output power 4)	100 kW	250 kW	345 kW	600 kW	700 kW	1050 kW	1200 kW
Power at cosφ = 0.95 3)	95 kW	240 kW	300 kW	475 kW	600 kW	830 kW	950 kW
Nominal AC current ($I_{N(AC)}$)	195 A	485 A	520 A	965 A	1040 A	1445 A	1445 A
Nominal output voltage ($U_{N(AC)}$) 5)	300 V	300 V	350 V	300 V	350 V	350 V	400 V
Output frequency	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz
Harmonic distortion, current 6)	< 3%	< 3%	< 3%	< 3%	< 3%	< 3%	< 3%
Distribution network type 7)	TN and IT	TN and IT	TN and IT	TN and IT	TN and IT	TN and IT	TN and IT
Efficiency							
Maximum 8)	98.0%	98.0%	98.6%	98.6%	98.6%	98.7%	98.8%
Euro-eta 8)	97.5%	97.6%	98.3%	98.2%	98.4%	98.5%	98.6%
Power consumption							
Own consumption in operation	310 W	310 W	310 W	490 W	490 W	650 W	650 W
Standby operation consumption	60 W	60 W	60 W	65 W	65 W	65 W	65 W
External auxiliary voltage 9)	230 V, 50 Hz	230 V, 50 Hz	230 V, 50 Hz	230 V, 50 Hz	230 V, 50 Hz	230 V, 50 Hz	230 V, 50 Hz
Dimensions and weight							
Width/Height/Depth, mm (W/H/D)	1030/2130/690	1830/2130/680	1830/2130/680	2630/2130/708	2630/2130/708	3630/2130/708	3630/2130/708
Weight appr. 10)	550	1100	1100	1800	1800	2320	2320

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APPENDIX4

LQAI> FLOW ANALYSIS WITHOUT PV

Project:	I\IAST.ERTHESIS	ETAP	Page:	1
Location:	HOUN CITY >LIBYA	12.6.0H	Dato:	28-06-2016
Contract:	NEAR EAST UNIVERSITY. EE.E Department		S'fI:	
Eugiueel':	SAND~füSTAFAAL-REFAI	Study Case: LF	Ro,islon:	Base
Filename:	HOUN SUBSTATION 220kV		Config:	**Normal**

DESIGN OF A LARGE SCALE SOLARPVSYST.E\\!A!\'D IMPACT ANALYSIS OF ITS JN!EGRATION INTO LIBYANPOWER GRID

Elec:ttjcal Transient 4,,ualvzer P'agrnm

Load Flow Anah-sis (Without PV}

Loading Category (1)!' Design

Geu~ı'tltionCateg<>cy (1): Design

Load Dh·ersity Factor: None

	Stuing	V-Control	Load	Total
Numbel' of Buses:	3	0	26	29

	XFI\IR.2	XF11IR3	Reactor	Line/Cable	Imp edauce	Tie PD	Total
Number ofBmncbes:	15	0	0	14	0	0	29

i\feıhod ot Solution:	Adapıre Nmton-Raphson :Method
I\fo:ıimum No. oflterntiou:	99
Precision of Solution:	0.0001000
System Fl'equency:	50.00Bz
Unit System:	I\letıic

Adjustments

Tolemnce	Apply Ad~~	Individual	Percent
Transfoımer Impedance:	Y<S	IndMdu,l	
Reacloı· Impedance:	Ytı	Indhidunl	
0\'el'loıa Heater Resistance:	No		
Transmission Line Length:	No		
Cable Lengtlı:	No		

TeınperanıreCol'reclion	Apply Adj~	luıfüidual /Global	~
Transmission Line Resistance:	Yts	Indhidunl	
Cable Resistance:	Yts	Indhidu.,ı	

Project: MASTER1'HES1S	ETAP		Page: S
Location: HOUNCITY· LIBYA	12.6.0H		Dal.: 28-06-2016
Contract: NEAR.EASTUNIVERSITI' -EEE D,partmeut			SN:
Engineer: SAN1>I\IUS'TAI'AAL-REFA,I	Study Case: LF		Rel'isiou: Base
Filename: HOUNSUBSTATION220kV			Config: Normal

DESIGNOF ALAR<:ESCALE SOLARPVSYS'I'EMAND II\IPAC'TANALYSISOF ITS INTEGRATIONII\'TOLIBYANPOWERGRIll

Bus Juput pata

Bus			Initial Voltage		X.00.d							
					C«m,;tmtkYA		Con.HautZ.		Comtantl		Gt'ueric	
ID	kV	Sub-sys	%Mag.	Ang.	MW	Mn,r	MW	Mvar	MW	Ml'ar	MW	~fr.'lt'
Bus1	66.000	1										
Bus2	66.000	I	99.1	-1.1								
Bus3	210.000	1	J00.0	0.0								
Bus4	220.000	3	100.0	o.o								
Bus5	2?0.000	I	100.0	ae								
Bus6	11.000	I	95.3	..1.2	0.000	0.995	0.000	o.:m				
Bus7	66.000	I	99.0	.1.2								
Bus8	66.000	I	99.3	..4,3								
Bus9	11.000	I	9S.4	-1.S	1.600	0.99'.?	0.400	o.us				
Bus10	11.000	I	98.0	-6.3	5.600	3.471	1.400	O.S68				
Bus13	66.000	I	96.6	-4.7								
Bus14	66.000	Z	98.1	-1.7								
Bus15	ILOOO	I	99.0	-7.6	4.800	1.m	1.200	0.744				
Bus16	11.000	2	9S.6	-4.7	4.800	2.975	1.200	0.744				
Bus17	66.000	1	99.2	.5,9								
Bus18	66.000	1	99.0	-1.6								
Bus19	ll.000	I	99.0	.7,5	4.400	0.000	1.100	0.000				
Bus20	ILOOO	I	98.9	-2.6	1.800	0.000	0.700	0.000				
Bus21	66.000	I	99.1	-6.5								
Bus22	11.000	I	98.1	-9.4	4.800	0.000	1.200	0.000				
Bus23	66.000	1	99.5	-6.9								
Bus25	Il.000	1	98.4	-1.9	1.600	0.991	0.400	o.us				
Bus27	66.000	I	99.1	-I.9								
Bus28	ILOOO	1	98.7	-5.8	2.400	1.487	o.600	0.372				
Bus29	11.000	1	98.7	-5.8	2.400	U81	o.600	un				
Bus30	66.000	I	98.8	-4.6								
Bus31	66.000	I	98.8	.1.4								
Bus32	11.000	1	98.3	-7.8	8.800	S.455	2.200	1.364				
Bus33	11.000	I	100.7	-2.8	4.000	2.479	1.000	0.620				
Total Number of Buses: 29					41.999	23.307	12.000	5.8?7	0.000	0.000	0.000	0.000

Generation Bus				Voltage		Generation			Mvar Limits	
ID	kV	Type	Sub-sys	%Mog.	Ang!•	MW	l\frar	%PF	Max	Min
Bus3	220.000	Smug	1	100.0	0.0					
Bu~.f	ll0,000	Smug	3	100.0	0.0					
Bu.S	220.000	S\ling	2	100.0	0.0					
						0.000	0.000			

Line/Cithle Ippuf pata

Line/Cıble ID	Libl'tll'y	Size	Length Adj.(ın)	%Tol	lill'bns•	T ('C)	R	X	\'
							Ohms er Siemens/10.00m per Conductor (Cable) oı· pel' J.'h~.e (Line)		
Lln•l		674	moo:0	0:0	1	-;r-	0.056003	0.374155	0.0000031
Lln•l		674	moo.0	-0.0	I	75	0.056001	0.341069	0.0000034
Lln,3		674	23000.0	0.0	I	7$	0.056001	0,342069	0.0000034
Lin<l		674	15000.0	M	I	75	O.OS6001	o,342069	0.0000034
LlntS		674	8000.0	0.0	I	7S	O.OS6001	0.341069	0.0000034
Lln,6		674	4000,0	0.0	I	75	O.OS6001	0.342069	0.0000034
Llne7		674	4000.0	0.0	I	75	0.056001	0,341069	0.0000034
Line$		674	4000.0	o.o	I	*15*	o;os6ooı	0.341069	0.0000034
Lin.9		674	4000.0	M	I	7S	O.OS600l	0,341069	0.0000034
Lind 0		674	8000.0	0.0	I	75	O.OS600l	0.341069	0.00000.\4
Lindi		674	8000.0	o.o	1	*15*	O.OS6001	0-341069	0.0000034
Lhe:12		674	11000.0	0.0	I	*15*	O.OS6001	0.341069	0.0000034
Lin,13		674	161000.0	o.o	I	**75**	O.OS6001	0.342069	0.0000034
LineU		674	140000.0	o.o	I	75	0.056001	0.3-l'..-069	0.0000034

Lint-*1* Cnble resistances are **listed tit the-sptdfied** temperatures.

2-"'indJug Tı·ausfonner Inm~tD.~.ta

Trnıı,foııneı		Rating					ZVariatlon			o/o Tap.Setting		AdjuS!ed	Phase Shift	
ID	Phfa	l!VA	Prim. eV	Stt.kV	%Zl	XJJlU	+.%	.$%	,,Tol,	Prim.	see.	%Z	Tıııt	Angle
Tl	J.J>Jns,	63.000	7l0.000	66.000	12.50	45.66	~	0	~	~	3.7;0	ll.5000.,	l>)l1	0.000
I'S	3.phau,	63.000	220.000	~.000	12.50	.J\$.00	0	0	0	0	(l.61~	12,\$000	Dyu	0.000
T4	.I-Ph.ıs,	10.000	66.000	il.ODO	8.3\$	U.00	0	0	0	0	0	8.3S00	Dı-u	0.000
TS	3.pı,.,,.	l0.000	66.000	11.000	10.00	l0.00	0	0	0	0	0	10.0000	Dı11	0.000
T6	.ı.rh.„.	10.000	66.ooo	11.000	ıo.oo	20.00	o	o	o	o	1.2so	10.0000	Dı11	0.000
T9	J.pJın,.	10.000	66.llOO	11,000	8•.15	13.00	0	0	0	0	4.375	8.3\$00	D)-u	0.000
TlO	3-Ph.ııt	10.000	66.000	11,000	8.l5	U.00	0	0	0	0	4.,7\$	8.3\$00	Dyıı	0.000
TU	3-Ph.m	20.000	66.000	IJ.000	10.00	20.00	0	0	0	0	0	10:0000	1>)l1	0.000
rıa	3-PJıns,	l0.000	66.000	Jl.000	10,00	20.00	0	0	0	0	0	lMOOO	Dı-u	0.000
Tl3	3-Pb•,.	10.000	66.000	11.000	8.35	IMO	0	0	0	0	0	8.3\$00	D)l1	0.000
Tl4	ı.rıınu	10.000	66.000	11.000	8,35	1,1.00	o	o	o	o	o	8.ısoo	Dyn	0.000
Tl6	3-Ph>><	20.000	66.000	11.000	10.00	20.00	0	0	0	0	o.615	10.0000	1>)l1	0.000
Tl7	3-Plıns,	10.000	66.000	11.000	10.00	10.00	0	0	0	0	0.625	10.0000	D)-.	0.000
TJ8	3,Plınse	20.000	66.000.	il.ODO	10.00	10.00	0	0	0	0	3.750	10.0000	Dı,ı	0.000
Tl9	3-Ph>st	20.000	66.000	11.000	10.00	20.00	0	0	o	0	3.750	10.0000	Dyn	0.000

Branch Coppections

CKT/Branch		Connected Bus ID		% Impedance, Pos. Seq., 100 ll[VA Base			
ID	Tıp,	From Bus	To Bus	R	X	Z	Y
T1	2wmm	Bus3	Bud	0'46	20.58	20.S9	
T3	lWXl'lılR	Buss	Bu.sl	0.44	19.96	19.97	
T4	2wmm	Busl	Bus6	6.40	83.25	83.50	
TS	2WXl'lılR	Bus7	Bus9	2.50	49.94	50.00	
T6	2WXIllR	Buss	Busl 0	l.S3	50.56	50.63	
T9	2wxnm	Busl3	BııslS	6.68	86.90	87.15	
T10	2WXIllR	Busl4	Bu,16	6.68	86.90	87.15	
Tl!	l\'\'Xl'lılR.	Busl7	Bu,19	2.SO	49.94	50.00	
Tl2	~WXFAIR	Busl8	Bu.110	2.50	49,94	50.00	
Tl3	2WXl'lılR	BusU	Bus:?2	6.40	83.25	83.50	
T14	zw:xı:ıım.	Busl3	Bıı')l::S	6.40	S3,2S	83.50	
T16	ZWXFMR	Bus27	Bus28	2.Sl	50.25	50.31	
T17	2wmm	Bu,27	Bu,29	2.51	$0,25	se.Sl	
T18	lW:xTiı:fR	Bu<.~0	Bu13:?	2.59	51.81	51.88	
T19	2wmm	Bus31	Bus33	2.59	51.81	Sl.88	
Line1	Lhıe	Bus?	Bu,14	2.48	16.58	16.77	0.2607629
Line2	U..	Busl	Bud3	2.48	15.16	15.16	0,2842267
Line3	Lin•	Busl	Bu,18	2.96	18.06	18.lO	0•.1387157
Line4	Liıιt	Bus27	Bu<l7	1.9.l	11.78	11.94	0.2?09015
Line5	Liıı•	Busl	Bu.s17	1.03	6.28	6.l7	0.1178142
Liıı,6	Lin,	Busl	Bus7	O.SI	3,U	3.18	0.05S9071
Line7	U..	Busl	Buss	0.51	3.14	3.18	0.0589071
Line8	Lin•	Busl	Bus7	0.51	3.14	3.18	0,0589071
Liıı,9	U..	Busl	Bus8	O.SI	3.14	3.18	0.0589071
Line10	Lint	Busl	Biıs.ll	1.03	6.28	6.17	0.1178141
Line11	U..	Bml	Bus30	1.03	6.28	6.37	0.117Sl42
Line12	Lin•	Busl?	Busll	2.70	16.49	16.71	0.3092622
Line13	Lin,	Bus17	Bu,23	20.70	IM.43	128.11	!.3710100
Line14	Line	Bus?!	Bu.<:23	18.00	109.94	nı.ıe	2.0617480

LOADfLQW REPORT (WithoutPV)

Bus		Volcage		Ge1:ıeratiou		Load		LoadFJow					XFMR
ID	kV	%M:ıg.	Ang.	At\Y	Mvar	MW	)frat	ID	?.f\1:	)frat·	Alnp	%PF	%Tap
Bu.1	66.000	9UI8	-5.1	0	0	0	0	Jin'13	6.017	3.96)	63.6	83.S	
								Busl7	19˜,!S	l.lSS	172.6	9.9.8	
								Bu'8	3.419	l.216	36.7	83.7	
								Bu'8	3.419	2,216	36.1	83.7	
								Bu'30	lo.979	7.688	118.3	81.9	
								Bu'3	-IMN	-18.606	417.3	91,9	3.750
								Bu'6	0.001	l.Z.ll	11.0	0.1	
Bnıl	66.000	98.852	-1.9	0	0	0	0	Butl4	6.009	3.99%	63.8	83.3	
								Buds	3.488	-0.Z-16	30.9	.99.8	
								Bu,7	0;994	M1Z	le.1	86.7	
								Bu,7	0,994	O.S7l	le.1	86.7	
								Bu'31	S.OU	J.198	Sl.7	84.4	
								Bu.S	-16.S07	.$.089	16!.7	89.8	0.625
•Bus.I	210.000	100.000	0.0	43.SSZ	2M66	0	0	Bu,!	43.582	23.466	IZ9.9	88.0	
*BlliS	220.000	100.000	0.0	16.Sll	8.78.1	0	0	Bu'2	16.Sll	8.783	49.1	88.1	
Bu,6	11.000	98.071	~<.l	0	0	0.000	I.µ!:	Bu.1	0.000	-L234	66.0	0.0	
Bu,7	66.000	98.828	-1.9	0	0	0	0	Busl	-Il.994	-Il.629	10.4	84,S	
								Ba'2	-Il.994	.ı>.629	10.4	84,S	
								Bu9	1.987	1.2.ç9	20.8	84.5	
Bu'8	66.000	99.027	.$.?	0	0	0	0	Bud	-3.478	-1.329	$7.0	SJ.I	
								Bu,l	-3.478	-2.329	37.0	83.1	
								B•tlO	6.9S6	4.6S7	73.9	83.1	
Bu,9	11.000	9S.U6	:1.S	0	0	1.986	1.231	Bus7	..J..986	-1.%31	124.9	8S.O	
BuslO	11.000	97.770	-7.2	0	0	6.938	4.JOI	Bu'8	-6.938	4.301	433.2	85.0	1.250
Busl3	66.000	98.344	-M	0	0	0	o	Bu<!	../i..004	-1.158	65.0	8%.l	
								BuslS	6.004	4.158	65.0	BZ.Z	
Bu,14	66.000	98.015	-U	0	0	0	o	Bu'2	-5.996	-1.155	65.1	82.2	
								Bu;16	5.996	4.155	65.1	82.1	
Bu,lS	11.000	98.691	.S.S	0	0	S.96S	M99	Bu'13	,<.968	-3.699	J7J.4	BS.O	4.375
Bud&	U.000	98.339	..S.4	0	0	S.960	3.694	Bu,U	-S.960	,1.694	JU.l	85.0	4.375
Busl7	66.000	98.917	-6.8	0	0	0	0	Bum	-Il.472	2.810	1?1.7	-9:,9	
								Bu'2l	6.601	-1.319	S9.S	-98.1	
								Bu.Z3	1.390	.J.644	19.0	44.6	
								Bu,19	S.480	O.ID	48.5	100.0	
Ba,18	66.000	98,765	-l.S	0	0	0	0	Bu.Z	-3.484	-1!.062	J0.9	100.0	
								BuslO	3.484	0.062	30.9	100.0	

Project:	l'ı!ASTER THESIS	ETAP	Pag.: 9
Location:	HOVN CIT\', LIBYA	12.6.0H	**Date:** 28-06'2016
Contract:	NEAR EAST UNIVERSITY -EEE Deparnnent		SN:
Engineer:	SAı'ID.I'ılll~7AfAAL-REFAI	Srudy Case; LF	Revisieu: **Base**
Filename:	**HOUN SUBSTATION 220kV**		Config: Normal

DESIGN OF A LARGE SCALE SOLAR PV SYSTEM AND IMPACT ANALYSIS OF ITS INTEGRATION INTO LIBYAN POWER GRID

Bus		Voltagıe		~ueratiou		lAad		Load Flow					XFMR
ID	kV	%Mag.	Ang.	MW	Mwır	MW	>.b11r	ID	MW	Mrar	Amp	%PF	%Tap
Bus19	11.0-00	98.740	.S.4	0	0	Mlı	0.000	Bu,17	.S.412	0.000	**290.9**	100.0	
Bus20	11.000	98.661	-3.3	0	0	3.481	0.000	Bu,ıs	-:l.481	0.000	**lS.,Z**	l00.0	
Bus21	66.000	*98.938*	-7.$	0	0	0	()	**Bu~U**	-6.ö90	1.091	$9.I	-98.7	
								Busl3	MOJ	-l;.198	13.S	~,9.6	
								Bu5ll	*5.986*	0..!06	SM	*99.9*	
Bus22	11.000	98.4?2	-JM	0	0	*5$62*	0.000	Bu<ll	.S.%2	0.000	SIS,e	100.0	
Bus23	66.000	*99.16.1*	.7,9	0	0	0	0	Bu,17	**.ISSS**	*-0.656*	13.5	90.4	
								Bu<ll	-M03	-M?l	7.6	69.6	
								Bu~S	1.988	1.m	ıu	su	
Bus25	11.000	98.077	.S.8	0	0	1.984	1.130	Bu,H	-1$84	.u.ıo	ll4&	85.0	
Bus27	66.000	98.847	.$.8	0	0	0	0	**Busl?**	13.;09	-1.797	ın.1	*-91.9*	
								Busl	-19.418	-1.026	17M	99.9	
								Bu:ıs	2984	**1,911**	3J..I	84.2	
								Bınl9	2$84	1.91?	*3U*	84.1	
Bus28	11.000	98.428	*-6.1*	0	0	**?.981**	l.S-18	Bu<l7	-2JS1	**.l.SIS**	187.0	BS.O	0.625
Bus29	11.000	98.428	-6.7	0	0	1.981	l.S-18	Bus27	-2$81	-1.848	{87.0	8$.0	o.625
Bus30	66.000	*98.1*	.Ş.Ş	0	0	0	0	Bu.si	-10$61	-7.688	US&	81.9	
								Bus.31	10&61	7.688	118.9	81&	
Bus31	66.000	*98.594*	.I.I	0	0	0	ŏ	Busl	-Ml9	-3.190	53.l	SM	
								8•'33	S.019	3.190	**53.l**	83.6	
Bus32	11.000	98.036	:S.7	0	0	ıasu	**6.76$**	**Bus..,o**	-lO&U	-6.76$	***681.S***	85.0	3.750
Bus33	11,000	100.463	*.),5.*	0	0	5.009	s.ıes	B!>'31	-5.009	-3.105	307.9	8!'.0	,.,.0

*** Indicates a voltage regulated bus (voltage controlled or swing type machine connected to it)**

 # indicates a bus with a load mismatch of more than 0.1 MVA

DESIGN OF A LARGE SCALE SOLAR PV SYSTEM AND IMPACT ANALYSIS OF ITS INTEGRATION INTO LIBYAN POWER GRID

Bus Lo:tdiug Summai)' Repı.\J't

Bus			Dlı-.rıly Conner(ed Load								Total Bus Load			
			Conut~ntl..,"A		C'<instaint		Conn;,utl		Gtutin:					
ID	kV	R.attd Amp	An,ı	Mrnr	ı\ft\'	l,h·ar	!.nV	}to'ı;r	AIW	lı'wır	MVA	% PF	Amp	Percent Londing
Bu..ı	210.000										0	0.0	e.e	
Busl	66.000		0	0	0	0	0	0	0	0	47.188	91.9	417·ı	
Busl	66.000		0	0	0	0	0	0	0	0	18.491	89.3	163.6	
Bus3	ll0.000		0	0	0	0	0	0	0	0	"49.498	88,0	129.9	
Buss	210.000		0	0	0	0	0	0	0	0	lS,711	88.3	49.l	
Bus6	11.000		0	0.995	0	0.239	0	0	0	0	1.234	0.0	66.0	
Bu,7	66.000		0	0	0	0	0	0	0	0	.l.3S2	84.5	l0.8	
Biis8	66.000		0	0	0	0	0	0	0	0	1.371	83.1	73.9	
Bus9	11.000		UOO	0.991	0..185	0.l.19	0	0	0	0	1.336	85.0	114.9	
Bus!O	11.000		S.600	3.471	1.338	0.830	0	0	0	0	8.163	SS.O	4.18.l	
Bud.I	66.000		0	0	0	0	0	0	o	0	7.;103	8?.1	65.0	
Bıı,U	66.000		0	0	0	0	0	0	0	0	7.Z94	82.2	65.1	
Bu'15	11.000		4.000	2.975	Llti!l:	0.724	0	0	p	0	7.0ll	8S.O	373.4	
Busl6	ll.000		4.000	2.97S	J.160	0.719	0	0	0	0	7.012	85.0	374.1	
Bu'17	66.000		0	0	0	0	0	0	0	0	13.794	97.7	12M	
BuslS	66,000		0	0	0	0	0	0	0	0	3.485	J00.0	36,9	
Bu,19	11.000		4.400	0	l.071	0	0	0	0	0	M71	100.0	190.9	
BuslO	11.000		1.800	0	o.681	0	0	0	0	0	3.481	100.0	185.l	
Busl!	66.000		0	0	0	0	0	0	0	0	6.736	97.8	59.6	
Bu,ll	11.000		4.000	0	1.162	0	0	0	0	0	5.962	100.0	318.6	
Busl3	66.000		0	0	0	0	0	0	0	0	2.363	84.1	20.8	
Busl;	11.000		1.600	0.991	0.38;	0,238	0	0	0	0	z.;134	85:0	124.9	
Busl7	66.000		0	0	0	0	0	0	0	0	19.SSO	98,l	175.7	
Bu,l8	11.000		2..100	1.487	0.381	0.360	0	0	0	0	3.!'07	BS.O	187.0	
Bum	11.000		l.400	US,'	e.SSl	0.,60	0	0	0	0	3.so,	SS.0	ISl,e	
Bus30	66.000		0	0	0	0	0	0	0	0	13.388	SU	118.9	
Biis31	66.000		0	0	0	0	0	0	0	0	d.00l	83.6	SJ.?	
Bus3l	11.000		UOO	5.455	Z.IU	I.III	0	0	0	0	ll.841	85.0	687.S	
Bus33	ıı.ooo		4.000	Z.479	ı.009	o.626	0	0	o	o	·s.893	SS.0	307.9	

" Indkatt.sopti•ntingload oh bus eseeeds dıe bıu critfotllimit{100.0\9,ortht Canı:inuousAmpttt ı·:ttüg)~
indirn.tts. oper:ıtinglond ot fl bus eseeeds the bıu murgi.ııaJ limit (9S.0% of thf CoJii:inuo\n Ampff't,ratin:),

Branch Loading Suumnag-y Rs;nort

CJÇf / Branch		Cable & Reactor			Transformer				
					Cnpnblllty (M\'A)	Londiııg(ioput)		l.o;ıdiııg (output)	
ID	T,ııt	Amp.:.dty (Amp)	Londing Amp	ıı'		AIVA	!	Ifl'A	%
Tl	TtaDrl'orıner				63.000	49.498	*18.6*	47.288	75.1
T.I	Tr.an.1formtr				6J.000	18.712	29.7	18.382	29.2
T4	Trausfonntr				10,000	U47	n.S	l.Z;l.l	U.:l
TS	'.fnn,:tonntr				20.000	***Z.352***	ll.S	2.336	ll,7
T6	Traııdonntı·				20.000	8.371	41.9	8.163	40.8
T9	TrABifOl'1n6'				10.000	7.303	73.0	**7.0?l**	70.2
no	TranUonner				10.000	7.294	72.9	7,0U	70.1
Tll	'Tr.msf'onmr				20.000	5.482	27.4	S.472	**27..t**
TlZ	t.....rónntr				20.000	3.485	17A	3·.ı81	17.4
Tl3	Tramlonnt<				10.000	5.994	*S9.9*	S.962	ôM
Tl4	Trau.üorıo.er				10.000	2~i63	**2$.6**	2,334	23.3
Tl6	Tramformtr				20.000	*3.5.u*	17.7	3.507	17.5
Tl7	Trautformtr				20.000	*.l..W*	17.7	3.507	17.S
TIS	Tramfoımer				20.000	13.388	*66.9*	usa	64.2
T19	Tnmfonntr				20.000	6.001	JO.O	S.893	**lt.S**

• Indicaıos a brnudı mıh op,r;ıling l••d ox<ttdiug üıe bDnrh capability.

Branc)ı LosşçsStfıtjtllaı"\·Renoı1

C'Kl'/Bmnch	From-ToBusFloı,·		To-FrouıBusFlow		Losses		%Bu,Voltag,,		Vd % Drop in Vmag
_m	~	M,·aı•	.. 1'fW	ıfrar	....},,·!_			To	
Lhi,2	6.017	3.963	-6.004	-1.158	ı..ı..ı	-195.ı	99.1	98.3	0.77
Lhi,S	19.518	1,15$	-19.478	-1.026	40.0	129.1	99.1	98.8	0.27
Lhi,7	:l.479	2.276	.J.478	-2.329	0.9	-52.3	99.l	99.0	0.09
Llıı,9	3.479	2,276	-.3.478	-2,329	0.9	-52.3	99.l	99.0	0.09
L&ı.ıı	10,919	1.68:i	.10.w1	-7.6Ss	1ss	o..ı	,99.ı	98.5	0.60
n	-43.m	-18.606	43.˙Sl	23.466	ıos.o	4859.9	99.ı	100.0	0.88
T4	0.001	1.247	0.000	-1.234	I.O	ı..ı.2,	99.1	98.l	1.05
ıı.eı	6.009	3.992	-5.996	-1.1SS	ıas	-162.6	98.9	98.o	0.84
Lhit3	3.488	,0.Z46	:J.m	,0.062	3.7	.JOS.?	98.9	98.8	0.09
Lint6	0.994	o.m	-0.994	-0.629	0.1	.s1.1	98.9	98.s	0.02
ııп.s	0.994	o.m	-0.994	-0.629	0.l	.s1.1	98.9	98.8	0.02
L&ı.ıo	s.ozz	3.19s	-5.019	..ı.z90	3.s	-91.s	98.9	98.6	0.26
T3	-16.507	-S.089	16.SlZ	8.78.l	1$.4	69-l.S	98.ll	100.0	1.15
TS	l.!l87	l.%59	-1.986	-1.231	U	28.3	98.S	98.1	0.68
T6	6.956	4.6S7	-6.938	-4.301	17.8	356.9	99.0	97.8	1.26
T9	6.004	4.1S8	-5.968	.J.699	35.3	459.1	98.3	98.1	0.35
TIO	5.996	4,155	-5.960	~1.694	35.5	461.1	98.0	98.3	0.32
Lhit4	-13.472	2.810	13.509	-1.797	37.4	12.8	98.9	98,8	0.07
Lhiell	6.602	:ı.sıs	-6.590	1.092	12.4	-126.9	98.9	98.9	0.0Z
Lln,13	1.390	-1.644	-1.385	-0.656	4.6	-2300.l	98.9	99.3	0.35
rıı	5.480	0.153	.S.m	0.000	1.1	153.4	98.9	98.7	o.ıs
rn	3.484	0.062	.J.481	0.000	s.ı	62.2	98.s	98.7	o.ıo
Llntl4	o.604	-1.398	-0.603	-0.m	o.9	.2019,1	98.9	99.3	o.ıı
Tl.I	S.986	0.306	-S.962	0.000	23.5	305.S	98.ll	98.4	0.52
TU	1.988	1.177	-1.984	-l.l30	M	47,2	99.3	98.1	J.19
Tl6	2.984	l.91Z	-2.981	-J.S48	.l.2	64.?	98.8	98.4	0.42
Tl7	!.984	1.91?	-l.981	-1.848	3.2	64.2	98.8	98.4	0.4?
TIS	10.961	7.688	-10.914	,4;,765	46.1	922.2	98.5	98.0	MS
n9	s.019	3.290	-5.009	.J.1os	M	1s.,o	98.6	ıoo.s	1.87
					464.8	3296.6			

Alı,rt Şmnınan• Report

	% Alert Settings	
	~	Marginal
Loading		
Bus	100.0	95.0
Cable	1(10.0	95.0
Reactor	100.0	95.0
Line	100.0	95.0
Transfoımer	100.0	95.0
Panel	100.0	95.0
Pı'Ote.:li\.• De,ice	100.0	95.0
Generator	100.0	95.0
Inwı1er/Charg:n	100.0	95.0
BusVolfage		
Oveı-Voltage	les,e	101.0
Unde-rVoltage	95.0	98.0
Qsnı-:rtoı: Em!a!bın		
Oveıfüclted (Q Max.)	100.0	95.0
Undeı-E:ı:dted (Q i\fin.)	100.0	

M:aı'l!inal Report

DniceID	Typt	**Condition**	Rating/Limit	Unit	Op,ratiug	% Optrntiıg	PhaseType
Busl 0	Bu,	Undtt\'olı.g,	11.00	kV	10.75	97.8	3-Phm

SU?IMARY OF TOTAL GENERATION, LOADING & DEMAND

	erw	llfraı'	llIVA	%PF
Sour(e (Suing Buses):	60.104	*32.249*	*68.109*	88.U Lagging
Seurce (Non-Suing Buses):	0.000	0.000	0.000	
Total Demand:	60.104	32.249	*68.209*	88.12 Lagging
Total l\lotor Load:	*47.999*	23.307	53.358	*89.96* Lagging
Total Static Load:	11.640	5.646	11.937	89.97 Lagging
Total Constant I Load:	0.000	0.000	0,000	
Total G.neıic Load:	0.000	0.000	0.000	
Apparent Losses:	0.465	3.297		
System ?ılismatch:	0.000	0.000		

Number of Iterations: 2

APPENDIX5

LOAD FLOW ANALYSIS WITRPV

Project:	!ILI.SIER THESIS	ETAP		Page:	1
Location:	HOUN cm.' -LIBYA	12.6.0H		Daıe:	28-06-2016
Contract:	NEAR EAST UNIVERSITY - EEE Depm'nneut			SN:	
Engineer:	SM'D !ıfüSTA.FA A.L-REFAI	**Stucly** Case:	LF	R»ision:	Base
Filename:	HOUN Sl.ııiSTATION 220kV			**Config:**	**Normal**

DES:IGN OF *A* L.\RGE SCALE SOLAR;PY SYSTEM AND IMPACI ANALYSIS OF ITS INTEGRATION INTO LIBYAN POWER GRID'

Ele:ctriC'al Transient Analyzer PrOgl'aın

Lgaıl Flow Analysis QVith PV)

Loading Calegoı)' (l}: Design

Geuel'ation Category (l): D•sigu

Load D.irersitr Factor: None

	s,\iug	V-Contl'ol	Load	Total
Number of Buses:	3	7	30	40

	nhm2	nhml	Beacı:or	hiuelCahle	lmRedı:mrt	IM/I!	.Im!
Number of Branches:	24	0	0	16	0	0	40

Method ofSolulion:	Adapli\"e Nemoıı-Rapkson Method
!ıfaıdınum No. of Iteration:	**99**
·Pl"edslon of Solulion:	0.0001000
System Frequ•ncy:	50.00Hz
Unit System:	Metric

Aıljuslıneııts

Tolerance	Apply Adjıısıınenıs	Jndhidual /Global	Pereenr
Transformer: Impedance:	**Yts**	hıdhidual	
Reactor Impedance:	y.,	hıdhidwıl	
Overload Heater Resistance:	No		
Tnıısınission Line Length:	No		
Cable Length:	No		

Temperamre C:oı.-erlioıı	Apply Adjustments	Indhidual /Global
Transmission Line Resistance:	Yts	hıdilidual
Cable Resistance:	**Yts.**	hıdiliduıl

DESIGN OF A LARGE SCALE SOLAR PV SYSTEM AND IMPACT .~NALYSIS OF ITS INTEGRATION INTO LIBYAN POWER GRID

BusJnput Data

Bus			·mitinl Voltage		Load							
					CousranttVA		Con:.tın.tlZ		C<>ust:ııı.tl		Giımic	
ID	kV	Sub..sp;	%Mng.	Ang.	MW	M,:ar	MW	Mrai·	·MW	!\h'ar	111\V	Ifraı·
Busl	6MOO	I	99.1	-S.1								
Bus:?	66.000	2	98.9	-1.9								
BuO	2%0.000	1	100.0	0.0								
Bu<I	:2I0.000	3	100.0	0.0								
Buss	120.000	l	100.0	0.0								
Bus6	11.000	I	98.1	-S.1	0.000	0.995	0.000	0.149				
Bus7	66.000	l	98.S	-1.9								
Bus8	66.000	1	99.0	..5.1								
Bus9	11.000	I	98.1	.2.s	1.600	0.992	0.400	C.Z4S				
Busl 0	11.000	1	97.S	-7.2	S.600	3.471	1.400	0.868				
Budl	66.000	I	99.l	-U								
Bu'12	66.000	1	99.4	-U								
Butl3	66.000	I	98~\	-S.6								
llusU	66.000	I	98.0	-:?.4								
Bınl5	11.000	1	98.1	-8.S	4.800	l.975	1.200	0.744				
Bus16	11.000	l	98.3	-SA	4.800	2.915	1.100	0.744				
Busl?	66.000	1	98.9	-6.8								
Bus18	66.000	2	98.8	.z.3								
Bud9	11.000	I	98.7	-S.4	4.400	0.000	1.100	0.000				
Bus?O	11.000	2	98.7	.J.3	2.800	0.000	o.700	0.000				
Busl!	66.000	I	98.9	-7.5								
Busl?	11.000	I	98.4	-IM	J.800	0.000	1.200	0.000				
Bus23	66.000	I	99.3	-7.9								
Buds	11.000	I	98.1	-8.8	1.600	0.991	0.400	0.248				
Bus%7	66.000	I	98.8	-S.8								
Bus2:8	11.000	I	98.4	-6.7	1.-100	1.487	0,600	0.37Z				
Bus~	11.000	I	98.4	.lI.1	l.400	US?	0,600	o.m				
ıiu,30	66.000	I	98.5	-5,S								
Bu'31	66.000	1	98.li	-S.1								
Bus3l	11.000	I	98.0	-S.7	8.800	5.455	l.lOO	LJ64				
Bus33	ILOOO	2	100.5	-3-<	4.000	1.479	1.000	0.610				
Bıı~J.f	0.400	I	100.0	1.1								
Bus35	0.400	1	100.0	I.I								

Project:	MASTER THESIS	ETAP	Page:	4
Location:	HOUN CITI' -LIBYA	12.~.0H	Date:	28,06-2016
Contract:	NEAR EAST UNIVERSITY-:EEE Department		SN:	
Engineer:	SAl'i'DIWSTAFA AL-REFAl	Study Case: LF	R•\'lslou:	Base
Fllenoine:	HOUN SUBSTATION 220kV		Config:	Nol'mal

DE~1GNOF A LARGE SCALE SOLAR PV SYSTEM A\'<'D IMPACT ANALYSIS OF ITS INTEGRATION INTO LIBYAN POWER GRID

Bus.			Initial Voltnge		Load							
					Constant kVA		Constant Z		Constant I		Generic	
ID	kV	Sub-sys	%~fng.	Ang.	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar
Bus36	OAQO'	1	100.0	I.I								
Bus.I?	MOO	I	100.0	1.1								
Bu'38	o.400	2	100.0	J.J								
Bu'39	0.400	2	100.0	3.3								
Bu$40	o.400	Z	100.0	3.3								
Bus41	II.000	I	9~	:-1.l								
Bm41	11.000	I	gB,6	I.O								
T-01nlNumberof Bum:: 40					47.999	23.307	11.000	5.827	0.000	0.000	0.000	0.000

Oeaererton **Bus**				Voltnge		Generntiou			llb'llrLimits	
ID	kV	Tıp,	~	%Mag.	Ang!,	MW	M,-ar	%PF	Max	Min
Bus.I	220.000	$I\llIg	I	100.0	0.0					
Bul..ı	220.000	**Suing**	3	100.0	0.0					
BmS	220.000	**smug**	I	100.0	0.0					
Buc;.,tt	0.400	**V'>ltag"' Control**	1	100.0	I.I	1.960			0.899	0.000
Bus35	MOO	**Volıage Control**	I	JOO.O	1.1	1.960			0.399	0.000
Bu'36	0.400	**Votıaıt Control**	I	100.0	I.I	1.960			0.899	0.000
Bu'37	o.400	**V~fAgt Control**	1	100.0	I.I	JMO			O.S99	0.000
Bus38	Q.400	**Voltagt ContNıl**	I	100.0	3.3	1.960			0.899	0.000
Bıı'39	o.400	**Volta-gt Control**	2	100.0	3.3	I.960)			o,s99	0.000
Bus40	0.~00	**Voltagt Control**	2	100.0	3.3	1.960			0.899	0.000
						13.719	0.000			

Line/Cable Input Data

Line/Cable			Ltngtb				Ohms oı' Siemeus/1000ın per ~nductor (Cnble)orper J,>hase (Llue)		
ID	Library	Sm	Adj.(m)	%Tol	li/Plı:ıs.	rco	R	X	y
C•bl,l	11MCUS3	-;-	100.0	0:0	l	--,g-	0.076.102	0.087400	-0.0001646
C•bl,Z	ınıcıss	300	100.0	0.0	1	75	0.076.102	O.Oll'i400	0.0001646
Lintl		674	19300.0	e.e	1	75	0.056003	o.mm	0.0000031
LintZ		674	moo.o	M	1	75	-0.056001	0.342069	0.0000034
Lint3		674	Z.1000.0	0.0	l	75	0.056001	0.342069	0.0000034
Lint4		m	15000.0	0.0	1	75	0.056001	0.342069	0.0000034
Line.$		6U	S000.0	0.0	1	75	0.056001	0.342069	0.0000034
Lin,6		674	4000.0	0.0	l	75	0.056001	0.342069	0.00000>l
Lin,7		674	4000.0	0.0	l	75	0.056001	0.;142069	0.0000034
Lin,S		674	4000.0	0.0	l	75	0.056001	0.342069	0.0000034
Lin,9		674	4000.0	0.0	1	75	0.056001	O.>12069	0.00000>l
LintlO		674	8000.0	0.0	1	75	0.056001	0.342069	0.0000034
Lin,ll		674	S000.0	0.0	l	75	0.056001	0.342069	0.0000034
LintlZ		674	11000.0	0.0	l	75	MS6001	0.342069	0.0000034
Lintl3		674	161000.0	0.0	l	75	O.OS6001	0.342069	0.00000M
Lin•l4		674	140000.0	0.0	1	75	O.OS6001	0.342069	0.0000034

Liııe **/ Cablt rtsisuuıctS** ere **listtd** at the- **spttifit'd ttınpt"ratl.tru.**

Pl'oje<t:	.ilL\SlER THESIS	ETAP	Page: ~
Location:	HO.l!N CITY· LIBYA	12.6.0H	**Date:** 28.06-2016
Contract:	NEAR EAST UNIVERSITY • EEE Deparnnent		SN:
Engineer:	SANDllWSTA:f'AAL-REFAl	Study Case: Lf	Re,ision: Base
Filfnnme:	HOUN: SUB&TATION 220kV		Config: **Nonnnl**

DESIGN OF A LARGE SCALE SOLARPVsYSTE!1lAND Li\lPACT ANALYSIS OF ITS lNIEGRATION INTO LIBYAN POWER GRID

k)'~'iudingTransformerluput Data

Tnmsfomıer·		Rating					**Z Variation**			%TapS.triug		Adjusred	PlıaseSlıift	
ID	!'hı,,.	MVA	Prim.kV	S.r.kV	%Zl	Xl/Rl	+£%	**-S%**	%Tol	Prim.	Stt.	%Z	T)'p•	**Anglt**
Tl	**3-Ph:k~**	63.000	Zl0.000	66.000	Jl.$1)	45,00	0	0	0	0	3.75011	•$000	**Dı11**	0.000
T3	.l-Ph>st	63.000	**210.000**	66.000	ll.50	45.00	0	0	0	0	**0.6!5**	!l.$000	Dyn	0.000
T4	**3-Phast**	10.000	66.000	!MOO	8.35	13.00	0	0	0	0	0	8.3500	**Dyn**	0.000
TS	3-pı,.,.	**'.l0.000**	66.000	11.000	10.00	10.00	0	0	0	0	0	10.0000	**Dyn**	0.000
T6	3-Ph≥st	20.000	66.000	11.000	10.00	20.00	0	0	0	0	Lı50	10.0000	**Dyn**	0.000
T7	**J..Pbast**	ll.S00	11.000	66.000	8.35	13.00	0	0	0	**-LlSO**	Q	8.3500	\'Nd	0.000
TS	**3-P.h.ı,"'**	ll.500	ll.000	66.000	8.35	13.00	0	0	0	**.l.uo**	0	8.3500	**\'Nd**	0.000
T9	**3--Pha$t**	10.000	66.000	11.000	8.35	13.00	0	0	0	0	4.375	8..1500	Dyn	0.000
TIO	3-Phas,	10.000	66.000	11.000	8.35	13.00	0	0	0	0	4.375	8.3500	**Dyu**	0.000
Tll	3.pı..,.	**Z0;000**	66.000	Jl.ODO	10.00	**20.00**	0	0	0	0	0	10.0000	**Dyıı**	0.000
Tl2	3.pı,,,.	**20.000**	66.000	11.000	10.00	20.00	0	0	0	0	0	10.0000	D)'ı	0.000
rlS	.l-Phast.	10.000	66.000	11.000	*8.35*	13.00	0	0	0	0	*0*	8.3500	l>yıı	0.000
T14	,ı.pı,.,.	10.000	66.000	ll.000	ass	13.00	0	0	0	0	0	8.3500	Dyıı	0.000
T16	3-pı..,.	20.000	66.000	11.000	10.00	10.00	0	0	0	0	*M";5*	10.0000	**Dyn**	0.000
Tl7	.l-l'h>st	**10.000**	66.000	ll.000	10.00	10.00	0	0	0	0	0.6?5	10.0000	**Dyn**	0.000
T18	**3-Plı:ısr**	20.000	66.000	ll.000	10.00	10.00	0	0	0	0	.1.750	10.0000	Dyıı	0.000
Tl9	3-pı,,.	20.000	66.000	11.000	10.00	20.00	0	0	0	0	3.750	10.0000	Dyn	0.000
TIO	3-pı.. ••	3.000	0.400	11.000	***6.15***	6.00	0	0	0	0	0	**~lSOO**	VNd	0.000
ra	**l-PhMt**	3.000	0..l00	ll.000	6.15	6.00	0	0	0	0	0	**··0S00**	\'Nd	0.000
nı	.l,Pha,t	3.000	0..l00	ll.000	***6;2$***	6.00	*0*	0	0	0	0	**6.:?S00**	\'Nd	0.000
Tl.l	,ı.pı., ••	3.000	0,400	ll.000	***6.25***	6.00	0	0	0	0	0	6.l.<00	VNd	0.000
Tl4	;ı.pı,.,.	3.000	0.400	11.000	**6.25**	6.00	0	0	0	0	0	6.2500	\'Nd	0.000
TlS	**3-.PbaSt,**	3.000	0..l00	11.000	**6.15**	6.00	0	0	0	0	0	6.2500	\'Nd	0.000
T16	3.pı,.,.	J.000	0..l00	11.000	**6.2$**	6.00	0	0	0	0	0	**6.l~**	\'Ñd	0.000

Brapch Connections

('KT/Branch		ConnectedBus ID		%Jmpedaııco, Pos. Seq., 100 l\IVABase			
ID	Type	:Fı<>ınllus	To Bus	R	X	Z	y
Tl	ZWXFMR	Bus3	Busl	0.46	20.58	10-59	
T3	2WXFMR	Bul5	Buasl	OA4	19.%	19.97	
T4	2WX:FlılR	Bud	Bu~	6.40	83.:ZS	83.50	
TS	2WXF1ılR	Bu~7	Bu.ı>	2.50	49.9-1	50.00	
T6	2WXF1ılR	But8	Bu,10	2.53	50.56	50.63	
T7	lWXF1ılR	Bus42	Buül	5.06	65.77	6.'97	
TS	1\VXF1ılR	Bus-tl	Bu,lZ	5.06	65.11	~S.97	
T9	lWXF1ılR	Bud3	Busl$	6.68	86.90	S7.15	
TlO	ZIVXF1ılR	Bu,14	Bud6	6.68	86.90	81.IS	
TU	ZWX:FlılR	Bu,17	Bus:1.9	1.50	49-94	50.00	
rn	l\VXF1ı1R	Busl8	Bus20	2.50	49.94	50.00	
Tl3	2\VXRIR	Bus:21	But??	6.40	83.'?5	8UO	
Tl4	2WXF1ı1R	Bm:ll	Bud$	6.40	83.25	SS.Se	
Tl6	l\VXF:MR	Bm2.7	Bw.?S	l.51	50.25	50.31	
Tl?	ıwxnm	Bu$l7	Bus29	2.51	SO.IS	50.31	
TIS	2WXF1ı1R	Bu,30	Bus32	l.59	51.Sl	51.SS	
Tl9	lWX:FMR	Bu,31	ıiu,33	2.59	51.81	51.SS	
no	ZIVXF1ı!R	Bı1$34	Bus41	34.25	205.SO	208.33	
rn	lWXF1ılR	.Bu13S	Bu..ıl	34.?5	lOS.SO	?08.33	
n2	ZWXRIR	Bm36	Buwl	34.25	?05.50	208.33	
T?3	?WXFl\lR	Bu,37	Bus41	34.15	20S.50	208.33	
Tl4	ZWXF1ı1R	Bud$	Bu~?	34.25	205.50	208.33	
TIS	?WXR!R	Bus39	Bus-12	34.25	205.50	?08.3.l	
Tl6	ıwxnm	Bu..ıo	Bus-1?	34.ZS	?OS.SO	?08.33	
C•bltl	Cal>I,	Bu,11	Bus!	O.Ol	0.0ł	0.03	0.0716998
Cablt:?	Cablt	Budz	Bnsl	0.0?	0.02	0.03	0.0716998
L!ıntl	L!ınt	Bw>Z	BusU	?.48	16.58	16.77	0.?607629
Uıı,2	Lfıı•	8ml	Busl3ı	2.48	15.16	15.36	0.:84?!67
Llıı,3	Llıı•	Bus?	Bnsl8	?.96	18.06	18.30	0.33S7157
Uno-I	Un,	Bu,27	Bu,17	1.93	11.78	11.94	0.1209015
LintS	Llıı•	Bml	Busl?	J.03	.6.ZS	6.37	0.1178142
Llııe6	Llıııe	Bu.Z	Bu.ç'7	O.SI	3.14	3.18	O.OSS9071
Uıı,7	Lín•	Busl	Bu.S	0.51	.1.14	3.18	0.0589071
L!ıı.S	Lin,	Buç:?	Buç7	O.SI	3.14	3.18	0.0589011
Lin,9	Un,	Busl	BU.S	O:SI	.1.14	3.18	0.0589071
UndO	Un,	Bu,?	Bu'31	1.es	6.18	6.37	0.1118142
Liıı•ll	Lín•	Bud	BuoO	1.03	6.18	6.37	0.11781.İ?

Project:	llL.\STER THESIS	ETAP	Page: 8
Locntion:	HOUN Cl1Y -LIBYA	12.6.0H	Date: 28--06-2016
Contrnct:	NEAREASTUN1"ERSI1Y ·EEE Deparnuent		S|'I:
Engineer:	SAl'<'D 1\lUSTAFA AL-REFAJ	Study Case; LF	Reli,lon: Base
Filename:	HOUN SUBSTATION 220kV		Config: Normal

DESIGN OF A LARGE SCALE SOLAR PV SYSTEM AND IMPACT ANALYSIS OF ITS INTEGRATION INTO LIBYAN POWER GRID

<-'KTIBı-auch		Connected Bus ID		% Impedance, Pos. Seq., 100 MVABase			
ID	Typ,	Frcm Bns	To Bus	R	X	Z	V
Liuel2	Lint	Bu,17	**Bu-;21**	*2.10*	16.-l!>	*16.11*	0.1092622
LlnH.I	Lint	**Bttd7**	**Bus23**	20.70	12M3	128.U	.Z-1710100
LIneU	Lint	Bu'21	Bui23	18.06	IOM4	nı.ıe	2.0617480

Pı'ojott:	I\USrER : THESIS	ETAP		Page:	9
Location:	HOUN CITY· LIBYA	12.ii.OH		Date:	IS-~6-IOrn
Contr.act:	NEAR EAST UNIVERSITY· EEE Department			SN:	
Eugiıı~er:	SANDAWSTAfAAJ...REF.U			**Redslon:**	**Base-**
rUename:	. HOUN SUBSTATION 220kV	**Study** Case:	LF	Config:	**Normal**

DESIGN OF A LARC."E; SCALE SOLAR PV SYSTEM A.ND DIP ACT ANALYSIS OF IT$ INTEGRATION INTO LIBYA!'<' POWER GRID

LOAD FLOW REPORT QVith P\2

Bus		Voltage		Generation		Load		Load Flott					XFillR
ID	kV	% Mag.	Aug.	MW	M\~r	hflY	!ıh-ar	ID	I\IW	Aka,·	Atnp	%PF	%Tııp
Busl	66.000	9!).388	-4.Z	0	0	0	0	Bml2	.1.1:.l	-0.376	68.,	99$	
								Bud3	6.02-1	.1.961	63.S	8.1.5	
								But?7	19.5.19	1.ns	172.3	99.8	
								Bu18	3..183	'.t:?78	~.6	8.).7	
								Bu~8	3..18.1	:U78	3M	8.).7	
								Bnt30	I0..991	7.691	118.I	81.9'	
								Bud	~,5.161	-18.211	353.3	II9.1	3.750
								But<i	0.001	uıs	11.0	0.1	
Bus2	66.000	99.061	-1.2	0	0	0	0	Butll	-5.821	-0.72~	51.8	99.2	
								Bud-l	6.014	3.993	63.7	83i3	
								BudS	3.491	.o.us	30.9	-99.1	
								Bu-.:7	0.994	0.573	10.1	86.7	
								Bu'>7	0.994	0.573	1.0.1	86.7	
								Bu53l	5.027	.ı.200	52.6:	S4.I:	
								Bus5	-lo.700	-7.365	1u.1	Sl.1	0.6:?5
***Bu~**	zıo.ooo	100.000	o.o	.15.844	I!.694	0	0	Bud	.IS.8-I4	21.694	110.0	85.6	
***Bus5**	220.000	100.000	0.0	10.708	7.711.	0	0	But2	10.708	7.711.	;14.6	81.1	
Bu<;6	11.000	98.3-U	-4.2	0	0	0.000	1.235	Bud	0.000	.J.2.I6	65.9	o.o	
Bm7	66.000	99.036	.I.I	0	0	0	0	Bml	-0.994	.0.630	10..ı	84.s	
								Busl	.o.994	.o.~,o	10.ı	Sl.S	
								Bu,;$1	1$89	1.160	lO.S	84.5	
Bu.S	66.000	99.297	-4.3	0	0	0	0	Bud	-3.482	-2.330	36.9	83.1	
								Bud	.J.482	-1.330	36.9	8.1.!	
								Bu,10	6$64	4.661	73.8	8.1.1	
Buı9	11.000	98.356	-1.8	0	0	1$87	1.23?	Bu,;7	-1.~S7	-LI3Z	III.II	85.0	
BuIO	11.000	98.048	-6.3	0	0	6.946	4.305	Bu,8	-6.946	-4,305	437.S	85.0	1.1se
Budl	**66.000**	519.06~	**-1.l**	0	0	0	0	Bu-.2	ssn	MSI	51.7	99.l	
								But41	-S.821	.0.6:.1	51.7	99.4	
Bnd2	66.000	99.390	-4.Z	0	0	0	0	Bu11	7.75-1	0.306	68.1	!>!1.9	
								Bu-s:41	.1.1:.l	.0.306	68.3	9M	
Bu,13	**66.000**	**98.615**	**-4.7**	0	0	0	0	Bud	-6.011	-4.161	64.8	Sl.2	
								Bnd5	6,011	4.161	64.8	82.l	
BmU	-	98.m	.1.1	0	0	0	0	Bu<;?	-6.001	-4.157	6S.O	82,Z	
								Bud6	~001	U57	65.0	82.2	
Bud$	11.000	98.983	-7.6	0	0	ö.915	3.703	Bud.I	.S.915	.J.10.1	371.S	85.0	4.315
Bu.d6	11.000	98~	-4.7	0	0	S,965	M97	BuıU	-S.965	-.1.697	373.7	ss.o	.f.37$

Project:	MASTER THESI$	ETAP	Page:	10
Lorntiou:	HOUN C.UY • LIBYA	12.6.0H	Date:	28-06-2016
Contract:	NEAR EAST lıNVERSITY • EEE Deparnnenr		SN:	
Engineer:	SANDMUS1AFAAL-REFAI	Study Case: LF	Redsion:	Base
Filename:	HOUN SUBS1ATION220kV		Config:	Noımal

DE.5IGN OF A LAR(.1: SCALE SOLARPV SYSTE.\[AND L\IPACT ANALYSIS OF ITS INTI:GRATION INTO LIBYA!.'ı'POWER GRID

Bus		Volrage		Generation		Load		Loadilow					XFMR
ID	kV	%Mag.	.-l..g.	SfW	?\foır	MW	l\frnr	ID	l\lW	Ab-ar	Aınp	%ıPF	%Tnp
Bu-:17	66.000	ı>ı>.m	-$.9	0	0	0	(ı	Bm27	-13.-1$7	l.837	121.S	-97.9	
								Buı;2.l	6.609	.1SSS	$9.S	-98.0	
								Bıu;l3	1.\91	-1.657	1u	~4.3	
								Bm19	5.48"	e.ıSS	48.4	100.0	
ButlS	66.000	98.973	-1.6	0	0	0	0	Bm:l	.JM7	~.062	30.8	100.0	
								Bu~?O	3.481	0.061	30.S	J00.0	
Bud!>	11.000	ı>!l.016	-7.5.	0	0	5.478	0.000	Bnd7	-5.478	0.000	290..1	J00.0	
BuıZO	11.000	98.SW	-2-6	0	0	3.484	0.000	Bu,18	.J.484	0.000	185.0	J00.0	
Busll	66.000	99.215	~.S	0	0	0	0	Bu,17	~97	1.1eS	S9.0	-98.6	
								Buı23	0..l0.l	.J.109	11S	.39.4	
								Bu'>ll	S.992	0.304	52.9	99.9	
Buıll	11.000	98.700	-9.4	0	0	S.969	0.000	Buı.:21	-5.969	0:000	317.4	J00.0	
BU$l3	66.000	99,515	.Ji.9	0	0	0	0	Bud?	.J.387	-M!'<5	13.S	9().4	
								Busl!	-o.603	..0.4]2.1	7.6	69.6	
								Buı.:1S	l.l>90	1.27S	20.8	84.l	
Busl&	11.000	98.360	-1.9	0	o	1,987	1.1S1	Busl3	-l.987	-1.!31	m.1	8.S.0	
BmZ7	66.000	!19.119	-1.9	0	0	0	0	Bttd1	13.$14	-1.816	121.9	-91.9	
								Bud	-19.499	-1.001	172.3	99.9	
								Bu'il8	l.9SS	1.914	31.3	84,l	
								Bus-29	2.988	1.914	31.3	84.l	
Bu.sl8	!1.000	98.703	-5.8	0	0	1.984	1.850	Buıl7	Hl.984	-1.8.<o	186.7	85.0	oms
Bu,29	!1.000	98.703	~S.S	0	0	l.?S4	1.850	Bum	-1.9$4	-1.850	18".7	85.0	0.625
Bus30	66.000	98.787	-1.6	0	0	0	0	Bud	-10.973	-7.691	118.7	81.9	
								Bu~l	10.973	7.692	118.7	81.9	
Bm31	66.000	SIS.SOZ	.l.4	0	0	0	0	Bu'il	..S.0?3	-3.191	S3.l	83.6	
								Bu't33	S.013	3.191	S3.l	83.6	
Bus3Z	11.000	98..126	-7.8	0	0	10.917	6.11.1	Bu,30	Hl0.9?7	-6.773	686.Z	85.0	3.750
.Bu'33	11.000	lOo.681	H1.S	0	0	5.014	3.108	Bu.JI	-5.0U	.J.!OS	307.5	85.0	3.750
ıtBuç34	0.400	100.000	1.1	1.960	0.1SS	0	0	Bu,41	1.960	0.258	28SJ.?	99.1	
"Bus3S	0.400	100.000	1,1	1.960	0.1SS	0	0	Bu<!!	l.l>60	0.258	?SSJ.l	!19.1	
.,Bm36	o.400	100.000	l.l	1.960	0.158	0	0	Bus4l	1.960	0.1SS	285,U	99.1	
"Bus37	0.400	100.000	1.1	1.960	0.ZSS	0	0	Bu,41	1.960	0.253	1853.l	!19.1	
"'Bn.s38	0.400	100.000	3.3	1.960	U18	!'	0	Bu<ll	1.960	0.378	lSS0.8	9S.1	
•BuQ9	0.400	100.000	''	1.960	0.378	0	0	Bu14?	1.960	0.378	lSSO.S	98.1	
*Bu'HO	0AQO	100.000	3.3	l.960	0.378	0	0	BuH1	1.960	0.378	lSSO,S	98.1	
Buı41	11.000	98.877	-1.Z	0	0	0	0	Bu-;12	7.786	0.71!	415.0	99.6	-1.sse
								Bu'34	-l.l>46	-0.178	103.8	99.6	
								Bu~S	-l.946	-0.178	103.S	99.6	
								Bu,36	-1.946	-0.178	103.8	99.6	

Prcjecr:	MASTER THESIS	ETAP	Pagt:	11
Location:	HOUN CITY -LIBYA	12.6.0H	Date:	28-06-2016
Contracn	NEAREAST UNIVERSID' - EEE Deparnnent		SN:	
Engin•er:	SAND I\WSTAFAAL-REI'Af		R~\ision:	Base
Filename:	HOUN Su1lSTATION 2lOkV	Study Case: LF	Coniig:	Nounal

DESIGN OF A LARGE SCA.LE SOLARPV SYSTEM AND IMPACT ANALYSIS OF ITS INTEGRATION INTOLIBYA.I'< POWER GRID

Bus		Voltage		Generation		Load		Load Flow					X:fMR
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	arw	1'.frar	Amp	%PF	%Tap
								Bu37	-1.946	.u.178	103.8	9M	
Bus42	11.000	98.6.10	I.O	0	0	0	0	Bnsll	5.S.18	0.$$7	314.3	98.9	~l.150
								Bu)S	-1.946	-0.296	1e1S	98./>	
								Bu~-'9	-1.946	-0.296	lOM	98.9'	
								Bw;~O	-1.946	~0.296	104.ll	98.9	

* ludicates a 1·olt:ı.gt<rtgubttd bes (\'~t:ı;r ro~'1J | or sning type m:u:hint' ecnuectedto it)

#fodiratts a bus nith a load mkmatch of mere th.ın0.1 .MYA

DESIGN OF A LARGE SCALE SOLARPV SYSTFM AND IMPACT ANALYSIS OF ITSINTEGRATIONI!\'TO LIBYA.'> POWER.GRID

Bus Loading Suınmarv**Renort**

Bus			Dinttly Connected Load								Total Bus Load			
			ConstantkYA		Com.tantZ		Comt.antI		Gtuttic					Ptl'(fUt
JD	kV	RAt,dAmp	MW	!\11-;ır	l\ffi'	MVar	XIW	Jı.frsır	MW	lıfrar	l\!VA	%PF	Aınp	Londiuç
Busl	210.000										o	0.0	0.0	
Bu'il	66.000		0	0	0	0	0	0	0	0	47.324	91.0	416.5	
Bısl	66.000		0	0	0	0	0	0	0	0	18.506	89.3	16),4	
Busl	2%0.000		o	0	0	0·	0	0	0	0	41.696	85.6	no.0	
BusS	ll0.000		0	0	0	0	0	0	0	0	13.195	81.l	M.6	
Ba'i6	11.000		0	0.~S	0	0.240	0	0	0	0	1,1,S;	0.0	6\$.9	
Bus7	66.000		0	0	0	0	0	0	0.	0	2.3\$.i	84.S	10.8	
Buss	66.000		0	0	0	0	0	0	0	0	8.3\$Q	83.1	73.8	
Bu'i!>	11.000		1.600	0.99.l	0.387	0.240	0	0	0	0	1.338	as.0	114.8	
Busl0	11.000		5.600	3.471	1.346	0.8.\.1	0	0	0	0	s.m	85.0	4n.s	
Bud!	66.000		0	0	0	0	0	o	0	0	5.857	99.4	51.7	
Busl;?	66.000		0	0	0	0	0	o	0	0	7,760	99.9	68.3	
B1td3	66.000		0	0	0	0	0	0	0	0	7.310	81.1	64.8	
Bud4	66.000		o	0	0	0	0	0	0	0	7.300	81.l	65.0	
Busl5	11.000		4.800	?.975	1.176.	0.729	0	o	0	o	7.030	85.0	J7Z.S	
Buı16	11.000		4.soo	l.975	1.166	O.?l?	0	0	0	0	7.018	85.0	373.7	
Busl7	66.000		0	0	0	0	0	0	0	0	13.814	97.6	nı.s	
BuslS	66.000		0	0	o	0	0	0	0	0	3.488	J00.0	30.8	
Busl.9	11.000		4.400	0	1.078	0	0	0	0	0	5A18	100.0	29M	
Bıs20	11,000		l.l!OO	0	o=	0	0	0	0	0	.l.484	100.0	185.0	
Busl!	66.000		0	0	0	0	0	o	0	0	6,745	97.8	59.5	
Busl2	11.000		4.800	0	1.169	0	0	0	0	0	~69	100.0	m.4	
Busl3	66.000		0	0	0	0	0	0	0	0	2365	8U	10.8	
BusZS	11.000		1.600	0.991	0.387	0.uo	0	0	0	0	2.337	85.0	124.7	
Busl?	66.000		0	0	0	0	0	o	0	0	19.871	98.1	17\$.4	
Bın28	11.000		?AOO	1.487	o.!'85	o.m	0	0	0	0	asn	85.0	186,7	
Bus29	11.000		uQO	1.487	0.585	0.36!	0	0	0	0	3.511	85.0	186.7	
Bus.10	66.000		0	0	0	0	0	o	0	0	13.400	su	118.7	
Bu.dl	66.000		0	0	0	0	0	0	0	0	6.006	SJ.6	S.\Z	
Busl!	11.000		8.800	5.455	U27	1.318	0	0	0	0	ll.856	as.0	686.ı	
Bus3l	11.000		4.000	:U79	l.OU	0.618	0	0	0	0	5.899	8S.O	307.S	
Bm.34	0.400		0	0	0	0	0	0	0	o	1.977	99.1	2a53,l	
Bus.IS	0.400		0	0	0	0	0	0	0	0	1.977	99.1	2853.l	
Busl6	0.400		0	0	0	0	0	0	0	0	1.977	99.l	2853.l	
Bum	0.400		0	o	o	0	0	0	0	0	l.m	99.1	1853,l	
Bus.IS	0.I00		0	0	0	0	0	0	0	0	1.996	98.?	ZSS0.8	

Bus			Directly Comected Load								Total Bus Load			
			Cous1:ıntkVA		ComtımtZ		Couıa:uı.tI		Generic					Percent
ID	kV	R>t«lAınp	MW	Mvar	MW	Mvar	:MW	l\frar	MW	Mvar	MVA	%FF	Aınp	Loadiıg
Bın39	MOO		0	0	0	0	0	0	0	0	1.9%	98.1	1880.8	
Bus40	o.400		0	0	0	0	0	0	0	0	*1.996*	98.?	2880.8	
Bu,H	11.000		0	0	0	0	0	0	0	0	1.Sl8	*99.6*	415.0	
Bus42	11.000		0	0	0	0	0	0	0	0	*5.906*	*98.9*	314_,	

ı Indir:ıtesopeNıtiugloadob burıex«etdıthebuş cdtk:ı,Jfüni(10(1.0%tıf11ıtCoutiuuoınAınptrt ı·ntlııi).

 # indicatesoptrnting lo:ld(ıf a bus eseeeds the bas marginallimlt (95.0%of fb(' Coutiuuon$Ampeı'trntiug).

Project:	i\U.SIER THESIS	ETAP	P;tg~: 1.f
Location:	HOUN CITY -LIBYA	12.6.0H	Date: 28-06-2016
Contract:	NEAR EAST UNIVERSITY - EEE Department		SN:
Engineel':	SAND MUSTAFA AL-BEEAI		Revision: Base
Filename:	HOUN SUBSTATION 220kV	Study Case: LF	Config: Nol'mal

DESIGN OF A L-\RGE SC..\LE SOLAR PV Si'S'TEM AND ThIPACT ANALYSIS OF ITS INTEGRATION INTO LIBYAN POWER GRID

13ra~çh LJla!ling Summary Rel.IoI'.t

CSr / Branch		Cable & Reacror			Transfonner				
						Loading (input)		Loading (output)	
ID	Iyp,	Ampacity (Amp)	Loo ding Amp	%	C•pabillty (MVAJ	M\'A	%	!ff A	%
Cabl,l	Cab!,	413.67	51.SO	II.23					
Cablel	Cnble	423.67	68.33	16.13					
Tl	Tr.amfor•mer·				t3.000	41.898	66.5	40.136	63.7
T.I	Tt-anı;for·mtr·				6MOO	13.195	20.9	12.990	20.6
T4	Trnmfor•m,1·				10.000	1.148	n.s	1.23S	12.4
TS	Tı,ınsforıne,ı•				20.000	2.354	11.8	2."8	11.7
T6	Iransforınl'l'				20.000	8.\80	41$	s.m	40.9
T7	Trnns:for-mN'				1?,500	5.906	47.1	5.851	46.9
TS	Tr·.a.nsforme-r				12.500	7.818	62.5	7.760	61.1
T9	Transfor·mtr·				10.000	7.310	73.1	7.030	70.3
r10	Tr·..a.ndol'mtt·				10.000	7.300	73.0	7.018	70-2
Ill	Traınformer•				20.000	5.488	27.4	5.418	1?..I
Il2	Tr·An~forme-r				10.000	3.488	17.4	3.484	17..1
Tl3	Trand'or·tne-r				10.000	6.000	60.0	5.%9	59.7
TU	Tr.:mı;forıntr•				10.000	2.•165	23.7	1.337	13.4
Tl6	Traısfermer				20.000	3.548	17.7	3.$11	IM
Tl7	Transformet·				?0.000	3.548	17.7	3.$11	17.6
TlS	TraUSCorner				20.000	13.400	67.0	l?.856	61.3
Tl9	Tr•:ınsf01•1ntr				?0.000	6.006	.l0.0	S.899	29.5
no	Trıns!or·mer·				.l.000	1.977	65.9	1.955	65.l
Ill	Tı:;uısforınu				:l.000	1.977	65.9	1.95..;	~.?
Ill	Trn.u')forıntr·				,\.000	1,977	65.9	1.95..;	65.1
rn	,Tr·aısformtr·				3.000	1.977	65.9	1.955	65.Z
T24	Tr':!nsformer·				3.000	1.996	66.5	l.969	65.6
rıs	Transformer·				3.000	1.996	66.5	1.%9	~.6
TM	Transfor·mer-				3.000	1.996	66.5	l.969	~.6

* Indii:att;S a branch trith <>ptrating load tx<"ttding the, brauc:h capability~

Br,,n~!ı. L<>sm fümıın~•T:R.e.ng rt

ClCT I Branch	From,.ToBuiFlon·		To.Fı·omBuıFlow		Losses		%Bus'Volt:ı.ge-		Yd % Drop
ID	l\!W	Mnu·	XI'W	J\frar	kW	kl'ar	I'u:-om	To	inVmag
Cable-:?	-7.754	-0.376	7.7!'4	0.306	O.I	-70.7	99.4	99.4	0.00
Lint>?	6.024	3.964	,snıı	-1.161	13.3	-m.ı	99.4	98.6	0.77
Llııt5	19:S..19	1.129	-19,499	-l.001	39.9	127.6	99.l	99.1	0.27
Lin,7	3.483	l.2?$	-3.m	-2.330	0.9	-5l.6	99.4	99.3	0:09
Llıı,9	3.483	2.278	~1.482	-2.330	0.9	..S.2.6	99.4	99.3	0.09
Lin,11	10.992	7.691	-10.973	-7.692	18.8	-0.6	99.4	98.S	o.60
Tl	-35.161	,ıs.ın	3$.84-1	ll.694	77,4	3482.1	99.4	J00.0	o.61
T4	0.001	l.Z48	0.000	-1.235	l.O	13.1	99.4	98.3	l.es
Cabid	-5.821	-0.725	5.8!1	0.6;.I	O.I	-70.3	9U	99.I	0.00
Lin,!	6.014	3.993	-MO!	-1.157	13.4	-163.9	99.l	98.l	0.84
Uıı,3	3.491	-0.248	-3.4S7	-0.062	3.7	~109.6	99.I	99.0	0.09
Lin,6	0.994	asıs	-0.994	-0.630	0.1	-57.4	99.1	99.0	O.Ol
UıttS	0.994	0.:73	-0.994	-0.630	O.l	-57.4	99.I	99.0	0.02
LintlO	5.027	3,200	-S.023	-3.:?9!	3.S	-92.3	99.1	98.8	0.26
T3	-10.700	-7.365	lo.708	7.711	7.7	345.4	99.l	100.0	0.94
TS	1.989	1.%60	-l.9S7	-1.2,Z	u	:?8.2	99.0	98.4	o.68
T6	6.964	4.661	-6.946	-1.305	17.8	,55.6	99.3	98.0	1,15
T7	,ssn	-0.654	5.838	0.SS7	17.9	232.8	99.l	98.6	O.l3
TS	-7.7!$1	-0.306	7.786	o.m	31.2	406.1	99.4	98,9	o.s1
T9	6.011	4.161	-5.975	-3.703	35.2	451.$	98.6	99.0	0.37
no	6.001	4.157	-5.965	-3.697	35.4	459.8	98.Z	98.6	0.34
Uııt4	-13.487	2.837	13.524	-2.826	37.;1	ıı.o	99.2	99.1	o.ıo,
Lintll	M09	-1.33.1	-6.597	1.104	ll.4	~2:?S.8	99.2	99.1	0.0l
Uıı,B	1.SSl	-1.657	-1.387	-0.656	4.6	-2313.2	99.1	99.5	0.35
TU	5.486	0.153	-5.478	0.000	7.6	152.9	99.2	99.0	e.ıs
TlZ	3.487	0.062	-3.484	0.000	3.1	62.0	99.0	98.9	o.ıo
Llıı,14	0.604	-1.409	-o.60;1	-0.62?	l.O	-2030.5	99.Z	99.S	0.:13
TlJ	5.991	0.304	-5.969	0.000	23.4	304.5	99.2	98.1	0.52
TU	1.990	l.Z78	-1.987	-1.231	3.6	47.0	99.5	98.4	1.18
Tl6	2.988	1.91,1	-2.984	-1.850	3.Z	64;0	99.l	98.1	0,42
Tl7	Z.98S	1.914	-2.984	-1.850	3.2	64.0	99.1	98.7	0.42
TlS	10.973	7.692	-10.927	-6.773	45.9	918.9	98.8	98.3	0.46
Tl9	5.023	3.292	-5.014	-3.108	9.Z	184,5	98.8	100.7	1.88
no	1.960	0.158	-1.946	-0.178	13-4	80..l	100.0	98.9	1.12
nı	1.960	0.258	-1.946	-0.178	13.4	80.3	J00.0	98.9	1.12

DESIGN OF A LARGE SCALE SOLAR PV SYSTEM AND IMPACT ANALYSIS OF ITS INTEGRATION INTO LIBYAN POWER GRID

Cl<ɪT/BrAnch	From-T0cBu\FJow		To-From Bus Flew		Losses		₀,⁄₀ Bus Volta.gt		Yd % Drop
ID	MW	I\frar	MW	Mvar	kW	kvar	From	To	inVm:ıg
T22	1.960	0.258	-1.946	-o.178	13.4	80.3	100.0	98.9	1.11
TI3	1.960	0.?58	.J.946	-o.178	13.4	S0.3	100.0	98.9	1.11
TI4	1.960	0.378	-1.946	.0.?96	13.6	Sl.9	100.0	98.6	ı.~7
ns	1.960	0,378	-1.946	.0.196	IM	81.9	100.0	98.6	1.37
TI6	1.960	0.378	-1.946	-M96	IM	81.9	100.0	98.6	1.37
					569.1	1586.S			

AJe¡:t Stnnmary Repol't

	% Aleı·t Settings	
	Critical	'Marginal
12ıı.!li!ll:..		
Bus	100.0	95.0
Cable	100.0	95.0
Reactor	100.0	95.0
Liıie	100.0	95.0
Tıııısfonntr	100.0	95.0
Panel	100.0	!IS.O
Pı'Otecth·eDelice	100.0	95.0
Generatoı·	100.0	95.0
Inveı1eıiCharger	100.0	95.0
Bus Voltage		
O\·erVoltag•	105.0	102.0
UnderVoltage	95.0	98.0
Generator Exdtntion		
O,·erfaclıed (Qıırax.)	J00.0	95.0
Undeı·facired (Q'Min.)	100.0	

SUMMARY OF TOTAL GENERATION, LOADING & DEM.4.ND

	MW	Jlfrıı·	MVA	%PF
Source (Sning Buses):	46.552	29.404	55.061	84.SS Lıgging
Source (Non-Swing Buses):	13.719	2.166	13.889	98.78 Lagging
Total Demand:	60.271	31,570	68.039	88.58 Lagging
Total 1fotor Load:	47.999	23.307	53.358	89.96 Lagging
Total Static Load:	ll.703	5.677	13.007	89.97 Lagging
Total Constant I Load:	0.000	0.000	0.000	
Total Geneıic Load;	0.000	0.000	0.000	
Apparent Losses:	0.569	2.587		
System 1ıflsıııotch:	0.000	0.000		

Number of Ireratıons; 3

APPENDIX6

SHORT .CIRCUIT ANALYSIS WITHOUT PV

Project:	MASTERTBI'SIS	ETAP 12.6.0H	Page:	1
Location:	HOUNCITY-LIBYA		Date:	28-06-2016
Contract:	NEAREAST tı"NIVERSITY-EEE Department		SN:	
Engineel':	SAı'\'D ?.fiJSTAFAAL-R.EFAI	Study Case: SC	R<lision:	Base
Filename:	HOtıN SUBSTATION220kV		Config:	Normal

DESIGNOF A LARGESC·\LE SOLARPV SYSTEMM'D IMPACT.ANALYSISOF ITS INTEGRATIONINTO LIBYANPOWER GRID

Eles;trical J'ran~ieut Amulyzer Program

.Short-Cirpuit Anah-sis Q\'jthout PY}.

1EC 60909 Standard
3-Phas<>Fault Currents

	Suing	V-Conn-ol	Load	Total
Nuıaber of Bum:	3	0	26	29

	XFl\IR2	XF1\IR3	Re-acror	Line!Cable	Impedance	Tkfl!	To!!ll
Number of Branches:	15	0	0	u	0	0	29

	Synchronous Geneı-a.tor	Power Gıid	Synchronous Motor	Induction ?.fachiues	Lumped Load	Total
Number of Machines:	0	3	0	0	13	16

System Frequency: 50.00Hz

Unit System: l\Ienir

Acljustuents

Tolerance	Apply Adjusıuıents	Indhidual /Global	P•*•ııt
Tı·ansfonner Impedance:	Vos	Indhid••l	
Reactor Impedance:	**Vts**	Indirida.I	
Overlead Heater Resistance:	No		
Transmission Line Length:	**No**		
Cable Length:	No		

Temperature Correction	Apply Adjushnenls	IndMdual /Global	_neg,.,,.C
Transmission Line Resistance:	**Yet**	IndiridUAI	
Cable Resistaıce:	Yr.s	Indi\idıw	

Bus Input pata

Bus					Initial Voltage	
ID	Typ•	Nom.kV	B»•k\'	$ub-$ys	%M'.ag.	Ang.
Bıı,l	l.o>d	66.000	6M75	1	99.Jl	..S.13
Bııı;::?	L•• d	(i(i.000	66.-11.\	I	98.85	-1.89
Bıı<3	SWNG	ll0.000	220.000	I	100.00	MO
Bu.-.t	SWNG	120.000	210.000	3	100.00	0.00
ButS	SWNG	ll0.000	ll0.000	I	100.00	0.00
Bıı,6	l.o>d	ll.000	11.413	I	98.07	~5.08
Bu,;7	Load	66.000	66.413	1	98.8.l	-1.91
Bıı.S	Load	66.000	68.47$	I	99.0.l	-5.19
Bu'i9	l.o>d	lLOOO	11.069	1	98.1$	~z..l,
B11dO	L•• d	ll.000	ll.SSS	I	97.77	-7.lO
Bu,13	Load	66.000	68.415	1	98.H	-5.61.
Bud4	Load	66.000	66.41;!	I	98.01	-:2..$2
Bu,15	Load	lLOOO	11.91?	I	98.69	..S.S.?
Bu,16	Load	11.000	11.553	?	98.H	.5.35
Bud7	Load	66.000	68.475	I	98.91	-6.80
Bu,18	Load	66.000	66.413	1	98.16	-1.16
Bıul9	Load	lLOOO	11.413	1	98.14	-8.41
Bu~20	Load	ll,000	11.069	2	98.66	.llS
But;ll	Load	66.000	68.47$	1	98.94	-7.46
Bus12	Load	11.000	11.413	1	98.42	-10.38
Bu,ZJ	Load	66.000	68.475	1	99.16	-1.89
Bu<2S	Load	lLOOO	11.413	1	98.08	,SSl
Bus17	Load	66.000	68.475	1	98.85	..S.S.l
Bu~18	Lo•d	11.000	1us.r	1	98.4:l	-6.69
Bu~29	Load	11.000	IUS4	I	98.43	-6.69
Bıu30	Load	66.000	68.415	1	98.!'Z	~ı:.49
Bu<3l	Load	66.000	66.413	Z	98.$9	-1.06
Bu.53?	Load	l!.000	11.840	1	98.04	-S.74
Bu'33	L•• d	lLOOO	ıus.ı	Z	100.46	-Ml

29Bu~Total

.'Ill voltag,. reported by ET.'IP • .-. üı %•f bm Nomi113l kY.
B= k\' ,..ıu,. efbuses •••••• ıtu1ated ond used lıtmı:lly by ET;'IP.

Line/Cable Input Data

Line/Cable ID	Library	Si:t	Length Adj.(m)	Length %Tot	#/!'hast	T(•C)	R	X	y
							Ohms or Siemens/1000m per Condn(tor (Cable) or per Phase (Line)		
Lluel		ô'/4	19.l00.0	0	I	15	0.05600	0.3N25	0.0000031
Lln,2		614	19300.0	0	1	15	0.05600	0.34207	0.0000034
Llu,3		674	23000.0	0	I	15	O.OS600	0.34207	0.0000034
tiu..ı		674	15000.0	0	I	75	0.05600	0.34207	0,0000034
LiueS		614	8000.0	0	I	75	0.05600	0.34207	0.0000034
Lin,6		614	4000.0	0	I	15	0.05600	0.34207	0.0000034
Llu,7		614	4000.0	0	1	15	0.05600	0.34201	0.0000034
ı.ıu,s		674	4000.0	0	I	15	0.05600	0.34207	0.0000034
Llu,9		674	4000.0	0	I	75	O.OS600	0.34207	0.0000034
Llue!O		674	8000.0	0	I	75	0.05600	0.34207	0.0000034
Llucll		674	8000.0	0	I	75	0.05600	0.34207	0.0000034
Liudl		614	21000.0	0	I	75	0.05600	0.34207	0.0000034
Liuel3		614	161000.0	0	I	75	0.05600	0.34207	0.0000034
].1Il,U		674	140000.0	0	I	75	0.05600	0..14207	0.0000034

Li.ur / Cablt resistances **are li~tcd at fht spttifitd** ttmpti'iafW'tS.

2-\Viudiııo; Transfol'ıner Input pata

Transfermer	R.1ttng					ZVaııation			%TnpSetdng		Adjusted
ID	lll\'A	Pıiın.kV	S~.kV	%Z	XIR	H~~	,5%	%Tol.	Priıı.	Ste.	%Z
Tl	63.000	2?0.000	~000	12.50	45.00	0	0	0	0	J.150	ı:t5000
T3	63.000	ll0.000	66.000	12.50	45.00	0	0	0	0	MlS	**12.5000**
T.ı	10.000	66.000	11.000	8.35	IMO	0	0	0	0	0	8.3500
TS	l0.000	66.000	11000	10.00	l0.00	0	0	0	0	0	10.0000
rs	10.000	66.000	ll.000	10.00	20.00	0	0	0	0	l.ZSO	10.0000
T9	10.000	66.000	11000	8.35	13.00	0	0	0	0	4.375	8.3500
TIO	10.000	66.000	11.000	8.35	13.00	0	0	0	0	4.375	8.3500
Tll	l0.000	66.000	11.000	10.00	10.00	0	0	0	0	0	10.0000
TU	!0.000	66.000	ILOOO	10.00	20.00	0	0	0	0	0	10.0000
TIJ	10.000	66.000	11.000	8.35	13.00	0	0	0	0	0	8.3500
TU	10.000	66.000	11.000	8.35	13.00	0	0	0	0	0	8.3500
Tl6	?0.000	66.000	11.000	10.00	20.00	0	0	0	0	0.625	10.0000
Tl7	20.000	66.000	11.000	10.00	20.00	0	0	0	0	M25	10.0000
TIS	20.000	66.000	ll.000	10.00	20.00	0	0	0	0	3.750	10.0000
Tl9	10.000	66.000	11.000	10.00	20.00	0	0	0	0	3.150	10.0000

Brall'r.fr'Collıtediops

ClCT/Brnn<h		Connette(! Bus ID		% Impedance, Pos. Seq., 100 MVAb			
ID	Type	Froııılfoi	T•Bus	R	X	Z	Y
Tl	2WXIIIR	Bus3	Busl	M3	IY.l8	19.29	
T3	lWXFMR	Buç!i	But?	0.-13	19.?8	19.29	
T4	zwxnm	Bu,l	Bu,6	Ml	16.98	77.Zl	
TS	lWXfMR	Bu,7	Bus9	1.43	48.62	48.@.l	
T6	lWXFlılR	Buı8	Bu\10	l.29	4S.14	4!'.80	
T9	lWXFMR	Bu,13	Bu,15	S.91	16.98	77.ll	
TlO	2WXFMR	Busl4	Bu,16	6.30	BU.I	SZ.08	
Tl!	lWXFMR	Buıl7	Bu,19	2,1.9	45.74	4S.S0	
Tl?	2WXFMR	BuslS	Bıi'.20	Z.43	48.6?	48.69	
TU	lWXfAIR	Busll	Bu,22	S.92	76.98	77.21	
TU	lWXFMR	Busl3	Bu,;15	5.92	76.98	77.U	
Tl6	lWXFlılR	Bus27	Bii,ZS	l.19	45.74	45.80	
Tl7	lWXFMR	Bu,27	Burı:29	Z,29	45.74	45.80	
TIS	1,vxnm	Bus30	Bus32	W	45.74	45.80	
Tl9	lWXFMR	Bu'31	Bus33	ı..13	48.62	48.69	
Lind	Lin,	Buıl	Bu,14	Z..IS	16.38	16.56	
LintZ	Lint	Bu,l	Buıl3	1.31	U.08	14.27	
Lin,3	Lint'	Busl	BuslS	2.92	17.8-1	18.08	
Llnt4	Lln,	Busl?	Bu,17	1.79	10.94	11.09	
I.in,5	Lin,	Busl	Busl?	0.96	5.8-1	'.91	
Liııt6	Lin•	Bu~	Bu>7	O.Si	3.10	3.14	
Line?	Lin•	Bml	Bu,S	0.48	2.91	2.96	
Lin,8	Line	Bu,2	Bu,7	0,51	3.10	3.14	
Lln,9	I.înt	Bu,l	Buı;S	o.-18	2.92	1.96	
LlndO	Line	Bu1r.?	Bus31	1.02	6.20	6.29	
Llndl	I.în,	Busl	Bu,30	0.96	S.84	5.91	
Llndl	Line	Bu,17	Bu,21	2.51	15.32	15.52	
Liud3	Lin•	Bu,17	Bu,23	19.?3	111.-16	119.0Z	
LlntU	Lin•	Bu,21	Buı23	16.?1	102.u	103.50	

power Gl'jd Input Data

Poweı·Gıid ID	Connected Bus ID	Rating JıffAsc;	Rating kV	% Impedance 100 l\IVABase R	% Impedance 100 l\IVABase X"	RIX
ın	Bu,J	22.101	**Zl0.000**	**45.02233**	**.fS0.2?330**	e.10
U2	B...1	22.101	220.000	4$.02nl	4$0.22330	aıe
U3	Bu,5	2ı.ıo1	220.000	45.022.13	4ro.zmo	0.10

Totafc.iiiı«iidP<>Ir.rGrldı(.;;3ii i;şjjjjl\IVA

:ı..umpeıl Load Input Data

Lumped Lead								Motol'Loads					
Lumped Load	Couaecred Bus	R.ıling				%Load		Loading		o;· ·Jmpe<lanct Machine Base			mFact.
ID	m	kVA	kV	Amp	%PF	MTR	STAT	kW	mr	R	X"	RIX"	MW/PP
Lumpl	**BU:rti**	1UU	11.000	65.25	0.0l	80	IO	0.1	*994.6*	**:t?S**	1S;n	e.1S	0.00
LuınpZ	Ba'9	**l3S3.S**	11.000	**1:23.53**	8!,.00	80	10	1600.4	991.S	l.S3	1$.31	0.10	1.60
Lomp3	Bu,ıo·	*sm.1*	11.000	**431,26**	85.00	80	:20	5600,0	3471.l	l.S3	**1S.S1**	e.1e	5.60
Lump4	**Bns:15**	7058.4	11.000	370.4?	85.00	S0	20	4799.7	2974.6	**1.SS**	1$.31	0.10	4.00
LumpS	Bu,16	7058.4	il.ODO	370.47	85.00	80	20	479?.7	2974.6	1.53	1S,31	o.ıo	4.00
Lump6	Buü9	SS00.0	11.000	288.68	100.00	80	20	4400.0	0.0	1.$3	15.31	0.10	4.40
Lump7	**Bu,;,20**	.1500.0	11.000	183.70	100.00	80	20	2800.0	0.0	L!'3	15,31	0.10	Z.80
LumpS	**Bual**	6000.0	11.000	314.91	100.00	80	IO	4800.0	0.0	L53	15.31	0.10	4.80
Lump.O	Bu;25	*2351.4*	11.000	123.4?	85.00	00	20	1S99.6	*99U*	LS3	1$.31	0.10	1.60
Luınpll	Bu'28	**3519-Z**	11.000	m.ZJ	SS.00	80	20	2399.8	1487.3	**1.SS**	15.31	0.10	2.40
Lumpl?	Bu'29	**3$29.l**	11.000	185.13	SS.00	S0	IO	**l.\99.S**	1,187.3	1.$3	**1S.S1**	O.JO	1.40
Lumpl3	**Bu.$3.l**	12941.9	11.000	679.17	85.00	80	10	8800,0	5454.8	LS3	15.31	0.10	8.80
Lumpl4	BwJ;I	**$882.$**	11.000	30B.7S	85.00	60	10	4000.0	*1419.2*	1.53	**1SS1**	0.10	4.00

Toı.l ConntcttdLump,d L«ıds (• 13), 69184.3 kYA

SHORT-CIRCUIT REPORT QVithont PV)

3-Phase fault at bus: Busl

Nominal kV	=	66.000	
Voltage c Factor	=	uo	(User-Defined)
Peak Value	=	S.352	kA MethodC
Steady *State*	=	0.173	kAnns

Contribution		Voltage & Initial Symmetrical Current (rms)				
From Bus m	ToBu, m	%V Fl'oinBus	kA ~~~~	kA	X'R	kA
Bn,I	Total	0.00	**0.211**	-2.151	10.2	t.161
Bu'13	Biisl	4.41	0.027	**-0.175**	10.3	0.176
Bus?7	Busl	5.37	0.08.l	-0.807	9.7	o.su
Bu.S	Busl	0.57	0.016	.0,172	10.9	0.17.1
Bu.S	Busl	0.57	0.016	-U72	10.9	0.17.1
BuS,O	Busl	J,29	0.044	*.0.495*	11.!	0.497
Bu.J	Busl	3.60	0.017	.0.172	10.3	0.173
Bus6	Bud	5.10	0.009	.0.058	*6.8*	*0.059*
Bu,JS	Bu'13	29.48	0.027	.0.275	10.3	0.276
Bu'17	Busl7	11.58	0.052	.0.498	9.5	0.501
Bu,28	**Bus27**	1.1..17	0.015	.0.154	IO.I	0.155
Bus29	Bu,27	13.37	0.015	-0.154	10.1	e.ISS
Busl0	BusS	18.49	0.031	-0.344	10.9	0.3-15
Bus3l	Bus30	29.80	0.044	.0.495	n.1	0,.197
U1	Bu.J	*96.39*	0.005	-0.054	10.3	0.054
Lumpl	Bus6	100.00	0.051	.0.351	6.8	0.354

Breal;in° and pc Fault Current !!<Al

Bastd on Tohıl Bus Fault Currtnt

TD (S)	lb sym	lbasym	Ide
0.0l	**Z.0.W**	3.029	**2.249**
0.0Z	*1.996*	*2.595*	1.658
0.03	1.960	2.309	**1.221**
0.04	ısn	2.m	6.900
0.0S	1.837	1,954	*0.666*
0.06	1.784	1.850	o.~91
0.07	1.m	1.759	0.362
0.0S	1.657	1.678	0.167

(Cont.)

3-Phase fault at bus: Busl

Nominal kV	=	66.000	
Volıag• c Factor	=	1.10	(User-D•fined)
Peak Value	=	5.352	kA l\IEtbod C
StMdyState	=	0.173	kAı-ms

Bı-enkiııı; and DC Fault Cnıı-eat !Mel

Based on Tota! Bus Fault Cuınnt

TD(S)	l\şym	**lbasym**	Id,
0.09	1.59-1	1.606	0.197
0.l0	1.531	1.539	0.147
OJ5	1.388	1.389	0.032
0.lO	1.250	1.250	0.007
0.25	**1.11S**	**1.11S**	0.001
0.JO	1.106	1.106	0.000

3-Phase fault nt bus: Busl

Nominal kV	=	66.000	
Voltage c Factor	=	1.10	(User-Defined)
Peak Value	=	2.464	kA l\fethodC
Steady State	=	0.184	M.nus

Connibution		Voltage & Initial Syımnenicnl Current (rms)				
From.Bus ID	**To Bus** JD	%V	kA	kA Inıagiuary	XIR	kA
Bu~2	Total	o.oo	0.095	-0.989	10.4	0.993
Bınl~	**Busl**	4.79	**0.027**	-0.274	10.3	0.275
Bu,18	**Bus?**	**2.97**	**0.015**	**~0.155**	**10.1**	0.156
Bıu7	**BusZ**	e.ıs	**0.005**	-0.0SS	10.3	0.055
Bus7	**Bm2**	0.18	**0.005**	-0.055	10.3	**0.055**
Bus.ll	Busl	1.77	**0.025**	.0.167	IM	O.l68
Buas5	Busl	3.71	0.018	-O.IS.I	10.3	o.1s.ı
Busl6	Bııs14	29.78	0.017	-0.174	10.3	0.275
Bu,20	BusIS	10.94	0.015	**..0.155**	10.?	0.156
Bu,9	Bus7	5.86	O.Oil	,e.ne	10.3	e.ııı
BusJ3	Bus31	16.06	0.015	-0.'767	10.6	0.168
us	BusS	99.38	0.005	-0.055	10.3	0.055

!l!'t•l;!na anı! DC !;)ult Current (!;ıl,l

Bast~ oı:ı. lo,hıl Bus fa.ult Currtııt

TD(S)	**Ibsym**	Ib asym	Ide
0.Ol	0,952	1.408	1.038
O.Ol	0.!137	1.211	0.767
0.03	0.910	1.0S0	0.566
0.04	0.894	0.987	0,418
0.05	0.848	o.902	0.309
0,06	0,817	0.849	0.128
0.07	0.788	0.806	0.169
0.08	0.759	0.769	e.ııs
0.09	0.730	0.736	0.092
0.10	0.701	0.70!'	0.008
e.ıs	0.638	0.638	0.015
0.z0	0-$77	0.577	0.003
0.25	0,$18	0.518	0.001
0.30	o.m	0.51%	0.000

3-Plıas, fault at bus: Bus9

NoıninalkV	=	11.000	
Voltage c Factor	=	1.10	(User-Defined)
Peak Value	=	10.860	kA MethodC
Steady State	=	1.005	kAıms

Contribution		Voltage & Initial Symmetıicat Current (rms)				
FromBus ID	To Bus ID	%V	kA	kA	XIR	kA
BusY	Total	0.00	0.368	..l.m	11.7	4.318
Bu~7	Bus!>ı	30.83	0.Z91	-3.$99	1l.1	3.611
Luınpl	Bus!>	100.00	0.010	-0.70.l	10.0	0.70?
Bus1	**Bus7**	31.8%	0.025	-0.300	n.1	0.301
Busl	Bu.~7	31.82	**0.025**	.j),300	1Z.1	0.301

BrE>akina and l!(fault CUl'l'flli ~;\)
Bastd on Tetel **Bus Fault** Current

TD($)	Th,ym	Ib:asym	Id<
0.0l	4.%09	6.2S6	4.669
0.0l	4.173	5.494	3.514
0.03	4.131	4.!154	Z.134
0.04	4.038	4.<.!S	**2,092**
0.05	3.SSO	4.199	1.605
0.06	3.780	3.!175	**l.l.?9**
0.07	3.682	3.800	0.941
0.0S	3.584	3.655	0.720
0.09	3.487	3.530	o.551
0.l0	3.392	3.418	0.424
e.ıs	3.167	3.169	o.m
0.10	2.!148	**Z,948**	0.029
0.25	2,736	**1,736**	0.008
0.30	**:.1.w**	**2.1:0**	**0.00?**

3-Plıase fault at bus: BuslO

NomjualkV	=	11.000	
Voltage c Factor	=	1.10	(User-Defıned)
Peak Value	=	19.898	kA l\IetbodC
Steadr State	=	0.927	kAnns

Contribution		Voltage & Initial S)'mmeniral Current ()ıns)				
FromBu, ID	To Bu, ID	%\" FromB~ ~	M.	kA .lın.agiuat}' ~,	XiR	le-\ 1'faguitudt
Bu,10	Toıa:1	0.00	Mtil	-1.868	11.9	7.896
Bu,i	Bu,10	46.89	MlS	-MOS	I.I.O	5Al4
Lump3	B11'10	100.00	O.Z46	-l.460	10.0	z.m
Bud	B..S	48.39	0.0~	--0.456	13.0	0-458
Bud	Btı:s8	48.39	0.03$	--0.456	13.0	0.4S8

Bu,ıl;inı;; ıı.ıd I:!£ f•!!lt CwT•Dt (!!Al

BasNlon Total Bus Fault Cumnt

TD(ŞJ	Ib~ın	Ib~~'lll	Id<
0.0l	7.6?1	n.sse	8.58-1
0.02	1,552	10.0~	**6.6ll**
0.03	,..m	9.o46	S.099
0.04	7.367	uıs	3.926
0.0S	1.llO	zası	3.056
0.06	7.047	7.-1.ll	Z•.159
0.07	6.889	r.ııs	ı.sıe
0.08	6.716	6.861	uo.ı;
0.09	6.W	6.633	J.084
0.10	6.315	U.I?	0.855
e.ıs	5.915	5.980	0.Z.17
0.10	5,586	5.SS6	0.065
0.25	5.?0S	S.208	0.018
0.30	S.180	5.180	0.005

Shoıt-Cfrc.uit Suınnı:uy fuport QVitlıout PV)

3-Pbase Fault Currents

Bus		Dt\ict		Deıice C•pndıy (kA)				Shoıt-Circuit Current (kA)		
ID	kV	ID	Type-	M:,kiug Ptak	Ilı sym	Ib nsyın.	Ide	1~-.-ip--	lb~ym	Ibasym~~
Bud	66.000	Busl	Bus					ı.161	~.~52	0,173
Bus2	66.(100	Bus'Z	Bn,					0.993	1.46-1	o.1S4
Bus9.	11.0-00	Bu'9	Bus					4.318	10.8@	1.005
Busl 0	!MOO	Busto	Bus					1.s%	1.M9S	0.9I7

ip is tnlculatcd using metbocl C
Ib does not iııdudt d,c:ıy of :uQD~ttrmiaalfııı:dttdüıdwıdion moton
Ik ii; tht maximum ~t,.Rdy st;de&ult tnn'fltt
Ide is based on XIR (rom Method C and lb a': ~cifi:ed abon

LV CB duty dtttnnintd ba~d on sersiee nı:ting,
Totnl through eurreııt is uu;d for de'\itt duty.
• Indicates a deviee uith calculartd duty tıettding tht dnic-t c-ap.abiliry.
#indkAtts a dedee uith ukubttd duty ~rittding tht dnict wrgiııa:J limit. (9$ % dmts dedce tnpabillty)

APPENDIX7

SHORT CIRCUIT ANALYSIS WITH PV

Project;	l\IASIER IJn:.'SIS	ETAP	Page:	1
Lecanòıı:	HOUN GIT-LIBYA	12.6 .0H	Date:	28--06-2016
Contract:	l\'EAR EAST Ul\TI'ERSilY • EEE Deparnneııt		SN:	
Engiıı •• r:	SA,'ID l\IUSTAFAAL-REFAI	StudyCase; SC	~\ision:	Base
Filename:	HOllN SUBSTATION 220kY		Config:	**Normal**

DESIGN OF A LARGE SCALESOLARPV SYSIEl\I AND IlılPACT ANALYSIS OF ITS L'?IEGRATION INTO LIBYA .ııPOWER GRID

Elechica)Transient Anah·zer f.l'ograı~

Shoıt-Cimıit Anah-sis QVitlıPV)

IEC 60909 Standard
3-Phase F;.ult Currents

	S"ing	V-Gontrol	Load	Total
Number of Buses:	3	7	30	40

	XFl\IR2	XFJI[R3	Reactor	Line/Cable	Iınnedıuıce	Tie PD	Toffil
Number of Branches:	24	0	0	16	0	0	40

	Synchl'OUOUS Generator	Powel' Grid	Syuchı-onous lıfot-01	Induction Illachiues	Lumped Load	Total
Number of Machines:	0	3	0	0	13	16

System Frequency: 50.00Hı

Unit ı;,~tem: l\Iehic

Adjustments

Tolerance	Apply Adjustments	Indhidual /Global	Percent
Transformer Impedance:	Ves	Iıdhidu:ıl	
Reactor Impedance:	**Yes**	IıdMdu.,J	
Overload Heater Resistance:	**No**		
Transmission Line Lenglh:	No		
Cable Length:	No		

Temperatw·• Con·ection	Apply Adj~	Individual /Global	~eec
Transmission *Line* Resistance:	Yes	Indhidual	
Cable Resistance:	·re-s	Indhidıııl	

Bus Input Data

Bus					Initial Voltage	
ID	Typ•	Noın.kV	B:ı.sf!ok\~	Sub-sys	%!tag.	Ang.
Bu,l	Load	66.000	68.415	1	99.39	-4.20
Bu'i1	Load	66.000	66.413	2	99.06	-1.IZ
Bu'3	SWNG	220.000	??0.000	1	100.00	0.00
Bu,4	SW:NG	220.000	Z?0.000	3	100.00	0.00
Bu'iS	SWNG	220.000	220.000	2	100.00	0.00
Bu«>5	Load	11.000	11.413	1	98.34	...l.lS
Bııs7	Load	66.000	66.413	2	99.04	-l.23
Bu,Ş	Lead	66.000	68.47$	1	99..10	-4.26
Bu'9	Load	11.000	ll.069	?	98..16	-1.80
BııslO	Load	11.000	1l.S55	I	98.0S	..6.26
Bu,11	Load	66.000	66.413	2	9M6	-U2
Bud:?	Load	66.000	68,,175	I	99.39	-4.20
Bu,13	Lo•d	66,000	68.475	1	98.62	-4.67
BusH	Lo:ıd	66.000	66,,113	2	98.21	-1.74
Bıı,15	Lo:ıd	11.000	11.912	1	98.98	-7.SS
Bu,16	Lo>d	11.000	11,553	2	98.S:	-4.67
Bınl7	Load	66.000	68.475	1	99.19	-5.86
BudS	Lo>d	66,000	66,,113	2	98.91	-l.S9
Bu,19	Lo•d	11.000	11.413	1	99.02	-7.46
Bn,20	ü»d	11.000	ll.069	2	98.87	-?.61
Bu,21	Lead	66,000	68.475	l	99.22	~6.S2
Buti:ı?	Load	11.000	11.413	1	98.70	-9.43
Bu,23	Load	66.000	68.475	l	99.$4	..6.94
Bu,25	I,,.d	11.000	11.413	1	98..16	-7.87
Bu,27	L»d	66.000	68.475	1	9U2	-4.91
Bus28	Load	11.000	11.484	1	98.70	-S.76
Buı?9	L»d	11.000	ll..lS,	1	98.70	-5.76
Bın30	Lo.ıd	66.000	68.475	1	98.19	-4.56
Bu'-11	Load	66.000	66.413	2	98.80	-l.38
Bıı'3?	Load	11.000	11.840	l	98..IJ	-1.19
Bus.33	L»d	11.000	1US4	I	lOo.68	·2.83.
Bu'34	C"'.	0.400	6.410	1	0.00	1.05
Bu'3S	G.n.	o.400	0.410	1	0.00	1.05
Bu'36	C.•.	0,400	MIO	1	0.00	I.OS
Bu,37	G.n.	0..100	0.410	1	0.00	l.es

DESIGN OF A LARGE SCALE SOLAR PY SYSTE.M A.1\1> IMPACT ANALYSIS ôFITS INTEGRATION INTO LJBYAN POWER GRID

Bus					Initial Voltage	
m	Typ,	Norn.kV	Ba.,;t-l;:Y	Sub-,ı~	%Mag.	Ang.
Bu'38	0...	0..l00	0.,1l,7	z	MO	3.28
Bu,39	l;:,•.	0.400	0.m	,2	0.00	.l.?S
Bu,40	C.n.	MOO	0.397	2	0.00	3.28
Buwl	Load	11.000	11.270	1	*98.88*	-1.13
Bu~:42	Load	11.000	10.930	?	98.63	1.01

40BumToıal

All ,·oltagtt rtporıtd by ETAP Art in % or bu, Nomiıuil kV.
Bın kV values erbuses **art cakufattd and U'Stdinttmally by ETAP.**

Line/Cable Input Data

Lino/Cable			lıugıh				Ohms or Siemens/1000 m per Conducror' (Cable) or per Phase (Line)		
ID	Library	Size	Adj.(ın)	%Tot.	#/Phııs.	T(•G')	R	X	y
Ca1ıı.l	llMCUS3	300	100.0	0	I	15	0.07630	0.08740	0.0001646
CabJeZ	1L\!CUS3	.100	100.0	0	1	15	0.076.10	0.08740	0.00016-16
Llıı.tl		674	19300.0	0	I	15	0.05600	O.J7J?5	0.00000.ıı
Lint2		614	19300.0	0	I	15	0.05600	0.34?07	0.00000-\4
Llı.,3		674	23000.0	0	I	15	0.05600	O.J4?07	iı.00000.IJ
Llı.'4		67J	15000.0	0	1	15	0.05600	0.3Jl07	0.00000.IJ
Lin,s		674	8000.0	0	1	75	0.05600	0.3U07	0,1)0\0034
Lint6		674	4000.0	0	I	15	O.OS600	O..lJ?07	0.0000034
Lint?		674	4000.0	0	1	15	0.05600	0.34107	0.00000.IJ
Llı.,8		674	4000.0	0	1	15	0.05600	0.14107	0.0000034
Llı.,9		674	4000-0	0	1	75	0.05600	0.34107	0.0000034
Llıı.eJO		674	8000.0	0	1	15	0.05600	0..lJ?07	0.0000034
Llıı.dl		674	8000.0	0	I	15	0.056~0	0.34207	0.0000034
Lint.tlZ		674	Zl000.0	0	I	75	0.05600	0.34107	0.0000034
Llıı.tU		674	161000.0	0	1	;5	O.OS600	0..lJ?07	0.00000.IJ
Llıı.dJ		674	140000,0	0	1	75	O.OS600	0.34?07	0.0000034

Linc I Cable resistsnces are **llsttd at the sptdfitd** temperatures,

2-Winding TransformerIunut D:ıta

Transformer	Rating					Z Variation			% Tap Setting		Adjuste<~.
ID	M\'A	Pl'ii,,;kV	S,c.k\"	%Z	XIR	+5%	-5%	%Tol	Prim..	S«.	%Z
Tl	63.000	I?0.000	6MOO	12,50	45,00	0	0	0	0	:1,750	11.5000
T3	6.1.000	220.000	66.000	12.SO	4MO	0	0	0	0	O.ili	12.5000
T4	10.000	6MOO	11.000	8.35	13.00	0	0	0	0	0	8,3500
T5	20.000	66.000	11.000	10.00	10.00	0	0	0	0	0	1-0.0000
T6	20.000	66.000	11.000	10.00	20.00	0	0	0	0	1.25-0	10.0000
T7	1%.SOO	11.000	66.000	8.35	13,00	0	0	0	-1.%50	0	8.3500
TS	12.500	11.000	60.000	s.35	13.oo	o	o	o	-1.1se	o	8.3500
T9	10.000	66.ooo	ıuoo	s.ıs	13.00	o	o	o	o	u1s	8.3500
TIO	10.000	66.000	lLOOO	8.35	1.1.00	0	0	0	0	4.375	8,3500
Tl!	20.000	66.000	11.000	10.00	20.00	0	0	0	0	0	10.0000
TU	20.000	66.000	11.000	10.00	20.00	0	0	o	0	0	10.0000
!13	10.000	66.000	lLOOO	8.35	13.00	0	0	0	0	0	8.3500
TU	10.000	66.000	11.000	8.35	U.00	0	0	0	0	0	8.\SOO
Tl6	l0.000	66.000	11.000	10.00	20.00	0	0	0	0	asıs	10.0000
Tl7	10.000	66.000	11.000	10.00	l0.0.0	0	0	0	0	0.625	10.0000
Tl8	10.000	66.000	11.000	10.00	20.00	0	0	0	0	3.750	10.0000
Tl9	20.000	66.000	1l,000	10.00	20.00	0	0	0	0	J.750	10.0000
no	3.000	0..ıoo	11.000	6.2s	6.00	o	o	o	o	o	M5oo
rn	.ı.doo	0.4oo	11.000	6.1s	G.oo	o	o	o	o	o	6.2soo
rn	3.000	0..ıoo	11.000	6.2s	6.00	o	o	o	o	o	6.?500
rıs	3.ooo	0.400	11.ooo	6.1s	6.oo	o	o	o	o	o	MSOO
TI4	3.000	0.400	l!.000	6.25	6.00	0	0	0	0	0	6.1500
rıs	J.ooo	0.400	11.000	6.2s	Mo	o	o	o	o	o	6.1500
Il6	J.000	6.400	11.000	6.25	6.00	0	0	0	0	0	6.2500

Bı:3nch Connections

Ch.ı/Branch		Connected Bus ID		o/o Imped.ınce, Pos. Seq., 100 MV Ab		
ID	Typt	From Bus	To Bus	R	X	Z
Tl	2\VXFMR	Bud	Bml	0-43	19.?S	19.29
n	2\Vlin!R	Bu,;-	Busl	0.43	19.?8	19,29
T4	zwxn.m	Bud	Bus6'	S.92	76.98	77.21
TS	?WlinlR	Bu,7	Bu,;9	1.43	48.62	4S.69
T6	l\VXFl,IR	Bu,8	BuslC	2.29	4S.74	45.80
T7	lWXFMR	Bu,42	Bud!	5.04	6SA7	65.66
TS	2Wlin!R	Bu,41	Bu.dl	4.74	61$8	61.77
T9	ZWXFMR	Bn,13	Busl':	S.9!	76.98	77.11
TIO	11\'XFAIR	BnsH	Bml6	6.30	81.84	82.08
TU	?WXFMR	Bu<ıl7	Bud9	2.?9	45,74	40.80
TiZ	2\VXFAIR	Bud8	Bu,;?0	2.43	48.62	48.69
TIJ	lWXF!ılR	Btnll	Bus22	5.91	76.98	77.21
TU	?WXFI.IR	Busl3	Bus25	S.92	76.98	77.21
Tl6	lWXFAIR	Bn,;l7	Bus?S	Z.19	45.74	4S.80
Tl7	lWXIllR	Bus27	Bın?9	2.29	45.74	4S.SO
TIS	ZWXF1ılR	Bus30	Bu'32	2.19	45.74	45.80
Tl9	?WXFAIR	Bu,31	Buç.»3	UI	48.62	48.69
no	2\VXIllR	Bu<ıl3.t	Bns41	31.39	188.32	190$2
TU	ıwxnm	Bu.JS	Bm4l	31.39	188.32	190.92
T:?2	lWXFAIR	Bu,36	Bm41	31.39	188.32	190.t.?
T23	lWX'fhlR	Bus31	Bus41	31.39	188.32	190.92
T24	ıwxnm	Bu,38	Bu.'>41	33.37	100.20	202.%
T25	lWXF!ılR	Bu,39	Bus42	33.37	200.20	201..96
T26	2WXFAIR	Bın..ıo	Bus42	33.37	200.20	20?.%
Cobı.l	C•bl•	Bndl	Busl	0.02	0.'12	0.03
Cablt2	Cobl,	BusiZ	Bıı,l	O.Cl	O.Cl	0.0!
Lind	Lint	Busl	BusU	1.45	16.38	16.56
Liue2	Unc	Busl	Bud}	2.31	U.08	U.17
Unt-3	Un,	Bu'l:?	Bud8	2.92	17.84	18.08
i.ıu..ı	Lin,	Bu,;27	Bnd7	1.79	10.94	Il,09
LiueS	Lin,	Bud	Bu,27	0.96	5.84	5.91
Lin•6	Line	Busl	Bus:7	0.51	3.10	3.14
Lin,7	Lin,	Bud	Bu.S	6.48	2.91:	2.96
Lln,8	Lin,	Bu52	Bu,7	0.51	$.10	3.14
Uıı,9	Line	Bud	Bu.S	6.48	2.92	2.96
Lind 0	Lin•	Bud	Bu.JI	I.OI	6.20	6.29
Lindi	Lin•	Bu,l	Bıu30	0.96	5.84	S.91

CKI/Brandı		**Connected Bus ID**		% Iıapedauce, Pos. Seq., 100 MVAb		
ID	I)p,	Frem Bus	**To Bus**	R	X	Z
Lint12	Lin,	Bıı,17	Buıll	asl	lS.ll	lS.Sl
L!n,!J	Lin,	Bu,17	**But23**	**19.Z.**	ll7A6	ll9.02
Lind.ı!	Lin,	Buı;;ll	Bu,23	16.7!	m.u	10..1.50

power Gıidippnt Data

PowerGıid	Connected Bus	Rating		% Impedance 100 l\IVA Base		
ID	ID	MYAsc	k\"	R	X"	RIX
U1	Bu,3	n.101	z10.000	4;.ozm	4;o.1z330	0.10
U1	Bu,4	1l.101	220.000	45.021J3	4$0.22330	0.10
U3	Buss	21.101	220.000	4$.02Z.I3	4$0.2?330	0.10

Total CowıectedPowtr Grids (=3): 66.303 MVA

Pl'oject:	i\USTER IRES~	ETAP	P•ge:	10
Location:	HOUNCfIT -LIBYA	12.o.OH	Date:	28-06-1016
Contrncn	l\'EAREASTlı'l\'lVERSilY-EEEDepartıneııt		SN:	
Engineer:	SANDMUSTAFAAL-REFAI	Study Case: SC	Rerislon:	Base
Filename:	HOUNSUBSTATION220kV		Config:	Noımal

DESIGNOF A LARGE SCALESOLARPV S\'STEJ\1ANDiı\IPAC:l' ANALYSISOr ITS)NTEGR..-)..:rIONlı'ffOLlll'l!ANPO'\l'ERGRID

Luınpeıl Load lııpııt Data

Lumped Load								Motoı Loads					
Lumped Load	Connected Bus	Rating				% Load		Loading		% lınped.,u<t l\lachine Base			m Facı.
ID	ID	k\:~	kV	Amp	% Pf	MTR	STAT	kW	b-.r	R	X"	JlJX"	MW/PP
Lump!	Bıi'6	12-13.l	11.000	6S.25	0.0l	80	20	0.1	99J.6	1.?S	!S.21	0.15	0.00
Luınp2	Bıı9	llSJ,S	11,000	ıas.ss	85,00	80	IO	1600.4	991.8	1.$3	15.31	MO	1.60
Lump3	BnılO	823S.7	11,000	432.16	85.00	80	IO	5600.0	.3471.1	1.$3	15:31	0.10	S.60
Lıınp4	Bu,lS	70S8.4	11.000	370.47	85.00	80	IO	4799.7	l97J.6	LS.\	lS:31	0.JO	4.80
Lump5	Bu,16	7058.4	11.000	370.47	85.00	80	20	4799.7	l!n4.6	l.SS	IS.31	0.10	4.SO
Lump6	Bu,19	SS00.0	11.000	288.68	100:00	80	20	4400.0	0.0	1.53	15.31	0.10	4.40
Lump7	Bn.ZO	3S0\l.O	11.000	183,70	100.00	80	20	2800.0	0.0	1.53	15.31	0.10	1.80
Lumps	B..Zl	6000.0	11.000	314.91	100.00	80	20	4800.0	0.0	L$3	15.31	0.10	4.80
Lump9	Bus2S	?3S?A	!1.000	12.1.47	SS.00	80	20	1S99.6	991.4	J.$3	15.31	0.10	1,60
Lumpll	B..ZS	3Sl9.2	11.000	185.13	SS.00	80	20	?399.8	1487.3	153	15.31	0.JO	2.40
Lump!?	Bu,?9	3S29.2	11.000	185,H	85.00	S0	20	2399.S	1,187.3	1.$3	15.~l	0.l0	2.40
Lumpl3	BusJl	12941.9	11.000	679.27	85.00	80	20	8800.0	5454.8	ı.SS	15.31	0.10	8.80
Luınpl4	BuslJ	5882.S	11.000	308.?5	85.00	80	IO	4000.0	24?9.2	1.53	15:31	0.IC	4.00

Tola! Conn•ıNlumpNl t.o,d,(• 13): 69184.3kV.~

SHORT-CIRCUIT REPORT (With PV)

3-PhaS<> fault at bus: Busl

Notuíu.ıl kV - 66.000
Voltage c Factol' = 1.10 (Useı·-J>efined)
Peak Value - 5.368 kA l\fetbod C
Steady State - 0.232 kArıus

Contribution		Voluge & lnlti.ıl Synımenical Current (nus)				
Fa-om Bus ID	ToBuı ID	%\'	kA	kA Imaginary	XIR	kA MnglUtudr
Busl	Total	0.00	0.327	~2.168	6.6	2.193
BmU	Bud	0.00	0.117	-0.017	O.I	0.118
Bus13	Busl	~.41	0.027	-0.275	10.3	o.!76
Btl$l7	Busl	5·.11	0.0S.1	-0.807	9.1	0.811
B1118	Busl	0.57	0.016	.0.rn	lo.9	0.173
Bus8	Busl	0.57	0.016	-0.171	lo.9	0.17.1
Bu.JO	Busl	.1.?9	0.W	-0.495	11,2	0.497
Bu,3	Busl	3.60	0.017	-0.172	10.3	0.17.1
Bu,6	Bu,l	5.10	0.009	-0.058	6.8	0.059
Bu,~!	Bu.dl	8.06	0.ll7	-0.017	O.I	0.118
Bud5	Busl.J	29.48	0.0l.1	..0.!75	10.3	0.276
Bu,17	Bıı,27	11.SS	0.0Sl	.0.498	9.5	0.SOI
Bu,l8	BU$?7	l.!..17	0,015	.0.1~	10.1	e.ıSS
Bu~29	Bm27	13·.17	0.01$	.0.1~	10.1	e.ıSS
Bu,10	BusS	18.49	0.031	.0.,l.l.l	10.9	0.3l5
Bu131	B....10	?9.80	0.0.l.l	.0.49S	11.1	0.497
ul	Bıı'3	96..1I>·	0.005	.0.0~	10.3	0.0~
Lump!	Bus6	100.00	0.0Sl	-0.351	6.8	0.3~

Breaking and DC fault Current lkA}

Bastd on Total Bus Fa.ult Cumnt

TD (S)	Ib sym	Ib asym	Idc
ael	:?.059	.1.0;0	2.250
0.0l	2.016	2.611	1.66-1
0.1)3	1.990	2.334	1.119
0.04	1.9.11	U.17	0.89.1
0.0S	1.8111	1.982	0.666
0.06	1.81.1	J.878	O.~

(Cont.)

3-Phase fault at bus: Busl

Nominal kV	=	66.000	
Vollage c Factor	=	1.10	(User-Defined)
Peak Value	=	S.368	kA l\fethodC
Steady State	=	0.232	kArms

:!!rn•Jiiıı•ıd_I!!;;Fan!!_Cn1:1:11_.!!;Al.

B~astd on T~.U: Bt;I$F4ultCtuTtnt

TD(S)	Ibsym	Ib:a$ym	Id,
0.07	1.750	1.7$6	0.360
0.0S	less	1.706	o.ul
0.09	1.62?	1.633	o.m
0.IO	1.559	1.$66	0.146
0.IS	UIS	UIS	0.032
0.Z0	1.m	1.27$	0.007
e.IS	1.ın	1.ul	0.001
0..I0	1.119	1.U9	0.000

3-Phase fault at bus: Busl

Nominal kV	=	66.000	
Voltage Factor	='	1.10	(User-Dtlined)
Peak Value	=	2.47;	kA l\fethodC
Steady State	=	0.221	kArms

Connibution		Voltage & Initial Symmetrical Current (rms)				
From Bus ID	To Bus ID	%Y	kA	kA	XIR	kA
Bud	Tot•!	0.00	0.1SI	-1.000	5.4	1.017
Busll	**Busl**	0.00	0.088	-0.011	0.1	0.089
Bus:l..t	Busl	*4.19*	0.027	-0.274	10.3	**0.275**
BuslS	Busl	2.97	0.015	,e.1SS	16.l	0.156
Bus7	**Bus:?**	e.IS	0.005	-0.055	10.:l	0.OS$
Bu,7	**Busi**	0.IS	0.005	-0.055	10.3	0.055
Bus.ll	**Busl**	1.77	0.025	-0.267	J0.6	0.268
Bu;S	**Bus?**	3.71	0.0IS	-0.183	le.S	O.IS4
Bu~2	Bu,11	6.07	0.088	-0.011	OJ	0.089
Busl6	BusU	29.78	0.027	**..0.?74**	10.:l	**0.!7S**
Bu.s:?0	BuslS	10.94	0.0I$	,e.1SS	10.2	e.ISS
Bus9	Bus7	*5.86*	0.on	.0.110	10.3	0.1I1
Bu~3	BusH	16.06	0.0M	-0.267	IM	0.268
U3	**BusS**	99.18	0.005	,e.eSS	10.3	0.055

_J!rnakin2am!_l;ll;_[au1t,!;u[;tu1_!MI

Ba.std on Total Bus Fault Current

TD(S)	lb sun	**lbasym**	Ide
0.0l	0.971'	1.-124	1.038
0.0z	0.960	**1.1S1**	0.771
0.03	0.943	1.099	0,$64
0.04	0.917	1.006	e.SIS
0.0S	0.870	0.923	0.309
0.06	0.SI0	0.870	<1.Z?7
0.07	0.810	0.827	0.167
0.0S	0.780	0.790	**0.123**
0.09	0.752	0.757	0.090
0.10	0.723	0.726	0.067
e.IS	0.659	*0.659*	0.015
0.20	0.596	0.596	0.003

(Cont.)

3-Plıase fault at bus: Bm2

Nominal kV	-	66.000	
Voltage< Factor	=	1.10	(User-Defined)
Peak Value	=	2.475	kA l\letlıod C
Steady State	=	0.221	kArıııs

Breaking aııd pc Fault Çuıı:mıt(l;A)

Bastd on Total Bus Fault Current

TD (S)	lb s;ın	lb asym	Ide
0.2$	0.sn	0.537	0.001
0.30	0.531	0.531	0.000

3-Phase fault at bus: Bus9

Nominal kV = ll.000
Voltage c Factor = 1.10 (User-!Mined)
Peak Value = 10.909 kA ll!eilıodC
Steady State = 1.199 kAnns

Contribution		Voltage & lnilial Spnmett·ical Cun·ent (nas)				
from Bus m	To Bus ID	%Y	kA	kA	XIR	kA
Bus9	Total	0.00	0.610	..1.347	7.1	4.390
Bus7	Bus9	31.45	0.540	.J.@	6.7	3.~
Lump2	Bus9	100.00	0.070	-0.703	10.0	0.707
BusZ	Bu,7	3Z.46	0.045	-0.304	6.7	0.307
Bu,;:?	Bus7	32.46	0.045	-0.304	6.7	0.307

Bı-ealdn~and DC Fault Curı·fnt ~
Bastd on Total Bus fault Current

!D(S)	Ibsym	Ib esym	Id,
0.0l	4.'?82	6.343	4.680
0.0Z	4.U6	5.564	3.596
0.03	4.204	$.016	2.7.l6
0.04	U1Z	4.609	2.083
0.05	3.954	4.269	1.610
0-06	3.85$	4.046	1.219
0.07	:1.757	3.87!	0.938
0.08	3.660	3.729	0.716
0.09	3.563	3.605	0.547
0.10	3.468	3.494	0.4!4
0.15	3.?44	$.?46	o.m
0.20	l.025	3.025	0.029
0.2$	Z.SU	2.813	0.008
0.30	2,798	Z.198	0.001

3-PJı.ıse fault at bus: BuslO

Nominal kV	=	11.000	
Voltage< Fa<ıor	=	1.10	(lisel'-Defined)
Peak Value	=	19.943	kA Method C
Steady State	=	1.226	kArms.

Connibution		Voltage	& Initial	Symmetical	Current	(rms)
From Bus	To Bus	%V	kA	kA	XIR	kA
r0	m					
Bud 0	r.I.I	0.00	O.S3S	.7.907	9.S	7.9S1
Bu.S	Busl 0	47.36	0$89	.$.441	'9.2	SA19
Lump3	Bu,10	100.00	0.246	-Z.460	10.0	1..173
Bu,;l	Bu<;S	48.88	0.0S0	.JJ.460	9.2	OA6Z
Busl	BusS	48.88	0.0S0	.0.460	9.Z	M6Z

_j!ı·tali!na and J!Cf •«!t CutJ •ut ~l

B:ısed on Totiil Bus Fault Curreur

TD (S)	ll> S)'ın	lbas,•ın	Ide
0.0l	7,678	ll.SZ6	8.597
0.0Z	7.608	10.099	6.641
0.03	1.529	9.096	S.104
0.04	7.1%4	8.397	3,922
0.0S	7.167	7.886	3.06%
0,06	7.118	1.499	?.361
0.07	6.947	7.181	1.Sle
0.0S	6.774	6.918	1.403
0.09	6.603	6.691	1.eSl
0.10	6.434	6.491	0.SSG
0.1S	6.035	6.040	0,%36
0.%0	S.646	S.646	0.065
0.25	5.168	5.168	0.018
0.30	S.Z40	5.240	0.00S

Short-Circuit Summary Report QVitlı f\')

3-Phas. Fault Currents

Bus		Delice		n.;ico Capacity (kA)				Shoı1-Ch'cuit cuı..-.ıt (kA)				
ID	IV	ID	Type	M•ldHg Peak	lb s,ın	Th asym	Ide	T!:*_	IV	Th~ın	Jba,;ym	~~
Busl	6MOO	Busl	Bu,					U93	s.368			o.n2
Busl	**66,000**	**Bus?**	Bus					1.011	*uIS*			0.Z1l
Bus9	11.000	Bus9	Bus					4.390	10.909			*1.199*
Bud 0	11.000	BuslO	Bu,					7,951	19.943			*l.Z26*

ip .b takuhtttdusing merhed ***C***
lb does n**ıt indude dtt:ıy qf non4mninıııl faulted induutri.on motors**
Ik is the uwimum :steady state- fıuılt current
Ide h based **on X/R from MethodC andlb** es **l'iptd.tiednbon**

LV CB duty dettıuüuedbastd on seıvice **ı-atiug.**
Total through current ıs used **for dni<"t dut)'.**
* Indicates **a dtlice \lith** **c:alcul:ıttd duty t:ı:cwiing the-** device **up:ı.bllity.**
\# **Wdi<:.ate-};** **ıı** derice **uith calndutt-d du~ t:ı:cttdiug tht dnict' m.,rgin.:ıl limit. (9$ %** **times..** devtee **<'ap;ıbility)**

APPEND1X8

HARMONICS ANALYSIS WITHOUT PV

Project:	I\L.\SIER THESIS	ETAP		Page:	1
Lacatton:	HOUN CTI\'· LIBYA	12.6.0H		Date:	28--06-2016
Conrrect:	!\'EAR EAST Ull"IVERSITY - E.EE Department			SN:	
Engıneer.	SAND ınısrAf A.AL-REf AI			Re,isiou:	Base
Ftlename:	HOUN SUBSTATION 220k'V	Study Case:	HA.	Config:	Nol'tnill

DESIGN Of A LARGE SCALE SOLARPV SYSTE!ıl Ar<"D II\IPACT ANALYSIS Of ITS INTEGRATION INTOIJBYAN POWER GRID

Electrical Transient Anahı:zer Pı·ograın

Harmonic Load flow (Without P,)

Loading: Op•ratingP, Q

Generation: OperatingP, Q, V

	Swing	V-Conn·ol	Load	~
Number of Buses:	3	0	26	29

	xnw	xnw	Rfactor	Lin•ICabl•	lın(!edancto	Ti,PD	lınJ:
Number ofBrnnrhes:	15	0	0	14	0	0	29

	Current	Volta,ıı:
Number of Barın, Sourres:	3	0

Numbff of Filrers:	0
Method of Solution:	Adapti,·e Neu1on-Raphson
Ilfanıuım No. of lie ration:	99
Precision of Solution:	0.0001000000
System Frequency:	50.00Hz
Unit SJ~teııı:	I\lenie

Adiustuients

Tolerance	Apply Adjustments	Indiiidual /Global	Percenr
Transformer Impedance:	Yes	Iııdhid1Lıl	
Reactor Impedauce:	Yts	Iııc!Mdıınl	
Overload Heater Resistance:	No		
Transmission Line Lengtlı:	No		
Cable Length:	No		

Temperature Correction	Apply Adjustments	Indil'idual /Global	Degree C
Transmissfeu Line Resistanu·:	Yts	Indhidual	
Cable Re-siçtance:	Yts	Indhidual	

Bus. Jupnt Data

Bus					Load								% Limits	
					CoustautkVA		ComtautZ		ComtuntI		Gtunit			
ID	kV	Sub-sys	% Mag.	Anı,	"M:W	MnU'	1\I\V	1\frnr	.M\\T	Mv,ır	).OV	I\I\";U'	V11ID	YIHO
Bıul	66.000	1	99.1	-30.0									J0.0D	10.00
Busl	66.000	2	98.9	J0.O									10.00	10.00
Bus3	IIMOO	1	J00:0	0.0									10.00	10.00
Bus.4	110.000	3	100.0	Q.O									10.00	10.00
Bus5	I?0.000	2	100.0	0.0									10.00	10.00
Bus6	11.000	1	98.I.	-60.!I	0.000	0.99!	0.000	0.!-19					MO	1.50
Buş7	66.000	2	98.8	J0.O									I0.a0	10.00
Bus8	66.000	1	99.0	-J0.O									10.00	10.00
Bıu9	11.000	2	98.I	-I.~	1.600	0.992	0.400	0.248					10.00	10.00
BmJO	11.000	1	97.S	-60.0	5.600	3.471	1.400	0,868					10.00	10.00
Bısll	66.000	1	98.1	-30.0									10.00	10.00
BusU	66.000	2	98.0	JO.O									10.00	10.00
Bud5	11.000	1	98.1	-60.0	4.800	2.975	1.100	0.744					10.00	10.00
Bul6	11.000	2	98-1	.5,,1	4.800	2.975	1.100	0.744					10.00	10.00
Bud7	66.000	1	98.9	.JO.O									10.00	10.00
Bud8	66.000	2	98.8	30.0									10.00	J0.00
Busls:ı	11.000	1	98.7	~0.0	4.400	0.000	1.100	0.000					I0.a0	10.00
BUsIO	11.000	2	98.7	-3.3	I,800	0.000	0.700	0.000					10.00	10.00
Busl!	66.000	1	98.9	-30.0									10.00	10.00
811$2?	ILOOO	1	98.4	-60.0	4.800	0:000	I.:Z00	0.000					10.00.	10.00
Bus?J	66.000	1	99.1	-30.0									10.00	10.00
Bm.1ri	11.000	1	98.1	-60.0	1.600	0.991	0.J00	0.248					10.00	10.00
Buıl7	66.000	1	98.8	-J0.O									10.00	10.00
BuslS	11.000	1	98.4	~0.0	:U00	1.487	0.600	0.372					10.00	10.00
Bml9	11.000	1	9U	-60.0	1.400	1.487	MOO	0,372					10.00	10.00
Bus30	66.000	1	98.5	.JO:O									10.00	10.00
Bu<ll	66.000	2	98.6	J0.O									10.00	10.00
Bus32	11.000	1	98.0	-60.!I	8.800	5.455	:.Z00	1.164					10.00	10.00
Bu<lJ	11.000	2	100.5	,,_,	J.000	ı.419	1.000	0.620					10.00	10.00
Tot:ıl Numbn o!Bu1t.s~ 19					41.999	IJ.307	I?.000	S.8Z7	0.000	0.000	0.000	0.000		

Gene-ration Bus				Voltage		Queratiou			M,-ııı·Liıuits	
ID	kV	Type	Sub-sys	% Mag.	Angle	MW	Ifrar	,ıPF	Max	Min
Bud	210.000	Sl\inı	1	100.0	0.0					

Generation Bııs				Voltage		Generation			llfüır Limits	
ID	kV	Type	Sub-sys	%Mıtg.	Au;:lt	MW	Mnu	%PF	Max	Min
Bu-:a	110.000	suuıg	3	100.0	0.0					
Bus5	.?.?0.000	Slling	2	100.0	0.0					
						0.000	0.000			

Cable lunut Pota

Cable ID	Libr,u·y	Size	Length	% Tol.	#/Phase	T (°C)	R1	X1	Y1	R0	X0	Y0

Cablt reshteuces **are liutd :n tht 1ptdfitd tıemptrarnrtıS**

Iı:al!i12Ü§İ!lU;LinfInıaut Data

Lint ID	Library	SIZ,	lıngth Adj.(m)	%Tol.	II/Ph>"	T(•CJ	RI	X1	\1	RO	XO	\'O
							Ohms or ~llıos 11000 m per Phase					
Lint]		674	moo.o	o.o	1	*15*	0.096003	**0.374255**	.00000ıU	0.200077	1-'60791	.0000017
Lint:?		674	moo.o	o.o	1	75	0.656001	**0.3-4Z069**	.00000.14	O.l00037	uııon	.0000016
Lbı,3		674	23000.0	o.o	I	*15*	0.056001	o.moı9	.0000034	o.ıoom	I..ıl4041	.0000016
Lint4		674	15000.0	o.o	I	***15***	0.056001	0.342009	.0000034	**0.200037**	l.4l-1041	.0000016
Lii:ıleS		67J	0000.0	o.o	I	75	0.056001	0.!42069	.0000034	0.200637	UlJ041	.0000016
Lbı,6		674	4000.0	o.o	1	75	0.056001	0.341009	,0000034	0.100637	I..ılJ041	,0000016
Lbı,7		674	4000.0	o.o	1	75	0.056001	0.34)069	.0000034	**0.200637**	1.424041	.0000016
Lbı,8		674	4000.0	o.o	I	75	0.056001	**0.342069**	,0000034	o.ıoom	Ul4041!	.0000016
Lbıt9		*674*	4000.0	o.o	I	75	0.056001	0.342009	,0000034	O.Z00637	1.424041	.0000016
LintlO		674	8000.0	o.o	1	***15***	0.056001	0.341069	.00000.14	**0.200637**	**l.4?4041**	,0000016
Lindi		674	8000.0	0.0	I	I;	0.056001	0.342069	.0000034	**0.20%37**	1.moıı	.0000016
Liıııtll		674	ı1000.ô	o.o	I	*lS*	0.056001	0.342-069	.0000034	0.100637	**l.424041**	.0000016
Lbıtl3		*614*	161000.0	o.o	1	75	0.056001	o.mo69	.0000034	0.)00637	l.4ıl04!	.0000016
Llnd4		67J	140000!0	o.o	I	75	0.0S<lllOl	0.341009	.0000034	0.200637	**l.4240.fl**	.0000016

***Unt* nıhtancts art listNI ~t ıh, ıptdfitd** temperatures

Pı·oject:	IllASTER THESIS	ETAP		**Page:**	*6*
Location:	HOUN CITY -LIBYA	12.6.0H		**Dare:**	28-06-2016
Contract:	NEAR EAST UNIV£RSITY - EEE Department			SN:	
Engineer:	SAı\'D ~WSTAFAAL-REFAl	Study Cose:	HA	Rerisicu:	Base
Fiename:	HOUN SUBSTATION220kV			**-Coufıg:**	**No.nnal**

D£S1GN OF A LARGE SCALE SOLARPV SYST£M AND IMPACT ANALYS1S•OFIT$ INTEGRATION INTO LIBYAı'IPOWER GRID

2-\Viııding Trausforıneı' Input Data

Tl'ansfonn,r	Rating					Z Vaıintion			%Tap s,ııing		Adju~t•d	Pluıs. Shift	
m·	MVA	Prim.kV	St<.kY	%2	XIR	+5%	-5%	%Tol.	Piiın.	Sec.	%2	T,ln•	Augit
Tl	~.000	llo.ooo	66.000	IZ.50	45.00	0	0	0	0	0	ll.5-000	l>)l1	30.000
T3	6.1.000	210.000	66.000	IZ.se	45.00	0	0	0	0	0	ll.5000	Dy.n	-30.000
H	10.000	66.ooo	11.ooo	.S.3S	13.00	0	0	0	0	0	S.35-00	Dyn	30.000
TS·	1o.ooo	66;000	11.000	10.00	20.00	0	0	0	0	0	10.0000	Dyn	30.000
!6	Z0.000	66.000	U.000	10.00	20.00	0	0	0	0	0	10.0000	J>ı11	30.000
T9	1o.ooo	66.ooo	11.ooo	8.3$	13.00	0	0	0	0	0	8.JS-00	Dyn	30.000
TIO	10.000	66,000	11.000	8,35	13.00	0	0	0	0	0	S.3500	Dy.n	30.000
Tll	1o.ooo	66,ooo	11.ooo	10.00	20.00	0	0	0	0	0	J0.0000	Dyn	30.000
TU	20.000	66.000	ll.000	10.00	~0.00	0	0	0	0	0	10.0000	Dyn	30.000
!13	10.000	66.000	11.000	8.3$	13.00	0	0	0	0	0	8.3500	l>)l1	30,000
TU	10.000	66.000	Jl.000	S.35	H.00	0	0	0	0	0	S.3500	Dyn	30.000
!16	20.000	66.000	11.000	10.00	20.0(1	0	0	0	0	0	10.0000	Dyn	30.000
Tl7	20.000	66.000	ll.OOO	10.00	20.00	0	0	0	0	0	10.0000	Dyzı	J0.000
TIS	20.000	66,000	11.ooo	10.00	20,00	0	0	0	0	0	10.0000	Dyu	30,000
TJ9	20.000	66.000	ll.000	10.00	1o.oo	0	0	0	0	0	10.0000	D)u	30.000

2-Viptlipg Tr=ınsrorıner Gı·oımr Jing Iıınut pata

Transformer-	Rating			Groundlng								
				Conn.	Piinm'I				Seroııdaı:I			
ID	MVA	Prim. kV	Sec. kV	Type	Type	kV	Amp	Ohm	Type	kV	Amp	Ohm
Tl	**63.000**	**220.000**	**66.000**	**D/Y**					**Solid**			
T3	63.000	220.000	66.000	DIY					Solid			
T4	10.000	66.000	JJ.000	M'					Solid			
T5	20.000	66.000	11.000	D/Y					Solid			
T6	1o.ooo	55.000	11.000	Dil.'					Solid			
T9	10.000	66.000	1J,000	D/Y					Solid			
TIO	10.000	66.000	ll.000	D/Y					Solid			
Tll	20.000	66.000	11.000	Dll.'					Solid			
Γ11	20.000	66.000	11.000	Dl\'					Solid			
TJJ	10.000	66.000	11.000	DJ\'					Solid			
Tl4	10.000	66.000	!LOOO	DJ\'					Solid			
Tl6	20.000	66.000	11.000	D/\Y					S.lid			

2-JVindin(1 Transfonriei· Crouuclin g Input Data

Transformer	Rating			Conn.	Grounding Primary		Secondary	
ID	MVA	~~.21!'..			Type	kV	Type	kV
Tl7	10.000	~000	ll.0-00	Dfl'			Solid	
Tl8	20.000	66.000	11.000	Dfl'			Solid	
Tl9	20.000	66.000	11.000	Dfl'			Solid	

BrauchConnedfons

C.'KT/Bran,h		Connected Bu, ID		% Positi\·t- Sequence Impedance (lOOllnıABaso)			
ID	T!P<	FroınBu.s	ToBm	R	X	Z	V
Tl	lWXFMR	Bu.J	Busl	0..1.1	19.84	19.8-1	
Tl	2WliBIR	Bus$	Buı.l	0..1.1	19.84	19.84	
H	lWXFMR	Bud	Bus~	6.40	83.15	SJ.50	
TS	1wx:nm	Btı~7	Bus9	:LS0	49.94	50.VO	
T6	2WliBIR	Buss	Busl0	1...~	49.94	saee	
T9	2WXD.IR	Bu~13	Bus15	MO	83.1$	83.50	
TIO	lWXFMR	Bud.l	Bus16	MO	83.!5	SJ.50	
TIJ	1wım.m	Bus17	Bud9	:l.50	49.94	50.00	
Tl1	1WXBIR	BuslS	Bu.ZO	Z.50	49.94	50.00	
T!J	2WXFMR	Buı21	Busll	6.40	83;1~	83.50	
T!4	lWXFlffi	Bus:?3	Bu;lS	6.40	83.15	83.50	
no	lWXBIR	Bu~17	BusZS	2.50	49.94	60.00	
Tl7	zw.xnm.	Bu$27	Bus29	Z.50	49.94	50.00	
TIS	lWXBIR	Bu.JO	Busll	1.W	49.94	50.00	
Tl9	1wım.m	Bu.JI	Bus:33	2.S0	4M4	50.00	
IJ11d	I.ł.:	Brısl.	Busl4	Z.48	16.58	1.6.77	0.1607619
Liııt-Z	I.I..	Busl	Bud3	2.48	15.16	LS.J6	0.28-12266
Lln,J	I.I.,	Bu'2	Busl$	ı.96	18.06	18.30	0.3J87157
Lln,4	Un,	Btt'27	Busl7	1.93	11.78	11.94	O.Zl0901S
LitııS	I.ł.:	Busl	Bu,27	1.03	6.28	M7	O.ll78141
Uıı,6	Lin,	Bu~:?	Bus-7	o,51	3.14	:l.18	0.05S9071
Line7	I.I.:	Busl	Bu'8	o.;ı	J.14	3.18	0.05S907l
Lines	Uıı,	Bu,2	Bus7	0.51	J.14	3.18	0,05S9071
Lhıt9	I.Jııt-	Bud	Bu.S	O.SI	3.14	:l.18	0.0589071
LlııdO	Uıı,	Bos?	Bu.JI	1.03	6.28	6.37	0.!178142
Llıoll	Lin,	Busl	Bu.JO	1.03	6.28	M7	0.1178142
Lindl	I.iut	lltt,17	Bus:21	Z.70	16.49	16.71	0.3092612
LiueU	I.ł.:	Btı,17	Busl3	20.70	llM3	ns.11	2.3710100
Llnd4	I.ł.:	Bu~l	Bus!~	18.00	109.94	111.40	2.0611480

Bı·an≤'.Jıtganeƒtioıı~

z~ı·o SequenceImpedance

Cl\.''T/Bra.nch		Connected Bus ID		% Impedance, Zer<>S<iq., 100 MV Ah			
.IO	T;''!'e	FremBus	ItıBus	RO	XO	Z0	YO
Tl	ZWXfnu·	Bus.l	Bud				
T3	2W.Xfmr	Ros$	Busl				
H	lWXimr	Busl	Bus6				
TS	lW.X:fmr	llın7	Bus!)(				
rS	2\VXfmr	B..S:	Busl0				
T9	lWXfmr	Bu,13	Bud$				
TlO	2\\'Xfmr	Busl4	Bus16				
TU	2WX6nr	Busl7	Bud9				
Tl2	2\\'Xfmı·	Bu,18	Bm.:?O				
Tl3	ZWXfuır	Bus:!l	Busll				
TH	2WX!mr	Bus:l3	Busl~				
Tl6	2\VX!ınr	B'''27	Busl8				
Tl7	lWX!ınr.	Bus27	Bus29				
TIS	2\\'X:f~r	Bus.l0	Bus.l2				
T!9	2\\'Xfmr	Bus31	Bus.l3				
Liu•l	Lint·	Bu$l	Bu,14	M6	60.?9	60,94	0.1410145
Lın,2	Lìn•	Bu.ı	Bll'iU	S.89	63.09	63.72	0.1341983
Lin,3	Un,	Busl	Bu,18	10.59	15.19	75.93	0.1$99Z!5
L!n'4	Lint·	Bus:l·1	Busl7	6,91	49.04	49.$2	0.1042992
LiutS	Lint·	S•• I	Bus17	$.68	:?635	26.41	0.05(;(;262
Llnt6	Lint·	Bu~l	Bus7	1.S4	1.1.ps	1an	0.0278131
L!n,7	Lin,	Busl	Bus8	1.84	U.08	U.21	M278lll
Liıt8	Lint·	Busl	Bus7	1.84	13.08	13.21	0.omrn
Lin,9	Lint·	Bud	Buss	1.84	13.0S	13.21	0.0278131
LiııdO	Lin•	Busl	Bus3l	3.68	26.15	26.41	0.0556162
Lintll	Lln,	Busl	Btts30	3.68	26.IS	26.41	0.055(;262
Liue-lZ	Lln,	Bu,17	Busl!	P,67	68.65	69.33	0.1460189
Lintl3	Lint·	Bus17	Bus23	74,16	526.33	5.11,!S.I	1.1194780
Lln,14	Lint	Bus!l	Bus23	64.48	457.68	46:?.IO	0.9734595

l\-Iachine. Input -Data

J\faclıiıı,		Connected Bus	Rating (Base)			% Negati,·•Se~. lııp.			Gı·ôuıd,ip.g			% Zero Seq. Imp.		
ID	Type:	ID	MVA	1V	RPM	XIR	lll	X!	~~		Amp	2::!	~2	
ul	Gıid	Bus.I	n.1el	l?0.000		10.00	9.9~	~9.~(l	\\)·e	Solid		10.00	35.648	356.48
U2	Gıid	Bın.t	ll.101	2?0.000		10.00	MSO	99.50	Wyf'	Solid		10.00	17.738	177.38
UJ	Grid	Bu.,S	22.101	110.000		10.00	9950	99.SO	Wyt	Solid		10.00	17.738	171,38

ffannonic Llbraıj'.

Current Harmonic Source in %

1.[nuufaduı·el': **ABB**
Moılel: ACS600 UP

Ordt-r	frtq. Hı	M.ag-. %	Or&r	Frtq. HrJ	1'fag.	Ordt-r	Frtq. Hı	?\fag. %	Ordn	Freq. Hı	Mag. %	Or.ittı·	fi:tq. Hı	ltag. %	Oı-dtt	Frtq, Hı	Mag, %
1,00	s0.00	100.00	s.oo	1w.oo	MO	1.00	3so.00	_1.w	11.00	ssaee	3.7o	13.00	650.00	3.70	11.00	850.00	o.so
19.00	950.00	0.30	23.00	1150.00	0.10	25.00	1250.00	0.S0									

Manufacturtı·: **ABB**
~lode!: ACS60() 12P

Oıdeı-	Freq. Hı	Mag.	Ordtı·	fnq. Hı	?ıbg. %	Oı·dtr	Frtq. Hı	M.:ıg:. %	Ordtr	Freq, JL	M:ıg. %	Ol'dtr	:Freq. Hı	Mag. %	Ordu	Freq, Hı	Mng. %
1.00	50.00	100.00	5.00	1S0.00	1.60	7.00	350.00	I.SO	11.00	556.00	3.70	1ıöö	"7sô.ôö	'''m''	17.00	s,0.öö	o.sö
19.00	9S0.00	030	23.00	mo.oo	o.ıo	2s.00	1ZS0.00	0.50									

Afonnfacıul'er: ABB
Model: ACS60012P

Orde-r	Ilı	%	[illegible]	H	[illegible]	[illegible]	[illegible]	%	[illegible]	[illegible]	%	[illegible]	[illegible]	%	[illegible]	Hı	[illegible]
1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
19.00	950.00	030	23.00	mo.oo	o.ıo	2s.oo	11so.oo	o.so									

Hartnonk Sout'ce'fTilm Lihrary

		Harıuoıl,i., $.9,u·çe Iuform,a ~QP				
BusID	Derice ID	~	Manufa,ıur.r	Mod,!	Fund.Fnq.	Mod. Fnı].
Bus.ŀ	ul	Curmıt	ABB	ACS600 llP	0.00	0.00
Bu~	U:?	Current	ABB	ACS600 12P	0.00	0.00
Bus5	U3	Current	ABB	ACS600 llP	0.00	0.00

fundameufa) Load Flow Renort OVithont PV).

Bus		Voltage		Generation		Load		Load Flow					XFlllR
ID	kV	,-6.\tag.	Ang.	AIW	l\frnr	MW	~frat	ID	M\\'	hfott'	Amp	% PF	% Tap
Busl	66.000	95.550	-35.0	0	0	0	0	Busl3	S.8.U	3.883	6.U	8.~	
								Bu~l7	19;134	1.494	17M	99.7	
								Bm8	3..&l5	l.24$	37.4	S.\.5	
								Buss	3.415	ıl48	37..1	83.S	
								Bus30	10."3	7.536	119.7	81.7	
								Bus3	-41$89	-1$.638	42$.6	91.6	
								Bus6	0.ll0l	1.130	11.l	0.I	
Bw:?	66.000	98.167	ZS.1	0	0	0	0	Busl4	5.~1	3.915	63.0	SJ.3	
								Busl8	3.480	-0.141	31.1	-99.8	
								Bus?	o.991	0$72	10,2	86.6	
								Bus7	o.1'91	o.sn	10.1	86.6	
								Bus31	4.939	3.144	SZ.1	84.4	
								Buss	-16.l03	-7.961	1S1,S	89.9	
* Bus3	ll0.000	100.000	0.0	41.694	23.334	0	0	Bu,l	41.69.t	Z3.J.4	117.7	87.7	
* Bus5	220.000	100.000	0.0	16.ll8	S.637	0	0	Bus?	16-318	8,637	·48.5	88.4	
Bus6'	11.000	94..178	-65.0	0	0	0.000	1,217	Bud	0.000	.ı.z17	67.6	0.0	
Bu,7	66,000	98.?.iZ	18.1	0	0	0	0	Bus?	-0.991	-0.618	IM	84.S	
								Bm2	-0.991	-O.ıll8	10-4	84,S	
								Bus9	1.98.\	1.156	l0.9.	84.S	
BusS	66,000	9S.4S7	..35.1	0	0	0	0	Busl	..3..IU	-Z.296	37.7	83.0	
								Busl	...JAU	.1.Z96	37.7	83.0	
								Bud 0	6.818	4.592	1s..l	a.to	
Bu,9	11.000	97,5.<s	-l.,	0	0	1.981	1.228	Bus7	-1.981	-ı.ns	lls.4	8S.O	
BmlO	11.000	91.940	-67.Z	0	0	6.809	,U:U	.Bu,8	-6-.809	...4.2U	452..I	85.0	
Bud3	66.000	94.766	..3S.5	0	0	0	0	Busl	-5.818	-4.057	6S.S	Sl.1	
								Busl$	5.8'.8	4.057	65.S	Sl.1	
B~l4	66.000	97.,1.10	17.6	0	0	0	0	Busl	~•.888	-4,077	64.l	82,1	
								Busl6	S.888	4.017	6-1.3	Sl.1	
Bud5	11,000	90.937	-<SM	0	0	5.792	J.590	BusU	-5.191	-3$90	393.l	85.0	
Bu,16	11.000	93.691	-5.3	0	0	5.853	3.627	Bu~U	-5.853	-3.627	385.8	85.0	
Busl7	66.000	9S.l81	..3M	0	0	0	0	Bns:17	-13.?82	?...ı61	114.ll	-98.1	
								BuS:l	6.SIO	.1.1se	60.7	-98.5	
								Bus?3	1.370	-1..181	18.S	-67.9	
								Busl?	5.403	0.161	49.6	100.0	
BusIS	66.000	98.179	17.8	0	0	0	0	Bus2	..3..176	-0-063	31.0	100.0	
								Bus20	3..176	G.063	3LO	100.0	
Bu"99	11.000	95,099	-68.5	0	0	5-395	0.C00	Bu,17	-5.395	0.ll00	197.7	100.0	

Bus		Volrage		Gtueration ~				LoadFlo~r					XFMR
ID	~~~~~~~							ID	~~~~~				
BuslO	11.000	98.074	•1.3	0	0	;1.473	MOO	Bu,18	-3.473	0.000	165.9	100.0	
Bt~Zl	66.000	95.278	,17.S	0	0	0	0	Bud7	-6.497	0.938	60.3	-99.0	
								Bus23	0.$9S	~1.25.9	us	-12.7	
								Bu.$:?2	S.90?	0.320	S-1.3	99.9	
Bus22	11.000	94.741	-7M	0	0	5.877	0.()00	Bu<ı.11	-5.811	0.00-0	JZ.S.6	100.0	
Bus23	66.000	95.541	-37.9	0	0	0	0	Bud7	-l.36S	-M49	13.8	90.J	
								Bus:?l	-0.59.f	-MB	7.8	69.6	
								BuslS	1.9S9	1.261	?1.3	eu	
BuslS	11.000	94.324	-68.9	0	0	1.955	1.212	Bu,l.l	-1.955	-Ul2	us.0	sse	
Busn	66.000	95.ZSO	.JS.8	0	0	0	0	Bud7	13.3Zl	..;2AU	124.4	-9S..f	
								Bud	-19.192	-1,345	176.7	99.8	
								Bus28	1.936	1.88.f	32.0	Sl.2	
								Bu.~9	2.936	l.SS4	·31.(1	ft.1.2	
Bwzs	ILOOO	94.197	-66.1	0	0	2.932	1,817	Bu,27	-2.932	-1.817	l!ill.?	SS.(I	
Bus29	11.000	94.197	-66.1	0	0	2.93?	l.S17	Bus27	-2.932	-1.817	192.Z	S5.0	
Bus30	66.000	94.938	,IS.4	0	0	0	0	Busl	-10.663	•7.5?4	110..;	Sl.1	
								Bus$l	10.663	7.524	110.3	81.7	
Bus31	66.000	98.0ll	ZS.0	0	0	0	0	Bus%	4.936	.J.235	Sl.1	83.6	
								Bus.13	4.936	3.235	Sl.7	S.l.<i	
Bud:?	11.000	90.861	-68.8	0	0	10.616	6.581	Bus.10	-ID.616	-6.581	7?1.5	85.0	
Bus.il	ILOOO	96.168	,I.S	0	0	4.917	3.0S-1	Bu,.11	4.9!7	..l.0S.l	316.o	ııs.o	

* Iıdic:dl'$u Yoltagtrtgul:ıtdbus (\·<>lrı:ıg:t «ııtroUtdcı' s:niug type m,'\th.i;nttonıtdtd to it)
# indk:ıtts a bus nitha Jo:ıd minmtch()f mo~ th:ınO.l MVA

Systeın H:n;mouiçs Bus Infüntıation

Bus		Voltage Distoı1kın								
ID	kV	Fund. %	RMS %	ASIJ1.! %	nııi %	TIF	mm %	TSI!D %	THDG %	mos %
Bud	66.000	95.55	95.SJ	109.35	7.11	147.90	0.00	0.00	7.71	7.71
BU$2	<i6.000	98.17	98$$	113.93	U6	131.63	0.00	0.00	7.66	7.66
'Bın3	2:?0.000	100.00	100.61	121.75	II.OS	129.91	0.00	0.00	11.0S	11.08
Bu~	110.000	JOO.CO	100.17	115.06	7.31	121.60	0.00	0.00	7,32	ui
#" Bu<S6	11.000	94.48	94.76	108.14	7.71	148N	0.00	0.00	7.71	7.11
Buı7	66.000	98,24	98.53	113.91	7.67	m.11	0.00	0.00	7.67	7.67
Bu<S	66.000	95.46	95.74	109.ll	7.69	147,Sl	0.00	Q.00	7.69	7,<i9
Bus9	11.000	91.56	97.83	m.Sl	7,S3	128.35	MO	0.00	7.SJ	7,53
BmlO	11.000	91.94	93.16	10U7	6.88	126.99	0.00	0.00	6.88	MS
Busl3	66MO	94.77	9$.04	108.45	7.67	148.38	0.00	0.00	7.67	7.67
Bml4	66.000	91.44	97.71	1USS	7.60	131.01	0.00	0.00	7.60	7.60
Buds	11.000	90.94	Sl.1l	101.60	6.Z6	lIJ,48	0.00	0.00	6.16	6.16
Bu,16	11.000	93.69	93.BS	106.01	6.36	10U1	0.00	0.00	6.36	6.36
Bud?	66.000	95.28	95.SI	108.29	7.04	131.44	0.00	0.00	1.01	1.04
Bus16	66.000	96.18	98.48	11C11	7.83	136.15	0.00	0.00	7.S3	7.83
B1t>l9	11.000	95.10	95.30	107.11	6.50	118.89	0.00	0.00	6.50	6.50
Bus20	11.000	98.07	98.35	11.1..11	7.53	128.6-l	0.00	0.00	7.53	7.<3
Bus21	66.000	95.28	95.49	10S.SS	6.70	136.U	0.00	0.00	6.70	6.70
Bml?	11.000	-ı-9-l.7J	94.88	105.:"66	5.48	99.ıı.	0.00	0.00	SAS	5.48
BuıZ3	66.000	95.54	95.99	11M3	9.70	149.73	0.00	0.00	S!'.70	9.70
Bu"Sl:S	11.000	94.32	91.73	111.68	9.32	Ul.77	0.00	0.00	9..12	9.31
Bm?1	66.000	95.25	95.$1	108.41	1.39	135,IS	0.00	0,00	1.39	7.39
Ba.U	11.000	94.10	94..1.ı	106.78	7.15	132.37	0.00	0.00	1.15	1.15
Bu-s:?9	11.000	94.20	94.-14	106.78	7.15	m.37	0.00	0.00	7.IS	7.IS
Bus30	66.000	9U4	9$.:?l	108.38	7.54	144.38	0.00	0.00	7~	7.54
s.,31	66.000	98.01	9$.30	113..<S	7.64	131.13	0.00	0.00	7.64	7.64
BuıJ?	11.000	90.86	91.03	101.33	6.16	110.97	0.00	0.00	6.16	6.16
Bus3l	11.000	96,27	96.52	nass	7.19	120.08	0.llO	0.00	7.19	7.19

• hıdkatt$TİID (TotalHaı'UlonkDittortfı)n]Es(ttds. tht Limit.

 # hdicatts nID (Indhidoal Hırmoıık Distol'tion) Excttd$ tlıt limit.

Pro Jett:	'.\USIER THESIS	ETAP	Page:	1S
Location:	HOUN CIIT-LIBYA	12.6.0H	Date:	28-06-2016
Connect:	NEAR EAST UNIVERSITY - EEE Department		SN:	
Engñeer;	SAJ\l) '.\(USTAfA AL-REI'AI	Stlulr Case: HA	Re\isiou:	Base
Filename:	HOUN S1'IBSTATION220ltV		Coufıg:	Normal

DESIGN OF A URGE SCALE SOLARPV 5Y&TEM: AI'"D IMPACT ANALYSIS OFITSINJEGRATIONINTO LIBYAı'I POWER GRID

Systeıp Hannonics Branctı·Jıiforınation

Bus		Current Discoiiioıı											
·FtomBu1ID	TllBu.sID	Fund. Amp	RMS Amp	ASU!ı! Amp	nm %	rrr	IT Aınp ~	ITI,	ITR Amp	·TIHD '•	TSHD %	THDG %	THDS _%
Bu.d	Busl3	~.?2	~.27	69.43	4;1$	80.84	5195.61	5195.61	MIi	0.00	0.00	4,IS	,US
	Busl7	176.61	111.29	nı.ss	8.70	143.72	25.180.07	2$180.07	0.00	0.00	0.00	8.70	8.70
	B...S	37,U	37.47	40.83	4.88	88.47	3315.13	3.3O$.l:3	0.00	0.00	0.00	4.88	4.S8
	B..S	37.43	37.47	40.6.~	4.88	88,47	Jfü.13	3315.13	0.00	0.00	0.00	4.88	4.88
	Bu.JO	l!M9	119.79	ll8,9S	4.15	12.81	8728.96	87lS.96	0.00	0.00	0.00	4.15	,US
	Bu~,	425.61	.ılıS.32	477.79	S,76	97.S7	4159S.09	41595.09	0.00	0.00	0.00	S.16	S.76
	BU<6	ll.1S	11.26	11,41	o.69	10:37	116.81	116.81	0.00	0.00	MO	M9	M9
Busl	Bu11.ı	63.o.t	63,10	68.91	4.38	70.90	4473.93	4473.93	0.00	0.00	0.00	4.38	4.38
	BuslS	ll.0S	31.20	37.41	9.70	185.H	57'6.Sl	5776.Sl	0.00	0.00	0.00	9.70	9.70
	But.7	le.1S	10.21	11.69	1.0l	12,.s1	1302.1$	uo:us	0.00	0.00	0.00	7.03	7.03
	Bu,7	10.19	1all	11.69	1.03	m.Sl	1302.28	130l,l8	0.00	0.00	0.00	7.03	7.0.1
	Bus..\l	Sl,12	S:1.20	Sil.OS	5.53	91,lJ	47S7,71	4151.11	0.00	0.00	0.00	5.53	5.:53
	Bm5	161.51	161.79	181.75	5.93	101.60	16600.!J	16600.!J	0.00	0.00	0.00	5.9.1	SJ13
Bu,J	Bud	127.~	117.90	w.~	S.76	97.57	m15;53	l:Z.178.53	0.00	0.00	0.00	5.76	S.76
Buss	Bu,l	48.45	48.54	54.SZ	5.93	l0:u0	4980.04	4980.04	0,00	0.00	0.00	5.93	5.93
Bu~6	Bud	67.$8	67.SS	68.47	0.69	10:37	700.87	700.87	0.00	0.00	0.00	0.69	0.69
Bu,7	Bu,2	10.45	10.47	11.79	6.17	105.07	1100.07	1100.07	0.00	0.00	0.00	6.17	6.17
	Bu~z	I0.4ö	10.47	11.79	ö.17	105,07	1100.07	1100.07	0.00	0.00	.0.00	6.17	6.17
	B"'9	10.90	10.94	lJ,$8	6.17	IOS.07	!200.14	llQO,U	0.00	0.00	0.00	6.17	6.17
BusS	Bnsl	37.70	37.7ö	41.36	s,n	96.06	3616.42	3626.ı?	0.00	0.00	0.00	S.1l	5.21
	Busl	37.70	37.75	41.36	5.zı	96.06	-~626.42	36Z6A?	0.00	0.00	0.00	5.11	S.11
	BuslO	7$.40	75.Sl	Sl.73	5.21	96,06	7l5l,S4	nsz.s~	0.00	0.00	0.00	5.21	5.21
Bu'9	Bu,:7	1:25.40	12S.63	Ul.46	6.17	105.07	13200.84	!1l00.84	0.00	0.00	0.00	6.17	6.17
Bu,10	BusS	.JS?.4l	45.l.04	496.35	S.1l	96.06	43517.0l	43517.0?	0.00	0.00	0.00	$.11	5.Zl
Bu~l3	Busl	65.SS	65.62	71.16	4.57	82.80	5.133.09	5.133.09	0.00	0.00	0.00	4.57	4.57
	Bud5	(i$.S$	6.'s62	71.16	t.1	81.80	5.IJJ.o9	54.13.09	0.00	0.00	0.00	.f.57	,U7
Bu~U	Busl	~,?j)	6.U7	70.78	4.87	78.15	5030.68	SOJ0.68	0.00	0.00	0.00	4.87	4.87
	Busl6	64.29	64,37	70.78	4.87	18.15	5030.68	S030.68	0.00	0.00	0.00	4.87	4.S7
Bu,;15	Bud3	J93.Z9	393.70	.f?tiP.f	4,;7	82.80	3!598.63	3!$98.5.l	0.00	0,00	0.00	4.57	4,51
Bud6	Busu·	36.<.75	386.!l	414.66	4.87	78.15	30184.05	30184.05	0.00	0.00	0.00	4.81	4.81
Bud7	Bu:sl7	t:U..O?	lU.1S	154.73	10.86	177.19	?!103.41	mo3.41	0.00	0.00	0.00	10.86	10.86
	aes1l	60.67	61.09	77.JS	n.rs	l.\9.40	14625.48	14625.48	0.00	0.00	0.00	n.rs	11.75
	Bu,s?3	18.52	19.23	%9.66	21.91	$?0...tS	6163.•5	6163..15	0.00	0.00	0.00	21.91	27.97
	Bu,19	.til.(il	49.71	$$AO	$.99	109.65	54$1.03	5.151.03	0.00	0.00	0.00	S.99	~.99
BudS	Busl	3M8	31.06	35.68	7.30	lU.61	3870.57	3870$7	0.00	0.00	0.00	7.30	7.30
	BusZO	Jo.98	31.06	3$.68	7:30	llJ.61	3870.57	3870.57	0.00	0.00	0.00	7.30	7:30
Bud9	Busl?	197.7$	198.?8	332.41	5.99	!OMS	n706.U	3l70U6	0.00	0.00	0.00	5.99	5.99
Bu,20	B~tl8	!SS.88	186.37	214.08	7.30	124.61	ım3.44	l.Uz.3.•U	0.00	0.00	0.00	7.30	7.30
Bu$2l	Busl7	60.?7	60.74	77.14	11.5$	llo.64	14009.08	14009.08	0.00	0.00	0.00	uss	n.ss
	Bus23	12.1s	14.16	rr.1l	49.54	879.14.	1?54l.19	125.12.29	0.00	0.00	0.00	49.5.1	49.54
	Bus2l	5.1.27	Sl.33	59.95	5.01	90,95	49U.45	494U5	0.00	0.00	0.00	5.oı	5.01

Projecr:	JIIASTER THESIS	ETAP	Paı.:	17
Location:	HOUN CITY· LIBYA	12.MH	**Date:**	28-06-2016
Contract:	NEAR EAST UNIVERSITY·' EEE Department		SN,	
Engiue~r:	SAND I\IUSTAfA AL-REFAl	StudyCase: HA	**Relision:**	**Base**
Filename:	HOUN SUBSTATION 220kV		Coufıg:	Nonna!

DESIGN OF ALARGESCALESOLARI'VSYSTEMA.l'IDIJIIPACTAN'ALYSISQFITSli\'IEGRATIONINTOLIBYANPOWERGRID

Bus		Cun .•nt Distortion											
Frcıu Bus **ID**	**ToBn,;ID**	**Fund.** ~-\mp	R.\IS Amp	ASUM Aup	nm %	nr	IT ~~.~--%	lTB	rrs	TIHD	TSHD %_,_~	THDG	THDS %_
Bmll	llu,21	*Jc.15,59*	316.00	35M7	**5.0l**	90.95	296'8.68	Z9648.~	0.00	0.00	ô.00	**S.0?**	**$.02**
Buı;l3	Bus17	13.84	13,90	16.6l	9.58	183.74	2554.51	**?5$4.~**	0.00	0.00	0.00	9.58	9.58
	Busl]	7.111	Wl	**10.:l?**	15,Sl	31690	**l$0G.6S**	2506.~	0.00	0.00	0.00	15.81	15.81
	Bu~lS	**21~\4**	**21.39**	u..1S	**7.21**	109.96	**1'52.16**	**1.ı:\Sl.16**	0.00	0.00	Q.00	**,.ll**	**,.ll**
Bu,;25	**Busl3**	nsel	**llS,34**	146.la	***1~1***	10996	14112.98	141ıı98	0.00	MO	0.00	**7.11**	**7.22**
Bu,,;27	Busl7	124.35	uses	154.78	**l0.61**	l?l.ll	21~5.0l	iıns.oı	0,00	0.00	0.00	IMZ	10,62
	Busl	176.69	171..l6	**21?.16**	8.111	US.16	)6'.8l0.37	26?80.37	0.00	0.00	0.00	**8.82**	**8.82**
	Bus?S	**32.04**	32.08	3S..l5	**,'',,**	101.36	.1184.10	3?8UO	0.00	0.00	0.00	5.SJ	*!W*
	Buç29	**.3!.04**	31,08	35.35	S..<3	**102,36**	32SUO	**3234.lO**	0.00	0.00	0.00	M.l	**S.53**
BmıS	Busl7	192.21	lSl.Sl	mm	**S...V**	10l..l6	19705.U	1970S.lS	0.00	0.00	0.00	5.53	S.SS
Bu129	**Bu.,?7**	**19_!.Zl**	191.51	**lll.07**	5.53	10?.36	mos.lS	1970S.lS	0.00	0.00	0.00	*5.53*	5.53
BU$30	Busl	**U0.25**	U0.37	130.35	H9	80.SS	97.ll.70	9732,70	0.00	0.00	0.00	4.49	*4.49*
	Bu.dl	**llOJS**	ll0.37	130-35	4.49	80.SS	97,\?.70	9731,70	0.00	0.00	0,00	4.49	4.49
Bus3l	**Busl**	52.67	52.76	*5895*	*5.'16*	*96.21*	5075.,7	5075.!'7	0.{10	MO	0.00	5.76	5.76
	Busl3	**Sl.67**	Sl.76	*5895*	**$..76**	96.U	5075.57	S075.S7	0.00	0.00	0.00	S.76	5.76
Bu.$32	Bu'30	721.51	**111.24**	**78.?.10**	4.49	80:115	***$$396.ZZ***	**SS396.ll**	0.00	0.00	0.00	4.49	*4.49*
llu,33	Bus31	316.02	316.55	353.11	S.76	*96,21*	.1045.\,45	304S3.4S	0.00	0.00	0.00	S.76	S.76

BUs Tahu}atign

Harınoııic Voltages (% ofFuudaıne:ntAlVoJtage-)

Bu~lD; **Busl**
Fuud. kV, 63.061

--	Hı	%	--	Hz	%	--	Hz	%	--	Hz	%	--	Hz	%	—	Ht	%			
5.00	lS0.00	2.2.\	7.00	3$0.00	0.54	11.00	5S0.00	4.71	13.00	6S0.00	5.58	17.00	850.00	nzs	IMO	9SMO	0,14			
13.00	1150.00	O.ll	?:S.00	1l50.00	0.8S															

Btı1D>: Bu'10
r••d.kY: !0.!23

Order	Freq,	Mag.	Order	F1't'q,	)fag.	Order	Freq,	Mn_g.	Onlu	Frtq.	Mng.	Or.det·	Fr~q.	Mag,	Ordtr	Freq.	Mag.
--	Hz	%	--	Hz	%	--	Hz	%	--	Hz	%	--~		%	--	Ht	%
$.00	lS0.00	Z.19	7.00	JS0.00	-0.Sl	11.00	SS0.00	4.26	13.00	650.00	4.87	17.00	850.00	O.ll	19.00	9SMO	an
23.00	IIS0.00	().09	15.00	l:1S0,1)0	0.SS												

BmID: Bus'.?
Fuud. kV: 64.856

—	Hı	ııı!	—	Hz	%	--	HZ	%	--.~		%	--	Hı.	%	--	Hz	%
$.00	150.00	2.9.f"	7.00	350.00	1.80	11.00	SS0.00	4.77	13.00	6S0.00	4.83	17.00	850.00	0.6.1	19.00	9S0.00	0.·16
ll.00	US0.00	e.ıı	?5.00	l?S0.00	0.S0												

Bu1ID: Bu,9
fund.k\': 10.?Jl

Ordea·	Freq. Hz%	M,g.	Or<kr	fr,q. Hz	M:ıg. %	Onttr	Frtq. Hz	lbg. %_Hz	Onltr	Frtq.	Mag. %	Oı'dtı'	Frtq. .Hz	M.g. %	Onltr	Fr.q. Hı%	ıı.g.
5.00	250.00	lJ}3	7.00	350.00	1.79	11.00	550.00	4.69	13.00	650.00	4.72	17.00	850.00	D.61	19.00	950.00	0.35
23.00	IIS-0.00	e.ıe	lS!00	llS0.00	0.46												

Bus Tabulation

H:irınonitVoltaçes (% ofNominnl Voltage)

Bıı,ID: Busl
Nom. kV: 66.-000

Order	Freq, ~%-_Hı	Mag.	Order	Freq.	.M:ıg. %	Oı-dtr	Freq, Hı	Mıtg, %	Oı·der	Freq. Hı%	l\L1g:.	Ordtı·	FrttJ.	Ala;.	Order	Freq.	Mag.
S.00	1S0.00	1.1;	7.00	350.00	0,51	11.00	550.00	4.50	H.00	6S0.00	5.33	17.00	85"0.00	O.l7	19.00	9!0.00	O.I.I
11.00	11s0.oo	0.1:l	:?$.00	12!-0:00	(1.8!												

Bus ID: :SuslO
Nom. kV: 11.000

Ordeı-	Freq.	Mag.	Ordtı·	Freq,	Mag. %	(h-dtr	Fnq. Hz	Mng. %	Order	Freq. Hı	~fag. %	Order	Freq. Hz	Mag. %	Order	Frtq. Hz	Mng. %
s.oo	ıso.oo	l.OJ	7.00	350.00	MS	11.00	sso.oo	J.96	13.00	650.00	4.53	17.00	8.,S0.00	0.Zl	ııı.oo	sse.ee	o.ıo
23.00	1150.00	0.0S	15.00	1250.00	0.54												

Bus ID: Bus2
Noın. kV: 66.000

Ordtr	freq. Hı	?ı.bg:, %	O.tdtr	FtNJ. .JL	Mıtg. %	Ordn	.frtq. Hı	Mag. %	Order	Frtq, Hı	~;. %	Ordtr	Ftt(J. Hz	Ma;. ttı	Ordtı·	Fttg. Hı	.Mng. %
s.oo	1S0.00	2,s9	1.00	350.oo	1.11	11.00	SS0.00	4.69	u.oo	.65-0.00	4.74	11.00	850.00	Mı	19.oo	9so.oo	0.36
11.00	11S0.00	o.ıı	2.5.00	1?50.00	0.49												

Bus ID: Bu,9
Noın. kV: 11.000

Ordtı·	Freq. Hz	Mag. %	Oı'dt-1·	frtq,	Ma;, %	Ordtr	Fa'fq. Hz	Mag. %	0l'dtr	Freq. Hı	M.ı;. %	Onl~r	Fffil, Hz	Ma;.	Ordtı·	frtq, H,	Mıg. %
5.00	250.00	2.86	7.00	3.<o.00	1.75	11.00	550.00	4.58	13.00	650.00	4.60	17.00	850.00	0.59	19.00	950.00	0.34
23.oo	11.0.00	0.10	:?5.00	1?$0.00	0.45												

VIHD <lnrlhidu;ıl Harmonic Dis1ortiou) Report

Rus		Voltage Distortion		
ID	kV	Fund. o/o	VIIID %	**Ordtı·**
Bu.6	11.000	*94.48*	*2.23*	5.00
Bus6	11.000	*94.48*	4.71	11.00
Bm6	11.000	*94.48*	5.58	13.00

Indieates buses **11ith !HD {lndMdunl H:ırmonk Distortion) ~xcttdi.ug tht limit**

VTHD (Total Harınonic Dis.tortion) Report

Bus		Voltage Dlstortion	
ID	**kV**	Fund. %	VTBD %
Bın3	Z10.000	100.00	11.es
Bu,6	11.000	*94.48*	7.71

Indicates buses **ıdtb 1lID (l'otal Ha~monic Distortion} excttdiug the limit**

Alert Snmınary Report

	% Alert Settings	
	Q:.iti£a!	Marginal
Indhi<lual Bus VTHD / VIHD values are used,		
Transformer		
Totall	100.0	95.0
!'ilw;		
CapadıorkV	100.0	95.0
Inductor Amp	100.0	95.0
Capacitor		
ll!a:ı:kV	100.0	95.0
Cabl<.>		
Aınpaclty	100.0	*95.0*

APPEND1X9

HARMONICS ANALYSIS WITH PV

Pl'Öje<t:	MASITR THESIS	ETAP	Page:	1
Location:	HOUN CITY· LIBYA	12.6.0H	Dare:	28-06-2016
Conrract:	NEAR EAST UI\'IVERSITY • EEE Department		SN:	
Engineer:	SMl> MUSTAFA AL-REFAI	Study Case: HA	**Rt,ision:**	**Base**
filename:	HOUN SUBSTATION 220kV		Coufig:	**Nol'mal**

DESIGN OF A LARGE SCALE SOLAR PV SYSTEM AND IMPACT ANALYSIS OF ITS ~TIGR.\TION INTO LIBYA :\PO'\VER GRID

Elech·k,ıl Transient Anal\7.er Pmgraın

Haımonic Load Flew (\'\1th P\')

Loading: OperatingP, Q

Genel'ation: OperatingP, Q, V

	SninL_	V-Control	Load	~ıl
Number of Buses:	3	7	30	40

	moo	XF!ıfR3	**Reattor**	Line/Cable	ImEedan<e	Tie PD	Tofil!
Number ofBı·anches:	24	0	0	16	0	0	40

	Qıruıı!	Y~!!a2
Number o! Bann. Sources:	4	0

Number of Filıeı~:	0

l\(ethod of Solution:	Adaptive Ne\lton-Raphson
Mn:dmuın No. of Itıration:	*99*
Precision of Solution:	0.0001000000
System Frequency:	50.00Hz
Unit Sı~ıem:	Metıic

Aıljustınents

Tolerance	Apply Adjustments	lndhidual /Global	**Percent**
Transformer Impedance:	**Yes**	Iııdhidnııl	
Reactor Impedance:	**Yes**	Iııc!Mdwıl	
o,·erload Heater Resistance:	No		
Transmission Line Length:	No		
Cable Length:	No		

Temperarure Cerreerien	Apply Adjustments	lııdhidual JGlobal	Degree C
TransmissionLine Resistance:	**Yes**	Iıdi\idıınl	
Cable Resistance:	**Yes**	Iıılhid••l	

Bus Input füta

Bus			lniriıJ.Voltag"		Load								%Liınlıs	
					Constant kVA		Com:tantZ		Coııstant I		Gtntric			
ID	kV	Sub-sys	%!ıl•g.	Ang.	!ı!W	ıh-aı·	MW	M,'ı2r'	MW	?\frAl'	MW	lfrnr	vrnn	vnm
Busl	6\1.000	J	98.8	-30.0									10:00	10.00
BwZ	66.000	I	100.0	30.0									JO.OD	10.00
Bus3	'.!20.000	1	JOO.O	0.0									5.00	5.00
Bus.ı	110.000	3	100.0	0.0									10:00	10.00
Bn'>li	II0.000	2	JOO.O	0.0									10.00	10:00
Bus(i	11.000	1	98.l	-60.0									S.00	5.00
Bus.7	66.000	2	98.8	30.0									J0.00	10:00
):lıı,8	66.000	I	99.0	-30.0									10.00	10.00
Bu$9	11.000	I	98.l	0.0									I0.00	10.00
Busl.0	11.000	1	97,8	-60.0									10.00	10.00
Busil	66.000	I	100.0	30.0									JO.OO	10.00
Budl	6il:OOO	1	100.0	-30.0									J0.00	JO.OO
Busl3	66.000	I	98.3	-30.0									10.00	10.00
Busl4	6\1.000	I	98.0	30.0									I0.00	10.00
Busl$	11.000	1	98.7	-60.0									10.00	10.00
Busl6	11,000	I	98.3	0.0									10.00	10.00
Busl7	66.000	l	98.9	-30:0									10.00	10.00
Bu,18	66.000	2	98.6	30.0									10.00	10.00
Busl9	11,000	1	98.7	-60.0									10.00	10.00
Bn.s?O	11.000	2	98.7	0.0									J0.00	10.00
Busll	66.000	1	98.9	-30.0									J0,00	10.00
BmlZ	11.000	J	98.4	-60.0									10,00	10.00
Bus:!3	6\1.000	1	99,3	-30.0									10.00	10.00
BmlS	11.000	1	98.l	-60.0									10.00	10.00
Bu,;27	6\1.000	1	98.8	..10.0									10.00	10.00
Bn~:s	11.000	I	98.4	-60.0									10.00	10.00
Bwl9	11.000	1	98.4	-60.0									10.00	10.00
Bus.JO	66.000	1	98.S	-30.0									10.00	10.00
Bus31	66.000	I	98.6	30.0									10.00	10.00
Bus32	11.000	1	98.0	-60.0									10.00	10.00
B'"3l	11.000	:	ıee.s	0.0									10.00	IO.~
Busl$	0..100	1	100.0	-50.0									10.00	10.00
Bu'35	0.400	1	100.0	-30.0									5.00	S:00
Bus36	0.400	I	100.0	-30.0									10.00	10.00

Project:	MASTER lHESIS	ETAP		Page:	4
Location:	HOUN CITY-LIBYA	12.6.0H		Date:	28-06-2016
Contracr;	NEAR EAST UNIVERSITY-EEEO.parmi•uť			SN:	
Engineer:	SAND MUSTAFA AL-REFAl	Study Case:	HA	Relision:	Base
Fileunme:	HOUN SUBSTATION 220kV			Config:	Normal

DESIGN OF A LARGE SCALE SOLARPV SYSTEM AND IMPACT ANALYSIS OF ITS INTEGRATION INTO LIBYAN POWER GRID

1111,			IllitinlYoltngt		Load								% Limits	
					ComtautkYA		ComtantZ		Constnnil		Gtuni('			
m									MW	Mvar	MW	lb~r	VTIID	\'IUD
Bus37	MOO	1	J00.0	-30.0									10.00	10.00
Bus38	0.400	2	100,0	30.0									5.00	5.00
Bus39	0.400	2	100.0	30.0									5.00	5.00
Bus40	0.400	2	100.0	.,0.0									5.00	5.00
Bus41	11.000	1	120.8	-60,0									10.00	10.00
Bm4l	11.000	2	98,9	0.0									10.00	10.00
Tonl Numbtri>fBu~: -40					0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Generadon Bus				Voltage		Generation			l\h-.rL!mlts	
ID	kV	T>pc	Sul>-.,ys	~iAb;.	;\11;:le	MW	Ifrat·	%PF	Atu	Min
Bus.\	220.000	S"i.ug	I	100.0	0.0					
Bus.f	220.000	Slliug	3	100.0	0.0					
Bu$5	ll0.000	S~ing	Z	100.0	0.0l					
Bus.14	0.400	Voltage Ceutrcl	1	100.0	.JO.O	1.952			0.000	0.000
BusJS	MOO	Yolt;,ge Control	I	100.0	.JO.O	1.952			0.000	0.000
Bus.16	0.400	Voltage Conh'Ol	I	100.0	~*0.0	1.952			0.000	0.000
Bus.17	MOO	Y<lU\g:e Colltrol	I	J00.0	.JO.O	1.952			0.000	0.000
Bus.IS	0..l00	V~tage-Control	Z	l00.0	JO.O	1.952			0.000	0.000
Bus.19	0.400	Yoltagt-Coiltt'Ol	?	l00.0	JO.O	1.952			0.000	0.000
Bns-10	0A00	V~raie Contr·ol	2	100.0	30.0	ul:2			0.000	0.000
						13.662	0.000			

C;ılıJe Input pata

Cable		Ungth				Oiııns oı'llfhos / 1000 m µ•r Couduetoı					
1D	l.ibrarı·y	Siu	Adj. (m)	% T,L	#/Ph,,e	T (•G)	RI	XI	YI	RO	XO	YO

1D	l.ibrarı·y	Siu	Adj. (m)	% T,L	#/Ph,,e	T (•G)	RI	XI	YI	RO	XO	YO
Cabltl	11MCUS3	300	J00:0	o.o	1	1s	o.omoı	o.omoo	0.00016-16	o.ı4oısı	o.mooo	
Cabltl	11MCUS3	300	J00.0	o.o	1	75	0.076JOl	O.OS7400	0.00016-16	O.l40J51	O.lHOOO	

Cabltl resistaueesare **lbtedat tbt sp«Jfitdltmptr.ıtum**

Tr:msmissfon Line Jnnut Data

Line ID	library	Siu	L<ugth Adj.(m)	%ToL	l((Ph,,.	T('C)	RI	XI	YI	RO	XO	YO
							Ohms or Mhos / 1000 m per Phase					
Un,!		674	19300.0	0.0	I	75	0.056003	0.374l55	.0000031	O.l00077	1.360791	.0000017
IJotl		614	19)00.0	o.o	1	1$	0.056001	0.342069	.OOOOOH	0.100637	l.4?4041	.0000016
Lint3		674	23000.0	0.0	1	75	0.056001	o.mo@	,0000034	0.100637	l.4l40U	.0000016
Llıı,4		674	15000.0	M	I	75	0.056001	0.34?069	.0000034	0.100637	1.424041	.0000016
Uıı,5		674	8000.0	0.0	I	75	0.056001	0.342069	.0000034	0.200m	1.414041	.0000016
Liıı,6		674	4000.0	0.0	I	15	0.056001	0.34?069	.0000034	0.200637	1.424041	.0000016
Une7		674	4000:0	0.0	I	75	0.056001	0.34?069	.OOOOOH	0.200637	1.424041	.0000016
UıtS		614	4000.0	0.0	I	75	0.056001	0.341069	.0000034	0.200637	J.4l4041	.0000016
Uııt9		674	4000,0	0.0	I	75	0.056001	0.34!069	.0000034	0.100637	1.424041	.0000016
IJntlO		674	8000.0	0.0	I	15	0.056001	0.342069	.0000084	0.200637	1.414041	.0000016
Uıı,U		674	8000:0	0.0	I	15	0.056001	0.342069	.000003-t	0.?00637	J.414041	.0000016
Llııtll		674	%1000:0	0.0	I	75	0.056001	0.341069	.0000084	0.100637	l.4l40ıl	.0000016
lJntH		674	161000.0	0.0	I	15	0.056001	O"l.ll069	.0000034	0.200637	l..lUO..lI	.0000016
Uıı,14		674	140000:0	0.0	I	15	0.056001	0.342069	.0000034	0.100637	1,424041	.0000016

Lint redsteııees**art lintel at the sptdfitd ttmptratul't$**

2-,Viıding Transformer Input Data

Trnnsfonner	Rating					Z Vaıiation			01G Tap Setting		Aclj\tsted	PhaseShift	
ID	MVA	Prim.kV	St'r~kV	%Z	X1R	+5%	~5%	%Tot	Prim.	Sec,	%Z	Typt	Angle
Tl	63.000	ıı0.000	66.000	ız.sc	~s.00	0	0	0	0	0	12.;000	Dı11	30.000
T3	63.000	ıı0.000	66.000	n.so	~s.00	0	0	0	0	0	ıı.woo	Dyıı	~10.000
T4	10.000	66.000	11.000	6.3.<	13.00	0	0	0	0	0	8.3500	Dı11	30.000
T5	20.000	66.000	11.000	J0.00	20.00	0	0	0	0	0	10.0000	D/"	30.000
T6	:0.000	66.000	11.000	10.00	lMO	0	0	0	0	0	10.0000	Dyn	30.000
T7	l?-500	11.000	66.000	8,3S	13.00	0	0	0	0	0	8.3500	\'Nd	30.000
TS	12.!00	11.000	66.000	S.3S	13.00	0	0	0	0	0	8.3500	\'Nd	30.000
T9	10.000	66.000	11.000	Ş.35	13.00	0	0	0	0	0	8.3500	Dyn	30.000
TIO	10.000	66.000	11.000	8.35	H.00	0	0	0	0	0	8.3500	Dyıı	30.000
Tll	Z0.000	66.000	11.000	10.00	20.00	0	0	0	0	0	10.0000	Dyn	30.000
ru	10.000	66.000	11.000	10.00	10.00	0	0	0	0	0	10.0000	Dyıı	30.000
TB	10.000	66.000	11.000	8.35	13.00	0	0	0	0	0	8.3S00	0)11	30.000
!14	10.000	66.0-00	11.000	s'ss	ıs.ee	0	0	0	0	0	s.;soo	Di"	.10.000
!16	10.000	66.0-00	ıı.000	10.00	20.00	0	0	0	0	0	10.0000	0)"11	:10.0-00
Tl7	20.000	66.000	11.000	10.00	20.00	0	0	0	0	0	10.0000	0)1>	30.000
rıs	10.000	66.000	11.000	10.00	10.00	0	0	0	0	0	10.0000	D)11	30.000
Tl9	10.000	66.000	ıı.0-00	10.00	10.00	0	0	0	0	0	10.0000	nl,.	:10.000
no	.1.000	0..100	11.0-00	6.zs	6.00	0	0	0	0	0	6.2500	"l'Nd	.JO.000
rn	1.000	0..100	11.000	6.2s	6.00	0	0	0	0	0	6.ısoo	\'Nd	-30.000
T2l	.1.0-00	0.400	ll.000	6.25	6.00	0	0	0	0	0	6.2500	\'Nd	-30.000
ras	1.000	0..100	11.000	s.ıs	6.00	0	0	0	0	0	6.2500	\'Nd	.JO.000
!14	:1.0-00	0.400	11.0-00	*6.25*	6.00	0	0	0	0	0	6.2500	\'Nd	~10.000
Tl!	3.000	0,400	11.000	*6.25*	6.00	0	0	0	0	0	6.lSOO	\'Nd	-30.000
T26	3.000	0.400	11.000	*6.ı.,*	6.00	0	0	0	0	0	6.2!00	\'Nd	.J-0.000

2..\\'jnding Tr:ınsformerGl'onudingIpput Data

Transformer	R.ıting			Grounding Conn.	Pıi.mary				Secondary			
ID	M:VA	PıiııkV	S,t.kV	Tıp•	T)-pe	k\'	Amp	Ohm	Typ,	k\'	Amp	Ohm
Tl	6MOO	ıı0.000	66.000	Dil'					Solid			
rs	63.00-0	ıı0.000	66.000	DIY					Solid			
T4	10.000	66.000	11.000	Dil.'					Solid			
TS	20.000	66.000	11.000	Dil'					S.tid			

2-ViudiugTraul≥fo11ller GrouptJing Input Data

Transformer ID	Rating MYA	~	~	Conn. ~	Grounding Primary T~l)t	~	~	Grounding Strondary 1)1)t	~
T6	20.000	66.000	11.000	D/Y				Solid	
!7	ll.SOO	11.000	66.000	DIY				Solid	
T8	ll.500	11.000	66.000	DN				Solid	
!9	10.1100	66.000	11.000	D/Y				Solid	
TIO	10.000	66.000	11.000	Dili				Solid	
Tl!	10.000	66.000	11.000	D/Y				Solid	
Tl:!	20.000	66.000	11.000	Dil:				Solid	
!13	!MOO	66.000	11.000	DIV				Solid	
TU	10.000	66.000	11.000	Dil:				Solid	
T16	10.000	66.000	11.000	Dil:				Solid	
!17	10.000	66.000	11.000	Dil:				Solid	
TIS	10.000	66.000	11.000	Dil:				Solid	
T19	10.000	66.000	11.000	Dili				Solid	
no	3.000	0.400	11.000	Dil:				Solid	
n1	3.000	0.400	11.000	D/Y				Solid	
Tl?	3.000	MOO	11.000	Dil:				Solid	
TZ3	3.000	0.400	11.000	Dil:				Solid	
Tl4	3.000	0.400	11.000	Dil:				Solid	
ris	3.000	0.400	11.000	D/Y				Solid	
Tl6	3,000	0.400	11.000	D/Y				Solid	

Brauch Connections

CI\.'T/Bı-anch		Connected Bu, ID		% Positi\'t-Sequence Impedance (100MYABa,.)			
IO	Type	Frcın Bus	To Bu,	R	X	Z:	y
T1	zw:xnm	Bus3	Busl	0..l.l	19.84	19.s.ı	
n	::wxnm	Bu.S	BusZ	0.44	19.84	19.&I	
T4	'!WXE\!R	Bu,;l	Bus6	6.40	83.IS	83.50	
TS	?WXFlffi	Bu<I	Bııs9	Z.50	49$4	$0.00	
T6	?WXFlffi	Bu.S	Busl0	2.50	49.94	$0.00	
T1	:.?WXF?tfR	Bus-fl	Bosll	5.12	6MO	~SO	
TS	2wxnm	Busu	Bu'12	&.U	6MO	~80	
T9	'IWxnIR	Busl3	Busl5	6.40	83.ZS	SS.Se	
TIO	lWXFMR	Butl4	Busl6	6.40	SS.IS	83.50	
Tll	?WXFlffi	Busl7	Busl9	l.SO	49.114	50.00	
Tl?	2wxnm	BuslS	Bu,20	?.50	4?.94	$0.00	
Tl3	?WXFllR	Busll	Bustz	6.40	S3..?S	83.SO	
TU	?WXFl!R	Bu,;?3	Bus25	6.40	$3.25	8,\.50	
Tl6	?WXFl!R	Bus27	Bus28	2.50	49.94	50.00	
T17	1wxnm	Busl7	Bu,29	l.50	49.94	50.00	
TIS	lWXFllR	Bus30	Bus32	l.50	49.94	$0.00	
Tl9	l:WXFMR	Bus31	Bu,33	1.50	49.94	50.00	
TZO	2WXFAIR	Bus34	BusJl	34.lS	205.50	208.13	
Tl!	?WXFl!R	Bus3$	Bus41	3.1.l.<	20!:.50	208.J3	
Tl?	2WXFl!R	Bus36	Bu,41	34.2$	205.50	208.13	
Tl3	ıwxnm	Bus37	Bıı,41	3U.5	20r...;o	208.J3	
T'!4	2WXFMR	Bus38	Bu,42	J..1.?5	20S...;.0	l0S.l3	
rıs	2WXFltR	Bus39	Bus-12	34.25	205.50	208.-'3	
Tl6	lWXBffi	Bu<IO	Bus.tl	34.lS	205.50	208.13	
Cablel	C.bl•	Busll	Bıısl	0.02	0.0l	0.0.l	0.0716998
Cable:!	Cablt	BusU	Busl	0.0l	0.02	0.03	0.0716998
Lin,!	Lint	Bu.çl	Busl4	2.48	16.58	16.77	o.%601619
Lind	Lint	Busl	Busl3	:us	15.16	15.36	o.2&12166
Lin,3	Lin,	Bus2	Buds	Z.96	ISM	18.30	O.l.!87157
u...1	Liu,	Bus:?7	Busl7	1.93	1L78	1L94	o.2209015
Lln,S	Liu•	Busl	Bus27	1.03	6.28	U1	o.msuı
Liu,6	ll..	Busl	Bus.7	0.51	3.14	$.18	0.0$89071
Liıı,7	Lint	Bıt'i:l	Bus8	o.51	3.14	S.IS	0.0$89071
LiıııS	Lm,	Bu,2	Bus7	o.51	3J4	j.J8	0.0$89071
Unt9	Llnt	Bud	Bus8	o.51	3.U	3.18	0.0$89011
u..IO	Lhıe	Busl	Bus31	L03	ô.IS	6.37	0.1178142
Lln,11	Lin•	Busl	Bus.~0-	1.03	6.18	6.37	0.117814?

DESIGNOF A LARGE SCALESOLARPV SYSTEMAND IMPACT Ai'<ALYSISôFIT$ ll\TEGRATION INTO LIBYANPOWER GRID

CKT/Braııch		Cı,nn..:ted Bus ID		% Posltin Sequence Impedance (lOOi\lVABase)			
ID	Type	From Btu:	To But	R	X	Z	y
Lind?	Lııe	B11'17	**Bu$ll**	1.70	**16.49**	16.71	0.3092622
Lintl3	**Line**	Bu'17	Bus23	20.70	**126.43**	128.ll	2.3710100
Litıd4	Lin•	**Btt~21**	**Busl..**	18.00	**109.94**	Il1.1C	2.0617480

J}ran5:hConııeıdious

Zero SequenceImpedance

CKT/Brandı		ConnectedBus ID		o/o lınpedauteIZı>roSeq. 100 i\tV Ab			
ID	T~'P"	Fı·onıBus	T<JBu~	RO	XO	Zil	\'O
Tl	2WXfuu·	Busl	Bu,l				
rs	!WXfınr	Buss	Bu,l				
T4	:nVXfınr	Bud	Bus6				
T5	2\VXfuu·	Bm7	Bu59				
T6	:1WXfınr	Bu.S	Bu,10				
T1	2WXfmt·	Bus,ll	Bu.~ll				
TS	ZWXfınr	Bus41	B~Il				
T9	lWXfmr	Busl3	Baul$				
TIO	2WXfınr	BusH	Busl6				
Tl!	2WXfınr	Bu!:17	Bnd9				
Tl2	2WXfını·	Bud8	Bns?-0				
TU	lWXftrU'	Bu,21	Bı.rt?2				
Tl4	2WXfınr	Bns23	Busl5				
Tl6	I\VXfmr	Bu,27	Bus28				
Tl7	2WXbnr	Bnsl7	Buıl9				
TIS	2WXfınr	Bu,30	Bu<l2				
T!9	2WXfuu·	Bu<ll	8"'33				
no	lWXfınr	Bus3.t	B"'41				
rn	lWXfmr	Bus3:ı::	Bu,41				
Tl?	2WXl'nır	Bu,36	Bus.ltl				
T23	lWXtım·	Bııs..'7	B"'41				
TI4	2WXfuu·	Bus38	Bm-1?				
TlS	lWXfmt·	Bu<l9	Bus.12				
TI6	lWXfmr	Bu,40	Bus-42				
Cahid	Cable	Bus.II	Bnsl	0.06	0.0$	0.07	
Cablr-l	C•bl,	Busll	Bud	O.o6	0.0$	0.67	
Lind	Liıı•	Busl	Busl-I	8,86	60.29	60.94	o.u1om
Uae-2	Liııt	Bud	Bm13	8.89	63.09	63.72	0.1341983
LıuJ	Lint	Busl	Bml8	10.$9	*15.19*	*15.9.*	O.lS99ISS
Liıit4	Liıı•	Bus:?7	Ba,17	6.91	49.04	49.52	0.1042992
Liue-5	Liıı,	Busl	Bın?7	3.68	*16.15*	%6.41	0.0556262
Lw6	Lüıe	Bu,;2	Bu~7	1.84	13.08	13.%1	0.0mm
Lıııt7	Liıie	Busl	B...S	1.84	l.1.08	13.21	0.0278131
Lin.S	Liıı,	Btis2	Bu'3;7	1.84	l.1.08	13.21	O.Ol78Ul
Liıı,9	Liııt	Busl	B.,8	1.84	13,08	13.2]	0.0278131
Lin.JO	Liııt	Bu~l	B..31	.l.68	*16.15*	26.41	0.05;6262

Cl\.ı/Bnıncb		ConnectedBns ID		% Impedance, Zero seq., 100 l\I'i'Ab			
ID	Tn>t	From Bus	To Bu~	RO	XO	ze	YO
Lınell	*Lıne*	Bud	BU>30	3,68	26.IS	26.41	0.0;Sl;m
Liıtll	**Line**	Bu,17	**Bt611**	9.67	*68,65*	69.33	0.1460189
LInıtl3	Liae	Bu,17	**Bu$23**	74,16	S26.33	531.53	1.1194780
LIneI4	Llıı•	**Butll**	**BmZ3**	*6U8*	4S7.6S	**-'61.lO**	0.9734595

Machiue **Input Data**

M.ı.chine		Connected Bus	Rnting(Base)			0/o Negattve Seq. Imp.			Gı·ouuding			%Z.ı·o Seq. Imp.		
ID	Tjpe	ID	MVA	1V	RľM	XIR	JU	X1	Conn.	Typı,	Amp	XIR	RO	XO
Ul	Glid	Bus3	22.101	220.000		10.00	9.9$0	99.50	Wyıe-	Solid		10.00	3M.CS	356.48
U2	Grid	Bu<l	22.101	ll0.000		10.00	9.950	99.50	Wyt	Solid		10.00	17.738	177,38
U3	Grid	B..S	22.101	120.000		IMO	9.9,0	99.50	Wy,	Solid		10.00	17.738	177.38

lfarmonic Libı·aıy

CUtl.ffil..ffa_ı·ın_cıııl_ç_S_Q lfff ~i ı,t o/o

l\Lınufactnrel': Typkal-IEEE
Model: 12 Pnlse2

Ordtı·	Fnq. Hz	Mag. %	Oı"<ltr	Freq. Hz	l.hg. %	Ordtr	Fttq. Hı,	Mng. L	Ordt.ı· --	Fttq, !!·.	Mag. L	Ordtr --	Frtq. ~	lbg. L	Or.&ı• --	Freq. !!·.	Mat;. L
1,00	S0.00	100.00	11.00	$SO.CO	8.lO	13.CO	6>0.00	6.70	2ı.oo	ıısо.oo	2.80	lS.00	ıısо.oo	2.JO	JMO	1750.00	MO
37.00	18$0.00	0.60	l7.CO	llS0.00	0.20	49.00	2450.00	0.'10									

:M.nuufactureı·: Typk,ıl-lEEE
Model: 12Pulse2

Or,1tr	Freq. Hz	M,g. %	Ordtr	Freq, Hı	M.,ıg. %	Ord:tr	Fr,q. Hz	Mng. %	Ordtr	Freq. Hz	Ma;. %	Oı·d,r	Foeq, Hz	Mag. %	Ordtı·	Fr,q. Hz	Mag. %
1.00	scee	100.00	11.00	550.00	S.'l0	13.00	6;0.00	6.70	23.00	1150.00	2.80	!MO	ln0.00	ı.'ıö	3S:ôö	"nıö.00	0.SO
37.00	1850.00	0-60	ıı.oo	?3$0.00	0.20	49.00	USO.OD	0.20									

Manufacturer; Typkal·IEEE
l'ıloılel: 12 Pul,e2

Order	Freq, Hz	Mag. %	Ordtr	Fn:,q. Hı	Mag-. ~fl'	Ordtr	Fı·eq. Hı	?tfııg. %	Ordu	Fnq, Hı	Mag. •	Ord,r	Fnq. Hz	Mag. %	Ord"	Freq, Hı	Mag. %
1.00	S0.00	100.00	11.00	SW.OD	8.lO	13.00	6>0.00	6.70	23.00	1150.00	2.80	!MO	ln0.00	ı.'ıö	3$.00	"rnö.öö	0.SO
37,00	1850.00	MO	'7.00	llS0.00	0.ẑo	l9.00	UW.00	0.%0									

l\fanufacturel': Typical~IEEE
Jl[odel: 12 Pulse2

Ordoı·	Fı"J, Hı	Mag. ~iı.	Ordt.r	Freq, Hz	M>g. %	Ordtr	Freq, Hz%	Mag.	Ordtr	Frtq. Hı	Mag. !!	Ordtr --	F~. !!?	Mag:; L	Ordtt' --	Frtq. !!?	Mag. -·-
1.00	;o.oo	100.00	11.00	s;o.oo	s.ıo	1J.oo	6SO.oo	6.70	23.00	mo.oo	2.8ll	15.00	1!50.00	2.30	3$.00	1750.00	0.S0
37.00	1850.00	MO	,1.00	%3S0.00	0.:?0	.t9.00	:ııs0.00	0.20									

Harmonic Sonrc:e froın Libraıy

Bu,ID	Derice ID	Harmonic Seurce Information				
		~	Al:ıuufacturt:1·	Moıltl	Fıtud. Frtq.	Mod. Fı'flJ.
Bıı,34	ln\'11	**Cmnut**	typkıd-trEE	lll'uls,l	0.00	0.00
Bus3~	lu\'15	**Cnrrtnt**	Typkıιl-IEEE	**12 Pulu·l**	0.00	0.00
Bıı'37	lm'l8	**Currtot**	Trpkıd-IEEE	**llPulse-1**	0.00	0.00
Bu,39	**Indl**	**Curi.ttt**	Typkıιl-IEEE	12 Pulstl	0.00	ae0

Project:	~IASIER THESIS	ETAP	Pago: 15
Loc.nfion:	HOllN CITY -LİBYA	12.6.0H	Dato: 28-06-2016
Contract:	NEAR EA.SI I!I\TI'ERSJTI' • :EEE Department		SN:
Eagineer:	SAND MUSIAf A A.1.-REF Al	Study Case: HA	Refüion: Base
Filenaıne:	HOllN .SUBSTATION 220kV		Config: **Normnl**

DESIGN OF A LARGE.SCALE SOLAR PV SYSTEM AI\'D IMPACT ANALYSIS OF ITS INIEGRAIIONINTO IJBYAN POWER GRID

fmulameutal Load pto,,• Report

Bus			~	Generation	~			Load Flow					XFlllR
ID	!!	~	~	2!.'!	~	~	~	ID	AnV	~	Amp	~	%Tap
Busl·	66.000	101.039	-Z9.I	0	0	0	0	**Bw.U**	-7.726	0.622	67.1	-99.7	
								BusU	0.000	.0.290	2S	0.0	
								Bus17	0.014	.$.Z?I	4>.6	.0.3	
								Buss	0.000	.0.060	ns	0.0	
								Bu.s$	0.000	.0.%0	0.5	0.0	
								Bus.10	0.000	.0.120	I.0	0.0	
								Bus3	7.712	>.180	SM	83.0	
								Busl$	MOO	MOO	0.0	0.0	
Busl	66.000	100.109	.10.,	0	0	0	0	**Bn.sll**	.-.199	0.384	50.S	-99.8	
								Bu,14	0.000	.0.261	!.3	0.0	
								Busl8	0.000	.03-10	3.0	0.0	
								Bus7	0.000	.0.059	as	0.0	
								Bm7	0.000	.0.059	as	0.0	
								Bu.ll	0.000	.0.11S	I.O	0.0	
								Buss	s.m	cus.1	50.S	99.7	
***Bus$**	220.000	100.000	0.0	-7.708	.s.ou	0	0	**Busl**	-7.708	..$.0I?	24.1	8S.8	
"Bus5	%20.000	100.000	0.0	-5.198	-0.386	0	0	**Busl**	-5.798	.0.386	15.1	99.8	
Bus6	11.000	101.039	.SS.1	0	0	0	0	**Bud**	0.000	0.000	0.0	0.0	
Bus7	66.000	100.110	30.7	0	0	0	0	**Busl**	0.000	0.000	0.0	0.0	
								Bns2	0.000	0.000	0.0	0.0	
								Bm9	0.000	0.000	0.0	0.0	
Bu.a	66.000	101.040	-19.J	0	0	0	0	**Bud**	0.000	0.000	0.0	0.0	
								Busl	0.000	0.000	0.0	0.0	
								Busl0	0.000	0.000	0.0	0.0	
Bus9	11.000	100.110	0.7	0	0	0	0	**Bus:?**	0.000	0.000	0.0	0.0	
Bud 0	11.000	101.040	-59,1	0	0	0	0	**Buss**	0.000	0.000	0.0	0.0	
Busll	66.000	100.110	30.7	0	0	0	0	**Busl**	5.799	.0.456	50.S	-99.7	
								Bus·il	.s.m	OA56	50.8	-99.7	
Busl?	66.000	101.041	-29.1	0	0	0	0	**Busl**	7.726	.0.695	61.2	-99.6	
								Bu..ıl	-7.7M	O.@S	61.2	-99.6	
Busl.I	66.000	101.061	-29.1	0	0	0	0	**Bud**	0.000	0.000	0.0	0.0	
								Bud5	0.000	0.000	0.0	0.0	
Bud4	66.000	100.130	30.7	0	0	0	0	**Bus?**	0.000	0.000	0.0	0.0	
								Buslil	0.000	0.000	0.0	0.0	
Bus*IS*	11.000	101.061	-59.I	0	0	0	0	**Bud!**	0.000	0.000	0.0	0.0	
Bud.6	11.000	100.130	0.7	0	0	0	0	**Bud4**	0.000	0.000	0.0	0.0	
Busl?	66.000	101.950	-29.2	0	0	0	0	**Bus27**	.0.007	4.968	41.6	-O.I	

Bus		Voltage		Geuentiou		Load		Load Flow					XfMR
m		~~~A~	.~~r~~					ID	~~~~%Top				
								Busll	0.00,t	~!..f86	21.3-	.e.1	
								Bus23	0.003	-:l.481	ll.3	.ü.I	
								Bud9	0.000	0.000	o.o	o.o	
Bus!S	66.000	100.139	.10.7	0	0	0	0	Buıl	0.000	0.000	o.o	o.o	
								Bu~O	0.000	0.000	o.o	o.o	
Btul9	11.000	IOl.950	-59.l	0	0	0	0	Busl7	0.000	0.000	o.o	o.o	
Busl 0	ll.000	100.139	0.7	0	0	0	0	Bus.18	0.000	0.000	0.0	0.0	
Bus:21	66.000	1020,:6	-29:3	0	0	0	0	Busl7	.o.001	un	18:6	.O.I	
								Busl.3	o.001	.:l.ın	18:6	-O.I	
								Bu~l2	0.0D0	C:000	0.0	o.o	
Busl?	11.000	101.326	-59.3	0	0	0	0	Busll	0.000	0.000	0.0	0.0	
Bm?3	66.000	103.500	-29.4	0	0	0	0	Bu:.ı7	0.000	.0.001	0.(1	~16.2	
								Bus?l	0.0D0	0.001	0.0	„16.:l:	
								Bu$!$	0.000	0.000	0.0	0.0	
Bıts2$	11.000	103.500	-S9A	0	0	0	0	Bus23	0.000	0.000	0.0	o.o	
Bus27	ff.OD0	ICl.363	-29,l	0	0	0	0	Bud7	0.ell	-'t,1~7	~4.6	..0.?	
								B,ul	-O.Oil	5.167	.f.1.6	..0.?	
								BuslS	0.0D0	0.000	o.o	o.o	
								Bıu.19	0.0D0	0.000	0.0	o.o	
Bus?S	11.000	101.363	-S9.1.	0	0	0	0	But:?7	0.000	0.000	0.0	0.0	
Buıl9	11.000	101.363	-59.2	0	0	0	0	Busl7	0.000	0.000	0.0	0.0	
Bw:30	66.000	ICl.elS	.29.1	0	0	0	0	Bud	0.000	0.000	0.0	0.0	
								Bus.1Z	0.000	0.000	o.o	o.o	
Bu,31	ff.ooo	ıoo.m	ıo.1	0	0	0	0	Busl	0.000	0.000	0.0	o.o	
								Bın.l3	0.000	0.000	o.o	0.0	
Bum	11.000	IOLOH	-5~.1	0	0	0	0	Bud 0	0.0D0	0.000	ll.0	0.0	
Bu,33	11.000	ıoo.m	o.,	0	0	0	0	But31	0.000	0.000	0.0	0.0	
Bu,34	0.400	101.6S5	-24.0	l.9SZ	0.000	0	0	Bus.ti	1:952	0.000	?776.4	J00.0	
BU'S85	0..l00	101.SSS	.1.1.0	lJISZ	0.000	0	0	BuHl	1.93?	0.000	l770A	J00.0	
Bın36	0..l00	101.685	.2.i.o	l.9Sl	0.000	0	0	Bus-II	1.95?	0.000	1770.4	100.0	
Bud7	0..l00	101.SSS	.1.1.0	1.951	0.000	0	0	Buwl	1.952	0.000	l77M	100.0	
Bus3S	0.400	100.161	~\S.Z	l.SISZ	0.000	0	0	BuçJ2	1.95?	0.000	2m.1	100.0	
Buı39	MOO	100.761	35.l	l.'J$Z	0.000	0	0	Bw41	1.951	0.000	2795.7	J00.0	
Bu~40	0.400	100.762	35.2	l.952	0.000	0	0	BuWl	1.951	0.000	?79S.7	J00.0	
Bın.U	11.000	ıoı.ıo.ı	-56.l	0	0	0	0	Busll	1.156	.0.303	403.0	-99.9	
								Bu~.f	-1.939	0.()76	100.7	.99.9	
								Bus35	-1.939	O.ı76	100.7	.99J	
								Bus36	-1.939	0.076	100.7	-99.9	
								Bm3i	-1.939	0.076	100.7	-99.9	

DESIGN OF A LARGE SCALE SOLARPV SYSTEM AND L\IPACT ANALYSIS OF ITS INTEGRATION INTO LIBYAN POWER GRID

Bu,		~		Geueı·ation		Load		Lo•d Flow					XFMR
ID	kV	~~~			M"r	.~~		ID	MW	~	~	°||.=	~
Bus>J:l	11.000	100.178	2.9	0	0	0	0	Bndl	5.817	-0.231	30S.O	-99.9	
								Bu~~s	.J.939	0.077	101.7	-99.9	
								Bus39	-1.939	0.077	10L7	-9M	
								Bu.1..f(l	-1.939	0.077	101.7	-99.9	

• Indk alts a ,·oltagt ngulattd bu'l (niltage tonfrolled er suing type- ın:ıddue coontdtd tt> if)
indkatt'S a bus fflth ıı load minnaırh of moı~ tlı.ı:u 0.1 '-ffA

§':strm Harmopics Bus Infoumatlon

Bns ID	IV	Fond. %	RMS %	ASIJ'll %	THD %	m	TIHD %	TSHD	THDG %	THDS %
Bud	66.000	101.0.1	JOI.O?	lOS.13	1.31	53.04	0,00	0.00	l.12	Z.3Z
Bu~l	66.000	100.11	100.ll	101.91	1.14	20.5-1	0.00	0.00	1.14	1.14
Bus3	220.000	100.00	100.03	103.91	:?.ZS	51.33	0.00	0.00	2.1!i	l.25
Bus5	.!20.00~	100.00	JOO.Ol	101.72	1.09	19.70	0.00	0.00	1,09	1,09
Bus6	11.000	101.04	101.01	!OS.13	2.32	$3.04	0.00	0.00	l.32	2;.l?
Bu-s:7	66.000	100.11	100.!Z	101.91	1.14	20.~8	0.00	0.00	1.14	1.14
BuuS	66.000	101.04	101,07	lOS,14	2;.~2	.$3..21	0.00	0.00	2.3::!	2.32
Bus9	11.000	100.11	100.ll	101.91	1.14	20.58	0.00	0.00	1.14	1.14
Busl0	11.000	101,04	101.01	105.14	l.31	53.ll	0.00	0.00	Z.32	2.32
Busl!	66.000	lee.11	lee.11	101.91	1.14	20.54	0.00	0.00	1.14	1.14
Busl%	6MOO	101.04	101.07	105.13	l.3:?	53.05	0.00	0.00	2.32	2.32
Bu,l.l	66.000	101,06	101.09	105.40	l.40	51$8	0.00	0.00	Z..l0	2..l0
Bud-t|	66.000	100.13	100.14	101.01	1.17	n.Sl	0.00	0.00	1.17	1.17
Bu,15	11.000	101.06	101,09	105.40	Z.40	57.58	0.00	0.00	l.40	!.40
Bu'16	ll.000	100.13	100.U	lel.el	1.17	21.51	0.00	0.00	1.17	1.11
Busl7	66.000	101.9S	101.97	!OS.Ol	1.89	36.15	0.00	0.00	1.8?	U!9
BudS	66.000	100.14	100.15	102.06	1.19	21.99	0.00	0.00	U9	1.19
Busl9	11.000	101.95	101.97	!OS.Ol	U9	36.15	0.00	0.00	1.89	1.89
BU$l0	11.000	100.14	100.1$	102.06	1.19	Zl.99	0.00	0.00	1.19	1.19
Busıl	66,000	102.33	101.34	105.s.ı	1.19	51.33	0.00	0.00	1.19	1.19
Busl?	11.000	101.33	101.34	105.84	1.79	51.33	0.00	0.00	1.79	1.79
Bus:?3	66.000	103.50	103.55	107.72	2.96	47.16	0.00	0.00	l.96	2.96
Bus-25	11.000	103.50	103.55	107.71	Z.96	47.16	0.00	0.00	2.96	Z.96
Bml7	66.000	101.36	101.39	105.02	Z.IS	43.49	0.00	0.00	l.15	l.15
BuslS	ll.000	101.36	101J9	105.0l	2.15	43.49	0.00	0.00	l.15	2.15.
Btnl9	ll.000	101.36	101.39	!OS.0l	1.15	43.49	0.00	0.00	2.15	2.1$
Bus30	66.000	101.04	101.07	105.17	?.33	S3.7>	0.00	0.00	a.ss	:?.33
Bus31	66.000	100.lL	100,ll	101.91	l.IS	20.70	0.00	0.00	1.15	LIS
Bus3l	11.000	101,04	IOl.o?	10!.17	2.33	53.73	0.00	0.00	2.33	'!.33
Bus33	ll.000	100.11	100.11	101.92	1,15	10,70	0.00	0.00	1.1$	1.15
Bus34	0.400	101.6S	101.91	ll?.50	6.13	213.30	0.00	0.00	6.73	6.73
Bus35	MOO	101.68	101.75	109.U	3.69	130.71	0.00	0.00	3.69	3.69
Bus36	0.400	101.68	101.91	117.50	6.73	273.JO	0.00	0.00	6.73	6.73
Bus37	D.400	101.68	101.91	117$0	6.73	273.30	0.00	0.00	6.73	6.73
Bus38	0.400	100.16	100.76	102.1'9	eSS	ZS.34	0.00	0.00	0.58	0.58
Bnh\9	0,400	100.76	100.83	110.01	3.61	181.76	0.00	0.00	3.61	3.61
Bus40	0.400	100.76	100.16	102.19	USS	18.34	0.00	0.00	aSS	0.58
Bn!41	11,000	101.10	101,18	109,18	3,9?	U0.38	0.00	0.00	3.97	3;97
Bus.I?	ll.000	lee.IS	100.18	101.70	0.6:?	30-46	0.00	0.00	MJ	0.63

ı. IndkatesTHD(rot.al HarmonicDistortion)Exctrds the Limit.
#. Indicates llID (IndhiduntHnnnonkDistortion} Euttds tht limit,

Pr·oject;	!ıL-1.STERTHESIS	ETAP	Page:	19
Location:	HOUN.CITY -LIBYA	12.MH	Date:	28-06-2016
Om tract:	NEAR EAST UNIVERSITY• .EEE Dèp•rnn•nl		Sfü	
Engineer:	SMII I\WSTAFA AL-R.EFAI	StudyCase: HA	R~,·isiou:	Base
Filenaıneı	HOUN SUBSTATION220kY		Conﬁg:	Normal

DESIGN OF A LARGE SCALE. SOLARPV SYSTEM A.'ID I.ılPAGT ANALYSIS OF ITS INTEGRATION INTOUB\'k'I POWER GRID

System ijar.egnics Bı·auch Ipfonn:ıfjgu

Bus		CurrentDistortion											
FromBu11D	ToBılŞID	Fuad. Amp	RMS Amp ~	ASUM	TIID %	TIF	IT Amp	1TB JTDL	!Tu Amp	TillD ··,o	TSIID %	TIIDG %	THDS %
Bud	Bttd2	67.11	67.1$	71.91	M6	98.65	66lH6	66'.U.$6	0.00	0.00	0.00	3.66	M6
	Bıcl3	1.51	Z.63	4.13	31.18	1067.19	1808.61	2808.61	0.00	0.00	0.00	31.18	31.18
	Bu~Z7	4S.64	4>.7I	51.39	6.51	115.97	$1871.8?	9871.82	0.00	0.00	0.00	6.57	6.51
	B'''ß	O:il	0.54	0.84	30.34	1005,48	5-17.0S	5-11.-08	0.00	0.00	0.00	30.34	30.34
	BusS	0.$?	0.5-l	o.84	30.34	1005.48	547.0S	547.08	0.00	0.00	0.00	30.34	30.34
	B~O	I.Q4	1.09	Ü9	30,44	I0IIJI	110?.09	Jl(ll.-09	0.00	0.00	0.00	30A4	3M4
	Bud	8().43	8-0.43	81.00	0.46	8.15	6S5.68	655.68	0.00	0.00	0.00	0.46	0.46
	Bu,6	0	0	0	0	0	0.00	655.68	0.00	0.00	0.00	0.00	0.00
Bu.12	Budl	50.79	50.79	51.38	1.64	41.16	1090.84	1090.84	0.00	0.00	0.00	1.64	1.64
	Busl4	.1.IS	1.31	1.86	13.81	316.86	730.SI	730.51	0.00	OM.	0.00	13.81	13.81
	BudS	1.97	3.00	3.73	13.91	313.86	970.03	970.03	0.00	0.00	0.00	13.91	13.9!
	Btts7	O.Sl	0.S.2	M4	13.58	304.59	!SS.S7	158.57	0.00	0.1)(1	0.00	13.SS	13.SS
	Bu11	0.$2	O.S?	0.64	13.58	304.59	158.57	158.51	0.00	0.00	0.00	IJ,SS	13.SS
	~!	1.0.,	1.04	1.19	13.61	306.03	318.66	318.66	0.00	0.00	0.00	lMI	13.61
	e~!:	50.83	50.83	~1.09	O~ti	5.95	302.37	301.37	0.00	0.00	0.00	0.36	0.36
Bu$.\	Bıcl	2U3	24.U	14.IO	0.46	aıs	196.70	196.70	0.00	0.00	0.00	0.46	0.46
Bu.S	Bus?	IS.IS	15.25	15.33	0.36	5.95	90.71	90.71	0.00	0.00	0.00	0.36	0.36
Busti	Bud	0	0	0	0	0	0.00	90.71	0.00	0.1)(1	0.00	0.00	0.00
But7	Butl	0	0	0	0	0	0.00	90.71	0.00	0.00	0.00	0.00	0.00
	B:.Z	0	0	0	0	0	0.00	90.71	0.00	0.00	0.00	0.00	0.00
	Bu,9	0	0	0	0	0	0.00	90.71	0.00	0.00	0.00	0.00	MO
Bu.S	Busl	0	0	0	0	0	0.00	90.71	0.00	0.00	0.00	0.00	0.00
	Bu,!	0	0	0	0	0	0.00	90.71	0.00	0.00	0.00	0.00	0.00
	BnslO	0	0	0	0	0	0.00	90.71	0.00	0.00	0.00	0.00	0.00
Bu,ı>	Bu,7	0	0	0	0	0	0.00	90.71	0.1)(1	0.00	0.00	0.00	0.00
Busl 0	B'''ß	0	0	0	0	0	0.00	90.71	0.00	0.00	0.00	0.00	0.00
Bu,11	B:.Z	50.8.1	50.84	sıss	1.80	44.89	Zl8l..17	1282.37	0.00	0.00	0.00	1.80	1.80
	B®'Z	50.83	50.84	52.SS	1.80	44.89	2?82.37	118?.J7	0.00	0.00	0.00	1.80	1.80
Bud?	Bıcl	67.16	67.IO	71.81	3.57	93.57	6288.?5	6188.I5	0.00	0.00	0.00	3.S7	3.57
	Bus,11	67.16	67.lO	71.81	3.57	93.51	6288.IS	6288.25	0.00	0.00	0.00	3,S7	3.57
Busl3	Busl	0	0	0	0	0	0.00	6288.15	0.00	0.00	0.00	0.00	0.00
	Bu.'ôl5	0	0	0	0	0	0.00	6:?88.Z5	0.00	0.00	0.00	0.00	0.00
Busl4	Bııs?	0	0	0	0	0	0.00	6288.IS	0.00	0.00	0.00	0.00	0.00
	Bud6	0	0	0	0	0	0.00	6?83.?5	0.00	0.00	0.00	0.00	0.00
Busl5	Bıcl3	0	0	0	0	0	0.00	6288~S	0.00	0.00	0.00	0.00	0.00
Bn,16	Bu,U	0	0	0	0	0	0.00	6l8S,1S	0.00	0.00	0.00	0.00	0.00
BUJ1'17	B1'27	4Z.6$	J?.77	48.61	8.07	ZSS.0.1	11036.00	11036.00	0.00	0.00	0.00	8.07	S.07
	Bıı~ll	11.33	21.45	25,19	1M6	448,69	9625.84	9615.~	0.00	0.00	0.00	10.66	10.66
	Bu,l3	%1.30	?I.H	23.80	6.56	181.11	3865.78	3865.78	0.00	0.00	0.00	6.56	6.56
	Busl?	0	0	0	0	0	0.00	3865.78	0.00	0.00	0.00	0.00.	0.00

Bus		Current Distortion											
Fl'omBw;ID	T<>BınID	Fund. ~~Y'>L	R.\!S	ASii~!	ran %	TIF	IT AffiL~	ITB	ITR Amp	mro %	TSHD %	THDG %	THDS %
Butl8	Busl	0	0	o	0	o	0.00	3865.78	0.00	0.00	0.00	0.00	0.00
	Bu~O	o	o	0	o	o	0,00	386.<.78	0.00	0,00	0.00	o.oo	0.00
Bu,sl9	Busl7	0	0	o	o	0	0,00	3865.78	0.00	0.00	o.oo	0.00	0.00
Bus:lO	BndS	0	o	0	o	o	0.00	3865.78	0.00	0.00	0.00	0.00	0,00
Bual	Bud7	18.57	18.72	B.OB	ll.90	445.83	8347.30	8347.30	0.00	0.00	0.00	12.90	nse
	Buı:3	18.57	18.7.2	23.0S	ll:90	445.83	83Ji.30	8.147.30	0.00	0.00	0.00	ll.90	1:.sıo
	Busl"?	0	o	0	o	0	0.00	8347.30	0.00	0.0Q	0.00	0.00	o.oo
Bus22	Bus?l	0	0	o	o	0	0.00	S3l7.30	0.00	0.00	0.00	o.oo	0.00
Bus:?J	,Bııl7	O:Ol	0.39	0.15	-4650.?0	Z613,0S	1019.93	1019.93	0.00	0,00	0.00	~S50,l0	4S50,l0
	Bus.?l	Ml	0.39	0.75	4850.10	1613.08	1019.93	1019.93	0.00	o.oo	0.00	4850.20	4850.20
	»11~.1s	o	o	o	o	o	0.00	1019.93	o.oo	0,00	0.00	o.oo	0.00
Bus25	Bum	0	o	o	0	o	0.00	1019.93	0.00	0.00	o.oo	0.00	o.oo
Bus:?7	Bus17	,U.59	44.71	50,S6	7.15	:37.32	10610;18	10610.28	0.00	0.00	o.oo	1.1S	1.15
	Busl	44.59	44.71	S0.56	7.15	237.ll	10610.28	10610,lS	0.00	o.oo	0.D0	7,lS	7~15
	Bus!S;	o	o	o	o	o	0.00	10610.)8	0.00	0,00	0.00	0,00	0.00
	Bru29'	o	o	0	o	o	0.00	101110.ZS	0.0D	0.00	0.00	0.00	o.oo
Bus?S	Bw27	o	0	o	o	o	0.00	10610.Z8	0.00	o.oo	o.oo	0.00	o.oo
Bu.sZ9	Btu.?7	o	o	o	o	o	o.oo	10610.28	0.00	0.00	o.oo	0.00	0.00
Bıııl30	Busl	0	0	o	o	o	0.00	10610.)8	0.00	0,00	0.00	0.00	0.00
	Bus3!	o	o	0	0	o	0.00	10610.lll	0.00	0.00	0.00	0.00	0.00
Bıııl31	Busl	0	o	0	o	o	o.oo	10610.18	o.oo	o.oo	0,00	0,00	0.00
	Bu,33	o	o	0	o	o	0.00	10610.lS	0.00	0.00	o.oo	0.00	0.00
Bus.\!	Bus..,0	o	o	0	o	0	0.00	10610,28	0.00	o.oo	0.00	0.00	0.00
Bıııl3B	Bıııl3l	o	o	o	o	o	0.00	10610.lS	0,00	0,00	0.00	o.oo	o.oo
Bıııl34	Bus41	2770.37	277.1.68	3033.78	4.89	m.69	354180.40	;541so.4o	0.00	0.00	0.00	4.89	4.89
Bu.s.35	.Bıısll	l770,j7	2770.40	179.?.lS	o.so	10.76	29801.97	29801.97	0,0D	o.oo	o.oo	e.se	ase
Bus36	Bw.ıl	2770.37	2773.68	3033.78	4.89	127.69	354180.40	354180.40	0.00	o.oo	0.00	J.89	4.89
II,.II	Bu>II	l7?0.37	2773.68	3033.76	J.89	m.69	;54130,40	3s41so.40	0.00	o.oo	0.00	4.89	4.89
Bus38	Bus.fl	2195.12	Z79:i.7!	l799.l7	O:o?	1.98	5S30.49	5530.49	0.00	o.oo	0.00	o.o,	0.07
Bus39	BUS.:l	ZWS.7!	2799,70	3082.91	5.34	136.04	380861.30	380861.30	0.D0	o.oo	o.oo	S..34	S.34
Bus40	Bu'S-12	2795.7!	2795.72	l799.27	O.o?	1.98	5530.49	5550;49	0.00	0.00	0.00	0.07	0.07
Bus41	Bud:?	402.96	403.22	4?0.94	l.S.7	93.57	37n9.53	37719.53	0.00	0.00	o.oo	3.57	3.$7
	Bıııl34	100.74	100.86	110.32	4.89	1?7.69	ll879.l9	llS79.l9	0.00	0.00	o.oo	4.89	4.89
	Bıı,35	100.74	100.74	101.53	o.so	10.76	1083.71	1083.71	0.00	0.00	0,00	ase	o.so
	Bıı,36	100.74	100.86	110.32	4.89	m.69	1!879,29	12879,29	OM	0.00	0.00	4.89	4.89
	Bıı,37	100.74	100.86	110.31	4.89	m.69	1?879.29	1?879.29	0.00	0.00	0,00	4.89	4.89
BııU	Busll	304.99	305.04	31s.,16	1.80	44.89	13694.ll	13694.l?	0.00	o.oo	0.00	1.80	1.80
	Bıı,38	101.66	101.66	101.79	O.o?	1.98	201.11	zel.n	0.00	0.00	0.00	0.07	0,67
	Bıı.s39	101.66	101.81	111,11	5.34	136.04	13849.!0	13849.50	0,00	0,00	o.oo	5.34	5-'4
	Bus40	101.66	101.66	101.79	0.07	1.98	sel.ll	lel.ll	o.oo	0.00	0.00	o.o,	o.oı

Bus Jabulatjou

Harmonic Voltages(% of Fundamentnl Voltage)

Bu~ID: Bntl.
Fıuıd. kV: 66.6$6

Ordtr	Freq,	Mııg.	Order	Frtq.	~lag.	Orıtex	Frtq,	l~g.	Order	Freq:	lbg.	Order	Fttq.	ILıg~	Ord.tr	Freq,	1'.lng.
--	Hz	%	--	Hı	%	---	Hz	%	--	Hı	%		!!!_	~	--.	!!!_	~
ıı.oo	ssaee	1.89	ıs.ce	6,o.oo	1.1s	2;.00	ıısо.оо	o.;J	ıs.oo	mo.oo	ass	JS.00	mo.oo	MS	37.00	1850.00	0.00
47.00	ıısо.оо	0.0J	49.00	2450.00	0.0l												

BmID: BnslO
Fund. kV: 11.114

O.rdu	Freq.	Mag.	Ordtr	Fı-tq.	Mag.	Order	Freq.	Mng,	Order	Fnq.	Mag.	Ordtl'	Frıq.	Mag.	Ordtr	Fre-q.	ling.
--	!!!._	!!_	--	!!!_	%	--	fu	%	---	fu	%	--	Hı	%	--	Hz	%
11.00	550.00	l.S9	13.00	650.00	1.18	23.00	1150.00	0.33	15.00	1250.00	0.S;	35.00	mo.00	MS	37.00	mo.oo	0.00
47.00	2350.00	0.0J	49.00	2450.00	0.0l												

Bus ID: Bnsll
Fund. kV: 66.072

Order	Freq,	Mag.	Order	Fn-n:,	M.ng.	Ordtı	Frtq.	:Mag.	Order	Freq,	:\fag.	O.rdtr	Freq.	Afag.	Order	Fnq.	.M.ıg.
--	!!!_	~	--	!!!_	%	—	Hz	%	—	Hı	•••	—	Hz	%	—	Hz%	
11.00	$S0.00	0.96	13.00	650.(10	0.59	?!.00	1150.00	0.12	25.00	1:!50.00	0.09	35.00	1750.00	0.O!	37.00	1850.00	0.Ol
47.00	lJS0.00	0.00	49.00	:US0.00	0.00												

Bus.ID:. Bus12
Fund.kV: 66.681

Ordu	Freq.	M,g.	Ordtr	Fı-t'ık,	Mag.	Oı·dtr	Ft"t<j.	Mııg.	Ordtr	Frt<J.	~l,g.	Order	Frtq.	l!,g.	Ordtr	Freq.	ll.l.
--	!!!._	~		!!!_	%	--	Hı	%	—	Hz	%		fu	%	·--	Hı	%
11.00	S50.00	1.89	13.00	650.00	1.18	23.00	mo.oo	0.33	25.00	1150.00	o.55	35.00	1150.00	0.0S	37.00	1850.00	0.0D
47.00	2350.00	0.03	49.00	2450.00	0.0l												

Bus ID: Bud3
Fund. kV:

—	Hz	%	—	Hz	%	—	Hz	,·	—	Hz	%	—	Hz	%	—	fu	%
ıı.oo	550.00	1.94	13.00	650.00	l.ll	23.00	11$0.00	0.37	:?5.00	1250.00	0.62	35.00	1750.00	0.06	37.00	18.<o.OO	0.00
47.00	?350.00	0.05	49.00	2450.00	0.04												

Bu1ID: Busı.t
Fund.kV: 66.0$6

Order	Frtq.	Mng.	Order	Fr,q.	Mng.	Order	Fttq.	)!:ıg.	Or<ltr	Frtq.	Ma:,	Ordtr	Freq.	~lag.	Ordtr	Frtq.	l!,g.
—	!L.~		—	!!!_	~	--	!!!._	~	--	!!!._	~		!!!_	~	·--	-1!.L.	_%_
11,00	550.00	o.99	13.00	650.00	Mı	23.00	mo.oo	0.13	ıs.oo	1Z50.oo	0.10	35.00	1750.00	0.03	37.00	1850.00	0.Ol
47.00	23$0.00	o.oo	49.00	2450.00	0.00												

BmID: B~l5
Fund. kV: 11.117

Order	Frtq.	?\fag,	Order	Freq,	Mng.	Oı-dn·	Freq.	1'.bıg.	Order	Fnq.	~.tıg.	Ordu	Fı'ti.J,	M,ı.g.	Order	Frtq.	Mag.
--	Hz	%	--	Hz	%	--	Hz	%	--	Hz	%		Hz	%	--	Hz	%
11.00	550.00	1.94	13.00	650.00	1.2?	:?.too	1150.00	0.37	:?5.00	U50.00	0.62	35.00	1750.00	0.06	37.00	1850.00	o.oo
47.00	2350.00	0.05	49.00	2450.00	0.04												

Bus ID: Busl6
Fund.kV: ıı.eu

Order	Frtq.	Mag.	Ordtr	Freq,	~lag.	Ordir	Freq,	11:ıg.	Ordtr	Fı-.q.	M>g.	Ordtr	Fr"ł.	l!:ıg.	Order	Freq.	Mag.
	Hz	%	—	Hz	%	—	Hz	%	—	Hz	%		Hz	%	—	Hı%	
11.00	550.00	0.99	13.00	650.00	0.61	23.00	IIS0.00	e.ıs	ıs.oo	usaee	0.10	JS.OD	1750.00	0.03	37.00	ISS0.00	0.D2

Project:	)LI.SIER THESIS	ETAP	Page-: 22
Location:	HOUN CTTY-LIBYA	12.6.0H	**Date:** 21Hl6-2016
Conrracr:	l'<.EAR EAST Ul'<Tl'ERSITY • EEE Deparnnen;		.SN:
Engıneerr	SAND MUSTAFA AL-REFAI	Study Case: HA	**Relision:** **Base**
Fileııaıne:	HOUN SUBSTATION 220kV		**Config:** **Normal**

I>E.5IGN OF A LARGE SCALE SOLAR PVSYSIEM AND Th!PACT ANALYSIS OF ITS INTEGRATION INTO LIBYAl'l PO\\'ER GRID

Bus Tabulation

H:ınnonic Voltages (0/0 of Fun<L1me-ntal Voltage)

BusJD: Bnsl6
Fwıd. kV, ıı.ou

Orde:r	Freq,	Mag,	Orofr	Frtq.	M.ng.	Oı·dtr	FrtCJ.	Mag.	Order	Fı'eq.	Mng:,	Order	Fttq.	ling.	Order	Freq,	Mng.
	--~-%	---~			...!L	--	~	...!L	--	~	...!L		~...!L	--~...!L			
47.00	2350.00	0.00	4MO	2450.00	0.00												

Bus ID: **:Su.d7**
Fund. kV: 67,287

Order	freq,	M,g.	Order	Freq. Hz	!ufag. %	Or&r	Freq. Hz	M:ıg. %	Order	Freq. 1h	Mag.	Order	Freq. Hz	Afag. %	Order	Freq. Hz	Mag. %
.--~-1!_																	
11.00	550.00	1.3)	13.00	650.00	1.33	23.00	1150.00	o.ıı	25.oo	1250.00	0.0S	35.00	17$0.00	0.0S	.17.00	1850.00	0.0S
,17.00	mo.oo	0.0l	49.00	1450.00	0.0l												

BusID: **BuslS**
Fund.kV~ 66.091

	Hz	%	--	Hz	%		Hz	%		Hz	%		Hl	%		Hz	%
11.00	550.00	ı,oo	IMO	650.00	*Mı*	zı.oo	mo.oo	o.u	25.oo	nsace	o.ıo	ss.oo	1750.oo	o.o3	37.oo	mo.oo	o.oı
,17.00	2350.00	0.0l	49.00	2450.00	0.0l												

Bus ID: **Bud!>**
Fund. kV: **1LI15**

Order	Freq,	Mag.	Ordtr	Frtq,	Mag.	Order	*Fitq.* Hı	Mag. %	Order	Freq. Hı	~ıığ. %	Order	Freq, Hz	Atıg-. %	Order	Freq. Hı%	M:ıg.
--~-1!---.~					...!L												
11.00	550.00	1.33	lJ.00	650.00	1.33	23.00	1150.00	O.II	25.00	1250.00	0.0!\	35.00	1750.00	0.0S	37.00	1850,00	0.0S
47.00	l350.00	0.0l	49.00	**1450.00**	0.0l												

Bu~ID: Bw2
Fund.kV: **66.07!**

Ordtr	Fı-.q.	)fag.	Ord,r	Fr«J,	~Lıg.	Ordtr	Fı·'<l,	Mag.	Order•	Freq,	Mag.	Ordtr	Freq,	"-lag.	Order	Freq,	Mag.
	~	-1!_	--	~	-1!_	--	~	%	--~-%	---~~--						*Hı*	%
11.00	550,00	0.96	13.00	650.00	0.59	**23.00**	1150.00	**O.Il**	**ZS.00**	**l:?S0.00**	*0.09*	35.00	1750.00	*0.0l*	37.00	1850.00	0.0l
47.00	2350.00	0.00	49.00	2450.00	0.00												

Bu,ID~ **Bus20**
Fund.kV: 11.015

Oı-du	Freq.	Mag,	Ordtr	freq;	Mag. %	Order	Freq, Hz	Mag. %	Oı'dtr	Freq. Hz	Mag. %	Orde-ı•	Frfl'J, Hz	Mag. %	Ordu	Freq, Hı	Ma;;:. %
	~-%	---~				--·											
11.00	550.00	1.00	13.00	650.00	0.ô:!	**13.00**	**1150.00**	**o.u**	**15.00**	**1250.00**	0.10	35.00	1750.00	0.03	37.00	18.'0.00	0.0:?
47,00	2350.00	0.0l	49.00	l450.00	0.0l												

Bus ID: **Bw?l**
Fuild. kV; 636

	Hi	%		Hı	%		Hı	%		Hl	%		Hl	%		Hz%	
11.00	550.oo	*0.99*	13.oo	650.oo	uı	zı.oo	1150.oo	o..ıı	ı5.oo	1250.oo	e.ss	35.oo	1750.oo	0.0Sl	ıı.oo	1850.oo	o.o,
,1.00	2350.00	o.oı	49.oo	2450.oo	0.00												

Bus ID~ **Bw.Zl**
Fund. kV: **1L?S6**

	Hz	-1!_		Hı	%	--	Hz	%	--	1h	%	--	Hz	%	--	Hı	%
ıı,oo	550.00	*o.99*	u.oo	650.00	1.12	ıı.oo	1150.oo	e.u	ıs.oo	mo.oo	nss	35.oo	1150,00	*M>9*	ıı.oo	mo.oo	*0.01*
47.00	2350.00	0.0l	49.00	l450.00	0.00												

Bus·Tabufatjoų

H,,rınonk Voltnges (% ofFundaınentalYoltng~}

Bus JD: Busl3
Fund.. k\': 68.310

Order	Freq. Hı	lhıg. ~?	Ordıer --	FNq, ·JL	M:ıg. f!iı	0.t·dt>r --	Freq. Hı	Mrıg. %	Ordtr	F.t·tq, Hı	Mag. %	Ordtr	Fnq. Hz	Ma.;. %	Order-	Freq. 1h	Mag. %
11.00	550.00	2.~	13.00	~-00	1.33	ZMO	mo.oo	(1,(15	25.00	ııS0.00	0.0S	3$.00	1750.00	0.00	noo	ıssaee	0.00
,1.00	Z3S0.00	0.00	,9.00	2450.00	0.00												

Bus ID: Busl$
F,wd.kV: [illegible]

--	fü	%	--	Hı	%		~	%	--	H	%	-	YL	y	--	fü	%
11.00	sso.oo	ı.65	1ı.00	~.oo	13;	l3.oo	ıısо.oo	nos	zs.ce	1250.00	0.0;;	35.00	11:0.00	0.00	J7.00	ıssо.oo	0.00
!WO	2350.00	0.00	49.00	US0.00	0.00												

Bus ID: Bml7
Fund.. k\': 66.900

Ordıer --	Fnq. Hz	Mag., l!:0	O~r --	Frtq. Hı	Mag. %	Ordıer --	Fttg. Hı	1.'1ug. %	Order --	Freq. Hı	Mng. %	Ordtr	Fnq. Hı	Mag. %	Ordtr	Freq, Hz	Jı.fng, %
U.00	5S0.00	ı.71	13.00	~-00	l.:?5	23.00	1150.00	e.ıs	2s.oo	mo.oo	0.JS	35.00	17:0.00	0.06	37.00	1850.00	0.03
!7.00	Z3S0.00	0.0!	49.00	:!.tS0.00	0.0l												

BmID: Bw2S
Fund.. k\': II.ISO

Order --·	Fmı, Hı	Ab;, %	Ordeı-	Frtq. Hı	Mag. %	Order	Fnq, Hı	Mng. %	Order --	Frtq, Hı	Mag. %	Ordrr --	Frrq, Hı	~bg. %	Ordtr --	Fttq, fü	Mag, %
11.00	sso.oo	L71	13.00	~.00	1.1S	uoo	ıısо.oo	o.ıs	ıs.oo	1250.00	0.JS	3.<.00	17:0.00	0.06	37.00	1850.00	0.03
47.00	l3S0.00	0.f,)!	,1!>.00	24$0:00	0:0l												

BınID: But19
Fund. k\'ı: II.ISO

--	Hı	%	--	Hı	%		Hı	%	---	Hı	%	--	Hı	%		Hı	%
11.00	5so.oo	1.11	u.oo	ClS0.00	1.1s	uoo	mo.oo	e.ıs	2;.00	mo.oo	ass	35.00	mo.oo	0.06	J!.oo	ıssо.oo	0.03
,1.00	l35o.oo	0.02	.1~.00	1.1sо.oo	0.01												

Bu,ID: BUU
Fund.. kV: ıı0.000

Or<ler	Frtq. Hz	Ma;. %	Order --	Frt4 Hz	Mag,	Onier	Fnq. Hz	M:ng %	Order	Freq. Hı	l.:Lıg:." %	Oı'dtr --	Frtq. Ht-	l\fa.ı:, %	Onlu --	Frtq. Hz	Mıg, %
<1.00	Z3S0.00	0.0	J~.00	24.<0.00	0.!												

Bm ID: Bns30
Fuud. kV: 66.688

Otdtr-	Frtq. fü	Mag. %	Ordtr	Fttq. Hz	Mıg: %	Ordtr	Frtq. Hz	Mng. 0/0	01-dtı·	Frtq. Hı	Mag. %	Ordt-r	Frt-q Hz	Mag. %	Order	Freq. Hz%	Mag.
ıı.00	sso.oo	1.se	13.00	6.<0.00	1.19	z.,.00	mo.oo	0,1.1	ıs.oo	ıısо.oo	0.56	Js.oo	1,so.00	0.0s	37.00	ıssо.oo	0.00
47.00	2350.00	Q.0l	.C9,0()	2450.00	0.0l												

Bu, ID: Bnül
FunıL kV: 66.0U

--	..1!!:_	~	__	..1!!:_	_!!'._	--	..1!!:_	%		Hı	%		Hı	%		Hı	%
11.00	550.00	o.97	13.00	~-00	Q.60	23.00	1150.00	o.ıı	25.00	mo.oo	0.09	35.00	1750.00	0.0?	37.00	1850,00	0.0l

Projecr:	MASTER THESIS	ETAP		p,,ge:	24
L::ıcatiou:	HOUN CITY · LIBYA	12.MH		**Date:**	28-06-2016
Contra rt:	NEAR EAST UNIVERSITY • EEE Deportment			SN:	
Eugiueer:	SAND ;rosTAF A AL-REF AI	**Study Case:**	HA	**Re,isio.n:**	Base
Filename:	HOUN SUBSTATION 220kV			**Coufig:**	**Noplla!**

DESIGN OF A LARGE scuz SOLARPV SYSTEM A,"\D IMPACT A.1\'ALYSIS OF ITS INTEGRATION INTO LIBYA,~ POWER GRID

Bus Tabulation

HatmonkYoltages (% of Fundamental Voltage)

Bu~IIh **Bus,\!**
Fund. k\': 66.0U

47.00	:!JS0.00	0.oo	4MO	U50.00	0.00												

Bu1ID: **B~Z**
Fund.kY: **11,115**

11.00	550.00	1.!>0	13.00	650.00	1.19	13.00	1150.00	03.1	!S.(10	11$0.00	0.56	35.00	1750.00	0.05	37.00	tS50.oo	0.00
47.00	mo.oo	0.0J	49.00	2450.00	0.t)l												

BuıID: Bw.l3
Fund.kV: **11.0U.**

Ordtl'	Frtq.	Mag.	Orde-r	Freq.	M:ıg.	Ordeı-	Fnqı	Alag. %	Ord<ı·	Fr«q,	~Lıg.	Oı·d,ı·	Fr,q.	l\J'ag.	Or-dtr	Fr,q. Hz	Afag. %
ll.00	550.00	0.97	13.00	650.00	0.60	Z3.00	llS0.00	e.11	25.00	1?50:.00	0.09	35.00	17;-0.00	0.0l	37.00	18;-0.00	0.0l
47.00	2350.00	0.00	49.00	24;-0.00	0.00												

Bu~ ID: Bw.ll
Fund.kV: 0.407

11.00	550.00	4.19	L•.oo	650.00	1.20	23.00	llS0.00	z.n	25.00	1?50.00	2.67	3;.oo	1750.00	Ul	37.00	1850.00	1.00
47.00	2350.00	0.46	49.00	U50.00	use												

Bu.,ID: **Bus3$**
Ftiud.kY: 0.407

Ordu·	Freq,	Ai~g.	Ordtr	Freq,	Mag. %	Orde-r	fnq. lIı	Abg. %	Ord-tr	Freq. Hı	ıt.1g:. %	Ordti'	Frtq. Hz	?Jfa g:. %	Ordti'	Freq. Hz%	Mag.
11.00	550.00	.l.05	13.00	6.<o.00	0.S0	23.00	llS0.00	1.32	25.00	1250.00	1.39	35.00	1750.00	MS	37.00	1850.00	0.39
47.00	1350.00	0.16	4MO	2450.00	0.17												

Bu~ID:, **Buu6**
Fuud. kY: 0.407.

Ordeı-	Fr,q.	Mag.	Or-d<r	Fr,q.	Mng,	0l'dtı·	Frtq. Hz	Uag. %	Ol'drr	Freq, 1h	~fag. %	Oı•deı·	freq. lIı:	Ma;. %	Ordu	Fff'(J, Hı	:Mag. %
11.00	550.00	4.79	13.00	650.00	1.2:0	13.00	1150.00	z.n	lS.00	1250.00	2.67	3$.00	1750.00	1.21	37.00	lS50.00	1.00
47.00	:?3S0.00	0.46	49.00	2450.00	0.50												

Bu'>ID: Bw.l7
Fund.kV: 6.407

	Hz	%		Hı	%		lIı	%		Hz	%		Hı%			.Hz%	
11.00	550.00	4.79	13.00	650.00	2.20	23.00	IIS0.00	!.72	25.00	1150.00	2.67	35.00	1750.00	1.11	37.00	1850.00	J.00
47.00	2350.00	0.46	49.00	2450.00	e.se												

Bu,ID: Bw.lS
Fuud.kV: 0.403

	Hı:	%		Hı	%		Hı	,:		fü	.:.		Hı	%		Hı%	
11.00	S50.00	0.37	13.00	650.00	e.u	23.00	115MO	0.!7	?5.00	1250.00	0.26	35,00	17;-0.00	e.ıs	37.00	1850.00	O.il
47.00	2350.00	0.06	49.00	2450.00	0.06												

Bus T;ıhpfati9p

Harıııonk Voltages(% ofFundaıneuıııl Voltage)

Bu~ID: Bus.W
Fund, kV: 0,403

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	5S0.00	ISS	13.00	~0.00	1.16	23.00	1150.00	.ı.11	25.oo	m:0.00	1.64	35.00	1750.00	o.94	n.00	ıssene	0.77
47.00	2350.00	0-'18	49.00	2450:00	0.40												

Bus ID: Bus-I
Fund. kV: 210.000

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %

BuslD: Bu,.10
Fund. kV: 403

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.37	13.00	~0.00	e.n	13.00	1150.00	0.17	IS.00	1250.00	0.26	3!'.00	1750.00	0.1s	37.oo	mo.00	O.il
47.00	23S0.00	0.06	49.00	2450.00	0.06												

Bu$ ID: Bus41
Fund,kV: n.nı

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	3.27	IMO	6.'0.00	0.5-1	13.00	1150.00	ul	25.00	ıı;o.oo	1.50	35.oO	1750.00	o.49	3,.00	ıSSe.ee	0.42
47.00	2350.00	0.17	49.00	2450:00	aıs												

Bu1ID: Bus42
Fund.kV: ll.010

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
ll.00	550,00	0.40	13.00	650:00	0.13	?."\.00	1150:00	o~	25.00	ım.00	0.18	l.<00	1750.00	0.16	37.00	ıssaoc	0.13
47.00	:ı.150.00	0.06	49.00	2450:00	0.0,												

Bus ID: Bu..S: •
Fuııd.kY: 120.000

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	Q.9)	13.00	650.00	0.57	23.00	1150.00	O.II	25.00	1250.00	0.0S	35.00	1750.00	0.0l	37,00	1850.00	0.0l
47.00	2350.00	0.00	49.00	2450.00	0.00												

BmlD: Bns6
Fund.kV: 11.1U

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	I.SJ>	13.00	650.00	1.1S	:ı.ı.oo	1150.00	0..13	15.oo	mo.00	0.51'	35.00	1750.00	Q.0S	37.00	1850.00	0.00
47.00	1150.00	0.03	49.00	l-l.'0.00	O.Ol												

Bu,mı Bus7
Fuud.kV: 66.071

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.96	13.00	650.00	0.5?	23.00	1IS0.00	0.u	15.00	1250.(l(l	0.09	:ı.<.00	1750.00'	0.0l	37.00	1850.00	0.0l
11.00	:1.1S0.00	0.00	49.00	2450.00	0.00												

Bus.Tahulafiou

HalınonkVoltages (% offundnmentnl Voltage)

Bus ID: B..S
Fund. kV: 66.687

Ordeı-	fı'tq, ,Hz··.·.	Mng. %	Ordtr	Ft~. .. Hz.,	lb;. %	Ordtı'	Freq. ·Hı.	?ı:Cne;_ %	Ordeı-	Frtq, Hz	~fag. %	Order	F~. Hı	Abg. ·.·.Y;·	Oı'd.tı·	FrαJ.. Hı	hf.ıg. %
11.00	ss0.00	ı.s9	13.00	~,;0.00	ı.ıs	ıı.oo	nsaee	e.ss	1s.00	uso.oo	0.55	ıs.oo	1750.00	0.0s	.ı1.ııo	ıss0.00	0.00
41.00	1350.00	0.0.I	49.00	l450.00	0.0l												

Buı;ID: Bm9
Fund. kV: .012

--.·.	Hı	~	--:·	Hz	Y;		Hı	%	--.	Hz	%	.--	Hı	y	--	Hı	%
11.00	ss0.00	0.96	13.00	'50.00	-0.59	2~00	1150.00	0.12	25,00	1250.00	0.09	35.00	1750.00	0.0l	37.00	1850.<ı0	0.01
47.00	1350.00	0.00	49.00	US0.00	0.00												

Bus Tabulation

Haımoulc Voltng.s (% of ~onlunl)'oltage)

BuslD: Busl
Noın. l;V: 66.000

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	~0.00	1.91	13.00	650.00	1.19	23.00	1150.00	0.33	1s.oo	1150.00	ass	35.00	1750.00	0.05	37.00	1sso.oo	0.00
47.00	1350.00	0.03	49.00	1,50.00	0.02												

Bus ID: Busl 0
Noın. kV: 11.000

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	1.91	13.00	6.50.00	1.19	13.00	1150.00	0.33	1s.oo	1250.00	uss	3500	1750.00	0.05	37.00	1850.00	0.00
47.00	2350.00	0.0J	49.00	2450.00	0.01												

Bus ID: Busll
Nom. kV: 66.000

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	ssaee	0.96	13.00	650.00	0.s9	1;.00	11so.oo	e.u	2s.oo	U50.00	o.o?	;s.oo	1750.00	o.o:	37.00	1ssane	o.o1
47.00	1350.00	o.on	49.00	2450.00	0.00												

Bu, ID: Bu,12
Nom. kV: [illegible]

Order	Freq. H,	Mag. %	Order	Freq. Hı	Mag. %	Order	Freq. Hı	Mag. %	Order	Freq. Hı	Mag. %	Order	Freq. Il,	Mag. %	Order	Freq. Hz	Mag. %
11.00	5S0.00	1.91	13.00	650.00	1.19	13.00	1150.00	e.ss	1Mo	11so.oo	ass	JS.DO	1750.00	0.05	37.00	1850.00	0.00
47.oo	2.1.,0.00	o.o1	49.00	2450.00	0.01												

Bus ID: Busl!
Nom. kV: 66.000

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	sso.oo	1.96	u.oo	650.00	1.11	13.00	11so.oo	o.11	1s.oo	1150.00	0.6.1	1s.oo	1750.00	0.0ii	37.00	1s5o.oo	0.00
47.00	2350.00	0.0s	49.00	2450.00	0.04												

Bus ID: Bu,14
Noın. kV: 66.000

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	sso.oo	0.,9	u.oo	650.00	Ml	11.oo	nsaee	o.11	1.5.00	mo.oo	o.1o	Js.oo	1750.00	0:0J	31.00	mo.on	o.o:
41.00	mo.oo	o.o1	49.00	1,50.00	0.00												

Bus ID: Busl5
Noın. kV: 11.000

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	S0.0D	1,96	11.oo	6.<0.00	1.23	13.00	1150.00	0.37	25.00	1250.00	0.6.1	35.00	1.750.00	0.06	37.()0	1850.00	0.00
11.00	mo.oo	0.05	49.00	11so.oo	0.04												

Bus Tnbn}atimı

HarıncmtcVoltages(% ofNoınınal Voltage)

Bus ID: Busl6
Nom. kV: 11,000

Ordtr	Freq. !!	~ı.g.	Oı-der	Fı'eq.	:\fag.	Order	Freq.	Mag.	OrdE-ı'	Freq,	)fag.	OrdtJ'	Freq.	l\.:f.ıg,	Ordtr	Freq.	:tı.lag.
ıı.oo	S$o.G0	0.99	n.00	6;0.00	Ml	as.ee	11$0.00	0.13	1S.00	lI50.00	0.JO	35.00	1750.00	0.03	37.00	1850.00	0.0:?
41.00	1350.00	0.0l	49.00	1450.00	o.o0												

Bus ID: Busl 7
Nom. kV: 66.000

Orde-r	Freq.	M:iğ,	Order	Freq,	Mog.	Order	rreq.	lfag, %	Order	Freq. . ııZ	}fog, %	Ordrı·	Freq, ııZ	:hl.ıg. %	Ordėr	Freq. ııZ	:Mat:, %
ıı.oo	:so.oo	!..16	13.00	6so.oo	1,3;	z.ı.od	1150.00	e.n	25.00	US-0.00	0.0S	3!.00	1750.00	0.0S	31.00	ısso.oo	0.0S
47.00	1.350,00	0.0l	49.00	2450.00	0.0l												

Bus ID: Bus!S
Nom. kV: 66.000

Order	FJ'cll,	Mag.	Order	Fr,q.	~ı.g.	Order	Freq, Hz	?ilag. %	Ordtr	Fr«J, Hz	?.fag, %	Oı-dtr	Freq. :Ht	Mag. %	Ord.tr	Freq. Hz	?\fag, %
11.00	sso.oo	1.00	13.00	6!0.00	Q.61	as.ee	115Q.00	o.u	ıs.oo	ıı50.00	o.ıo	35.00	1750.oo	o.03	31,00	ısso.oo	Mı
47.00	2350.00	0.0l	49.00	:WS0.00	0.0l												

Bus ID: Bu.19
Nom. kV: U.0

--.··	Ht	%	--·	Hı	%	---	Hz	%		Hı	%	--	Hz	%	--	Hz	%
ıı.oo	sso.oo	1.36	ıs.ee	650.00	1.SS	13.00	1150.00	e.ıı	ıs.oo	1250.00	o.os	ıs.oo	11so.oo	o.os	37.00	ısso.oo	e.ea
47.oo	1.350.oo	o:oı	49.oo	ı,so.oo	0.0l												

Bu,ID: Bu,2
Nom. kV: 66.000

Order	Freq.	Abg,	Order	Fr,q. Hz	Mog, %	Order	Fr.q. 1I,	Mag. %	Order	Fttq. ııZ	ıı.g. %	Ordtr	Fr,q. Hz%	Mıg.	Ordtr	Freq. Hz%	ıı.g.
ıı.oo	:so.oo	0.96	ıı.oo	6S0.00	0.59	l3.00	u50.00	0.n	ıs.oo	1250.00	0.09	3S.od	1150.00	o.oz	31.00	ısso.oo	o.oı
41:00	2350.00	0.00	49.00	2450,00	0.00												

Bns ID: BusZO
Nom. kV: 11.000

Ordtr	Ft'l'q. Hı	M:ıg. %	Ol'dtr	Freq. Hz	!\.lag, %	Order	Freq,	!\tag. %	Ol-dtr	Freq, Hı:	Ma.g. %	Order	Fı·tq,	M.ıg.	Ordtr	Freq,	Mag.
ıı.oo	ssase	1.00	ıs.ee	6So.oo	Ml	23.00	11;0.00	o.u	ıs.oo	!l50.oo	o.ıo	35.00	17!0.00	0.03	37.oo	ıssc.ee	0.0:?
47.00	2350.00	Ml	49.00	uso.oo	0.0l												

Bus ID: Bus21
Nom. kV: 66.000

Ot'dtr	Frt(l, lh	ıı.g. %	Order	Fr,q.	~ı.g.	01'dc-r	Freq,	Mog. %	Ordtr	Fr,q. Hz%	~ı.g.	Order	Frtq.	?ı.bg.	Order	Freq.	?\fag,
U,00	.so.oo	1.01	13.00	6so.oo	1.3s	23.00	ııso.oo	0.4ı	ıs.oo	mo.oo	o.sı	35.00	1150.00	0.09	37.00	ısso.oo	0.07
41.00	13$0.00	0.0l	49.00	2450.00	0.00												

Bus Talmlatiou

Ha11nouk Voltages(% ofNoıuinal Voltage)

Bu, ID: Bus22
Noın. kV: 11.000

Ordtr	Freq, Hz	ALıg; %	Ordel·	Fı>tq, Hı	'-bg. %	Ordtt	Fnq. Hı-	Ma;. %	O.tdtr	Freq. Hı	Mag. %-	Order	Frtq. Hı	Mag. %	Order	Freq.	Mtl:g:. %
11.00	sso.oo	1.01	11.00	6so.oo	1.ss	z,.oo	1150.00	o.4:	1s.oo	1:50.00	0.s1	3;.00	1750.00	0.09	.11.00	ıasaee	o.o,
41.00	21so.oo	o.o1	49.00	2450.00	0.00												

Bu, ID: llns23
Noın. kV: 66.000

Ordeı'	Freq. Hı	Mag. %	Order	Freq. Hı	Mag. %	Order	Fttq. Hı	Mag, %	Oı'iltı•	Fnq, Hı	I\!ag, %	Order	Freq, Hı	Mag. ~--	Onltr	Freq, Hı	?\fag, %
11.00	sso.oo	2.74	13.00	6$1).00	1..17	23.00	1150.00	0.0S	1S.00	1250.00	0.0S	35.00	1750.00	0.00	37.00	1850.00	0.00
47.00	2350.00	o.oo	49.00	2450.00	0.00												

Bus ID: Bus25
Noın. kV: 11.000

Oı·der	F~. -2!!	Mng. _,:_	Order	Freq. -2!!	Mag. ::	Ordtr	}'nq. Hz	A!.ag. %	Order	Frtq. 1h	Mag. ~--	Order	Frtq, Hı	Mag. ~--	Ordtı·	Freq. !!!	M..ıg. ~
11.00	$50.00	1.74	U.00	650.00	l..17	23.00	1150.00	0.0S	2$.00	1250.00	0.05	35.00	1750.00	0.00	37.00	1850,00	0.00
47.00	2350.00	0.00	49.00	2450.00	0.00												

Bn< ID: llus27
Noın. kV: 66.000

Oı·dor	Fffil, Hı	Mng. %	.Ordtr --	Freq. Hı	M•g. %	Ordtr	Fffil. Hı	M•&· %	01'1,r	Preq. Hı	Mag. %	Order	fr«ı. 1h	Mıg. %	Ord,r	fr,q. Hı	~tıg. %
11.00	sso.oo	1.1,	13.00	650.00	J.Z6	z.1.00	1150.00	0.19	25.00	1?50.00	ass	35.00	11so.oo	0.06	31.00	ıeso.ee	o.o;
41.00	mo.oo	0.01	49,00	2450.00	o.o1												

BusID: Bus2S
Noın. kV: 11.000

Oı:dtı'	Fnq. Hı%	Mng.	Ordtr	Fr«ı. 1h	i\b:g.. %	OnU'r	Frt'q. Hı	Mag! ,,	Or&,r	Ft'«q. Hı	Mag. %	Ordtr	Frtq. Hı	Mag. %	Ordtl'	Freq, Hı%	'Mng.
11.00	550.00	1.73	13.00	650.00	l.l6	23.00	1150.00	0.19	25.00	1250.00	0..15	.1$.oo	11so.oo	0.06	,1.00	mo.oo	0.0.1
47.00	2350.00	0.0l	49.00	2450.00	0.0l												

Bus ID: Bus29
Noın. kV: 11.000

--	Hı	%		Hı	%	--	Hi	%		Hı	!i		Hı	%	--	Hz	%
11.00	S50.00	1.7il	11.00	650.00	1,16	23.00	1150.00	0.19	25.00	1250.00	0.35	35.00	1750.00	0.06	37.00	1850.00	O.Ol
47.00	2350.00	0.0l	49.00	2450.00	0.0l												

BusID: Bus3
Noın. kV: 220.000

Oı·der	Fr.q. ...1!!_	Mog. ~	Ordtr --	Fr~. ~	Mag. %	Ordu	Frtq. Hı	Mag. %	(h;dtr	Fı-tq. Hı	Mag. %	Order	fı"I'(ı, Hı	Mag. ~	Ord.tr	Frtq, ...1!!	?ı.b(!:, %
11.00	550.00	1.83	1.1.00	650.00	1.U	11.00	1150,00	O.il	IS.(10	1?50.00	0.53	3.<00	1750.00	0.04	37.00	1850.00	0,00
47.00	mo.oo	0.03	49.00	2450.00	0.0l												

Project:	lllASTER THESIS	ETAP	Page: 30
Location:	HOUN CITY-LIBYA	12.6.0H	Date: 28-06-lOlő
Con tr.net:	NEAR EAST Ul'i'l\'El.lSITY - EEE Depaı-tm•nt		SN:
Eugiueeı-:	SAJ\'D lh:tJSTAFAAL-REFAI		Rt-,ision: Base
Filename:	HOUN Sl11lSTATION220kV	SnıdyCase: HA	Couflg: Non.nal

DESIGN OF A LARGE SCALE SOL.:\RPV S):'SmIAı'ID IhIPACT ANALYSIS OFITSIN.I'EGRATIONINTO LIBYANPO\\'ER GRID

Bus Tabulation

Hamıooit Volt.lges (% o!Nomiıal Voltag•)

Biis ID: Bus30
Nom. kV: 66.000

Oı'det	Fı'tq. Hı	Mag. %	Oı·der	Frıtq. Hz	Mag. ~b	Order	Frt-q. Hı	Ib;. %	O.rdtr	fXtq. .YL	)Lıg. %	Ordtı·	Ertq. 3L	Jı.lag. y	Oıdeı-	Freq. Hı	hfag. %
11.00	550.00	1.92	13.00	650.00	1.10	23.00	1150.00	0.34	25.00	ll5:0.00	0.56	3;.00	1750.00	0.0$	37.00	1850,00	0.00
47.00	2350.00	0.0.l	4?.00	1450.00	o.o:												

Bus ID: Bu'31
Nom. kV: 66.000

Ordel' ...	Freq. Hı	Mng. %	Ordeı·	Freq, Hz	M'.ag. %	Ordtr	Ftt4 Hı:y	Mag.	Ordtr	Frtq. Rı	If:ıg. i\	Ordıtr	Frtq, Hı	M.-ıg. ~--·	Order ·YL~	Frtq.	Alng
11.00	Sl0.00	0.97	13.0o	650.00	MO	l.l.00	1150ı00.'	0.12	25.90	ı:50.00	0.0ll	3s.oo	1,so.00	(1.02	'7,00	1850.00	0.0l
41:00	2350.00	0.00'	49.00	2450.00	0.00												

Bus ID: Bu,32
Nom, kV: 11.000

[illegible]	Hı	[illegible]	[illegible]	H1	%	[illegible]	Hı	%	[illegible]	Hı	%	[illegible]	Hz	%	[illegible]	liL.	%
11.00	550.00	1.92	IJ,00	650.00	l.ZO	23.00	ll50:00	0.34	25.00	Jl50.00	0.56	35.00	1750.00	0.0S	37,00	1850.00	0.00
47.00	2350,00	0.0.l	4MO	2450.00	0.0Z												

Bus ID: Bus33
Nom. kV: 11.000

[illegible]	Hı	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	%	[illegible]	Hz, ...	[illegible]	[illegible]	Hı	%	[illegible]	Hı	%
11.00	sso.oo	0.:1	13.00	650:oo	MO	l.l.00	1150:oo	o.u	ıs.oo	!l50.oo	0.0l,	3;.00	mo.00	0.01	37.00	1850.00	0,0l
41.00	2350.00	0.00	49.00	2450.00	0.00												

Bus ID: Bus34
Nom. kV: 0.400

[illegible]	Hı	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	%	[illegible]	Hz	%	[illegible]	3L	%	[illegible]	Hı	%
11.00	550.00	4.81	l.l.00	650.00	1.1..ı	.23.00	1150.00	'l.77	ı;.oo	1?50.oo	1.11	35.00	1750.00	l.'13	31.00	1850,00	1.02'
41,00	l3~0.00	0.47	49,00	2450.00	O.SI												

Bus ID: Bus35
Nom. kV: 0.400

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	%	[illegible]	Hı	%	[illegible]	Hı	%	[illegible]	Ilı9	[illegible]
11.00	sso.oo	J.10	IJ.oo	650.0o	asl	l!.00	1150.00	ı.34	ıs.oo	mo.00	l.u	ıs.oo	1750.00	0.46	.11.00	1850.00	0.39
47.00	2350.00	o.16	.•~.00	2450.00	0.17												

Bus ID: Busl~
Nom. kV: 6.400

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	%	[illegible]	Hı:	%	[illegible]	Hz	%	[illegible]	Hı	%
11.00	550.00	4.87	13.oo	6So.oo	2.24	l!.00	1150:oo	:.11	ıs.oo	nsaee	2.11	.ı;.oo	11so.oo	1.1J	ll.00	ıs5o.oo	ı.oı
47.00	2350,00	0.47	4MO	ı.iso.ııo	O.SI												

Bus Tahu1:ıtiou

Hnrmouk Voltage,.,;(%, ofNoınlunl Voltage)

Bus ID: Bus37
Noın. kV: 0.400

Order	Freq. H::	**?ı.fıtg.** %	**O.rtkr**	**Frtq.** Hz	**Mag.** %	**Ordtt**	**Fı~q.** Hz	**Ung.** %	**Ordtr**	Freq, **Hı**	**M:ıg.** %	**Ordtr**	Freq. **Hı:**	**lfsıg-.** %	**Ordu**	**frtq.** **lb**	**Mag.** %
11.00	550.00	4.87	13.00	~.oo	2.14	13.oo	mo.oo	1.77	ıs.oo	1250.oo	2.11	35.00	1750.oo	1.23	37.oo	mo.oo	ı.oı
47.00	2350.00	6.47	**49.00**	**?.ıS0.00**	0.51												

Bus ID: Bııs38
Nom. kV: 0.400

Ordtr	Freq. Hı	**,i\bg.** %	**Order** --	**Frtq.** **Hz**	**Mag.** %	**Ordtt** --	**Frtq,** **Hı**	**Mng.** %	**Otdtı-** _	**Fttq.** **Hı.**	M:ıg. %	**Ordtr**	**Fttq.** **Hz**	**Mag.** %	**Ordf'l'**	**Fnq.** **Hz**	**Afog:.** %
11.00	5S0.00	0.38	U.00	~.00	**OJ~**	13.oo	mo.00	0.27	25,00	1250.00	**0,16**	35.00	1750.00	0.15	3MO	1850.00	e.IS
47.00	**2350.00**	0.06	**49.00**	**2450.00**	0-06												

Bus ID: Bus39
Noın. kV: o.400

Ordtt· —	**Fı't<J.,** ffL	**M:ıg.** %	**Ordtr** —	**Fn-q.** Hz	**Al:ıg:.** %	**Orıltr** —	**Fı"tq,** Hz	**Mng.** %	***Ordtr***	**freq.** 1h	**Mag.** %	**Ordu·** —	**Frtq.** *Hı*	**Mag.** %	***Oı-dtr*** —	**Frtq,** Hz	**Mag.** %
11.00	~S-0.00	1.1'4	13.00	~.00	1.77	13.oo	ıısoıoo	1.18	?5.00	1250.00	1.6S	35.00	1750.00	**0.95**	3MO	1850.00	0.77
47.00	ı3SO.OO	e.SS	49.oo	U50.oo	0.41												

Bu,ID: Bu,4
Nom. kV: [illegible]0.000

[illegible] ----	[illegible] **Hı**	[illegible] %o	[illegible] --	[illegible] *Hı*	[illegible] %	[illegible] _	[illegible] Hz	[illegible] %	[illegible] _	[illegible] **Hı**	[illegible] %	[illegible] --	[illegible] *Hı*	[illegible] %	[illegible] --	[illegible] H	[illegible] %

Bus ID: Bus40
Noın. kV: [illegible]400

[illegible] __	[illegible] Hı	[illegible] %	[illegible] __	[illegible] Hı	[illegible] %	[illegible] __	[illegible] Hı	[illegible] **%**	[illegible] __	[illegible] **Hı_%**	[illegible] ,	[illegible] __	[illegible] **Hı**	[illegible] tı+t	[illegible] _	[illegible] **Hı**	[illegible] %
11.00	SS0.00	0.IS	1.l-00	650.00	**0.12**	23.00	1150.00	0.1,	2S.00	1250.00	O.16	3S.00	1750.00	e.IS	37.00	1850.00	0.13
47.00	13S0.00	0.06	49.00	2450.00	0.06												

Bus ID: Bus41
Nom. kV: [illegible]000

[illegible] --	[illegible] **Hz**	[illegible] %	[illegible] --	[illegible] ***Hı***	[illegible] %	[illegible] --	[illegible] **Hı**	[illegible] %	[illegible] --	[illegible] **Hı**	[illegible] ,~	[illegible] --	[illegible] **Hz**	[illegible] '%	[illegible] —	[illegible] ***Hı***	[illegible] :%
11.00	550.00	3.11	13.00	~.oo	nss	23.00	1150.00	1.43	lS.00	1250.00	ı.sı	35:00	1750.00	M9	37.00	ISS0.00	o.u
47.00	2350.00	0.17	49.00	2450.00	0.19												

Bus ID: Bus42
Nom. kV: [illegible]000

[illegible] _	[illegible] Hı	[illegible] %	[illegible] _	[illegible] Hz	[illegible] %	[illegible] _	[illegible] Hı	[illegible] %	[illegible] _	[illegible] Hz	[illegible] %	[illegible] --	[illegible] Hı	[illegible] %	[illegible] _	[illegible] Ht%	[illegible]
11.00	550,00	0.40	u.00	650.oo	o.1ı	13.oo	ıısoıoo	0.19	25.oo	1150.00	0.:IS	35.00	1750.oo.	0.17	37.oo	ıssace	o.u
47.00	IJS0.00	0.06	49.00	:ı.150.00	0.07												

Bııs!D: Bu,S
Nom. kV: 220.000

Ordtr --	Freq, !!!	**Mag.** ~	**Ordtr** --	**Fmı.** !!!	)fag. %	Oro,r —	F.-q. Hı	~fag. %	Oı..tor —	Freq. Hı	Mag. I:	Ord,r —	Fwı, Hı	Mıg. %	Ordtr —	FWj. Iı%	Mng.
11.00	550.00	0.91	U.00	6.S-0.00	**0$7**	23.00	US0.00	e.ıı	**IS.00**	**1250.00**	0.08	ıs.oo	11s0.00	**0.02**	37.00	1850.00	0.0l

Bus Tabulation

Harmonic- Voltages(% ofNomiuıl Voltage)

Bıı,ID: BusS
Noın.. kV: 220.000

Orde-r	Freq. _!!;_	Mag. ~	Ordtr	Freq. _!!;_	~fag, ~	Oı'der	Preq. _!!!..._	Mag. ~	Ordtı·	Freq. _!!!..._	l\:fag. ~	Oı•dt.ı·	Fı·eq. _!!;_	Mag. ~	Ordu	FWJ. _!!!..._	htıg. ~
47.00	2350.00	0.00	49.00	Z450.00	0.00												

BusID: Buro
Noın. kV: Jl.000

Order	Frtq. _!!;_ ~	Mag.	Ordeı-	Frtq:. Hz	Mng. %	Oı'dt-r	Freq, Hz	Mag. %	Ordtr	Freq. Hz	M:ıg. %	Order	Fı:tq, Hz	.l.r.g. %	Ordeı-	Fwıı. Hz%	htıg.
ıı.oo	S50.oo	1.91	IS.ee	650.00	1,19	**23.00**	1150.00	0.;;	!$.00	1250.00	e.ss	ss.ee	1750.00	MS	37.00	1850.00	0.00
41.90	1.lS0.00	0.0;	49.00	**24$0.00**	0.0l												

BusID: Bus7
Nom. kV: 66.000

Ordtı·	Fı'tq. Hı	Mag. %	Ordtı·	Fı't'{J, Hz	?\fag. %	o,·du	fnq. Hz	lbg. %	Ordtr	Fr('g, fü	:?\:fıg. %	Order	Freq. Hı	Mag. %	Onltr	fnq. Hı	hhg. %
ıı.oo	s;o.oo	o,97	13.00	650.00	0.$9	23.oo	nse.ee	0.12	2s.00	llS0.00	0.09	3$.00	1750.00	0.0l	37.00	1850.00	0.0l
47.00	2350:00	0.00	49.00	24$0.00	0.00												

BusID: Bu'8
Nom. kV: 66.000

Order	FWJ. _!!;_	Mag. _%_	Oı.:ı.r	Frtq. _!!!..._	Mng. ~	Ot'der	Ftf'q. Hz	Mag. %	Ordtı·	Fttq. H:	Atıg. %	Order	Freq, _!!;_	M.ıg:. ~	Ordtr	Frtq. _!!!..._	Mag. ~
11.00	SS0.00	1.91	13.00	650.00	1.19	23.00	1150:00	e.ss	2;.00	1:50.00	e.ss	35.00	1750.00	o.o;	37.00	1850.00	0.00
47.00	2350,00	0.03	49.00	2450.00	**0.02**												

BusID: Bus9
Nom. kV: 11.000

Ordeı-	FWJ. Hz	M•g. %	01-dtl'	Ft't'q. Hi	Mrig. %	Ol·dtr	Fnq. Hz	Mag. %	Onkr	Freq. Hz	ling. %	Onler	Frtq, Hz	Abg. %	Ordtr	Fttq. Hz%	htıg.
11.00	55(1.00	0.97	13.00	650.00	0.59	23.00	1150.00	0.12	ZS.00	**llS0.00**	0,09	35.00	**1750.00**	**0.02**	37.00	1850.00	0.0l
47.00	2350.00	0.00	49.00	24$0.00	0.00												

Alert SwnınarY Report

	% Aleı1 Settings	
	Critical	**Marginal**
.§l.u.		
Indhidual Bus VTHD I VI.HDvalues a,.• used.		
Traıısformer		
Toıall	ıeae	9M
filter		
Capacitor kV	JQ0.0	95.0
Inductor Amp	100.0	95.0
Capacitor		
Ma:ı: kV	100.0	95.0
Cabl<.>		
Aınpadty	100.0	95.0

APPENDIX 10

HARMONICS .ANALYSIS WITH FILTERS. AND NO PV CONNECTION

Project:	MASTER THESIS	ETAP	Page:	1
Location:	HOUN C.1TY • LIBYA	12.6.0H	Date:	28-06-2016
Ccnrract:	l'i"EAR. EAST t!':NIVERSITY - EEE Depaı1menr		$N:	
Engineer:	SAND 2\IDSTAF 'A AL-REFAI	Study Case: HA.	Revisloıı;	Base
Filename:	HOh"N Sh!lSTATION 220kV		Coııfig:	Normal

DESIGN OF ALAR.GE SCALEŞOLARPV SYŞTEMAND IllPAÇT ANALYSIS OF ITS INTEGRATION INTO LIBYAN POWER GRID

Electıical Transient Analvzeı-Program

Haıınonk study ni\h fütei~ and no PV connection

Loading: Opemting P, *Q*

Generation: Operating P, *Q*, V

	Snin~	V-Conn·ol	L~	Inını!
Number o!Buses:	3	0	26	2P

	XFllfR2	Xfl\lR.3	R.eacıoı	Line/Cable	Impedance	Tie PD	Total
Number of Brandıes:	15	0	0	14	0	0	29

	Current	}'o)ıage
Number of Haıın. Sources:	3	0

Number offiliei,: 2

Method of Solution:	Adaptive Nen1on-R.aphson
Maximum No. oflt<rntion:	99
Precision of Solution:	0.0001000000
System Frequeucy:	50.00Hz
Unit System:	Metıic

Adjustnmıts

Tolerance	Apply Adjustments	Indhidual /Global	Percent
Transformer Inpedance;	Yes	ludhidu.ıl	
Reactor ImpedaucE>:	Yes	hdhidual	
Overload Heater Rfsl.sıance:	No		
Transmission Line Lengtlı:	No		
Cable Length:	No		

Temperature Correerion	Apply Adjustments	Indhidual {Global	Degree C
Transmission Line Roshlance:	Yes	hdMdu:ıl	
Cable Resistance:	Yes	IııdMdual	

DESIGN OFA LARGE SC:AL'ESQLARPVSYSIEıVI AND IMPACT ANALYSIS OF ITS INTEGRATION INTO LIBYAı'<POWERGRID

Bus Juppt pata

Bus					Load								%Limits	
					ConstımtkVA		Cou:stantZ		Const.ant I		Generic			
ID	kV	Sub-sy:$	'%:M.,g.	Ang.	MW	lı.tn,r	MW	?ık:ıt·	:MW	M\'~r	MW	Ml'='r	VTHD	VIHD
Busl	6MOO	1	98.8	-30.0									10.00	10.00
Bnd	66.000	2	JQ0.0	.,0.0									10.00	10.00
Bus3	110.000	1	JQQ.0	e.e									10.00	10.00
Bus4	IZ0.000	3	100.0	0.0									10.00	10.00
Bw5	Z20.000	2	!0tı.-0	0.0									10.00	10.00
Bus0	11.000	1	98.1	.6ll.O									2.50	I.SO
Bus7	66.000	2	98.8	30.0									10.00	10.00
Buss	66.000	1	99.0	-30.0									10.00	10.00
Bu.ı>	11.000	2	98.1	0.0									10.00	10.00
Busl 0	11.000	1	97.S	,60.0									10.00	10.00
Busl3	66.000	1	98.3	.S0.0									10.00	10.00
Bud4	66.000	2	98.0	30.0									10.00	10.00
Bu'3.15	11.000	1	98.7	.6ll.O									10.00	10.00
Bus:16	11.000	2	98.J	0.0									10.00	10.00
Bnd7	66.000	1	98.9	-30.0									10.00	10.00
BuslS	66.000	2	98.S	J0.O									10.00	10.00
Bud9	11.000	1	98.7	-60.0									10.00	10.00
Busl0	11.000	2	98.7	0.0									10.00	10.00
Bnsll	66.000	1	98.9	,S0.0									10.00	10.00
Bu,;l2	11.000	1	911.4	.6Q.O									10.00	10.00
Bu,23	66.000	1	99.3	-30.0									10.00	10.00
BuslS	1UOO	1	98.1	-60.0									10.00	10.00
Bml7	66.000	1	98.8	-JO.O									10.00	10.00
Bml8	11.000	1	98.4	-60.0									10.00	10.00
Bus29	11.000	1	98.4	-60.0									10.00	10.00
Bu,;JO	66.000	1	98.$	-30.0									10.00	10.00
BusJL	66.000	2	9M	30.0									10.00	10.00
Bo<Jl	11.000	1	98.0	.6Q.O									10.00	10.00
Bus33	n.000	2	100S	0.0									10.00	10.00
Total Numbtt of Buses: 19					0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Generation Bus				Voltag•		Generation			IlhırLimits	
ID	kV	Type	Sub..sys	%lıbg.	Angle	MW	Mv:ır	%PF	I\Vv:	Min
Bus3	:U0.000	Suing	1	100.0	0.0					

Generation Bus				Voltage		Generation			1\fyar Limits	
ID	kV	Type	Sub-sys	% Mag.	Angle	MW	Mvar	% PF	Max	Miu
Bus4	220.000	Swing	3	100.0	0.0					
Bus5	220.000	Swing	2	100.0	0.0					
						0.00-0	MOO			

Cable Input Data

Cable ID	Libr.ıt,·	Size	Length •n•L	f//Plııı"	T(•C)	RI	XI	YI	RO	XO	YO

Cable resistauces are listed at the specified temperatures

Jran.'ᵹmiss.ionLine Input Data

Line ID	I.lb,~,y	Siu	Ltııgrh Adj.(m)	%Tol	1//Plııtt	T {'C)	Rl	Xl	YI	RO	XO	YO
							Ohms or lllhos / 1000 m peı· Phase					
Un,ı		674	moo.o	o.o	I	lS	o.o~	o.mı;;	.ooooon	0.200011	l.36om	.0000011
Liu,2		674	l9m.O	0.0	I	7$	0.056001	0·:142069	.0000034	0.200637	1.424041	.0000016
Ltıı,3		674	2300<l.0	o.o	I	75	0.056001	o.m~	.0000034	o.zoom	1.424041	.0000016
Lln,4		674	15000.0	0.0	I	75	0.056001	0.34%%9	,0000034	0.200637	1.424041	.0000016
Ll•••		674	sooo.o	o.o	I	15	0.056001	o.ıı:oo	.0000034	o.zoom	1.424041	.0000016
Un,6		674	4000.0	o.o	I	rs	o.056001	o.m~	.00000.14	0.2006>1	1.424041	.0000016
Un,7		674	4000.0	o.o	1	lS	0.056001	o.moı;9	.00000.14	o.zoom	ı..ıı4on	.0000016
Ltıı,S		674	4000.0	0.0	1	15	0.056001	0.34%069	.0000034	o.200637	J.4ı.l041	.0000016
Liıııt9		674	4000.0	0.0	I	7$	0.0$6001	0.341%9	,0000034	o.2006.'7	Uı;1041	,0000016
Lln,10		674	8000.0	0.0	I	75	0.0$6001	0.34?%9	.0000034	0.2006J7	U24041	.0000016
Until		674	8000.0	0.0	1	75	0.056001	0.34?%9	,0000034	0.200637	Ul4041	,0000016
LlntU		674	21000.0	0.0	I	1S	0.0$6001	0.34?06~	,0000034	0.2006.17	Ul4041	,0000016
Until		674	161000.0	0.0	I	75	0.0.<ı;oOJ	0.342%9	:oooOOJ4	o.2006.'7	Uı;1041	.0000016
Llntl4		674	140000.0	0.0	I	75	M.<6001	0.342069	.00000.14	M006J7	1.424041	.0000016

l.J.u,ı, reststaeces are **listed at tht sp«ified temptratum**

2-WindiugTrau,fonuerInput Data

Transformer	Rating					Z Vnuia1ion			%Tap Setting		A<ljusied	Phase Shift	
ID	**MVA**	**Prim.kY**	**St-t,kY**	**%Z**	**X/R**	**+S.%**	**-5%**	**%Tol.**	**Prim,**	**Stt.**	**%Z**	**Type**	Anglt
Tl	6.1.000	I?0.000	66.000	**12.50**	4$.00	0	0	0	0	0	U.$000	**Dyn**	.!0.000
T3	il.\.000	110.000	66.000	!HO	4:\.00	0	0	0	0	0	12.SOOO	Dyn	-30.000
T4	10.000	66,000	11.000	ass	13.00	0	0	0	0	0	8.3500	**J)yn**	J(),000
TS	10.000	66.000	11.000	10.00	20.00	0	0	0	0	0	10.0000	**Dyn.**	30.000
16	20.000	66.000	I!.000	10.00	10.00	0	0	0	0	0	10.0000	Jlyn	.10.000
T9	10.000	66.000	ILOOO	8.35	13.00	0	0	0	0	0	8.3500	IJyn	J0,000
TIO	10.000	66.000	11.000	8.35	13.00	0	0	0	0	0	8.3~0	**Dyn**	30.000
TIL	20.000	66.000	11.000	10.00	20.00	0	0	0	0	0	10.0000	**Dyn**	.!0.000
TI?	20.000	66.000	11.000	10.00	**10.00**	0	0	0	0	0	10.0000	**Dyn**	30.000
TB	10.000	66.000	11.000	8.35	13.00	0	0	0	0	0	8.3~	Dyn	.!0.000
TU	10.000	66.000	II.ODO	**8.35**	13.00	0	0	0	0	0	8.3~0	~11	J(),000
!16	20.000	66.000	11.000	10.00	20.00	0	0	0	0	0	10.0000	Dyn	J().000
Tl7	20.000	66.000	11.000	10.00	20.00	0	0	0	0	0	10.0000	~11	30.000
TIS	20.000	66.000	11.000	10.00	20.00	0	0	0	0	0	10.0000	D~11	30.000
TI9	20.000	66.000	11.000	10.00	20.00	0	0	0	0	0	10.0000	~'ll	30.000

2-\Vipr{iug Tr;msfonner Groj.Indjug Illput pata.

Tı-ausfonner	Rating			Gı'Oundlng					
				~	Pıimu·y	Secmduy			
ID	~~.~	Jl!:.			Tl'Pt		kV	Amp	Ohm
Tl	6.1.000	120.000	66.000	Dil.'		Solid			
T3	@-000	I?0.000	66.000	Di\'		Solid			
T4	10.000	66.000	11.000	DIY		S.Ud			
T5	20.000	66.000	11.000	Dil.'		S.lid			
T6	20.000	66.000	11.000	Dil.'		Solid			
Tl>	!MOO	66.000	11.000	Di\'		Solid.			
TIO	10.000	66.000	11.000	Di\'		Solid			
TI!	Z0.000	66.000	11.000	Dil.'		Solid			
ru	Z0.000	66.000	11.000	Dil.'		S.Ud			
Tl.I	10.000	66.llOO	11.000	il.I\'		Solid			
TU	10.000	66.000	11.000	Dil.'		Solid			
Tl6	20.000	66.000	11.000	Dil.'		Solid			

DESIGNOFA LARGE SCALES9LARPY SYSTIW Al\'D IMPACT ANALYSISOF ITS INTEGRATIONINTO LIBYANPOWER GRID

2-\Viucling Tnuısfor.ıneľ Gronnı}ipg Iunut Data

Trausf<inner	Riıdug			~	Grounding					
					Primary			Secondaı1·		
ID	~.Priın.k~r		~~		TJ|>t'	kV	Amp	Typt-	kV	~~
Tl7	20.000	66.000	11.000	D/Y				Solid		
TlS	20.000	6MOO	11.000	D/Y				Solid		
Tl9	20.000	66.000	11.000	Dl\'				Solid		

Branch Connections

C 1\ 7/Branrh		Connected Bus ID		% Poslnve Sequence Impedance (100 MVA Bnse)			
ID	Type	FromBru	ToBu.;	R	~	Z	Y
Tl	2W XFMR	Bus.l	Busl	0,44	19.84	19.84	
T3	lWXFMR	Bu.S	Bu,2	0.44	19.84	19.84	
T4	ZW XFMR	Busl	Bu,6	6.40	83.25	83.$0	
TS	2WXFMR	Bu,7	Bu;9	l.SO	*49.94*	50.00	
T6	aw XFMR	Bus8	Busl0	*2.SO*	49.l›4	50.00	
T9	lWXFım	Bu,13	Busl5	6,40	83.25	83.50	
TlO	2wxnm	Busl4	Busl6	6.40	*S3.Z5*	83.50	
rl1	2WXFıJR	Bu,17	Bus19	1.50	49.94	50.00	
rn	2W XFMR	Brn!S	Bu,20	*2.50*	49.l›4	50.00	
Tl3	lWXFım	Bus2l	Bu.zı	UO	*83.25*	*83.50*	
Tl4	lWXFılR	Bu,?3	Bu,25	6.40	S3.25	83.50	
Tl6	**lWXFMR**	**Bus?7**	**BusZS**	?.SO	**49.9.J**	**50.00**	
Tl7	lWXFı!R	Bus27	Bu,19	2.50	49.l›4	50.00	
TIS	lWXFılR	Bu'30	Bus32	*2,50*	49.94	50.00	
Tl9	2WXFı!R	Bus.ll	Bu,33	2.50	49.l›4	50.00	
Lind	Lin,	Bu,ı	Bu,14	*2,48*	*16.58*	16.77	0.2607629
Lin,ı	Lin,	Bud	Busl3	2.48	15.16	*15.36*	0.2842266
Lin,3	Lin,	Bu,2	Bu,18	2.l›6	18.06	18.30	0.3367157
Lln,4	Lin,	Bu<Z7	Busl7	1.93	11.78	11.94	0.2l09015
Lin,5	*Lint*	Busl	Bum	LOJ	6,28	6.37	0.1178142
Lint&	Lin,	Busl	Bus7	Ml	.1.14	3.18	0.0589071
Lin,7	Lin,	Bud	Buss	USl	.ı.14	3.18	0.0589071
Lin,8	Llıı,	Bu,2	Bus7	o.51	3.14	3.18	0.0589071
Lin,9	Lin,	Busl	Bus8	*0,51*	3.14	3.IS	0.05890;J
LlntlO	Lin,	Bwi2	Bus.il	1.03	*6.28*	6.37	0.1178142
Lin,11	Lint	Busl	Bus.JO	I.OJ	*6,28*	6.37	0.1178142
Lind?	**Lwr**	**Busl?**	**Bus21**	**1;;70**	**16..,9**	**16.71**	**0.309!622**
Llntl3	Lin,	Busl7	Busl.'	20.70	!ZMJ	128.l!	2.3710100
Lintl4	Lin,	Bus21	Bu,23	18.00	109.l›4	l!!.40	1.0617480

Branch ,:gnntction:ı;
Zero Sequence Impedance

CKT/Bl'andı		ComıerteılBus ID		% Imped.ıuce,:Uro ~q., 100 JiffAb			
ID	T;pe	From Bu!';	To Bus	RO	XO	ZO	YO
Tl	%\\'Xlmr	Busl	Busl				
rS	2\\'Xfmr	B"5-5	Bm2				
n	:!WXfuır	Bud	Bu'.6				
T$	IWXIml	Bu,7	Bus9				
T6	IWXfmr	Bus8	Busl 0				
T9	2\\'Xfınr	Bud3	Bud$				
no	IWXfmr	Bus14	Busl6				
Tll	ZWXfuır	BuS:17	Bıısl9				
Tl2	:?WXfmr	Bu'18	Bm:?O				
TB	:?WXfmr	Bus21	Busl2.				
TU	2\VXfmr	Bu-.13	Busts				
Tl6	2\VX!mr	Bus27	Bu':?S				
Tl7	ZWX!mr	Busl7	Bus29				
Tl6	2WXftnr	BusJO	Bm32				
Tl9	2\VXfmr	Busl!	BuhU				
Lin•!	Lin,	Busl	Bud-i	*8.86*	*60.29*	60:94	0.1410145
Llnt2	Lint	Bud	BusB	8.89	6.1.09	63.72	0.1341983
Lln,3	Lin•	Bud	Buds	*10.59*	*15.19*	75.93	0.159925$
Lint-I	Lint·	Busl7	Bınl7	6.91	49.04	*49.52*	0.1042992
LintS	Lin,	Bud	Bus:l7	J.6S	*26.15*	26.U	0.055626:Z
Lln,6	Lin,·	Busl	Bus7	l.64	13.0S	13.Z!	0.0278131
Llnt7	Lint·	Bud	Bus.S	1.64	13.08	13.Zl	0.0278131
Line8	Lint·	Busl	Bus7	1.64	IMS	lS.1l	0.0278131
Lint9	Lint·	Bud	Buss	1.84	13.08	13,21	0.0278131
LlntlO	Lin,	Bus1	Bus31	3.6S	26.15	26.41	0.05$6262
Liutll	Lint·	Busl	Bud 0	J.68	*26.15*	26.41	0.0556262
LindZ	Lin•	Bu,17	Busll	*9.61*	*68.65*	69.33	0.1460189
Llnd3	Lin,	Busl7	Bud3	74.16	*516.33*	SSl.SS	1.1194780
Uud4	Lin,	Budl	Bııs23	64.4S	457.66	*462.10*	0.9734595

1\-faclıjne Input Data

Madtlııe		Connected Bus	R.,ting (Bose)			%Negath-e Seq. Imp.			Grounding			%Zero Seq. Imp.		
m	**Typt**	ID	*MVA*	kV	RJ>!I	XIR	JU	X!	Conn.	Typt	Amp	XIR	RO	XO
ul	Grid	Bus3	zÜÔi~--~-;;;--;~Solid--ıô.öö-;-~											
ın	Gıid	Busl	:U.!Ol	220.000		10.00	9.95(1	99.50	Wyt	Solid		10.00	17.738	177.38
U3	**Grid**	**BusS**	ll.101	l!0.000		10.00	*9.95(l*	99.50	**-Wyt**	Solid		10.00	17.738	177.38

ffarıuoni<".Librauy

_Cuıı: ·e~t Haımo.nk Source in %

:?.Lınufncture-r: ABB
Model: ACS60012P

Order	Fı·tq.	M,g.	Oı•dtr	Frtq,	Mag.	Order	Fr«J.	M,g.	Order	Freq,	M.g.	Order	Fnq.	l!,ıg.	Order	Freq.	M,g.
----	L	%	--	1h	%	--~		%	--	Hı	%	--	L	%	--	1h	%
1.00	S0.00	100.00	5.00	ZS0.00	2.60	7.00	350.00	1.50	11.00	550.00	3.70	13.00	650.00	3.70	17.00	850.00	e.SO
19.00	9$0.00	o_,o	23.00	1150.00	0.JO	:?$.00	1250.00	ase									

Manufacturer: •.\JIB
MoıM: ACS60012P

Ordtr	Freq.	1ı.bg.	Ordtı•	Freq,	1ı.bg.	Ordtr	Frtq.	Mag.	Ordtl'	Fı-:ıı.	Mag.	Ordtı•	Frtq.	1ı.fag.	Ordtr	Frtq.	1ı.bg.
--~	....!L	--~			%	—	Hı	%	—	Hı	%	—	Hı	%	—	1h	%
ı.oo	so.oo	100.00	s.oo	ıso.oo	2.60	1.00	350.oo	ı.se	11:00	s;o.oo	;.10	13.00	ssaee	3.10	11.00	s5o.oo	o.so
IMO	950.00	0.30	?.~.00	1150.00	0.IO	25.00	ıı;o:oo	ase									

l\Innufac.turer: ABB
Model: ACS60012P

Order	Freq,	1ı.fag.	Order	Frtq.	Mag.	Ordtt	Freq.	Mag.	Oıiltr	Frtq.	Afag-.	Order	Freq,	Mag.	Grder	Freq.	Mog.
	1h	%		1h	%		1h	%		1h	%		1h	%		1h	%
1.00	S0.00	100.00	~	""inöö	~	--;:öö	7sö':öö	1.sö	ü.öö	~	--r.;ö	llÖ-0	65MÖ	--r.;ö	rı:öö	8$0.00	0.50
19.00	950.00	0.30	23.00	1150.00	o.ıo	:?5.00	ll50.00	use									

Harmonic Source from Libraıy

BndD	Dtdce-ID	Harmonic Source Information				
		~	M'.anufortuJ'tl'	Mod'1	Flllld. Frtq.	Mod. Frtq.
Bu.!	UJ	Cıu·n.nt	ABB	ACS6001lP	0.00	0.00
Bu>!	ul	Currtııt	ABB	ACS600 IZP	0.00	0.00
Bus$	U3	Cwnııt	ABB	ACS6001ZP	0.00	MO

Filtel' Input Data

Filler Type: Siıgle-Tuued

Filler	Connected Bus	Capacitor Cl			Inductor LI			_,!;_
ID	ID	IV	AfaxkV	lo••r	XI	QF•ct.	MaxI	Obm
HF2	Bu~:?	66.000	0.000	62000.-0	0.0000	0.00	0.0	0.0000
HF!	Bml	66.000	0.000	62000.0	0.0000	0.00	0.0	0.0000

DESIGN OF A LARGE SCALE SOLAR PV SYSTEMA,"TI1MPACT ANALYSIS Of ITS INTEGRATION INTO LIBYANPO\\':ER GRID

fmıdameufal Loml Flow Rs,port shnly witlı filters uml no PV coune<'.tiot

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	%Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	% PF	% Tap
Busl	66.000	115.507	.J0.2	0	0	0.000	-82.720	Bu,13	0.000	-0.379	Z.9	0.0	
								Bus27	o.oıs	.1;.SS?	~I.1	..0.3	
								BU$8	MOO	-0.079	M	0.0	
								lh.ıs.8	0.000	-0.079	e.s	·0.0	
								l!u,30	-0.000	-0.157	1.1	0.0	
								Buı3	..o.oıs	,0.30,	'583.9	o.o	
								Bus6	0.000	0).000	o.o	o.o	
Busl	**66.000**	lU.1SS	!9.S	0	0	0.000	.$0.913	Bu,H	0.000	-0-'IO	1,6	0.0	
								BııslS	0.000	-0.442	3.4	o.o	
								Bus7	0.000	-0.077	0.6	o.o	
								Bus7	0.000	-0.071	0.6	o.o	
								Bus31	0.000	-0.154	1.2	ae	
								BusS	0.000	Sl.003	6l7.9	o.o	
*Bus3	**1?0.000**	**100.000**	0.0	0.JSS	.1s.m	0	0	Busl	e.ISS	.1s.11?	ZOS.l	-0.4	
*Bus5	Zl0.000	100.000	o.o	**0.117**	**-71.782**	0	0	Bus2	**0.217**	**-11-182**	ISS.4	-0.3	
Bus6	11.000	115_<()7	-60.1	0	0	0	0	Bud	0.000	0.000	0.0	o.o	
Bus7	66.000	114.%40	l?.8	0	0	0	0	Busl	0.000	0.000	0.0	o.o	
								Bıır.l	0.000	0.000	0.0	0.0	
								Buı,9	0.000	0.000	o.o	0.0	
Bus8	66.oOO	115.SOS	.JO.1	0	0	0	0	Busl	0.000	0.000	o.o	o.o	
								Bud	0.000	0.000	0.0	0.0	
								Busl0	0.000	0).000	o.o	0.0	
Bus?	11.000	114,240	-0.1	0	0	0	0	Bus7	0.000	0.000	o.o	o.o	
Busl0	11.000	115<0S	.1;0.1	0	0	0	0	Bus8	0.000	0.000	M	0.0	
Busl3	66.000	11;.;31	..l0.1	0	0	0	0	Bud	0.000	0.000	0.0	0.0	
								Busl::*;	0.000	0.000	o.o	0.0	
BusU	66.000	114.263	l9.S	0	0	0	0	Bus2	0.000	0.000	0.0	0.0	
								Busl6	0.000	0.000	0.0	0.0	
Butl5	11.000	llS.SSl	.1;0.1	0	0	0	0	Bud3	0.000	0.000	o.o	0.0	
Busl6	11.000	IH.263	-0,l	0	0	0	0	Bud4	0.000	0.000	0.0	o.o	
Busl7	66.000	116.549	.J0.3	0	0	0	0	Bm.t7	-0.009	6.493	48.7	-0.I	
								Bu-.ll	**0.00S**	**.J.249**	14.4	-0,I	
								Busl3	0.004	.J:244	24.3	.0.I	
								Bud9	0.000	0.000	0.0	0.0	
BusIS	66.000	114.273	29.ll	0	0	0	0	Bud.	0.000	0).000	M	0.0	
								Busl 0	0.000	0.000	0.0	o.o	
Bud$/	11,000	116.549	...0.I	0	0	0	0	Bu'.S:17	0.000	0.000	0.0	o.o	

Prujer̲t: JIL<\STER THESIS	ETAP	Pag•:	1S
Location: HOUN CITY -LIBYA	12.6.0H	Date:	28,,06-2016
Contract: NEAREAST UNI'l'ERSITY-EEE D•piirtın•nt		**SN:**	
Engineer: SM"D !WSTAFAAL-REFAI	Stucly Case: HA	Revistoıe	**Base**
Filename: HOUN Sh'llSTATION 220kV		**Config:**	**Nonnal**

DE.5IGN OF A LARGE SCALE SOLARPYSYfıTI:J'ıl Aıı'D ll,IPACT ANALYSIS OF **ITS** INTEGRATION INTO LIBYAı" POWER GRID

Bus		Volt•jı•		G~neratiou		Load		Load Flow					Xfl\IR
ID	**kV**	**%)ıhg.**	**Ang.**	**MW**	**Xfow**	**MW**	**:Mrzır**	**ID**	**1.fiV**	**Afr-lr**	**Amp**	**% PF**	**% Tap**
·**Bus20**	11.000	114.%73	.0.:	0	0	0	0	BuslS	0.000	0.000	M	0.0	
BusZl	U.000	116.979	030.\	0	0	0	0	**Bud7**	-0.003	**?.839**	21.1	-0.I	
								Busl3	0.003	-1.839	**U,l**	**-0.1**	
								Busl2	0.000	0.000	0.0	0.0	
Btıs22	11.000	116.9:ııı	-60..1	0.	0	0	0	**Busll**	0.000	0.000	0.0	0.0	
Bus:23	U.000	118..llO	-30,4	0	0	0	0	**Bus17**	0.000	-0.001	0.0	-16.2	
								Busn	0.000	0.001	0.0	-16.2	
								Bm:?$	0.000	0,000	0.0	0.0	
Busl$	ll.000	118..llO	-60.4	0	0	0	0	Bnsl3	0.000	0.000	0.0	M	
Bu'27	U.000	115.678	-30.2	0	0	0	0	Bu'17	0.015	-6.7S3	**Si.O**	**-0.l**	
								Bml	-0.015	~.753	**!il.i)**	**-0.1**	
								Bu1,28	0.000	0.000	0.0	0.0	
								Busl9	0.000	0.000	0.0	0.0	
Bus28	11.000	115.878	-60.1	0	0	0	0	**Bus27**	0.000	0.000	0.0	0.0	
Bu.,;19	11.000	115.878	-60.1	0	0	0	0	**Bus27**	0.000	0.000	0.0	0.0	
BudO	U.000	*115.511*	-30.2	0	0	0	0	**Bus1**	0.000	0.000	0.0	0.0	
								Bud2	0.000	MOO	0.0	0.0	
B"'31	66.000	*IU.UI*	:9.s	0	0	0	0	**Bwl**	0.000	0.000	0.0	0.0	
								Bm33	0.000	0.000	0.0	0.0	
Bus32	11,000	115.Hl	-60,2	0	0	0	0	BuıJO	0.000	0.000	0.0	0.0	
Bm33	11.000	114.243	-0.1	0	0	0	0	B"'31	0.000	0.000	0.0	0.0	

„ Indiraı,.s a 1•0Jtnge rtguJat,d bw {,·oltage- tonkollrd or 5ning typr m:ırhint romll'C'ttd to it)
·11 indiu.fes n. bus fflth a t«ldı.¢rnıatch'cf mot1' than 0.l 1nrA

SYstem BaumCmics Bus Lufortn.1tion

Bus		Voltage Distortiori								
ID	k\"	Fund. %	RMS ′	ASU!ı! %	11ID %	TIF	TIHD %	TSHD %	11IDG %	THDS %
Bud	66,000	ıIssı	!15.51	117.(l.l	MS	8.34	0.00	0.00	0.68	MS
Busl	66.000	114.24	114.U	115.81	o.69	1,1G	MO	0,00	0.69	o.69
Bu,J	220.000	100.00	100.44	119.56	9.40	nı,ss	-0.00	0.00	9.40	9.40
Bu.5	110.000	100.00	100..17	117.Sl	Ml	19U9	0.00	0.00	8.62	M?
Bu,6	11.000	115.Sl	115.51	117.04	0.68	B4	MO	0.00	0.68	0.GS
Bm7	66,000	114.U	JU.14	llS.SI	M9	7.77	0.-00	0.00	0.69	0.69
Bu,8	66.000	115.51	115.51	117.05.	MS	8.JS	0.00	0.00	o.68	MS
Bus9	ıı,ooo	114.?4	lU.14	115.Sl	0.69	7.77	o.oo	o.oo	0.69	-0.69
Busl)	11.000	115.51	llS.51	11'.05	o.68	8.35	MO	0.00	o.68	MS
Busll	66.000	115.$3	115.5.1	ırııe	0.69	ıi.ol	o.oo	-0.00	-0.69	M9
Bud4	66.000	114.26	114.27	115.86	o.70	8.01	0.00	0.00	0.70	0.70
Bu<l5	11.UOO	115-<3	115.ôJ	117.10	0.69	S.61	0.00	0.00	0.69	0.69
Bu,16	11.000	1U.l6	ll4.27	115.86	0.70	8.01	0.00	0.00	0.70	0.70
Busl7	66.000	116.55	116.SS	119.03	1.oo	14.26	o.od	o.od	1.oo	1.00
Bus18	66.000	11U7	114.lS	115.89	0.71	8.U	0.00	0.00	0.71	0.71
Bu,19	11.000	116.55	116.SS	119.0J	1.00	U.26	0.00	0.00	1.00	1.00
BuslO	11.000	114.17	114.?8	l!S.89	0.71	S.U	0.00	0.00	0.71	0.71
Bu<ll	66.000	116.ı>S	116$	119.ı>l	1.19	18.49	0.00	0.00	1.19	1.19
Bus?l	11.000	116.98	116,99	119.!ll	1.19	18.49	0.00	0.00	1.19	1.19
Busl.!	66.000	118.32	1183-I	!Zl.SS	1.00	13.18	0.00	0.00	1.00	2.00
BuslS	11.000	11S.3l	118.14	U2.58	1.00	uıs	0.00	0.00	1.00	1.00
Bu<17	66.000	115.88	115.88	117.72	0.77	9.45	0.00	0.00	0.77	0.77
Bu,28	11.000	115.88	IIS.88	117.72	0.77	9.45	0.00	0.00	0.77	0.77
Bu.:9	11.000	llS.88	llS.88	117,72	0.77	9.45	0.00	0.00	0.77	0.77
Bus.lo	66.ooo	115.Sl	ııs.sı	117.05	MS	8.38	o.od	o.od	o.GS	o.68
Bus.il	66.000	114.14	lU.25	115.Sl	0.69	7.80	0.00	0.00	0.69	0.69
Bus.ıı	11.000	nssı	ıIssı	111.0s	o.68	ass	o.oo	o.oo	o.GS	o.68
Bus.il	ıı.ooo	1u.24	ıu.ıs	11uı	o.69	1.so	o.oo	o.oo	o.69	o.69

hdk:ı.tt1THD (f oral H"rmonic Distortion) Eseeeds **the Limit.**
 # lndkatts nm (lndMdualHımnonk Distortion) Eundt 1ht ümir.

System Harmonics Branch Informatfou

Bus		Curreut Dlstcrnon											
FromBmID	**ToBu'ill,)**	**Fund.** Amp	RMS Amp	ASUM **Amp**	THD %	TIF	IT **Amp~Amp**	1TB	ITu	mm %	TSHD %	THDC %	THDS %
Busl	Bu,13	:1.Sl	*Z.88*	**3.13**	U7	108.88	313.Jl	313.31	0.00	0.00	0.00	6.17	6.17
	Busl?	**$!.17**	$l.37	60.24	8.81	86.<3	452M6	*4526.65*	0.00	0.00	0.00	SS1	8.81
	Bu,8	MO	0.60	0.67	*M9*	106.75	*63.66*	*63.66*	0.00	0.0il	0.00	6.09	M9
	B..S	o.60	o.60	0.67	6,09	106,75	*63.66*	*63.66*	0.00	0.00	0.00	6.09	6.09
	B"'30	1.19	1.19	1.34	,.10	107.0l	m.-4	**127.61**	0.00	0.0il	0.00	6.10	6.10
	Bus3	*683.89*	685.06	768.76	S.85	99.34	68057.16	68057.16	0.00	0.00	0.00	5.85	~.8$
	Bu,6	0	0	0	0	0	0.00	68057.16	0.00	0.00	0.00	0.00	0.00
Bus?	**Busl4**	l.61	l.61	**2..93**	***5.PZ***	101.39	l~.70	l-4.70	0.00	0.00	0.00	**S.Sl.?**	**5.9!**
	Btıs!S	3J9	3.39	3.81	5.95	lOl.34	347.06	347.06	0.0il	0.00	0.00	5.95	***~.9S***
	Bı.tS7	0.59'	**,:ı.~9**	*o.66*	5.85	99.40	**5S.<i2**	**58.62**	0.0il	0.00	0.00	***5,8S***	***S.$$***
	Bus7	0.$9	0$	*0.66*	5.85	99.40	58.62	***~8.6Z***	0.00	0.tı0	0.00	*S.85*	*5.85*
	»~n	**1.1S**	1,18	**1.32**	SJl6	*99.66*	117.53	117,53	0.00	0,00	0.00	*5.86*	*5.86*
	Bu,5	617.93	6)9.00	705.90	**5.85**	*99.35*	62488.11	6US8.71	0.00	0.00	0.00	*S.85*	S.85
BusJ	Bud	lOS,17	205.Sl	230.63	**5,8$**	99,34	20417.15	**l0-117,15**	0.00	0.0il	0.00	5.85	***S.85***
Bu,$	**.Bın?**	ISSJS	188.70	**lll.77**	***5.$5***	*99,3,'*	*18146.61*	18746.61	0.00	0.0il	aee	$.65	*5.85*
Bu.~6	Busl	0	0	0	0	0	0.00	18746.6)	0.00	0.00	0.00	0.00	0.00
B11s7	**Bus2**	0	0	0	0	0	0.00	**167-16.6?**	0.00	0.0il	0.00	0.00	0.00
	Bwl	0	0	0	0	0	0.00	18746.6)	0.00	0.0il	0.00	0.00	0.00
	Bu,s9	0	0	0	0	0	0.00	18746.lil	0.00	0.00	0.00	0,00	0.00
Bu.S	**Btıd**	0	0	0	0	0	0.00	18746.6?	0.00	0.00	0.00	0.00	0.00
	Busl	0	0	0	0	0	0.00	18746.6?	0.00	0.00	0.00	0.00	0.00
	Busl 0	0	0	0	0	0	0.0il	18746.lil	0.00	0.00	0.00	0.00	0.00
Bus9	Bus7	0	0	0	0	0	0.00	18N6.6l	0.00	0.00	aee	0.00	0.00
Bu~10	Bus$	0	0	0	0	0	0.0il	18746.6?	0.00	0.oq	0.00	0.00	0.00
Bu,13	**Bud**	0	0	0	0	0	0.00	18746.lil	0.00	0.00	0.00	0.00	0.00
	Busl*ti*	0	0	0	0	0	0.00	*18146.62*	0.00	0.00	0.00	0.00	0.00
Bu,U	**Busl**	0	0	0	0	0	0.00	*18146.62*	0.00	0.00	0.00	0.00	0.00
	Budf	0	0	0	0	0	0.00	**187-16.62**	0.0il	0.00	0.00	0.00	0.00
Bud~	Bıı,13	0	0	0	0	0	0.00	*18146.61*	0.0il	0.00	0.0il	0.00	0.00
Bud6	**Busl4**	0	0	0	0	0	0.00	18746.62	0.00	0.00	0.00	0.00	0.00
Bu,17	Bu,l7	48.73	48.9+	**f:6,$0**	9.17	*85.66*	4191.34	4191.34	0.00	0.00	0.00	9.17	9.17
	Bndl	**2-t3!)**	**24.50**	28$7	*9.59*	104.0S	1548.96	***25.fS.96***	0.0il	0.00	0.00	*9.59*	*9.59*
	Busl3	**24.3$**	24.44	27.93	**8.7i**	67.97	1661;37	1661;37	0.00	0.0il	0.00	8.71	8.77
	Bııs19	0	0	0	0	0	0.00	*16ıS1J1*	0.0il	0.00	0.00	0.00	0.00
BudS	**Bus!**	0	0	0	0	0	0.00	l661J7	0.00	0.00	0.00	0.00	0.00
	Busl0	0	0	0	0	0	0.0il	1661.37	0.0il	0.00	0.00	0.00	0,00
Busl9	Bıı,17	0	0	0	0	0	0.0il	l661J7	0.0il	0.00	0.0il	0.00	0.00
lh.t.$?0	Bus!S	0	o	0	0	0	0.00	1661J7	0.00	0.00	0.00	0.00	0.00
Busll	Busl7	**ll.13**	**?Ll.f**	1S.O1	10.06	87.86	1874.43	1874.43	0.00	0.0il	0.00	10.06	10.06
	Bw:?3	**21.23**	**:?1.3.ı**	l5.0l	10.06	87.86	1874.43	1874.43	0.00	0.0il	0.0il	10.06	10.06
	Bud.?	0	0	0	0	0	0.00	1874.43	0.00	0.0il	0.0il	0.00	0.00

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Bus FromBufID	ToBu-slD	Fund.. Atnp	RMS Amp	ASUM Amp	TDD %	TIF	IT	m/ %	ıra	1lllD	TSHD %	THDG %	THDS %
Bu;'?l	Bu~zı	0	0	0	0	0	0.00	1674..13	0.00	0.00	0.00	0.00	0.00
Bus23	Bu,17	0.0l	0.13.	0.W	140t38	270l.48.	34M7	349.97	0.00	0.00	0.00	U04.38	1404.;18
	Bu..21	0.0l	0.13	0.29	1404.38	2702.48	34M7	349.97	0.00	0.00	0.00	uous	1404.\8
	BuslS	0	0	0	0	0	0.00	349.97	0.00	0.00	0.00	0.00	0.00
BuslS	Bns!3	0	0	0	0	0	0.00	349.97	0.00	0.00	0.00	0.00	0.00
Bu~17	Bu,17	50.98	51.18	SS.99	8.96	81,49	4476.34	4l78.'14	0.00	0.00	0.00	s.96	8.96
	Busl	50.98	Sl.lS	S8.99	8.96	87.49	4478.34	4l7S.34	0.00	0.00	0.00	8.96	8.96
	BU$?8	0	0	0	0	0	0.00	4l78J.I	0.00	0.00	0.00	0.00	0.00
	Busl9	0	0	0	0	0	0.00	4l76J.I	0.00	0.00	0.00	0.00	0.00
Bus.28	Bu$l7	0	0	0	0	0	0.00	4476.34	0.00	0.00	0.00	0.00	0.00
Bıul9	Bu~?	0	0	0	0	0	0.00	4l76.;14l	0.00	MO	0.00	0.00	0.00
Bu.JO	Bıı,I	0	0	0	0	0	0.00	4478.34	0.00	0.00	0.00	0.00	0.00
	B11'3l	0	0	0	0	0	0.00	4478.34	0.00	0.00	0.00	0.00	0.00
Budl	Bus?	0	0	0	0	0	0.00	4l78J.I	0.00	0.00	0.00	0.00	0.00
	BU$..'3	0	0	0	0	0	0.00	4478.34	0.00	0.00	0.00	0.00	0.00
BusJ2	BU<30	0	0	0	0	0	0.00	4l7S.l4	0.00	0.00	0.00	0.00	0.00
Bu,3$	Bus51	0	0	0	0	0	0.00	4478.34	0.00	0.00	0.00	0.00	0.00

Bus Tabulation

Harmonic Voltages (% of Fundamental Voltage)

Bus ID: Bus1
Fund. kV: 76.235

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
5.00	150.00	0.35	7.00	350.00	[illegible]	11.00	550.00	0.36	13.00	650.00	0.29	17.00	850.00	0.01	19.00	950.00	0.01
23.00	1150.00	0.00	15.00	1150.00	0.01												

Bus ID: Bus10
Fund. kV: 12.706

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
5.00	250.00	[illegible]	7.00	350.00	[illegible]	[illegible]	[illegible]	0.36	13.00	650.00	0.19	17.00	850.00	0.01	19.00	950.00	0.01
[illegible]	[illegible]	0.00	15.00	1150.00	0.02												

Bus ID: Bus~l
Fund. kV: 75.397

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
5.00	150.00	0.50	7.00	350.00	0.21	11.00	550.00	0.3?	13.00	650.00	0.17	17.00	850.00	0.03	19.00	950.00	0.01
13.00	1150.00	0.00	25.00	1250.00	0.01												

Bus ID: Bus9
Fund. kV: 11.566

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
5.00	150.00	0.50	7.00	350.00	0.21	11.00	550.00	0.32	13.00	650.00	0.17	17.00	850.00	0.03	19.00	950.00	0.01
13.00	1150.00	0.00	15.00	1250.00	0.02												

Bus Tabulation

Harmonic Voltages (%.of Nominal Volıage)

BıısID: Busl
Norn. kV: 66.000

Order	Freq.	Mag.	Order	Freq,	Mag.	Ordtı·	Frtq.	Mng.	Ordtı·	Freq,	lıfag.	Order	Fıe,q.	l!ng.	Ordtr	Freq.	l\.fag.
__	.....!L-L--			_.11!._	_L	--	.....!L_L		--	.....!L_L		--	.....!L_L		--	.....!L_L	
5.00	250.00	e.ss	7.00	3!0.00	0.16	11.00	!50.00	0.41	13.00	6S0.00	0.54	11.00	sso.oo	o.oz	19.00	9;0.00	o.oı
23.00	1150.00	0.0J	ZS.00	ll!0.00	0.0?												

Bus ID: Bus!O
Nom. kV: [illegible]

--	Hı	%	.--	Hı	%	__	Hı	%	--	Hz	%	____	Hı	%	--	Hr	%
5.00	250.00	OS!	7.00	3!0.00	0.16	11.00	550.00	0.41	13.00	650.00	0.34	17.00	8,0.00	0.0?	19.00	950.00	0.0l
23.oo	ıışo.oo	o.oı	25.oo	nso.ee	o.oı												

Bus ID: Bus2
Norn: kV: 6<i.000

Order	Freq,	Mag.	Ordtr	Freq.	Mag.	Ordtı·	Ft<tq.	Mıg.	Oı-dtr	Freq.	Mag.	Ordu	Freq,	Mıtg.	Order	Freq.	Mag.
__	Hz	%	__	Hz	%	_	Hı	~	--	Hı	%	--	Hı	%		Hı	%
5.00	250.00	0.58	7.00	350.00	0.24	11.00	550.00	0.37	13.00	650.00	0.31	17.00	850.00	0.03	19.00	950.00	0.0l
23.oo	mo.oo	0.00	zs.ee	mo.oo	o.oı												

Bus ID: Bus9
Norn. kV: [illegible]

	Hı	%	__	Hı	%	__	Hı	%	__	Hı	%	__	Hı	%	__	Hı%	
5.00	ısọ.oo	0.58	1.00	350.W	0.1.1	ıı,oo	sso.w	0.31	13.0o	650.oo	0.31	17.oo	850.00	aes	19.00	,so.oo	0.02
l;l,00	1150.00	0.00	2S.00	mo.oo	0.0?												

Filter O.·N·loadiug

Filtel'			CapacitolCl			Indu<toı•LI			CapacitorC2			InductorL2		
			~fat.	Opr.	%	Mıu.	Opr.	%	hfax.	Opr.	%	Afnx.	Opr.	%
ID	Type	Coun«tfon	kV	kV	0\-trVolt	.<lmp	•\mp ~		kV	kV	OnrYoh	..\mp	•\mp	Owrlond
HFI	3	Wyo	0.000	63.074	NIA	0.00	627.63	N/A						
HFZ	3	Wy<	0.000	62.408	NJA	0.00	62M4	NIA						

Filter Types: 0 = By-Pass, 1 = High-Pass (Damped), 2 = High-Pass (Undamped), 3 = Single Tuned, 4 = 3rd Order Damped, 5 = 3rd Order C-Type

Alert Summan• Report

% Alert Settings

	Critical	Marginal
Aw.		
Indhidua!Bus VIHD /VIHJhıılues are used.		
Transformer		
Totali	100.0	95.0
Filter		
Capacitor kV	100.0	9$.0
Iuductor Amp	100.0	95.0
Capacitor		
l\JaxkV	J00.0	9S.O
Cable		
Ampacity	100.0	95.0

APPENDIX 11

HARMONICS ANALYSIS WITH FILTERS AND PV

Proj.ct:	MASTER THESIS	ETAP		Page:	1
Location:	HOUN Cm' -UBYA	12.6.0H		**Date:**	28-06-2016
Contract:	!\'EAR EAST UI\'IVERSITY • EEE. Deparnnent			**SN:**	
Engineer.	SAı"\'D› MUSTAFA AL-REF AI	Study Case:	HA	Revisionı	Base
Fileuaıne:	HOUN SUBSTATION 220kV			Coufıg:	**Normal**

DESIGN OFA LARGE SC~sU.E; SOLARPV SYSTEM AND IlıIPACT ANALYSIS OF ITS; INTEGRATION INTO LIBYAN POWER GRID

Electrical Transient Anah-:ıeıProgram

Harmonic study with filters and PV coımection

Loading: Op•mıin~ P, Q

Generation: Opuaiing P, Q, V

	Slıin.L_	V-Conn-ol	Load	Total
Number of Buses:	3	7	30	40

	XFMIU	XFMR3	Reaeter	Line/Cable	Impedance	Tie PD	Total
Number offüanrbes:	24	0	0	16	0	0	40

	CuıTent	~·
Number of Harın. Sources:	4	0

Number of Filters:	2

Method of Solution:	Adaplivo Ne111on-Raphson
Ma;nuuım No. of Iteration:	99
Precision **of Solution:**	0.0001000000
S}'Stem Frequency:	50.00H:ı
Unit Syst<m:	I\feuic

DESIGN OF A LARGE SCALE SOL.\R l'V SYSTEM Aı'ɪD Il'ıɛPACT ANALYSIS OF ITS INTEGRATIONINTO Lll!YAı'i POWER GRID

Adju:!ifmeuts

Tolerance	Apply A,ljusıments	Indhidual /Global	Percent
Traıısformer Impedance:	Yes	hıdMdwıl	
Reactor Impedance:	Yes	hıdhiduıl	
Overload Heater Resistance:	No		
Transmission Line Lenglh:	No		
Cable Length:	No		

Temperııtıı·e Correctioıı	Apply Adjustments	Indhidual /Global:	Degree C
Transmission Lin• Resistance:	Yes	hıdMdwıl	
Cable Resistance:	Yes	Iıdhidu,l	

ProjW:	MASTER THESIS	ETAP	Page: 3
Location:	HOUN CITY· LIBYA	12.6.0H	D~te: 2S-06s20l6
Contractı	NEAR EAST I.INI'VI.R.5ITY •EEE Iieparrmeiır		S.N:
Engineer-:	SA.'lhD 1,WSTAFA AL-REF AI	Study Co,., HA	Reviston: Base
Filenme:	HOUNSUBSTATION220kV		Coufig: Normal

DESIGN OF A LARGE SCALE SOLARPV SYSTEM AND Th!PACT ANALYSISOFIT'S INTEGRATION INTO LIBYAN POWER GRID

Bus Jnput·Data

Bus			Iwtial Vulfagr		Load								o/oLbnlts	
					Con$tant kY~\.		ComıantZ		Conştantl		Gto,rii:			
m	kV	Sub-.,,'S	% ?\l:ıg.	Ang.	MW	Akar	MW	Mrnr	MW	M,-111-	MW	M,ur	\'TIID	VIIID
Bu~l	,,MOO	I	98.S	..I0.0									10.00	10.00
Bus.1	66.000	2	100.0	J0.O									10.00	10.00
BusJ	II0.000	I	100.0	0.0									5.00	S.00
Bus4	220.000	3	100.0	0.0									10.00	10.00
Bus5	II0.000	2	100.0	0.0									10.00	10.00
Bıu6	II.000	I	98.1	-6-0.0									5.00	MO
Bus7	66.000	1	98.S	30.0									10.00	10.00
llus8	66.000	I	92.0	-Se,e									IMO	10.00
Bus.9	II.000	2	98.1	0.0									10.00	10.00
Busl 0	II.000	1	97.8	-60.0									10.00	10.00
Busll	66.000	2	100.0	30.0									10.00	10.00
Busl?	66.000	I	100.0	.JO.O									10.00	10.00
Bu,13	66.000	I	98.1	-30.0									10.00	10.00
BusU	66.000	1	98.0	30.0									10.00	10.00
Busl5	11.000	I	98.1	.I;0.0									10.00	10.00
Bınl6	11.000	I	98.1	0.0									10.00	10.00
Bml7	66.000	1	98.9	-30.0									10.00	10.00
Bud8	66.000	I	98.S	J0.O									10.00	10.00
Bwl9	11.000	I	98.1	-!0.0									10.00	10.00
Bu,20	II.000	Z	98.7	0.0									10.00	10.00
Bus'.?!	66.000	I	98.9	.JO.O									10.00	10.00
Bus?!	11.000	1	98A	-60.0									10.00	10.00
Bıu:?3	66-000	I	99.)	.JO.O									10.00	10.00
Buç?S.	11.000	i	98.1	-60.0									10.00	10.00
Bus27	66.000	I	98.8	.JO.O									10.00	10.00
Bu,VJ	11.000	I	98.4	-60.0									10.00	10.00.
Bus19	II.000	I	98.4	-!0.0									10.00	10.00
Bus30	66.000	I	98.5	..l0.0									10.00	10.00
Busl!	66.000	I	98.6	30.0									10.00	10.00
Bud:?	II.000	I	98.0	-60.0									10.00	10.00
Bus3J	11,000	I	100.S	0.0									10.00	10.00
Bud.fi	0.400	I	100.0	-J0.O									10.00	10.00
Bu$3S	o.400	I	100.0	,,0.0									5.00	5.00
Bu,16	0.400	I	100.0	.Jo.0									10.00	10.00

Project:	MASTER THESIS	ETAP	Page: 4
Location:	HOUN CITY-LIBYA	12.6.0H	Date: 28-06-2016
Contract:	NEAR EAST UNIVERSITY · EEE Department		SN:
Engineer:	S.U.1) MIDSLAFA AL-REFAI	Study Case: HA.	Revision: Base
Filename:	HOUN SUBSTATION 110kV		Config: Normal

DESIGN OF A LARGE SCALE SOLARPV SYSTEM AND IMPACT ANALYSIS OF ITS INTEGRATION TO LIBYAN POWER GRID

Bus ID	kV	Sub-sys	Initial Voltage % Mag.	Ang.	Constant kVA MW	Mvar	Constant Z MW	Mvar	Constant I MW	Mvar	Generic MW	Mvar	% Limits VTHD	THD
Bus37	[illegible]		[illegible]	[illegible]										
Bus38	0.400	2	100.0	30.0									5.00	5.00
Bus39	0.400	2	JOO.O	JO.O									5.00	5.00
Bus40	MOO	2	100.0	30.0									5.00	5.00
Bus41	11.000	1	120.s	-60.o									10.00	10.00
Bus42	11.000	2	98.9	0.0									10.00	10.00
Total Number of Buses: 40					0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Generation Bus ID	kV	Type	Sub-sys	Voltage %Mag.	Angle	Generation MW	Mvar	%PF	Mvar Limits Max	Min
Bus1	120.000	Swing	1	100.0	0.0					
Bus4	110.000	Swing	3	100.0	0.0					
Bus5	110.000	Swing	1	100.0	0.0					
Bus34	0.400	Voltage Control	1	100.0	-30.0	1.952			0.000	0.000
Bus35	0.400	Voltage Control	1	100.0	-30.0	US!			0.000	0.000
Bus36	0.400	Voltage Control	1	100.0	-30.0	1.952			0.000	0.000
Bus37	0.400	Voltage Control	1	100.0	-30.0	1.951			0.000	0.000
Bus38	0.400	Voltage Control	2	100.0	30.0	1.95;			0.000	0.000
Bus39	0.400	Voltage Control	2	100.0	30.0	1.952			0.000	0.000
Bus40	MOO	Voltage Control	2	100.0	30.0	1.952			0.000	0.000
						13.66?	O.MO			

DES!GNOl'.ALARGESCAL[SOLARPVSYSTEMANDI11lPACTAı'IALYSlS0l'ITSINTEGRAJIONlNJOLIBYANJ>O'\\'ERGIUD

CableInput Data

Cable			Length				Olnns or l\lhos / 1000 m per Conductor					
ID	Ubr.ary	Size	Adj.(m)	% Tol.	#/Phase	T (°C)	R1	X1	Y1	R0	X0	Y0
Cnbl,l	ınrcess	,ıoo	100.0	0.0	1	15	0.076302	0.081400	0.0001616	0.140.151	o.w,ooo	
Cab1tl	IL\ICUS3	JOO	100.0	0.0	1	*11*	o.oı6302	o.omoo	0.0001616	0.240351	o.mooo	

Cable resistances are listed at the specified temperatures

Tı-ausmissionLinç Input pata

Line			Lfugth				Ohms or Mbos J 1000 m per Phnse					
ID	l.!br,')'	Sin	Adj.(m)	%ToL	~'l'ha,<	~--R_ı_~			v_l	R_o_	~--Y_o_	
LJn.ı		674	moo.o	0.0	I	75	0.0ö600l	o.mı;;	.00000;1	0.200011	l..!60791	.0000017
LJn,2		*614*	moo.o	0.0	ı	*lS*	o.os60oı	o.ıııo69	.oooou	0.200637	uııoh	.0000016
Lin,,		674	z,ooo.o	0.0	I	*1;*	o.o;60oı	o.Jl1069	.oooou	0.200637	1.mo.u	.0000016
Linö!		674	15000.0	0.0	1	75	0.0ö6001	0.34?069	.0000034	M00637	1.lll041	.0000016
L!nt5		674	8000.0	0.0	I	7;	0.0ö6001	0.3l1069	.ooooo;ı	0.200637	1All041	.0000016
Lin'6		674	4000.0	0.0	I	*15*	0.056001	0.3l1069	.0000031	0.100637	l.4!40ll	.0000016
Lhtt7		**674**	**4000.0**	**0.0**	**I**	**75**	**0.056001**	**0.34206$1**	**.000003-'**	**0.200637**	**lAl-40-U**	**.0000016**
Lln,8		674	4000.0	0.0	1	75	0-656001	0.3U069	.0000031	0.200637	Ull041	.0000016
Lin,9		674	4000.0	0.0	1	rs	0.0,6001	o.mo69	.ooooo;ı	0.200637	ı..ııoh	.0000016
u.;10		61'4	8000.0	0.0	ı	*1;*	0.0;6001	o.mo69	.ooooo;i	o.200ö11	uı40ıı	.0000016
Linell		61'4	8000.0	0.0	l	75	0.056001	0.342069	.0000034	0.200637	Ul40ll	.0000016
Lln,12		674	21000.0	0.0	I	*1s*	0.Alö600I	o.342069	.ooooo.ıı	o.?00ö17	1.moı1	.()OOOl6
L!n,13		674	161000.0	0.0	ı	*1;*	o.oö60oı	o.Jııo69	.ooooo;ı	0.200637	I..I=I	.0000016
L!n'14		674	140000.0	0.0	I	75	0.0,6001	0.342069	.0000034	M00637	1.424041	.0000016

Lint t'tthtımcts ere **listtd at lht sptdfitd ttınptraturts**

2-Winding Transfoıner Input Data

Tı-ansfonner ID	Rating IffA	PiiIlLkY	Sec. kV	% Z	XIll	Z Variation + 5%	• 5%	% ToJ.	%Tap Setting :Prlın.	Ste.	Adjusted % Z	Phns• Shift Type	Anglt
Tl	63.000	220.000	66.000	ll.50	45.00	0	0	0	0	0	ıı.~000	Dyn	30.000
T3	<3.000	220.000	66.000	l!.50	45.00	0	0	0	0	0	12.5000	Dyn	.J0.000
T4	10.000	66.000	11.000	8.35	ıaee	0	0	0	0	0	8.3500	Dyn	30.000
rs	20.000	66.000	11.000	10.00	20.00	0	0	0	0	0	10.0000	Dyn	30.000
T6	20.000	66.000	11.000	10.0!)	l0.00	0	0	0	0	0	10.0000	Dyıı	30.000
T1	12.;o0	11.000	66.000	8.35	13.00	0	0	0	0	0	S.3500	\'Nd	30.000
TS	12.soo	11.000	66.000	8.35	13.00	0	0	0	0	0	8.3500	'iNd	30,000
'19	10.000	66.000	11.000	8.35	13.00	0	0	0	0	0	8.3500	D;1ı	30.000
TlO	10.000	66.000	11.000	8.35	13.00	0	0	0	0	0	8.3500	Dyn	30.000
Tll	20.000	66.000	11.000	10.00	20.00	0	0	0	0	0	10.0000	I>)11	30.000
TU	10.000	66.000	11.000	10.00	20.00	0	0	0	0	0	10.0000	D)-ıı	30.000
TU	10.000	66.000	11;000	8.35	uoo	0	0	0	0	0	8.3500	Dyu	30.000
Tl4	10.000	66.000	11.000	8.35	U.00	0	0	0	0	0	8.3500	D)'U	30.000
Tl6	20.000	66.000	lLOOO	10.00	l0.00	0	0	0	0	0	10.0000	D;1ı	30.000
Tl7	10.000	66.000	11.000	10.00	20.0l>	0	0	0	0	0	10.0000	D;1ı	30.000
TlS	20.000	66.000	11.000	10.00	?0.00	0	0	0	0	0	10.0000	Dy~	30.000
Tl9	20.000	66.000	11.000	10.00	20.00	0	0	0	0	0	10.0000	Dyn	30.000
n0	3.000	0.400	11.000	6.ZS	6.00	0	0	0	0	0	6.2500	"\'Nd	.j0.000
n1	3.000	0.400	11.000	6.ı;	6.00	0	0	0	0	0	6.2500	\'Nd	-30.000
Tll	3.000	0.100	11.000	6.25	6.00	0	0	0	0	0	6.2500	\'Nd	-30.000
Tl3	3.000	0.400	11.000	6.15	6.00	0	0	0	0	0	6.2500	\'Nd	-30.000
124	3.000	0..100	11.000	6.lS	6.00	0	0	0	0	0	6.1500	\'Nd	-30.000
Tl5	3.000	0.400	11.000	6.25	6.00	0	0	0	0	0	6.1500	\'Nd	.j0.000
!26	3.000	0.400	11.000	6.25	6.00	0	0	0	0	0	6.1500	\'Nd	-30.000

2-\Yiudin(L' Tran.~fo1mer·_ G1;oundiuo: Innut Dato

Transformer ID	R.ııinJ[M'\'A	~~~		Couu.	Grounding Piiın.1ı;· TYP'"	kV	Amp	Ohm	Se<ondary T~pt	kV	Amp	Ohm
Tl	63.000	220.000	66.000	DIY					Solld			
rs	6.\000	ll0.000	66.000	DI\'					Solid			
T4	10.000	66.000	11.000	DIY					Solid			
T5	10.000	66.000	11.000	D/Y					Solld			

2-.Lin.uui .!i:an.sform~r !TJ;211!ldinaInu•It Data

Trausfcmıer	Rating			Coun.	Grounding Pıimaı:y				Serondaı)'			
ID	MVA	Prim.kV	Sec.kV	Type	TJ-pt	k\'	Amp	Obın	I)ııe	ev	Amp	Obın
T6	20.000	66.000	11.000	D/Y					Solid			
TI	u.~00	11.000	66.000	D/Y					Solid			
TS	IZ.see	11.000	66.000	D/Y					Solid			
T9	10.000	66.000	11.000	D/Y					Solid			
TIO	10.000	66.000	11.000	D/Y					Solid			
TI!	l0.000	66.000	11.000	D/Y					Solid			
TI2	l0.000	66.000	11.000	D/Y					Solid			
r1S	10.000	66.000	11.000	D/Y					Solid			
TU	10.000	66.000	11.000	D/Y					Solid			
Tl6	20.000	66.000	11.000	D/Y					Solid			
Tl7	20.000	66.000	11.000	D/Y					Solid			
TIS	2:0.000	66.000	11.000	D/Y					Solid			
Tl9	:?0.000	66.000	11.000	D/Y					Solid			
T20	3.000	0.400	11.000	D/Y					Solid			
n1	3.000	MOO	ll.000	D/lt					Solid			
!22	3.000	MOO	11.000	D/Y					Solid			
n1	;1.000	MOO	U.000	D/Y					Solid			
!24	3.000	MOO	11.000	D/Y					Solid			
ns	3.000	MOO	11.000	D/Y					Solid			
Tl<i	3.000	uoo	11.000	D/Y					Solid			

Project:	MASTER TlttSIS	ETAP		]:>age:	8
Locatiou:	HOUNCI1Y • LIBYA	12.6.0H		Date:	28-06-2016
Contract:	NEAREAST UNIVERSITY · EEE Department			SN:	
Englneer:	SANDMUSTAFAAL-REFAI	Study Case:	HA	Rol"islon:	Base
Filename:	HOUNSUBSTATION220kV			C~nfıg:	**Noımal**

DESIGNOf A LARGE SCALE SOLARPV SYSTEMAND ThlPAC.'TANAL'l/51SOf ITS INTEGRATIONil\'TOlJBYA>'I! POWER GRID

Branch Connections

CKT/Branch		Connected Bus ID		% Pos!ti\·eSequeııceIınpedance (lOOl\[VABase)			
ID	T)'Pt	From Bus	To Bus	R	X	Z	
Tl	**iWXFllR.**	Busl	Boil·	(l..U	19.84	19.84	
T3	2WXFMR	BU$$	ıı.,z	0.44	19.34	19.84	
T4	**1WXFMR**	Buıl	*&,6*	6.40	**83.IS**	83.50	
TS	**lWXFI!R**	**Bııs7**	&'9	**2.50**	*49.94*	50.00	
T6	**lWXFMR**	Bu.S	**Bud 0**	**2.$0**	*49.94*	50.00	
T7	2WXFllR	**Bus.il**	Buul	**5.12**	66.60	66.80	
TS	**2WXD.fR**	Bu,41	**Bus11**	**S.1l**	66.ó0	66.80	
T9	lWXFllR	Bu,13	**Busl!-**	6.40	**S3.2S**	83,50	
TlO	2\VXFl!R	Bu,H	*&d6*	**MO**	**83.1$**	S:.$0	
Tl!	2WXFllR	Buı17	Busl?	**:1~**	*49.94*	50.00	
T12	2WXFMR	Butl8	Bu;20	**Z.$0**	*49.94*	SMO	
T13	2WXFllR	**Bu'Sll**	**BusU**	6.40	83.25	S>.50	
Tl4	lWXFlffi	Busl3	**B~lS.**	6.40	83.25	83.50	
T16	lWXFllR	**Bua7**	**Bus:?S**	**1.50**	*49.94*	50.00	
T17	**2W:a:MR.**	**Buısl7**	*&'29*	1.50	*49.94*	50.00	
TIS	**lWXFA!R**	ButlO	Bus32	**!.SO**	*49.94*	5(1.00	
T19	**ZWXFMR**	Bus.II	Bus33	1.50	*49.94*	50.00	
no	lWXFllR	&s34ı	Bu>ll	**34.25**	105.50	208.33	
Tl!	!WXFllR	Bus3S	ıı..ıı	**34.15**	**:!O!.M**	208.33	
Tl?	2WXFl!R	Bus.16	ıı.:ıı	**34.ZS**	**10!:.SO**	20S.3l	
T..3	2WXFllR	Butl7	Bus41	***S.l..IS***	205.50	208.ll	
Tl4	**2WXFMR**	Butl8	**Bu«!**	**~.:$**	205.50	208.ll	
TI$	**:?:WXFMR**	Bus.19	**BnN?**	34.25	205.50	208.ll	
!26	**lWXFMR**	**Bu.140**	Bu'42	34.25	205;50	208.33	
C.~l,l.	**Cablt**	Busll	Bu,l	0.0l	**0.0?**	0.03	0.0716998
Cable-l	Cab!•	**Bud!**	Busl	0.02	0.0l	0.03	0.0716998
Llud	**Liut**	**Busl**	ıı:,u	1.48	*16.58*	16.71	0.2607629
Liue!	Liu•	Bud	Bu.,13	1.48	15.16	15.36	**0.2S.f2266**
Llu,3	Li••	**Bıt~**	Bu,18	?.96	18.06	18.30	o·mım
Lint.ı	**Lint**	BU:Z7	Bu,17	L93	11.78	ıi.94	**0.?109015**
Une5	Llııe	Busl	ıı.,ıı	I.Ol	**6.28**	6.37	o.l17S14l
Lindi	Liu•	**Bus?**	Bu,,7	O.SI	3.14	3.18	0.0589071
Llu,7	**Lint**	ıı:.,ı	Buss	o.51	1.14	3.18	0.0589071
Llnt8	Liu,	Bu.Z	*ıı:,1*	0.51	1.14	3.18	0.0589071.
Llu,9	**Lint**	Butl	ıı:..s	o.51	1.14	3.18	0.0589071
LludO	Liu,	**Bu,;1**	Busl!	1.03	*6.28*	*6.31*	0.1178142
ı.ıu,ıı	**Line**	Bud	Bus30	LOl	*6.28*	*6.)1*	o.1178142

CKT/Bı-aıdı		Connected Bus ID		% **PositiveSequenceImpedance** (100 I\IV A Base)			
ID	Typ•	**From Bus**	**To Bus**	R	X	Z	y
LinelZ	**Line**	**Bus:17**	**Busll**	Z.:r0	16.49	16.71	0.30926Z2
Lint'l3	**Line**	Bud7	**Busll**	20.70	126.43	128.1!	2.3710100
Liud4	Liue	**BuJ21**	Bus2.l	18.00	109.94	111.40	2.0617480

.Dr:aucl! C9Ill!e£tion.s

Zero Sequence Impedance

CKT/Brauch		Connectod Bus ID		% Impedance, Z.ro Sl'q., 100 M:VAlı			
ID	Tuıt	From Bus	To Bu~	RO	XO	ZO	ve
Tl	lWXfı.nr	Bn,3	Busl				
T3	:?WXfmr	Bus5	Busl				
n	?WXfmr	Bu,l	But6				
TS	lWXfm.r	Bus7	Bus9				
T6	lWX!mr	Bu,s8	Bu,10				
T7	:2\VXfmr	Bu<I?	Bııdl				
TS	?WXfmr	Bu<ll	Bu<ll				
19	lWXfmr	Bud3	BuslS				
TIO	2WX1mı.·	Bu,U	Bud6				
TU	ZWXfınr	Bu,17	Bad9				
Tll	ZWXfinr	Bu,18	Bın20				
Tl3	lWXfmr	Bus21	Bual				
TU	?WX!mr	Bm23	BQ$IS				
Tl6	lWX!ınr	Bıul7	Busl8				
Tl7	lWXf'mr	Bus:27	Busl9				
TIS	lWXfıru·	Bu,30	BUPl				
rıs	lWX!nu·	Buol	Bıu33				
no	2WXfmr	Bıu34	Bu<II				
TZI	2WX!mr	Bu,35	Bıt'4!				
nı	lWXfmr	Bu,36	Bu<il				
ru	lWXfmr	Bu,37	Bu<ll				
n,	2\VXfmr	Bu,38	Bus-41				
TIS	lWXfmr	Bu,39	Bm-ft?				
Tl6	lWX!mt	Bus40	Bın.ıl				
Cıbld	Cablt	Bud!	Bud	0.06	0.0S	0.67	
Cnhltl	cal,l,	Bu.sl2	Bnsl	0.06	0.0S	0.01	
Lille!	Liu,	Bus:?	BusU	8.86	60.19	60.94	0.1410145
Lind::	u.,	Bnd	Bud3	8.89	6M9	63.71'	0.1341983
Lint3	Lìu,	Bus?	Busl8	10.59	75.19	15.93	0.1599155
Liu,4	Liut	8"'17	Bınl7	6.91	49.04	49.52	0.1041992
Un,$	Liu,	Bud	Bus17	:1.68	%6.IS	26.41	0.0556262
Liut6	Line	Bus%	Bui?	1.84	13.08	1S.n	0.0278Bl
L!ııe7	Line	Busl	BıuS	U4	U.08	13.l!.	0.0218131
LiutS	Liu•	Bu:ı?	Bus7	1.84	13.08	13.21	0.0278131
Linc.9	Uıı.	Bu.,sl	BmS	1.84	13.08	1S.11	0.0278131
Llııe-10	Lfııt	Busl	Bıu31	MS	26.15	26.41	0,055626?

DESIGN OF A LARGE SCALE SOLAR PV SYSTEM ANDThfi>ACTANAL\~1S OF ITS INTEGRATION INTO LIBYAN POWER GRID

Ck'T/Branch		Connected Bus ID		% Impedance, Zero Seq., 100 MVAb			
ID	Type	From Bu,:	To Bu~	R0	X0	Z0	Y0
Liudl	Liu•	Busl	B"'30	3.68	16.15	16.41	0.0556261
Liud:?	Liu,	Bus17	Bus?l	9.61	68.65	69.33	O.l.ı60189
Liud.\	Ltne	Bus17	:Sus:?3	74.16	516.33	S31.5.l	J.1194780
Lln'14	Line	Bus'll	Bu..~23	61.48	457.68	46:.10	0.973459$

Machine Input Dat:ı

~Lıdıine		Connected Bus	Rating (Base)		% Negati\'e Seq. Imp.			Grounding			% Z..ro Seq. Imp.		
ID	Typt'	ID	l~	kV ~	XıR	R?	Xl	Cowı.	Type	Amp	XiR	RO	~
ul	Grid	Bu.!	22.101	220.000	10:00	Mso	99.;o	Wl·,	solid		10.00	J.;.<;48	356..lll
u2	(Md	B'''4	22.101	120.000	10:00	9.950	99.50	Wr,	Solid		10.00	17.738	177.38
U3	Grid	BusS	22.101	110.000	10.00	9.950	99.50	\l')·•	Solid		10.00	17.738	177.38

Harınonic Libmıy

Current Harmonic Source in %

llanufarturer: Typkal-IEEE,
Model: 12 Pulsel

Ordtı·	Freq,	Mog.	O«l<r	Fr,q.	lbg.	Ordtı·	Freq,	M•g.	Ordrı·	Freq,	I'.fag.	Ordtr	Freq.	Mag.	Ordtr	Freq,	hfag..
---	-!iL.	.....1L	--	-!iL.	.....1L	--	-!iL.	_%_		-!iL.	.....1L	--	-!iL.	.....1L	--	-!iL.	.....1L
1.00	so.oo	100.00	11.00	sso.oo	sJo	1.1.00	650.oo	6.7o	**13.00**	11so.oo	1.so	25.0o	mo.oo	z..10	1.<.00	11so.oo	-0.ao
37.0.0	1850.00	o.60	47.00	Z,IS0.00	0;lO	49.00	141'0.00	o.1o									

Mamıfartur.er: TypicaHEEE,
Model: 12 Puls.2

Order	Fr,q.	Mog.	Ordtr	Fr,q.	li.ıg.	Ordor	Freq.	Mag.	Ordtr	Freq.	M.ıg.	Ot'dtr	Freq.	lhg:.	Ordtt	Freq.	Mag.
	•	%		•	%		•	%		•	%		•	%		•	%
1.00	S0.00	100.00	11.00	SS0.00	SJO	13.00	61'0.00	6.70	lel.00	1150.oÖ	--r.so-	run ~		13Ô	3iôö	'im'oo	o.so'
37.00	ısso.oo	MO	47.00	:1.,so.00	0.20	49.00	uso.oo	o.1o									

!\lanufactut'er: Typical-IEEE
lllod•l: 12 Puls.2

Oı·dtr	fr,q;	llig.	Ordtr	Fr,q.	lı:g.	Oı-de-r	Ft<tq.	Afag.	Ordn	Freq.	~fag.	Order	fr«ı,.	Mag.	Ol-dtr	Freq.	)fag,
	•	%		•	%		•	%		•	%		•	%		•	%
1.00	S0.00	100.00	IJ.00	5S0.00	8.30	13.00	650.00	6.70	13.00	1150.00	1.80	run ~		13Ô	3iôö	'lll0.00	o.so'
37.00	1850.00	MO	47.00	z.ıso.00	o.1o	49.00	**l,l~.00**	o.1o									

?.!nnıfactw·er: Tnıkal-lEEE
Moılel: llPulse2

Orde-r	Freq.	lı.g.	Ord,r	ff"l,	ll•g.	Order	Fr,q.	Mag.	Oıslor	Fı·,q.	~l.g.	Ordtr	Freq.	Afag.	O«k<r	Fr,q.	Mag
	•	%	—	•	'"1-.			%	—	•	%	--	Hı	%	---	Hı	0/0
1.00	s0.e0	100.00	n.ee	sso.oo	ase	13.00	~s0.00	MO	1.1.00	mo.oo	1.so	?S.00	11so.oo	1.,0	1.<.00	11so.oo	o.so
noo	ısso.oo	Mo	47.00	1.1so.00	0.20	49.00	uso.oo	o.1o									

H•nnouk Source froın Librat'\'

Bu.cıJD	Dni« ID	Hannonk Source Infioımation				
		~	Mauuf.acturtr	Modtl	Fund.Fttq.	Mod.Fı·tq.
Bu,3~	In,·11	Currtut	T)lık•l-IEEE	llPulstl	0.00	MO
BmJ6	Im·l5	Current	Typical-IE££	il Pulul	0.00	0.00
Bu'37	Inr!S	Curnut	Tı}lic.:ıl•!EEE	UPulu2	0.00	0.00
Bu,39	Im-:21	CUJTttıt	Tıpical;JEEE	ꓵPulıtZ	0.00	0.00

DESIGN OF A L.\RGE $CALE SOL<\.RPVSYSTEM A,'lD L\[PACT ANALYSIS OF ITS INTEGR.\TIONINTO LIBYAN POWER GRID

Filter Input Data

FilterType: Single-Tuned

Filter ID	Connected Bus ID	Capacitoı· Cl kV	l\fnxkV	l~·nı·	Inductor LI Xl	Q Fact,	l\faxI	! Ohm
HFZ	Busl	66.000	100.000	420.7	8S.5804	90.00	100.0	0.0000
HF1	Bu'>l	66.000	100.000	140.1	ZS7.0066	70.00	100.0	0.0000

Fmufamental Load Flow Rtnort

Bus		Voltage		Gener.atiou		Loi)cl		Load Flow					XfMR.
ID	kV	%I~		MW	Mrnr	MW	Mm	ID	Iffi'	~	Amp	%PF	~
Busl	66.000	101J168	-29.1	0	0	0.000	-0.144	Busll	.:.7.726	0.622	67.I	-99.1	
								Bud3	0.000	-'1.?90	2.5	0.0	
								Bus27	O:OU	.S.I74	~ö.7	-1).3	
								Bm8	0.000	--OMO	M	0.0	
								BnsS	0.000	--0.060	0.;	0.0	
								Bus30	0.000	..0.120	1.0	0.0	
								Bus3	7.712	SJIS	81.1	81.3	
								Bus6	0.000	0.000	0.0	0.0	
Busl	66.000	100.193	30.7	0	0	0.000	.0.4Zö	Busl!	-5.799	OJS.I	50.7	-99.8	
								Busı.ı	0.000	~.162	I:3	0.0	
								BuslS	0.000	--0.340	3.0	0.0	
								Bus7	0,000	.I),059	0,$	0.0	
								Bus7	0.000	--0.059	as	0.0	
								BusJl	0.000	--O.US	I.O	0.0	
								Bus5	5.199	0.881	51.2	98.9	
* Bus3	110.000	100.000	0.0	-7.708	-5.157	0	0	Bınl	R7.70S	R$.I57	:1I•\	S.U	
*Bu.'>5	220.000	100.000	0.0	-5.798	-0.SIJ	0	0	Busl	.S.798	-0.813	15.4	99.0	
Bus6	11.000	1OI.068	-59.1	0	0	0	0	Busl	0.000	0.000	0.0	0.0	
Bus7	66.000	100.194	30.7	0	0	0	0	Bus2	0.000	0.000	0.0	0.0	
								Bus2	0.000	0.000	0.0	0.0	
								Bu.S	0.000	0.000	0.0	0.0	
Bus8	66.000	!OL069	-29.1	0	0	0	0	Bınl	0.000	0.000	0.0	0.0	
								But!	0.000	0.000	0.0	0.0	
								Bud 0	0.000	0.000	0.0	0.0	
Bus9	11.000	100.194	0.7	0	0	0	0	Busl	0.000	0.000	0.0	0.0	
Busl0	11.000	101.1169	-59.1	0	0	0	0	Bus8	0.000	0.000	0.0	0.0	
Busll	116.000	100.194	30.7	0	0	0	0	Busl	S.m	--0.455	$0.8	-99.1	
								Bus42	-5.199	0.455	$0:8	-99.1	
BwılZ	66.000	101.1169	-19.1	0	0	0	0	Busl	7.726	--0.69!:	67.1	-99.6	
								Bus41	-7.126	0.691'	67.1	-99.6	
Bu,13	66.000	101.090	-29.1	0	0	0	0	Busl	0.000	0.000	0.0	0.0	
								Bu,15	0.000	0.000	0.0	0.0	
Bu,14	66.000	100.?15	30.7	0	0	0	0	Busl	0.000	0.000	0.0	0.0	
								Busl6	0.000	0.000	0.0	0.0	
Buds	11.000	101.090	-59.ı	0	0	0	0	Bud.}	0.000	0.000	0.0	0.0	
Busl6	11.000	100.?15	0.7	0	0	0	0	BusU	0.000	0.000	0.0	0.0	
Bu,17	116.000	101.980	-29.1	0	0	0	0	Bus27	-0.007	4.911	42.6	-e.1	

Project:	IWTI:R THESIS	ETAP		Page:	17
Lccation:	HOUNCITY.LIBYA	12.6.0H		Date:	28-06-2016
Contract:	!'.'EAR EA->T IJi\'IVERSITI' • EEE Deparru>•nt			SN:	
Eugluee1·:	SANDMUSTAFAAL-RUAJ	Stucly Case:	HA	R,;ι,\i~ion:	Base
Filename:	HOUN SUBSTATION 220kV			Coullg:	Normal

DESIGN OF A LARGE SC.UX SOLARPV ι,-ι·sn:~IALLI'D ThfPACT ANAL\'SIS OF ITS INTEGRATIONThTO LIBYAN PO\\'ERGRID

Bus ID	kV	'I~\£.ag.	Ang.	Geufl'ation MW	Mv:ιr	Load MW	M,·m:	UadFlow ID	MW	?ι-frar	Amp	%Pf	% Tap
								Bus21	0.00.1	.USS	Z1.1	-e.1	
								Bus23	0.003	-1.48.i	II.3	.e.1	
								Bus19	0.000	0.000	0.0	0.0	
BudS	66.OOO	10-0.2:U	30.7	0	0	0	0	Bus?	0.000	0.000	0.0	0.0	
								BmlO	0.000	0.000	0.0	0.0	
Busl9	11.000	101.I'Sil	~sι>.Z	0	0	0	0	Btιs17	0.000	0.000	0.0	0.0	
Busl 0	11.000	100.m	0.,	0	0	0	0	Busl$	0.000	MOO	0.0	0.0	
Bu'21	"·000	1013..~	..:29.3	0	0	0	0	Btιsl7	-0.002	1.17J	1U	.e.1	
								BusH	0.002	-1.173	18.6	-0.I	
								Bu1!2	0.000	0.000	0.0	0.0	
Busll	11.000	102.356	.S9.3	0	0	0	0	Bu~zl	0.000	0.000	0.0	0.0	
Bm:13	66.000	103.530	-29.4	0	0	0	0	Busl?	0.000	--0.001	(I.0	.16.2	
								Bus?!	0.000	0.001	0.0	-16.1	
								Bus15	0.000	0.000	0.0	0.0	
B~2$	11.000	103.530	-59.4	0	0	0	0	Bnsl3	0.000	0.000	0.0	0.0	
Bu~27	66.000	101.392	~I9.1	0	0	0	0	Bus17	O.OU	-5.170	4.t.~	.{1,2	
								Bust	-0.011	5..170	44.~	.0.I	
								BuslS	0.000	0.000	0.0	0.0	
								Bus29	0.000	0.000	0.0	0.0	
Bu~28	11.000	101.302	.S9.Z	0	0	0	0	Bus17	0.000	0.000	0.0	0.0	
Buι;.29	11.000	10LJ9l	-59.1	0	0	0	0	Bu~:?7	0.000	0.000	0.0	0.0	
Bus30	66,000	101.0.\ι	-19.1	0	0	0	0	Bud	0.000	0.000	0.0	0.0	
								Bus32	0.000	0.000	0.0	0.0	
Bus.il	66.000	100.197	30.7	0	0	0	0	Busl	0,000	Q.000	0.0	0.0	
								Bus3l	0.000	0.000	0.0	M	
Busl!	ILOOQ	101.071	-59.1	0	0	0	0	Bus.10	0.000	0.000	0.0	0.0	
Bus3l	11,000	100.197	0.7	0	0	0	0	Bus31	0.000	0.000	0.0	0.0	
Bus.14	0.400	101.713	-14.0	1.951	0.000	0	0	But-ti	1,95.?.	0.000	2769.6	J00.0	
Bu.\5S	0..I00	101.11.ι	.u.o	1.951	0.000	0	0	8U\,U	1..952	0.000	2769.6	100.0	
8tι,d6	0..I00	101.113	.u.o	1.9S:?	0.000	0	0	Bu<II	1.952	0.000	2769.6	100.0	
Busl7	MOO	101.713	.u.o	1.95:?	0.000	0	0	Bus41	J.9$2	0.000	2769.6	J00.0	
Bus38	0.400	100:8-I7	JS.I	1.9:il	0.000	0	0	BU,W:?	1.952	0.000	?79.1.4	100.0	
Bus.19	MOO	100:8-I7	JS.I	1.9:il	0.000	0	0	Bus4l	1.952	0.000	z19ü	100.0	
Bus40	0..I00	I00.S.Il	SS.1	1.9£il	0.000	0	0	8U\,'2	I.PS?	0.000	279.1.4	J00.0	
Bus.£1	11.000	101,133	-56.?:	0	0	0	0	Bud?	7.756	-0.303	402.8	.99,9	
								Bnd<l	.I.939	0.076	100.7	-99.9	
								Bus3S	-1.939	0.076	10&.7	.99,9	
								BuιJ6	-1.1'39	0.076	100.?	-99.9	
								Busn	-1.9.19	0.076	100.7	-99.9	

DESIGN OF A LARGE SCALE SOLAR PV SYSTEM AND IMPACT ANALYSIS OF ITS INTEGRATION INTO LIBYAN POWER GRID

Bus		Voltage		~ıtration		Load		LoadFlow					XFMR
ID	!ᵛ	~	..!1!..,	~	2!!:!	~	i\Mw	ID	MW	2!!:!	~	~	~
Bus4:?	11.000	100.263	2.9	0	0	0	0	Bmll	S.S17	-'1.231	30J.7	-99.9	
								Btu38	-1.9.19	0.077	101.6	-99.9	
								Bw.19	.J.939	0.077	101.6	-99.9	
								BmO	-1.939	ıum	101.6	-99.9	

" Indicntes n ı.olngıC" r~atfd bu1 (\'oltagt- «nfT«lıld or rning ~pıe· madıint cenneeted to it)
iudiı;atts:ı bus "ilh :l Iead mi'>tn:ıt(hof m<ırt fbaıı OJ MVA

Systeni ij;~;;~oniC:c;. Bnş Information

Bus		VoJtao;e. Distorrıôu								
ID	k~'	Fund. %	RMS	ASUM %	'IllD %	nr	TlllD %	TSHD	THDG	THDS %
Btı~l	6MOO	101.07	101.09	103.78	1,85	52.15	0.00	0.00	us	1.85
Bml	66.000	100.19	100.ıo	101.86	!AO	31.80	0.00	0.00	1.40	1..10
Busl	**110.000**	100.00	100.02	102.60	*1.19*	50.48	0.00	0.00	1.79	1.79
Bu-sS	**l:20.000**	100.00	100.01	101.59	1.3;	30-51	0.00	0.00	u,	1.34
Bıı,6	11.000	101.07	101.09	*l0;.1s*	*1.85*	Sz.15	M-0	0.00	1.85	J.85
Bu,7	66.000	100,19	100.?0	101.86	1.40	31.8!\	0.00	0.00	1.40	!AO
Buss	66.000	101.07	101.09	103.79	1.85	52.31	0.00	0.00	1.85	ISS
Bus9	11.000	100.19	100.10	101.86	1.40	31.85	0.00	0.00	uo	1.40
Bud 0	11.000	101m	101-09	103.79	1.SS	52.31	0.00	0.00	1.85	I.BS
Bus.II	66.000	100.19	100.ıo	101.86	1.40	31.80	0.00	0.00	1.40	u0
Bud!	66.000	101.07	101.09.	103.78	1.85	52.15	MO	0.00	1.85	I.SS
Bıd3	66.000	IOI.O?	101.11	104.0l	1.93	ı:6.50	0.00	0.00	1.93	1.93
Bu!iU	66.000	100.ll	100.23	101,97	1.45	33.17	MO	0.00	*U5*	1.45
BudS	ll.000	101,09	lel.ıı	104.0l	1.93	56.50	0.00	0.00	1.93	*1.93*
Bu,16	11.000	**100.12**	100.H	101.n	*1.45*	33.17	0.00	0.00	*U5*	1.45
Bu'17	66.000	101.98	102.00	104.34	1.97	*44.U*	0.00	0.00	l.97	J.97
Bu,18	66.000	100.ll	100.23	102.02	1.47	33.81	0.00	0.00	1.47	1,47
Bu<!?	11.000	101.98	102.00	104.34	1.97	*44.U*	0.00	0.00	U7	1.97
BuslO	11.000	**1(10.?2**	100.2.1	**102.02**	**1.47**	33.81	0.00	0.00	*U1*	1.47
Busll	66.000	102.\6	102.38	105.45	l.06	*,1.63*	0.00	0.00	*l.06*	2.06
Busll	11.000	102.36	IOl.38	105.45	*Z.06*	*51.63*	0.00	0.00	l.06	2.06
Bınl3	66,000	IOM3	**103.SS**	105.69	1,97	43.0S	0.00	0.00	1.97	1.97
Bu-.25	11.000	103.53	103.55	105.69	1.97	4M8	0.00	0.00	*1.91*	J.97
Bust7	66.000	101.39	101.41	103.91	1.88	46.1l	0;00	0.00	*1.88*	1.88
Bus:?8	11.000	101.39	101.41	103.91	1.88	**46.12**	0.00	0.00	1.88	1.88
Bu'i29	11.000	101.39	101.41	103.91	1.88	*46.ll:*	0.00	0.00	1.88	1.88
Bu,30	66.000	101.07	101.09	103.82	1.86	**52.81**	0.00	0.DO	J.86	1.86
B"'31	66.000	lOD.20	100.21	101.87	1.40	**31.0?**	0.00	0.00	Ul	1.41
Bus32	11.000	101.07	101.09	103.82	1.86	52.81	0.00	0.00	1.86	1.86
B"'33	11.000	lOD.lO	100.ll	101.87	uo	**32.01**	0.00	0.00	*Ul*	!Al
Bu.34	0..100	101.71	101.87	llSSS	*5.56*	**266.09**	0.00	0.00	**5$6**	5.$6
B"'35	OAOO	101.11	101.75	107.60	l.50	!H.38	ll.00	0.00	**1.50**	2.SO
Bus36	0.400	101.71	101.87	llSSS	5.56	266.09	0.00	0.00	5.$6	'\.56
BuR7	0..100	101.71	101.87	llSSS	*5.56*	266.09	0.00	0.00	*5.56*	5.,6
B"'38	0,.l00	100.85	100.86	103.95	J.80	46.03	0.00	0.00	I.SO	I.SO
Bıu39	0..l00	100.85	100.97	m.47	*4.91*	192.81	0.00	0.00	4.91	4.91
Bus40	o.400	l00.85	100.86	103.9S	1.80	46.03	0.00	0.00	I.SO	1.80
Bus.fl	11.000	lel.ıs	101.17	107.4?	*2.69*	152.5.l	0.00	0.00	*2.69*	*2.69*
Bus.I?	11.000	100.26	l00.ıs	103.S7	1.93	49.42	0.00	0.00	1.9.l	*1.9.l*

*** J.ndkıııe,sTHDa<>1alHarmook:Distortion)0(ttd'ı rhr- Unit.**
#J'Jıdiç;\ttıIHD (Indi:ridualH3nnoolDis.tortion)[xe«ds the Lim.it.

Systfıı Harmonics Brandı Infonn:ııtğoıı

Bus F1-omBu~ID	To Btu IO	Cuneut Distortion Fund. Amp	RMS Amp	ASlı'M Amp	nm %	rır	rr Amp	mı	rrs Amp	TIIID %	TSIID %	T!IDG %	THDS %
Busl	BU$IZ	67.09	67.13	71.92	3.70	98.60	6619.,1	6619.,1	0.00	0.00	0.00	3.70	3.10
	Bud3	2.Sl	2.61	3.76	27.98	1043.89	I?I,f.26	2W.26	0.00	0.00	0.00	17.98	27.98
	Bu.s27	4S.6S	45.69	49.33	4.34	197.18	9010.11	9010.11	0.00	0.00	0.00	4.34	4.34
	Bus8	0.52	0.54	0.71	27.13	984.55	m.29	sıı.w	0.00	0.00	0.00	27.13	27.13
	BmS	(1.52	0.54	0.71	!7.13	984.S,	$31,29	S31.I9	0.00	0.00	0.00	27.13	27.13
	B'''30	1.04	1.08	1.54	17.23	991.ll	1010.01	1070.0,	0.00	0.00	0.00	'.27.13	27.23
	Bu~3	Sl.lS	81.13	sus	o.ı2	7.60	61Ml	616-61	0.00	0.00	0.00	O.J2	(I.32
	Bıu6	0	0	0	0	0	0.00	6!Ml	0.00	0.00	0.00	0.00	0.00
Bus2	BuslI	50:74	50.75	s2.,S	1.69	42.(14	2133.63	:?133.63	0.00	0.00	0.00	U9	1.69
	Busl.t	2.29	aSS	l.'88	lS.83	466.0l	!OSJ.93	1083.93	0.00	0.00	0.00	JS.SJ	1M3
	BuslS	2..97	3.0?	3.76	!S.99	,'73.!.\	1430.~0	wo.ıo	0.00	0.00	0.00	18.99	18.99
	Bu,7	(1.52	0.$3	MS	18..19	4Sl.S!1	:?37.6-1	237.6-t	0.00	0.00	0.00	18.49	18..19
	Bu,7	o.;2	O.SJ	0.65	18.49	452.59	237.64	m.64.	0.00	0.00	0.00	18.49	18.49
	Bus31	1.03	1.0$	1.19	18.53	4~.'Z!	m.02	,t77,02	0.00	0.00	0.00	18.5.:t	IS.SJ
	Bu-.S	Sl.ll	Sl.ll	Sl.lS	O.l9	8.61	441.11	441..11	0.00	0.00	0.00	0.39	0.19
BusJ	Busl	U.34	24.34	24.44	0.32	7.60	184.98	18498	0.00	0.00	0.00	0.32	0.3?
Btı.\5	Busl	l!..16	15.36	15.43	0..19	8.6l	132..19	132-'9	0.00	0.00	0.00	0.39	0.39
B'''6	Bnsl	0	0	0	0	0	0.00	132.39	0.00	0.00	0.00	0.00	0.00
Bus7	Bus!:	0	0	0	0	0	0.00	13?.39	0.00	0.00	0.00	0.00	0.00
	Busl	0	0	0	0	0	0.00	13l.3~	0.00	0.00	0.00	0.00	0.00
	Bus9	0	0	0	0	0	0.00	13?.39	0.00	0.00	0.00	0.00	0.00
B'''8	Busl	0	0	0	0	0	0.00	132..19	0.00	0.00	0.00	0.00	0.00
	Bu,!	0	0	0	0	0	0.00	132.39	0.00	0.00	0.00	0.00	0.00
	Busl 0	0	0	0	0	0	0.00	132.39	0.00	0.00	0.00	0.00	0.00
Bu.dl	Bw7	0	0	0	0	0	0.00	!32.39	0.00	0.00	0.00	0.00	0.00
Buslo	BuıS	0	0	0	0	0	0.00	131.39	0.00	0.00	0.00	0.00	0.00
Buçll	Bıul	S0.79	50.80	Sl.35	1.58	41.SS	ll:27.24	211?.l.ı	0.00	0.00	0.00	1.58	1.58
	Bns.4l	50.19	50.80	5ZJS	l.SS	41.88	lU7.U	?117.U	0.00	0.00	0.00	1.58	1.58
Busl:?.	Bud	67.14	67.19	"B?.02	3.19	95.13	6'32.11	6432.11	0.00	0.00	0.00	3.79	3.79
	B'''41	67.U	67.19	71.0?	3.79	95.73	6432,11	6432,11	0.00	0.00	0.00	J.79	3.19
Bud3	lhnl	0	0	0	0	0	0.00	6132.11	0.00	0.00	0.00	0.00	0.00
	Bud5	0	0	0	0	0	0.00	643.?.ll	0.00	0.00	0.00	0.00	0.00
Bud.ı	Ba~l	0	0	0	0	0	0.00	seı.ıı	0.00	0.00	0.00	0.00	0.00
	B,.ıd6	0	0	0	0	0	0.00	6-H:?.U	0.00	0.00	0.00	0.00	0.00
Busl5	Bıu!J	0	0	0	0	0	0.00	6132.11	0,00	0,00	0.00	0.00	0.00
Bus!6	Busu	0	0	0	0	0	0.00	6432.11	0.00	0.00	0.00	0.00	0.00
Busl7	Bw17	.C:?.6-t	,1?.68	45.77	M9	226.17	%5l..15	%52..15	0.00	0.00	0.00	4.09	4.09
	BU$l1	ll.34	ıı.39	?,US	7.01	nı,Sl	8798.41	S798,lll	0.00	0.00	0.00	7,01	7.01
	Bwl3	?1.30	21.31	l!.61	Z.65	161.77	3441.68	3447.68	0.00	0.00	0.00	l.65	!.6S
	Bu.sl9	0	0	0	0	0	0.00	3447.68	0.00	0.00	0.00	0.00	0.00

Prcjeer:	lUSTER '11IES15	ETAP 12.6.0H	Page: 21
Location:	HOUN CITY -LIBYA		**Date:** 28-06-2016
Ccıııııcte	NEAR EAST UNIVERSITY -EEE Deparnneut		SN:
Engineer:	SAJ\'D ~!USTAYA AL-REY AI	Stndy Case: HA	Rerisiom **Base**
Filename:	HOUN SUBSTATION220kY		Config: **Noımal**

DESIGN OF A LARGI: SCALE SOL.ınPV SYSTEM At'N']) L\IPAC.T ANALYSIS OF ITS INTEGRATION INTO LIBYA>'< POWI:RGRID

Bus		Current Distortion											
Fı'OmBu-s:lD	**T0Bn1ID**	Fuud. Amp	RAL~	ASv1ıl	1llD	TIF	IT	1TB	ITR	TIllD	TSHD	THDG	THDS %
Bus!S	Busl	0	o	0	0	0	0.00	.u41:6s	0.00	0.00	0.00	0.00	0.00
	Bll.$20	0	0	0	0	0	0.00	.U47.68	0.00	0.00	0.00	0.00	0.00
Butl9	**Bud7**	0	0	0	0	0	0.00	*.l.UUS*	0.00	0.00	0.00	0.0D	0.00
Bu~20	Butl8	0	0	0	o	0	0.00	3,147,68	0.00	0.00	0.00	0.00	0.00
Buısll	**Bud7**	l8.S7	16.6!	n.u	*6.94*	;199.58	7439.84	7439.84	0.00	0.00	0.0D	*6.94*	*6.94*
	Busl.3.	18.57	18.6!	n.u	*6.94*	399,58	7439.84	7439.84	0.00	0.00	0.00	*6.94*	*6.94*
	Butl?	0	0	o	o	0	0.00	U,9.84	0.00	0.00	0.00	0.00	0.00
Bu-s-Z.?	**Bnsll**	0	0	o	o	0	0.00	7439.84	0.00	0.00	0.00	0.00	0.00
Busl3	Butl7	Ml	0,38	0.57	4660.62	**28.f7.3S**	1068.16	1068.26	0.00	0.00	0.00	4660.61	**4660.62**
	Busl!	0.0l	0.38	**0.57**	**4660.62**	2847.38	1068.,6	1068.26	0.0D	0.U0	0.00	*4660,62*	4660.62
	Busl5	0	o	0	0	0	0.00	1068.26	0.00	0.00	0.00	0.00	0.00
Busl$	**BU$23**	0	0	0	0	o	0.00	!06M6	0,00	0.00	0.00	0,00	0.00
Busl7	**Bu:sl7**	44.61	**.U.65**	4S.Zl	4.30	213.40	**9528.12**	**95:?S.12**	0.00	0.00	0.-00	4.30	4.30
	Busl	44.61	*44.65*	48.Zl	4.30	213.40	***9S28.lt***	***9SZ8.1Z***	0.00	0.00	0.00	4.30	4.30
	Bud.S	0	o	o	0	0	0.00	**95!8.11**	0.00	0.00	0.00	0.00	0.00
	Bud9	0	0	0	0	o	0.00	9528.ll	0.00	0.00	0.00	0.00	0,00
BuslS	**Bns17**	0	o	o	o	o	0.00	***9528.U***	0.00	0.00	0.00	0.00	0.00
Busl9	Busl7	o	o	0	0	o	0.00	**95?8.L?.**	0.00	0.00	0.00	0.00	0.00
Buı.lO	Bud	0	o	o	o	o	0.00	9:tlSll?	0.00	0.00	0.00	0,00	0.00
	Bus32	0	0	o	o	0	0.00	**95?8.U**	0.00	0.00	0.00	0.00	0.00
Buı.ll	**Bus2**	0	o	o	0	o	0.00	**~lS.12**	0.00	0.00	0.00	0.00	0.0D
	Bus33	0	0	o	0	o	0.00	**!>528.ll**	0.00	0.00	0.00	0.00	0.00
Bu~2	BusJO	0	o	o	0	o	0.00	**95?8.ll**	0,00	0.00	0.00	0.00	0.00
Bu.s33	Bus31	0	0	o	o	o	0.00	9$28.ll	0.00	0.00	0.00	0,00	0.00
Bu,34	**BuıU**	21'69,58	2773.lO	3041. 73	S.ll	129.85	:l60095.00	360095,00	0.00	0.00	0.00	**S.ll**	**S.ll**
Buı.lS	Bu,41	*2769.58*	*2169.59*	2784.39	*0.21*	8.90	***U6$6.:U***	**246"56.:?:l**	0.00	0.00	0.00	**0.27**	**(1.17**
B"'3ð	Bus.il	**1769.~**	**2'73.lO**	3041.73	S.ll	1!9:SS	36009S.00	36009$.00	0.00	0.00	0.00	**S.ll**	S.11
Bus..\?	Bus41	*1169.SS*	ım.1O	3041.73	S.ll	129.85	:l60095.00	360095.00	0.00	0.00	0.00	**S.ll**	S.11
Bus.JS	**BuWl**	ım..ıs	ıı9,.3s	!803.04	**0.:U**	5.17	14430,SS	W30.58	0.00	0.00	0.00	0:23	0.23
Buı.l9	Bus.il	2793.3B	2797.0l	3070.48	5.11	l3l.97	371924.50	.l71924.SO	0.00	0.00	0.00	5.11	**S.ll**
Buı40	**BUW?**	2793_,s	2793.3s	ısbı.oı	0.23	**5.17**	U430.58	W3o.ss	0.00	0.00	0,00	**0.23**	**0.23**
Bu~.U	**Busl2**	**401.S!-**	40l.14	m.ıo	3.79	95.73	38591.68	38591.68	0.00	0.00	0.00	3.79	**3.79**
	Bus34	100.71	100.84	nası	su	**U!>.85**	13094.37	13094.37	0.00	0.00	0.00	**S.ll**	5.11
	Busl$	100.71	100.71	101.25	**0.27**	8.90	*896,59*	*896.59*	0.00	0.00	0.00	O.l7	0.27
	Bu,36	100.11	100.84	ııe.Sl	**S.ll**	129.85	13094.37	13094.37	0.00	0.00	0.00	5.11	S.11
	Bu.'S-37	100.71	100.84	nası	5.11	**129.85**	13094.37	13094.37	0.00	0.00	0.00	S,11	S.11
BU$,'2	Bud!	304.73	304.77	314.ll	1.58	41.88	12763.43	12763.43	0.00	0.00	0.00	1.58	**1.SS**
	Bus38	101.53	101,58	101.93	**0.13**	5,17	*5?4,15*	**Sl4.75**	0.00	0.00	0.00	**0.?3**	0.23
	Bm9	101.58	101.71	111.65	5.11	13?.97	13524.53	**13S:U.5l**	0.00	0.00	0.00	*5.11*	**S.ll**
	Bus.fO	101.SS	101,58	101.93	0.23	5,17	Sl4.7S	5l4.7S	0.00	0.00	0.00	0.23	**0·?3**

Bus Ta\mlafigu

Hamıonk VoJtages (% of Fuud;unental Vcltnge,)

Bus ID: Bud
Fuud. kV: 66.705

—	H,	%	—	Hz	,tı	—	H:ı;	%	—	Hz	%	—	Hz	%	—	H,	%
11.00	ssaee	o.oı	13.00	,;.sıı.oo	ı.,s	ı,.oo	ıısо.оо	e.Sl	ıs.oo	1150.00	e.se	35.00	mo.oo	0.05	,1.00	ısso.oo	0.00
41.00	2350.00	0.03	-19.00	2450.00	0.0l												

Bus ID: BnslO
Fund. kV: ...

	Hz	%	--	Hz	,ti	--	H:ı	%	--	Hı	%	--	H	%		H	%
11.00	550.00	0.0l	U.00	6$0,00	1.15	2~00	1150.00	0.32	25.00	1250.00	0.Sl	35.00	1750.00	0.05	31.00	1850.00	0.00
,11.00	2550,00	0.03	49.00	mo.oo	0.0l												

BmID: Bud!
fund. kV: ...

—	H,	%	—	Hz	%	—	Hı	%	—	Hı	%	—	Hz	\1	—	H,	%
11.00	sso.oo	0.00	B.00	6$0.00	1.39	13.00	1150.00	0.ıs	zs.00	ızsaeo	0.10	3S.00	ıtsaoo	0.0l	37.00	1850.00	0.0l
41.00	l3S0.00	MO	-lll.00	1450.00	0.00												

Bus JD: Bu.dl
Fund. kV: 66.706

—	Hı	%	—	H,	%	—	H,	%	—	Hı	%	—	Hz	%	—	Hı	%
ıı.oo	sso.oo	0.01	ıs.ee	®.oo	1.1s	uoo	ııso.oo	o.3ı	ıs.oo	mo.oo	o.so	35.00	11so.oo	0.05	~1.00	ısso.oo	0.00
47.00	l3S0.00	0.03	49.00	US0.00	0.0?												

Bu'i ID: Busl3
Fund. kV: 66.719

Order	Fnq.	M.ag.	Ordtr	Frtq.	lı.bg.	Order	Frtq.	1'fag.	Ordeı-	Frtq.	M.ıg.	Order	Fnq.	ling.	Order	Frtq.	Mag.
—	Hı	%	—	Hz	t~	—	Hı	%	—	Hı:	%.	—	Hı	%	—	H,	%
11.00	550.00	0.0l	ı:ı.oo	6S0.00	I.Sl	lJ.00	1150.00	0.35	15.00	1250.00	o.s,	35.00	11S0.00	0.06	31.00	1650.00	0.00
47.00	lJS0.00	0.0S	-19.00	2-lS0.00	0.04												

Btı1:ID: BusU
Flınd. kV: 66.ı.t?

Order	Fn,q.	Mag.	Ordu	Frtq,	Mag.	Ord.tr	Flstq.	Mag.	Order	Fnq.	M:ıg.	Ord.tr	Frtq.	M:ag.	Ordtt	Fl'fq.	l\:lng.
--	.:!!L ~		--	Hı	•A	—	H,	%	—	Hı.%		—	Hı	t,~	—	Hı	%
ıı.oo	sso.oo	0.00	U.00	®.oo	ı.e	ııoo	ıısaee	e.ıs	zs.oo	ızso.oo	o.ıı	35.00	11so.oo	0.03	37.00	mo.oo	0.oz
41.00	lJS0.00	0.0l	49.00	ı.ı.<0.00	0.00												

Bu1ID: Bu:sl5
Fuud. kV: n.ne

Order	Fı·eq.	M:ıg:.	Ordt.r	FltCJ:;	M~t·	Ordtr	Freq,	h!ng.	Ordtı·	Fttq,	Mag.	Ordtr	Fttq,	?lb_:.·.	Oı·der	Freq.	Mag.
—	Hı	%	—	fu	%	—	Hz	%	—	Hı	%	—	.Hı	%_Hı~			
11.00	550.00	0.0l	U.00	6$0.00	I.SI	?.too	1150.00	0.35	ıs.oo	ll!-0.00	o.51	35.00	17S0.00	0.06	31.00	!Sl'0.00	0.00
47,00	)350.00	MS	-19,00	?450.00	0.04												

Bn,;ID: Bml6
Fuud,kY: ıı.oı.ı

Order	fl'N!ı	Mng.	Ord<r	r••q:	Mag.	Ordtt·	F••q.	Mag.	Order	füq.	l\!:ıg.	Ord<r	f•"«ı	A!,g.	Ord,r	Fl'N!	ALıg.
—	Hı	%	—	Hı:	%	—	Hı	%	—	Hz	%	—	Hı	~--	!:!:	~	
11.00	SSMO	0.00	B.00	6S0.00	UJ	lıOO	1150.00	e.ıs	ıs.oo	uso.oo	e.ıı	35.00	1750.00	0.0.1	31.00	1850.00	0.01

Bus Tabulation

Harmonic Voltages (% of Fundamental Voltage)

Bus ID: **Bus16**
Fund. kV: 11.014

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
47.00	2350.00	0.01	49.00	2450.00	0.00												

Bus ID: **Bus17**
Fund. kV: 61.306

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
[illegible]	550.00	0.01	[illegible]	650.00	1.97	23.00	[illegible]	[illegible]	[illegible]	[illegible]	0.05	35.00	[illegible]	-0.05	37.00	1850.00	0.05
47.00	[illegible]	0.01	[illegible]	2450.00	0.01												

Bus ID: **Bus18**
Fund. kV: 66.145

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.00	13.00	650.00	[illegible]	23.00	1150.00	0.16	[illegible]	1150.00	0.11	[illegible]	[illegible]	0.03	37.00	1850.00	0.01
47.00	1350.00	0.01	49.00	[illegible]	0.01												

Bus ID: **Bus19**
Fund. kV: 11.218

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.01	13.00	650.00	1.97	23.00	1150.00	0.10	25.00	1150.00	0.05	35.00	1750.00	0.05	37.00	[illegible]	0.05
41.00	[illegible]	0.01	49.00	[illegible]	0.01												

Bus ID: [illegible]
Fund. kV: 66.115

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.00	13.00	650.00	1.55	23.00	1150.00	0.13	[illegible]	1250.00	0.10	[illegible]	1150.00	0.01	37.00	1850.00	0.01
47.00	2350.00	0.00	[illegible]	2450.00	0.00												

Bus ID: **Bus20**
Fund. kV: 11.015

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.00	13.00	650.00	1.45	23.00	1150.00	0.16	[illegible]	1150.00	0.11	35.00	1750.00	0.03	37.00	1850.00	0.01
47.00	1350.00	0.01	49.00	1450.00	0.01												

Bus ID: **Bus21**
Fund. kV: 67.555

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.01	13.00	650.00	1.95	11.00	1150.00	0.19	25.00	[illegible]	[illegible]	35.00	1750.00	[illegible]	37.00	1850.00	[illegible]
47.00	[illegible]	0.01	[illegible]	[illegible]	0.00												

Bus ID: [illegible]
Fund. kV: 11.759

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.01	13.00	650.00	[illegible]	[illegible]	1150.00	0.39	25.00	[illegible]	[illegible]	35.00	1750.00	[illegible]	37.00	[illegible]	[illegible]
47.00	2350.00	[illegible]	49.00	2450.00	0.00												

Bus Tabulation

Ha11no:ııjc_V~}J;ıges (% ofFuudaınental Voltage)

Bn, ID: Busl3
Fund. kY: 68.330

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.0l	13.00	6;0,00	1.91	2.1.00	nsaen	e.es	25.00	1250.00	aes	.lS.00	ıı;0.00	0.00	lı.00	ıS;0.00	0.00
17.00	2350.0f.t	0.00	49.00	l4..Gl.OO	0.00												

Bus ID: Bml5
Fund.kV: 11..lSS

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	Ml	13.00	650.00	1$7	2$.00	1150.00	0.0S	ZS.00	mo.00	0.0S	35.00	1750.00	0.00	.11.00	ısse.cu	0.00
,1.00	:1.lS0.00	0,(10	49.00	l4S0.00	0.00												

Bus JD: Bus:27
Fund. kV: [illegible]

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.02	13.00	~.00	1.84	23.00	1150,00	0.17	ZS.00	1250.00	0.31	35.()0	1750.00	0.0l;	31.00	1850.00	0.03
47.00	2350.00	0.0l	-19.00	1..tS0.00	0.0l												

Bus ID: Busl8
Fund. kV: [illegible]

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.0l	13.00	6..S0.00	I.S4	23.00	1150.00	o.17	2s.00	mo.00	0.32	JS.00	1750.00	0.0,	31.or	1850.oo	0.03
47.oo	mo.00	0.01	49.00	2450.00	0.0l												

Bu-:ID; Busl9
Fund. kV: 11,1$,\

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.0?	IMO	6S0.00	ı.S4	zMo	mo.00	0.11	1,.00	mo.00	0.32	35.00	17,0.00	0.0l;	;11.00	lal:0.00	0.03
47.00	2350.00	0.02	49.00	2450.00	0.0l												

Bu,ID: Bw:3
Fund. kV: 120.000

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	SS0.00	0.0Z	IS.e0	~.OO	1.69	Z3.00	mo.00	0.30	25.00	mo.00	0.49	35.00	17,0.00	0.0.I	37.00	1850.00	0.00
47.00	2.150.00	0.0J	49.00	24..S0.00	0.(I?												

BmID: Bus30
Fund. kV, 66.707

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
ıı.oo	550.00	0.0?	13.00	~.00	J.76	lJ.00	1150.00	0.31	15.00	1?50.00	0.52	35.00	17S0.00	0.05	37.00	1850.00	0.00
17.00	2350.00	Ml	19.00	u;0.00	0.0l												

Bu.-.ID: Bus.il
Fund.kV: 66.130

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.00	13.00	6!'0.00	1.39	23.00	1150.00	o.u	?5.00	mo.00	0.IO	35.00	17S0.00	0.01	37.00	1850.00	0.0l

Project:	~M.STER THE1,1S	ETAP		Page:	25
Loration:	HOUNCI1Y-LIBYA	12.6.0H		Date:	28-06-2016
Centract:	NEAR EA..5T IJNIVERSI1Y - EEi': Department			SN:	
Engineer:	SAı'\'D?ı!USTAFAAL-REFAI	Srudy Case:	HA	Re,·!sion:	Base
Filename:	HOUN! SUBSTATION220kV			Config:	Nonna!

DE.5IGN OF A LARGE SCALESOLARPV SYSTEM .\ı',D nIPAC.T ANALYSIS OF ITS INTEGR~TIQNJJI,'TO LIBYA."< POWER &'RID

Bus Tahufation

Hannonic Volıag•s (% ofFundaiıı,nal Voltage)

nu.;JD: Bus31
Fund. kY: 66.130

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
47.00	1350.00	aee	49.00	z.150.00	0.00												

Bu\ID: Bus:32
fıud. kY: 11.118

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.01	13.00	~.00	1.76	z.ı.oo	mo.00	0.3?	25.00	mo.00	0.$2	35.00	1.751).QO	0.0S	37.00	1850.00	0.00
47.00	Z3S0,00	-0.03	49.00	1450.00	0.0?												

BufID: Bw3
Fund. kV: 11.0ll

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	SS0.00	0.00	13.00	650.00	1.19	23.oo	ıısо.oo	0.14	ısee	U50.00	o.ıo	35.00	1750,00	0.02	37.oo	mo.oo	o.oı
47.00	1350.00	-0.00	49.00	2451!.00	0.00												

Bu<ı:ID: Bu,.1.1
Fund. kV: o.407

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
ıı.oo	550.00	3.18	13.00	650.oo	ıse	23.oo	ııso.oo	2.11	ıs.oo	1250.oo	2.6J	ssee	1150.oo	1.21	n.oo	mo.oo	ı.oo
47.00	2350.00	0.46	49,00	2450,00	o.so												

Bu'ilD: Bu,35
Fund.kV: 0.407

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
1!.00	550.00	1.42	ıs.ee	~.00	0.S4	23.00	1150.00	1..ıo	?5.00	12:50.00	1.36	3?.00	1750.00	0.4$	)7.00	1850.00	O.J?
47.00	mo.oo	0.16	49.00	2.ıso.00	0.17												

Bu'ilD: Bu,36
Fuud.k\': 0.407

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	3.18	13.00	~.00	1.90	z.ı.oo	1150.00	1.71	:?S.00	l!S0.00	1.63	l6.00	1750.00	1.21	37.00	1850.00	1.00
47.00	2350.00	o.46	49.00	2450,00	o.so												

Bu~ ID: Bus37
Fund. kV: 0.407

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	J.18	ıs.ee	6?0,00	1.90	z.ı.oo	1150.00	2.11	?!too	11.?0.oo	ı.63	35.oo	1750.oo	1.11	37.00	mo.oo	ı.oo
47.00	zı50.oo	M6	49.00	?450.00	0,50												

Bu'ilD: Bus.JS
Fund.kV: D.403

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
ıı.oo	550.00	0.49	B.oo	6.S0.00	us	z.ı.oo	ıısaee	o.ıs	2;.00	1250.00	0.2,	;;.oo	11so.oo	e.ıs	;1.00	1850.00	o.u
47.00	2»0.00	0.06	49.00	?450.00	0.06												

DESIGN OF A LARGE SCALE SOLARPV ~'YSIEM AND II\IPACT ANALYSIS OF ITS INIEGRATIONINTOLIBYAı"ı! N POWER GRID

Bus Tahnfation

Haımoıık Voltages(% ofFwıdamt>ntal Voltage)

Bu,ID: BmJ9
Fund. kV: 0.40.1

Order	Freq. Hz	Abg. %	Order	Frtq. Hz	Mag. %	Order	Freq. Hı	!fag. %	Oı.,Jtr	Freq. Ilı	M,ıg. %	Order	Freq. JL	Ab;. %	Or-dtr	Frtq. .JL	M:ıg. %
11.00	SS0.00	1.29	13.00	650.00	3.18	23.00	IIS0.00	1.75	'.!!6.00	ıısо.оо	1.63	3$.00	17$0.00	0.94	37.00	ıssо.оо	0.77
47.00.	2350.00	tı..17	49.00	24$0.00	0.40												

Bu.1lD: Bu.4
Fund.kl': :?10.(100

Or&J·	Freq, Hı	Al:tg. %	Ordtı·	Frtq.	Mag. %	Oı-dtt·	Frtq. Hı	Mag. %	Order	Frtq. Hı	l\fag. %	Ol'der	Frtq. Hı	Mag. %	0.rdtr	·fı'f'q. Hı	M:ıg. y

Bus ID: Bu$.(0
Fund.k\': 403

	~ Hı	11:'f		~ Hz	%		~ Hı	%		~ Hıy			~ Hı_%			~ Hz	%
11.00	sso.oo	OA9	13.00	6$0.00	1.68	!3.00	1l50.00	0.ZS	Z5.00	1lS0.00	O.IS	35.00	!7S0.00	e.ıs	.17.00	1SS0.00	O.il
47.00	23$0.00	0.06	49.00	2450.00	0.06												

Bu,Ifü Bın41
Fund.kV: 1l.11S

Order	Fnq. Hı	Mag. %	Ordtr	Fr-tq. Hz	Mag. %	Oı·dtr	Frtq. Hı	Abg:. %	Ordtr	Frtq. Hz%	Mag.	Oı•deı·	Frfi!, Hz	Mag. %	Ordu	Fı-tq. Hı	Mng. %
11.00	SS0.00	1.53	13.00	6..'0.00	0.$7	23.00	1150.00	1.40	ZS.Cn	ıısо:оо	1.46	ss.ee	ırse.ee	o.49	31.00	ıssо.оо	o.4ı
47.00	mo.ço	o.17	49.00	mo.oo	e.ıa												

Bus ID: Bu.41
Fund.kV: 1l.029

Ordtr	f«q. Hı	Mag. %	Ordtr	fnq. lb.	~fag. %	Ordtr	Frtq. Hı	M:ıg:. !'0	Oı:dtı-	Frt-q. Hz	Mag. %	Order	Fnq, Hz	Mag. %	Ordtr	Fnq_, Hz	Ma;, %
11.00	sso.oo	O.S3	13.00	650.00	ı.so	ı.ı.oo	ıısо.оо	0.21	ıs.oo	-ıısо.оо	0.1,	ss.ee	1750.oo	0.16	37.00	18.'0.00	O.B
47.00	2350.00	0.06	49.00	USO.OD	0.07												

BmID: Bu<S
Fund. kV: ll0.000

Ordtı·	fttq. ffL	M.ag. %	Ordtr	Frtq. Hı.	ıfag. %	Ordtt·	Fı'fq, Hı	Uag. %	Ordu'	Fr-eq. Hı	M:ıg. %	Ordtr	Frtq. Hı	Mag. %	Ordtr	Fnq:. Hı	M:r:g. %
11.00	550.00	0.00	13.00	6$0,00	1.33	23.00	1150.00	e.ıs	ıs.co	1250.00	0.09	35.00	1750.00	O.Ol	37.00	18S0.00	0.0l
47.00	23$0.00	0.00	49:00	2450.00	0.00												

Btu ID: Bu:«i'
Fuud.. kV: 11.118

Orderı·	frtq. Hı	Mag. %	Ordtr	Frtq. Hz	Mag. %	Ordtı•	Fuq. Hı	lhg. %	Ordtr	FrNJ. Hı	!\fag. %	Oı·det•	Freq. Hı	Mıg. %	Order	Fnq. Hı	Mag. %
11.00	SS0.00	0.01	13.00	650.00	1.75	23.00	mo.oo	0-\1	25.00	l?...Ç0.00	0.S0	.ıs.oo	1750.00	0.0S	37.00	18S0.00	0.00
47.00	2350.00	0.03	49.00	mo.oo	0.0l												

Buı;ID: Bn<7
Fund.kV: 66.128

Ordtr	Fr,q. Hı	Mag. %	Onkr	Freq. JL	Afag. %	0l'dti'	Freq, Hı	)fag. %	Ordtr	Fr,q, Hı	Mag. %	Ordrı•	Freq. Hı	M,g. %	Or<!tr	Fr,q. Hı	Afag. %
u.oo	sso.oo	0.00	13.00	6.'0.00	lal?	23.00	1150.00	0.u	15.00	1250.00	e.ıe	35.00	1750.00	0.0l	37.00	18.'0.00	0.0l
47.00	231'0.00	0.00	49.00	US0.00	0.00												

Bus Tahuıattou

Haıınonic Voltag.S (% of Fundamental Voltage)

Bu~ID: **BusS**
Fund. kV: 66.706

Ordeı-	Ft'tq. -1.!!.....	Mag. ~	Oı·det' --	Frtq. -1.!!.....	Ma;. ~	Ordtl' —	Freq. Hı	M.ıtg. %	Ordtr —	Freq, Hı	Mag. %	Ordtr —	Freq, Hz	Mag. %	Otdn —	Freq. Hz%	Mng:.
11.00	550.00	**0.02**	1.k00	6$0.00	*ı.1s*	Z.1.00	llS0.00	**0.3l**	25.-0(1	**ll..~~00**	0.51	.l5.00	1750.00	aes	37.00	1850.00	0.00
47.00	m0.00	0.03	49.00	1450.00	0.0l												

BııID: Bu,9
Fund.kV, 1l.011

[redacted]	Hı ~	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted].%H	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]z	[redacted]	[redacted]	Hz% ~	[redacted]
11.00	550,00	0,00	13.00	f$0.00	1.39	23.00	llS0.00	o.u	2,.00	12$0.00	aıe	3,.00	17$0.00	0.0l	37.00	1850.00	0.0l
Jı.00	m0.00	0.00	19.00	,Js0.00	0.00												

Proje-ct:	~USTER THESIS	ETAP		Page:	IS
Location:	HOUN crrv -LIBYA	12.6.0H		Date:·	28-06-2016
Contract:	1"EAR EAST UNIVERSITY . EEE. Department			SN:	
Engineer:	SA!',1) MUSTAf 'A AL-REF'AI	SnıdyCase:	HA	Reısion:	Base
Filename:	HOUN Sıı'BSTATION 220kV			Omfig:	Normal

DESIGN OF A LARGE SCALE SOLARPV SY!;TEM .ru'\1) IMPACT ANALYSIS OF ITS JNTEGRA1'10NINIO LIBY.ru~ PO\\'ERGRID

Bııs Tabulation

Hnrmoıık Voltages (% ofNomlıınl Voltage)

Bus ID: Busl
Nom. kV: 66.000

Order·	Freq. Hı	Mng. %	Ordtr	Frtq. Hı	Mag. %	Ordtr	Freq, Hz	Mng. %	Order	Freq, Hz%	Mıı;,	Order	Fr«.ḳ	Mag.	Order	Frtq.	Mng..
11.00	550.00	0.02	IJ.00	~.00	1.77	l.1.00	1150.00	0.32	25.00	ll50.00	O.SI	35.00	1750.00	0.0S	37.00	1850.00	0.0D
47.00	l.150.00	0.03	49.00	2450.00	0.0?												

Bus ID: Bu,10
Nom. kV: 11.000

Order	Freq,	Mag.	Ordtr	Freq. Hz	lfa;. %	Or.ılı·r	Freq. H,	:Ung. %	Order	Freq,	Mag.	Or&ı·	Freq.	lb,g.	Orderı·	Freq. Hz	Mag. %
11.00	550,00	0.0l	13.00	650.00	1.77	l.1.00	1150.00	0.32	25.00	1150.00	O.SI	.ıs.oo	11so.oo	0.0S	.ll.00	1850.oo	0.00
47.oo	mo.oo	o.o.ı	4.9.00	2450.00	0.0l												

Bus ID: Bu'11
Nom. kV: 66.000

ONler	Freq; fü	Mag. %	ONltr	F"'ą, Hı	ll>g. lo	Oro..-	Freq, Hz	Alng. %	Ordeı-	Freq. Hı	~fag. %	Order·	Fnq. Hı	lbg. %	Grdeı-	Freq. Hı%	Atıg.
11.00	550.00	0.00	IJ.00	650.00	1.39	l.1.00	1150.00	0.13	25.00	1250.00	0.10	3.<.00	1750.00	0.0l	37.00	1850.00	0.0l
47.00	2350.00	0.0D	49.00	US0.00	0.00												

Bus ID: Busl2
Nom. kV: [redacted]

[redacted]																	
	Hı	%		Hı	%		Hı	%		Hı	%		Hı	%		Hz%	
11.00	SS0.00	0.0l	13.00	6.'0.00	1.77	23.00	1150.00	0.32	25.00	1250.00	O.SI	JS.O-0	1750.00	0.0S	37.00	1850.00	0.00
47.00	2350.00	0.03	49.00	2450.00	0.0?												

Bus ID: Bu'13
Nom. kV: 66.000

Order	·Fnq. Hı	~lag. %	Or<ltr	Frtq. Hı	Mag. %Hı	ONl,r	f"'ą,	Mng. %	Order	Freq, Hz.	~J· %	Ordu	f"'ą· Hı	Abg.	Ord,r	F·.·q.	Abg.
11.00	550.00	0.02	U.00	650.00	!.SJ	l.1.00	1150.00	O.JS	ıs.oo	1250.oo	0.SB	35.00	1750.00	0.06	1l.00	ısso.ce	0.0D
47.00	2350.00	0.0S	49.00	:!450.00	0.04												

Bu, ID: Bu,14
Noın. kV: 66.000

Ol'deı·	Fnq.	Ma;.	Ordtr	F~.·	Mag.	Oı·dtr	Preq.	M.l;g;, %	Order	Freq, Hı	M..'lg. %	Ortkr	Fttq. Hı	lbg.	Ordtr	Frt.q. Hı	Mng.. %
11.00	ssaoa	0.00	!J.00	6.'0.00	1.44	IJ.00	1150.00	0.ıS	25.0o	1250.oo	o.ıı	ssee	1750.oo	o.o.ı	ıı.oo	ıeso.oe	0.02
47.oo	mo.oo	o.oı	4MO	2450.00	0.00												

Bus ID: Bus!S
Nom. kV: U.000

Order	F"'ą.	Mag,	Or.ı.r	Fnq,	Mag.	ONlıı·	Freq.	lfag. %	Order·	Freq, Hı	~g.	Ord,r	F"'ą, Hı	Alag.	ONlor·	Freq, Hı	Mag. %
11.00	sso.oo	0.02	U.00	650.00	1.83	l.1.00	1150.00	0.35	25.00	1250.00	0.58	JS.O-0	1750.00	0.06	37.00	1850.00	0.0-0
41.00	!350.00	0.05	49,00	mo.oo	0.04												

Bus Tabulation

Harmonic Voltages (% of Nominal Voltage)

Bus ID: Bus16
Nom. kV: 11.000

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.00	13.00	650.00	[illegible]	23.00	1150.00	[illegible]	[illegible]	[illegible]	0.11	35.00	[illegible]	0.03	37.00	1850.00	[illegible]
47.00	2350.00	0.01	19.00	2450.00	0.00												

Bus ID: Bus17
Nom. kV: 66.000

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.01	13.00	650.00	2.01	23.00	1150.00	0.10	25.00	1250.00	0.05	35.00	1750.00	0.05	37.00	1850.00	0.08
47.00	2350.00	0.01	49.00	2450.00	0.01												

Bus ID: Bus18
Nom. kV: 66.000

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.00	13.00	650.00	[illegible]	[illegible]	1150.00	0.16	[illegible]	[illegible]	0.11	35.00	[illegible]	0.01	[illegible]	[illegible]	0.02
47.00	2350.90	0.01	49.00	2450.00	0.01												

Bus ID: Bus19
Nom. kV: 11.000

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.01	13.00	650.00	2.01	23.00	1150.00	0.10	25.00	[illegible]	0.05	[illegible]	[illegible]	[illegible]	[illegible]	1850.00	0.05
47.00	2350.00	0.01	49.00	2450.00	0.01												

Bus ID: Bus2
Nom. kV: 66.000

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.00	[illegible]	650.00	[illegible]	23.00	1150.00	0.14	[illegible]	[illegible]	0.10	[illegible]	[illegible]	0.01	31.00	[illegible]	0.01
47.00	2350.00	0.00	49.00	2450.00	0.00												

Bus ID: Bus20
Nom. kV: 11.000

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
11.00	550.00	0.00	13.00	650.00	[illegible]	23.00	[illegible]	0.16	[illegible]	1250.00	0.12	35.00	1750.00	0.03	37.00	1850.00	[illegible]
47.00	2350.00	0.01	49.00	2450.00	0.01												

Bus ID: Bus21
Nom. kV: 66.000

Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %	Order	Freq. Hz	Mag. %
[illegible]	550.00	0.01	[illegible]	650.00	1.99	[illegible]	[illegible]	0.40	[illegible]	[illegible]	[illegible]	35.00	1750.00	[illegible]	37.00	1850.00	0.07
47.00	2350.00	0.01	49.00	2450.00	0.00												

B'ds Tah'nl3tion

Hnrmonic Voltagts (0/q ôfNOmin'atVôJtage)

Bus ID; Bııs22
Nom. kV: 11.000

Ordtı-	Freq.	**Mag.**	Order	Freq.	**Mn;,**	**Ordtr**	**Frtq,**	**Mag.**	**Ordtr**	Freq,	**Afag.**	**Ordtl'**	Freq.	M•g.	Ord.r	Fr,q.	Mng.
—	Hz	%	—	Hz	%	—	Hz	%	—	Hz%		—	-1!!-	_%		.....!!:.....	JL..
11.00	550.00	0.0l	13.00	650.00	1.99	23.00	1150.00	0.40	15.00	1250.00	0.52	35.00	17$0.00	0.09	37.00	1850.00	0.07
47.00	2350.00	0.0l	49.00	2456.-00	0.00												

Bu, ID: Bus23
Nom. kV: li6.000

Ordtt'	**I'nq.**	**Mag.**	**Order**	Freq.	**Ma;.**	**OJ'dtr**	**Fnq.**	**Alag.**	**Ordtr**	**Freq.**	**'.Mag:.**	Order	Fı·"ŀ	Uıg.	Ord>r	Fı,q.	Mag.
--	Hz	%	—	Hz	%	-~		%	--·~y				~	...JL_	___	....!!.....	...JL..
11.00	550.00	0:0l	13.00	650.00	2.04	2,.00	mo.oo	0.0S	25.00	1250.00	0.05	35.oo	mo.oo	0.00	37.00	1850.00	0.00
47.00	2350.00	0.00	49.00	2450.00	0.00												

Bıı, ID: Bus25
Nom. kV: 11.000

[redacted]	~	[redacted]	[redacted]	~	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	~	[redacted]	[redacted]	~	[redacted]	[redacted]	[redacted]	[redacted]
—	Hz	%	—	Hı	%	—	Hz	%	—	Hz	%	—	Hı'-.			Hz%	
11.00	550.00	0.0l	13.00	650.00	l.04	23.00	1150.00	0.0$	l!6.00	1250.00	0.0S	35.00	1750.00	0.00	37,00	1850.00	0.00
47.00	2350.00	0.00	49.00	2450.()0	0.00												

Bus ID: Bus27
Now. kV: 66.000

Ordtr	Frtq.	Mng.	Ord.r	Fr«J.	M>g.	Order	Frtq.	M•g.	Oıkr	Fr«J.	Mng.	Ol'dtr	Fı<q.	Mag.	Ordtr	Fr«J.	M>g.
—	Hı	I·.	—	Hi~	_	—	Hı	%	—	Hı%			~	....ıL	--	__§_	....JL..
11.00	550.00	0.0l	13.00	650.00	1.87	23.00	1150.00	0.1S	25.00	l:?50.00	0.1,1	35:00	1750.00	0.66	37.00	1850.00	0.03
47.00	2)50.00	0.0?	4MO	2450.00	0.0l												

Bus ID: Bu,28
Noın. kV: 11.000

Order	**Frtq.**	**Mag.**	**Order**	**Fı·tq.**	**~tıg.**	**Ôl·dra•**	**Frtq.**	**Mag.**	**Order**	**Fı'f'g,**	**Mag.**	Ordeı-	Freq.	**Mag,.**	**Ordtr**	Freq,	**Mag.**
--	~	....JL..	--	~	....JL..	--	~	....JL..	--	~	....JL..		~	....JL..	--	....!!:.....	....JL..
11.00	S.S0.00	0:0l	13.00	650.00	1.87	23.00	1150.00	e.ıs	ıs.00	1250,00	uss	ıs.00	1150.00	0.06	37.00	1850.00	0.0.I
47.00	ııs0.00	0.0.?	49.00	2450.00	0.0l												

Bus ID: Buszıı
Noın. kV: 11.000

Ordtı·	**Frtq.**	**Maı,.**	**Ordtı•**	Freq.	**Mag.**	**Ot-dt:r**	**Fnq.**	**Mag.**	**Ordtr**	**Fı't"ŀ**	**Mng.**	**Ordtr**	**Fı'tq,**	**Mag.**	**Order**	**Frtq.**	**:Mng.**
--·	Hı	"	--	Hz	%	—	Hı	%	—	Hz	%		~....JL_		___	....ŀ!:.....	_..ıL
11.00	550.00	0.0l	13.00	650.00	1.87	23.00	1150.00	e.ıs	?5.00	1250.00	0.33	ıs.00	11s0.00	0.06	37.00	1850.00	0.03
47.00	2350.00	0.0l	49.00	2450.00	0.0l												

Bus ID: Bus3
Nom. kV: 220.000

Ordtr	**Frtq.**	**?ıbg.**	**Ordtr**	Freq.	**?\fag.**	**Ol·dtı•**	**Frttj.**	M,g.	Ordtı·	Fr,q.	~bg.	Oı•dtr	Frtq.	M>g.	Ordtr	Frtq.	Mag.
--	_!!!_	....JL..	--	~	....JL..	--	~	%	--~....JL_			___	~....JL_		___	Hı	%
11.00	550.00	0.02	15:00	6.S0.00	1.69	23.00	1150.00	0.30	15.00	l:?S0.00	0.49	35.00	1760.00	Ml	37.00	1850.00	0.00
41.00	2350.00	0.03	49.00	2450.00	0.0l												

Project:	~U.STER THESIS	ETAP		Page:	31
Location:	HOUN CITY -LIBYA	U.6.0H		Date:	28-06-2016
Conrracc	NEAR EAST UJ\'IVERSITY - EEE Deparnneut			SN:	
Engineer:	SA!\'D MUSTAFA AL-REUI.	Study Caw:	HA	Re,isiou:	Base
Filename:	HOUN SUBSTATION 220kV			Config:	NormaJ

DESIGN OF.A LARGE SCALE SOI.AR;PY SYSTEll! Al'ID IMPACT A.I'11ALYSIS OF ITS INTEGRATION II\'TO LIBYA.'lPOWERGRID

Bus Tabulation

Harmculc Voltages(% of Nominal Voltage)

Bus ID: Bus30
Noın. kV: 66.000

Ordtr	Frtq. H<	Mag. %	O~'Otr	Freq, Hı	lbg. %	Onlu	Freq. Hz	M.ıg. %	Ord.tr	Freq,	Mag.	Ord,,	Fnq.	Mag.	Order	Freq,	?t.tıg.
11.00	ssc.ee	0.01	13.00	650.00	1.?8	23.00	11$0.00	0.32	2$.00	1250.00	0.52	;;.00	11so.00	0.0;	37.00	1850.00	0.00
47.00	2350.00	uos	49.00	I4S0.00	0.03												

Bus ID: Bus31
Noın. kV: 66.000

Ordtr	Freq, Hı.	Mag. %	Ordn	Freq. Hz	Mag.	Ordtr	Freq.	1-fog.	Ordtt'	Irtq,	~bg.	Order	frtq, Hz	M•g. %	Order	Fr,q. .Hı	Mag. (:i)
11.00	550.00	0.00	13,00	650.00	1.40	IJ.00	1150.00	0.14	25.00	mo.oo	0.10	35.00	17>0.00	(1.02	37.00	1850.00	0.0l
47.00	2350.00	0.00	49.00	24S0.00	0.00												

Bus ID: Bus32
NomıkV: 11.000

Ordeı-	Freq,	Mag.	Order _liz	Freq,	Mag. %	Ordc-r	Freq, Hz	Mag. %	Ordrr	frtq. Hz	1\hg. %	Ordtr	Freq. Hz	}!Jig.	Order	Fı't<j,	M.ıg.
11.00	550.00	0.0l	13,00	650.00	1.18	z;.00	ıı1:0.00	0..ıl	Z5.00	1250.00	0.Sl	;s.00	11so.00	0.0S	37.00	1850.00	0.00
47.00	2350.00	0,03	49.0-0	l4!'0.00	0.03												

Bus ID: Bus33
Nem, kV: [illegible]

--	Hı	%		Hz	%		Hz	%		Hz	%		Hz	%		Ht	.Y
ıı.ee	s.s0.00	0.00	ıs.ee	650,00	1..10	1.,.00	ıı1:0.00	0.u	zı:.00	1250.00	0.10	3s.00	mo.oo	0.01	37.00	1sso.00	0.01
47,00	23$0.00	0.00	49.00	2450.00	0.00												

Bus ID: Bus.'4
Nom. kV: 0AOO

Order	Freq. %	M:ıg.	Order	Frtq, Hz	M:ıg. %	Ordu	F«q. Hz	!!Jig. %	Order	Freq, Hz%	!!Jig.	Order	Frtq. Hz	h.lng. %	Order	Frtq.	h!Jlg.
11.00	5$0.00	3.23	13.00	6so.00	1.93	23.00	11so.00	z.16	ıs.00	1?50.00	2.68	.ıs.00	11so.00	1.23	'.7.00	1850.00	I.Ol
47.00	2350.00	0.47	49.00	mo.oo	0.51												

Bus ID: Bus35
Nom. kV: 6.400

Order	Freq. Hz	Mag. %	Order	Freq. Hz	M:ıg. %	Ordn	Freq. Hz	Ma_ı. %	Order	Freq. Hz%	?ıbg.	Oı·deı•	Frtq,	Mag.	Order	Freq,	Abg,
11.00	550.00	I.ts	13.00	650.00	0.54	23,00	1150.00	1.33	!$.00	1250.00	1.38	3S.00	1750.00	0.46	37.00	1850,00	0.39
47.00	ZJS0.00	0.16	49.00	2450.00	0.17												

Bu, ID: Bus36
Noın. kV: [illegible]

	Hz	%		Hz	%		Hz	%		Hz	%		Hz	%		Hz%	
11.00	sso.00	.1.1;	13.00	650.00	ı.93	23.00	ıise.ce	2.16	ıs.00	1250.00	ı.68	35.00	ıiso.oo	ı.ıs	:11.00	ıs5o.00	ı.oı
47.00	mo.oo	0:47	ıtoo	2450.00	e.sı												

Bus Tabplation

Hanoouk Voltages(% of Nominal Voltage)

Bus ID: Bııs37
Noıµ. kV: MOO

	Hı	%		Hz	%		Hz	%		Hı	%		Hz	%		Hz%	
11.00	:so.oo	3,23	13,00	650.00	ı.93	23.00	1150.00	ı.16	ıs.oo	mo.oo	ı.68	3;.00	1150.00	1.1S	37.00	1850.00	ı.oı
.ıı.00	l350.00	0A7	49.00	ı,so.00	e.sı												

Bus ID: Bus38
Nom. kV: o.400

Oı•dtl'	Fı·tq. 2!.__L	Mng.	Ordtı·	Freq. Hz	M>g. ~	Ordtı·	Freq. Hı	M'·tg. «	Ordtr	Freq. H:z	Mag. %	Ordrı·	Freq. Hı%.	)fag.	Ordrr	Freq. Hz%	!\fog.
11.00	550.00	0.S0	IJ.00	650.00	1.70	23.00	1150.00	O.M	25.00	1250.00	0.ZS	3$.00	1750.00	aıs	37.00	1850.00	0.13
,l.00	l3So.oo	0.06	;9,00	ı,so.oo	0.06												

Bus ID: Jlm39
Nom. kV: 400

	Hz	%		Hz	%		Rt	%		Hz	%		Hz	%		Hz%	
11.00	550,00	2.31	13.00	650.00	s.n	23.00	1150.00	J.77	?S,00	1250,00	1.64	.ııt.oo	11so.oo	0.9,	37.00	18!0,00	0,77
,1.00	mo.oo	0.38	49.oo	2450.00	o.41												

Bus ID: Bus4
Nom. kV: 0.000

	Hz	%		Hı	%		Hz	%		Rt	%		Hı	%		Hz%	

Bu, ID: Bus40
Noin. kV: MOO

Oı<l,r	fl"'!, Hz	M,g. %	Ordtı·	Freq. Ht	M,g. -%	Ordtr	Fnq. H:z	Mag. %	Onlor	fnq. Hı	IUag. _L	Ordtr	Fnq, Hı	Abg. ~--2!.__%_	Oı<lıı·	f•"'I	Mıg,
11.00	550.00	0.$0	13.00	650.00	J.70	23.00	1150.00	0.16	15.00	1150.00	O.IS	35.00	1750.00	e.ıs	37.00	,1850.00	0.13
47.00	mo.oo	0,06	49.00	2450,00	0.06												

Bus ID: Bus41
Nom. kV: 11.000

Orderı·	Freq. Rt	Mııg. %	Onltr --	Fffli 2!.__	Mag. -L	Ordtr --	Frtq. 2!.__	lf.ıg. ~	Ordtr --	F'rtq,. Hz	~- %	Ordtr --	Frıı,q. 2!.__	Mag. -L	Ordtr --	Frtq. 2!.__	Mng. _l_.-
11.00	:S0.00	1.Sl	13.00	650.00	0.$3	23.00	1150.00	UI	25.00	l?S0.00	UB	35.00	1750.00	0.49	37.00	IS!0.00	0.41
47.00	2350.00	017	49,00	2450.00	0.19												

Bu., ID: Bus42
Noın. kV: 11.000

Order --	Freq. 1h	Mag. ɑ,~	Ordt.r	Freq, Hz	Ma:. ,6	Ordtr	Frtq. Hz	ltng. %	ONU'r	.Frt:q. Hı	M~g. %	Ordtı· --	Frfi):, -2!.L.	Mag. _L	Ordtı' ---	Fl'tq. Hı	M:ıg. %
11.00	$50.00	0.53	13.00	650.00	1.81	23.00	1150.00	0.17	lS.00	1250.00	0.??	35.00	1750.00	0.16	37.00	1850.00	0.13
'7.00	1350.00	0.06	.9.00	2.$50.00	0.07												

Bu., ID: BusS
Nom. kV: 220.000

													Hz	%		Rt%	
11.00	550,00	0.00	U.00	650.00	1.33	23.oo	mo.00	0.13	ıs.00	mo.00	0.09	35.00	1750.00	O.ol	.l7.00	1850.00	0.0l

Bus Tabnlation

Baruıoule Voltnges (0/o ofNoıniual Voltage)

Bus ID: **Buss**
Noın. kV: 220.000

Order	Freq. Hz	Mag. %	Order	Freq, Hz	}ıbg'. %	Ord,r	Freq. Hz	~-lag. %	Order	Freq. Hı	Ifag. %	Ordtr	Fnq. Hı	JıUg. %	Order	Freq. Hı%	?ı.fag.
41.00	2350.00	0.00	4~.00	2450.00	0.00												

Bu,ID: Bus6
Nom. kV: 11.000

--	Hı	%	--	Hz	%	—	_l!L	%	--	Ht	·ó	--	Hı	%	—	Hz	%
11.00	550.00	0.0l	13.oo	ı50.oo	1.77	23.00	1150.00	0.32	I5.00	l:?50.00	0.$1	3.<.oo	1150.oo	0.05	37.00	1850.00	0.00
47.00	2350.00	0.03	49.00	2450.00	{l.l)?												

Bu,ID: Bu,7
Noın. kV: 66.000

Order --	F:rtq. Hz	M.-ıg. %	Order --	F~. lh,	M.lg-. %	Order ·--	Freq, Hı	ling. %	Order —	Fnq. Hz	Mag. %	Ordtr --	Fı"t<{ Hı	lbg. %	Order --	Frt-q. H~	hing. %
11.00	5$0.00	0.00	13.00	~.00	1.SS	23.00	11!'0.00	0.14	25.00	125-0.00	0.IO	35.00	1750.00	0.02	37.00	18S0.00	0.0l
47.00	2350.00	0.00	49.00	2450.00	0.00												

Bıı,JD: Busll
Noın. kV: ôô.00~

Order --~	Frtq. _!!	Mag. _--~	Or&r	Frıtq,	!.fag. SS	Orotr	Freq, Hz	1.fag. !!	Ordeı• --	Freq. ~	M.:ıg. !!	Ordn	Fl"ɉ, Ili	Mag. %	Oı:d<r	Frtq. Hz	~fag. %
11.00	!'.<0.00	0.0?	13.00	~.00	1.71	:!3.00	11$0.00	0.3l	25.00	1250.00	0.51	35.00	17$0.00	0.05	37.00	18$0.00	0.00
,L00	mo.oo	0.03	49.00	2450.00	0.0!												

Bus ID: Bııs9
Noın. kV: ll.000

Oı·der	Freq, Hz	.Ung:. %	Order	fnq. Hz	Mag. %	Order	Freq. Hz	Mng. %	Ordeı-	Freq. Hz	?\fag. %	Ordtr	Frtq,. Hı.	M.ıt.g. %	Order	Freq. Hı%	Mng.
11.00	!'.<0.00	0.00	13.00	65-0.00	1.39	23.00	1150.00	0.14	25.00	125-0.00	0.IO	35.00	1750.00	0.0l	37,00	1850.00	0.0l
47.00	2350.00	0.00	49.00	24$0.00	0.00												

Filter O.·erJoaıliug

Filteı·			Capacitor Cl			Iııductor Ll			Capacitor C2			Inductor L2		
			hfa".	Opıs	%	lbx.	Opr.	%	hLıs.	Opr.	%	Mnx.	Opr,	%
ID	TıL	Conu0<riou	kY	k\'	Orn-\'olt	Amp	Aııp	Omioad	kY	kV	OnrVoll	Amp	~	Om1o,d
ID'l	3	Wyt	100,000	64.674	6.1.7	100.00	1.31	2.3						
HF2	3	Wye	100,000	S7.193	S7.1	100.00	4.12	4.1						

Filter- **Typt!I: O= By-P~, l = High-Pav; (D:ıtnpt-ıl), l = Highı-P:m (Uncbmped), 3 = Singlt** Taued, **4 >JJ'd Ordu** Damped, ***5.,.* 3rd Ordtr C-Type**

Alert Summary Report

	% Alert Settings	
	Critical	**Marginal**
IndMdual Bus VTBD / VJHD values are used.		
Transformer-		
Totall	100.0	9M
Filter		
CapadıorkV	100.0	9S.O
Inductor Amp	100.0	9M
Capacitor		
Il!ax kV	100.0	9S.O
Cable		
Ampadty	100.0	9?.0

APPENDIX 12

TRANSIENT STABILITY ANALYSIS WITHOUT PV

Projecu	llfASTER THESIS	ETAP	Pa.gt:	1
Location:	HOUN CITY -LIBYA	12.6.0H	**Date:**	28-06-2016
Conrract:	NEAREASTUNfVERSm· -EEE. Department		SN:	
Engineer;	SANDJIIUSTAFA AL-REHJ	Study Case: TS	**Redsiou:**	**Base**
Ffümame:	HOUN SUBSTATION220kV		Coufig:	**Normal**

DESfGN OF A U.RGE SCALE SOLARPV SYSTEM ANDIlıIPACI ANALYSISOF ITS INTEGRATION INTO LIBYAı"S POWER GRID

Electrka1 Tl'ansieut.Aualyı:el'Program

Transient Stabiliıv Analvsis QVithout PV}

lnitlal Loading Categoı)·(1):	Design
Initial Generation C.ıtegory (1):	Design
Load Dh'er:siey Factor:	**None**

	Sıriug	V-Conn-ol	Load	Total
Number of Bııses:	3	0	l9	42

	XFMR2	:ı:::FI\lR3	Reacıoı·	Line/C..ıble	lmp,!fance	Tie PD	SPDI	Total
Number of Braaelıesı	*26*	0	0	16	0	10	0	52

	&'yurhrnnoıl~ Generator	Power Gıid	**Syııchı·ouous** Motor	**Induction** Illaddues	**Lumped** Loa~	---1!ı!J!!
Numboı·oHfachiııes:	**0**	**3**	**0**	**0**	*U*	17

I\{ethod of the Initial LF Solution:	Adaptiı·e Ne111oıı-Raphsou
I\Lı:timum Numberofiteraıioru:	1000
Solution Precision for the: Initial LF:	0.0001000000
Acceleranóıı Factor for the Initial LF:	0.00
Iirne Ineremeut for lutegradon Steps (At):	0.001.0
Tüne Inc•.•menr for Plots:	20 times At
System Frequency:	SO.OOHz
Fı.•quencr Dependeııt Models for Macbiues and Network are Not Use<!	
Unit Systeın;	Meh·k

Adjustments

Tolerance	Apply Adjusnnencs	Indhidual /Global	Percent
Trausformer **Impedance:**	**Yts**	hıdMdual	
Reactor Impedance:	**Yes**	hıdhidual	
'Orerload Hearer Resistance:	No		
Tı·aıısınission Line Length:	No		
Cable Length:	No		

Temperature Correction	Applv Adjusnmeuts	Indhidual /Global	
Tı-nnsınission.Line Resistance:	**Yes**	hıdMdual	
Cable Resistance:	**Yes**	hıdhiduııl	

Bus Input Data

Bus			IuitialVolrage		Load							
					CoostantkVA		Con,şt.rntZ		Const;mtl		Gtnttic	
ID	kl'	Sub-sy;<a	%llig.	Ang.	MW	!h-a.r	MW	Afrnr	MW	lh:tr	MW	?ıfr.1r
Bud	6<>.000	l	99.I	-5.1								
Busl	6<).000	1	98.9	-1.9								
Bus;.,	Zl.0.000	l	100.0	0.0								
Bm4	220.000	l	J00.0	0.0								
Bus5	Zl0.000	l	100.0	0.0								
Busti	11.000	l	98.l	-S.1	0.000	o.995	0.000	0.249				
Bns7	66.000	l	98.S	-1.9								
Bu~a	6<>.000	l	99.0	-5.l								
Bus9	ll.000	l	98.1	-Z.5	uoo	0.991	0..lOO	0.148				
Busl 0	11.000	l	97.S	.1.2	S.600	3.471	1.400	0.868				
Budl	66.000	l	99.l	-1.2								
Budl	6<>.000	l	99.4	..f.l								
BuslJ	6<>.000	l	98.$	-M								
Busl4	66.000	1	98.0	-lA								
Bus!S	11.000	l	98.1	.$.5	4.800	Z.915	1..200	0..744				
Bud6	11.000	1	98.3	..SA	4.800	1.975	l.lOO	0.744				
Bus17	66.000	1	98.9	.•.S								
Busts	66.000	l	98.S	.1~								
Bm19	11.000	l	98.7	.$.4	4.400	0.000	LIOO	0.000				
BuslO	11.000	1	98,7	-3.3	1.800	0.000	0.700	0.000				
Bus21	6<,.000	l	98.9	-7.5								
Bu.sZl	11.000	l	98.4	-10.4	4.800	0.000	l.200	0.000				
Btl,$?..,	66.000	l	99.3	-7.9								
Bus24	6<>.000	l	100.0	0.0								
Bus?~	11.000	l	98.l	.$.8	1.600	0.991	0.400	0.248				
Bus26	11.000	l	100.0	0.0	4.000	1.419	1.000	o.610				
But:?7	66.000	l	98.8	..S.8								
Bu.28	11.000	l	98.4	-6.7	?AOO	1.481	Q.600	U12				
Bu,29	11.000	1	98.4	.••7	2.400	J.487	0.600	0,37?				
Bu,JO	66.000	l	98.5	-SS								
Bu,31	6<>.000	l	98.6	-Z.1								
8ui3l	11.000	l	98.0	-S.7	8.800	5.455	l.200	1.$6.1				
Bı"33	!l.000	l	100-~	.J.5	4.000	l.m	1.000	0.610				
Bus.\.&	MOO	l	100.0	l.l								

Bu,			IuirinlVoltng:t		Load							
					C(lnsüıntkVA		ConmmıZ		CeustaıtI		Gtutic	
ID	k\'	Sub-sys	%Mag.	.bg.	MW	Mnır	MW	:Ml'tlr	MW	Mnr	MW	Mu~r
Bus3S	MOO	1	100.0	1.1								
Bus36	0..l00	1	100.0	1.1								
Buı.17	MOO	1	100.0	1.1								
Bus.IS	0.400	I	100.0	,.3								
Buı.19	MOO	1	J00.0	3.I								
Bu1.ıo	0..l00	I	100.C	3.3								
Bu,41	11.000	1	98.9	J.2								
Bm.:.U:	11.000	I	98.6	1.0								
T-0tnl Number of Buru: 42					!'1.999	25.785	13.000	6.446	0.000	0.000	0.000	MOO

Nott: D}'I'l,1mically mod.tied mt.ıtor lo:.ds art ııot included in ıue bus ıııotoı· toad. S« ıuachiwt- and ınot\lr p~tt for detrül.

Geııw.ltionBus				Voltage		Oenerafioıı			l\Ivar Limits	
ID	kV	T}1It		~~		MW	Mvar	%PF	Max	Min
Bus3	2I0.000	smng	1	100.0	M					
Bus4	210.000	Suing	1	100.0	0.0					
Bm5	120.000	S'!\ing	1	100.0	0.0					
						0.000	0.000			

Prcject:	MASTER THESIS	ETAP	Page:	5
Location:	HOUN CITY LIBYA	12.6.0H	Date:	28-06-2016
Conrrnctr	1i'EAR L\ST UNI'I'ER.51TY • EEE Department		SN:	
Engin ee.:	SAND INISr.U'A AL-REF Al	Study Case: TS	Re,ision:	Base
Filename:	HOUN SUBSTATION 2lOkV		Coufig:	Normal

DESIGN OF A URGE SCALE SOUR PV SYSTEM A1'ID IMPACT ANALYSIS OF ITS INTEGRATJ:ON!NTO LIBYA,'i' POWER GRID

Liue/Cable Iuput Dat;1

Line/Cable			Length	Ohms or Siemens per 10-00 m per Conductor (Cable) or p<l Phase (Line)								
JD	Ubnuy	Siu	Adj,(ırı)	% Tol.	#IPh.ıs.t	T (9C)	R1	X1	V1	RO	XO	YO
Cable!	llMCUS3		J00.0	0.0	I	75	0.076302	0.087400	0.0001646	0.240351	0.215000	
Cable-1	l!MCUS3	■	J00.0	0.0	1	75	0.076302	0.087400	0.0001046	O.l403S1	0.215000	
Lind		ff■l	m00.0	0.0	1	15	0.056003	0.374255	0.0000031	0.200077	1.360791	0.0000017
lint.2		ffl	19300.0	0.0	1	75	0.056001	0.342069	0.0000034	0.200637	1.424041	0.0000016
Lln,J		ffl	:!3000.0	0.0	1	75	0.056001	0.34206?	0.0000034	0.200637	1.424041	0.0000016
Line-I		ffl	1$000.0	0.0	1	75	0.0.«?001	0.342069	0.00000.1.1	0.200m	1.424041	0.0000016
Lint$		ffl	8000.0	0.0	1	75	0.056001	0.342069	0.0000034	0.2006.17	1.424041	0.0000016
Lln,6		ffl	4000.0	0.0	1	75	0.056001	0.3420ıl9	0.0000034	0.2006>7	1.424041	0.0000016
Lint7		ffl	4000.0	0.0	1	15	0.056001	O.J42069	0.0000034	0.200637	1.424041	0.0000016
Lln,8		ffl	4000.0	0.0	1	75	0.056001	0.1.120ıl9	0.00000J4	0.100637	1.424041	0.0000016
Llıı,9		ffl	4000.0	0.0	1	;;,	0.056001	0.341069	0.0000034	0.100637	1.414041	0.0000016
ıııı.10		ffl	8000.0	0.0	1	1;.	0.0$6001	0.341069	0.00000J4	0.1006.•7	1.424041	0.0000016
Llıtll		ffl	8000.0	0.0	1	75	0.056001	0.34106?	0.0000034	0.?00637	1.424041	0.0000016
l.,fne-12		ffl	21000.0	0.0	1	75	0.056001	0.3410ıl?	0.00000.1.1	0.100637	J.4?4041	0,0000016
Llıol3		ffl	161000.0	0.0	1	75	0.056001	0.34206?	0.0000034	0.1006'7	1.424041	0.0000016
LintU		ffl	140000.0	0.0	1	7;.	0.056001	0.34106?	0.0000034	0.100637	1.4!4041	0.0000016

Lhıe-/ Cable- resıseeees are llsttd at the spccifitd temperatures.

2~\Vimling Tr·ausfonnerlnput Data

Tnmsfonner	Rntbıg					Z Variation			%Tap Setting		Adju,sted	Phase Shift	
ID	M\'A	PriiiüV	Sn.kV	%.Z	XIR	+5%	-S%	%Tol.	Prim.	see.	%Z	Typ,	Ang!,
Tl	63.000	220.000	66.000	n.se	4S.OO	0	0	0	0	3.7so	ıı.spoo	Dyn	0.000
TI	63,000	110.000	66.000	12.SO	4S.OO	0	0	0	0	0..625.	Il-~O	Dyn	0.000
TJ	63.000	110.000	66.000	12.$0	45.00	0	0	0	0	0.625	11.5000	Dyu	0.000
T4	10.000	66.000	11.000	MS	13.00	0	0	0	0	0	8.JSOO	Dyn	0.000
TS	ıo.ooo	66.000	ıı.ooo	10.00	10.00	0	0	0	0	0	10.0000	Dyn	0.000
!6	10.000	66.000	11.000	10.00	20.00	0	0	0	0	1.ıso	10.0000	Dfı:ı	0.000
T1	Il.500	11.000	66.000	S.3S	13.00	0	0	0	.1.1se	0	S..1S00	YNd	0.000
TS	!1.500	11.000	66.000	8.35	13.00	0	0	0	.1.1se	0	s..iS00	YNd	0.000
T9	10.000	66.000	ıı.ooo	8.35	13.00	0	0	0	0	4.375	6.3500	Dyn	0.000
no	10.000	66.000	11.000	8.35	13.00	0	0	0	0	4.375	8.3500	Dyn	0.000
Tll	ıo.ooo	66.000	ıı.ooo	10.00	10.00	0	0	0	0	0	10.0000	Dyii	0.000
TI2	ıo.ooo	66.oob	11.000	10.00	20.00	0	0	0	0	0	10.0000	Dyn	0.000
TU	10.000	66.000	11.000	8.35	13.00	0	0	0	0	0	S..1S00	~·n	0.000
Tl4	10.000	66.000	11.000	8.35	13.00	0	0	0	0	0	S..JS00	llyn	0.000
TIS	10.000	66.000	11.000	8.35	ü.oo	0	0	0	0	J.7S0	S.3SOO	D:L-ll	0.000
!16	20.000	66,000	11.000	10.00	ıo.oo	0	0	0	0	M";S	10.0000	~ıı	0.000
!17	20.000	66.000	ıuoo	10.00	10.00	0	0	0	0	MIS	10.0000	Dı;:I1	0.000
TIS	10.000	66.000	11.000	10.00	:!0.00	0	0	0	0	3.750	10.0000	ll)'II	0.000
Tl9	10.000	66.000	11.000	10.00	20.00	0	0	0	0	3.750	10.0000	Dyn	0.000
TIO	3.000	0..ıoo	11.000	6.25	6.00	0	0	0	0	0	6.ISOO	'!:'Nd	0.000
rn	J.000	0..ıoo	11.000	6.15	6.00	0	0	0	0	0	6J500	\'Nd	0.000
rn	.1.000	o..ıoo	11.000	6.ıs	6.00	0	0	0	0	0	6.2500	\'Nd	0.000
UJ	.1000	o..ıoo	11.000	6.IS	6.00	0	0	0	0	0	usoo	\'Nd	0.000
Tl.S	J.000	MOO	11,000	6.IS	6.00	0	0	0	0	0	6.2500	\'Nd	0.000
us	J.000	MOO	11.000	6,IS	6.00	0	0	0	0	0	6.2500	\'Nd	0.000
126	3.000	0.400	11.000	6.25	6.00	0	0	0	0	0	6.2500	\'Nd	0.000

2-,Vinding Tl'ansforınerGrounding Input Data

Transformer	Rating			Gı-ounding								
				~	Piinary				Se,cndary			
ID	MY~\	Prim.. kV	Ste. kV	T~Pf'	T~Pt	kV	Amp	Ohm	Twr	kV	Amp	Ohn
Tl	63.000	ııo.opo	66.ooo	ııır					S.Ud			
TI	~.000	II0.000	66.000	ll/Y					Sclid			

2-\Viuding Tnusformer Gı·ouucling Juput Data

Transformer	Rating			Conn.	Gı-ouuding Pıimarr				Se<ondıu:y			
ID	MVA	~	Stt.k\'	~	Typ,	kV	Amp	Ohm	T)pt	kV	Amp	Ohm
T3	6iooo	220.000	66.000	DJY					Solid			
n	10.0-00	66.0-00	11.000	Dl\'					Solid			
TS	20.000	66.000	11.000	Dl\'					Solid			
T6	lMOO	66.000	lLOOO	Dl\"					Solid			
T7	12.500	11.000	6$.000	DJY					Solid			
TS	1asee	11.000	66.000	Dl\'					Solid			
Tl>	10.000	66.000	11.000	DIY					Solid			
TIO	10.000	66.000	11.000	DIY					Solid			
Tll	20.000	66,000	ll.000	Dl\'					Solid			
rn	20.000	66.000	11.000	Dl\"					Solid			
TB	10.000	66.000	11.000	Dl\"					Solid			
TU	10.000	66.000	lLOOO	Dl\'					Solid			
TIS	10.000	66.000	ll.000	Dl\'					Solid			
TI6	20.000	66.000	lLOOO	DJY					Solid			
TI7	?0.000	66.000	11.000	DIY					Solid			
ns	20:.000	66.000	ll.000	Dl\'					Solid			
TI9	10.000	66.000	11.000	DIY					Solid			
T20	3.000	0.400	11.000	Dl\'					Solid			
n1	3.000	MOO	11.000	DIY					Solid			
n1	3.000	0.400	11.000	D/Y					Solid			
TI3	3.000	0.400	11.000	DJY					Solid			
TI4	3.000	0.400	11.000	Dl\'					Solid			
n,	3,000	o.400	11.000	DJY					Solid			
TI6	3.000	MOO	11.000	Dl\'					Solid			

Braucl1 Coupectious

CKT/Bnınch		Connected Bus ID		% Impedauce, Pos. Seq., 100 I\IVA Base			
ID	Tıl't	Fı'cm Bus	ToBıu	R	X	Z	y
Tl.	2w:xnm.	Bu<l	**Busl**	0.46	zass	I0.S9	
Tl.	IWXFMR	Bu<l	Busl	OA4	~.96	19.97	
T3	IWXFIlR	**Bu~**	**Bus2**	M4	19.96	19.97	
T4	2WXFIlR	Bıd	**Bus6**	6AO	**S.\.15**	83.SO	
TS	IWXFIlR	Busl	Bus9	**I.$0**	49.9J	S0:00	
T6	IWXBIR	Bu,s	Busl0	**2.5J**	S0.$6	sass	
T7	**2wxam**	BusJ2	Bu,11	S.06	6$.77	6$.97	
TS	IWXFMR	Bu<ll	**Busl2**	S.06	6$.77	65.97	
T9	IWXOIR	Busl3	Bu,15	MS	suo	S7.I5	
TIO	2WXFMR	**Btul.t**	Busl6	6.6S	86.90	**87.15**	
Tl!	**zwxnm.**	**Bu~l7**	Busl9	2.50	49.94	50.00	
TiZ	ıwxnıa	Bu,18	**Bu.~%0**	**I.SO**	49.94	S0.00	
Tl3	IWXBIR	**Bus2l**	**BU$22,**	6.40	**83.25**	8.1.50	
T14	ıwxnm	.Bu.:!.I	Bus25	6.40	**83.?5**	63.50	
T15	ıwxnm	**Bud4**	Bu,26	6.64	86.38	8MJ	
Tl6	**IWXEl!R**	**Bu.s27**	Busl$	**?.51**	**SO.?$**	SOS!	
Tl7	IWXFMR	**Bu~Z7**	Bu,29	**ZSl**	**50.:?5**	SOS!	
TlS	I\VXFIlR	B11"1)	**Bus3:?**	**! ~**	51,81	51.88	
Tl9	IWXFIlR	B11<ll	Bus33	**ıs9**	51.81	Sl.88	
no	**IWXFMR**	Bu"44	Bu,U	**34.25**	**IOS.50**	108.33	
nı	**!\VXFMR**	BusJS	Buı41	**3-f.2$**	**20$.SO**	208.33	
nı	IWXFIlR	Bıı,36	Bu,41	**3.f.25**	**205.50**	208.33	
T23	IWXFIlR	BusJ7	Bu,41	**3.1.ZS**	205.SO	108.33	
TZ4	IWXBIR	BusJS	Bu,Jl	34.lS	205.50	20S.3J	
ns	I\VXBIR	Bus39	**Bu·.4?**	**3~.I5**	205.50	208.33	
Tl6	ıwxnm	**Buo;:40**	Bu,42	**J.J.ZS**	105.50	**:208.33**	
Cabltl	Cablt	Butll	**Busl**	**0.02**	**0.0l**	0.03	0.0716998
Cabltl	**Cablt**	Bu,12	Busl	**0.0Z**	0.0l	0.03	0.0716998
Lind	Lint	**Bu'il**	BusU	?.48	16.58	16.77	0.1607619
Lint2	**1.\\f':**	Busl	Blld3	lAS	IS.16	ISS6	O.!SJ1167
Lin,3	Lint	**Busl**	Busl8	m	18.06	18.30	OS387!57
Liıı,4	Lint	**Bu.a,7**	**Bud1**	1.93	11.78	11.94	0.2209015
Liıı,S	Lin,	Bu,l	Bu,17	1.03	**6.ZS**	6S7	0.1178142
Lin,6	Lint	Bıı.Z	**Bus7**	0.51	3.U	3.18	0.0589071
Lin,7	Llııt	Bu,l	**Bu~8**	0.51	3.U	J.18	O.OS89071
Liıı,S	Lint	**Bu'.l**	**BuS:7**	0.51	**.I.U**	3.1&	0.0-<$9071
Lin,9	Lin,	Busl	**Bus$**	O.SI	3.U	3.1$	0.0$89071

CKT/Bmndı		CouMrted Bus ID		% Impedance, Pos. Seq., 100 JIIVA Base			
ID	Type	**From Bus**	**ToBn**	R	X	Z	Y
Lind 0	**Linl'**	**BusZ**	Bu..ıl	1.03	6.lS	6.37	0.117SUl
Lind!	Lin,	Busl	Bus.JO	1.03	*6.28*	6..l7	O.msul
Lint!:?	Lin,	Busl7	Bııs?l	2.70	16.49	16.71	O..l09l6:i
Line:13	Llıı•	Busl7	**Bw23**	20.70	ll6.43	llS.11	2.:1710100
Lin,U	Lino	**Bus21**	BuslJ	18.00	109.94	111.40	2.0617480
S'\'11	Ti,Swfüh	Busl	**Bus:?.**				
SWl	TloSlıitrh	Bu,7	Buss				
sws	TieSnitrh	Busl3	Busl4				
SW4	Ti,Snitrh	Buıl7	Bus!S				
SWS	**TjtSlTitcb**	**Buı;l3**	**Busl_4**				
SW6	**TitSldtch**	Bus25	**Bus26**				
SWr	**TitSnitrh**	**Bın-ZS**	Bıısl9				
sws	**TitSnitc-h**	BusJO	BusJl				
SW9	**Tit Snitch**	**Bus32**	Bus33				
S'\'110	**TitSnitrh**	Bus41	**Bus.t2**				

Braııclı !:onueC'tions
Zem Sequence Impedaııce

CKT/Brnııch		Coııııected Bus ID		% Impedance, Zeı-o Seq.• 100 MV Ab			
ID	Typ,	FroU]Bm:	To Bus	RO	XO	Z0	YO
Tl	2WXFMR	Bu,3	Bud				
T2	2WXFMR	Bus4	Bml				
T3	2WXFMR	BnsS	Bud				
T4	2WXFMR	Busl	Bu~6				
T5	2WXFAIR	Bus7	Bm9				
T6	2WXFMR	Bn,S	Bud 0				
T7	2\\'XFMR	Bus42	Bndl				
TS	2WXFMR	Bus.tl	Buı12				
Tl>	?WXFAIR	Bud.I	BmHi				
no	2WXFMR	Busu	Bud6				
Tl!	2WXFAIR	Bml7	Busl9				
rı1	ZWXFMR	Busl8	Bus20				
Tl3	2WXFMR	Bus21	Bud?				
TU	l\VX!AIR	Busl3	BmlS				
rıS	2wxnm	Bus:U	Bus26				
Tl6	2wxnm	Bus27	Bml8				
Tl7	2\VXFMR	Bus27	Bud9				
Tl8	lWXFllR	Bud~	Bud?				
TJ9	lWXFllR	Bus31	Bus33				
TIO	2WX!AIR	Busl.I	Bus41				
Tll	lWXFMR	Busl$	Bu,41				
Tl2	lWXFMR	Bus..\6	Bu,41				
Tl.I	lWXFMR	Bu,37	Buıç.,n				
T24	2WXFMR	Bus38	Bu~12				
!2$	lWXFllR	Bu,39	Bu5-'l				
T26	lWXBIR	Bus.JO	Bus42				
Cnbld	C.bl,	Budl	Bu~?				
C••ı,2	C:ıblt	Busil	Bud				
Lino!	Lin•	Bus:?	Bu,U				o.mo us
LintZ	Uıt	Bud	Bud3				0.1341983
Llıt:I	Lin,	Bus2	BudS				0.1$99?SS
Lln-4	Llıt	Bın27	Bud7				0.10J299?
UntS	Llı,	Bud	Bus2.7				O.OS..<tım
Llıt6	Un,	Bu:s:?	Bu1:7				0.0?78131
Liuc7	Lint	Bı,l	8U'$8				0.0278131

DESIGN Of A LARGE SCALE SOLARPV $\'STEM A\'D IMPACT ANALYSIS Of ITS INIEGRATION INTO LIBYA\'! POWER GRID

C.'KTIBranch		Connected Bus ID		% Impedance, Zero Seq., 100 l\lVAb			
ID	Typ•	From Bus	To Bus	RO	XO	ZO	YO
Lin,8	Liu,	Bu<l	Bu,7				O.Ol78131
Lin,9	Lin,	Bud	BuçS				0.0mm
u.,10	Line	Bus1	B:.31				O.OSS6163
Lintll	Lln,	Bud	Bu,30				O.OSS6Z63
Lindl	Liu,	Busl?	Bull				0.1460189
Lin,13	Lin,	Busl7	Bud3				1.1l9t780
Lin.t4	Lin,	Busll	Bus:2~				0.973.tS9S
S\Vl	TI,Snilch	Bu,l	Bu':2				
SWl	TI,Smtch	Bui?	Bu'i8				
SW3	Tit$\dtch	Bu,13	Bu,14				
SW4	ThSnitdı	Busl?	Bu,JS				
SWS	n,Snitch	Bus?.3	Bus:?4				
SW6	n,Smt<h	Bus!S	Bu,16				
SW7	Tit Snitch	Bu,18	Bu'29				
SWS	!~Snitch	BuQO	Bu,31				
SW9	Tit Snitch	Bus.Jl	Bn'33				
SWJO	Tit Snitch	Bu,41	BuH2				

S,pchrpuous l\fadıine Pypıneters

l\!adlinE'			Rat~			Po:,~1·~C~!9~~~~ ~,P,~auce (Ojo)								Zero Seq. Z (%)			
ID	Typt	Moıuı	Ml'A	kY	R.,	Xd"	Xd'	Xa	Xq"	Xq'	Xq	XI	XIR	RO	XO
ul	Pou~rGrid	NJA	2:UOl	220.000	9.9ı		99,$0							35.<i:5	3~.48
ul	PoıtrtrGrid	NfA	Z?.101	12:0,000	9.95		99.50							17.7'	171.38
U3	PowtrGrld	NIA	I?.I(ı'ı	ll0.000	9.95		99.50							17.74	117.38

Ma<hine	Ccınecred Bus	Time Constants (Sec.)				H (Sec.),D (!ılWpu/Hı)		& Saturati			Gf.uerator oı· Loading		Groun<Ung		
ID	m	'fd(l"	T<lo~	Tqo"	Tqo'	H	%D	S100	SllO	Sbruk	M.W	M.~r	Coııu.	Typt	Amp.

ıtı<hin•		Gfue,ratorJMotor			Coupling			Pıime :Monr/L-0ad			Equhılenıt Total		
ID	;l!-	Rl'M	WR'	H	Rl'M	WR'	H	Rl'M	WR'	H	RPM	WRı	H

WR²: kg-m² H,MW.S«IMVA

MacWne		Shaft Tol'slon.			
ID	Typ•	Dl	D?	Kl	K2

Dl, Dl: MW(pıı).'Spttd(pu) Kl, KZ, MW (pu)IR:ıdiaııı

Lump~rl L00d Input Data

Couw:ntion.ı1 Type

ID	kV	kYA	kW	kvat	% PF	Amp	Load %Motor	Load OA>,Static	Ta	Gamma
Lumpl	11.000	1243	0	1243	0.0l	65.3	S0	20	0	0
LumplO	11.000	5882	5000	3098	85.000	.!08.7	80	20	0	0
Lumpll	11.000	3529	3000	18$9	85	18,.2	80	lO	0	0
LumpU	11.000	3~29	3000	1859	SS	1SS.1	80	20	0	0
Lumpl3	ll.000	12942	11000	6818	85.000	679.3	S0	20	0	0
LumpU	11.000	5SS3	5000	3099	85.000	308.8	S0	lO	0	0
Lmnp2	11.000	,23s;3	2000	1240	85	123.5	80	20	0	0
Lump3	11.000	8236	7000	4339	85.000	432.)	80	20	0	0
Lump4	lLOOO	7058	6000	3718	85	370.5	S0	lO	0	0
Lumps	11.000	iOSS	6000	3718	85	.170.S	80	lO	0	0
Lump6	11.000	5500	5500	0	100	1SS.,	80	lO	0	0
Lump7	11.000	3500	3500	0	100	183.7	S0	le	0	0
Lump8	11.000	6000	6000	0	100	314.9	80	20	0	0
Lump9	11.000	:?3$2	2000	1239	85	123.S	80	20	0	0

LOAD FLOW REPORT QVithout PV}@T - 0.000-

Bus ID	kY	Voltage ~Mng.	Ang	Generation '.MW	Ahtr	Load l\fW	A.frnl'	Load flow ID	MW	l\frar	Amp	%PF	Xfl\fR ~
Busl	~	'" 1ms ~		---0	---0	---0	---0	Bu,13	6.·oiT	3S6:i ~		Srr ---	
								Bus?7	19.518	1.1$5	l.n.6	99.S	
								l!u,S	3.-179	Z.?76	36.1	SM	
								Bu'8	3,479	l.276	36.1	83.7	
								BudO	!Ml?	7.~	118.J	81.9	
								Bu'>3	..l,.m	-18.606	417.3	91.9	:1.750
								Bm6	0.001	1.247	11.0	O.l	
Busl	66.000	98.852	-27.ö	0	0	0	0	Bu.'>l.l	6.009	3.9?2	63.S	83.3	
								Bnd8	3.488	-0.1"6	3M	-99.S	
								Bus7	0.994	-0.S72	le.l	86.7	
								Bus?	0.9?4l	(l.$71	10.1	86.7	
								Bus31	5.0??	3.198	51.7	8'.4	
								Bll'i$	-16.50F	.$.089	161.7	-89.8	o.6%5
"Bus3	Zl0.000	100.000	-39.5	0	0	0	0	Bud	-13382	23.466	129.9	88.0	
								ul	-&.US?	-?.!.-166	ll9.?	88.0	
•BuW	220.000	100.000	o.o	0	0	o	0	ul	0.000	0.000	o.o	o.o	
"Bus5	110.000	100.000	.z~.6	0	o	o	0	Bm2	16.Sl?	8.783	49.1	88.3	
								U)	-16.5.?l	.Il.m	49.1	88.3	
Bu,6	11.000	98.071	-1-1.6	o	o	0.000	1.23'	Bud	0.000	-1,.234	66.0	o.o	
Bus7	66.000	98.818	-27.5	0	o	o	0	Bus!	.0.994	.I).629	10.4	84.5	
								Bu?	.0.9?4	-0.6?S,	10-4	8'.5	
								B,~	J.981	L25~	20.8	84.S	
Bu,8	66.000	99.021	-44.7	0	0	o	0	Bud	-3.478	-2.329	.\7.0	83.1	
								Bud	-3.478	-2.Jl?	37.0	83.l	
								Busl0	6.9S6	4.657	73.9	83.1	
Bu~	11.000	98.U6	-28.1	0	o	1.986	J.2$1	Bm'l'	-US<i	-1.231	Jl4.9	85.0	
B"¥O	11.000	97.770	-46.1	0	o	6.938	4.301	Bu.S	-6-'38	...l...l01	436;?	85.0	1.250
Bud3	66.000	98.344	..lS.1	0	0	0	0	Bud	-6.004	-4.158	6S.O	Sl.1	
								BuslS	6.004	4.158	65.0	82.?	
Busu	66.000	98.015	-28.0	0	o	o	0	Bu.12	-S.9?6	.US,	65.l	SZ.1	
								Bud6	S.996	4,1S5	65.l	82.l	
BudS	il.000	98.69?	-48.0	0	0	S.968	.1.699	B"l3	.S.968	,"6б9	373i4l	85.0	4.375
Bnd6.	11.000.	98.339	,\l.O	0	o	S.960	).694	Bu,U	-S-'60	-M9'	374.2	85.0	4.375
Busl7	66.000	98.91.7	-46..1l	0	0	o	0	Bu.127	-13.472	l.810	!ll.7	-97.9	
								Busl!	6.60?	-1.319	59.5	-98.l	
								Bus?3	l.390	.1.W	IM	-61.6	
								Bu,19	S.480	0.1$3	48.$	100.0	

Pl'Oject:	MASTER THESIS:	ETAP	Page; 15
Location:	HOUN CITI'. • LIBYA	12.6.0H	Date: 28-06·2016
Contract:	NEAR EAST UNIVER.5IT'!t' • EEE Depaı-nneur		SN:
Engineer:	SAND MUSTAFA A.L-REFAI	Study Casee TS	Revislon; **Base**
Filename:	HOUN Slı"BSTATION 220kV		**Config:** **Normal**

DESIGN OF A LARGE SCALE SOLAR PV SYSTUI A.ND IMPACT ANALYSIS OHTS INTEGRATION INTO LIBYAN POWER GRID

LOAD FLOW REPORT QVithout P\') ® T- aeee.

Bus		Voltage		Generation		Load		Load Flow					XThIR
ID	hV	% Mag,.	Ang.	MW	M1:ar	MW	Afrar	ID	MW	1'für	Amp	'-~F	%Tap
BuılS	«ı000	7.ırr	-:rtı'	---0	---0	---0	---0	Bu1,l	.,3.48-1	~-;ö.;100:ö—			
								BuılO	3.48-1	0.061	30.9	J00.0	
BU<.:1!>	11.000	98.740	,47,9	0	0	5.471	0.000	11«17	~5.412:	0.000	29f>.9	100.0	
B"'20	11.000	98.661	.28.9	0	0	3.481	0.000	Buıı:18	.S.1S1	0.000	185.1:	100.0	
Bus:?1	«1.000	98.938	-47.0	0	0	0	0	**Bud7**	-6.590	1.09.?	59.1	.98.7	
								Bu,;%3	0.604	,1.SSS	13.5	.,39,6	
								Busll	5.986	0..106	$3.0	99.9	
Busl.?	11.000	98..tll	-49.9	0	0	5.962	0.000	Bu,ll	-5.962	0.000	318.0	J00.0	
11"23	«ı000	99.26)	,47.,	0	0	0	0	Bu,17	.J..\85	--0.656	13.5	90..!!	
								Bul:ll	.0.603	-asn	7.6	69.6	
								Bus?:i	1.988	**1.ın**	10.8	84.1	
BU$I5	11.000	98.077	.48.3	0	0	1.98-1	1.1Se	**Bud3**	.J.984	**-1.230**	m.9	85.0	
B"27	6!5.000	98.847	,45,j	0	0	0	0	**Bud7**	13.509	-2.797	12?.1	.91.9	
								Bud	-19.478	.J.026	11?.6	!ll>.9	
								llus28	2.984	1.911	3J..1	**8.f.l**	
								Busl~	2.98-1	1.912	3U	8-1.1	
Bu,28	11.000	98.4?8	-46.2	0	0	1.9S1	LS48	**Busl7**	-ZSS1	-1.848	187.0	85.0	0.625
Busl9	11.000	98.428	-46.1	0	0	1.981,	1.SIS	Bus 21	-2.981	.J,848	187.0	85.0	0.625
Bus30	66.000	98.515	-1S.0	0	0	0	0	**Bud**	-10.961	-7.688	118.9	81.9	
								Bu'32	10.961	7.688	mu	81.9	
Bus3l	66.000	98.594	-27.7	0	0	0	0	**Busl**	-5.019	.J;?90	$3.1	SM	
								Buç33	S.019	3.190	53.ı	SM	
Bus.\?	11.000	98.036	**-18.2**	0	0	10.914	6.765	Bus30	-lo.914	.6.765	687.5	85.0	3.750
Bus33	11.000	100.463	.ZS>.l	0	0	5.009	3.105	Bu\31	-5.009	.,3.105	307.9	85.0	3.750
Ul	110.000	291.911	0.0	$4.612	133.771	0	0	Bu,;3	54.61Z	133.771	129.9	37.8	
ul	110.000	100.000	0.0	0	0	0	0	Bu.,.1	0.000	0.000	0.0	0.0	
U3	2!0.001)	16?.988	0.0	18.099	24.547	0	(l	Bu~5	18.0!ll>	24.547	49.1	$9.J	

***'Indicates a ,·oltag(' regulated bus (Yoltag(' ccutrehed 01· sniııg typ('machine** ceenecred **to it)**

\# **indkatt.<;abuçniflıa kıadınisınatçbofmon,than0.l MVA**

Projtct:	MASTER IHESIS	ETAP	P~gt:	16
Location:	HOUN *CITY* -LIBYA	12.6.0H	Date:	28--06-2016
Coun·act:	NEAR EAST UNIVERSm' •Dili Deparlıneııl		SN:	
Engineer:	SAND MUSTAFA AL-REFAI	Study Case: TS	Rwldou:	Base
Fileunmıe:	HOUN SUBSTATION 220kY		Confıg:	Noımal

DESIGN OF A LARGE SCALE SOLARPV SYSIElll A.1\'D IMPACT ANALYSIS OFIIS' L'iIEGRATION INTO LIBYAN POWER GRID

LOAD FLOW REPORT {Without PV} *(a)* T-- 0.800-

Bus		Voltage		Gt-nerntion		Load		Load Flow					XFllfR
ID	kV	% M•g.	.\.J/l.	MW	Mrnr	MW	Afr•ı·	ID	MW	II,11r	Aınp	%PF	%Top
Bu-.1	7.öôo-	~	-3$.,	---0	---0	---0	~	Bu-.U	~	~	--:;;:r	81.9	---
								Bu.'>Z7	30.507	-10.7SS	146.1	.94.3	
								BusS	S,446	3.266	1S.,	8$.8	
								Busll	$.446	3.166	28.7	8$.8	
								llU,:;0	11.m	I0.!174	92,9	SJ.6	
								Bn,:;	-68.374	-13.SIS	314.!I	98.0	3,750
								B~ı:,6	0.001	1.929	8.7	0.0	
BusZ	ı66.000	98.S&l	-17.$	0	0	0	0	Bud.J	6,009	3.992	63.8	83.3	
								BudS	3.488	-0.246	30.!I	-99.8	
								Bu,;7	0.994	0.512	ıo.ı	86.7	
								Bus7	0.994	f),!7.2	10.1	86.7	
								Bu,:,1	s.022	3.198	Sl.7	SU	
								Buss	-16.507	-S.089	16?.7	89.8	e.SIS
Bn,3	120.000	1SS.5S9	-33.1	0	0	0	0	Bıtd	68.435	16.!'94	98.0	97.1	
								Ul	-6U35	-16.594	98.0	Sl-7.l	
Bus4	120.000	100.000	0.0	0	0	0	0	.llZ	0.000	0.000	0.0	0.0	
Bus5	ll0.000	100.000	-1.<.6	0	0	0	0	BusZ	16.51?	8.783	49.1	88.3	
								UJ	-16.Sll	.$.783	49.1	88.3	
Bus6	11.000	192.967	-35.3	0	0	0.000	1.910	Busl	0.000	,l.!/20	52.1	0.0	
Bus7	(;6,000	98.S?S	-17.5	0	0	0	0	Buı;2	-0.994	.0.6?9	lo..J	84.5	
								BusZ	-0.994	-0.629	ıo.4	S.u:	
								Bu,9	1.987	1.259	l0.8	84.l\	
Bus8	66.000	193.717	-35.3	0	0	0	ô	Bud	-S.446	-3•.lS.l	19.Z	S.l.?	
								Bu,!	-S.446	-3.483	19.Z	$4.1	
								Buı;lO	10.891	6.!166	SU	S.u	
Bu,9	11.000	98.146	-2S.l	0	0	1.986	l,Z31	Bu~7	-1.986	-LZ31	l:?4.9	SS.0	
Busl 0	11.000	19.f.lO?	-36.1	0	0	10.880	6.7.U:	Btı~	-10.880	4744	346.0	85.0	I.MO
Busl3-	(;6.000	193.1l?	.3$.$	0	0	0	0	Bud	.9.555	-6.197	5L6	83.!l	
								Bud5	9.555	6.197	51.6	83.9	
Bu,14	66.000	98.015	.1S.0	0	0	0	ô	Busl	-S.996	-U55	65.1	Sl.2	
								Bus16	5.996	.uSS	SS.1	8!,1	
Busl5	lLOOO	198.606	-36.7	0	0	9.533	S.908	Bud3	-9.533	-5.908	296.4	85.0	.1.m
Busl6	11.000	98.339	-31.0	0	0	S.960	3.69.f	Bu-.1.1	-S.960	-3.694	374.1	8$.0	4,375
Bnsl7	66.oOO	19.f.744	-36.0	0	0	0	0	Busl7	-?L105	15.770	11SS	.se.1	
								Busli	10.341	-7.83.I	58.3	-79.7	
								Bn,.,..3	2.193	.S.031	37.4	-26.3	
								Bn,19	8.571	0.097	38.$	J00.0	

Project:	lU5ıER THESIS	ETAP	Page:	17
Location:	HOUN' CITY -LIBYA	12.6.0H	**Date:**	28'-06-2016
Contracr:	!\'EAR EAST lll\'l:VERSITY - EEE Depnrtuent		SN:	
Eugineer:	SAJ\'D MUSTAFA AL-REF AI	Stncly Case: TS	**Re\i1ion:**	**Base,**
Filename:	HOUN SUBSTATION 220kV		**Con.fig:**	**Nonn;'ll**

DESIGN OF A LARGE SCALE SOLARPV SY;,TEl\f_ A1\'D ThIPAC! ANALYSIS OHTS INTEGRATIO!HNTO LIBYAN POWER GRID

LOAD FLOW REPORT≤Without PVl@) T-- 0.SQQ-

Bl.t<S		Voltage		Oeneradeu		Load		Load flow					XF!i1R
ID	kV	%~Lıg.	Ang.	l\f.W	M,·ar	l\!W	li\'it	ID	SfW	Mv:ı.r	Amp	%PF	~
BudS:	~	98'.m	-:r,:;r	--0-	---0	---0	---0	Bu.Z	~	-0J>62	~·WM		---
								Busl 0	3.m	**0.062**	3o.9	100.0	
Bnd9	11.000	194.6Zl	-36.7	0	o	*8.561*	**0.000**	**Bnd7**	*.S.561*	0.000	**131.0**	100.0	
BınW	11.000	*98.661*	***~28.9***	0	0	J..181	**(l.000**	**Buds**	.ı.481	MOO	**lSS.l**	100.0	
Bus21	~000.	**195.217**	...16.3	0	0	0	0	**Bm:17**	**~10.~,29**	***6.'1?8***	**55.;1**	**.S1S**	
								Bu~3	0~;S	**-6.9?0**	31J	-13.7	
								Busll	**9.371**	0.191	**42.0**	100.0	
Busll	11.000	194.868	*.J1.5*	0	0	9.3;7	0.000	Bu,ll	-9sl57	0.000	**252.0**	100.0	
Bml3	<16.000	19U1S	-36.6	0	0	0	0	**Btıd1**	**-1.1SS**	.Q.998	lo.7	90.9	
								Bus11	**-0.953**	..0.973	6.1	70.0	
								But1~	3.136	!.97l	16.S	84.7	
Bu.sl~	11.000	195.883	-36.9	o	0	3.134	**1.9-t?**	**Bu.tn**	...1.134	**-1.9.ı?**	*98.8*	85.0	
Busl7	[redacted]	*193.919*	-35.6	o	o	0	0	Bu,17	21.141	-16-'8$	120.6	-79.0	
								Busl	..10.478	10.$10	14$.4	*-94,$*	
								BuslS	*4.669*	**2Jı3.1**	**2.ı.9**	8-1.7	
								Bu,;29	*4.669*	**2.931**	14~	8-1.7	
Bu.sl6	11.000	l.94.375	.SS.e	o	0	4.667	**l.S9'l**	**Busl7**	-4.667	**..2.891**	**l.lS.Z**	85.0	0.625
Bw:29	11.000	194.375	...16.0	0	0	*4.661*	**l.S9l**	**Bu,;?7**	-4.667	**.2.89?**	**US.?**	85.0	0.6lS
Bu<.10	<16.000	19JJ41	**.35.5**	o	0	o	0	**Bud**	-17.399	-11.343	94.0	*83.8*	
								Budl	17.399	11.34.1	94.0	S3.8	
Bus31	<16.000	98.S94	-27.7	0	0	0	0	**BusZ**	**..S.019**	**-..\..290**	**S.u**	83.6	
								Bus..\3	5.019	**3.190**	SM	83.6	
Bus32	11.000	197.370	...16.8	o	0	l7J70	10.767	Bus30	**.11.sro**	-10.767	5-13.S	*85.0*	3.7S0
Bus38	11.000	100.46.1	-19.1	o	o	**!i.009**	3.105	Bu<.11	-S.009	.3.lOS	307.9	*lS»*	.1.750
Ul	**IZ0.000**	291.912	o.o	74.714	*19.386*	0	0	Jlu,3	74.714	79.386	98.0	*68.S*	
UZ	**210.000**	100.000	o.o	0	0	0	0	Bu>l	0.000	0.000	0.0	o.o	
U3	**210.000**	m.988	o.o	18.099	**24.~,**	o	0	**Burl-**	18.099	**Z.l.Sn**	49.1	*S9J*	

* **Indicates a \·oltage** regulated **bus** (voltage **coıın·olled or S\ling type machine** ceıuıecsed ***to* it)**

ft. iudk:ıtts a bus l\ith a lo:ıd mbıw.tdı of mere **than 0.1 MVA**

LOAD FLOW REPQRT (Without PV} ® I= 1.00n-

Bus		Voltage-		Oeneratıcn		Load		Load flow					XFllffi
m	IS	% Mag..	Aug.	MW	Mrnı-	MW	M\'ar	ID	MW	l\h'.ı:r	Amp	%:PF	~
Busl	66.00O	0.ÖÖÖ··~		---0	·--r	---0	--r	Bml3	0:0-Ö0	0.ÔÖÖ	--0:Ö	0.Ö	---
								Busli	0.000	0.000	0.0	0.0	
								Bu1S	0.000	0.000	0.0	0.0	
								Bu~S	0.000	0.000	0.0	0.0	
								B~130	0.000	0.000	0.0	0.0	
								Bu,3	0.000	0.000	511.2	0.0	3.750
								Bm6	0.000	MOO	0.0	0.0	
Bcl	tl6.000	0.000	90.0	0	0	0	0	Bud4	0.000	0.000	0.0	0.0	
								BmlS	0.000	0.000	0.0	0.0	
								Bu'i7	0.000	0.000	0.0	0.0	
								Bu$1	0.000	0.000	0.0	0.0	
								Budl	0.000	0.000	e,e	0.0	
								Bu15	0.000	0.000	0.0	0.0	0.615
Bw3	!to.000	I!.164	4.>	0	0	0	0.	Bwl	0.168	7.579	161.2	2.2	
								Ul	.\l,168	~7.~79	162.1	2:.?	
Bu'i4	ll0.000	100:000	0.0	0	0	0	0	U.?:	0.000	0.000	0.0	0.0	
Btt'iS	220.000	0.000	90.0	0	0	0	0	Bml	0.000	0.000	0.0	0.0	
								U3	0.000	0.000	94.$	0.0	
Bus6	11.000	0.000	90:0	0	0	0	0	Bud	0.000	0.000	0.0	0.0	
Bui7	66.000	0.000	90.0	0	0	0	0	Bu'>2	0.000	0.000	0.0	0.0	
								Bu,l ¦	0.000	0.000	0.0	0.0	
								Bus.9	0.000	0.000	0.0	0.0	
Bus8	66.000	0.000	90.0	0	0	0	0	Bud	0.000	0.000	0.0	0.0	
								Bud	0.000	0.000	0.0	0.0	
								Bu,10	0.000	0.000	0.0	0.0	
Bus9	11.000	0.000	90.0	0	0	0	0	Bu~7	0.000	0.000	0.0	0.0	
BudO	11.000	0.000	90.0	0	0	0	0	Bu~s	0.000	0.000	0.0	ao	l.'1$0
Bad3	66.000	0.000	90.0	0	0	0	0	Bu.">l	0.000	0.000	0.0	0.0	
								Buds	0.000	0.000	0.0	0.0	
Bu.14	tl6.000	0.000	90.0	0	0	0	0	Bm?	0.000	0.000	0.0	0.0	
								Bud6	0.000	0.000	0.0	0.0	
Bm:IS.	11.000	0.000	90.0	0	0	0	0	Bu,13	0.000	0.000	0.0	0.0	4.37$
Bud6	11.000	0.000	90.0	0	0	0	0	Bud.$	0.000	0.000	0.0	0.0	4.37,
Bu,17	66.000	0.000	90.0	0	0	0	0	Bu~17	0.000	0.000	0.0	ao	
								Bmll	0.000	0.000	0.0	0.0	
								Bus23	0.000	0.000	0.0	0.0	
								Bud9	0.000	0.000	0.0	0.0	

LOADFLOWREPORTQVithoutPV}@I= 1.000-

Bus		Voltage		Generation		Load		Load Flow					XBIR
ID	IV	% M.:tg.	Ang.	MW	M,·.nr	MW	Ji.h-nr	ID	MW	Ifrar	Amp	%PF	%Top
Bu,18	66.000	0.000	90.0	0	0	0	0	Bu,z	0.000	0.000	0.0	0.0	
								Bu,20	0.000	0;000	0.0	0.0	
Bu,19	11.000	0.000	90.0	0	0	0	0	Bu,17	0.000	0.000	0.0	0.0	
Bu,20	11.000	0.000	90.0	0	0	0	0	Bud8	0.000	0.000	0.0	0.0	
Bu,21	66.000	0.000	90.0	0	0	0	0	Bu,17	0.000	0.000	0.0	0.0	
								Bu,23	0.000	0.000	0.0	0.0	
								Bu,ız	0.000	0.000	0.0	0.0	
Bu.ız	11.000	0.-000	90.0	0	0	0	0	Bıull	0.000	0.000	0.0	0.0	
Bu,H	66.000	0.000	90.0	0	0	0	0	Bn,17	0.000	0.000	0.0	0.0	
								Bu,21	0.000	0.000	0.0	0.0	
								Bus15	0.000	0.000	0.0	0.0	
Bu,2s	11,000	0.000	90.0	o	o	0	o	Bm23	0.000	0.000	0.0	o.o	
Busl7	66.000	0.000	90.0	0	0	0	0	Bu,17	0.000	0.000	0.0	0.0	
								Bu,!	0.000	0.000	0.0	0.o	
								Bu,28	0.000	0.000	0.0	0.0	
								Bu,29	0.000	0.000	0.0	0.0	
Bu,28	11.000	0.000	90.0	0	0	0	0	Bı~27	0.000	0.000	0.0	0.0	0.6ZS
Bus29	11.000	0.000	90.0	0	0	0	0	Buı27	0.000	0.000	0.0	0.0	MZS
Bus30	66.000	0.000	90.0	0	0	0	0	Bud	0.000	0.000	0.0	o.o	
								Bu'3Z	0.000	0.000	0.0	0.0	
Bus31	66.000	0.000	90.0	0	0	0	0	Bu,2	0.000	0.000	0.0	0.0	
								Bu,33	0.000	0.000	0.0	o.o	
Bu'3l	11.000	0.000	90.0	0	0	0	0	Bu'30	0.000	0.000	0.0	0.0	3.7S0
Bus33	11,000	0.000	90.0	0	0	0	0	Bu'3l	0.000	0.000	0.0	M	3.7S0
U!	??0.000	?91.l>I?	0.0	17-\71	179.600	0	0	Bu,.ı	17.J.71	1'19.600	16?.:2	9.6	
U2	?20.000	100.000	M	0	0	0	0	Bu,4	0.000	0.000	0.0	0.0	
U3	??0.000	. 1152:.988	(1J)	s.se	58.,tlO	0	0	BmS	5.S-1!2	5S.4lCI	9~.5	10.6	

⁴ **Indicates a voltage** regulated **bus (t'Oltage** conrrolled **or suing type,** machius **connected to it)**

 # iudkattt a busllith a loadDUsıwıtdı of mo~ than 0.1 MVA

Dvuaınk Stahilitı'

The tabulated plot data ls not printed since the option of "Skip Tabulated Plots" ls checked.
To print tabulated plot data go to the Transient Stability Srudy Case Editor and in the Info Page uncheck the "Skip Tabulated Plots" option.

Systeın Islanding Index

Tim,(Stc.)	EletnentID	Typ•	Zon,No.
0.000	Bud	Bus	2
0.000	Bu,10	Bus	2
0.000	Bu,13	Bus	2
0.000	Busl~	Bus	1
0.000	Bu,ıs	Bu,	2
0.000	Busl6	Bus	1
0.000	Bud7	Bus	2
0.000	Busl8	Bus	1
0.000	Bu<l9	Bus	2
0.000	Bus2	Bu,	1
0.0-00	Busl0	Bus	1
0.000	Bu12l	Bus	2
0.000	Busll	Bu,	2
0.000	Bus-23	Bus	2
0.00-0	Bus25	Bus	2
0.000	Bus27	Bus	2
0.0-00	Bus28	Bus	2
0.000	Bus29	Bus	2
0.00-0	Bus3	Bus	2
0.000	Bus30	Bus	2
0.000	Bu'31	Bus	1
0.0-00	Bus32	Bus	2
0.0-00	Bu'33	Bu,	1
0.0-00	Bu:;.ı	Bus	3
0.000	Bus$	Bus	1
0.000	Bus6	Bu,	2
0.000	Bu,;7	Bu,	1
0.0-00	Bu.S	Bu,	2
0.0-00	Bus9	Bus	1
0.000	Ul	Pou-.r Grid (Rt£)	2
0.0-00	Ul	Powtr Grid (Rt£)	3
0.000	U3	Power Grid (Re£)	1

Acti9n Suınmat'\'

EnıtID	Thnet5ec,)	Dt\i~Typt	Dtd('tID	Attion
t,·tnt2	e.see	Bu,	Busl	3 Phase Fnıdt
event2	0.S00	Bu,	Bu$$	jph.,.Fnult

APPENDIX 13

TRANSIENT STABILITY ANALYSIS WITH PV

Project:	IıL-1.STER THESIS	ETAP	Png.:	1
Location:	HOUN CITY -LIBYA	I?.6.0H	Date:	28--06-2016
Conn-acr:	!\'EAR EAST UNIVER.~ITY - EEE Deparınent		SN:	
Engineer:	SAND IıWSTAFA AL-REFAI	Study Ca": TS	Revisieu:	Base
Filename:	HOUN SUBSTATION220kV		Coınfig:	**Normal**

DESIGN OF A LARGE SCALE SOLAR PV SYSTEM AND IMPACT Aı'"Af.\'SIS OF ITSI!'<TEGRATION I!'<'IO LIBYAN P0'1'ER GRID

Electıical Transient Anah-zerProgram

Transient Stabilitv Auah'Sis (With PV)

Initial Loading Categoı)· (1): Design

Initial G•neration Category (I): Design

L<ıad Diwrsity Factor: None

	Smog	\'-Cóntrol	Load	Total
Number of Buses:	**3**	7	32	**42**

	XFMR2	XFMR3	Re-Mto1	Line/Cable	Impedance	Tie PD	SPDT	Total
Number of Brauch es:	26	0	0	16	0	10	0	52

	Syn<"bronous Generator	Power Gııd	S-ynchronous Motor	luduı:tion Machin.s	Lumped Load	_Tuın!.
Number of}fa(hiııes:	0	3	0	0	14	17

Method of the Initial LF Soluliou:	Adapth"I'. Neu1ou-Raphson
i\Lıximum Numbtr o{ Itıe-rntioıı:	1000
Solution Precision for the Initial LF:	0.0001000000
Acceleration Factor for the Initial LF:	0.00
Tbne Increment for Integrariou Steps (At):	0.0010
Tûne Increment toı· Plots:	20tlmes6.t
System Frequency:	50.00Hz
Fnqueucş Dependent i\lodels. for Machines and Network are **Not** Used	
Uıılt Sysıem:	Menic

Adiustıneuts

Tolerance	Apply Adjustin•nts	Indhidual /Global	Percent
Transformer' Impedance:	\'(.s	hıdMdual	
Reactor Impedance:	'\~es	hıdMdual	
Overload Heateı· Resisıan«:	No		
Tmnsınissiou Line Length:	No		
Cable Lengtlı:	No		

Temperature Corı-.cıion	Apply Ad~	IndMdual /Global	Degree C
Transınisstoıı **Line Reslstau.ce:**	y~	hıdMdu:ıl	
Cable Resistance:	Ytt	hıdhidııal	

Bns Ippuf Data

Bus			InitblY-,Jı.ıg:~		Lond							
					Comhn.ıtkVA		C<ınstantZ		Consfautl		Gentric	
ID	IV	Sub-s.)":S	%M,g.	Aug.	MW	Mn,r	MW	Mnr	MW	Mr-'I'	?\!W	Mvt\!'
Bud	66.000	I	99..1	-.¢2								
Busl	66.000	I	J>9.I	,I.I								
Busl	ıı0.000	I	J00I0	o.o								
Bus4	lI0.000	I	J00.0	0.0								
BmS	220.000	I	J00I0	0.0								
Bm(i	11.000	I	9S.3	-.¢2	0.000	0.995	0.000	0.2~9				
Bus7	66.000	I	99.0	-1.Z								
Bus8	66,000	I	99~	-I~								
Bus9	Il.000	1	98.4	-1.8	1.600	0.,92	0..I00	M4S				
Bud 0	ILOOO	I	98.0	-6~	5.600	3.471	JAOO	o.868				
Budl	66.000	1	99.1	-1.2								
Busll	66.000	I	99.4	-1.2								
Bud3	66.000	I	98.6	-1.7								
Bud-l	66.000	I	98.2	-L7								
Bu,15	Il.000	I	99.0	-7.6	4.800	l.915	LlOO	0.744				
Bus16	11.000	I	9$.6	.4,7	4,800	2.9'75	1.100	0.744				
Busl7	66.000	I	99.2	-5.9								
Busl8	66.000	I	99.0	.J.6								
Busl9	11.000	I	9M	-7.5	4.400	0.000	J.100	0.000				
Bu-.10	ILOOO	I	98.l>	.!.(i	l.SOO	0.000	0.700	0.000				
Bu-.11	66.000	I	99.2	-6.5								
Busl?	11.000	I	98.7	-9.4	4.800	0.000	1.200	0.000				
Bu-.23	66.000	I	99.5	-6.9								
Busl-l	66.000	t	J00.0	0.0								
Bus2S	Il.000	I	98..1	-7.9	1.600	0.991	0.400	0.US				
BusZ6	11.000	1	100.0	o.o	4.000	:U79	1.000	o.620				
Bnsl?	U.000	I	99.1	-4.9								
Busl$	ILOOO	I	98.1	-<.$	2.400	1.487	0.600	0.m				
BusW	11.000	I	98.7	-S,8	2.400	U81	0.600	(I.37!				
BtıdO	66.000	I	98.8	-.I.6								
Busl!	66.000	I	98.8	-U								
Busll	11.000	I	9~	-7,8	8.800	5.455	:?.200	W64				
Busl3	Il.000	1	100.7	,as	4.000	?.419	1.000	0.610				
Bu,34	0..I00	I	J00.0	İ.1								

Project: 1iL.\.STER THESIS	ETAP.	Pagec	4
Locafiou; HOUN CTIY -LIBYA	12.6.OH	**Date:**	28-06-2016
Contract; NEAR I'Mff l.t'J\1VI'.RSITY - Efil'. Deparnnenr		SN:	
Engineer: SA!\1> 1ifüSTAFA AL-JIBFAI	**StudrCase:** TS	**Re,ision:**	**Bast**
Fileuaıne; HOUN SUBSTATION Z20kV		Config:	Noppa!

DESIGN OFA LARGE SC'ALESOLARP\' SYSTEM AND IMPACT ANAL'I!SL~ OT ITS INTEGRATION INTO LIBYAN POWER GRID

Bus			lnitfoJ\'oltagt		Load							
					C0111bntkVA		Con~tuntZ		Conrtuntl		Ctn~ic	
ID	k\'	Sub-sys	%Mag.	Ang.	MW	M'fth·	MW	?ı,fnu-	MW	M\-ar	MI\'	lıfr~r
Bu<.\$	0..100	I	IO O.;	I.I								
Bu<.16	0..100	I	100.0	1.1								
Bu<.17	0.400	1	100.0	1.1								
Bu<.18	0.400	1	100.0	3.3								
llu<.19	0.400	I	100.0	3.3								
Bu,40	0..100	1	l-00.0	3.3								
llu>ll	ll.000	1	*98.9*	.I.I								
Bm4l	u.000	1	*98.6*	1.0								
Tot:ılNmnbtro!Bum:	**42**				*sı.m*	*25.185*	13.000	6A46	0.000	0.000	0.000	0.000

Notti D~<UUlili:tlllyno:dtledmotorlC>adsare uoi indudtd in fbe bus **ınotorlcıtd. Su nı:u:hintandmotoı·pagesfor detail.**

Geııel'arion Bus				Voltage		~ne ration			l\hm- Limits	
ID	kY	1°)Pt	Sub~yr.		~~	MW	Mwır	%PF	Max	Min
llu<.l	2:W.000	**Snjng**	1	100.0	0.0					
Buw	220.000	$niııg	1	100.0	0.0					
Bu$$	**220.000**	**Sning**	I	100.0	0.0					
Bu<.14	MOO	**Voltl!lgt** Centrcl	1	100.0	1.1	1.960.			*0.899*	0.000
Bn\35	MOO	**Vtıllag:e C,anta·ol**	I	100.0	1.1	1.960			0.899	0.000
Bu<.16	MOO	**Vo1tagt CouwoJ**	I	100.0	!.I	L960			0.899	0.000
Bu<.17	MOO	**Yoltagır Control**	1	100.0	1.J	1.960			0.899	0.000
Bus38	0.400	**Voltnge Control**	1	100.0	3.3	*1.960*			0,899	0.000
Bu'39	MOO	**Volıagı;>Contl'ol**	I	100.0	3.3	*1.960*			*0.899*	0.000
BuuO	MOO	**Volta:«< Couh'OI**	I	100.0	3.3	1.960			0.899	0.000
						13.719	0.000			

Line/Cable Input Data

Liue/Cabl•			Lıngtlı				Ohms or Siemens perlOOO m per Conductor {Coble) or per Pbase {Line)					
ID	Library	Sın	Adj.(01)	,t-Tol	#/Plı;ısr	T(''CJ	Rl	XI	YI	RO	XO	YO
Ctıbld	l!MCUS.I	JQQ	100.0	o.o	1	75	0.076302	0.087400	0.0001646	0.240351	0.21$1)(10	
Cab lel	11MCUS3	.IQQ	J00.0	0.0	I	75	0.076302	O.OS7400	0.0001646	0.240351	0.mooo	.
u..ı		674	19300.0	0.0	I	75	0.056008	0.374?$5	0.0000031	0.200077	1360791	0.0000017
Lint'l		674	19300.0	0.0	I	75	0.056001	t.342069	0.00000.14	0.200637	1.424041	0.0000016
Liıɪt'3		674	23000.0	o.o	I	75	0.056001	0.3-1?069	0.00000.14	0.200631	1.424041	0.0000016
L!ıı,4		614	15000,0	0.0	I	75	0.056001	0:3-12069	-0.0000084	0.200631	1.424041	0.0000016
LiiıeS		614	8000.0	0.0	1	75	0.056001	0.3~?069	0.0000084	0.200637	1.424041	0.0000016
U.'6		674	4000.0	0.0	I	1$	0.056001	0.3-1%069	0.0000084	O.l.00637	l.4?4041	0.0000016
u..,		614	4000.0	o.o	1	75	0.056001	0.3-12069	0.00000Jl	0.100637	1.4240,U	0.0000016
Llnı:8		674	4000.0	0.0	1	15	0.056001	0.J.1?069	0.0000034	0.200637	l.4:?:4041	0.0000016
u.,9		674	4000.0	o.o	I	75	0.056001	0.3-1?069	0.0000081	0.200637	1.414041	0.0000016
u.,ıo		674	8000.0	o.o	I	7$	O.OS6001	0.3-1?%9	0.0000084	0.200637	uuon	0.0000016
Linell		674	8000.0	o.o	1	75	0.056001	0.342069	0.00000.14	0.200637	Ul40ll	0.0000016
Line-ll		674	21000.0	o.o	I	75	0.056001	0.3-12069	0.0000084	0.100637	1.424041	0.0000016
Lind3		674	161000.0	o.o	1	15	0.056001	0.3-11%9	0.0000084	0.100637	1.424041	0.0000016
U.'14		614	140000.0	o.o	I	75	0.056001	o.341(16~	0.00000.14	0.200637	J..124041	0.0000016

Line/ Cuble n.U.~ranctt: m tiıttd aJtht$ptrifitd ttmpmtnıtt$.

2-Windiug Transfonner Input Data

Transformer	Rating					ZVaıiation			%Tap Setting		Adjusıed	Phose Slıifı	
ID	MVA	Prim. kV	Sec. kV	%Z	X/R	+ 5%	-S%	%Tol.	.Pıim.	Set,	%Z	Typt	Anglt
T1	63.000	z10.000	66.000	12.70	45.00	0	0	0	0	3.750	11,5000	,Dyn	0.000
r1	63.000	220.000	66.000	ll.SO	~5.00	0	0	0	0	M15	11 .7000	Dytı	0.000
T3	6l.OOO	220.000	66.000	ıase	45.00	0	0	0	0	(l.6lS	U.5000	Dyn	0.000
T4	10.000	66.000	11.000	S.35	1.1.00	0	0	0.	0	0	8.3500	Dyn	0.000
TS	ıo.ooo	66.000	11.000	10.00	.10.00	0	0	0	0	0	10.0000	Dytı	0.000
T6	10.000	<>6.000	11.000	10.00	10.00	0	0	0	0	1.150	10.0000	Dyn	0.000
T7	n.see	ıı.ooo	66.000	S.35	1.1.00	0	0	0	-1.150	0	8.3500	'!:'Nd	0.000
TS	u.soo	11.000	66.000	8.3S	13.00	0	0	0	-1.150	0	8.3500	\'Nd	0.000
T9	10.000	66.000	11.000	ass	13.00	0	0	0	0	4.315	8.3500	Dyn	0.000
TIO	10.000	66.000	11.000	8.35	1.1.00	0	0	0	0	~.375	8.3500	Dyn	0.000
T1l	20.000	66.000	11.000	10.00	;?0.00	0	0	0	0	0	10.0000	Dyn	0.000
TiZ	20.000	66.000	11.000	10.00	20.00	0	0	0	0	0	10.0000	Dyu	0.000
T13	10.000	66.000	11.000	8.35	13.00	0	0	0	0	0	8.3500	D:m	0.000
TU	10.000	66.000	11.000	8.35	U.00	0	0	0	0	0	8.3500	Dyu	0.000
TIS	10.000	66.000	11.000	8.35	13.00	0	0	0	0	3.750	8.3500	D,u	0.000
Tl6	ıo.ooo	66.000	11.000	10.00	10.00	0	0	0	0	M15	10.0000	Dyu	0.000
Tl7	20.000	66.000	11.000	10.00	10.00	0	0	0	0	M15	10.0000	Dyn	0.000
TIS	10.000	66.000	11.000	10.00	20.00	0	0	0	0	3.750	10.0000	D;11	0.000
TI9	20.000	66.000	11.000	10.00	20.00	0	0	0	0	3.750	10.0000	D~'E	0.000
no	3.000	o..ıoo	11.000	6.25	6.00	0	0	0	0	0	6.lSOO	YNd	0.000
nı	3.000	o..ıoo	11.000	6.25	6.00	0	0	0	0	0	6.?SOO	'!:'Nd	0.000
nZ	3.000	0.400	11.000	6.15	6.00	0	0	0	0	0	6.2500	\'Nd	0.000
TZ3	3.000	o..ıoo	11.000	6.15	6.00	0	0	0	0	0	6.2500	\'Nd	0.000
Tl_,	MOO	0.400	11.000	6.15	6.00	0	0	0	0	0	6.2500	\'Nd	0.000
ns	3.000	0.400	11.000	6.25	6.00	0	0	0	0	0	usoo	\'Nd	0.000
T26	3.000	o.~oo	11.000	6.25	6.00	0	0	0	0	0	6.2.<1)0	\'Nd	0.000

2-Wiuding Tı-ansformer Grnunıliug Input Data

Trausfol'mer	Rating			Grounding							
				Conn,	Pıimar,:			Secondal'y			
ID	MVA	~	~	..,l!!_	Tn,<	k_Y_	~	~ .2	kV	Amp	Ohın
T1	63.000	220.000	66,000	Dl\'				Solid			
n	ssnee	ııo.ooo	66.000	Dil!				Solid			

2-Winılin"Tr:ınsformeı· Grnundin" Input Data

Trnıısformer	Rating			Conn.	Grounding Primary	Grounding Secondary			
ID	IffA	~~~			Tır<. !': ~ ~	-2!!	kY	Amp	Ohm
T3	63.000	Zl0.000	66.000	orı:		Solid			
T4	!MOO	66.000	11.000	Dil.'		Solid			
TS	Z0.000	66.000	11.000	Dil.'		Solid			
T6	Z0.000	66.000	11.000	Dil.'		S.lid			
T7	IZ.$00	11.000	66.000	Dil.'		Solid			
ta	l?.$00	11.000	66.000	DIY		Solid			
T9	10.000	66,000	11.000	Dil.'		Solid			
TlO	10.000	66.000	11.000	Dil.'		Solid			
Tll	20.000	66.000	11.000	DIY		Solid			
rı1	20.000	66.000	11.000	Dil.'		Solid			
Tl3	10.000	66.000	11.000	Dil.'		S.Ud			
Tl4	10.000	66.000	ll.000	Dil.'		Solid			
rıs	10.000	66.000	ll.000	Dil.'		Solid			
Tl6	20.000	66.000	n.ooo	DIY		Solid			
Tl7	20.000	66,000	ll.000	Di\'		S.Ud			
Tl8	20.000	66.000	11.000	Di\"		Solid			
Tl9	20.000	66.000	11.000	DIY		Solid			
no	3.000	MOO	11.000	Dl\'		S.Ud			
T1l	3.000	MOO	ll.000	Dil.'		Solid			
T22	3.000	0.400	ll.000	DIY		Solid			
T23	3.000	o.400	11.000	Di\'		Solid			
T24	3.000	0.400	11.000	Di\'		Solid			
T2S	3.000	MOO	11,000	DIY		Solid			
T26	3.000	0A00	11.000	Dl\'		Solid			

Br:ɪ:pc-hConuçı:tions

CKT/Br.ıncb		Connected Bus ID		·% Impedance, Pos. Seq., 100 llffA Base			
ID	Typ<	Frcm Bns	To Bus	R	X	Z	y
Tl	lWXF!ılR	Bus.l	Busl	0.46	20.58	20.59	
Tl.	lW:ūl.IR	Bu~.tl	Buıl	0.44	19.96	19.97	
T3	lWXFA1R	Buss	Busl	0.44	19.96	19.97	
T4	2WXF!ı!R	Bud	Bu,6	6.40	83.ts-	83.50	
T5	2WXFMR	Bus7	Bus9	l.50	49.94	50.00	
T6	2WXF~!R	Bnı8	Busl0	::3.53	50.56	50.63	
T7	?WXFAIR	Bus,U	Busll	S.06	65.77	6$.97	
TS	2WXF!ı!R	Buwl	Busl2	S.06	65.77	65.97	
T9	lWXf.MR	Busl3	Busl$	6.68	$6.90	81,15	
TIO	ZWXF!ı!R	Busl4	Busl6	6.6S	M.90	S1.15	
TU	2WXF!ı!R	Bu,17	Busl9	1.50	49.94	50.00	
ru	ZWXDıtR	Bu,ıs	Bus20	1.50	49.94	50.00	
Tl3	2wxı:ı,.m.	Busl!	Busll	6.40	83.15	83.SO	
TU	ZWXF!ı!R	Bus?3	Busl$	6.40	$3,Z$	83.50	
TIS	lWXF!ı!R	Bu,24	Bus16	6.64	$6.38	S6.63	
TJ6	2\VXF!ı!R	Bus:!7	ButZS	1.$1	50.1$	50.31	
Tl7	lWXFMR	Bus?:7	Bus29	Z.::l	se.lS	50.31	
TIS	zw.XFMR	Bus30	Bus3l	1.59	51.Sl	51.88	
Tl9	lWXF!ı!R.	BU'l31	BU'l33	2.$9	51.81	51.88	
no	lWXI:1.m	Bud.f	Bus41	34.25	?05.50	208.33	
Tl!	lWXE!,!R	Bııs3S	Bu,41	34.25	205.50	208.43	
TZ2	lWxn!R	Bu,36	Bu.,;-11	34.25	205.SO	208.33	
Tl3	lWXE],!R	Bus.l7	Bus-il	3-t.ZS	lOUO	?08.33	
Tl•	2WXFMR	Bus,l8	Bns4l	34.ZS	?OS.50	lOS.33	
rSS	lWXFMR	Bus.l9	Bus-12	J.J.25	205.50	208.33	
Tl6	?WXFMR	Bus40	Bus-t.?	34.25	lOS.50	208.33	
C:ıb1tl	Cable	Bndl	Bus2	0.0l	0.0l	0.03	0.0716998
Cablt2	Cable	Busl?	Busl	0.0l	0.0l	0.03	0,0;16998
Line!	Liu,	Busl	BusU	~.4$	16.58	16.17	0.2607619
Uı:ıc!	Liu,	Bıı;l	Busl3	2.48	15.16	15.36	O.l8.ı1267
Lin:t3	Liu,	Bus2	Busl8	1.96	18.06	18.30	0.33811$7
Liu..ı	Un,.	Bus21	Busl1	1,93	11.18	11.94	0.2%09015
Lhı.e5	Liu•	Busl	Bu.'>27	1.03	6.lS	6.37	o.!178Ul
Liu,6	Lin,	Bu~l	Bııs1	ası	3,U	3,18	0.0589071
Liu,1	Lin•	Bud	Bu,S	O.Sl	3.14	3.18	0.05$9071
Lin,8	Liu,	Bu~l	Bus7	0.51	3.U	3.18	O.OSS9071
Uıı,9	Uıı,	Busl	BnıS	0.51	3.U	3.18	0.0589071

CKT/Brnıırh		Connected Bus ID		% Impedance, Pos. Seq., 100 MVA Base			
ID	Type	From Bu,;	To Bus:	R	X	Z	y
Líndo	Lin,	Busl'	Bus.il	1.03	6.28	6.37	0.1178141
Lin,11	Lint	Bud	Bus30	1.03	6.28	6.37	o.1178142
Linell	Lin,	Bu,17	Bu:21	1.70	16.49	16.71	0.3092622
Lind:i	Lin,	Buıl7	Busl3	20.70	126.43	ııs.n	2,3710100
Lind4	Liue:	Bu~.21	BuslJ	18,Q-0	109.9~	111.e	1,0617480
SWl	TiiSmtch	Bnıl	Busl				
SW.2	TieSmkh	Bu,7	Bu,8				
SW3	Ti,Smtch	Busl.I	BuıU				
SW4	Ti,Smtch	Bus.17	BuslS				
SW5	Ti,Smtch	Bu,23	Bus24				
SW6	Tie:Snitch	Bu:!S	Bus26				
SW7	Tit Snitch	Bus.28	Bu.sl9				
SWS	TitSl\itch	BusJO	Bus.II				
SW9	Tit Snitc-h	Bud?	Bus.U				
SW10	Tie Snitch	Bu.11	Bu,42				

I!ra!!ch Connections

Zero Sequence Impedance

CICT/Bmnch		Connected Bus ID		% Impedance, Zero Seq., 100 J\IYAb			
ID	Tıp•	Frem Bus	To Bus.	RO	XO	2J)	VO
Tl	IWXFMR	**Bus3**	Busl				
T2	zw:xn.m	Bıs4	Busl				
T3	nv:xn.m	**Bt$S**	**Bu,;2:**				
T4	IWXElılR	Busl	Buw				
TS	**IW:'i:BfR**	Bu,7	Bus9				
T6	IWXFlılR	Bu,S	Busl 0				
T7	**IWXFMR**	**BU$•ıl**	Busll				
TS	IWXFlılR	lhı'41	**Busll**				
T9	IWXFMR	Bu,B	**Busts**				
TIO	zw:xn.m	Bu,14	Bu,16				
rıı	zwxnm	Btıs17	Bu,19				
TU	2w:xn.m	BusIS	**Bm20**				
TU	zw:xn.m	Busl!	**But!l**				
Tl4	**ZW"Xf'AfR**	Bu,2.l	**Busl5**				
TIS	IWXF!ılR	Busl4	Bu,26				
T16	ıw:xn.m	**Bu\17**	Bus28				
Tl7	**2WXF.&fR**	Bu,27	**Butl9**				
TIS	ZWXF!ılR	Bıs.10	Busl!				
Tl9	2WXFMR	Busl!	Bus33				
no	ıw:xn.m	Bu≤.\4	Bus41				
rn	zw:xnm	Busl5	Bus41				
Tl2	2wxnm	Bus36	Bus41				
T23	IWXFMR	Busl7	Bus41				
T24	zwxnm	BuslS	Bus42				
rıs	?WXF!ılR	Bu,39	**Bu~.f2**				
Tl6	IWXFMR	Bu,40	**BuWl**				
C,bld	C.bl•	Bud!	**Bud**				
Cable?	Cab!•	**Bud1**	**Busl**				
Llnel	Lln•	Busl	BusU				o.uıous
Unt:?	Un•	Bud	Bu,U				OJ.141983
Lind	Un,	**BmZ**	BusIS				O.IS99?5S
Unt-1	Un•	Bus27	Bu,17				0.10~?992
Lin,5	Liıı•	Bud	**Bu'i17**				0.0556!63
Llnt6	Liıı•	Bıul	Bu,7				0.0?78131
tın,7	Lin,	Bud	Bu.S				0.0?781'1

CKr/Brand,		Connected Bus ID		% Impedance, Zero Seq., 100 lllYAl>			
ID	Typ•	From Bus	To Bns	RO	XO	t»	YO
Liıı,8	Liu,	Bus!	Bus7				0.0Z7SUJ
Liıı,9	Liu•	Busl	BınS				o.onsm
LiudO	Liu•	Busl	Bn,31				0.05.'6163
Liıı,11	Liu,	Busl	Bus30				0.0556263
Liıı,12	Liu•	Bud?	Bnıll				O.l4601S9
LinelJ	Liu,	Bu,17	Bıı,23				1.1194780
Liu'14	Liu,	BusZl	Busl$				0.9734595
SWl	TieSmıch	Bml	Bml				
SWl	Tit-Sltitch	Bu,7	Bus8				
SW3	Til"Snıch	Bus13	Bn,14				
sm	TI,Smlth	Busl7	Bud8				
SW5	Tıe-S1rlkh	BuslJ	Bu<;:24				
SW6	Tat-Snitch	Bus25	Buı,26				
SW7	r •• s1lit<h	BusZS	Bu,19				
SWB	Ti,Snil<h	Bıı.10	Bum				
SW9	T1tSuitth	Bus32	Bn533				
SWlO	TN'Snitcb	Bn,n	Bm42				

DESIGN OF A MRGE SCALE SOLAR PV SY.STEM ,\ND lliIPAC:T ANALYSIS OF ITS INTEGRATION INTO LIBYAN POWER GRID

Syuchropous ~·Iachint> Parameters

l\fachiue,			Rating		Positin Sequence Impedance_!%)										Z.ro S•_q. Z (%)	
ID	T~Jlt	Modol	MVA	kV	R.,	Xd"	Xd'	Xa	Xq"	Xq'	Xq	XI	XIR	RO	XO
ul	PonnGrid	NIA	ZZ.101····	.120~(100	9.95		99.50							3S.6S	3$6.48
u:	Pon'₫rGrid	NIA	l!.101	llo;ooo	9.95		99.$0							11.74	111.38
U3	Power Grid	NIA	Z?.101	ll0.(100	9.9$		99.SO							11.14	m..ıS

Machi••	Connected Bus	Time Ccnstants (Sec.)				H (Sec.), D (Jl{Wpu/Hı) & Satnrati					Generator or Loading		Grounding		
ID	ID	Tdo"	Tdo'	Tqo"	Tqô'	H	<1¡iD	$100	SlZO	Sbrm:k	M\Y	ıfrar	Coun.	Typt	Amp

l\lncliine		Generarorll\totoı·			Coupling			Pıimel\fonr/Load			Equh·aıent Total		
ID	Type	Rl'M	WR'	H	RPM	WR'	H	RPM	WR²	H	Rl'M	WR²	H

WR²: kg-m² H,MW-So<IMVA

Ma<lune		Shaft Tersten			
ID	Typt	Dl	Dl	Kl	Kl

Dl, D?, MW (pu)/Sp,ed (pu) Kl, K2: l\fW (pu)fl₴ldiant

Lumpefl Load Input Data

Connntion.ıl Type

ID	kV	kVA	kW	kvar	%PF	Amp	Load %Motor	Load %Stntk	r.	Gamma
Lum pl	11.000	1243	0	ım	0.01	65.3	B0	10	0	0
LumplO	11.000	5SS1	5000	3098	85.000	308.7	S0	10	0	0
Luınpll	11.000	3519	3000	1859	85	185.Z	S0	20	0	0
LuınplZ	11.000	3529	3000	1859	85	185.1	80	10	0	0
Luınpl3	11.000	11941	11000	6818	85.000	619.3	80	10	0	0
Luınpl4	11.000	5883	5000	3099	85.000	308.8	80	10	0	0
Luınpl	11.000	1353	1000	mo	85	123.5	80	10	0	0
LwnpJ	11.000	8136	7000	4339	85.000	431.3	80	10	0	0
Lump4	11.000	7058	6000	3718	85	370.5	S0	10	0	0
LumpS	11.000	7058	6000	3718	85	370.5	80	10	0	0
Luınp6	11.000	5500	SSW	0	100	188.7	S0	Z0	0	0
Luınp7	11.000	3500	3500	0	100	183.7	S0	10	0	0
Lınnp8	11.000	6000	6000	0	100	3U.9	80	10	0	0
Luınp9	11.000	2351	1000	1239	85	nas	80	10	0	0

Project:	~IASTER THESIS:	ETAP	Page:	14
Location:	ROUNC,TTY-LIBYA	12.6.0H	Date:	28-06-2016
Contract:	1'1:AREASTUNIVERSITY-EEEDepal'lmeut		SN:	
Engineer:	SAND A!USTAFA AL-REFAI	SludyC1se: TS	Rel'ision:	Base
Filenamtı:	ROUN SUBSTATION 220kV		Config:	Normal

DES£GN OI: A LARGE SÇAU:SOLARPV SVSTem AND IMPAC,T ANALY$ES OI:ITSINTEGRATIONINTOLIBYA.>,POWERGRID

LQAD.FLOWREPQRT<WithPV} ,®I≡0.000

Bus ID	kV	Voltage % Mag.	Ang.	Generation MW	Generation Mvar	Load MW	Load Mvar	Load Flow ID	MW	Mvar	Amp	%PF	XFMR %Tap
Busl	U:000	99.388	~	0	0	0	0						
								Bu.s13	6.014	3.96.1	63.$	S3.5	
								Busl7	19.539	1.129	171.3	99.8	
								BusS	J..IS3	1.178	36.6	S3.7	
								Bu.S	3..183	?,278	36.6	83.7	
								Bu~O	10.991	M91	118.1	81.9	
								Bu3	.J$.161	-18;?11	353.3	SS.1	J.750
								Bu~6	0.001	L:?48	11,e	O.I	
Bm2	66.000	99.061	.19.0	0	0	0	0	Bu,11	.(1.8)1	.(J.725	S1S	99.1	
								Bud4	MH	3.993	63.7	S3.3	
								Bud8	3..191	.11.US	30.9	-99.7	
								Bm7	0.994	0.573	JO.I	86.7	
								Bm7	0.994	0.573	10.1	S6.7	
								Bu31	5.027	3.?00	52.6	84.4	
								Bu~s	-10.700	-7.365	IU.1	SJ..I	0.61S
•Bus.\	!10.000	100.000	-35.3	0	0	0	0	Bml	35.W I	?L\594	n0.0	85.6	
								U1	-35.844	-?U94	110.0	SS.S	
*Bus4	2?0.000	100.000	0.0	0	0	0	0	UZ	0.000	0.000	0.0	0.0	
"Bu~s	220.000	100.000	-17.8	0	0	0	0	Busl	J0.708	7.711	34.6	81.1	
								US	-10.708	.7,711	34.6	81.1	
Bu,6	11.000	98.343	-3M	0	0	0.000	1.235	Bud	0.000	.1ZSS	6.S.9	0.0	
Bu17	66.000	99.036	-19.0	0	0	0	0	But:?	.Q.994}	.(J.630	10.4	84.5	
								Bu$2	.(J.994	.(J.630	10.4	84.S	
								Bu.l>	1.98!>	1.160	20.8	84.S	
Bu,8	66.000	99-297	.J9.6	0	0	0	0	Bud	-3AS1	-Z.330	36.9	83.I	
								Busl	-3.482	-1..1.'IO	36.9	SS.1	
								Bud 0	6.964	4.661	73.8	.83.1	
Bus9	11.000	98.356	-19.6	0	0	1.987	1.232.	Bus7	.J,987	-1.132	124.8	BS,O	
BclO	11.000	98.048	-11.6	0	0	6.946	4.305	Bu,S	~.946	-1.305	,'31.$	BS.O	1.250
Bud!	66.000	99.061	-19.0	0	0	0	0	Busl	SSD	0.6.<.il	51.7	99..1	
								Bu>I?	-5.SU	.(J.654	51.7	99.4	
Bud:?	66,000	99.390	-39.5	0	0	0	0	Bud	7.754	0.306	Ql.3	99.9	
								Bu>ll	.7.754	.(J.306	68.3	9M	
Bu'13	66.000	98.615	..I0.0	0	0	0	0	Busl	.6.011	-I.Ml	64.8	SZ.?	
								Bud5	6.011	4.161	6-1.8	Sl.?	
B"'I4	66.000	98.'.?24	-19.S	0	0	0	0	Bu,l	~.001	-1.157	65.0	82.1	
								Bud6	6,001	,.1$1	65.0	Sl,Z	

LOAD FLOW REPORT oVitu PV\@T =0.000-

Bus ID	kV	Voltage %Mag.	Ang.	Generation MW	Generation }ifr:ıı-	Load MW	Load Mrnt·	Load Flow ID	MW	M,-.r	Amp	%PF	Xfi\IR
Bud$	II.000"°	98.9$3'	~	---0	--0-	S'.m	3.1O3	Busl3	-!i.97$	J.703	m.s	85.0	.j,37$
Butl6	11.000	9S.S6l	-22.4	0	0	5.96$	3.697	Bu,U	-5.96S	-3.691	373.7	BS.O	4.J7S
Busl7	66.000	99.192	..u.1	0	0	0	0	Bu,;2:7	-13.,187	l.837	121.-5	-97.9	
								Bın21	M09	.J.\3.1	S9.5	-98.0	
								BuS23	1.191	-l.657	19.l	-64.l	
								Bu,19	5.486	e.lSS	48.4	100.0	
Bu,18	66.000	98.913	.19,.ı	0	0	0	0	Buıl	.J.487	-0.0<i2	30.8	!OM	
								Bu.,10	3.,187	0.061	30.S	100.0	
Bus!9	11.000	99.016	..u.S	0	0	5:478	0.000	Bu,17	-!i.478	0.000	290·.l	100:0	
Busl 0	11.000	98.870	-1M	0	0	3.484	0.000	Bu<IS	-3.484	0.000	185.0	J00.0	
Busll	66.000	99.l!S	..ıı.9	0	0	0	0	BMl7	-6.597	1.1el	59.0	-98.6	
								Bu~13	0.604	-U09	13.S	.J9.4	
								Busl?	S.992	0.10l	52:.9	99.9	
B"'2l	11.000	98.700	..ı.ı.8	0	0	5.969	0.000	Bu,ıı	-5.969	0.000	317.4	100.0	
Busl3	66.000	99.545	-11.3	0	0	0	0	Busl7	-l.'187'	.0.656	13.5	90.4	
								Bu,ll	.0.603	.(UiU	7.6	69.6	
								BmlS	1.990	1.178	20.S	.84.1	
Busl5	11.000	98.160	~-2	0	0	1.987	1.nı	Bu,l3	.l.987	-1.231	124.7	85.0	
Bıı~21	66.000	99.119	-10.l	0	0	0	0	Busl7	13.524	-1.826	uu	-91,9	
								Bud	-lM!l!l	-1.001	17l.l	99.9	
								Bın28	1.988	uu	31.1	84.2	
								Bu.'sl9	l.988	1.914	31.l	8-l.Z	
BuslS	11.000	98.703	-IIJ	0	0	l.984	1.8..(()	Busl7	-1$184	-1.850	186.7	85.0	0.615
Busl9	11.000	98.703	-lJ.l	0	0	ı.984	1.850	Busl7	-2.98'	-1.850	156.7	SS.0	0.625
Bus30	66.000	95.787	.J9.9	0	0	0	0	Bud	-10.973	-7.693	118.7	Su	
								Buı3l	10.973	1.692	l!S.7	81.9	
Buı31	66.000	98.SOZ	-lt.l	0	0	0	0	Bu1Z	-5.023	.J...19.?	S3.l	SM	
								Bu'S33	S.01.1	3.191	53.l	83.6	
Bus3l	11.000	98.316	-IM	0	0	lo.927	6.773	Bu,30	-10.927	-6.7i3	686.2	85.0	3,750
Bus33	11.000	100,68!	-lb.ti	0	0	5.0U	3.108	Busl!	.S.(114	.J.108	307.$	85.0	3.750
"Bus34-	0.400	100.000	-34.l·	0	0	0	0	Bıı~.fl	1.960	O.MS	2853.1	99.l	
								In,1	.0.980	-0.129	.1426.6	99.l	
								lılı·4	.WISO	.0.ll9	UIM	99.1	
"Busl$	0.400	100.000	..l.l.l	0	0	0	0	Bu,41	1.1l60	0.158	2853.1	99.l	
								lıl,-8	.0.980	.0.119	1416.6	99.1	
								lıl,'I	.0.980	.0.1?9	UIM	99.1	
'Bus36	0.400	100.000	.J.j.Jı	0	0	0	0	Buı41	1.960	0.158	IW.2	99.1	

DESIGN OF A LARGE SCALE SOLAR PV SY&'IE~f A.ND IMPACT A1~YSIS OF ITS IN"tEGRATION INTO LIBYAilPOWER GRID

LOADFLOW REPORT QVith PV}@T = 0.000-

Bus ID	kV	Voltage %Mag.	Ang.	Generation MW	Mvar	Load MW	Mvar	Load Flow ID	MW	Mvar	Amp	%PF	Xfmr
								IodO	-[illegible]	-MI9	141M	99.1	
								I:ln;I	-M80	~0.129	W6.6	99.1	
*Bu.~37	MOO	100.000	-~.3	0	0	0	0	Bu<ll	1.960	(i.258	1853.1	99.1	
								Inv12	-0.980	-UI9	141M	99.1	
								Inv91	-0.980	.o.m	142M	99,1	
•Bus3S	MOO	100.000	-14.$	0	0	0	0	Bu'4l	1,960	o.378	1880,8	98.1	
								Ior90	-MSO	.0,189	1440A	.98;2	
								Io,-89	.()980	.().189	1440A	98.2	
"Bm39	0.400	100.000	~14,5	0	0	0	0	Bu'4Z	1,960	0.378	1880,8	98.1	
								Im'S7	.(),980	.(1.1119	1440.4	98.2	
								Io.-86	-0.980	,0,189	WM	98.2	
•Bu~.10	0.400	100.000	.us	0	0	0	0	BnW?	1.960	0.378	1880,8	98,1	
								Jud Ol	.()980	-0.1119	1440.4	98.2	
								IorU	-0.980	,0,189	WM	98.2	
Bm.tl	11.000	98.871	-36.6	0	0	0	0	BnsU	7.786	0.711	415.0	99.6	-1.lSO
								Bnd.t	-1.946	.().178	103.8	99.6	
								Bu135	-1.946	-0.178	103.8	99.6	
								Bm36	-1.946	.().178	103.8	99.6	
								Bum	-1.?46	-0.178	103.8	99.6	
Bus42	11.000	98.630	-16.S	0	0	0	0	Budl	5.838	0.887	314.1	98.9	-1.250
								Bn&	-1.946	.0.296	104.8	98.9	
								Bu-39	-1.946	-0.296	IOU	98.9	
								BuwO	-1.946	-O.Z96	104.8	98.9	
Ul	110.000	I62.I07	0.0	43.747	100.727	0	0	Bu13	43.747	100,717	110,0	39,8	
Ul	ZZ0.000	100.000	0.0	0	0	0	0	Bu'4	0.000	0.000	0.0	0.0	
U.l	:?20.000	146.534	0.0	Jl,49!	15..$$0	0	0	Bu<iS	11.491	1$.$$0	34.6	59.4	
In\-2	0.400	160.800	-37.1	1.584	0.129	0	0	Bu134	l.S84	0.129	WM	99.7	
Io,-4	0.400	160.800	-37.1	1.584	O~IZ~	0	0	Bu'.4	1.584	W9	1416.6	99.1	
Inx8	OAOO	160.800	-37.1	1.584	0.129	0	0	Bu3	1.584	0.129	Ul6.6	99.7	
In,-7	D.400	160,800	~1,.1	1.584	0.119	0	0	Bm.l5	1.584	0.IW	1426.6	99.7	
IovlO	0.400	160.800	-37.1	1.584	0.119	0	0	Bu".66	1.584	0.129	HM.6	99.1	
In,~	0.400	160.800	-37.1	1.584	0.119	0	0	Bu"66	1.584	0.129	1426.6	99.7	
Io,'11	D.400	160.800	-37.1	1.584	OJ29	0	0	Bu137	1.584	0.129	1416.6	99.7	
Ind!	OAOO	160.800	-37.1	1.584	0.119	0	0	Bu~7	1.584	0.129	Ul6.6	99.1	
lnv90	D.400	161.026	,18.7	l.S96	0.189	0	0	Bu138	l.S96	0.189	1440.4	99.3	
ln\'ll9	OAOO	161.016	-18.7	!.S96	0.189	0	0	Bu138	I.S96	0.189	W0.4	99.3	
In,-87	0.400	161.0!6	-18.7	1.596	0.189	0	0	Bm39	1.596	0.1119	1440.4	99,3	

Proj.ct:	i\L-\STER THESIS	ETAP	Pago:	17
Lccnrlon:	HOllN CITY· LIBYA	12.6.0H	Date:	28-06-2016
Conrrarr:	NEAR EAST UNIVERSITY • EEE: 0.paruıienı		SN:	
Engineer:	SAND MUSTAFAAL-R.EFAI	Snıdy Case: TS	R.tli;ioll:	Base
Filename:	HOUN SUllSTATION220kV		Conflg:	Normal

DESIG.'N OF A LARGE SCALE SOLAR PV 5'YSIEM Al>"D IMPACT ANAL'\'SIS OF ITS INTEGRATION INTO LIBY.4.ı'IPO\YER GRID

LOAD FLOW REPORT OVifl PVl®I= 0.000

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	?ı.fW	}ı.frar	Amp	%PF	% Tap
Inv86	0.400	161.026	-18.7	1.596	0.189	0	0	Bus39	1.596	0.189	1440.4	99.3	
Inv102	MOO	161.0?6	-18.7	1.$96	0.189	0	0	BQHO	J.5%	0.ISl>	1.W0,.I	99;:1	
Inv14	0.J00	161.0!6	-18.7	1$96	0.189	0	0	Bus-10	1.596	0.189	1440.J	99.3	

* Indicates a "olfage regulated bus (roltage tonn·olltd or ming •YP" macbine ccnueeted to it)

\# indkn1t:sa bus wtıb :ı load mismatchf)fmere than0.I M'\'A

Project:	:\l.\STER THESIS	ETAP	Page: 1S
Location:	HOUN CTTY • LIBYA	12.6.0H	Date: 28-06-2016
Contra.ct:	NEAR:EASIU!'<1VER.51IY -EEE Departinenr		SN:
Engiueer:	SA!\'D lWSIAFAAL-REFAI	SiudrCase: TS	Rerisioii: Base
Filename:	HOUN SUBSIATION220kY		Config: Non.nal

DESIGN OF A L4.R(,"E: SCALE SOLAR PV SYSTEMAi'ID IMPACT ANALYSIS OF !IS INTEGRATION INIO LIBYAi',"POWERGRID

LOAD FLOW REPORT (With PVl@ .T= 0.800-

Bus ID	kV	Voltage % M:ig.	Ang.	Generation MW	M,111•	Load MW	hl\~r	Load Flow ID	SrW	Mm	Amp	%PF	XFMR %Top
Butl	~	"iiün47	~	---0	--0-	---0	---0	Bu,U	-:üö'9	~	---;.r	99.8	--
								Busl3	7.14!	4.264	"3.1!	85.9	
								Bus2'1	23.005	~l.S5!	148.4	-99:1.!	
								Bus8	4.IOS	2,563	31.0	84.8	
								Bus8	4.105	?.S63	31.0	84.S	
								Bus30	13,023	S.W	99.8!	83.5	
								Bus3	46.971	-16.1.83	318.2	94.6	3.750
								Buw	0.001	1A6l	9.4	0.1	
Bu:.2	~.000	99.061	-19.0	0	0	0	0	Bmll	-5.821	.().72S	S1S	99.l	
								Bud-1	MU	3.993	6.1.7	83.3	
								Bu,18	3.491	.0.?4S	30.9	-9?.7	
								Bus7	0.994	0.573	10.1	86.7	
								Bm7	0,994	0.573	1a1	86,7	
								Bu~.n	5.0.?7	l.100	Sz.6	84.4	
								But!t'	.10.100	-1.365	114.7	Sl,4	0.62$
B"'3	Z?0.000	134,501	.J5.z	0	0	0	0	Bud	47.0.14	19.109	99.1	92.6	
								Ul	.47.0.14	-19.109	99.1	91.6	
Bu.~.ı	!?O.Ol)()	100.000	0.0	0	0	0	0	UZ	0.000	0.000	0.0	0.0	
Bus5	ZZ0.000	100.000	-17.8	0	0	0	0	Busl	10,708	7.711	34.6	81.1	
								U3	-lo.708	-7.711	.l.l.6	SU	
Buw	11.000	US.756	.JS.l	0	0	0.000	1.453	Bu,!	0.000	.1.4;;.ı	S6.Z	0.0	
Bus7	66.000	99.036	-19.0	0	0	0	0	Busl	-0.994	-0.630	lo.4	84.5	
								Busl	-0.994	.().630	10..1	8-1.5	
								Bus9	1.989	l.260	Z0.S	8-4.S	
Bu.S	66.000	136.512	..ıs.z	0	0	0	0	Bud	4.105	-2.669	31.4	83.S	
								Bm1	=ues	.Z.~Sl	.11.4	83.S	
								Busl0	8.109	5.337	61.7	83.8	
Bus9'	11.000	98.356	-19.6	0	0	1.987	1.23!	Bus7	-l.987	-U3l	1?4.8	85.0	
Busl0	lLQOO	136.18;1	.J9.5	0	0	8.196	S.080	Bus8	-8.196	~~.080	371.7	85.0	1.250
Busl!	~-000	99.062	-19.0	0	0	0	0	Busl	5:8%1	MS4l	51.7	99..l	
								Bus.il	.S.$Zl	-0.654	51.7	99..1	
Busil	66.000	136.648	-38.1	0	0	0	0	Bml	U1O	0.lSO	18.1	99.9	
								B"'41	4.410	-().150	l8.Z	99.9	
Bu.1:U	66.000	!I6.017	.JS.5	0	0	0	0	Bu,;;l	-7.13!	-1.7.14	55.1	S.l.3	
								Busl;	7.1,12	4.7.14	55.l	83-1	
Bud.ı:	~000	98.l:?..t	-19.;	0	0	0	0	Bus?	~.001	4.157	6.~.0	8Z.l	
								Bu,;;16	6.001	4.157	65.0	Sl.:?	

Proje<:t:	l\L-1.STER THESIS	ETAP	Page: 19
Locatlon:	HOUN (TIY 'LIBYA	12.6.0FJ	Date: 28--06-2016
Contract:	NEAR EAf.-TUNIVER&TIY -EEE Department		SN:
ı:u~ueer:	$AND i\WST.4J'A AL-REFAI	Study Case: TS	R»ision: Base
Filenmne:	HOUN SUBSTATION 220kV		Con fig: **Nof[Ω]al**

DESIGN OF A LARGE SCALE SOLAR PV SYSTElll AND L\!PACT ANALYSL~ Of ITS INTEGRATION INTO LIBYAı'I POWER GRID

LOAD FLOW REPORT fWith PY> @T~ 0.800-

Bus		Voltıtge		Generation		Load		Loaciflow					Xfl\IB
ID	kV	% M•g.	Aııg.	SſW	Mvar	XſW	M,'.'r	ID	AnV	M,·ar	Amp	,,PF	-;..'I.;-
Bus!S	'"ii.000	m660	"7o:İ	---0	--0-	-:;To,	~	BusJ.3	'7ıöf	~	316.S	'"ru	''"7.m
Bud Ci	ll.000	*98.564*	-lM	0	0	S.965	.1.697	Bml4	**:.5.965**	-3.697	373.7	sse	:1.375
Busl7	~.000	136.1196	-39.l	0	0	0	0	**Bu~l?**	-ll'.901	7.046	111.l	*-91.4*	
								Busll	7.790	•.J.462	*$U*	-91.4	
								Bml3	l.645	***.J.-695***	**l$.S**	-40.7	
								Bud9	M66	e.1ll	41..1	100.0	
Bu,18	~.000	98.973	-19•.1	0	0	0	0	**Busl**	.J,187	**...O.t6l**	30.8	100.0	
								BuslO	3.487	**(1,(162**	30.8	100.0	
Busl9	11.000	l36.8S8	-40.l	0	0	M60	**0,000**	**Bud?**	-6.460	0.000	247.8	10-0.0	
Busl 0	ll.000	98.870	-20.4	0	0	3.484	0.000	Bu,18	.3,184	0,000	ISM	100.0	
Bu,;;21	66.000	**137.ZUJ**	-J9.7	0	0	0	0	**Busl7**	-7.780	?.94.1	SJ.O	*-93.5*	
								Busl3	0.716	.J,163	20.7	**.u.l**	
								Busll	7.064	**0.2:?l**	**.J5.l**	100.0	
Bu~l	IJ.000	136.831	-41.S	0	0	7.047	0.000	Busl!	-7.047	0.000	170.3	100.0	
Busl3	~.000	138.llS	-40.0	0	0	0	0	**Busl7**	-1.640	*--0,159*	ll..l	90.8	
								Busl!	-0.714	--0.733	*6.5*	*69.8*	
								Bu'>'25	**l.3S.C**	1.-191	17.6	84.S	
Bus25	lLOOO	lSS.1u	-40.5	0	0	**l.351**	**1.457**	**Bııs23**	.Z..lSl	-US7	105.9	S.,0	
Bus27	~.000	136.604	-38.6	0	0	0	0	**Bnd7**	IS.933	-7.267	ll2.I	-91.0	
								Bud	-22.97S	2,813	*Ull,Z*	~.3_	
								Bu'.28	J.m	2,lZ7	26.7	84.S	
								Bud9	**3.52]**	**2.l27**	***Z.6.1***	ses	
Busl8	ll.000	136.580	**.J9.2**	0	0	:1.519	**!.181**	**Busl7**	-J.519	.2.181	159.1	S.,.0	MlS
Bus29	ll,000	136.580	-39.l	0	0	3,519	**2.181**	**Busl?**	*-J.519*	.a.lSl	*159.1*	**SS..0**	**0.62~**
Bus30	66.000	136.151	-38.4	0	0	0	**0**	**Bud**	-13.009	.3.704	100.6	83.1	
								BU532	13.009	8.704	106.6	83.1	
Bus.il	~.000	98.802	-19.l	0	0	0	**0**	**Bu-.1**	**..S.(123**	**..3.29?**	**53.ı**	83.6	
								Bu'33	**S.023**	3.292	**53.?**	83.6	
Bw3l	ll.000	137.781	-40.4	0	0	**U.976**	**8.0.U**	**Bu.~O**	-12.976	-3.044	581.6	85.0	3.750
Bus.il	l!.000	100.682	-l0.6	0	0	S.0U	3.105	Bu'31	-5.014	-3.108	307.5	85.0	3.760
Bus.14	0.400	13ö.S65	-3M	0	0	0	0	Buwl	1.106	*0.068*	1179.8	*99.8*	
								lıid	--0.5.'<.\i	--0.0~	*589.9*	*99.8*	
								lu,•4	-0•.S3	--0.0~	*589.9*	!>l).8	
Bu'35	0.400	B5.S6S	-JM	0	0	0	0	Bu,41	1.106	0.068	*ll19.8*	*99.8*	
								lıu-8:	--0.553	--0.0~	*589.9*	*99.8*	
								lu,•7	-0.553	--0.034	*589.9*	!>l).8	
Bu'3o	0-400	135.565	*-J6.6*	0	0	0	0	**Bu141**	1.106	0.068	1179.S	*99.8*	

LOAD FLOW REPORT QVith P\J\ @T = 0.800-

Bus ID	kV	Voltage 0/~ ~fag'.	Ang.	Generation MW	Generation Mrar	Load MW	Load M,:u	Load Flow ID	MW	Mvar	Amp	%PF	XFMR %Top
								Ind 0	~-fü	~--;		99.8	---
								ID\-9	-0.S.<3	-0.03-1	589.9	99.8	
Bus37	0..100	1SS.SSS	-36.6	0	0	0	0	Bu,41	1.106	0.068	1179.8	99.8	
								tn,·ll	~.5$.\	-0.03-I	589.9	99.8	
								lmlll	~.5:'3	~.034	589.9	99.8	
Bu,38	0.400	100.000	-14.5	0	0	0	0	Bu,42	1.960	0.378	2S80,8	98.2	
								Im-90	-o.980	~-189	1440.4	9$,2	
								Im·89	-0.980	~.189	1440.4	98.l	
Bus39	0..100	100.000	-14.5	0	0	0	0	Btu42	1,960	0.378	2880.S	98.1	
								Im·87	~.980	-D.189	1440.4	98.l	
								In,-86	-0.980	~.189	1440.4	98.l	
Bu,40	0..100	100.000	.u.S	0	0	0	0	B'"4l	1.960	0.378	lSS0.8	98.Z	
								lnl'"l0!	~.980	~.189	1440.4	98.2	
								lıı.-14	-0.980	~.189	1440.4	98.2	
Bu>ll	11.000	135.19?	-37.3	0	0	0	0	Busl2	4.41$	O.ll9	17U	99.9	-USO
								Bu,.'4	-1.104	~.055	42.9	9M	
								Bıı,35	-1.104	-0.055	41.9	99.9	
								Bus36	-1.104	~.055	41.9	99.9	
								BuU7	-1.104	~.055	42.!>	99.9	
Bus42	ll.000	98.6.lO	-16.8	0	0	0	0	Bud!	5.038	O.SS7	314.3	98.9	~l.150
								Bu'38	-1.946	~.196	104.8	98.9	
								Bw.39	-l.946	-0.296	104.8	98.9	
								Busl0	-1.946	-0.196	104.8	98.9	
U1	220.000	262.107	e.e	Sl.448	83.2!>!	0	0	BusJ	$.\..148	8.1.m	99.I	~.0	
U2	ll0.000	100.000	0.0	0	0	0	0	Busl	0,000	0.000	0.0	0.0	
U3	ll0.000	U6.ö.\4	0.0	IU9l	15.550	0		OB~	11.492	15550	31.6	59.4	
Ind	0.400	160.800	.$7.I	o,656	0.034	0	0	Bu'34	0.656	0.034	5S9.9	99.9	
Inr4	0..100	160.800	-37.l	0.656	0.034	0	0	Bu~\.I	0.65<1	0.03-I	5S9.9	99.9	
InrS	0.400	160,800	.J7.l	0.656	0.0>l	0	0	Bus3S	0.656	0.034	589.9	99.9	
rın-7	MOO	160.800	.J7.l	0.6$6	0.034	0	0	But3S	o.656	0.034	589.9	99.9	
In\'10	0.400	160.800	-37.1	0.65<1	0.031	0	0	Bu,36	MS<S	0.034	589.9	99.9	
[ll,-ll	0..100	160.800	-37.l	0.65<1	0.034	0	0	BusJ6	MS<S	0.034	589.9	99.9	
Ind2	0..100	160.800	.J7.1	MS<S	0.0J.I	0	0	BusJ7	0.656	0.034	589.9	99.9	
Im-91	0..100	160.800	.$7.1	0.656	0.0J.I	0	0	BnsJ7	0.656	0.034	589.9	99.9	
Inı-90	0.400	161.016	-18.7	I.S96	0.189	0	0	Bu'38	l.S96	0.189	1440.4	99.3	
Inr89	0..100	161.026	-111.7	1.596	0.189	0	0	BusJS	1.596	0.189	1440.4	99.3	
lnrS7	0-100	161.026	-18.7	l.S96	0.189	0	0	Bm39	1.596	0.189	1440.4	99..l	

LOAD FLOW REPORT QVjtb P\'.l @ T = 0.800

Bus		Voltage		~ne-ration		Load		Load Flow					XFMR
ID	kV	%Ifag,	Aug,	MW	Mvar	MW	Ifrar	ID	MW	Ifrıır	Amp	%PF	%Tap
Inv86	**0.400**	**161.026**	**-18.7**	**1.596**	**0.189**	**0**	**0**	**Bus39**	~	~	r.i7or-;;;-		---
Ind Ol	0.400	161.0?6	-18.7	*1.596*	0.189	0	0	Bu,.10	1.596	0.189	Wo.4	99,3	
In\'14	MOO	161.026	-18.7	*l.596*	0.189	0	0	Bu<40	*1.596*	0.189	1440..t	99_,	

* Indicates **a ,·oltage** regulated **bus (,·oltnge eerarclled or ming t)pe machine .couuected to it)**

iudiçlltt-.sa bu,;. uitb a JO,ld mlnnatc-hsat mere tb.'l:a **0.1 IffA**

LOADFLOW REPORT QVith PV)@T– 1,000-

Bus		Voltag•		Genel'ation		Load		Load Flow					XJ:1\[R
ID	SV	Oıtt,Mag...	~~g.	MW	M,ıu-	MW	Ifrar	ID	MW	M,·ar	Amp	%PF	~
Bu.'>f	~··~		9o.O	---0	--0-	---0	---;	Budl	0.000	0.'000	lU7	O:O	-
								Bud3	0.000	0.000	0.0	0.0	
								BmZ7	0.000	0.000	0.0	0.0	
								Bıı,8	0.000	0.000	0.0	0.0	
								Bıı;8	0.000	0.000	0.0	0.0	
								Buı}O	0.000	0.000	0.0	o.o	
								B"'33	0.000	MOO	468.0	0.0	3.750
								Bu,,<i	0.000	0.000	0.0	0.0	
Bu'>I	6/i.000	1.9~	59.9	0	0	0	0	Budl	.0.0u	..0.1.14	131$	5.5	
								BusU	o.605	0.003	1.9	8.1.4	
								Bud8	0.003	0.000	0,9	.99,1	
								Bıı,7	0.001	0.000	0$	86.7	
								Bu,7	0.001	0.000	0.3	SM	
								Bu'3l	0.005	0.003	M	84.3	
								Bu~	0.010	M37	129.1	2.1	0.625
811$3	220.000	11.012	43	0	0	0	0	Busl	0.136	6.110	US.7	2.ı	
								Ul	-0.136	-6.110	w:.1	:2.ı	
Bus4	220.000	100.000	0.0	0	0	0	0	tn	0.000	0.0D0	0.0	0.0	
Bu.,;S	220.000	0.000	90.0	0	0	0	0	Bu-.:1	0.000	0.000	39.0	0.0	
								UJ	0.000	0.000	8!':0	o.o	
Bu,6	11.000	0.000	90.0	0	0	0	0	Bud	0.000	0.000	0.0	0.0	
Bu,7	66.000	1963	59.ll	o	0	0	0	B11'i2	.0.001	..0.001	03	84.5	
								Bu-.:?	..0.001	..0,001	M	SIS	
								Bu.ı>	0.0Ql	0.001	0,6	84.S	
Buss,	~.000	0.000	90.0	0	0	0	0	Busl	0.000	0.000	0.0	o.o	
								Busl	0.000	0.000	0.0	0.0	
								Bu1lO	0.000	0.000	0.0	0.0	
Bus9	11.000	l.943	59$	0	0	0.00?	0.001	Bıı,7	..0.00?	.0.001	3.6	85.0	
Busl0	11.000	0.000	90.0	0	0	0	0	Bu.S	0.000	0.000	0.0	0.0	1.250
Bu,11	6/i.000	1961	59.ll	0	0	0	0	Busl	0.015	0.445	1313	5,6	
								Bu'Wl	..O.o?S	,OMS	Ul.$	S.6	
Bııslı	~.000	0.0DS	S.S	0	0	0	o	Busl	0.001	0.001	174.7	65.8	
								Bu«!	..0.001	.0.001	174,7	6S.8	
Bıısl3	~.000	0.000	90.0	0	0	0	o	Busl	0,000	0.000	0.0	0.0	
								Buil5.	0.000	0.000	0.0	0.0	
BusU	~.000	l.ll40	59.4	0	0	0	0	Bu<l	.0.005	.0.004	1.9	S?.3	
								Bu;l6	0.00S	0.004	1.9	81.3	

	9Tl	8'96?L	681i	6fl'O	lt'•!I	0	0	0	0	S'Lf	9S9'ft	00t"0	9f'llll
	!Yll	1"819,	S6!l'O·	690'0"	1,.ulll								
	9"ll	t'819f	S6S'O"	690'0"	S-lll1								
	!Yll	8'96U	68!"t	ôfl'O	lt'llll	0	0	0	0	8'Lf	989'.t	oot'O	Sf'llll
	91!	t'Sl9f	S6$'0"	690'0"	t-"'Ir								
	9't!	t'819:	S6S'O"	690'0"	z.mJ								
	9T!	8'96?£	6811	sere	ttıng	0	0	0	0	S'Lf	989'z	00t'O	tf'11![
osL'f	0·ss	t6	m·o-	s00·0-	ı£>•ıı	r00·0	s00·0	0	0	rss	no·,	0001!	w•a
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	,ro	0·0	000·0	000·0	:ı••ıı								
	0·0	0·0	000·0	000·0	sıma								
	0·0	0·0	000·0	000·0	ımıı								
	0·0	0·0	00,ro	000·0	w•ıı	0	0	0	0	0'06	000·0	000·99	w•ıı
	0·0	0·0	000·0	000·0	,tsng	0	0	0	0	0'06	000'0	000·tı	sı•nıı
	0·0	0·0	00011	000·0	sımıı								
	,ro	0·0	00011	000·0	w•ıı								
	,ro	0·0	000·0	000·0	Lı••ıı	0	0	0	0	0·06	000·0	000·99	;ımıı
	0·0	0·0	000·0	000·0	rısnıı	0	0	0	0	0·0.	000·0	000·u	ıımıı
	0·0	**0·0**	**000·0**	**000·0**	**ttnıg**								
	0·0	0·0	000·0	000·0	,ısnıı								
	0·0	0·0	000·0	000·0	ı.ıma:	0	0	0	0	0·06	000·0	000·99	usnıı
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	0·0	0·0	000·0	000·0	51sna:								
	0:0	0·0	000·0	000·0	Hrna								
	0·0	0·0	00011	000·0	nsna:								
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·000'1 = T ® lXd •il'AO.L8:0d:ni A\0'11 avoi

anJ!'> ~1:Ll.LOd NV,\111'1 O.I.N'.I NOIIVII!:>3'..LN'.I sır.m SIS,\ Tl'NV .LJV dl~ a.>ı.rv J\!lll..'i'AS Ad'llV'10S 3.'IVOS 3'J:J'llV'l V SO NF.JIS3'a

ıem.ıoı.r ::lguo:) .\.'!Oll NOIIV.LSII.IIS NlIOH :ameu•ıH

•seıı :ııoısıcı•ı,ı: Sl :ase;:ı ·.,pnıs IV.IIll-'IVVJ:VISill\t<L\!VS :ı,anflu3'

:IIIS ıuamuedao: :ın ·,UISll3'AL'<fl ısv:;ı ın;:;ı.'l! :ı,e.ıııo;:ı

9I0l"9@"8Z :aıea ao·g·,t V.\111'1 • A.ID N1lOII :nop•>O'J

:ı :•!•d dV.L:£1 sısmı 1i'.llS'\,'l\t ,1,.fo.ı.ı

Project:	MASTER THESIS	ETAP	Page:	24
Location:	HOUN CITY - LIBYA	12.6.0H	Date:	28--06-2016
Contract:	NEAR EAST UNIVERSITY - EEE Department		SN:	
Engineer:	SAAD MUSTAFA AL-REFAI	Study Case: TS	Jw,işiou:	Base
Filename:	HOUN SUBSTATION 220KV		Coufig:	Noımal

DESIGN OF A LARGE SCALE SOLAR PV SYSTEM AND IMP'AC,TANJ\LYSIS01; ITS INTE<::RATIONINTO LIBYAI'!POWI.R GRID

LOAD FLOW REPORT (With PV) @ T = 1.!!fill::

Bus		Voltage		Generation		Loaıl		Load Flow					Xfl\1R
ID	kV	% Mag.	Ang.	MW	Mvar	MW~		ID	MW	lılvar	Amp	%PF	°%Top
								Jn,·10	~	-:ö'.m	36Ts:i	ü7	---
								Iını-9	-0.069	.(t.$95	3618.-1	11.6	
Bus37	0.400	23.686	37.8	0	0	0	0	BuıU	0.139	1.1S9	1296.8	11.6	
								Iıı\'Il	-OM9	--0$9S	3618.4	lH	
								ın,·91	--0.069	--0.$95	3618.4	11.6	
Bus38	0.400	23.363	56.5	0	0	0	0	Bm:42	0.135	1.176	7313.7	11.4	
								Jn,-90	--0.067	--0$88	36%.9	11,4	
								!nvS9	--0.067	--0.SSS	36%.9	n.,	
Bus39	0.400	23.363	56.5	0	0	0	0	Bm-lZ	0.135	1.176	7313.7	11.4	
								!nvS7	.-0.067	--0.<88	3656.9	ıu	
								IovS6	:-0.067	--0.<88	36$6.9	n.s	
Bus40	0.400	23.363	56.5	0	0	0	0	Bus.tl	e.ıss	1.176	1.m.1	ll.4	
								lndOl	.-0.067	:-0.58$	36$6.9	11.4	
								!nvl4	.0.067	:-0.$88	36S6.9	ıu	
Bus41	11.000	13.177	40.0	0	0	0	0	Ba'iU	0.?0$	2.657	106!.4	7.7	-1.250
								Bm34	--0.051	--0.664	26$.3	7.7	
								Buo.lS	--0.0.<l	:-0-"4	265..l	7.7	
								Bu,36	--0.051	.0.664	US.\	7.1	
								Bu'i37	:-0.0S!	.0.664	l6S..l	7.7	
Bus42	11.000	12.832	58.9	0	0	0	0	Bull	0.140	1.946	797.9	7.l	.1.1~0
								BuıJS	-0.047	--0.649	266.0	7.2	
								Bu,39	-l)J).17	-11.649	26M	7,2	
								Bu'i40	-l)J).17	--0.649	266.0	7.:L	
Ul	220.000	262.107	0.0	14.004	144.797	0	0	Bu'>3	14.004	1-14.797	rn:.1	9.6	
U2	220.000	100.000	0.0	0	0	0	0	Bu>!	0.000	0.000	0.0	0.0	
U3	220.000	146.534	0.0	4.'22	47.220	0	0	Bu'i5	.ı.721	47.l!O	8$.0	JO.O	
1n,1.	0.400	160.800	-37.l	4.0ll	O.S9S	0	0	Bu,34	4.021	0.595	3618.4	98.9	
ın,·4	0.400	160.800	.,l7,l	,1.011	asss	0	0	Bu13.f	4.011	0.595	.1618.4	98.9	
ın,11	0.400	160.800	-37.1	4.0Z!	O.S9S	0	0	Bus3S	.f.O?l	M9S	3648.4	98.9	
ln\"7	o.400	160.800	-37.1	4.0!1	·o.S95	0	0	Bu~S	.l.on	M9S	36111.4	98.9	
!n\'lO	0.400	160.800	-37,1	4.021	0.595	0	0	Bu,36	4.021	O.S9S	3618.4	98.9	
Ih,-r>	0,100	160.800	-37.l	4.0?!	0.595	0	0	Bu,36	4.0?1	0$95	.1648.4	98.9	
!n\'ll	0.400	160.800	.nı	4.021	0.595	0	0	Bu,n	4.021	0-'95	3618.-1	98.9	
ın,-ł>ı	0.400	160.800	-37.l	.ı.O!l	0.$95	o	0	Bn,37	4.0?1	0.595	:1618.4	98.9	
Jn,-90	0,.l00	161.026	-ls.7	4.037	0.588	0	0	Bum	4.037	0.58$	3656.9	99.0	
In,·89	ll.400	161.016	-18.7	4.037	0.585	0	0	Bum	4.o.17	0.588	3656.9	99.0	
In,117	0.400	161.0?6	-IS.7	4.037	0.588	0	0	Buı39	4.037	O.<SS	3656.9	99.0	

LOAD FLOW REPORT OVith PY} @ T = 1.000-

Bu,		Voltage		Generation		Load		Load Flow					Xfl\IR
ID	k\'	% Mag.	Ang.	MW	hb'ar	MW	~frar	ID	MW	Mm	Amp	%PF	%Top
lnv86	MOO	"iTı:öü	""Ts:;	~	O:;	--"o'	---;	~	4.037	0.588	3656.9	99.0	
lndOZ	o.JOO	161.016	-18. 7	J.OJ7	0.$88	0	0	Bu,JO	J.037	0.$88;	36.,6.9	99,0	
hwlJ	MOO	161.-016	-18.7	J,037	O.SSS	0	0	BnwO	J.037	0.$88!	36S6.9	95Ul	

* Indicates a ,~ottage regulated bus (,·oltage <'Ontrollecl or s'1ing type machine eouueered to it)

indicalr.<;;a bu!>nitha loadminn:ıtctfofmere I~uo.1MVA

D"ııaınkSt:ıbility

The ıabnlated plot data is ııotprinted sin<•.tll~ ?PIion o{"S\jii>Tabulated Plı>ts"is rberked.
To print tabulated ploı data go tc)(be Tl'ansient Stability Study Caso Editor and in the Info Page uıcheck the "Skip Tabulated Plots" option.

System Islandin.&Jnde:.

Thne(S«.)	Element ID	Typ<	ZontNo.
0.000	Busl	Bu-'	2
0.000	Busl 0	Bus	2
0.000	Busll	Bus	1
0.000	Busl%	Bus	2
0.000	Buıl3	Bu,	2
0.000	Bu,U	Bus	1
0.000	Bu,15	Bus	2
0.000	Bu,16	Bu,	1
0.000	Busl7	Bus	2
0.000	Bu,18	Bu,	1
0.000	Bud9	Bu,	2
0.000	BusZ	Bu,	1
0.000	Bıı;20	Bu,	1
0.000	**Bus?l**	Bus	2
0.000	**Bus22**	Bu,	2
0.000	**Busll**	Bu,	2
0.000	Bu,25	Bus	2
0.000	**Bus%7**	Bu,	2
0.000	Bın28	Bu,	2
0.000	Bu,29	Bus	2
0.000	Bu,3	Bus	2
0.000	Bus30	**Bus**	2
0.000	Bus:31	**Bw;**	1
0.000	Bus32	Bu,	2
0.000	Bus33	Bu,	1
0.000	Ilu,3.I:	Bu,	2
0.000	Bus35	Bu,	2
0.000	Bus:36	B11,	2
0.000	Bus.'7	Bus	2
0.000	Bu,38	Bu,	1
0.000	Bus:39	Bns	1
0.000	Bu.ı	**BUS**	3
0.000	Bu>IO	Bu,	1
0.000	Bu,U	Bu,	2
0.000	**Bus42**	B111	1
0.000	**Bın5**	Bu,	1

DESIGN OF A LARGE SCALE SOLAR PV SYSTEM AND IMPACT ANALYSIS OF ITS IN'IEGRATION INTO LIBYAN POWER GRID

System Isfanding Inıl~;ı:

Time (Ste,)	EltmeutlD	Typ•	Zour-No.
0.000	Bu,6	B,ıs	2
0.000	**Bu~7**	Bu,	1
0.000	Bın8	Bu,	2
0.000	Bu'9	Bu,	1
0.000	Ial'IO	PowtrGrid	2
0,000	lıl\'102	PomrGrid	1
0.000	Iavll	**P-0mrGrid**	2
MOO•.	Ind4	**PonuGıid**	1
0.000	Ind	**PomrGrid**	2
0.000	In,·4	**PomrGrid**	2
0.000	ln\'1	**PomrGrid**	2
0.000	Ia,·S	PewtrGrid	2
0.000	Im-86	Pom,rGrid	1
0.000	Iıı,-87	**PomrGrid**	1
0.000	Jıı,·89	Pomı·Grid	1
0.000	I.,-ıı	PomrGrid	2
0.000	Ia~O	**PO\\'tJ"Grid**	1
0.000	ın,-ııı	**PomrGrid**	2
0.000	Ul	Pomr Grid (Rot)	2
0.000	Ul	Pomr Grid (Ro£)	3
0.000	U3	Pomr Grid (Roi)	1

oı.\ctign Suınmary

EwntID	Timf(Se<.)	Derice Type	Dedc,ID	Attion
t\'fDtl	0.S00	Bus	Busl	J PlınseFoult
tventl	0.800	Bus	Bu~	3 PlınseFoult