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Extended EDAS Analysis for Multi-Criteria Decision-Making Based on Distributed Generation (DG) Technologies System

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Abstract. *Recently, there has been a growing interest in distributed generation (DG) technologies, driven by various factors such as fuel price uncertainties, environmental constraints, and increasing power consumption along with transmission capacity shortages, in modern power systems. DG, which involves utilizing clean and renewable energy sources for power generation within the distribution system, has gained significant attention globally. Many developing countries, including Libya, are considering the adoption of DG technologies as part of their energy system expansion plans. Libya, located in North Africa and characterized by vast desert lands, has abundant solar radiation, making solar energy a promising and sustainable source of power. However, despite this energy potential, the southern part of Libya faces frequent power outages. In order to effectively maintain service quality, it is essential to conduct quantitative evaluation of wireless sensor networks. the evaluation of wireless sensor networks involves addressing the multiple attribute group decision-making (MAGDM) problem. To tackle the challenges of MAGDM, an extension of the classical EDAS (Evaluation based on Distance from Average Solution) method is proposed in this paper. The proposed method incorporates interval-valued intuitionistic fuzzy sets (IVIFSs), which provide a more flexible and comprehensive representation of uncertainty, to handle the complexities of MAGDM. The paper begins with a brief review of essential concepts related to IVIFSs. Then, the weights of attributes are determined using the CRITIC method. Subsequently, the IVIF-EDAS method is established by integrating the EDAS method with IVIFSs, and all the calculation procedures are described.*

Keywords: *Social data mining technologies, Smart Private Classroom Courses (SPOCs), MCDM.*

1. INTRODUCTION

To determine the best position and size for DGs in main distribution systems in order to reduce overall power losses. The 'proper loss equation' in applied expressive power systems refers to the objective function that is taken into account as the overall power loss. The technique only examines the dimension of a single DG that will be inserted in the system; hence it is not appropriate for solving the decimal digits-based problem. In order to maximise the DG's efficiency and locate available leeway in the system while adhering to set temperature and voltage restrictions, Hancock and Wallace implement OPF. This work takes into account multiple loads and DG units with a non-uniform power factor, but the author ignores time-varying loads. Singh and Goswami suggest using GA to resolve a nodal cost-based formula for the best distribution of DG for power improvement, loss minimization, and other voltage-related issues. The voltage rise is a crucial element to take into account because it significantly hinders the implementation of DG for distribution systems. However, this research only addresses one specific type of DG, a direct current (DG) with a lagging factor of power of 0.9. El-Sonkoly developed a multi-objective index-based strategy based on PSO and weighted method for optimal seating and assessment of tasking-DG resource in distribution networks with various loads. The paper only employed PSO to arrange DG units with an undefined power factor, that is not a practical approach for DG scaling. PSO is capable of identifying the best global arrangement in a short simulations period. The DG scheduling problem, which involves concurrent DG, reactive resource, and network configuration scheduling, is resolved by Golshan and Arefifer using TS. deciding where to install, how big to make it, and how to use reactive power and distributed generation resources as well as voltage regulators' tap positions and network configuration on selected buses of the distribution system, is achieved through problem-solving. However, the algorithm used, known as TS, is acknowledged for its time-consuming nature, and due to its complexity, many parameters cannot be accurately determined. The notion of "distributed generation, or DG, is one that has a lot of potential since it offers an alternate way to deal with the problems that conventional power systems have in terms of technology, finances, and the environment. The positioning of generation units inside the power system has a number of technical benefits, such as improved power quality, increased dependability, and efficient and effective energy management. As the spread of generating unit eliminates the need of substantial transmission infrastructure, DG systems have the potential to economically minimise the capital expenditure required to build power systems. Additionally, by offering a more effective way of producing and distributing electricity and by encouraging the incorporation of renewable energy sources, DG power systems can have a beneficial effect on the environment. To solve technical concerns connected to the operation, oversight, and safety of DG systems, however, significant studies and psychometric testing are now being conducted on the usage of DG for power systems as it is a relatively new idea in the electric power business. As photovoltaic distributed generation (DG) becomes more integrated into the electricity system, it becomes crucial to identify the threshold of DG penetration that ensures network security, reliability, significant advantages for utilities as well as customers. Prior research, however, failed to take into account the effects of the system's DG dispersion level, ideal DG position, and interpolation. This research suggests a stochastic method to establish the solar DG penetration threshold in order to address these uncertainties. An iterative optimization platform is utilized to calculate the penetration threshold while considering voltage and current constraints. This study also looks into how network properties are affected by the temporal variability of solar DG. Numerous studies have concentrated on figuring out how to integrate overcurrent relays using computations or simulations in power distribution networks. However, most of these methods have been developed for regular radial distribution systems and have utilized various algorithms. Research on intersect/network distribution networks that include distributed generation (DG) into their security, however, has not been as extensive. Overcurrent relays have been included in the past using both manual and automated techniques, but these integrations have often excluded DG from the computational analysis. When evaluating a DG (Distributed Generation) installation, it is important to assess the potential impacts of ungrounded operation. Analysing if the gearbox system can be briefly detached is required for this. A typical case is when the utilities end of the communication line trips while the DG units are linked via a transformer that supplies the power with an HV (High Tension) delta connection. In such circumstances, there may be a risk of an overvoltage in the damaged phases in the event of an electrical fault in a subsurface network. This risk may be particularly significant in situations where the transmission length is long and the connected load is minimal, resulting in over voltages in the faulted phases that can exceed the phase-to-phase voltage value. Studies should be done to establish what surge arresters or additional machinery needs to be downsized to limit the risks linked to excess voltages if unfounded operation is under consideration.

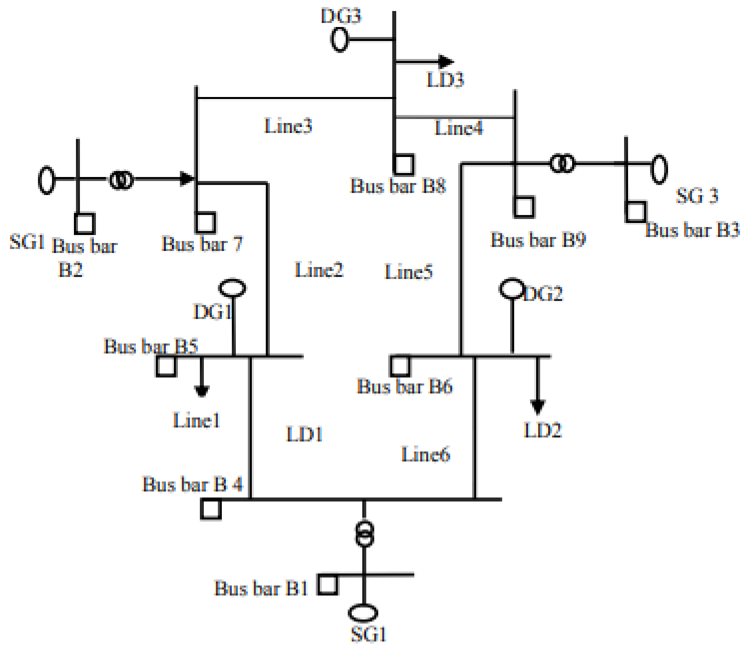

FIGURE 1. IEEE 9 test bus system with Distributed Generation (Dg) System Units

2. MATERIALS AND METHOD

An innovative method for making decisions is the "EDAS (Evaluation based on the Distance from Average Solution) method", which was first presented by Ghorabaee et al. Unlike other methods like TOPSIS and VIKOR that require calculating distances from positive and negative ideal solutions, by focusing simply on how far away behind an average solution (AV), EDAS streamlines the process. Combining "positive distance from average (PDA)" and "negative distance from average (NDA)", EDAS aims to select the best option from a group of alternatives. Over time, researchers have explored the applications of EDAS in various domains. While Kahraman et al. established a new EDAS approach that combines intuitionistic numbers that are uncertain and utilised it in the selection of solid waste disposal sites, Ghorabaee et al. presented an enhanced EDAS approach to supplier selection. By extending the EDAS method's use to timeframe-valued neutrosophic sets, Karasan used it to order the country's national environmentally friendly development goals. The EDAS method is a widely used ranking approach in integrated decision-making models, known for its unique normalization approach that sets it apart from other Multi-Criteria Decision Making (MCDM) methods. Several researchers have further extended the EDAS method to incorporate different types of uncertainty or to apply it to specific domains. For instance, to deal with evaluation uncertainty, Stanujkic et al. expanded the EDAS approach to incorporate interval grey numbers. Continuous a type-2 fuzzy sets theory was used by Ghorabaee et al. to build an EDAS expansion. Fuzzy EDAS was used by Kahraman et al. as a tool for decision-making in waste management, particularly for assessing waste disposal systems. For evaluating several steam boiler technology options, Kundakci suggested a hybrid decision-making tool that merged the MACBETH & EDAS methodologies. An EDAS-based the MCDM model with fuzzy set theory as a basis for selecting the material was proposed by Zindani et al., allowing for assessment and prioritisation of various materials. To choose the best neighbourhood for the first-time visitor in Istanbul, Turkey, Torkayesh et al. utilised a comprehensive decision-making model that combines EDAS and Entropy approaches while taking into account several technical, the environment, and social elements. While Peng et al. introduced timeframe-valued fuzzy soft decision-making techniques based on MABAC, closeness measurement, and EDAS, Kahraman et al. expanded the EDAS method to fuzzy sets that are intuitionistic. Using EDAS and a novel similarity metric, Peng and Chong introduced methods for neutrosophic soft making of choices. To assess cleaner output in gold mines, Liang et al. created an integrated EDAS-ELECTRE approach with picture fuzzy information. An innovative interval-valued neutrosophic EDAS approach was presented by Karasan and Karaman. Using traditional and fuzzy EDAS modifications, Galina et al. created decision analysis tools. Expanded hesitant fuzzy multilingual the MCDM method (Multi-Criteria Decision Making) cases were subjected to the EDAS approach by Feng et al.

3. RESULT AND DISCUSSION

TABLE 1. Distributed Generation (Dg) System

	Number of Units	Installed Capacity (MW)	Available Capacity (MW)
Steam	14	1240	590
Gas	32	4611	3487
Combined Cycle	15	2355	2055
Other Resources	12	582	225
AVj	18.25000	2197.00000	1589.25000

Shows the table 1 Distributed Generation (DG) System using the Analysis method in EDAS. Steam, Gas, Combined cycle and other resources in alternative value. Evaluation parameters in number of units, installed capacity (MW) and Available capacity (MW) is seen all Average in Value.

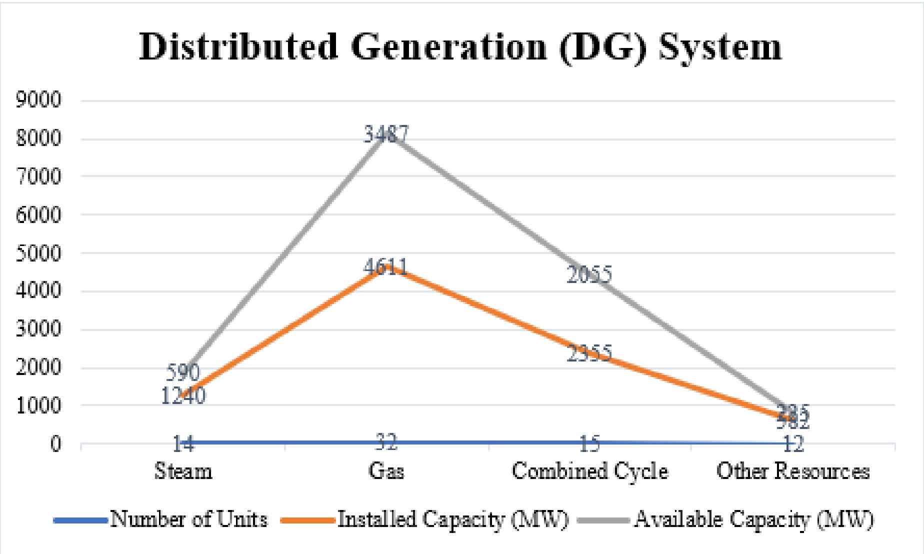

FIGURE 2. Distributed Generation (Dg) System

Shows the figure 1 Distributed Generation (DG) System using the Analysis method in EDAS. Steam, Gas, Combined cycle and other resources in alternative value. Evaluation parameters in number of units, installed capacity (MW and Available capacity (MW).

TABLE 2. Positive Distance from Average (PDA)

	Positive Distance from Average (PDA)		
Steam	0.00	0.00	0.63
Gas	0.75	1.10	0.00
Combined Cycle	0.00	0.07	0.00
Other Resources	0.00	0.00	0.86

Table 2 shows the Positive Distance from Average (PDA) in Distributed Generation (Dg) System using the Analysis method in EDAS Analysis, Steam, Gas, Combined cycle and other resources in alternative value. Evaluation parameters in number of units, installed capacity (MW and Available capacity (MW) is seen all Maximum Value.

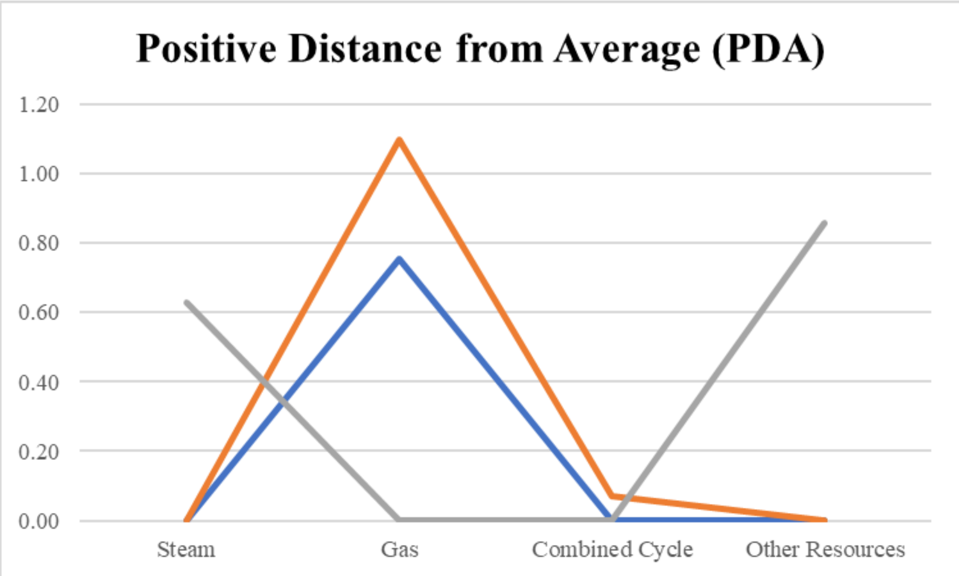

FIGURE 3. Positive Distance from Average (PDA)

shows the figure 2 Positive Distance from Average (PDA) in Distributed Generation (Dg) System using the Analysis method in EDAS Analysis, Steam, Gas, Combined cycle and other resources in alternative value. Evaluation parameters in number of units, installed capacity (MW and Available capacity (MW) is seen all Maximum Value.

TABLE 3. Negative Distance from Average (NDA)

	Negative Distance from Average (NDA)		
Steam	0.23288	0.43559	0.00000
Gas	0.00000	0.00000	1.19412
Combined Cycle	0.17808	0.00000	0.29306
Other Resources	0.34247	0.73509	0.00000

Table 3 shows the Negative Distance from Average (NDA) in Distributed Generation (Dg) System using the Analysis method in EDAS Analysis, Steam, Gas, Combined cycle and other resources in alternative value. Evaluation parameters in number of units, installed capacity (MW and Available capacity (MW) is seen all Maximum Value.

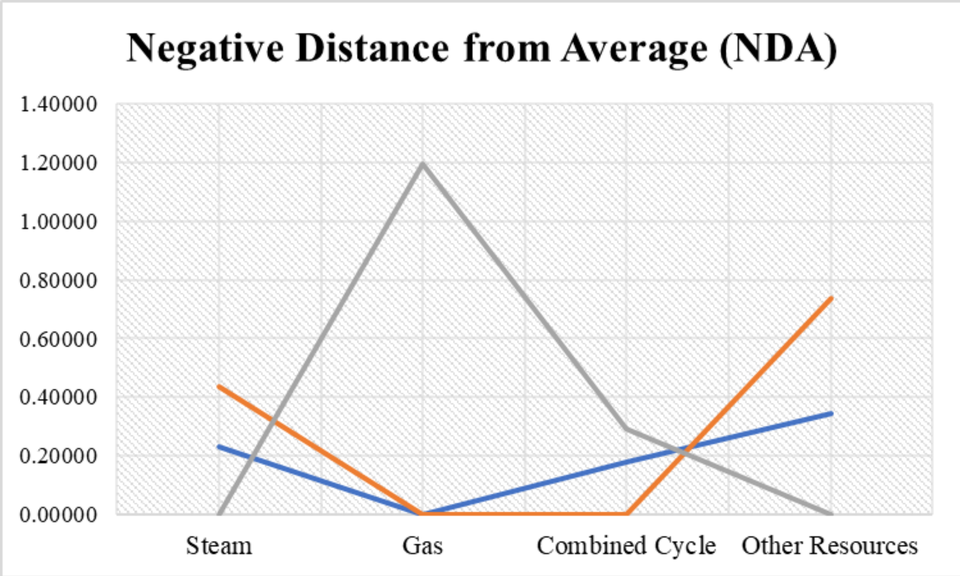

FIGURE 4. Negative Distance from Average (NDA)

Shows the figure 3 Negative Distance from Average (NDA) in Distributed Generation (Dg) System using the Analysis method in EDAS Analysis, Steam, Gas, Combined cycle and other resources in alternative value. Evaluation parameters in number of units, installed capacity (MW and Available capacity (MW) is seen all Maximum Value.

TABLE 4. Weight

	Weight		
Steam	0.25	0.25	0.25
Gas	0.25	0.25	0.25
Combined Cycle	0.25	0.25	0.25
Other Resources	0.25	0.25	0.25

Table 4 shows the Weightages used for the analysis. We take same weights for all the parameters for the analysis

TABLE 5. Weighted PDA and SPi

	Weighted PDA			SPi
Steam	0.00000	0.00000	0.15719	0.15719
Gas	0.18836	0.27469	0.00000	0.46305
Combined Cycle	0.00000	0.01798	0.00000	0.01798
Other Resources	0.00000	0.00000	0.21461	0.21461

Table 5 shows the Weighted PDA, SPi in Distributed Generation (Dg) System using the Analysis method in EDAS Analysis is shown the Table 2 and Table 4 in Multiple Value. Steam, Gas, Combined cycle and other resources in alternative value. Evaluation parameters in number of units, installed capacity (MW and Available capacity (MW) is seen all Multiple Value.

TABLE 6. Weighted NDA and SNi

	Weighted NDA			SNi
Steam	0.05822	0.10890	0.00000	0.16712
Gas	0.00000	0.00000	0.29853	0.29853
Combined Cycle	0.04452	0.00000	0.07327	0.11779
Other Resources	0.08562	0.18377	0.00000	0.26939

shows the table 6 Weighted NDA, SNi in Distributed Generation (Dg) System using the Analysis method in EDAS Analysis is shown the Table 2 and Table 4 in Multiple Value. Steam, Gas, Combined cycle and other resources in alternative value. Evaluation parameters in number of units, installed capacity (MW and Available capacity (MW) is seen all Multiple Value.

TABLE 7. NSPi, NSNi, ASi and Rank

	NSPi	NSNi	ASi	Rank
Steam	0.33947	0.44020	0.38983	2
Gas	1.00000	0.00000	0.50000	1
Combined Cycle	0.03883	0.60544	0.32214	3
Other Resources	0.46346	0.09761	0.28054	4

Table 6 shows the Final Result of Distributed Generation (Dg) System using the Analysis for EDAS Method. NSPi in Distributed Generation (Dg) System is calculated using the Gas is having Higher Value and combined cycle is having Lower value. NSNi in calculated using the combined cycle is having is Higher Value and gas is having Lower value. ASi in calculated using the gas is having is Higher Value and other resources is having Lower value.

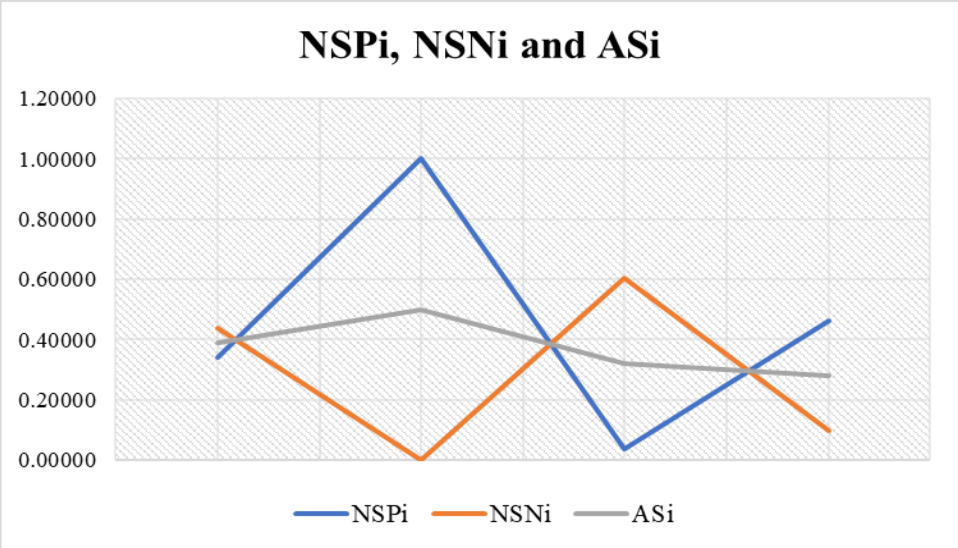

FIGURE 5. NSPi, NSNi and ASi

Shows the figure 4 Final Result of Distributed Generation (Dg) System using the Analysis for EDAS Method. NSPi in Distributed Generation (Dg) System is calculated using the Gas is having Higher Value and combined cycle is having Lower value. NSNi in calculated using the combined cycle is having is Higher Value and gas is having Lower value. ASi in calculated using the gas is having is Higher Value and other resources is having Lower value.

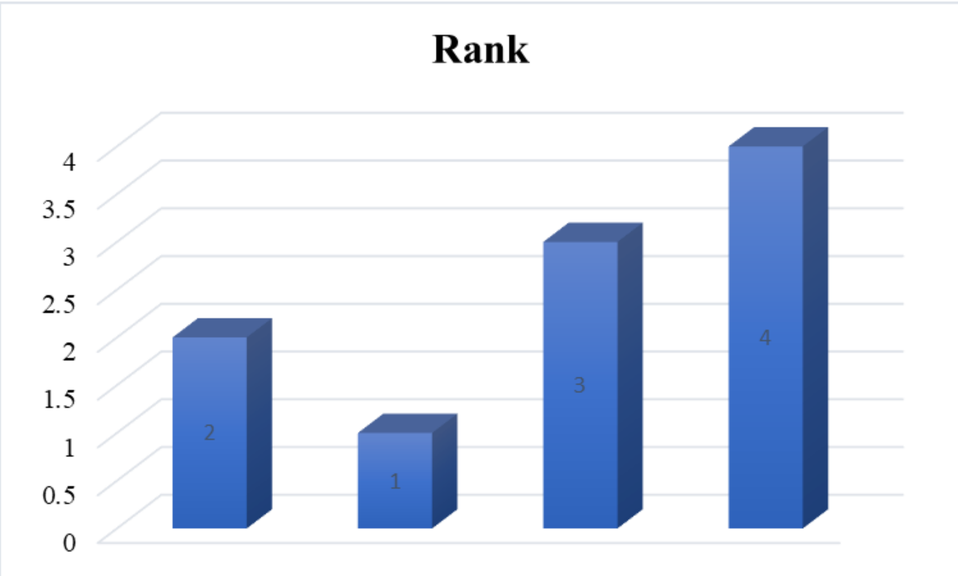

FIGURE 6. Rank

Shows the figure 5 Ranking for Distributed Generation (Dg) System. Gas is got the first rank whereas is the Other Resources is having the Lowest rank.

4. CONCLUSION

Currently, there are several obstacles and barriers that continue to impede the widespread adoption of Distributed Generation (DG) in the market. These obstacles include high costs and uncertain performance of many DG technologies, lack of uniform standards and communication protocols, and challenges related to distribution system architecture. Despite these barriers, DG is expected to play a crucial role in future distribution systems. Therefore, supply engineers require new planning tools that can help maximize the benefits of DG while addressing the uncertainties associated with it. To address these challenges, an algorithm for optimal allocation of DG in a given network has been proposed. This algorithm utilizes a process based on the application of Genetic Algorithm (GA) and Multi-Objective (MO) optimization techniques, allowing the planner to tailor the solution to their specific needs. In the context of a liberalized energy market, this algorithm can be used to identify the most suitable sites for DG installation, and evaluate the additional credits provided by Distribution System Operators (DISCOs) if DG is strategically placed to maximize the benefits to the network. This proposed algorithm aims to provide a valuable tool for planners and decision-makers in the field of DG planning, enabling them to overcome barriers and make informed decisions for effective DG integration in distribution systems. The proposed Multi-Objective (MO) methodology for DG site planning can be further improved by incorporating considerations related to the liberalized energy market, interaction with the transmission grid, ancillary services market, Demand Side Management (DSM), and other relevant factors. Power quality aspects and sizing should also be taken into account in the planning process to ensure optimal performance of DG systems. EDAS (Evidential Reasoning-based Decision Analysis) is a multiple-criteria decision-making approach that is relatively recent yet has been frequently applied in the scientific literature. Investigators have already created a number of EDAS expansions, including type-2 fuzzy EDAS, interval grey EDAS, fuzzy intuitive EDAS, and ordinary fuzzy EDAS. However, in this chapter, the proposed methodology introduces the first-ever application of neutrosophic EDAS, which considers the degree of indeterminacy. The proposed Indeterminacy Valued Neutrosophic (IVN) EDAS takes into account the degree of truthiness, degree of falsity, and degree of indeterminacy of decision makers. This allows for a more comprehensive and nuanced assessment of decision maker's preferences and uncertainties, providing a more robust and flexible approach to DG site planning. Further studies and applications of the IVN EDAS methodology can contribute to advancing the field of decision making in DG planning, considering the complexities and uncertainties associated with the decision-making process in the context of neutrosophic sets. Distributed Generation (Dg) System using EDAS method of Gas is got the first rank whereas is the Other Resources is having the Lowest rank.

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