Inaam I. Ali
University of technology
Baghdad, Iraq.
30037@uotechnology.edu.iq.

Omar. Y. Saeed
University of technology,
Baghdad, Iraq.
omar_yasin86@yahoo.com.

Received on: 22/01/2017
Accepted on: 08/06/2017

Optimal Reconfiguration and Distributed Generation placement in Baghdad Distribution Sector

Abstract- *The power losses in distribution system are high, which form 70 – 80% of total transmission and distribution losses. High losses have severe impact on stability, reliability as well as economy. Therefore, minimization of these losses is very necessary. In this paper proposed various schemes to reduce the active power losses in distribution network, given as:*
- Optimum reconfiguration network,
- Optimum Distributed Generation (DG) placement and
- Optimum reconfiguration with optimum (DG) placement.
Using Cymdist software to implement the optimal reconfiguration algorithm and proposed Genetic Algorithm (GA) to find the size and location, which programmed under MATLAB software package. Whereon the proposed methodology (GA) simplifies the problem by dividing it in two phases, namely Placement Planning Model (PPM) and Size Planning Model (SPM) thereby reducing the search space. It was the integration of the two methods were used after each method individually to obtain minimum real power losses with better bus voltage (better efficiency for network).To verify the proposed algorithms, IEEE 33-bus system and al – jihad neighborhood distribution system (Baghdad distribution sector) are tested. The simulation results are compared with proposed works in literature.

Keywords- *Power Losses, Reconfiguration, Distributed Generation, Genetic Algorithm, Cymdist, and MATLAB.*

How to cite this article: I.I. Ali and O.Y. Saeed "Optimal Reconfiguration and Distributed Generation Placement in Baghdad Distribution Sector," *Engineering & Technology Journal*, Vol. 35,Part A, No. 3, pp. 333-343, 2018.

1. Introduction

High R/X ratio and voltage drop causing high losses in distribution networks, which account for 80% of total transmission and distribution losses. Distribution power losses can be divided into two categories technical and non-technical losses. The technical losses area related to the material properties and its resistance to the flow of the electrical current that is dissipated as heat. The most obvious examples are the power dissipated in distribution lines and transformers due to their internal electrical resistance. In addition, technical losses are easy to be simulated and calculated. On the other hand, non-technical losses are caused by clandestine connections, frauds in energy meters, diversity of readings and deficiencies (or losses) in the processes of energy measurement [1]. The growth of electrical demand required to develop radial distribution system (RDS) not by build more power plant but by finding local solution like (Distributed Generation (DG)) .The passive RDS construction (shape) is change by adding DG or shunt-capacitor–bank to become active. The modern power distribution network is constantly being faced with an ever-growing load demand, this increasing load is resulting into increased burden and reduced voltage [2]. The distribution network also has a typical feature that the voltage at nodes reduces if moved away from substation. This decrease in voltage is mainly due to insufficient amount of "Reactive power". Even in certain industrial area critical loading, it may lead to voltage collapse. Thus to improve the voltage profile and to avoid voltage collapse reactive compensation is required. It is well known that loss in a distribution networks are significantly high compared to that in a transmission networks. Such non-negligible losses have a direct impact on the financial issues and overall efficiency of distribution utilities. The need of improving the overall efficiency of power delivery has forced the power utilities to reduce the losses at distribution level [3]. The various methods of losses minimization for distribution system are:

i.Network Re-conductoring.

https://doi.org/10.30684/etj.36.3A.13
2412-0758/University of Technology-Iraq, Baghdad, Iraq

ii. Distribution transformer locating and sizing.
iii. Automatic voltage booster.
iv. High voltage distribution system.
v. Reactive power compensation.
vi. Distribution generation locating and sizing.
vii. Building new substation [4].

2. Problem Formulation

The main purpose of the use of the mathematical formula is to reduce losses and improve voltage and get the better performance of the network and the accompanying reduce the cost of design and operational and the promise of a future plan to cover population growth of consumer demand for electric power. This section describes the formulation of losses reduction in distribution system using various techniques given as:

- Optimal configuration network.
- Optimal DG placement and sizing.

Mathematical Formulation

The major aim of math equation to determine the optimal rating and siting of DG and Reconfiguration in distribution bus system in order to minimize as possible as the loss of RDN (Radial Distribution Network) [5] with voltage profile improvement. Figure (1) shows a branch of balance bus system that will adding to its DG

The active power (P_i) and reactive (Q_i) that passing through branch "j" from bus "i" to bus "i+1" given as:

$$P_i = P_{i+1} + r_J \frac{(P_{i+1}^2 + Q_{i+1}^2)}{V_{i+1}^2} \quad (1)$$

$$Q_i = Q_{i+1} + x_J \frac{(P_{i+1}^2 + Q_{i+1}^2)}{V_{i+1}^2} \quad (2)$$

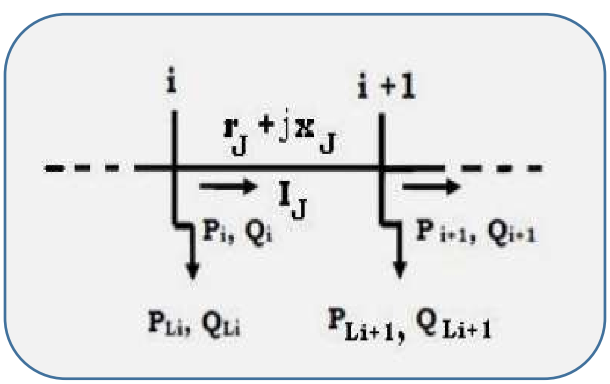

Figure 1: Branch of bus system

The voltage value and angle at each bus are determined in forward method. Assume a voltage $V_i \angle \delta_i$ at node "i" and $V_{i+1} \angle \delta_{i+1}$ at node "i+1" then the current "I_J" pass through the section having an impedance ($Z_J = r_J + jx_J$) represent the overhead line section parameters as:

$$I_J = \frac{(V_i \angle \delta_i - V_{i+1} \angle \delta_{i+1})}{r_J + jx_J} \quad (3)$$

The math formula for total real and reactive power for radial distribution system (RDS) with and without the impact of adding DG that will evaluate the behavior of system and the change that happen through this equations :[6]

Total real power loss (TPL)

$$= \sum_{j=1}^{Nb} r_J \frac{(P_i^2 + Q_i^2)}{V_i^2} \quad (4)$$

Total reactive power loss (TQL)

$$= \sum_{j=1}^{Nb} x_J \frac{(P_i^2 + Q_i^2)}{V_i^2} \quad (5)$$

The loss reduction in network problem is formulated as:

$$= min \sum_{i}^{Nb} r_i \frac{P_I^2 + Q_I^2}{V_I^2} \quad (6)$$

3. Constraints

✓ Power balance constraint
✓ Real power limits $P_{i\ DG,\ Min} \le P_{i\ DG} \le P_{i\ DG,\ MAX}$
✓ Reactive power limits $Q_{i\ DG,\ Min} \le Q_{i\ DG} \le Q_{i\ DG,\ Max}$
✓ Voltage deviation limits at each bus: $0.95 \le V_i \le 1.05$
✓ Capacity limits of branch distribution due thermal limits and design consideration for distribution equipment:

$S_{i,j} \le S_{i,j}$ max
$S_{i,j}$ =apparent power flow for section i, j
$S_{i,j}$ =Maximum apparent power flow for section i, j

✓ Radial structure (topography of network).

4. Optimum Configuration Network Algorithm

Configuration changeable may be performed by changing the status of network switches (open/close), in such a way that radially is always re-established after the proposed solution method starts with a meshed distribution system obtained by considering all switches closed. Then, the switches are opened successively to eliminate the loops. The opening criterion is based on minimum total power loss increase, and this is determined using a "Load-Flow program", as shown in Figure 2.

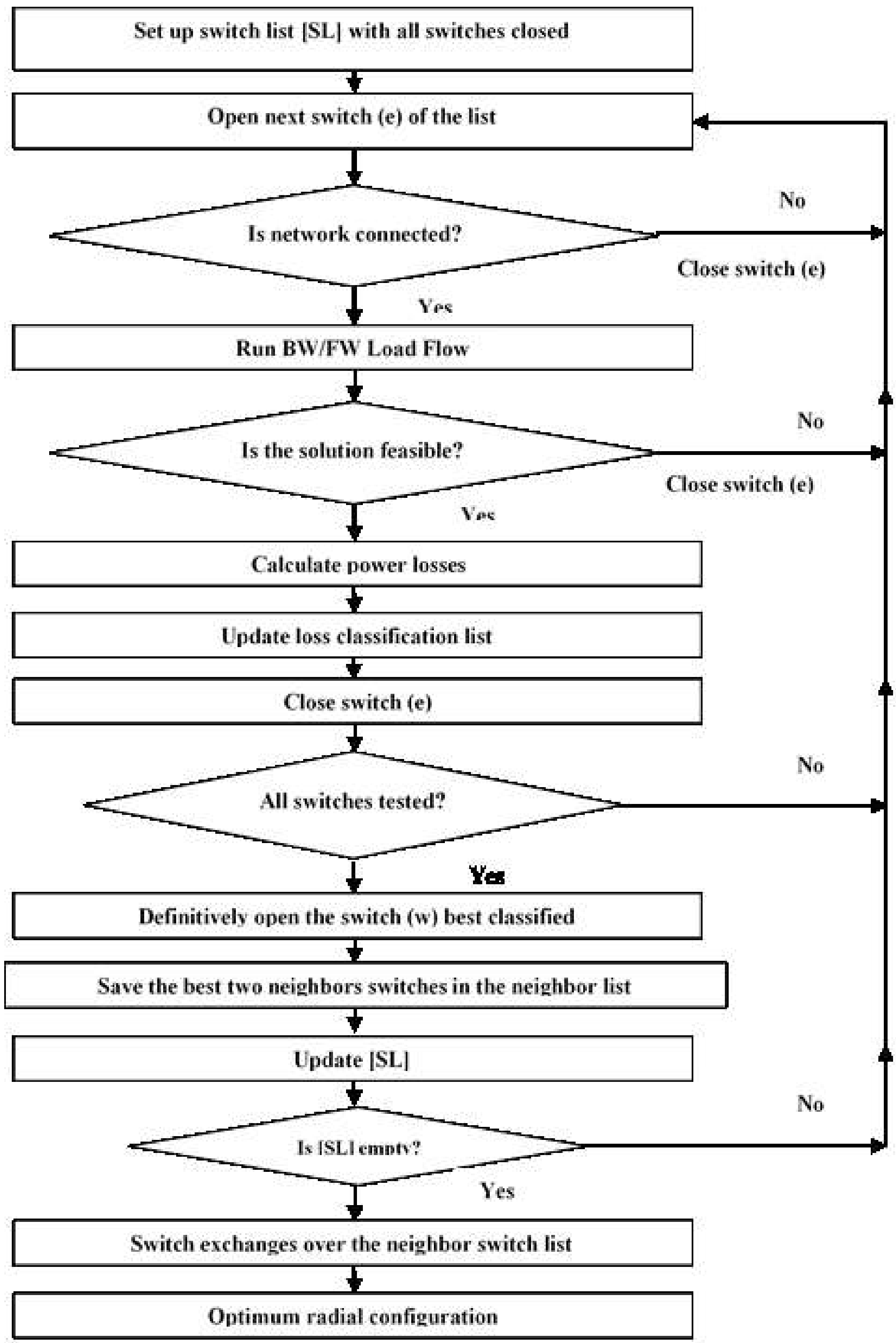

Figure 2: The proposed algorithm flowchart for re-configuration network

5. Optimal DG placement Algorithm

Genetic algorithms work by optimizing the fitness function. When applying Genetic Algorithms to optimize the DG placement and sizing problems, an important thing is the coding of the potential solutions. The initial population (coded variables) is the candidate ratings and siting of DG units. Each chromosome is represented by a vector. The chromosome coding in this study as seen in Figure 4 is defined as bus number and DG capacities.

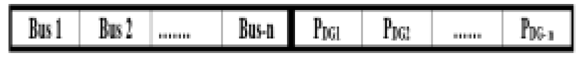

Figure 3: Chromosome coding

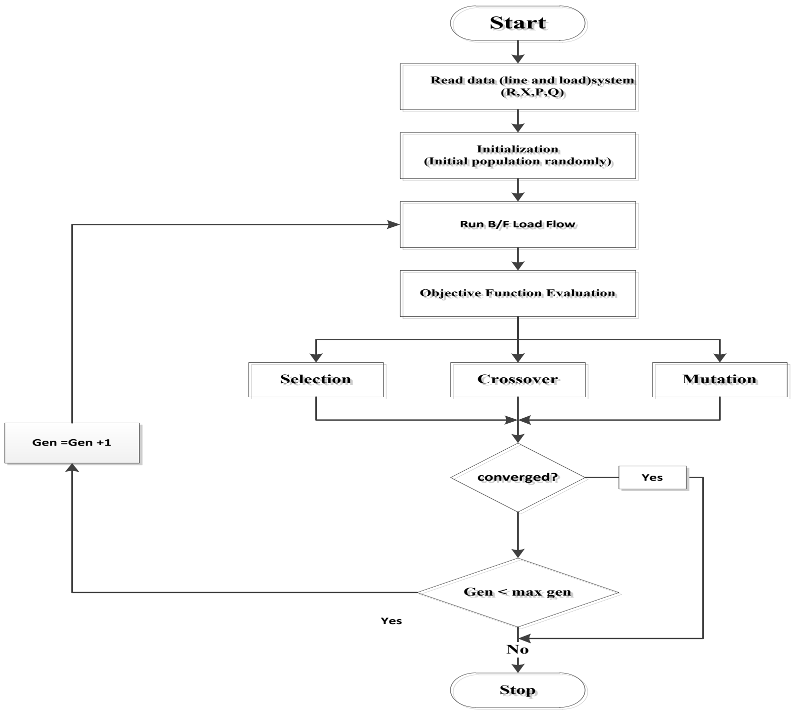

Figure 4: Flowchart for DG allocation using GA

Bus-n is a discrete number between 1 and the total number of buses. P_{DG-n} is continuous numbers ranging from zero to the maximum value of DG capacity (MW). Genetic Algorithm searches for the best answer in a continuous way between boundary limits; consequently the optimal case is GA output.

GA methodology discussed above is implemented using the following steps:

Step 1: (Initialization): Generates random-ly n chromosomes for position and size of DG.

Step 2: (fitness): evaluate each chromosome in the initial population using the objective function, J. search for the best value of the objective function J best. Set the chromosome associated with J best as the global best.

Step 3: ("new population"): create a new population by repeating the following procedure until the new population is accomplished:

- **Selection:** choose two parent chromosomes from a population according to their fitness.
- **Crossover:** with a cross-over probability, cross-over the parents to form a new child.
- **Mutation:** with a mutation probability approach mutates new child at each chromosome.
- **Acceptance:** put new child in a new population.

Step ٤: (Re-placement): use new generated population for a further run of algorithm.

Step ٥: If the fitness function is fulfilled then stop, else move to step 2 [7].

The GA parameters used in the present work given as:

Population size: 25 max .Generation:100

Cross over rate: 0.01 type of selection: Roulette Wheel

Mutation rate: 0.٠7 type of cross over: Arithmetic

https://doi.org/10.30684/etj.36.3A.13
2412-0758/University of Technology-Iraq, Baghdad, Iraq

Figure 4 shows the flow chart of optimal sitting and sizing of distributed generation.

6. Simulation Results and Discussion

I. Test system and Al-Jihad District distribution system:

The proposed approaches have been tested on IEEE 33-Bus and AL-JIHAD Neighborhood distribution system. These systems are simulated by implemented in Cyme programs and MATLAB programming (GAs) using personal computer with CORE-i3 processor having 2.4 GHz speed and 3GB RAM.

IEEE 33-bus test system:

A single line diagram of the 12.66 kV, 33-bus test radial distribution system is shown in Figure 5. It has one feeder with three different laterals, 32 branches and a total peak load of 3715 kW and 2300 kVAR. The total active loss power of the base case system is 202.20 kW. The base configuration of the system is having 5 loops or tie switches (switches 33–37) which are kept normally open is shown in dotted lines which is closed only during fault condition to maintain continuity of supply or can be closed to change circuit resistance to reduce losses. Table 1 illustrate the line and load data of IEEE-33 test system.

Table 1: the line and load data of IEEE-33 test system

Sec. No.	Sending bus	Receiving bus	Section resistance R (ohm)	Section reactance X (ohm)	Receiving bus active power P (kW)	Receiving bus reactive power Q (kVAR)
1	S_N_1	1	0.0922	0.0470	100	60
2	1	2	0.4930	0.2511	90	40
3	2	3	0.3660	0.1864	120	80
4	3	4	0.3811	0.1941	60	30
5	4	5	0.8190	0.7070	60	20
6	5	6	0.1872	0.6188	200	100
7	6	7	0.7114	0.2351	200	100
8	7	8	1.0300	0.7400	60	20
9	8	9	1.0440	0.7400	60	20
10	9	10	0.1966	0.0650	45	30
11	10	11	0.3744	0.1238	60	35
12	11	12	1.4680	1.1550	60	35
13	12	13	0.5416	0.7129	120	80
14	13	14	0.5910	0.5260	60	10
15	14	15	0.7463	0.5450	60	20
16	15	16	1.2890	1.7210	60	20
17	16	17	0.7320	0.5740	90	40
18	1	18	0.1640	0.1565	90	40
19	18	19	1.5042	1.3554	90	40
20	19	20	0.4095	0.4784	90	40
21	20	21	0.7089	0.9373	90	40
22	2	22	0.4512	0.3083	90	50
23	22	23	0.8980	0.7091	420	200
24	23	24	0.8960	0.7011	420	200
25	5	25	0.2030	0.1034	60	25
26	25	26	0.2842	0.1447	60	25
27	26	27	1.0590	0.9337	60	20
28	27	28	0.8042	0.7006	120	70
29	28	29	0.5075	0.2585	200	600
30	29	30	0.9744	0.9630	150	70
31	30	31	0.3105	0.3619	210	100
32	31	32	0.3410	0.5302	60	40
33	7	20	2.000	2.000	---	---
34	8	14	2.000	2.000	---	---

35	11	21	2.000	2.000	---	---
36	17	32	0.5000	0.5000	---	---
37	24	25	0.5000	0.5000	---	---

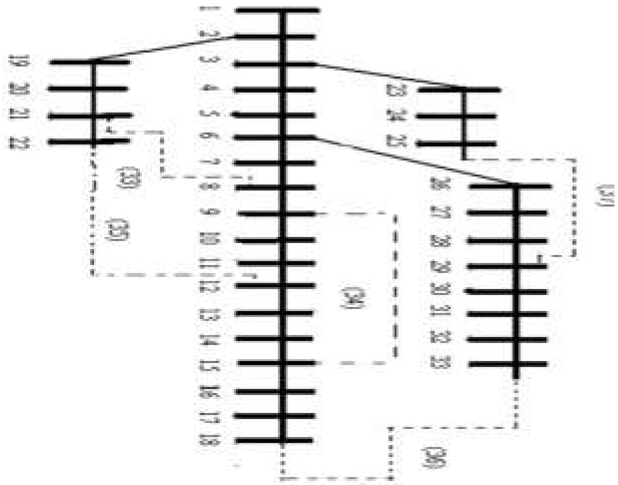

Figure 5: The configuration of the 33-bus radial distribution system [8]

AL-JIHAD distribution network

AL-Jihad neighborhood is located in the south-west of the city of Baghdad , where the feed own secondary power station consist of 14 feeders , two of them for special purpose other than residential belongs to feed the Baghdad airport road and by examining the feeders loads will notice exceed the permissible limits (including in the design tables for overhead lines and cable conductors according to MOE of Iraq) therefore AL-Jihad district is considered among the worst cases in electrical power losses and for this reason have been selected .Figure (6) shows initial configuration of AL-Jihad distribution system.

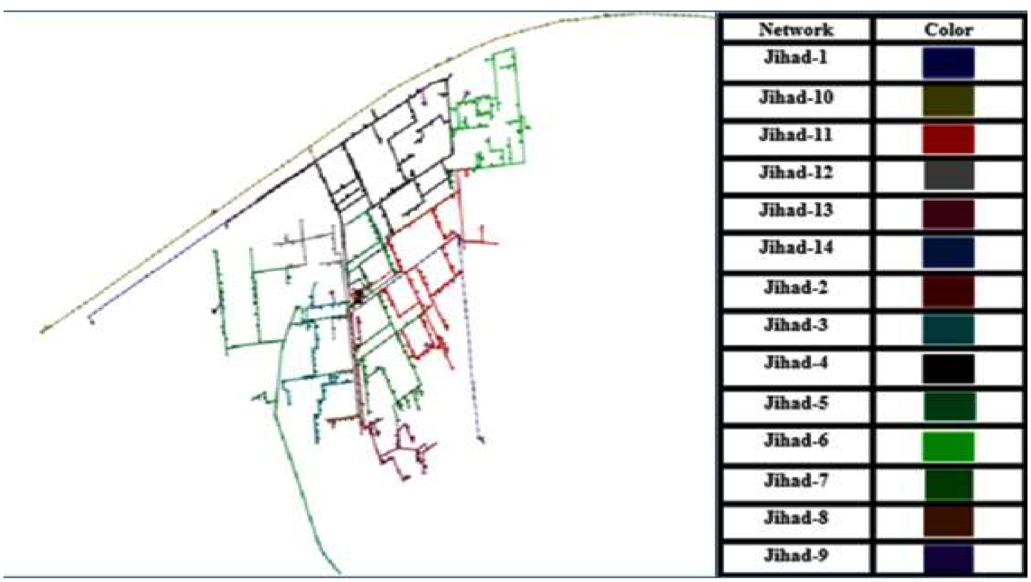

Figure 6: Initial configuration of JIHAD distribution system

II. Optimal configuration network

The proposed approach will test on 33-bus and on AL-JIHAD distribution system.

Case (1): IEEE 33-bus test system:

Table (2) illustrate the changes after applying the network configuration optimization by opening/closing the sectionalizing and tie switches that give a solution for power loss reduction as well as voltage improvement by using Cymdist tool .

Table 2: Simulation results for 33-bus after Re-configuration network

Item	Base case	Reconfiguration
Real Power Loss(KW)	202.53	117.07
V_{min}(p.u)	0.917	0.95
Switches Opened	33,34,35,36,37	7,9,14,28,32

Based on these results it show that the real power losses after applying optimal configuration network analysis is reduced about 42.19% and p.u voltage level of system raise from 0.917 to 0.95 p.u. Figure 6 shows voltage profile for each bus whereon the results show the different voltage level for default case and after change topography of distribution network for proposed method, pre switching optimization placement the voltage level from 7-18 are Low .After network configuration the voltage level of those buses are improved.

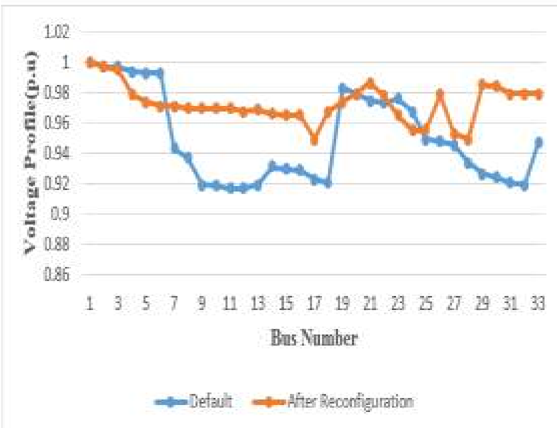

Figure 7: Voltage profile for 33-bus before and after re-configuration network analysis

To show the effectiveness of the proposed method (optimal re-configuration network) the results are compared with proposed work of Ref. [9]. The real power loss, voltage profile and open switches are illustrate in Table 3. It can be observed that, the results obtained by the proposed method is the best, whereon minimize the number of abnormal conditions (low voltage, high voltage and overload) to zero.

Table 3: Comparison simulation results of 33-bus after optimal configuration analysis

Item	Proposed method	Proposed of Ref. [9]
Real Power Loss(kW)	117.07	139.5
Real Power Loss%	42.19	31.16
V_{min}(P.U)	0.95	0.9343
Open Switches	7,9,14,28,32	7,9,14,32,37

Case (2): AL-Jihad neighborhood distribution system

Table (4) illustrate the real power loss (kW), voltage level (p.u) and open switches before and after validate and examine optimal configuration network analysis by opening/closing the sectionalizing and tie switches with satisfying all constrains.

Table 4: Simulation results for AL-Jihad distribution system after Re-configuration network

Item	Base case	Re-configuration
Real Power Loss (kW)	730.61	625.41
V_{min}(p.u)	0.949	0.949

Open Switches	11KV_JIHAD_1_5 11KV_JIHAD_1_6 11KV_JIHAD_1_55 11KV_JIHAD_1_56 11KV_JIHAD_5_42 11KV_JIHAD_7_80 11KV_JIHAD_8_84 11KV_JIHAD_9_21 11KV_JIHAD_11_63	11KV_JIHAD_1_12 11KV_JIHAD_4_10 11KV_JIHAD_4_110 11KV_JIHAD_5_5 11KV_JIHAD_7_87 11KV_JIHAD_7_96 11KV_JIHAD_7_102 11KV_JIHAD_8_72 11KV_JIHAD_11_51

The results obtained show following notes:

1. The real power loss after optimal configuration network analysis become 625.41 and reduced about 14.398%.
2. No change occur in voltage level of system after apply Re-configuration technique.

Figure (8) shows the difference in real power losses before and after optimal configuration network analysis.

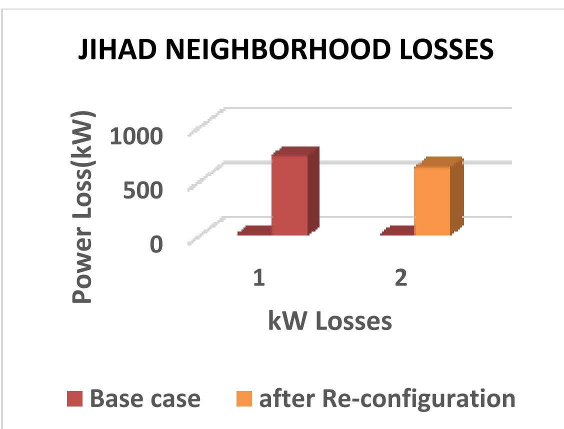

Figure 8: Total power Loss for JIHAD DS

III. Optimal Size and Location of DG

The DG location and size problem are formulated as an optimization problem based on GA, which have been discussed previously. The minimization of active power losses is the objective function has been considered. Simulation programs are implemented by using MATLAB package then the results are compared with Cymdist package. The proposed approach has been tested on IEEE-33 bus and AL-Jihad Neighborhood. (Sector in Baghdad distribution networks).

Case (1): IEEE-33 bus test system:

The first test system represent in Cymdist software then run the load flow analysis without DG, and with connected DGs in the locations which gained from GA and dependable sizes, in different numbers as steps one, two and three DGs in each time repeated load flow analysis to determine the active power losses and compare with the results obtained from R2013a MATLAB.The simulation results obtained in Table (5) illustrate real power loss (kW) without and with DG placement that gained from GA/MATLAB with its location and size. The results Total system power loss is obtained from the results of power flow studies when DG is placed at different buses with peak loading conditions.

Table 5: Simulation results of 33-bus without and with DG placement

Item	Location (Bus No.)	Size (kW)	Power Loss(kW) Using proposed method GA	Power Loss(kW) Using Cymdist Tool
Without DG	-----	-----	202.8954	202.53
1 DG	6	3715	121.3521	120.83
2 DG	13 30	1200.7 1510.3	100.8311	100.13
3 DG	13 24 30	792.5 1100.3 1086	73.2141	72.73

The results show that the total power losses without DG units in its highest value is 202.53 kW, but after the optimal size DG units are connected in the optimal locations on the distribution test system, the total active power loss for one, two and three DG units in its highest value became (120.83, 100.13, 72.73 kW respectively). Thus there is a reduction power loss about 40.339%, 50.56%, 64.089% of the total active power losses in the system because the increasing in delivered power to the network provides from DGs that connected near some loads. The improvement in bus voltage level of the system shown in Figure (9) without and with DG placement.

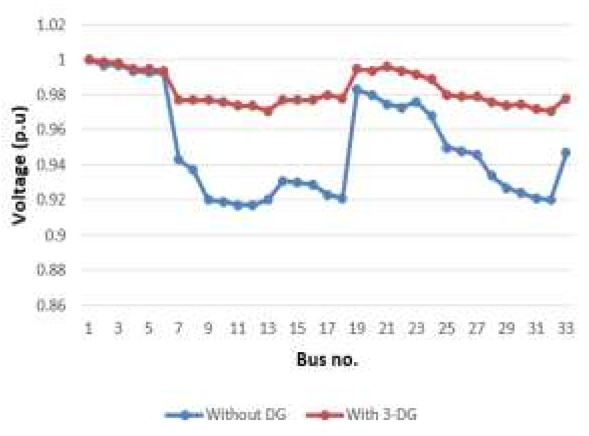

Figure 9: Voltage profile before and after 3-DG placement

It is observed that in all the cases the voltage profile improves, when the number of DG units installed in the system are increased except third case depict A small change in voltage level after install three DG , while satisfy all the current and voltage constraints.

To show the effectiveness of the proposed method the results are compared with those obtained in Table (6).

Table (6): Comparison results of IEEE-33 bus system after DG placement

Proposed method (GA)			Proposed method of Ref.[10]		
Location (Bus Number)	Size (kW)	Power Loss (kW)	Location (Bus Number)	Size (kW)	Power Loss (kW)
13	792.5		17	107	
24	1100.3	72.73	18	572.4	96.76
30	1086		33	1046.2	

Case (2): AL-Jihad district distribution system:

Nowadays the increasing demand in Iraqi distribution network and load as a result of natural population increase with the age of the network, which requires the development of distributed systems. This factor causes further voltage drop, increased losses, as a result reduction of the bus voltage stability and load imbalance. Therefore, the usage of distributed generations (DGs) has been increased.The simulation results obtained in Table (7) illustrate the real power losses without and with DG placement and its siting and size.

Table 7: Simulation results of AL-Jihad network without and with DG placement

Item	Location (Bus No.)	Size(kW)	Power Loss(KW) Using proposed method GA	Power Loss(kW) Using Cymdist
Without DG	------	------	730.03	730.61
1 DG	Jihad 14-32	3754	478.891	481.45
2 DG	Jihad 12-49 Jihad 5-24	1100.45 2145.57	467.347	469.89
3DG	Jihad 14-30 Jihad 7-90 Jihad 11-66	2754 3100.3 3008.2	457.891	461.45

The results show that the total power losses without DG units in its highest value is 730.61 kW, but after the optimal size DG units are connected in the optimal locations on the distribution test system, the total active power loss for one, two and three DG units in its highest value became (478.891, 467.347, 457.891 kW respectively). Thus there is a reduction power loss about 34.57%, 36.03%, 37.327% of the total active power losses in the system because the increasing in delivered power to the network provides from DGs that connected near some loads. The improvement in bus voltage level of AL-Jihad distribution system shown in Figure (10) whereon small difference in voltage level between adding three DG appear.

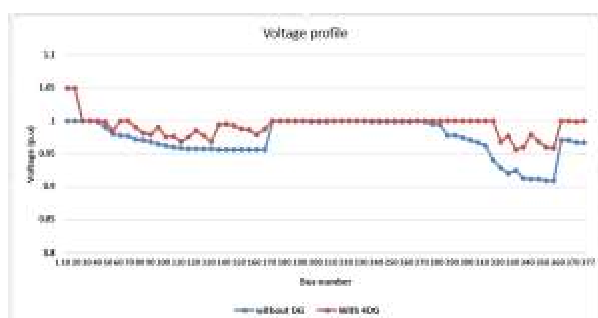

Figure 10: Voltage profile for AL-Jihad distribution system after 3 DG

IV. Optimal reconfiguration with optimum (DG) placement:

Case (1): IEEE-33 bus test system:

Based on proposed method the simulation results obtained in Table (8) illustrate and reviewing several scenarios for real power loss ,locations of DG and open switches.

Table 8: Simulation results of 33-bus after DG placement with re-configuration

Item	Power Loss (kW)	Location Bus No.	Switches Opened
DG only	72.73	13 24 30	-----
Re-configuration only	117.07	----	7,9,14, 28,32
Re-configuration with DG placement	52.34	13 24 30	7,8,10,2 6

The base case power flow gives the total real power loss 202.53 kW but after optimal configuration network kW losses become 117.07 and when apply DG placement after re-configuration as scenario more effective total power loss fell to 52.34 kW with reduction reach to (74.157%).The improvement in bus voltage level of system based on apply this proposed method shown in Figure (11).

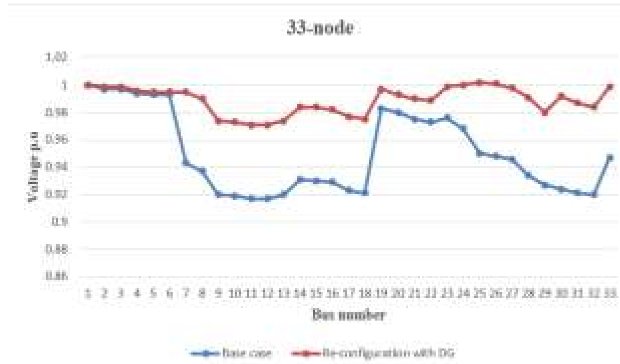

Figure 11: Voltage profile of IEEE-33 test system

Case (2): AL-Jihad neighborhood distribution system:

Simulate AL-Jihad network in Cymdist software, run the load flow analysis without DG, and with connected DGs in the locations which gained from GA and dependable sizes, in different numbers as steps one, two and three DGs and then apply optimal configuration network analysis to obtain results report that illustrate in Table (9).in each time repeated load flow analysis to determine the active power losses and compare with the results obtained from MATLAB.

Table 9: simulation results of AL-JIHAD distribution system

Item	Power Loss(kW)	Location (Bus No.)	Switches Opened
DG only	461.45	JIHAD 14-30 JIHAD 7-90 JIHAD 11-66	----
Reconfiguration Only	625.41	------	JIHAD_1_12 JIHAD_4_10 JIHAD_4_110 JIHAD_5_5 JIHAD_7_87 JIHAD_7_96 JIHAD_7_102 JIHAD_8_72 JIHAD_11_51
Re-configuration with DG siting	408.39	JIHAD 14-30 JIHAD 7-90 JIHAD 11-66	JIHAD_8_72 JIHAD_4_14 JIHAD_11_49 JIHAD_5_5 JIHAD_7_67 JIHAD_5_15 JIHAD_11_66 JIHAD_1_12

The results showed that the combination of the distributed generation allocation with the reconfiguration provided lower losses reach to 408.39 kW than non-combined applications of these techniques. The obtained results were very effective, and the computation efforts were feasible for power systems optimization, requiring a non-prohibitive number of power flow simulations. Therefore, the proposed methodology has a potential application for the optimization of large electric distribution systems. Losses reduction become (44.103%) of its initial value. The changes that have arisen in the improvement of the efficiency of AL-Jihad distribution system after the optimal location and size of the generators and the application of better topography of the network will reflect positively on the delivery of voltage and frequency standard within the borders of the Ministry of the Iraqi electricity (MOE).the improvement of bus voltage level shown in Figure (12).

Figure 12: Voltage profile of AL-Jihad distribution system

7. Conclusions

1. It is clear from the simulation results that the optimal DG placement technique consider the better solution for reduction losses as well as maximize bus voltage level but with respect to cost and space in case of AL-Jihad distribution network (Baghdad distribution sector).
2. The DG location and sizing problem are formulated as an optimization problem based on genetic algorithm, GA intelligent technique is dedicated successfully for optimal sizing and allocation of DG.
3. The DGs have considerable effect in power losses minimization and improved of the voltage profile and utilized many DG with optimum location and size are preferable than one DG.
4. Implementation of Re-configuration with DG placement provide the best mean of power losses reduction and voltage improvement.

References

[1] R.S. Rao, S.V.L. Narasimham and M. Ramalingaraju, "Optimal Capacitor Placement in a Radial Distribution System Using Plant Growth Simulation Algorithm," Electrical Power and Energy Systems, Vol. 33, issue 5, pp. 1133-1139, 2011.

[2] S.K. Injeti and N.P. Kumar, "Planning and Operation of Active Radial Distribution Networks for Improved Voltage Stability and Loss Reduction," World Journal of Modelling and Simulation, Vol. 8, No. 3, pp. 211-222, 2012.

[3] W.V. Jahnavi, "Reduction of Losses in Distribution System Using HVDS with Real Time Application," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 3, Issue 9, September 2014.

[4] S.S. Mustafa, M.H. Yasen and H.H. Abdullah, "Evaluation of Electric Energy Losses in Kirkuk Distribution Electric System Area," Iraq J. Electrical and Electronic Engineering, Vol.7 No. 2, 2011.

[5] A. Mohapatra, S. Behera, S. Nayak and B.K. Panigrahi, "A Study on DG and Capacitor Placement in Radial Distribution System," IEEE International Conference on Power Electronics, Drives and Energy Systems December16-19, 2012.

[6] S. Pande and J.G. Ghodekar, "Reduction of Power Loss of Distribution System by Distribution Network Management," International Journal of Multidisciplinary Sciences and Engineering, Vol. 3, No. 11, November 2012.

[7] Y.Tang,X. Mao,andR.Ayyanar,"Distribution System Modeling Using Cymdist for Study of High Penetration of Distributed Solar Photovoltaic,"IEEE Transactions on Power Systems,978-1-4673-2308-6, 2012.

[8] M. Khosravi, "Optimal Placement Distributed Generation by genetic algorithm to Minimize Losses in Radial Distribution Systems," Bull. Env. Pharmacol. Life Sci., Vol. 3, 2014.

[9] R. Rajaram, K.S. Kumar and N. Rajasekar, "Power System Reconfiguration in a Radial Distribution Network for Reducing Losses and to Improve Voltage Profile Using Modified Plant Growth Simulation Algorithm with Distributed Generation (DG)," Energy Reports,pp.116-122, 2015.

[10] R.S. Rao, K. Ravindra, K. Satish and S.V.L. Narasimham, "Power Loss Minimization in Distribution System Using Network Reconfiguration in the Presence of Distributed Generation," IEEE Transition on Power System, Vol. 28, No. 1, 2013.

Author(s) biography

Dr. I. I. Ali received her B.S. degree in Electrical Engineering from Electrical Engineering Department, University of Technology, Baghdad, Iraq in 1996. She received her M.Sc. degree and Ph.D. degree in Power System Engineering from Electrical Engineering Department, University of Technology, Iraq in 2001 and 2009, respectively.
Currently, she is lecturer at the University of Technology. Her research interests include power system stability, power system control, FACTs devices, power quality improvement and renewable energy.

O. Y. Saeed received his B.S. degree in Electrical Engineering from Electrical Engineering Department, University of Technology, Iraq in 2008. He received his M.Sc. degree in Power System Engineering from Electrical Engineering Department, University of Technology, Iraq in 2017.