Optimal Positioning and Proper DG Capacity Design Along With Optimization of Maneuver Points; In Networks of 20 KV Power Distribution in Golpayegan County

Shapour Haddadipour, Vahid Amir, Hamed Hashemi

Faculty Member of Kashan Branch, Islamic Azad University, Kashan, Iran

Abstract
Recent developments in the field of renewable resource technology, and increased demand and the need for clean and cheap energy, have led to a growing trend towards distributed generation (DG). The idea of using distributed generation (DG) sources is becoming more and more important day by day due to the changes that have taken place in power systems and new innovations, especially in the field of power electronics and the high benefits of using DGs. The aim of this paper is to investigate the optimal positioning and proper DG capacity design along with optimization of maneuver points; in networks of 20 kV power distributions in Golpayegan County. The genetic algorithm is used in MATLAB software to find the optimal points for installing DGs resources, and the GAMS software has been used to optimize the costs of installing and operating power generation sources. Results indicate that the installation of DG within the 7th feeder of Golpayegan has had a significant effect on the loss of tangible reduction and voltage recovery and the process of exploiting the network will be radically transformed, especially in the event of a power failure. According to the chart analysis, maneuvering points have had a greater impact on the improvement of reliability indices in Golpayegan 7th feeder.
Keywords:
DG, Golpayegan, maneuver points, optimal placement, power distribution

1. Introduction

Increasing demand for electric power on the one hand as well as creating electricity markets has led electric companies around the world to find alternatives in order to traditional concentrating power plants. By increasing environmental crises due to the fossil fuels consumption, the use of renewable sources for production is also of prime importance for most countries in all over the world. The solution used by power companies is to reduce power plants and disperse them in different parts of the network. Therefore, the production takes place beside the load which reduces losses and the capacity needed to power the network, and also, it improves the voltage profile. In addition, it provides the possibility of using a variety of power generation motors (including the wind, and etc.) and perhaps most importantly, it allows the participation of a large number of investors in electricity generation which could eliminate the risks posed by the construction of centralized power plants and reduces the cost of electricity. Different effects of distributed generation sources on the economic and technical conditions of power grids are examined in the reference. The power marketing develops due to the possibility of the presence of distributed generation resources in the electricity markets. But, this has different technical consequences. However, one of the impacts of distributed generation sources on the technical condition of the networks is the impact on network losses; the factor that is used in some cases in decision making. DGs usually provide the required power at a low distance to the load. Therefore, the effect of the presence of distributed generation resources on distribution networks (and transmission) is positive.

Recent developments in the field of renewable resource technology, coupled with increased demand and the need for clean and cheap energy, have led to a growing trend towards distributed generation (DG). According to the changes in power systems and new innovations, especially in the field of power electronics and the high benefits of using DGs, the idea of using distributed generation sources (DGs) is becoming more and more important day by day. Using DG units in the power system, if properly done, leads to increase the system stability, the system reliability, and also, reduction of losses and reducing the final cost of production. One of the important issues regarding the use of distributed generation resources is the choice of finding an appropriate place to install them in the network. With the advancement of technology, electrical installations have found the ability to access automation systems which the network rearrangement is one of the most significant applications of this (Pavani et.al, 2013). In this method, when a fault occurs at any point in the network, the electric power distribution networks are able to provide electricity for the consumers with isolating the fault location, until the fault is eliminated. This will improve the reliability of the network. It reconfigures the network in such a way that the network will have the lowest losses. This is possible by the keys that are placed and installed in different parts of the network (Bernardon et.al, 2013). In addition, the use of distributed products in power distribution networks improves network reliability and also reduces network

Manuscript received August 5, 2026
Manuscript revised August 20, 2026
https://doi.org/10.22937/IJCSNS.2026.26.8.18

losses. Also, the use of renewable energy as a dispersed environmental product reduces the pollution caused by the use of fossil fuels in power plants. Meanwhile, creating one or more distributed sources, repair, maintenance and exploitation have a cost which should be considered during implementation and operation in order to minimize the cost function (Sung-Min Cho et.al, 2012).

A major part of the losses occurs in the power grid in the distribution sector. DG units, in addition to providing local load, can improve various power system indices if they are used optimally at the appropriate location and with optimal estimates and calculations. Also, at the same time, determining the maneuver points is very important due to the location of these dispersed production resources.

Here, the loss and voltage profile are the most important indicators. Connecting distributed products affects network performance and this effect is based on the type, number, size, location, and type of connection to the network. A solution that will be presented to determine the capacity and location of distributed generation units will be very important because capacity determination and location determination are not independent of each other, and the optimal and correct answer will be obtained if both of these quantities are optimized. There are several ways to reduce losses such as capacitor placement, an increase of transmission voltage level, a rating of conductors, use of DGs, network rearrangement and etc. Therefore, the aim of this paper is to investigate the optimal positioning and proper DG capacity design along with optimization of maneuver points; in networks of 20 kV power distributions in Golpayegan County.

Mohammadi (2011) discusses optimization of distributed generation by genetic algorithm in order to reduce losses and increase network reliability. The optimal amount of dispersed products is estimated and experienced in suitable buses for the distribution of distributed products. The genetic algorithm in this paper only determines the proper location of distributed generation. Distributed production units are located in places where the highest performance index of the system is there. The simulation results indicate the usefulness of optimal placement of dispersed production in comparison with other methods of losses reduction. It also indicates that the distribution of distributed generation in a radial distribution network is not only beneficial for reducing losses but also improves network reliability indices. Here, the reliability of the network has not been compared with the distributed energy indices and the average unpowered energy has been used (Mohammadi et al., 2011).

Sung-Min (2012) presents a new objective function for the network rearrangement problem with distributed products which has led to a reduction in the cost of network rearrangement and distributed generation due to increased network reliability. In this paper, it is forbidden to operate distributed products at the time of the creation of an error and the creation of an island state for distributed products due to network security issues. So, with the creation of errors on the network of distributed products, they should also be disconnected from the network and this means imposing losses on the owners of distributed products. This objective function is optimized by genetic algorithm and in MATLAB software. The results indicate that the distribution of DG is correct and the method of rearrangement is for economic savings in distribution networks (Sung-Min et.al, 2012).

Kavousi-Fard (2012) has introduced a multi-purpose objective function to examine the network replication rearrangement and to demonstrate the improvement of network reliability which includes minimizing SAIFI, SAIDI and AENS network losses. This multi purpose function is optimized by the ASFLA algorithm. Results indicated that the rearrangement of the distribution network has a significant effect on improving network reliability and decreasing its losses. Meanwhile, in this paper, the proposed method is compared with several other methods, which this one was better than the others (Kavousi-Fard and Akbari-Zadeh, 2012).

Bernardon (2013) presents a method for network replication automatically and with the presence of dispersed products in the normal operating mode of the distribution network. The network rearrangement in this paper is based on an exploratory search method to find the best mode of network operation. In this method, it is assumed that all the keys installed on the network can be changed remotely by remote control. The AHP has been used to find the best mode of network operation. In this way, advanced algorithms in the monitoring and supervision of the network allow the measurement and issuance to command to the equipment. In this paper, this method simulates a real network in different scenarios. Automatic network overlay can improve network performance and reduces losses and increases the reliability of the network (Bernardon et al., 2013).

Rashtchi and Pashai (2012) studied the problem of radial distribution network rearrangement using an ant colony search algorithm. DG was studied to reduce losses, to determine the location and optimal size of dispersed products in accordance with the constraints of the problem because the ant colony optimization algorithm is a powerful and intelligent algorithm for optimizing problem-solving. Here, MATLAB software is used for two types of distribution feeders to simulate the algorithm. The results indicate the efficiency of the ant colony algorithm for solving the problem of rearrangement. After the distribution of distributed generation sources in the network, losses have been significantly reduced (Rashtchi and Pashai, 2012).

Amanulla (2012) presents a method for rearranging the distribution network, to reducing losses and increasing the reliability of the network. A probabilistic model is considered for gaining reliability of load points and, by a minimizing algorithm, found the sets between the source and the load points. Then, to find the optimal mode of operation, the crochet keys of the network are used in terms of improving reliability and loss reduction of the particle pool search algorithm. The effect of this method has been proved on the two radial distribution networks. In this research, unpowered energy indices have been used to demonstrate the improvement of network reliability which indicates the amount of unpowered energy in the network.

Cheng (2012) seeks to reduce the total system losses by adding electric cars in the completely planned way and according to the network load profiles throughout the day; because electric cars can be discharged and discharged either as a load or as a dispersed generation in the network. This research tried to manage the connection of electric vehicles as loads in the network because the network load is breaking by connecting an electric car to charge to the hourly profile network. It increases the number of losses as well as network security. Therefore, they should not connect to lines with maximized current. In general, the purpose of this article is to carry out network rearrangements to minimize losses in the presence of electric cars In a way that the growth of the presence of a vehicle in the distribution network is in accordance with the project of development of electric vehicles (Chang, 2012).

Murthy (2012) presents a method for increasing the reliability of the radial distribution network with the presence of distributed products. Estimation of consumer load capacity is the main part of this article is in the distribution network planning because estimating the reliability of the distribution network can predict the unplugged distribution system based on the system topology and the reliability of the network equipment. Distributed products have been able to increase the reliability of the system by their presence. In this paper, they tried to optimize the optimal repair time and the rate of failure of each part of the network by using an artificial bee colony algorithm. For this purpose, SAIDI, SAIFI, and AENS indicators have been used (Murthy et.al, 2012).

Pavani (2013) has evaluated a method for rearranging the distribution network with the presence of dispersed products in order to reduce losses and improve network reliability. Firstly, it is based on the geographical constraints of the network and on the end buses of the keys to perform the rearrangement. Their final location is then specified by the algorithm which has been specified in the article along with the location of the installation of distributed generation and their size. At first, all keys are open and still, the DG is not installed. The reliability of the system at load points is calculated by the probabilistic model of the network. The findings of the paper are the DG placement for various system loadings and various system configurations and to obtain the best DG location for any system configuration. A search-based algorithm is designed for accomplishing it. For solving the problem of rearrangement with distributed products in order to reduce losses and improve reliability with the priority of supplying all network loads, the problem has been solved in the radial distribution networks 33 and 69, and the answer was acceptable (Pavani and Singh, 2013).

Gupta (2013) has shown the efficiency and effectiveness of genetic algorithm for improving reliability and improving the quality of power when rearrangement technique is applied. Two objective functions in this paper are formulated for the network market to improve the quality of power and increase the reliability of the network. Different goals of power quality and reliability have been considered in the objective function such as power losses, bus voltage profiles, SAIFI, SAIDI, and ENS. This objective function is solved by a genetic algorithm. To illustrate the functionality of the target function, it has implemented it on two different standard networks, and its results are very satisfactory in comparison with other methods. The rearrangement makes the distribution network more flexible in case of an error and also in the normal operating conditions and gives decision-making power to the grid operator for providing different loads (Gupta et.al, 2013).

2. Methodology

This project focuses on determining the optimum points of maneuver and optimal placement of distributed generation resources to determine the candidate points and reducing the search space to accommodate distributed generation resources in the wide distribution networks, and to perform a parallel network rearrangement. Lowering the search space will increase processing speed; it also increases the accurately in distributed networks. The purpose of this research is to reduce losses and improve the voltage profile which improves the utilization of the network. Here, the issue is a nonlinear problem which Genetic Algorithm is used to solve it. This algorithm has a higher convergence accuracy and speed than other intelligent search methods in solving the problem of rearrangement and location of distributed generation resources. Both methods of using distributed generation and network rearrangement can reduce losses, improve network voltage profiles and improve network reliability indices. Now, if these two methods are used simultaneously in the power grid, we will see that the results are much more favorable. Genetic Algorithm has been used in MATLAB software to find optimal points for installing scattered resources. Since the economic problem of the network is also important, the GAMS software has been used to optimize the costs of installing and operating power sources.

3. Simulation and Numerical Results

The first scenario

Here, we indicate information of keys and lines and data about the rate of breakdown of lines for the first scenario (constant load). Table 1 demonstrates the information about the sources of power production used to solve the problem of economic load distribution in the GAMS software. In the cost functions of the production units, the investment is paid for each megawatt of production capacity.

Table 1: Information on power generation sources

Unit Number	P_{max}(MW)	P_{min}(MW)	α	β	γ
1 (Main)	150	30	175	10,7	0,0012
DG 1	5	1	85	2,8	0
DG 2	5	1	38	1,3	0

The simulation was performed using a genetic algorithm and in MATLAB software. Then, this simulation was performed in the Cyme software and the results are compared to verify the relevant information. Table 2 shows the comparison of four network modes in the constant load scenario, which losses are shown in four modes. Also, the optimal installation sites for distributed generation and manning points are shown.

Table 2: Comparison of four network modes

Network Mode	Losses (kW)	ENS (MWh/year	Installation location of DG	Rearrangement Points	The value of the objective function
Basic Mode	370	816	-	-	288.48
Only Rearrangements	353	614	-	(13.6), (14.6) and (7.9)	286.64
Only DG	163	746	keys numbers 16 and 12	-	165.86
Rearrangements & DG	156	597	keys numbers 16 and 12	(13.6), (14.6) and (18.9)	165.24

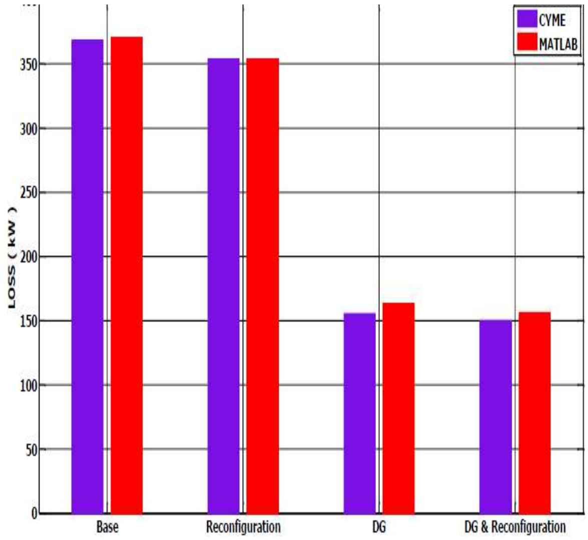

Figure. 1: Comparison of power loss results in MATLAB and CYME for steady load mode

The results in the first scenario represent the very good performance and efficiency of simultaneous use of both dispersed products and points of network maneuvering, in order to reduce losses and improve reliability. Rearrangement has had a better performance than DG in improving the indicator of non-distributed energy. On another hand, the use of DGs in the network serves to improve the voltage profile and reduces network losses, much better than rearrangement. It is obvious that the simultaneous use of dispersed products and rearrangement to improve reliability as well as reducing network losses is far more beneficial than their separate use.

The second scenario

Here, we indicate information of key and lines and data about the rate of breakdown of lines for the first scenario (constant load) just like the first scenario. Table 3 shows the results of the four grid modes, and again, according to the first scenario, the efficiency, and utility of the proposed method are shown to reduce losses and improve reliability as well as improve the network voltage profile. In this scenario, network rearrangement alone was better than using distributed products alone in the network to improve the network energy distribution index. The use of DGs to reduce losses and improve the network voltage has improved better performance in compare to rearrangement. As demonstrated in the first scenario, the simultaneous use of dispersed products and rearrangement to improve reliability as well as reducing network losses is far more beneficial than their separate use.

Table 3: Comparison of the results of four network modes

Network Mode	Losses (kW)	ENS (MWh/year	Installation location of DG	Rearrangement Points	The value of the objective function
Basic Mode	337+390i	1028	-	-	303.2653
Only Rearrangements	332+368i	842	-	(13.6), (14.6) and (18.9)	290.8141
Only DG	131+136i	1023	Keys number 16 and 12	-	215.5544
Rearrangements & DG	118+124i	823	Keys number16 and 12	(13.6), (14.6) and (18.9)	166.1814

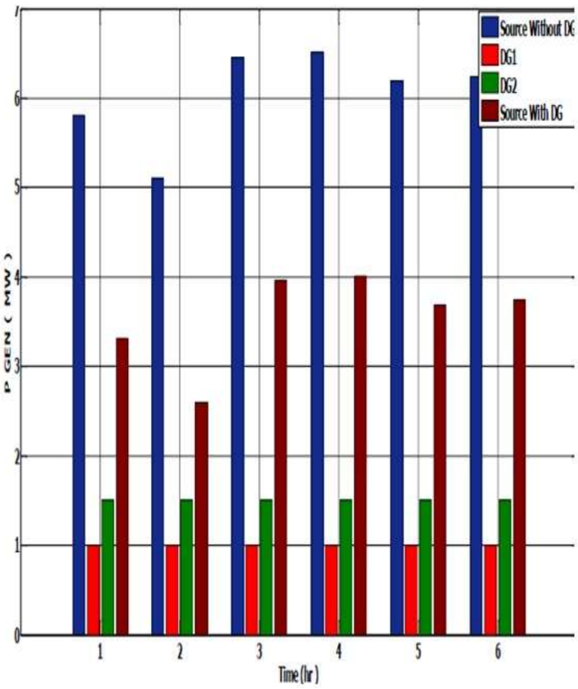

Figure. 2: Primary Trans load before and after installation of distributed generation

Table 4 indicated the numerical results of network reliability evaluations in all four modes.

Table 4: Numerical Results of Network Reliability Indicators

Network Mode	SAIFI	CAIDI	AENS	ASAI	ASUI
Basic Mode	0.202	1.4819	0.2929	0.8858	0.1142
Only Rearrangements	0.202	1.2018	0.2399	0.9039	0.0961
Only DG	0.202	1.0199	0.2915	0.9209	0.0791
Rearrangements & DG	0.202	0.9611	0.2345	0.909	0.091

4. Results of Network Efficiency Coefficients

Table 5 indicates the results of network efficiency coefficients including the coefficient of return on energy sources and the coefficient of return of infrastructure and the total return coefficient of the network. As the results show, the efficiency of energy sources in optimal mode is better than the rest. The efficiency coefficient of power generation resources at the time of the use of scattered production is better than the mode of rearrangement due to the greater impact of distributed generation resources on reducing losses.

Table 5: Results of network efficiency coefficients

Network Mode	η_1	η_2	η	η%
Basic Mode	0.9691	0.6768	0.7441	74.41
Only Rearrangements	0.9694	0.7747	0.751	75.1
Only DG	0.9816	0.4861	0.4772	47.72
Rearrangements & DG	0.9891	0.4805	0.4752	47.52

5. Conclusion and Future Research

The desire to earn more profits will lead to network utilization close to their nominal capacity. In this situation, an error can cause a higher number of disconnects and a higher level of demand for power. Errors led to disconnection in the downside zone of the error due to the radial distribution of the distribution network. Keys are installed in feeders in order to increase the reliability and reduce the amount of energy not sold (ENS) in the distribution network. These keys are open in normal mode and they are called the maneuvers keys. The defective part is isolated from the rest of the network with the aid of the disconnector when an error occurs. Then using the maneuvers' keys, the surplus capacity of the same feeder or another feeder can be used as the supportive network for loads without power. The presence of distributed generation sources (DGs) will seriously alter the process of exploiting the network, especially if blackout time. In the case of power failure in the network, DGs can reduce the amount of power outage, by creating an intense isle.

The aim of this paper is to investigate the optimal positioning and proper DG capacity design along with optimization of maneuver points; in networks of 20 kV power distributions in Golpayegan County. The genetic algorithm is used in MATLAB software to find the optimal points for installing DGs resources, and the GAMS software has been used to optimize the costs of installing and operating power generation sources. The results indicate that the installation of DG in the 7th feeder of Golpayegan has had a significant effect on the loss of tangible reduction and voltage recovery and the process of exploiting the network will be radically transformed, especially in the event of a power failure. According to the chart analysis, maneuvering points have had a greater impact on the improvement of reliability indices in Golpayegan 7th feeder. Different effects of distributed generation sources on the economic and technical conditions of power grids are examined in the reference. The power marketing develops due to the possibility of the presence of distributed generation resources in the electricity markets. But, this has different technical consequences. However, one of the impacts of distributed generation sources on the technical condition of the networks is the impact on network losses; the factor that is used in some cases in decision making. DGs usually provide the required power at a low distance to the load.

Therefore, the effect of the presence of distributed generation resources on distribution networks is positive. According to the changes in power systems and new innovations, especially in the field of power electronics and the high benefits of using DGs, the idea of using distributed generation sources (DGs) is becoming more and more important day by day. Using DG units in the power system, if properly done, leads to increasing the system stability, the system reliability, and also, reduction of losses and reducing the final cost of production. One of the important issues regarding the use of distributed generation resources is the choice of finding an appropriate place to install them in the network. When a fault occurs at any point in the network, the electric power distribution networks are able to provide electricity for the consumers with isolating the fault location, until the fault is eliminated. This will improve the reliability of the network. It reconfigures the network in such a way that the network will have the lowest losses. In networks that do not have the ability to install large power plants to provide load growth over the next few years, it is better to use DGs. It frees up the capacity of lines, and also, the need to establish a new network will be transferred to subsequent years. Where, there is the economic justification for performing both techniques simultaneously, it is recommended to use both techniques simultaneously.

- The role of smart grids in capacity and rearrangement DG power networks
- Smart electricity distribution network protection with DG
- The status of electric vehicles as DG in Smart Networks
- Considering the new network security structure with new generation of intelligent relays in island mode of DGs
- Using storage devices for peaking and creating a smart grid.

References

[1] Mohammadi, M., and Akbari Nasab, M. (2011). DG Placement with Considering Reliability Improvement and Power Loss Reduction with GA Method. Research Journal of Applied Sciences, Engineering and Technology 3.838-842

[2] Sung-Min, C., Shin, H., and Park, J. (2012). Distribution System Reconfiguration Considering Customer and DG Reliability Cost. Journal of Electrical Engineering & Technology Vol. 7, No. 4, pp. 486~492

[3] Rashtchi, V., and Pashai, S. (2012). Network Reconfiguration in Distribution Power System with Distributed Generators for Power Loss Minimization. International Conference on Advances in Computer and Electrical Engineering (ICACEE).

[4] Amanulla, B., Chakrabarti, S., and Singh, S. (2012). Reconfiguration of Power Distribution Systems Considering Reliability and Power Loss.IEEE TRANSACTIONS ON POWER DELIVERY, VOL. 27. NO. 2

[5] Chang, R. F., Chang, Y. and Lu, C. L. (2012). Loss Minimization of Distribution Systems with Electric Vehicles by Network Reconfiguration. International Conference on Control Engineering and Communication Technology.

[6] Murthy, G. V. K., Sivanagarju, S., and Satyanarayan, S. (2012). Reliability Improvement of Radial Distribution System with Distributed Generation. International Journal of Engineering Science and Technology (IJEST).

[7] Pavani, P. Singh, S. N. (2013). Reconfiguration of radial distribution networks with distributed generation for reliability improvement and loss minimization. IEEE Power and Energy society general meeting (PES).

[8] Gupta, N., Swarnkar, A. Niazi, K. R. (2013). Distribution network reconfiguration for power quality and reliability improvement using Genetic Algorithms. Electrical Power and Energy Systems 54

[9] Kavousi-Fard, A. R., Akbari-Zadeh, M. (2012). Reliability enhancement using optimal distribution feeder reconfiguration. Neuron-computing journal 106

[10] Bernardon, D. P., Mello, A. P. P., Fitscher, L. L., Canha, L. N., Abaide, A. R. Ferreira, A. A. B. (2013). Real-time reconfiguration of distribution network with distributed generation. Electric Power Systems Research 107.

[11] Pavani, P., Singh, S. N. (2013). Reconfiguration of radial distribution networks with distributed generation for reliability improvement and loss minimization, 978-1- 4799-1303