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Impact of Distributed Generations on RDS using Short Circuit and Harmonics Analysis

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Abstract*: This paper presents a new method using Particle Swarm Optimization (PSO) to optimally place Distributed Generators (DG) in distribution networks (DN). The main goals are to reduce harmonics, perform short circuit analysis, assess how DG improves the voltage profile and system reliability, and minimize both active and reactive power losses. The optimization process uses an objective function (OF) for load flow calculations within the distribution network. MATLAB-DIgSILENT simulations were conducted on an IEEE 33 bus DN to evaluate the impact of DG. The study investigates harmonics and short circuits under conditions both with and without DG, showing significant improvements in system performance, such as voltage profile and harmonics, thus confirming the effectiveness of the proposed PSO-based approach.*

This study utilizes PSO techniques to tackle network issues associated with the installation of various types of multiple Distributed Generators (DGs). The comparative analysis of PSO methods, with and without DG, highlights the superior results achieved by the proposed approach. When applied to the IEEE 33 bus system, the suggested method leads to significant reductions in harmonics, improvements in the voltage profile, and notable decreases in both active and reactive power losses.

Keywords: Particle Swarm Optimizer (PSO)**,**Radial Distribution System (RDS), Optimal Power Flow (OPS), Distribution Network (DN), Distributed Generator (DG)

I. INTRODUCTION

Distributed generation is becoming increasingly important due to its potential to enhance the efficiency and reliability of distribution systems [1]Prakash and Khatod (2016) Published in order to improve the efficiency, dependability, and stability of power distribution networks, the review highlights the significance of appropriate DG installation and sizing.[2.]Montoya, Gil-González, and Grisales-Noreña (2020) The study demonstrated the model's capability to find exact solutions that improve network performance by reducing power losses and enhancing voltage profiles[3]. Galiveeti, Goswami, and Choudhury (2018) investigated the combined impact of PEVs and DG on the reliability of distribution systems. The results indicated that strategic DG deployment can mitigate the adverse effects of PEVs on system reliability, highlighting the need for coordinated planning[4]. Grisales and Restrepo Cuestas (2017) The review highlighted the significant role of DG in enhancing the operational efficiency and reliability of distribution networks [5]. Din et al. (2019) Their research focused on integrating advanced computational methods with physical infrastructure to optimize DG deployment [6]. Ullah, Wang, and Radosavljević (2019) The study demonstrated that PPSO could effectively determine optimal DG locations and sizes, resulting in significant improvements in network performance [7]. Essallah, Khedher, and Bouallegue (2019) explored the integration of DG into electrical grids, focusing on optimal placement and sizing under varying load conditions [8].Magadum and Kulkarni (2019) proposed a fuzzy logic-based approach for the optimal placement and sizing of multiple DG units. The results showed that the fuzzy logic approach could effectively optimize DG placement [9].Das, Das, and Patra (2019) investigated how distribution networks functioned when dispatchable DGs and shunt capacitors were positioned and sized optimally[10]. Davda and Parekh (2012) They focused on system reliability, voltage regulation, and power quality, providing valuable insights for power engineers and policymakers [11].Marshall et al. (1991) Their work, published in IEE Proceedings C

Generation, Transmission and Distribution, proposed a methodology for minimizing the cost and improving the efficiency of electricity distribution [12].

Karimyan et al. (2016) explored the ideal distribution of dispatchable DG components in distribution networks, taking into account the load growth [13].Lakervi and Holmes (2003) The authors discuss various components and configurations of distribution systems, offering practical solutions for modern network challenges [14]. Ibiyemi and Kadiri (2017) their work focuses on enhancing the efficiency and reliability of power distribution in industrial settings. The algorithm aims to optimize the allocation of electrical resources, reduce energy consumption, and improve the overall performance of machine tools [15]." Cadena (2021) provided a useful manual on power distribution for live event production." The third edition, published by Routledge, provides detailed information on the design, installation, and maintenance of power distribution systems for entertainment venues [16].

II. SYSTEM MODELLING AND METHODOLOGY

A. Distributed Generator

This includes a formulation of the problem. Reducing power loss dependent on DG size and seating is the challenge. Two case studies will be used as examples to minimize losses as much as possible. In addition to lowering actual P_L, using real power loss as an objective function will reduce reactive power losses and enhance the system's voltage profile. PSO approach should be used to tackle this issue.

This section presents the Objective Function (OF), which comprises many system performance factors. This OF is used with the PSO approach for the suggested work

$$OF = b_1 \times IP^{LOSS} + b_2 \times IV^{DEVIATION} + b_3 \times IQ^{LOSS} \quad (1)$$

The weight factors b_1, b_2, and b_3, with relative values of 0.40, 0.30, and 0.30, indicate the amount of weight assigned to each variable system index based on priority The Index of the real and reactive loss with voltage deviation are, respectively, $IP^{LOSS}$and IQ^{LOSS} with $IV^{Deviation}$

$$IP^{LOSS} = \frac{P^{LOSS}_{With\,DG}}{P^{LOSS}_{Without\,DG}} \quad (2)$$

$$IQ^{LOSS} = \frac{Q^{LOSS}_{With\,DG}}{Q^{LOSS}_{Without\,DG}} \quad (3)$$

$$\mathrm{IV}^{Deviation} = \max\left(\frac{\Delta \mathrm{V}}{\mathrm{V}_{\mathrm{Reference}}}\right) \quad (4)$$

B. Optimization Techniques

Optimization approaches, namely PSO DG sizing, and DG siting problems, all tackled concurrently. This approach mitigates the drawbacks associated with employing sensitivity analysis for determining the optimal DG unit placement and underscores the benefits of addressing this challenge simultaneously. Mathematical Model of PSO

$$v_i^{t+1} = \underbrace{v_i^t}_{\text{Inertia}} + \underbrace{c_1 r_1 (pbest_i^t - p_i^t)}_{\text{Personal influence}} + \underbrace{c_2 r_2 (gbest^t - p_i^t)}_{\text{Social influence}} \quad (5)$$

The variables 'k','s_1', and's_2' indicate the weighting factors, 'r_1' and 'r_2' are random values between 0 and 1, and 'W' stands for the weighting function in this formula. The velocity of particle 'i' at iteration 'k' is represented by 'V_i' (k), while the updated velocity of particle 'i' is indicated by 'V_i' (k + 1). The particle 'i' position at iteration 'k' is shown by 'Yi' (k), while the revised position of particle 'i' is indicated by 'Y_i' (k + 1). For particle 'i', 'Pi' (k) denotes the personally best particle; 'G' (k) denotes the globally best particle.

C. Harmonics Analysis

Harmonics refer to sinusoidal voltages or currents characterized by frequencies that are integer multiples of the fundamental frequency at which the supply system is intended to operate.Harmonic distortion refers to the occurrence of harmonics in power systems due to nonlinear devices within the distribution system. A nonlinear device is characterized by a current not directly proportional to the supplied voltage.

Harmonic distortion can be expressed as a Fourier series due to its characteristics of periodic distortion, which is given by

D. Short Circuit Analysis

The repercussions of a short circuit can be severe, contingent on the system's capability to sustain short circuit current and the duration it persists. At the point of the short circuit, local consequences may include electrical arcs causing insulation damage, conductor welding, and fire. Electrodynamic forces on the faulty circuit can result in bus bar and cable deformation, while excessive temperature rise may harm insulation. Short-circuit events also affect other circuits within the network or nearby networks. Voltage drops occur in neighbouring networks during short circuits, and network segments may shut down, impacting even "healthy" portions depending on the overall network design.

III. RESULT AND DISCUSSION

This Thesis explored the best configuration and sizing of distributed generation (DG) for a specific load under two scenarios:

1. without DG (Base Case)
2. with DG

Using DIgSILENT Power Factory and Particle Swarm Optimization (PSO), the study assessed the proposed approach's effectiveness on an IEEE 33 bus distribution system. Figures 1 to 4 show graphical representations of various aspects like Total Harmonics Distortion (THD %), active,reactive power profiles and,Voltage Profile with and without DG..

In Case I, Table 1 show power loss (PLOSS) at 0.21 MW, reactive loss (QLoss) at 0.14 MVAr, power supplied to the grid (Pgrid) at 3.92 MW, and reactive power to the grid (Qgrid) at 2.44 MVAr.

In the alternative scenario, three DG units are placed at buses 16, 24, and 30 of the IEEE 33 bus distribution network. This results in a significant reduction of reactive loss (QLoss) to 0.01 MVar and power loss (P_{LOSS}) to 0.01 MW and. The power supplied to the grid reactive power to the grid (Qgrid) lowers to 0.53 MVar and (Pgrid) decreases to 0.85 MW, and. Additionally, reactive power generated (Qgen) is 1.78 MVar, (Pgen) is 2.88 MW, and leading to reductions of 92.85% in Q_{LOS}S and 95.23% in P_{LOSS} and, as shown in Table 1.

TABLE 1 Load Flow Calculations For Ieee 33

Case		1	2
DG Generation	Q(MVar)	-	1.78
	P(Mw)	-	2.88
Total Power Losses	Q_{LOSS} (MVar)	0.14	0.01
	P_{LOSS}(Mw	0.21	0.01
Grid Power	Q(MVar)	2.44	0.53
	P(Mw	3.92	0.85

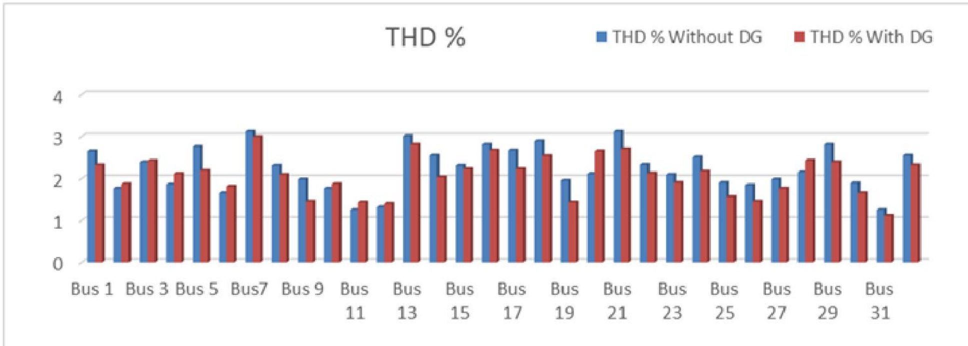

Fig. 1 THD %

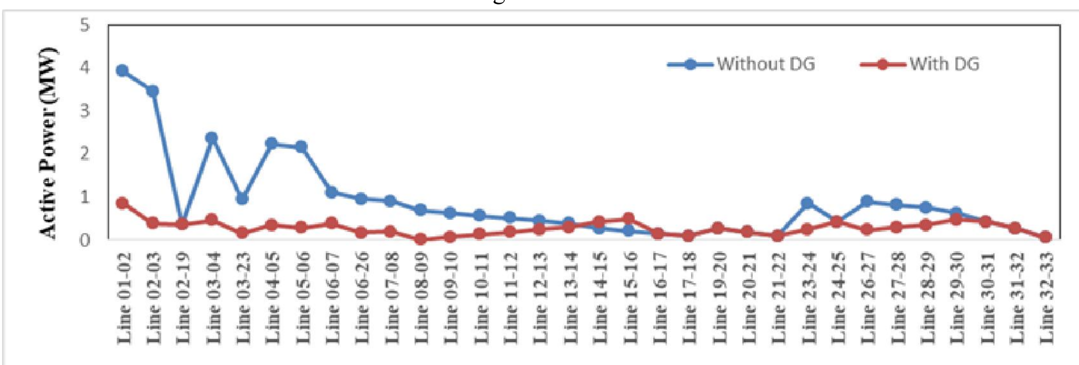

Fig.2 Active Power

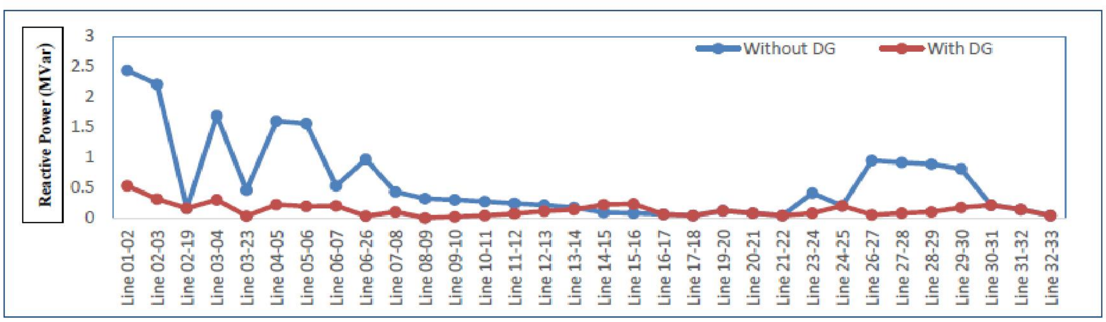

Fig.3 Reactive Power

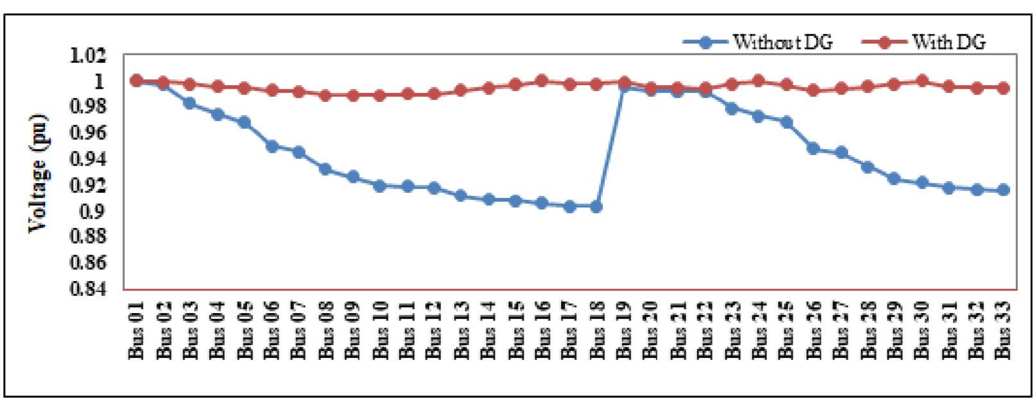

Fig.4 Voltage Profile in IEEE 33 Bus

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IV. CONCLUSION

An iterative observer has been successfully implemented to accurately estimate and identify harmonic injections within the network. The estimation results obtained show a high degree of accuracy when compared to actual values. Additionally, the research explores harmonic estimation in real-time environments and examines various short-circuit parameters both with and without Distributed Generation (DG).

Using DIgSILENT software and the Particle Swarm Optimization (PSO) method, this study introduces optimal placement and sizing strategies for DGs within a practical distribution system. The research evaluates two scenarios: one with DGs and one without. For a 33-bus Radial Distribution System (RDS), DGs were optimally placed at bus numbers 16^{th} , 24^{th} ,and 30^{th} to minimize power loss (P_{LOSS}) and reactive power loss (Q_{Loss}) while improving the voltage profile. By applying optimization techniques and thoroughly analysing all scenarios, the most favorable outcome is found in case II, where all three DGs are located at the specified buses simultaneously. Results from case II show significant improvements in computational efficiency, convergence, techno-economic benefits, and substantial reductions in P_{LOSS} (95.23%) and Q_{LOSS} (92.85%).

The harmonic analysis revealed that non-linear loads significantly contribute to waveform distortions, leading to increased total harmonic distortion (THD) levels across the system. These distortions can cause adverse effects such as equipment overheating, increased losses, and malfunctioning of protection devices. The study highlights the importance of identifying harmonic sources and implementing appropriate mitigation techniques, such as harmonic filters, to maintain power quality and ensure the smooth operation of the system.

The short circuit analysis demonstrated the system's response to different fault conditions, including single-line-to-ground, line-to-line, and three-phase faults. The results showed that the system experienced substantial fault currents and voltage drops during these events. The performance of protection devices was evaluated, and it was found that proper coordination and settings are crucial to effectively isolate faults and minimize damage. The study emphasizes the need for robust protection schemes to enhance system resilience and prevent widespread outages.

The research has certain limitations, and there is scope for future investigations. Subsequent studies could explore a comparative analysis of the proposed objective function against alternative objectives, aiming to minimize reactive power loss and maximize system load capacity. Additionally, the research could delve into the impact of optimal distributed generation (DG) placement within the context of the deregulated electricity market, aiming to maximize social welfare, minimize location marginal pricing (LMP), and reduce total generation cost.

REFERENCES

[1]. P. K. Kaushal and M. Tomar, "Real and reactive power loss minimization of IEEE33 bus by optimal DG placement using LSO in RDS," in 2017 International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS), 2017.

[2]. P. Prakash and D. K. Khatod, "Optimal sizing and siting techniques for distributed generation in distribution systems: A review," Renew. Sustain. energy Rev., vol. 57, pp. 111–130, 2016.

[3]. O. D. Montoya, W. Gil-González, and L. F. Grisales-Noreña, "An exact MINLP model for optimal location and sizing of DGs in distribution networks: A general algebraic modeling system approach," Ain Shams Eng. J., vol. 11, no. 2, pp. 409– 418, 2020.

[4]. Mahmoud, Shahbazi, Philippe, et al. Real-time power switch fault diagnosis and fault-tolerant operation in a DFIG-based wind energy system. Renewable energy, vol. 116, no. 9, pp. 209-218, 2018.

[5]. L. F. Grisales and B. J. Restrepo Cuestas, "Location and sizing of distributed generation: A review," Cienc. eIng. Neogranadina, vol. 27, no. 2, pp. 157–176, 2017.

[6]. F. U. Din, A. Ahmad, H. Ullah, A. Khan, T. Umer, and S. Wan, "Efficient sizing and placement of distributed generators in cyber-Physical power systems," J. Syst. Archit., vol. 97, pp. 197–207, 2019.

[7]. Z. Ullah, S. Wang, and J. Radosavljević, "A novel method based on PPSO for optimal placement and sizing of distributed generation," IEEJ Trans. Electr. Electron. Eng., vol. 14, no. 12, pp. 1754–1763, 2019

[8]. S. Essallah, A. Khedher, and A. Bouallegue, "Integration of distributed generation in electrical grid: Optimal placement and sizing under different load conditions," Comput. Electr. Eng., vol. 79, p. 106461, 2019.

[9]. R. B. Magadum and D. B. Kulkarni, "Optimal Placement and Sizing of Multiple Distributed Generators using Fuzzy Logic," 5th Int. Conf. Electr. Energy Syst. ICEES 2019, no. February, pp. 1–6, 2019.

[10]. S. Das, D. Das, and A. Patra, "Operation of distribution network with optimal placement and sizing of dispatchable DGs and shunt capacitors," Renew. Sustain. Energy Rev., vol. 113, no. September 2017, p. 109219, 2019.

[11]. T. Davda and B. R. Parekh, "System impact analysis of renewable distributed generation on an existing radial distribution network," in 2012 IEEE Electrical Power and Energy Conference, 2012.

[12]. Marshall, A., Boffey, T., Green, J., & Hague, H. (1991). Optimal design of electricity distribution networks. IEE Proceedings C Generation, Transmission and Distribution, 138(1), 69. https://doi.org/10.1049/ip-c.1991.0009. 52

[13]. KARIMYAN, P., VAHIDI, B., ABEDI, M., & AHADI, S. M. (2016). Optimal dispatchable DG allocation in a distribution network considering load growth with a mixed-PSO algorithm. TURKISH JOURNAL OF ELECTRICAL ENGINEERING &Amp; COMPUTER SCIENCES, 24, 3049–3065. https://doi.org/10.3906/elk-1404-207.

[14]. Lakervi, E., & Holmes, E. J. (2003). Electricity Distribution Network Design (Energy Engineering) (2nd ed.). The Institution of Engineering and Technology.

[15]. Ibiyemi, S., &Kadiri, K. (2017). A Modified Optimal Electricity Distribution Algorithm For Machine Tool. LAP LAMBERT Academic Publishing.

[16]. Cadena, R. (2021). Electricity for the Entertainment Electrician & Technician: A Practical Guide for Power Distribution in Live Event Production (3rd ed.). Routledge.