First Libyan international Conference on Engineering Sciences & Applications (FLICESA_LA)
13 – 15 March 2023, Tripoli – Libya

Renewable Energies (PV -System) and its Applications in Semi-Desert Areas

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Abstract**—**Libya suffers from frequent power outages and long hours. This is where we must search for solutions, the most important of which is to rely on renewable and alternative energies such as solar energy, which is available across large areas in our country and is characterized by the presence of sunlight throughout the year. The electrical system network is known as the electrical network system serving the Libyan state, which contains long transmission and distribution networks, and suffers from many problems such as high losses, low voltage, and low electrical power transmitted to end users.

In this paper, a power and voltage generating station has been studied and designed in the Ghat region, which is in the southwest of Libya, which suffers from interruptions and lack of continuity of electric current with low voltage and high losses in transmission lines. These renewable energy plants have been developed as Distribution Generators (DG). It is installed on the connecting rods in different areas of the city with the aim of feeding the city in addition to the existing network. The existing network has been studied before and after the addition of this station or electric voltage stations in terms of performance, improvement of operation, reduction of losses, and regulation of voltages using the (NEPLAN) Software. The solar power plant has been designed by (PV Sol preimum2021) program. The network has been studied while it is isolated and fed only with solar energy The simulation results showed that the PV power plant offering Ghat City electric a remarkable that increasing its reliability and enhancing its operation isolated or connection with grid. Conclusions have been drawn from the work.

Keywords: PV Module, NEPLAN, Optimal load flow, Short circuit

I. Introduction

Renewable energy is generally defined as energy that is collected from renewable resources that are naturally replenished on a human timescale. It includes sources such as sunlight, wind, rain, tides, waves, and geothermal heat[1]. Although most renewable energy sources are sustainable, some are not. For example, some biomass sources are considered unsustainable at current rates of exploitation [1].

parentheses, following the example. Some components, such as multi-leveled equations, graphics, and tables are not prescribed, although the various table text styles are provided.

II. METATOLOGE

In this Thesis, the design procedures for developing a renewable energy plant for the city of GHAT including a solar power plant will be introduced through the following steps and this will be done using the (PV sol) application for this study, along with the use of load flow analysis software (NEPLAN).

The following steps will performance for this research: -
1-Collecting all a viable data for Ghat city concerning the electrical demand, rate of local grow in, electrical network paraments and demand Types.
2-the deep study to find out the maximum possible energy of solar radiation.
3-Run the load flow on the exitance circuit to find out sits performance and define the weaknesses.
4-Design the PV-Solar power station according to the needs and solar emission availability.
5-Run simulation study to check for number of generator station needed as a DG units and check for the best location s to improve the circuit performance using optimal power flow.
6-Run the Ghat electrical network as an isolated grid feed only by PV-System as contingency case

III. Photo- Voltaic Systems (PV system) .

A photovoltaic system, also named solar PV power system, or PV system, is a power system designed to supply usable solar power by means of photovoltaic. It consists of an arrangement of several components, including solar panels to absorb and convert sunlight into electricity, a solar inverter to change the electric current from DC to AC, as well as mounting, cabling and other electrical accessories to set up a working system. It may also use a solar tracking system to improve the system's overall performance and include an integrated battery solution, as prices for storage devices are expected to decline. Strictly speaking, a solar array only encompasses the ensemble of solar panels, the visible part of the PV system, and does not include all the other hardware, often summarized as balance of system (BOS). Moreover, PV systems convert light directly into electricity and shouldn't be confused with other technologies, such as concentrated solar power or solar thermal, used for heating and cooling[2].

IV.Determination of Appropriate PV Module.

A. PV Module.

One of the most important stages in preparing the design requirements for solar energy is the selection of the plate used to generate energy according to the information obtained previously (location temperature, solar radiation and horizon angle est.), and from which the appropriate plate for these data can be chosen from one of the global manufacturers that have great experience and quality of the industry.
The Module is Panasonic VBHN240SJ2, and the data sheet of this module is given Table (1) Data sheet for VBHN240SJ25.

Table 1: Data sheet for VBHN240SJ25

PV Module:	
Manufacturer	Panasonic
Available	Yes
Cell Type	HIT
Only Transformer Inverters suitable	No
Efficiency	19.05
Width	798mm
Height	1580mm
Depth	35mm
Weight	15kg
VPP	43.6V
IPP	5.51A
Output	240W
Open Circuit Voltage	52.4V
Short-Circuit Current	5.85A

B. The Panel Design: -

In this design, I have chosen type of design grid connected PV system, I also chose the panel **VBHN240SJ25,** We need 7MWatt. That mean we need 29167 panel every one give 240 watt. So, we need 29167 panel.

29167 → 7000.08KW »7MWatt [3].

- Part 1.

143 mode string *17 mode series = 2431 panel

2431panel *240 watt =58344 kwp

58344kwp * no of inverter (7) = 4084.04 kwp.

- Part2

162 mode string *15 mode series = 2430 panel

2430panel *240 watt =583200 kwp

583200kwp * no of inverter (5) = 2916.00

Part1+part2= 4084.04+2916.00= 7000.04 kwatt = 7MWatt as shown Figure (1) diagram for module. And shown Table The number of Inverter) [3].

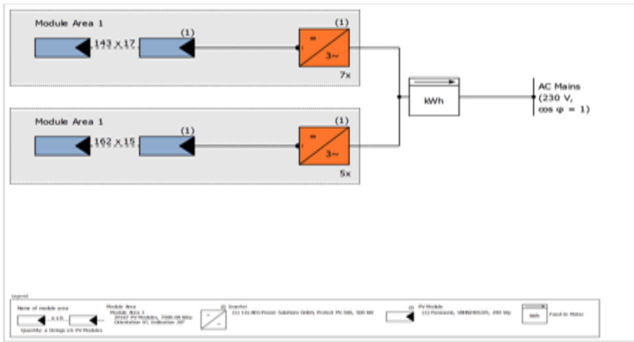


Fig (1) diagram for module [3].

V. Case Studies and analysis

The electric circuit of Ghat city as semi-desert city connected to Libyan electric Grid by a (220/66) kv substation Trough two 220/66 kv power transformer with 20MVA size. And 63MVA size. The system main buses and step-down transformer (66/11) considered as the peak loads as shown in Fig (2) The result of Normal load flow operation (NLF)[4].

The network under-study is a real data of Ghat electrical network, and to study its performance.

the software NEPLAN will be applied for simulation using different scenarios, each scenario contains load flow and short circuit, the description of these cases is as following: -

A -Study the performance of the electric system using software NEPLAN for normal load flow analysis and for optimal power flow analysis (OPF).

B -Also, the unconventional methods of DG penetration will be applied with (OPF) to enhance the system performance. Using The PV-power plant as a DG unit.

A. Case 1: Ghat Electric Network (Normal Operation)

Considering The 4 substation Alwanat,Tahal ,Ghat and Elbrekt. feed from (220/66)kv Alawanat substation . considering this network is operating at steady state normal operation with peak load.

of p=19.395MVA and 66.457KV at the four mentioned buses Table (2) shown the names and sizes and peak loads of The Network system.

The simulation investigates the base network without any penetration of PV system, the result load flow shown in figure (2) the load flow Results and Table (2) the name and percentage voltage of buses.

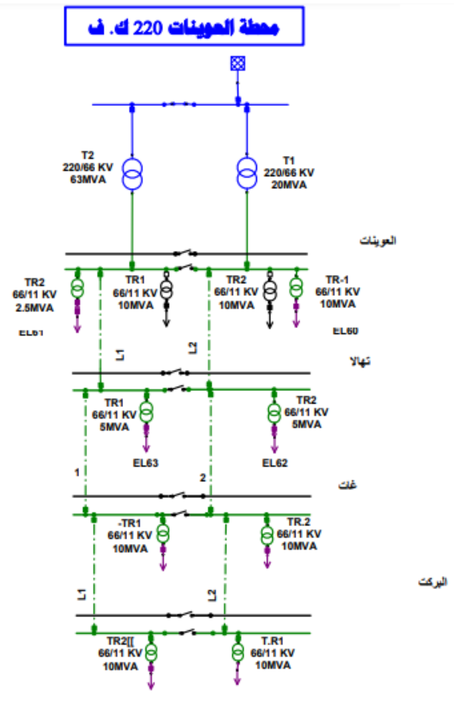


Fig (2) The result of Normal load flow operation (NLF).

Table (2) the name and percentage voltage of buses

	ID	Name	U	u	U ang	P Load	Q Load	P Gen	Q Gen	Q Shunt	Sens. PG/	Sens. QG	DU
			kV	%	°	MW	MVar	MW	MVar	MVar	Nodal		Feeder
1	107688	B-10768802	0	0	0	0	0	0	0	0	0	0	0
2	107688	B-10768802	0	0	0	0	0	0	0	0	0	0	0
3	107688	B-10768803	0	0	0	0	0	0	0	0	0	0	0
4	107688	B-10768803	0	0	0	0	0	0	0	0	0	0	0
5	107688	B-10768803	0	0	0	0	0	0	0	0	0	0	0
6	107688	B-10768803	0	0	0	0	0	0	0	0	0	0	0
7	107734	N107734575	0	0	0	0	0	0	0	0	0	0	0
8	107734	N107734576	11.622	105.66	-3.2	0.8	0.496	0	0	0	0.006612	0.008954	0
9	107734	N107734577	11.051	100.46	-2.6	1	0.62	0	0	0	0.005718	0.004812	0
10	107734	N107734578	0	0	0	0	0	0	0	0	0	0	0
11	107734	N107734586	10.575	96.14	-6.8	3.6	2.231	0	0	0	0.061025	0.04194	0
12	107734	N107734586	10.478	95.26	-9.2	3.8	2.355	0	0	0	0.072839	0.054855	0
13	107734	N107734586	10.627	96.61	-6.6	3.5	2.169	0	0	0	0.057783	0.039747	0
14	107734	N107734586	10.525	95.68	-9	3.8	2.355	0	0	0	0.069423	0.052527	0
15	107735	N107734593	11.154	101.4	-3.6	1	0.62	0	0	0	0.029872	0.02096	0
16	107734	N107734593	11.112	101.02	-5.7	1	0.62	0	0	0	0.037028	0.030206	0
17	107688	البركت	62.645	94.92	-6.9	0	0	0	0	0	0.063843	0.048764	0
18	107688	1-66البركت	63.092	95.59	-4.7	0	0	0	0	0	0.053651	0.036977	0
19	107687	العويدات	67.815	102.75	-2.8	0	0	0	0	0	0.005719	0.008392	0
20	107687	العويدات	67.835	102.78	-0.8	0	0	0	0	0	0.001592	0.002073	0
21	107715	220العويدات	220	100	0	0	0	19.111	11.827	0	0	0	0
22	107687	2-220العويدات	220	100	0	0	0	0	0	0	0	0	0
23	107687	اوبارى 1-66	0	0	0	0	0	0	0	0	0	0	0
24	107687	اوبارى 3-66	0	0	0	0	0	0	0	0	0	0	0
25	107687	تهالا	65.221	98.82	-4.9	0	0	0	0	0	0.033974	0.028249	0
26	107687	1-66تهالا	65.458	99.18	-2.8	0	0	0	0	0	0.027136	0.019208	0

B. Case2: Network with Short circuit.

The simulation investigates the base network without any penetration of PV system, the result short circuit shown in figure (3) The result short circuit without PV below.

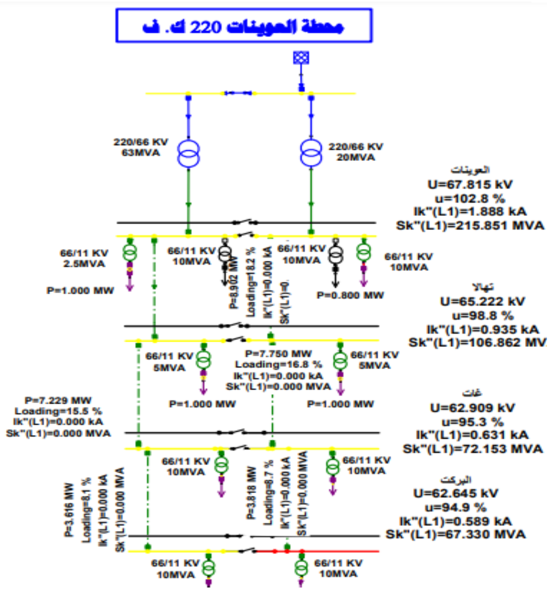


Fig (3): The result short circuit without PV.

The results shown that That the short circuit current within the stander range of less than 32 Kamp Also with in accepted ranges. Using NEPLAN, the voltage percentage results shown in Table (3) the name and percentage voltage on main buses.

Table (3) the name and percentage voltage on main buses.

No	Substation	Voltage (%)
1	220العوينات/66 kv	102.8
2	تهالا	98.8
3	غات	95.3
4	البركت	94.9

Using NEPLAN, the ampere results show short circuit (**max. 5.716 kA**) and thedesigned short-circuit current for the network is (**30.0 K. A**) are shown in table (4). the S.C result on the buses.

Table (4) the S.C result on the buses

	ID	Fault location	Un	Ik"(RST)	Sk"(RST)	Fault Type
			kV	kA	MVA	
1	1076880	البركت	66.000	0.589	67.330	3phase
2	1076880	1-66البركت	66.000	0.741	84.760	3phase
3	1077345	N1077345761	11.000	3.884	73.994	3phase
4	1077345	N1077345776	11.000	1.636	31.176	3phase
5	1077355	N1077345933	11.000	2.641	50.326	3phase
6	1076877	العوينات	66.000	1.888	215.851	3phase
7	1076877	العوينات	66.000	5.716	653.431	3phase
8	1076877	2-220العوينات	220.000	29.99	11430.460	3phase
9	1076877	تهالا	66.000	0.935	106.862	3phase
10	1076877	1-66تهالا	66.000	1.392	159.077	3phase
11	1077345	N1077345861	11.000	2.314	44.093	3phase
12	1077155	220العوينات	220.000	30.00	11431.530	3phase
13	1077345	N1077345861	11.000	2.679	51.039	3phase
14	1077345	N1077345861	11.000	2.218	42.254	3phase
15	1077345	N1077345861	11.000	2.550	48.587	3phase
16	1077345	N1077345933	11.000	2.285	43.540	3phase
17	1076880	عات	66.000	0.631	72.153	3phase
18	1076880	عات	66.000	0.810	92.567	3phase

C. Case3: Network with optimal operation

In this part, we are looking for the best location at the generation substations to connecting on the network, taking into account the calculation of losses, which is the least possible and does not exceed 5% increase or decrease of the value of the voltage, and after running the program, we obtained the best sites in terms of operation and connection to the network as well as the capacity of the solar power stations and the number of four sites as shown in the figure (4). The optimal operation results.

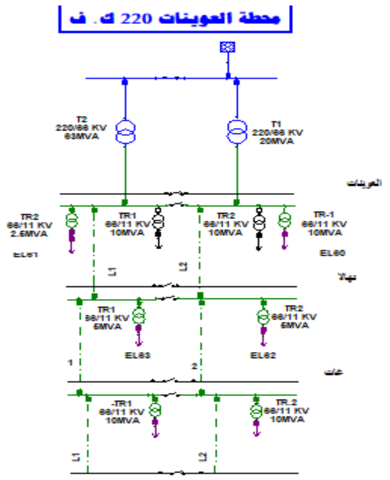
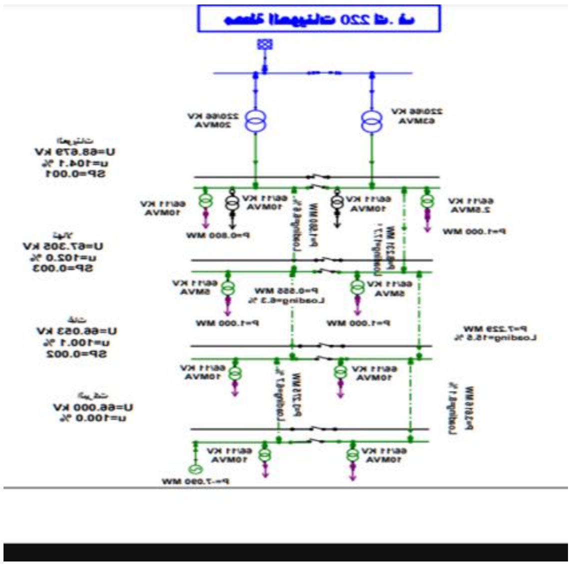


Fig (4): The optimal operation result

D. Case 4: System operation with PV connected using OPF.

In this case, work is being done to locate the PV solar panels on the electricity network, and during their operation it was observed that there is a decrease in the voltage of the Elbrikt bus, Due to this decrease of voltage, PV technology was used and connected to the Elbrikt bus to compensate for this decrease and maintain the stability of operation, But in this case of operation the amount of decrease in electrical power is unknown in order to be compensated for this plant as a result of the loss of the electricity power of the network .After using PV technology at the Elbrikt bus station and applying the simulation program with OPF mode, it became clear that the necessary power needed by the electricity network for stability is 7MW, and with this electrical power this problem. Is solved and put in a stable state as shown fig.(5),and Table (5) the optimal power flow with PV shows the analysis of the resul



Fig(5): The optimal operation with PV result

Table (5) the Optimal power flow with PV

2	From	To	P Loss	Q Loss	P Imp	Q Imp	P Gen	Q Gen	P Load	Q Load
3	Area/Zo	Area/Zo	MW	MVar	MW	MVar	MW	MVar	MW	MVar
4	Network		0.349	-1.17	11.759	9.511	18.849	10.296	18.5	11.466
5	Area 1		0.349	-1.17	0	0	18.849	10.296	18.5	11.466
6	Zone 1		0.349	-1.17	0	0	18.849	10.296	18.5	11.466
7										
8	Un		P Loss	Q Loss	P Loss	Q Loss				
9	kV		MW	MVar	MW	MVar				
10	66		0.287	-2.351	0.047	0.885				
11	220		0	0	0.015	0.296				
12										

E. Case 5 considering 3PV substation connected Ghat Network.

The system simulation with grid connection is shown in Figure (6).In this case, a 7MW PV station size is considered to be connected at each busbar suffering low voltage profile.3DG Units at 7MWeach are connected, two DG's at Elbrikt busbar, and the third at the Alwanat busbar. The results of optimal operation with 3PV Units with grid-connected are shown in Table (6). Table (7) shows the voltage profile in percent which gives agood performance

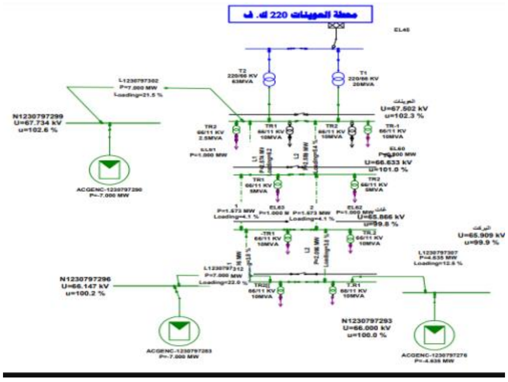


Fig (6) The optimal operation with 3 PV with grid result.

Table (6) shown the PV with grid connected Simulation Result.

6	From	To	P Loss	Q Loss	P Imp	Q Imp	P Gen	Q Gen	P Load	Q Load
7	Area/Zo	Area/Zo	MW	MVar	MW	MVar	MW	MVar	MW	MVar
8	Network		0.179	-2.114	4.679	0.675	18.679	9.352	18.5	11.465
9	Area 1		0.179	-2.114	0	0	19.337	6.176	19.157	8.289
10	Zone 1		0.179	-2.114	0	0	19.337	6.176	19.157	8.289
11										
12	Un		P Loss	Q Loss	P Loss	Q Loss				
13	kV		MW	MVar	MW	MVar				
14	66		0.129	-3.06	0.045	0.849				
15	220		0	0	0.005	0.097				
16										

Using NEPLAN, the voltage percentage results with increase or decrease of lessthan 5% are shown in Table (7).

Table (7) the voltage profile on buses with grid connected.

No	Substation	Voltage (%)
1	220العوينات/66 kv	103.9
2	تهالا	101.9
3	غات	100.1
4	البركت	100.0

Through the result of the program in this case 3, we noticed that the value of the voltagedeviation is small, which is the least possible and does not exceed 5%, an increase or decrease of the voltage value

F. Case 6: Isolated Network of Ghat city with PV units.

From this case, the study was selected for one of the renewable energies using solar energy source, where the light energy emitted by the sun is utilized and converted into direct electrical energy using PV panel technology, which works in semi-desert areas. The PV panel technology for the production of electrical power was analyzed and connected to the main network of the electricity company, in this case an advanced computer software called NEPLAN was used. Many analyses and tests were carried out for the daily load curve, and the rates of light radiation emitted by the sun at a site inside the southern Libyan city of Ghat. Through previous studies of the electricity company and knowledge of the normal operating condition of the stability of the electricity network so that it can be reach the objective required of this study is to operate the Ghat City network as an isolated network separate from the network of the main electricity company. Therefore, this case of PV technology will be illustrated through its site, so that the amount of decrease and increase in the range of ± (5%), as shown in Table (7). This type of technology has been applied to convert renewable solar energy into electrical energy by using PV technology on the Ghat plant, in order to produce an electrical power of 19,393 MW, which is sufficient for the current electrical power requirements of the consumer during the peak period of the main company. Electrical energy should also be stored in high-quality batteries to be used overnight, as shown in Figure (7). The optimal operation isolated result.

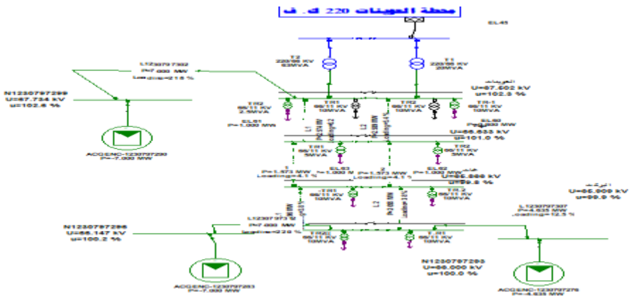


Fig (7): The optimal operation isolated result.

Table (8) shows the results of the isolated system simulation. Where the losses are 0.136 MW which is highly reduced .and the voltage of buses is enhanced.

Table (8) optimal power flow with 3PV isolated

6	From	To	P Loss	Q Loss	P Imp	Q Imp	P Gen	Q Gen	P Load	Q Load
7	Area/Zo	Area/Zo	MW	MVar	MW	MVar	MW	MVar	MW	MVar
8	Network		0.136	-2.21	4.635	0.579	18.635	9.255	18.5	11.465
9	Area 1		0.136	-2.21	0	0	18.635	9.255	18.5	11.465
10	Zone 1		0.136	-2.21	0	0	18.635	9.255	18.5	11.465
11										
12	Un		P Loss	Q Loss	P Loss	Q Loss				
13	kV		MW	MVar	MW	MVar				
14	66		0.086	-3.146	0.045	0.855				
15	220		0	0	0.004	0.082				

Through the result of the program in this case, one can noticed that the value of the voltage deviation is within the permissible range of ±5%. As a result, Table (9) shows the conclusion of case study result.

Table (9) conclusion case study result

Case study	P loss (MW)	Q loss (MVAR)
Case1(load flow)	0.611	0.361
Case3(OPF)	0.611	0.361
Case4(OPF with PV)	0.349	-1.17
Case5(with pv with id)	0.179	-2.114
Case6(with pv isolated)	0.136	-2.21

VI. Conclusion

The following conclusion are summarized: -

1.Libya has an abundance of renewable energies, especially solar energy.

2.Renewable energy is characterized by its abundance and clean ways of using and producing it, in addition to the possibility of Transforming it into the various forms of energy that man needs in all aspects of his life activities. Whether thermal, light, electrical or mechanical energy.

3.Renewable energy systems can be applied from the small residential level to the small residential level. A village or the level of several villages together and on a large scale.

4. although the initial cost of the units of the renewable energy systems increased to a large degree, it is considered economical in the case of its long-term use, as it does not cost more than periodic maintenance About 3-5% annually of the actual cost.

5. stations can be 'connected to' local 'grids' to generate electricity.

6. using PV -solar power generator able to find a solution to the problem of electricity cuts that our country suffers from, and to provide electricity from solar energy sources.

Through this study the local distribution network is taken as case study analysis and studies show that PV penetration is a good solution for system improvement where the following benefits are achieved:

•Increase system efficiency.

•Reduce system losses.

•Optimization of line voltage profile and load capacity due to delivery of product generation near the consumption area.

•Additional power storage for additional power outages.

Also, during emergencies, PV breakthrough keeps the system performance within the satisfactory range. During the minimum and peak loads of the daily load curve PV can maintain the system within the operation ranges.

Also, through this research where a local distribution system is chosen a great benefit are accomplished by applying the DG penetration besides enhancing system performance such as:

•Losses are reduced.

•Bus voltage violations are cleared.

•The higher efficiency of the system is accomplished.

References

[1] Renewable energy resources: Current status, future prospects. Ella ban, Omar; Abu-Rub, Haitham; Blaabjerg, Frede (2014).
[2] Agp., fraunhofer institute for solar energy system ise. 11 march 2016.
[3] Appendix A (PV design) Greeted with PV*SOL Premium 2021(R3) Valentin software GmbH.
[4] Neplan, 5.5.5 editor. 1988-2015.

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