Expand of Alkhoms 30KV Power Distribution Network

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Abstract— **One of the aims of the General Electrical Company of Libya (GECOL) is to supply the customers with electric energy a wording to the standard specification. Alkhoms is a Libyan city and it is one of GECOL areas. Because of the conditions increasing of the loads in Alkhoms and in all Libyan cities, the electric network should be able to feed the increasing and future loads. So it is necessary to adopt a strategic plan for future expanding of the network. The aim of this paper is to know the operating state of the electrical power system by the conditions of the power circulation, as well as developing the network until 2023 and studying the proposed solutions to solve the problems Alkhoms – Libya network. This paper has been used NEPLAN software which had estimated and solved the future expanding problems of Alkhoms networks.**

Index Terms: **Power circulation, expanding of the network, NEPLAN software.**

I. INTRODUCTION

The electrical power distribution system is the final stage in electricity delivery to end users. The most important function of a modern electric power system is to provide electric power to its customer at the lowest possible cost and with an acceptable level of reliability. Also, reliability is one of the major factors for planning, designing, operating and maintaining electric power system [1].

The network expansion or reconfiguration in distribution system is to find a configuration with minimum losses while satisfying the operation constraints under a certain load pattern. The operating constraints are voltage drop, current capacity and radial operating structure of the system [2]. The voltage and power on/through both ends of a feeder are used to describe the load and its distribution pattern within the feeder line [3]. Power system network is heavily overloaded because the system is not expanded or it has been expanded without proper planning and increasing the required level of capital expenditure.

There are many problems of electrical network expansion and the general form problem of this expansion can be stated as follows [4]:

- Existing network configuration.
- Available line types and the corresponding cost.
- All possible routes (length and right of way).
- Load generation pattern at target year.

The three important factors influencing the expansion of the distribution system are:

A. Load Forecasting:

There are two common time scales of importance to load forecasting:

- Long-range, with time horizons on the order of 15 or 20 years away.
- Short-range, with time horizons of up to 5 years distant [5].

In this work long-range time scale (20 years) has been chosen.

B. Substation Expansion:

There are some factors affecting the substation expansion such as transmission voltage, feeder limitation, power losses, economic factors, existing substation locations, etc., but in the system expansion plan the present system configuration, capacity, and the forecasted loads can play major roles [5].

C. Substation Site Selection:

The important factors affecting the substation site selection are the distance from the load centers and from the existing sub-transmission lines as well as other limitations, such as availability of land, its cost, and land use regulations [6].

The existing system is the 30 KV network of Alkhoms city and it is consists of two main rings, which branches off the main station and substations, the first ring is called Alkhoms Switching ring, and the second one is called Alkhoms Generation ring. These two rings have been feed by 220 KV, one from Alkhoms Switching and the other from Alkhoms Generation.

II. ELECTRICITY NETWORK COMPONENTS

The expansion of Alkhoms network until 2023 has been done for the two main rings, Alkhoms switching ring, and Alkhoms Generation ring.

A. Alkhoms Generation Ring

Alkhoms Generation ring consists of some working stations and substations as shown in figure (1). These working station and substations:

- Alkhoms Generation station 220KV has two transformers 220\30KV of 63MVA each.
- Alkhoms Generation substation 30KV.
- Lepda substation 30KV, has two transformer 30\11 KV of 20MVA each.
- Albandar substation 30KV, has a transformers 30\11 KV of 20MVA.
- Soqlkhmees 30KV, has two transformers 30\11 KV of 20MVA each.

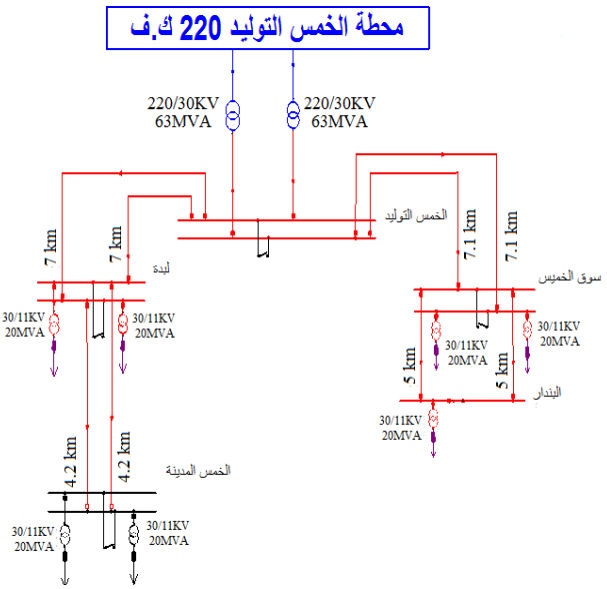

Figure 1. Alkhoms Generation Ring.

B. Alkhoms Switching ring

The second ring of Alkhoms network is Alkhoms switching ring and also consists of some working stations and substations. Apart of this ring is shown in figure (2). The working station and substations of this ring is listed as following:

- Alkhoms switching station 220 KV has two transformers 220\30KV of 63MVA each.
- Alkhoms switching substation 30 KV has two transformers 30\11 KV of 20MVA each.
- Alkhoms Almadina substation 30KV has two transformers 30\11 KV of 20MVA each.
- Albarkat substation 30KV has a transformer 30\11 KV of 20MVA.
- Esment Lebd a substation 30KV has four transformers 30\11KV of 10MVA each.
- Esment Almergeb substation 30KVhas two transformers 30\11KV of 10MVA each.
- Seleen substation 30KV has a transformer 30\11 KV of 20MVA.
- Alakhshab substation 30KV has two transformers 30\11 KV of 20MVA each.
- Mesalatah substation30KV has two transformers 30\11KV one is 10MVA and the other is 20MVA.
- Almazraa substation 30KV has two transformers 30\11KV of 10MVA each.

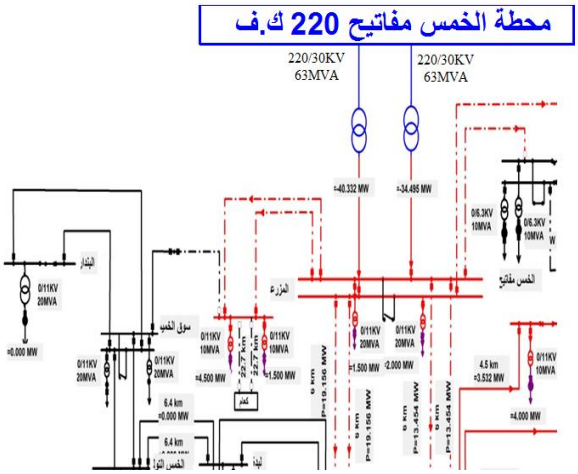

Figure 2. Part of Alkhoms Switching Ring.

III. LOAD GROWTH FACTOR

The factor of load growth is taken as 8% in this work as given in reference [7, 8], but may be this percentage is not applicable for our country due to the uncontrolled and random loads. The equation of load growth factor which is gives an approximation of the future density is:

$$P_n = P(1+0.08)^n \qquad (1)$$

The expansion for 10 years has been obtained from equation (1), where the maximum load of both rings is 120 MW.

$$P_{10} = 120(1+0.08)^{10} \quad = 259 \text{ MW}$$

Newton Raphson method calculation was used in NEPLAN software to obtain the overload elements and nodes for 30 KV Alkhoms network.

IV. NEPLAN SOFTWARE

NEPLAN is power system software applied worldwide for network planning, modeling and analysis. NEPLAN is used in more than 80 countries by more than 600 companies, such as small and large electrical utilities, industries and universities [8].

NEPLAN permits to define, develop and manage the power systems elements, data, library and graphics. The main elements used currently in educational process for network design and applications are:

- Classic compensating and Voltage Control devices: shunt capacitors, series capacitors, shunt reactors, synchronous condensers, regulating transformers such as tap-changing transformers
- FACTS devices: Controlled static VAR compensators SVC, Static Compensators STATCOM, Thyristor Controlled Series Capacitors TCSC, United Power Flow Controller UPFC, and Phase Shift Transformer PST.
- Generating Units Controls devices: Generators, Excitation system, Automatic Voltage Regulator AVR, Power System Stabilizer PSS.
- Power System Loads: static loads, induction motors and load models parameters.

In this work, this software has been used for Alkhoms network expansion from 2013 up to 2023.

V. RESULTS

According to GECOL data 2013 supplied for Alkhoms switching and generation rings, the analysis and expansion up to 2023 for both rings have been done. The tables I up to VI illustrate load flow, elements and nodes situation of Alkhoms switching ring before and after treatments from 2013 up 2023. Whereas for Alkhoms generation ring, the treatment of element (L2) and nodes up to 2023 is illustrated from table VII up to IX.

These results were obtained after added extra stations and replaced some lines for these rings.

Table 1. Load Flow Summary Of Alkhoms Switching Ring (Over Load Elements And Nodes) In 2013

Un		P Loss Line	Q Loss Line	P Loss Transformer	Q Loss Transformer
kV		MW	MVar	MW	MVar
30		6.579	11.159	0.706	8.151
220		0	0	0.414	8.279
Overloads					
Nodes (lower)	%				
N1077252630	85.82				
N1077252630	81.51				
مسلاتة	79.92				
N1077252630	77.36				
البركات	75.42				
البركات	75.42				
Elements	%	Type			
L10	143.67	Line			
L9	143.67	Line			
L4	118.63	Line			
L3	118.63	Line			
L1077377586	100.41	Line			
L1	96.53	Line			
L2	96.53	Line			
T2	92.32	2W Transformer			

Table 2. Elements Situation of Alkhoms Switching Ring in 2013

	Node name	Element name	Type	Loading %	Kind	Optimization	kind New	Loading %New	Long KM
1	الخمس مفاتيح-B30	L3	Line	118.63	2*130/30	Replaced	2*Bear	47.2	6
2	الخمس مفاتيح-B30	L4	Line	118.63	2*130/30	Replaced	2*Bear	47.2	6
3	الخمس مفاتيح-B30	T2	2W Transf.	92,32	220/30kv-63MVA	No change	-	65.1	-
4	البركات	L1077377586	Line	100,41	2*130/30	Replaced	Bear	53.6	6
5	الخمس المدينة-2-30	L3	Line	118,63	2*130/30	Replaced	2*Bear	47.2	6
6	الخمس المدينة-2-30	L4	Line	118.63	2*130/30	Replaced	2*Bear	47.2	6
7	الخمس المدينة-2-30	L9	Line	143,67	2*130/30	Replaced	2*Bear	61.5	19.5

Table 3. Nodes Situation of Alkhoms Switching Ring in 2013

	Name	U	u	U (new)	U(new)	Optimization	Kind Of
	Node	kV	%	KV	%		Optimization
1	البركات	21.79	72.63	28.67	79,92	addition	suht(-24Mvar)
2	البركات	21.79	72.63	28.67	75.42	addition	suht(-24Mvar)
3	مسلاتة	23.61	78.68	28.66	75.42	addition	suht(-15Mvar)

Table 4. Load Flow Summary of Alkhoms Switching Ring in 2023

Un		P Loss Line	Q Loss Line	P Loss Transformer	Q Loss Transformer
kV		MW	MVar	MW	MVar
30		13.69	25.507	1.944	24.792
220		0	0	0.784	21.245
Overloads					
Nodes (lower)	%				
N1077252630	87.9				
مسلاتة	80.77				
N1077252630	79.72				
البركات	76.3				
البركات	76.3				
N1077252630	74.01				
Elements	%	Type			
TR2-1077019610	153.9	2W Transformer			
TR2-1077019553	147.5	2W Transformer			
L9	136.37	Line			
L10	136.37	Line			
L3	133.86	Line			
L4	133.86	Line			
TR2-1077020100	127.06	2W Transformer			
EL4	119.36	Line			
L8	104.76	Line			
L1077377586	101.55	Line			
TR2-1077019368	100.89	2W Transformer			
T1	96.72	2W Transformer			
T2	95.42	2W Transformer			
EL3	92.25	Line			
L1077020211	86.23	Line			
L2	84.11	Line			
L1	84.11	Line			

Table 5. Elements Situation of Alkhoms Switching Ring In 2023

	Node	Element	Type	Loading	Kind	Optimization	New kind	Loading	Long
	Name	name		%				%new	km
1	الخمس مفاتيح	T1	2W Transf.	89.96	220/30KV-100MVA	No change	No change	68	-
2	N1077252630	TR2-1077019368	2W Transf.	94.44	30/11KV-20MVA	No change	No change	72.22	-
3	N1077252630	TR2-1077019553	2W Transf.	143.99	30/11KV-25MVA	Addition	30/11KV-25MVA	64.6	-
4	N1077252630	TR2-1077020100	2W Transf.	118.32	30/11KV-10MVA	Replaced	30/11KV-20MVA	65.53	-
5	N1077252630	TR2-1077019610	2W Transf.	138.76	30/11KV-25MVA	No change	No change	78.7	-
6	الأخشاب-2-30	L8	Line	104.76	xple240cu new	Addition	2*xple240cu new	50.01	7
7	البركات	L1077377586	Line	99.79	Bear	Addition	Bear	45.07	6
8	البركات	TR2-1077019553	2W Transf.	158.87	30/11kv-25MVA	Addition	30/11KV-25MVA	64.6	-
9	الممس التوليد	L1077020211	Line	84.8	xple240cu new	Addition	2*xple240cu new	40.71	7.1
10	الممس المدينة	TR2-1077019368	2W Transf.	100.89	30/11KV-20MVA	No change	No change	72.22	-
11	الممس المدينة	L8	Line	103.35	xple240cu new	Addition	2*xple240cu new	50.01	7
12	الممس المدينة-2-30	L3	Line	140.43	2*Bear	No change	No change	44.88	6
13	الممس المدينة-2-30	L4	Line	140.43	2*Bear	No change	No change	44.88	6
14	الممس المدينة-2-30	EL3	Line	91.44	xple240cu new	Addition	xple240cu new	76.8	4.2
15	الممس المدينة-2-30	EL4	Line	118.52	xple240cu new	Addition	2*xple240cu new	63.46	4.2
16	الممس مفاتيح-220	T3	2W Transf.	82.63	220/30KV-100MVA	No change	No change	40.8	-
17	الممس مفاتيح-220	T2	2W Transf.	98.13	220/30KV-63MVA	No change	No change	58	-
18	الممس مفاتيح 220	T1	2W Transf.	96.72	220/30KV-100MVA	No change	No change	68	-
19	سوق الممس	L1077020211	Line	86.13	xple240cu new	Addition	2*xple240cu new	40.71	7.1
20	لبدة	EL4	Line	119.33	xple240cu new	Addition	2*xple240cu new	63.46	4.2
21	لبدة	TR2-1077020100	2W Transf.	127.35	30/11KV-10MVA	Replaced	30/11KV-20MVA	65.53	-
22	لبدة-2-30	EL3	Line	92.23	xple240cu new	Addition	2*xple240cu new	76.8	4.2
23	مسلاتة	L1077377586	Line	99.78	Bear	Addition	Bear	45.07	6
24	مسلاتة	TR2-1077019610	2W Transf.	153.15	30/11kv-25MVA	No change	No change	78.7	-
25	الخمس مفاتيح-B30	T3	2W Transf.	77.76	220/30KV-100MVA	No change	No change	40.8	-

Table 6. Nodes Situation of Alkhoms Switching Ring In 2023

	Name	U	U	U(new)	U	Optimization	Kind of	New name
	Node	kV	%	KV	new %		Optimization	Node
1	البركات	21.543	71.81	31.189	104	Addition	Bus	البركات-2-30
2	البركات	21.543	71.81	31.189	104	Addition	Bus	البركات-2-30
3	مسلاتة	24.332	81.11	29.948	99.8	Addition	Bus	مسلاتة-2-30

The comparison of Alkhoms switching ring before treatment and after for lines and transformers has been shown in figures 3, and 4 respectively.

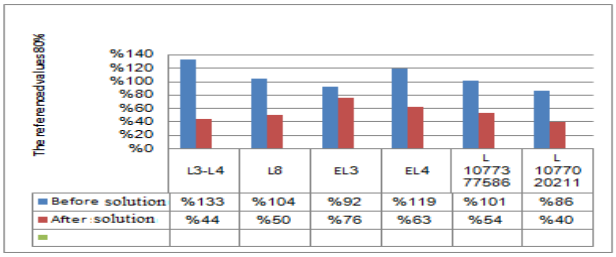

Figure 3. Alkhoms Switching Ring for Lines before and after Treatment.

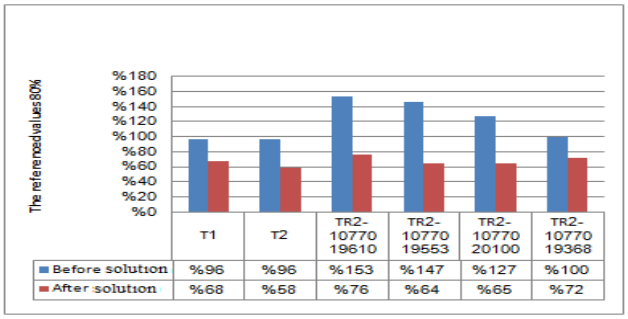

Figure 4. Alkhoms Switching Ring for Transformers beforeand after Treatment.

Table 7. Load Flow Summary of Alkhoms Generation Ring In 2013

Un		P Loss Line	Q Loss Line	P Loss Transformer	Q Loss Transformer
kV		MW	MVar	MW	MVar
30		0.49	-2.293	0.243	4.055
220		0	0	0.127	2.527
Overloads					
Nodes (upper)	%				
B-1077471127	113.52				
B-1077471128	113.52				
Elements	%	Type			
L2	88.93	Line			

Table 8. Load Flow Summary of Alkhoms Generation Ring In 2023

Un		P Loss Line	Q Loss Line	P Loss Transformer	Q Loss Transformer
kV		MW	MVar	MW	MVar
30		1.361	-1.883	1.146	9.17
220		0	0	0.639	12.766
Overloads					
Elements	%	Type			
TR2-1077024228	117.13	2W Transformer			
TR2-10770241760	113.25	2W Transformer			
T2	112.31	2W Transformer			
TR2-1077024226	95.16	2W Transformer			
T1	87.61	2W Transformer			

Table 9. Elements situation of Alkhoms Generation Ring In 2023

	Node	Element	Type	Loading	Kind	Optimization	New kind	Loading
	Name	name		%				New %
1	B-1077471083	T1	2W Transf.	87.61	220/30kv-63MVA	Change Tap	16To17	48.54
2	B-1077471107	T2	2W Transf.	112.31	220/30kv-63MVA	Addition	220/30kv-100MVA	48.86
3	B-1077471129	TR2-1077024228	2W Transf.	117.12	30/11kv-25MVA	Addition	30/11kv-25MVA	65.45
4	B-1077471132	TR2-1077024226	2W Transf.	95.16	30/11kv-25MVA	No change	-	65.62
5	B-1077471136	TR2-10770241760	2W Transf.	113.25	30/11kv-25MVA	Addition	30/11kv-25MVA	56.62
6	B-1077471144	TR2-10770241760	2W Transf.	113.24	30/11kv-25MVA	Addition	30/11kv-25MVA	56.61
7	B-30 الخمس التوليد	T2	2W Transf.	104.29	220/30kv-63MVA	Addition	220/30kv-100MVA	47.6
8	B-30 لبدة	TR2-1077024226	2W Transf.	95.16	30/11kv-25MVA	No change	-	65.63
9	الخمس التوليد	T1	2W Transf.	82.75	220/30kv-63MVA	change Tap	16To17	45.15
10	لبدة	TR2-1077024228	2W Transf.	117.13	30/11kv-25MVA	Addition	30/11kv-25MVA	65.45
11	B-1077471107	T3	2W Transf.	48.86	220/30kv-100MVA	New	-	-
12	N1077475213	TR2-1077475207	2W Transf.	54.14	30/11kv-25MVA	New	-	-
13	N1077475182	TR2-1077475173	2W Transf.	43.06	30/11kv-25MVA	New	-	-
14	B-30 الخمس التوليد	T3	2W Transf.	45.45	220/30kv-100MVA	New	-	-
15	لبده	TR2-1077475207	2W Transf.	54.15	30/11kv-25MVA	New	-	-
16	البندار	TR2-1077475173	2W Transf.	43.06	30/11kv-25MVA	New	-	-

The following chart is illustrated the elements (Transformers) of Alkhoms generation ring before and after treatment at2023.

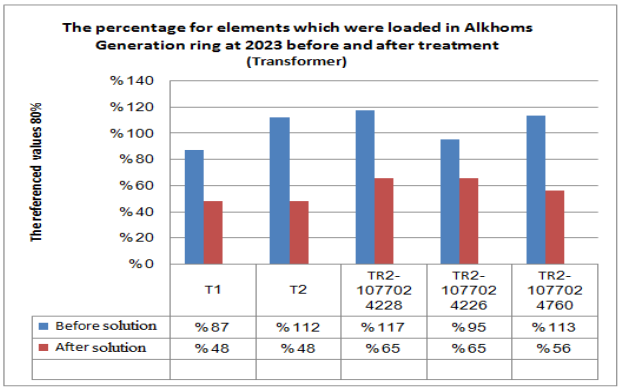

Figure 5. Alkhoms Switching Ring for Lines before and after Treatment.

VI. CONCLUSION

This paper was studied the expansion of 30 kV Alkhoms switching and Alkhoms generation rings network. Based to GECOL 2013 data, this work was done for the two rings up to 2023. NEPLAN software is been used for all analyzed and expansion. The existing network 30 kV of Alkhoms city was analyzed and the load flow calculations were performed for peak operation and for the assumed loading. The results of NEPLAN software have been illustrated in tables and figures of this paper.

REFERENCES

[1] S R. Billinton, and R. N. Allan, "Reliability Evaluation of Power Systems," 2nd ed., University of Saskatchewan, Canada Editor Plenum, New York, 1996.

[2] R.srinivasa Rao, S.V.L.Narasimham "Anew Heuristic Approach for Optimal Network Reconfiguration in Distribution System" international journal of applied science. Engineering and technology 5/1/2009.

[3] J. Liu, Senior Member, IEEE, Bi Pengxiang, Zhang Yang Yanqing, and Wu Xiaomeng "Power Flow Analysis on Simplified Feeder" Modeling.IEEE. Transaction on power delivery .vol.19.no.1.january .2004.

[4] A. Salem Sultan "Analytic Study for 66 kV Sub Transmission System Planning" The international journal of engineering and information technology (IJEIT), vol. 2, no. 1, 2015
[5] H. Chuang, C. Chen, Y. Ching , C. Chung, "Optimal Expansion Planning of Distribution Substations for Taipower Distribution System," International Conference on Power System Technology, 2010.
[6] T. Gonen, "Electric Power Distribution System Engineering," CRC Press, New York, 2008.
[7] R. L. Sullivan "Power System Planning", McGraw-Hill, New York, 1977.
[8] A. K. Fadel, H. K. Temraz, A. A. Ishak, M. A. Elsharkawy, "A Heuristic Approach For Power Distribution system Planning," Proc MEPCON, vol. 2, PP. 679-686, March, 2000.
[9] B. Dorin, C. Moldovan, M. Muj a Rotation and M. Muji "Power Engineering Education using NEPLAN software" Universities Power Engineering Conference, 2008. UPEC 2008. 43rd International.

BIOGRAPHIES

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