International Journal of Engineering and Information Systems (IJEAIS)
ISSN: 2643-640X
Vol. 5 Issue 2, February - 2021, Pages: 157-159

Improvement Performance Of Radial Distribution System By Optimal Placement Of Photovoltaic Array

Jalilov Urinboy[1], Hasanov Mansur[2]

[1,2]Faculty of Power engineering and Radio electronics, Jizzakh Polytechnic Institute, Jizzakh city, Uzbekistan
mansur_hasanov@mail.ru

Abstract— *This article presents the performance improvement of a Radial Distribution System (RDS) by optimally placing a photovoltaic (PV) array using a Differential Evolution (DE) algorithm. This article aims to reduce real power losses, improve the voltage profile (VP). The result showed that the optimal placement of the photovoltaic array is more efficient. The test system reviewed here is a standard 33 bus system. The proposed approach was implemented in the MATLAB software*.

Keywords— photovoltaic array; differential evolution algorithm; radial distribution system

1. INTRODUCTION

Electricity produced at a generating station is delivered to consumers through a network of transmission and distribution systems. It is often grim to draw a line between transmission and distribution systems in a large power grid. The main function of the electricity distribution system is to provide electricity to individual consumer premises. The distribution of electricity to different consumers is ensured at a much lower voltage level. The distribution of electricity to all consumers is carried out through distribution networks. Distribution systems have faced many challenges over the past few decades. There are two main sources of losses in power distribution systems. These are transformers and power lines. In the distribution system, the transmission lines connecting the substation to the loads are one of the major sources of transmission line losses. Almost all of the real power that is lost in the distribution system is due to copper losses [1-3].

PV produces energy when exposed to sunlight, and several other components are needed to properly conduct, control, convert, distribute and store the energy produced by the array. In restructured power systems, the use of distributed generation energy resources, including photovoltaic (PV), fuel cells, small wind turbines, etc. The advantage of distributed generation energy resources includes reducing power losses, improving VP, and increasing network reliability. To achieve the advantages of DG units, the choice of the optimal location and capacity becomes a major problem [3-5].

2. PROBLEM FORMULATION

Objective function

The objective of this article is to reduce the actual power loss and improve the RDS voltage [1].

Real power loss

The first term of the objective function is the real power loss, which is determined by equation (1)

$$P_{LOSS} = \sum_{j=1}^{n_f} \sum_{k=1}^{n_s} R_k \,|{I_k}^2| \tag{1}$$

where,

I_k − Is the current passing through line *k*

n_f − Is the total number of branches

n_s − Total number of sections in the system

R_k −Resistance of the line section between buses *k* and *k* + 1

Voltage Profile improvement

The second goal of this work is to improve the voltage profile (VP), which is represented by the VP index in equation (2).

$$VP = \sum_{j=1}^{n_f} \sum_{k \in lb} |\, V_k - V_{ref,k}| \tag{2}$$

where,

$lb -$ Collection of the load buses

$V_{ref,k} -$ Nominal voltage at load bus k.

$V_k -$ Voltage amplitude at bus k.

3. DIFFERENTIAL EVOLUTION ALGORITHM (DEA)

Differential Evolution Algorithm (DEA) is a robust and versatile function optimizer that is easy to use and delivers results in a very short period [6]. It is a simple and extremely powerful method of evolutionary computation that solves real-life problems based on the principles of natural evolution. The optimization process is carried out using three main operations: mutation, crossover, and selection. Once in every generation, each vector of parameters of the current population becomes a target vector or a parent vector. For each target vector, the mutation operation creates a new parameter vector, called the mutant vector, by adding the weighted difference between two randomly selected vectors to a third (also randomly selected) vector. The crossover operation generates a new vector, a test vector, by mixing the parameters of the mutant vector with the parameters of the target vector. If the trial vector has a better fitness value than the target vector, then the trial vector replaces the target vector in the next generation. Thus, after each generation, a new modified set is created, and this continues until the iteration is completed or a globally optimal solution is obtained. The flow chart of DEA is shown in Fig.1.

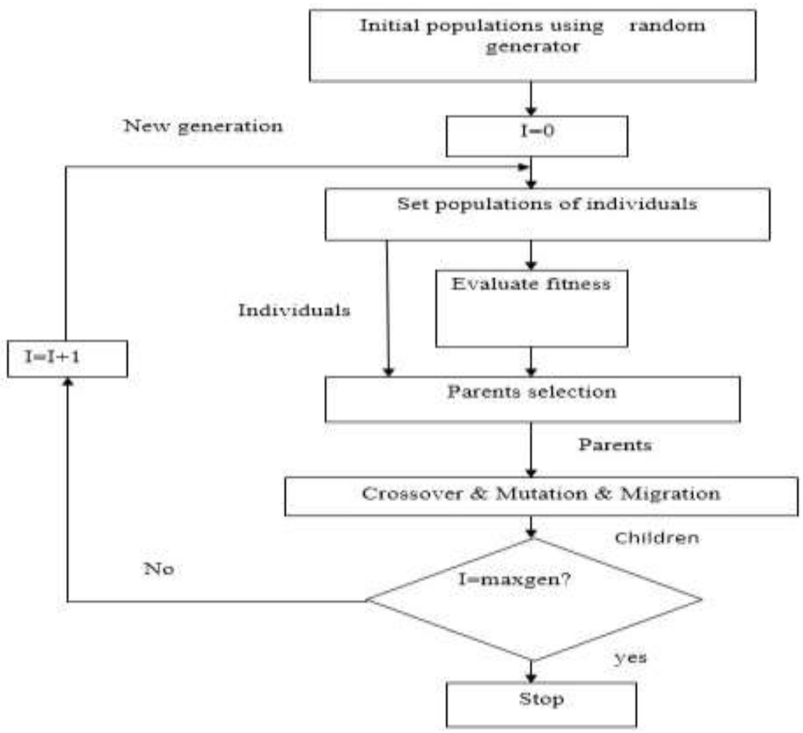

Fig. 1. Flow chart for DEA

4. SIMULATION AND RESULTS

Based on the proposed methodology, a program was written in MATLAB software. To evaluate the effectiveness of the proposed approach, the program was applied to test systems at nominal load. The test system is a standard 33-bus RDS with a total load of 3.7 MW and 2.3 MVar as shown in Fig.2. The power flow is performed using S_{base} = 100MVA and V_{base} = 12.66 kV [3].

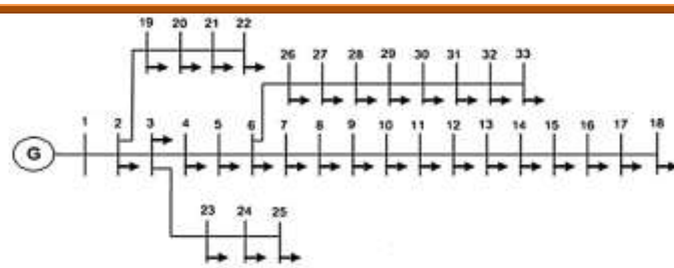

Fig.2. The standard 33-bus distribution system

In this paper, the power flow is analyzed using the reverse / forward sweep algorithm in the base case. Without PV array allocation and with optimal PV array allocation. The observed results are presented in Table 1. It can be seen from the results that the power losses in the base case are 210.986 kW. The VP index is calculated as 0.90378 pu.

Table 1: The observed results

PV- location	PV- size	Power loss	Voltage profile (minimum voltage at the bus)
6	2590.19 kW	111.017	0.95836 pu /18 bus

5. Conclusion

The proposed approach is used to reduce power losses and improve VP in the radial distribution system. To test the effectiveness of the proposed approach was tested on a test system with a standard 33 bus system. For the 33-bus system, the loss reduction is 53% improved and the VP performance is improved over the base system.

References

[1] M. M. Aman, G. B. Jasmon, A. H. A. Bakar, H. Mokhlis, “A new approach for optimum simultaneous multi-DG distributed generation Units placement and sizing based on maximization of system loadability using HPSO (hybrid particle swarm optimization) algorithm”, Energy, vol. 66, pp. 202-215, 2014.

[2] M. Khasanov, S. Kamel, M. Tostado-Véliz, and F. Jurado, "Allocation of Photovoltaic and Wind Turbine Based DG Units Using Artificial Ecosystem-based Optimization," in 2020 IEEE International Conference on Environment and Electrical Engineering and 2020 IEEE Industrial and Commercial Power Systems Europe (EEEIC/I&CPS Europe), 2020, pp. 1-5: IEEE.

[3] M. Mashhour, M. A. Golkar and S. M. M. Tafreshi, “Optimal sizing and siting of distributed generation in radial distribution network: Comparison of unidirectional and bidirectional power flow scenario”, IEEE Bucharest Power Tech, Bucharest, pp. 1-8, June 28th - July 2nd 2009.

[4] M. Khasanov, S. Kamel, K. Xie, P. Zhou and B. Li, "Allocation of Distributed Generation in Radial Distribution Networks Using an Efficient Hybrid Optimization Algorithm," 2019 IEEE Innovative Smart Grid Technologies - Asia (ISGT Asia), Chengdu, China, 2019, pp. 1300-1305.

[5] M. H. Moradi, M. Abedin, “A combination of genetic algorithm and particle swarm optimization for optimal DG location and sizing in distribution systems”, Electrical Power and Energy Systems, vol. 34, pp. 66–74, 2012.

[6] K. Price and R. Storn, “Differential evolution: a simple Evolution strategy for fast optimization,” Dr. Dobb’s Journal. vol. 264, pp. 18-24, April 1997.