Palestine Polytechnic University

College of Engineering

Department of Electrical Engineering

Title

Performance Analysis of Various Voltage Stability Indices in Distribution System

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الإهداء

بسم الله الرحمن الرحيم

(وقل اعملوا فسيرى الله عملكم و رسوله و المؤمنون)

صدق الله العظيم

إلهي لا يطيب الليل إلا بشكرك و لا يطيب النهار إلا بطاعتك . . و لا تطيب اللحظات إلا بذكرك . . ولا تطيب الآخرة إلا بعفوك . . و لا تطيب الجنة إلا برؤيتك . .

الله جل جلاله

إلى من بلغ الرسالة و أدى الأمانة . . و نصح الامة . . إلى نبي الرحمة و نور العالمين . .

سيدنا محمد صلى الله عليه و سلم

إلى من كللهم الله بالهيبة و الوقار . . إلى من علمونا العطاء بدون انتظار . . إلى من نحمل أسماءهم بكل افتخار . . نرجو من الله أن يمد في أعمارهم ليروا ثمارا قد حان قطافها بعد طول انتظار و ستبقى كلماتكم نجوم نهتدي بها اليوم و في الغد و إلى الأبد . .

آباءنا الأعزاء

إلى ملائكتنا في الحياة . . إلى معنى الجد إلى معنى الحنان و التفاني . . إلى بسمة الحياة و سر الوجود إلى من كانت أدعيتهن سر نجاحنا و حنانهن بلسم جراحنا إلى أغلى الحبايب . .

أمهاتنا الحبيبات

إلى الذين تقاسموا معنا أفراحنا و أحزاننا في هذه الدنيا . .

إخوتنا و أخواتنا

إلى رفقاء الدرب اللذين شاركونا رحلة هذا العمر و رسمنا معهم أجمل الذكريات . .

أصدقاءنا و زملاءنا

إلى من أحبهم قلبنا و آنس بهم و أنس بنا

نهدي ثمرة جهدنا

شكر و تقدير

حينما ترخي الكلمات أهدابها لتعانق عنان السماء و تتخذ من أسلوب التفرد ما يغذيها تميزا و وفاء ستسمو حروفها لتسلك من نشيد الحب تقديرا و عرفانا للأستاذ القدير د . نسيم إقطيط روافد عطائه النقي بروعة حضوره لإفادة الآخرين فلك منا كل التقدير و الامتنان .

شكر من القلب بكل معاني الشكر و التقدير لمن ترك بصمة الخير شكر لمن يستحق الشكر جامعة بوليتكنك فلسطين لاحتضانها لنا على طول سنوات الدراسة .

يسرنا أن نتقدم بخالص الشكر و وافد الامتنان على ما وجدنا ما كان لنا من نصح و توجيه و إرشاد لمن يستحق الشكر بمعنى عبارة الشكر و التقدير فإننا نضع بصمة الشكر و التقدير لأساتذتنا مشكورين .

إلى الوالدين الكريمين ، حفظهما الله وأدامها سراجا منيرا لدربنا .

إليكم جميعا نتقدم بشكرنا و عرفاننا فلولاكم لما وصلنا إلى هذه الخطوة في مشوارنا الطويل و إلى هذه الدرجة من سلم الارتقاء .

Abstract:

The use of electric power generation systems that penetrate into distribution networks such as Distribution Generator (DG) , Solar energy(PV) which affect voltage coils and loads has become a way to address the increased demand for electrical energy, as the increased demand has caused the system to run at its maximum capacity or at the point of voltage breakdown; It has therefore become necessary to determine the maximum capacitance of the system before voltage breakdown occurs due to system instability.

The research reviews the concept of voltage stability index (VSI) as an indicator of weak transmission lines and distribution lines that are most prone to voltage breakdown. The references also evaluate many voltage stability indices.

A study was carried out on one of the low voltage networks Beit Sahour (Eish Ghurab), and a number of voltage stability indices (LQP, LVSI, FVSI, Lmn) were calculated, through the use of the power analysis program (ETAP), and the resulting data were collected on Excel and calculate the indices mentioned above.

الملخص:

أصبح استخدام أنظمة توليد الطاقة الكهربائية التي تخترق شبكات التوزيع مثل Distribution Generator (DG) Solar energy(PV) التي تؤثر على ملفات الجهد والأحمال وسيلة لمعالجة الطلب المتزايد للطاقة الكهربائية ، حيث أن الطلب المتزايد تسبب في تشغيل النظام بأقصى طاقاته أو عند نقطة انهيار الجهد ؛ لذلك أصبح من الضروري تحديد الحد الأقصى لسعة النظام قبل حدوث انهيار الجهد بسبب عدم استقرار النظام.

يستعرض البحث مفهوم مؤشر استقرار الجهد (VSI) كمؤشر على الخطوط الناقلة الضعيفة وخطوط التوزيع الأكثر عرضة لانهيار الجهد ، كما وتقوم المراجع أيضا بتقييم العديد من مؤشرات استقرار الجهد.

تم تنفيذ دراسة على إحدى شبكات الضغط المنخفض في مدينة بيت ساحور (منطقة عش غراب) ، وحساب عدد من مؤشرات استقرار الجهد (LQP , LVSI , FVSI , Lmn) ، وذلك من خلال استخدام برنامج تحليل القوى (ETAP) ، وجمع البيانات الناتجة على برنامج Excel وحساب المؤشرات المذكورة السابقة.

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Introduction

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1.1 Overview

Electricity has become an important part of human life due to its presence in all areas of his life, especially since we live in the age of technology and information. Due to its great important, maintaining the efficiency and stability of the electricity network is an important thing to do. There is a lot of different loads connected with the power system and some of these loads may disturb important parameters in distribution system such as voltage.

Voltage instability causes a decrease in the efficiency of distribution system, From this point of view, based on the importance of maintaining voltage stability our scientific research will work through studying a specific network to find appropriate voltage stability indices for distribution system.

1.2 Motivation

1. A malfunctions in one of the transformers that convert from high to low voltage or vice versa and the resulting interruption in the feeding to the network.
2. One of the large loads in the network stopped as a result of a malfunction, which causes an excess of energy in the network or a sudden rise in demand outside peak times so that the stability of the network affected negatively.
3. A malfunction in some electrical devices as a result of unbalance in electrical network which causes a financial losses.

1.3 Objectives

1. Studying the performance analysis of various voltage stability indices in distribution system through studying the load profile curve of the connected load to the network.
2. Examining a number of line and bus voltage stability to find their effectiveness of determining the weakest lines/buses in the system.
3. Studying the impact of the solar energy system (PV) and distribution generator (DG) on the stability of distribution system.

1.4 Importance

1. To have a safe, efficient and reliable power system for electrical network under both normal and abnormal conditions.
2. Maintaining the strength and performance of electrical loads connected with the network and avoiding their failure.
3. Reducing as much as possible the financial losses that affecting negatively the utility and the consumer as a result of problem in stability of network.

1.5 Methodology

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

1. Data collection: The collected data of Beit Sahour involved the information about main transformer of the network , the distance between each point in the grid, information about the conductors that used in the network with its all parameters and the information about the PV stations which connected with the network. All data about this network is taken from JDECO Company .
2. Power flow analysis : All data collected of Beit Sahour network is used to draw the single line diagram of the network in ETAP software. All the parameters of transformer ,lines and loads were entered to ETAP program . Then the simulation process will be done to study the stability of the network.

1.6 Literature Review

Paper compares different kinds of stability indices in order to identify the voltage stability of a particular power system in transmission and distribution system, A number of line and bus voltage stability indices are examined in this paper to find their effectiveness of determining the weakest lines/buses in the system , the author used ETAP and EXCEL for simulation and presented a detailed comparison before and after each case .[1]

The noteworthy to discover the maximum ability boundary prior to voltage collapse should be undertaken. A preliminary warning can be perceived to evade the interruption of power system’s capacity. The effectiveness of line voltage stability indices (LVSI) is differentiated in this paper. The main purpose of the indices used is to predict the proximity of voltage instability of the electric power system. On the other hand, the indices are also able to decide the weakest load buses which are close to voltage collapse in the power system, the author used ETAP and EXCEL for simulation[2].

This paper compares the performance of several indices which furnish important information about the proximity of the system to voltage collapse. All these method has been implemented on IEEE 39 bus test systems, where their performances of these indicator is explored over both stable and unstable region, by varying the load at a particular bus and gradually increasing the load in all load buses[3].

1.7 Time plan

Table 1.1:Time plan for first semester

Week / Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Selection the idea of project and take the agree on it														
Collecting information & research papers that needed in project to start working														
Bringing the necessary data to work from Jerusalem District Electricity Company (JDECO)														
Data analysis and starting preliminary calculations for the project														
Preparing the final report														
Preparing the presentation														

Table 2.2:Time plan for second semester

Week / Task	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Collecting data about load profile of the connected loads and PV services														
Analysis in ETAP and calculating the voltage stability indices using Excel														
Ploting the curves of the results and discussing it														
Preparing the final report														
Preparing the presentation														

Chapter Two

Power System

2.1 Introduction

2.2 Power flow

2.3 Power system stability

2.4 Voltage stability

2.5 Voltage Stability Indices (VSI)

2.6 Data

2.7 Parameters that affected distribution power system stability

2.1 Introduction

The electric power system is a network of interconnected components which generate electricity by converting different form of energy . Potential energy, kinetic energy and chemical energy are the most common forms of energy converted to electrical energy and then transmit the electrical energy to the load centers to be used by the consumer . The production and transmission of electricity is relatively efficient and expensive, also electricity is not easily stored and should immediately used as it is being produced.[4]

The electric power system consists of three main subsystems: the generation subsystem , the transmission subsystem and the distribution system . Electricity is generated at the generation station by converting a primary source of energy to electrical energy. The voltage output of the generators is then stepped-up to appropriate transmission levels using a step-up transformer. The transmission subsystem then transmits the power close to the load centers. The voltage then stepped-down to appropriate levels. The distribution subsystem then transmit the power close to the consumer where the voltage stepped-down to appropriate levels for use by a residential , industrial and commercial customer .

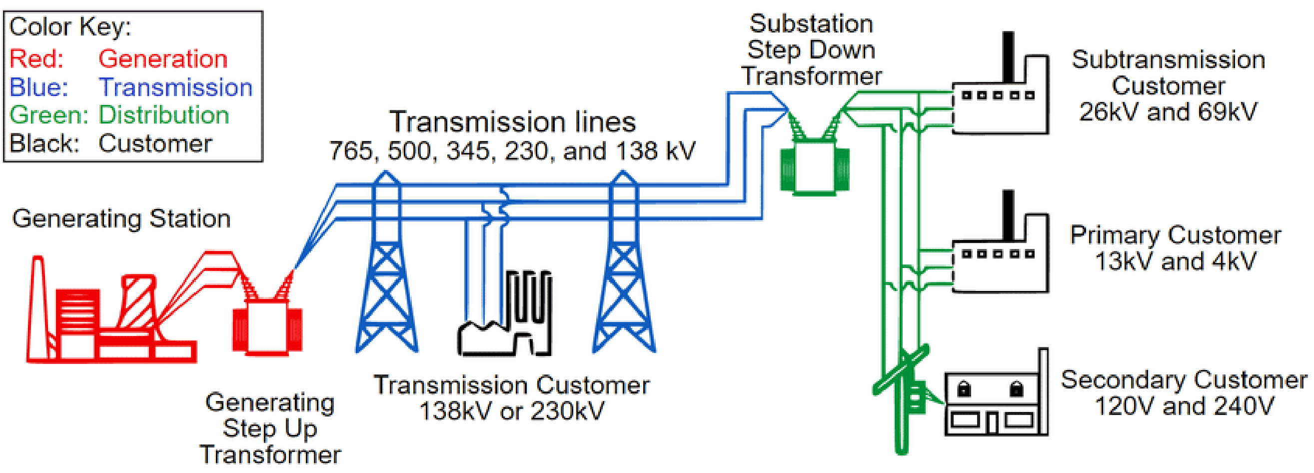

Figure 2.1 : Structure of the Electrical Power System[5]

2.2 Power flow

Power flow study usually uses simplified notation and focuses on various forms of AC power (reactive, real and apparent) rather than voltage and current. It analysis the power system in steady state operations . The great importance of power flow studies is planning the future expansion of power systems as well as in determining the best operation of existing systems. There is a number of software programs that used for implementations of power flow studies.[6]

2.3 Power system stability

Power system engineering forms a vast and major portion of electrical engineering studies. It is mainly concerned with the production of electrical power and its transmission from the sending end to receiving end as per requirements, incurring a minimum amount of losses. The power often changes due to the variation of load or due to disturbances.

For these reasons, the term power system stability is of utmost importance in this field. It is used to define the ability of the system to bring back its operation to steady state condition within a minimum possible time after having undergone any transience or disturbance.[7]

Power system stability is defined as the ability of an electrical power system, for certain initial operating conditions, to restore an operating equilibrium state after experiencing a physical disturbance, while constraining most of the system's variables so that the entire system remains practically sound. [8]

2.4 Voltage stability

Refers to the ability of a power system to maintain steady voltages at all buses in the system after being subjected to a disturbance from a given initial operating condition.[8]

Voltage stability is related to the capability of a power system to keep up acceptable voltages in the system not only under normal conditions but also being exposed to a disturbance.

When a disruption occurs and causes a progressive and uncontrollable decline in the voltage, the system becomes a part of a state of the voltage instability. Instability can occur because of simple reactive power consuming when load increases. These incidents may result in further reactive demands due to the outcomes like increased losses in transmission line and distribution line.[1]

2.5 Voltage Stability Indices (VSI)

Even though voltage stability is a dynamic problem, static indexes still plays a very important role in voltage stability analysis [1]. Voltage stability indicators also work to know how close the current operation point is to static stability limit, and predict future changes to the nature of the system. The most important indicators of voltage stability:

A. Fast Voltage Stability Index (FVSI).
B. Line Stability Index (Lmn).
C. Online Stability Index (LVSI).
D. Line Stability Factor (LQP).

Voltage Stability Index (VSI) is driven based on system variable parameters (bus voltage and current magnitudes) to determine the distance between the current operating point and the voltage collapse point.

A. Fast Voltage Stability Index (FVSI):

This index is formulated from the voltage quadratic equation of the two-bus system FVSI is based on the concept of power flow through the line of the network [1], and defined as follows:

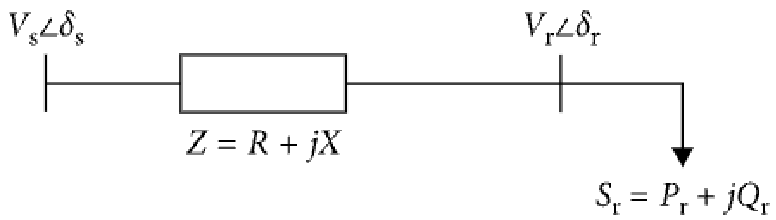

Figure 2.2 : The electrical equivalent of a typical branch of distribution network

$$FVSI = \frac{4Z^2\, Qr}{Vs^2 X} \quad (1)$$

The FVSI is directly proportional to reactive power while active power is indirectly related through the bus voltage. An FVSI less than (< 1) indicates a stable condition. If the FVSI is close to (-1), the particular line is close to instability. If the FVSI goes beyond (>1), indicates the instability of the voltage and the formation of a danger to the system.

B. Line Stability Index (Lmn) :

The concept of this index is based on the flow of energy in a single line, as it works on the technique of X_{12}reducing the power system network to a single line. and defined as follow

$$L_{mn} = \frac{4XQ_r}{[V_s \sin(\theta - \delta)]^2} \quad (2)$$

The Lmn is directly proportional to reactive power while active power is indirectly related through the bus voltage. And be (0≤Lmn≤1), The closer its value is to 1, the closer to the point of instability.

C. Online Stability Index (LVSI):

Index (LVSI). This index is similar to the (Lmn) index, but it is derived from the relationship between the reactive power at the receiving end and voltage at the sending end. LVSI is defined as:

$$LVSI = \frac{4RP_r}{[V_s \cos(\theta - \delta)]^2} \quad (3)$$

The LVSI relationship is a direct relationship with active power of the receiving end bus and is indirectly related with reactive power through the sending end voltage unlike the case for FVSI and Lmn [1]. And be (0≤LVSI≤1), The closer its value is to 1, the closer to the point of instability.

D. Line Stability Factor (LQP):

It is an index based on monitoring the stability of the line, as it tracks stressful lines with the possibility of tracking the load. It is an effective and reliable index to identify weaknesses in any emergency circumstances. With the improvement of this index made it suitable for online application.

Using the same concept of load flow studies has derived the LQP relationship such that the active and reactive power on receiving bus can be expressed as [9]

$$LQP = 4\left(\frac{X}{V_s{}^2}\right)\left(\frac{X}{V_s{}^2}P_s{}^2 + Q_r\right) \tag{4}$$

LQP is directly proportional to active power and active power. And be
($0 \leq$ LQP ≤ 1), The closer its value is to 1, the closer to the point of instability.

Table 2.1 : Comparison of the indexes[1]

Index	Formulation	Relative variables	Assumption	Critical value
FVSI	$\frac{4Z^2\,Qr}{Vs^2X}$	Q V Z X	δ = 0	1.0
L_{mn}	$\frac{4XQ_r}{[V_s\sin(\theta-\delta)]^2}$	Q V δ X	NO	1.0
LVSI	$\frac{4RP_r}{[V_s\cos(\theta-\delta)]^2}$	P V δ R Q	NO	1.0
LQP	$4\left[\frac{X}{V_s^2}\right]\left[\frac{X}{V_s^2}P_s^2 + Q_r\right]$	P Q V X	R/X<<1	1.0

2.6 Data

1- The main transformer for Eish Ghurab distribution network in Beit Sahour city in Bethlehem. has the following parameters:

S=400 KVA

Transforming ratio = 11KV/400 V

2- The PV services that connected to the network:

Table 2.2 : PV services

Number of service	Power (KW)
300201460	82.41
300202852	4.25
300202200	10.4

Note : The rest of the data is in **Appendix A**

3- GIS Map: (Beit Sahour)

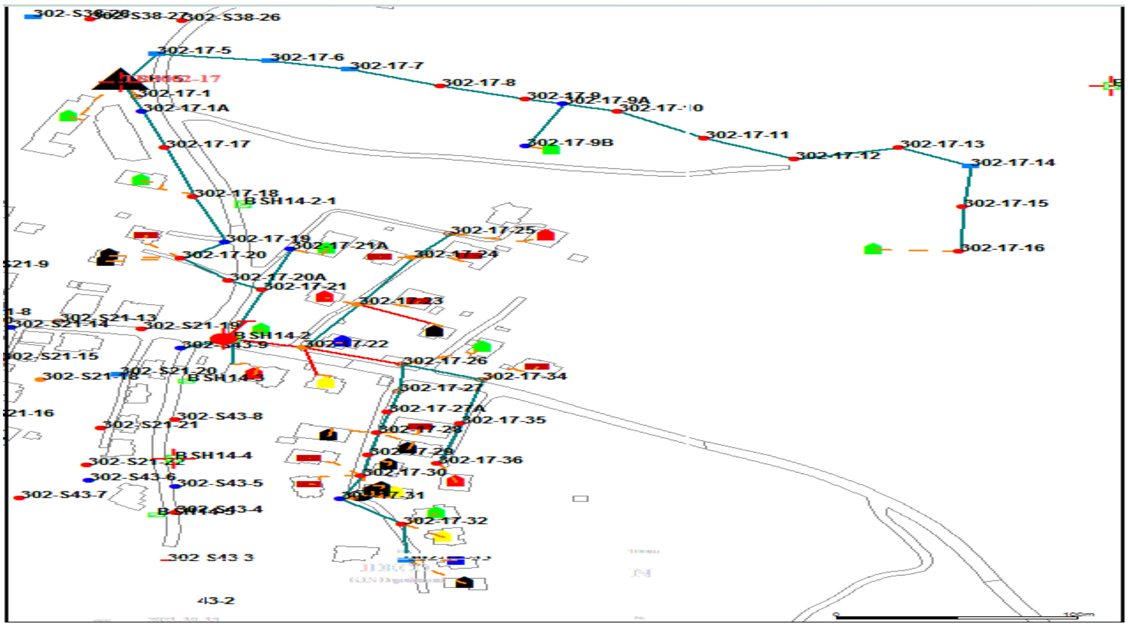

Figure 2.3 : GIS Map

2.7 Parameters that affected distribution power system stability

i. Reactive power margin :

Reactive power margin is one of the proposed indices for estimating the voltage stability for a particular network . It can be calculated by the distance between the lowest MVAR point of Q-V curve and voltage axis . The negative values of reactive supply represents how much more load can be added on that particular bus before it reaches loading limit to prevent voltage collapse. Reactive power margins generally used for finding voltage instability problems for compatible bus groups. [1]

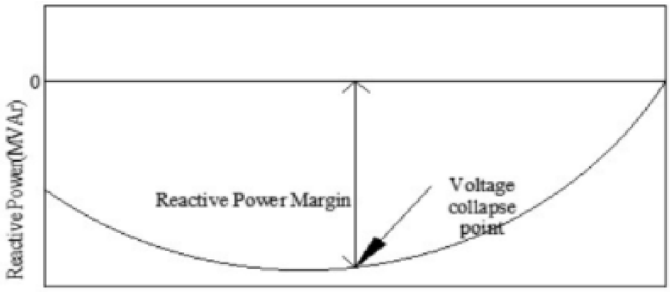

Figure 2.4: Q-V curve and reactive power margin [2]

ii. Real power method :

This is one of the widely used methods of voltage stability analysis. This gives the available amount of active power margin before the point of voltage instability. For radial systems, the voltage of the critical bus is monitored against the changes in real power consumption. For large meshed networks, P can be the total active load in the load area and V can be the voltage of the critical or representative bus. Real power transfer through a transmission interface or interconnection also can be studied by this method.[10]

iii. Line :

The cables have different resistance and reactance, which affects the stability of the voltage to a certain extent, as the increase in the reactance value causes an increase in the current draw, causing system to consume more reactive power and the voltage drops further , The effect of the resistance of the cables on the distribution system and the voltage stability , where the increase in the resistance value causes an increase in the voltage value in the cable above the permissible limit (1.05 pu), and the increase in the voltage causes an increase in the active power according to the relationship (P = VI), which causes the The presence of a difference between the output energy of the station and the energy needed in the network, and this causes the formation of an unbalanced system, and causes the system to collapse.

iv. Effect of PV :

Since the existing of synchronous generators are decreasing their power production with the increased penetration of photovoltaic (PV) generation at distribution systems, the impact on their voltage stability has become non-negligible and more analysis is needed. show the impact of solar–PV generation on short- and long-term on voltage stability and power distribution systems . for example, the impact of the dynamic behavior of photovoltaic (PV) power generation systems on short-term voltage stability, and high PV penetration can influence the voltage profile depending on loading conditions and amount of PV penetration.[10]

v. Effect of Distribution Generators:

DGs are small-scale power generations (typically in the range from 3 kW to 10,000 kW) are used to improve the traditional electric power systems. Integrating DG units into the power systems has many benefits like improving voltage profiles and load factors, grid reinforcement, deferring or eliminating for system upgrades, reducing power losses and on-peak operating costs, and improving system integrity, reliability, and efficiency. To achieve these benefits, an appropriate size and place must be selected where the DG units are installed. Installing these units in the inappropriate places may diminish the reliability of the system and may also lead to an increase in the system losses and costs [11].

Chapter Three

Network Modeling

3.1 Introduction

3.2 Modeling the main case

3.3 Modeling the PV case

3.4 Modeling the distribution generator case

3.1 Introduction

In this chapter the simulation of an example of Beit Sahour distribution subnetwork is done using power flow analysis program (ETAP). The network is connecting of one distribution transformer as mentioned in chapter two and number of loads from two kinds single phase and three phase . Also the PV services which injection real power to the network . All the previous contacts used to built the main case of the network in reality . Then some additions were added to the real network as : Two PV services , Distribution Generator (DG).

3.2 Modeling the main case

The design of the real Beit Sahour subnetwork needed a large amount of data represented as one distribution transformer , the length of cabels and overhead lines and the PV services in reality. The details of the distribution network as show **Appendix B** for main case .

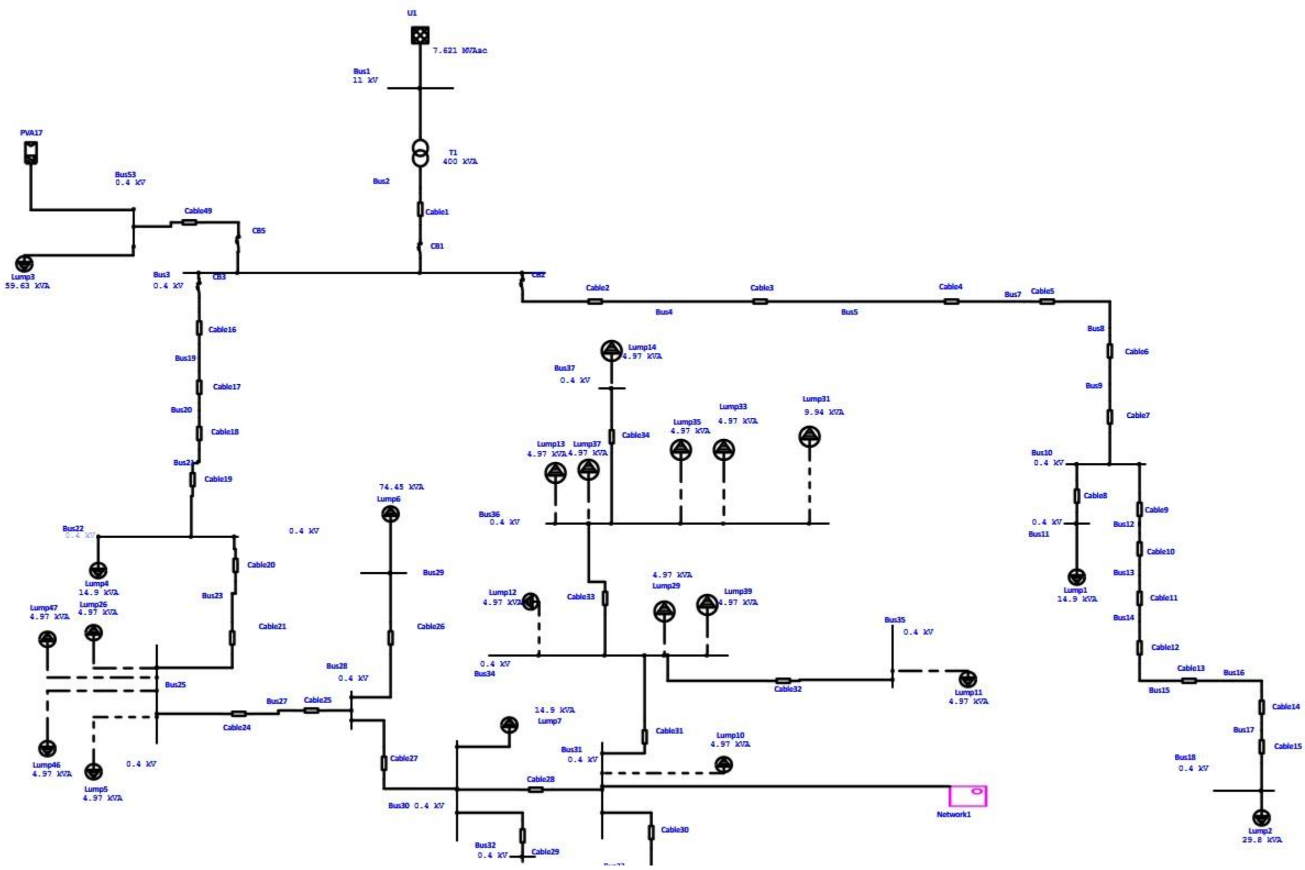

Figure 3.1 :Main case network in ETAP

3.3 Modeling the PV case

In this case two PV services have been added to the real network one at bus 29 (50 KW) and another one at bus 18 (20 KW). The details of the distribution network as show **Appendix B** for PV case .

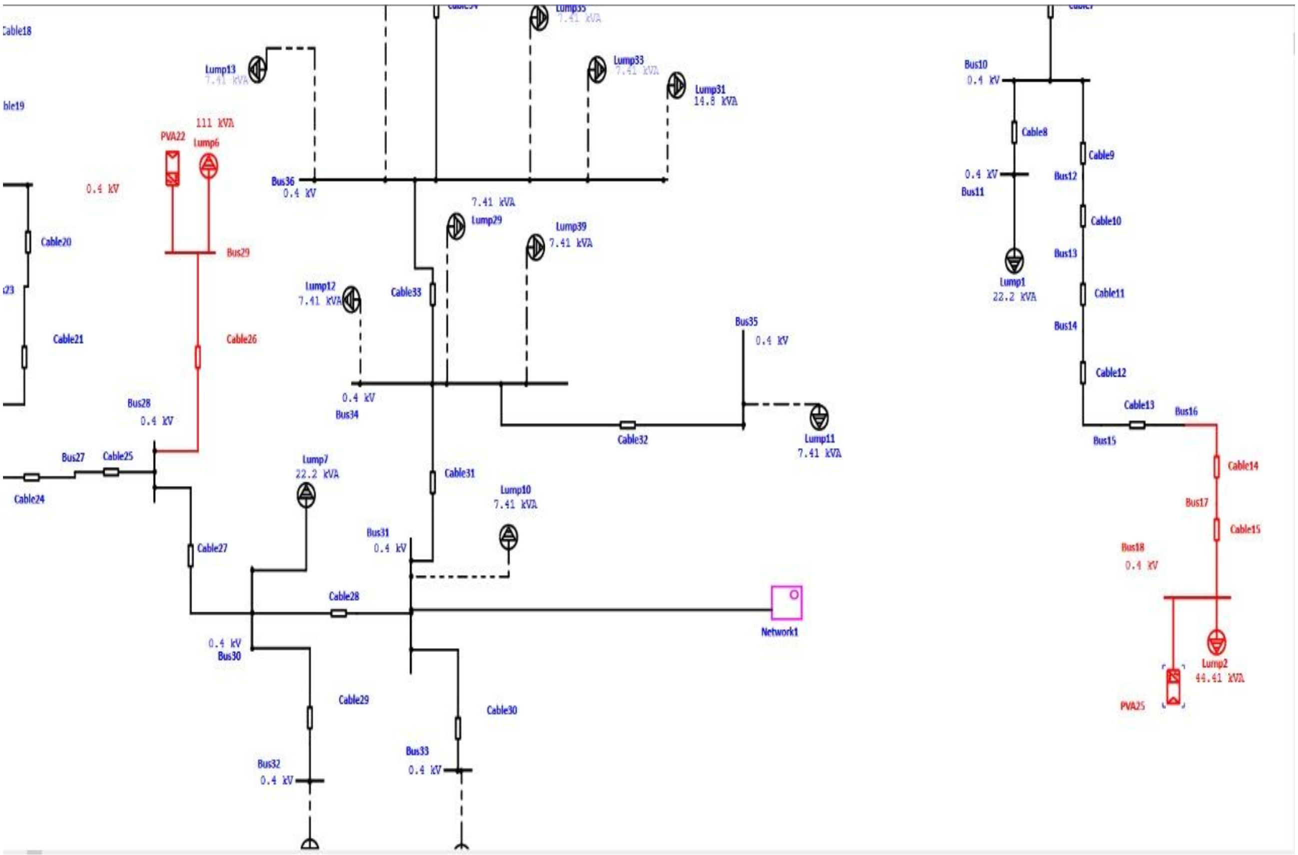

Figure 3.2 :PV case network in ETAP

3.4 Modeling the distribution generator case

In this case a distribution generator have been added to the real network at bus 36 with maximum real power 200 KW and maximum reactive power 91.13 Kvar. The details of the distribution network as show **Appendix B** for distribution generator case .

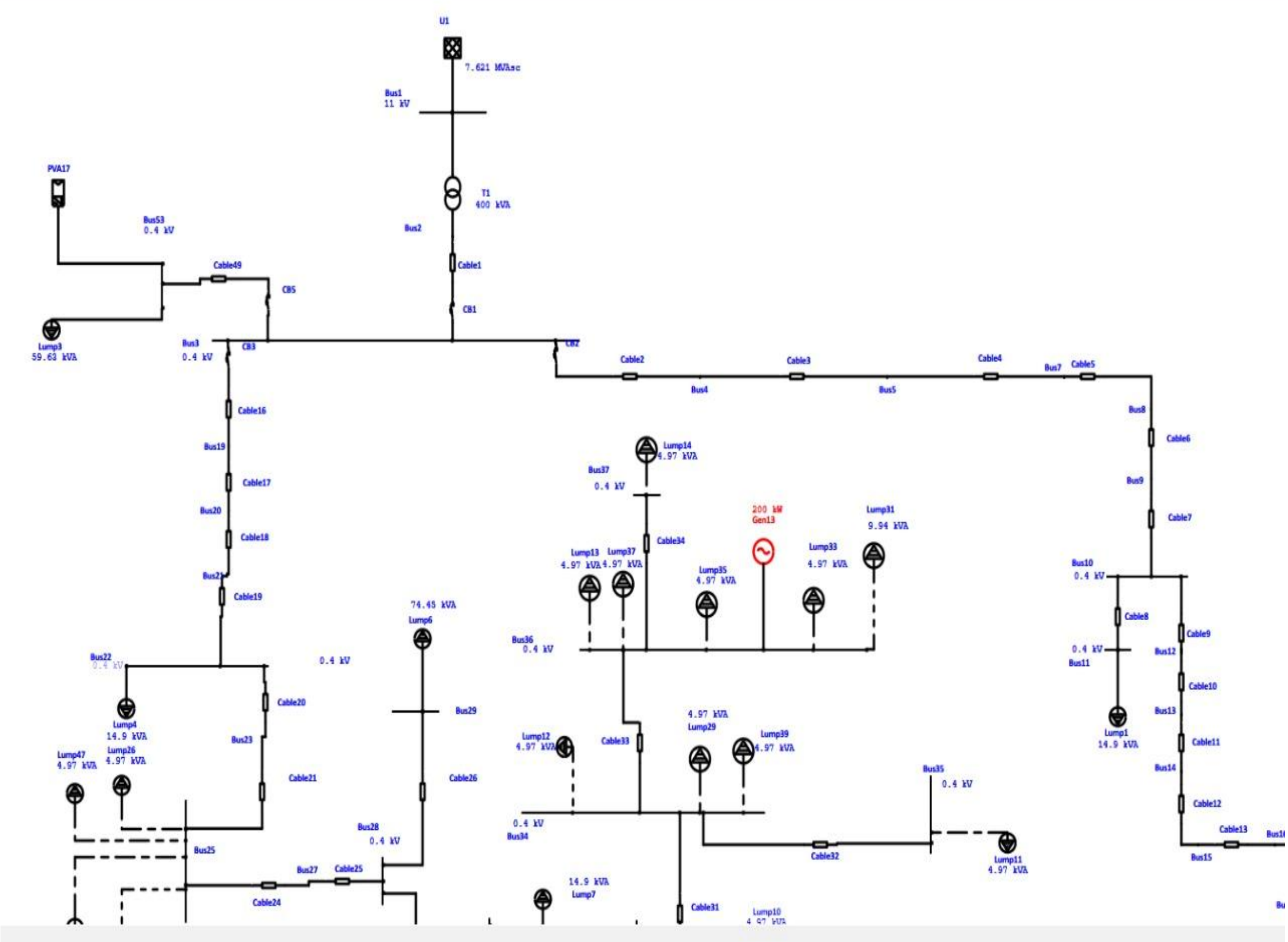

Figure 3.3 :DG case network in ETAP

3.5 ETAP reports

After running the ETAP for the three cases at 13:00 PM for example, the results of the **Load flow** were obtained in **Appendix C .**

Chapter Four

Results

4.1 Introduction

4.2 Study cases

4.1 Introduction

In this chapter the results of power flow of the modeling of network is explained. The parameters that needed to calculate the indices were obtained from the power flow in ETAP. The resulted indices used to specify whether the voltage stability of the network is good or not in the three different cases that mentioned in chapter 3.

4.2 Study cases

To get sure of the voltage stability and the effectiveness of voltage stability indices on the low voltage network , in terms of monitoring the situation of distribution lines and loads that connected to the network, Excel program used to enter the results that were obtained from power flow in ETAP . The results were calculated for 24 hours load profile as shown in figure 4.1 of the maximum demand day on 2021 which was 22/12/2021 for Eish Ghurab distribution network in Beit Sahour city in Bethlehem , and this method is used in the three study cases that mentioned in chapter 3 with some additions for each case .

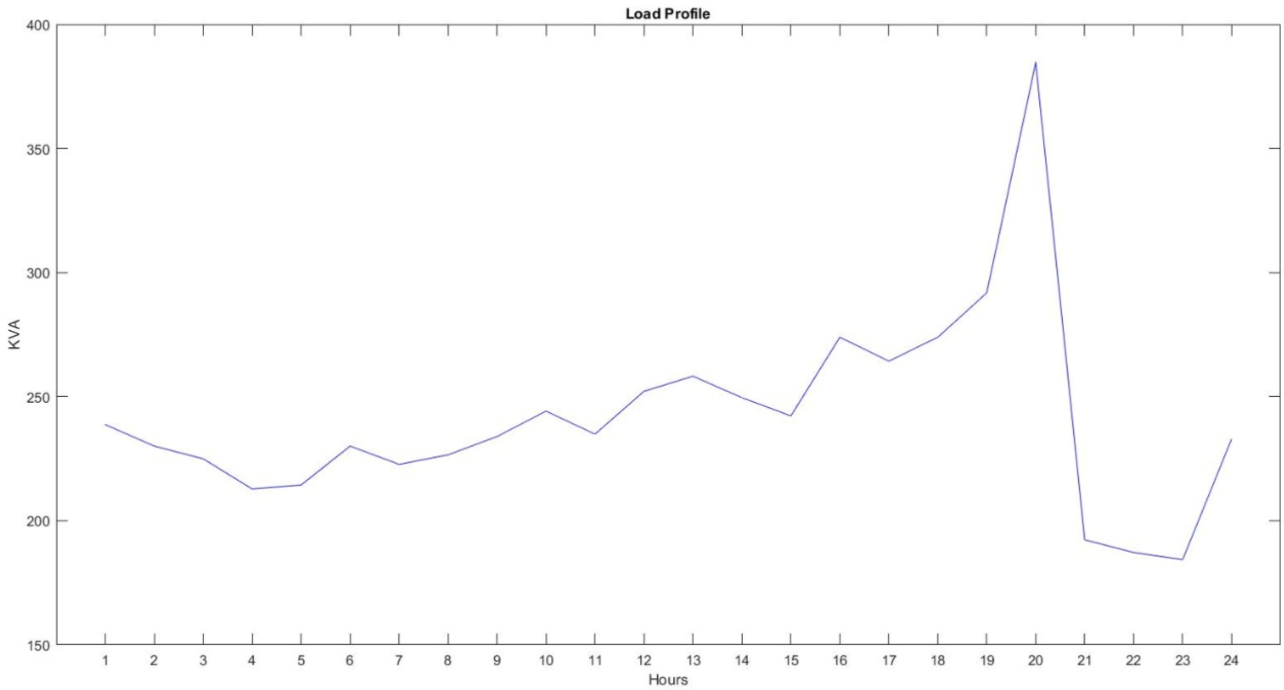

Figure 4.1 :Load profile of transformer

When added PV services on the main network they injected a real power to the loads that connected with it . So, the real power that absorbed from the network becomes less as the production of solar energy increases which reduces the losses in the network , so the voltage stability is better and the voltage stability indices becomes less than the main case.

In the case of adding a distribution generator on bus 36 a real and reactive power injected to network . So, the real and reactive power that flow from bus 3 to bus 22 decreased which reduced the losses on the network and the voltage stability becomes better as shown in the following figures.

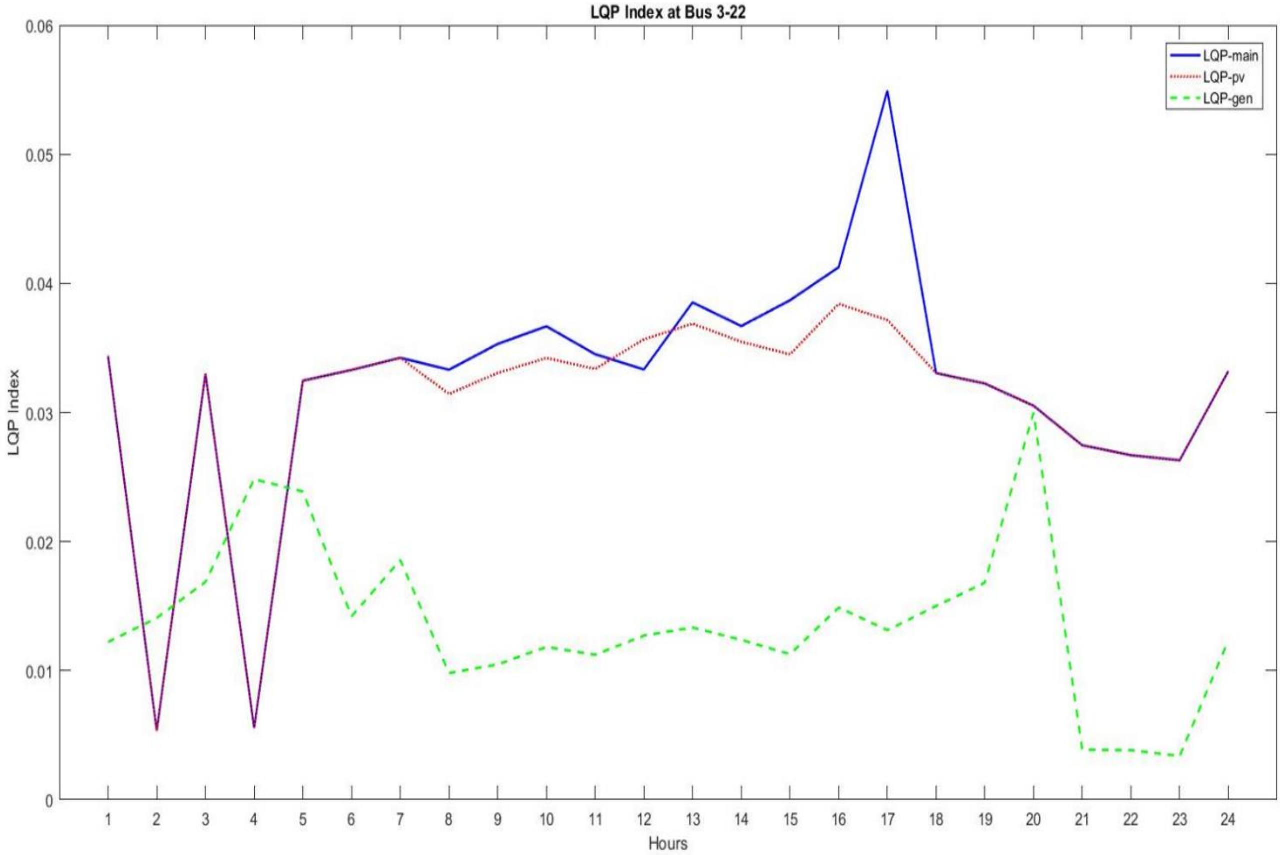

Figure 4.2 :LQP Index at Bus 3-22

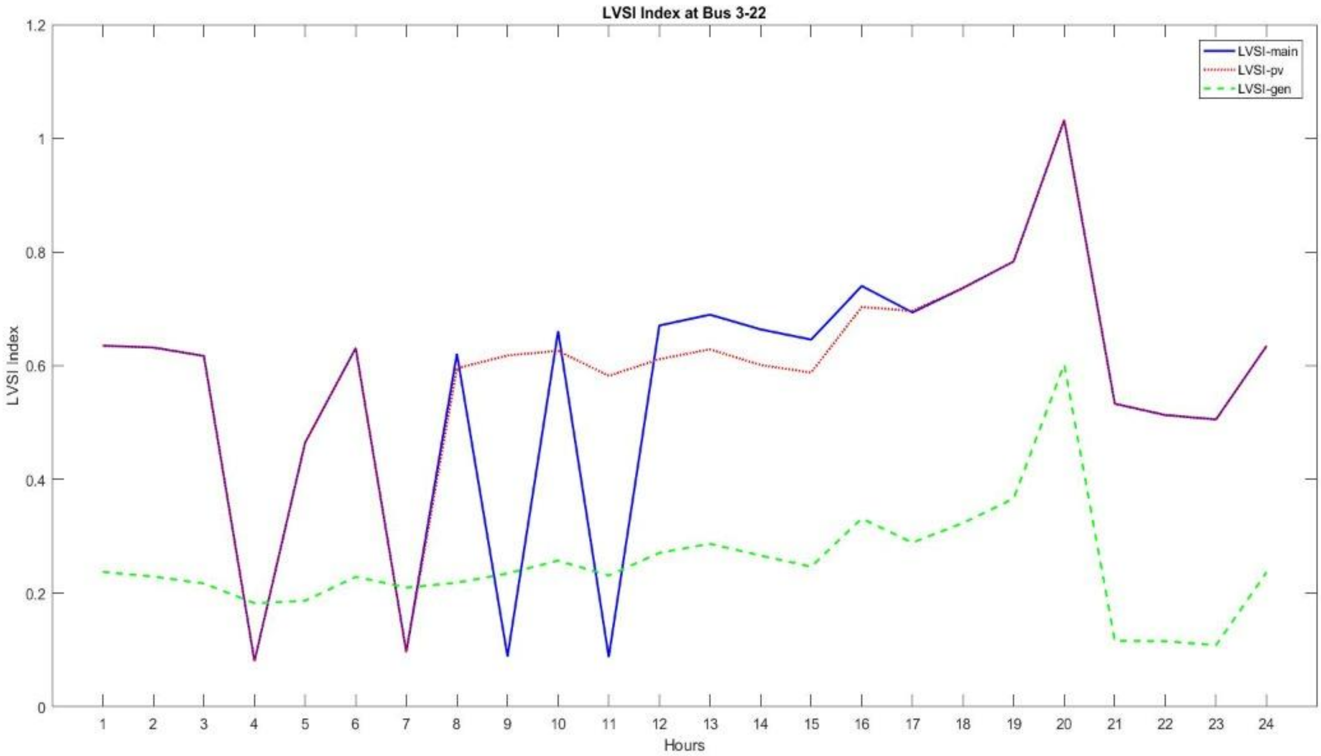

Figure 4.3 :LVSI Index at Bus 3-22

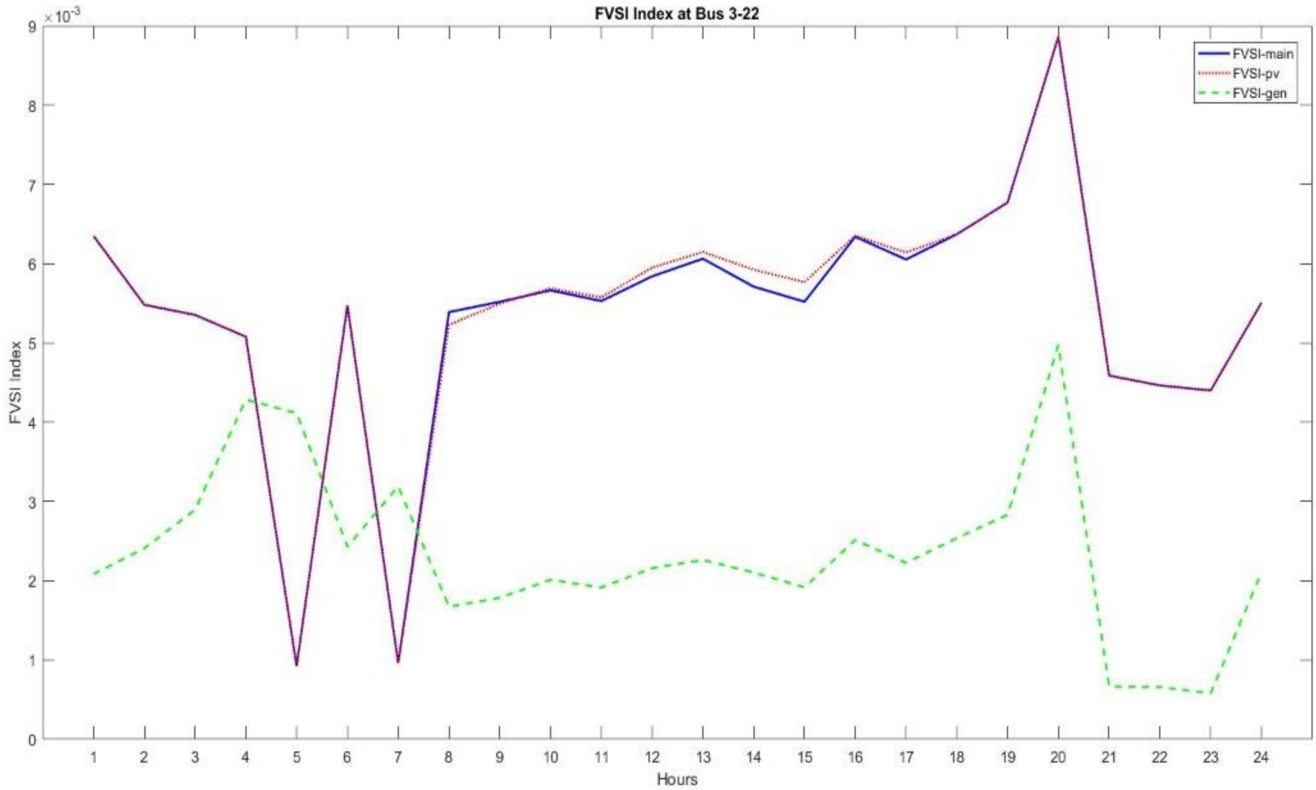

Figure 4.4 :FVSI Index at Bus 3-22

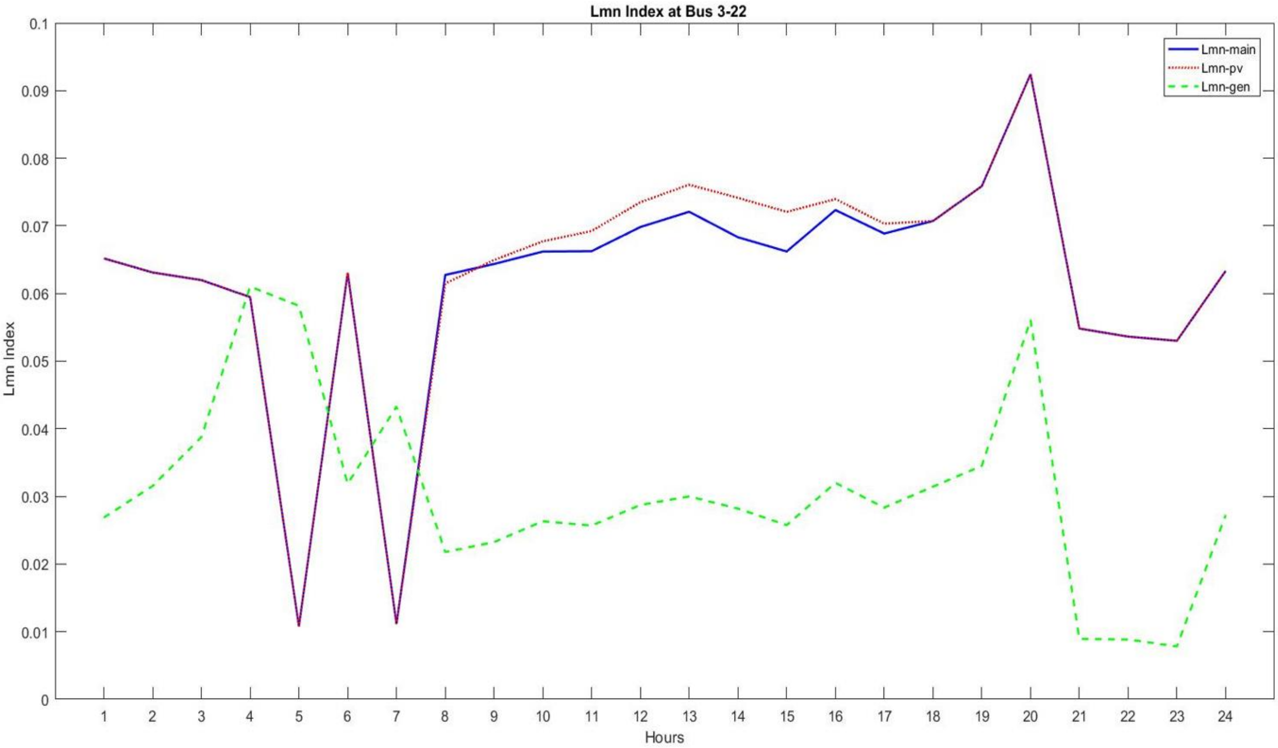

Figure 4.5 :Lmn Index at Bus 3-22

When added PV services on the main network and using the voltage stability indices , the real power that absorbed from the network becomes less as the production of solar energy increases which reduces the losses in the network . Also , when the number of the solar energy increases the voltage stability is better.

When added a distribution generator on bus 36 and running it at maximum values the real and reactive power that injected to the bus form a surplus on the bus and the voltage stability decreased as shown in the following figures.

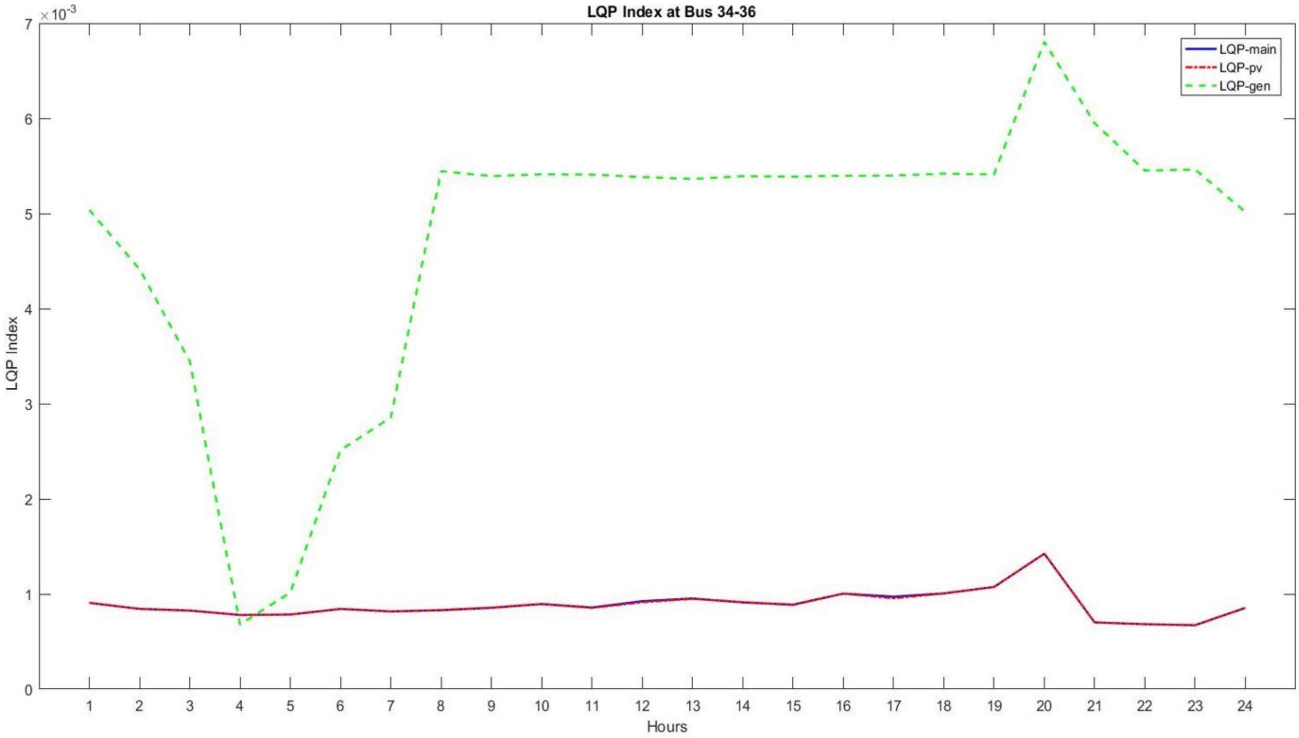

Figure 4.6 :LQP Index at Bus 34-36

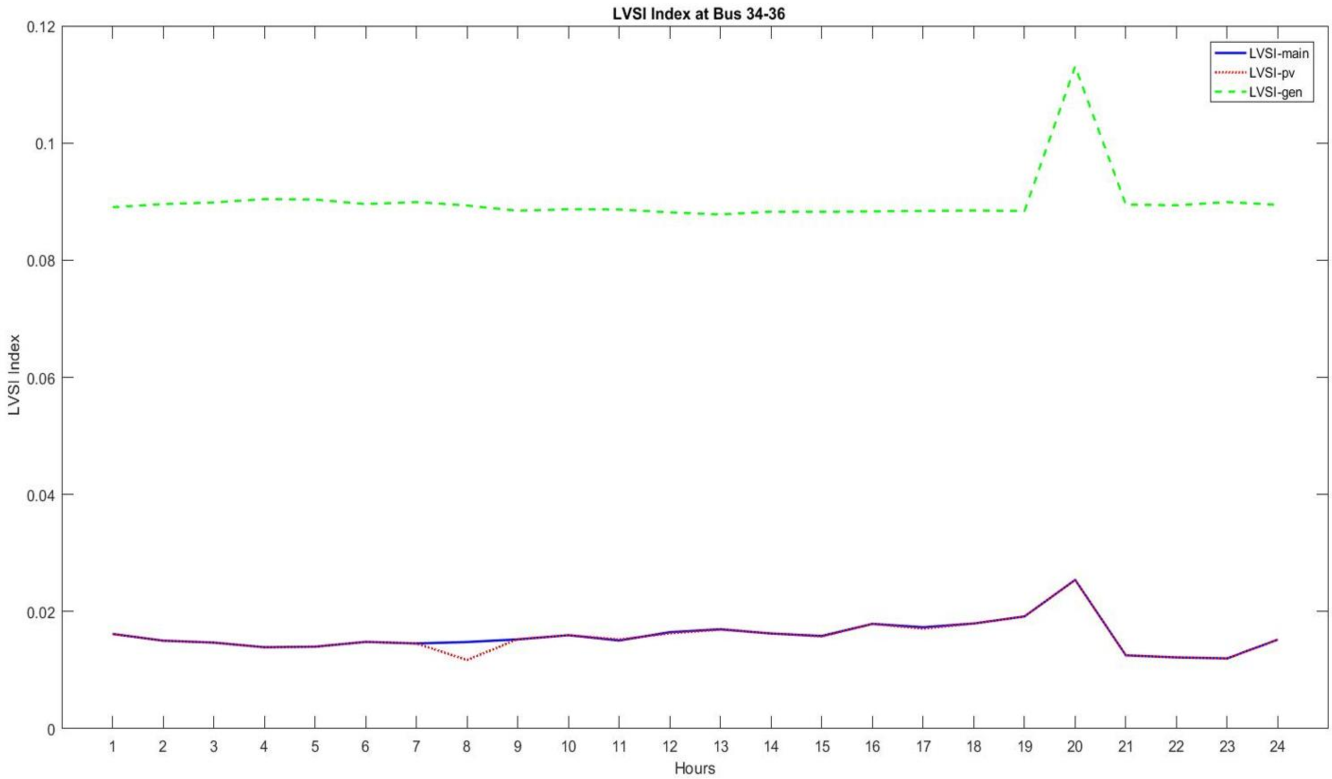

Figure 4.7 :LVSI Index at Bus 34-36

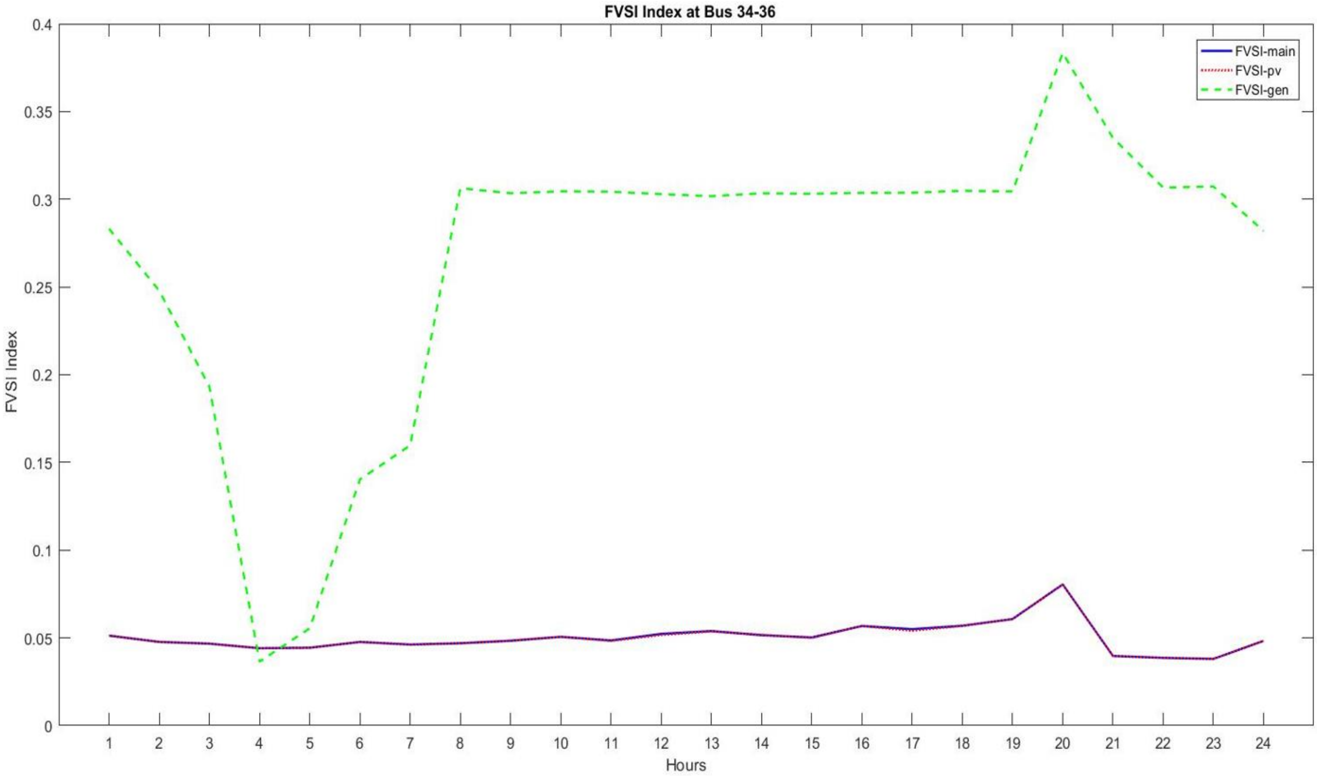

Figure 4.8 :FVSI Index at Bus 34-36

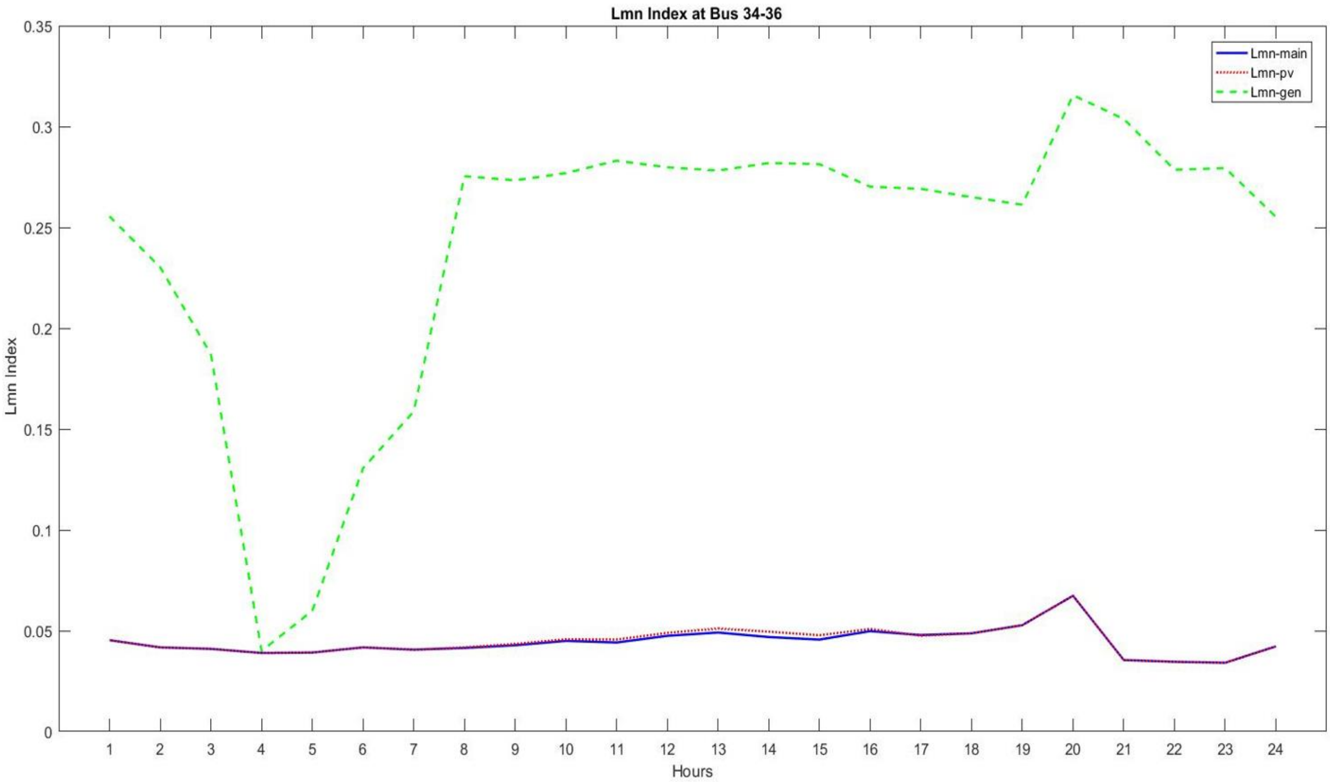

Figure 4.9 :Lmn Index at Bus 34-36

The PV services that added to the main network doesn’t affect this bus . On the other side, in the case of adding a distribution generator on bus 36 the distance between the source of power and bus 38 deacreases . As a result, the voltage drop decreased and the stability of the voltage increased.

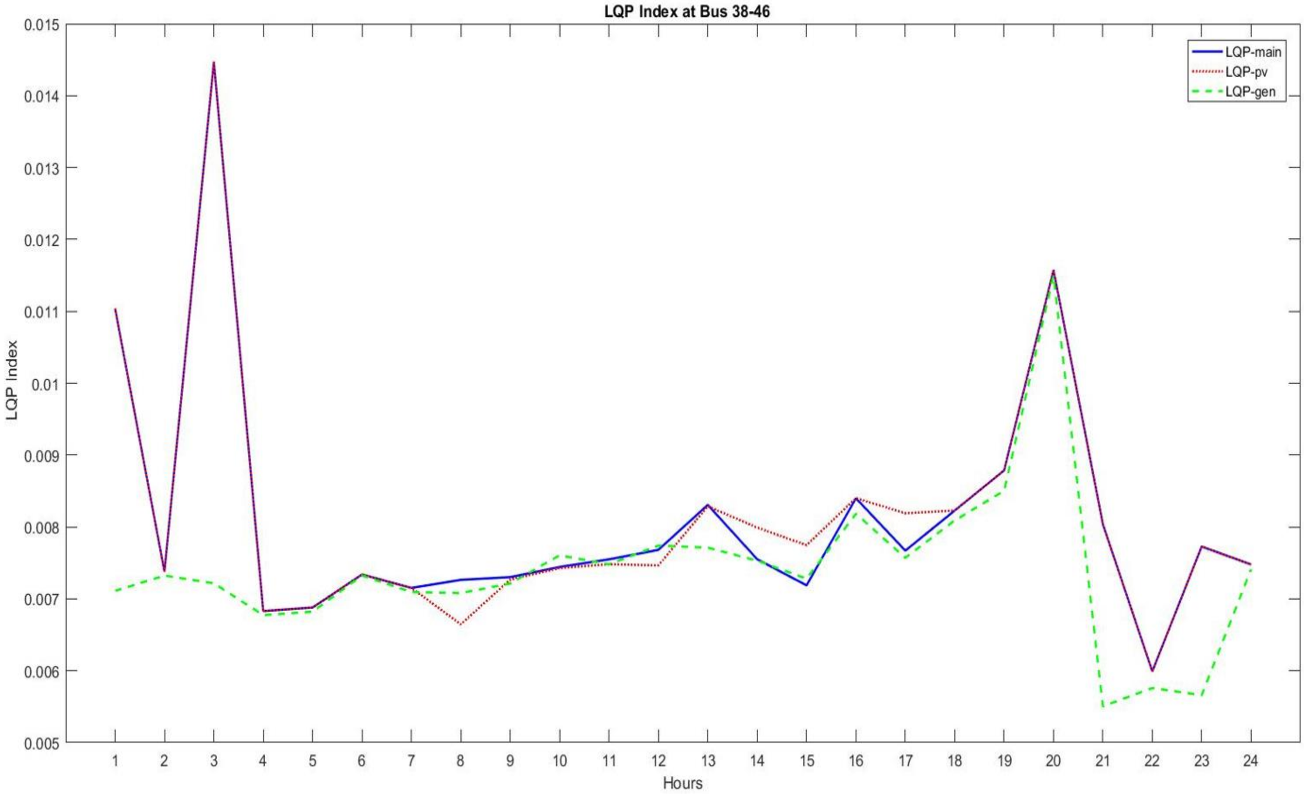

Figure 4.10 :LQP Index at Bus 38-46

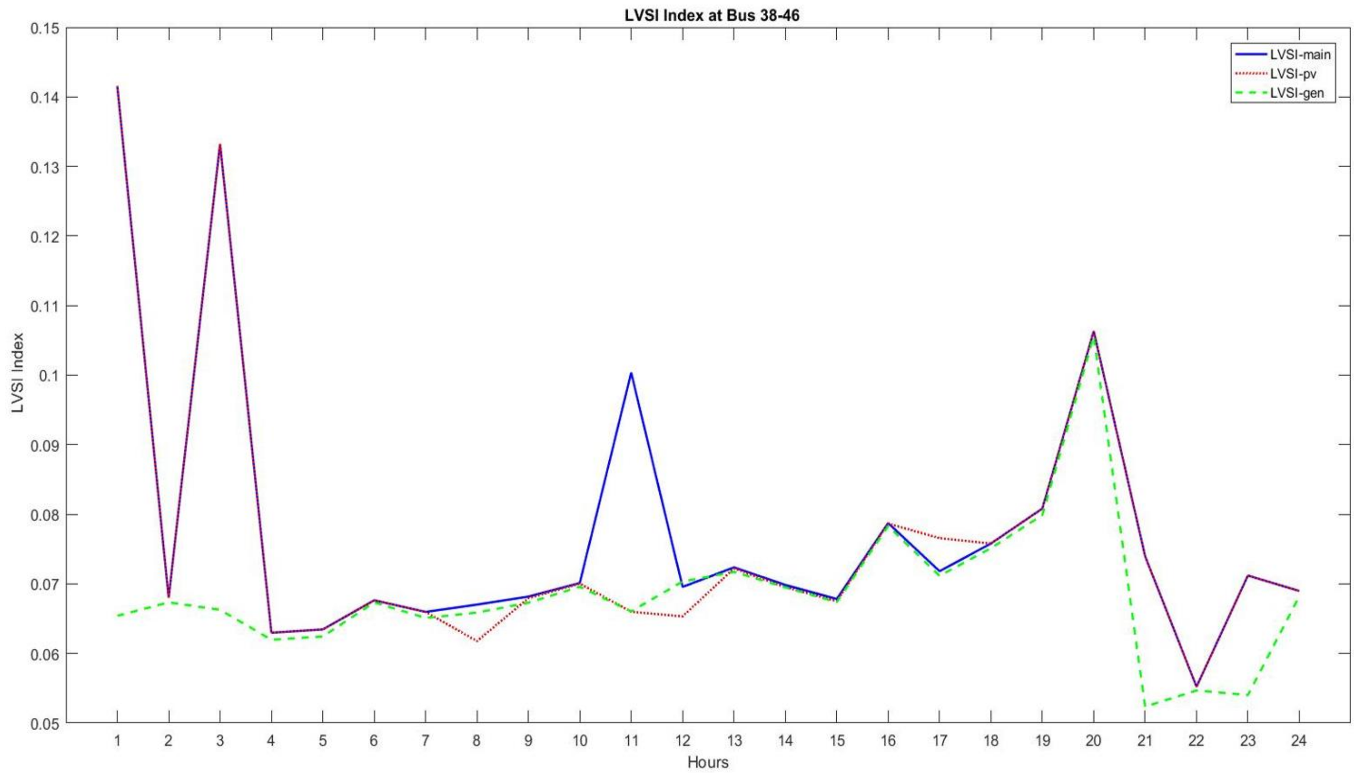

Figure 4.11 :LVSI Index at Bus 38-46

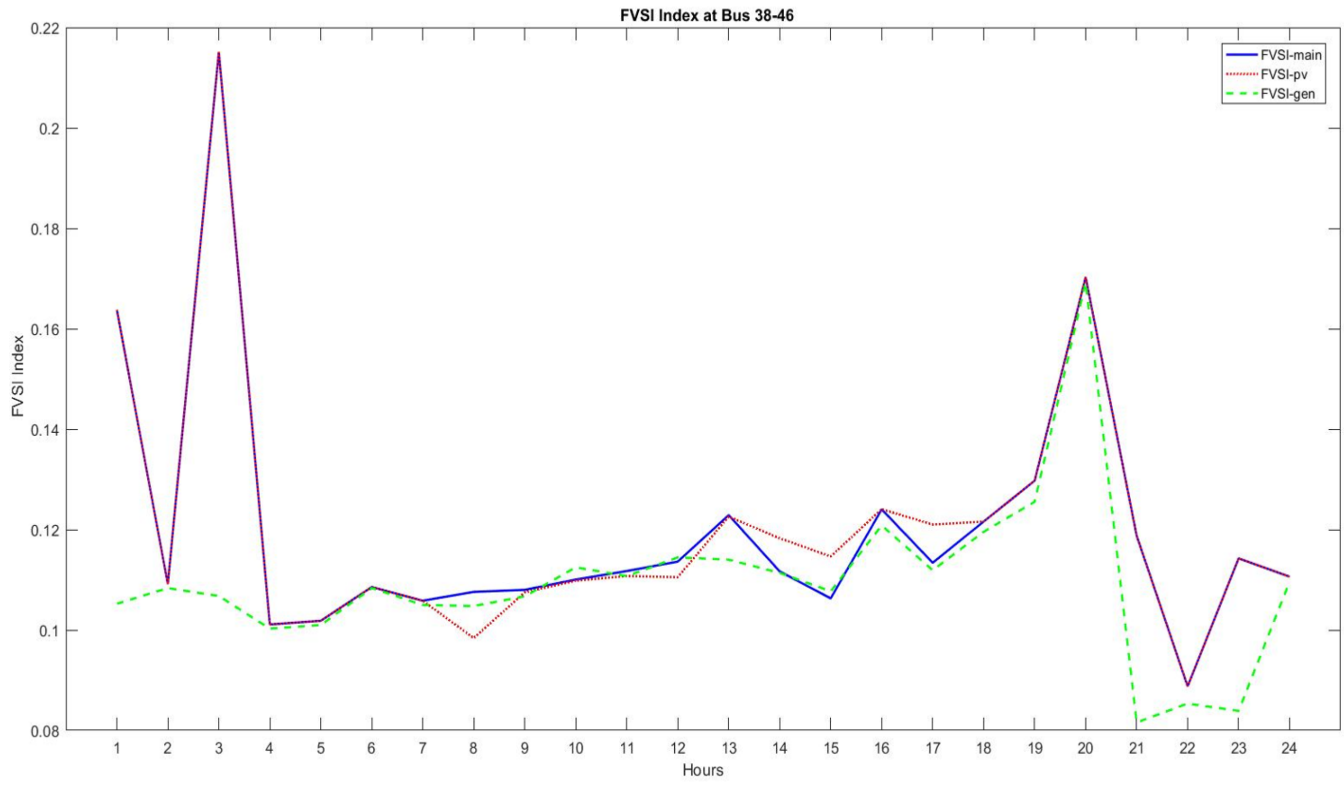

Figure 4.12 :FVSI Index at Bus 38-46

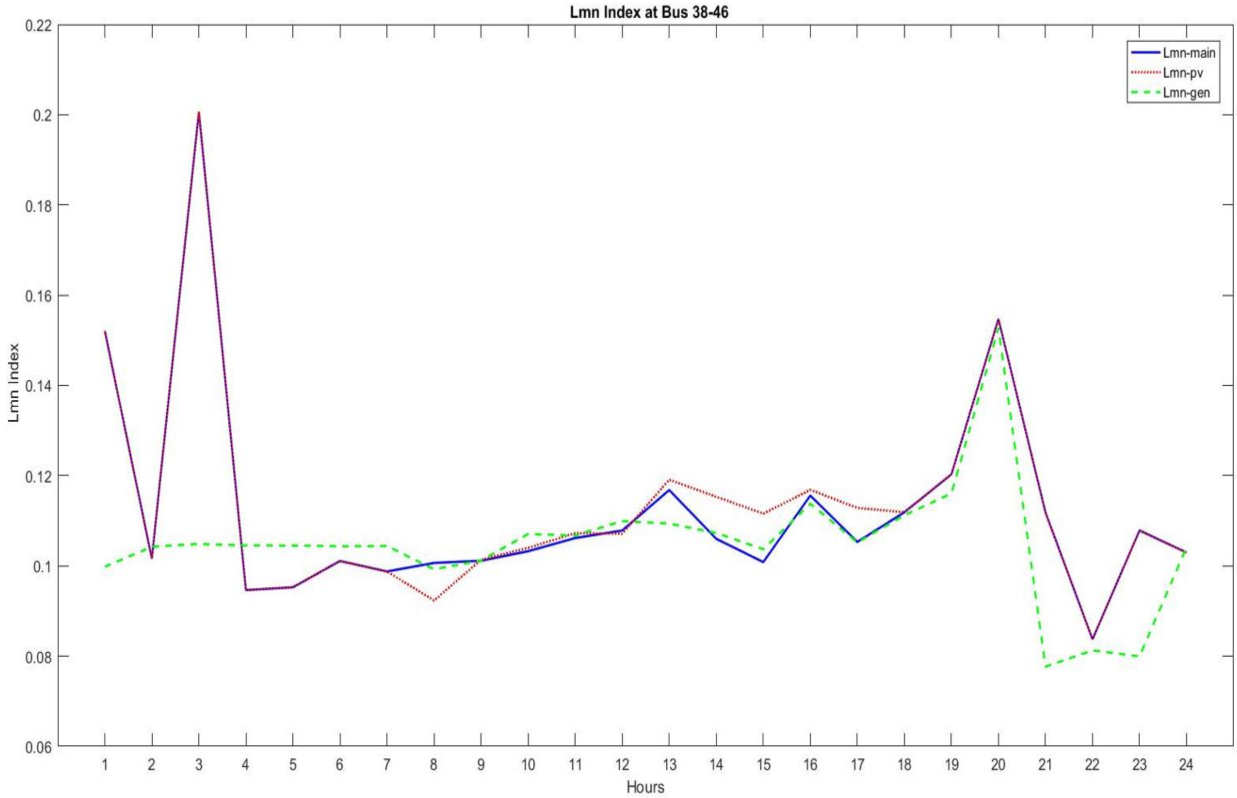

Figure 4.13 :Lmn Index at Bus 38-46

Chapter Five

Conclusion

5.1 Conclusion

5.2 Recommendations

5.1 Conclusion

1. Power system stability and voltage stability have been introduced , which form an important part of maintaining the reliability of the network . Also, described some explanations about voltage stability indices that used in project (LQP, LVSI ,FVSI and Lmn).

2. Discussed the adecuacies of the indices for assessing the most sensitive bus or line on the verge of voltage collapse for modern distribution system.

3. Line stability index (LQP) is the only index which linked directly to the real and reactive power of the receiving bus and sending bus . Also LQP is the most likely index to perform better in modern distribution systems.

4. Showing the impact of solar–PV generation on short- and long-term on voltage stability and power distribution systems . for example, the impact of the dynamic behavior of photovoltaic (PV) power generation systems on short-term voltage stability, and high PV penetration can influence the voltage profile depending on loading conditions and amount of PV penetration.

5. Using indices to show the impact of adding a distribution generator to the network which leads to improvement in power quality that supplied to the customers , and studying the impact of DG on the whole network.

5.2 Recommendations

1. Studying the effect of increasing the loads that connected to the network to almost 50% of its value in the next years and its impact on voltage stability of the network.

2. Studying the effect of adding some electrical cars charging points.

3. Studying the effect of adding a distribution generator with 25% of the value of real and reactive power of the previous assumed generator (200KW,91.13Kvar) and see its affect on voltage stability.

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LOAD FLOW REPORT

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	V	% Mag.	Ang.	kW	kvar	kW	kvar	ID	kW	kvar	Amp	%PF	%Tap
* Bus1	11000	100.000	0.0	184.5	100.3	0.0	0.0	Bus2	184.549	100.313	11.0	87.9	
Bus2	400	100.517	-0.3	0.0	0.0	-0.1	0.1	Bus3	181.615	97.276	295.8	88.2	
								Bus1	-181.539	-97.333	295.8	88.1	2.500
Bus3	400	100.409	-0.3	0.0	0.0	0.0	0.0	Bus2	-181.416	-97.180	295.8	88.1	
								Bus4	41.201	17.483	64.3	92.1	
								Bus19	135.213	53.655	209.1	92.9	
								Bus53	4.970	26.021	38.1	18.8	
Bus4	400	100.050	-0.3	0.0	0.0	0.0	0.0	Bus3	-41.041	-17.451	64.3	92.0	
								Bus5	41.041	17.451	64.3	92.0	
Bus5	400	100.030	-0.3	0.0	0.0	0.0	0.0	Bus4	-41.032	-17.450	64.3	92.0	
								Bus7	41.032	17.450	64.3	92.0	
Bus7	400	100.020	-0.3	0.0	0.0	0.0	0.0	Bus5	-41.028	-17.449	64.3	92.0	
								Bus8	41.028	17.449	64.3	92.0	
Bus8	400	100.004	-0.3	0.0	0.0	0.0	0.0	Bus7	-41.021	-17.447	64.3	92.0	
								Bus9	41.021	17.448	64.3	92.0	
Bus9	400	99.980	-0.3	0.0	0.0	0.0	0.0	Bus8	-41.016	-17.433	64.3	92.0	
								Bus10	41.016	17.433	64.3	92.0	
Bus10	400	99.806	-0.3	0.0	0.0	0.0	0.0	Bus9	-40.938	-17.417	64.3	92.0	
								Bus11	13.632	5.792	21.4	92.0	
								Bus12	27.306	11.626	42.9	92.0	
Bus11	400	99.499	-0.2	0.0	0.0	13.6	5.8	Bus10	-13.585	-5.787	21.4	92.0	
Bus12	400	99.802	-0.3	0.0	0.0	0.0	0.0	Bus10	-27.305	-11.626	42.9	92.0	
								Bus13	27.305	11.626	42.9	92.0	
Bus13	400	99.791	-0.3	0.0	0.0	0.0	0.0	Bus12	-27.302	-11.625	42.9	92.0	
								Bus14	27.302	11.625	42.9	92.0	
Bus14	400	99.780	-0.3	0.0	0.0	0.0	0.0	Bus13	-27.299	-11.625	42.9	92.0	
								Bus15	27.299	11.625	42.9	92.0	
Bus15	400	99.763	-0.3	0.0	0.0	0.0	0.0	Bus14	-27.294	-11.624	42.9	92.0	
								Bus16	27.294	11.624	42.9	92.0	
Bus16	400	99.756	-0.3	0.0	0.0	0.0	0.0	Bus15	-27.292	-11.624	42.9	92.0	
								Bus17	27.292	11.624	42.9	92.0	

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	V	% Mag.	Ang.	kW	kvar	kW	kvar	ID	kW	kvar	Amp	%PF	%Tap
Bus17	400	99.747	-0.3	0.0	0.0	0.0	0.0	Bus16	-27.289	-11.624	42.9	92.0	
								Bus18	27.289	11.624	42.9	92.0	
Bus18	400	99.736	-0.3	0.0	0.0	27.3	11.6	Bus17	-27.286	-11.624	42.9	92.0	
Bus19	400	100.351	-0.3	0.0	0.0	0.0	0.0	Bus3	-135.123	-53.653	209.1	92.9	
								Bus20	135.152	53.659	209.2	92.9	
Bus20	400	100.345	-0.3	0.0	0.0	0.0	0.0	Bus19	-135.144	-53.657	209.2	92.9	
								Bus21	135.146	53.657	209.2	92.9	
Bus21	400	100.308	-0.3	0.0	0.0	0.0	0.0	Bus20	-135.094	-53.643	209.2	92.9	
								Bus22	135.101	53.642	209.2	92.9	
Bus22	400	100.240	-0.3	0.0	0.0	13.8	5.9	Bus21	-135.004	-53.616	209.2	92.9	
								Bus23	121.244	47.750	187.6	93.0	
Bus23	400	100.186	-0.3	0.0	0.0	0.0	0.0	Bus22	-121.176	-47.732	187.6	93.0	
								Bus25	121.162	47.724	187.6	93.0	
Bus25	400	100.052	-0.3	0.0	0.0	18.4	7.8	Bus23	-120.977	-47.720	187.6	93.0	
								Bus27	102.605	39.885	158.8	93.2	
Bus27	400	100.033	-0.3	0.0	0.0	0.0	0.0	Bus25	-102.586	-39.880	158.8	93.2	
								Bus28	102.587	39.880	158.8	93.2	
Bus28	400	100.027	-0.3	0.0	0.0	0.0	0.0	Bus27	-102.581	-39.878	158.8	93.2	
								Bus29	69.382	29.198	108.6	92.2	
								Bus30	33.202	10.679	50.3	95.2	
Bus29	400	98.575	0.0	0.0	0.0	68.2	29.1	Bus28	-68.249	-29.073	108.6	92.0	
Bus30	400	100.011	-0.3	0.0	0.0	13.7	5.9	Bus28	-33.197	-10.678	50.3	95.2	
								Bus31	14.943	2.869	22.0	98.2	
								Bus32	4.599	1.959	7.2	92.0	
Bus31	400	99.897	-0.3	0.0	0.0	4.5	1.9	Bus30	-14.926	-2.866	22.0	98.2	
								Bus33	4.590	1.957	7.2	92.0	
								Bus34	-149.237	-69.582	237.9	90.6	
								Bus38	155.081	68.588	245.0	91.5	
Bus32	400	100.009	-0.3	0.0	0.0	4.6	2.0	Bus30	-4.599	-1.959	7.2	92.0	
Bus33	400	99.895	-0.3	0.0	0.0	4.6	2.0	Bus31	-4.589	-1.958	7.2	92.0	
Bus34	400	99.959	-0.3	0.0	0.0	13.8	5.9	Bus31	149.343	69.597	237.9	90.6	
								Bus35	4.591	1.954	7.2	92.0	
								Bus36	-167.718	-77.419	266.7	90.8	

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	V	% Mag.	Ang.	kW	kvar	kW	kvar	ID	kW	kvar	Amp	%PF	%Tap
Bus35	400	99.851	-0.3	0.0	0.0	4.6	2.0	Bus34	-4.585	-1.953	7.2	92.0	
Bus36	400	100.029	-0.3	200.0	91.1	27.5	11.7	Bus34	167.852	77.437	266.7	90.8	
								Bus37	4.601	1.951	7.2	92.1	
Bus37	400	100.027	-0.3	0.0	0.0	4.6	2.0	Bus36	-4.601	-1.951	7.2	92.1	
Bus38	400	99.807	-0.3	0.0	0.0	13.7	5.8	Bus31	-154.957	-68.491	245.0	91.5	
								Bus42	24.816	9.718	38.5	93.1	
								Bus44	116.456	52.957	185.0	91.0	
Bus40	400	99.801	-0.3	0.0	0.0	0.0	0.0	Bus42	-1.993	0.020	2.9	100.0	
								Bus41	1.991	0.013	2.9	100.0	
Bus41	400	99.801	-0.3	0.0	0.0	0.0	0.0	Bus40	-1.991	-0.014	2.9	100.0	
								Bus47	1.993	0.013	2.9	100.0	
Bus42	400	99.802	-0.3	0.0	0.0	22.8	9.7	Bus38	-24.814	-9.718	38.5	93.1	
								Bus40	1.993	-0.020	2.9	100.0	
Bus44	400	99.790	-0.3	0.0	0.0	0.0	0.0	Bus38	-116.435	-52.952	185.0	91.0	
								Bus45	116.436	52.990	185.0	91.0	
Bus45	400	99.779	-0.3	0.0	0.0	0.0	0.0	Bus44	-116.422	-52.987	185.0	91.0	
								Bus46	116.422	53.019	185.1	91.0	
Bus46	400	99.768	-0.3	0.0	0.0	27.5	11.7	Bus45	-116.409	-53.016	185.1	91.0	
								Bus48	88.937	41.342	141.9	90.7	
Bus47	400	99.800	-0.3	2.6	1.9	4.6	2.0	Bus41	-1.992	-0.013	2.9	100.0	
Bus48	400	99.759	-0.3	0.0	0.0	4.6	1.9	Bus46	-88.928	-41.340	141.9	90.7	
								Bus49	84.348	39.433	134.7	90.6	
Bus49	400	99.751	-0.3	0.0	0.0	31.9	13.6	Bus48	-84.341	-39.431	134.7	90.6	
								Bus50	31.663	14.262	50.2	91.2	
								Bus56	20.799	11.604	34.5	87.3	
Bus50	400	99.747	-0.3	0.0	0.0	13.7	5.8	Bus49	-31.661	-14.262	50.2	91.2	
								Bus51	17.985	8.444	28.8	90.5	
Bus51	400	99.743	-0.3	0.0	0.0	9.2	3.9	Bus50	-17.984	-8.444	28.8	90.5	
								Bus52	8.764	4.592	14.3	88.6	
Bus52	400	99.743	-0.3	0.0	0.0	8.8	4.6	Bus51	-8.764	-4.593	14.3	88.6	
Bus53	400	100.409	-0.3	48.8	0.0	53.7	26.0	Bus3	-4.970	-26.021	38.1	18.8	
Bus56	400	99.551	-0.3	6.5	0.0	27.2	11.6	Bus49	-20.752	-11.590	34.5	87.3	

* 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

LOAD FLOW REPORT

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	V	% Mag.	Ang.	kW	kvar	kW	kvar	ID	kW	kvar	Amp	%PF	%Tap
* Bus1	11000	100.000	0.0	492.2	222.3	0.0	0.0	Bus2	492.237	222.312	28.3	91.1	
Bus2	400	97.536	-1.1	0.0	0.0	0.0	0.0	Bus3	472.333	202.629	760.6	91.9	
								Bus1	-472.335	-202.609	760.6	91.9	2.500
Bus3	400	97.260	-1.1	0.0	0.0	0.0	0.0	Bus2	-471.017	-201.995	760.6	91.9	
								Bus4	43.971	18.649	70.9	92.1	
								Bus19	367.049	154.242	590.9	92.2	
								Bus53	60.004	29.056	98.9	90.0	
Bus4	400	96.864	-1.0	0.0	0.0	0.0	0.0	Bus3	-43.776	-18.610	70.9	92.0	
								Bus5	43.776	18.610	70.9	92.0	
Bus5	400	96.842	-1.0	0.0	0.0	0.0	0.0	Bus4	-43.766	-18.608	70.9	92.0	
								Bus7	43.766	18.608	70.9	92.0	
Bus7	400	96.831	-1.0	0.0	0.0	0.0	0.0	Bus5	-43.760	-18.607	70.9	92.0	
								Bus8	43.760	18.607	70.9	92.0	
Bus8	400	96.814	-1.0	0.0	0.0	0.0	0.0	Bus7	-43.752	-18.605	70.9	92.0	
								Bus9	43.747	18.608	70.9	92.0	
Bus9	400	96.787	-1.1	0.0	0.0	0.0	0.0	Bus8	-43.740	-18.590	70.9	92.0	
								Bus10	43.746	18.587	70.9	92.0	
Bus10	400	96.595	-1.0	0.0	0.0	0.0	0.0	Bus9	-43.652	-18.568	70.9	92.0	
								Bus11	14.534	6.173	23.6	92.0	
								Bus12	29.118	12.396	47.3	92.0	
Bus11	400	96.257	-1.0	0.0	0.0	14.5	6.2	Bus10	-14.477	-6.167	23.6	92.0	
Bus12	400	96.591	-1.0	0.0	0.0	0.0	0.0	Bus10	-29.117	-12.396	47.3	92.0	
								Bus13	29.117	12.396	47.3	92.0	
Bus13	400	96.579	-1.0	0.0	0.0	0.0	0.0	Bus12	-29.113	-12.396	47.3	92.0	
								Bus14	29.113	12.396	47.3	92.0	
Bus14	400	96.567	-1.0	0.0	0.0	0.0	0.0	Bus13	-29.109	-12.395	47.3	92.0	
								Bus15	29.110	12.395	47.3	92.0	
Bus15	400	96.548	-1.0	0.0	0.0	0.0	0.0	Bus14	-29.103	-12.394	47.3	92.0	
								Bus16	29.104	12.395	47.3	92.0	
Bus16	400	96.540	-1.0	0.0	0.0	0.0	0.0	Bus15	-29.101	-12.395	47.3	92.0	
								Bus17	29.102	12.395	47.3	92.0	

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	V	% Mag.	Ang.	kW	kvar	kW	kvar	ID	kW	kvar	Amp	%PF	%Tap
Bus17	400	96.530	-1.0	0.0	0.0	0.0	0.0	Bus16	-29.098	-12.395	47.3	92.0	
								Bus18	29.099	12.395	47.3	92.0	
Bus18	400	96.518	-1.0	0.0	0.0	29.1	12.4	Bus17	-29.095	-12.394	47.3	92.0	
Bus19	400	97.096	-1.1	0.0	0.0	0.0	0.0	Bus3	-366.331	-154.222	590.9	92.2	
								Bus20	366.330	154.237	590.9	92.2	
Bus20	400	97.080	-1.1	0.0	0.0	0.0	0.0	Bus19	-366.268	-154.220	590.9	92.2	
								Bus21	366.269	154.220	590.9	92.2	
Bus21	400	96.976	-1.0	0.0	0.0	0.0	0.0	Bus20	-365.855	-154.106	590.9	92.2	
								Bus22	365.855	154.106	590.9	92.2	
Bus22	400	96.783	-1.0	0.0	0.0	14.6	6.2	Bus21	-365.089	-153.893	590.9	92.1	
								Bus23	350.470	147.664	567.2	92.2	
Bus23	400	96.620	-1.0	0.0	0.0	0.0	0.0	Bus22	-349.848	-147.493	567.2	92.1	
								Bus25	349.847	147.470	567.2	92.1	
Bus25	400	96.218	-0.9	0.0	0.0	19.4	8.2	Bus23	-348.152	-147.423	567.2	92.1	
								Bus27	328.800	139.198	535.6	92.1	
Bus27	400	96.157	-0.9	0.0	0.0	0.0	0.0	Bus25	-328.579	-139.137	535.6	92.1	
								Bus28	328.584	139.145	535.6	92.1	
Bus28	400	96.136	-0.9	0.0	0.0	0.0	0.0	Bus27	-328.509	-139.124	535.6	92.1	
								Bus29	77.786	32.649	126.7	92.2	
								Bus30	250.721	106.471	409.0	92.0	
Bus29	400	94.443	-0.6	0.0	0.0	76.2	32.5	Bus28	-76.244	-32.479	126.7	92.0	
Bus30	400	96.003	-0.9	0.0	0.0	14.4	6.1	Bus28	-250.354	-106.370	409.0	92.0	
								Bus31	231.175	98.182	377.6	92.0	
								Bus32	4.787	2.039	7.8	92.0	
Bus31	400	94.088	-0.7	0.0	0.0	4.6	1.9	Bus30	-226.161	-97.166	377.6	91.9	
								Bus33	4.631	1.972	7.7	92.0	
								Bus34	50.751	21.611	84.6	92.0	
								Bus38	166.140	71.658	277.6	91.8	
Bus32	400	96.001	-0.9	0.0	0.0	4.8	2.0	Bus30	-4.787	-2.039	7.8	92.0	
Bus33	400	94.086	-0.7	0.0	0.0	4.6	2.0	Bus31	-4.630	-1.972	7.7	92.0	
Bus34	400	94.066	-0.7	0.0	0.0	13.8	5.9	Bus31	-50.737	-21.609	84.6	92.0	
								Bus35	4.606	1.960	7.7	92.0	
								Bus36	32.290	13.754	53.9	92.0	

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	V	% Mag.	Ang.	kW	kvar	kW	kvar	ID	kW	kvar	Amp	%PF	%Tap
Bus35	400	93.951	-0.6	0.0	0.0	4.6	2.0	Bus34	-4.600	-1.959	7.7	92.0	
Bus36	400	94.052	-0.7	0.0	0.0	27.7	11.8	Bus34	-32.285	-13.753	53.9	92.0	
								Bus37	4.616	1.966	7.7	92.0	
Bus37	400	94.050	-0.7	0.0	0.0	4.6	2.0	Bus36	-4.616	-1.966	7.7	92.0	
Bus38	400	93.987	-0.7	0.0	0.0	13.8	6.0	Bus31	-165.981	-71.533	277.6	91.8	
								Bus42	27.684	11.792	46.2	92.0	
								Bus44	124.458	53.788	208.2	91.8	
Bus40	400	93.979	-0.7	0.0	0.0	0.0	0.0	Bus42	-4.595	-1.957	7.7	92.0	
								Bus41	4.603	1.962	7.7	92.0	
Bus41	400	93.978	-0.7	0.0	0.0	0.0	0.0	Bus40	-4.603	-1.962	7.7	92.0	
								Bus47	4.603	1.961	7.7	92.0	
Bus42	400	93.980	-0.7	0.0	0.0	23.1	9.8	Bus38	-27.682	-11.792	46.2	92.0	
								Bus40	4.595	1.957	7.7	92.0	
Bus44	400	93.968	-0.7	0.0	0.0	0.0	0.0	Bus38	-124.431	-53.781	208.2	91.8	
								Bus45	124.439	53.782	208.2	91.8	
Bus45	400	93.955	-0.7	0.0	0.0	0.0	0.0	Bus44	-124.421	-53.777	208.2	91.8	
								Bus46	124.427	53.778	208.2	91.8	
Bus46	400	93.943	-0.7	0.0	0.0	27.6	11.8	Bus45	-124.410	-53.774	208.2	91.8	
								Bus48	96.808	42.015	162.1	91.7	
Bus47	400	93.976	-0.7	0.0	0.0	4.6	2.0	Bus41	-4.603	-1.961	7.7	92.0	
Bus48	400	93.932	-0.7	0.0	0.0	4.6	2.0	Bus46	-96.797	-42.012	162.1	91.7	
								Bus49	92.206	40.055	154.5	91.7	
Bus49	400	93.924	-0.7	0.0	0.0	32.5	13.8	Bus48	-92.197	-40.053	154.5	91.7	
								Bus50	31.849	14.357	53.7	91.2	
								Bus56	27.849	11.851	46.5	92.0	
Bus50	400	93.919	-0.7	0.0	0.0	13.8	5.9	Bus49	-31.847	-14.357	53.7	91.2	
								Bus51	18.033	8.472	30.6	90.5	
Bus51	400	93.915	-0.7	0.0	0.0	9.2	3.9	Bus50	-18.032	-8.472	30.6	90.5	
								Bus52	8.828	4.589	15.3	88.7	
Bus52	400	93.914	-0.7	0.0	0.0	8.8	4.6	Bus51	-8.828	-4.589	15.3	88.7	
Bus53	400	97.259	-1.1	0.0	0.0	60.0	29.1	Bus3	-60.004	-29.056	98.9	90.0	
Bus56	400	93.648	-0.7	0.0	0.0	27.8	11.8	Bus49	-27.763	-11.827	46.5	92.0	

* 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

LOAD FLOW REPORT

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	V	% Mag.	Ang.	kW	kvar	kW	kvar	ID	kW	kvar	Amp	%PF	%Tap
* Bus1	11000	100.000	0.0	335.5	181.9	0.0	0.0	Bus2	335.535	181.890	20.0	87.9	
Bus2	400	98.900	-0.6	0.0	0.0	0.0	0.0	Bus3	325.634	172.008	537.5	88.4	
								Bus1	-325.597	-172.051	537.4	88.4	2.500
Bus3	400	98.704	-0.6	0.0	0.0	0.0	0.0	Bus2	-324.977	-171.692	537.5	88.4	
								Bus4	27.049	7.302	41.0	96.5	
								Bus19	293.303	138.509	474.3	90.4	
								Bus53	4.606	25.845	38.4	17.5	
Bus4	400	98.471	-0.6	0.0	0.0	0.0	0.0	Bus3	-26.984	-7.290	41.0	96.5	
								Bus5	26.984	7.290	41.0	96.5	
Bus5	400	98.459	-0.6	0.0	0.0	0.0	0.0	Bus4	-26.981	-7.289	41.0	96.5	
								Bus7	26.981	7.289	41.0	96.5	
Bus7	400	98.452	-0.6	0.0	0.0	0.0	0.0	Bus5	-26.979	-7.289	41.0	96.5	
								Bus8	26.979	7.289	41.0	96.5	
Bus8	400	98.442	-0.6	0.0	0.0	0.0	0.0	Bus7	-26.976	-7.289	41.0	96.5	
								Bus9	26.976	7.289	41.0	96.5	
Bus9	400	98.429	-0.6	0.0	0.0	0.0	0.0	Bus8	-26.974	-7.283	41.0	96.5	
								Bus10	26.974	7.283	41.0	96.5	
Bus10	400	98.316	-0.6	0.0	0.0	0.0	0.0	Bus9	-26.943	-7.277	41.0	96.5	
								Bus11	13.269	5.637	21.2	92.0	
								Bus12	13.674	1.639	20.2	99.3	
Bus11	400	98.013	-0.5	0.0	0.0	13.2	5.6	Bus10	-13.222	-5.633	21.2	92.0	
Bus12	400	98.314	-0.6	0.0	0.0	0.0	0.0	Bus10	-13.674	-1.640	20.2	99.3	
								Bus13	13.674	1.640	20.2	99.3	
Bus13	400	98.309	-0.6	0.0	0.0	0.0	0.0	Bus12	-13.673	-1.640	20.2	99.3	
								Bus14	13.673	1.640	20.2	99.3	
Bus14	400	98.304	-0.6	0.0	0.0	0.0	0.0	Bus13	-13.672	-1.640	20.2	99.3	
								Bus15	13.672	1.640	20.2	99.3	
Bus15	400	98.296	-0.6	0.0	0.0	0.0	0.0	Bus14	-13.671	-1.641	20.2	99.3	
								Bus16	13.671	1.641	20.2	99.3	
Bus16	400	98.292	-0.6	0.0	0.0	0.0	0.0	Bus15	-13.671	-1.641	20.2	99.3	
								Bus17	13.671	1.641	20.2	99.3	

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	V	% Mag.	Ang.	kW	kvar	kW	kvar	ID	kW	kvar	Amp	%PF	%Tap
Bus17	400	98.288	-0.6	0.0	0.0	0.0	0.0	Bus16	-13.670	-1.641	20.2	99.3	
								Bus18	13.670	1.641	20.2	99.3	
Bus18	400	98.283	-0.6	12.9	9.7	26.6	11.3	Bus17	-13.669	-1.642	20.2	99.3	
Bus19	400	98.575	-0.6	0.0	0.0	0.0	0.0	Bus3	-292.840	-138.496	474.3	90.4	
								Bus20	292.860	138.511	474.4	90.4	
Bus20	400	98.563	-0.6	0.0	0.0	0.0	0.0	Bus19	-292.819	-138.500	474.4	90.4	
								Bus21	292.821	138.499	474.4	90.4	
Bus21	400	98.480	-0.6	0.0	0.0	0.0	0.0	Bus20	-292.554	-138.426	474.4	90.4	
								Bus22	292.558	138.424	474.4	90.4	
Bus22	400	98.326	-0.5	0.0	0.0	13.3	5.7	Bus21	-292.064	-138.287	474.4	90.4	
								Bus23	278.769	132.618	453.2	90.3	
Bus23	400	98.197	-0.5	0.0	0.0	0.0	0.0	Bus22	-278.372	-132.509	453.2	90.3	
								Bus25	278.360	132.489	453.1	90.3	
Bus25	400	97.882	-0.5	0.0	0.0	17.7	7.6	Bus23	-277.278	-132.459	453.1	90.2	
								Bus27	259.539	124.903	424.7	90.1	
Bus27	400	97.833	-0.4	0.0	0.0	0.0	0.0	Bus25	-259.400	-124.865	424.7	90.1	
								Bus28	259.402	124.865	424.7	90.1	
Bus28	400	97.817	-0.4	0.0	0.0	0.0	0.0	Bus27	-259.354	-124.852	424.7	90.1	
								Bus29	38.293	28.988	70.9	79.7	
								Bus30	221.064	95.862	355.5	91.7	
Bus29	400	96.969	-0.1	30.1	0.0	67.9	28.9	Bus28	-37.810	-28.935	70.9	79.4	
Bus30	400	97.701	-0.4	0.0	0.0	13.1	5.6	Bus28	-220.786	-95.786	355.5	91.7	
								Bus31	203.272	88.287	327.4	91.7	
								Bus32	4.410	1.878	7.1	92.0	
Bus31	400	96.044	-0.2	0.0	0.0	4.2	1.8	Bus30	-199.503	-87.523	327.4	91.6	
								Bus33	4.284	1.827	7.0	92.0	
								Bus34	46.950	19.990	76.7	92.0	
								Bus38	144.071	63.919	236.9	91.4	
Bus32	400	97.699	-0.4	0.0	0.0	4.4	1.9	Bus30	-4.410	-1.879	7.1	92.0	
Bus33	400	96.042	-0.2	0.0	0.0	4.3	1.8	Bus31	-4.284	-1.827	7.0	92.0	
Bus34	400	96.023	-0.2	0.0	0.0	12.8	5.5	Bus31	-46.939	-19.988	76.7	92.0	
								Bus35	4.269	1.816	7.0	92.0	
								Bus36	29.848	12.712	48.8	92.0	

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	V	% Mag.	Ang.	kW	kvar	kW	kvar	ID	kW	kvar	Amp	%PF	%Tap
Bus35	400	95.919	-0.2	0.0	0.0	4.3	1.8	Bus34	-4.263	-1.816	7.0	92.0	
Bus36	400	96.011	-0.2	0.0	0.0	25.6	10.9	Bus34	-29.843	-12.712	48.8	92.0	
								Bus37	4.274	1.823	7.0	92.0	
Bus37	400	96.009	-0.2	0.0	0.0	4.3	1.8	Bus36	-4.274	-1.823	7.0	92.0	
Bus38	400	95.957	-0.2	0.0	0.0	12.8	5.4	Bus31	-143.956	-63.828	236.9	91.4	
								Bus42	22.944	8.925	37.0	93.2	
								Bus44	108.250	49.468	179.0	91.0	
Bus40	400	95.951	-0.2	0.0	0.0	0.0	0.0	Bus42	-1.680	0.144	2.5	-99.6	
								Bus41	1.676	-0.122	2.5	-99.7	
Bus41	400	95.951	-0.2	0.0	0.0	0.0	0.0	Bus40	-1.676	0.122	2.5	-99.7	
								Bus47	1.677	-0.122	2.5	-99.7	
Bus42	400	95.952	-0.2	0.0	0.0	21.3	9.1	Bus38	-22.943	-8.925	37.0	93.2	
								Bus40	1.680	-0.145	2.5	-99.6	
Bus44	400	95.940	-0.2	0.0	0.0	0.0	0.0	Bus38	-108.230	-49.463	179.0	91.0	
								Bus45	108.227	49.489	179.0	90.9	
Bus45	400	95.930	-0.2	0.0	0.0	0.0	0.0	Bus44	-108.214	-49.485	179.0	90.9	
								Bus46	108.211	49.507	179.0	90.9	
Bus46	400	95.919	-0.2	0.0	0.0	25.6	10.9	Bus45	-108.198	-49.504	179.0	90.9	
								Bus48	82.608	38.623	137.2	90.6	
Bus47	400	95.950	-0.2	2.6	1.9	4.3	1.8	Bus41	-1.677	0.122	2.5	-99.7	
Bus48	400	95.910	-0.2	0.0	0.0	4.3	1.8	Bus46	-82.600	-38.621	137.2	90.6	
								Bus49	78.332	36.834	130.3	90.5	
Bus49	400	95.903	-0.2	0.0	0.0	29.8	12.7	Bus48	-78.326	-36.833	130.3	90.5	
								Bus50	29.465	13.284	48.6	91.2	
								Bus56	19.048	10.858	33.0	86.9	
Bus50	400	95.899	-0.2	0.0	0.0	12.7	5.4	Bus49	-29.463	-13.284	48.6	91.2	
								Bus51	16.728	7.865	27.8	90.5	
Bus51	400	95.895	-0.2	0.0	0.0	8.6	3.6	Bus50	-16.728	-7.865	27.8	90.5	
								Bus52	8.160	4.263	13.9	88.6	
Bus52	400	95.895	-0.2	0.0	0.0	8.2	4.3	Bus51	-8.160	-4.263	13.9	88.6	
Bus53	400	98.704	-0.6	48.8	0.0	53.4	25.8	Bus3	-4.606	-25.845	38.4	17.5	
Bus56	400	95.712	-0.2	6.5	0.0	25.5	10.8	Bus49	-19.005	-10.846	33.0	86.9	

* 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