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Evolutionary Computing Techniques for Distributed Generation: Survey

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Abstract— Distributed Generation (DG) refers to the production of electricity from various small-scale energy sources situated near the consumer, rather than centralized power plants. In recent years, there has been a significant focus on integrating DG units into distribution systems. The primary goals of using DG are to enhance the voltage profile, improve voltage stability, and reduce power losses. DG aims to decrease system losses, optimize voltage levels, and increase voltage stability within a power network. Various optimization techniques based on evolutionary computing, such as Genetic Algorithms (GA), Artificial Bee Colony (ABC), Particle Swarm Optimization (PSO), and Differential Evolution (DE), have been proposed to address the DG optimization problem. These methods are applied to solve the problem as both single-objective and multi-objective optimization tasks. An overview of the studies and advancements in the subject of distributed generation is provided in this publication, reviewing studies that utilize evolutionary computing techniques. It also discusses the types of DG; the technologies employed, and related concepts.

Keywords— ***Distributed generation (DG); types and technology; Single objective optimization problem (SOOP) and Multi objective optimization problem (MOOP)***

INTRODUCTION

Distributed Generation (DG) is defined as 'generation plants connected to the distribution system'. In the same Directive, the distribution is defined as 'the transport of electricity on high-voltage, medium voltage and low voltage distribution systems with a view to its delivery to customers, but not including supply' [1]. Different classifications are utilized at the national level. An overview of the main definitions in use worldwide is shown below:

1.The Institute of Electrical and Electronics Engineers Inc. (IEEE) defines the DG as generation of electricity by facilities sufficiently smaller than central plants, usually 10 MW or less, so as to allow interconnection at nearly any point in the power system [2].

2.The International Energy Agency (IEA) defines DG as generating plant serving a customer onsite or providing support to a distribution system, connected to the grid at distribution-level voltages [3].

3.DG, according to the US Department of Energy (DOE), is modular electric generation or storage that is situated close to the point of use. The DOE considers distributed power systems to typically range from less than a kilowatt (kW) to 10 MW in size as DG unit [4].

4.The Electric Power Research Institute (EPRI) treats small generation units from a few kW up to 50 MW and/or energy storage devices typically sited near customer loads or distribution and sub-transmission substations as distributed energy resources [5].

In addition, in regards to the rating of distributed generation power units, the following dissimilar definitions are currently used: The Electric Power Research Institute defines distributed generation as generation from 'a few kilowatts up to 50 MW' [6]. As per the Gas Research Institute, distributed generation is 'typically [between] 25 and 25 MW' [7]. Preston and Rastler define the size as 'ranging from a few kilowatts to over 100 MW' [8]. Cardell defines distributed generation as generation 'between 500 KW and 1 MW' [9] and the International Conference on Large High Voltage Electric Systems (CIGRE´) defines DG as 'smaller than 50 –100 MW' [10].

1. DISTRIBUTED GENERATION

Decentralized generation, dispersed generation, embedded generation, onsite generation, distributed energ, and Re distributed energy are some of the names used to describe distributed generation (DG).It entails producing power u sing a variety of small-scale energy sources. While most countries produce electricity in large centralized facilities, such as fossil fuel, nuclear, hydropower plants, or other large-scale plants, DG offers an alternative [11]. The classification of DG [12], based on their ratings, can be categorized as micro, small, medium, or large, as shown in Fig. 1.

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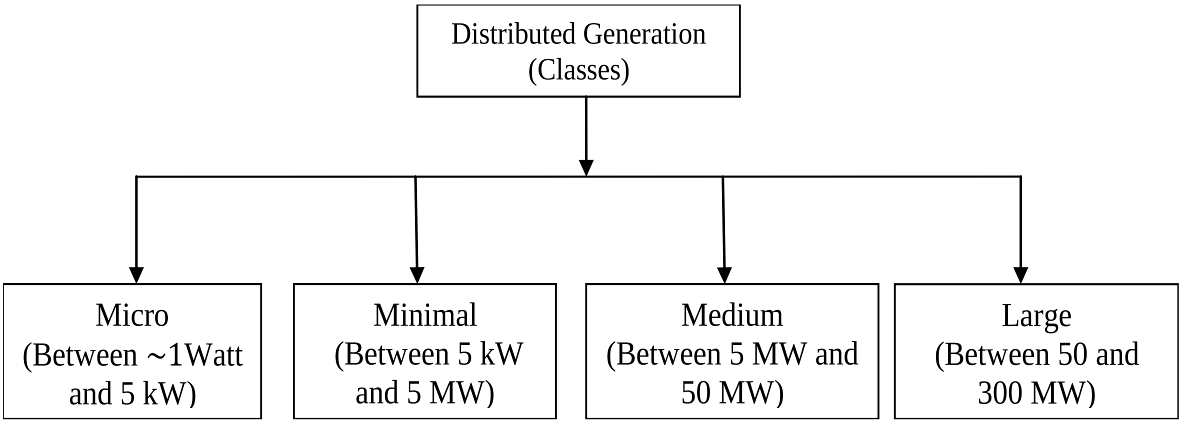

Figure.1. Distributed Generation classes

The following is a condensed summary of the main topological categories of the electric system, as seen in Figure 2, to give some context for distributed generations. The first is generation, which creates electricity using energy of some kind. Transmission is the next step, which distributes high-voltage power from the massive generators to the rest of the system. Next is distribution, which provides the customer with electricity and is linked to transmission. The electric load or demand is another term for the quantity of electricity that the customer needs. To satisfy electric demand the electricity must be produced by the generators and delivered to the load when it is needed [13].

To help explain what DG is, below is a brief summary of the primary topological kinds in the electric system, as depicted in Figure 2. The first is generation, which is the process of using energy of some kind to produce electricity. The next step is transmission, which transfers high-voltage energy from enormous generators to the wider system. Next is the distribution system, which supplies electricity to consumers and is connected to the transmission network.

The amount of electricity that customers require is known as the electrical load or demand. The electric load or demand is the quantity of electricity that users need. In order to meet this demand, electricity must be generated by power plants and supplied to the load when needed [13].

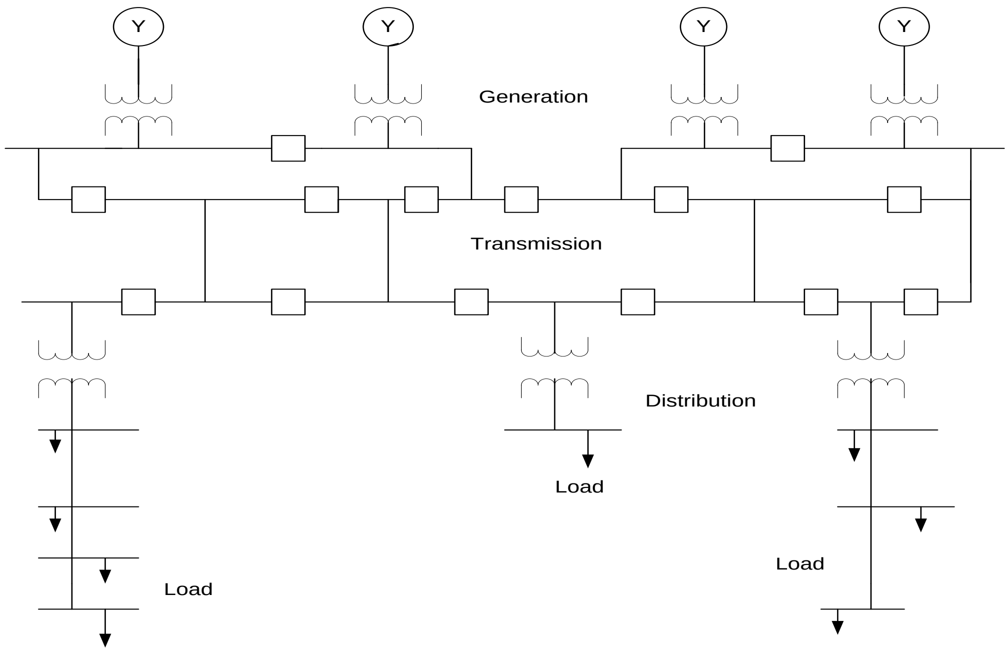

Figure: 2 Diagram of Electric network layout diagram

Large units (usually hundreds of MWs) connected to the transmission network produce the majority of the system's electricity. Distributed generation (DG) is the idea of integrating several small generation sources dispersed across

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the distribution system. If energy storage devices are included with DG it has been known as dispersed storage and generation (DSG) [13].

2. TYPES AND TECHNOLOGIES OF DISTRIBUTED GENERATION

There are different types of DGs from the constructional and technological points of view as shown in Fig.3 [14]. DGs can be broadly classified into two categories: conventional and non-conventional generators.

2.1 Traditional Generator

A more modern kind of combustion turbine, micro turbines are constructed to produce energy and heat on a small scale. They provide a clean and efficient solution for direct mechanical drive markets, such as compression and air-conditioning [15]. Micro turbines typically have outputs ranging from 25 kW to 500 kW and were developed from automotive and truck turbochargers, as well as auxiliary power units (APUs) for small jet engines and airplanes [15].

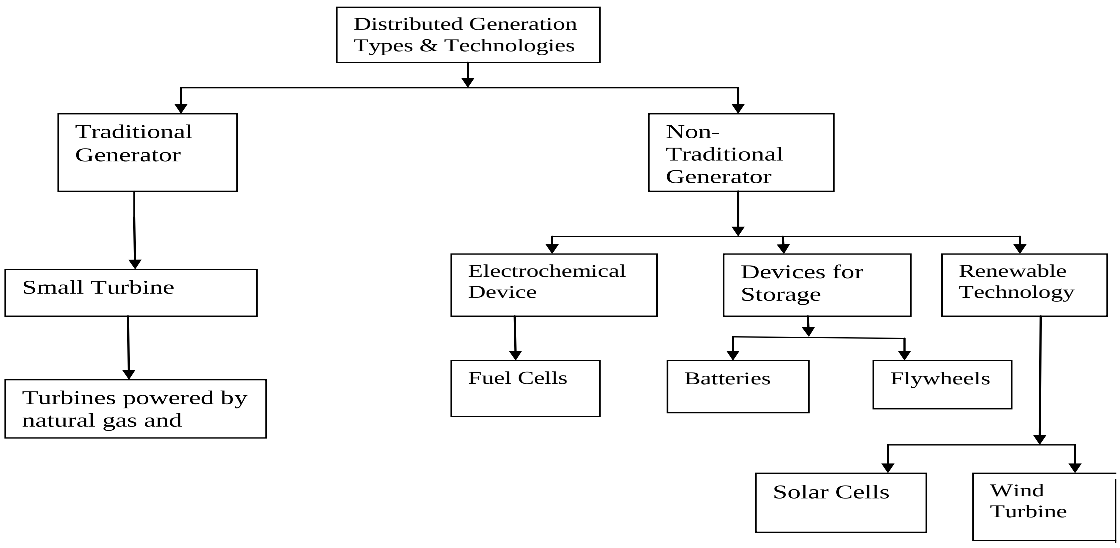

Figure.3. Distributed generation types and technologies

Gas turbines generate high-pressure gas and high temperatures. The turbine shaft rotates with the aid of this high pressure, which in turn drives a compressor, an electric alternator, and a generator. Gas turbines are typically used for capacities above 1 MW, but nowadays, electricity can also be generated using small modular systems, such as a micro-gas turbine with a capacity of 200 kW [16].

2.2 Non- Traditional Generators

Electrochemical devices, storage devices, and renewable devices are examples of non-traditional generators.

2.2.1 Electrochemical Devices

The fuel cell (FC) is a device that uses electrochemical processes to convert chemical energy into thermal energy and electric power. As long as its fuels are available, it can be used as a battery to generate electricity. Unlike fuel cell, batteries do not need to be charged for the consumed materials during the electrochemical process since these materials are continuously supplied [17]. For both stationary and portable systems, FC capabilities range from kW to MW. It provides clean power and heat for several applications by using gaseous and liquid fuels [18]. FCs can use a variety of hydrogen-rich fuels such as natural gas, gasoline, biogas or propane [19].

2.2.2 Devices for Storage

Flywheels, batteries, and other components make up storage devices, which are used when needed and charged during periods of low load demand. To provide the necessary peak load demand, they are typically coupled with

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other DG types [20]. These batteries feature a charging controller that cuts off the charging process when the batteries are fully charged, protecting against overcharge and over discharge.

2.2.3 Renewable Technology

Photovoltaic (PV) systems and wind turbines are two examples of renewable equipment that are frequently utilized for distributed generation (DG). Using semiconductors, photovoltaic (PV) technology transforms solar energy into direct current electricity to provide electricity. Sun panels composed of several sun cells containing photovoltaic materials are used in PV power generation. The following materials are frequently found in PV panels: polycrystalline silicon, cadmium telluride, copper indium gallium selenide/sulfide, amorphous silicon, and mono-crystalline silicon. Depending on its size, each solar cell normally produces 2–4A with an output voltage of 0.5V. These cells create an array when connected in series, which normally supplies 12V to charge batteries. PV systems are modular, allowing them to be connected to offer varying power ranges, though they come with limitations. PV systems generally provide low output power, land costs can be expensive where the systems are installed, and their efficiency is constrained by weather conditions and geographic features [21].

The nacelle, a capsule-shaped structure that houses instruments, including the generator that transforms the mechanical energy from the rotating rotor into electricity, a tower to mount the wind turbine, and a rotor with wind-driven blades constitutes modern wind energy systems. The rotor blades must be both strong and lightweight to ensure aerodynamic efficiency and durability in high winds. The wind turbines rotor captures kinetic energy from the wind to generate electricity. The advantages of wind turbines include the absence of greenhouse gas emissions and other pollutants, their suitability for energy generation in remote areas, lower land requirements compared to power stations, and the fact that no fossil fuels are used in the energy production process.

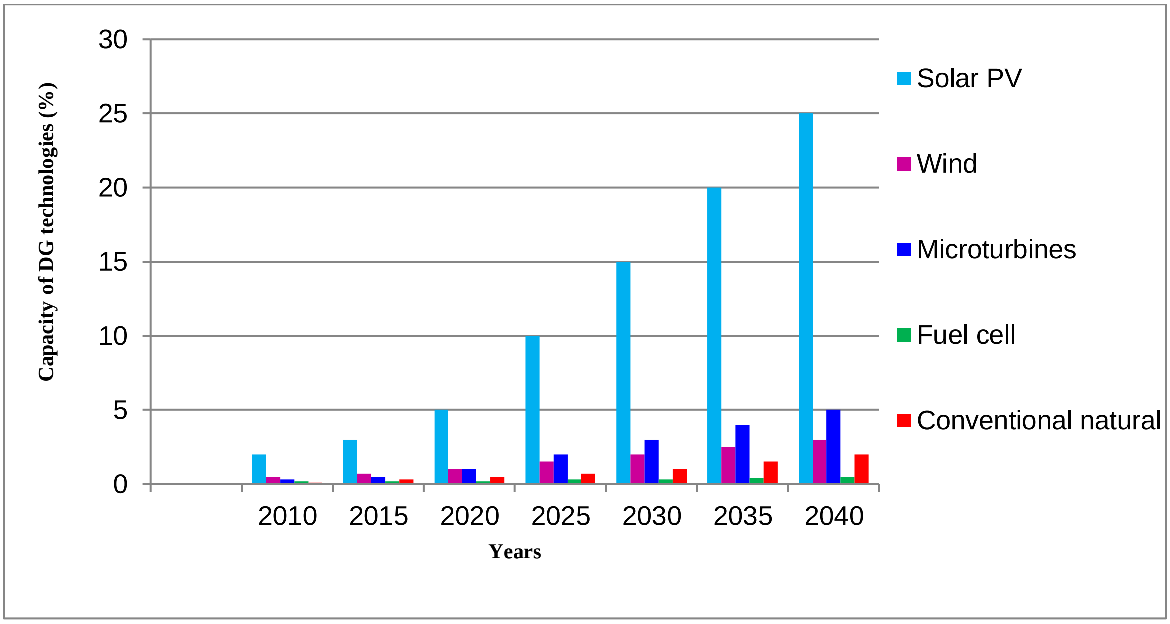

Figure.4. shows the capacity of DG technologies in years [22].

Combined Heat and Power (CHP) is a form of Distributed Generation (DG) that uses waste heat from on-site generation for water and space heating, among other uses. Both the business and industrial sectors frequently use these technologies. The Energy Information Administration's (EIA) modeling of DG and CHP in the residential and commercial sectors is illustrated in the following data. There are two types of DG: residential and non-residential. All non-residential, non-CHP installations are categorized as belonging to the business sector for modeling purposes. DG in buildings includes both conventional and non-conventional energy generators, as described in Table 1 [22].

Table1. Technologies for distributed generation that is sector-specific

	Domestic	Industrial
	Solar	Solar photovoltaic

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Traditional Generator	photovoltaic	
	Wind	Wind
		Hydroelectric
		Wood
		Solid waste from towns and cities
Non-Traditional Generator	Fuel cells powered by natural gas	Fuel cells powered by natural gas
		reciprocating engines powered by natural gas
		Turbines powered by natural gas
		Micro-turbines powered by natural gas
		Diesel reciprocating engines
		Coal

3. DG AS A SINGLE OBJECTIVE OPTIMIZATION PROBLEM

To address the DG placement problem as a single-objective optimization issue, researchers have focused on one of the following objectives: minimizing losses, improving the voltage profile, or enhancing voltage stability.

3.1 LOSS MINIMIZATION

Kashem et.al[23], proposed an efficient technique was used to determined the switching combinations, select the status of the switches, and find the best combination of switches for minimum loss. In the first stage of the proposed algorithm, The optimal switching combination was identified after a small number of switching combinations were produced. In order to find another switching combination that would produce a lower loss than the loss found in the first stage, a thorough search was conducted in the second stage. Test findings on a 33-bus system showed that the suggested approach may identify the best switching alternatives for an ideal (or nearly optimal) configuration with less calculation. A comparative research was presented, comparing the results with those of previously reported established procedures.

In a reasonable amount of computer time, the suggested method may automatically determine the best switching configuration for any input load situation of the system, making it suitable for continual reconfiguration to minimize losses. The technique might also be used to locate tie switches, provide the fewest number of sectionalizing switches in the branches, and plan and build power systems prior to the actual deployment of distribution networks, all of which would lower installation and switching costs.

Moradi et.al [24], were proposed a Genetic Algorithms (GA) for solving optimal multi-distributed generation location and capacity. Reducing actual power loss while adhering to operational and security restrictions was the primary goal. Photovoltaic, synchronous condenser, wind turbine, and hydro power are the four types of distributed generation (DG) that were taken into consideration: distributed real power sources only, distributed real and reactive power sources, DG supplying real power and consuming reactive power, and DG supplying both real and reactive power. To show how successful the suggested algorithm is, a thorough performance analysis of the 33-bus system was conducted.

VOLTAGE PROFILE IMPROVEMENT

Vatankhah et.al [25] determined optimum size and location of distributed generators for maximizing voltage profile in distribution systems. For this purpose, It was suggested to use the Particle Swarm Optimization (PSO) technique. The application of novel coding in PSO, which took into account the active and reactive capabilities of DGs to increase voltage profile enhancement, was a significant advance in this study. In addition, four sets of weighting variables were chosen in accordance with the significance and criticality of the various loads. The 33-bus distribution system was used to test the suggested method's efficacy.

Ela et.al [26], proposed an optimal proposed approach (OPA) to establish the optimal sitting and sizing of DG with multi-system constraints to achieved a single or multi-objectives by genetic algorithm (GA). In addition to verifying the optimization outcomes produced by GA, linear programming (LP) was utilized to investigate the effects of different DG ratings and locations on the goal functions. The OPA's capabilities were tested on an actual segment of the West Delta sub-transmission network, which is a component of the Egypt network. The findings

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demonstrated that enhancing the voltage profile, raising the spinning reserve, decreasing power flows in essential lines, and minimizing system power losses all depended on the appropriate placement and sizing of DG.

VOLTAGE STABILITY IMPROVEMENT

Aman et.al [27], proposed an algorithm for Distributed Generator placement and sizing for distribution systems based on a novel index. Stable node voltages were taken into consideration when creating the index, which is known as the power stability index (PSI). To visualize the effect of DG on system losses, voltage profile, and voltage stability, an analytical method was used. 12-bus, modified 12-bus, and 69-bus radial distribution networks were used to test the suggested algorithm. After comparison, it was discovered that the test results closely matched those of the Golden Section Search (GSS) algorithm.

Arya et.al [28], described a viewpoint for voltage stability measurement accounting uncertainties in line parameters and settings of reactive power control variables. The odds of voltage breakdown under different operating situations were estimated using Monte-Carlo simulation. The continuous power flow algorithm was used to determine static voltage stability limits for a range of sampled values of system characteristics and control variables. A radial basis function (RBF) network was used to calculate the probabilistic risk of voltage collapse because Monte-Carlo simulation was time-consuming. Monte-Carlo simulation was used to create training and testing examples. Two common test systems were used to implement the developed algorithm.

4. MULTI-OBJECTIVE FUNCTION

To solve the optimization problem of DG as the multi-objective function such as, reduce the power losses, improved voltage profile, voltage stability, reliability and power quality by the researchers as follows;

Renan et.al [29],proposed a multi-objective approach to a distribution network planning process that deals with the challenges derived from the integration of DG. A multi-objective description of the popular Evolutionary Particle Swarm Optimization method (MEPSO) was the application's main component. Using two distribution networks in a specific DG penetration state, a comprehensive performance comparison was conducted between MEPSO and two alternative multi-objective optimization (MOO) metaheuristics: the Multi-objective

Tabu Search (MOTS) and the Non-dominated Sorting Genetic Algorithm II (NSGA-II). When compared to the other approaches, the MEPSO algorithm shown promising qualities and continuously maintained a high level of performance, even though all three approaches were useful in distribution system planning. All three approaches were shown to be useful for planning distribution systems, but the MEPSO algorithm stood out for its consistently high performance and promising features.

Ganguly et.al [30], presented a multi-objective planning approach for electrical distribution systems under uncertainty in load demand incorporated distributed generation. Radial and meshed systems both were considered. Both radial and meshed systems were considered. The two goals of system planning were to reduce the risk factor and the overall installation and operating expenses. The risk factor was created as a function of the degree of network constraint violations and the contingency load-loss index (CLLI), which measured load loss under contingencies. By minimizing CLLI, network dependability was enhanced. The number of feeders and their routes, the number and placement of sectionalizing switches, and the type of network topology (radial or mesh) were among the network factors that were optimized. To effectively identify non-dominated solutions, a multi-objective particle swarm optimization (MOPSO) variation was utilized, which uses heuristic selection and assignment of leaders or guides.

Kayal et.al [31], proposed a constrained multi-objective Particle Swarm Optimization (PSO) based Wind Turbine Generation Unit (WTGU) and photovoltaic (PV) array placement approach for power loss reduction and voltage stability enhancement of radial distribution system. The formulation of the DG placement problem demonstrated the efficacy of the WTGU and PV array performance models. Wind and solar-powered DGs were evaluated on 12-bus, 15-bus, 33-bus, and 69-bus radial distribution systems while operating in various active and reactive power modes. It was suggested to utilize a Voltage Stability Factor (VSF) to gauge the system's buses' voltage stability levels.

Moradi et.al [32], were proposed a combined genetic algorithm (GA)/particle swarm optimization (PSO) for optimal location and sizing of DG on distribution systems. The objective was defined as the minimization of network power losses, the strengthening of voltage stability and regulation in radial distribution systems while keeping in mind security and operational constraints. 33- and 69-bus systems were subjected to a thorough performance investigation in order to show how successful the suggested algorithm is.

Taghikhani et.al [33], studied indicates that placing and application of DGs by modified shuffled frog leaping algorithm (MSFLA) would be reduced losses and improved voltage profile of power systems. Analysis was done on the Line Loss Reduction Index (LLRI) and the Voltage Profile Improvement Index (VPII). MATLAB software was used to simulate the MSFLA on the IEEE-70 bus radial distribution system. The tested results indicated that better results were obtained with the MSFLA method compared to the SFLA method on the 70-bus radial distribution system."

Rao et.al [34], proposed a method which applied an artificial bee colony algorithm (ABC) for capacitor placement in distribution systems with an objective of improving the voltage profile and reduction of power loss. The clever foraging behavior of a swarm of honeybees served as the inspiration for the ABC algorithm, a novel population-based metaheuristic technique. It was observed that the ABC method had the advantage of not requiring external parameters, including crossover rate and mutation rate, which were difficult to determine in advance for GA and differential evolution. An additional benefit was that the algorithm's neighborhood source production mechanism, which resembled a mutation process, was used to implement its global search capability. Computer simulations on a 69-bus system were used to validate the suggested methodology, and the outcomes were contrasted with those of other methods found in the literature. It was found that the suggested approach performed better than the others in terms of computing efficiency and solution quality.

Musa et.al [35], proposed an enhanced particle swarm optimization (PSO) algorithm for Distributed Generation placement and sizing using multi-objective optimization concept. The approach was founded on the integration of PSO with Evolutionary Programming (EP). Faster convergence and increased DG size accuracy were attained by combining the advantages of EP and PSO. By examining the less congested region of the current solution space to provide more non-dominated solutions, the quality of the solution was improved. The standard IEEE 33-bus test system was used to evaluate the suggested methodology. The findings showed that the suggested algorithm may solve the multi-objective DG sizing problem with well-distributed Pareto-optimal non-dominated solutions.

CONCLUSION

This paper provides a concise overview of research conducted by various scholars on the optimal placement and sizing of Distributed Generations (DGs). Different researchers have approached this problem using diverse objectives and optimization techniques, treating it either as a single-objective or multi-objective optimization problem. Common objectives, such as minimizing losses, improving voltage stability, and enhancing the voltage profile, have been considered in addressing the DG placement challenge. Methods based on sensitivity analysis and evolutionary computing techniques have been discussed in the literature for solving this issue. While sensitivity-based methods are precise and quick, they tend to be complex in nature. In contrast, evolutionary computing techniques, which have been recently developed, are simpler and more practical to implement.

References

[1] Directive 2003/54/EC of the European Parliament and of the Council of 26 June 2003 concerning common rules for the internal market in electricity and repealing Directive 96/92/EC, Official Journal of the European Union No. L 176, 15.07.2003 P. 0037-0055.

[2] Institute of Electrical and Electronics Engineers (IEEE) 1547 Work Group, P1547 standard series for interconnecting distributed resources with electric power systems, IEEE Standard, 2003.

[3] Conseil International des Grands Réseaux Electrique (CIGRE) WG 37-23, Impact of increasing contribution of dispersed generation on the power system, Final Report, 2003.

[4] U.S. Department of Energy (DOE), Distributed Energy Program. Website: http://www.eere.energy.gov/de/

[5] The Electric Power Research Institute (EPRI). Website: www.epri.com

[6] D. Sharma, R. Bartels, Distributed electricity generation in competitive energy markets: a case study in Australia, in: The Energy Journal Special issue: Distributed Resources: Toward a New Paradigm of the Electricity Business, The International Association for Energy Economics, Clevland, Ohio, USA, pp. 17–40,1998.

[7] See Electric Power Research Institute web-page Jan.1998: http://www.epri.com/gg/newgen/disgen/index.html.

[8] Gas Research Institute, Distributed Power Generation: A Strategy for a Competitive Energy Industry, Gas Research Institute, Chicago, USA 1998.

[9] J. Cardell, R. Tabors, Operation and control in a competitive market: distributed generation in a restructured industry, in: The Energy Journal Special Issue: Distributed Resources: Toward a New Paradigm of the Electricity Business, The International Association for Energy Economics, Clevland, Ohio, USA, pp. 111–135, 1998.

[10] CIGRE, Impact of increasing contribution of dispersed generation on the power system; CIGRE Study Committee no 37, Final Report, Sept. 1998.

Published online on: December 2024
Corresponding Author’s E-mail ID:soet_alka@vikrantuniversity.ac.in

[11] Alka Yadav, and Laxmi Srivastava, "Optimal Placement of Distributed Generation: An Overview and Key Issues", Proceedings of International Conference on Power, Signals, Controls and Computation (EPSCICON), Jan. 2014.
[12] Thomas, A. Göran, S. Lennart, "Distributed generation: a definition", Electric Power System Research, Vol. 57, pp. 195-204, Dec 2001.
[13] Paul Robinson "Analysis of Distributed Resources potential impacts on Electric system Efficacy" Dec. 2009.
[14] W. El-Khatan and Salama MMA, "Distributed generation technologies, definitions and benefits," Electrical Power System Research, Vol. 71, pp. 119–128, Jan. 2004.
[15] Sibasish Patnaik and Ankur Sachdev, "Design and Development of Micro Turbine" Graduation dissertation, Department of Mechanical Engineering National Institute of Technology Rourkela 2009.
[16] M. Suter, "Active filter for a microturbine", in: Proceedings of the Telecommunications Energy Conference, INTELEC 2001, Twenty-Third International, pp. 162–165, Jan. 2001.
[17] M.W. Ellis, M.R. Von Spakovsky, D.J. Nelson, "Fuel cell systems: efficient, flexible energy conversion for the 21st century", in: Proceedings of the IEEE, Vol. 89, pp. 1808–1818, Dec. 2001.
[18] M. Farooque, H.C. Maru, "Fuel cells the clean and efficient power generators", in: Proceedings of the IEEE, Vol. 89, pp. 1819–1829, Dec. 2001.
[19] Wm. L. Hughes, "Comments on the hydrogen fuel cell as a competitive energy source", in: Proceedings of the Power Engineering Society Summer Meeting IEEE, Vol. 1, pp. 726–730, July 2001.
[20] B. Lasseter, Microgrids, "distributed power generation", in: Proceedings of the Power Engineering Society Winter Meeting IEEE, Vol. 1, pp. 146–149, 2001.
[21] J.L. Del Monaco, "The role of distributed generation in the critical electric power infrastructure", in: Proceedings of the Power Engineering Society Winter Meeting IEEE, Vol. 1, pp. 144–145, Feb. 2001.
[22] Modeling distributed generation in the buildings sectors, Supplement to the Annual Energy Outlook 2013, Release date: Aug. 29,2013, Website: www.eia.gov/forecasts/aeo/nems/2013/buildings/
[23] M. A. Kashem, V. Ganapathy, G. B. Jasmon, M. I. Buhari, "A Novel Method for Loss Minimization in Distribution Networks", Electric Utility Deregulation and Restructuring and Power Technologies, 2000. Proceedings. DRPT 2000, pp. 251 - 256.
[24] M.H.Moradi, M.Abedinie, H. bagheri tolabi, "Optimal Multi-Distributed Generation Location and Capacity by Genetic Algorithms", IPEC, 2010 Conference Proceedings, pp. 614 - 618 Oct. 2010.
[25] M. Vatankhah, S.M. Hosseini, "PSO Based voltage Profile improvement by optimizing the size and location of DGS", International Journal on "Technical and Physical Problems of Engineering", Vol. 4, Issue 11, pp.135-139, June 2012.
[26] A.A. Abou El-Elaa, S.M. Allama, M.M. Shatlab, "Maximal optimal benefits of distributed generation using genetic algorithms", International Journal of Electric Power Systems Research Vol. 80, Issue 7, pp. 869–877, July 2010.
[27] M.M. Aman, G.B. Jasmon , H. Mokhlis , A.H.A. Bakar, "Optimal placement and sizing of a DG based on a new power stability index and line losses" International Journal of Electrical Power and Energy Systems, Vol. 43, pp. 1296–1304, May 2012.
[28] L.D. Arya , L.S. Titare , D.P. Kothari, "Determination of probabilistic risk of voltage collapse using radial basis function (RBF) network", International Journal of Electric Power Systems Research, Vol. 76, Issues 6–7, pp. 426–434, April 2006.
[29] Renan S. Maciel, Mauro Rosab, Vladimiro Mirandab, Antonio Padilha-Feltrina, "Multi-objective evolutionary particle swarm optimization in the assessment of the impact of distributed generation" International Journal of Electric Power Systems Research, Vol. 89, pp. 100–108, Aug 2012.
[30] S. Ganguly ,N.C.Sahoo ,D.Das, "Multi-objective particle swarm optimization based on fuzzy-Pareto-dominance for possibilistic planning of electrical distribution systems incorporating distributed generation", International Journal of Fuzzy Sets and Systems, Vol. 213, pp. 47–73, Feb 2013,
[31] Partha Kayal, C.K. Chanda, "Placement of wind and solar based DGs in distribution system for power loss minimization and voltage stability improvement", International Journal of Electrical Power & Energy Systems, Vol. 53, pp. 795-809, Dec 2013.
[32] M.H. Moradi, M. Abedini, "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.
[33] M.A.Taghikhani, "DG Allocation and Sizing in Distribution Network Using Modified Shuffled Frog Leaping Algorithm", International Journal of Automation and Power Engineering, pp. 10-18, April 2012.
[34] R. Srinivasa Rao, "Capacitor Placement in Radial Distribution System for Loss Reduction Using Artificial Bee Colony Algorithm", World Academy of Science, Engineering and Technology Vol. 4, pp.222-226, 2010.
[35] H. Musa, S.S. Adamu, "Enhanced PSO Based Multi-Objective Distributed Generation Placement and Sizing for Power Loss Reduction and Voltage Stability Index Improvement", Energytech, 2013 IEEE, pp. 1 – 6, May 2013.

Published online on: December 2024
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