An-Najah National University

Faculty of Graduate Studies

Improving Tubas Electrical Distribution Network Power Flow Parameters By Adding A Photovoltaic Based Distributed Generation Unit And A Medium Voltage Transmission Line

by

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- Dr.Moien Omar/Internal Examiner	……………………

Dedicate

اهدي هذا العمل إلى قدوتي الأولى , ونبراسي الذي ينير دربي , إلى من أعطاني ولم يزل يعطيني بلا حدود , إلى من رفعت راسي عاليا افتخر به .... أبي العزيز

أدامه الله ذخرا لي

إلى التي رآني قلبها قبل عينيها , وحضنتني أحشائها قبل يديها , إلى شجرتي التي لا تذبل , إلى الظل الذي أوي إليه في كل حين .... أمي الحبيبة

حفظها الله

إلى الشموع التي تنير لي الطرق إخواني وأخواتي وأبنائهم حفظهم الله

إلى الأهل والأقارب والأصدقاء وكل من رافقني في دربي ولم يترك يدي في كل الظروف

إلى الشهداء والأسرى البواسل للمسجد الأقصى وقبة الصخرة ولهذا الوطن الحبيب

إلى أستاذي الكريم الدكتور ماهر خماش

لهم جميعا اهدي ثمرة جهدي

الإقرار

أنا الموقع أدناه مقدم الرسالة التي تحمل العنوان :

IMPROVING TUBAS ELECTRICAL DISTRIBUTION NETWORK POWER FLOW PARAMETERS BY ADDING A PHOTOVOLTAIC BASED DISTRIBUTED GENERATION UNIT AND A MEDIUM VOLTAGE TRANSMISSION LINE

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List of abbreviations

IEC	International Electrotechnical Commission[1]
S	Apparent power
MVA	Mega Volte Amperes
PV , PVsystem	Photo Voltaic , Photo Voltaic System
KV	Kilo Volte
Trans. , T	Transformers , Transformer
SLD	Signal Line Diagram
mm^2	mile meter square
SCADA	Supervisory Control And Data Acquisition[2]
ETAP	Electrical Transient And Analysis Program[3]
AC	Alternative Current
DC	Direct Current
ANSI	American National Standards Institute[4]
OTI	Office Of Transient Initiative[5]
ISO	International Organization Of Standardization[6]
CEO	Chief Executive Officer[7]
dba	doctor of business administration[8]
MS-DOS	Microsoft Disk Operation System[9]
KM	Kilo Meters
KVA	Kilo Volt Amperes
P , P_{max}	real power , real power maximum
KW	Kilo Watts
Q , Q_{max}	reactive power , reactive power maximum
L	Load
m	meter
G	Generator
B	Bus
MW	Mega Watts
PF	Power Factor
EFF	Efficiency Fill Factor
C	Capacitor , Capacitance
NIS	New Israel Shekel
SI	International System of units[48]
F	Farad (capacitance unit)
Ơ	Electric charge
W	Work
dƠ	The derivative of the electric charge
dV	The derivative of the electric voltage
t	The time in the seconds

Improving Tubas Electrical Distribution Network Power Flow Parameters by Adding a Photovoltaic Based Distributed Generation Unit and A Medium Voltage Transmission Line

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Abstract

This thesis presents a set of proposed solutions to solve a set of problems in Tubas electricity network, and these solutions were chosen as the best solutions in terms of practicality, terms of cost and income for each of these solutions. Also, this thesis dealt with a set of solutions proposed by the company (Tubas Electricity Company) and the proposed solutions in the thesis were developed as additional solutions to the solutions proposed by the company and not as an alternative to it. It is important to mention that the Tubas electricity network has several connection points between the company's network and the network of the Qatari Israeli company and the North Electricity Company's network. During this thesis, all these points will be discussed and their impact on the Tubas electricity network.

The objectives to be achieved in this thesis, improving the power parameters of Tubas electricity network (especially the Al-Fara’a area), design of technique to distribute the power generated by the new "Al-Fara'a town generator (new source with new transmission line or PVsystem), providing a stable electrical current for some loads in Tubas electricity network, reducing pressure on some transformers in Tubas

electricity network, improving the power factor (PF) for some low power factor (PF) loads, providing stable electrical current for some new loads without affecting the old loads for some areas of Tubas electricity network, improving and development of Tubas electrical distribution network by reducing the consumption of electricity from IEC, establishment and design of a new generator, new source or PV system in the network to support the increase of the capacity of power consumed in the network, reducing the shortages at peak hours for some areas of Tubas network and feed new places from North Electricity Company network.

Chapter 1
The Introduction

1.1 Introduction:

Tubas is one of the northern areas of the West Bank characterized by abundant agricultural areas , and therefore requires large amounts of water and electricity consumption. It relies on the Qatari-Israeli company (IEC) to provide electricity. As electricity consumption increases in the domestic, commercial, industrial and agricultural sectors. There is a problem in the provision of electricity continuously to the consuming sectors. 40MVA peak value which consist of : 20MVA from Tyaseer connection point and 20MVA from Al-Jalameh connection point is considered as a problem in terms of insurance of continuity of electricity supply .

The problem is in Al-Fara'a town which is located in Tyaseer region "Tyaseer connection point", which causes to disconnect the electricity from some area (as we explained previously, there are two connection points to feed Tubas electricity company " Tyaseer connection point and Al-Jalameh connection point". The pressure on the electric power is at the time of the peak on Al-Fara'a area which receives the supply from Tyaseer connection point, and to reduce this pressure, the electrical power is cutoff from Arab American University areas that receive the supply from Al-Jalameh connection point. That is, the pressure will be on al-Fara'a area while the cut will be on Arab American University areas, this is the actual problem).

Near Tubas behind Al-Fara'a town a new transmission line from another source is under reconstruction to increase its capacity from 5 MVA to 20 MVA another solution is adding a PV system in Al-Fara'a town. This new source or PV system will be connected to transmission lines at a voltage of 33KV, to supply Tubas network and connect it with specific connection points, each connection point feeds an area in Tubas network and has a limited power value.

The table (1.1.1) shows the Distribution of regions in terms of consumption in Tubas network, and the transformers used in every region [10].

Table (1.1.1): The distribution of regions and the number of transformers in Tubas network

<table>
<tr><th colspan="3">Transformation Substations 33KV/0.4KV</th><th colspan="2">Connection points</th></tr>
<tr><td rowspan="8">TYASEER Connection point</td><td>TYASEER village (2 transformers)</td><td rowspan="8">134 Trans.</td><td rowspan="8">TYASEER</td><td rowspan="8">20 MVA (Real consumption 10-11 MVA)</td></tr>
<tr><td>AQABEH village (1 transformer)</td></tr>
<tr><td>TUBAS city (39 transformers)</td></tr>
<tr><td>KESHDA village (2 transformers)</td></tr>
<tr><td>RAS AL-FARA'A region (19 transformers)</td></tr>
<tr><td>WADI AL-FARA'A region (23 transformers)</td></tr>
<tr><td>AL-FARA'A CAMP region (15 transformers)</td></tr>
<tr><td>TAMMON municipality (16 transformers)</td></tr>
</table>

	ATOOF municipality (17 transformers)			
AL-JALAMEH Connection point	TYASEER village (2 transformers)	118 Trans.	AL-JALAMEH	8 up to20 MVA (Real consumption 10-15 MVA)
	TUBAS city (13 transformers)			
	KESHDA village (1 transformer)			
	AL-FARA'A CAMP region (2 transformers)			
	AQQABA municipality (7 transformers)			
	AL-KFIER village(3 transformers)			
	AL-ZABABEDA municipality (11 transformers)			
	RABA town (7 transformers)			
	TELFEET village (7 transformers)			
	TINEEN village (1 transformer)			
	ARAB AMERICAN UNIVERSITY JENIN "AAUJ" region (9 transformers)			
	PRIVATE PROJECT region (5 transformers)			

	DREAM LAND region (8 transformers)			
	JALQAMOUS village (4 transformers)			
	AL-MGHAYER village (4 transformers)			
	AL-MTELLEH village (1 transformer)			
	UM AL-TOOT village (3 transformers)			
	MESELYEH municipality (9 transformers)			
	AL-JARBA village (4 transformers)			
	MERKEH village (6 transformers)			
	AL-ZAWYAH village (3 transformers)			
	ANZAA village (2 transformers)			
	HAFEERI village (1 transformer)			
	WADI DOUQ village (2 transformers)			
	BEER AL-BASHA village (3 transformers)			

In this thesis we choose "Al-Fara'a town" as a solution to improve Tubas network, this is due to the lack of electricity in the town of al-Fara'a and its continuous interruption. The design includes also a construction of a new transmission line, the new transmission line is used to transmit electrical energy from the new generator, new source (this new source is from the connection point "Al-Jalameh") or PV system. This transmission line is required to transfer only the new power generated because the old network cannot transfer the new power (which is about 15MVA) so we need to design and construct this transmission line to transfer power for several regions (Al-Fara'a town "Wadi Al-Fara'a", Ras Al-Fara'a, Al-Fara'a Camp, Tammon town, Atoof town, the valleys Tubas city and other places from another network "North Electricity Company") and to connect the new generator, new source or PV system with Tubas network. This new generator, new source or PV system will solve the problem of shortage in the power supplied and will redistribute the extra load between the regions. and feed other places from north network (Al-Nasaryeh town, the town of Yaseed, Al-Bathan town, and Sier town), and feed the north network by about 10MVA .

To complete the design of Al-Fara'a town generator, new source or PV system it is required to study the existing loads and the shortage in the network capacity in order to enhance the load distribution on the different regions, and to calculate the losses wasted in the network with the old network and after adding new generator, new source or PV system and transmission line to reduce them.

1.2 Work steps:

Several steps in the design are to be performed including:

1. Studying the load profile of Tubas network with the annual rate of increase of the power consumption to avoid future problems, and studying the load profile of new places ("North Network Sier, Al-Nasaryeh, Yaseed, Al-Bathan town").

2. Design of a new feeder (transmission line) between the new generator, new source or PV system and Tubas network "north network" including the new transmission line parts with the lowest cost.

3. Development of a ring distribution network .

4. Studying the Single Line Diagram (SLD) after connecting the new generator, new source or PV system to Tubas network by using load flow and fault analysis simulation programs.

5. To solve the problem in the area of Ras Al-Fara'a (Agricultural area) it is suggested to supply additional power of 15MVA That can be obtained from the new source or PV system (These 15MVA are the result of increasing the capacity of the town of Al-Fara'a from 5MVA to 20MVA, Where the capacity of the town is 5MVA and that is insufficient) 15MVA are required To feed this area, then new transmission lines are to be designed to connect this new source or PV system to Tubas network of minimum cost. A fault analysis study will be performed for the network with new and existing generators. The new transmission line is required to feed new places from north network by about 10MVA .

6. The final step in this thesis are to study the economical feasibility of connecting the new source or PV system and the new transmission line to the network, to link all regions with a ring system and connect them with priority loads that need more than one source. Then by using ETAP simulation programs the new network with a new connection point and new transmission line will be studied and analyzed to find the new modifications in its performance.

1.3 The working procedures in the thesis:

1.3.1 The working procedures in the thesis for Tubas network:

Tubas network will be fully analyzed including all the regions, villages, towns and municipalities, with a focus on the town of Al-Fara'a.

Analyze includes 30 areas of a village, a town and municipality, which are as follows (Tubas city, Tyaseer village, Aqabeh village, Ras Al-Fara'a area, Wadi Al-Fara'a area, Al-Fara'a Camp area, Keshda village, Tammon municipality, Atoof municipality, Aqqaba municipality, Al-Kfier village, Al- Zababeda municipality, Raba town, Telfeet village, Tineen village, Arab American University - Jenin (AAUJ) area, Private Project area, Dream Land area, Al-Mghayer village, Al-Mtelleh village, Jalqamous village, Um Al-Toot village, Meselyeh municipality, Al-Jarba village, Merkeh village, Al-Zawyah village, Anzaa village, Hafeeri village, Wadi Douq region and the village of Beer Al-Basha), each one separately with a focus on Al-Fara'a area (Ras Al-Fara'a, Al-Fara'a Camp and Wadi Al-Fara'a).

After analyzing all these regions, the problem in each area will be determined and suitable solutions will be suggested for each region. After clarifying the existing problems and possible solutions, the solutions to each region are to be applied separately and follow up the results. Then we develop solutions for the regions together (for Tubas network as a whole) and determine the feasibility of these solutions with a focus on Al-Fara'a region (Ras Al-Fara'a, Al-Fara'a Camp and Wadi Al-Fara'a).

After studying the proposed solutions, we conduct an economic study (costs) is to be conducted to find out which solutions are the most economical and choose them as an optimal solution to the problems.

1.3.2 The working procedures in the thesis for Tubas network with North electricity company:

There are connection points between Tubas electricity company and North electricity company, including old connection points, such as (Sier, AL-Nasaryeh), some of which are new connection points, such as (Yaseed, Al-Bathan). The connection point (Sier) is from AL-Kfier region and the connection points for each of (Yaseed, Al-Bathan, Al-Nasaryeh) from the region of Wadi Al-Fara'a.

The supplied power from Tubas electricity company to the North electricity company at the old connection points reached 3MVA, and with the addition of the new connection points, there will be a supplied power of 10MVA, for old and new connection areas.

Control of the distribution of electricity to the areas of the connection points (Sier village, Al-Nasaryeh area, Yaseed village, Al-Bathan town) will be done by the north electricity company, as for the source it will be from Tubas electricity company.

In this thesis, we will study the effect of rising the electrical power supplied by the connection points with the north company from 3MVA to 10MVA on Tubas network [11], and to find any problems or negative effects resulting from these connection points (Sier village, Al-Nasaryeh area, Yaseed village, Al-Bathan town), and if we find any problems, solutions will be presented to them in this thesis taking into consideration the economic cost of possible solutions and choosing the optimal and least expensive solution.

After identifying the problems, if there are problems we will apply the appropriate solutions and work out these solutions practically, with the proposed solutions for the regions of Tubas network, especially Al-Fara'a area (Ras Al-Fara'a, Al-Fara'a Camp, Wadi Al-Fara'a) and do an economic study of the cost of these solutions together, and choose the best and least expensive solutions.

1.4 The ETAP program:

In this thesis, we will use the ETAP program extensively, so it is important to know what the ETAP program is and why it is used as a simulation system in this thesis.

Electrical Transient Analyzer Program (ETAP) is an electrical network modeling and simulation software tool, used by power systems engineers to create an "electrical digital twin" and analyze electrical power system dynamics, transients and protection [12]. Dr. Farrokh Shokooh is the founder and current CEO of ETAP. While Dr. Shokooh worked at Fluor Corporation [13], he was made in charge of selecting electrical engineering software. Realizing a lack of comprehensive, efficient and intelligent power system analysis software, the vision of Electrical Transient Analyzer Program (ETAP) was born. Dr. Shokooh left Fluor Corporation to develop ETAP and founded Operation Technology, Inc (OTI) in 1986. OTI dba ETAP is an ISO 9001-certified electrical power system design and automation software company headquartered in Irvine, California, with international offices in India, UAE, KSA, Brazil, Mexico, France, UK, Malaysia and China.

ETAP was developed for utilization on MS-DOS operating system and intended for commercial and nuclear power system analysis [14] and system operations. OTI has been developing ETAP for 30 years by providing the comprehensive and widely used enterprise solutions for generation, transmission, distribution, industrial, transportation, and low-voltage power systems. Power system simulation requires an electrical digital twin consisting of a power system network model that includes system connectivity, topology, electrical device characteristics, historical system response and real-time operations data in order to make offline or online decisions. ETAP power engineering software utilizes an electrical digital twin in order for electrical engineers and operators to perform following studies in offline or online mode:

- Load flow or power flow study.[15]
- Short circuit or fault analysis.[16]
- Protective device coordination, discrimination or selectivity.[16]
- Transient or dynamic stability.[17]
- Substation design and analysis.[18]
- Harmonic or power quality analysis.[19]
- Reliability.[20]
- Optimal power flow.
- Power system stabilizer tuning.[21]
- Optimal capacitor placement[22]
- Motor starting and acceleration analysis.[23]
- Voltage stability analysis.[24]
- Arc flash hazard assessment.[25]
- Ground loop impedance calculation.[26]
- Battery modeling and simulation.[27]

The software applications , ETAP software applications include:

- Power system design for ANSI and IEC networks.[28]
- Electric supply substation simulation.[29]

- Monitoring and feeder analysis.[30]
- Simulation of distributed photovoltaic power.[31]
- Study of a DC network.[32]
- Open-phase fault analysis[33] - Multiple events across the nuclear power industry have highlighted the need for greater understanding of what happens during an open phase fault. These open phase events have occurred on the high side of offsite power supply transformers and have involved loss of one or two phases.
- Diesel power plant analysis.[34]
- Combined cycle power plant analysis.[35]
- AC/DC hybrid system simulation.[36]
- Wind turbine design and analysis.[37]
- Harmonics in railway power systems.[38]
- Rural distribution system analysis.[39]
- Distributed generation protection.[40]
- Reliability assessment of renewable energy systems.[41]
- Wind and PV penetration studies.[42]

Chapter 2
The Analysis

2.1 Tubas network transformers, PV systems, transmission lines, cables, circuit breaker and Reclosers:

There are 253 transformers, one of them is an autotransformer (Or auto transformer), the autotransformer is a type of electrical transformer with only one winding. The “auto” prefix refers to the single coil acting alone (Greek for “self”) – not to any automatic mechanism. An auto transformer is similar to a two winding transformer but varies in the way the primary and secondary winding of the transformer are interrelated[43]. And 95 solar systems, 355 transmission lines of different lengths and sizes (50mm^2, 70mm^2, 95mm^2, 110mm^2, 150mm^2) as these lines are overhead transmission lines and 34 cables of different lengths and sizes (95mm^2, 300mm^2 "intersection area") as these lines are underground lines spread in 30 areas of Tubas electricity network. In Tubas electricity network, a groups of (Reclosers and circuit breakers) are used to protect from faults on the network, about 10 Reclosers and 26 circuit breakers.

The Reclosers (Relays for reconnection of autonomous circuits), in the electric power distribution field, are defined as a group of circuit breaker designed for use on high-power distribution networks to detect and stop instantaneous faults, also known as reconnection relays or self-connecting relays, they are high-voltage circuit breakers with integrated current and voltage sensors and a protective relay, used as an assembly to protect high distribution networks commercial autonomous circuit reconnection relays are subject to American National Standards Institute / IEEE C37.60, IEC 111-62271 and 200-62271 standards[44]. the three main voltage are 15.5KV, 27KV and 38KV.

For high distribution networks, the majority of faults are transient, such as lightning strikes, flash floods or foreign objects contact with exposed distribution lines. On this basis, 80% of outages can be resolve by a simple shutdown process. Self-control circuit reconnection relays are designed to handle a short operating circuit of the close/open mode, so electrical engineers can optionally test several shutdowns before moving to the shutdown phase.

Reconnect relays are often used as a major component of smart grids. They are computer-controlled circuit breakers that can be operated and inspected remotely using a SCADA system or other communication systems. This feature allows organization collect data on their network performance and develop automated reboot plans. This automation can be distributed (Performed at the level of remote reconnection relay) or central (Shutdown and open commands issued by a central room to be executed by relays for reconnecting the remote autonomous circuits).

More details about the transformers, solar systems, transmission lines, cables, Reclosers and circuit breakers in Tubas network, are listed in the appendix A at section A.1 .

2.2 Analysis of Tubas Network:

2.2.1 Analysis of Tubas City:

2.2.1.1 The Components of Tubas City Network:

Tubas city network consists of 52 transformers and 29 PV systems (solar systems), spread over 12 districts of the city [10]. The transformers: One of the transformers is an autotransformer, 23 of the transformers connected to loads only, 7 of the transformers connected to solar systems only and 21 of the transformers connected to loads & solar systems together. The solar systems (PV systems): 21 of them connected with loads and 8 of the solar systems connected with network without loads (3 of them are proposed from Tubas network, 2 of them under construction and 3 of them are existing).

Tubas city consists of 12 different zone as follows (The first of the city "Northern region", the first intersection, the Southern region1, the Southern region2, the areas near Al-Fara'a areas, the Eastern region1, the Eastern region2, town center1, town center2, center of the Western region, the Western region and the far Western region):

1. The first of the city "Northern region" (Tubas city):

There are 4 transformers (one of them is a auto transformer) in this zone, 10 Buses (two of them are shared with another zone), 1 circuit breaker, 3 load centers and 2 solar systems.

2. The first intersection (Tubas city):

There are 3 transformers in this zone, 9 Buses (three of them are shared with another zone), 3 load centers and 1 solar system.

3. The Southern region1 (Tubas city):

There are 3 transformers in this zone, 11 Buses (two of them are shared with another zone), 1 circuit breaker, 3 load centers and 1 solar system.

4. The Southern region2 (Tubas city):

There are 4 transformers in this zone, 12 Buses (two of them are shared with a another zone), 1 circuit breaker, 4 load centers and 1 solar system.

5. The areas near Al-Fara'a areas (Tubas city):

There are 7 transformers (two of them are under construction "T249 & T250") in this zoon, 17 Buses (five of them are shared with another zone, two of them are under construction "Bus676 & Bus673"), 1 circuit breaker, 5 load centers and 4 solar systems (two of them are under construction "PV38 & PV87").

6. The Eastern region1 (Tubas city):

There are 2 transformers in this zone, 9 Buses (two of them are shared with another zone), 1 circuit breaker, 2 load centers and 2 solar systems.

7. The Eastern region2 (Tubas city):

There are 7 transformers (three of them are proposed"T18, T251 & T252") in this zone, 12 Buses (four of them are proposed "Bus576, Bus577, Bus664 & Bus677" and one of them is shared with another zone), 2 load centers and 6 solar systems (three of them are proposed "PV10, PV88 & PV89").

8. The center of the town1 (Tubas city):

There are 2 transformers in this zone , 9 Buses (three of them are shared with another zone) , 1 circuit breaker , 2 load centers and 2 solar systems .

9. The center of the town2 (Tubas city):

There are 6 transformers in this zone, 15 Buses (two of them are shared with another zone), 1 circuit breaker, 6 load centers and 2 solar systems.

10. The center of the Western region (Tubas city):

There are 8 transformers in this zone, 22 Buses (three of them are shared with another zone), 1 circuit breaker, 8 load centers and 5 solar systems.

11. The Western region (Tubas city):

There are 5 transformers in this zone, 14 Buses (two of them are shared with another zone), 5 load centers and 3 solar systems.

12. The far Western region (Tubas city):

There is 1 transformer in this zone, 2 Buses, 1 load center.

- The location of Tubas city network in Tubas network as a whole: The figure (2.2.1) shows the location of Tubas city network in Tubas network as a whole.

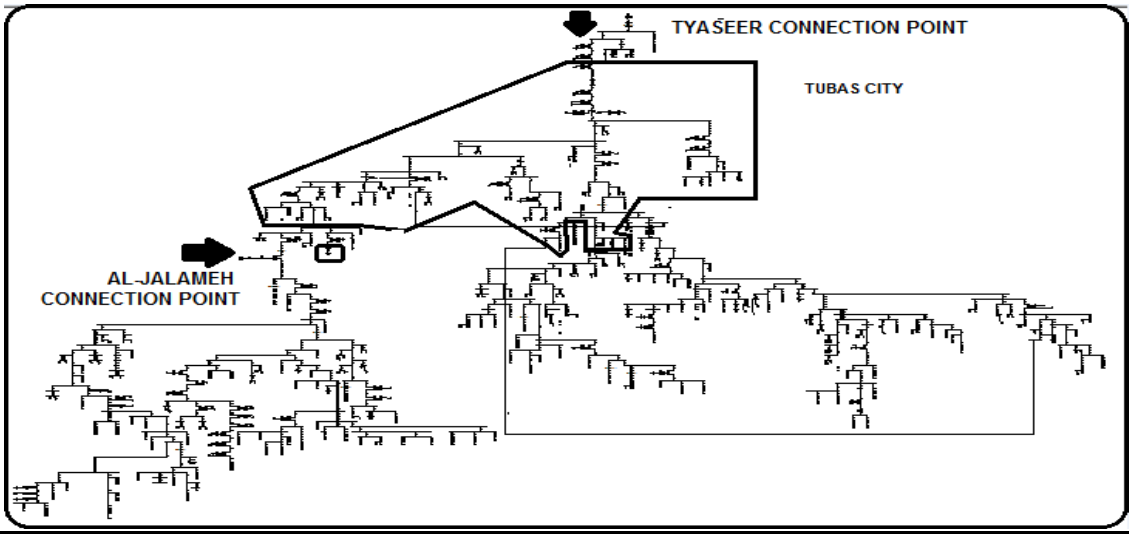

Figure (2.2.1): The location of Tubas city network in Tubas network as a whole

More details about the different zones of the city of Tubas network and what it contains from transformers, solar systems and loads, are listed in the appendix A at section A.2, Title A.2/1./1).

2.2.1.2 The Problem of Tubas City Network:

There are five actual problems in the network of the city of Tubas, and usually the cause of these problems is either as a result of pressure on the transformers, especially during peak hours, or because of the long distance between the loads and the transformers that feed it.

- The problem 1: This problem exists at transformer (T8\\AL-THOGHRAH). And this transformer is located in region {The first of the city "Northern region"}. There are regions connected to transformer (T8) away from it by (2 - 2.5) KM, and these regions include houses (Loads) that suffer from the problem of weak electrical current, especially during the night period (the weak current is evident by weak lighting) duo to the distance from the transformer and because of the large number of homes (Loads) along the transmission line (400volt) as shown in the following figure: The figure (2.2.2) shows the distance between the loads (Lupm7 – distant homes) and transformer T8 in the first of the city "Northern region" in Tubas city.

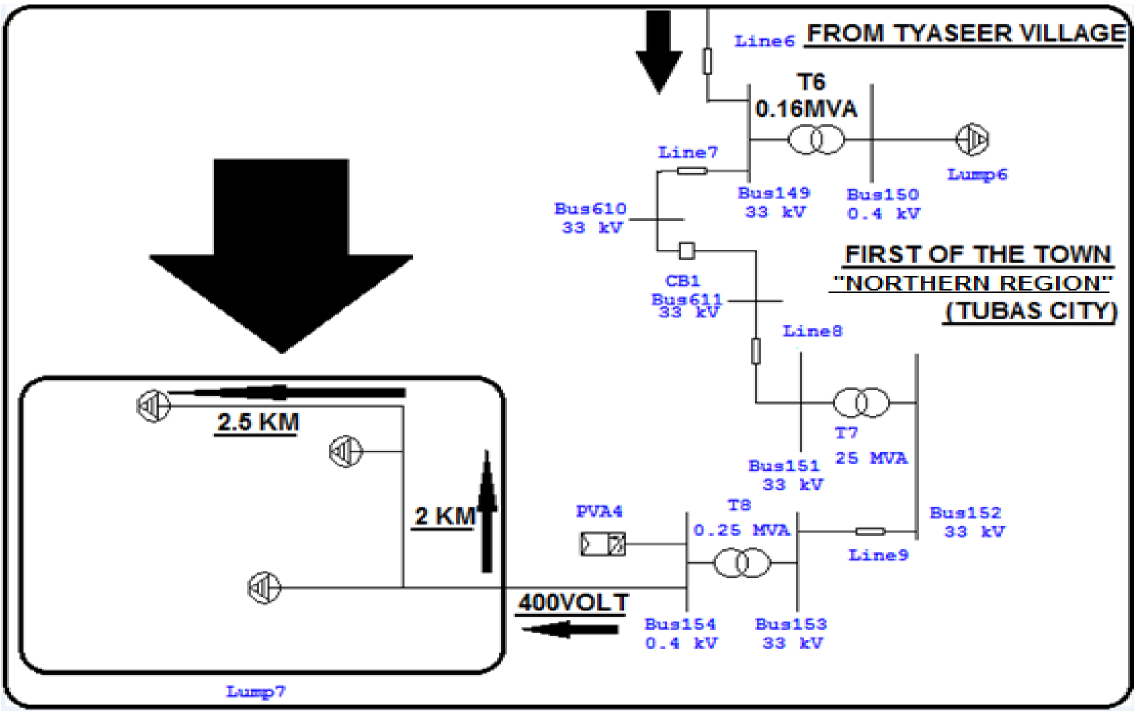

Figure (2.2.2) : The transformer loads (T8) in Tubas city network

More details about the problem 1 in the city of Tubas network, are listed in the appendix at section A, Title A.2/1./2) .

The table (2.2.1) shows the load values connected with transformer T8 located in the first of the town "Northern region" in Tubas city [10].

Table (2.2.1) : The transformer(T8) and the values on it in Tubas city network

The transformer number & name	The load number & name	The power factor PF%	The active power Pmax (KW)	The reactive power Qmax (KVAR)	The capacity for the transformer (KVA)	The transformer loads (KVA)
T8(AL-THOGHRAH)	L 7	100	168.4	0.5	250	168.39

From table(2.2.1) we see the capacity of T8 equals 250 KVA and the loads on it is approximately 169 KVA, meaning that the transformer can bear more loads, but the problem is the distance between the transformer (low voltage side – 400volt) and the loads (distant homes).

So to solve this problem, several solutions can be developed as follows:

1) Placing a solar systems on the roofs of these distant homes.

2) Placing a new transformer with a capacity of 50 KVA near these loads (distant homes) this requires a set of towers to transfer power at 33 KV for a distance of 2 KM and then to transfer power at 400 volt for a distance of 500 meters.

3) Extending the 400 volt line to a distance of 1.5 KM from the transformer (T3 \\ SCHOOL-TYASEER) located in the village of Tyaseer and near this area compared to the transformer (T8 \\ AL-THOGHRAH), but this needs to transfer power at 400 volt for a distance of 1.5 KM through a difficult mountain road.

- The problem 2: This problem exists at transformer (T23 \\ KAZIYA AL-MOTHEDOON). And this transformer is located in region {The Southern region2}. On this transformer the power (Pmax) value of the load terminal is 109.8 KW and there is a need to raise this power.

So we suggest a solar system a solar system with value of 5 KW.

- The problem 3: This problem exists at transformer (T28 \\ TUBAS MUNICIPLAITY WELL). And this transformer is located in region {the center of the town2}. This transformer is far from the nearest transformer which is more than 1500 meters away and this transformer (T28) is a special transformer for the well agricultural municipality of Tubas city and it is connected only to the well pump, and this pump is not always operated as shown in table (A.2.1) row 23 and two columns 5&6, Pmax and Qmax are equals zeros, the problem is that there is a control room in the well and special guard room in the well and this room needs lighting and an air condition system and this needs power at a 400 volt line and the transformer (T28) often does not work or connect with the network and to obtain 400 volt for the special control room in the well , the 400 volt line must be transfer from the nearest transformer (T27) which is 1542 meters away. This is a problem because of the distance. To solve this problem we suggest setting up a solar system for the control room of 5 KW, so that there will be a 400 volt power line for the uses of the control room.

- The problem 4: This problem exists at transformers (T29 \\ RAWDA), (T30 \\ AMN WATANY CENTER 1) and (T31 \\ AMN WATANY CENTER 2). These transformers are located in region {the center of the town2}. The transformer (T29) is a transformer for the new national security center (Amn Watany Center) / Al-Rawda neighborhood, this transformer feeds the Amn Watany Center and some homes in Al-Rawda neighborhood, also the transformers (T30 & T31) are transformers for national security camp (Amn Watany Camp) in the area. These transformers feeds the Amn Watany Camp and a group of homes in Al-Rawda neighborhood. The problem is that if there are training exercises in the camp or meetings in the center, the load from the camp and the center is high, so that most of the feeding is from the transformers (T29, T30 & T31) to the camp and the center, and this weakness the electrical current on the houses of the Rawda neighborhood connected with these transformers. To solve this problem we suggest placing a set of solar systems in Al-Rawda neighborhood and distributing them to the neighborhood in order to help in organizing electrical current on homes with training cases in the camp and the center.

- The problem 5: This problem exists at transformer (T137 \\ CUSTOMS POLICE (TUBAS)). This transformer is located in region {the center of the Western region}. This transformer (T137) is for the customs police only. There are homes in the area that get electricity from distant transformers through 400 volt transmission lines travel long distances and over residential areas. And not isolated, so thus constitute a danger to homes and residents. There was a previously proposed solution to this problem by connecting these houses with the customs police transformer (T137), but this proposal was rejected, where the transformer remains for the customs police only, so that this does not affect the electricity current of the customs police. To solve this problem we suggest setting up a special solar system for houses near the customs police and connecting it with the transformer (T137) and disconnecting the 400 volt line that is not isolated and dangerous, in this way we get rid of the danger of non-isolated lines and these houses do not affect the electricity of the customs police where there is a solar system in nearby homes.

* Note : The powers (Qmax & Pmax) in table (2.2.1) data from Tubas electricity company, and these values are the average annual load capacity for the year 2019.

* Note : All of these suggested solutions will be discussed in more details in chapter 3 (The Solutions) in this thesis.

2.2.2 Analysis of Keshda Village:

2.2.2.1 The Components of Keshda Village Network:

Keshda village network consists of 3 transformers and 1 PV system (solar system), spread over 2 districts of the village [10]. The transformers : 2 of them are connected to loads only and 1 of them is connected to load & solar system together. The solar system (PV system): is connected with load.

Keshda village consists of 2 different zone as follows (the center of the village and the Southern region).

1. The center of the village (Keshda village):

There are 2 transformers in this zone, 6 Buses (two of them are shared with another zone), 2 load centers and 1 solar system.

2. The Southern region (Keshda village):

There is 1 transformer in this zone, 3 Buses (one of them is shared with another zone) and 1 load center.

- The location of Keshda village network in Tubas network as a whole:

The figure (2.2.3) shows the location of Keshda village network in Tubas network as a whole.

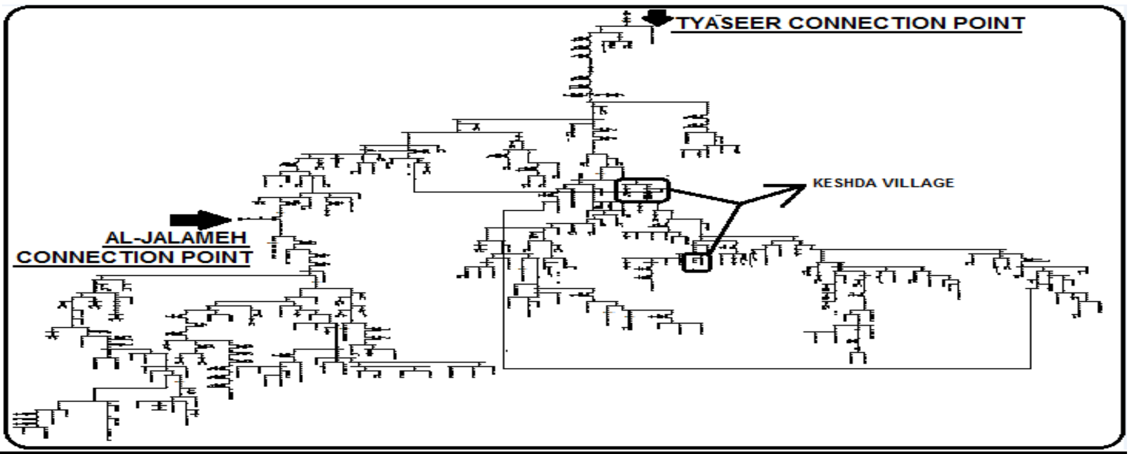

Figure (2.2.3) : The location of Keshda village network in Tubas network as a whole

More details about the different zones of the village of Keshda network and what it contains from transformers, solar systems and loads, are listed in the appendix A at section A.2, Tile A.2./2./1) .

2.2.2.2 The Problems of Keshda village network:

In the village of Keshda there is one problem and this problem exists because the large of the distance between the regions of the village.

- The problem: This problem exists at transformer (T46 \\ MOA'YAD AL-FAKHRI). This transformer is located in region {the Southern region}. The problem is that the feeding area of the village's Southern region (T46) is far from the feeding area of the village's central region (T35 & T36). As the feeding of the Southern region of the village from Ras Al-Fara'a area (center of the town – Ras Al-Fara'a area) and the feeding for the central region of the village from the city of Tubas (The areas near Al-Fara'a areas

– Tubas city). The feeding areas (center of the town – Ras Al-Fara'a & the areas near Al-Fara'a areas – Tubas city) the distance between them reaches more than 3000 meters (the length of the transmission line between the feeding areas) as shown in the following figure: The figure (2.2.4) shows the distance between the zones of Keshda village network and the feeding areas for each zone.

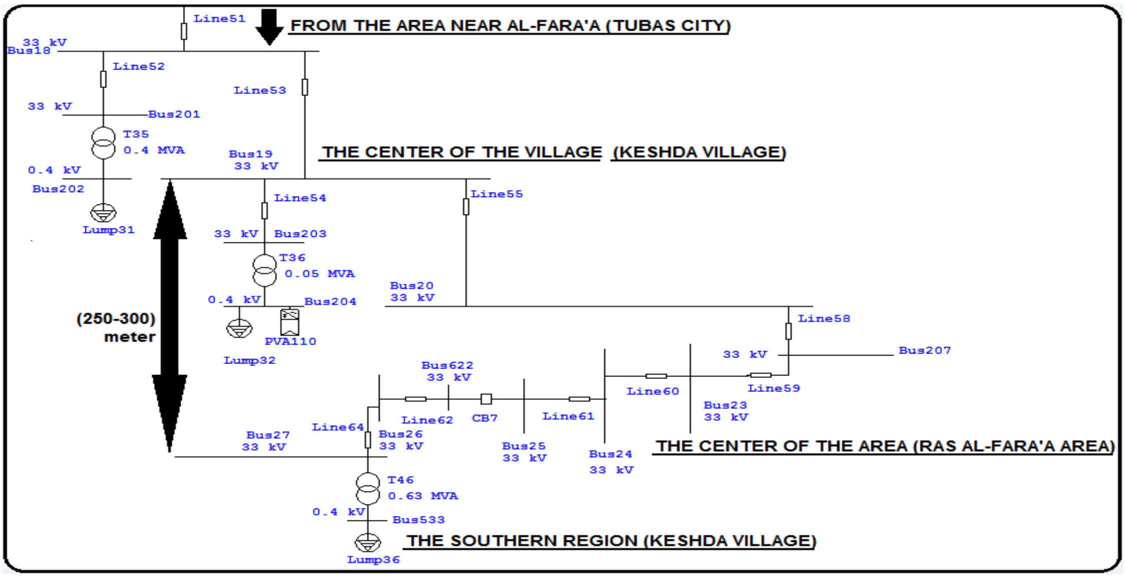

Figure (2.2.4) : The distance between the zones of Keshda village network and the feeding areas for each zone

More details about the problem in the village of Keshda network, are listed in the appendix A at section A.2, Title A.2./2./2) .

As shown in the figure (2.2.4), the length of transmission lines (33 KV) between the feeding areas (center of the town – Ras Al-Fara'a & the areas near Al-Fara'a – Tubas city) are as follows **(**L55(644m) – B20 – L58(375m) – B207 – L59(344m) – B23 – L60(158m) – B24 – L61(322m) – B25 – CB7 – B622 – L62(891m) – B26 – L64(315m) – B27 – T46**)** These lines together reach 3049 meters long . Note that the actual distance between the Southern region of the village and the central region of the village is (250-300) meters , as shown in the figure (2.2.4).

The actual problem is that the village council of the village of Keshda must communicate with Al-Fara'a municipality in case of an defect in the village's Southern region (T46), because this area is fed from Ras AL-Fara'a region (center of the town – Ras Al-Fara'a) of municipality of Al-Fara'a. Likewise, the village council of Keshda village should communicate with the municipality of Tubas in case of any defect in the village's central region (T35 & T36) because feeding this region from the city of Tubas (the areas near Al-Fara'a – Tubas city).

Therefore, the village council should coordinate between the municipality of Tubas and the municipality of Al-Fara'a in case of any defect in the village or the maintenance of the village network. To solve this problem. We suggest a direct connection between regions of the village in this way, feeding the village becomes from the Southern region (the areas near Al-Fara'a – Tubas city), and thus the village council has to deal with the municipality of Tubas only (Tubas municipality – electricity department).

* Note : This is suggested solution will be discussed in more details in chapter 3 (The Solutions) in this thesis.

2.2.3 Analysis of Tyaseer Village:

2.2.3.1 The components of Tyaseer Village Network:

Tyaseer village network consists of 5 transformers (one of them is a proposed) and 3 PV systems (solar systems), spread over one district in the village [10]. The transformers: 2 of them are connected to loads only, 1 of them is connected to solar system only (proposed) and 2 of them are connected to loads & solar systems together. The solar systems (PV systems): two of them are connected with load and one of them is connected with the network without any load (proposed). In Tyaseer village there is one zone in the village (Tyaseer village).

Tyaseer village: There are 5 transformers (one of them is proposed "T253") in this zone, 11 Buses (one of them is proposed "Bus678", and two of them are shared with another zone), 4 load centers and 3 solar systems (one of them is proposed "PV3").

- The location of Tyaseer village network in Tubas network as a whole:

The figure (2.2.5) shows the location of Tyaseer village network in Tubas network as a whole.

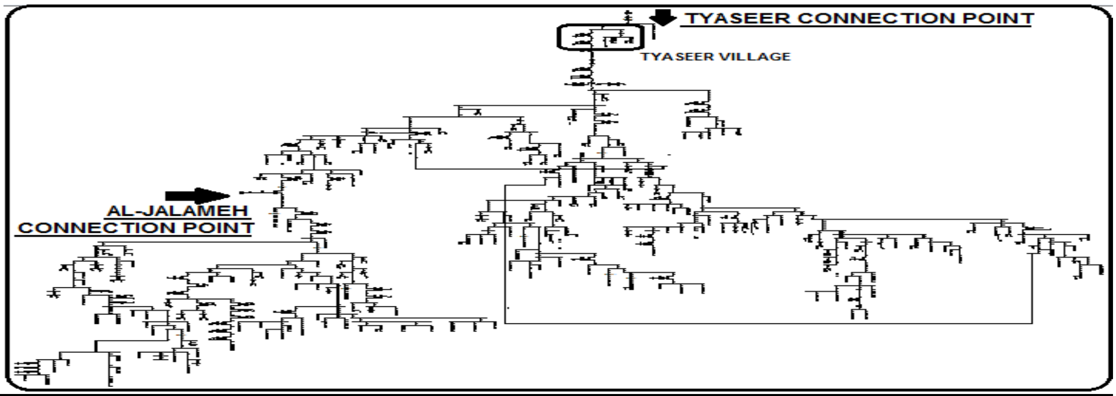

Figure (2.2.5) : The location of Tyaseer village network in Tubas network as a whole

More details about the zone of the village of Tyaseer network and what it contains from transformers, solar systems and loads, are listed in the appendix A at section A.2, Title A.2./3./1) .

2.2.3.2 The Problems of Tyaseer Village Network :

- The problem: This problem exists at transformer (T3 \\ SCHOOL-Tyaseer). This transformer is located in the region {Tyaseer village region}. This transformer feeds Tyaseer school and a group of surrounding houses, the topic is that the headmaster wants to reduce the school's consumption of electricity and make it one of the environmentally friendly schools. So we suggest that solar cells (a solar system) be placed on the roof of the school, and this makes the school one of the environmentally friendly schools that depend on clean energy.

* Note : This is suggested solution will be discussed in more details in chapter 3 (The Solutions) in this thesis.

2.2.4 Analysis of Aqabeh Village:

2.2.4.1 The Components of Aqabeh Village Network:

Aqabeh village network consists of 1 transformer, 1 load center and no PV system (solar system) in the village, spread over 1 district of the village [10]. The transformer : is connected to load only. In Aqabeh village there is one zone in the village (Aqabeh village) **.**

Aqabeh village: There is 1 transformer in this zone, 5 Buses (one of them is shared with another zone), 1 circuit breaker, 1 load center and no solar systems in the village.

- The location of Aqabeh village network in Tubas network as a whole: The figure (2.2.6) shows the location of Aqabeh village network in Tubas network as a whole.

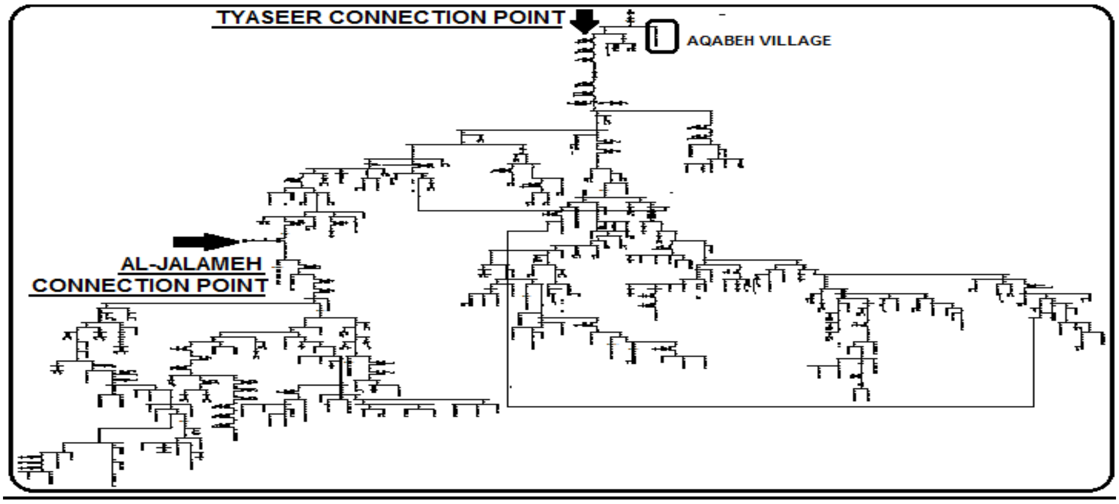

Figure (2.2.6) : The location of Aqabeh village network in Tubas network as a whole

More details about the zone of the village of Aqabeh network and what it contains from transformers, solar systems and loads, are listed in the appendix A at section A.2, Title A.2./4./1) .

2.2.4.2 The Problems of Aqabeh Village Network:

There is no obvious problem in this small village, as this village has one transformer (T1), has a capacity of 160 KVA and the loads of the village (25 – 28)KVA, So the situation of the village is good.

2.2.5 Analysis of Ras Al-Fara'a Region:

2.2.5.1 The Components of Ras Al-Fara'a Region Network:

Ras Al-Fara'a region network consists of 19 transformers and 5 PV systems (solar systems), spread over 5 districts in the region [10]. The transformers: 14 of them are connected to loads only and 5 of them are connected to loads & solar systems together, The solar systems (PV systems): are connected with loads.

Ras Al-Fara'a region network consists of 5 different zone as follows (the Northern region, the center of the town, the Southern region, the center of the Eastern region and the Eastern region).

1. The Northern region (Ras Al-Fara'a region):

There is 1 transformer in this zone, 3 Buses (two of them are shared with another zone) and 1 load center.

2. The center of the town (Ras Al-Fara'a region):

There are 5 transformers in this zone, 13 Buses (two of them are shared with another zone), 5 load centers and 1 PV system (solar system).

3. The Southern region (Ras Al-Fara'a region) :

There are 6 transformers in this zone, 12 Buses (one of them is shared with another zone, 5 load centers and no PV systems (solar systems).

4. The center of the Eastern region (Ras Al-Fara'a region):

There are 4 transformers in this zone, 12 Buses (two of them are shared with another zone), 4 load centers and 1 PV system (solar system).

5. The Eastern region (RAS AL-Fara'a region):

There are 3 transformers in this zone, 7 Buses (three of them are shared with another zone), 3 load centers and 3 PV systems (solar systems).

- The location of Ras Al-Fara'a region network in Tubas network as a whole: The figure (2.2.7) shows the location of Ras Al-Fara'a region network in Tubas network as a whole.

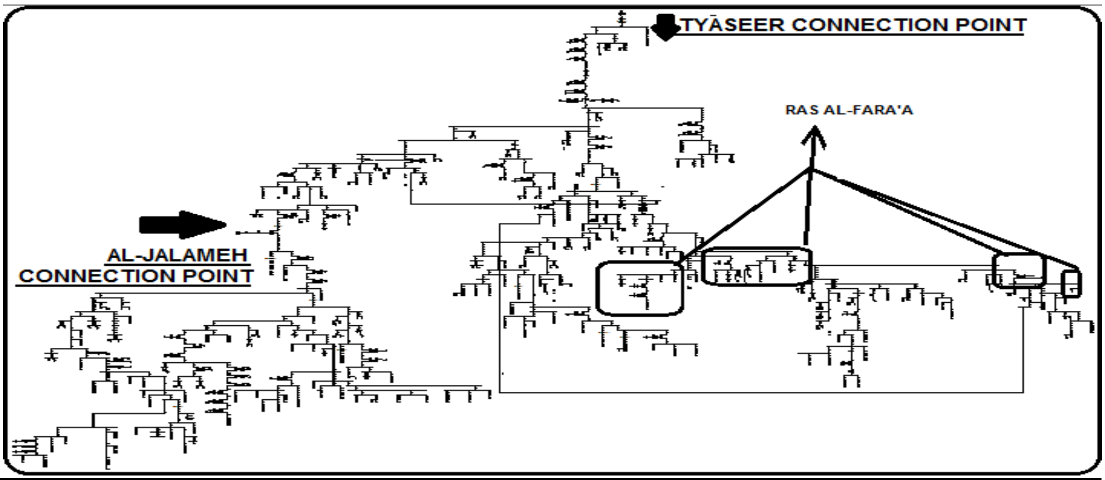

Figure (2.2.7) : The location of Ras Al-Fara'a region network in Tubas network as a whole

More details about the different zones of the region of Ras Al-Fara'a network and what it contains from transformers, solar systems and loads, are listed in the appendix A at section A.2, Title A.2./5./1) .

2.2.5.2 The Problems of Ras Al-Fara'a Region Network:

In this region there is one problem and this problem exists in agricultural areas as there is pressure on transformers in those areas.

- The problem: This problem exists at Eastern Regions. This problem is located in regions {the center of the Eastern region and the Eastern region}. In this regions there are 7 transformers, in the Eastern region there are three of them (the transformers T85, T87 & T96), which is an agricultural region, there are agricultural wells with large water pumps and during the irrigation periods there is pressure on the transformers (T85, T87 & T96), and this is a problem on the houses in the region, so there is a continuous interruption in the electrical current in this region. In the Eastern center region (center of Eastern region) there are 4 transformers (T57, T58, T59 & T60) and it is also an agricultural region, also this region suffers from pressure of agricultural wells in it.

To solve the problem of wells in these regions, we suggest the following:

1) Establishing a sufficient solar system to solve this problem approximately (0.4 MW) and distributing thus solar systems to several transformers in these regions.

2) Placing a generator in these regions (about 10 MW).

3) Create a new transmission line (33 KV) from Al-Jalameh connection point to this region.

* Note : All of these suggested solutions will be discussed in more details in chapter 3 (The Solutions) in this thesis.

2.2.6 Analysis of Atoof Town:

2.2.6.1 The Components of Atoof Town Network:

Atoof town network consists of 17 transformers and 1 PV system (solar system), spread over 4 districts in the town [10]. The transformers: 16 of them are connected to loads only and 1 of them are connected to loads & solar systems together, The solar system (PV systems): is connected with loads.

Atoof town network consists of 4 different zone as follows (the Western region , the first of the town, the center of the town and the Eastern region) .

1. The Western region (Atoof town):

There are 3 transformers in this zone, 10 Buses (two of them are shared with another zone, 3 load centers and no PV systems (solar systems).

2. The first of the town (Atoof town):

There is 1 transformer in this zone, 5 Buses (one of them is a shared with another zone), 1 Recloser, 1 load center and no PV systems (solar systems).

3. The centre of the town (Atoof town):

There are 7 transformers in this zone, 19 Buses (two of them are shared with another zone), 7 load centers and no PV systems (solar systems).

4. The Eastern region (Atoof town):

There are 6 transformers in this zone, 19 Buses (one of them is a shared with another zone), 2 Recloser, 6 load centers and 1 PV system (solar system).

- The location of Atoof town network in Tubas network as a whole: The figure (2.2.8) shows the location of Atoof town network in Tubas network as a whole.

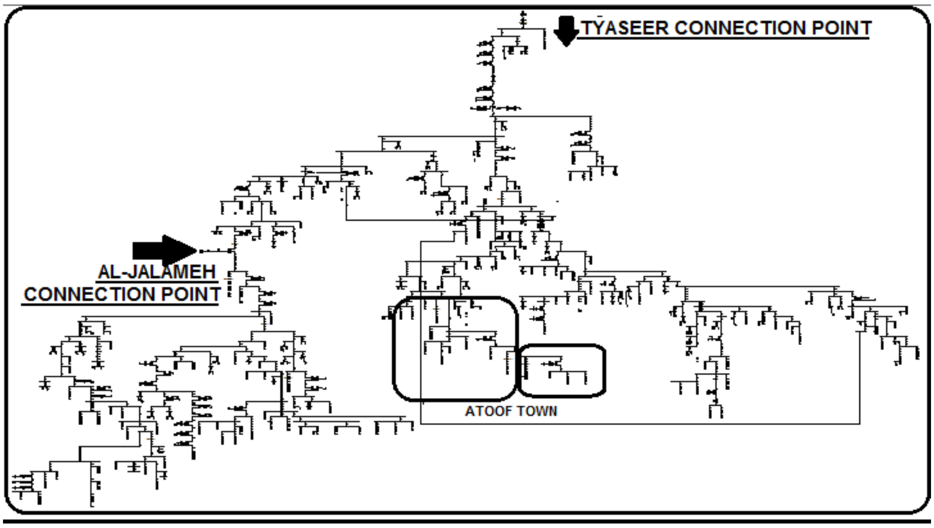

Figure (2.2.8) : The location of Atoof town network in Tubas network as a whole

More details about the different zones of the town of Atoof network and what it contains from transformers, solar systems and loads, are listed in the appendix A at section A.2, Title A.2./6./1) .

2.2.6.2 The Problems of Atoof Town Network:

In the town of Atoof there are two problems and these problems due to low power factors in the town and high the reactive power values in the town of Atoof.

- The problem 1: This problem exists at transformer (T116 \\ MOWAFAQ FAKHRY). This transformer is located in region {the Western region}. The table (2.2.2) shows the transformer T116 that located in the Western region of Atoof town with the load values it contains [10].

Table (2.2.2) : The transformer (T116) and the values on it in Atoof town network

The transformer's name & number	The transformer's capacity (KVA)	The active power Pmax (KW)	The reactive power Qmax (KVAR)	The power factor PF%	The load's name & number
T 116 (MOWAFAQ FAKHRY)	400	128.4	388.34	31.3	L 106

As shown in table (2.2.2) the power factor is less than 80% this is considered small value for PF. According to table (2.2.2) the value of Qmax = 388.34KVAR is greater than the value of Pmax that equal 128.4KW, and according to the equations.

$S = \sqrt{(P^2 + Q^2)}$. Equation (2.1)[45][46][47]

$PF = \frac{P}{S}$. Equation (2.2)[45][46][47]

So, the PF is depends on reactive power (Q) and when Qmax is increasing more than Pmax then the PF is decreasing.

To solve the problem of PF decrease we must address the problem of reactive power increasing it is important to note that the power factor decrease causes:

1) Increase in losses.

2) Decrease in machine efficiency.

3) Penalties from electricity provider.

4) Increase in electricity bill.

So, when the power factor less than 80%, 10% penalty on total monthly bill.

So, to solve this problem we place capacitor bank next to the load (L106) in order to give Q(reactive power) to load that it needs and thus Q request from the transformer side decreases and thus improving the power factor (PF).

The ideal capacitor is characterized by a constant capacitance C, in farads in the SI system of units, defined as the ratio of the positive or negative charge Q on each conductor to the voltage V between them [49]. A capacitance of one farad (F) means that one coulomb of charge on each conductor causes a voltage of one volt across the device [50].

In practical devices, charge build-up sometimes affects the capacitor mechanically, causing its capacitance to vary. In this case, capacitance is defined in terms of incremental changes.

The total energy W stored in a capacitor (expressed in Joule) is equal to the total work done in establishing the electric field from an uncharged state[51]:

$W = \frac{1}{2} CV\text{^}2$. Equation (2.3)

And the power equal:

$p = \frac{1}{2t} CV\text{^}2$. Equation (2.4)

- The problem 2: This problem exists at transformer (T125 \\ BAQEEA). This transformer is located in region {the center of the town – Atoof town}. The table (2.2.3) shows the transformer T125 that located in the center of the town of Atoof town with the load values it contains [10].

Table (2.2.3) : The transformer(T125) and the values on it in Atoof town network

The transformer's name & number	The transformer's capacity (KVA)	The active power Pmax (KW)	The reactive power Qmax (KVAR)	The power factor PF%	The load's name & number
T 125 (BEQEEA)	400	136.8	109.1	74.0	L 115

As shown in table (2.2.3) the power factor is less than 80% this is considered to be a few PF. As is situation at the transformer (T116) and to solve this problem we place capacitor bank next to the load (L115), so that the capacitor bank gives the load the necessary reactive power (Q) and thus the demand for the transformer decreases and the power factor improves.

* Note : The powers (Qmax & Pmax) in tables (2.2.2) and (2.2.3) data from TUBAS electricity company, and these values are the average annual load capacity for the year 2019.

* Note : All of these suggested solutions will be discussed in more details in chapter 3 (The Solutions) in this thesis**.**

2.2.7 Analysis of Jalqamous Village:

2.2.7.1 The Components of Jalqamous Village Network:

Jalqamous village network consists of 4 transformers and 4 PV systems (solar systems), spread over 1 district in the village [10]. The transformers: are connected to loads & PV systems, The solar systems (PV systems): are connected to loads. In Jalqamous village network there is one zone in the village (Jalqamous village)**.**

Jalqamous village: There are 4 transformers in this zone, 8 Buses (three of them are a shared with another zone), 4 load centers and 4 solar systems (PV systems).

- The location of Jalqamous village network in Tubas network as a whole: The figure (2.2.9) The location of Jalqamous village network in Tubas network as a whole.

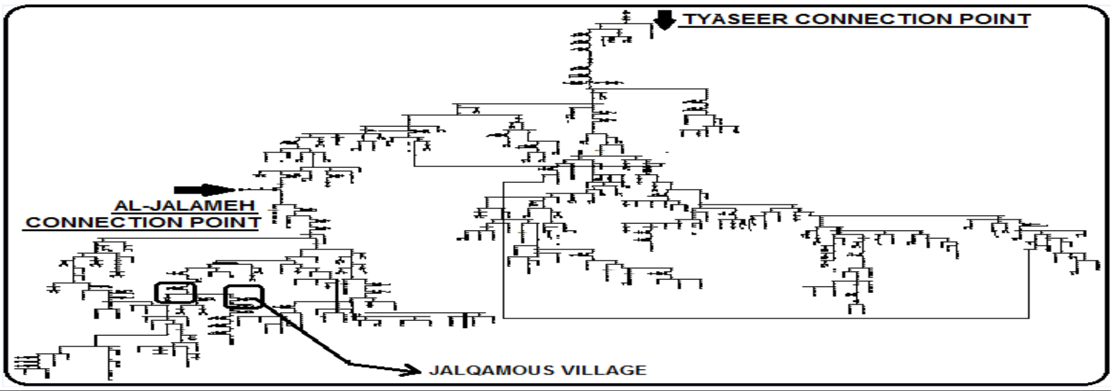

Figure (2.2.9) : The location of Jalqamous village network in Tubas network as a whole

More details about the zone of the village of Jalqamous network and what it contains from transformers, solar systems and loads, are listed in the appendix A at section A.2, Title A.2./7./1) .

2.2.7.2 The Problems of Jalqamous Village Network:

In the village of Jalqamous, there is actually one problem, and it is because of the presence of the water tank pump for the area, where this huge pump is connected to one of the village transformers with a large number of houses on the same transformer.

- The problem: This problem exists at transformer (T200 \\ WEASTERN). This transformer is located in region {the Jalqamous village region}. This transformer feeds a group of houses, as well as the area's water tank. The water tank that feeds a group of villages (Jalqamous, Al-Mghayer, Al-Mtelleh And Um Al-Toot), the transformer (T200) according to table (A.2.19.1.1) "see the appendix at section A, Title A.2.19.1" its load reaches 130KVA while its capacity is 160KVA, so when the water tank and its large pump are turned on , there is a lot of pressure on the transformer. So that the demand for the transformer becomes greater than its capacity and the demand for it may reach 200KVA, in this case a group of houses in the area is separated when the pump is running, and this is considered an actual problem for the homes and residents of the village.

The figure (2.2.10) shows the loads (large number of houses and the water tank pump) that connected to transformer T200 that located in Jalqamous village.

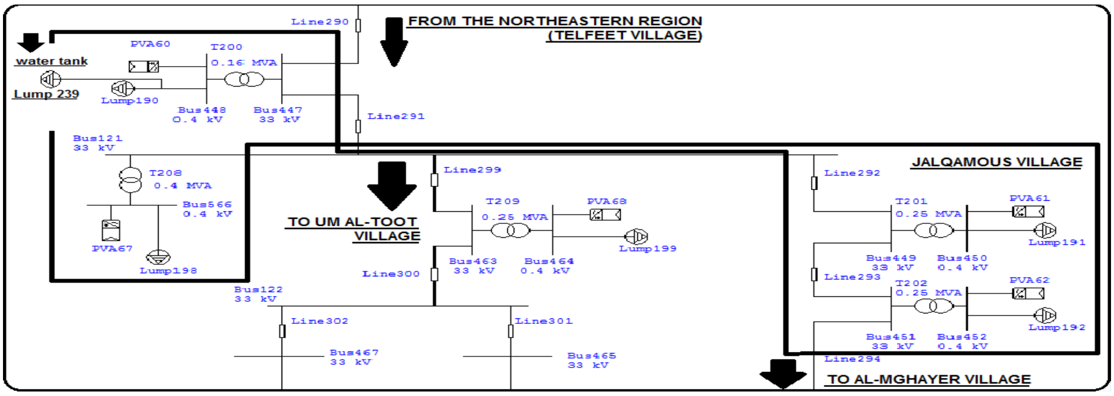

Figure (2.2.10) : The large loads on transformer(T200) in Jalqamous village network

To solve this problem, we suggest placing a transformer for the water tank with a capacity of 160KVA, so that this new transformer with stands the pressure of the water tank, and in return the transformer (T200) will feed the houses without pressure on it.

* Note : This is suggested solution will be discussed in more details in chapter 3 (The Solutions) in this thesis**.**

* Note : In the same way in the previous analysis , we analyzed all regions of Tubas electricity network "Tubas city, Keshda village, Tyaseer village, Aqabeh village, Ras Al-Fara'a region, Wadi Al-Fara'a region, Al-Fara'a Camp region, Tammon town, Atoof town, Aqqaba town, Al-Zababeda town, Al-Kfier village, Raba town, Telfeet village, Arab American

University Jenin 'AAUJ' area, Tineen village, Private Project area, Dream Land area, Jalqamous village, Al-Mghayer village, Al-Mtelleh village, Um Al-Toot village, Meselyeh town, Al-Jarba village, Merkeh village, Al-Zawyah village, Anzaa village, Al-Hafeeri village, Wadi Douq village and Beer Al-Basha village".

2.3 Analysis of the Connection Points between Tubas Network and North Company Electricity Network:

There are connection points between Tubas electricity company and the north electricity company, including old connection points, such as (Sier, Al-Nasaryeh), some of which are new connection points, such as (Yaseed, Al-Bathan) [10]. Where the connection point (Sier) is from Al-Kfier village region and the connection points for each of (Yaseed, Al-Bathan, Al-Nasaryeh) from the region of Wadi Al-Fara'a.

The feeding from Tubas electricity company to the north electricity company at the old connection points reached 3MVA (1.5 MVA for Sier connection point & 1.5 MVA for Al-Nasaryeh connection point) , and with addition of the new connection points, there will be a feed of 10MVA, for old and new connection areas (3 MVA for old connection point "Sier & Al-Nasaryeh" and 7 MVA for new connection point " 3 MVA for Yaseed connection point & 4 MVA for Al-Bathan connection point") [11].

The figure (2.3.1) shows the locations for the connection points between Tubas electricity company and the North electricity company.

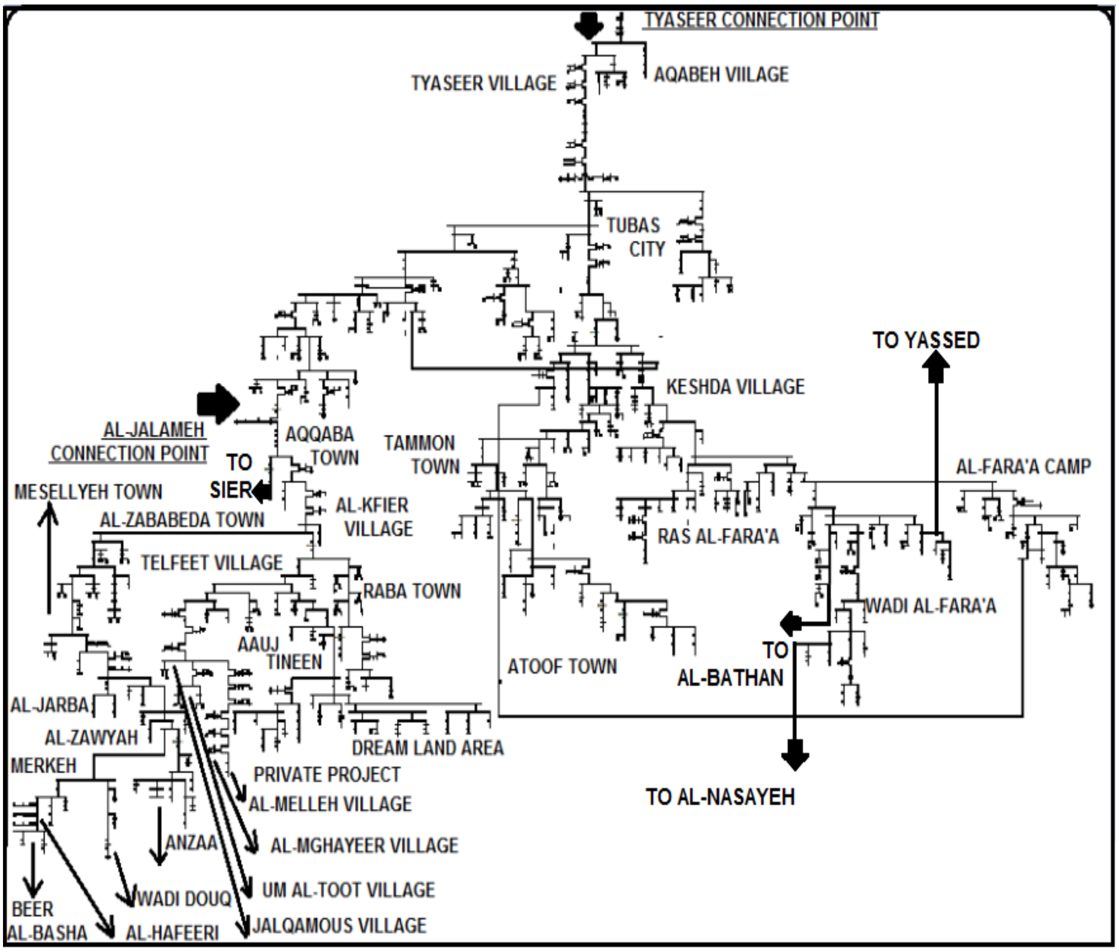

Figure (2.3.1) : Shows Tubas network and the connection points with North company network

Chapter 3
The Solutions

3.1 The Suggested Solutions to the Problems of Tubas Electricity Network:

In this section of the thesis, possible solutions are presented to all the actual problems in Tubas network, as there are 33 problems in the network distributed over 21 areas in Tubas network as a whole, and these areas are (Tubas city, Keshda village, Tyaseer village, Ras Al-Fara'a area, Wadi Al-Fara'a area, Al-Fara'a Camp area, Tammon town, Atoof town, Aqqaba town, Al-Zababeda town, Al-Kfier village, Raba town, Telfeet village, Private Project area, Jalqamous village, Al-Mghayer village, Um Al-Toot village, Meselyeh town, Al-Jarba village, Al-Zawyah village and Wadi Douq village). In this section the proposed solution to these problems and the impact of these solution on the network are presented.

3.1.1 The Suggested Solutions to the Problems of Tubas City Network:

There are five problems in Tubas city network. These problems were discussed in the previous chapter (chapter 2 : The Analysis), and these problems are distributed over the regions of the city of Tubas.

- The problem 1 : This problem is due to the large distance between the transformer and some of the loads that it feeds. The intended transformer is (T8 // AL-THOGRAH which is located in the Northern region of the Tubas city).

The figure (3.1.1) shows the distance between the transformer (T8//AL-THOGHRAH) and some the loads far from it by using the simulation program (ETAP Program).

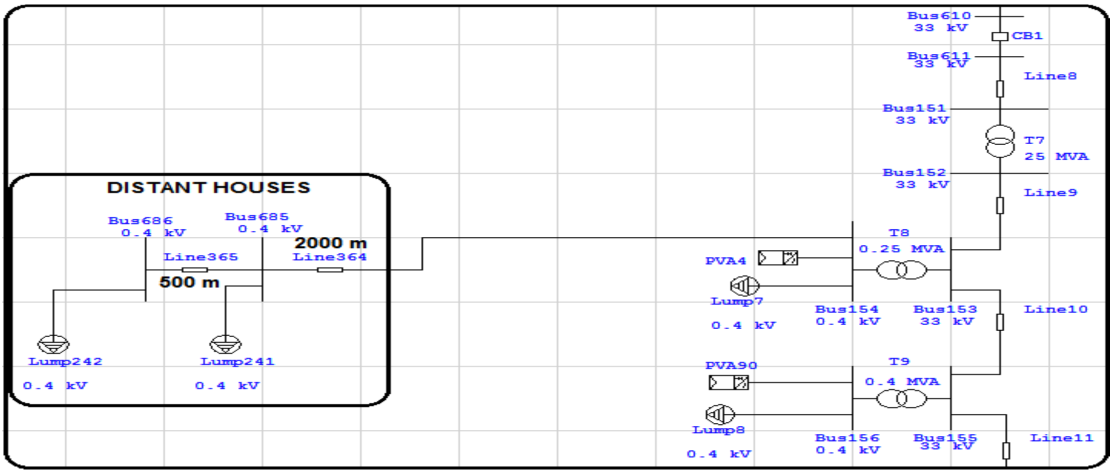

Figure (3.1.1) : The distance between the transformer(T8) and its loads (distant houses) in Tubas city network

The figure (3.1.2) shows the power factors for the loads of the transformer (T8//AL-THOGHRAH) as well as the electrical currents of these loads, as Bus154 indicates the location of loads near the transformer(T8//AL-THOGHRAH) and Buses(685 & 686) refer to the location of the transformer (T8//AL-THOGHRAH) as shown in the previous figure (3.1.1), these values from ETAP simulation program.

ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp
Bus152	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus153	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus154	0.400		0.016	0	0.012	0	0	0	0	0	0.029	100.0	68.6
Bus155	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus685	0.400		-0.001	0	0.001	0	0	0	0	0	0.001	100.0	3.5
Bus686	0.400		-0.002	0	0.002	0	0	0	0	0	0.002	100.0	4.8

Figure (3.1.2) : The power factors and electrical currents at the transformer (T8) in Tubas city network

* Note : In the previous figure , in the third column , there are positive and negative values . What is meant by this is that the negative values are the

demand from the Bus and the positive values are the values given by the Bus [52].

- The solutions: Three solutions have been proposed to this problem, and we will present these solutions separately and study the effect of these solutions on the network in terms of power factors as well as electrical currents of transformer loads (T8//AL-THOGHRAH).

1) Adding a new solar systems next the distant houses (Load241 & Load242), PV116 and PV117, such as the solar system PV116 adding to the Bus685 next to the load Load241 which is 2000 meters away from its transformer (T8//AL-THOGHRAH) and the solar system PV117 adding to the Bus686 next to the Load242 which is 2500 meters away from its transformer (T8//AL-THOGHRAH). The figure (3.1.3) shows the power factors for the loads of the transformer (T8//AL-THOGHRAH) as well as the electrical currents of these loads, Bus154 is next to the Load7 which is near to the transformer(T8//AL-THOGHRAH) and Buses(685 & 686) are beside the loads "Load241 & Load242" which are away from the transformer (T8//AL-THOGHRAH). These results are obtained after adding the new solar systems (PV116 & PV117) as a first solution to the first problem in the city of Tubas, these values from ETAP simulation program.

ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp
Bus152	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus153	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus154	0.400		0.016	0	0.012	0	0	0	0	0	0.029	100.0	68.6
Bus155	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus685	0.400		0.004	0	0.001	0	0	0	0	0	0.005	100.0	11.9
Bus686	0.400		0.003	0	0.002	0	0	0	0	0	0.005	100.0	11.9

Figure (3.1.3) : The power factors and the electrical current at the transformer (T8) after adding the suggested solar systems solution (PV116 & PV117) in TUBAS city network

From figure (3.1.2) and figurer (3.1.3) we see that the addition of the suggested solar systems (PV116 & Pv117) did not affect the power factors, but it increased the current at the loads (Load241 next Bus685 and Load242 next Bus686). Whereas, the power factor and electric current of the Load7 at Bus154 did not change after the addition of the new solar systems. Likewise, the power factors at loads (Load241 & Load242) were not negatively affected after the addition of the new solar systems. While the electric currents at loads (Load241 and Load242) besides (Bus685 and Bus686) respectively have been changed and their values were increased at Load241 from 3.5 Amperes to 11.9 Amperes ,and at Load242 from 4.8 Amperes to 11.9 Amperes. This is what is actually required , meaning not to negatively affect the power factors and increase the current on the distant loads (Load241 & Load242) that suffer from the problem of weak electric current to them in the first place. So the suggested solution is a good as a solution to the existing problem .

2) Adding a new transformer (T254) next the distant houses (load241 & load242), such as the transformer (T254) gets 33KV electrical power through the new transmission line Line358 which is connected to the

network at Bus153 located next to the transformer (T8//AL-THOGHRAH), where the new transformer T254 is located next to the Load241 and is 500 meters away from the Load242. The figure (3.1.4) shows the power factors and the electrical current for the loads (Load241, Load242 & Load7), as Bus154 next the load Load7 near the transformer(T8//AL-THOGHRAH) and Buses(685 & 686) beside the loads "Load241 & Load242" away from the transformer (T8//AL-THOGHRAH) and beside the new transformer (T254). These results are obtained after adding the new transformer (T254) as a second solution to the first problem in the city of Tubas, these values from ETAP simulation program.

ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp
Bus152	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus153	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus154	0.400		0.016	0	0.012	0	0	0	0	0	0.029	100.0	68.6
Bus155	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus679	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus680	0.400		-0.001	0	0.001	0	0	0	0	0	0.001	100.0	3.5
Bus687	0.400		-0.002	0	0.002	0	0	0	0	0	0.002	100.0	4.8

Figure (3.1.4) : The power factors and the electrical currents at the transformer(T8) loads after adding the suggested transformer(T254) in Tubas city network

From figure (3.1.2) and figurer (3.1.4) we see that the addition of the suggested transformer (T254) did not affect the power factors and the electrical currents at the loads (Load241 next Bus679, Load242 next Bus680 and Load7 next Bus154). Whereas, the power factor and electric current of the Load7 at Bus154 did not change after the addition of the new transformer. Likewise, the power factors at loads (Load241 & Load242) were not negatively affected after the addition of the new transformer. While the electric currents at loads (Load241 and Load242) besides

(Bus679 and Bus680) respectively, haven't change but the current is improved so that there is no weakening of the current.

This is what is actually required, meaning not to negatively affect the power factors and improve the current on the distant loads (Load241 & Load242) that suffer from the problem of weak electric current to them in the first place. So the suggested solution is a good solution to the existing problem.

3) Adding a new transmission line (low voltage – 400volt – TL367) from (T3 – SCHOOL – Tyaseer village) to the distant houses (load241 & load242), such as the new transmission line (TL367) connected between the Bus148 which is located next to transformer (T3//SCHOOL TYASEER) and Bus688 which is next to the loads (Load241 & Load242) located in the Northern region of the city of Tubas, at a distance of (2000-2500 meters) from transformer (T8//AL-THOGHRAH). The figure (3.1.5) shows the power factor at Bus688 next the loads (Load241 & Load242 "distance houses"), after adding the new transmission line (TL367), these values from ETAP simulation program.

Bus675	0.400	-0.004	-0.001	0.004	0.001	0	0	0	0	0.004	95.6	8.9
Bus676	0.400	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus677	0.400	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus678	0.400	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus688	0.400	-0.003	0	0.003	0	0	0	0	0	0.003	99.8	8.3

Figure (3.1.5) : The power factor at the distance houses (load241 & load242) after adding the suggested new transmission line(TL367) in Tubas city network

From figure (3.1.2) and figure (3.1.5) we can see that adding the suggested new transmission line(TL367) between the transformer

(T3//SCHOOL TYASEER) and the loads (Load241 & Load242) did not significantly affect the power factor as it changed from 100% to 99.8% (little change by 0.02%) and this change is not considered a negative change and also, as shown in figure (3.1.2) in column 13 the electric current was for loads (Loads241 is 3.5ampers and Loads242 is 4.8ampers) where the sum of the currents of these loads is equal to 8.3ampers, and after adding the new transmission line (TL367) from figure (3.1.5) in column 13 the electric current does not change from 8.3ampers for the loads (Load241 & Load242) together. So the suggested solution is a good solution to the existing problem.

* The best solution will be chosen from among the three solutions proposed in chapter 4 (The Costs), after conducting an economic study (cost) of all solutions and selecting the best solution.

More details about the suggested solutions to the problem1 of Tubas city network, are listed in the appendix B at section B.1, Title B.1./1. .

- The problem 2: the need to increase the real power (Pmax) on the loads at the transformer (T23 // KAZIYA AL-MOTHEDIIN) and reduce the power demand on that transformer. The figure (3.1.6) shows the power factor at Bus178 next to the transformer (T23//KAZIYA AL-MOTHEDIEN) as shown in column 12 and the real power demand as shown in column 3, these values from ETAP simulation program.

Bus176	0.400	-0.026	-0.007	0.026	0.007	0	0	0	0	0.027	96.2	65.6
Bus177	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus178	0.400	-0.008	-0.002	0.008	0.002	0	0	0	0	0.008	96.2	19.6
Bus179	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus180	0.400	-0.014	-0.005	0.019	0.005	0	0	0	0	0.020	96.8	47.4

Figure (3.1.6) : The power factor at the transformer(T23) in Tubas city network

- The Solution: To increase the real power to be supplied to the loads at T23(KAZIYA AL-MOTHEDIEN) and to reduce the real power demand on the transformer we suggested the installation of a new solar system (PV13 – 5KWp) to the Bus178 next to the transformer (T23//KAZIYA AL-MOTHEDIEN). The figure (3.1.7) shows the power factor in column 12 at Bus178 adjacent to the transformer (T23//KAZIYA AL-MOTHEDIEN) near to the Load19 in the Southern region 1 in the Tubas city and the real power loaded onto Bus178 is in column 3 after adding the new solar system (PV13) to the Bus178.

Bus176	0.400	-0.026	-0.007	0.026	0.007	0	0	0	0	0.027	96.2	65.6
Bus177	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus178	0.400	-0.003	-0.002	0.008	0.002	0	0	0	0	0.008	96.2	19.6
Bus179	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus180	0.400	-0.014	-0.005	0.019	0.005	0	0	0	0	0.020	96.8	47.4

Figure (3.1.7) : The power factor at the transformer(T23) after adding the suggested solar system(PV13) in Tubas city network

From figure (3.1.6) and figure (3.1.7) at Bus178 in column 12 we see that the addition of the suggested new solar system(PV13) did not affect the power factor at T23(KAZIYA AL-MOTHEDIEN). But looking at column 3 in those figures, we see that the real power demand was in figure (3.1.6), that is, before the addition of the new solar system approximately 8KW but going to back to figure (3.1.7) in column 3, we see that the real power demand has decreased to 3KW. That is, the new solar system provide 5KW for Load19 near the transformer (T23//KAZIYA AL-

MOTHEDIEN) in the Southern region 1 of the city of Tubas. So the suggested solution is a good solution to the existing problem.

More details about the suggested solutions to the problem2 of Tubas city network, are listed in the appendix B at section B.1, Title B.1./1. .

- The problem 3: the needing for the low voltage transmission line (400volt) to feed the control room to the municipality well in the city of Tubas at the transformer(T28// TUBAS MUNICIPALITY WELL), to obtain this transmission line, we need to transport (400volt) along 1500 meters, which is financially costly and practically ineffective in obtaining stable current and this is a problem. The figure (3.1.8) shows the power factor in column 12 at Bus188 next the control room for the municipality well in the center of the town2 of Tubas city, as well as the electrical current in column 13 for the control room and the real power in the column 3, by setting shut off the well pump, these values from ETAP simulation program.

Bus185	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus186	0.400	0.014	-0.002	0.009	0.002	0	0	0	0	0.023	99.5	54.6
Bus187	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus188	0.400	0	0	0	0	0	0	0	0	0	100.0	0.2
Bus189	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0

Figure (3.1.8) : The power factor at the transformer(T28) "control room for the municipality well" in TUBAS city network

- The solution: We suggest to feeding the control room in the municipality well (Tubas city) with a new solar system (PV18 – 5KW), this solar system provides the necessary energy for the control room so that it provides the necessary current for the control room to be used in lighting, the air conditioning system and the security system at all time. The figure (3.1.9) shows the power factor in column 12 at Bus188 which is adjacent to the transformer (T28//TUBAS MUNICIPALITY WELL) near the Load24 in the center of the town2 (Tubas city) after adding the new solar system (PV18) to the Bus188. And also showing (the real power loaded & the electrical current) onto Bus188 is in columns (3 & 13) respectively, these values from ETAP simulation program.

Bus185	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus186	0.400	0.014	-0.002	0.009	0.002	0	0	0	0	0.023	99.5	54.6
Bus187	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus188	0.400	0.005	0	0	0	0	0	0	0	0.005	100.0	11.7
Bus189	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0

Figure (3.1.9) : The power factor at the transformer(T28) after adding the suggested solar system(PV18) in TUBAS city network

From figure (3.1.8) and figure (3.1.9) at Bus188 in column 12 we see that the addition of the suggested new solar system(PV18) did not affect the power factor at T28(TUBAS MUNICIPALITY WELL). But looking at column 13 in figure (3.1.8) we see the electrical current is about 0.02 amperes, after adding the new solar system (PV18) we see in column 13 in figure (3.1.9) that the electrical current is increased to 11.7 amperes, and when looking at column 3 in those figures, we see that the real power demand was about 0KW as seen in figure (3.1.8). That is, before the addition of the new solar system in the absence of any load in the control room, but going to back to figure (3.1.9) in column 3, we see that Bus188 has become a power source as it has given 5KW. In other words, the new solar system provide 5KW for Load24 (control room for the municipality well in Tubas city) and in the event that the control room is not operational the power produced from the new solar system is transferred to the grid near the transformer (T28//TUBAS MUNICIPALITY WELL) in the center of the town 2 (Tubas city). So the suggested solution is a good solution to the existing problem.

More details about the suggested solutions to the problem3 of Tubas city network, are listed in the appendix B at section B.1, Title B.1./1. .

- The problem 4: The pressure on the transformers in Al-Rawda neighborhood (T29 // RAWDA – NEW AMN WATANY CENTER, T30 // AMN WATANY CENTER 1 & T31 // AMN WATANY CENTER 2) as a result of the excessive demand for electric power by the security centers (National security – AMN WATANY) in cases of military training and security meetings. This affects the stability of the electric current on the homes of the neighborhood. This is the actual problem that we need to find a suitable solution. The figure (3.1.10) shows the power factors in column 12 and the real power demand in column 3 for the transformers(T29 at Bus190, T30 at Bus192 and T31 at Bus194) in neighborhood of Al-Rawda in the center of the town (Tubas city), these values from ETAP simulation program.

ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp
Bus190	0.400		-0.005	-0.001	0.005	0.001	0	0	0	0	0.005	98.3	11.3
Bus191	33.000		0	0.006	0	0	0	0	0	0	0.006	0.0	0.2
Bus192	0.400		-0.009	-0.002	0.009	0.002	0	0	0	0	0.009	97.5	22.4
Bus193	33.000		0	0.006	0	0	0	0	0	0	0.006	0.0	0.2
Bus194	0.400		-0.014	-0.007	0.014	0.007	0	0	0	0	0.016	89.1	37.3

Figure (3.1.10) : The power factors at the transformers (T29 , T30 & T31) in Tubas city network

- The solution:

- At the transformer (T29//RAWDA-NEW AMN WATANY CENTER) to solve the problem of pressure on the transformer(T29) and the problem of the instability of the electric current on the houses surrounding this transformer, especially in peak periods, we suggested a new solar system (PV19 – 5KWp) as this solar system provides electrical energy to some of the houses surrounding the transformer (T29//RAWDA-NEW AMN WATANY CENTER) in the neighborhood of Al-Rawda and reduce the pressure on the transformer (T29). The figure (3.1.11) shows the power factor in column 12 at Bus190 adjacent to the transformer (T29//RAWDA-NEW AMN WATANY CENTER) near the Load25 in the center of the town 2 (Tubas city) after adding the new solar system (PV19) to the Bus190. And also showing (the real power loaded & the electrical current) onto Bus190 is in columns (3 & 13) respectively ,these values from ETAP simulation program.

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					Percent
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Loading
Bus190	0.400		0	-0.001	0.005	0.001	0	0	0	0	0.005	98.5	11.9	
Bus191	33.000		0	0.006	0	0	0	0	0	0	0.006	0.0	0.2	
Bus192	0.400		-0.009	-0.002	0.009	0.002	0	0	0	0	0.009	97.5	22.4	
Bus193	33.000		0	0.006	0	0	0	0	0	0	0.006	0.0	0.2	
Bus194	0.400		-0.014	-0.007	0.014	0.007	0	0	0	0	0.016	89.1	37.3	

Figure (3.1.11) : The power factor at the transformer(T29) after adding the suggested solar system(PV19) in Tubas city network

From figure (3.1.10) and figure (3.1.11) in column 12 at Bus190 we see that the addition of the suggested solar system(PV19) did not negatively affect the power factor at T29 (RAWDA-NEW AMN WATANY CENTER), the power factor slightly increasing from 98.3% to 98.5% (about 0.02%). Also in figure (3.1.11) we notice that the electrical current in column 13 equals 11.3 amperes, and after adding the new solar system(PV19) the electrical current increases slightly at Bus190 to 11.9 amperes, as in evident in figure (3.1.11) in column 13 at Bus190, and for the electrical power as shown in figure (3.1.10) in column 3, the demand for real power is equals 5KW and after adding the new solar system(PV19), the demand for real power becomes zero kilowatts as is evident in figure (3.1.11) in column 3 at Bus190 . whereas the new solar system(PV19) provided the necessary electrical power to the houses surrounding the transformer(T29//RAWDA-NEW AMN WATANY CENTER) and in cases of pressure on the transformer(T29) as result of increased load due to military training in the security center (Amn Watany Center) the new solar system(PV19) provides the electrical power needed for homes and helps stabilize the electrical current on homes. This is what is needed. So the suggested solution its good as a solution to the existing problem .

- At the transformer (T30//AMN WATANY CENTER1) to solve the problem of pressure on the transformer(T30) and the problem of the instability of the electric current on the houses surrounding this transformer, especially in peak periods, we suggested a new solar system (PV20 – 5KWp) as this solar system provides electrical energy to some of the houses surrounding the transformer (T230//AMN WATANY CENTER1) in the neighborhood of Al-Rawda and reduce the pressure on the transformer(T30). The figure (3.1.12) shows the power factor in column 12 at Bus192 adjacent to the transformer (T30//AMN WATANY CENTER1) near the Load26 in the center of the town 2 (Tubas city) after adding the new solar system (PV20) to the Bus192. And also showing (the real power loaded & the electrical current) onto Bus192 is in columns (3 & 13) respectively, these values from ETAP simulation program.

Bus			Constant kVA		Constant Z		Constant I		Generic				
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp
Bus190	0.400		-0.005	-0.001	0.005	0.001	0	0	0	0	0.005	98.3	11.3
Bus191	33.000		0	0.006	0	0	0	0	0	0	0.006	0.0	0.2
Bus192	0.400		-0.004	-0.002	0.009	0.002	0	0	0	0	0.009	97.5	22.4
Bus193	33.000		0	0.006	0	0	0	0	0	0	0.006	0.0	0.2

Figure (3.1.12) : The power factor at the transformer(T30) after adding the suggested solar system(PV20) in Tubas city network

From figure (3.1.10) and figure (3.1.12) in column 12 at Bus192 we see that the addition of the suggested solar system(PV20) did not negatively affect the power factor at T30(AMN WATANY CENTER1), the power factor not change from 97.5%. Also in figure (3.1.10) we notice that the electrical current in column 13 equals 22.4 amperes, and after adding the new solar system(PV20) the electrical current not change at Bus192, as in evident in figure (3.1.12) in column 13 at Bus192, and for the electrical power as shown in figure (3.1.10) in column 3 ,the demand for real power is equals 9KW and after adding the new solar system(PV20) , and the demand for real power becomes 4KW as is evident in figure (3.1.12) in column 3 at Bus192. Whereas the new solar system(PV20) provided the necessary electrical power to the houses surrounding the transformer (T30//AMN WATANY CENTER1) and in cases of pressure on the transformer(T30) as result of increased load due to military training in the security center1 (AMN WATANY Center1) the new solar system(PV20) provides the electrical power needed for homes and helps stabilize the electrical current on homes . this is what is needed. So the suggested solution is a good solution to the existing problem .

- At the transformer (T31//AMN WATANY CENTER2) to solve the problem of pressure on the transformer(T31) and the problem of the instability of the electric current on the houses surrounding this transformer, especially in peak periods, we suggested a new solar system (PV21 – 5KWp) as this solar system provides electrical energy to some of the houses surrounding the transformer (T231//AMN WATANY CENTER2) in the neighborhood of Al-Rawda and reduce the pressure on the transformer(T31). The figure (3.1.13) shows the power factor in column 12 at Bus194 adjacent to the transformer (T31//AMN WATANY CENTER2) near the Load27 in the center of the town2 (Tubas city) after adding the new solar system (PV21) to the Bus194. And also showing (the real power loaded & the electrical current) onto Bus194 is in columns (3 & 13) respectively, these values from ETAP simulation program.

Bus193	33.000	0	0.006	0	0	0	0	0	0	0.006	0.0	0.2
Bus194	0.400	-0.009	-0.007	0.014	0.007	0	0	0	0	0.016	89.1	37.3
Bus195	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus196	0.400	-0.008	-0.002	0.013	0.002	0	0	0	0	0.014	98.4	32.5

Figure (3.1.13) : The power factor at the transformer(T31) after adding the suggested solar system(PV21) in Tubas city network

From figure (3.1.10) and figure (3.1.13) in column 12 at Bus194 we see that the addition of the suggested solar system(PV21) did not negatively affect the power factor at T31(AMN WATANY CENTER2) ,the power factor not change from 89.1%. also in figure (3.1.10) we notice that the electrical current in column 13 equals 37.3 amperes, and after adding the new solar system(PV21) the electrical current not change at Bus194, as in evident in figure (3.1.13) in column 13 at Bus194, and for the electrical power as shown in figure (3.1.10) in column 3, the demand for real power is equals 14KW and after adding the new solar system(PV21), and the demand for real power becomes 9KW as is evident in figure (3.1.13) in column 3 at Bus194. Whereas the new solar system(PV21) provided the necessary electrical power to the houses surrounding the transformer (T31//AMN WATANY CENTER2) and in cases of pressure on the transformer(T31) as result of increased load due to military training in the security center2 (Amn Watany Center2) the new solar system(PV21) provides the electrical power needed for homes and helps stabilize the electrical current on homes. This is what is needed. So the suggested solution is a good solution to the existing problem .

More details about the suggested solutions to the problem4 of Tubas city network, are listed in the appendix B at section B.1, Title B.1./1. .

- The problem 5: The houses next to the customs police station get the electrical power from the transformer(T135//AL-HAWOOZ 1) by the transmission line(TL368), which is 3000 meters long, which is a transmission line to transmit the low voltage (400volt) and this transmission line is non-isolated and dangerous to the homes. Where is the transmission line (TL368) is passes over a group of the residential homes in the Western regions of the city of Tubas, and this is considered a dangerous to homes and residents. Therefore a solution must be found to this problem. The figure (3.1.14) shows the power factors in column 12, electrical currents in column 13 and the demand of real powers in column 3 for the transformers (T135//AL-HAWOOZ 1 & T137//CUSTOMS POLICE) at buses (Bus689 & Bus362) respectively. In the center of the Western region (Tubas city).

Bus675	0.400	-0.004	-0.001	0.004	0.001	0	0	0	0	0.004	95.6	8.9
Bus676	0.400	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus677	0.400	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus678	0.400	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus689	0.400	-0.008	-0.002	0.008	0.002	0	0	0	0	0.009	97.9	20.5
Bus359	33.000	0	0.006	0	0	0	0	0	0	0.006	0.0	0.2
Bus360	0.400	0.097	-0.009	0.031	0.009	0	0	0	0	0.129	99.8	309.5
Bus361	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus362	0.400	-0.001	0	0.001	0	0	0	0	0	0.001	100.0	1.2
Bus363	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0

Figure (3.1.14) : The power factors at the transformer(T135) at Bus689 and transformer(T137) at Bus362 in Tubas city network

- The solution: To solve the problem we use the presence of a transformer close to homes (Load243), which is the transformer (T137//CUSTOMS POLICE) meaning that we say that these homes are separated from the transformer (T135//AL-HAWOOZ 1) far from homes with a low voltage transmission line with a length of 3000 meters, so that these homes (Load243) do not affect the transformer (T137//CUSTOMS POLICE) and it does not affect the stability of the electrical current in the customs police station, which is connected to its transformer (T137//CUSTOMS POLICE) as we suggest to put a new solar system on the roof of one of the houses (PV45 – 5KWp), so we get rid of the old transmission line (TL368 – low voltage transmission line – 400volt) that is not isolated, and consider a dangerous on homes and residents in the Western regions of the city of Tubas, and we do not put pressure on the transformer (T137//CUSTOMS POLICE) such as the new solar system (PV45) will reduce the loads and pressure on the transformer (T137//CUSTOMS POLICE). The figure (3.1.15) shows the houses (Load243), the location of disconnected the houses from the transformer (T135//AL-HAWOOZ 1), the location of the connection of these houses with the transformer (T137//CUSTOMS POLICE) and the figure shows the location of the new solar system (PV45) that will be used to reduce the pressure on the transformer (T137//CUSTOMS POLICE).

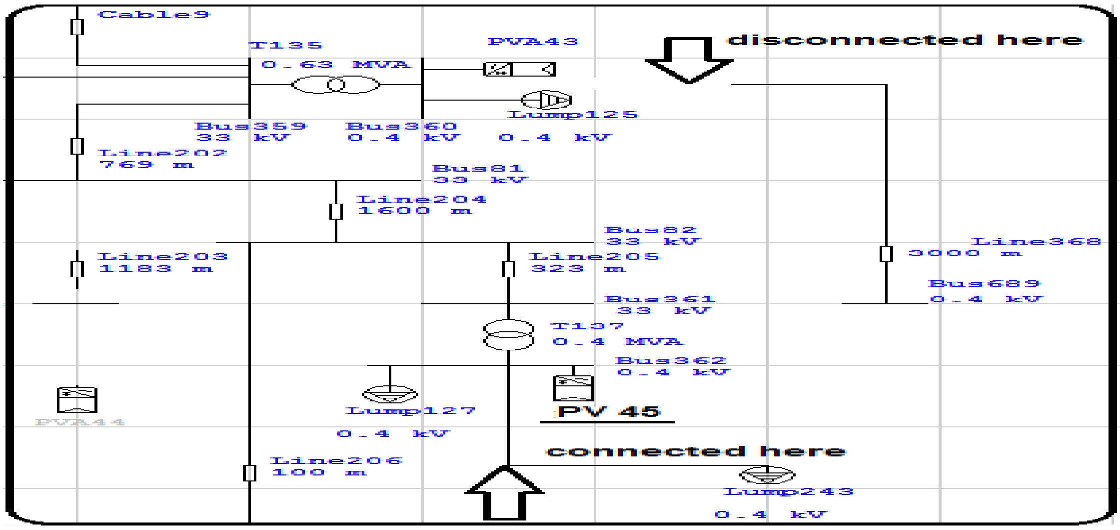

Figure (3.1.15) : The suggested new connection between the houses(load243) and the transformer(T137) with a new solar system(PV45) to solve the problem 5 in Tubas city network

The figure (3.1.16) shows the power factors in column 12, electrical currents in column 13 and the demand of real powers in column 3 for the transformers (T135//AL-HAWOOZ 1 & T137//CUSTOMS POLICE) at buses (Bus689 & Bus362) respectively. In the center of the Western region (Tubas city), after adding the new solar system (PV45), disconnecting the Load243 from transformer (T135) and connecting the Load243 to transformer (T137) next to new solar system (PV45) at Bus362, these values from ETAP simulation program.

Bus677	0.400	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus678	0.400	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus689	0.400	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus360	0.400	0.097	-0.009	0.031	0.009	0	0	0	0	0.129	99.8	309.5
Bus361	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus362	0.400	-0.004	-0.002	0.009	0.002	0	0	0	0	0.009	98.1	21.7
Bus363	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus364	0.400	0.006	-0.001	0.003	0.001	0	0	0	0	0.009	99.7	21.7

Figure (3.1.16) : The power factors at the transformer(T135) and the transformer(T137) after adding the suggested solar system(PV45) and load(243) to transformer(T137) in Tubas city network

From figure (3.1.14) we note that the power factors in column 12 for buses (Bus689 & Bus362) are equal to (97.5% & 100%) respectively, the electrical currents in column 13 for buses (Bus689 & Bus362) equals (20.5 amperes & 1.2 amperes) respectively and in column 3 we note that the demand for the real powers of buses (Bus689 & Bus362) are equal to (8KW & 1KW). After disconnecting the Load243 from the transformer (T135//AL-HAWOOZ 1) that is meaning disconnecting Bus689 from transformer (T135//AL-HAWOOZ 1) and connecting the Load243 to transformer (T137//CUSTOMS POLICE). We note in figure (3.1.16) in column 12 the power factor, in column 13 the electrical current, in column 3 the demand for the real power and they are all equal to zeros. This is because Bus689 has been completely disconnected from the electrical grid.

In figure (3.1.16) at Bus362 in column 12 we notice that the power factor has become 98.1% meaning that it decreased slightly by (1.9%), and this is due to the addition of Load243 to transformer (T137//CUSTOMS POLICE) at Bus362, also at Bus362 in figure (3.1.16) we notice in column 13 that the electric current has increase to the value of 21.7 amperes (increased by 20.5 amperes) and the reason for this increase is an addition the Load243 to Bus362 next to the transformer (T137//CUSTOMS POLICE) as well as adding the Load243 to Bus362 with a new solar system (PV45) affects the demand for real power at Bus362 and this is evident in figure (3.1.16) where we note that the demand for real power in column 3 equals 4KW. Consequently, the connected of the Load243 to Bus362 next to the transformer (T137//CUSTOMS POLICE), which increased the electrical current and electrical power on Bus362, and this is increase in order not to put pressure on the transformer (T137//CUSTOMS POLICE) , anew solar system was added (PV45). Where this solar system provides the increase in the electric current and the electrical power of the transformer (T137//CUSTOMS POLICE) at Bus362. And for the power factor, which decreased by (1.9%) this is a small change and is not considered a negative change in the power factor. So the adding for the Load243 and the solar system (PV45) to Bus362 that next to the transformer (T137//CUSTOMS POLICE) does not put a pressure on the transformer (T137//CUSTOMS POLICE), and provides a safe electrical current for the Load243. So the suggested solution is a good solution to the existing problem .

More details about the suggested solutions to the problem5 of Tubas city network, are listed in the appendix B at section B.1, Title B.1./1. .

3.1.2 The Suggested Solutions to the Problems of Keshda Village Network:

There is one problem in Keshda village network. This problem was discussed in chapter 2 (The Analysis), and this problem is distributed among the regions of the village of Keshda.

- The Problem: The distance between the feeding areas (the center of the town – Ras Al-Fara'a and the areas near Al-Fara'a areas – Tubas city) and the regions in the village (the center of the village and the Southern region of the village). As the village of Keshda gets electricity from two different areas , and the problem is coordination with these areas, trying to causes any defect in the village. The figure (3.1.17) shows the power factors in column 12 at the transformers in the village of Keshda (T35//PICKE FACTORY at Bus202, T36//KESHDA MAIN at Bus204 and T46//MOA'YAD ALFAKHRI at Bus533), shows the electrical current and the demand of the real power in columns (13&3) respectively, these values from ETAP simulation program.

ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp
Bus532	0.400		0	0	0	0	0	0	0	0	0	100.0	0.2
Bus533	0.400		-0.006	-0.002	0.006	0.002	0	0	0	0	0.006	95.6	14.7
Bus534	0.400		-0.027	-0.012	0.027	0.012	0	0	0	0	0.029	91.1	70.4
Bus535	0.400		-0.012	-0.006	0.012	0.006	0	0	0	0	0.013	89.3	31.6
Bus200	0.400		0.005	-0.001	0.005	0.001	0	0	0	0	0.010	99.6	23.7
Bus201	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus202	0.400		-0.007	-0.004	0.007	0.004	0	0	0	0	0.008	90.3	19.8
Bus203	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus204	0.400		0.008	0	0.001	0	0	0	0	0	0.009	99.9	21.7
Bus205	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0

Figure (3.1.17) : The power factors at the transformers (T35, T36 and T46) in Keshda village network

- The solution: We suggest a new connection between the regions of the village of Keshda (by TL 357 – 300meters) from the center of the village at Bus19 to the Southern region of the village at Bus27, so that the feeding becomes from one area (from the areas near Al-Fara'a areas "Tubas city", the Southern region of the city of Tubas). The figure (3.1.18) shows the new transmission line (TL357 – medium voltage – 33KV) that built between the regions of the village of Keshda from Bus19 to Bus27 and shows the disconnecting location between the Southern region of the village of Keshda and the center of the town of Ras Al-Fara'a area .

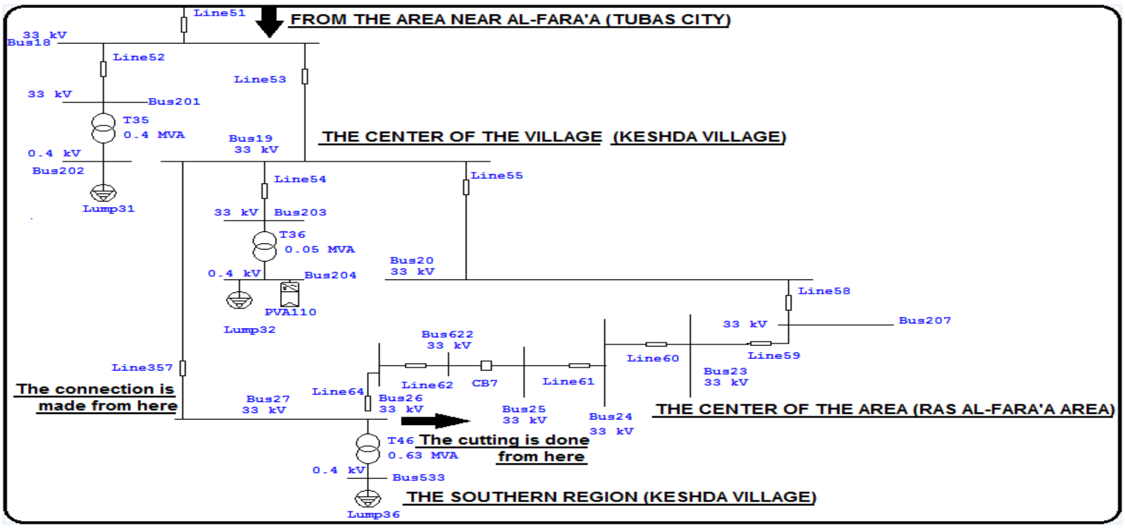

Figure (3.1.18) : The adding new transmission line between the regions of the village in Keshda village network

The figure (3.1.19) shows the power factors in column 12 at the transformers in the village of Keshda (T35//PICKE FACTORY at Bus202, T36//KESHDA MAIN at Bus204 and T46//MOA'YAD ALFAKHRI at Bus533), shows the electrical current and the demand of the real power in columns (13&3) respectively after adding the new transmission line (TL357) between the regions of the village of Keshda, these values from ETAP simulation program.

Bus200	0.400	0.005	-0.001	0.005	0.001	0	0	0	0	0.010	99.6	23.7
Bus201	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus202	0.400	-0.007	-0.004	0.007	0.004	0	0	0	0	0.008	90.3	19.8
Bus203	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus204	0.400	0.008	0	0.001	0	0	0	0	0	0.009	99.9	21.7
Bus532	0.400	0	0	0	0	0	0	0	0	0	100.0	0.2
Bus533	0.400	-0.006	-0.002	0.006	0.002	0	0	0	0	0.006	95.6	14.7
Bus534	0.400	-0.027	-0.012	0.027	0.012	0	0	0	0	0.029	91.1	70.4
Bus535	0.400	-0.012	-0.006	0.012	0.006	0	0	0	0	0.013	89.3	31.6

Figure (3.1.19) : The power factors at the transformers (T35 , T36 and T46) after adding the suggested transmission line (TL357) in Keshda village network

From figure (3.1.17) and figure (3.1.19) we see the addition of the suggested new transmission line (TL357) between the regions of Keshda village and it did not affect the power factors in the transformers (T35//PICKE FACTORY, T36//KESHDA MAIN and T46//MOA'YAD AL-FAKHRI), and also did not affect the electric currents and electric powers in the village. But the important point is that the difficulty of coordination between the regions has been eliminated, so that there is one feeding point for the regions of the village of Keshda. So the suggested solution is a good solution to the existing problem .

More details about the suggested solutions to the problems of Keshda village network, are listed in the appendix B at section B.1, Title B.1./2.

3.1.3 The Suggested Solutions to the Problems of Tyaseer Village Network:

There is one problem in Tyaseer village network. This problem was discussed in the previous chapter (chapter 2 : The Analysis), and this problem is distributed among the regions of the village of Tyaseer.

- The problem: The need to make the village school an environmentally friendly school, at transformer (T3 // SCHOOL – TYASEER) at Bus148. The figure (3.1.20) shows the power factor in column 12, the electrical current in column 13 and the demand of real power in column 3 for the transformer (T3//SCHOOL – TYASEER) at Bus148 in the village of Tyaseer, these values from ETAP simulation program.

Bus146	0.400	-0.009	-0.005	0.019	0.005	0	0	0	0	0.019	96.5	46.3
Bus147	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus148	0.400	-0.001	0	0.001	0	0	0	0	0	0.001	94.2	2.6
Bus149	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus150	0.400	-0.005	-0.002	0.005	0.002	0	0	0	0	0.006	95.6	13.6
Bus151	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0

Figure (3.1.20) : The power factor at the transformer (T3 // SCHOOL – TYASEER) in Tyaseer village network

- The solution: We suggested a new solar system(PV2 – 5KWp) at T3(SCHOOL – TYASEER) to make the school an environmentally friendly school depends on solar energy, considering that solar energy is a renewable energy source. The figure (3.1.21) shows the power factor in column 12, the electrical current in column 13 and the demand of real power in column 3 for the transformer (T3//SCHOOL – TYASEER) at Bus148 in the village of Tyaseer after adding the new solar system (PV2), these values from ETAP simulation program.

Bus146	0.400	-0.009	-0.005	0.019	0.005	0	0	0	0	0.019	96.5	46.3
Bus147	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus148	0.400	0.004	0	0.001	0	0	0	0	0	0.005	99.7	11.7
Bus149	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus150	0.400	-0.005	-0.002	0.005	0.002	0	0	0	0	0.006	95.6	13.6
Bus151	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0

Figure (3.1.21) : The power factor at the transformer (T3 // SCHOOL – TYASEER) after adding the suggested solar system (PV2) in TYASEER village network

From figure (3.1.20) and figure (3.1.21) we see in column 12 that the addition of the suggested solar system (PV2) did not negatively affect the power factor at the transformer (T3//SCHOOL-TYASEER), the power factor slightly increasing from 94.2% to 99.7% (about 5.50%), we see in column 13 an increase in electric current from 2.6 amperes to 11.7 amperes (about9.1 amperes) in column 3 we see demand of the real power before adding the new solar system (PV2) to Bus148 it is about 1KW, after adding the new solar system (PV2) to Bus148, Bus148 will be a source because the solar system will produce 5KW, 1KW of them is used for the load and the other 4KW of which goes to the grid. So the suggested solution is a good solution to the existing problem .

More details about the suggested solutions to the problems of Tyaseer village network, are listed in the appendix B at section B.1, Title B.1./3. .

3.1.4 The Suggested Solutions to the Problems of Aqabeh Village Network:

As we explained previously in chapter 2 (The Analysis) in this village there are no actual problems, so there are no suggested solutions for this village.

3.1.5 The Suggested Solutions to the Problems of Ras Al-Fara'a Area Network:

There is one problem in Ras Al-Fara'a area network. This problem was discussed in the previous chapter (chapter 2 : The Analysis), and this problem is distributed among the regions of the area of Ras Al-Fara'a.

- The problem: The agricultural areas in the eastern regions (the Eastern region and the center of the Eastern region of the area), and the resulting pressure on the transformers of the region and the houses in the region. Because of the large number of water wells in these areas and the pressure they casus on the transformers of the agricultural area (T85//TUBAS WELL, T87//AL-SHAREEF, T96//MALHAMEH, T57//AL-HAJ HA

HAKEEM, T58//ABO HAMED, T59//AL-KHARRAZ & T60//MOWAFAK AL-FAKHRY 'SHARAKEH WELL').

- The solutions:

1) We suggest a new solar systems in this regions with a value of approximately (0.4MWp) and the distribute these systems to several transformers in the regions referred to , as follow: The new solar systems (PV118 '150KWp' & PV119 '150KWp') to transformers (T96//MALHAMEH at Bus280 & T87//AL-SHAREEF at Bus541) respectively, in the Eastern region, and the new solar systems (PV120 '50KWp' & PV121 '50KWp') to transformers (T60//MOWAFAK AL-FAKHRY 'SHARAKEH WELL' at Bus232 & T59//AL-KHARRAZ at Bus230) respectively, in the center of the Eastern region as follow: The figure (3.1.22) shows the power factors in column 12, the electrical currents in column 13 and the demand of real powers in column 3 at buses (Bus280 & Bus541) in the Eastern region of Ras Al-Fara'a area. Before adding the new solar systems in this region, these values from ETAP simulation program.

Bus277	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus278	0.400	-0.014	-0.002	0.014	0.002	0	0	0	0	0.014	98.7	34.6
Bus279	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus280	0.400	0.003	-0.002	0.011	0.002	0	0	0	0	0.014	99.0	33.7
Bus281	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus538	0.400	0.014	-0.003	0.009	0.003	0	0	0	0	0.023	99.0	54.9
Bus539	0.400	-0.007	-0.003	0.007	0.003	0	0	0	0	0.007	93.1	17.5
Bus540	0.400	-0.002	-0.004	0.025	0.004	0	0	0	0	0.025	98.5	60.3
Bus541	0.400	0.007	-0.003	0.011	0.003	0	0	0	0	0.018	98.4	44.1
Bus542	0.400	0.002	-0.002	0.007	0.002	0	0	0	0	0.009	98.2	22.1
Bus543	0.400	-0.045	-0.009	0.045	0.009	0	0	0	0	0.046	98.0	110.1

Figure (3.1.22) : The power factors at the transformers(T96 at Bus541 and T87 at Bus180) before adding the suggested solar systems(PV118 & PV119) in Ras Al-Fara'a area network

The figure (3.1.23) shows the power factors in column 12, the electrical current in column 13 and the demand of real power in column 3 at buses (Bus280 & Bus541) in the Eastern region of Ras Al-Fara'a area. After adding the new solar systems (PV118 '150KWp' at Bus180 & PV119 '150KWp' at Bus541) in this region, these values from ETAP simulation program.

Bus278	0.400	-0.014	-0.002	0.014	0.002	0	0	0	0	0.014	98.7	34.6
Bus279	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus280	0.400	0.139	-0.002	0.011	0.002	0	0	0	0	0.151	100.0	362.2
Bus281	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus282	0.400	-0.014	-0.005	0.014	0.005	0	0	0	0	0.015	93.9	35.8
Bus538	0.400	0.014	-0.003	0.009	0.003	0	0	0	0	0.023	99.0	54.9
Bus539	0.400	-0.007	-0.003	0.007	0.003	0	0	0	0	0.007	93.1	17.5
Bus540	0.400	-0.002	-0.004	0.025	0.004	0	0	0	0	0.025	98.5	60.3
Bus541	0.400	0.144	-0.003	0.011	0.003	0	0	0	0	0.155	100.0	372.2
Bus542	0.400	0.002	-0.002	0.007	0.002	0	0	0	0	0.009	98.2	22.1
Bus543	0.400	-0.045	-0.009	0.045	0.009	0	0	0	0	0.046	98.0	110.1

Figure (3.1.23) : The power factors at the transformers(T96 at Bus541 and T87 at Bus180) after adding the suggested solar systems(PV118 & PV119) in Ras Al-Fara'a area network

The figure (3.1.24) shows the power factors in column 12, the electrical current in column 13 and the demand of real power in column 3 at buses (Bus230& Bus232) in the center of the Eastern region of Ras Al-Fara'a area. Before adding the new solar systems in this region, these values from ETAP simulation program.

ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp
Bus228	0.400		-0.004	-0.003	0.004	0.003	0	0	0	0	0.005	83.2	12.5
Bus229	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus230	0.400		-0.003	-0.002	0.003	0.002	0	0	0	0	0.004	91.0	8.8
Bus231	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus232	0.400		-0.007	-0.003	0.007	0.003	0	0	0	0	0.008	93.9	18.6

Figure (3.1.24) : The power factors at the transformers(T60 at Bus232 and T59 at Bus230) before adding the suggested solar systems(PV120 & PV121) in Ras Al-Fara'a area network

The figure (3.1.25) shows the power factors in column 12, the electrical current in column 13 and the demand of real power in column 3 at buses (Bus232 & Bus230) in the center of the Eastern region of Ras Al-Fara'a area. After adding the new solar systems (PV120 '50KWp' at Bus232 & PV121 '50KWp' at Bus230) in this region, these values from ETAP simulation program.

Bus			Constant KVA		Constant Z		Constant I		Generic				
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp
Bus228	0.400		-0.004	-0.003	0.004	0.003	0	0	0	0	0.005	83.2	12.5
Bus229	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus230	0.400		0.042	-0.002	0.003	0.002	0	0	0	0	0.046	99.9	109.7
Bus231	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus232	0.400		0.038	-0.003	0.007	0.003	0	0	0	0	0.046	99.8	109.8

Figure (3.1.25) : The power factors at the transformers (T60 and T59) after adding the suggested solar systems solution (PV120 & PV121) in Ras Al-Fara'a area network

The solar systems and these capacity of these solar systems were distributed in this way, taking into account the available areas in each region.

From figure (3.1.22) and figure (3.1.23) we see in column 12 that the addition of the suggested solar systems (PV118 & PV119) did not negatively affect the power factors of the transformers (T87 & T96) respectively as the power factors increased slightly from 99.0% to 100% (about 1.00%) at Bus280 next to the transformer T87and it increased from 98.4% to 100% (about 1.6%) at Bus541 next to the transformer T96, in column 13 we see that the electrical currents have increased significantly as it has increased the value of the electric current at Bus280 from 33.7 amperes to 362.2 amperes (increased by about 328.5 amperes) and the value of the electric current at Bus541 increased from 44.1 amperes to 372.2 amperes (increased by about 328.1 amperes), and in column 3 we see that the real power demand at Bus280 was 3KW towards the grid (meaning that before the addition of the new solar systems, Bus280 was considered a source of power of 3KW, because of the existence of an old solar system at Bus280 which is 'PV102-15KWp' as evident in figure (A.2.31)) and after adding the new solar system 'PV118-150KWp' to Bus280, this is bus now gives 139KW to the grid (increased the electrical power by 136KW), and at Bus541 the real power demand was 7KW towards the grid (meaning that before the addition of the new solar systems, Bus541 was considered a source of power of 7KW, because of the existence of an old solar system at Bus541 which is 'PV103-20KWp' as evident in figure (A.2.31)) and after adding the new solar system 'PV119-150KWp' to Bus541, this is bus now gives 144KW to the grid (increased the electrical power by 137KW). So the addition of the new solar systems for the Eastern region of the Ras Al-Fara'a area (PV118 at Bus280 next to the transformer (T87//AL-SHAREEF) and PV119 at Bus541 next to the transformer (T96//MALHAMEH)) helped to provide electrical power for the grid with an amount 136KW at Bus280 and 137KW at Bus541, a total of 273KW towards grid, and this is required to solve the problem of pressure on the region transformers.

From figure (3.1.24) and figure (3.1.25) we see in column 12 that the addition of the suggested solar systems (PV120 & PV121) did not negatively affect the power factors of the transformers (T60 & T59) respectively as the power factors increased slightly from 91.0% to 99.9% (about 8.90%) at Bus230 next to the transformer T59 and it increased from 93.9% to 99.8% (about 5.9%) at Bus232 next to the transformer T60, in column 13 we see that the electrical currents have increased significantly as it has increased the value of the electric current at Bus230 from 8.8 amperes to 109.7 amperes (increased by about 100.9 amperes) and the value of the electric current at Bus232 increased from 18.6 amperes to 109.8 amperes (increased by about 91.2 amperes), and in column 3 we see that the real power demand at Bus230 was 3KW and after adding the new solar system 'PV121-50KWp' to Bus230, this is bus now gives 42KW to the grid (increased the electrical power by 45KW), at Bus232 the real power demand was 7KW and after adding the new solar system 'PV120-50KWp' to Bus232, this is bus now gives 38KW to the grid (increased the electrical power by 45KW). So the addition of the new solar systems for the center of the Eastern region of Ras Al-Fara'a area (PV120 at Bus232 next to the transformer (T60//MOWAFAK ALFAKHRY 'SHARAKEH WELL') and PV121 at Bus230 next to the transformer (T59//AL-KHARRAZ)) helped to provide electrical power for the grid with an amount 45KW at Bus230 and 45KW at Bus232, a total of 90KW towards grid, and this is required to solve the problem of pressure on the region transformers. So the suggested solution is a good solution to the existing problem.

2) A new generator (G1 – 10MW) in these regions at Bus231 next the transformer (T60//MOWAFAK ALFAKHRY 'SHARAKEH WELL'), this generator will help to feed the agricultural areas and decrease the pressure on the transformers in this regions. The figure (3.1.26) shows the power factors in column 12, the electrical currents in column 13, and the real

powers demand in column 3, for the transformers (T57//AL-HAJ HAKEEM, T58//ABO HAMED, T59//AL-KHARRAZ, T60//MOWAFAK ALFAKHRY, T85//TUBAS WELL, T87//AL-SHAREEF and T96//MALHAMEH) these transformers are located in the Eastern regions of Ras Al-Fara'a area, before adding the new suggested generator to Bus231, these values from ETAP simulation program.

Bus225	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus226	0.400	0	-0.006	0.014	0.006	0	0	0	0	0.015	92.3	36.1
Bus227	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus228	0.400	-0.004	-0.003	0.004	0.003	0	0	0	0	0.005	83.2	12.5
Bus229	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus230	0.400	-0.003	-0.002	0.003	0.002	0	0	0	0	0.004	91.0	8.8
Bus231	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus232	0.400	-0.007	-0.003	0.007	0.003	0	0	0	0	0.008	93.9	18.6
Bus276	0.400	0.003	-0.001	0.002	0.001	0	0	0	0	0.005	99.5	11.7
Bus280	0.400	0.003	-0.002	0.011	0.002	0	0	0	0	0.014	99.0	33.7
Bus541	0.400	0.007	-0.003	0.011	0.003	0	0	0	0	0.018	98.4	44.1

Figure (3.1.26) : The power factors at the transformers(T57 , T58 , T59 , T60 , T85 , T87 and T96) at the Eastern regions before adding the suggested generator(G1) in Ras Al-Fara'a area network

The figure (3.1.27) shows the power factors in column 12, the electrical currents in column 13, and the real powers demand in column 3, for the transformers (T57//AL-HAJ HAKEEM, T58//ABO HAMED, T59//AL-KHARRAZ, T60//MOWAFAK ALFAKHRY, T85//TUBAS WELL, T87//AL-SHAREEF and T96//MALHAMEH) these transformers located in the Eastern regions of Ras Al-Fara'a area, after adding the new suggested generator to Bus231, these values from ETAP simulation program.

Bus226	0.400	0	-0.006	0.014	0.006	0	0	0	0	0.015	92.3	36.1
Bus228	0.400	-0.004	-0.003	0.004	0.003	0	0	0	0	0.005	83.2	12.5
Bus229	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus230	0.400	0.042	-0.002	0.003	0.002	0	0	0	0	0.046	99.9	109.7
Bus231	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus232	0.400	0.038	-0.003	0.007	0.003	0	0	0	0	0.046	99.8	109.8
Bus276	0.400	0.003	-0.001	0.002	0.001	0	0	0	0	0.005	99.5	11.7
Bus280	0.400	0.003	-0.002	0.011	0.002	0	0	0	0	0.014	99.0	33.7
Bus541	0.400	0.007	-0.003	0.011	0.003	0	0	0	0	0.018	98.4	44.1

Figure (3.1.27) : The power factors at the transformers (T57 , T58 , T59 , T60 , T85 , T87 and T96) at the EASTERN regions after adding the suggested generator(G1) in RAS AL-FARA'A area network

From figure (3.1.26) and figure (3.1.27) we notice that the power factors in column 12 have changed the value of some of them after adding the new suggested generator (G1) for example on Bus230 the values of power factor changed from 91.0% to 99.9% (it increased by 8.9%), at Bus232 the value of the power factor changed from 93.9% to 99.8% (it increased by 5.9%) and the rest of the values of the power factor did not change and their values are all more than 80%, so we consider acceptable and good values, from figures (3.1.26) & (3.1.27) in column 13 we see the electrical currents, where part of them changed especially at buses (Bus230 & Bus232) where the electrical current a Bus230 changed from the value 8.8 amperes to 109.7 amperes (it increased by 100.9 amperes), at Bus232 from 18.6 amperes to 109.8 amperes (it increased by 91.2 amperes), as for the demand for real power in figures (3.1.26) & (3.1.27) in column 3, as is evident, the electrical power has changed at buses (Bus230 & Bus232) at Bus230 the demand for electrical power was equal to 3KW and after adding the new generator, Bus230 became 42KW of electrical power to the grid (that is, Bus230 has became a source of electrical power by 45KW of which 3KW are consumed for the loads on the Bus230 and 42KW the rest goes to the grid), at Bus232 the electrical power demand was equal to 7KW, and after adding the new generator, Bus232 became an electrical power of 38KW (meaning that Bus232 became a source of electrical power by 45KW , of which 7KW are consumed for the loads on the Bus232 and the rest of the 38KW goes to the grid). This is what is required to improve the power factors and provide more electrical power for agricultural areas in Ras Al-Fara'a area (the Eastern region & the center of the Eastern region). So the suggested solution is a good solution to the existing problem.

3) Building a new transmission line (TL359 – Ring1) from Al-Jalameh connection point at Bus365 in the region "the center of the Western region – Tubas city" to the agricultural areas in Ras Al-Fara'a area "the center of the Eastern region and the Eastern region" at Bus231 next the transformer (T60//MOWAFAK ALFAKHRY 'SHARAKEH WELL'). The figure (3.1.28) shows the power factors in column 12, the electrical currents in column 13, and the real powers demand in column 3, for the transformers (T57//AL-HAJ HAKEEM, T58//ABO HAMED, T59//AL-KHARRAZ, T60//MOWAFAK ALFAKHRY, T85//TUBAS WELL, T87//AL-SHAREEF and T96//MALHAMEH) these transformers located in the Eastern regions of Ras Al-Fara'a area, before adding the new suggested transmission line between Bus365 to Bus231, these values from ETAP simulation program.

Bus225	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus226	0.400	0	-0.006	0.014	0.006	0	0	0	0	0.015	92.3	36.1
Bus227	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus228	0.400	-0.004	-0.003	0.004	0.003	0	0	0	0	0.005	83.2	12.5
Bus229	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus230	0.400	-0.003	-0.002	0.003	0.002	0	0	0	0	0.004	91.0	8.8
Bus231	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus232	0.400	-0.007	-0.003	0.007	0.003	0	0	0	0	0.008	93.9	18.6
Bus276	0.400	0.003	-0.001	0.002	0.001	0	0	0	0	0.005	99.5	11.7
Bus280	0.400	0.003	-0.002	0.011	0.002	0	0	0	0	0.014	99.0	33.7
Bus541	0.400	0.007	-0.003	0.011	0.003	0	0	0	0	0.018	98.4	44.1

Figure (3.1.28) : The power factors at the transformers (T57 , T58 , T59 , T60 , T85 , T87 and T96) at the Eastern regions before adding the suggested transmission line(TL359-Ring1) in Ras Al-Fara'a area network

The figure (3.1.29) shows the power factors in column 12 , the electrical currents in column 13 , and the real powers demand in column 3, for the transformers (T57//AL-HAJ HAKEEM , T58//ABO HAMED, T59//AL-KHARRAZ, T60//MOWAFAK ALFAKHRY, T85//TUBAS WELL, T87//AL-SHAREEF and T96//MALHAMEH) these transformers located in the Eastern regions of Ras Al-Fara'a area, after adding the new suggested transmission line between Bus365 to Bus231, these values from ETAP simulation program.

Bus226	0.400	0	-0.006	0.014	0.006	0	0	0	0	0.015	92.3	36.1
Bus228	0.400	-0.004	-0.003	0.004	0.003	0	0	0	0	0.005	83.2	12.5
Bus229	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus230	0.400	-0.003	-0.002	0.003	0.002	0	0	0	0	0.004	91.0	8.8
Bus231	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus232	0.400	-0.007	-0.003	0.007	0.003	0	0	0	0	0.008	93.9	18.6
Bus276	0.400	0.003	-0.001	0.002	0.001	0	0	0	0	0.005	99.5	11.7
Bus280	0.400	0.003	-0.002	0.011	0.002	0	0	0	0	0.014	99.0	33.7
Bus541	0.400	0.007	-0.003	0.011	0.003	0	0	0	0	0.018	98.4	44.1

Figure (3.1.29) : The power factors at the transformers (T57 , T58 , T59 , T60 , T85 , T87 and T96) at the Eastern regions after adding the suggested transmission line(TL359-Ring1) in Ras Al-Fara'a area network

From figure (3.1.28) and figure (3.1.29) we see the adding for suggested transmission line (TL359 – Ring1) it did not adversely affect the power factors at the center of the Eastern region (T57 "the power factor at Bus226 not changed from 92.3%", T58 "the power factor at Bus228 not changed from 83.2%", T59 "the power factor at Bus230 not changed from 91.0%", T60 "the power factor at Bus232 not changed from 93.9%") and at the Eastern region (T85 "the power factor at Bus276 not changed from 99.5%", T87 "the power factor at Bus280 not changed from 99.0%", T96 "the power factor at Bus541 not changed from 98.4%"). In cases of pressure the new transmission line help to provide the electrical current to these areas (agricultural areas), as this current helps reduce the pressure on the area transformers and helps stabilize the current on homes in the area. So the suggested solution is a good solution to the existing problem.

* The best solution will be chosen from among the three solutions proposed in chapter 4 (The Costs), after conducting an economic study (cost) of all solutions and selecting the best solution.

More details about the suggested solutions to the problems of Ras Al-Fara'a region network, are listed in the appendix B at section B.1, Title B.1./4. .

3.1.6 The Suggested Solutions to the Problems of Atoof Town Network:

There are two problems in Atoof town network. These problems were discussed in the chapter2 (Chapter 2 : The Analysis), and these problems are distributed among the regions of the town of Atoof.

- The problem 1: The low power factor of (31.3%) at the transformer (T116 // MOWAFAQ FAKHRY), due to the higher reactive power (Q_{MAX}) value at Bus326 next to the transformer (T116//MOWAFAQ FAKHRY). The figure (3.1.30) shows the power factor in column 12, the electrical current in column 13 and the demand for reactive power in column 4, for the transformer (T116//MOWAFAQ FAKHRY) at Bus326 in the Western region of town of Atoof, these values from ETAP simulation program.

Bus324	0.400	-0.002	-0.001	0.002	0.001	0	0	0	0	0.002	96.4	5.2
Bus325	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus326	0.400	-0.009	-0.028	0.009	0.028	0	0	0	0	0.029	31.3	70.8
Bus327	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus328	0.400	-0.002	-0.001	0.002	0.001	0	0	0	0	0.002	87.3	5.0

Figure (3.1.30) : The power factor at the transformer(T116 // MOWAFAQ FAKHRY) in Atoof town network

- The solution: We suggested a capacitor bank (C1 – 350KVAR) at Bus326 next to the transformer (T116//MOWAFAQ FAKHRY) it provide the reactive power (Q) for the load (L106) and reduces its demand for the transformer thus improving the power factor. The figure (3.1.31) shows the power factor in column 12, the electrical current in column 13 and the demand for reactive power in column 4, for the transformer (T116//MOWAFAQ FAKHRY) at Bus326 in the Western region of town of Atoof, after adding the new capacitor bank (C1) at Bus326, these values from ETAP simulation program.

Bus324	0.400	-0.002	-0.001	0.002	0.001	0	0	0	0	0.002	96.4	5.2
Bus325	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus326	0.400	-0.009	-0.006	0.009	0.006	0	0	0	0	0.011	86.5	70.6
Bus327	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus328	0.400	-0.002	-0.001	0.002	0.001	0	0	0	0	0.002	87.3	5.0

Figure (3.1.31) : The power factor at the transformer(T116 // MOWAFAQ FAKHRY) after adding the suggested capacitor bank(C1) in Atoof town network

From figure (3.1.30) and figure (3.1.31) we see in column 12 the addition of the suggested capacitor bank (C1) did not negatively affect the power factor at the transformer (T116//MOWAFAQ FAKHRY) but on the contrary it increased the power factor from 31.3% to 86.5% (about 55.2%), in column 4 we notice the reactive power demand has decreased, as the value before adding the capacitor bank was 28KVAR, after adding the capacitor bank at Bus326 next the transformer (T116//MOAWFAQ FAKHRY), the value decreased to 6KVAR, and this helped increase the value of the power factor, as we noticed , and thus the power factor is more than 80% and this an improvement in the power factor is required. So the suggested solution is a good solution to the existing problem .

- The problem 2: The low power factor of (74%) at the transformer (T125 // BAQEEA), due to the higher reactive power value at Bus344 next to the transformer (T125 // BAQEEA). The figure (3.1.32) shows the power factor in column 12, the electrical current in column 13 and the demand for reactive power in column 4, for the transformer (T125 // BAQEEA) at Bus344 in the center of the town of Atoof town, these values from ETAP simulation program.

ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp
Bus342	0.400		-0.011	-0.005	0.011	0.005	0	0	0	0	0.012	91.1	28.9
Bus343	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus344	0.400		-0.010	-0.008	0.010	0.008	0	0	0	0	0.013	74.0	30.3
Bus345	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0

Figure (3.1.32) : The power factor at the transformer(T125 // BAQEEA) in Atoof town network

- The solution: We suggested a capacitor bank (C2 – 50KVAR) at Bus344 next to the transformer (T125//BAQEEA) it provide the reactive power (Q) for the load (L115) and reduces its demand for the transformer thus improving the power factor. The figure (3.1.33) shows the power factor in column 12, the electrical current in column 13 and the demand for reactive power in column 4, for the transformer (T125//BAQEEA) at Bus344 in the center of the town of Atoof town, after adding the new capacitor bank (C2) at Bus344, these values from ETAP simulation program.

ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp
Bus342	0.400		-0.011	-0.005	0.011	0.005	0	0	0	0	0.012	91.1	28.9
Bus343	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus344	0.400		-0.010	-0.004	0.010	0.008	0	0	0	0	0.013	94.1	30.0
Bus345	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0

Figure (3.1.33) : The power factor at the transformer(T125 // BAQEEA) after adding the suggested capacitor bank(C2) in Atoof town network

From figure (3.1.32) and figure (3.1.33) we see in column 12 the addition of the suggested capacitor bank (C2) did not negatively affect the power factor at the transformer (T125//BAQEEA) but on the contrary it increased the power factor from 74.0% to 94.1% (about 20.1%), in column 4 we notice the reactive power demand has decreased, as the value before adding the capacitor bank was 8KVAR, after adding the capacitor bank at Bu344 next the transformer (T125//BAQEEA), the value decreased to 4KVAR, and this helped increase the value of the power factor, as we noticed, and thus the power factor is more than 80% and this an improvement in the power factor is required. So the suggested solution is a good solution to the existing problem .

More details about the suggested solutions to the problems of Atoof town network, are listed in the appendix B at section B.1, Title B.1./6. .

3.1.7 The Suggested Solutions to the Problems of Jalqamous Village Network:

There is one problem in Jalqamous village network. This problem was discussed in the chapter2 (Chapter 2 : The Analysis), and this problem is distributed among the regions of the village of Jalqamous.

- The problem: the pressure on the transformer (T200 // WESTERN) due to the presence of a water tank at a distance of 1000meters from the transformer (T200 // WESTERN), and when the tank pump is turned on, there will be pressure on the transformer (T200 // WESTERN), and instability in the current at the loads connected with the transformer (T200 // WESTERN). The figure (3.1.34) shows the power factor in column 12, the electrical current in column 13, the demand for real power in column 3 and the demand for reactive power in column 4, for the transformers (T200//WESTERN – Jalqamous at Bus448, T201//PPOLICE – Jalqamous at Bus450, T202//EASTERN – Jalqamous at Bus452 & T208//MIDDLE – Jalqamous at Bus566) in the village of Jalqamous, when the water tank pump turned off (Load239), these values from ETAP simulation program.

Bus448	0.400	0.027	-0.001	0.009	0.001	0	0	0	0	0.037	100.0	88.2
Bus449	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus450	0.400	0.004	0	0.001	0	0	0	0	0	0.005	100.0	11.7
Bus451	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus452	0.400	0.001	-0.001	0.004	0.001	0	0	0	0	0.005	98.2	11.9
Bus566	0.400	0.021	-0.003	0.016	0.003	0	0	0	0	0.037	99.7	88.9

Figure (3.1.34) : The power factors at the transformers(T200 , T201 , T202 and T208) when the tank pump turned off in Jalqamous village network

The figure (3.1.35) shows the power factor in column 12, the electrical current in column 13, the demand for real power in column 3 and the demand for reactive power in column 4, for the transformers (T200//WESTERN – Jalqamous at Bus448, T201//PPOLICE – Jalqamous at Bus450, T202//EASTERN – Jalqamous at Bus452 & T208//MIDDLE – Jalqamous at Bus566) in the village of Jalqamous, when the water tank pump turned on (Load239), these values from ETAP simulation program.

Bus448	0.400	0.009	-0.004	0.009	0.001	0	0	0	0	0.037	90.8	88.8
Bus449	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus450	0.400	0.004	0	0.001	0	0	0	0	0	0.005	100.0	11.7
Bus451	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus452	0.400	0.001	-0.001	0.004	0.001	0	0	0	0	0.005	98.2	11.9
Bus566	0.400	0.021	-0.003	0.016	0.003	0	0	0	0	0.037	99.7	88.9

Figure (3.1.35) : The power factors at the transformers(T200 , T201 , T202 and T208) when the tank pump turned on in Jalqamous village network

From figure (3.1.34) and figure (3.1.35) in column 12 we see the change in the power factor at Bus448 after the water pump (Load239) of the water tank started working, where the value of the power factor before the water pump started was 100% and after the pump was turned on, the power factor was reduced to 90.8% (decreased the power factor by 9.2%), looking at column 13 we see that the electrical current has changed from the value of 88.2 amperes before the water pump was started 88.8 amperes after the pump was started , in column 3 we notice that the demand for real power was 27KW towards the grid (due to the presence of an old solar system connected to Bus448 "PV60 – 40KWp" as shown in figure (A2.104)), and after operating the pump, the demand for the real power became 9KW towards the grid (the electric power given from the Bus448 to the grid decreased by 18KW, due to the operation of the water pump), and in column 4 we notice that the demand for reactive power has increased where it was before the operation the water pump is 1KVAR, and after the pump is turned on , it is 4KVAR.

So we notice that the operation of the water pump (Load239) increases the demand for the electrical power on the transformer (T200//WESTERN – Jalqamous) and this increase is considered a problem , then it increases the pressure on the transformer (T200/WESTERN – Jalqamous) and affect the stability of the electric current on the loads connected with the transformer (T200//WESTERN – Jalqamous). This problem must be solved .

- The solution: We suggest a new transformer (T255-160KVA) next to the water tank (load239) this transformer (T255) it will bear the pressure of the tank pump, thus reducing the pressure in the village, especially at transformer T200, we use transmission line (TL362 – 1000metr – overhead line) and buses (Bus681, Bus682) to connected the new transformer (T255) to the electrical network. The figure (3.1.36) shows the power factor in column 12, the electrical current in column 13, the demand for real power in column 3 and the demand for reactive power in column 4, for the transformers (T200//WESTERN – Jalqamous at Bus448 , T201//PPOLICE – Jalqamous at Bus450, T202//EASTERN – Jalqamous at Bus452 & T208//MIDDLE – Jalqamous at Bus566), the power factor in column 12, the electrical current in column 13, the demand for real power in column 3 and the demand for reactive power in column 4, for the new transformer

(T255 at Bus681) in the village of Jalqamous, when the water tank pump turn on (Load239), after adding the new transformer (T255), these values from ETAP simulation program.

Bus448	0.400	0.027	-0.001	0.009	0.001	0	0	0	0	0.037	100.0	88.2
Bus449	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus450	0.400	0.004	0	0.001	0	0	0	0	0	0.005	100.0	11.7
Bus451	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus452	0.400	0.001	-0.001	0.004	0.001	0	0	0	0	0.005	98.2	11.9
Bus566	0.400	0.021	-0.003	0.016	0.003	0	0	0	0	0.037	99.7	88.9
Bus681	0.400	-0.009	-0.001	0.009	0.001	0	0	0	0	0.009	98.6	21.1

Figure (3.1.36) : The power factors at the transformers(T200 , T201 , T202 and T208) after adding the suggested transformer(T255 at Bus681) in Jalqamous village network

From figure (3.1.35) and figure (3.1.36) we see in column 12 that the addition of the suggested transformer (T255) did not negatively affect the power factors, at Bus448 next to the transformer (T200 // WESTERN - Jalqamous), the power factor increased slightly from 90.8% to 100% (about 9.2%), we also notice in column 13 the electric current has decreased from the value of 88.8 amperes to the value of 88.2 amperes, in column 3 we see that the real power demand at Bus448 was 9KW towards the grid, and after adding the new transformer 'T255-160KVA' to Bus681 which is 1000meters away from Bus448, Bus448 now gives 27KW to the grid (the increase in the real power is 18KW), and in column 4 we see the demand for the reactive power was 3KVAR after adding the new transformer, the value reduce to 1KVAR. So the addition of the new transformer (T255) helped to provide additional electrical power at Bus448 and this help to reduce the pressure on the transformer (T200 // WESTERN - Jalqamous) connected with Bus448 especially in cases of running the water pump next the new transformer (T255). So the suggested solution is a good solution to the existing problem .

More details about the suggested solutions to the problems of Jalqamous Village Network, are listed in the appendix B at section B.1, Title B.1./7. .

* Note : In the same way as the previous method in analyzing the proposed solutions to the problems of each region, all the proposed solutions for all regions of Tubas electricity network (Tubas city, Keshda village, Tyaseer village, Aqabeh village, Ras Al-Fara'a region, Wadi Al-Fara'a region, Al-Fara'a Camp region, Tammon town, Atoof town, Aqqaba town, Al-Zababeda town, Al-Kfier village, Raba town, Telfeet village, Arab American University Jenin 'AAUJ' area, Tineen village, Private Project area, Dream Land area, Jalqamous village, Al-Mghayer village, Al-Mtelleh village, Um Al-Toot village, Meselyeh town, Al-Jarba village, Merkeh village, Al-Zawyah village, Anzaa village, Al-Hafeeri village, Wadi Douq village and Beer Al-Basha village).

3.2 The Proposed Solutions to the Problems of Tubas Electricity Network by the Company itself (by Tubas Electricity Company):

There are three solar systems proposed by Tubas electricity company, two solar systems of which are located in the city of Tubas with a value of (8000KWp & 5406Kwp) and one solar system is located in the village of Tyaseer, whose value is (2000KWp) [10].

3.2.1 In Tubas City Network:

There are two solar systems proposed by Tubas electricity company in the city of Tubas (the first system is divided into three parts, which are PV10 with a value of 2000KWp, PV88 with a value of 3000KWp and PV89 with a value of 3000KWp, with a total of 8000KWp & the second system is divided into two parts which are PV38 with a value of 2703KWp and PV87 with a value of 2703KWp , with a value of 5406KWp).

3.2.1.1 Palestine Investment Fund PV Stations (Proposed):

This proposed located in Eastern region 2 – Tubas city, there are three stations (one of them is 2000KWp (PV10), the other is 3000KWp (PV88), and the last one is 3000KWp (PV89)), at each station there is a transformer with 1MAV rated (at PV10 there is transformer T18, at PV 88 there is transformer T251, and at PV 89 there is transformer T252), this stations are proposed by Tubas electricity company in Tubas city to solve the problems in the network.

The figure (3.2.1) shows the power factor in column 12, the electrical current in column 13 and the demand for real power in column 3, for the transformers (T12//ALLAN at Bus162, T13//AL-DAIR at Bus164, T14//TRANSFORMERS FACTORY at Bus166, T15//HASSAN MKHEBER at Bus168, T16//CZ PV STATION1 at Bus574, T17//CZ PV STATION2 at Bus575, T18//PALESTINE INVESTMENT FUND PV STATION1 at Bus577, T251//PALESTINE INVESTMENT FUND PV STATION2 at Bus664, T252//PALESTINE INVESTMENT FUND PV

STATION3 at Bus677) in the EASTERN regions of TUBAS city, before adding the solar systems proposed (PV10, PV88 & PV89) at buses (Bus577, Bus664 & Bus677) respectively, these values from ETAP simulation program.

Bus162	0.400	0.011	-0.005	0.013	0.005	0	0	0	0	0.024	98.1	58.3
Bus164	0.400	0.015	-0.002	0.009	0.002	0	0	0	0	0.024	99.7	57.4
Bus166	0.400	-0.002	0	0.002	0	0	0	0	0	0.002	98.1	4.4
Bus168	0.400	-0.014	-0.007	0.014	0.007	0	0	0	0	0.016	89.1	37.3
Bus574	0.400	0.118	0	0	0	0	0	0	0	0.118	100.0	282.8
Bus575	0.400	0.317	0	0	0	0	0	0	0	0.317	100.0	762.4
Bus577	0.400	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus664	0.400	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus677	0.400	0	0	0	0	0	0	0	0	0	0.0	0.0

Figure (3.2.1) : The power factors at the transformers(T12, T13, T14, T15, T16, T17, T18, T251 & T252) in Eastern regions of Tubas city before adding the solar systems proposed (PV10 , PV88 and PV89) in Tubas city network

The figure (3.2.2) shows the power factor in column 12, the electrical current in column 13 and the demand for real power in column 3, for the transformers (T12//ALLAN at Bus162, T13//AL-DAIR at Bus164, T14//TRANSFORMERS FACTORY at Bus166, T15//HASSAN MKHEBER at Bus168, T16//CZ PV STATION1 at Bus574, T17//CZ PV STATION2 at Bus575, T18//PALESTINE INVESTMENT FUND PV STATION1 at Bus577, T251//PALESTINE INVESTMENT FUND PV STATION2 at Bus664, T252//PALESTINE INVESTMENT FUND PV STATION3 at Bus677) in the EASTERN regions of TUBAS city, after adding the solar systems proposed (PV10, PV88 & PV89) at buses

(Bus577, Bus664 & Bus677) respectively, these values from ETAP simulation program.

Bus162	0.400	0.011	-0.005	0.013	0.005	0	0	0	0	0.024	98.1	58.3
Bus164	0.400	0.015	-0.002	0.009	0.002	0	0	0	0	0.024	99.7	57.4
Bus166	0.400	-0.002	0	0.002	0	0	0	0	0	0.002	98.1	4.4
Bus168	0.400	-0.014	-0.007	0.014	0.007	0	0	0	0	0.016	89.1	37.3
Bus574	0.400	0.118	0	0	0	0	0	0	0	0.118	100.0	282.8
Bus575	0.400	0.317	0	0	0	0	0	0	0	0.317	100.0	762.4
Bus577	0.400	1.802	0	0	0	0	0	0	0	1.802	100.0	4336.0
Bus664	0.400	2.702	0	0	0	0	0	0	0	2.702	100.0	6499.3
Bus677	0.400	2.702	0	0	0	0	0	0	0	2.702	100.0	6499.3

Figure (3.2.2) : The power factors at the transformers (T12, T13, T14, T15, T16, T17, T18, T251 and T252) in Eastern regions of Tubas city after adding the solar systems proposed (PV10 , PV88 and PV89) in Tubas city network

From figure (3.2.1) and figure (3.2.2) we see in column 12 that the addition of the proposed solar systems (PV10 , PV88 & PV89) did not negatively affect the power factors at the old transformers in the Eastern regions, as (the transformer "T12//ALLAN" at Bus162 the power factor not change from 98.1%, the transformer "T13//AL-DAIR" at Bus164 the power factor not change from 99.7%, the transformer "T14//TRANSFORMERS FACTORY" at Bus166 the power factor not change from 98.1%, the transformer "T15//HASSAN MKHEBER" at Bus168 the power factor not change from 89.1%, the transformer "T16//CZ PV STATION1" at Bus574 the power factor not change from 100% and the transformer "T17//CZ PV STATION2" at Bus575 the power factor not change from 100%). As for the new transformers that the proposed solar systems will connect with it as follow (PV10 at Bus577 next the transformer "T18//PALESTINE

INVESTMENT FUND PV STATION1", PV88 at Bus664 next the transformer "T251//PALESTINE INVESTMENT FUND PV STATION2" and PV89 at Bus677 next the transformer "T252//PALESTINE INVESTMENT FUND PV STATION3") it power factors was zeros as shown in figure (3.2.1) in column 12 because it not connected to the grid before adding the proposed solar systems to it, and after adding the proposed solar systems to these transformers, the value of the power factors for all these transformers became 100%, which is an excellent power factor. So the addition of these proposed solar systems did not affect the power factors in the network.

From figure (3.2.1) and figure (3.2.2) we see in column 13 that the addition of the proposed solar systems (PV10 , PV88 & PV89) did not negatively affect the electric currents at the old transformers in the Eastern regions, as (the transformer "T12//ALLAN" at Bus162 the electric currents not change from 58.3 amperes, the transformer "T13//AL-DAIR" at Bus164 the electric currents not change from 57.4 amperes, the transformer "T14//TRANSFORMERS FACTORY" at Bus166 the electric currents not change from 4.4 amperes, the transformer "T15//HASSAN MKHEBER" at Bus168 the electric currents not change from 37.3 amperes, the transformer "T16//CZ PV STATION1" at Bus574 the electric currents not change from 282.8 amperes and the transformer "T17//CZ PV STATION2" at Bus575 the electric currents not change from 762.4 amperes), as for the new transformers that the proposed solar systems will connect with it as follow (PV10 at Bus577 next the transformer "T18//PALESTINE INVESTMENT

FUND PV STATION1", PV88 at Bus664 next the transformer "T251//PALESTINE INVESTMENT FUND PV STATION2" and PV89 at Bus677 next the transformer "T252//PALESTINE INVESTMENT FUND PV STATION3") it electric currents was zeros as shown in figure (3.2.1) in column 13 because it not connected to the grid before adding the proposed solar systems to it, and after adding the proposed solar systems to these transformers, the value of the electric currents changed for all these transformers to be 4336.0 amperes at Bus577 next to the transformer T18 to which the first station of the proposed solar system is connected, 6499.3 amperes at Bus664 next to the transformer T251 to which the second station of the proposed solar system is connected, 6499.3 amperes at Bus677 next to the transformer T252 to which the third station of the proposed solar system is connected. So the addition of these proposed solar systems (PV10 , PV88 & PV89) to the Eastern Region2 of the city of TUBAS greatly increased the electric currents on the buses (Bus577, Bus664 & Bus677) that connected with the transformers of these solar systems. So it is important to pay attention to these high electric currents and design the network next to the new transformers to suit these electrical currents, to be used in the best way to solve the problems of Tubas Electricity Network in the city of Tubas .

From figure (3.2.1) and figure (3.2.2) we see in column3 that the addition of the proposed solar systems (PV10, PV88 & PV89) did not negatively affect the real power demand at the old transformers in the Eastern regions, as (the transformer "T12//ALLAN" at Bus162 the real power demand does not change from 11KW that goes towards the grid and the reason it goes towards the grid is because Bus162 is connected to an old solar system "PV5 – 25KWp", the transformer "T13//AL-DAIR" at Bus164 the real power demand does not change from 15KW that goes towards the grid and the reason it goes towards the grid is because Bus164 is connected to an old solar system "PV6 – 25KWp" , the transformer "T14//TRANSFORMERS FACTORY" at Bus166 the real power demand does not change from 2KW , the transformer "T15//HASSAN MKHEBER" at Bus168 the real power demand does not change from 14KW, the transformer "T16//CZ PV STATION1" at Bus574 the real power demand does not change from 118KW that goes towards the grid and the reason it goes towards the grid is because Bus574 is connected to an old solar systems "PV7 – 120KWp & PV8 – 10KWp", and the transformer "T17//CZ PV STATION2" at Bus575 the real power demand does not change from 317KW that goes towards the grid and the reason it goes towards the grid is because Bus575 is connected to an old solar system "PV9 – 350KWp"), As for the new transformers that the proposed solar systems will connect with it as follow (PV10 at Bus577 next the transformer "T18//PALESTINE INVESTMENT FUND PV STATION1", PV88 at Bus664 next the transformer "T251//PALESTINE INVESTMENT FUND PV STATION2" and PV89 at Bus677 next the transformer "T252//PALESTINE INVESTMENT FUND PV STATION3") it real powers demand was zeros as shown in figure (3.2.1) in column 3 because it not connected to the grid before adding the proposed solar systems to it, and after adding the proposed solar systems to these transformers, the value of the real powers demand changed for all these transformers to be 1802KW towards the grid at Bus577 next to the transformer T18 to which the first station of the proposed solar system is connected, 2702KW towards the grid at Bus664 next to the transformer T251 to which the second station of the proposed solar system is connected, 2702KW towards the grid at Bus677 next to the transformer T252 to which the third station of the proposed solar system is connected . So the addition of these proposed solar systems (PV10 , PV88 & PV89) to the Eastern region2 of the city of Tubas resulted in an increased the real power to the grid for the buses (Bus577, Bus664 & Bus677) that connected with the transformers of these solar systems, these electrical powers that were provided to the network help to solve problems in the city of Tubas. But it is important to mention that the increase in the real electrical power besides the loads reduced the demand for the real electrical power by the network, but the demand for reactive electrical power by the network for the loads remained the same as before the addition of these solar systems, and this make the reactive electrical power (Q) greater than the real electrical power (P) this will reduce the power factors of the network. Therefore attention must be paid to this point, as the decrease in the power factor of the network imposes financial penalties on Tubas electricity network by the Israeli Qatari (IEC). In order to avoid a decrease in the power factors, we follow the values of these factors in the network and in case they decrease so that they cause financial penalties to the network. We solve the problems of these factors decreasing in several ways, including the use of capacitor banks next to the transformers that may suffer from low factor in the network.

So the proposed solar system is a good solution to the existing problems in the network, but attention should be given to power factors.

More details about the proposed solutions to the problems of Tubas electricity network by Tubas company itself in Tubas city network "Palestine Investment Fund PV Stations", are listed in the appendix B at section B.2, Title B.2./1./1) .

* Note : We analyzed only one proposal of the solutions proposed by Tubas electricity company (in Tubas city "1. Palestine Investment Fund PV stations (Proposed), 2. Jafa PV Plant (Under Construction)", In Tyaseer village "Tyaseer Filtering Station PV Plant (Proposed)"). Details of this proposal and the rest of proposals are listed in the appendix B at section B.2 Titles B.2./1./1), B.2./1./2) and B.2./2.

3.3 The Suggested Solutions for the effects of Connection Points between Tubas Electricity Company and the North Electricity Company in Tubas Network:

There are four connection points between Tubas electricity company and the North electricity company which are (Sier connection point, Al-Nasaryeh connection point, Al-Bathan connection point and Yaseed connection point) [10], two of which are old (Sier connection point & Al-Nasaryeh connection point) and the other are new (Al-Bathan connection point and Yaseed connection point), as these points are all located on the

33KV medium voltage line. In this section we will study the effect of these points on the areas of Tubas electricity company , especially on the area of the village of Al-Kfier and Wadi Al-Fara'a area.

3.3.1 In AL-Kfier Village Network:

- Sier Connection Point:

This connection point with 2MVA [11]. At Bus93 in the village of Al-Kfier to village of Sier at Bus672 through 1309 meters of transmission lines (33KV) with circuit breaker (CB21) and Recloser (R7).

The figure (3.3.1) shows the power factor in column 12, the electrical current in column 13 and the demand for real power in column 3, for the transformers (T155//AL-KFIER MAIN at Bus388, T156//AL-MAHAJER EAST at Bus390 and T157//AL-MAHAJER1 at Bus392) in the village of Al-Kfier, before connecting the Sier connection point at Bus93 in Al-Kfier village, these values from ETAP simulation program.

Bus388	0.400	0.008	-0.001	0.002	0.001	0	0	0	0	0.010	99.8	23.6
Bus390	0.400	0	0	0	0	0	0	0	0	0	100.0	0.2
Bus392	0.400	-0.002	-0.002	0.002	0.002	0	0	0	0	0.003	80.9	7.1

Figure (3.3.1) : The power factors at the transformers(T155 ,T156 and T157) in Al-Kfier village before connecting the connection point (Sier) in Al-Kfier village network

The figure (3.3.2) shows the power factor in column 12, the electrical current in column 13 and the demand for real power in column 3, for the transformers (T155//AL-KFIER MAIN at Bus388, T156//AL-

MAHAJER EAST at Bus390 and T157//AL-MAHAJER1 at Bus392) in the village of, after connecting the Sier connection point at Bus93 in Al-Kfier village, these values from ETAP simulation program.

Bus388	0.400	0.008	-0.001	0.002	0.001	0	0	0	0	0.010	99.8	23.6
Bus390	0.400	0	0	0	0	0	0	0	0	0	100.0	0.2
Bus392	0.400	-0.002	-0.002	0.002	0.002	0	0	0	0	0.003	80.9	7.1
Bus672	33.000	-0.122	-0.076	0.122	0.076	0	0	0	0	0.144	85.0	4.2

Figure (3.3.2) : The power factors at the transformers(T155 ,T156 and T157) in Al-Kfier village after connecting the connection point (Sier) in Al-Kfier village network

The Table (3.3.1) shows the details for the loads of the connection point of the village of Sier "Load244" [11].

Table (3.3.1) : The details for the load of the connection point (Sier) in Al-Kfier village network

The load	The real power (Pmax – KW)	The reactive power (Qmax – KVAR)	The power factor
Load 244 (SIER)	1700	1045	85%

From figure (3.3.1) and figure (3.3.2) we see in column 12 that the connecting of the connection point (SIER) did not negatively affect the power factors at the old transformers in Al-Kfier village, as (the transformer "T155//AL-KFIER MAIN" at Bus388 the power factor not change from 99.8%, the transformer "T156//AL-MAHAJER EAST" at Bus390 the power factor not change from 100%, and the transformer "T157//AL-MAHAJER1" at Bus392 the power factor not change from 80.9%). As for the new loads (the loads of the connection point of the village of Sier "Load244") it power factor was zero because it not connected to the grid before connecting Sier connection point with it, and after connecting Sier connection point to these loads, the value of the power factor for these loads became 85.0%, which is an excellent power factor. So the connecting of Sier connection point did not affect the power factors in the network.

From figure (3.3.1) and figure (3.3.2) we see in column 13 that the connecting of the connection point (Sier) did not negatively affect the electric currents at the old transformers in the Al-Kfier village, as (the transformer "T155//AL-KFIER MAIN" at Bus388 the electric currents not change from 23.6 amperes, the transformer "T156//AL-MAHAJER EAST" at Bus390 the electric currents not change from 0.2 amperes and the transformer "T157//AL-MAHAJER1" at Bus392 the electric currents not change from 7.1 amperes). As for the new loads (the loads of the connection point of the village of Sier "Load244") it electric current was zero because it not connected to the grid before connecting Sier connection point with it, and after connecting Sier connection point to these loads, the value of the electric current changed for these loads to be 4.2 amperes at Bus672. So the connecting of Sier connection point to Al-Kfier village increased the electric current on the Bus672 that connected with the new loads (the loads of the connection point of the village of Sier "Load244").

From figure (3.3.1) and figure (3.3.2) we see in column3 that the connecting of the connection point (Sier) did not negatively affect the real power demand at the old transformers in Al-Kfier village, as (the transformer "T155//AL-KFIER MAIN" at Bus388 the real power demand does not change from 8KW that goes towards the grid and the reason it goes towards the grid is because Bus388 is connected to an old solar system "PV52 – 10KWp", the transformer "T156//AL-MAHAJER EAST" at Bus390 the real power demand does not change from 0KW and the transformer "T157//AL-MAHAJER1" at Bus392 the real power demand does not change from 2KW), As for the new loads (the loads of the connection point of the village of Sier "Load244") it real power demand was zero because it not connected to the grid before connecting Sier connection point with it, and after connecting Sier connection point to these loads, the value of the real power demand changed for these loads to be 122KW at Bus672. So the connecting of the connection point (Sier) to Al-Kfier village, resulted in an increased the real power demand at Bus672 that connected with the new loads (the loads of the connection point of the village of SIER "Load244") . but it is important to note that there will be an additional (MVA) demand and thus this will put pressure on the network . but it is good that Al-Jalameh connection point is close to the village of Al-Kfier, and this helps to provide the necessary energy in case of pressure on the network .

3.3.2 In Wadi AL-Fara'a Area Network:

- Al-Bathan Connection Point:

This connection point with 4MVA [11]. From Bus243 in the area of Wadi Al-Fara'a (the center of the town) to town of Al-Bathan at Bus671 through 800 meters of transmission lines (33KV).

The figure (3.3.3) shows the power factor in column 12, the electrical current in column 13 and the demand for real power in column 3, for the transformers (T63//HESBEH at Bus238, T64//KAZEYA at Bus240 , T65//SCHOOL – Wadi Al-Fara'a at Bus242, T66//ABU SHEHADEH at Bus244, T67//AL-BASATEEN at Bus246, T68//ABO KHADER at Bus248) in the center of the town of Wadi Al-Fara'a, before connecting Al-Bathan connection point at Bus243 in Wadi Al-Fara'a area, these values from ETAP simulation program.

Bus238	0.400	-0.004	-0.001	0.004	0.001	0	0	0	0	0.005	96.7	10.9
Bus239	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus240	0.400	-0.001	-0.003	0.011	0.003	0	0	0	0	0.011	97.3	27.2
Bus241	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus242	0.400	0.022	-0.003	0.010	0.003	0	0	0	0	0.032	99.7	77.4
Bus243	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus244	0.400	0	-0.001	0.005	0.001	0	0	0	0	0.005	98.2	11.9
Bus245	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus246	0.400	0.005	-0.006	0.019	0.006	0	0	0	0	0.024	97.4	58.7
Bus247	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus248	0.400	-0.006	-0.003	0.011	0.003	0	0	0	0	0.011	96.9	27.2

Figure (3.3.3) : The power factors at the transformers(T63 ,T64 , T65 , T66 , T67 and T68) in the center of the town before connecting the connection point (Al-Bathan) in Wadi Al-Fara'a area network

The figure (3.3.4) shows the power factor in column 12, the electrical current in column 13 and the demand for real power in column 3, for the transformers (T63//HESBEH at Bus238 , T64//KAZEYA at Bus240, T65//SCHOOL – Wadi Al-Fara'a at Bus242, T66//ABU SHEHADEH at Bus244, T67//AL-BASATEEN at Bus246, T68//ABO KHADER at Bus248) in the center of the town of Wadi Al-Fara'a, after connecting the AL-Bathan connection point at Bus243 in Wadi Al-Fara'a area, these values from ETAP simulation program.

Bus238	0.400	-0.004	-0.001	0.004	0.001	0	0	0	0	0.005	96.7	10.9
Bus239	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus240	0.400	-0.001	-0.003	0.011	0.003	0	0	0	0	0.011	97.3	27.2
Bus241	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus242	0.400	0.022	-0.003	0.010	0.003	0	0	0	0	0.032	99.7	77.4
Bus243	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus244	0.400	0	-0.001	0.005	0.001	0	0	0	0	0.005	98.2	11.9
Bus245	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus246	0.400	0.005	-0.006	0.019	0.006	0	0	0	0	0.024	97.4	58.7
Bus247	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus248	0.400	-0.006	-0.003	0.011	0.003	0	0	0	0	0.011	96.9	27.2
Bus671	33.000	-0.245	-0.152	0.245	0.152	0	0	0	0	0.288	85.0	8.4

Figure (3.3.4) : The power factors at the transformers(T63 ,T64 , T65 , T66 , T67 and T75) in the center of the town after connecting the connection point (Al-Bathan) in Wadi Al-Fara'a area network

The Table (3.3.2) shows the details for the loads of the connection point of the area of Al-Bathan "Load246" [11].

Table (3.3.2) : The details for the connection point (Al-Bathan) in Wadi Al-Fara'a area network

The load	The real power (Pmax – KW)	The reactive power (Qmax – KVAR)	The power factor
Load 246 (AL-BATHAN)	3400	2107	85%

From figure (3.3.3) and figure (3.3.4) we see in column 12 that the connecting of the connection point (Al-Bathan) did not negatively affect the power factors at the old transformers in the center of the town of Wadi Al-Fara'a area, as (the transformer "T63//HESBEH" at Bus238 the power factor not change from 96.7%, the transformer "T64//KAZEYA" at Bus240 the power factor not change from 97.3%, the transformer "T65//SCHOOL – Wadi Al-Fara'a" at Bus242 the power factor not change from 99.7%, the transformer "T66//ABU SHEHADEH" at Bus244 the power factor not change from 98.2%, the transformer "T67//AL-BASATEEN" at Bus246 the power factor not change from 97.4%, the transformer "T68//ABO KHADER" at Bus248 the power factor not change from 96.9%). As for the new loads (the loads of the connection point of the area of AL-BATHAN "Load246") it power factor was zero because it not connected to the grid before connecting Al-Bathan connection point with it, and after connecting Al-Bathan connection point to these loads, the value of the power factor for these loads became 85.0%, which is an excellent power factor. So the connecting of Al-Bathan connection point did not affect the power factors in the network.

From figure (3.3.3) and figure (3.3.4) we see in column 13 that the connecting of the connection point (Al-Bathan) did not negatively affect the electric currents at the old transformers in the center of the town of Wadi Al-Fara'a area, as (the transformer "T63//HESBEH" at Bus238 the electric currents not change from 10.1 amperes, the transformer "T64//KAZEYA" at Bus240 the electric currents not change from 27.2 amperes, the transformer "T65//SCHOOL – Wadi Al-Fara'a" at Bus242 the electric currents not change from 77.4 amperes, the transformer "T66//ABU SHEHADEH" at Bus244 the electric currents not change from 11.9 amperes, the transformer "T67//AL-BASATEEN" at Bus246 the electric currents not change from 58.7 amperes, the transformer "T68//ABO KHADER" at Bus248 the electric currents not change from 27.2 amperes). As for the new loads (the loads of the connection point of the village of Al-Bathan "Load246") it electric current was zero because it not connected to the grid before connecting Al-Bathan connection point with it, and after connecting Al-Bathan connection point to these loads, the value of the electric current changed for these loads to be 8.4 amperes at Bus671. So the connecting of Al-Bathan connection point to Wadi Al-Fara'a area increased the electric current on the Bus671 that connected with the new loads (the loads of the connection point of the area of Al-Bathan "Load246").

From figure (3.3.3) and figure (3.3.4) we see in column3 that the connecting of the connection point (Al-Bathan) did not negatively affect the real power demand at the old transformers in the center of the town of Wadi Al-Fara'a area, as (the transformer "T63//HESBEH" at Bus238 the real power demand does not change from 4KW, the transformer "T64//KAZEYA" at Bus240 the real power demand does not change from 1KW , the transformer "T65//SCHOOL – Wadi Al-Fara'a" at Bus242 the real power demand does not change from 22KW that goes towards the grid and the reason it goes towards the grid is because Bus242 is connected to an old solar system "PV33 – 35KWp", the transformer "T66//ABU SHEHADEH" at Bus244 the real power demand does not change from 0KW, the transformer "T67//AL-BASATEEN" at Bus246 the real power demand does not change from 5KW that goes towards the grid and the reason it goes towards the grid is because Bus246 is connected to an old solar system "PV35 – 25KWp", the transformer "T68//ABO KHADER" at Bus248 the real power demand does not change from 0KW). As for the new loads (the loads of the connection point of the village of Al-Bathan "Load246") it real power demand was zero because it not connected to the grid before connecting Al-Bathan connection point with it, and after connecting Al-Bathan connection point to these loads, the value of the real power demand changed for these loads to be 245KW at Bus671. So the connecting of the connection point (Al-Bathan) to Wadi Al-Fara'a area, resulted in an increased the real power demand at Bus671 that connected with the new loads (the loads of the connection point of the area of Al-Bathan "Load246"). But it is important to note that there will be an additional (MVA) demand and thus this will put pressure on the network . So to solve this problem we can take advantage of the suggested generator ("G1" which was discussed in detail in the appendix B at the section B.1 "The Solutions" at Title B.1./4.) "The suggested solutions of the problems of Ras Al-Fara'a region network") in Ras Al-Fara'a area or take the advantage of the suggested new transmission line ("TL360 – Ring2" which was discussed in detail in the appendix B at the section B.1 "The Solutions" at Title B.1./4.) "The suggested solutions of the problems of Ras Al-Fara'a region network") in Ras Al-Fara'a Area, (In Ras Al-Fara'a and in Wadi Al-Fara'a regions there are same solutions like asG1).

* Note : In the same previous way, all the connection points between Tubas electricity network and the North electricity network (In Al-Kfier village network "Sier connection point", In Wadi Al-Fara'a area network "Al-Nasaryeh connection point, Al-Bathan connection point and Yaseed connection point") were mentioned two connection points (Sier connection point "old connection point" and Al-Bathan connection point "new connection point") and the rest of the details for these points between Tubas electricity company and the North electricity company are listed in the appendix B at section B.3, Titles B.3./1. And B.3./2. .

Chapter 4
The Costs

4.1 The Costs of the Suggested Solutions in Tubas Electricity Network:

In this section, we will conduct an economic study of all proposed solutions to solve the problems in Tubas electricity network to choose the best solutions from them in terms of construction and operational financial costs, as there are several proposed solutions for some problems and through this section we will determine the cost of each proposed solution and choose the best solution in terms of economic (construction and operational costs).

We will choose the most appropriate solution from among these solutions in terms of practicality only, and the cost of these solutions is only mentioned and cannot be relied upon in the most appropriate choice as there is a discrepancy in price and cannot be relied upon to determine the most appropriate solution among them, as we need to complete the economic study in its full form. And dealing with the construction costs and income of these proposed solutions separately in order to calculate the future work of each solution among these solutions, and so we can consider that we have made an economic feasibility, but in this thesis we have determined the construction costs only an a mention and not as a reference to choose the most appropriate solution [53].

4.1.1 The Costs of the Suggested Solutions in Tubas City:

There are five problems in the city of Tubas with 7 suggested solutions (see Chapter 3, section 3.1.1).

- To the problem 1 there are three suggested solutions.

1) The new suggested solar systems (PV116 & PV117). The table (4.1.1) shows the cost of the solar systems (PV116 & PV117) that is to be built in the Northern region (the first of the city) of Tubas city.

Table (4.1.1) : The cost of the solar systems(PV116 & PV117) in the Northern region of

The number of each solar system	The ratings (KWp & KV_{AC})	The space needed for the solar system
PV 116 Inv 116	5 KWp 0.4 KV_{AC}	32 m^2 (space needed for the solar panels) 50 m^2 (space needed for the solar system with taking into account the shadows)
	The cost for the solar system with the components included with the solar system (wires , cables , inverter , solar panels , constructor)	
	4250 $	
The number of each solar system	The ratings (KWp & KV_{AC})	The space needed for the solar system
PV 117 Inv 117	5 KWp 0.4 KV_{AC}	32 m^2 (space needed for the solar panels) 50 m^2 (space needed for the solar system with taking into account the shadows)
PV 117 Inv 117	The cost for the solar system with the components included with the solar system (wires , cables , inverter , solar panels , constructor)	
	4250 $	
The total cost of the suggested solution (solar system PV116 & solar system PV117)		
4500$ + 4500$ = 8500$		

From table (4.1.1) the suggested solution requires a cost of (8500$ = 30000NIS).

2) The suggested new transformer (T254) with new transmission line (TL358). The table (4.1.2) shows the cost of the suggested transformer and the transmission line (T254 & TL358) respectively in the Northern region(the first of the city) of Tubas city.

Table (4.1.2) : The cost of the transformer and the transmission line (T254 & TL358) respectively in the Northern region of Tubas city

<table>
<tr><td>The number of the transformer</td><td>The ratings (KVA , KV)</td><td colspan="2">The cost of the transformer</td><td colspan="3">The cost for the arm and tower in place to carry the transformer (central type arm , tension type tower)</td></tr>
<tr><td rowspan="3">T 254</td><td>50 KVA (33/0.4) KV</td><td colspan="2">6000 $</td><td colspan="3">3000 $</td></tr>
<tr><td colspan="5">The cost of the components included with the transformer (wires , insulator "3" (type of ABB), isolators "6" (type of porcelain), fuses "3" (type of dropout), lighting arrestors "3", oil tank)</td><td>The total cost of the transformer</td></tr>
<tr><td colspan="5">4500 $</td><td>13500 $</td></tr>
<tr><td>The number of the transmission line</td><td colspan="2">The rating (KV_{AC})</td><td colspan="2">The length (meters)</td><td colspan="2">The sizing (mm^2)</td></tr>
<tr><td rowspan="5">TL 358</td><td colspan="2">33 KV_{AC} (medium voltage line)</td><td colspan="2">2000</td><td colspan="2">158 (150)</td></tr>
<tr><td colspan="2">The number and type of the towers</td><td colspan="2">The number and type of the arms</td><td colspan="2">The number and type of the isolators</td></tr>
<tr><td colspan="2">8 (suspension)
7 (tension)</td><td colspan="2">8 from type of side arms (4 long arms , 4 short arms)
7 from type of central</td><td colspan="2">60 from type of porcelain</td></tr>
<tr><td colspan="4">The cost of each meter in the transmission line with the components included with the transmission line
(towers, arms, wires, isolators)</td><td colspan="2">The total cost of the transmission line</td></tr>
<tr><td colspan="4">60 % / meter</td><td colspan="2">120000 $</td></tr>
<tr><td colspan="7">The total cost of the suggested solution (transformer T254 & transmission line TL358)</td></tr>
<tr><td colspan="7">13500$ + 120000$ = 133500$</td></tr>
</table>

From table (4.1.2) the suggested solution requires a cost of(133500$ = 470000NIS).

3) The new suggested transmission line (TL367 – low voltage – 400volt). The table (4.1.3) shows the cost of the suggested transmission line (TL367) in the Northern region (the first of the city) of Tubas city.

Table (4.1.3) : The cost of the transmission line(TL367) in the Northern region of Tubas city

<table>
<tr><th>The number of the transmission line</th><th>The voltage rating (V)</th><th colspan="2">The length (m)</th><th>The type of wires in the transmission line</th></tr>
<tr><td rowspan="3">TL 367</td><td>400</td><td colspan="2">1500</td><td>95 mm^2 (type of ABC)</td></tr>
<tr><td>The number and the type of columns in the transmission line</td><td colspan="2">The cost for each meter included the components (wires , columns and excavation)</td><td>The total cost</td></tr>
<tr><td>15 (wooden columns)</td><td colspan="2">12 $/ meter</td><td>18000 $</td></tr>
</table>

From table (4.1.1.3) the suggested solution requires a cost of (18000$ = 63000NIS).

- To the problem 2 there is one suggested solution.

* The new suggested solar system (PV13). The table (4.1.4) shows the cost of the suggested solar system (PV13) in the Southern region 2 of Tubas city.

Table (4.1.4) : The cost of the solar system(PV13) in the Southern region 2 of Tubas city

<table>
<tr><th>The number of each solar system</th><th>The ratings (KWp & KV_{AC})</th><th>The space needed for the solar system</th></tr>
<tr><td>PV 13
Inv 13</td><td>5 KWp

0.4 KV_{AC}</td><td>32 m^2 (space needed for the solar panels)
50 m^2 (space needed for the solar system with taking into account the shadows)</td></tr>
<tr><td rowspan="2">PV 13
Inv 13</td><td colspan="2">The cost for the solar system with the components included with the solar system (wires , cables , inverter , solar panels , constructor)</td></tr>
<tr><td colspan="2">4250 $</td></tr>
</table>

From table (4.1.4) the suggested solution requires a cost of (4250$ = 15000NIS).

- To the problem 3 there is one suggested solution.

* The new suggested solar system (PV18). The table (4.1.5) shows the cost of the suggested solar system(PV18) in the center of the town 2 of Tubas city.

Table (4.1.5) : The cost of the solar system(PV18) in the center of the town 2 of Tubas city

The number of each solar system	The ratings (KWp & KV_{AC})	The space needed for the solar system
PV 18 Inv 18	5 KWp 0.4 KV_{AC}	32 m^2 (space needed for the solar panels) 50 m^2 (space needed for the solar system with taking into account the shadows)
	The cost for the solar system with the components included with the solar system (wires , cables , inverter , solar panels , constructor)	
	4250 $	

From table (4.1.5) the suggested solution requires a cost of (4250$ = 15000NIS).

- To the problem 4 there is one suggested solution.

* The new suggested solar systems (PV19 , PV20 & PV21). The table (4.1.6) shows the cost of the suggested solar system (PV19) in the center of the town 2 of Tubas city.

Table (4.1.6) : The cost of the solar system(PV19) in the center of the town 2 of Tubas city

The number of each solar system	The ratings (KWp & KV_{AC})	The space needed for the solar system
PV 19 Inv 19	5 KWp 0.4 KV_{AC}	32 m^2 (space needed for the solar panels) 50 m^2 (space needed for the solar system with taking into account the shadows)
	The cost for the solar system with the components included with the solar system (wires, cables, inverter, solar panels, constructor)	
	4250 $	

The table (4.1.7) shows the cost of the suggested solar system (PV20) in the center of the town 2 of Tubas city.

Table (4.1.7) : The cost of the solar system(PV20) in the center of the town 2 of Tubas city

The number of each solar system	The ratings (KWp & KV_{AC})	The space needed for the solar system
PV 20 Inv 20	5 KWp 0.4 KV_{AC}	32 m^2 (space needed for the solar panels) 50 m^2 (space needed for the solar system with taking into account the shadows)
	The cost for the solar system with the components included with the solar system (wires, cables, inverter, solar panels, constructor)	
	4250 $	

The table (4.1.8) shows the cost of the suggested solar system (PV21) in the center of the town 2 of Tubas city.

Table (4.1.8) : The cost of the solar system(PV21) in the center of the town 2 of Tubas city

The number of each solar system	The ratings (KWp & KV_{AC})	The space needed for the solar system
PV 21 Inv 21	5 KWp 0.4 KV_{AC}	32 m^2 (space needed for the solar panels) 50 m^2 (space needed for the solar system with taking into account the shadows)
	The cost for the solar system with the components included with the solar system (wires, cables, inverter, solar panels, constructor)	
	4250 $	

The table (4.1.9) shows the total cost of the suggested solution of solar systems (PV19, Pv20 & PV21) in the center of the town 2 of Tubas city .

Table (4.1.9) : The total cost of the suggested solution of solar systems (PV19 , PV20 & PV21) in the center of the town 2 of Tubas city

The total cost of the suggested solution (solar system PV19 , solar system PV20 & solar system PV21)
4250$ + 4250$ + 4250$ = 12750$

From table (4.1.9) the suggested solution requires a cost of (12750$ = 45000NIS).

- To the problem 5 there is one suggested solution.

* The new suggested solar systems (PV19 , PV20 & PV21). The table (4.1.10) shows the cost of the suggested solar system (PV21) in the center of the Western region of Tubas city.

Table (4.1.10) : The cost of the solar system(PV21) in the center of the Western region of Tubas city

<table>
<tr><th>The number of each solar system</th><th>The ratings (KWp & KV_{AC})</th><th>The space needed for the solar system</th></tr>
<tr><td rowspan="3">PV 45
Inv 45</td><td>5 KWp

0.4 KV_{AC}</td><td>32 m^2 (space needed for the solar panels)
50 m^2 (space needed for the solar system with taking into account the shadows)</td></tr>
<tr><td colspan="2">The cost for the solar system with the components included with the solar system (wires, cables, inverter, solar panels, constructor)</td></tr>
<tr><td colspan="2">4250 $</td></tr>
</table>

From table (4.1.10) the suggested solution requires a cost of (4250$ = 15000NIS).

4.1.2 Keshda Village:

There is one problem in the village of Keshda with 1 suggested solution (see Chapter 3, section 3.1.2).

- To the problem there is one suggested solution .

* The new suggested transmission line (TL357). The table (4.1.11) shows the cost of the suggested transmission line (TL357) in Keshda village region.

Table (4.1.11) : The cost of the transmission line(TL357) in Keshda village

<table>
<tr><th>The number of the transmission line</th><th colspan="2">The rating (KV_{AC})</th><th>The length (meters)</th><th>The sizing (mm^2)</th></tr>
<tr><td rowspan="5">TL 358</td><td colspan="2">33KV_{AC} (medium voltage line)</td><td>300</td><td>158 (150)</td></tr>
<tr><th>The number and type of the towers</th><th colspan="2">The number and type of the arms</th><th>The number and type of the isolators</th></tr>
<tr><td>2 (suspension)
2 (tension)</td><td colspan="2">2 from type of side arms (2 of long arms)
2 from type of central</td><td>18 from type of porcelain</td></tr>
<tr><th colspan="3">The cost of each meter in the transmission line with the components included with the transmission line
(towers, arms, wires, isolators)</th><th>The total cost of the transmission line</th></tr>
<tr><td colspan="3">60 $ / meter</td><td>18000 $</td></tr>
</table>

From table (4.1.11) the suggested solution requires a cost of (18000$ = 65000NIS).

4.1.3 Tyaseer Village:

There is one problem in the village of Tyaseer with 1 suggested solution (see Chapter 3, section 3.1.3).

- To the problem there is one suggested solution.

* The new suggested solar system (PV2). The table (4.1.12) shows the cost of the suggested solar system (PV2) in Tyaseer village.

Table (4.1.12) : The cost of the solar system(PV2) in the Tyaseer village

The number of each solar system	The ratings (KWp & KV_{AC})	The space needed for the solar system
PV 2 Inv 2	5 KWp 0.4 KV_{AC}	32 m^2 (space needed for the solar panels) 50 m^2 (space needed for the solar system with taking into account the shadows)
	The cost for the solar system with the components included with the solar system (wires, cables, inverter, solar panels, constructor)	
	4250 $	

From table (4.1.12) the suggested solution requires a cost of (4250$ = 15000NIS).

4.1.4 Aqabeh Village:

As mentioned previously in the third chapter (The Solutions) at section 3.1.4 (The suggested solutions of the problems of Aqabeh town network), there is no suggested solutions in the village, so there is no economic study for the village.

4.1.5 Ras Al-Fara'a Area:

There is one problem in the area of Ras Al-Fara'a with 3 suggested solutions (see Chapter 3, section 3.1.5).

- To the problem there are three suggested solutions.

1) The new suggested solar systems (PV118, PV119, PV120 & PV121). The table (4.1.13) shows the cost of the suggested solar systems (PV118 & PV119) in the Eastern region of the area of Ras Al-Fara'a.

Table (4.1.13) : The cost of the solar systems(PV118 & PV119) in the Eastern region of Ras Al-Fara'a area

The number of each solar system	The ratings (KWp & KV_{AC})	The space needed for the solar system
PV 118 Inv 118	150 KWp 0.4 KV_{AC}	960 m^2 (space needed for the solar panels) 1500 m^2 (space needed for the solar system with taking into account the shadows)
	The cost for the solar system with the components included with the solar system (wires, cables, inverter, solar panels, constructor)	
	127500 $	
The number of each solar system	The ratings (KWp & KV_{AC})	The space needed for the solar system
PV 119 Inv 119	150 KWp 0.4 KV_{AC}	960 m^2 (space needed for the solar panels) 1500 m^2 (space needed for the solar system with taking into account the shadows)
	The cost for the solar system with the components included with the solar system (wires, cables, inverter, solar panels, constructor)	
	127500 $	

The table (4.1.14) shows the cost of the suggested solar systems (PV120 & PV121) in the center of the Eastern region of the area of Ras Al-Fara'a.

Table (4.1.14) : The cost of the solar systems(PV120 & PV121) in the center of the Eastern region of the area of Ras Al-Fara'a

The number of each solar system	The ratings (KWp & KV_{AC})	The space needed for the solar system
PV 120 Inv 120	50 KWp 0.4 KV_{AC}	350 m^2 (space needed for the solar panels) 500 m^2 (space needed for the solar system with taking into account the shadows)
	The cost for the solar system with the components included with the solar system (wires , cables , inverter , solar panels , constructor)	
	42500 $	
The number of each solar system	The ratings (KWp & KV_{AC})	The space needed for the solar system
PV 121 Inv 121	50 KWp 0.4 KV_{AC}	350 m^2 (space needed for the solar panels) 500 m^2 (space needed for the solar system with taking into account the shadows)
	The cost for the solar system with the components included with the solar system (wires , cables , inverter , solar panels , constructor)	
	42500 $	

The table (4.1.15) The total cost of the suggested solution of solar systems (PV118, PV119, PV120 & PV121) in the Eastern regions (the Eastern region & the center of the Eastern region) of the area of Ras Al-Fara'a.

Table (4.1.15) : The total cost of the suggested solution of solar systems (PV118, PV119, PV120 & PV121) in the Eastern regions of Ras Al-Fara'a area

The total cost of the suggested solution (solar system PV118 , solar system PV119 , solar system PV120 & solar system PV121)
127500$ + 127500$ + 42500$ + 42500$= 340000$

From table(4.1.15) the suggested solution requires a cost of (340000$ = 1190000NIS).

2) The new suggested generator (G1). The table (4.1.16) shows the cost of the suggested generator (G1) in the center of the Eastern region of the area of Ras Al-Fara'a.

Table (4.1.16) : The cost of the generator(G1) in the center of the Eastern region of Ras Al-Fara'a area

<table>
<tr><th>the number of the generator</th><th>The rating of the generator</th><th colspan="2">The number of the generators in the system to obtain the required capacity</th><th colspan="2">The cost for each generator in the system</th></tr>
<tr><td rowspan="3">G1</td><td>10 MW</td><td colspan="2">5 generator with rating 1.5MW
2 generator with rating 1.25MW</td><td colspan="2">270000$ (for 1.5MW)
225000$ (for 1.25 MW)</td></tr>
<tr><th colspan="2">The space for each generator</th><th colspan="2">The total space for the system</th><th>the total cost</th></tr>
<tr><td colspan="2">15 m^2 (space needed for each generator)
20 m^2 (space needed for each generator with taking into account the area of ventilation)</td><td colspan="2">105 m^2 (for generators)
140 m^2(for the system)</td><td>1800 000$</td></tr>
</table>

From table (4.1.16) the suggested solution requires a cost of (1800000$ = 6300000NIS).

3) The new suggested transmission line (TL359 – Ring1). The table (4.1.17) shows the cost of the suggested transmission line (TL359 – Ring1) in the center of the Eastern region of the area of Ras Al-Fara'a.

Table (4.1.17) : The cost of the transmission line(TL359-Ring1) in the center of the Eastern region of Ras Al-Fara'a area

<table>
<tr><th>The number of the transmission line</th><th>The rating (KV_{AC})</th><th>The length (meters)</th><th>The sizing (mm^2)</th></tr>
<tr><td rowspan="5">TL 359</td><td>33KV_{AC}
(medium voltage line)</td><td>2000</td><td>158 (150)</td></tr>
<tr><td>The number and type of the towers</td><td>The number and type of the arms</td><td>The number and type of the isolators</td></tr>
<tr><td>8 (suspension)
6 (tension)
2 (transposition)</td><td>8 from type of side arms (6 long arms & 2 short arms)
8 from type of central</td><td>72 from type of porcelain</td></tr>
<tr><td colspan="2">The cost of each meter in the transmission line with the components included with the transmission line (towers , arms , wires , isolators)</td><td>The total cost of the transmission line</td></tr>
<tr><td colspan="2">60 % / meter</td><td>120000 $</td></tr>
</table>

From table(4.1.17) the suggested solution requires a cost of (120000$ = 425000NIS).

4.1.6 Atoof town:

There are two problems in the town of Atoof with 2 suggested solution (see Chapter 3, section 3.1.9).

- To the problem 1 there is one suggested solution.

* The new suggested capacitor bank (C1). The table (4.1.18) shows the cost of the capacitor bank (C1) in the Western region of the town of Atoof.

Table (4.1.18) : The cost of the capacitor bank(C1) in the Western region of the town of Atoof

The number of the capacitor bank	The ratings (KVAR & KV)	The cost for the capacitor bank with the components included with the capacitor bank (wires, control, plate)
C1	350KVAR , 0.4KV	8000$

From table (4.1.18) the suggested solution requires a cost of (8000$ = 28000NIS).

- To the problem 2 there is one suggested solution.

* The new suggested capacitor bank (C2). The table (4.1.19) shows the cost of the capacitor bank (C2) in the center of the town of the town of Atoof.

Table (4.1.19) : The cost of the capacitor bank(C2) in the center of the town of the town of Atoof

The number of the capacitor bank	The ratings (KVAR & KV)	The cost for the capacitor bank with the components included with the capacitor bank (wires, control, plate)
C2	50KVAR , 0.4KV	1140$

From table (4.1.19) the suggested solution requires a cost of (1140$ = 4000NIS).

4.1.7 Jalqamous Village:

There is one problem in the village of Jalqamous with 1 suggested solution (see Chapter 3, section 3.1.19).

- To the problem there is one suggested solution.

* The new suggested transformer (T255) with new transmission line (TL362). The table (4.1.20) shows the cost of the suggested transformer and the transmission line (T255 & TL362) respectively, in Jalqamous village region.

Table (4.1.20) : The cost of the transformer and the transmission line(T255 & TL362) respectively in Jalqamous village

<table>
<tr><td>The number of the transformer</td><td>The ratings (KVA , KV)</td><td>The cost of the transformer</td><td colspan="2">The cost for the arm and tower in place to carry the transformer (central type arm , tension type tower)</td></tr>
<tr><td rowspan="3">T 255</td><td>160 KVA (33/0.4) KV</td><td>8500 $</td><td colspan="2">3000 $</td></tr>
<tr><td colspan="3">The cost of the components included with the transformer (wires , insulator "3" (type of ABB) , isolators "6" (type of porcelain) , fuses "3" (type of dropout) , lighting arrestors "3" ,oil tank)</td><td>The total cost of the transformer</td></tr>
<tr><td colspan="3">4500 $</td><td>16000 $</td></tr>
<tr><td>The number of the transmission line</td><td colspan="2">The rating (KV_{AC})</td><td>The length (meters)</td><td>The sizing (mm^2)</td></tr>
<tr><td rowspan="5">TL 362</td><td colspan="2">33KV_{AC} (medium voltage line)</td><td>1000</td><td>158 (150)</td></tr>
<tr><td colspan="2">The number and type of the towers</td><td>The number and type of the arms</td><td>The number and type of the isolators</td></tr>
<tr><td colspan="2">5 (suspension)
2 (tension)
1 (transposition)</td><td>5 from type of side arms
(5 of long arms)
3 from type of central</td><td>33 from type of porcelain</td></tr>
<tr><td colspan="3">The cost of each meter in the transmission line with the components included with the transmission line (towers , arms , wires , isolators)</td><td>The total cost of the transmission line</td></tr>
<tr><td colspan="3">60 % / meter</td><td>60000 $</td></tr>
<tr><td colspan="5">The total cost of the suggested solution
(transformer T255 & transmission line TL362)</td></tr>
<tr><td colspan="5">16000$ + 60000$ = 76000$</td></tr>
</table>

From table (4.1.20) the suggested solution requires a cost of (76000$ = 266000NIS).

* Note : In the same way as the previous method, by determined the costs of the proposed solutions, we determined the cost of the of all the proposed solutions for all the problems in all regions of Tubas electricity network (30 different regions "Tubas city, Keshda village, Tyaseer village, Aqabeh village, Ras Al-Fara'a region, Wadi Al-Fara'a region, Al-Fara'a Camp

region, Tammon town, Atoof town, Aqqaba town, Al-Zababeda town, Al-Kfier village, Raba town, Telfeet village, Arab American University Jenin 'AAUJ' area, Tineen village, Private Project area, Dream Land area, Jalqamous village, Al-Mghayer village, Al-Mtelleh village, Um Al-Toot village, Meselyeh town, Al-Jarba village, Merkeh village, Al-Zawyah village, Anzaa village, Al-Hafeeri village, Wadi Douq village and Beer Al-Basha village).

4.2 The Costs of the Proposed Solutions in Tubas Electricity Network (Proposed Solutions by the Company – by Tubas Electricity Company):

In this section, we will conduct an economic study (we determine the cost and the income) of all solutions proposed by Tubas electricity company itself, to solve the problems in the network and to know the costs of these proposed solutions on the electricity network, as there are several solutions proposed by Tubas electricity company and through this section we will determine the cost of each proposed solution separately and the amount of its economic cost (construction and operational cost).

4.2.1 In Tubas City Network:

- **Palestine Investment Fund PV Plant (Proposed):**

The solar systems in this proposed solution as follow (the solar system PV10 with the transformer "T18//PALESTINE INVESTMENT FUND PV STATION1", the solar system PV88 with the transformer "T251//PALESTINE INVESTMENT FUND PV STATION2" and the solar system PV89 with the transformer "T252//PALESTINE INVESTMENT FUND PV STATION3").

The table (4.2.1) shows the cost of the proposed solar system by Tubas electricity company and the new transformer (PV10 & T18//PALESTINE INVESTMENT FUND PV STATION1) respectively in the Eastern region2 of Tubas city.

Table (4.2.1) : The cost of the solar system and the transformer(PV10 & T18) respectively in the Eastern region 2 of Tubas city

<table>
<tr><th>The number of each solar system</th><th>The ratings (KWp & KV_{AC})</th><th>The space needed for the solar system</th></tr>
<tr><td rowspan="3">PV 10
Inv 10</td><td>2000 KWp

0.4 KV_{AC}</td><td>12800 m^2 (space needed for the solar panels)

20000 m^2 (space needed for the solar system with taking into account the shadows)</td></tr>
<tr><td colspan="2">The cost for the solar system with the components included with the solar system (wires , cables , inverter , solar panels , constructor)</td></tr>
<tr><td colspan="2">1700000 $</td></tr>
</table>

<table>
<tr><th>The number of the transformer</th><th>The ratings (KVA , KV)</th><th>The cost of the transformer</th><th colspan="2">The cost for the arm and tower in place to carry the transformer (central type arm , tension type tower)</th></tr>
<tr><td>T 18</td><td>1000 KVA (33/0.4) KV</td><td>20000 $</td><td colspan="2">3000 $</td></tr>
<tr><td rowspan="2">T 18</td><td colspan="3">The cost of the components included with the transformer (wires , insulator "3" (type of ABB) , isolators "6" (type of porcelain) , fuses "3" (type of dropout) , lighting arrestors "3" ,oil tank)</td><td>The total cost of the transformer</td></tr>
<tr><td colspan="3">4500 $</td><td>27500 $</td></tr>
<tr><td colspan="5">The total cost of the proposed solar system by TUBAS Electricity Company (the solar system PV10 with the transformer T18)</td></tr>
<tr><td colspan="5">1700000$ + 27500$ = 1727500$</td></tr>
</table>

The table (4.2.2) shows the cost of the proposed solar system by Tubas electricity company and the new transformer (PV88 &

T251//PALESTINE INVESTMENT FUND PV STATION2) respectively in the Eastern region 2 of Tubas city.

Table (4.2.2) : The cost of the solar system and the transformer(PV88 & T251) respectively in the Eastern region 2 of Tubas city

<table>
<tr><th>The number of each solar system</th><th>The ratings (KWp & KV_{AC})</th><th colspan="2">The space needed for the solar system</th></tr>
<tr><td rowspan="3">PV 88
Inv 88</td><td>3000 KWp

0.4 KV_{AC}</td><td colspan="2">19200 m^2 (space needed for the solar panels)

30000 m^2 (space needed for the solar system with taking into account the shadows)</td></tr>
<tr><td colspan="3">The cost for the solar system with the components included with the solar system (wires , cables , inverter , solar panels , constructor)</td></tr>
<tr><td colspan="3">2550000 $</td></tr>
<tr><td>The number of the transformer</td><td>The ratings (KVA , KV)</td><td>The cost of the transformer</td><td>The cost for the arm and tower in place to carry the transformer
(central type arm , tension type tower)</td></tr>
<tr><td rowspan="3">T 251</td><td>1000 KVA
(33/0.4) KV</td><td>20000 $</td><td>3000 $</td></tr>
<tr><td colspan="2">The cost of the components included with the transformer (wires , insulator "3" (type of ABB) , isolators "6" (type of porcelain) , fuses "3" (type of dropout) , lighting arrestors "3" ,oil tank)</td><td>The total cost of the transformer</td></tr>
<tr><td colspan="2">4500 $</td><td>27500 $</td></tr>
<tr><td colspan="4">The total cost of the proposed solar system by TUBAS Electricity Company
(the solar system PV88 with the transformer T251)</td></tr>
<tr><td colspan="4">2550000$ + 27500$ = 2577500$</td></tr>
</table>

The table (4.2.3) shows the cost of the proposed solar system by Tubas electricity company and the new transformer (PV89 & T252//PALESTINE INVESTMENT FUND PV STATION3) respectively in the Eastern region 2 of Tubas city.

Table (4.2.3) : The cost of the solar system and the transformer(PV88 & T252) respectively in the Eastern region 2 of Tubas city

<table>
<tr><td>The number of each solar system</td><td colspan="2">The ratings (KWp & KV_{AC})</td><td colspan="3">The space needed for the solar system</td></tr>
<tr><td>PV 89
Inv 89</td><td colspan="2">3000 KWp

0.4 KV_{AC}</td><td colspan="3">19200 m^2 (space needed for the solar panels)
30000 m^2 (space needed for the solar system with taking into account the shadows)</td></tr>
<tr><td rowspan="2">PV 89
Inv 89</td><td colspan="5">The cost for the solar system with the components included with the solar system (wires , cables , inverter , solar panels , constructor)</td></tr>
<tr><td colspan="5">2550000 $</td></tr>
<tr><td>The number of the transformer</td><td>The ratings (KVA , KV)</td><td colspan="2">The cost of the transformer</td><td colspan="2">The cost for the arm and tower in place to carry the transformer
(central type arm , tension type tower)</td></tr>
<tr><td>T 252</td><td>1000 KVA (33/0.4) KV</td><td colspan="2">20000 $</td><td colspan="2">3000 $</td></tr>
<tr><td rowspan="2">T 252</td><td colspan="4">The cost of the components included with the transformer (wires , insulator "3" (type of ABB) , isolators "6" (type of porcelain) , fuses "3" (type of dropout) , lighting arrestors "3" ,oil tank)</td><td>The total cost of the transformer</td></tr>
<tr><td colspan="4">4500 $</td><td>27500 $</td></tr>
<tr><td colspan="6">The total cost of the proposed solar system by TUBAS Electricity Company
(the solar system PV89 with the transformer T252)</td></tr>
<tr><td colspan="6">2550000$ + 27500$ = 2577500$</td></tr>
</table>

The table **(4.2.4)** The total cost of the proposed solution by Tubas electricity company of solar systems (the solar system PV10 with the transformer "T18//PALESTINE INVESTMENT FUND PV STATION1", the solar system PV88 with the transformer "T251//PALESTINE INVESTMENT FUND PV STATION2" and the solar system PV89 with the transformer "T252//PALESTINE INVESTMENT FUND PV STATION3") in the Eastern region2 of the city of Tubas.

Table (4.2.4) : The total cost of the proposed solution by Tubas electricity company of solar systems(PV10 with T18 , PV88 with T251 & PV89 with T252) in the Eastern region2 of Tubas city

The total cost of the proposed solution by TUBAS Electricity Company (the solar system PV10 with the transformer T18 , the solar system PV88 with the transformer T251 , and the solar system PV89 with the transformer T252)
1727500$ + 2577500$ + 2577500$ = 6882500$

From table (4.2.4) the proposed solution requires a cost of (6882500$ = 25000000NIS).

* Note : In the same way as before in determining the costs of the solutions proposed by Tubas electricity company , we have determined the costs of the solutions proposed by the company (In Tubas city "1. Palestine Investment Fund PV Stations (Proposed), 2. Jafa PV Plant (Under Construction)", in Tyaseer village "Tyaseer Filtering Station PV plant (Proposed)"), as shown in the appendix C at section C.1, Titles C.1./1. And C.1./2. .

4.3 The Costs for the Suggested Solutions for the effects of Connection Points between Tubas Electricity Company and the North Electricity Company in Tubas Network:

In this section, we will conduct an economic study of the effects of connection points between Tubas electricity company and the North electricity company, as there are four connection points between the two companies in the areas of the village of Al-Kfier and Wadi Al-Fara'a of Tubas electricity company, and in this section we will determine the cost of the effects of the connection points on Tubas electricity company and the amount of the cost treatment these effects economically.

4.3.1 In Al-Kfier Village Network:

- At Sier Connection Point:

At this connection point there is pressure on the electrical power on Tubas network and this pressure (especially on Al-Kfier village network), it is handled automatically because the connection point of Al-Jalameh is close to the village of Al-Kfier, so there are no negative effects on the electricity network at the connection point there is no economic study of the effects of connecting the connection point with the network of the village of Al-Kfier.

4.3.2 In Wadi Al-Fara'a Area Network:

- At Al-Nasaryeh Connection Point, Al-Bathan Connection Point and Yaseed Connection Point:

These connection points put pressure on Tubas electricity network (especially on network of Wadi Al-Fara'a area), so we previously suggested the developing a new generator or a new transmission line, and it is should be noted that there is a proposal to place a new generator (G1) or a new transmission line (Tl360 - Ring2) in Wadi Al-Fara'a area to address the problem of pressure on the network caused by agricultural areas in Wadi Al-Fara'a area, and therefore this proposal (a new generator "G1" or a new transmission line "TL360 – Ring2") can be used to help reduce the pressure caused by the connection points in Wadi Al-Fara'a area, so the economic study of this part is for the suggested new generator in Wadi Al-Fara'a area is about (1800000$ = 6300000NIS) and for the new transmission line

"TL360 – Ring2" is about (150000$ = 530000NIS). So to address the effects of the connection points in the area of Wadi Al-Fara'a, there are two proposals (new generator "G1" and new transmission line "TL360 – Ring2"), and each proposal has a specific economic cost and also has practical benefits on the network in the future. Therefore , our choice of the best solution will be based on the least expensive and most beneficial in the future.

Chapter 5
The Results

In this chapter there will be three parts, in the first part the optimal solution will be chosen from among several solutions to solve each problem and explaining the reason for choosing each solution from the practical side, and choosing the best solutions for each region separately from the practical side just, in the second part of this section will present the final cost results for each region separately, in the third part, we will summarize the total cost of the solutions suggested in this thesis and the total cost of the solutions proposed by Tubas electricity company.

5.1 The Results of each Region in Tubas Network Separately:

In this part, each problem and its proposed solutions will be presented and the best solution to the problem will be chosen from practical sides.

5.1.1 In Tubas City Network:

There are five problems in the city of Tubas with 7 suggested solutions (see Chapter 3 at section 3.1.1, and Chapter 4 at section 4.1./1.).

- To the problem 1 there are three suggested solutions. The table (5.1.1) shows the cost of the suggested solutions in the Northern region (the first of the city) of Tubas city.

Table (5.1.1) : The cost of the suggested solutions in the Northern region of Tubas city

The number for each suggested solution	The suggested solution	The cost for each suggested solution
1	Solar systems PV116 & PV117	8500$ = 30000NIS
2	Transformer with transmission line T254 & TL358	133500$ = 470000MIS
3	Low voltage transmission line TL367	18000$ = 63000NIS

From table (5.1.1) we see that the suggested solar systems is the least expensive, but this area (the Northern region (the first of the city) – Tubas city) is a residential area, that is, it has a new buildings every day so using the solar systems is not feasible to solve the problem of unstable current in this area and because the loads will increase continuously and the current will remain unstable, the suggested transformer with new transmission line it is the most expensive but fast in construction and good for the future as this area is an architectural residential area, and the suggested low voltage transmission line its cost is moderate, but the construction of this transmission line need a longer time than other suggested solutions and also, since the area (the Northern region (the first of the city) – Tubas city) is a residential area and there is a new building every day, this suggested solution is not a advantage of it because there is an increase in buildings (loads) so that the problem will not be solved in the long time.

Then we recommend the second suggested solution which is transformer (T254) with new transmission line (TL358 – 33KV – overhead line) although its cost is high , but in the long run it is the most beneficial.

- To the problems (the problem 2, the problem 3, the problem 4 & the problem 5) there is one suggested solution to every problem and we recommend each proposal as a solution to the proposed problem, because it is appropriate from the economic and practical.

5.1.2 In Keshda Village Network:

There is one problem in the village of Keshda with one suggested solution (see Chapter 3 at section 3.1.2, and Chapter 4 at section 4.1./2.).

- To the problem there is one suggested solution, and we recommend it as a good solution to solve the problem in the village from the economic and practical aspects.

5.1.3 In Tyaseer Village Network:

There is one problem in the village of Tyaseer with one suggested solution (see Chapter 3 at section 3.1.3, and Chapter 4 at section 4.1./3.).

- To the problem there is one suggested solution, and we recommend it as a good solution to solve the problem in the village from the economic and practical aspects.

5.1.4 In Ras Al-Fara'a Area Network:

There is one problem in the area of Ras Al-Fara'a with three suggested solutions (see Chapter 3 at section 3.1.5, and Chapter 4 at section 4.1./5.).

- To the problem there are three suggested solutions. The table (5.1.2) shows the cost of the suggested solutions in the agricultural areas – the

Eastern regions (the Eastern region, the center of the Eastern region) of Ras Al-Fara'a area.

Table (5.1.2) :The cost of the suggested solutions in the Eastern regions

The number for each suggested solution	The suggested solution	The cost for each suggested solution
1	Solar systems PV118 , PV119 ,PV120 & PV121	340000$ = 1190000NIS
2	New generator G1	1800000$ = 6300000MIS
3	new transmission line – ring1 TL359	120000$ = 425000NIS

From table (5.1.2) we see that the suggested solar system is of medium cost as compared to other solutions, but needs large areas, at the second suggested solution (G1) we see this suggestion as very costly, and at the third suggested solution (Ring1) we see it as the least expensive, but the construction is more difficult than other solutions.

Then we recommend the first suggestions, which is the medium cost solar systems although they need a large areas, but these agricultural areas in the Eastern regions of Ras Al-Fara'a area have enough space for theses solar systems .

5.1.5 In Wadi Al-Fara'a Area Network:

There is one problem in the area of Wadi Al-Fara'a with three suggested solutions (see Chapter 3 at section 3.1.6, and Chapter 4 at section 4.1./6.).

- To the problem there are three suggested solutions. The Table (5.1.3) shows the cost of the suggested solutions in the agricultural areas (the Eastern region , the first of the town) of Wadi Al-Fara'a area.

Table (5.1.3) : The cost of the suggested solutions in the Eastern region and the first of the town of Wadi Al-Fara'a area

The number for each suggested solution	The suggested solution	The cost for each suggested solution
1	Solar systems PV122 , PV123 & PV124	255000$ = 900000NIS
2	New generator G1	1800000$ = 6300000MIS
3	new transmission line – ring2 TL360	150000$ = 530000NIS

We see table (5.1.3) the suggested solar system is of medium cost compared to other solutions, but need a large areas and in Wadi Al-Fara'a area (especially in the Eastern region and in the first of the town) there are no large areas, at the second suggested solutions (G2) we see this suggested solution very costly and at third suggestion (Ring2) it is least expensive but the construction is more difficult than other solution.

Then we recommended the third suggestions, although it is difficult to establish, but it is least costly and also the least needed for the space that not available in Wadi Al-Fara'a' area.

5.1.6 In Al-Fara'a Camp Area Network:

There are two problems in the area of Al-Fara'a Camp with four suggested solutions (see Chapter 3 at section 3.1.7, and Chapter 4 at section 4.1./7.) .

- To the problem 1 there is one suggested solution and this solution is good to solve the problem1 from the economic and practical aspects, so we recommend this solution.

- To the problem 2 there are three suggested solutions. The Table (5.1.4) shows the cost of the suggested solutions in the agricultural areas (the center of the town) of Al-Fara'a Camp area.

Table (5.1.4) : The cost of the suggested solutions in the center of the town

The number for each suggested solution	The suggested solution	The cost for each suggested solution
1	Solar system PV83	170000$ = 600000NIS
2	New generator G1	1800000$ = 6300000MIS
3	new transmission line – ring3 TL361	180000$ = 635000NIS

From table (5.1.4) we see the suggested solar system it is the least expensive and it does not need a large area, at the second suggested solution (G1) it is very costly and at the third suggested solution (Ring3) need default construction more than other solutions.

Then we recommend the first suggested solution (solar system) because it does not need a large area and it is the least expensive, so it is good from the economic and practical aspects.

5.1.7 In Tammon Town Network:

There is one problem in the town of Tammon with one suggested solution (see Chapter 3 at section 3.1.8, and Chapter 4 at section 4.1./8.).

- To the problem there is one suggested solution and this solution is good to solve the problem in the town it is good from the economic and practical aspects, so we recommend this solution.

5.1.8 In Atoof Town Network:

There are two problems in the town of Atoof with one suggested solution (see Chapter 3 at section 3.1.9, and Chapter 4 at section 4.1./9.).

- To the problem 1 there is one suggested solution and this solution is good to solve the problem 1 in the town it is good from the economic and practical aspects, so we recommend this solution.

- To the problem 2 there is one suggested solution and this solution is good to solve the problem 2 in the town it is good from the economic and practical aspects, so we recommend this solution.

5.1.9 In Aqqaba Town Network:

There is one problem in the town of Aqqaba with one suggested solution (see Chapter 3 at section 3.1.10, and Chapter 4 at section 4.1./10.).

- To the problem there is one suggested solution and this solution is good to solve the problem in the town it is good from the economic and practical aspects, so we recommend this solution.

5.1.10 In Al-Zababeda Town Network:

There is one problem in the town of Al-Zababeda with one suggested solution (see Chapter 3 at section 3.1.11, and Chapter 4 at section 4.1./11.).

- To the problem there is one suggested solution and this solution is good to solve the problem in the town it is good from the economic and practical aspects, so we recommend this solution.

5.1.11 In Al-Kfier Village Network:

There is one problem in the village of Al-Kfier with one suggested solution (see Chapter 3 at section 3.1.12, and Chapter 4 at section 4.1./12).

- To the problem there is one suggested solution and this solution is good to solve the problem in the village it is good from the economic and practical aspects, so we recommend this solution.

5.1.12 In Raba Town Network:

There is one problem in the town of Raba with one suggested solution (see Chapter 3 at section 3.1.13, and Chapter 4 at section 4.1./13.).

- To the problem there is one suggested solution and this solution is good to solve the problem in the town it is good from the economic and practical aspects, so we recommend this solution.

5.1.13 In Telfeet Village Network:

There is one problem in the village of Telfeet with one suggested solution (see Chapter 3 at section 3.1.14, and Chapter 4 at section 4.1./14.).

- To the problem there is one suggested solution and this solution is good to solve the problem in the village it is good from the economic and practical aspects, so we recommend this solution.

5.1.14 In Private Project Area Network:

There are two problems in the area of Private Project with two suggested solutions (see Chapter 3 at section 3.1.17, and Chapter 4 at section 4.1./17.).

- To the problem 1 there is one suggested solution and this solution is good to solve the problem 1 in the area it is good from the economic and practical aspects, so we recommend this solution.

- To the problem 2 there is one suggested solution and this solution is good to solve the problem 2 in the area it is good from the economic and practical aspects, so we recommend this solution.

5.1.15 In Jalqamous Village Network:

There is one problems in the village of Jalqamous with one suggested solution (see Chapter 3 at section 3.1.19, and Chapter 4 at section 4.1./19.).

- To the problem there is one suggested solution and this solution is good to solve the problem in the village it is good from the economic and practical aspects, so we recommend this solution.

5.1.16 In Al-Mghayer Village Network:

There are three problems in the village of Al-Mghayer with three suggested solutions (see Chapter 3 at section 3.1.20, and Chapter 4 at section 4.1./20.).

- To the problem 1 there is one suggested solution and this solution is good to solve the problem 1 in the village it is good from the economic and practical aspects, so we recommend this solution.

- To the problem 2 there is one suggested solution and this solution is good to solve the problem 2 in the village it is good from the economic and practical aspects, so we recommend this solution.

- To the problem 3 there is one suggested solution and this solution is good to solve the problem 3 in the village it is good from the economic and practical aspects, so we recommend this solution.

5.1.17 In Um Al-Toot Village Network:

There are two problems in the village of Um Al-Toot with two suggested solutions (see Chapter 3 at section 3.1.22, and Chapter 4 at section 4.1./22.).

- To the problem 1 there is one suggested solution and this solution is good to solve the problem 1 in the village it is good from the economic and practical aspects, so we recommend this solution.

- To the problem 2 there is one suggested solution and this solution is good to solve the problem 2 in the village it is good from the economic and practical aspects, so we recommend this solution.

5.1.18 In Meselyeh Town Network:

There are two problems in the town of Meselyeh with two suggested solutions (see Chapter 3 at section 3.1.23, and Chapter 4 at section 4.1./23.).

- To the problem 1 there is one suggested solution and this solution is good to solve the problem 1 in the town it is good from the economic and practical aspects, so we recommend this solution.

- To the problem 2 there is one suggested solution and this solution is good to solve the problem 2 in the town it is good from the economic and practical aspects, so we recommend this solution.

5.1.19 In Al-Jarba Village Network:

There are two problems in the village of Al-Jarba with two suggested solutions (see Chapter 3 at section 3.1.24, and Chapter 4 at section 4.1./24.).

- To the problem 1 there is one suggested solution and this solution is good to solve the problem 1 in the village it is good from the economic and practical aspects, so we recommend this solution.

- To the problem 2 there is one suggested solution and this solution is good to solve the problem 2 in the village it is good from the economic and practical aspects, so we recommend this solution.

5.1.20 In Al-Zawyah Village Network:

There is one problems in the village of Al-Zawyah with one suggested solution (see Chapter 3 at section 3.1.26, and Chapter 4 at section 4.1./26.).

- To the problem there is one suggested solution and this solution is good to solve the problem in the village it is good from the economic and practical aspects, so we recommend this solution.

5.1.21 In Wadi Douq Village Network:

There is one problems in the village of Wadi Douq with one suggested solution (see Chapter 3 at section 3.1.28, and Chapter 4 at section 4.1./28.).

- To the problem there is one suggested solution and this solution is good to solve the problem in the village it is good from the economic and practical aspects, so we recommend this solution.

5.2 The Results for Tubas Network as a whole:

In this parts we will summarize the final results of the costs of all the solutions chosen as acceptable solutions to problems from practical side.

5.2.1 In Tubas City Network as a whole:

There are five problems in the city of Tubas (see Chapter 3 at section 3.1.1, Chapter 4 at section 4.1./1. and Chapter 5 at section 5.1), the first problem has three suggested solutions and one has been chosen which is suitable for it from the economic point of view , and the rest of the problems each one of them has one solution chosen as the best solution from the economic point of view, and in Tubas city there are also solutions proposed by Tubas electricity company (see Chapter 3 at section 3.2) and these solutions have an economic cost that was previously presented in details (se Chapter 4 at section 4.2), these costs will be presented in their final form in this part. The table (5.2.1) shows the cost of the suggested solutions to solve the problems in the city of Tubas as a whole.

Table (5.2.1) : The cost of the suggested solutions in Tubas city network as a whole

The suggested solution for each problem	The cost for each suggested solution	The location (zone) for each suggested solution
Transformer & transmission line T254 & TL358	133500$ = 470000NIS	The Northern region "the first of the city"
Solar system PV13 , inv 13	4250$ = 15000MIS	The Southern region 2
Solar system	4250$ = 15000NIS	The center of the town 2

PV18 , inv 18		
Solar systems PV19 , inv 19 PV20 , inv20 PV21 , inv21	12750$ = 45000NIS	The center of the town 2
Solar system PV45, inv 45	4250$ = 15000NIS	The center of the Western region
The proposed solution (proposed by Tubas Electricity Company)	The cost for proposed solution	The location (zone) for proposed solution
Solar systems PV10 , inv10 with T18 PV88 , inv88 with T251 PV89 , inv89 with T252	6882500$ = 25000000NIS	The Eastern region 2
The proposed solution " under construction" (proposed by Tubas Electricity Company)	The cost for solution (under construction solution)	The location (zone) for solution (under construction solution)
Solar systems PV38 , inv38 with T249 PV87 , inv87 with T250	4690100$ = 16500000NIS	The areas near Al-Fara'a areas

- The total cost for the solutions suggested by this thesis of the city of Tubas.

133500$ + 4250$ + 4250$ + 12750$ + 4250$ = 159000$ = 560000NIS

- The total cost for the solutions proposed by Tubas Electricity Company of the city of Tubas.

6882500$ + 4690100$ = 11572600$ = 41500000NIS .

5.2.2 In Keshda Village Network as a whole:

There is one problem in the village of Keshda (see Chapter 3 at section 3.1.2, Chapter 4 at section 4.1./2. and Chapter 5 at section 5.1) this problem has one suggested solution and this solution was chosen because its economically and practically appropriate to the problem. The Table

(5.2.2) shows the cost of the suggested solution to solve the problem in the village of Keshda as a whole .

Table (5.2.2) : The cost of the suggested solution in the Keshda village network as a whole

The suggested solution	The cost for the suggested solution	The location (zone) for the suggested solution
transmission line TL357	18000$ = 65000NIS	Between the center of the village and the Southern region of the village

5.2.3 In Tyaseer Village Network as a whole:

There is one problem in the village of Tyaseer (see Chapter 3 at section 3.1.3, Chapter 4 at section 4.1./3. and Chapter 5 at section 5.1), this problem has one suggested solution and this solution was chosen because its economically and practically appropriate to the problem, and in Tyaseer village there is also solution proposed by Tubas electricity company (see Chapter 3 at section 3.2) and these solutions have an economic cost that was previously presented in details (see Chapter 4 at section 4.2), these costs will be presented in their final form in this part. The Table (5.2.3) shows the cost of the suggested solutions to solve the problems in the village of Tyaseer as a whole.

Table (5.2.3) : The cost of the suggested solutions in Tyaseer village network as a whole

The suggested solution	The cost for the suggested solution	The location (zone) for the suggested solution
Solar system PV2 , inv2	4250$ = 15000NIS	Tyaseer village region
The proposed solution (proposed from Tubas Electricity Company)	The cost for proposed solution	The location (zone) for proposed solution
Solar systems PV3 , inv3 with T253	1747500$ = 6500000NIS	Tyaseer village region

- The total cost for the solution suggested by this thesis of the village of Tyaseer.

4250$ = 15000NIS .

- The total cost for the solution proposed by Tubas electricity company of the village of Tyaseer.

1747500$ = 6500000NIS .

5.2.4 In Al-Fara'a Regions (Ras Al-Fara'a, Wadi Al-Fara'a and Al-Fara'a Camp) Network as a whole:

There are four problems in the region of Al-Fara'a (see Chapter 3 at sections 3.1.5, 3.1.6, 3.1.7, Chapter 4 at sections 4.1./5., 4.1./6., 4.1./7. and Chapter 5 at section 5.1), this problems have ten suggested solutions, the problem in Ras Al-Fara'a area has three suggested solutions and an appropriate solution has been chosen for it from an economic and practical point of view, the problem in Wadi Al-Fara'a area has three suggested solutions and an appropriate solution has been chosen for it from an economic and practical point of view, the problem in Al-Fara'a Camp area has three suggested solutions and an appropriate solution has been chosen for it from an economic and practical point of view, and the rest of the problems are one problem with one suggested solution which is chosen as the best solution in economic and practical terms. The Table (5.2.4) shows the cost of the suggested solutions to solve the problems in the region of Al-Fara'a (Ras Al-Fara'a, Wadi Al-Fara'a, Al-Fara'a Camp) as a whole.

Table (5.2.4) : The cost of the suggested solutions in Al-Fara'a region network as a whole

The suggested solution for each problem	The cost for the suggested solution	The location (zone) for the suggested solution
Solar systems PV118 , inv118 PV119 , inv119 PV120 , inv120 PV121 , inv121	340000$ = 1190000NIS	The Eastern region (Ras Al-Fara'a area)
Transmission line TL360 – Ring2	150000$ = 530000NIS	The first of the town (Wadi Al-Fara'a area)
Solar system PV83 , inv83	170000$ = 600000NIS	The center of the town (Al-Fara'a Camp area)

- The total cost for the solutions suggested by this thesis of the region of Al-Fara'a.

340000$ + 150000$ + 170000$ = 660000$ = 2320000NIS .

5.2.5 In Tammon Town Network as a whole:

There is one problem in the town of Tammon (see Chapter 3 at section 3.1.8, Chapter 4 at section 4.1./8. and Chapter 5 at section 5.1), this problem has one suggested solution and this solution was chosen because its economically and practically appropriate to the problem. The Table (5.2.5) shows the cost of the suggested solution to solve the problem in the town of Tammon as a whole.

Table (5.2.5) : The cost of the suggested solutions in Tammon town network as a whole

The suggested solution	The cost for the suggested solution	The location (zone) for the suggested solution
Solar system PV86 , inv86	4250$ = 15000NIS	The Western region

5.2.6 In Atoof Town Network as a whole:

There are two problems in the town of Atoof (see Chapter 3 at section 3.1.9, Chapter 4 at section 4.1./9. and Chapter 5 at section 5.1) these problems have one suggested solution for each problem and have been chosen as a suitable solution because it is both economical and practical for the problem. The Table (5.2.6) shows the cost of the suggested solution to solve the problem in the town of Atoof as a whole.

Table (5.2.6) : The cost of the suggested solutions in Atoof town network as a whole

The suggested solution for each problem	The cost for the suggested solution	The location (zone) for the suggested solution
Capacitor bank "C1"	8000$ = 28000NIS	The Western region
Capacitor bank "C2"	1140$ = 4000NIS	The center of the town

- The total cost for the solutions suggested by this thesis of Atoof town.

8000$ + 1140$ = 9140$ = 32000NIS .

5.2.7 In Aqqaba Town Network as a whole:

There is one problem in the town of Aqqaba (see Chapter 3 at section 3.1.10, Chapter 4 at section 4.1./10. and Chapter 5 at section 5.1), this problem has one suggested solution and this solution was chosen because its economically and practically appropriate to the problem. The Table (5.2.7) shows the cost of the suggested solution to solve the problem in the town of Aqqaba as a whole.

Table (5.2.7) : The cost of the suggested solutions in Aqqaba town network as a whole

The suggested solution	The cost for the suggested solution	The location (zone) for the suggested solution
Solar system PV125 , inv125	17000$ = 60000NIS	The Western region

5.2.8 In Al-Zababeda Town Network as a whole:

There is one problem in the town of Al-Zababeda see Chapter 3 at section 3.1.11, Chapter 4 at section 4.1./11. and Chapter 5 at section 5.1), this problem has one suggested solution and this solution was chosen because its economically and practically appropriate to the problem. The Table (5.2.8) shows the cost of the suggested solution to solve the problem in the town of Al-Zababeda as a whole.

Table (5.2.8) : The cost of the suggested solutions in Al-Zababeda town network as a whole

The suggested solution	The cost for the suggested solution	The location (zone) for the suggested solution
Solar system (PV75 , Inv75)	17000$ = 60000NIS	The Western region

5.2.9 In Al-Kfier Village Network as a whole:

There is one problem in the village of Al-Kfier (see Chapter 3 at section 3.1.12, Chapter 4 at section 4.1./12. and Chapter 5 at section 5.1), this problem has one suggested solution and this solution was chosen because its economically and practically appropriate to the problem. The Table (5.2.9) shows the cost of the suggested solution to solve the problem in the village of Al-Kfier as a whole.

Table (5.2.9) : The cost of the suggested solutions in Al-Kfier village network as a whole

The suggested solution	The cost for the suggested solution	The location (zone) for the suggested solution
Capacitor bank "C3"	280$ = 1000NIS	Al-Kfier village region

5.2.10 In Raba Town Network as a whole:

There is one problem in the town of Raba (see Chapter 3 at section 3.1.13, Chapter 4 at section 4.1./13. and Chapter 5 at section 5.1), this problem has one suggested solution and this solution was chosen because its economically and practically appropriate to the problem. The Table (5.2.10) shows the cost of the suggested solution to solve the problem in the town of Raba as a whole.

Table (5.2.10) : The cost of the suggested solutions in Raba town network as a whole

The suggested solution	The cost for the suggested solution	The location (zone) for the suggested solution
Capacitor bank C4	150$ = 500NIS	The Southern region (Raba town)

5.2.11 In Telfeet Village Network as a whole:

There is one problem in the village of Telfeet see Chapter 3 at section 3.1.14, Chapter 4 at section 4.1./14. and Chapter 5 at section 5.1), this problem has one suggested solution and this solution was chosen because its economically and practically appropriate to the problem. The Table (5.2.11) shows the cost of the suggested solution to solve the problem in the village of Telfeet as a whole.

Table (5.2.11) : The cost of the suggested solutions in Telfeet village network as a whole

The suggested solution	The cost for the suggested solution	The location (zone) for the suggested solution
Capacitor bank "C5"	570$ = 2000NIS	Telfeet village region

5.2.12 In Private Project Area Network as a whole:

There are two problems in the area of Private Project (see Chapter 3 at section 3.1.17, Chapter 4 at section 4.1./17. and Chapter 5 at section 5.1), these problems have one suggested solution for each problem and have been chosen as a suitable solution because it is both economical and practical for the problem. The Table (5.2.12) shows the cost of the suggested solution to solve the problem in the area of Private Project as a whole.

Table (5.2.12) : The cost of the suggested solutions in Private Project area network as a whole

The suggested solution for each problem	The cost for the suggested solution	The location (zone) for the suggested solution
Capacitor bank "C6"	280$ = 1000NIS	Private Project area
Capacitor bank C7	150$ = 500NIS	Private Project area

- The total cost for the solutions suggested by this thesis of the area of Private Project.

280$ + 150$ = 430$ = 1500NIS .

5.2.13 In Jalqamous Village Network as a whole:

There is one problem in the village of Jalqamous (see Chapter 3 at section 3.1.19, Chapter 4 at section 4.1./19. and Chapter 5 at section 5.1), this problem has one suggested solution and this solution was chosen because its economically and practically appropriate to the problem. The Table (5.2.13) shows the cost of the suggested solution to solve the problem in the village of Jalqamous as a whole.

Table (5.2.13) : The cost of the suggested solutions in Jalqamous village network as a whole

The suggested solution	The cost for the suggested solution	The location (zone) for the suggested solution
Transformer with transmission line (T255 & TL362)	76000$ = 266000NIS	Jalqamous village region

5.2.14 In Al-Mghayer Village Network as a whole:

There are three problems in the village of Al-Mghayer (see Chapter 3 at section 3.1.20, Chapter 4 at section 4.1./20. and Chapter 5 at section 5.1), these problems have one suggested solution for each problem and have been chosen as a suitable solution because it is both economical and practical for the problem. The Table (5.2.14) shows the cost of the suggested solution to solve the problem in the village of Al-Mghayer as a whole.

Table (5.2.14) : The cost of the suggested solutions in Al-Mghayer village network as a whole

The suggested solution for each problem	The cost for the suggested solution	The location (zone) for the suggested solution
Solar system PV63 , inv63	4250$ = 15000NIS	Al-Mghayer village region
Solar system PV65 , inv65	4250$ = 15000NIS	Al-Mghayer village region
Solar system PV66 , inv66	4250$ = 15000NIS	Al-Mghayer village region

- The total cost for the solutions suggested by this thesis of the village of Al-Mghayer.

4250$ + 4250$ + 4250$ = 12750$ = 45000NIS .

5.2.15 In Um Al-Toot Village Network as a whole:

There are two problems in the village of Um Al-Toot (see Chapter 3 at section 3.1.22, Chapter 4 at section 4.1./22. and Chapter 5 at section 5.1), these problems have one suggested solution for each problem and have been chosen as a suitable solution because it is both economical and practical for the problem. The Table (5.2.15) shows the cost of the suggested solution to solve the problem in the village of Um Al-Toot as a whole.

Table (5.2.15) : The cost of the suggested solutions in Um Al-Toot village network as a whole

The suggested solution for each problem	The cost for the suggested solution	The location (zone) for the suggested solution
Capacitor bank "C8"	150$ = 500NIS	Um Al-Toot village region
Transformer with transmission line "T256 & TL363"	76000$ = 266000NIS	Um Al-Toot village region

- The total cost for the solutions suggested by this thesis of the village of Um Al-Toot.

150$ + 76000$ = 76150$ = 266500NIS .

5.2.16 In Meselyeh Town Network as a whole:

There are two problems in the town of Meselyeh (see Chapter 3 at section 3.1.23, Chapter 4 at section 4.1./23. and Chapter 5 at section 5.1), these problems have one suggested solution for each problem and have been chosen as a suitable solution because it is both economical and practical for the problem. The Table (5.2.16) shows the cost of the suggested solution to solve the problem in the town of Meselyeh as a whole.

Table (5.2.16) : The cost of the suggested solutions in Meselyeh Town Network as a whole

The suggested solution for each problem	The cost for the suggested solution	The location (zone) for the suggested solution
Capacitor bank "C9"	150$ = 500NIS	The Eastern region
Capacitor bank "C10"	700$ = 2500NIS	The Eastern region

- The total cost for the solutions suggested by this thesis of Meselyeh town.

150$ + 700$ = 850$ = 3000NIS .

5.2.17 In Al-Jarba Village Network as a whole:

There are two problems in the village of Al-Jarba (see Chapter 3 at section 3.1.24, Chapter 4 at section 4.1./24. and Chapter 5 at section 5.1), these problems have one suggested solution for each problem and have been chosen as a suitable solution because it is both economical and practical for the problem. The Table (5.2.17) shows the cost of the suggested solution to solve the problem in the village of Al-Jarba as a whole.

Table (5.2.17) : The cost of the suggested solutions in Al-Jarba village network as a whole

The suggested solution for each problem	The cost for the suggested solution	The location (zone) for the suggested solution
Capacitor bank "C11"	'1400$ = 5000NIS	Al-Jarba village region
Capacitor bank "C12"	150$ = 500NIS	Al-Jarba village region

- The total cost for the solutions suggested by this thesis of the village of Al-Jarba.

1400$ + 150$ = 1550$ = 5500NIS .

5.2.18 In Al-Zawyah Village Network as a whole:

There is one problem in the village of Al-Zawyah (see Chapter 3 at section 3.1.26, Chapter 4 at section 4.1./26. and Chapter 5 at section 5.1), this problem has one suggested solution and this solution was chosen because its economically and practically appropriate to the problem. The

Table (5.2.18) shows the cost of the suggested solution to solve the problem in the village of Al-Zawyah as a whole.

Table (5.2.18) : The cost of the suggested solutions in Al-Zawyah village network as a whole

The suggested solution	The cost for the suggested solution	The location (zone) for the suggested solution
Capacitor bank "C13"	850$ = 3000NIS	Al-Zawyah village region

5.2.19 In Wadi Douq Village Network as a whole:

There is one problem in the village of Wadi Douq (see Chapter 3 at section 3.1.28, Chapter 4 at section 4.1./28. and Chapter 5 at section 5.1), this problem has one suggested solution and this solution was chosen because its economically and practically appropriate to the problem. The Table (5.2.19) shows the cost of the suggested solution to solve the problem in the village of Jalqamous as a whole.

Table (5.2.19) : The cost of the suggested solutions in Wadi Douq village network as a whole

The suggested solution	The cost for the suggested solution	The location (zone) for the suggested solution
Capacitor bank "C14"	500$ = 1750NIS	Wadi Douq village region

5.3 The Total Cost of Tubas Network as a whole:

As we explained previously, after analyzing Tubas network and identifying the problems in it, a set of solutions of these problems were proposed and appropriate practical solutions were chosen for these problems, and in this section we will summarize the cost of the all these solutions in addition to the cost of a set of solutions previously proposed by Tubas electricity company. The table (5.3.1) shows the total cost of the solutions suggested by this thesis and the total cost of the solutions proposed by Tubas electricity company.

Table (5.3.1) : The total cost of the solutions suggested of Tubas network as a whole

The number	The name of each region	The total cost of the solutions suggested by this thesis	The total cost of the solutions proposed by Tubas electricity company
1	TUBAS city	159000$ = 560000NIS	11572600$ = 41500000NIS
2	KESHDA village	18000$ = 65000NIS	--
3	TYASEER village	4250$ = 15000NIS	1747500$ = 6500000NIS
4	AL-FARA'A area	660000$ = 2320000NIS	--
5	TAMMON town	4250$ = 15000NIS	--
6	ATOOF town	9140$ = 32000NIS	--
7	AQQABA town	17000$ = 60000NIS	--
8	AL-ZABABEDA town	17000$ = 60000NIS	--
9	AL-KFIER village	280$ = 1000NIS	--
10	RABA town	150$ = 500NIS	--
11	TELFEET village	570$ = 2000NIS	--
12	PRIVATE PROJECT area	430$ = 1500NIS	--
13	JALQAMOUS village	76000$ = 266000NIS	--
14	AL-MGHAYER village	12750$ = 45000NIS	--
15	UM AL-TOOT village	76150$ = 266500NIS	--
16	MESELYEH town	850$ = 3000NIS	--
17	AL-JARBA village	1550$ = 5500NIS	--
18	AL-ZAWYAH village	850$ = 3000NIS	--
19	WADI DOUQ village	500$ = 1750NIS	--
The total		1058720$ = 3722750NIS	13320100$ = 48000000NIS
The total cost of the Tubas Network solutions			14378820$ = 51722750NIS

* Note : The solutions proposed in this thesis are additional solutions to the solutions proposed by Tubas electricity company itself.

Chapter 6
Conclusions & Recommendations

6.1 The Conclusions:

In this section, we will explain a set of conclusions that we obtained after completing the analysis of Tubas electricity network, and identify the problems and appropriates solutions for Tubas network.

1. We have practically concluded that adding a solar system with large electrical capacity to the electrical network negatively effects the network, especially on the power factor (PF), as the large solar system increases the value of the reactive power (Q) required from the network itself and when increasing the value of the reactive power (Q) the value of the power factor (PF) decreases, unless we reduce this effect while designing the solar system and choosing the appropriate location for it in relation to the network.

2. The system used by Tubas Electricity Company to connect the solar systems to the electrical network is (on-grid system), where the status of the solar system is related to the status of the network as a whole, meaning that if the electrical network is stopped for any reason or malfunction, the solar system is separated from the grid electrical and from the loads.

3. Through analyzing Tubas Electricity Network, there are several problems in the network as a result of the low power factor, and the best solution to these problems as we suggested is to add capacitors bank next to

the transformers that suffer from low power factor. These capacitors help to raise the lower power factor.

4. During the analysis of Tubas Electricity Network, there are several problems in the network as a result of the of the long distance between the loads and the transformers that feed them with electrical energy, and to solve this problem it was necessary to add new transformers near the loads to provide them with the necessary electrical energy in a good and stable manner, and it is important to mention that the areas that they have been selected to put new transformers, which are urban development areas, so adding these transformers to these areas helped to solve the current problems and also helped to provide future electrical energy for these urban areas.

5. If a new generator is added to the network with a capacity of 10MW, for example, it becomes clear that there is no single generator with this capacity in the west bank , but several generators with capacities (1.5MW & 1.25MW) are placed together to obtain the required power.

6. During the analysis of Tubas network that there are several rings between the different regions in the network, and after developing a set of proposed solutions, three new rings were proposed for the network, but after the economic study, only one of them was chosen, which is Ring number 2 that connects the Western region of the city of Tubas and the first of the town of the region of Wadi Al-Fara'a, at cost of 150000$, approximately 530000NIS.

7. During the analysis of Tubas Electricity Network, there are four connection points between Tubas Electricity Company and the North electricity company, two of them which are old (Sier connection point, Al-Nasaryeh connection point) and two of them are new, which are (Al-Bathan connection point, Yaseed connection point). It has been shown with us that these points transmit electrical energy in one direction, to tubas electricity network only. So these connection points are the loads located on Tubas Electricity Network.

8. During the analysis of Tubas network, there are 6170KW of solar systems in the network and distributed to its different regions in 90 different solar stations, and there is also an amount of 15406KW of solar systems distributed over 6 different solar stations proposed by the Tubas network, and after analyzing the problems present in it and the development of proposed solutions to solve the problems of the network. Several solar stations have been proposed as solutions to the problems of the network, with electrical capacity totaling 1005KW distributed over 26 different solar stations.

9. The total cost of all the solutions proposed in this thesis to solve the problems of Tubas network is equal 1058720$, approximately 3722750NIS. Of which 590750$ is the cost of the proposed solar systems, of which 14470$ is the cost of the proposed capacitors bank, of which 285500$ is the cost of the new transformers with all its components and accessories, of which 18000$ is the cost of the new transmission line connecting the areas of the village of Keshda, and the rest 150000$ is the

cost of the new transmission line (Ring 2) that connects between the Western region of the city of Tubas and the first of the town in the region of Wadi Al-Fara'a.

10. There are two connection points between Tubas Electricity Company and the Qatari – Israeli company (IEC), which are (Tyaseer connection point, Al-Jalameh connection point), and at each connection point there is a station (Switchgear) on the Palestinian side, which contains (circuit breaker "C.B", Recloser "R", meters) are controlled by an electric current by the Tubas Electricity Company.

11. The Tubas Electricity Network contains medium voltage transmission lines with a length of more than 171 KM, including 159KM for the overhead transmission lines, and 12KM for transmission lines underground (cables).

12. After analyzing the Tubas electricity network, it become clear to us that there is one autotransformer in the network.

6.2 The Recommendations & Perspectives:

After analyzing each area of Tubas electricity network (30 area) separately, analyzing the problem of each region developing the proposed solutions for each problem, and choosing the most appropriate solution for each problem in practice. We recommend for each area the best solution to suit it's problem. So we recommend a set of solutions as follows:

- Tubas city : New transformer and new medium voltage transmission line in the Northern region of the city next to the transformer (T8//AL-

THOGHRAH), new solar systems in the regions (the Southern region 2 next to the transformer (T23//KAZIYA AL-MOTHEDOON), the center of the town 2 next to the transformers (T28//TUBAS MUNICPLITY, T29//RAWDA, T30//AMN WATANY CENTER1 and T31//AMN WATANY CENTER2) and the center of the Western region next to the transformer (T137//CUSTAMS POLICE – Tubas)) of the city.

- Keshda village : New medium voltage transmission line between the regions (the center of the village and the Southern region of the village).

- Tyaseer village : New solar system next to the transformer (T3//SCHOOL – Tyaseer) in the village.

- Ras Al-Fara’a region : New solar systems in the Eastern regions (the Eastern region next to the transformers (T87//AL-SHAREEF and T96//MALLHAMEH) and the center of the Eastern region next to the transformers (T59//AL-KHARRAZ and T60//MOWAFAK ALFAKHRY – SHARAKEH WEEL).

- Wadi Al-Fara’a region : New medium voltage transmission line (Ring) between the regions (the center of the Western region of Tubas city at Bus365 and the first of the town of Wadi Al-Fara'a town at Bus231).

- Al-Fara’a Camp region : New solar systems in the regions (the first of the town next to the transformer (T86//SCHOOL – Al-Fara'a Camp) and the center of the town next to the transformer (T88//AIN)) of Al-Fara'a Camp area.

- Tammon town : New solar system in the Western region of the town next to the transformer (T114//AL-RFAID2 – WATANIA MOBILE).

- Atoof town : Capacitors bank in the regions (the Western region next to the transformer (T116//MOWAFAQ FAKHRY) and the center of the town next to the transformer (T125//BAQEEA)) of Atoof town.

- Aqqaba town : New solar system in the Western region of the town next to the transformer (T154//HAWOOZ AQQABA).

- Al-Zababeda town : New solar system in the Western region of the town next to the transformer (T217//ABU JONY).

- Al-Kfier village : Capacitor bank next to the transformer (T157//AL-MAHAJER1) in the village.

- Raba town : Capacitor bank in the Southern region of the town next to the transformer (T163//RABA CUTER STONE).

- Telfeet village : Capacitor bank in the Northeastern region in the village next to the transformer (T198//KAABEIEH).

- Private Project area : Capacitors bank next to the transformers (T180//ZAKARNEH2 and T181//ZAKARNEH1) in the area.

- Jalqamous village : New transformer and new medium voltage transmission line in the village next to the transformer (T200//WESTERN).

- Al-Mghayer village : New solar systems next to the transformers (T203//MARAH KARRAS , T205//EASTERN and T206//POSTER) in the village.

- Um Al-Toot village : Capacitor bank next to the transformer (T210//SCHOOL) and new transformer with new medium voltage transmission line next to the transformer (T210//SCHOOL) in the village.

- Meselyeh town : Capacitors bank in the Eastern region next to the transformers (T218//MANASHEER EAST and T219//MANASHEER - Meselyeh).

- Al-Jarba village : Capacitors bank next to the transformers(T227//MAIN – JARBA and T229//ALI CUTTER STONE – Jarba) in the village.

- Al-Zawyah village : Capacitor bank next to the transformer (T234//EIN – Al-Zawyah) in the village.

- Wadi Douq village : Capacitor bank next to the transformer (T239//WADI DOUQ) in the village.

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Appendix A : The analysis.

A.1. Tubas network in terms of transformers, PV systems, transmission lines, cables, circuit breakers and Reclosers:

The table (A.1.1) shows the transformers and solar systems in Tubas Electricity Network, as there are 253 transformers and 95 solar systems spread in 30 areas of Tubas electricity network.

Table (A.1.1) : The transformers & PV systems in TUBAS network

The Number of the transformers in ETAB program	The Name of the transformers in TUBAS company	The capacity of the transformers (KVA)	The location of the transformers	The Number of the PV systems in ETAB program at each transformer	The KWp for the PV system
T 1	AQABEH MAIN	160	AQABEH		
T 2	TYASEER MAIN	400	TYASEER	PV 1 (Existing)	10
T 3	SCHOOL (TYASEER)	160	TYASEER		
T 4	TYASEER FILTERING STATION 1	630	TYASEER	PV 109 (Existing)	100
T 5	TYASEER FILTERING STATION 2	630	TYASEER		
T 6	MEDICAL HERBS	160	TUBAS		
T 7	**AUTO TRANSFORMER**	**25000**	TUBAS		
T 8	AL-THOGHRAH	250	TUBAS	PV 4 (Existing)	30
T 9	TOOP FACTOTY	400	TUBAS	PV 90 (Existing)	5
T 10	QETAF COMPANY	160	TUBAS		
T 11	HEALTH	250	TUBAS		

T 12	ALLAN	250	TUBAS	PV 5 (Existing)	25
T 13	AL-DAIR	250	TUBAS	PV 6 (Existing)	25
T 14	TRANSFORMERS FACTOTY	400	TUBAS		
T 15	HASSAN MKHEBER	630	TUBAS		
T 16	CZ PV STATION 1	160	TUBAS	PV 7 & PV 8 (Existing)	120 10
T 17	CZ PV STATION 2	400	TUBAS	PV 9 (Existing)	350
T 18	PALESTINE INVESTMENT FUND PV STATION	400	TUBAS	PV 10 (Proposed)	2000
T 19	SAMEEH	250	TUBAS	PV 11 (Existing)	15
T 20	AL-MASA'EED	400	TUBAS	PV 12 (Existing)	5
T 21	AL-ANABOSI	250	TUBAS		
T 22	ABO OMAR	400	TUBAS		
T 23	KAZIYA AL-MOTHEDOON	250	TUBAS		
T 24	ABO SHIHAB	630	TUBAS	PV 14 (Existing)	5
T 25	KARAG	400	TUBAS	PV 15 (Existing)	122
T 26	TUBAS CLUB	630	TUBAS	PV 16 (Existing)	22
T 27	MASRIYA	250	TUBAS	PV 17 (Existing)	24
T 28	TUBAS MUNICIPALITY WELL	630	TUBAS		
T 29	RAWDA	250	TUBAS		
T 30	AMN WATANY CENTER 1	1000	TUBAS		
T 31	AMN WATANY CENTER 2	1000	TUBAS		
T 32	NABEEHA	400	TUBAS	PV 22 (Existing)	5

T 33	TUBAS WELL	630	TUBAS		
T 34	MOHAFADA	250	TUBAS	PV 23 (Existing)	10
T 35	PICKE FACTORY	400	KESHDA		
T 36	KESHDA MAIN	50	KESHDA	PV 110 (Existing)	10
T 37	AL-HAWOOZ (AL-FARA'A CAMP)	400	AL-FARA'A CAMP	PV 24 (Existing)	5
T 38	AL-MASLAMANI 1	400	AL-FARA'A CAMP	PV 25 (Existing)	250
T 39	AL-MASLAMANI 2	630	AL-FARA'A CAMP	PV 26 (Existing)	550
T 40	AL-MASLAMANI 3	630	AL-FARA'A CAMP	PV 27 (Existing)	550
T 41	AL-MASLAMANI 4	630	AL-FARA'A CAMP	PV 28 (Existing)	550
T 42	AL-MASLAMANI 5	630	AL-FARA'A CAMP	PV 29 (Existing)	550
T 43	AL-MASLAMANI 6	630	AL-FARA'A CAMP	PV 30 (Existing)	550
T 44	DEWAN	160	RAS AL-FARA'A		
T 45	GAZAH	400	RAS AL-FARA'A		
T 46	MOA'YAD AL-FAKHRI	630	KESHDA		
T 47	KHALET AL-QASER 2	630	RAS AL-FARA'A		
T 48	KHALET AL-QASER 1	400	RAS AL-FARA'A		
T 49	FASYEL WWLL	630	RAS AL-FARA'A		

T 50	ASHRAF KHADER	100	RAS AL-FARA'A		
T 51	HUSSEN AL-AARAJ	250	RAS AL-FARA'A		
T 52	MOHAMMAD AL-BASHEER	630	RAS AL-FARA'A		
T 53	AGRICULTURAL PROJECT	630	RAS AL-FARA'A		
T 54	KAZEYEH SAMARA	400	RAS AL-FARA'A	PV 99 (Existing)	5
T 55	AL-ASHQAR STON CUTTER	400	RAS AL-FARA'A		
T 56	THYAB	400	RAS AL-FARA'A		
T 57	AL-HAJ HAKEEM	630	RAS AL-FARA'A	PV 100 (Existing)	15
T 58	ABO HAMED	630	RAS AL-FARA'A		
T 59	AL-KHARRAZ	250	RAS AL-FARA'A		
T 60	MOWAFAK AL-FAKHRY SHARAKEH WELL	630	RAS AL-FARA'A		
T 61	RAFAT	250	WADI AL-FARA'A	PV 80 (Existing)	5
T 62	SAFENEH	400	WADI AL-FARA'A	PV 81 (Existing)	20
T 63	HESBEH	250	WADI AL-FARA'A		

T 64	KAZEYA	400	WADI AL-FARA'A	PV 32 (Existing)	10
T 65	SCHOOL (WADI AL-FARA'A)	250	WADI AL-FARA'A	PV 33 (Existing)	35
T 66	ABU SHEHADEH	250	WADI AL-FARA'A	PV 34 (Existing)	5
T 67	AL-BASATEEN	630	WADI AL-FARA'A	PV 35 (Existing)	25
T 68	ABO KHADER	400	WADI AL-FARA'A	PV 105 (Existing)	5
T 69	ABO SHHAB	250	WADI AL-FARA'A		
T 70	ABO TAREQ	250	WADI AL-FARA'A		
T 71	SAMEER MOTLAQ	400	WADI AL-FARA'A		
T 72	3ESAWI	400	WADI AL-FARA'A		
T 73	FARAH	400	WADI AL-FARA'A		
T 74	SAMER MOTLAQ	250	WADI AL-FARA'A		
T 75	HUSSAN HMOUD	250	WADI AL-FARA'A		
T 76	MAMDOH	400	WADI AL-FARA'A		
T 77	CHEBS FACTORY	250	WADI AL-FARA'A		
T 78	ALHAFRIA	250	WADI	PV 79 (Existing)	25

			AL-FARA'A		
T 79	YASEED EAST	160	WADI AL-FARA'A	PV 36 (Existing)	5
T 80	YASEED WEST (ABO ASA'D)	250	WADI AL-FARA'A		
T 81	KASARET ABO ASA'D	630	WADI AL-FARA'A		
T 82	MASHAQI WELL	250	WADI AL-FARA'A		
T 83	KASARET AL-SHAM	630	WADI AL-FARA'A		
T 84	WESTREN (AL-FARA'A CAMP)	400	AL-FARA'A CAMP	PV 37 (Existing)	5
T 85	TUBAS WELL	100	RAS AL-FARA'A	PV 101 (Existing)	5
T 86	SCHOOL (AL-FARA'A CAMP)	630	AL-FARA'A CAMP		
T 87	AL-SHAREEF	400	RAS AL-FARA'A	PV 102 (Existing)	15
T 88	AIN (AL-FARA'A CAMP)	630	AL-FARA'A CAMP		
T 89	WATER WELL PV	160	AL-FARA'A CAMP	PV 84 (Existing)	160
T 90	WELL	400	AL-FARA'A CAMP		
T 91	STADIUM	250	AL-FARA'A CAMP		
T 92	OLD STATION	630	AL-FARA'A CAMP	PV 85 (Existing)	25
T 93	SALAH KHALAF	250	AL-FARA'A CAMP		

T 94	UN CLIMC	400	AL-FARA'A CAMP	PV 104 (Existing)	15
T 95	UN SCHOOL (AL-FARA'A CAMP)	630	AL-FARA'A CAMP		
T 96	MALHAMEH	630	RAS AL-FARA'A	PV 103 (Existing)	20
T 97	TUBAS PARK	100	TUBAS		
T 98	KHALET AL-LOOZ	160	TUBAS		
T 99	AL-ASHAREEN	250	TAMMON		
T 100	MO2YAD FRIDGES	400	TUBAS		
T 101	JAFA CONSUMPTION TR	160	TUBAS	PV 115 (Existing)	350
T 102	WELL 1 (TAMMON)	630	TAMMON	PV 91 (Existing)	10
T 103	WELL 2 (TAMMON)	1000	TAMMON		
T 104	FIRST OF THE TOWN (TAMMON)	400	TAMMON	PV 92 (Existing)	20
T 105	POLIC (TAMMON)	250	TAMMON	PV 93 (Existing)	5
T 106	BORHAN	250	TAMMON	PV 94 (Existing)	25
T 107	AL- BATMAH	160	TAMMON	PV 95 (Existing)	25
T 108	NATIONAL SECURITY (TAMMON)	160	TAMMON		
T 109	AL-RFAID	630	TAMMON	PV 96 (Existing)	47
T 110	AL-BATTAH	250	TAMMON	PV 39 (Existing)	23
T 111	AL-MISHMAS	400	TAMMON	PV 111 (Existing)	25
T 112	AL-MISHMAS WEST	400	TAMMON	PV 40 (Existing)	15
T 113	AL-RAS	250	TAMMON	PV 112 (Existing)	13
T 114	AL-RFAID 2 ,WATANIA MOBILE	250	TAMMON		

T 115	RAS AL-MATTALEH	100	TAMMON		
T 116	MOWAFAQ FAKHRY	400	ATOOF		
T 117	HAKIM	630	ATOOF		
T 118	TAMMON AGRI WELL	630	ATOOF		
T 119	AL-WEDON	160	TAMMON	PV 97 (Existing)	15
T 120	TAWHEED	250	ATOOF		
T 121	YOUNES	250	ATOOF		
T 122	BEQEEAA 1	250	ATOOF		
T 123	TAMMON AGRI COMPANY	400	ATOOF		
T 124	MOWAFAQ & ASHQAR	400	ATOOF		
T 125	BAQEEA	400	ATOOF		
T 126	AL-JALHOOM	160	ATOOF		
T 127	ABHAA	250	ATOOF		
T 128	ABU DERGHAM	400	ATOOF		
T 129	ATOOF MAIN	100	ATOOF	PV 98 (Existing)	12
T 130	SALEH NAJI	250	ATOOF		
T 131	BEQEEAA 2	400	ATOOF		
T 132	PEARL & BASIL	250	ATOOF		
T 133	CORN VALLEY (ATOOF)	250	ATOOF		
T 134	AL-HELAL	400	TUBAS	PV 42 (Existing)	15
T 135	AL-HAWOOZ 1 (TUBAS)	630	TUBAS	PV 43 (Existing)	141
T 136	AL-HAWOOZ 2 (TUBAS)	250	TUBAS	PV 113 (Existing)	

T 137	CUSTAMS POLICE (TUBAS)	400	TUBAS		
T 138	AL-DAQANYA	250	TUBAS	PV 46 (Existing)	15
T 139	GOLDEN GOAT	100	TUBAS	PV 114 (Existing)	10
T 140	STONE CUTTER (TUBAS)	630	TUBAS		
T 141	POLICE TR (TUBAS)	250	TUBAS		
T 142	SAFEH NORTH	160	TUBAS	PV 47 (Existing)	30
T 143	AL-AQABEH	400	TUBAS	PV 48 (Existing)	10
T 144	GAS STATION (AQQABA)	400	AQQABA	PV 49 (Existing)	8
T 145	HYDROLGY PV PLANT	400	TUBAS	PV 50 (Existing)	250
T 146	EASTREN AQQABA	400	AQQABA		
T 147	AQQABA WATER TREAMENT	250	AQQABA		
T 148	DAWAJEN AQQABA	100	AQQABA		
T 149	SALHAB	250	TUBAS		
T 150	WESTREN AQQABA	630	AQQABA	PV 51 (Existing)	20
T 151	ZEREENI	400	AQQABA	PV 106 (Existing)	15
T 152	TUBAS HOPITAL 1	630	TUBAS		
T 153	TUBAS HOSPITAL 2	630	TUBAS		
T 154	HAWOOZ AQQABA	250	AQQABA	PV 107 (Existing)	97
T 155	AL-KFIER MAIN	100	KFIER	PV 52 (Existing)	10
T 156	AL-MAHAJER EAST (AL-KFIER)	250	KFIER		
T 157	AL-MAHAJER 1 (AL-KFIER)	400	KFIER		

T 158	EASTREN (AL-ZABABEDA)	630	AL-ZABABEDA		
T 159	MUNICIPALTY (AL-ZABABEDA)	400	AL-ZABABEDA		
T 160	AUUJ INTERSECTION	400	AL-ZABABEDA	PV 53 (Existing)	10
T 161	MANASHEER ZA (AL-ZABABEDA)	250	AL-ZABABEDA	PV 54 (Existing)	5
T 162	ZAGHLOUL	160	AL-ZABABEDA	PV 55 (Existing)	15
T 163	RABA CUTTER STON	630	RABA		
T 164	DAWAJEN RABA	250	RABA		
T 165	RAHWA	100	RABA		
T 166	RAWHA 2	250	RABA		
T 167	EAST OF RABA	400	RABA	PV 57 (Existing)	6
T 168	MIDDEL OF RABA	400	RABA		
T 169	MARAH KHOUBEH	160	RABA		
T 170	MAIN (TLFEET)	160	TLFEET		
T 171	ADMINISTRATIVE SCIENCE	630	AUUJ		
T 172	GOLDEN STAR	630	TLFEET		
T 173	HASHASH	630	TLFEET		
T 174	DENTINSITRY	630	AUUJ		
T 175	REGISTRATION BUILDING	630	AUUJ		
T 176	DALBAH	630	TLFEET		
T 177	TINEEN MAIN	160	TINEEN		

T 178	AL-DAHYA	250	DREAM LAND		
T 179	QETAA CUTTER STON (PRIVATE PROJECT)	630	PRIVAT PROJECT		
T 180	ZAKARNEH 2	630	PRIVAT PROJECT		
T 181	ZAKARNEH 1	630	PRIVAT PROJECT		
T 182	MASSI CUTTER STONES (PRIVATE PROJECT)	630	PRIVAT PROJECT		
T 183	MASSI ASFALT STONES (PRIVATE PROJECT)	630	PRIVAT PROJECT		
T 184	PRINCESS PLACE	250	DREAM LAND		
T 185	ROYAL IN	630	DREAM LAND		
T 186	OFFICE (DREAM LAND)	1000	DREAM LAND		
T 187	CODITIONING	250	AUUJ		
T 188	LAW	1000	AUUJ	PV 108 (Existing)	48
T 189	GYM	1000	AUUJ		
T 190	ELECTRICAL COLUMNS	1000	AUUJ		
T 191	SODOR	160	TLFEET		
T 192	AAFAQ	630	DREAM LAND		
T 193	AL-BARA'A	400	DREAM LAND		
T 194	MEDICINE	630	AUUJ	PV 58 (Existing)	48

T 195	ENGINEERING COLLEGE	630	AUUJ	PV 59 (Existing)	70
T 196	DREAM 1	400	DREAM LAND		
T 197	DREAM 2	400	DREAM LAND		
T 198	KAABEIEH	100	TLFEET		
T 199	KHERBAT AESHEH	100	TLFEET		
T 200	WESTREN (JALQUMOUS)	160	JALQUMOUS	PV 60 (Existing)	40
T 201	POLICE (JALQUMOUS)	250	JALQUMOUS	PV 61 (Existing)	5
T 202	EASTREN (JALQUMOUS)	250	JALQUMOUS	PV 62 (Existing)	5
T 203	MARAH KARRAS	160	AL-MGHAYER		
T 204	WESTREEN (AL-MGHAYER)	250	AL-MGHAYER	PV 64 (Existing)	8
T 205	EASTREN (AL-MGHAYER)	250	AL-MGHAYER		
T 206	POSTER (AL-MGHAYER)	160	AL-MGHAYER		
T 207	AL-MTELLEH	160	AL-MTELLEH		
T 208	MIDDLE (JALQUMOUS)	400	JALQUMOUS	PV 67 (Existing)	40
T 209	MANSHEER UM AL-TOOT EAST	250	UM AL-TOOT	PV 68 (Existing)	70
T 210	SCHOOL (UM AL-TOOT)	160	UM AL-TOOT		
T 211	MAIN (UM AL-TOOT)	400	UM AL-TOOT	PV 70 (Existing)	18

T 212	SCHOOL (AL-ZABABEDA)	630	AL-ZABABEDA	PV 71 (Existing)	35
T 213	MIDDEL (AL-ZABABEDA)	400	AL-ZABABEDA	PV 72 (Existing)	15
T 214	WEASTREN (AL-ZABABEDA)	400	AL-ZABABEDA		
T 215	SEFFERYA	400	AL-ZABABEDA	PV 73 (Existing)	40
T 216	AGRICULTURE COLLOGE	400	AL-ZABABEDA	PV 74 (Existing)	51
T 217	ABU JONY	250	AL-ZABABEDA		
T 218	MANASHEER EAST (MESELYA)	630	MESELYA		
T 219	MANASHEER (MESELYA)	630	MESELYEH		
T 220	MESELYA WATER FILTERING EAST STATION	630	MESELYEH	PV 78 (Existing)	50
T 221	EASTREN (MESELYA)	400	MESELYEH	PV 76 (Existing)	18
T 222	FAQASET ALUADD	160	MESELYEH		
T 223	WEASTREN (MESELYA)	400	MESELYEH	PV 77 (Existing)	25
T 224	MESELYA WATER FILTRING WEST STATION	100	MESELYEH		
T 225	WITH IN THE TOWN (MESELYA)	250	MESELYEH		
T 226	WELLS (MESELYA)	630	MESELYEH		
T 227	MAIN (JARBA)	400	AL-JARBA		

T 228	EAST (JARBA)	250	AL-JARBA		
T 229	ALI CUTTER STONE (JARBA)	250	AL-JARBA		
T 230	AL-FAKHER PLASTIC FACTORY	400	AL-JARBA		
T 231	WADI AL3EFSHE	50	MERKEH		
T 232	ABU ABEAA	250	MERKEH		
T 233	FAQASET AL-KARMD	160	AL-ZAWYAH		
T 234	EIN (AL-ZAWYAH)	100	AL-ZAWYAH		
T 235	MIDDLE (AL-ZAWYAH)	250	AL-ZAWYAH		
T 236	ANZA 2	250	ANZA		
T 237	ANZA MAIN	250	ANZA		
T 238	ABU OMAR (MERKEH)	50	MERKEH		
T 239	WADI DUOQ	100	WADI DOUQ		
T 240	WADI DUOQ 2	630	WADI DOUQ		
T 241	SCHOOL (MERKEH)	400	MERKEH		
T 242	WATER PUMP (MERKEH)	100	MERKEH		
T 243	MASRARA	100	MERKEH		
T 244	HAFEERI	100	HAFEERI		
T 245	MIDDLE (BEER AL-BASHA)	400	BEER AL-BASHA		
T 246	EASTREN (BEER AL-BASHA)	250	BEER AL-BASHA		
T 247	SAUDI FACTORY FOR AL	250	BEER AL-BASHA		

T 248	AMN WEQA2E (TUBAS)	250	TUBAS		
T 249	JAFA PV PLANT	2180	TUBAS	PV 38 (under Construction)	2702
T 250	JAFA PV PLANT	2180	TUBAS	PV 87 (under Construction)	2072
T 251	PALESTINE INVESTMENT FUND PV STATION	1000	TUBAS	PV 88 (Proposed)	3000
T 252	PALESTINE INVESTMENT FUND PV STATION	1000	TUBAS	PV 89 (Proposed)	3000
T 253	AVD PV PLANT	2000	TYASEER	PV 3 (Proposed)	2000

The table (A.1.2) shows the transmission lines in Tubas Electricity Network and the lengths of these lines as well as the sizes of the lines (the intersection area), as these lines are overhead transmission lines, of the sizes used in these lines (50mm^2, 70mm^2, 95mm^2, 110mm^2 and 150mm^2).

Table (A.1.2) : The transmission lines in Tubas network

The Number of the transmission lines in ETAB program	The Number of bus's at the beginning and ending of each transmission line in ETAB program		The Length of each transmission line (meters)	The size (the intersection area) of each transmission line (mm^2)
	From Bus	To Bus		
TL 1	609	144	881	50
TL 2	1	2	668	150
TL 3	2	600	908	150
TL 4	2	573	251	150
TL 5	573	147	518	150

TL 6	147	149	886	150
TL 7	149	610	116	150
TL 8	611	151	200	150
TL 9	152	153	551	150
TL 10	153	155	660	150
TL 11	155	578	187	150
TL 12	578	4	91	150
TL 13	4	612	27	70
TL 14	613	161	133	70
TL 15	580	163	557	50
TL 16	163	5	248	50
TL 17	5	165	1384	50
TL 18	5	167	905	50
TL 19	165	6	200	50
TL 20	6	576	200	50
TL 21	4	169	227	150
TL 22	169	7	110	150
TL 23	7	8	44	110
TL 24	8	171	224	50
TL 25	8	173	75	110
TL 26	173	175	189	110
TL 27	175	614	62	110
TL 28	615	9	360	110
TL 29	9	177	145	70
TL 30	9	179	164	110
TL 31	179	10	325	110

TL 32	7	181	348	110
TL 33	181	11	146	110
TL 34	11	12	200	110
TL 35	12	183	60	50
TL 36	616	13	215	50
TL 37	13	185	447	50
TL 38	185	187	1542	50
TL 40	13	14	174	50
TL 41	14	189	340	50
TL 42	189	15	1416	50
TL 43	617	195	449	50
TL 44	10	197	113	150
TL45	10	618	170	150
TL 46	619	674	250	150
TL 47	674	17	68	110
TL 48	17	199	864	50
TL 49	17	581	273	110
TL 50	602	620	357	70
TL 51	621	18	738	70
TL 52	18	201	349	70
TL 53	18	19	425	70
TL 54	19	203	395	70
TL 55	19	20	644	70
TL 56	20	205	305	70
TL 57	205	21	297	70
TL 58	20	207	375	70

TL 59	2017	23	344	70
TL 60	23	24	158	70
TL 61	24	25	322	70
TL 62	622	26	891	50
TL 63	25	209	135	50
TL 64	26	27	315	50
TL 65	27	588	890	50
TL 66	26	28	232	70
TL 67	28	29	100	50
TL 68	29	211	800	50
TL 69	211	213	602	50
TL 70	213	215	598	50
TL 71	28	217	110	50
TL 72	24	219	125	50
TL 73	219	30	676	50
TL 74	30	221	1220	50
TL 75	30	223	183	50
TL 76	23	31	260	70
TL 77	31	32	321	70
TL 78	32	225	98	70
TL 79	225	227	266	70
TL 80	32	229	75	70
TL 81	31	33	390	70
TL 82	33	231	430	70
TL 83	33	34	100	70
TL 84	34	623	375	70

TL 85	624	35	155	70
TL 86	35	233	234	70
TL 87	233	235	670	70
TL 88	35	36	680	70
TL 89	36	37	84	70
TL 90	37	237	167	70
TL 91	237	239	509	70
TL 92	239	241	438	50
TL 93	241	243	667	50
TL 94	243	671	800	150
TL 95	37	38	150	70
TL 96	38	245	745	70
TL 97	245	247	829	70
TL 98	247	625	130	70
TL 99	626	39	97	70
TL 100	39	249	620	70
TL 101	39	40	820	70
TL 102	40	627	56	70
TL 103	628	41	1081	70
TL 104	41	42	250	70
TL 105	42	251	238	70
TL 106	42	253	503	70
TL 107	41	603	230	70
TL 108	604	43	330	70
TL 109	43	257	290	70
TL 110	43	259	411	70

TL 111	41	261	94	70
TL 112	36	44	453	50
TL 113	44	263	621	50
TL 114	36	45	1325	50
TL 115	45	265	109	50
TL 116	45	46	824	50
TL 117	46	267	238	50
TL 118	46	47	912	50
TL 119	47	269	369	50
TL 120	269	271	411	50
TL 121	34	48	258	50
TL 122	48	273	88	50
TL 123	48	49	242	50
TL 124	49	275	120	50
TL 125	49	277	80	50
TL 126	48	279	243	50
TL 127	279	50	347	50
TL 128	50	281	180	50
TL 129	50	51	152	50
TL 130	51	283	195	50
TL 131	51	52	50	50
TL 132	52	285	60	50
TL 133	285	53	147	95
TL 134	52	287	35	50
TL 135	287	54	80	50
TL 136	54	289	100	50

TL 137	54	629	59	70
TL 138	674	56	244	95
TL 139	56	57	1202	95
TL 140	57	295	315	50
TL 141	295	58	200	50
TL 142	58	297	389	50
TL 143	58	53	1200	95
TL 144	57	631	406	95
TL 145	632	299	313	95
TL 146	56	301	205	95
TL 147	301	633	25	70
TL 148	634	303	567	70
TL 149	303	59	1391	70
TL 150	59	60	949	70
TL 151	60	305	119	70
TL 152	60	61	135	70
TL 153	61	62	351	70
TL 154	62	307	59	70
TL 155	62	309	206	70
TL 156	62	63	650	70
TL 157	63	311	468	70
TL 158	311	64	94	70
TL 159	64	313	431	70
TL 160	3313	65	236	70
TL 161	65	315	266	70
TL 162	65	317	644	70

TL 163	317	589	820	70
TL 164	64	319	500	50
TL 165	63	635	43	95
TL 166	636	66	163	95
TL 167	66	321	554	50
TL 168	66	323	666	95
TL 169	323	67	1370	95
TL 170	67	68	280	70
TL 171	68	325	99	70
TL 172	68	69	531	70
TL 173	69	70	59	70
TL 174	70	327	254	70
TL 175	70	329	290	70
TL 176	70	331	681	70
TL 177	67	71	206	70
TL 178	71	637	180	70
TL 179	638	333	307	70
TL 180	71	72	100	95
TL 181	72	335	250	70
TL 182	72	73	116	95
TL 183	73	74	254	70
TL 184	74	337	494	70
TL 185	74	75	400	70
TL 186	75	339	70	70
TL 187	75	341	315	70
TL 188	341	343	600	50

TL 189	73	345	181	95
TL 190	354	76	1274	95
TL 191	76	347	270	50
TL 192	76	77	500	95
TL 193	77	639	69	70
TL 194	640	349	784	70
TL 195	77	78	310	95
TL 196	78	641	46	95
TL 197	642	351	291	95
TL 198	78	353	768	50
TL 199	353	79	274	50
TL 200	79	355	190	50
TL 201	79	357	1074	50
TL 202	359	81	769	70
TL 203	81	203	1182	70
TL 204	81	82	1600	95
TL 205	82	361	323	50
TL 206	82	581	100	95
TL 207	80	590	200	110
TL 208	359	590	500	70
TL 209	590	83	493	110
TL 210	83	645	121	110
TL 211	646	84	930	110
TL 212	84	363	135	50
TL 213	84	365	1017	110
TL 214	83	85	286	110

TL 215	83	86	1050	110
TL 216	86	367	656	110
TL 217	86	369	197	110
TL 218	369	87	118	110
TL 219	87	88	245	110
TL 220	88	371	5	110
TL 221	88	373	879	50
TL 222	88	89	1156	110
TL 223	89	90	577	50
TL 224	90	375	519	50
TL 225	90	377	266	50
TL 226	377	379	1070	50
TL 227	92	383	73	70
TL 228	91	385	1580	110
TL 229	385	647	230	110
TL 230	648	593	154	110
TL 231	593	649	131	110
TL 232	650	651	57	110
TL 233	652	93	83	110
TL 234	93	387	156	110
TL 235	387	94	185	110
TL 236	93	655	533	70
TL 237	656	657	172	70
TL 238	658	672	554	70
TL 239	94	389	593	110
TL 240	94	391	496	110

TL 241	391	393	1085	110
TL 242	393	95	297	110
TL 243	95	395	133	70
TL 244	95	96	65	110
TL 245	96	659	246	70
TL 246	660	97	98	70
TL 247	97	397	105	70
TL 248	297	399	422	70
TL 249	399	401	922	70
TL 250	401	403	1215	70
TL 251	403	98	652	70
TL 252	98	661	34	70
TL 253	662	405	1417	70
TL 254	98	407	1863	70
TL 255	407	409	349	70
TL 256	409	99	780	70
TL 257	99	411	617	70
TL 258	99	100	210	70
TL 259	100	413	1837	70
TL 260	663	101	2523	70
TL 261	101	102	299	70
TL 262	102	103	287	70
TL 263	103	104	48	70
TL 264	104	105	44	70
TL 265	105	590	141	70
TL 266	106	417	50	70

TL 267	417	107	27	70
TL 268	107	419	103	50
TL 269	419	108	254	50
TL 270	108	594	509	50
TL 271	108	109	1077	50
TL 272	109	423	280	50
TL 273	423	110	92	50
TL 274	110	425	98	50
TL 275	110	427	81	50
TL 276	109	429	148	50
TL 277	597	111	115	50
TL 278	112	433	244	70
TL 279	111	113	247	70
TL 280	113	117	186	70
TL 281	117	435	714	70
TL 282	117	437	259	70
TL 283	594	595	625	95
TL 284	595	421	565	50
TL 285	102	118	246	70
TL 286	118	119	388	70
TL 287	119	120	72	70
TL 288	119	443	396	70
TL 289	665	445	390	70
TL 290	445	447	1230	70
TL 291	447	121	818	70
TL 292	121	449	467	70

TL 293	449	451	474	70
TL 294	451	453	917	70
TL 295	453	455	1245	70
TL 296	455	457	464	70
TL 297	457	459	808	70
TL 298	459	461	1110	70
TL 299	121	463	1466	70
TL 300	463	122	301	70
TL 301	122	465	476	70
TL 302	122	467	108	70
TL 303	96	123	140	110
TL 304	123	471	147	110
TL 305	666	124	103	95
TL 306	124	473	78	95
TL 307	473	125	408	95
TL 308	126	127	152	95
TL 309	124	128	164	70
TL 310	128	479	482	95
TL 311	128	477	279	70
TL 312	477	481	1569	70
TL 313	481	483	416	70
TL 314	483	129	546	70
TL 315	129	485	557	50
TL 316	129	487	155	70
TL 317	487	130	237	70
TL 318	130	489	679	95

TL 319	130	491	29	70
TL 320	491	493	550	70
TL 321	493	131	46	70
TL 322	131	667	79	50
TL 323	668	132	620	50
TL 324	132	495	181	50
TL 325	132	497	1156	50
TL 326	131	133	2607	70
TL 327	133	499	485	70
TL 328	133	134	316	70
TL 329	134	501	120	95
TL 330	134	135	1775	95
TL 331	135	503	195	95
TL 332	135	136	362	95
TL 333	136	669	225	95
TL 334	670	505	283	95
TL 335	505	137	830	95
TL 336	137	507	200	95
TL 337	137	138	1122	95
TL 338	138	139	336	95
TL 339	138	509	326	95
TL 340	138	511	2295	50
TL 341	136	141	231	95
TL 342	141	515	116	95
TL 343	515	517	1400	95
TL 344	141	598	317	95

TL 345	599	521	1100	95
TL 346	142	523	783	95
TL 347	523	525	661	95
TL 348	525	527	1696	95
TL 349	527	143	1153	95
TL 350	143	529	791	50
TL 351	1	608	74	50
TL 352	605	606	28	95
TL 353	607	1	78	95
TL 354	581	602	61	110
TL 355	603	255	230	50
TL 356	604	255	30	110

Note : the impedance and the sequences for all transmission lines adding to the ETAP program to completing the simulation [54][55][56].

The table (A.1.3) shows the cables in Tubas Electricity Network and the lengths of these cables as well as the sizes of the cables (the intersection area), as these cables are underground lines, of the sizes used in these cables (95mm^2 and 300mm^2).

Table (A.1.3) : The cables in Tubas network

The Number of the cables in ETAB program	The Number of bus's at the beginning and ending of each cable in ETAB program		The Length of each cable (meters)	The size (the intersection area) of each cable (mm^2)
	From Bus	To Bus		
Cable 1	157	578	489	95
Cable 2	578	159	400	95
Cable 3	161	580	792	95

Cable 4	15	191	50	95
Cable 5	15	193	50	95
Cable 6	21	22	106	95
Cable 7	55	630	136	95
Cable 8	55	293	267	95
Cable 9	80	359	295	95
Cable 10	89	91	469	95
Cable 11	91	381	500	95
Cable 12	87	92	486	95
Cable 13	653	654	4500	95
Cable 14	103	415	110	95
Cable 15	396	106	31	95
Cable 16	107	597	315	95
Cable 17	111	112	356	95
Cable 18	112	431	85	95
Cable 19	113	114	60	95
Cable 20	114	115	193	95
Cable 21	114	116	38	95
Cable 22	118	439	152	95
Cable 23	439	441	137	95
Cable 24	123	469	259	95
Cable 25	125	126	48	95
Cable 26	127	475	232	95
Cable 27	139	140	57	95
Cable 28	511	513	328	95
Cable 29	517	519	470	95

Cable 30	598	142	123	95
Cable 31	142	599	54	95
Cable 32	600	3	83	95
Cable 33	11	643	128	300
Cable 34	644	80	149	300

The table (A.1.4) shows the Reclosers with the maximum current in Tubas Electricity Network.

Table (A.1.4) : The Reclosers in Tubas network

The Number of the Recloser in ETAB program	The Number of bus's at the beginning and ending of each Recloser in ETAB program		The Rating of each Recloser	
	From Bus	To Bus	Max. Amperes	KV
REC 1	606	607	400	33
REC 2	618	619	200	33
REC 3	637	638	400	33
REC 4	639	640	400	33
REC 5	641	642	400	33
REC 6	647	648	400	33
REC 7	655	656	400	33
REC 8	659	660	400	33
REC 9	661	662	400	33
REC 10	669	670	400	33

In Tubas network, 26 circuit breakers are used. The table (A.1.5) shows the circuit breakers that using in Tubas Electricity Network with the maximum current.

Table (A.1.5) : The Circuit breakers in Tubas network

The Number of the Circuit breakers in ETAB program	The Number of bus's at the beginning and ending of each Circuit breakers in ETAB program		The Rating of each Circuit breakers	
	From Bus	To Bus	Max. Amperes	KV
C.B 1	610	611	400	33
C.B 2	312	613	400	33
C.B 3	314	615	400	33
C.B 4	183	616	400	33
C.B 5	14	617	400	33
C.B 6	620	621	400	33
C.B 7	25	622	400	33
C.B 8	623	624	400	33
C.B 9	625	626	400	33
C.B 10	627	628	400	33
C.B 11	629	55	400	33
C.B 12	630	291	400	33
C.B 13	631	632	400	33
C.B 14	633	634	400	33
C.B 15	635	636	400	33
C.B 16	643	644	400	33
C.B 17	645	646	400	33

C.B 18	593	653	400	33
C.B 19	644	650	400	33
C.B 20	651	652	400	33
C.B 21	657	658	400	33
C.B 22	97	663	400	33
C.B 23	471	666	400	33
C.B 24	667	668	400	33
C.B 25	608	609	400	33
C.B 26	443	665	400	33

A.2. The analysis of Tubas network:

1. The analysis of Tubas city:

1) The components of Tubas city network:

The table (A.2.1) shows the numbers, names of the transformers in Tubas city network, the solar systems in the city and the values of the loads on each transformer [10].

Table (A.2.1) : The transformers, PV systems & loads in Tubas city

The Number & Name of each transformer in Tubas city in ETAB program	The Number and value of each PV systems in TUBAS city in ETAB program	The Number of each load at each transformer in ETAB program	PF 100 %	P_{MAX} (KW)	Q_{MAX} (KVAR)
T 6 MEDICAL HERBS		L 6	95	75.4	22.9
T 8 AL-THOGHRAH	PV 4 30 KWp	L 7	100	168.4	0.5
T 9	PV 90	L 8	98	159.3	29.9

TOOP FACTOTY	5 KWp				
T 10 QETAF COMPANY		L 9	95	5.0	1.5
T 11 HEALTH		L 10	93	42.8	14.9
T 12 ALLAN	PV 5 25 KWp	L 11	93	184.2	65.9
T 13 AL-DAIR	PV 6 25 KWp	L 12	97	120.3	25.9
T 14 TRANSFORMERS FACTOTY		L 13	97	25.5	5.5
T 15 HASSAN MKHEBER		L 14	87	191.9	98.5
T 16 CZ PV STATION 1	PV 7 & PV 8 120 KWp & 10 KWp Respectively				
T 17 CZ PV STATION 2	PV 9 350 KWp				
T 18 PALESTINE INVESTMENT FUND PV STATION	PV 10 (Proposed) 2000 KWp				
T 19 SAMEEH	PV 11 15 KWp	L 15	97	165.5	37.4
T 20 AL-MASA'EED	PV 12 5 KWp	L 16	95	232.1	67.4
T 21		L 17	99	91.6	2.8

AL-ANABOSI					
T 22 ABO OMAR		L 18	95	363.7	103.8
T 23 KAZIYA AL-MOTHEDOON		L 19	95	109.8	30.5
T 24 ABO SHIHAB	PV 14 5 KWp	L 20	96	265.1	69.5
T 25 KARAG	PV 15 122.15 KWp	L 21	96	184.6	47.3
T 26 TUBAS CLUB	PV 16 22 KWp	L 22	98	144.5	25.5
T 27 MASRIYA	PV 17 24 KWp	L 23	96	121.7	30.3
T 28 TUBAS MUNICIPALITY WELL		L 24		0	0
T 29 RAWDA		L 25	98	63.8	12.4
T 30 AMN WATANY CENTER 1		L 26	97	125.8	29.3
T 31 AMN WATANY CENTER 2		L 27	87	191.9	98.5
T 32 NABEEHA	PV 22 5.2 KWp	L 28	98	185.2	33.2
T 33 TUBAS WELL		L 29	90	182.0	76.2

T 34 MOHAFADA	PV 23 10 KWp	L 30	98	66.0	11.5
T 97 TUBAS PARK		L 87		0	0
T 98 KHALET AL-LOOZ		L 88	97	9.4	2.0
T 100 MO2YAD FRIDGES		L 90	92	104.6	39.4
T 101 JAFA CONSUMPTION TR	PV 115 350 KWp	L 91		0	0
T 134 AL-HELAL	PV 42 15 KWp	L 124	95	248.3	70.4
T 135 AL-HAWOOZ 1 (TUBAS)	PV 43 141.4 KWp	L 125	94	435.9	124.4
T 136 AL-HAWOOZ 2 (TUBAS)	PV 113 10 KWp	L 126	97	138.4	26.1
T 137 CUSTAMS POLICE (TUBAS)		L 127	100	6.7	0
T 138 AL-DAQANYA	PV 46 15 KWp	L 128	96	319.2	74.7
T 139 GOLDEN GOAT	PV 114 10 KWp	L 129	96	36.8	8.5
T 140 STONE CUTTER (TUBAS)		L 130		0	0

T 141 POLICE TR (TUBAS)		L 131		0	0
T 142 SAFEH NORTH	PV 47 30 KWp	L132	98	80.5	14.3
T 143 AL-AQABEH	PV 48 10 KWp	L 133	87	104.4	49.8
T 145 HYDROLGY PV PLANT	PV 50 250 KWp	L 135		0	0
T 149 SALHAB		L 139	91	9.4	3.5
T 152 TUBAS HOPITAL 1		L 142		0	0
T 153 TUBAS HOSPITAL 2		L 143	90	434.1	170.8
T 248 AMN WEQA2E (TUBAS)		L 238	95	49.3	15.1
T 249 JAFA PV PLANT	PV 38 (Under Construction) 2702.7 KWp				
T 250 JAFA PV PLANT	PV 87 (Under Construction)				

	2702.7 KWp				
T 251 PALESTINE INVESTMENT FUND PV STATION	PV 88 (Proposed) 3000 KWp				
T 252 PALESTINE INVESTMENT FUND PV STATION	PV 89 (Proposed) 3000 KWp				
T 7 AUTO TRANSFORMER					

* Note : The powers (Qmax & Pmax) in table (A.2.1) data from Tubas Electricity Company, and these values are the average annual load capacity for the year 2019.

The figure (A.2.1) shows the Northern region of Tubas city, and the transformers, loads and solar systems it contains.

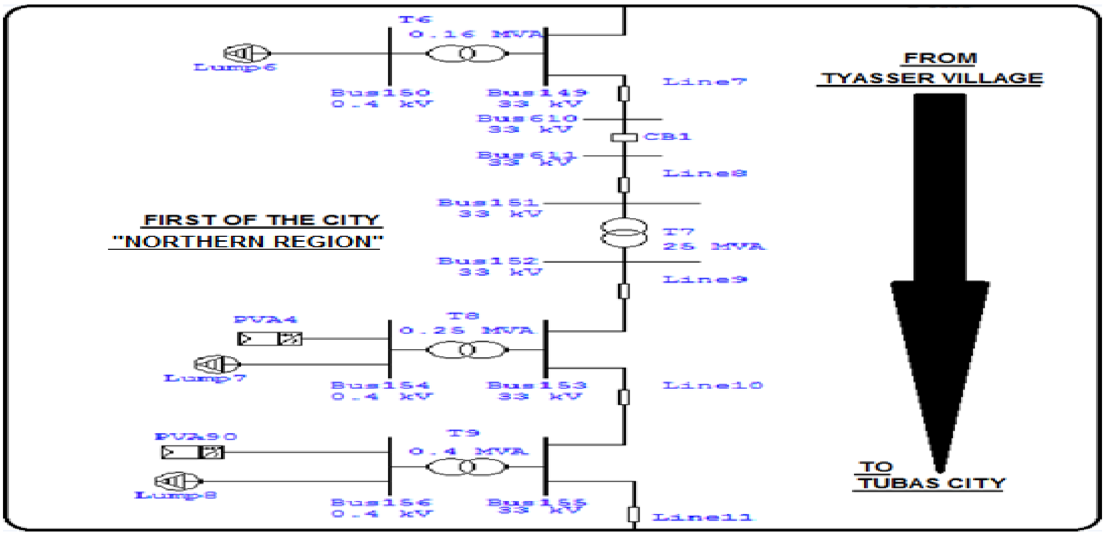

Figure (A.2.1) : The transformers, PV system & loads in the first of the city "Northern region"

The figure (A.2.2) shows the first intersection of Tubas city, and the transformers, loads and solar systems it contains.

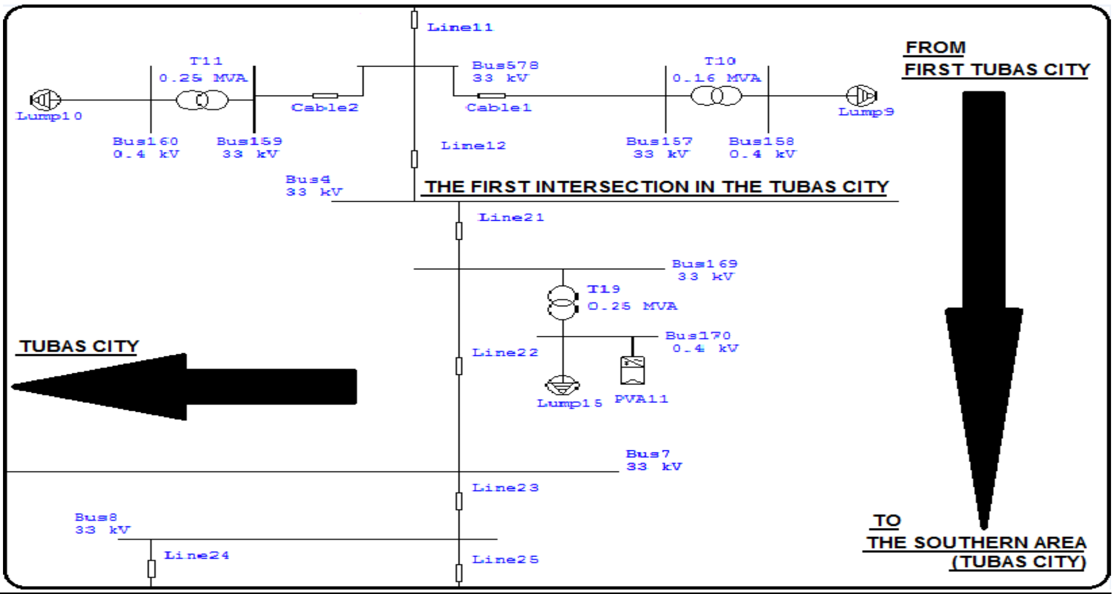

Figure (A.2.2) : The transformers, PV systems & loads in the first intersection

The figure (A.2.3) shows the Southern region 1 of Tubas city, and the transformers, loads and solar systems it contains.

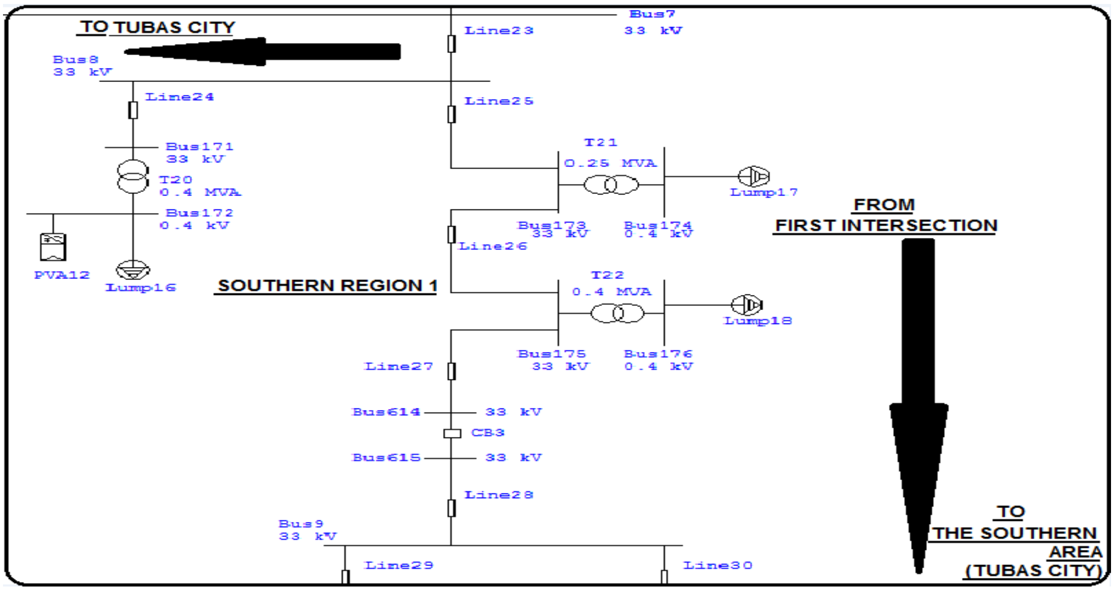

Figure (A.2.3) : The transformers, PV systems & loads in the Southern region 1

The figure (A.2.4) shows the Southern region 2 of Tubas city, and the transformers, loads and solar systems it contains.

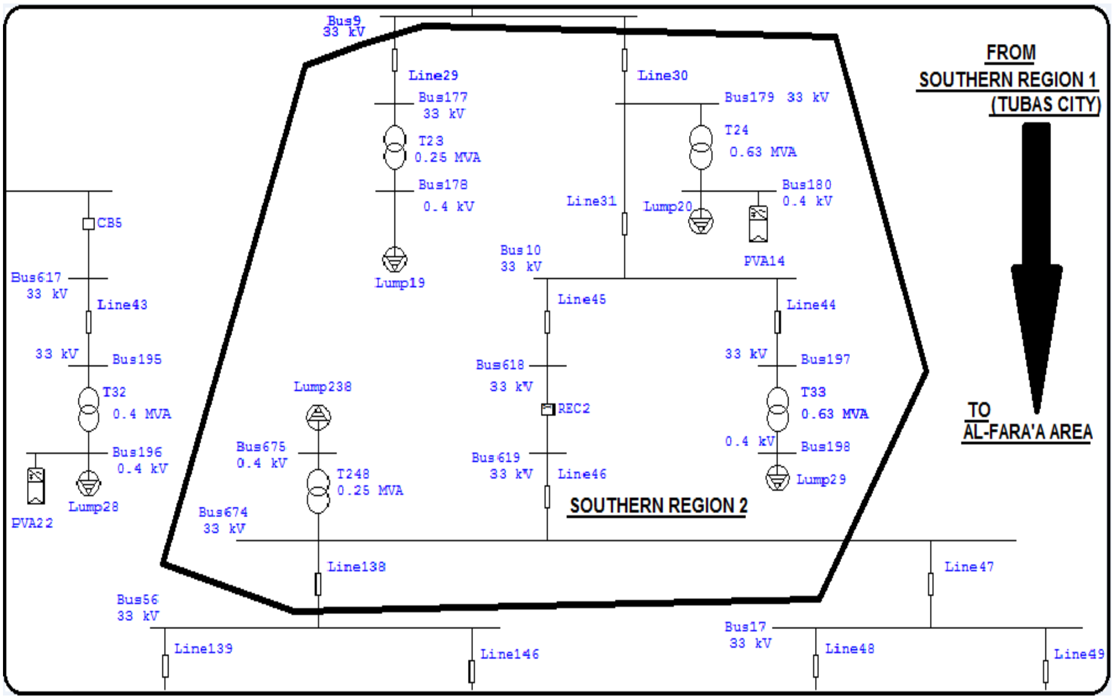

Figure (A.2.4) : The transformers, PV systems & loads in the Southern region 2

The figure (A.2.5) shows the areas near Al-Fara'a areas of Tubas city, and the transformers, loads and solar systems it contains.

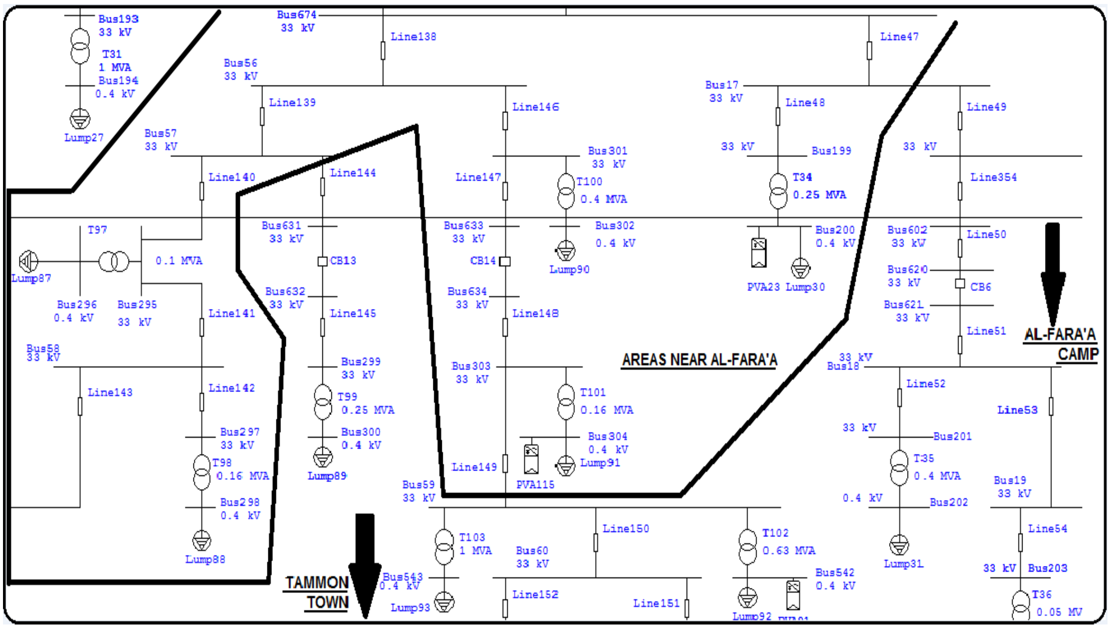

Figure (A.2.5) : Shows the transformers, PV systems & loads in the areas near Al-Fara'a area

The figure (A.2.6) shows the areas near Al-Fara'a areas of Tubas city with the under construction transformers "T249 & T250" and the under construction solar systems "PV38 & PV87".

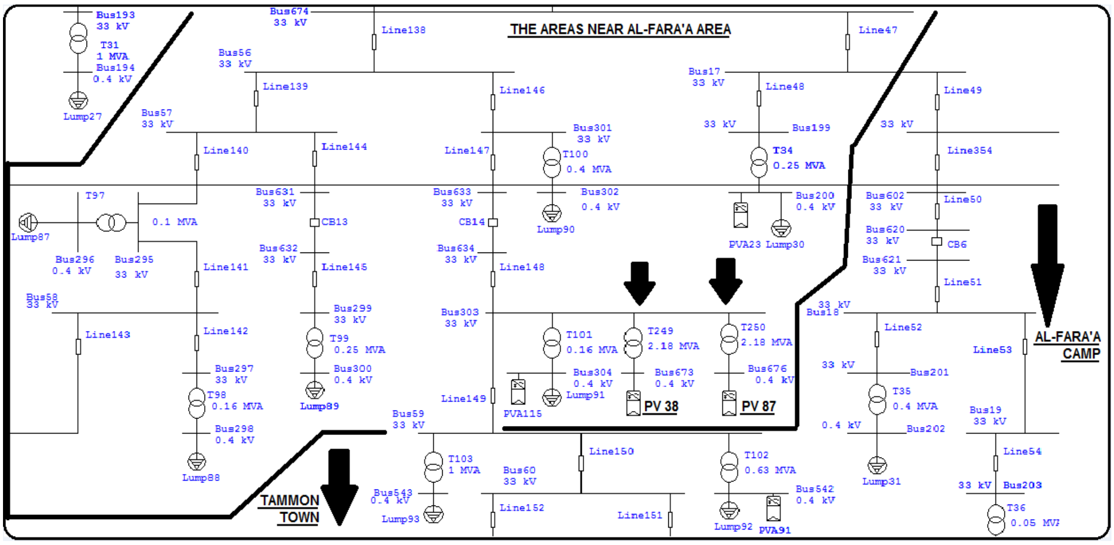

Figure (A.2.6) : The transformers, PV system & loads in the areas near Al-Fara'a areas with PV38 at T249 & PV87 at T250

The figure (A.2.7) shows the Eastern region 1 of Tubas city, and the transformers, loads and solar systems it contains.

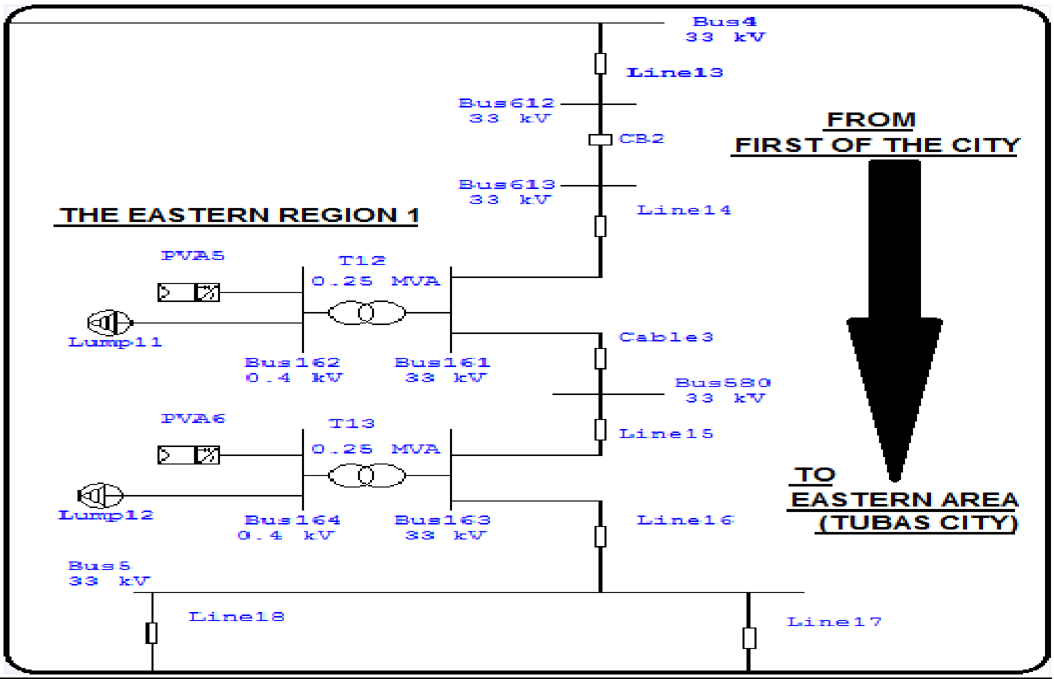

Figure (A.2.7) : The Transformers, PV systems & loads in the Eastern region 1

The figure (A.2.8) shows the Eastern region 2 of Tubas city, and the transformers, loads and solar systems it contains.

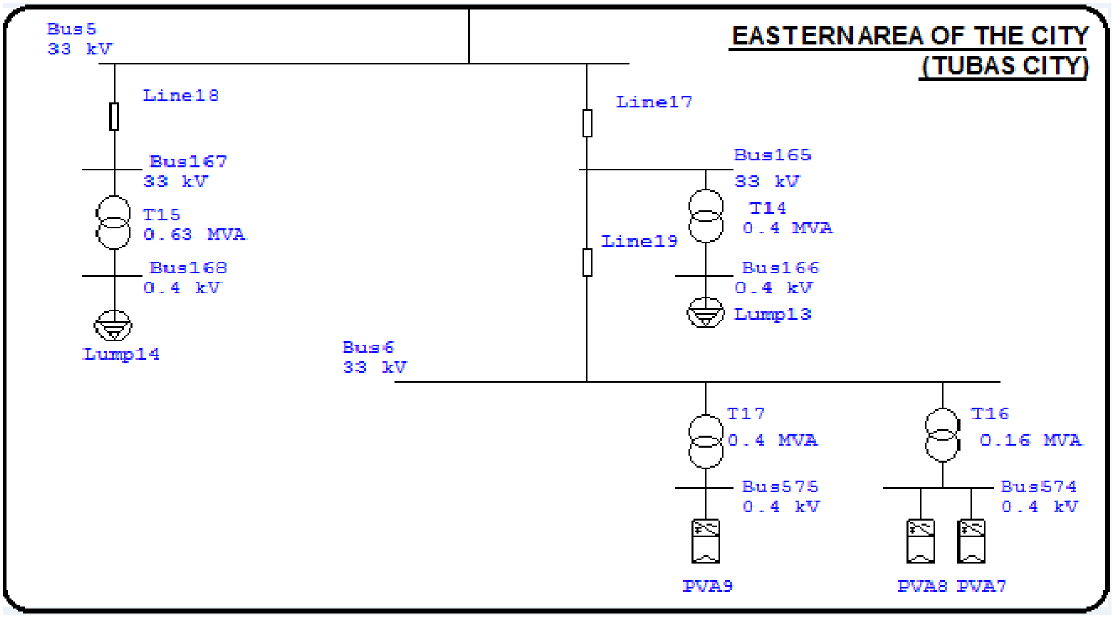

Figure (A.2.8) : The transformers, PV systems & loads in the Eastern region 2

The figure (A.2.9) shows the Eastern region 2 of Tubas city with proposed transformers "T18, T251 & T252", proposed buses "Bus576, Bus577, Bus664 & Bus677" and proposed solar systems "PV10, PV88 & PV89 ".

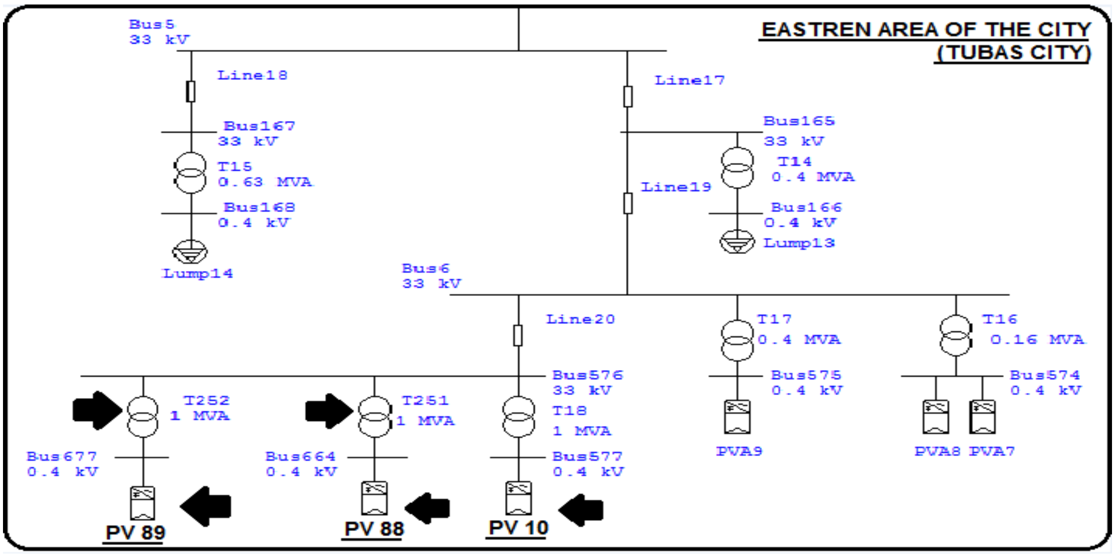

Figure (A.2.9) : The transformers, PV systems & loads in the Eastern region 2 with PV10 at T18, PV88 at T251 & PV89 at T252

The figure (A.2.10) shows the center of the town 1 of Tubas city, and the transformers, loads and solar systems it contains.

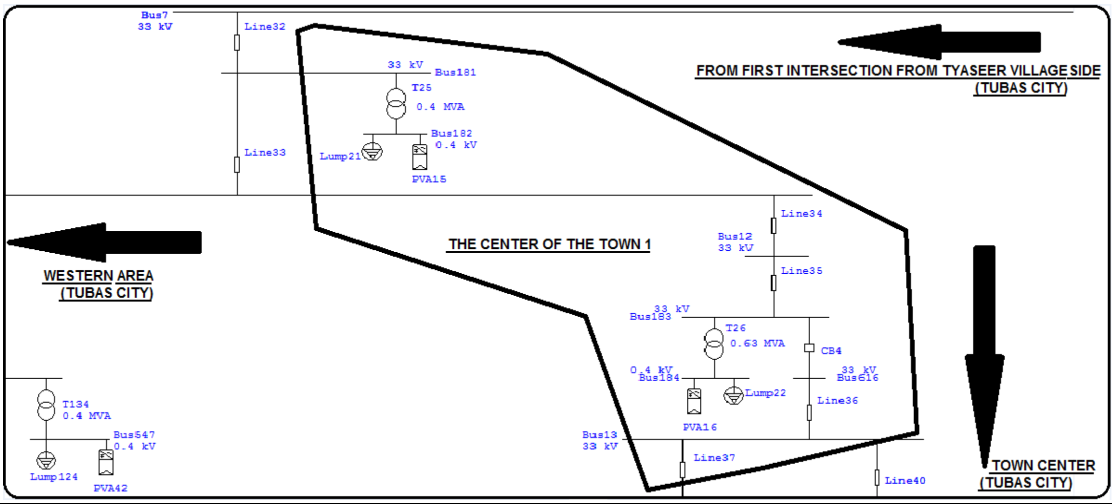

Figure (A.2.10) : The transformers, PV systems & loads in the center of the town 1

The figure (A.2.11) shows the center of the town 2 of Tubas city, and the transformers, loads and solar systems it contains.

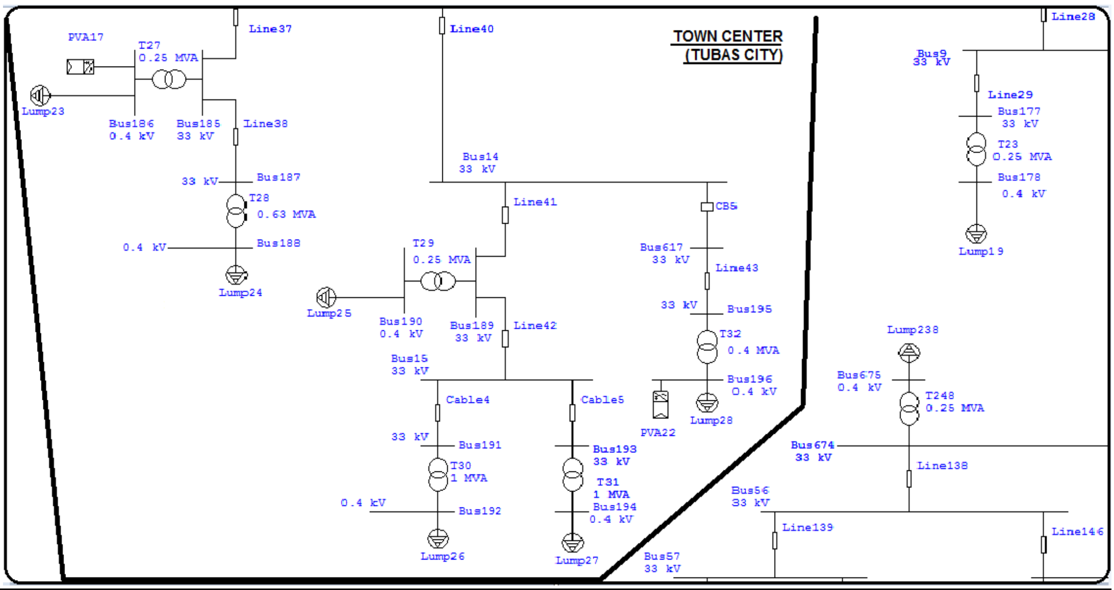

Figure (A.2.11) : The transformers, PV systems & loads in the center of the town 2

The figure (A.2.12) shows the center of the Western region of Tubas city, and the transformers, loads and solar systems it contains.

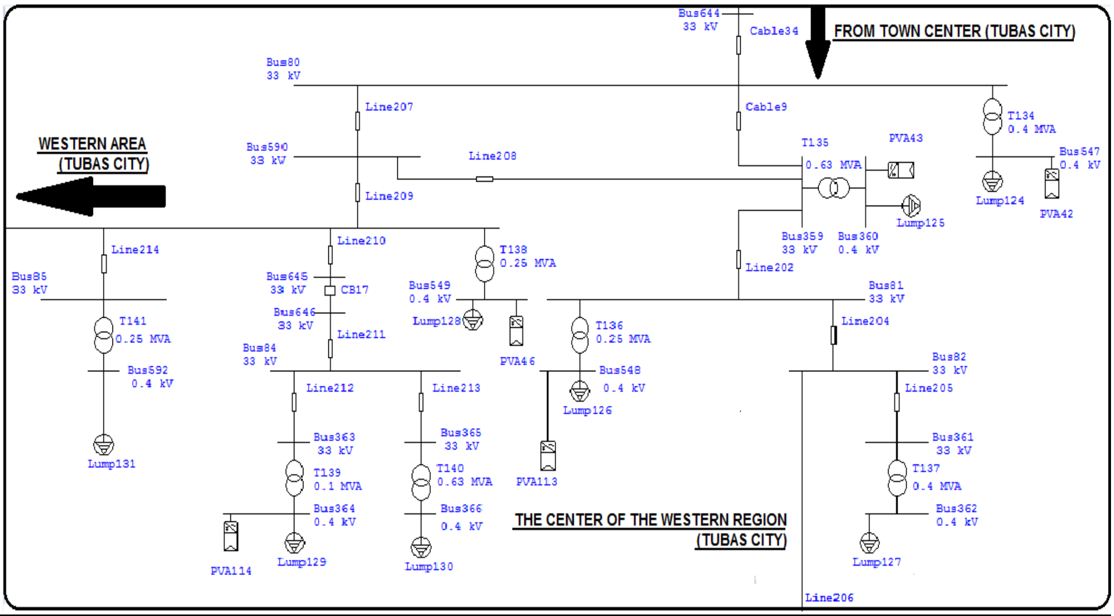

Figure (A.2.12) : The transformers, PV systems & loads in the center of the Western region

The figure (A.2.13) shows the Western region of Tubas city, and the transformers, loads and solar systems it contains.

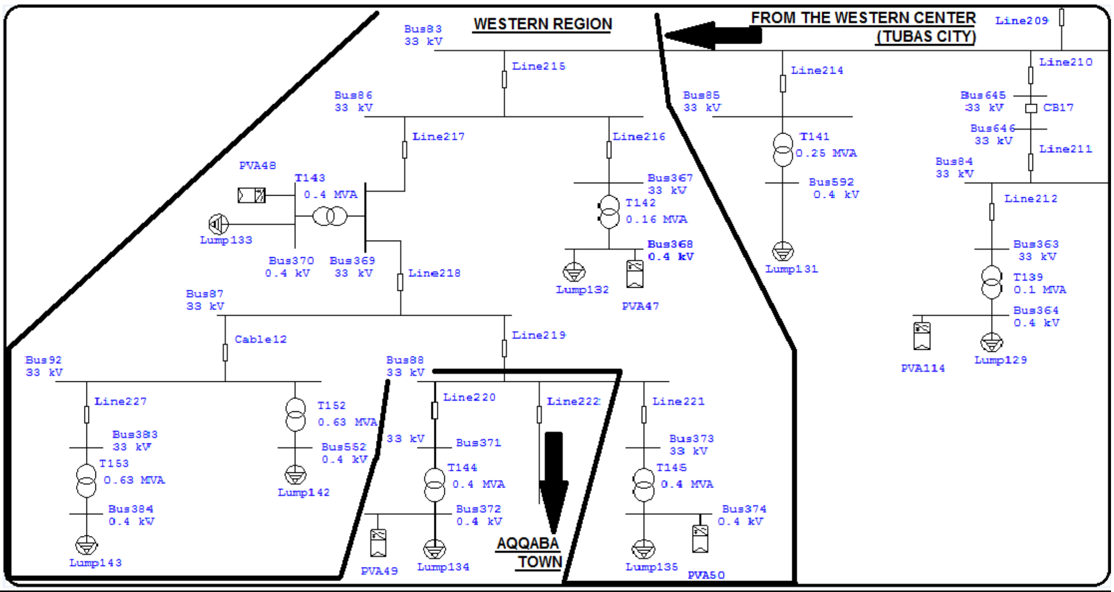

Figure (A.2.13) : The transformers, PV systems & loads in the Western region

The figure (A.2.14) shows the far Western region of Tubas city, the transformers and loads it contains.

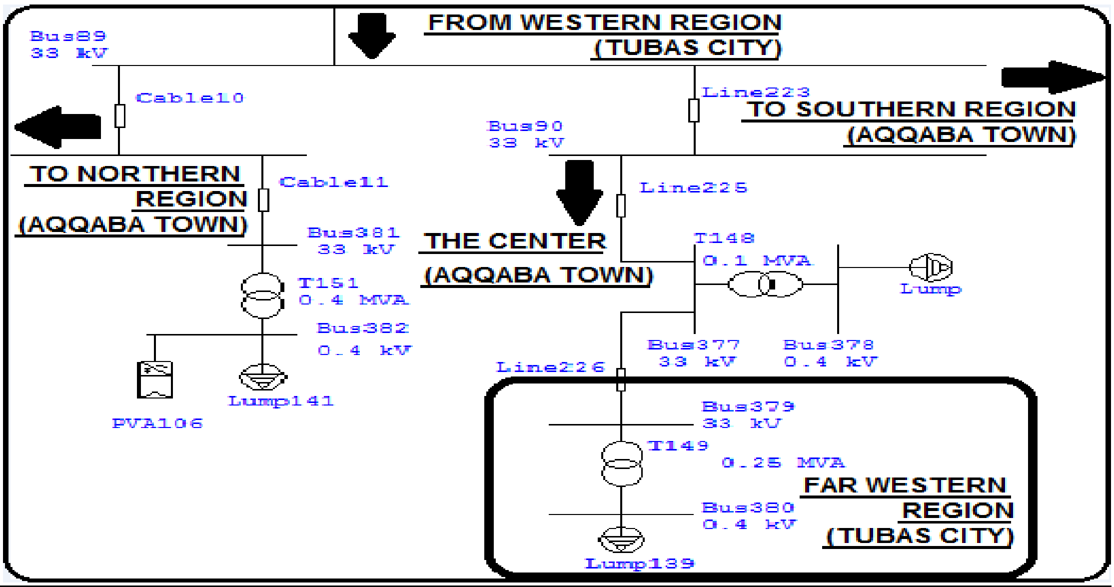

Figure (A.2.14) : The transformers & loads in the far Western region

The figure (A.2.15) shows the zones of the Tubas city network in reality, by using the GPS system [57]. Such as: 1) The first of the city "Northern region". 2) The first intersection. 3) The Southern region 1. 4) The Southern region 2. 5) The areas near Al-Fara'a areas. 6) The Eastern region 1. 7) The Eastern region 2. 8) The center of the town 1. 9) The center of the town 2. 10) The center of Western region. 11) The Western region. 12) The far Western region.

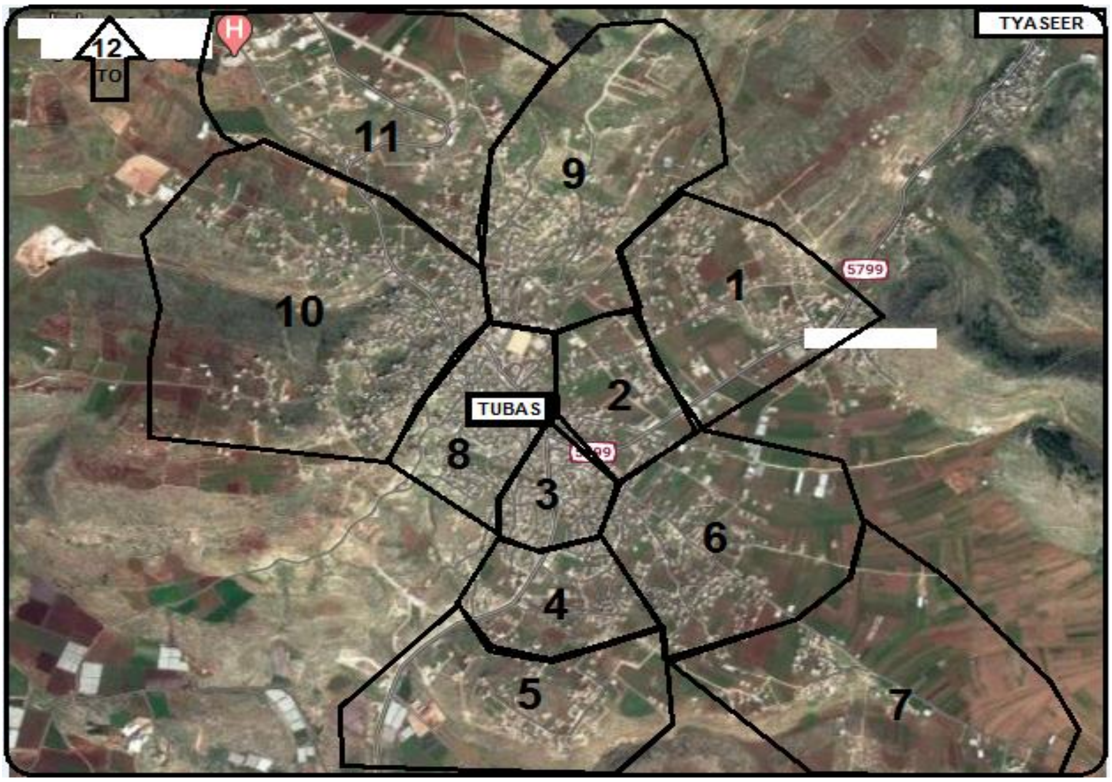

Figure (A.2.15) : The zones of Tubas city network in reality

2) The problem of Tubas city network:

The figure (A.2.16) shows the distance between the loads (Lupm7 – distant homes) and transformer T8 in the first of the city "Northern region" in Tubas city in reality, by using the GPS system [57].

Figure (A.2.16) : The transformer loads (T8) in Tubas city network in reality

2. The analysis of Keshda village:

1) The components of Keshda village network:

The table (A.2.2) shows the transformers, loads and the solar systems in the village of Keshda, and the load values in the village of Keshda [10].

Table (A.2.2) : The transformers, PV systems & loads in Keshda village

The Number & Name of each transformer in Keshda village in ETAB program	The Number and value of each PV systems in Keshda village in ETAB program	The Number of each load at each transformer in ETAB program	PF 100 %	P_{MAX} (KW)	Q_{MAX} (KVAR)
T 35 PICKE FACTORY		L 31	88	102.7	49.1
T 36 KESHDA MAIN	PV 110 10 KWp	L 32	89	8.9	3.8
T 46 MOA'YAD AL-FAKHRI		L 36	94	80.7	25.1

* Note : The powers (Qmax & Pmax) in table (A.2.2) data from Tubas Electricity Company, and these values are the average annual load capacity for the year 2019.

The figure (A.2.17) shows the center of the village of Keshda village, the transformers, the solar systems and loads it contains.

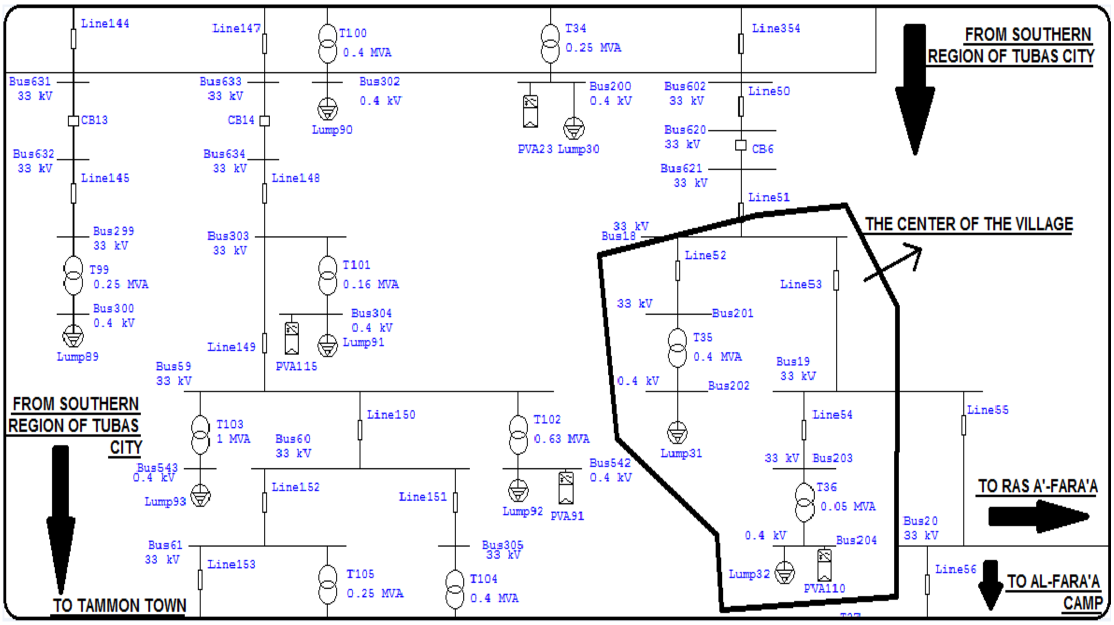

Figure (A.2.17) : The transformers, solar system & loads in the center of the village

The figure (A.2.18) shows the Southern region of Keshda village, the transformers and loads it contains.

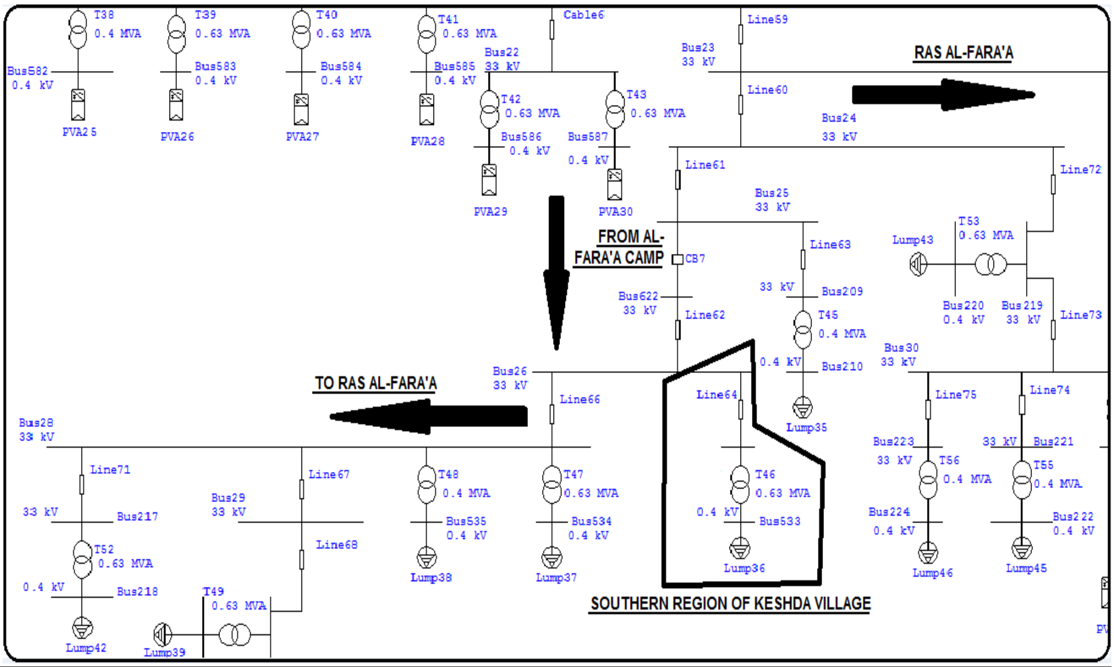

Figure (A.2.18) : The transformer & load in the Southern region

The figure (A.2.19) shows the zones of Keshda village network in Tubas network as a whole.

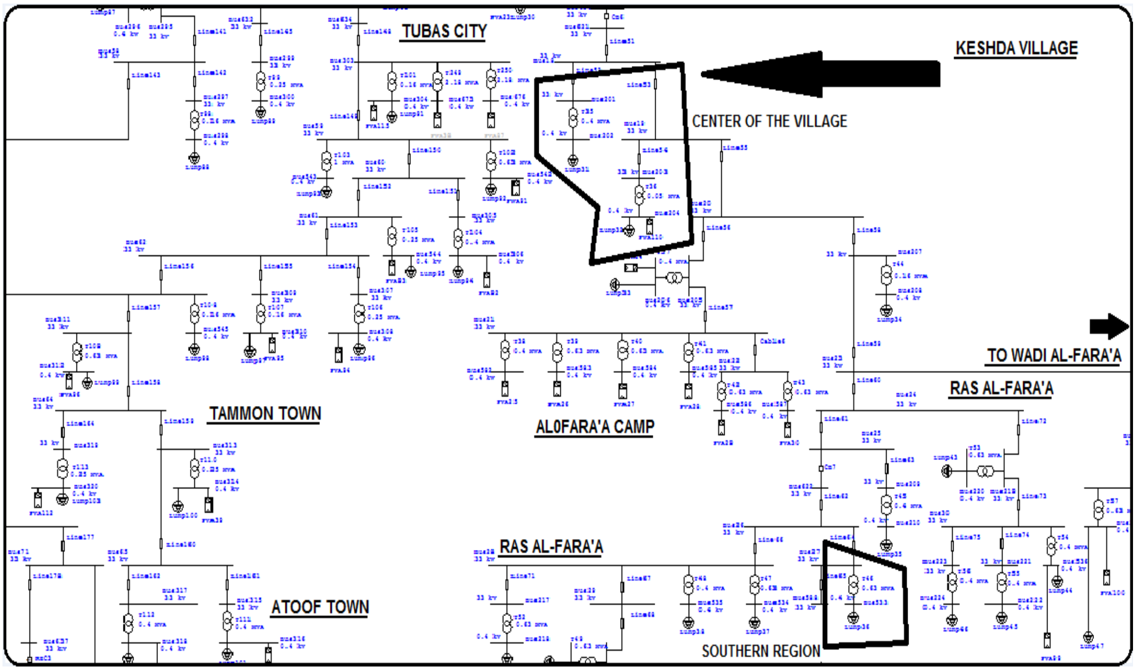

Figure (A.2.19) : The zones of the Keshda village network in the Tubas network as a whole

The figure (A.2.20) shows the zones of Keshda village in reality by using the GPS system [57]. Such as: 1) The center of the village. 2) The Southern region.

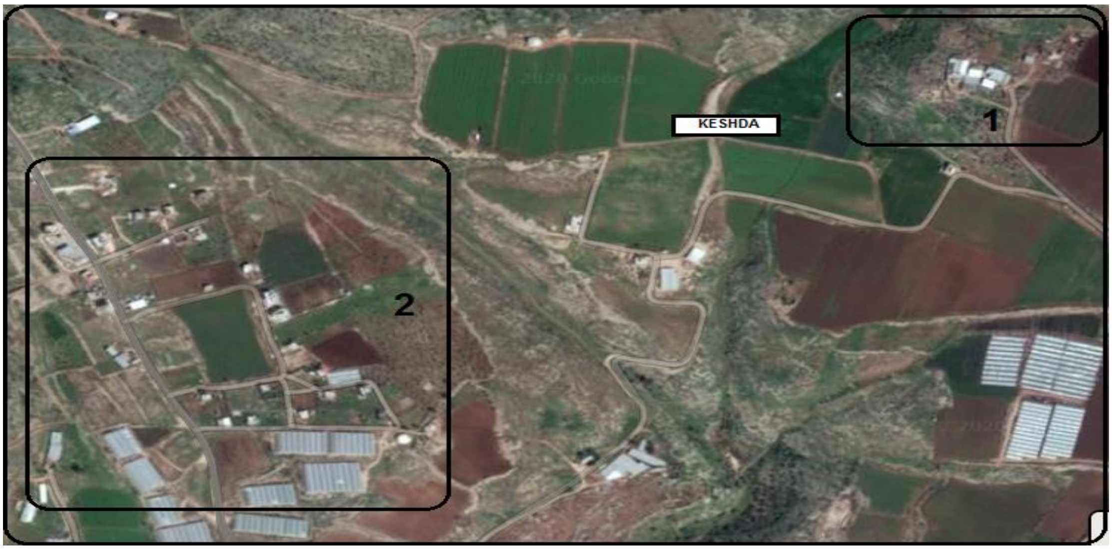

Figure (A.2.20) : The zones of the Keshda village in reality

2) The problems of Keshda village network:

The figure (A.2.21) shows the distance between the zones of Keshda village in reality, by using the GPS system [57]. Such as: 1) The center of the village. 2) The Southern region.

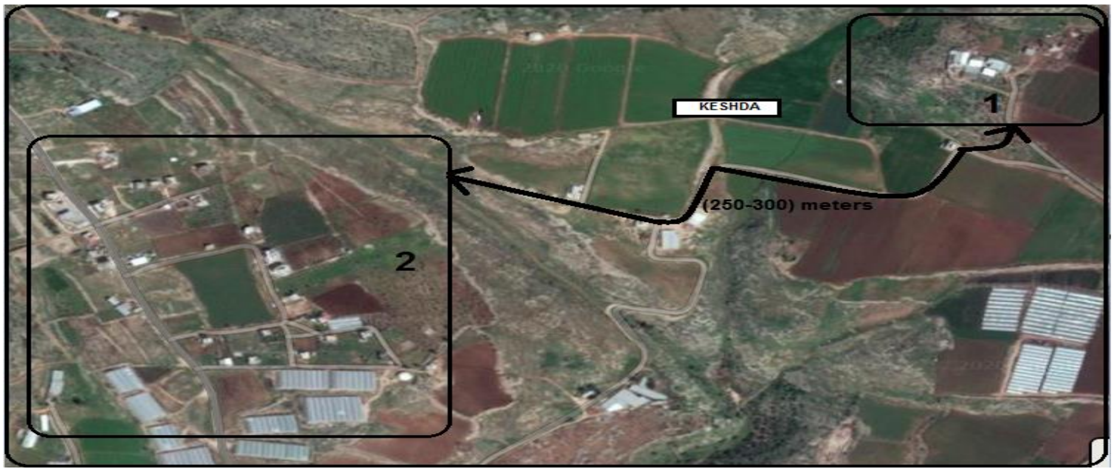

Figure (A.2.21) : The distance between the zones of the Keshda village network in reality

3. The analysis of Tyaseer village:

1) The components of Tyaseer village network:

The table (A.2.3) shows the transformers, loads and the solar systems in village of Tyaseer, with load values in the village [10].

Table (A.2.3) : The transformers, PV systems & loads in Tyaseer village

The Number & Name of each transformer in Tyaseer village in ETAB program	The Number and value of each PV systems in Tyaseer village in ETAB program	The Number of each load at each transformer in ETAB program	PF 100 %	P_{MAX} (KW)	Q_{MAX} (KVAR)
T 2 TYASEER	PV 1 10 KWp	L 2	96	258.1	70.4

MAIN					
T 3 SCHOOL (TYASEER)		L 3	94	14.1	4.6
T 4 TYASEER FILTERING STATION 1	PV 109 100 KWp	L 4	98	18.7	1.5
T 5 TYASEER FILTERING STATION 2		L 5		0	0
T 253 AVD PV PLANT	PV 3 (proposed) 2000 KWp				

* Note : The powers (Qmax & Pmax) in table (A.2.3) data from Tubas Electricity Company, and these values are the average annual load capacity for the year 2019.

The figure (A.2.22) shows the transformers, the solar systems & loads in Tyaseer village.

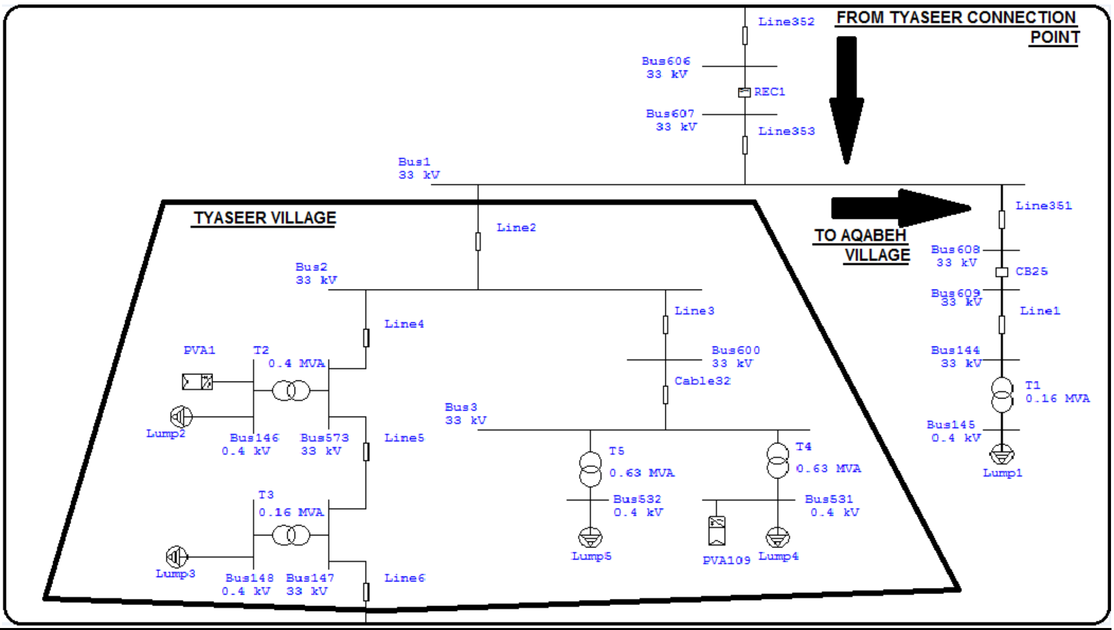

Figure (A.2.22) : The transformers, the solar systems & loads in the Tyaseer village

The figure (A.2.23) shows Tyaseer village of Tubas city with proposed transformer "T253", proposed bus "Bus687" and proposed solar system "PV3".

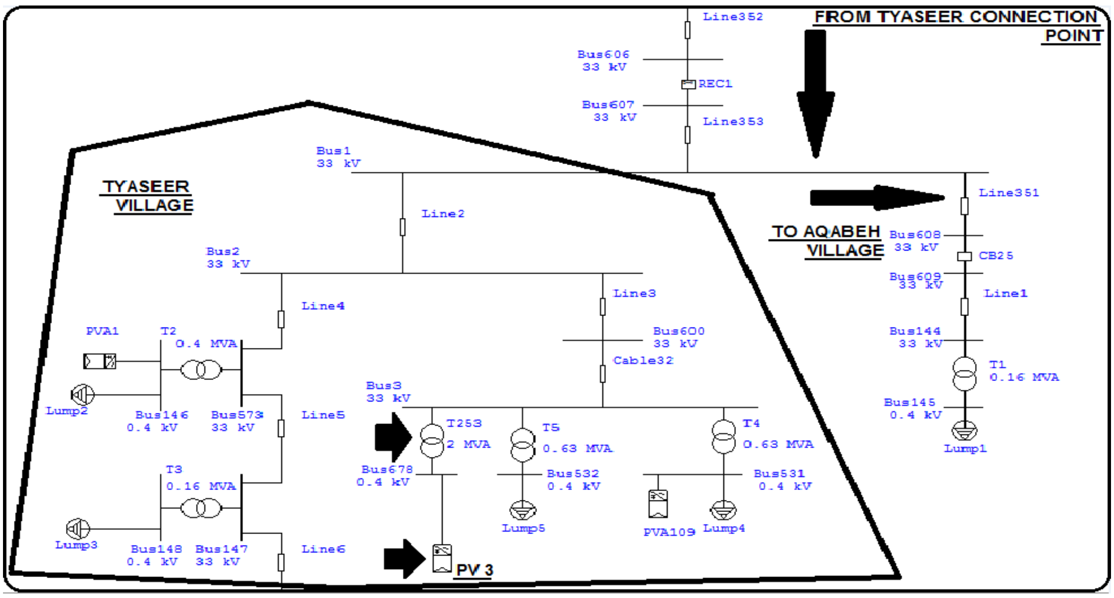

Figure (A.2.23) : The transformers, PV systems & loads in the Tyaseer village with PV3 at T253

The figure (A.2.24) shows the zones of Tyaseer village in reality with the location of the transformers in the village, by using the GPS system [57].

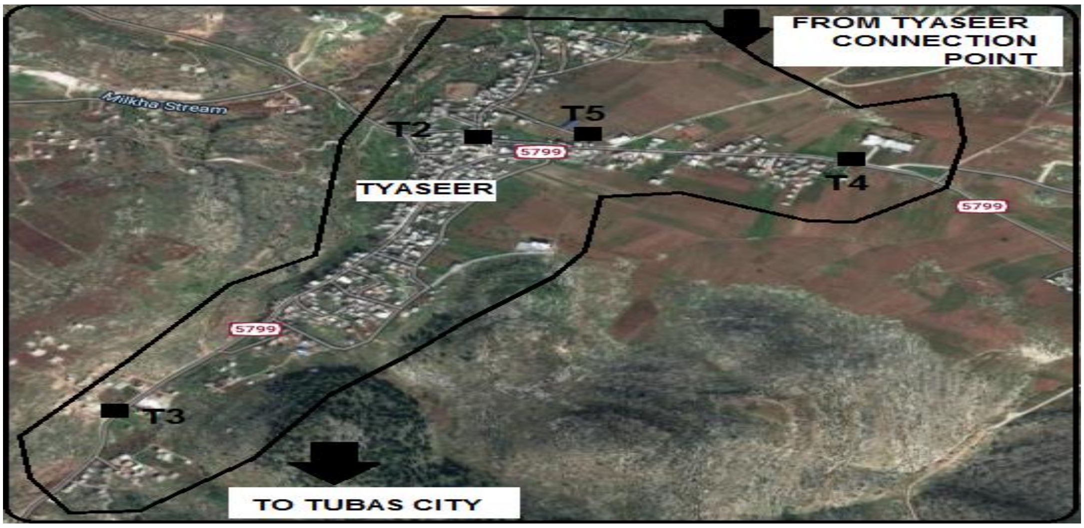

Figure (A.2.24) : The location of the Tyaseer village network in reality

4. The analysis of Aqabeh village:

1) The components of Aqabeh village network:

The table (A.2.4) shows the transformer and the load values in the village of Aqabeh [10].

Table (A.2.4) : The transformer & loads in Aqabeh village

The Number & Name of each transformer in Aqabeh village in ETAB program	The Number of each load at each transformer in ETAB program	PF 100 %	P_{MAX} (KW)	Q_{MAX} (KVAR)
T 1 AQABEH MAIN	L 1	92	26.5	9.9

* Note : The powers (Qmax & Pmax) in table (A.2.4) data from Tubas Electricity Company, and these values are the average annual load capacity for the year 2019.

The figure (A.2.25) shows Aqabeh village, the transformer and the load it contains.

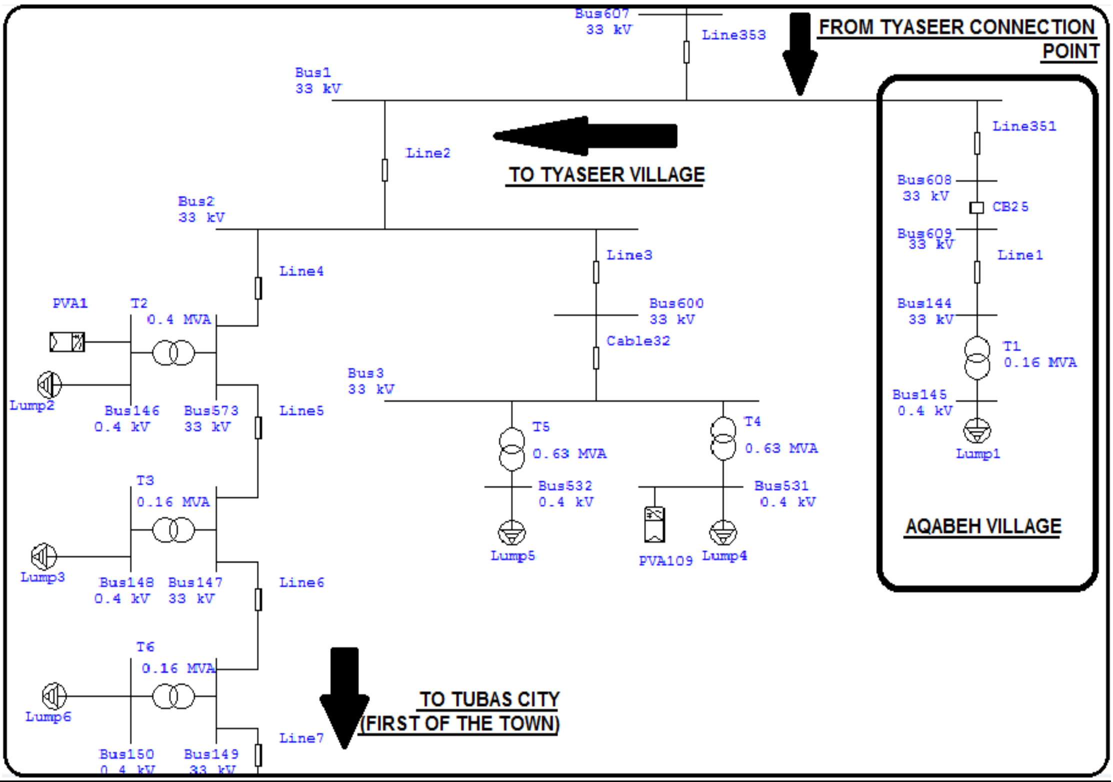

Figure (A.2.25) : The transformer & loads in the Aqabeh village

The Figure (A.2.26) shows the location of Aqabeh village network in reality with the location of the transformer in the village, by using the GPS system [57].

Figure (A.2.26) : The location of the Aqabeh village network in reality

5. The analysis of Ras Al-Fara'a region:

1) The components of Ras Al-Fara'a region network:

The table (A.2.5) shows the transformers, loads and the solar systems in the region of Ras Al-Fara'a with the load values [10].

Table (A.2.5) : The transformer, PV systems & loads in Ras Al-Fara'a region

The Number & Name of each transformer in Ras Al-Fara'a region in ETAB program	The Number and value of each PV systems in Ras Al-Fara'a region in ETAB program	The Number of each load at each transformer in ETAB program	PF 100 %	P_{MAX} (KW)	Q_{MAX} (KVAR)
T 44 DEWAN		L 34	97	18.9	4.0
T 45 GAZAH		L 35	81	110.7	71.8
T 47 KHALET AL-QASER 2		L 37	89	369.8	168.2
T 48 KHALET AL-QASER 1		L 38	87	163.0	82.0
T 49 FASYEL WWLL		L 39	87	141.2	70.8
T 50 ASHRAF KHADER		L 40		0	0
T 51 HUSSEN AL-AARAJ		L 41	89	166.4	77.4
T 52		L 42	86	411.2	213

MOHAMMAD AL-BASHEER					
T 53 AGRICULTURAL PROJECT		L 43	87	182.2	92.5
T 54 KAZEYEH SAMARA	PV 99 5 KWp	L 44	96	33.9	9.1
T 55 AL-ASHQAR STON CUTTER		L 45	92	73.4	28.0
T 56 THYAB		L 46	85	145.8	79.8
T 57 AL-HAJ HAKEEM	PV 100 15 KWp	L 47	91	191.0	79.8
T 58 ABO HAMED		L 48	80	60.7	40.0
T 59 AL-KHARRAZ		L 49	89	45.6	20.9
T 60 MOWAFAK AL-FAKHRY SHARAKEH WELL		L 50	92	100.5	37.2
T 85 TUBAS WELL	PV 101 5 KWp	L 75	95	26.1	7.3
T 87 AL-SHAREEF	PV 102 15 KWp	L 77	98	155.6	27.0
T 96 MALHAMEH	PV 103	L 86	95	148.4	44.5

* Note : The powers (Qmax & Pmax) in table (A.2.5) data from Tubas electricity company, and these values are the average annual load capacity for the year 2019.

The figure (A.2.27) shows the Northern region, the transformers, the solar systems and loads it contains.

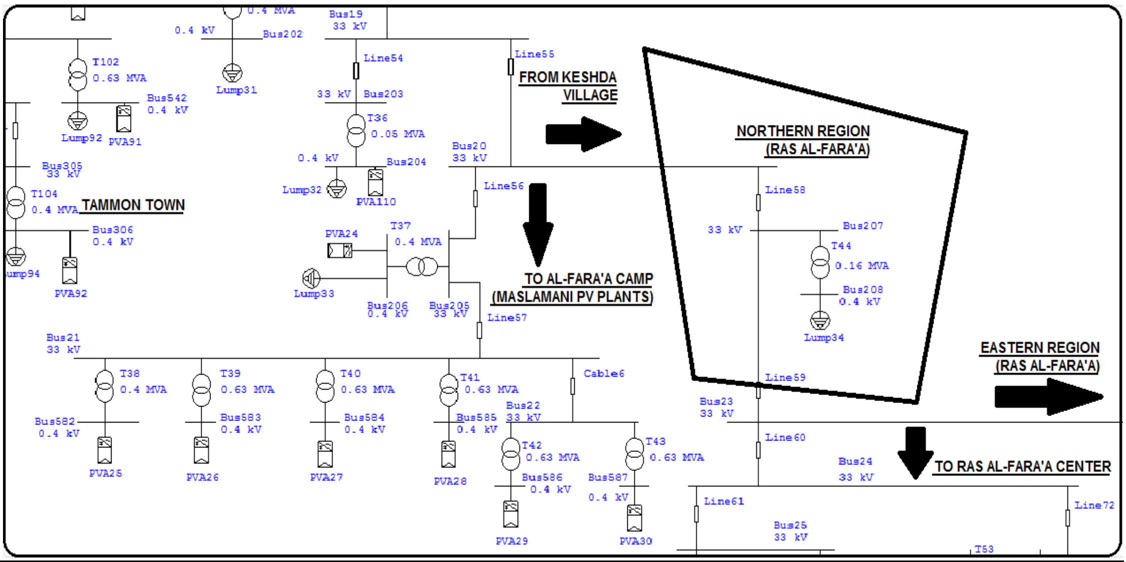

Figure (A.2.27) : The transformer & loads in the Northern region

The figure (A.2.28) shows the center of the town, the transformers, the solar systems and loads it contains.

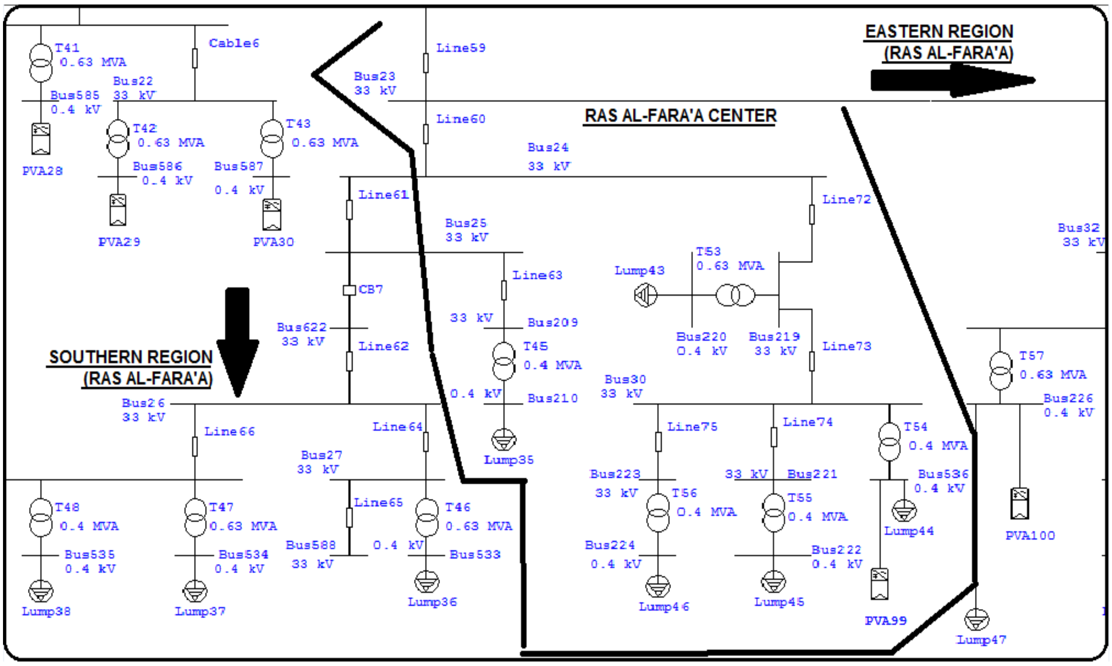

Figure (A.2.28) : The transformers, the solar systems & loads in the center of the town

The figure (A.2.29) shows the Southern region, the transformers and loads it contains.

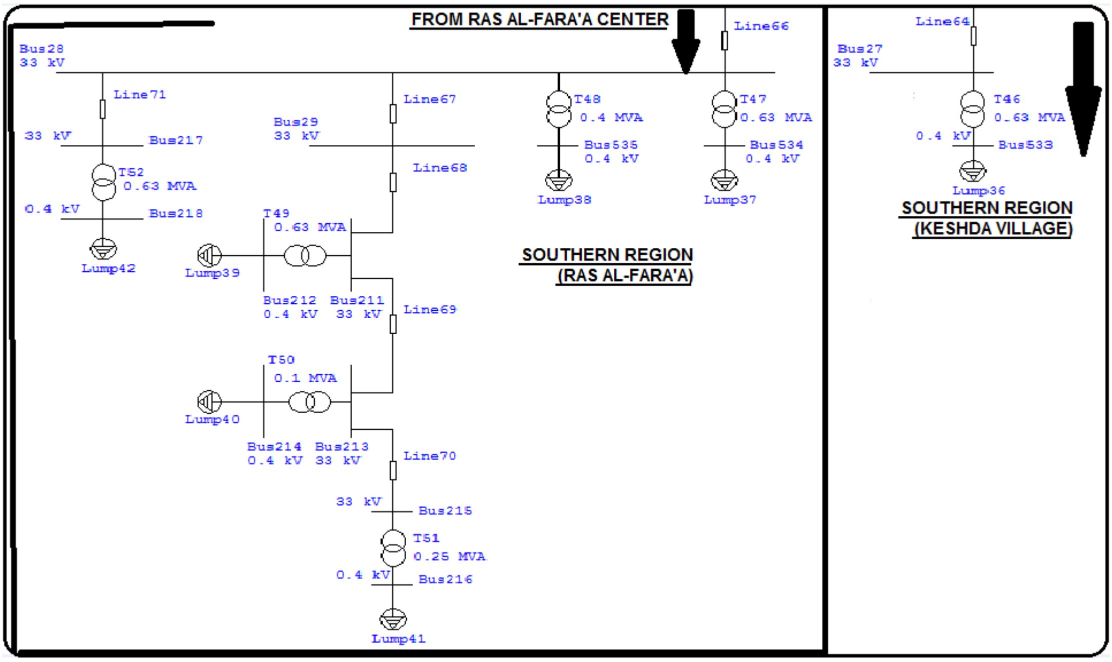

Figure (A.2.29) : The transformers & loads in the Southern region

The figure (A.2.30) shows the center of the Eastern region, the transformers, the solar systems and loads it contains.

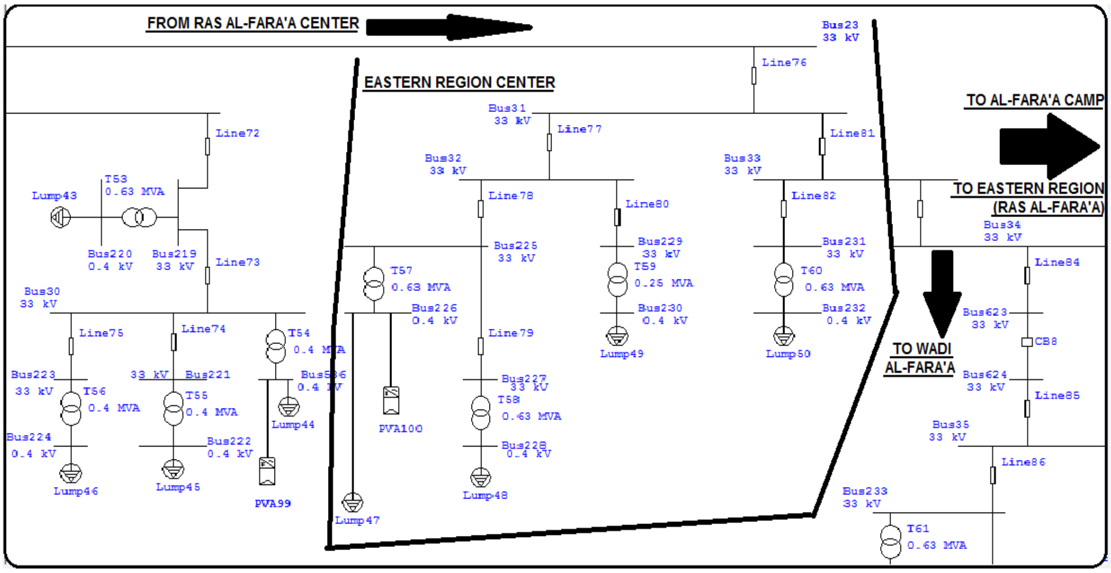

Figure (A.2.30) : The transformers, the solar systems & loads in the center of the Eastern region

The figure (A.2.31) shows the Eastern region, the transformers, the solar systems and loads it contains.

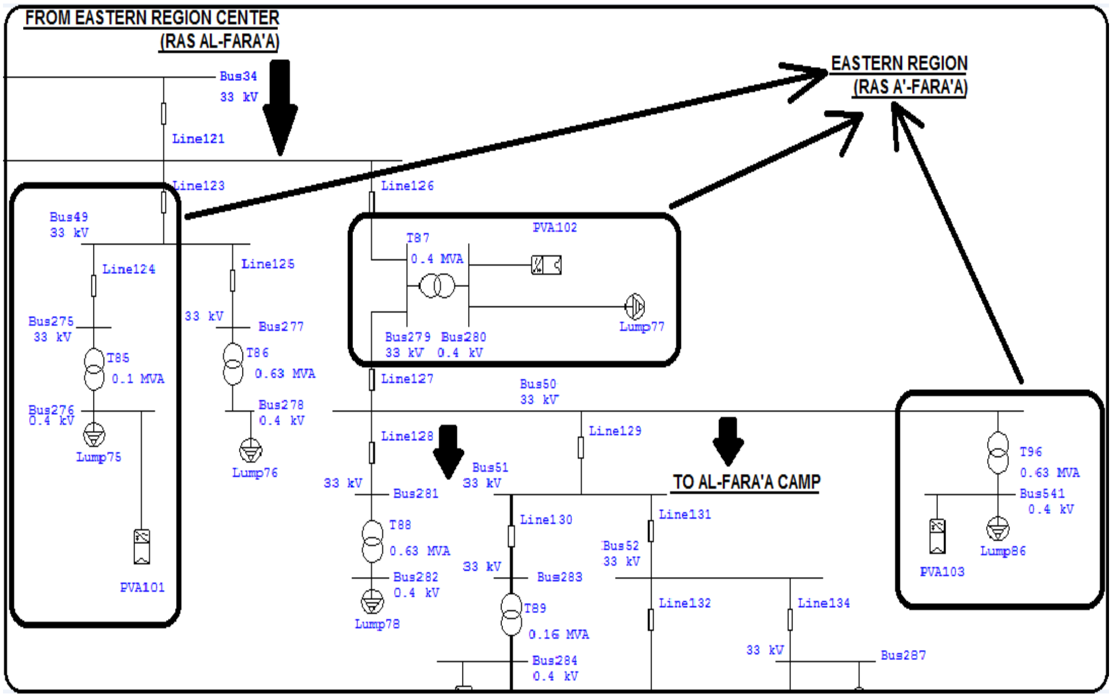

Figure (A.2.31) : The transformers, the solar systems & loads in the Eastern region

The figure (A.2.32) shows the zones of Ras Al-Fara'a region network in Tubas network as a whole.

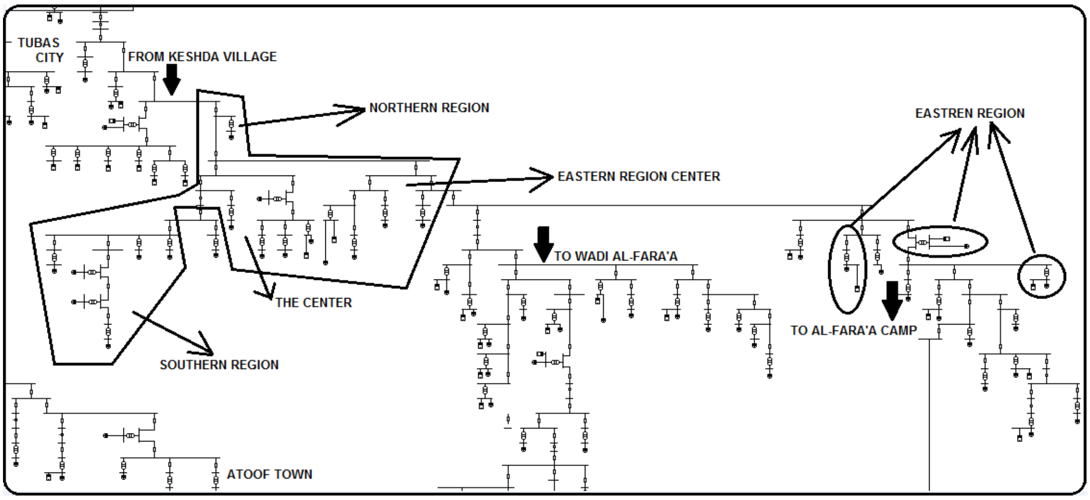

Figure (A.2.32) : The zones of the Ras Al-Fara'a region network in the Tubas network as a whole

The figure (A.2.33) shows the zones Of Ras Al-Fara'a region network in reality, by using the GPS system [57]. Such as: 1) The Northern region. 2) The center of the town. 3) The Southern region. 4) The centre of the Eastern region. 5) The Eastern region .

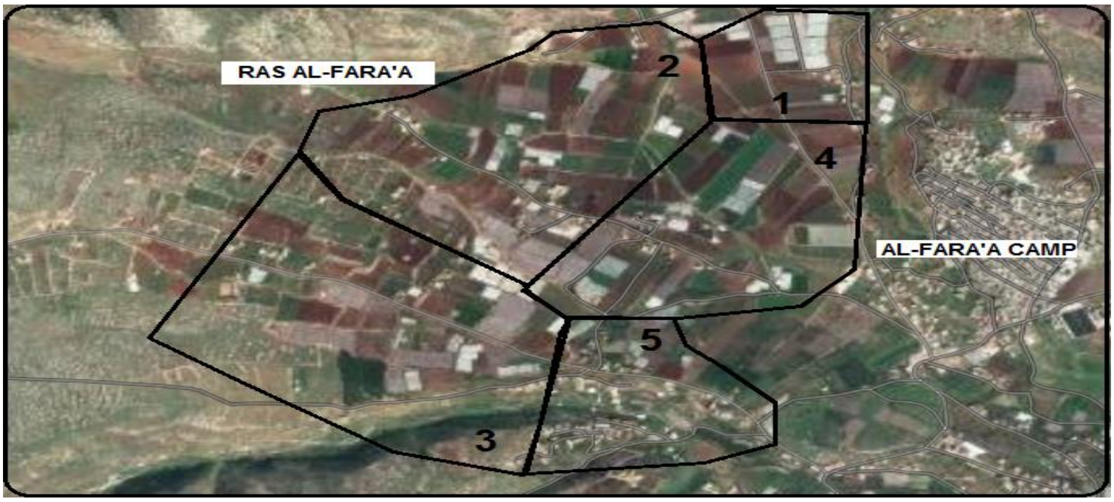

Figure (A.2.33) : The zones of the Ras Al-Fara'a region network in reality

6. The analysis of Atoof town:

1) The components of Atoof town network:

The table (A.2.6) shows the transformers, the solar system and loads in the town of Atoof, and the load values in the town [10].

Table (A.2.6) : The transformers, PV systems & loads in Atoof town

The Number & Name of each transformer in Atoof town in ETAB program	The Number and value of each PV systems in Atoof town in ETAB program	The Number of each load at each transformer in ETAB program	PF 100 %	P_{MAX} (KW)	Q_{MAX} (KVAR)
T 116 MOWAFAQ FAKHRY		L 106	31.33	128.4	388.34
T 117 HAKIM		L 107	85	25.5	14.3
T 118 TAMMON AGRI WELL		L 108	89	105.8	49.6
T 120 TAWHEED		L 110	95	112.4	31.6
T 121 YOUNES		L 111		0	0
T 122 BEQEEAA 1		L 112	92	213.6	1119
T 123 TAMMON AGRI COMPANY		L 113	84	146.9	84.1
T 124 MOWAFAQ & ASHQAR		L 114	89	151.9	69.3
T 125 BAQEEA		L 115	74	136.8	109.1
T 126 AL-JALHOOM		L 116	95	15.2	4.4
T 127		L 117	99	2.3	0.3

ABHAA					
T 128 ABU DERGHAM		L 118	95	187.9	53.4
T 129 ATOOF MAIN	PV 98 12 KWp	L 119	96	18.3	4..7
T 130 SALEH NAJI		L 120		0	0
T 131 BEQEEAA 2		L 121	86	239.4	128.5
T 132 PEARL & BASIL		L 122	89	10.1	4.5
T 133 CORN VALLEY (ATOOF)		L 123		0	0

* Note : The powers (Qmax & Pmax) in table (A.2.6) data from Tubas electricity company, and these values are the average annual load capacity for the year 2019.

The figure (A.2.34) shows the Western region of the Atoof town, the transformers and the loads it contains.

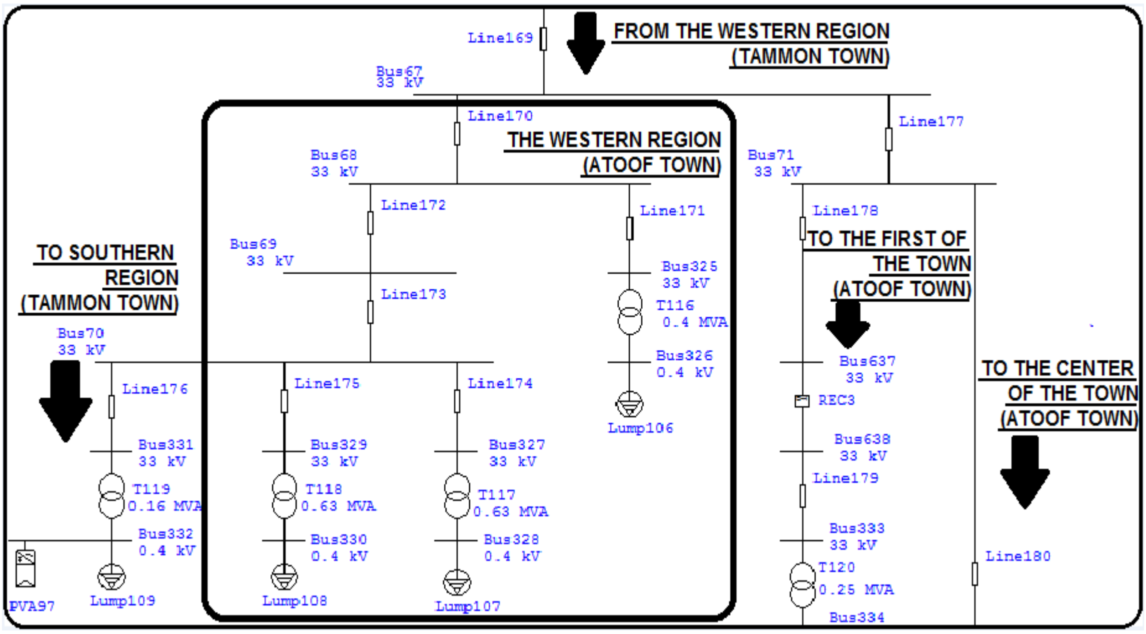

Figure (A.2.34) : The transformers & loads in the Western region

The figure (A.2.35) shows the first of the town of the Atoof town, the transformer and the loads it contains.

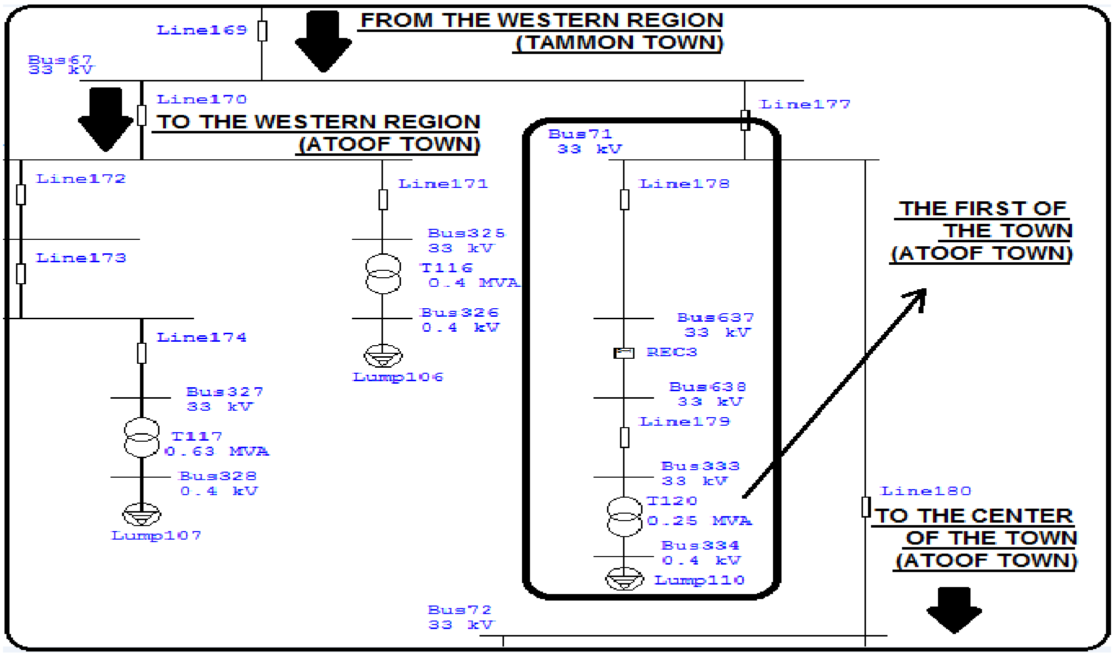

Figure (A.2.35) : The transformer & loads in the first of the town

The figure (A.2.36) shows the center of the town of the Atoof town, the transformers and the loads it contains.

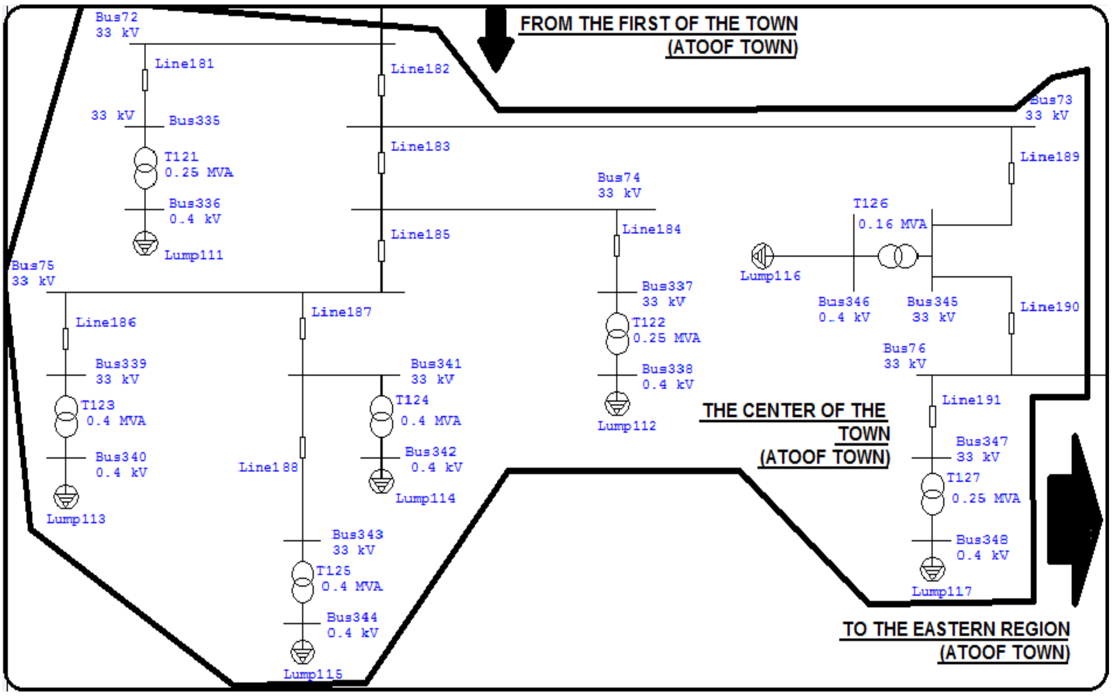

Figure (A.2.36) : The transformers & loads in the center of the town

The figure (A.2.37) shows the Eastern region of the Atoof town, the transformer and the loads it contains.

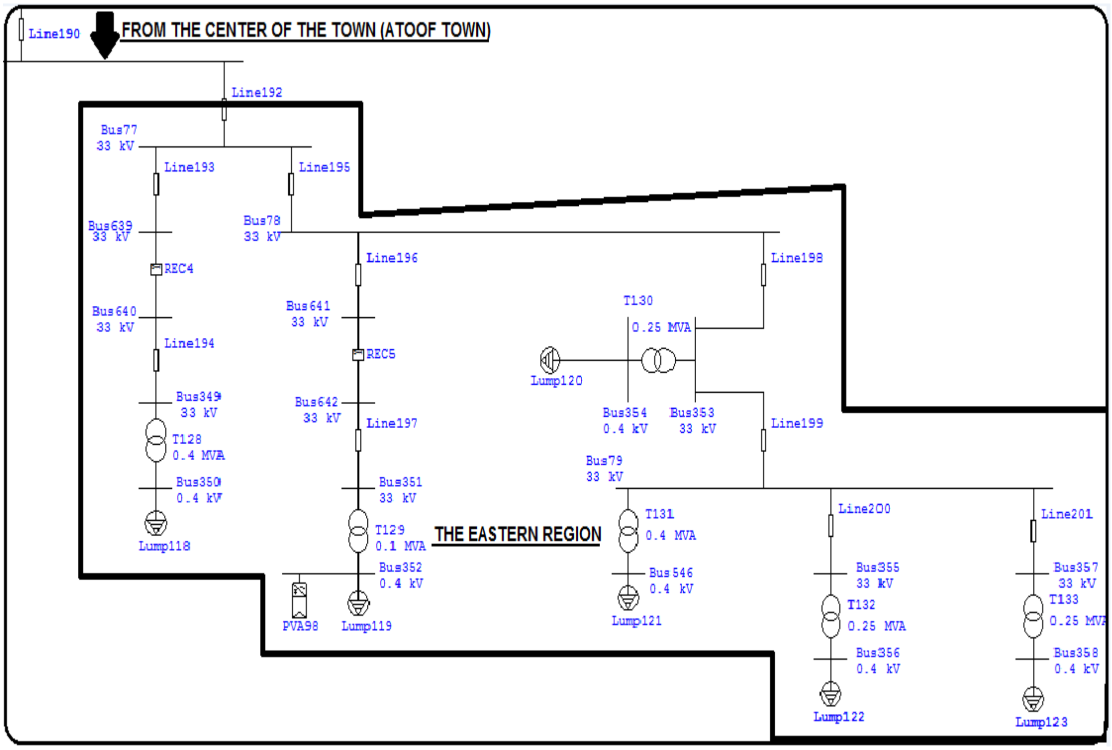

Figure (A.2.37) : The transformers & loads in the Eastern region

The figure (A.2.38) shows the zones of Atoof town network in Tubas network as a whole.

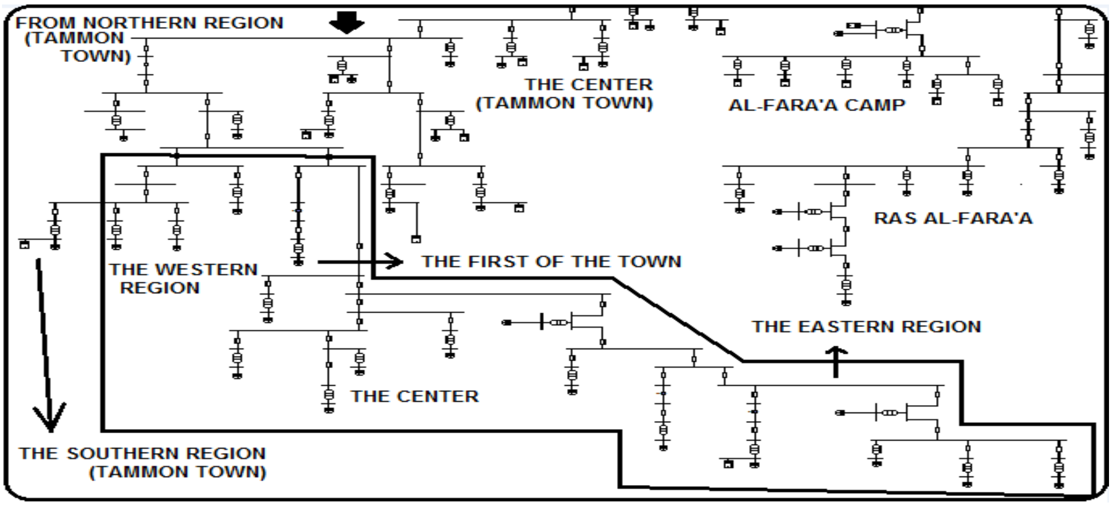

Figure (A.2.38) : The zones of the Atoof town network in the Tubas network as a whole

The figure (A.2.39) shows the zones of Atoof town network in reality, by using the GPS system [57]. Such as: 1) The Western region. 2) The first of the town. 3) The center of the town. 4) The Eastern region.

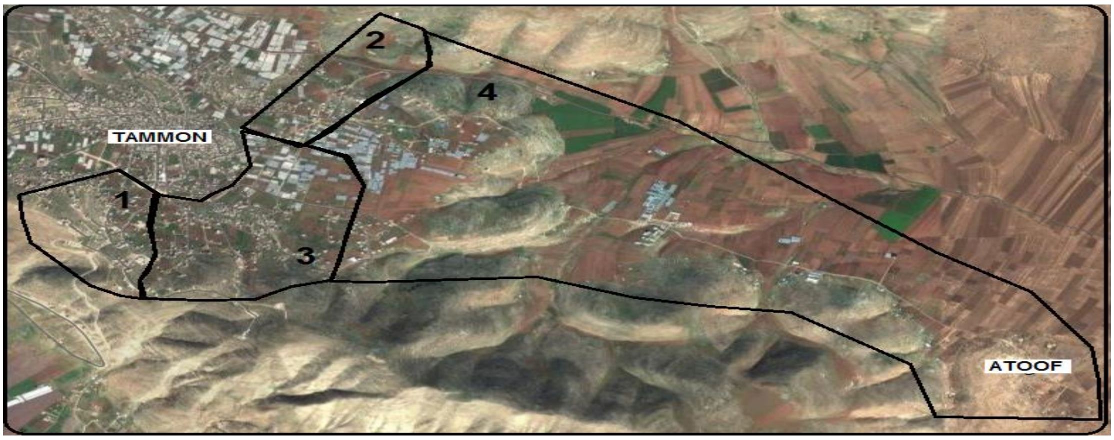

Figure (A.2.39) : The zones of the Atoof town network in reality

7. The analysis of Jalqamous village:

1) The components of Jalqamous village network:

The table (A.2.7) shows the transformers, the solar systems and loads in Jalqamous village, and the load values in the village [10].

Table (A.2.7) : The transformers, PV systems & loads in Jalqamous village

The Number & Name of each transformer in Jalqamous village in ETAB program	The Number and value of each PV systems in Jalqamous village in ETAB program	The Number of each load at each transformer in ETAB program	PF 100 %	P_{MAX} (KW)	Q_{MAX} (KVAR)
T 200 WESTERN (JALQUMOUS)	PV 60 40 KWp	L 190	99	129.1	14.7
T 201 POLICE (JALQUMOUS)	PV 61 5 KWp	L 191	100	14.8	0.8
T 202 EASTERN (JALQUMOUS)	PV 62 5 KWp	L 192	96	51.6	12.8
T 208 MIDDLE (JALQUMOUS)	PV 67 40 KWp	L 198	98	216.0	37.8

* Note : The powers (Qmax & Pmax) in table (A.2.7) data from Tubas Electricity Company, and these values are the average annual load capacity for the year 2019.

The figure (A.2.40) shows the transformers, the solar systems and loads in the village of Jalqamous.

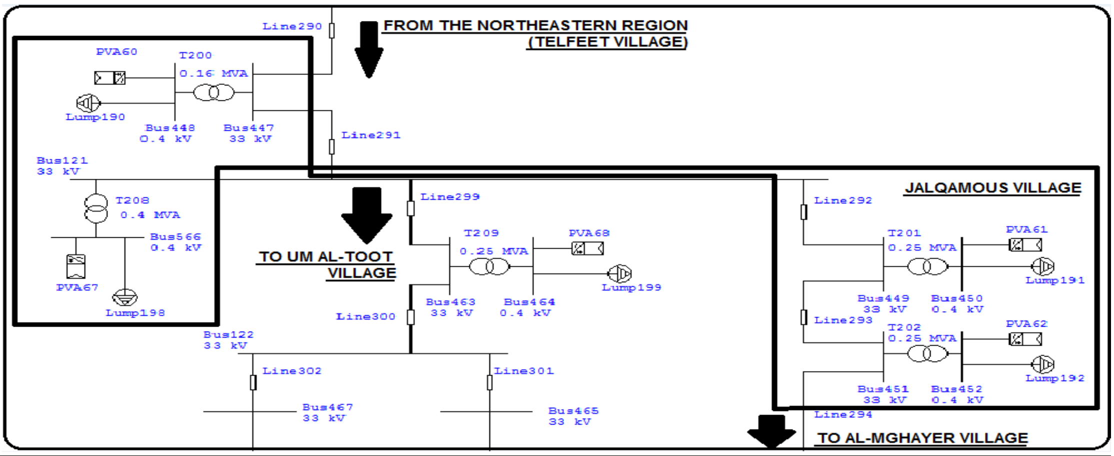

Figure (A.2.40) : The transformer & loads in the Jalqamous village

The figure (A.2.41) shows the zone of Jalqamous village network in Tubas network as a whole.

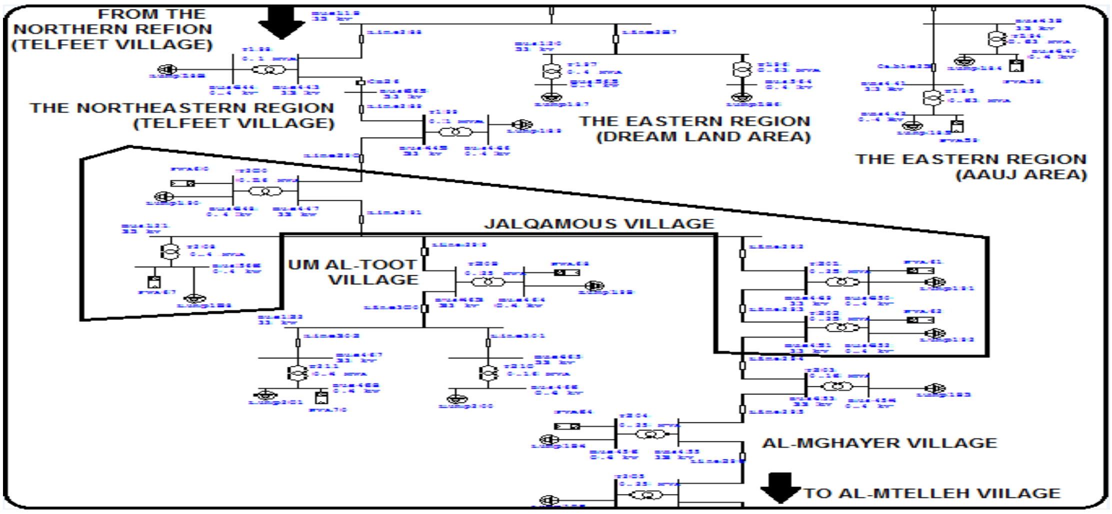

Figure (A.2.41) : The zone of the Jalqamous village network in the Tubas network as a whole

The figure (A.2.42) shows the zone of Jalqamous village network in reality, by using the GPS system [57]. With the location of the transformers in the village.

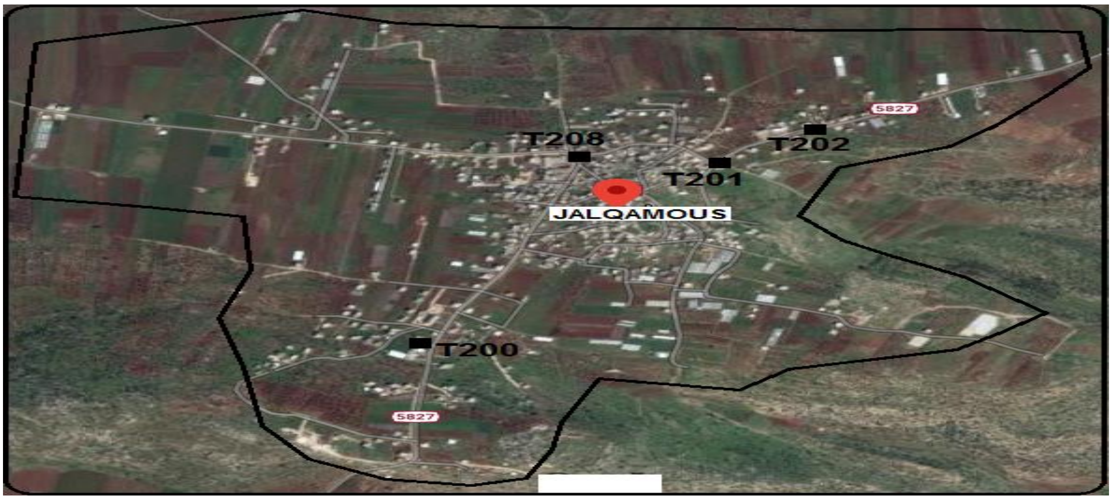

Figure (A.2.42) : The zone of the Jalqamous village network in reality

2) The problems of Jalqamous village network:

The figure (A.2.43) shows the large loads on transformer (T200) in Jalqamous village network in reality by using the GPS system [57]. With the location of the transformer (T200), and the location of the water tank pump that connected to the transformer (T200) at a distance of 1000 meters.

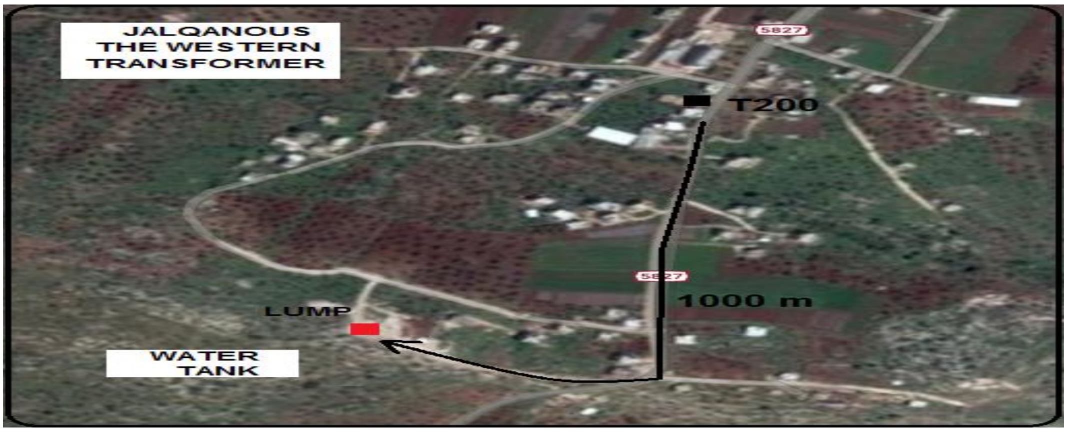

Figure (A.2.43) : The large loads on transformer(T200) in Jalqamous village network in reality

Appendix B : The solutions.

B.1. The suggested solutions to the problems of Tubas network:

1. The suggested solutions to the problems of Tubas city network:

- For problem 1: The table (B.1.1) shows the details of the loads (distant houses) that get fed from the transformer (T8//al-AL-THOGHRAH which is located in the Northern region of Tubas city) [10].

Table (B.1.1) : The details for the distant houses in Tubas city network

The load	The real power (Pmax – KW)	The reactive power (Qmax – KVAR)
Load 241	20	0.5
Load 242	28	0.6

The figure (B.1.1) shows the large distance between the transformer (T8 // AL-THOGRAH) and some loads that it feeds, which are 2000-2500 meters away from it, located in the Northern region of the city of Tubas, The figure (B.1.1) obtained using the global positioning system (GPS system[57].

Figure (B.1.1) : The distance between the transformer(T8) and its loads in Tubas city network

The figure (B.1.2) shows the addition of the solar system PV116 to Bus685 next to the load Load241 which is 2000 meters away from its transformer (T8//AL-THOGHRAH) and the addition of the solar system PV117 to Bus686 next to the Load242 which is 2500 meters away from its transformer (T8//AL-THOGHRAH).

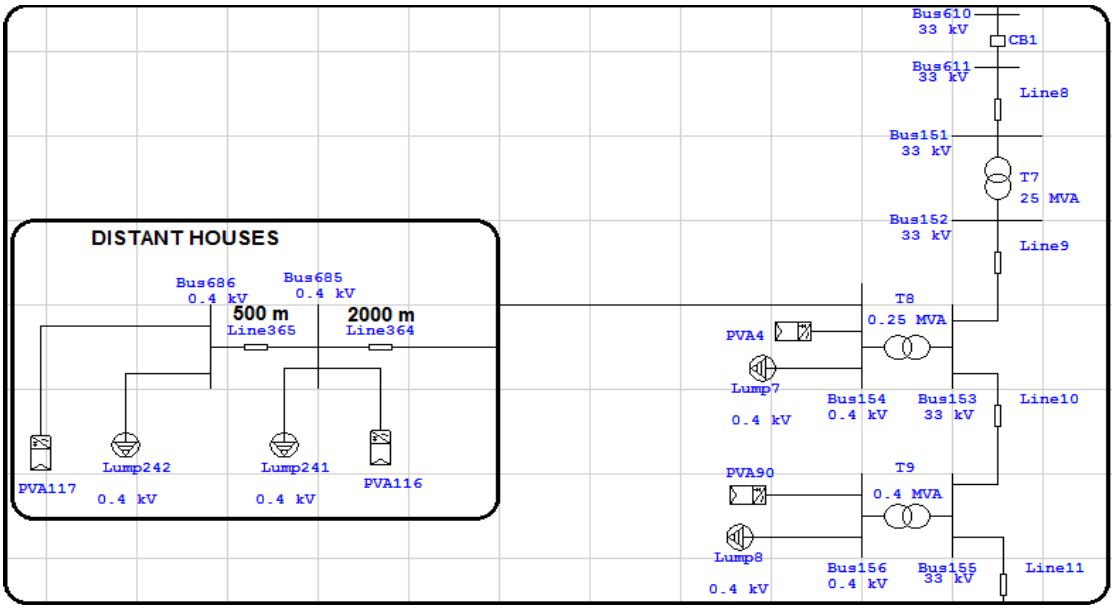

Figure (B.1.2) : The addition of PV116 (next Load241 at Bus685) & PV117 (next Load242 at Bus686) at the transformer(T8) in Tubas city network

The figure (B.1.3) shows the addition of the new solar systems (PV116 &Pv117) next to the loads (distant houses "Load241 & Load242") which receives the electrical supply from transformer (T8//AL-THOGHRAH) which is located in the Northern region of Tubas city.

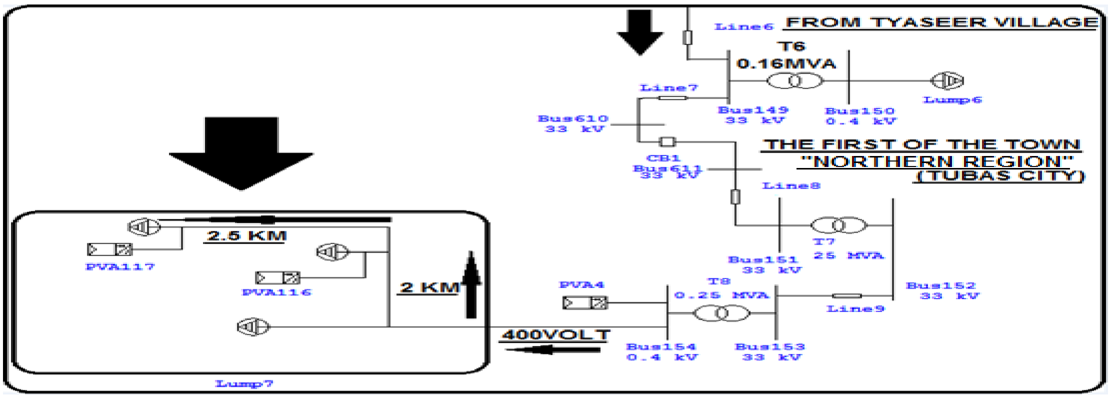

Figure (B.1.3) : The adding for PV116 & PV117 at the transformer (T8) next the loads Load241 & L242 respectively in Tubas city network

The table (B.1.2) shows the details of the new solar systems (PV116 & PV117) proposed to solve the first problem in the city of Tubas located in the Northern region of the city.

Table (B.1.2) : The details for the suggested solar systems solution for problem 1 in Tubas city network

The number of the solar system	The value of the solar system	The power value for each panel	The open circuit voltage value for each panel	The max pick (voltage & current) values for each panel
PV 116	5 KWp	110 watts	15 V_{OC}	12 Vmp // 9.17 Amp
	The short circuit current value for each panel			
	10.08 A_{SC}			
Inv 116	The number of the inverter	The rated power	The rated voltage	The factors (EFF & PF)
	Inv 116	5 KW (DC)	400 VOLT (AC)	90% (efficiency fill factor)
		4.5 KVA (AC)		100% (power factor)
The number of the solar system	The value of the solar system	The power value for each panel	The open circuit voltage value for each panel	The max pick (voltage & current) values for each panel
PV 117	5 KWp	110 watts	15 V_{OC}	12 Vmp // 9.17 Amp
	The short circuit current value for each panel			
	10.08 A_{SC}			

Inv 117	The number of the inverter	The rated power	The rated voltage	The factors (EFF & PF)
	Inv 117	5 KW (DC)	400 VOLT (AC)	90% (efficiency fill factor-DC)
		4.5 KVA (AC)		100% (power factor-AC)

The figure (B.1.4) shows the power factors for the loads of the transformer (T8//AL-THOGHRAH) as well as the electrical currents of these loads , as Bus154 indicates the location of loads near the transformer(T8//AL-THOGHRAH) and Buses(685 & 686) refer to the location of the transformer (T8//AL-THOGHRAH).

ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp
Bus152	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus153	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus154	0.400		0.016	0	0.012	0	0	0	0	0	0.029	100.0	68.6
Bus155	33.000		0	0	0	0	0	0	0	0	0	0.0	0.0
Bus685	0.400		-0.001	0	0.001	0	0	0	0	0	0.001	100.0	3.5
Bus686	0.400		-0.002	0	0.002	0	0	0	0	0	0.002	100.0	4.8

Figure (B.1.4) : The power factors and electrical current at the transformer(T8) before adding the suggested transformer(T254) in Tubas city network

The figure (B.1.5) shows the transformer (T254) which is located between buses (685 & 686) and gets 33KV electrical power through the new transmission line Line358 which is connected to the network at Bus153 located next to the transformer (T8//AL-THOGHRAH), where the new transformer T254 is located next to the Load241 and is 500 meters away from the Load242.

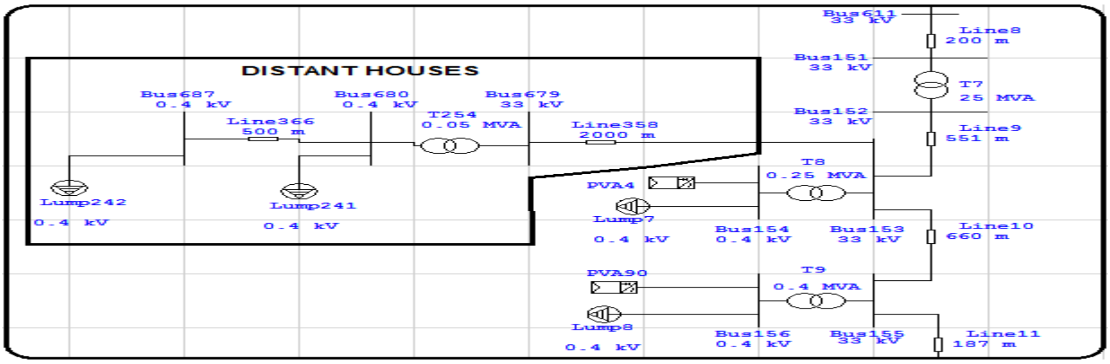

Figure (B.1.5) : The addition of the suggested transformer(T254) with new transmission line(TL358) in Tubas city network

The figure (B.1.6) shows the location of the suggested transformer(T254), which will be next to the Load241, where a new transmission line (Line358) will be built to transmit 33KV from Bus153 which is located next to the transformer (T8//AL-THOGHRAH), where the length of the new transmission line will be (2000 meters).

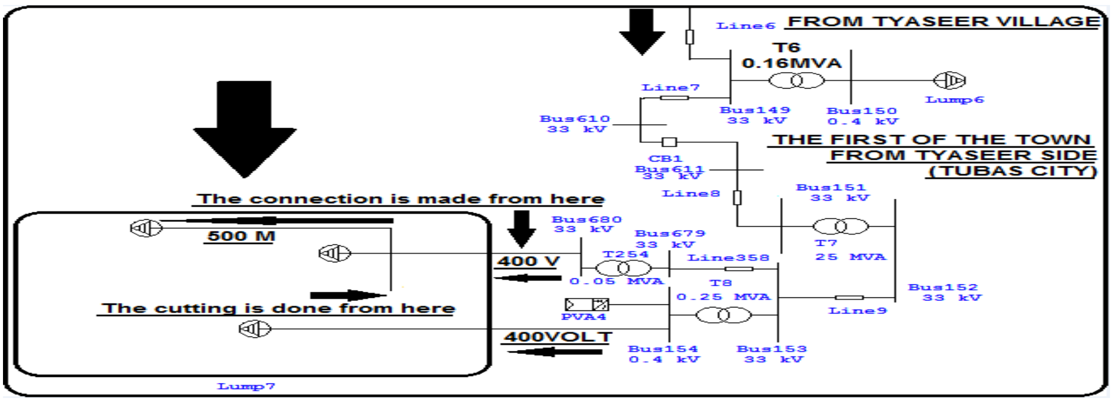

Figure (B.1.6) : The addition of the suggested transformer(T254) as a solution of problem 1 in Tubas city network

The table (B.1.3) shows the details for the suggested transformer(T254) and the new transmission line(TL358) that located in the Northern region of the city of Tubas. and this suggested transformer(T254) it is used to reduce the pressure on the transformer(T8//AL-THOGHRAH) and also to improve the electric current at the loads (Load241 & Load242).

Table (B.1.3) : The details for the suggested transformer and new transmission line to solve the problem 1 in Tubas city network

The suggested transformer	The voltage rating (KV)	The power rating (KVA)	The connection bus's From bus - to bus -
T 254	33/0.4	50	From (B679) to (B680)
The suggested transmission line	**The voltage rating (KV)**	**The length (meters)**	**The intersection size (mm^2)**
TL 358	33	2000	158

The figure (B.1.7) shows the new transmission line (TL367) between the Bus148 which is located next to transformer (T3//SCHOOL TYASEER) and Bus688 which is next to the loads (Load241 & Load242) located in the Northern region of the city of Tubas, at a distance of (2000-2500 meters) from transformer (T8//AL-THOGHRAH).

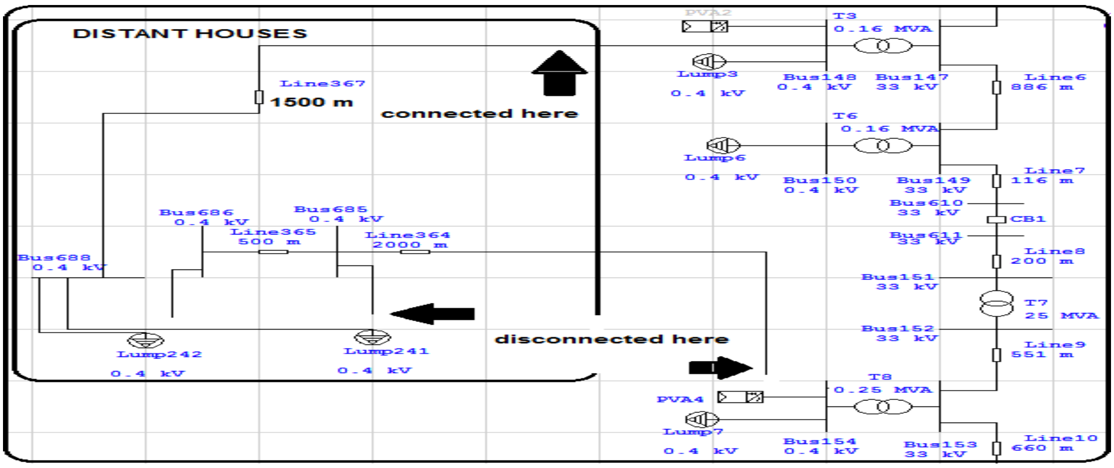

Figure (B.1.7) : The new low voltage transmission line(TL367) between the transformer(T3) and the distance houses (load241 & load242) in Tubas city network

The figure (B.1.8) shows the new transmission line (TL367 – 400Volt – low voltage – 1500meters) that connecting between the transformer (T3//SCHOOL TYASEER) and the loads (Load241 &

Load242), as these loads (Load241 & Load242) are loads belonging to the Northern region of the city of Tubas, at a distance of (2000-2500 meters) from transformer (T8//AL-THOGHRAH).

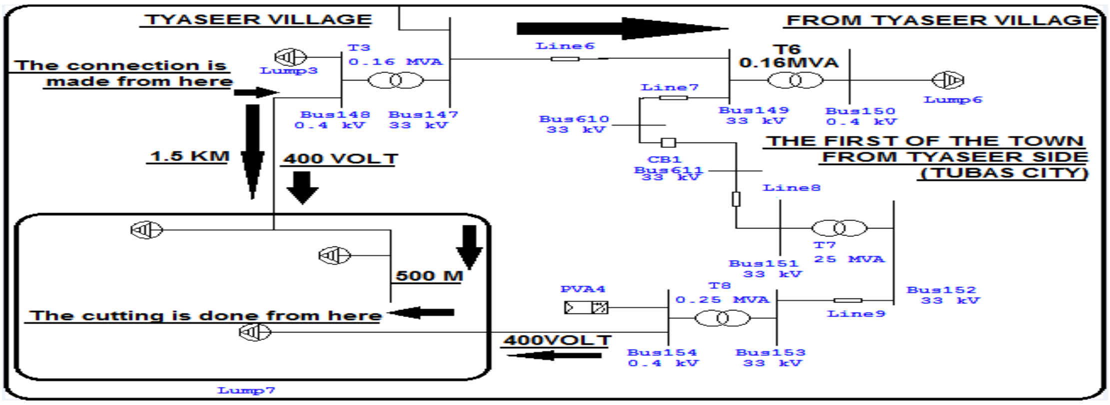

Figure (B.1.8) : The new low voltage transmission line(TL367) in Tubas city network

The table (B.1.4) shows the details for the new transmission line (TL367) that located between the transformer (T3//SCHOOL TYASEER) and the loads (Load241 & Load242).

Table (B.1.4) : The details for the suggested transmission line to solve the problem 1 in Tubas city network

The suggested transmission line	The voltage rating (KV)	The length (meters)	The intersection size (mm^2)
TL 367	0.400	1500	34

- For problem 2: The figure (B.1.9) shows the addition of the new solar system (PV13 – 5KWp) to Bus178 next to the transformer (T23//KAZIYA AL-MOTHEDIEN) near to the Load19 in the Southern region1 of the city of Tubas.

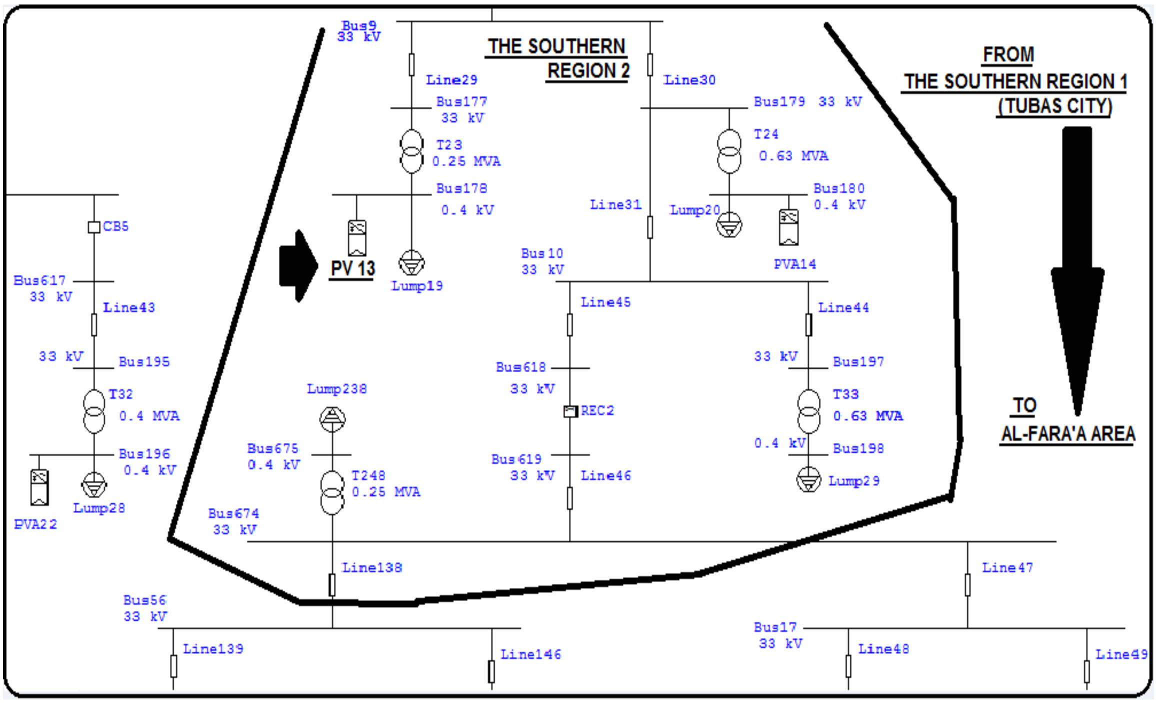

Figure (B.1.9) : The adding suggested solar system(PV13) at the transformer(T23) in Tubas city network

The table (B.1.5) shows the details for the new solar system (PV13) to be built next to the transformer (T23//KAZIYA AL-MOTHEDIEN) near the Load19 . as is evident in the table , the solar system is built completely from the smallest details using the simulation program (ETAP) .

Table (B.1.5) : The details for the suggested solar system (PV13) to solve the problem 2 in Tubas city network

<table>
<tr><th>The number of the solar system</th><th>The value of the solar system</th><th>The power value for each panel</th><th>The open circuit voltage value for each panel</th><th>The max pick (voltage & current) values for each panel</th></tr>
<tr><td rowspan="3">PV 13</td><td>5 KWp</td><td>110 watts</td><td>15 V_{OC}</td><td>12 Vmp // 9.17 Amp</td></tr>
<tr><td colspan="4">The short circuit current value for each panel</td></tr>
<tr><td colspan="4">10.08 A_{SC}</td></tr>
<tr><td rowspan="3">Inv 13</td><td>The number of the inverter</td><td>The rated power</td><td>The rated voltage</td><td>The factors
(EFF & PF)</td></tr>
<tr><td rowspan="2">Inv 13</td><td>5 KW (DC)</td><td rowspan="2">400 VOLT (AC)</td><td>90% (efficiency fill factor)</td></tr>
<tr><td>4.5 KVA (AC)</td><td>100% (power factor)</td></tr>
</table>

- For problem 3: The figure (B.1.10) shows the addition of the new solar system (PV18 – 5KWp) to Bus188 next to the transformer (T28//TUBAS MUNICIPALITY WELL) near the Load24 in the center of the town2 (Tubas city).

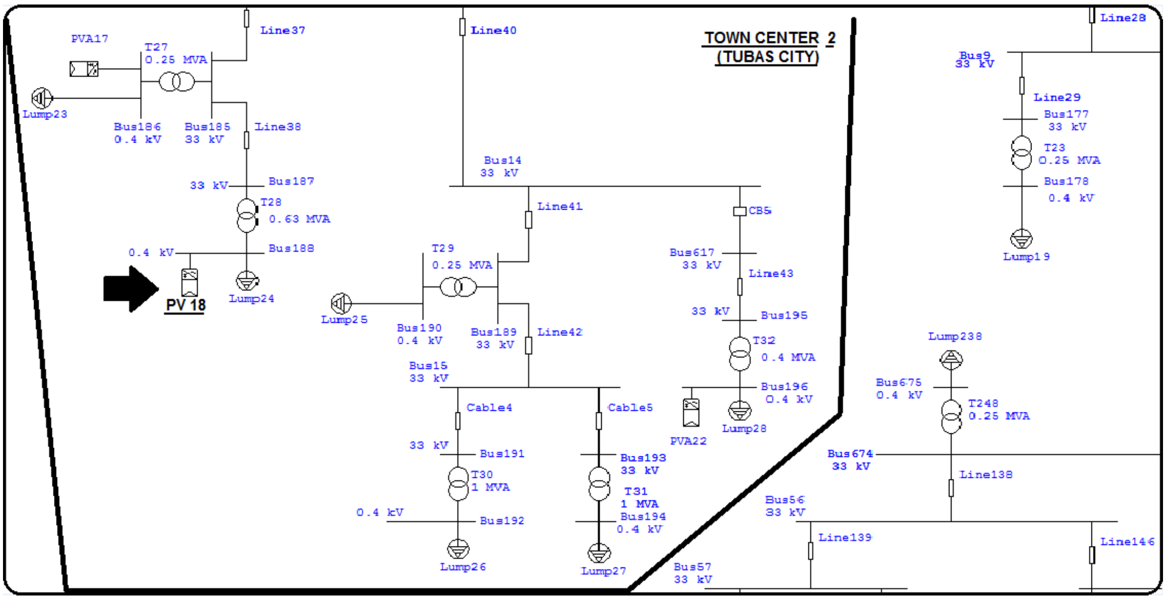

Figure (B.1.10) : Adding of the suggested solar system(PV18) at the transformer (T28) in Tubas city network

The table (B.1.6) shows the details for the new solar system (PV18) to be built next to the transformer (T28//TUBAS MUNICIPALITY WELL) near the Load24. AS is evident in the table, the solar system is to be built completely from the smallest details using the simulation program (ETAP).

Table (B.1.6) : The details for the suggested solar system to solve the problem 3 in Tubas city network

The number of the solar system	The value of the solar system	The power value for each panel	The open circuit voltage value for each panel	The max pick (voltage & current) values for each panel
PV 18	5 KWp	110 watts	15 V_{OC}	12 Vmp // 9.17 Amp
	The short circuit current value for each panel			
	10.08 A_{SC}			

Inv 18	The number of the inverter	The rated power	The rated voltage	The factors (EFF & PF)
	Inv 18	5 KW (DC)	400 VOLT (AC)	90% (efficiency fill factor)
		4.5 KVA (AC)		100% (power factor)

- For problem 4: The figure (B.1.11) shows the addition of the new solar system (PV19 – 5KWp) to Bus190 next to the transformer (T29//RAWDA-NEW AMN WATANY CENTER) near the Load25 in the center of the town2 (Tubas city).

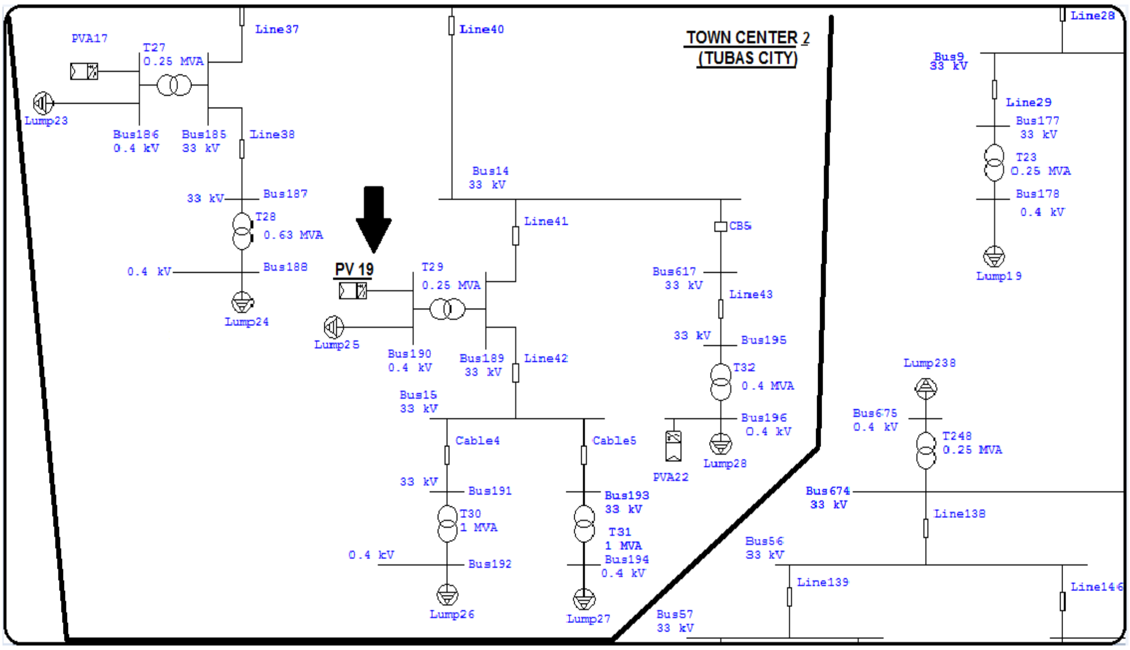

Figure (B.1.11) : The adding suggested solar system(PV19) at the transformer (T29) in Tubas city network

The table (B.1.7) shows the details for the new solar system (PV19) that being built next to the transformer (T29//RAWDA-NEW AMN WATANY CENTER) near the Load25. As is evident in the table , the solar system is built completely from the smallest details using the simulation program (ETAP).

Table (B.1.7) : The details for the suggested solar system to solve the problem 4 in Tubas city network

The number of the solar system	The value of the solar system	The power value for each panel	The open circuit voltage value for each panel	The max pick (voltage & current) values for each panel
PV 19	5 KWp	110 watts	15 V_{OC}	12 Vmp // 9.17 Amp
	The short circuit current value for each panel			
	10.08 A_{SC}			
Inv 19	The number of the inverter	The rated power	The rated voltage	The factors (EFF & PF)
	Inv 19	5 KW (DC)	400 VOLT (AC)	90% (efficiency fill factor)
		4.5 KVA (AC)		100% (power factor)

The figure (B.1.12) shows the addition of the new solar system (PV20 – 5KWp) to Bus192 next to the transformer (T30//AMN WATANY CENTER1) near the Load26 in the center of the town2 (Tubas city).

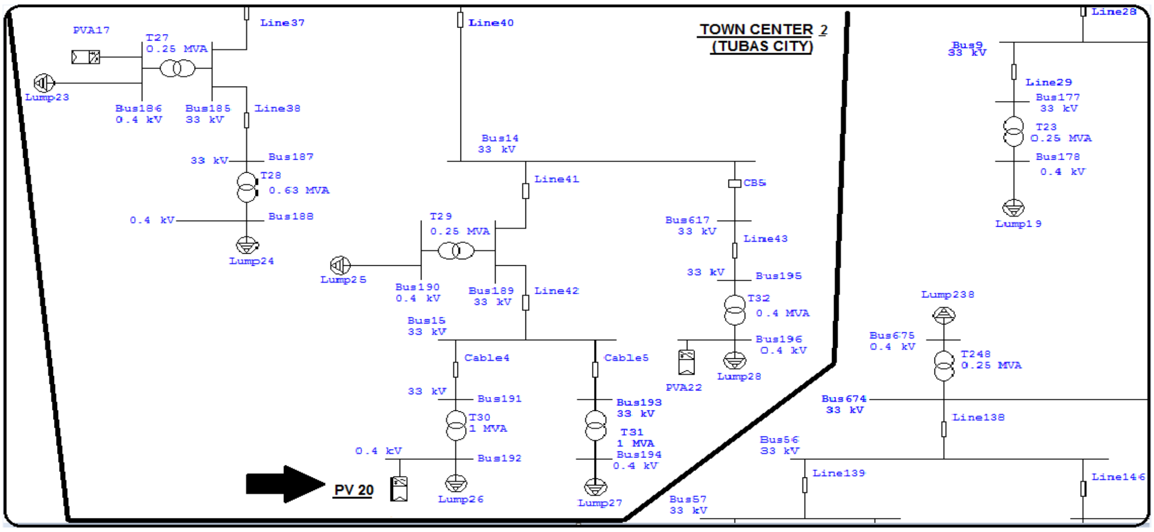

Figure (B.1.12) : The adding suggested solar system(PV20) at the transformer (T30) in Tubas city network

The table (B.1.8) shows the details for the new solar system (PV20) that being built next to the transformer (T30//AMN WATANY CENTER1) near the Load26. As is evident in the table, the solar system is built completely from the smallest details using the simulation program (ETAP).

Table (B.1.8) : The details for the suggested solar system to solve the problem 4 in Tubas city network

<table>
<tr><th>The number of the solar system</th><th>The value of the solar system</th><th>The power value for each panel</th><th>The open circuit voltage value for each panel</th><th>The max pick (voltage & current) values for each panel</th></tr>
<tr><td rowspan="3">PV 20</td><td>5 KWp</td><td>110 watts</td><td>15 V_{OC}</td><td>12 Vmp // 9.17 Amp</td></tr>
<tr><td colspan="4">The short circuit current value for each panel</td></tr>
<tr><td colspan="4">10.08 A_{SC}</td></tr>
<tr><td rowspan="3">Inv 20</td><td>The number of the inverter</td><td>The rated power</td><td>The rated voltage</td><td>The factors (EFF & PF)</td></tr>
<tr><td rowspan="2">Inv 20</td><td>5 KW (DC)</td><td rowspan="2">400 VOLT (AC)</td><td>90% (efficiency fill factor)</td></tr>
<tr><td>4.5 KVA (AC)</td><td>100% (power factor)</td></tr>
</table>

The figure (B.1.13) shows the addition of the new solar system (PV21 – 5KWp) to Bus194 next to the transformer (T31//AMN WATANY CENTER2) near the Load26 in the center of the town2 (Tubas city).

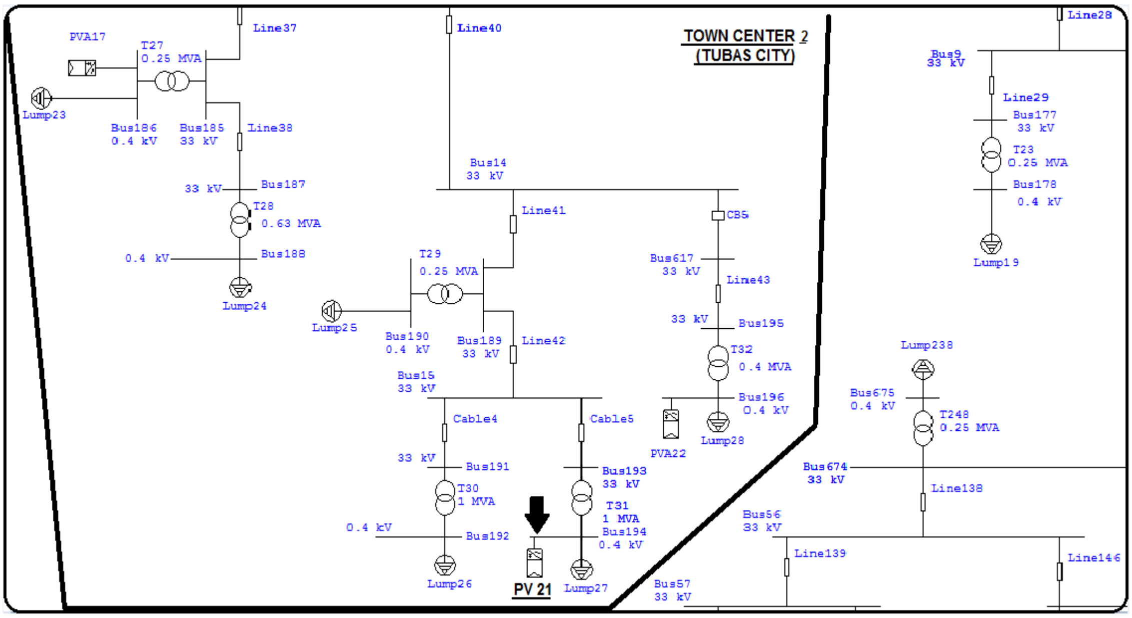

Figure (B.1.13) : The adding suggested solar system(PV21) at the transformer (T31) in Tubas city network

The table (B.1.9) shows the details for the new solar system (PV21) that being built next to the transformer (T31//AMN WATANY CENTER2) near the Load27. AS is evident in the table, the solar system is built completely from the smallest details using the simulation program (ETAP).

Table (B.1.9) : The details for the suggested solar system to solve the problem 4 in Tubas city network

<table>
<tr><th>The number of the solar system</th><th>The value of the solar system</th><th>The power value for each panel</th><th>The open circuit voltage value for each panel</th><th>The max pick (voltage & current) values for each panel</th></tr>
<tr><td rowspan="3">PV 21</td><td>5 KWp</td><td>110 watts</td><td>15 V_{OC}</td><td>12 Vmp // 9.17 Amp</td></tr>
<tr><td colspan="4">The short circuit current value for each panel</td></tr>
<tr><td colspan="4">10.08 A_{SC}</td></tr>
<tr><td rowspan="3">Inv 21</td><td>The number of the inverter</td><td>The rated power</td><td>The rated voltage</td><td>The factors (EFF & PF)</td></tr>
<tr><td rowspan="2">Inv 21</td><td>5 KW (DC)</td><td rowspan="2">400 VOLT (AC)</td><td>90% (efficiency fill factor)</td></tr>
<tr><td>4.5 KVA (AC)</td><td>100% (power factor)</td></tr>
</table>

- For problem 5: The figure (B.1.14) shows the homes(Load243) that next the transformer (T137//CUSTMOS POLICE) these homes receive the electrical power from the transformer (T135//AL-HAWOOZ 1) through the transmission line (TL368 – low voltage transmission line – 3000meters).

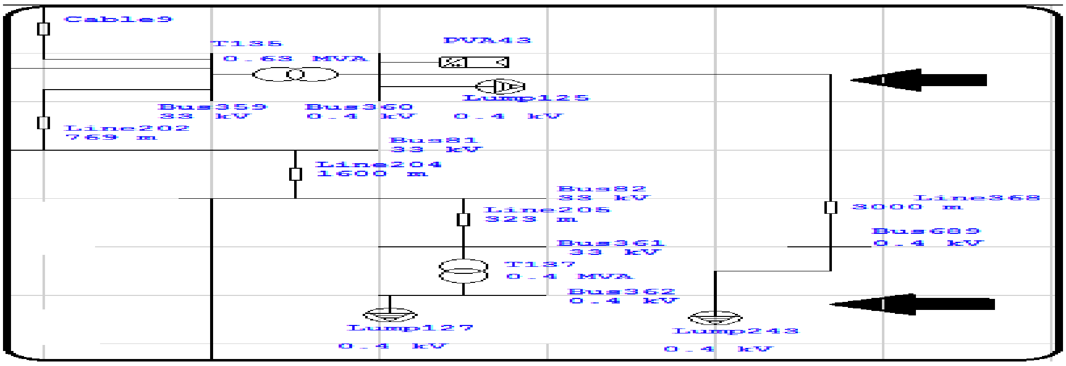

Figure (B.1.14) : The houses (laod243) next to the customs police station receive electrical power from the transformer(T137) which is 3000m away through (TL368) in Tubas city network

The table (B.1.10) shows the details for the new solar system (PV45) that being built next to the transformer (T137//CUSTOMS POLICE) near the loads (Load127 & Load243). AS is evident in the table, the solar system is built completely from the smallest details using the simulation program (ETAP), and the table showing the details for the Load243.

Table (B.1.10) : The details for the suggested solar system to solve the problem 5 and the Load243 in Tubas city network

<table>
<tr><th>The number of the solar system</th><th>The value of the solar system</th><th>The power value for each panel</th><th>The open circuit voltage value for each panel</th><th>The max pick (voltage & current) values for each panel</th></tr>
<tr><td rowspan="3">PV 45</td><td>5 KWp</td><td>110 watts</td><td>15 V_{OC}</td><td>12 Vmp // 9.17 Amp</td></tr>
<tr><td colspan="4">The short circuit current value for each panel</td></tr>
<tr><td colspan="4">10.08 A_{SC}</td></tr>
<tr><td rowspan="2">Inv 45</td><td>The number of the inverter</td><td>The rated power</td><td>The rated voltage</td><td>The factors
(EFF & PF)</td></tr>
<tr><td>Inv 45</td><td>5 KW (DC)</td><td>400 VOLT (AC)</td><td>90% (efficiency fill</td></tr>
</table>

				factor)
		4.5 KVA (AC)		100% (power factor)

The number of the load	The real power of the load	The reactive power of the load	The voltage rating of the load
L 243	116 KW	20 KVAR	400 VOLT

2. The suggested solutions to the problems of Keshda village network:

The figure (B.1.15) shows the distance between the regions of the village of Keshda such as the region1(the center of the village) gets the electrical power from the Southern regions of Tubas city (the areas near Al-Fara'a areas) and the region 2 (Southern region of the village) gets the electrical power from the center of the town (Ras Al-Fara'a area). The figure (B.1.15) obtained using the global positioning system (GPS system[57]).

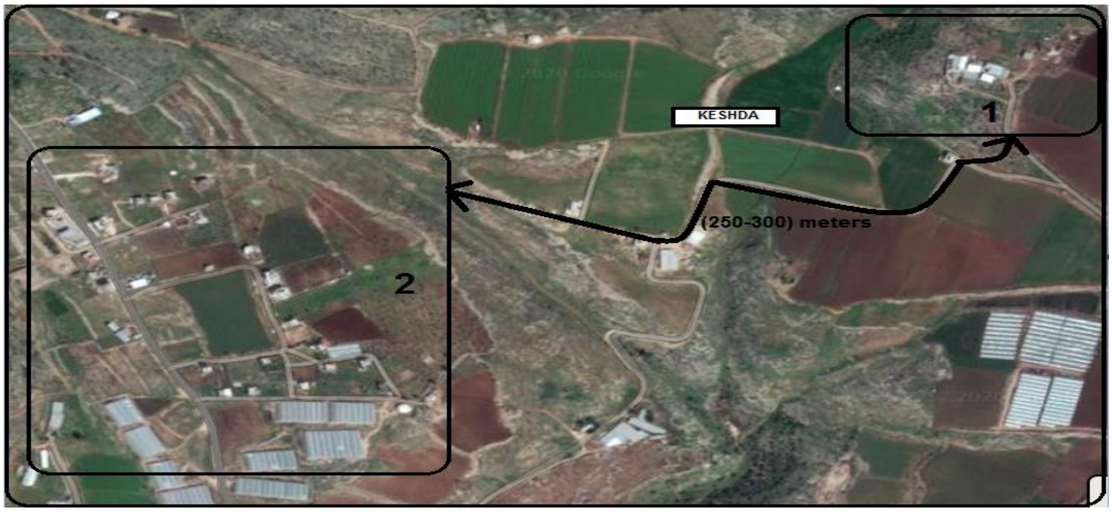

Figure (B.1.15) : The distance between the regions in the village in Keshda village network

The figure (B.1.16) the distance between the feeding areas that feeding the regions of the village of Keshda (the areas near Al-Fara'a areas "Tubas city" that feeding the center of the village "Keshda village" and the center of the town "Ras Al-Fara'a area" that feeding the Southern region of the village.

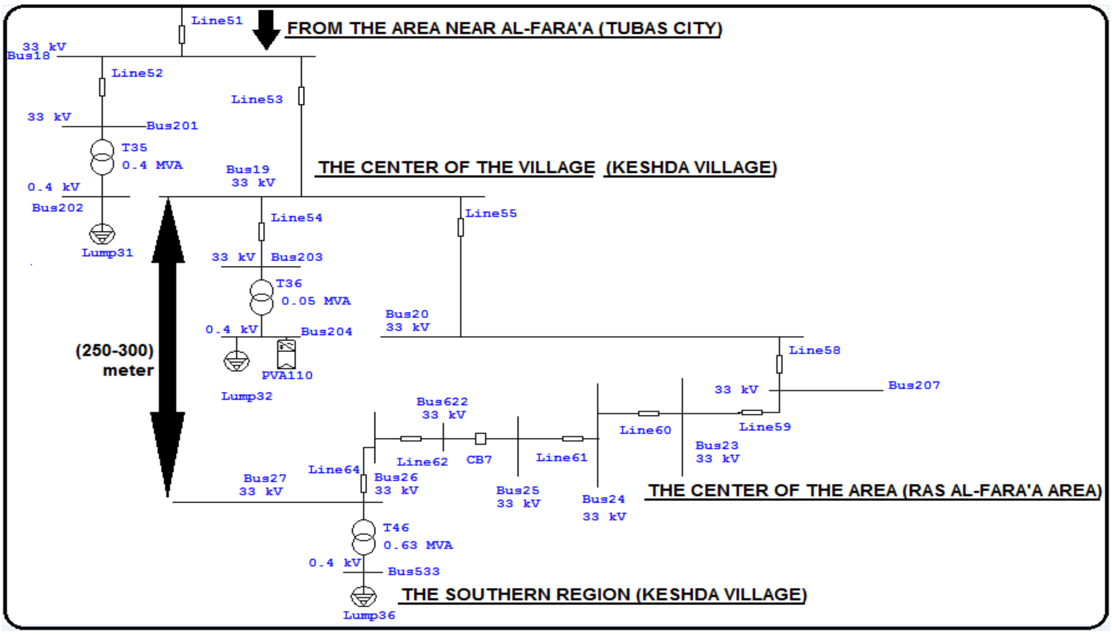

Figure (B.1.16) : The distance between the feeding areas (the center of the town – Ras Al-Fara'a area and the areas near Al-Fara'a areas – Tubas city) in Keshda village network

The table (B.1.11) shows the details for the new transmission line that connection between the regions of the Keshda village. AS shown in the figure (3.1.18) in chapter 3.

Table (B.1.11) : The details for the suggested transmission line to solve the problem in Keshda village network

The suggested transmission line	The voltage rating (KV)	The length (meters)	The intersection size (mm^2)
TL 357	33	300	158

3. The suggested solutions to the problems of Tyaseer village network:

The figure (B.1.17) shows the adding new solar system (PV2 – 5KWp) to Bus148 at the transformer (T3//SCHOOL-Tyaseer) in the village of Tyaseer.

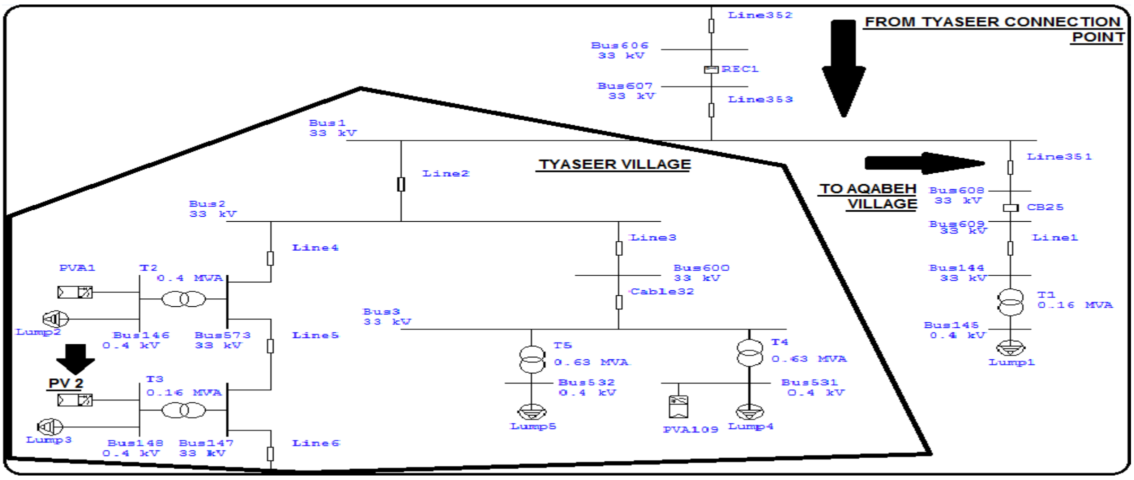

Figure (B.1.17) : The adding suggested solar system(PV2) at the transformer (T3) in Tyaseer village network

The table (B.1.12) shows the details for the new solar system (PV2) that being built next to the transformer (T3//SCHOOL - Tyaseer) near the Load3. AS is evident in the table, the solar system is built completely from the smallest details using the simulation program (ETAP).

Table (B.1.12) : The details for the suggested solar system to solve the problem in Tyaseer village network

The number of the solar system	The value of the solar system	The power value for each panel	The open circuit voltage value for each panel	The max pick (voltage & current) values for each panel
PV 2	5 KWp	110 watts	15 V_{OC}	12 Vmp // 9.17 Amp
	The short circuit current value for each panel			
	10.08 A_{SC}			
Inv 2	The number of the inverter	The rated power	The rated voltage	The factors (EFF & PF)
	Inv 2	5 KW (DC)	400 VOLT (AC)	90% (efficiency fill factor)
		4.5 KVA (AC)		100% (power factor)

4. The suggested solutions to the problems of Ras Al-Fara'a area network:

The figure (B.1.18) shows the addition of the new solar systems (PV118 – 150KWp & PV119 – 150KWp) to buses (Bus280 next the transformer'T87' & Bus541 next the transformer'T96') respectively, in the Eastern region of Ras Al-Fara'a area.

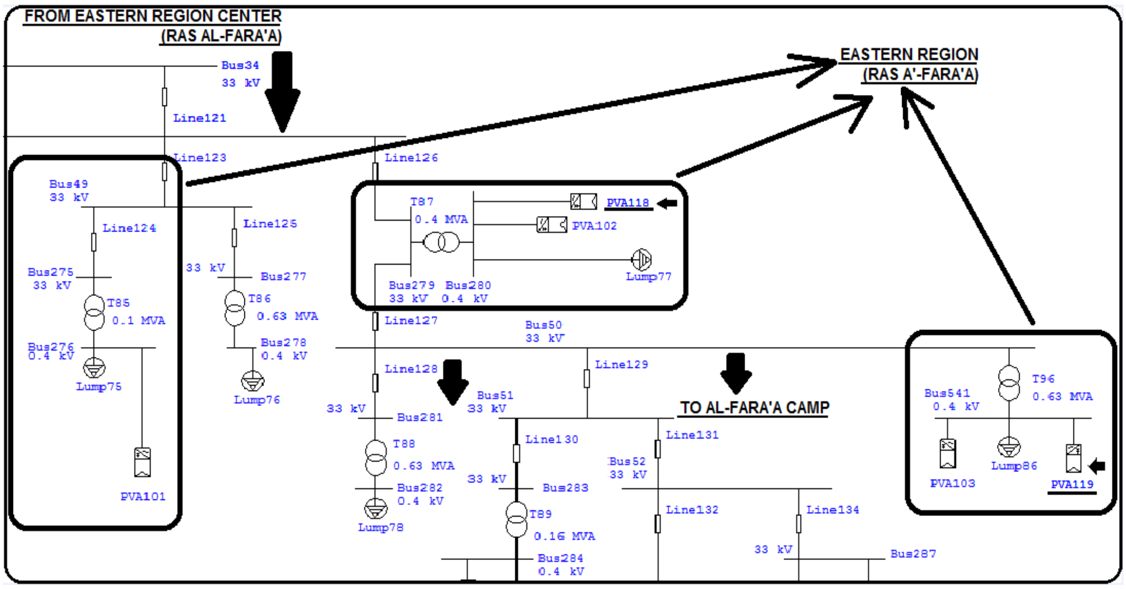

Figure (B.1.18) : Adding of the suggested solar systems(PV118 & PV119) in Ras Al-Fara'a area network

The figure (B.1.19) shows the adding for the new solar systems (PV120 –50KWp & PV121 –50KWp) to buses (Bus232 next the transformer'T60' & Bus230 next the transformer'T59') respectively, in the center of the Eastern region of the Ras Al-Fara'a area.

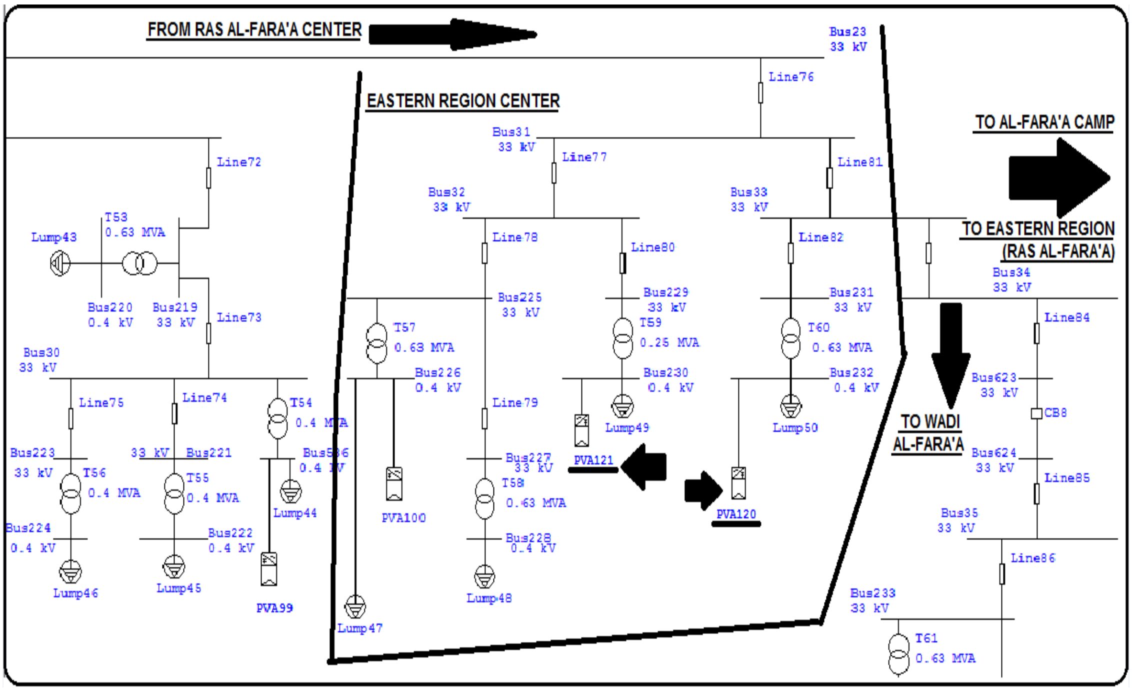

Figure (B.1.19) : The adding suggested solar systems(PV120 & PV121) in Ras Al-Fara'a area network

The table (B.1.13) shows the details for the new solar systems (PV118, PV119, PV120 & PV121) that being built next to the transformers (T87//AL-SHAREEF, T96//MALHAMEH, T60//MOWAFAK ALFAKHRY 'SHARAKEH WELL' & T59//AL-KHARRAZ) near the loads (Load77, Load86, Load50 & Load49) respectively. AS is evident in the table, the solar systems are built completely from the smallest details using the simulation program (ETAP).

Table (B.1.13) : The details for the suggested solar systems to solve the problem in Ras Al-Fara'a area network

The number of the solar system	The value of the solar system	The power value for each panel	The open circuit voltage value for each panel	The max pick (voltage & current) values for each panel
PV 118	150 KWp	110 watts	15 V_{OC}	12 Vmp // 9.17 Amp
	The short circuit current value for each panel			
	10.08 A_{SC}			

Inv 118				
	The number of the inverter	The rated power	The rated voltage	The factors (EFF & PF)
	Inv 118	150 KW (DC)	400 VOLT (AC)	90% (efficiency fill factor)
		135 KVA (AC)		100% (power factor)
The number of the solar system	The value of the solar system	The power value for each panel	The open circuit voltage value for each panel	The max pick (voltage & current) values for each panel
PV 119 PV 119	150 KWp	110 watts	15 V_{OC}	12 Vmp // 9.17 Amp
	The short circuit current value for each panel			
	10.08 A_{SC}			
Inv 119	The number of the inverter	The rated power	The rated voltage	The factors (EFF & PF)
	Inv 119	150 KW (DC)	400 VOLT (AC)	90% (efficiency fill factor)
		135 KVA (AC)		100% (power factor)
The number of the solar system	The value of the solar system	The power value for each panel	The open circuit voltage value for each panel	The max pick (voltage & current) values for each panel
PV 120	50 KWp	110 watts	15 V_{OC}	12 Vmp // 9.17 Amp
	The short circuit current value for each panel			
	10.08 A_{SC}			
Inv 120	The number of the inverter	The rated power	The rated voltage	The factors (EFF & PF)
	Inv 120	50 KW (DC)	400 VOLT (AC)	90% (efficiency fill factor)
		45 KVA		100% (power factor)

		(AC)		
The number of the solar system	The value of the solar system	The power value for each panel	The open circuit voltage value for each panel	The max pick (voltage & current) values for each panel
PV121	50 KWp	110 watts	15 V_{OC}	12 Vmp // 9.17 Amp
PV121	The short circuit current value for each panel			
	10.08 A_{SC}			
Inv 121	The number of the inverter	The rated power	The rated voltage	The factors (EFF & PF)
	Inv 121	50 KW (DC)	400 VOLT (AC)	90% (efficiency fill factor)
		45 KVA (AC)		100% (power factor)

The figure (B.1.20) shows the addition of a new generator (G1 – 10MW) at the Bus231 next to the transformer (T60//MOWAFAK ALFAKHRY 'SHARAKEH WELL').

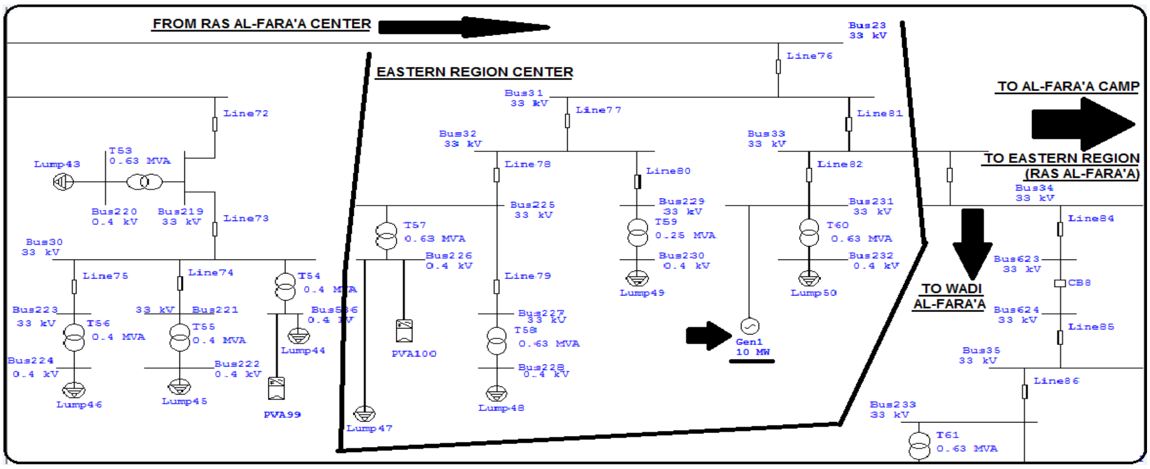

Figure (B.1.20) : The adding suggested generator(G1) at Bus231 in Ras Al-Fara'a area network

The table (B.1.14) shows the details for the new suggested generator (G1) that located in the center of the Eastern region of Ras Al-Fara'a area at

Bus231 next the transformer (T60//MOWAFAK ALFAKHRY 'SHARAKEH WELL').

Table (B.1.14) : The details for the suggested generator(G1) at Bus231 to solve the problem in Ras Al-Fara'a area network

The number of the generator	The power rating		The voltage rating
G 1	10 MW	11.765 MVA	33 KV
	The power factor	The efficiency	The operation mode
	85%	95%	Voltage control

The figure (B.1.21) shows the new suggested transmission line (TL359 – Ring1 – 2000meters – overhead line) that connected between the Western regions of Tubas city to agricultural areas of Ras Al-Fara'a area (between Bus365 and Bus231), next to the transformer (T60//MOWAFAK ALFAKHRY) that located in the center of the Eastern region of Ras Al-Fara'a area.

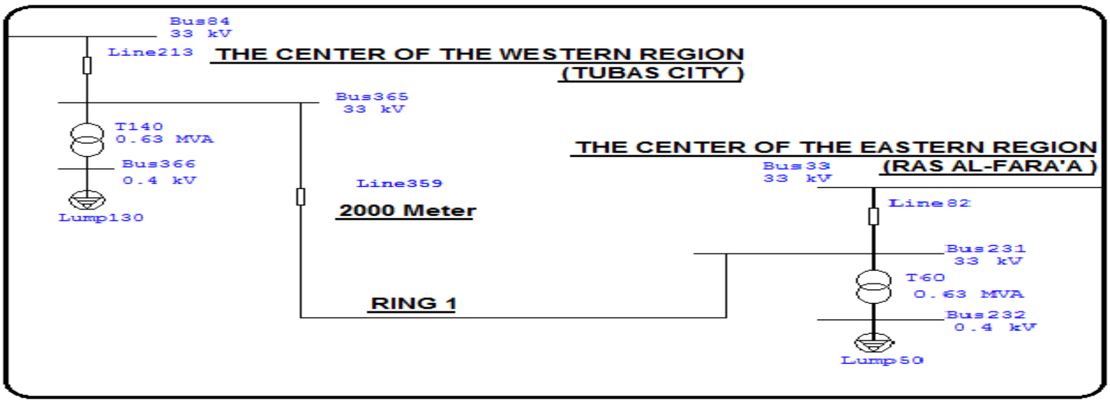

Figure (B.1.21) : The suggested transmission line(TL359-Ring1) between Bus365 and Bus231 in Ras Al-Fara'a area network

The figure (B.1.22) shows the new suggested transmission line (TL359 – Ring1 – 2000meters – overhead line) between the Western region

"Tubas city" at Bus365 and the center of the Eastern region "Ras Al-Fara'a area" at Bus231.

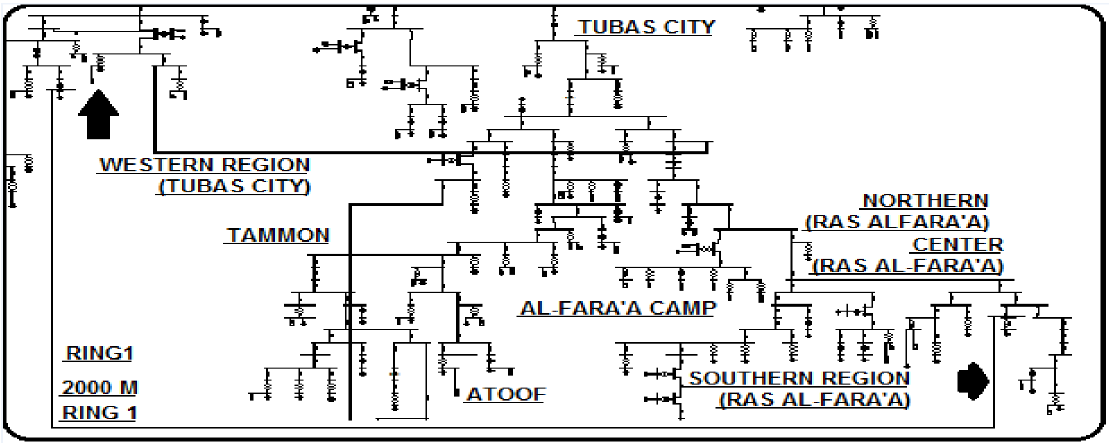

Figure (B.1.22) : The suggested transmission line(TL359-Ring1) between Tubas city and Ras Al-Fara'a area in Ras Al-Fara'a area network

The table (B.1.15) shows the details for the new suggested transmission line (TL359 – Ring1) that connected between the Buses (Bus365 at the center of the Western region ' Tubas city' and Bus231 at the center of the Eastern region 'Ras Al-Fara'a area' .

Table (B.1.15) : The details for the suggested transmission line(TL359-Ring1) between Bus365 and Bus231 to solve the problem in Ras Al-Fara'a area network

The suggested transmission line	The voltage rating (KV)	The length (meters)	The intersection size (mm^2)
TL 359	33	2000	158

5. The details of the suggested solutions to the problems of Atoof town network:

- Fro problem 1: The figure (B.1.23) shows the adding of new suggested capacitor bank (C1) in the Western region of Atoof town, next to the transformer (T116//MOWAFAQ FAKHRY) at Bus326.

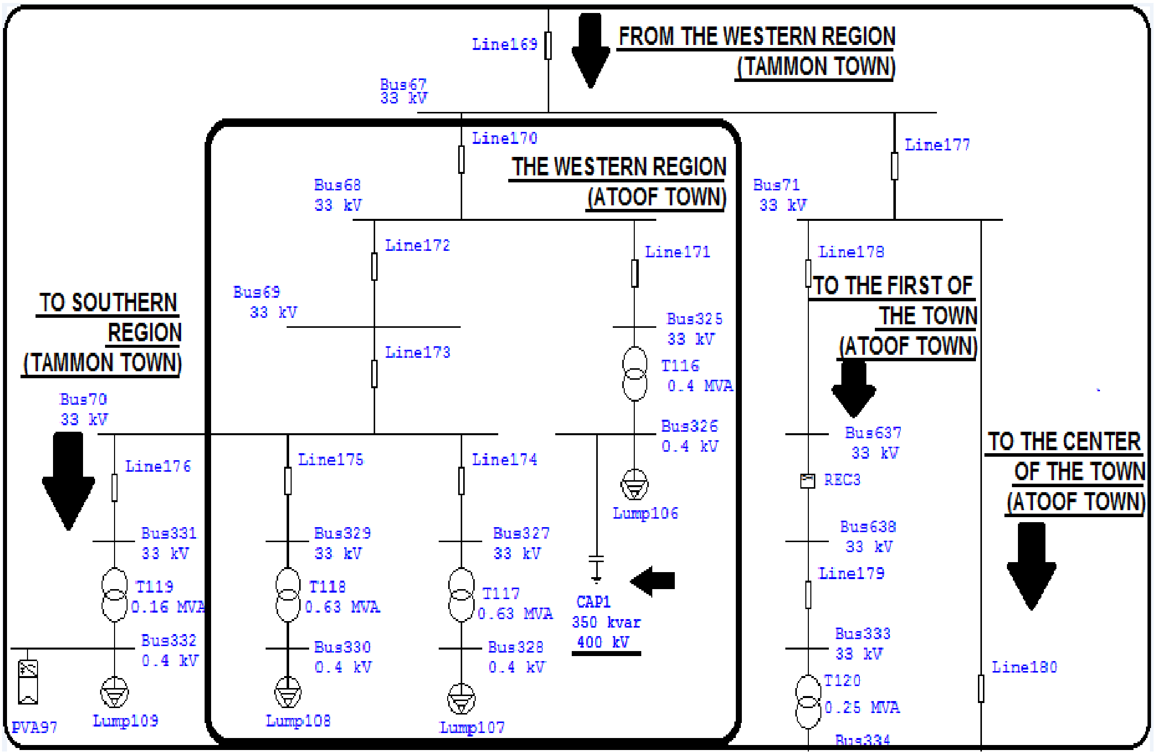

Figure (B.1.23) : Adding of the suggested capacitor bank (C1) next to the transformer (T116) at Bus326 in Atoof town network

- For problem 2: The figure (B.1.24) shows the adding of new suggested capacitor bank (C2) in the center of the town of Atoof town, next to the transformer (T125//BAQEEA) at Bus344.

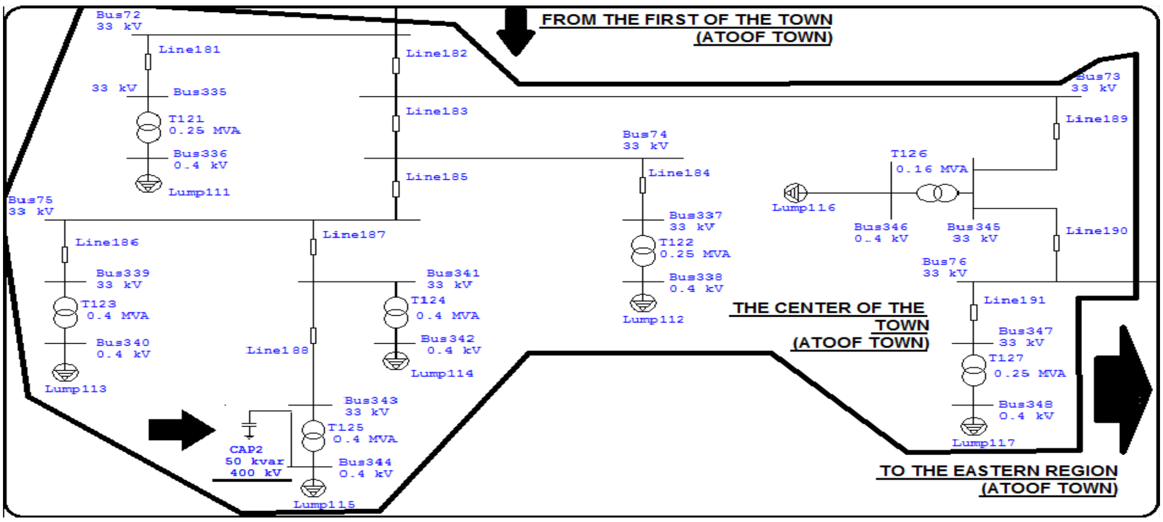

Figure (B.1.24) : Adding of the suggested capacitor bank(C2) to the transformer (T125) at Bus344 in Atoof town network

6. The suggested solutions to the problems of Jalqamous village network:

The figure (B.1.25) shows the location for the water tank (Load239) at Bus448, at a distance of 1000meters from the transformer (T200 // WESTERN) in the village of Jalqamous.

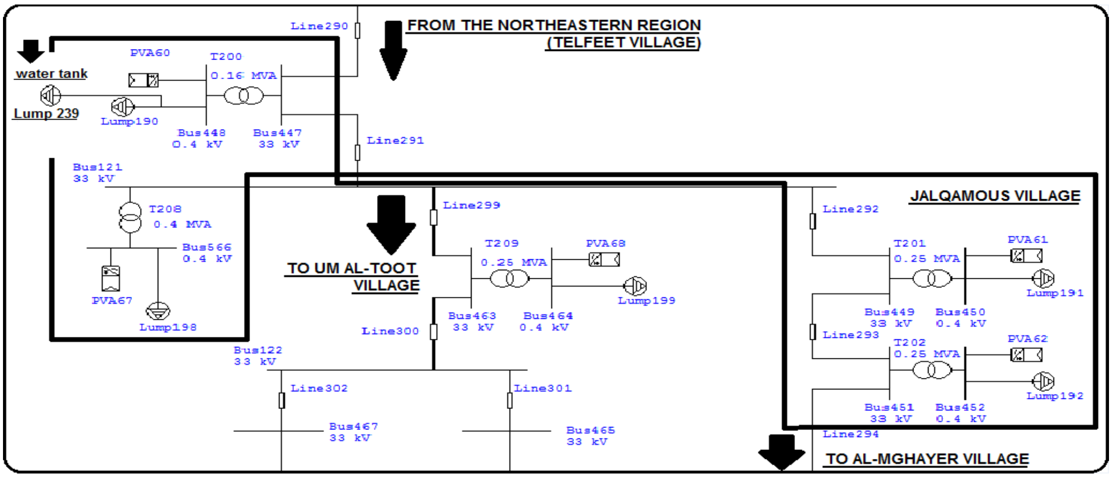

Figure (B.1.25) : The water tank (Load239) next the transformer(T200) in Jalqamous village network

The figure (B.1.26) shows the new suggested transformer (T255) that built in Jalqamous village, at distance of 1000mters from the transformer (T200//WESTERN – Jalqamous) and the new transmission line that using to connected the new transformer (T255) to the grid at Bus447.

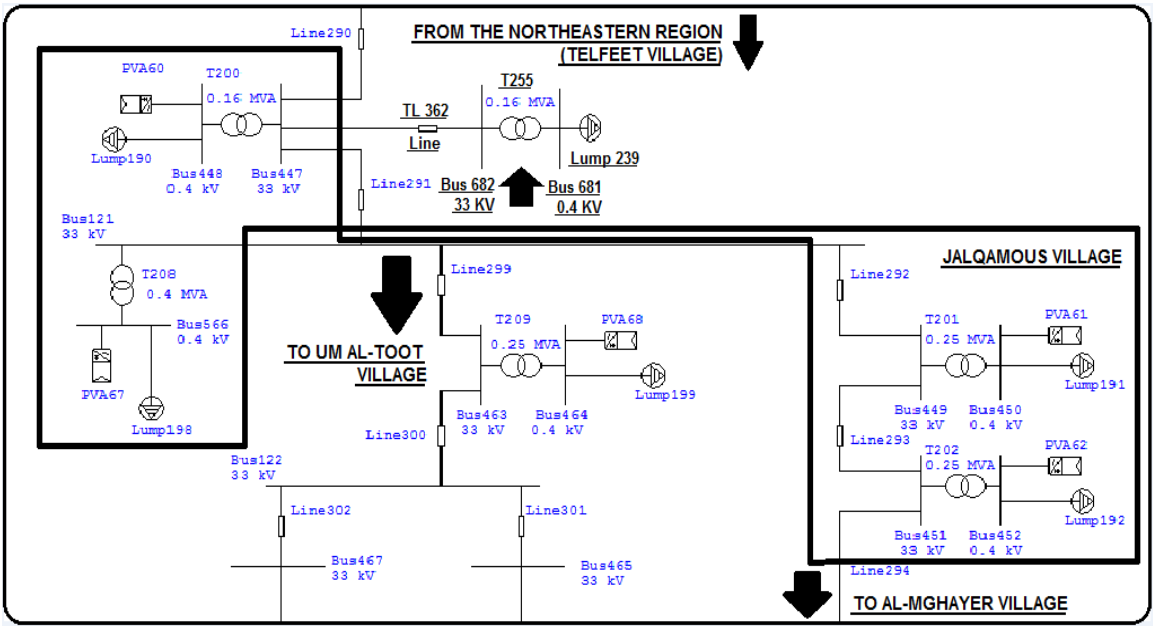

Figure (B.1.26) : Adding of the suggested transformer(T255) next to the Load239(water tank) in Jalqamous village network

The table (B.1.16) shows the details of the new transformer (T255), the new transmission line (TL362). The water tank (Load239) in the village of Jalqamous [10].

Table (B.1.16) : The details of the suggested transformer, the transmission line and the bus's to solve the problem in Jalqamous village network

The suggested transformer	The voltage rating (KV)	The power rating (KVA)	The connection bus's From bus - to bus -
T 255	33/0.4	160	From (B682) to (B681)
The suggested transmission line	The voltage rating (KV)	The length (meters)	The intersection size (mm^2)
TL 362	33	1000	158
The number and name of the load	The real power of the load	The reactive power of the load	The voltage rated of the load
L 239 (water tank)	120KW	20KVAR	400VOLT

B.2 The proposed solutions to the problems of Tubas electricity network by the company itself (by Tubas electricity company):

1. In Tubas city network:

1) Palestine Investment Fund PV Stations (Proposed):

The table (B.2.1) shows the details for the proposed solar system (PV10) by Tubas Electricity Company, that being built next to the transformer (T18) next Bus577. As is evident in the table, the solar system is built completely from the smallest details using the simulation program (ETAP).

Table (B.2.1) : The details for the proposed solar system (PV10) by Tubas Electricity Company and the transformer(T18) in Tubas city network

<table>
<tr><th>The number of the solar system</th><th>The value of the solar system</th><th>The power value for each panel</th><th>The open circuit voltage value for each panel</th><th>The max pick (voltage & current) values for each panel</th></tr>
<tr><td rowspan="3">PV 10</td><td>2000 KWp</td><td>110 watts</td><td>15 V_{OC}</td><td>12 Vmp // 9.17 Amp</td></tr>
<tr><td colspan="4">The short circuit current value for each panel</td></tr>
<tr><td colspan="4">10.08 A_{SC}</td></tr>
<tr><td rowspan="2">Inv 10</td><td>The number of the inverter</td><td>The rated power</td><td>The rated voltage</td><td>The factors (EFF & PF)</td></tr>
<tr><td>Inv 10</td><td>2000 KW (DC)</td><td>400 VOLT (AC)</td><td>90% (efficiency fill factor)</td></tr>
</table>

		1800 KVA (AC)		100% (power factor)
The suggested transformer	The voltage rating (KV)	The power rating (KVA)	The connection bus's From bus - to bus -	
T 18	33/0.4	1000	From (B576) to (B577)	

The table (B.2.2) shows the details for the proposed solar system (PV88) by Tubas Electricity Company, that being built next to the transformer (T251) next Bus664. As is evident in the table, the solar system is built completely from the smallest details using the simulation program (ETAP).

Table (B.2.2) : The details for the proposed solar system(PV88) from Tubas Electricity Company and the transformer(T251) in Tubas city network

The number of the solar system	The value of the solar system	The power value for each panel	The open circuit voltage value for each panel	The max pick (voltage & current) values for each panel
PV 88	3000 KWp	110 watts	15 V_{OC}	12 Vmp // 9.17 Amp
	The short circuit current value for each panel			
	10.08 A_{SC}			
Inv 88	The number of the inverter	The rated power	The rated voltage	The factors (EFF & PF)
	Inv 88	3000 KW (DC)	400 VOLT (AC)	90% (efficiency fill factor)
		2700 KVA (AC)		100% (power factor)
The suggested	The voltage	The power rating	The connection bus's	

transformer	rating (KV)	(KVA)	From bus - to bus -
T 251	33/0.4	1000	From (B576) to (B664)

The table (B.2.3) shows the details for the proposed solar system (PV89) by Tubas Electricity Company, that being built next to the transformer (T252) next Bus677. As is evident in the table, the solar system is built completely from the smallest details using the simulation program (ETAP) .

Table (B.2.3) : The details for the proposed solar system(PV89) from Tubas Electricity Company and the transformer(T252) in Tubas city network

<table>
<tr><th>The number of the solar system</th><th>The value of the solar system</th><th>The power value for each panel</th><th colspan="2">The open circuit voltage value for each panel</th><th colspan="2">The max pick (voltage & current) values for each panel</th></tr>
<tr><td rowspan="3">PV 89</td><td>3000 KWp</td><td>110 watts</td><td colspan="2">15 V_{OC}</td><td colspan="2">12 Vmp // 9.17 Amp</td></tr>
<tr><td colspan="6">The short circuit current value for each panel</td></tr>
<tr><td colspan="6">10.08 A_{SC}</td></tr>
<tr><td rowspan="3">Inv 89</td><td>The number of the inverter</td><td>The rated power</td><td colspan="2">The rated voltage</td><td colspan="2">The factors (EFF & PF)</td></tr>
<tr><td rowspan="2">Inv 89</td><td>3000 KW (DC)</td><td colspan="2" rowspan="2">400 VOLT (AC)</td><td colspan="2">90% (efficiency fill factor)</td></tr>
<tr><td>2700 KVA (AC)</td><td colspan="2">100% (power factor)</td></tr>
<tr><td>The suggested transformer</td><td>The voltage rating (KV)</td><td colspan="2">The power rating (KVA)</td><td colspan="3">The connection bus's From bus - to bus -</td></tr>
<tr><td>T 252</td><td>33/0.4</td><td colspan="2">1000</td><td colspan="3">From (B576) to (B677)</td></tr>
</table>

The figure (B.2.1) shows the adding of solar systems proposed by Tubas Electricity Company (PV10 at Bus577 next to the transformer "T18//PALESTINE INVESTMENT FUND PV STATION1", PV88 at Bus664 next to the transformer "T251//PALESTINE INVESTMENT FUND PV STATION2" & PV89 at Bus677 next to the transformer "T252//PALESTINE INVESTMENT FUND PV STATION3") in the Eastern region 2 of the city of Tubas [10].

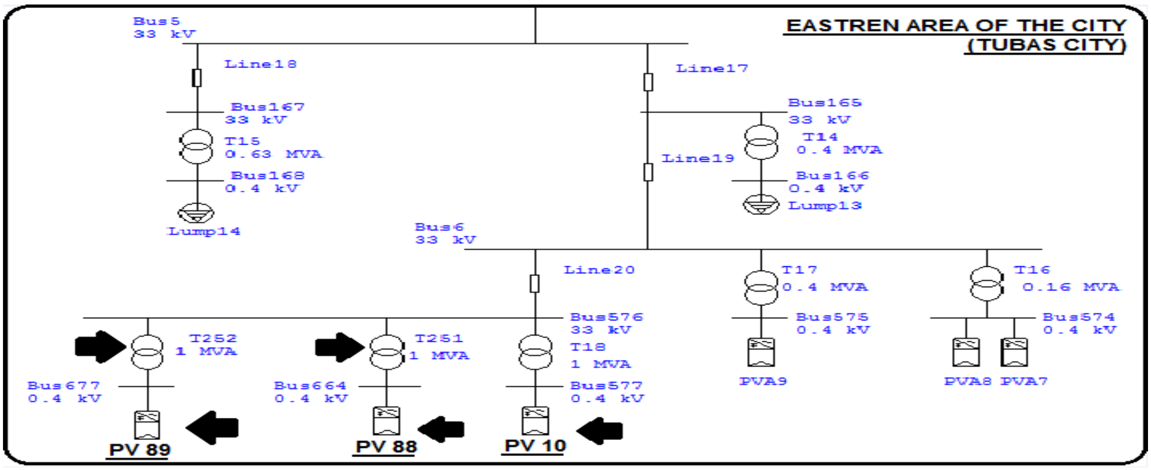

Figure (B.2.1) : The solar systems proposed (PV10, PV88 and PV89) at the transformers (T18, T251 and T252) respectively in Tubas city network

The figure (B.2.2) shows the Eastern region 2 (Zone 7) with the proposed solar systems (PV10 next to the transformer "T18//PALESTINE INVESTMENT FUND PV STATION1", PV88 next to the transformer "T251//PALESTINE INVESTMENT FUND PV STATION2" & PV89 next to the transformer "T252//PALESTINE INVESTMENT FUND PV STATION3") in the city of Tubas [10]. The figure (B.2.2) obtained using the global positioning system (GPS system [57]).

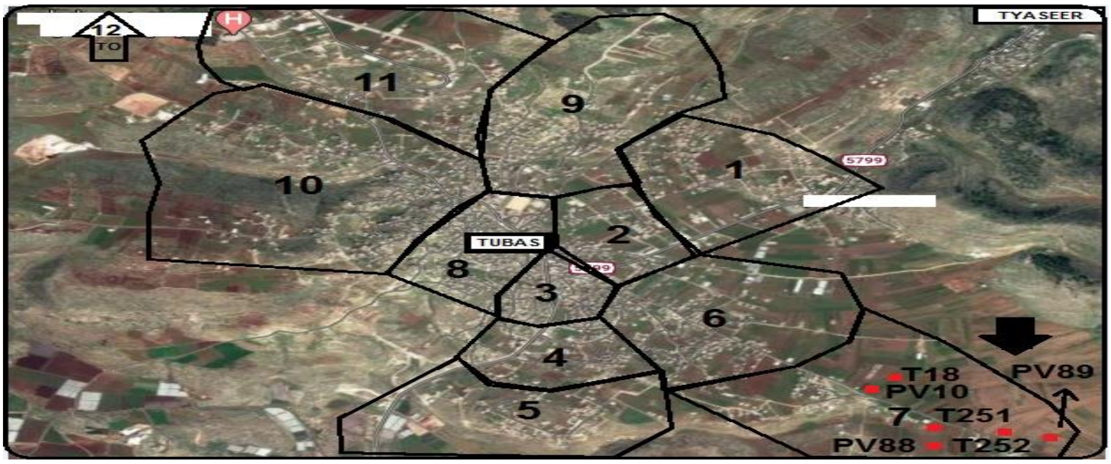

Figure (B.2.2) : The Eastern Region2 with the proposed solar systems (PV10 at T18, PV88 at T251 and PV89 at T252) in Tubas city network by using the GPS system

2) Jafa PV Plant (Under Construction):

This solar system is located in areas near Al-Fara'a areas – Tubas city. There are two stations (one of them is 2703KWp (PV38), the other is 2703KWp (PV87)), at each station there is a transformer with 2.18MAV rated (at PV38 there is transformer T249 and at PV87 there is transformer T250), this stations are proposed by Tubas Electricity Company to solve the problems in the network. The figure (B.2.3) shows the power factor in column 12, the electrical current in column 13 and the demand for real power in column 3, for the transformers (T34//MOHAFADA at Bus200, T97//TUBAS PARK at Bus296, T98//KHALET ALLOOZ at Bus298, T100//MO2YAD FRIDGES at Bus302, T101//JAFA CONSUMPTION TR at Bus304, T249//JAFA PV PLANT1 at Bus673, T250// JAFA PV PLANT2 at Bus676) in the areas near the Al-Fara'a areas of Tubas city, before adding the solar systems proposed (PV38 & PV87) at buses (Bus673 & Bus676) respectively, these values from ETAP simulation program.

Bus200	0.400	0.005	-0.001	0.005	0.001	0	0	0	0	0.010	99.6	23.7
Bus296	0.400	0	0	0	0	0	0	0	0	0	100.0	0.2
Bus298	0.400	-0.001	0	0.001	0	0	0	0	0	0.001	97.6	1.6
Bus302	0.400	-0.008	-0.003	0.008	0.003	0	0	0	0	0.008	93.7	19.4
Bus304	0.400	0.315	0	0	0	0	0	0	0	0.315	100.0	758.8
Bus673	0.400	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus676	0.400	0	0	0	0	0	0	0	0	0	0.0	0.0

Figure (B.2.3) : The power factors at the transformers(T34, T97, T98, T100, T101, T249 & T250) in areas near Al-Fara'a areas before adding the solar systems(PV38 and PV87) in Tubas city network

The table (B.2.4) shows the details for the proposed solar system (PV38) by Tubas Electricity Company, that being built next to the transformer (T249) next to the Bus673. As is evident in the table, the solar system is built completely from the smallest details using the simulation program (ETAP).

Table (B.2.4) : The details for the solar system(PV38) from Tubas Electricity Company and the transformer(T249) in Tubas city network

<table>
<tr><th>The number of the solar system</th><th>The value of the solar system</th><th>The power value for each panel</th><th>The open circuit voltage value for each panel</th><th>The max pick (voltage & current) values for each panel</th></tr>
<tr><td rowspan="3">PV 38</td><td>2703 KWp</td><td>110 watts</td><td>15 V_{OC}</td><td>12 Vmp // 9.17 Amp</td></tr>
<tr><td colspan="4">The short circuit current value for each panel</td></tr>
<tr><td colspan="4">10.08 A_{SC}</td></tr>
<tr><td rowspan="2">Inv 38</td><td>The number of the inverter</td><td>The rated power</td><td>The rated voltage</td><td>The factors
(EFF & PF)</td></tr>
<tr><td>Inv 38</td><td>2703 KW (DC)</td><td>400 VOLT (AC)</td><td>90% (efficiency fill factor)</td></tr>
</table>

		2433 KVA (AC)		100% (power factor)

The suggested transformer	The voltage rating (KV)	The power rating (KVA)	The connection bus's From bus - to bus -
T 249	33/0.4	2180	From (B303) to (B673)

The table (B.2.5) shows the details for the proposed solar system (PV87) by Tubas Electricity Company, that being built next to the transformer (T250) next to the Bus676. As is evident in the table, the solar system is built completely from the smallest details using the simulation program (ETAP).

Table (B.2.5) : The details for the proposed solar system(PV87) from Tubas Electricity Company and the transformer(T250) in Tubas city network

The number of the solar system	The value of the solar system	The power value for each panel	The open circuit voltage value for each panel	The max pick (voltage & current) values for each panel
PV 87	2703 KWp	110 watts	15 V_{OC}	12 Vmp // 9.17 Amp
	The short circuit current value for each panel			
	10.08 A_{SC}			
Inv 87	The number of the inverter	The rated power	The rated voltage	The factors (EFF & PF)
	Inv 87	2703 KW (DC)	400 VOLT (AC)	90% (efficiency fill factor)
		2433 KVA (AC)		100% (power factor)

The suggested transformer	The voltage rating (KV)	The power rating (KVA)	The connection bus's From bus - to bus -
T 250	33/0.4	2180	From (B303) to (B676)

The figure (B.2.4) shows the power factor in column 12, the electrical current in column 13 and the demand for real power in column 3, for the transformers (T34//MOHAFADA at Bus200, T97//TUBAS PARK at Bus296, T98//KHALET ALLOOZ at Bus298, T100//MO2YAD FRIDGES at Bus302, T101//JAFA CONSUMPTION TR at Bus304, T249//JAFA PV PLANT1 at Bus673, T250// JAFA PV PLANT2 at Bus676) in the areas near the Al-Fara'a areas of Tubas city, after adding the solar systems proposed (PV38 & PV87) at buses (Bus673 & Bus676) respectively, these values from ETAP simulation program.

Bus200	0.400	0.005	-0.001	0.005	0.001	0	0	0	0	0.010	99.6	23.7
Bus296	0.400	0	0	0	0	0	0	0	0	0	100.0	0.2
Bus298	0.400	-0.001	0	0.001	0	0	0	0	0	0.001	97.6	1.6
Bus302	0.400	-0.008	-0.003	0.008	0.003	0	0	0	0	0.008	93.7	19.4
Bus304	0.400	0.315	0	0	0	0	0	0	0	0.315	100.0	758.8
Bus673	0.400	2.440	0	0	0	0	0	0	0	2.440	100.0	5870.3
Bus676	0.400	2.440	0	0	0	0	0	0	0	2.440	100.0	5870.3

Figure (B.2.4) : The power factors at the transformers(T34, T97, T98, T100, T101, T249 and T250) respectively in areas near Al-Fara'a areas after adding the solar systems(PV38 and PV87) in Tubas city network

From figure (B.2.3) and figure (B.2.4) we see in column 12 that the addition of the proposed solar systems (PV38 & PV87) did not negatively affect the power factors at the old transformers in the areas near Al-Fara'a areas, as (the transformer "T34//MOHAFADA" at Bus200 the power factor not change from 99.6%, the transformer "T97//TUBAS PARK" at Bus296 the power factor not change from 100%, the transformer "T98//KHALET ALLOOZ" at Bus298 the power factor not change from 97.6%, the transformer "T100//MO2YAD FRIDGES" at Bus302 the power factor not change from 93.7% and the transformer "T101//JAFA CONSUMPTION TR" at Bus304 the power factor not change from 100%), as for the new transformers that the proposed solar systems will connect with it as follow (PV38 at Bus673 next the transformer "T249//JAFA PV PLANT1" and PV8 at Bus676 next the transformer "T250//JAFA PV PLANT2") it power factors was zeros as shown in figure (B.2.3) in column 12 because it not connected to the grid before adding the proposed solar systems to it, and after adding the proposed solar systems to these transformers, the value of the power factors for all these transformers became 100%, which is an excellent power factor. So the addition of these proposed solar systems did not affect the power factors in the network.

From figure (B.2.3) and figure (B.2.4) we see in column 13 that the addition of the proposed solar systems (PV38 & PV87) did not negatively affect the electric currents at the old transformers in the areas near Al-Fara'a areas, as (the transformer "T34//MOHAFADA" at Bus200 the electric currents not change from 23.7 amperes, the transformer "T97//TUBAS PARK" at Bus296 the electric currents not change from 0.2 amperes, the transformer "T98//KHALET ALLOOZ" at Bus298 the electric currents not change from 1.6 amperes, the transformer

"T100//MO2YAD FRIDGES" at Bus302 the electric currents not change from 19.4 amperes and the transformer "T101//JAFA CONSUMPTION TR" at Bus304 the electric currents not change from 758.8 amperes), as for the new transformers that the proposed solar systems will connect with it as follow (PV38at Bus673 next the transformer "T249//JAFA PV PLANT1" and PV87 at Bus676 next the transformer "T250//JAFA PV PLANT2") it electric currents was zeros as shown in figure (B.2.3) in column 13 because it not connected to the grid before adding the proposed solar systems to it, and after adding the proposed solar systems to these transformers, the value of the electric currents changed for all these transformers to be 5870.3 amperes at Bus673 next to the transformer T249 to which the first station of the proposed solar system is connected and 5870.3 amperes at Bus676 next to the transformer T250 to which the second station of the proposed solar system is connected . So the addition of these proposed solar systems (PV38 & PV87) to the areas near Al-Fara'a areas of the city of Tubas greatly increased the electric currents on the buses (Bus673 & Bus676) that connected with the transformers of these solar systems. So it is important to pay attention to these high electric currents and design the network next to the new transformers to suit these electrical currents, to be used in the best way to solve the problems of Tubas Electricity Network in the city of Tubas.

From figure (B.2.3) and figure (B.2.4) we see in column3 that the addition of the proposed solar systems (PV38 & PV87) did not negatively affect the real power demand at the old transformers in the areas near Al-

Fara'a areas, as (the transformer "T34//MOHAFADA" at Bus200 the real power demand does not change from 5KW that goes towards the grid and the reason it goes towards the grid is because Bus200 is connected to an old solar system "PV23 – 10KWp" as shown in figure (B.2.5), the transformer "T97//TUBAS PARK" at Bus296 the real power demand does not change from 0KW, the transformer "T98//KHALET ALLOOZ" at Bus298 the real power demand does not change from 1KW, the transformer "T100//MO2YAD FRIDGES" at Bus302 the real power demand does not change from 84KW and the transformer "T101//JAFA CONSUMPTION TR" at Bus304 the real power demand does not change from 315KW that goes towards the grid and the reason it goes towards the grid is because Bus304 is connected to an old solar system "PV115 – 350KWp"), as for the new transformers that the proposed solar systems will connect with it as follow (PV38 at Bus673 next the transformer "T249//JAFA PV PLANT1" and PV87 at Bus676 next the transformer "T250//JAFA PV PLANT2") it real powers demand was zeros as shown in figure (B.2.3) in column 3 because it not connected to the grid before adding the proposed solar systems to it, and after adding the proposed solar systems to these transformers , the value of the real powers demand changed for all these transformers to be 2440KW towards the grid at Bus673 next to the transformer T249 to which the first station of the proposed solar system is connected and 2440KW towards the grid at Bus676 next to the transformer T250 to which the second station of the proposed solar system is connected. So the addition of these proposed solar systems (PV38 & PV87) to the areas near Al-Fara'a areas of the city of Tubas resulted in an increased the real power to the grid for the buses (Bus673 & Bus676) that connected with the transformers of these solar systems, these electrical powers that were provided to the network help to solve problems in the city of Tubas. But it is important to mention that the increase in the real electrical power besides the loads reduced the demand for the real electrical power by the network, but the demand for reactive electrical power by the network for the loads remained the same as before the addition of these solar systems, and this make the reactive electrical power (Q) greater than the real electrical power (P) this will reduce the power factors of the network. Therefore attention must be paid to this point, as the decrease in the power factor of the network imposes financial penalties on the Tubas Electricity Network by the Israeli Qatari (IEC). In order to avoid a decrease in the power factors, we follow the values of these factors in the network and in case they decrease so that they cause financial penalties to the network. We solve the problems of these factors decreasing in several ways, including the use of capacitor banks next to the transformers that may suffer from low factor in the network.

So the proposed solar system is a good solution to the existing problems in the network, but attention should be given to power factors.

The figure (B.2.5) shows the adding of solar systems proposed by Tubas Electricity Company (PV38 at Bus673 next to the transformer "T249//JAFA PV PLANT1" & PV87 at Bus676 next to the transformer "

T250//JAFA PV PLANT2") in the areas near Al-Fara'a areas of the city of Tubas [10].

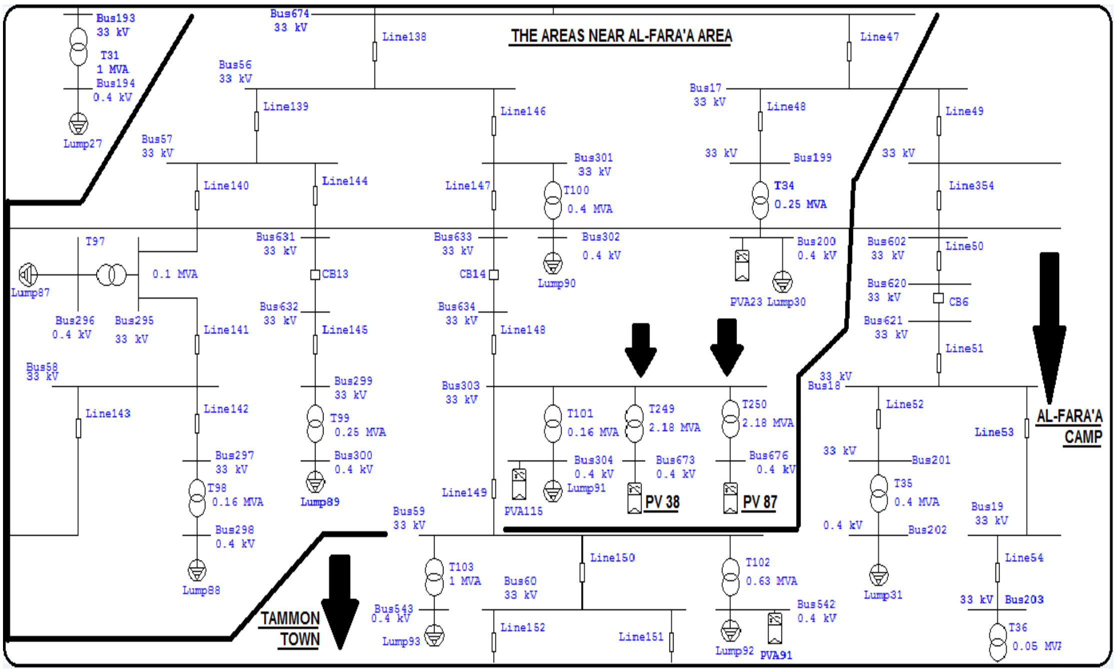

Figure (B.2.5) : The solar systems(PV38 and PV87) at (T249 and T250) respectively in Tubas city network

The figure (B.2.6) shows the areas near Al-Fara'a areas (Zone 5) with the proposed solar systems (PV38 at Bus673 next to the transformer "T249//JAFA PV PLANT1" & PV87 at Bus676 next to the transformer "T250//JAFA PV PLANT2") in the city of Tubas [10]. The figure (B.2.6) obtained using the global positioning system (GPS system [57]).

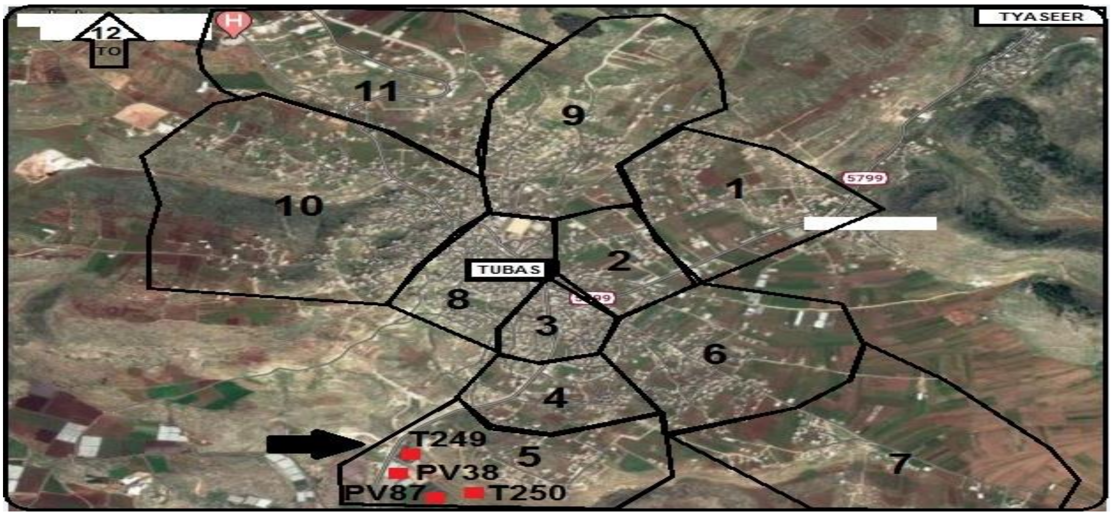

Figure (B.2.6) : The areas near Al-Fara'a areas with the solar systems (PV38 at T249 and PV87 at T250) in Tubas city network by using the GPS system

2. In Tyaseer village network:

- Tyaseer Filtering Station PV Plant (Proposed):

This proposed is located in Tyaseer village region, there is one station (about 2000KWp (PV3)), at this station there is a transformer with 2MAV rated (T253), this station is proposed by Tubas Electricity Company to solve the problems in the network.

The figure (B.2.7) shows the power factor in column 12, the electrical current in column 13 and the demand for real power in column 3, for the transformers (T2//TYASEER MAIN at Bus146, T3//SCHOOL - Tyaseer at Bus148, T4//TYASEER FILTERING STATION1 at Bus531, T5//TYASEER FILTERING STATION2 at Bus532 & T253//AFD PV PLANT at Bus678) in Tyaseer village, before adding the solar system proposed (PV3) at Bus678, these values from ETAP simulation program.

Bus146	0.400	-0.009	-0.005	0.019	0.005	0	0	0	0	0.019	96.5	46.3
Bus148	0.400	-0.001	0	0.001	0	0	0	0	0	0.001	94.2	2.6
Bus531	0.400	0.089	0	0.001	0	0	0	0	0	0.090	100.0	216.8
Bus532	0.400	0	0	0	0	0	0	0	0	0	100.0	0.2
Bus678	0.400	0	0	0	0	0	0	0	0	0	0.0	0.0

Figure (B.2.7) : The power factors at the transformers(T2, T3, T4, T5 and T253) in Tyaseer village before adding the proposed solar system(PV3) in Tyaseer village network

The table (B.2.6) shows the details for the proposed solar system (PV3) by Tubas Electricity Company, that being built next to the transformer (T253) next Bus678. As is evident in the table, the solar system is built completely from the smallest details using the simulation program (ETAP).

Table (B.2.6) : The details for the proposed solar system(PV3) by Tubas Electricity Company and the transformer(T253) in Tyaseer village network

The number of the solar system	The value of the solar system	The power value for each panel	The open circuit voltage value for each panel	The max pick (voltage & current) values for each panel
PV 3	2000 KWp	110 watts	15 V_{OC}	12 Vmp // 9.17 Amp
	The short circuit current value for each panel			
	10.08 A_{SC}			
Inv 3	The number of the inverter	The rated power	The rated voltage	The factors (EFF & PF)
	Inv 3	2000 KW (DC)	400 VOLT (AC)	90% (efficiency fill factor)
		1800 KVA (AC)		100% (power factor)
The suggested	The voltage	The power rating	The connection bus's	

transformer	rating (KV)	(KVA)	From bus - to bus -
T 253	33/0.4	2000	From (B3) to (B678)

The figure (B.2.8) shows the power factor in column 12, the electrical current in column 13 and the demand for real power in column 3, for the transformers (T2//TYASEER MAIN at Bus146, T3//SCHOOL - Tyaseer at Bus148 , T4//TYASEER FILTERING STATION1 at Bus531, T5//TYASEER FILTERING STATION2 at Bus532 & T253//AFD PV PLANT at Bus678) in Tyaseer village, after adding the solar system proposed (PV3) at Bus678 ,these values from ETAP simulation program.

Bus146	0.400	-0.009	-0.005	0.019	0.005	0	0	0	0	0.019	96.5	46.3
Bus148	0.400	-0.001	0	0.001	0	0	0	0	0	0.001	94.2	2.6
Bus531	0.400	0.089	0	0.001	0	0	0	0	0	0.090	100.0	216.8
Bus532	0.400	0	0	0	0	0	0	0	0	0	100.0	0.2
Bus678	0.400	1.802	0	0	0	0	0	0	0	1.802	100.0	4336.0

Figure (B.2.8) : The power factors at the transformers(T2, T3, T4, T5 and T253) in Tyaseer village after adding the proposed solar system(PV3) in Tyaseer village network

From figure (B.2.7) and figure (B.2.8) we see in column 12 that the addition of the proposed solar system (PV3) did not negatively affect the power factors at the old transformers in the Tyaseer village, as (the transformer "T2//TYASEER MAIN" at Bus146 the power factor not change from 96.5%, the transformer "T3//SCHOOL - Tyaseer" at Bus148 the power factor not change from 94.2%, the transformer "T4//TYASEER FILTERING STATION1" at Bus531 the power factor not change from 100% and the transformer "T4//TYASEER FILTERING STATION2" at Bus532 the power factor not change from 100%), As for the new transformer that the proposed solar system will connect with it (PV3 at Bus678 next the transformer "T253//AFD PV PLANT") it power factor was zero as shown in figure (B.2.7) in column 12 because it not connected to the grid before adding the proposed solar system to it, and after adding the proposed solar system to this transformer, the value of the power factor for this transformers became 100%, which is an excellent power factor. So the addition of this proposed solar system did not affect the power factors in the network.

From figure (B.2.7) and figure (B.2.8) we see in column 13 that the addition of the proposed solar system (PV3) did not negatively affect the electric currents at the old transformers in Tyaseer village, as (the transformer "T2//TYASEER MAIN" at Bus146 the electric currents not change from 46.3 amperes, the transformer "T3//SCHOOL - Tyaseer" at Bus148 the electric currents not change from 2.6 amperes, the transformer "T4//TYASEER FILTERING STATION1" at Bus531 the electric currents not change from 216.8 amperes and the transformer "T4//TYASEER FILTERING STATION2" at Bus532 the electric currents not change from 0.2 amperes), as for the new transformer that the proposed solar system will connect with it (PV3 at Bus678 next the transformer "T253//AFD PV PLANT") it electric current was zero as shown in figure (B.2.7) in column 13 because it not connected to the grid before adding the proposed solar system to it, and after adding the proposed solar system to this transformer, the value of the electric current changed for this transformer to be 4336.0 amperes at Bus678 next to the transformer T253 to which the station of the proposed solar system is connected. So the addition of this proposed solar system (PV3) to Tyaseer village greatly increased the electric current on the Bus678 that connected with the transformer of this solar system. So it is important to pay attention to this high electric current and design the network next to the new transformer to suit this electrical current, to be used in the best way to solve the problems of Tubas electricity network in the village of Tyaseer.

From figure (B.2.7) and figure (B.2.8) we see in column3 that the addition of the proposed solar system (PV3) did not negatively affect the real power demand at the old transformers in Tyaseer village, as (the transformer "T2//TYASEER MAIN" at Bus146 the real power demand does not change from 9KW , the transformer "T3//SCHOOL - TYASEER" at Bus148 the real power demand does not change from 1KW, the transformer "T4//TYASEER FILTERING STATION1" at Bus531 the real power demand does not change from 89KW that goes towards the grid and the reason it goes towards the grid is because Bus531 is connected to an old solar system "PV109 – 100KWp" , and the transformer "T4//TYASEER FILTERING STATION2" at Bus532 the real power demand does not change from 0KW), as for the new transformer that the proposed solar system will connect with it (PV3 at Bus678 next the transformer "T253//AFD PV PLANT") it real power demand was zero as shown in figure (B.2.7) in column 3 because it not connected to the grid before adding the proposed solar system to it, and after adding the proposed solar system to this transformer, the value of the real power demand changed for this transformer to be 1802KW towards the grid at Bus678 next to the transformer T253 to which the station of the proposed solar system is connected. So the addition of this proposed solar system (PV3) to Tyaseer village, resulted in an increased the real power to the grid for the Bus678 that connected with the transformer of this solar system, this electrical power that was provided to the network help to solve problems in the village of Tyaseer. but it is important to mention that the increase in the real electrical power besides the loads reduced the demand for the real electrical power by the network, but the demand for reactive electrical power by the network for the loads remained the same as before the addition of this solar system, and this make the reactive electrical power (Q) greater than the real electrical power (P) this will reduce the power factors of the network. Therefore attention must be paid to this point, as the decrease in the power factor of the network imposes financial penalties on Tubas electricity network by the Israeli Qatari (IEC). In order to avoid a decrease in the power factors, we follow the values of these factors in the network and in case they decrease so that they cause financial penalties to the network. We solve the problems of these factors decreasing in several ways, including the use of capacitor banks next to the transformers that may suffer from low factor in the network.

So the proposed solar system is a good solution to the existing problems in the network, but attention should be given to power factors.

* Note : The solutions proposed in this thesis are additional solutions to the solutions proposed by the Tubas Electricity Company itself.

The figure (B.2.9) shows the adding of solar system proposed by Tubas Electricity Company (PV3 at Bus678 next to the transformer "T253//AFD PV PLANT") in the village of Tyaseer [10].

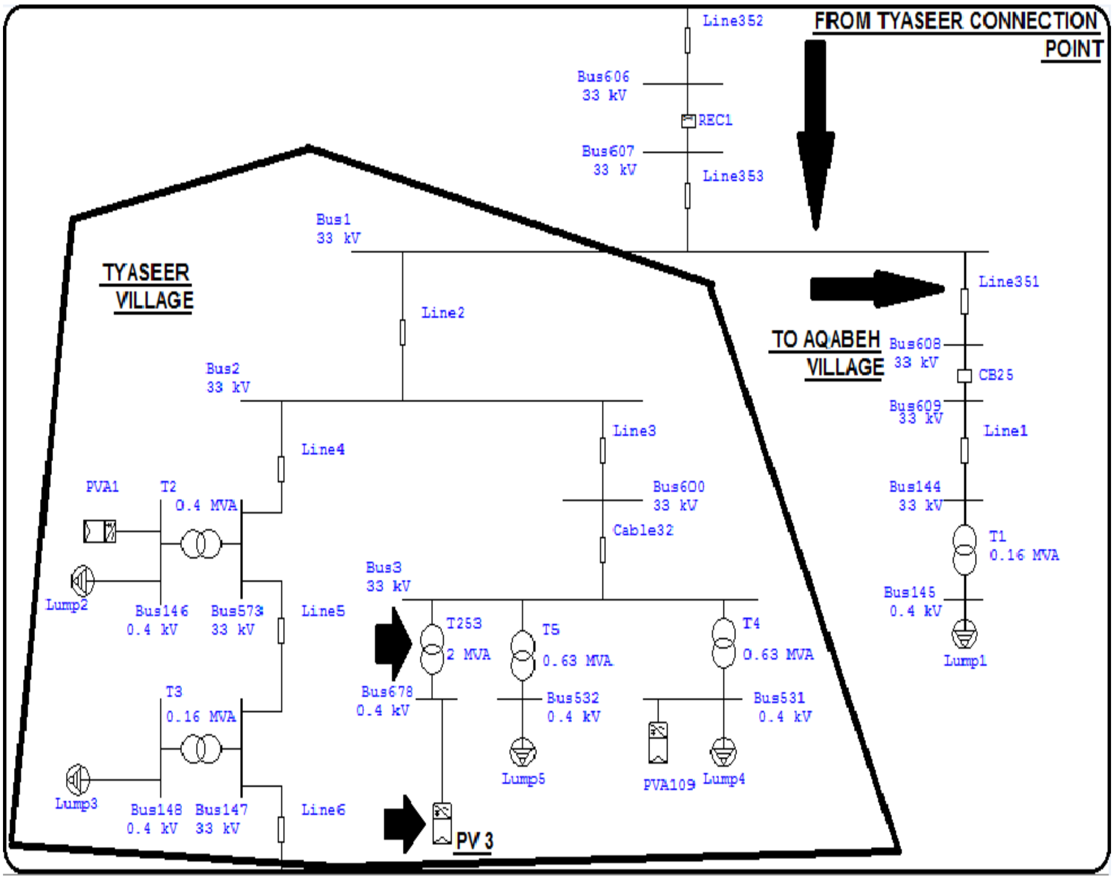

Figure (B.2.9) : Shows the proposed solar system (PV3) with (T253) in Tyaseer village network

The figure (B.2.10) shows Tyaseer village with the proposed solar system (PV38 at Bus678 next to the transformer "T253//AFD PV PLANT") in the village of Tyaseer [10]. The figure (B.2.10) obtained using the global positioning system (GPS system [57]).

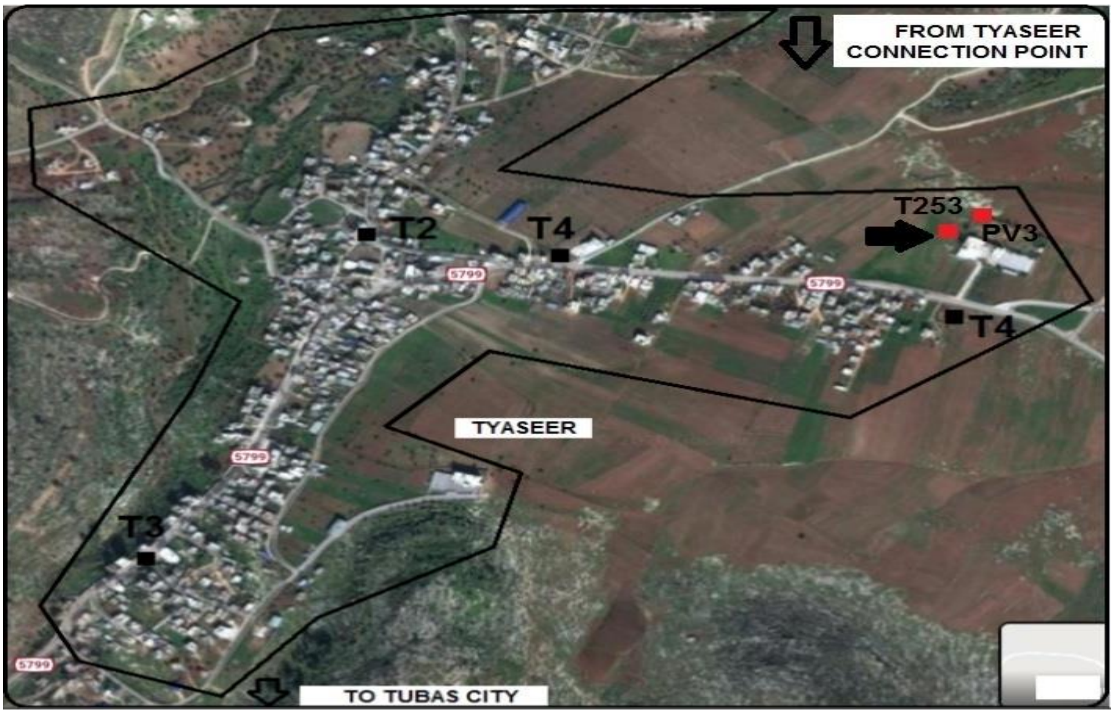

Figure (B.2.10) : The Tyaseer village with the proposed solar system(PV3 at T253) in Tyaseer village network by using the GPS system

B.3 The suggested solutions for the effects of connection points between Tubas Electricity Company and the North Electricity Company in Tubas network:

1. In Al-Kfier village network:

- Sier connection point:

The figure (B.3.1) shows Sier connection point at Bus93 which is located in the village of AL-Kfier, as well as the transmission lines between the village of Al-Kfier and the village of Sier (TL236 "533meters", Bus655, Recloser "R7", Bus656, TL237 "172meters", Bus657, circuit breaker "C.B21", Bus658, TL238 "554meters", Bus672, the loads of the connection point of the village of Sier "Load244") [10].

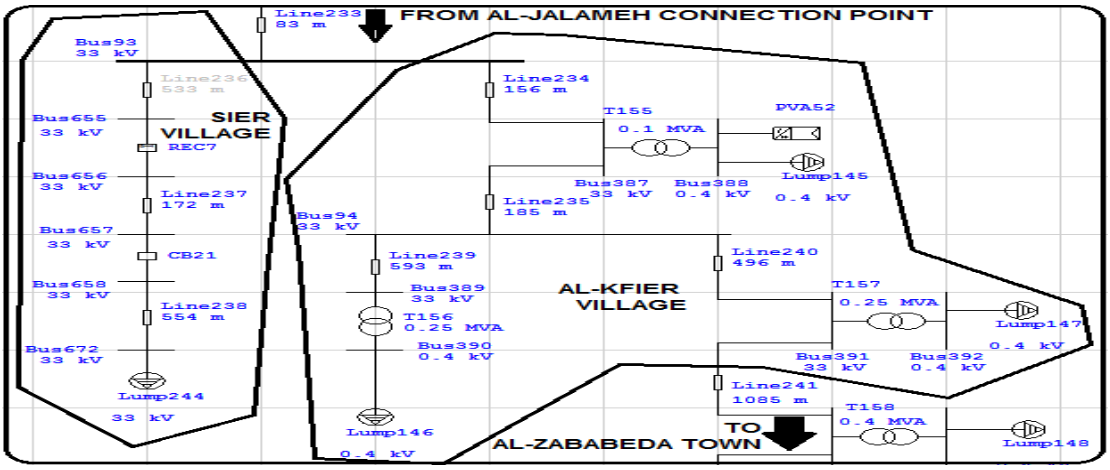

Figure (B.3.1) : The connection point (Sier) at Al-Kfier village network

2. In Wadi Al-Fara'a area network:

- Al-Nasaryeh connection point:

This connection point with 1MVA [11]. From Bus42 in the Southern region (Wadi Al-Fara'a) to area of Al-Nasaryeh.

The figure (B.3.2) shows the power factor in column 12, the electrical current in column 13 and the demand for real power in column 3, for the transformers (T71//SAMEER MOTLAQ at Bus252, T72//3ESAWI at Bus254, T73//FARAH at Bus256, T74//SAMER MOTLAQ at Bus258, T75//HASSAN HMOUD at Bus260, T76//MOMDOH at Bus262) in the Southern region of Wadi Al-Fara'a, before connecting Al-Nasaryeh connection point at Bus42 in Wadi Al-Fara'a area, these values from ETAP simulation program.

Bus252	0.400	-0.010	-0.003	0.010	0.003	0	0	0	0	0.010	94.4	24.6
Bus253	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus254	0.400	-0.003	-0.001	0.003	0.001	0	0	0	0	0.003	94.4	7.3
Bus255	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus256	0.400	-0.008	0	-.0008	0	0	0	0	0	-0.008	99.9	20.3
Bus257	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus258	0.400	-0.008	0	0.008	0	0	0	0	0	0.008	99.9	18.2
Bus259	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus260	0.400	-0.004	-0.002	0.004	0.002	0	0	0	0	0.004	88.1	10.6
Bus261	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus262	0.400	-0.008	-0.003	0.008	0.003	0	0	0	0	0.009	94.5	21.6

Figure (B.3.2) : The power factors at the transformers(T71, T72, T73, T74, T75 and T76) in the Southern region before connecting the connection point (Al-Nasaryeh) in Wadi Al-Fara'a area network

The Table (B.3.1) shows the details for the loads of the connection point of the area of Al-Nasaryeh "Load245" [11].

Table (B.3.1) : The details for the connection point (Al-Nasaryeh) in Wadi Al-Fara'a area network

The load	The real power (Pmax – KW)	The reactive power (Qmax – KVAR)	The power factor
Load 245 (Al-Nasaryeh)	850	527	85%

The figure (B.3.3) shows the power factor in column 12, the electrical current in column 13 and the demand for real power in column 3, for the transformers (T71//SAMEER MOTLAQ at Bus252, T72//3ESAWI at Bus254, T73//FARAH at Bus256, T74//SAMER MOTLAQ at Bus258, T75//HASSAN HMOUD at Bus260, T76//MOMDOH at Bus262) in the Southern region of Wadi Al-Fara'a, after connecting the Al-Nasaryeh connection point at Bus42 in Wadi Al-Fara'a area, these values from ETAP simulation program.

Bus252	0.400	-0.010	-0.003	0.010	0.003	0	0	0	0	0.010	94.4	24.6
Bus253	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus254	0.400	-0.003	-0.001	0.003	0.001	0	0	0	0	0.003	94.4	7.3
Bus255	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus256	0.400	-0.008	0	-.0008	0	0	0	0	0	-0.008	99.9	20.3
Bus257	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus258	0.400	-0.008	0	0.008	0	0	0	0	0	0.008	99.9	18.2
Bus259	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus260	0.400	-0.004	-0.002	0.004	0.002	0	0	0	0	0.004	88.1	10.6
Bus261	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus262	0.400	-0.008	-0.003	0.008	0.003	0	0	0	0	0.009	94.5	21.6
Bus42	33.000	-0.061	-0.038	0.061	0.038	0	0	0	0	0.072	85.0	2.1

Figure (B.3.3) : The power factors at the transformers(T71, T72, T73, T74, T75 and T76) in the Southern region after connecting the connection point (Al-Nasaryeh) in Wadi Al-Fara'a Area Network

From figure (B.3.2) and figure (B.3.3) we see in column 12 that the connecting of the connection point (Al-Nasaryeh) did not negatively affect the power factors at the old transformers in the Southern region of Wadi Al-Fara'a area, as (the transformer "T71//SAMEER MOTLAQ" at Bus252 the power factor not change from 94.4%, the transformer "T72//3ESAWI" at Bus254 the power factor not change from 94.4% , the transformer "T73//FARAH" at Bus256 the power factor not change from 99.9% , the transformer "T74//SAMER MOTLAQ" at Bus258 the power factor not change from 99.9%, the transformer "T75//HASSAN HMOUD" at Bus260 the power factor not change from 88.1% and the transformer "T76//MOMDOH" at Bus262 the power factor not change from 94.5%), as for the new loads (the loads of the connection point of the area of Al-Nasaryeh "Load245") it power factor was zero because it not connected to the grid before connecting Al-Nasaryeh connection point with it, and after connecting Al-Nasaryeh connection point to these loads, the value of the power factor for these loads became 85.0%, which is an excellent power factor. So the connecting of Al-Nasaryeh connection point did not affect the power factors in the network.

From figure (B.3.2) and figure (B.3.3) we see in column 13 that the connecting of the connection point (Al-Nasaryeh) did not negatively affect the electric currents at the old transformers in the Southern region of Wadi Al-Fara'a area , as (the transformer "T71//SAMEER MOTLAQ" at Bus252 the electric currents not change from 24.6 amperes, the transformer "T72//3ESAWI" at Bus254 the electric currents not change from 7.3 amperes, the transformer "T73//FARAH" at Bus256 the electric currents not change from 20.3 amperes , the transformer "T74//SAMER MOTLAQ" at Bus258 the electric currents not change from 18.2 amperes, the transformer "T75//HASSAN HMOUD" at Bus260 the electric currents not change from 10.6 amperes and the transformer "T76//MOMDOH" at Bus262 the electric currents not change from 21.6 amperes), as for the new loads (the loads of the connection point of the village of Al-Nasaryeh "Load245") it electric current was zero because it not connected to the grid before connecting Al-Nasaryeh Connection Point with it, and after connecting Al-Nasaryeh Connection Point to these loads, the value of the electric current changed for these loads to be 2.1 amperes at Bus42. So the connecting of Al-Nasaryeh connection point to Wadi Al-Fara'a area increased the electric current on the Bus42 that connected with the new loads (the loads of the connection point of the area of Al-Nasaryeh "Load245").

From figure (B.3.2) and figure (B.3.3) we see in column3 that the connecting of the connection point (Al-Nasaryeh) did not negatively affect the real power demand at the old transformers in the Southern region of Wadi Al-Fara'a area, as (the transformer "T71//SAMEER MOTLAQ" at Bus252 the real power demand does not change from 10KW, the transformer "T72//3ESAWI" at Bus254 the real power demand does not change from 3KW, the transformer "T73//FARAH" at Bus256 the real power demand does not change from 8KW, the transformer "T74//SAMER MOTLAQ" at Bus258 the real power demand does not change from 8KW, the transformer "T75//HASSAN HMOUD" at Bus260 the real power demand does not change from 4KW and the transformer

"T76//MOMDOH" at Bus262 the real power demand does not change from 8KW), as for the new loads (the loads of the connection point of the village of AL-NASARYEH "Load245") it real power demand was zero because it not connected to the grid before connecting Al-Nasaryeh connection point with it , and after connecting Al-Nasaryeh connection point to these loads, the value of the real power demand changed for these loads to be 61KW at Bus42. So the connecting of the connection point (Al-Nasaryeh) to Wadi Al-Fara'a area, resulted in an increased the real power demand at Bus42 that connected with the new loads (the loads of the connection point of the area of Al-Nasaryeh "Load245"). But it is important to note that there will be an additional (MVA) demand and thus this will put pressure on the network. So to solve this problem we can take advantage of the suggested generator ("G1" which was discussed in detail in the appendix, in the section B "THE SOLUTIONS" at Title B.1./5.) "The suggested solutions of the problems of Wadi Al-Fara'a region network", in Wadi Al-Fara'a area or take the advantage of the suggested new transmission line ("TL360 – Ring2" which was discussed in detail in the appendix, at section B "The Solutions" at Title B.1./5.) "The suggested solutions of problems of Wadi Al-Fara'a region network", in Wadi Al-Fara'a area.

The figure (B.3.4) shows Al-Nasaryeh connection point at Bus42 which is located in the Southern region of Wadi Al-Fara'a area, as well as the loads of the connection point of the area of Al-Nasaryeh "Load245") [10].

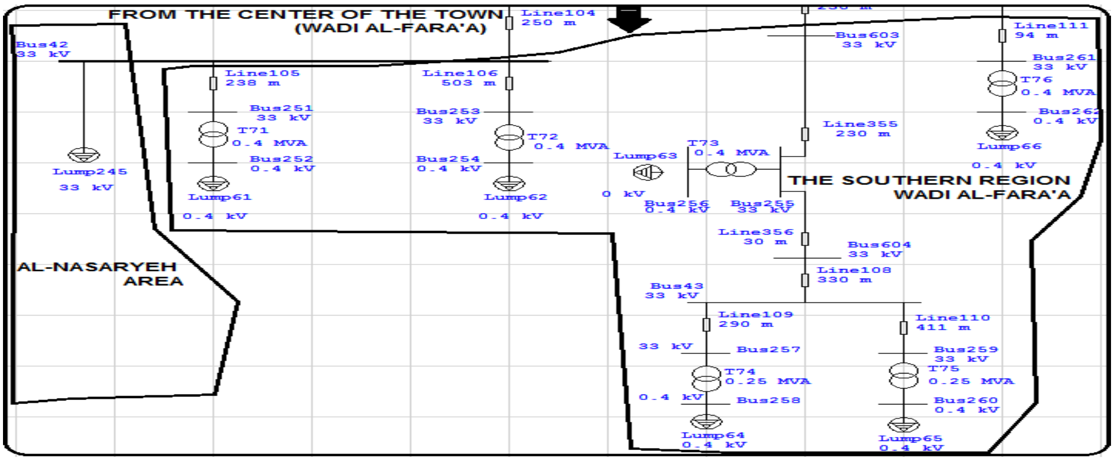

Figure (B.3.4) : The connection point (Al-Nasaryeh) at Wadi Al-Fara'a area network

- Al-Bathan connection point:

The figure (B.3.5) shows Al-Bathan connection point at Bus243 which is located in the area of Wadi Al-Fara'a, as well as the transmission line between the area of Wadi Al-Fara'a and the town of Al-Bathan (TL94 "800meters", Bus671, the loads of the connection point of the town of Al-Bathan "Load246") [10].

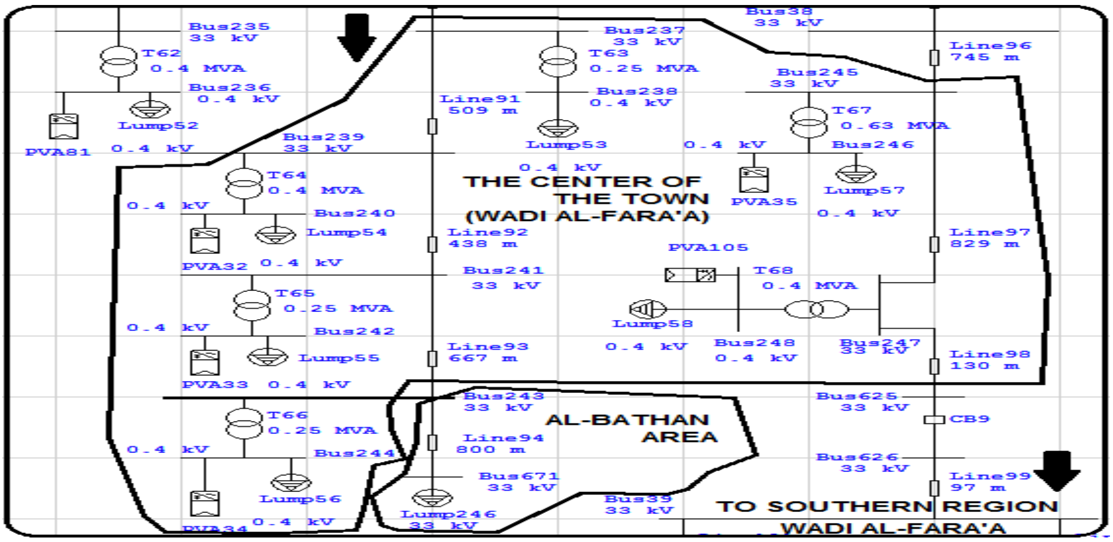

Figure (B.3.5) : The connection point (Al-Bathan) at Wadi Al-Fara'a area network

- Yaseed connection point:

This connection point with 3MVA [11]. From Bus46 in the Eastern region (Wadi Al-Fara'a) to area of Yaseed village.

The figure (B.3.6) shows the power factor in column 12, the electrical current in column 13 and the demand for real power in column 3, for the transformers (T77//CHEBS FACTORY at Bus264, T78//ALHAFRIA at Bus538, T79//YASEED EAST at Bus266, T80//YASEED WEST "ABO ASA'D" at Bus268, T81//AL-KASARET ABO ASA'D at Bus539, T82//MASHAQI WELL at Bus270, T83//KASARET AL-SHAM at Bus272) in the Eastern region of Wadi Al-Fara'a, before connecting Yaseed connection point at Bus46 in Wadi Al-Fara'a area, these values from ETAP simulation program.

Bus264	0.400	0	0	0	0	0	0	0	0	0	89.4	0.4
Bus266	0.400	0.003	-0.001	0.002	0.001	0	0	0	0	0.005	98.7	11.8
Bus267	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus268	0.400	-0.003	-0.001	0.003	0.001	0	0	0	0	0.003	89.0	7.2
Bus269	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus270	0.400	0	0	0	0	0	0	0	0	0	89.4	0.4
Bus271	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus272	0.400	0	0	0	0	0	0	0	0	0	100.0	0.2
Bus273	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus538	0.400	0.014	-0.003	0.009	0.003	0	0	0	0	0.023	99.0	54.9
Bus539	0.400	-0.007	-0.003	0.007	0.003	0	0	0	0	0.007	93.1	17.5

Figure (B.3.6) : The power factors at the transformers(T77, T79, T80, T82, T83, T78 and T81) respectively in the Eastern region before connecting the connection point (Yaseed) in Wadi Al-Fara'a area network

The Table (B.3.2) shows the details for the loads of the connection point of the area of Yaseed "Load247" [11].

Table (B.3.2) : The details for the connection point (Yaseed) in Wadi Al-Fara'a area network

The load	The real power (Pmax – KW)	The reactive power (Qmax – KVAR)	The power factor
Load 247 (Al-Bathan)	2550	1580	85%

The figure (B.3.7) shows the power factor in column 12, the electrical current in column 13 and the demand for real power in column 3, for the transformers (T77//CHEBS FACTORY at Bus264, T78//ALHAFRIA at Bus538, T79//YASEED EAST at Bus266, T80//YASEED WEST "ABO ASA'D" at Bus268, T81//AL-KASARET ABO ASA'D at Bus539, T82//MASHAQI WELL at Bus270, T83//KASARET AL-SHAM at Bus272) in the Eastern region of Wadi Al-Fara'a, after connecting Yaseed connection point at Bus46 in Wadi Al-Fara'a area, these values from ETAP simulation program.

Bus264	0.400	0	0	0	0	0	0	0	0	0	89.4	0.4
Bus266	0.400	0.003	-0.001	0.002	0.001	0	0	0	0	0.005	98.7	11.8
Bus267	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus268	0.400	-0.003	-0.001	0.003	0.001	0	0	0	0	0.003	89.0	7.2
Bus269	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus270	0.400	0	0	0	0	0	0	0	0	0	89.4	0.4
Bus271	33.000	0	0	0	0	0	0	0	0	0	0.0	0.0
Bus272	0.400	0	0	0	0	0	0	0	0	0	100.0	0.2
Bus538	0.400	0.014	-0.003	0.009	0.003	0	0	0	0	0.023	99.0	54.9
Bus539	0.400	-0.007	-0.003	0.007	0.003	0	0	0	0	0.007	93.1	17.5
Bus46	33.000	-0.184	-0.114	0.184	0.114	0	0	0	0	0.216	85.0	6.3

Figure (B.3.7) : The power factors at the transformers(T77, T79, T80, T82, T83, T78 and T81) respectively in the Eastern region after connecting the connection point (Yaseed) in Wadi Al-Fara'a area network

From figure (B.3.6) and figure (B.3.7) we see in column 12 that the connecting of the connection point (Yaseed) did not negatively affect the power factors at the old transformers in the Eastern region of Wadi Al-Fara'a area, as (the transformer "T77//CHEBS FACTORY" at Bus264 the power factor not change from 89.4%, the transformer "T78//ALHAFRIA" at Bus538 the power factor not change from 99.0%, the transformer "T79//YASEED EAST" at Bus266 the power factor not change from 98.7%, the transformer "T80//YASEED WEST "ABO ASA'D"" at Bus268 the power factor not change from 89.0%, the transformer "T81//AL-KASARET ABO ASA'D" at Bus539 the power factor not change from 93.1%, the transformer "T82//MASHAQI WELL" at Bus270 the power factor not change from 89.4%, the transformer "T83//KASARET AL-SHAM" at Bus272 the power factor not change from 100%) , As for the new loads (the loads of the connection point of the area of Yaseed "Load247") it power factor was zero because it not connected to the grid before connecting Yaseed connection point with it, and after connecting Yaseed connection point to these loads, the value of the power factor for these loads became 85.0%, which is an excellent power factor. So the connecting of Yaseed connection point did not affect the power factors in the network.

From figure (B.3.6) and figure (B.3.7) we see in column 13 that the connecting of the connection point (Yaseed) did not negatively affect the electric currents at the old transformers in the Eastern region of Wadi Al-Fara'a area, as (the transformer "T77//CHEBS FACTORY" at Bus264 the electric currents not change from 0.4 amperes, the transformer "T78//ALHAFRIA" at Bus538 the electric currents not change from 54.9 amperes, the transformer "T79//YASEED EAST" at Bus266 the electric currents not change from 11.8 amperes, the transformer "T80//YASEED

WEST "ABO ASA'D" at Bus268 the electric currents not change from 7.2 amperes, the transformer "T81//AL-KASARET ABO ASA'D" at Bus539 the electric currents not change from 17.5 amperes, the transformer "T82//MASHAQI WELL" at Bus270 the electric currents not change from 0.4 amperes, the transformer "T83//KASARET AL-SHAM" at Bus272 the electric currents not change from 0.2 amperes) , As for the new loads (the loads of the connection point of the village of YASEED "Load247") it electric current was zero because it not connected to the grid before connecting Yaseed connection point with it, and after connecting Yaseed connection point to these loads, the value of the electric current changed for these loads to be 6.3 amperes at Bus46. So the connecting of Yaseed connection point to Wadi Al-Fara'a area increased the electric current on the Bus46 that connected with the new loads (the loads of the connection point of the area of Yaseed "Load247").

From figure (B.3.6) and figure (B.3.7) we see in column3 that the connecting of the connection point (Yaseed) did not negatively affect the real power demand at the old transformers in the Eastern region of Wadi Al-Fara'a area, as (the transformer "T77//CHEBS FACTORY" at Bus264 the real power demand does not change from 0KW, the transformer "T78//ALHAFRIA" at Bus538 the real power demand does not change from 14KW that goes towards the grid and the reason it goes towards the grid is because Bus538 is connected to an old solar system "PV79 – 25KWp", the transformer "T79//YASEED EAST" at Bus266 the real power demand does not change from 3KW that goes towards the grid and the reason it goes towards the grid is because Bus266 is connected to an old solar system "PV36 – 5KWp", the transformer "T80//YASEED WEST "ABO ASA'D"" at Bus268 the real power demand does not change from 3KW, the transformer "T81//AL-KASARET ABO ASA'D" at Bus539 the real power demand does not change from 7KW, the transformer "T82//MASHAQI WELL" at Bus270 the real power demand does not change from 0KW, the transformer "T83//KASARET AL-SHAM" at Bus272 the real power demand does not change from 0KW), as for the new loads (the loads of the connection point of the village of Yaseed "Load247") it real power demand was zero because it not connected to the grid before connecting Yaseed connection point with it, and after connecting Yaseed connection point to these loads, the value of the real power demand changed for these loads to be 184KW at Bus46. So the connecting of the connection point (Yaseed) to Wadi Al-Fara'a area, resulted in an increased the real power demand at Bus46 that connected with the new loads (the loads of the connection point of the area of YASEED "Load247"). But it is important to note that there will be an additional (MVA) demand and thus this will put pressure on the network. So to solve this problem we can take advantage of the suggested generator ("G1" which was discussed in detail in the appendix, at the section B "The Solutions" at Title B.1./5.) "The suggested solutions of problems of Wadi Al-Fara'a region network", in Wadi Al-Fara'a area or take the advantage of the suggested new transmission line ("TL360 – Ring2" which was discussed in detail in the appendix, at the section B "The Solutions" at Title

B.1./5.) "The suggested solutions of problems of Wadi Al-Fara'a region network", in Wadi Al-Fara'a area.

The figure (B.3.8) shows Yaseed connection point at Bus46 which is located in the area of Wadi Al-Fara'a, as well as the loads of the connection point of the town of Yaseed "Load247") [10].

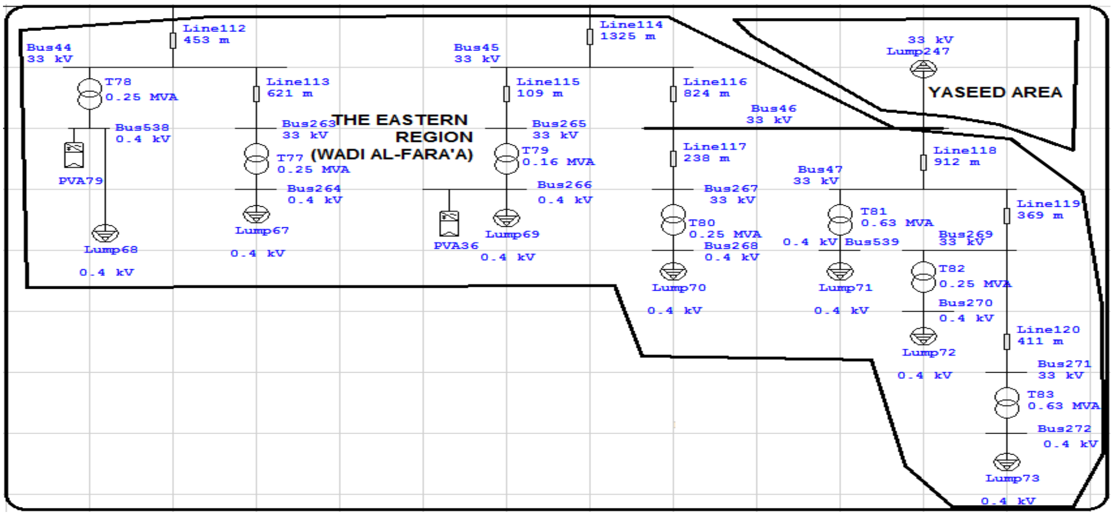

Figure (B.3.8) : The connection point (Yaseed) at Wadi Al-Fara'a area network

Appendix C : The Costs.

C.1 : The costs of the proposed solutions in the Tubas electricity network (proposed solutions by the company – by Tubas Electricity Company):

1. In Tubas city:

- Jafa PV Plant (Under Construction):

There are two solar systems (two solar stations) as follow (the solar system PV38 with the transformer "T249//JAFA PV PLANT1", the solar system PV87 with the transformer "T250//JAFA PV PLANT2").

The table (C.1.1) shows the cost of the proposed solar system by Tubas Electricity Company and the new transformer (PV38 & T249//JAFA PV PLANT1) respectively in the areas near Al-Fara'a areas of Tubas city.

Table (C.1.1) : The cost of the solar system and the transformer(PV38 & T249) respectively in the areas near Al-Fara'a areas of Tubas city

<table>
<tr><th>The number of each solar system</th><th colspan="2">The ratings
(KWp & KV_{AC})</th><th colspan="2">The space needed for the solar system</th></tr>
<tr><td rowspan="3">PV 38
Inv 38</td><td colspan="2">2703 KWp
0.4 KV_{AC}</td><td colspan="2">17300 m^2 (space needed for the solar panels)
27000 m^2 (space needed for the solar system with taking into account the shadows)</td></tr>
<tr><td colspan="4">The cost for the solar system with the components included with the solar system (wires, cables, inverter, solar panels, constructor)</td></tr>
<tr><td colspan="4">2297550 $</td></tr>
<tr><td>The number of the transformer</td><td>The ratings
(KVA , KV)</td><td colspan="2">The cost of the transformer</td><td>The cost for the arm and tower in place to carry the transformer</td></tr>
</table>

			(central type arm , tension type tower)	
T 249	2180 KVA (33/0.4) KV	40000 $	3000 $	
	The cost of the components included with the transformer (wires , insulator "3" (type of ABB), isolators "6" (type of porcelain), fuses "3" (type of dropout), lighting arrestors "3", oil tank)			The total cost of the transformer
	4500 $			47500 $
The total cost of the proposed solar system by TUBAS Electricity Company (the solar system PV38 with the transformer T249)				
2297550$ + 47500$ = 2345050$				

The table (C.1.2) shows the cost of the proposed solar system by Tubas Electricity Company and the new transformer (PV87 & T250//JAFA PV PLANT2) respectively in the areas near Al-Fara'a areas of Tubas city.

Table (C.1.2) : The cost of the solar system and the transformer(PV87 & T250) respectively in the areas near Al-Fara'a areas of Tubas city

The number of each solar system	The ratings (KWp & KV_{AC})		The space needed for the solar system
PV 87 Inv 87	2703 KWp 0.4 KV_{AC}		17300 m^2 (space needed for the solar panels) 27000 m^2 (space needed for the solar system with taking into account the shadows)
PV 87 Inv 87	The cost for the solar system with the components included with the solar system (wires, cables, inverter, solar panels, constructor)		
	2297550 $		
The number of the transformer	The ratings (KVA , KV)	The cost of the transformer	The cost for the arm and tower in place to carry the transformer (central type arm , tension type

			tower)	
T 250	2180 KVA (33/0.4) KV	40000 $	3000 $	
	The cost of the components included with the transformer (wires , insulator "3" (type of ABB), isolators "6" (type of porcelain), fuses "3" (type of dropout), lighting arrestors "3", oil tank)			The total cost of the transformer
	4500 $			47500 $
The total cost of the proposed solar system by TUBAS Electricity Company (the solar system PV87 with the transformer T250)				
2297550$ + 47500$ = 2345050$				

The table (C.1.3) shows the total cost of the proposed solution by Tubas Electricity Company of solar systems (the solar system PV38 with the transformer "T245//JAFA PV PLANT1", the solar system PV87 with the transformer "T250//JAFA PV PLANT2") in the areas near Al-Fara'a areas of Tubas city.

Table (C.1.3) : The total cost of the proposed solution by Tubas Electricity Company of solar systems(PV10 with T18, PV88 with T251 & PV89 with T252) in the Eastern region2 of Tubas city

The total cost of the proposed solution by TUBAS Electricity Company (the solar system PV38 with the transformer T249 and the solar system PV87 with the transformer T250)
2345050$ + 2345050$ = 4690100$

From table (C.1.3) the suggested solution requires a cost of (4690100$ = 16500000NIS).

2. In Tyaseer village network:

- Tyaseer Filtering Station PV Plant (Proposed):

There is one solar system in this proposed (the solar system PV3 with the transformer "T253//AFD PV PLANT").

The Table (C.1.4) shows the cost of the proposed solar system by Tubas Electricity Company and the new transformer (PV3 with T253//AFD PV PLANT) respectively in the Tyaseer village region.

Table (C.1.4) : the cost of the solar system and the transformer(PV3 & T252) respectively in the Tyaseer village

<table>
<tr><th colspan="2">The number of each solar system</th><th colspan="2">The ratings
(KWp & KV_{AC})</th><th colspan="2">The space needed for the solar system</th></tr>
<tr><td colspan="2" rowspan="3">PV 3
Inv 3

PV 3
Inv 3</td><td colspan="2">2000 KWp

0.4 KV_{AC}</td><td colspan="2">12800 m^2 (space needed for the solar panels)

20000 m^2 (space needed for the solar system with taking into account the shadows)</td></tr>
<tr><td colspan="4">The cost for the solar system with the components included with the solar system (wires, cables, inverter, solar panels, constructor)</td></tr>
<tr><td colspan="4">1700000 $</td></tr>
<tr><th>The number of the transformer</th><th colspan="2">The ratings
(KVA, KV)</th><th>The cost of the transformer</th><th colspan="2">The cost for the arm and tower in place to carry the transformer
(central type arm, tension type tower)</th></tr>
<tr><td rowspan="2">T 253</td><td colspan="2">2000 KVA, (33/0.4) KV</td><td>40000 $</td><td colspan="2">3000 $</td></tr>
<tr><td colspan="4">The cost of the components included with the transformer (wires , insulator "3" (type of ABB), isolators "6" (type of porcelain), fuses "3" (type of dropout), lighting arrestors "3", oil tank)</td><td>The total cost of the transformer</td></tr>
</table>

	4500 $	47500 $
The total cost of the proposed solar system by TUBAS Electricity Company (the solar system PV3 with the transformer T253)		
1700000$ + 47500$ = 1747500$		

From table (C.1.4) the suggested solution requires a cost of (1747500$ = 6500000NIS).

جامعة النجاح الوطنية

كلية الدراسات العليا

تحسين معاملات تدفق الطاقة لشبكة طوباس لتوزيع الكهرباء عن طريق إضافة وحدة توليد موزعة تعتمد على الخلايا الكهروضوئية وخط نقل للجهد المتوسط

إعداد

القسام الحاج

إشراف

د. ماهر خماش

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2021

تحسين معاملات تدفق الطاقة لشبكة طوباس لتوزيع الكهرباء عن طريق إضافة وحدة توليد موزعة تعتمد على الخلايا الكهروضوئية وخط نقل للجهد المتوسط

إعداد

القسام الحاج

إشراف

د. ماهر خماش

الملخص

تقــدم هــذه الأطروحــة مجموعــة مــن الحلــول المقترحــة لحــل مجموعــة مــن المشــاكل الموجــودة فــي شــبكة كهربــاء طوبــاس, وقــد تــم اختيــار هــذه الحلــول كأفضــل حلــول مــن حيــث التطبيــق العملــي والتكلفــة والمــردود المــادي لكــل مــن هــذه الحلــول . كمــا تناولــت هــذه الأطروحــة مجموعــة مــن الحلــول المقترحــة مــن قبــل شــركة الكهربــاء (شــركة كهربــاء طوبــاس) وتــم وضــع الحلــول المقترحــة فــي الأطروحــة كحلــول إضــافية للحلــول المقترحــة مــن قبــل الشــركة وليســت كبــديل لهــا. وتجــدر الإشــارة إلــى أن شــبكة كهربــاء طوبــاس يوجــد بهــا عــدة نقــاط ربــط بــين الشــبكة نفســها والشــبكة القطريــة وشــركة كهربــاء الشــمال. وخــلال هــذه الأطروحــة ســيتم مناقشــة كــل هذه النقاط وتأثيرها على شبكة كهرباء طوباس.

الأهــداف المــراد تحقيقهــا فــي هــذه الرســالة, تحســين معــايير الطاقــة لشــبكة كهربــاء طوبــاس (خاصــة منطقــة الفارعــة)، تصــميم تقنيــة لتوزيــع الطاقــة المولــدة مــن مولــد مدينــة الفارعــة الجديــد (مصــدر جديــد). باســتخدام خــط نقــل جديــد أو نظــام PVs جديــد، ممــا يــوفر تيــارًا كهربائيًــا ثابتًــا لــبعض الأحمــال فــي شــبكة كهربــاء طوبــاس، ممــا يقلــل الضــغط علــى بعــض المحــولات فــي شــبكة كهربــاء طوبــاس، ويحســن معامــل القــدرة (PF) لــبعض أحمــال معامــل القــدرة المنخفضــة (PF)، تــوفير تيــار كهربــائي مســتقر لــبعض الأحمــال الجديــدة دون التــأثير علــى الأحمــال القديمــة لــبعض منــاطق شــبكة كهربــاء طوبــاس، وتحســين وتطــوير شــبكة توزيــع

الكهربـــاء فـــي طوبـــاس مـــن خـــلال تقليـــل اســـتهلاك الكهربـــاء مـــن IEC، وإنشـــاء وتصـــميم مولـــد جديـــد، مصـــدر جديـــد أو نظـــام كهروضـــوئي فـــي الشـــبكة لـــدعم زيـــادة ســـعة الطاقـــة المســـتهلكة فـــي الشـــبكة، ممـــا يقلـــل الـــنقص فـــي ســـاعات الـــذروة لـــبعض مناطق شبكة طوباس وتغذية أماكن جديدة من شبكة شركة كهرباء الشمال.