Re planning Consideration of Az-zawia (30 kV) Electric network and Redesign.

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Abstract

The study of (30 kv) electric network of Libyan grid is an essential to upgrade the power network for handling the continuous load growth due to growth of population and economy of the country.

The (30kv) electric network is the sub-transmission system that links the transmission system with distribution system, and transferring a high power to the costumers. The power losses is increased in this part of electric system, since it is considered to be medium level.

The system re-planning and redesign should be applied periodically as load demand increased through years and applying the new planning methodologies that depends on new technologies that takes the renewable energy and environmental issues in consideration which will result in a great plans, and an electric grids that matching the world grids and handle the new technologies, such as smart grid technologies.

In this research, a re-planning and redesign for Az-zawia electric grid of (30kv) level will be applied using conventional methods and new technologies of distribution generation (DG) method.

The study will compare between the two methods and conclusion will be deduced for the future load forecast up to next twenty years.

1- Introduction.

The methodology of conventional distribution system planning is to meet the load demand growth by adding new substation system and feeders or expanding the existing ones. In the large population, area where the load demand is yearly increased the adding and/or expanding the distribution substations start not be easy due to the difficulties in construction inside the city centers and the increase of cost due to inflations.

In this case another way or methodology can be introduced that depend on the new technologies which leads to the idea of future smart grid systems. The penetration of distribution generation within the electric network can be considered as the other way in the re-planning and redesign consideration, procedure.

Deregulation of the electric utility industry, environmental concerns associated with traditional fossil fuel generation power plants, volatility of electric energy costs, and world regulatory support of “green” energy, and rapid technological developments all support the proliferation of distributed generation in electric utility systems. The growing rate of DG deployment also suggests that alternative energy-based solutions will play an increasingly important role in the smart grid and modern utility.

Large-scale implementation of distributed generation can lead to the evolution of the distribution network from a “passive” (local/limited automation, monitoring, and control) system to an “active” (global/integrated, self-monitoring, semi-automated) system that automatically responds to the various dynamics of the electric grid, resulting in higher efficiency.
In this research, the DG will be considered as an option in the re-planning and redesign study of Az-zawia (30KV) sub-transmission system for next twenty years or more choosing DG to be connected to the sub transmission buses specially the remote ones and/or that suffering the voltage dips due to load increasing, this will compensate for adding feeders or expanding the substations.

2- Distribution generation definitions, and applications.

The term “distributed generation,” or DG, refers to the small-scale generation of electric power by a unit sited close to the load being served. DG technologies range in size from (50 kW to 50 MW), and include both fully commercial systems, such as reciprocating engines, and others that are primarily in the laboratory, such as fuel cells.

Distribution generation (DG) are defined as small generator for units installed in (T&D) system at low and medium voltage levels.

The concept of (DG) application in (T&D) systems is not new; there is an increase trend towards DG applications in power systems. It is predicted that DG will have a share of about (40%) or more year by year, of the new generation units being on lined, including the renewable energy sources.

Distributed generation (DG) technologies can provide energy solutions to some customers that are more cost-effective, more environmentally friendly, or provide higher power quality or reliability than conventional solutions

Distributed generation (DG) is currently being used by some customers to provide some or all of their electricity needs. There are many different potential applications for DG technologies. For example, some customers use DG to reduce demand charges imposed by their electric utility, while others use it to provide premium power or reduce environmental emissions. DG can also be used by electric utilities to enhance their distribution systems.

3-Re-planning Methodology and Master Plan.

For any re-planning and redesign study, (T&D) system should have an assumptions and condition that should be considered and taken through planning procedure. According to this assumptions a master plan will be designed considering all or most of the factors effecting the system and choosing the best methodology possible that leads to the best system performance. A master plan for re-planning and redesign of Az-zawia 30kv sub- transmission system will be performed using conventional and DG penetration methods.

The conventional method is the one where the system substation and feeder can be expanded and/ or new components are added that keeps the system, meeting the load growth of the future years. In this method transformer and lines are upgraded a units can be added to keep system performance meet the required energy demand.

The DG penetration method is the one where a DG size is considered and connected to the system bus bars that suffering voltage dips or close to the loaded lines. The DG penetration considering only the connection of DG to the system buses of certain chosen size, and study its impacts on system performance.

The methodology of the conventional plan is given in the next flow chart in figure 1

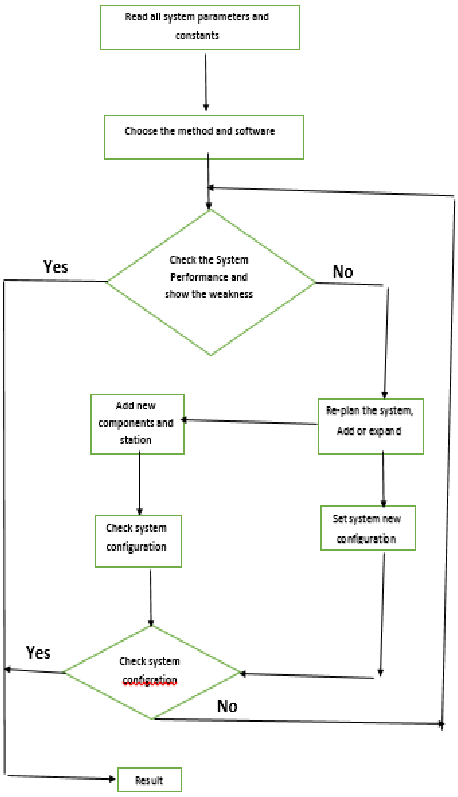

Fig. (1) Flow chart for conventional re-planning and redesign master plan.

The methodology used in this conventional planning method is summarized in the following steps:

1- Collect system data and arrange it, for computer analyses.

2- Choose the software required for system performance study.

3- Consider the rated loads on system transformers and check for system performance, at this loading.

4- From result define the system weakness.

5- Use annual growth of (8%) considered by GCOLE and exponential forecast to find the number of years for the system to reach the rated loading.

6- Check which year the system start suffering weakness.

7- Starting this year find the modification required to upgrade the system.

8- Check the system for every five years in the future up to twenty years and modify the system to meet the load demand.

9- Show the new results each time.

4-Methodology and Master plan for DG penetration method.

In this method, the flowchart is shown in figure (2).

The following steps are considered for this planning starting from step 6 in the conventional planning methodology.

1- Check which year the system start suffering weakness.

2- Add a certain DG size at the buses have voltage violations or close to loading lines.

3- Change the location and size of DG that gives better results and less power losses and solve for weakness.

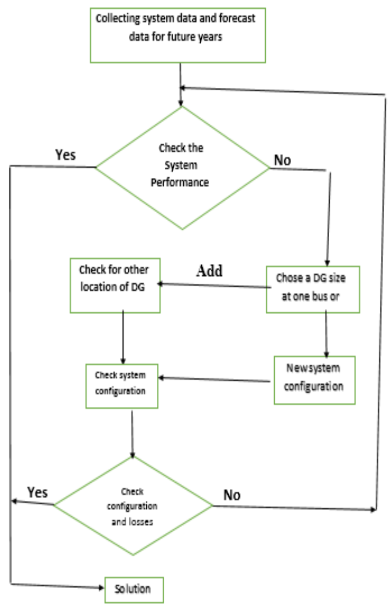

Fig. (2) Master plan using DG penteration.

4- Repeats the procedure for next five years of growth and show the new results.

5- Continuous the procedure up to twenty years growth of load.

In both cases, show your analysis.

5. Az-zawia30kv system Description.

Az-zawia 30kv sub transmission electrical network is fed from (220/30kv) of Al-harsh substation, and (220/30kv) close to generation plant in figure 3.

The (30kv) network configuration have fourteen bus bars where the loads are fed through (30/11kv) transformers. In this research the procedure of re-planning and redesign will be applied to Az-zawia (30kv) network using the conventional planning methods of the adding and expansions to the system configuration to meet the load growth requirements.

Also, DG penetration will be considered, that to add a DG units to the system through the (30kv) choosen buses in the area of high loading densities and/or suffering low voltage profile.

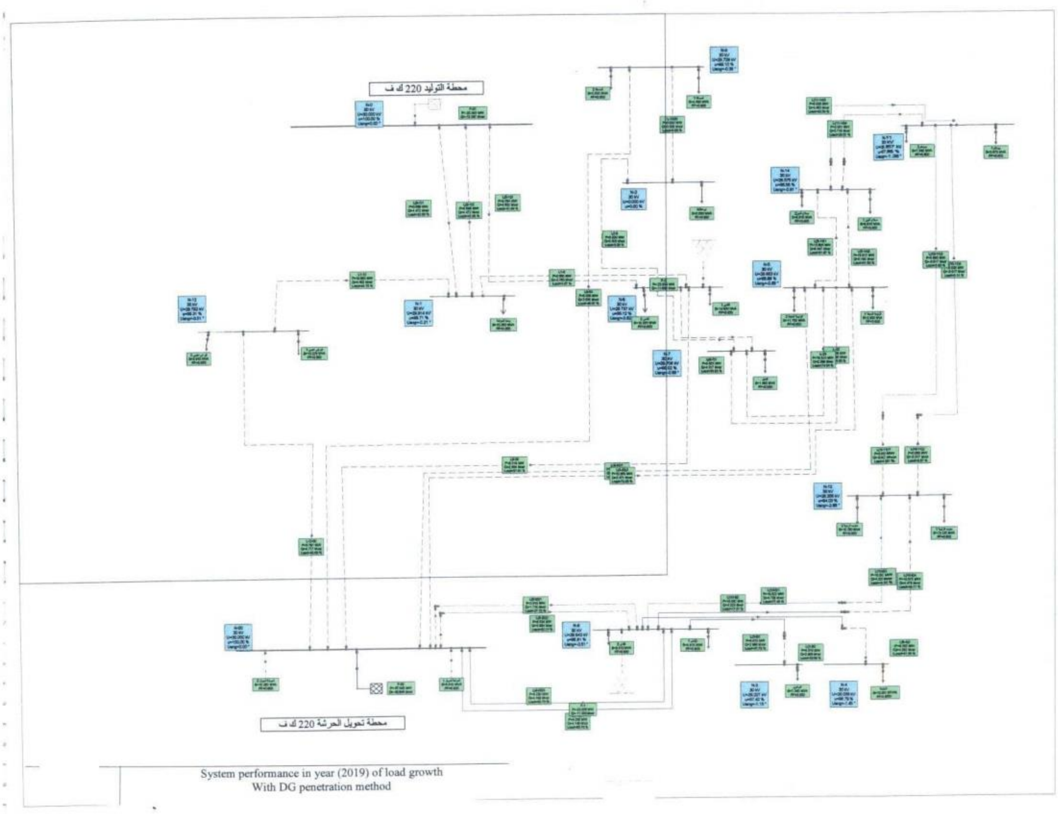

Fig.3 shows Azzawia 220/30 KV network

The procedure of re-planning and redesign will follow the master plan steps explained in last section.

The 30kv line diagram is shown with all system data and loading of year 2014, each (220/30kv) substation have two (220/30) transformer of 100 MVA size each.

The following assumptions are considered through this study:

- The system loads taken from GECOL are during august 2014 and considered as the yearly highest loads.

•The (30/11kv) transformers MVA rating are considered as the rated loads of (30kv) system.

•The buses voltage limits in normal operating condition are ranged between (95% to 105%) .

•The loading limits of the lines are (100%) loading according the line empacity (current carrying capacity).

•The load is uniformly distributed through Az-zawia area, which means that the load density MVA/km is uniformly distributed through the area.

• If a contingency which is up normal conditions is considered the voltage limits range will be (90% to 110%) and the load ability is (120%).

For the re-planning and re-design the following procedure steps are considered:

•Study the circuit performance at rated loading condition by using load flow analysis program (NIPLAN).

•Considering annual load growth of 8% and using exponential load growth procedure to find, in how many years, this rated load will be reached.

•Considering the peak load of year 2014, that is the actual loads and run the program for performance analysis to check for system weakness.

•Consider the short-range period of five years and check the system performance considering the changes needed in the past annual analysis and make remedy needed.

•Consider also the longer period of ten year and twenty years planning and, repeat the same procedure, and find the new plan and design.

•For second case study, all past steps will be repeated but considering the distribution generation, as the solution for the system deregulation by adding a certain size of DG to the buses suffering voltage violation and /or close to loaded feeders.

•According to GECOL the annual load growth is given to be (8%) annually.

•For safety re-planning and redesign the exponential load growth is considered.

In all cases, total power losses are counted and compare with the redesigned cases for analysis.

6. Case studies and analysis

In this section some case studies will be chosen for this research to introduce best analysis possible for the chosen network.

6.1 Case i: considering actual peak loads of year 2014.

In this case, Using NIPLAN softwear the analysis shows that the network suffering of feeders overloading, that should considered for redesign.

This rated load will be reached according to annual load growth of 8% and using exponential load growth procedure after (n) years that can be calculated as follows.

$$\boldsymbol{S}n = \boldsymbol{S}o(\mathbf{1} + \boldsymbol{g})^{\boldsymbol{n}} \ldots\ldots\ldots\ldots\ldots \quad (1)$$

Assuming annual load growth $\boldsymbol{g} = \mathbf{0.08}$

To find the number of years for the transformers to start reaching rated loading, consider the highest actual load on one of the buses at year 2014.

Use the exponential load growth given in equation (1) to find the number of year **n** considered the actual present load of 2014 at bus number **9** in the network, fed by (30/11) transformer of 20 MVA rated, transformer, which is the highest load.

Use equation (.1) to find number of year **n** at bus 9 since the peak load now is 10 MVA

$\mathbf{20} = \mathbf{10}(\mathbf{1} + \mathbf{0.08})^{\boldsymbol{n}}$, Solving for **n** ⇒ **n**=9 years.

Then the rated loading will be reached after 9 years that means 2023 is the year for the circuit to have rated loading though it's buses.

To check for system weakness the year 2014 will checked.

In this case, the actual peak loads of year 2014 is considered as show in figure(3) for the analysis of system performance it is found , to be perfect and have no negative indicators .Table (1) shows the system performance at actual loadingof year (2014).

Table (1) shows the system performance for actual loading year (2014).

From	To	P Loss	Q Loss	P Imp	Q Imp	P Gen	Q Gen	P Load	Q Load
Area/Zone	Area/Zone	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Network		1.157	-7.28	120.632	50.582	120.632	50.582	119.475	57.862
Area 1		1.157	-7.28	0	0	120.632	50.582	119.475	57.862
Zone 1		1.157	-7.28	0	0	120.632	50.582	119.475	57.862
Un		P Loss Li	Q Loss L	P Loss T	Q Loss				
kV		MW	MVar	MW	MVar				
30		1.157	-7.28	0	0				

6.2 Case ii: considering the loads reached the rated values.

The rated sub-transmission transformers sizes are considered as the rated loads Table shows the results of system performance, using NIPLAN software.

As shown in table 2.

Table (2).the system performance results at rated load

From	To	P Loss	Q Loss	P Imp	Q Imp	P Gen	Q Gen	P Load	Q Load
Area/Zone	Area/Zone	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Network		13.251	19.874	373.251	194.234	373.251	194.234	360	174.36
Area 1		13.251	19.874	0	0	373.251	194.234	360	174.36
Zone 1		13.251	19.874	0	0	373.251	194.234	360	174.36
Un		P Loss Li	Q Loss L	P Loss T	Q Loss				
kV		MW	MVar	MW	MVar				
30		13.251	19.874	0	0				

Elements	%	Type
L(5-00)2	290.45	Line
L(5-14)1	286.81	Line
L(5-14)2	286.81	Line
L6-00	261.17	Line
L(8-00)4	253.6	Line
L(8-00)3	253.6	Line
L(5-00)1	245.73	Line
L(8-00)5	241.32	Line
L(8-00)2	232.49	Line
L(0-1)3	191.78	Line
L(10-8)2	147.2	Line
L(10-8)1	147.2	Line
L(8-4)1	140.36	Line
L(3-8)1	140.35	Line
L9-00	136.7	Line
L(11-14)3	135.17	Line
L(11-14)1	133.9	Line
L(8-00)6	108.56	Line
L(8-00)1	104.64	Line

6.2 Case iii five years load growth, the year (2019) is considered.

In this case, the five years growth is considered with 8% annual growth.

The system performance are shown in Table (3).

The study shows that the system will suffer from feeder overloading.

To solve this problem the expanding of the substation feeder will be considered.

.The cables L(8-00)4 , L(8-00)3 , L(8-00)5 , L(5-00)2 , L(8-00)2 , L(5-14)1 , L(5-14)2 ,L(6-00)which are of (240 & 150mm^2) size will be re-conducted by(630mm^2) cable sizes.

Table (3) shows the load flow of the network after 5 years.

From	To	P Loss	Q Loss	P Imp	Q Imp	P Gen	Q Gen	P Load	Q Load
Area/Zone	Area/Zone	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Network		2.529	-4.234	172.998	78.325	172.998	78.325	170.469	82.559
Area 1		2.529	-4.234	0	0	172.998	78.325	170.469	82.559
Zone 1		2.529	-4.234	0	0	172.998	78.325	170.469	82.559
Un		P Loss Li	Q Loss L	P Loss T	Q Loss				
kV		MW	MVar	MW	MVar				
30		2.529	-4.234	0	0				
Overloads									
Elements	%	Type							
L(8-00)4	116.63	Line							
L(8-00)3	116.63	Line							
L(8-00)5	110.97	Line							
L(5-00)2	108.37	Line							
L(8-00)2	106.92	Line							
L(5-14)2	104.08	Line							
L(5-14)1	104.08	Line							
L6-00	101.36	Line							

Taking this remedy in consideration and run for the system performance,

The results shown in Table (4), no weakness are shown in the system performance.

Table (4) the system performance after remedy (2019)

From	To	P Loss	Q Loss	P Imp	Q Imp	P Gen	Q Gen	P Load	Q Load
Area/Zone	Area/Zone	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Network		1.627	-7.605	172.096	74.954	172.096	74.954	170.469	82.559
Area 1		1.627	-7.605	0	0	172.096	74.954	170.469	82.559
Zone 1		1.627	-7.605	0	0	172.096	74.954	170.469	82.559
Un		P Loss Li	Q Loss L	P Loss T	Q Loss				
kV		MW	MVar	MW	MVar				
30		1.627	-7.605	0	0				

Notice: The reconducting of such lines need a lot of effort and high cost,and takes time that may effect the city replanning.

6.3 Case iv: system performance after ten years (2024) of load growth.

The load growth after ten years, which is year 2024, is considered including the changes done in year 2019 on the network, the performance are shown in table (5).

The weakness of the system is found to be the heavy loading of the feeders.

In this case, most feeders are heavily loaded that makes the solution by expanding the system feeders is not practical any more.

The following expanding and adding to the system is considered:

•A new (220/30kv) substation considered as shown with two (220/30kv) transformer of size (100MVA) each given name (N000).

•A new (30/11kv) substation is added given name (N 14).

•The cables L(10-8)1 , L(10-8)2 , L(8-4)1 , L(5-00)2 which are of (240 & 150mm^2) size will be re-conducting by(630mm^2) cable sizes.

Table (5) the system load flow analysis for year (2024).

From	To	P Loss	Q Loss	P Imp	Q Imp	P Gen	Q Gen	P Load	Q Load
Area/Zone	Area/Zone	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Network		3.42	-1.976	253.998	119.384	253.998	119.384	250.578	121.36
Area 1		3.42	-1.976	0	0	253.998	119.384	250.578	121.36
Zone 1		3.42	-1.976	0	0	253.998	119.384	250.578	121.36
Un		P Loss Li	Q Loss L	P Loss T	Q Loss				
kV		MW	MVar	MW	MVar				
30		3.42	-1.976	0	0				
Overloads									
Elements	%	Type							
L(8-00)3	122.32	Line							
L(8-00)4	122.32	Line							
L(10-8)2	118.15	Line							
L(10-8)1	118.15	Line							
L(5-00)1	114.71	Line							
L(5-00)2	114.71	Line							
L6-00	105.97	Line							
L(8-4)1	100	Line							

Added new line: L(8-00) , L(000-10) , L(000-11) , L(14-5) , L(6-00) , L(5-00) and double line L(000-5) , L(000-14) , L(14-5) , L(000-13). The results shown in table 6.

After adding, those changes the performance of the circuit is checked and the analysis shows that all weaknesses are avoided as shown in table (6).

Table (6) the system performance consider growth (2024).

From	To	P Loss	Q Loss	P Imp	Q Imp	P Gen	Q Gen	P Load
Area/Zone	Area/Zone	MW	MVar	MW	MVar	MW	MVar	MW
Network		1.46	-11.561	252.038	109.799	252.038	109.799	250.578
Area 1		1.46	-11.561	0	0	252.038	109.799	250.578
Zone 1		1.46	-11.561	0	0	252.038	109.799	250.578
Un		P Loss Li	Q Loss L	P Loss T	Q Loss			
kV		MW	MVar	MW	MVar			
30		1.46	-11.561	0	0			

6.4 Summary and discussion of results.

In this case using conventional method of adding and expansion of system elements for re-planning and redesign shows the following:

•The (30kv) system have a good voltage profile even in future load growth up to ten years.

•The lines are suffering overloading as load increased through load forecast with growth rate of 8%.

•The system should be reconfigured every five years by recon-ducting and / or doubling the system lines to handle the load growth.

•Also a two substations of (30kv) and (220/30kv) substation should be added to new the lines should be connected or added as well.

The addition and expansion to the system is a task that need time, effort, and budget to be implemented. Also those procedure will be done inside the city, which needs to reconstruct and rebuild the manholes and the city streets by such civilian works.

This procedure will affect the commercial and industrial as well the social activity in the area that maybe considered in cost calculations.

7. Case studies considering the DG penetration method.

In this case and according to the new technology solutions for upgrading the electric distribution system performance, the electric distribution generation will be considered, to be added to the distribution system.

Repeating the same re-planning and redesign for Az-zawia central distribution network but assuming DG connected to the remote buses with sizes between (5MVA to 25MVA).

The procedure is as the follows in each case:

1- Connect a DG with (25MVA) size to the buses pluses considering the larger size cables and check for best system performance that can solve the system weakness for next years.
2- For future growth take the added DG and cables in consideration and proceed.

7.1 Case i: Considering five years growth (2019).

The Five -year growth after year 2014 is considered and table (7) shown the system weakness.

Table (7) the system load flow analysis for year(2019).

From	To	P Loss	Q Loss	P Imp	Q Imp	P Gen	Q Gen	P Load	Q Load
Area/Zone	Area/Zone	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Network		2.529	-4.234	172.998	78.325	172.998	78.325	170.469	82.559
Area 1		2.529	-4.234	0	0	172.998	78.325	170.469	82.559
Zone 1		2.529	-4.234	0	0	172.998	78.325	170.469	82.559
Un		P Loss Li	Q Loss L	P Loss T	Q Loss				
kV		MW	MVar	MW	MVar				
30		2.529	-4.234	0	0				
Overloads									
Elements	%	Type							
L(8-00)4	116.63	Line							
L(8-00)3	116.63	Line							
L(8-00)5	110.97	Line							
L(5-00)2	108.37	Line							
L(8-00)2	106.92	Line							
L(5-14)2	104.08	Line							
L(5-14)1	104.08	Line							
L6-00	101.36	Line							

To solve the weakness of the system performance the following will be considered:

•Adding two 25 MVA DG'S at buses (N 8), (N 6).

•The cables L(5-14)1, L(5-14)2 which are of (240 & 150mm^2) size will be re-conducting by (630mm^2) cable sizes.

•The system performance shown in Table (8) that shows a greater system performance

Table (8) the system performance consider growth (2019).

From	To	P Loss	Q Loss	P Imp	Q Imp	P Gen	Q Gen	P Load	Q Load
Area/Zone	Area/Zone	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Network		1.569	-6.426	126.038	54.133	172.038	76.133	170.469	82.559
Area 1		1.569	-6.426	0	0	172.038	76.133	170.469	82.559
Zone 1		1.569	-6.426	0	0	172.038	76.133	170.469	82.559
Un		P Loss Li	Q Loss L	P Loss T	Q Loss				
kV		MW	MVar	MW	MVar				
30		1.569	-6.426	0	0				

The total system losses are found to be (1.569) MW compared with total losses before adding DG that was (2.529) MW that means the total system losses reduced by 0.960 MW.

7.2- Case ii: Loading growth after ten years (2024).

The load growth after ten years, which is year 2024, is considered including the changes done on year 2019 on the network, the performance are shown in table (9).

Table (9) the system load flow analysis for year (2024).

From	To	P Loss	Q Loss	P Imp	Q Imp	P Gen	Q Gen	P Load	Q Load
Area/Zone	Area/Zone	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Network		4.176	-0.514	208.754	98.846	254.754	120.846	250.578	121.36
Area 1		4.176	-0.514	0	0	254.754	120.846	250.578	121.36
Zone 1		4.176	-0.514	0	0	254.754	120.846	250.578	121.36
Un		P Loss Li	Q Loss L	P Loss T	Q Loss				
kV		MW	MVar	MW	MVar				
30		4.176	-0.514	0	0				

Elements	%	Type
L(5-00)2	127.8	Line
L(8-00)4	125.25	Line
L(8-00)3	125.25	Line
L(10-8)2	120.5	Line
L(10-8)1	120.5	Line
L(8-00)5	119.17	Line
L(8-00)2	114.82	Line
L(5-00)1	108.42	Line
L6-00	106.87	Line
L(8-4)1	101.72	Line

To solve for the weakness of the system performance the following will be done respectively.

•Adding four (25 MVA) DG'S at buses (N7), (N 4), (N 5) and (N 10).

•The cable L(8-10)1 which is of (240 & $150mm^2$) size will be re-conductred by ($630mm^2$) cable sizes table 10 shows the system performance after adding DG..

Table (10) the system performance considering growth (2024).

From	To	P Loss	Q Loss	P Imp	Q Imp	P Gen	Q Gen	P Load	Q Load
Area/Zone	Area/Zone	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Network		0.814	-8.788	113.392	46.572	251.392	112.572	250.578	121.36
Area 1		0.814	-8.788	0	0	251.392	112.572	250.578	121.36
Zone 1		0.814	-8.788	0	0	251.392	112.572	250.578	121.36
Un		P Loss Li	Q Loss L	P Loss T	Q Loss				
kV		MW	MVar	MW	MVar				
30		0.814	-8.788	0	0				

The total system losses are found to be (0.814) MW compared with total losses before adding DG that was (4.176) MW, that the reduction in power losses is 3.362MW.

7.3-Case iii: Circuit performance after fifteen years growth (2029).

In this case, the load growth of (8%) is considered as well and exponential growth, taking the remedies of year 2024 in account.

The system performance analysis using NIPLAN are shown in table (11).

Table (11) the system load flow analysis for year (2029).

From	To	P Loss	Q Loss	P Imp	Q Imp	P Gen	Q Gen	P Load	Q Load
Area/Zone	Area/Zone	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Network		2.766	-3.311	232.326	108.708	370.326	174.708	367.56	178.019
Area 1		2.766	-3.311	0	0	370.326	174.708	367.56	178.019
Zone 1		2.766	-3.311	0	0	370.326	174.708	367.56	178.019
Un		P Loss Li	Q Loss L	P Loss T	Q Loss				
kV		MW	MVar	MW	MVar				
30		2.766	-3.311	0	0				
Overloads									
Elements	%	Type							
L(5-14)2	136.37	Line							
L(5-14)1	136.37	Line							
L(5-00)2	124.78	Line							
L-(5-7)	118.21	Line							
L9-00	107.37	Line							
L6-00	106.28	Line							
L(3-8)1	105.95	Line							
L(5-00)1	105.87	Line							

To solve the weakness of the system performance the following aspects must considered:

•Adding three (25MW) DGs at buses (N3), (N14) and (N9).

Table (12) shows the system performance consider growth up to year (2029) after remedy**.**

Table (12) the system performance considering growth (2029)**.**

From	To	P Loss	Q Loss	P Imp	Q Imp	P Gen	Q Gen	P Load	Q Load
Area/Zone	Area/Zone	MW	MVar	MW	MVar	MW	MVar	MW	MVar
Network		1.487	-6.415	162.047	72.604	369.047	171.604	367.56	178.019
Area 1		1.487	-6.415	0	0	369.047	171.604	367.56	178.019
Zone 1		1.487	-6.415	0	0	369.047	171.604	367.56	178.019
Un		P Loss Li	Q Loss L	P Loss T	Q Loss				
kV		MW	MVar	MW	MVar				
30		1.487	-6.415	0	0				

The total system losses are found to be (1.487) MW compared with total losses before adding DG that was (2.766) MW.

8. Summary and discussion of results.

In using the **DG** penetration method, it is found that , the system can handle the load growth by adding DG's units to the bus bars that suffering low voltages or close to over loaded lines. This method shows that adding DG's compensate the adding and expanding the system cable and sub stations for remedy.

Adding of DG's units of (25 MVA) is applied now in many electric power systems in the world that adds benefits to the system performance. The following advantages are noticed using DG penetration method.

- Power losses are reduced up to (60%) or more.
- Voltage profile is upgraded.
- Efforts of reconstructing and rebuilding is saved as well as it's cost is saved.
- Time for adding such units is reduced compared to the time needed for adding or expanding of system substation and power lines and cables.

8.1- Cost evaluation and comparison study.

Through this research, one can see the benefits that be accomplished by using the method of DG penetrations in the electric power system. Checking the cost needed to add a distribution generation (DG) to the system and according to the world reports and studies.[3], it is found that.

The overall cost of adding one DG of (1MVA) size will be in the range of one million dollar at the most.

So adding DG with (25MVA) size will not exceed 25 million dollar.

From the local company's information that works in the field of construction of electric cables [3], the average cost of installing 1km of cable is about 250,000 dollars. Adding to the cost, the impacts of the reconstruction procedure on the social activities and economies that delaying the live activities in the city centers and load centers.

As an example adding and re-conducting of 100km cables will cost (25 million) dollars and this will need to added power from central generation units to the increased load and more losses will be increased.

Considering the cost of power needed and added system losses comparing to DG added system and the resulting power losses, it clear that DG benefits are great.

From loss point of view if by adding DG to the system saves (5MW) for example:

The energy saved will be: 5MW x 8760h = 438000 MWh / year.

For a period of 20 year energy saved is: E = 20 x 43800 = 876,000 MWh.

By kilowatt-hour: E = 876 x1000000 kWh.

If cost (0.05) dinnar is considered for one kWh:

Cost saved = 876000000 x 0.05 = 43800000. Which about 44 million dinnar.

Table 13 shows the comparisons of losses before and after adding the DG.

To find the benefits of using DG for cost saving and loss reduction according to this research and depending on the world reports about DG technologies effect and benefits over local cable costs and installation according to 2014 offers by locate construction companies.

In an atmosphere of changing customer energy needs, DG technologies, alone or in combination, may offer superior economics or a better overall energy solution for some energy customers.

Table 13 the comparative the system loss before and after added DG.

	The system power loss in MW		
Year of growth	**Before added DG**	**After add DG**	**Loss reduction**
2019	**2.529**	**1.569**	**0.839**
2024	**4.176**	**0.814**	**3.362**
2029	**2.766**	**1.487**	**1.179**
2034	**6.182**	**1.139**	**5.043**

8.1 Conclusions

Az-zawia network sub transmission systems was studied for re-planning and re-designing according to load growth for short period and long period plans, using conventional methods of adding and/or expanding to the system for good performance.

The results shown that the system suffering only form feeder loading where the necessary solution is considered up to year of 2034.

Also using the new technologies of distribution generation (DG) for re-planning procedure by adding units of DG to the buses close to/ or connected with loaded feeders.

This method shows a great solution compared to the conventional ones in system performance that:

- Reducing the number of re-conducing and doubling of feeders that reduces the power loss.

- reducing the overall construction and operation costs,

- Save time and effort of reconstruction.

- enhancing the voltage profile of the network.

- The DG may be a renewable energy system of photovoltaic (PV) or wind energy which have a great future in libya.

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