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Integration of Photovoltaic Distributed Generation in Grid Distribution Network: A Literature Review

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Abstract— Distributed Generation (DG) will become a future generation system known as a renewable energy source. Renewable energy is a topic being developed due to being environmentally friendly. It fulfills the need for electrical energy to replace fossil energy sources to reduce climate change due to carbon emissions towards net-zero emissions by 2050, reducing climate change by 1.5^0 C to 2^0 C. Solar photovoltaic (PV) is an energy source that has been widely developed and has enormous potential; where PV can be integrated off the grid and on the grid. Integrating PV into the network is challenging, so the network remains stable and reliable due to intermittent energy generation. This paper reviews the integration of PV-DG distribution networks. Topology, optimization, and impacts on the distribution network are also discussed in this paper. The literature review results show that PV-DG integrated into the grid has an impact caused by intermittent PV generation.

Keywords: PV integration, Optimization, DG impacts.

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1. Introduction

Electrical energy is one of the most important factors in driving economic and social growth, which can directly affect the quality of life. Almost all sectors require electrical energy to support modern infrastructure such as households, agriculture, health, transportation and so on [1], [2]. The growth of the population and the global economy of the world, along with the ongoing industrial revolution in the Asian region, particularly in countries that are not part of the organization for economic co-operation and development (non-OECD), including China, India, and ASEAN countries, have resulted in an increase in energy demand. This increase in energy demand is primarily met by fossil energy sources, namely coal, oil, and gas. However, it is important to note that the utilization of conventional energy sources can lead to environmental issues [1], [3]–[5]. the conventional energy sources can cause environmental problems. The large environmental impact due to the use of conventional energy sources, which has resulted in a global crisis in the form of climate change due to carbon emissions. The carbon emissions have become an important international issue for many leaders of countries in the world who are members of the international community of the united nations framework convention on climate change (UNFCCC) at the conference of parties (COP) in France [6], [7]. Therefore, after receiving support from 195 countries, they agreed to address and take action to prevent and reduce environmental impacts, known as net-zero emissions by 2050 [7].

Incorporating and making a contribution towards environmental sustainability through the examination and involvement in academic research has demonstrated that innovation and

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technological advancements have resulted in the emergence of renewable energy as a viable alternative to address energy challenges. This is particularly significant as fossil energy sources, which have been continuously exploited, are anticipated to have limited availability in the foreseeable future. [8], [9]. The energy that is environmentally friendly, characterized by low carbon dioxide (CO2) emissions or negligible air pollution, has the potential to mitigate climate change resulting from greenhouse emissions caused by global warming. This energy source facilitates the stabilization of the world's climate change by reducing temperatures between 1.5^0C to 2^0 C [10]–[16]. Renewable energy is the best choice where its availability does not decrease, such as: sun, water, wind, geothermal, marine energy and biomass [8], [14], [17]. The renewable energy has reached 3,064 GW at the end of the 21st century [2], [18] The hydroelectric power plants, with 1,230 GW installed capacity consisting, which are the largest energy source in the world, PV of 849 GW, wind power of 825 GW, geothermal energy of 16 GW, marine energy of 524 MW and biofuel of 143 GW [18].

The use of solar energy as a renewable energy source functions as an energy source that is always available during the day almost throughout the world, which effectively meets the increasing energy needs. Apart from that, solar energy is the largest energy obtained by the earth. [19], [20]. The utilization of solar power has witnessed a surge in tandem with the amplified potential of PV-based power facilities. This remarkable growth, as cited by references [21], [22], has experienced an exponential rise in recent times, surpassing alternative sources of sustainable energy. Solar power plants are the second largest source of renewable energy [18], with the total number of PV installations installed throughout the world at the beginning of 2022 amounting to 167.8 GW. It has increased of 21% with PV statistical data in the 2015-2022 period [18]. The utilization of solar energy is anticipated to assume a paramount role in the 21st century, emerging as the preeminent renewable energy source, as societies undergo a transition towards sustainable development [23]. Several countries in the world show ambitious goals to build PV systems such as European countries including Germany, Italy, Spain, the United States, and Asia such as Japan and China. Japan has set a total installed capacity of 53 GW in 2030 [24], the United States is targeting 246 GW and 36 GW of installed PV capacity in 2020 [25] where California is the largest state in the construction of PV installations [26].

Utilization of PV based energy is widely used from micro to large scale connected to the electricity grid through DG, with the categories micro DG 1W<5 kW, small DG 5kW<5MW, medium DG 5MW<50 MW and large DG 50 MW<300 MW [27]. Integration between the DG and grid can increase the capability to provide power, enhancing reliability, security, flexibility and power quality [28]–[36]. Furthermore, because of its ability to control internal loads and generators, it has lower network investment and contributes to sufficient generation [29]. The PV-based energy is widely used from micro scale [30], [31] small scale [32], [33] connected to the electricity grid through DG. However, it has a little number of the researchers conducted to study and implemented the integration of PV-based DG in medium and large scale of grid power system [34]. The integration of DG between large-scale PV and grids power system transmission network presents several technical challenges that arise such as voltage control, power quality and protection issues [35].

The PV system sources connected to the DG system have benefits in the electricity system, namely reducing losses through energy transmission and distribution, reducing investment in transmission and distribution lines and increasing the availability of energy sources during peak loads [37]. The integration of DG in the electric power system results in increasing electrical voltage in the distribution system [38][39]. However, the DG integration can cause several problems such as adding reactive power to the network, protection problems, power conditioning, power quality, and electricity tariffs. The voltage increase must be controlled, so that excessive voltage increases do not occur. The conventional method used to control this voltage is by utilizing distribution network operators. The transfer of electrical energy from the grid source to the PV electricity source must not have a transfer time lag because it causes electronic devices not to work, so a support system in the form of automatic distribution is added [40], [41].

The automatic distribution makes it possible to divert power from the main source to a backup source, but this technology is still considered conventional, because the automatic system can only move power and cannot be controlled remotely [42], [43]. Therefore, the growth and complexity of systems, distribution procedures require smart systems to plan, create and operate electric power

distribution systems [44]–[46]. The primary objective of the smart grid is to facilitate monitoring, analysis, control, and communication. This is done with the ultimate aim of enhancing energy services through the active engagement of customers/loads, the efficient management of generation and distribution, and the optimization of energy reserves. The main benefit of using small girds is to facilitate network reconfiguration operations to minimize power losses in the distribution system [47], [48]. According to [49]–[52] the development of smart grid aims for the safe operation of large power networks under disturbances, minimizing the risk of power outages, and increasing resilience, providing electric power with reliability high, high quality, and high efficiency.

The integration of DG into grid networks has potentially to promote a more resilient, sustainable and efficient energy supply system, increased efficiency, reliability and resilience [38]–[52] Hence, this integration of DG into grid networks approach to energy systems holds great promise for a sustainable and reliable future electricity infrastructure [53]–[56]. This paper aims to review the integration of DG from the PV into the power system of a grid distribution network. Topology, optimization, and impacts on the distribution network are also discussed in this paper. The writing structure in this paper contains an introduction. Next, this paper discusses the method and stages of conducting a literature review presented in Section 2. Section 3 presents the results and comprehensive discussion of integrated DG applications and types of technologies for PV systems, including distribution network topology and PV-DG impacts. Finally, Section 4 contains conclusions.

2. Method

This literature review paper used the literature analysis method by collecting and identifying published papers from databases that discuss PV and detailed discussions regarding DG technology integrated into the grid system. Before the first review, determine the research question: What is solar photovoltaic's topology, optimization and impact integrated with the distribution network system? The paper collection technique was searching for papers in the SCOPUS database using Publish or Perish software using the keywords "Photovoltaic" AND "distributed generation", where the maximum search is 200 articles with the search year from 2013-2023. One hundred ninety-seven papers were obtained for the second search using the keywords " Renewable Energy", AND "Photovoltaic" AND "Distributed Generation" " AND "on Grid" obtained as many as 26 articles, so the total articles obtained were 223 search results as the selected research objects.

The articles obtained will be studied by looking at the title and abstract to determine whether the paper is appropriate for writing a literature review paper; anything unneeded will be removed. From the screening of titles and abstracts, around 97 papers were obtained. The second step was to collect the full text of the paper and then read the entire paper to see whether the paper was included in the papers expected for the objective. The final step focused on analysis. For writing a literature review paper, anything unsuitable will be removed. From the screening of titles and abstracts, around 97 papers were obtained. The second step was to collect the full text of the paper and then read the entire paper to see whether the paper was included in the papers expected for the objective. The final step focused on analysis.

3. Result and Discussion

The energy produced by PV is unstable, so the available energy supply is also not constant, which can cause an imbalance between generation and demand, especially when demand is too high. However, PV cannot produce the appropriate energy, making network management difficult [25]. The main challenge of PV systems is matching intermittent energy generation with timely fulfilment of electricity demand and flexibility in load management [25], [57]–[61] In using PV energy and the network effectively, the main problem is system reliability [62]. To control a PV system connected to a network to increase the efficiency of the system output [18]. Hence, it is optimal and produces high-quality energy regarding power quality, stable voltage, and interference-[63]–[65] The disturbances are due to overvoltage on the lines due to reverse power flow, voltage fluctuations due to intermittent generation in PV systems, varying frequencies, and harmonic voltage and current distortion produced by inverters [63], [65]–[67]. It is a problem that must be resolved [68]

PV generators in several published papers are categorized in several sizes, from micro to large scale, connected to the electricity grid via DG. Various literature defines DG inconsistently, including decentralized, district, distributed, and local renewable energy sources or regions and countries connected to a distribution system. Distribution generation that is integrated into the distribution system can be categorized as micro DG 1W<5 kW, small DG 5kW<5MW, medium DG 5MW<50 MW and large DG 50 MW<300 MW [27]. There are two categories of PV systems: stand-alone systems that can operate independently and those connected to a distribution network [25]. The PV system connected to the network is optimized for power management, which takes into account PV components' performance index constraints so that several mathematical strategies are used, including linear programming [69], quadratic programming, non-linear [70] and dynamic programming [71][72], techniques artificial intelligence (AI), artificial neural network (ANN), genetic algorithm and fuzzy logic (FL)[73][74]. The electricity distribution network is the infrastructure that distributes electrical energy from generators to loads at medium voltage and low voltage [75]. Based on the topology of the distribution network configuration, it can be grouped into three types: system radial, loop and spindle distribution networks.

Radial network system because this channel is drawn radially from a point which is the source of the network and branches to the load points being served. Specifications of the radial network: a. simple form, b. cheap investment costs, c. the quality of power service is relatively poor, because the voltage losses and power losses that occur on the lines are relatively large, and d. continuity of power service is less guaranteed because between the source point and load point there is only one alternative channel [76], [77]. The loop distribution network system is a closed form, also called a ring network. The arrangement of the channel circuit forms a ring which allows load points to be served from two channel directions, so that service continuity is more guaranteed and the power quality is better, because the voltage drop and line power losses are smaller. The loop distribution network has quality and continuity better power service, but investment costs are more expensive and suitable for use in dense areas and require high reliability [78]–[80] The spindle distribution network system has advantages, including: a. increased reliability or continuity of system service, b. minimize losses due to interference, c. very good for supplying load areas that have fairly high load density, and d. network expansion is easy [81], [82]. The distribution network topology on the grid and solar photovoltaic-distributed generation (PV-DG) in term of model, nodes, topology, voltage and total load is discussed in Section 3.1, the optimization for PV system is reviewed in Section 3.2, and the PV-DG impacts is reviewed in Section 3.3.

3.1. Distribution Network Topology

The integration of PV in the grid electric power system will bring about new changes in electricity planning and operations, especially in the voltage profile and system power losses [82]–[84] PV has intermittent output power depending on temperature conditions, season, humidity, cloud movement so that the output power always changes all the time [85]–[87]. The intermittent and integrated output power means that the distribution system must make adjustments both in terms of topology model, voltage regulation and stability, and total load [88]–[90]. Therefore, the review literature for distribution network topology on PV-DG shows in Table 1.

Table 1**.** Distribution network topology on PV-DG

Reference	Nodes	Topology	Voltage	Load Description	General Description
[71]	30	Ring	-	-	Non-linear optimal power flow (OPF) with particle swarm optimization (PSO) technique with multiple DGs
[72]	85	Radial	11 kV	315.926 kW 198.438 kVAr	Optimal solar photovoltaic (SPV) to solve non-linear and multivariable problems using the archimedes optimization algorthm (ASA).

[89]	13	Radial	24.9 kV	3466 kW and 2120 kVAr	PV-DG is represented as a constant P-Q or P-V, thereby exerting diverse influences on power flow investigations in unbalanced distribution networks..
[91]	13 and 34	Radial	24.9 kV 4.16 kV	1769 kW and 1044 kVAr	The planning of the active distribution system (ADSP) for the PV-DG unit involves the utilization of two specific benchmarks, namely the energy that surpasses the standard level (EEN) and the energy that remains unfulfilled (UE).
[92]	123 and 137	-	69kV or 11.4 kV	3490 kW 50-1000kW	Load variation with a peak load of 3490 kW with 2 stages using the coyote optimization algorithm (COA).
[93]	33 and 69	Radial	12.66 kV	3715 kW and 2300 kVAr ; 3790 kW and 2690 kVAr	Discusses the optimal location and size of DG-based PV connected to the distribution network using PSO algorithm
[94]	13	Radial	-	3466 kW and 2120 kVAr	Open-source distribution system simulator (OpenDSS) to reduce the impact of load and voltage unbalance.
[95]	37	Radial	-	-	The results of the imperialist competitive algorithm (ICA) show better accuracy and efficiency compared to the PSO algorithm using openDSS in MATLAB.
[96]	33 and 69	Radial	-	-	Comparing the genetic algorithm (GA) and particle swarm optimization (PSO) presents an opportunity to enhance the performance of the system by effectively mitigating power losses, while simultaneously ensuring voltage profiles are maintained and harmonic distortion is minimized. This can be achieved through the identification and optimization of the placement and magnitude of PV systems.
[97]	14	Radial	110 kV	10 MW	OpenDSS uses Matlab to determine the optimal location of PV-DG
[98]	13	Radial	69 kV	26.28 MW and 7.58 MVAr	From the research results using the improved gravitational search algorithm (IGSA), we obtained better results than PSO in the PV optimization and size technique.
[99]	33 dan 69	Radial	12.6 kV	3720 kW, 2300 kVAr	Using the ant lion optimization algorithm (ALOA) to determine DG's optimal location and size.

DG is very necessary to integrate PV as a distributed resource into the grid. The integration of PV-DG into the electricity grid has a significant impact on reducing real power losses, operating costs and increasing system stability due to intermittent solar PV generation. The placement of solar PV-DG locations and the selection of PV size need to be designed optimally to improve the performance of the electricity network [76]. There are several standards used in integrating renewable energy sources with

the grid, namely IEEE 929-2000 IEEE 929-2000 [100], IEEE 519 [101], IEEE 157.47, IEEE 1547.5[102], ANSI C84 [103], IEC 555, IEC and IEC 61000 [18][104], UL 1741 [105], The specifications used include control systems, protection and power quality for PV systems. The size and configuration of a grid-connected PV system should consider the type of load and power flow to improve system stability.

3.2. Optimization for Photovoltaic System

Plans for optimizing distribution networks based on PV consider various operational constraints and minimizing losses and load balancing such as reducing power losses, increasing and decreasing voltage, system stability and annual economic [61], [106], [107]. Optimization of PV-DG needs to be done to increase network efficiency. In research studies, many algorithms are used to optimize distribution networks that originate from PV to evaluate the capacity and positioning of PV-DG units, namely the dingo optimization algorithm (DOA[108], [109] PSO - a heuristic algorithm [110][111], slime mould algorithm (SMA)[112]. The PV-DG placement scenario was simulated using MATLAB and OpenDSS which was validated using IEEE with various nodes and buses.

The Hyper-spherical search algorithm (HSSA) is employed to ascertain the optimal position and dimensions of the PV generation system. This algorithm is then tested on the IEEE 69 and IEEE 118 radial distribution systems utilizing the Power Loss Index (PLI) technique. The aim is to identify the bus with the highest potential for installation and to determine the most efficient location and economically viable size for the system. [113]. Meanwhile [97], in order to ascertain the most optimal location for the implementation of PV-DG within a medium voltage network system model that utilizes the IEEE 14 bus system and employs the OpenDSS in MATLAB, the utilization of PSO algorithms is also employed for the purpose of determining both the location and size of the PV generation that would ultimately result in the most optimal outcome in terms of minimizing total active power loss, voltage deviation, and the operating time of overcurrent relays that were subjected to testing in accordance with the IEEE 33-bus and 69-bus standards [93]. In a similar vein, the IGSA is employed and has exhibited the highest level of performance and has ultimately provided a superior solution as compared to the IGSA which was tested on the IEEE-13 bus network for the express purpose of enhancing the overall voltage profile of the network [98]. The Biogeography-Based optimization (BBO) algorithm with the IEEE standard was used in testing the 10, 69, 85, and 118 buses on MATLAB software [114].

To substantially improve the performance of the distribution network under various loading conditions, especially the efficiency of the PV-DG network. The DOA plays an essential role in optimizing all branches of the distribution network and determining the central location of the PV-DG with the optimal size of each machine [109]. Exploration and exploitation are components of the DOA algorithm. The circle phase of exploration examines the problem space as broadly as feasible. The exploitation is referred to as the attack phase, and it is used to arrive at the current best answer in the algorithm's final iteration.

3.3. Photovoltaic DG Impacts

Photovoltaic DG system integration has advantages and disadvantages that impact voltage and frequency, hosting capacity (HC), and power quality (PQ). PV distributed generators affect the RMS working voltage and frequency in sub-voltage [108], overvoltage [110], frequency and control. The impact on HC is in the form of active power, apparent power, non-active power [111], [112] and two-way current behaviour and electrical protection [113]. The impact on power quality can be seen from the total harmonic distortion (THD) indicator on current and voltage [115] and total rated-current Distortion (TRD). Distribution system impact studies must be carried out based on the results of connection feasibility studies. This study focuses on the potential adverse system impacts identified for (i) connection points and (ii) alternative connection points that result in the least potential adverse impacts on the system. The distribution system impact study consists of (i) power flow analysis in the distribution system, (ii) short circuit analysis, (iii) equipment termination rating analysis, (iv) set point protection and coordination study, (v) voltage drop study, and/or earthing review, (vi) analysis of the impact of distribution system operations

Impact on Voltage and Frequency

PV-DG can positively and negatively impact voltage and frequency. So, it is necessary to carry out prevention with a control strategy on the power converter that connects the PV to the distribution network. Sudden changes in solar PV power injection and rapid changes in voltage will occur within the permitted voltage [116]. DG integration in the electric power distribution network can improve network performance in general [27]. On DG-injected locations, the voltage profile gets better and electrical power losses decrease [67]. It is caused by the injection of DG into the tissue. DG as a power plant must have voltage and the same frequency as the nominal voltage and distribution network frequency as if providing refreshment of the tissue at the DG injection site [117] . However, the distribution pattern of power losses in the distribution network in this configuration has changed compared to before DG integration. Power losses in the distribution network will be further optimized by reconfiguring the network.

Impact on Power Quality

The impact of distributed PV generation is also influenced by location factors and the size of distributed PV generation. The adverse effects that arise are increasing imbalance in the distributed network which results in power losses due to reduced load current. To reduce the impact on distributed PV generation, the location and size of the DG were designed. In analyzing, many researchers use software such as DigSILENT Power Factory [118][119], MATLAB [88].

Radial network configuration sourced from PV creates a two-way current flow by increasing efficiency but can also reduce system stability. A modified plant growth simulation algorithm minimises actual power loss due to continuous generation in line with varying power generation so that it can be applied in actual lifetime [106]. Power quality parameters in a network are integrated with the PV grid. The potential impact of integrating PV in a low-voltage secondary network has the potential for disruption due to voltage drops caused by low levels of PV penetration due to generation. The existence of protection on the network, which prevents the flow of power to the upstream feeder by breaking the circuit with a relay to protect the transformer, will cause negative impacts [120] other adverse impacts of PV-DG include voltage profiles, overload and flicker.

4. Conclusion

This paper discusses the integration of PV-DG distribution network, namely, topology, optimization, and impacts on the distribution network. The literature review results found that DG was necessary to integrate PV as a distributed resource into the grid. Integrating solar PV-DG into the electricity grid significantly reduces actual power losses and operating costs and increases system stability due to intermittent solar PV generation. The potential adverse system impacts are identified for (i) connection points and (ii) alternative connection points that result in the least potential adverse impacts on the system. The placement of solar PV-DG locations and the selection of PV size need to be designed optimally to improve the performance of the electricity network using IEEE standards. In optimizing and increasing the efficiency of distribution network systems integrated with PV, many methods and algorithms are used, such as DOA, PSO - a heuristic algorithm, SMA, GA, HSSA, ALOA. The BBO for determining location and size in distribution networks. Optimizing and improving the voltage profile on the distribution network uses methods such as the IGSA, ASA, ICA, which employed the OpenDSS and MATLAB. The PV-DG distribution system integration has advantages and disadvantages that impact voltage and frequency, HC, and PQ. Therefore, optimizing PV-DG distribution system integration into the grid system has been challenging.

References

[1] Nasruddin *et al.*, “Potential of Geothermal Energy for Electricity Generation in Indonesia: A review,” *Renew. Sustain. Energy Rev.*, vol. 53, no. 2016, pp. 733–740, 2016, doi: 10.1016/j.rser.2015.09.032.

[2] T. Bin Nadeem, M. Siddiqui, M. Khalid, and M. Asif, “Distributed energy systems: A review of classification, technologies, applications, and policies:,” *Energy Strateg. Rev.*, vol. 48, no.

April, 2023, doi: 10.1016/j.esr.2023.101096.

[3] N. Kannan and D. Vakeesan, "Solar Energy for Future World: - A Review," *Renew. Sustain. Energy Rev.*, vol. 62, pp. 1092–1105, 2016, doi: 10.1016/j.rser.2016.05.022.

[4] S. D. Musa, T. Zhonghua, A. O. Ibrahim, and M. Habib, "China's energy status: A critical look at fossils and renewable options," *Renew. Sustain. Energy Rev.*, vol. 81, no. March, pp. 2281–2290, 2018, doi: 10.1016/j.rser.2017.06.036.

[5] M. E. Meral and D. Çelík, "A comprehensive survey on control strategies of distributed generation power systems under normal and abnormal conditions," *Annu. Rev. Control*, vol. 47, no. xxxx, pp. 112–132, 2019, doi: 10.1016/j.arcontrol.2018.11.003.

[6] T. Hickmann, O. Widerberg, M. Lederer, and P. Pattberg, "The United Nations Framework Convention on Climate Change Secretariat as an orchestrator in global climate policymaking," *Int. Rev. Adm. Sci.*, vol. 87, no. 1, pp. 21–38, 2021, doi: 10.1177/0020852319840425.

[7] D. Xu, S. Abbas, K. Rafique, and N. Ali, "The race to net-zero emissions: Can green technological innovation and environmental regulation be the potential pathway to net-zero emissions?," *Technol. Soc.*, vol. 75, p. 102364, 2023, doi: https://doi.org/10.1016/j.techsoc.2023.102364.

[8] L. Li *et al.*, "Review and outlook on the international renewable energy development," *Energy Built Environ.*, vol. 3, no. 2, pp. 139–157, 2022, doi: 10.1016/j.enbenv.2020.12.002.

[9] D. Maradin, "Advantages and disadvantages of renewable energy sources utilization," *Int. J. Energy Econ. Policy*, vol. 11, no. 3, pp. 176–183, 2021, doi: 10.32479/ijeep.11027.

[10] K. Hansen, C. Breyer, and H. Lund, "Status and perspectives on 100% renewable energy systems," *Energy*, vol. 175, pp. 471–480, 2019, doi: 10.1016/j.energy.2019.03.092.

[11] D. C. Momete, "Analysis of the Potential of Clean Energy Deployment in the European Union," *IEEE Access*, vol. 6, pp. 54811–54822, 2018, doi: 10.1109/ACCESS.2018.2872786.

[12] D. Gielen, F. Boshell, D. Saygin, M. D. Bazilian, N. Wagner, and R. Gorini, "The role of renewable energy in the global energy transformation," *Energy Strateg. Rev.*, vol. 24, no. January, pp. 38–50, 2019, doi: 10.1016/j.esr.2019.01.006.

[13] C. Breyer *et al.*, "On the History and Future of 100% Renewable Energy Systems Research," *IEEE Access*, vol. 10, no. June, pp. 78176–78218, 2022, doi: 10.1109/ACCESS.2022.3193402.

[14] Z. Xu *et al.*, "Towards high resolution monitoring of water flow velocity using flat flexible thin mm-sized resistance-typed sensor film (MRSF)," *Water Res. X*, vol. 4, p. 100028, 2019, doi: https://doi.org/10.1016/j.wroa.2019.100028.

[15] R. Vakulchuk, I. Overland, and D. Scholten, "Renewable energy and geopolitics: A review," *Renew. Sustain. Energy Rev.*, vol. 122, no. October, p. 109547, 2020, doi: 10.1016/j.rser.2019.109547.

[16] K. Hesaroor and D. Das, "Annual energy loss reduction of distribution network through reconfiguration and renewable energy sources," *Int. Trans. Electr. Energy Syst.*, vol. 29, no. 11, pp. 1–21, 2019, doi: 10.1002/2050-7038.12099.

[17] C. Sweeney, R. J. Bessa, J. Browell, and P. Pinson, "The future of forecasting for renewable energy," *Wiley Interdiscip. Rev. Energy Environ.*, vol. 9, no. 2, pp. 1–18, 2020, doi: 10.1002/wene.365.

[18] M. Morey, N. Gupta, M. M. Garg, and A. Kumar, "A comprehensive review of grid-connected solar photovoltaic system: Architecture, control, and ancillary services," *Renew. Energy Focus*, vol. 45, pp. 307–330, 2023, doi: 10.1016/j.ref.2023.04.009.

[19] A. Qazi *et al.*, "Towards Sustainable Energy: A Systematic Review of Renewable Energy Sources, Technologies, and Public Opinions," *IEEE Access*, vol. 7, pp. 63837–63851, 2019,

doi: 10.1109/ACCESS.2019.2906402.

[20] B. Maharmi, J. Sidi, and M. Machdalena, "Solar Panel Tracking Control Monitoring System," *J. Ocean. Mech. Aerosp. -science Eng.*, vol. 67, no. 2, pp. 40–46, 2023, doi: 10.36842/jomase.v67i2.348.

[21] P. Pereira da Silva, G. Dantas, G. I. Pereira, L. Câmara, and N. J. De Castro, "Photovoltaic distributed generation – An international review on diffusion, support policies, and electricity sector regulatory adaptation," *Renew. Sustain. Energy Rev.*, vol. 103, no. April 2018, pp. 30–39, 2019, doi: 10.1016/j.rser.2018.12.028.

[22] D. Oudes and S. Stremke, "Next generation solar power plants? A comparative analysis of frontrunner solar landscapes in Europe," *Renew. Sustain. Energy Rev.*, vol. 145, p. 111101, 2021, doi: 10.1016/j.rser.2021.111101.

[23] D. Murillo-Yarce *et al.*, "A review of control techniques in photovoltaic systems," *Sustain.*, vol. 12, no. 24, pp. 1–22, 2020, doi: 10.3390/su122410598.

[24] K. Ogimoto, I. Kaizuka, Y. Ueda, and T. Oozeki, "A good fit: Japan's solar power program and prospects for the new power system," *IEEE Power Energy Mag.*, vol. 11, no. 2, pp. 65–74, 2013, doi: 10.1109/MPE.2012.2234408.

[25] C. Lupangu and R. C. Bansal, "A review of technical issues on the development of solar photovoltaic systems," *Renew. Sustain. Energy Rev.*, vol. 73, no. February, pp. 950–965, 2017, doi: 10.1016/j.rser.2017.02.003.

[26] Y. Yang, P. Enjeti, F. Blaabjerg, and H. Wang, "Wide-scale adoption of photovoltaic energy: Grid code modifications are explored in the distribution grid," *IEEE Ind. Appl. Mag.*, vol. 21, no. 5, pp. 21–31, 2015, doi: 10.1109/MIAS.2014.2345837.

[27] R. O. Bawazir and N. S. Cetin, "Comprehensive overview of optimizing PV-DG allocation in power system and solar energy resource potential assessments," *Energy Reports*, vol. 6, pp. 173–208, 2020, doi: 10.1016/j.egyr.2019.12.010.

[28] M. Bajaj and A. K. Singh, "Grid integrated renewable DG systems: A review of power quality challenges and state-of-the-art mitigation techniques," *Int. J. Energy Res.*, vol. 44, no. 1, pp. 26–69, 2020.

[29] E. Niesten, "Network investments and the integration of distributed generation: Regulatory recommendations for the Dutch electricity industry," *Energy Policy*, vol. 38, no. 8, pp. 4355–4362, 2010.

[30] M. Mathew, M. S. Hossain, S. Saha, S. Mondal, and M. E. Haque, "Sizing approaches for solar photovoltaic-based microgrids: A comprehensive review," *IET Energy Syst. Integr.*, vol. 4, no. 1, pp. 1–27, 2022.

[31] A. Sharma *et al.*, "Performance assessment of institutional photovoltaic based energy system for operating as a micro-grid," *Sustain. Energy Technol. Assessments*, vol. 37, p. 100563, 2020.

[32] M. Kandasamy, R. Thangavel, T. Arumugam, J. Jayaram, W.-W. Kim, and Z. W. Geem, "Performance Enhancement of Radial Power Distribution Networks Using Network Reconfiguration and Optimal Planning of Solar Photovoltaic-Based Distributed Generation and Shunt Capacitors," *Sustainability*, vol. 14, no. 18, p. 11480, 2022.

[33] B. Parida, S. Iniyan, and R. Goic, "A review of solar photovoltaic technologies," *Renew. Sustain. energy Rev.*, vol. 15, no. 3, pp. 1625–1636, 2011.

[34] M. S. Thopil, R. C. Bansal, L. Zhang, and G. Sharma, "A review of grid connected distributed generation using renewable energy sources in South Africa," *Energy Strateg. Rev.*, vol. 21, pp. 88–97, 2018.

[35] A. S. N. Huda and R. Živanović, "Large-scale integration of distributed generation into

distribution networks: Study objectives, review of models and computational tools," *Renew. Sustain. Energy Rev.*, vol. 76, pp. 974–988, 2017.

[36] E. H. Arya, B. Maharmi, and M. Lutfi, "Analysis of Oil Dielectric Strength Insulation on Oil Circuit Breakers Based on Service Life and Operating Frequency," *J. Ocean. Mech. Aerosp. - science Eng.*, vol. 66, no. 2, pp. 50–56, 2022, doi: 10.36842/jomase.v66i2.300.

[37] J. Atkinson and I. M. Albayati, "Impact of the Generation System Parameters on the Frequency Response of the Power System: A UK Grid Case Study," *Electricity*, vol. 2, no. 2, pp. 143–157, 2021, doi: 10.3390/electricity2020009.

[38] S. Ruiz-Romero, A. Colmenar-Santos, F. Mur-Pérez, and Á. López-Rey, "Integration of distributed generation in the power distribution network: The need for smart grid control systems, communication and equipment for a smart city - Use cases," *Renew. Sustain. Energy Rev.*, vol. 38, pp. 223–234, 2014, doi: 10.1016/j.rser.2014.05.082.

[39] S.-E. Razavi *et al.*, "Impact of distributed generation on protection and voltage regulation of distribution systems: A review," *Renew. Sustain. Energy Rev.*, vol. 105, pp. 157–167, 2019.

[40] O. T. Huxley *et al.*, "The uncertainties involved in measuring national solar photovoltaic electricity generation," *Renew. Sustain. Energy Rev.*, vol. 156, p. 112000, 2022.

[41] M. Obi and R. Bass, "Trends and challenges of grid-connected photovoltaic systems–A review," *Renew. Sustain. Energy Rev.*, vol. 58, pp. 1082–1094, 2016.

[42] F. A. Viawan and D. Karlsson, "Combined local and remote voltage and reactive power control in the presence of induction machine distributed generation," *IEEE Trans. Power Syst.*, vol. 22, no. 4, pp. 2003–2012, 2007.

[43] S. Jain and V. Agarwal, "An integrated hybrid power supply for distributed generation applications fed by nonconventional energy sources," *IEEE Trans. energy Convers.*, vol. 23, no. 2, pp. 622–631, 2008.

[44] E. Martinot, L. Kristov, and J. D. Erickson, "Distribution system planning and innovation for distributed energy futures," *Curr. Sustain. Energy Reports*, vol. 2, pp. 47–54, 2015.

[45] D. P. Bernardon and V. J. Garcia, *Smart Operation for Power Distribution Systems: Concepts and Applications*. Springer, 2018.

[46] M. Romero, W. Guédria, H. Panetto, and B. Barafort, "Towards a characterisation of smart systems: A systematic literature review," *Comput. Ind.*, vol. 120, p. 103224, 2020.

[47] B. Sultana, M. W. Mustafa, U. Sultana, and A. R. Bhatti, "Review on reliability improvement and power loss reduction in distribution system via network reconfiguration," *Renew. Sustain. energy Rev.*, vol. 66, pp. 297–310, 2016.

[48] O. Badran, S. Mekhilef, H. Mokhlis, and W. Dahalan, "Optimal reconfiguration of distribution system connected with distributed generations: A review of different methodologies," *Renew. Sustain. Energy Rev.*, vol. 73, pp. 854–867, 2017.

[49] O. Mohammed, T. Youssef, M. H. Cintuglu, and A. Elsayed, "Design and simulation issues for secure power networks as resilient smart grid infrastructure," in *Smart Energy Grid Engineering*, Elsevier, 2017, pp. 245–342.

[50] J. O. Petinrin and M. Shaaban, "Smart power grid: Technologies and applications," in *2012 IEEE international conference on power and energy (PECon)*, IEEE, 2012, pp. 892–897.

[51] S. Khoussi and A. Mattas, "A brief introduction to smart grid safety and security," in *Handbook of system safety and security*, Elsevier, 2017, pp. 225–252.

[52] D. K. Panda and S. Das, "Smart grid architecture model for control, optimization and data analytics of future power networks with more renewable energy," *J. Clean. Prod.*, vol. 301, p. 126877, 2021.

[53] J. R. Aguero, E. Takayesu, D. Novosel, and R. Masiello, "Modernizing the grid: Challenges and opportunities for a sustainable future," *IEEE Power Energy Mag.*, vol. 15, no. 3, pp. 74–83, 2017.

[54] I. Colak, E. Kabalci, G. Fulli, and S. Lazarou, "A survey on the contributions of power electronics to smart grid systems," *Renew. Sustain. Energy Rev.*, vol. 47, pp. 562–579, 2015.

[55] F. F. Yanine and E. E. Sauma, "Review of grid-tie micro-generation systems without energy storage: Towards a new approach to sustainable hybrid energy systems linked to energy efficiency," *Renew. Sustain. Energy Rev.*, vol. 26, pp. 60–95, 2013.

[56] M. E. El-Hawary, "The smart grid—state-of-the-art and future trends," *Electr. Power Components Syst.*, vol. 42, no. 3–4, pp. 239–250, 2014.

[57] N. Mlilo, J. Brown, and T. Ahfock, "Impact of intermittent renewable energy generation penetration on the power system networks – A review," *Technol. Econ. Smart Grids Sustain. Energy*, vol. 6, no. 1, 2021, doi: 10.1007/s40866-021-00123-w.

[58] V. Samoylenko, P. Ilyushin, and A. Pazderin, "Balancing unpredictable load and intermittent renewables by semi-dispatchable distributed generation," *Proc. 2020 Ural Smart Energy Conf. USEC 2020*, pp. 134–137, 2020, doi: 10.1109/USEC50097.2020.9281248.

[59] S. Pranith, S. Kumar, B. Singh, and T. S. Bhatti, "Multimode operation of PV-battery system with renewable intermittency smoothening and enhanced power quality," *IET Renew. Power Gener.*, vol. 13, no. 6, pp. 887–897, 2019, doi: 10.1049/iet-rpg.2018.5843.

[60] W. Zheng and B. Zou, "Evaluation of intermittent-distributed-generation hosting capability of a distribution system with integrated energy-storage systems," *Global Energy Interconnection*, vol. 4, no. 4. Elsevier, pp. 415–424, 2021. doi: 10.1016/j.gloei.2021.09.003.

[61] M. R. Elkadeem, M. Abd Elaziz, Z. Ullah, S. Wang, and S. W. Sharshir, "Optimal Planning of Renewable Energy-Integrated Distribution System Considering Uncertainties," *IEEE Access*, vol. 7, pp. 164887–164907, 2019, doi: 10.1109/ACCESS.2019.2947308.

[62] X. Fu, H. Chen, R. Cai, and P. Yang, "Optimal allocation and adaptive VAR control of PV-DG in distribution networks," *Appl. Energy*, vol. 137, pp. 173–182, 2015, doi: 10.1016/j.apenergy.2014.10.012.

[63] T. Remani *et al.*, "Integration of distributed generation in the power distribution network: The need for smart grid control systems, communication and equipment for a smart city—Use cases," *Appl. Energy*, vol. 5, no. 1, pp. 2192–2203, 2015, doi: 10.1109/TPEL.2018.2828538.

[64] P. Wang, W. Wang, and D. Xu, "Optimal sizing of distributed generations in DC microgrids with comprehensive consideration of system operation modes and operation targets," *IEEE Access*, vol. 6, pp. 31129–31140, 2018, doi: 10.1109/ACCESS.2018.2842119.

[65] P. Wang *et al.*, "Integration of distributed generation in the power distribution network: The need for smart grid control systems, communication and equipment for a smart city—Use cases," *Appl. Energy*, vol. 5, no. 1, pp. 2192–2203, 2015, doi: 10.1109/TPEL.2018.2828538.

[66] S. Sakar, M. E. Balci, S. H. E. Abdel Aleem, and A. F. Zobaa, "Integration of large- scale PV plants in non-sinusoidal environments: Considerations on hosting capacity and harmonic distortion limits," *Renewable and Sustainable Energy Reviews*, vol. 82. pp. 176–186, 2018. doi: 10.1016/j.rser.2017.09.028.

[67] S. S. Parihar and N. Malik, "Analysing the impact of optimally allocated solar PV-based DG in harmonics polluted distribution network," *Sustain. Energy Technol. Assessments*, vol. 49, no. September 2021, p. 101784, 2022, doi: 10.1016/j.seta.2021.101784.

[68] F. Blaabjerg, D. M. Ionel, Y. Yang, and ..., "Renewable energy systems: technology overview and perspectives," *Renew. Energy …*, 2017, doi: 10.1201/9781315367392-1.

[69] T. Beck, H. Kondziella, G. Huard, and T. Bruckner, "Optimal operation, configuration and sizing of generation and storage technologies for residential heat pump systems in the spotlight of self-consumption of photovoltaic electricity," *Appl. Energy*, vol. 188, pp. 604–619, 2017, doi: 10.1016/j.apenergy.2016.12.041.

[70] M. R. Elkadeem and M. A. Abido, "Optimal planning and operation of grid-connected PV/CHP/battery energy system considering demand response and electric vehicles for a multi-residential complex building," *J. Energy Storage*, vol. 72, no. PB, p. 108198, 2023, doi: 10.1016/j.est.2023.108198.

[71] H. M. H. Farh, A. M. Al-Shaalan, A. M. Eltamaly, and A. A. Al-Shamma'a, "A novel severity performance index for optimal allocation and sizing of photovoltaic distributed generations," *Energy Reports*, vol. 6, pp. 2180–2190, 2020, doi: 10.1016/j.egyr.2020.07.016.

[72] V. Janamala and K. R. Rani, "Optimal allocation of solar photovoltaic distributed generation in electrical distribution networks using Archimedes optimization algorithm," *Clean Energy*, vol. 6, no. 2, pp. 1036–1052, 2022, doi: 10.1093/ce/zkac010.

[73] A. Mohammad and F. Mahjabeen, "Revolutionizing Solar Energy: The Impact of Artificial Intelligence onPhotovoltaic Systems," *Int. J. Multidiscip. Sci. Arts*, vol. 2, no. 1, pp. 117–127, 2023, [Online]. Available: https://doi.org/10.47709/ijmdsa.vxix.xxxx

[74] H. Kakigano, Y. Miura, and T. Ise, "Distribution voltage control for DC microgrids using fuzzy control and gain-scheduling technique," *IEEE Trans. Power Electron.*, vol. 28, no. 5, pp. 2246–2258, 2013, doi: 10.1109/TPEL.2012.2217353.

[75] J. Caballero-Peña, C. Cadena-Zarate, A. Parrado-Duque, and G. Osma-Pinto, "Distributed energy resources on distribution networks: A systematic review of modelling, simulation, metrics, and impacts," *Int. J. Electr. Power Energy Syst.*, vol. 138, no. December 2021, 2022, doi: 10.1016/j.ijepes.2021.107900.

[76] R. Syahputra, I. Robandi, and M. Ashari, "Performance improvement of radial distribution network with distributed generation integration using extended particle swarm optimization algorithm," *Int. Rev. Electr. Eng.*, vol. 10, no. 2, pp. 293–304, 2015.

[77] R. Syahputra, I. Robandi, and M. Ashari, "PSO based multi-objective optimization for reconfiguration of radial distribution network," *Int. J. Appl. Eng. Res.*, vol. 10, no. 6, pp. 14573–14586, 2015.

[78] K. A. Khan, M. M. Quamar, F. H. Al-Qahtani, M. Asif, M. Alqahtani, and M. Khalid, "Smart grid infrastructure and renewable energy deployment: A conceptual review of Saudi Arabia," *Energy Strateg. Rev.*, vol. 50, p. 101247, 2023.

[79] M. A. Basit, S. Dilshad, R. Badar, and S. M. Sami ur Rehman, "Limitations, challenges, and solution approaches in grid-connected renewable energy systems," *Int. J. Energy Res.*, vol. 44, no. 6, pp. 4132–4162, 2020.

[80] L. Taylor and T. A. Short, *Distribution reliability and power quality*. Crc Press, 2018.

[81] A. Bagheri, H. Monsef, and H. Lesani, "Integrated distribution network expansion planning incorporating distributed generation considering uncertainties, reliability, and operational conditions," *Int. J. Electr. Power Energy Syst.*, vol. 73, pp. 56–70, 2015.

[82] M. S. ElNozahy and M. M. A. Salama, "Technical impacts of grid-connected photovoltaic systems on electrical networks—A review," *J. Renew. Sustain. Energy*, vol. 5, no. 3, 2013.

[83] B. P. Singh, S. K. Goyal, and S. A. Siddiqui, "Grid connected-photovoltaic system (GC-PVS): Issues and challenges," in *IOP conference series: materials science and engineering*, IOP Publishing, 2019, p. 12032.

[84] E. D. Melaku, E. S. Bayu, C. Roy, A. Ali, and B. Khan, "Distribution network forecasting and expansion planning with optimal location and sizing of solar photovoltaic-based distributed

generation," *Comput. Electr. ...*, 2023, [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0045790623002860

[85] F. Barbieri, S. Rajakaruna, and A. Ghosh, "Very short-term photovoltaic power forecasting with cloud modeling: A review," *Renew. Sustain. Energy Rev.*, vol. 75, pp. 242–263, 2017.

[86] M. Q. Raza, M. Nadarajah, and C. Ekanayake, "On recent advances in PV output power forecast," *Sol. Energy*, 2016, [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0038092X16302547

[87] M. Konstantinou, S. Peratikou, and A. G. Charalambides, "Solar photovoltaic forecasting of power output using LSTM networks," *Atmosphere (Basel).*, vol. 12, no. 1, p. 124, 2021.

[88] A. M. Soliman, S. M. Emara, and M. N. F. Nashed, "Grid Performance Enhancement Study Under Restricted Placement and Sizing of PV Distributed Generation," *J. Electr. Eng. Technol.*, vol. 18, no. 1, pp. 229–237, 2023, doi: 10.1007/s42835-022-01219-8.

[89] M. Emmanuel and R. Rayudu, "The impact of single-phase grid-connected distributed photovoltaic systems on the distribution network using P-Q and P-V models," *Int. J. Electr. Power Energy Syst.*, vol. 91, pp. 20–33, 2017, doi: 10.1016/j.ijepes.2017.03.001.

[90] M. Emmanuel, R. Rayudu, and I. Welch, "Grid capacity released analysis and incremental addition computation for distribution system planning," *Electr. Power Syst. Res.*, vol. 152, pp. 105–121, 2017, doi: 10.1016/j.epsr.2017.06.013.

[91] M. Emmanuel, R. Rayudu, and I. Welch, "Grid capacity released analysis and incremental addition computation for distribution system planning," *Electr. Power Syst. Res.*, 2017, [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0378779617302626

[92] G. W. Chang and N. Cong Chinh, "Coyote optimization algorithm-based approach for strategic planning of photovoltaic distributed generation," *IEEE Access*, vol. 8, pp. 36180–36190, 2020, doi: 10.1109/ACCESS.2020.2975107.

[93] N. Belbachir, M. Zellagui, A. Lasmari, C. Z. El-Bayeh, and B. Bekkouche, "Optimal integration of photovoltaic distributed generation in electrical distribution network using hybrid modified PSO algorithms," *Indones. J. Electr. Eng. Comput. Sci.*, vol. 24, no. 1, pp. 50–60, 2021, doi: 10.11591/ijeecs.v24.i1.pp50-60.

[94] M. Emmanuel and R. Rayudu, "Equipment loading and voltage unbalance in the distribution network with distributed PVs," *IEEE PES Innovative Smart Grid Technologies Conference Europe*. pp. 9–14, 2016. doi: 10.1109/ISGT-Asia.2016.7796353.

[95] S. Alvarado-Reyes, P. Villar-Yacila, and H. Fiestas, "Imperialist competitive algorithm applied to the optimal integration of photovoltaic distributed generation units into a microgrid," *e-Prime - Adv. Electr. Eng. Electron. Energy*, vol. 2, p. 100086, 2022, doi: 10.1016/j.prime.2022.100086.

[96] M. Q. Duong, T. D. Pham, T. T. Nguyen, A. T. Doan, and H. Van Tran, "Determination of optimal location and sizing of solar photovoltaic distribution generation units in radial distribution systems," *Energies*, vol. 12, no. 1, 2019, doi: 10.3390/en12010174.

[97] J. Torres, A. A. Recalde, and I. Endara, "Optimal sizing of distributed photovoltaic generation in a MV network," *2020 IEEE PES Transmission and Distribution Conference and Exhibition - Latin America, T and D LA 2020*. 2020. doi: 10.1109/TDLA47668.2020.9326137.

[98] S. Daud, A. F. A. Kadir, C. K. Gan, and A. R. Abdullah, "Optimal allocation and sizing of photovoltaic-based distributed generation for voltage dip improvement," *PECON 2016 - 2016 IEEE 6th International Conference on Power and Energy, Conference Proceeding*. pp. 89–94, 2017. doi: 10.1109/PECON.2016.7951539.

[99] E. S. Ali, S. M. Abd Elazim, and A. Y. Abdelaziz, "Ant Lion Optimization Algorithm for renewable Distributed Generations," *Energy*, vol. 116, pp. 445–458, 2016, doi:

10.1016/j.energy.2016.09.104.

[100] R. M. Hudson, T. Thorne, F. Mekanik, M. R. Behnke, S. Gonzalez, and J. Ginn, "Implementation and testing of anti-islanding algorithms for IEEE 929-2000 compliance of single phase photovoltaic inverters," in *Conference Record of the Twenty-Ninth IEEE Photovoltaic Specialists Conference, 2002.*, IEEE, 2002, pp. 1414–1419.

[101] I. Wallace, "Key Changes and Differences between the New IEEE 519- 2014 Standard and IEEE 519-1992," *Alcatel Telecommun. Rev.*, vol. 11, no. 1, pp. 91–103, 2014.

[102] W. Group, "IEEE Application Guide for IEEE Std 1547, IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems," *IEEE Std 1547.2-2008*, no. April, pp. 1–207, 2008.

[103] S. Shafiq, B. Khan, and A. T. Al-Awami, "An Autonomous DG Controller Using Artificial Intelligence Approach for Voltage Control," in *2020 2nd International Conference on Smart Power & Internet Energy Systems (SPIES)*, IEEE, 2020, pp. 446–451.

[104] S. S. Rangarajan, E. R. Collins, J. C. Fox, and D. P. Kothari, "A survey on global PV interconnection standards," in *2017 IEEE Power and Energy Conference at Illinois, PECI 2017*, IEEE, 2017, pp. 1–8. doi: 10.1109/PECI.2017.7935716.

[105] R. Mahmud, A. Hoke, and D. Narang, "Validating the test procedures described in UL 1741 SA and IEEE P1547.1," in *2018 IEEE 7th World Conference on Photovoltaic Energy Conversion, WCPEC 2018 - A Joint Conference of 45th IEEE PVSC, 28th PVSEC and 34th EU PVSEC*, IEEE, 2018, pp. 1445–1450. doi: 10.1109/PVSC.2018.8547346.

[106] R. Rajaram, K. Sathish Kumar, and N. Rajasekar, "Power system reconfiguration in a radial distribution network for reducing losses and to improve voltage profile using modified plant growth simulation algorithm with Distributed Generation (DG)," *Energy Reports*, vol. 1, pp. 116–122, 2015, doi: 10.1016/j.egyr.2015.03.002.

[107] L. Luo *et al.*, "Optimal siting and sizing of distributed generation in distribution systems with PV solar farm utilized as STATCOM (PV-STATCOM)," *Appl. Energy*, vol. 210, pp. 1092–1100, 2018, doi: 10.1016/j.apenergy.2017.08.165.

[108] S. O. Ayanlade *et al.*, "Optimal Allocation of Photovoltaic Distributed Generations in Radial Distribution Networks," *Sustain.*, vol. 15, no. 18, 2023, doi: 10.3390/su151813933.

[109] B. G. Sujatha and G. S. Anitha, "Grid synchronisation of photovoltaic distributed generation using hybrid FUZZY-PI controller," *Int. J. Innov. Technol. Explor. Eng.*, vol. 9, no. 1, pp. 5385–5390, 2019, doi: 10.35940/ijitee.A4740.119119.

[110] O. Babayomi, O. Babatunde, and T. Okharedia, "Sustainability of Distributed Generation in a Reconfigured Distribution Network," *2018 IEEE PES/IAS PowerAfrica, PowerAfrica 2018*. pp. 619–622, 2018. doi: 10.1109/PowerAfrica.2018.8521031.

[111] N. Belbachir, M. Zellagui, A. Lasmari, C. Z. El-Bayeh, and B. Bekkouche, "Optimal PV Sources Integration in Distribution System and Its Impacts on Overcurrent Relay Based Time-Current-Voltage Tripping Characteristic," *12th International Symposium on Advanced Topics in Electrical Engineering, ATEE 2021*. 2021. doi: 10.1109/ATEE52255.2021.9425155.

[112] T. D. Pham, T. T. Nguyen, and L. C. Kien, "Optimal Placement of Photovoltaic Distributed Generation Units in Radial Unbalanced Distribution Systems Using MATLAB and OpenDSS-Based Cosimulation and a Proposed Metaheuristic Algorithm," *Int. Trans. Electr. Energy Syst.*, vol. 2022, 2022, doi: 10.1155/2022/1446479.

[113] M. A. E. H. Mohamed, A. Elnozahy, and A. Y. Abdelaziz, "Optimal energy saving of photovoltaic distributed generation system with considering environment condition via hyper-spherical search algorithm," *WSEAS Trans. Power Syst.*, vol. 13, pp. 311–325, 2018, [Online]. Available: https://api.elsevier.com/content/abstract/scopus_id/85062277920

[114] R. Bawazir, N. Cetin, M. Mosbah, and S. Arif, "Improvement of the Voltage Profile of the Distribution Network by Optimal Integration of PVbased Decentralised Source," *2020 International Conference on Electrical Engineering, ICEE 2020*. 2020. doi: 10.1109/ICEE49691.2020.9249895.

[115] E. Ghiani and G. Pisano, "Impact of Renewable Energy Sources and Energy Storage Technologies on the Operation and Planning of Smart Distribution Networks," in *Operation of Distributed Energy Resources in Smart Distribution Networks*, Elsevier, 2018, pp. 25–48. doi: 10.1016/B978-0-12-814891-4.00002-3.

[116] F. H. M. Rafi, M. J. Hossain, and J. Lu, "Hierarchical controls selection based on PV penetrations for voltage rise mitigation in a LV distribution network," *Int. J. Electr. Power Energy Syst.*, vol. 81, pp. 123–139, 2016.

[117] H. Alatrash, R. A. Amarin, and C. Lam, "Enabling large-scale PV integration into the grid," *2012 IEEE Green Technol. Conf.*, no. Lv, 2012, doi: 10.1109/GREEN.2012.6200939.

[118] N. M. Saad *et al.*, "Impacts of photovoltaic distributed generation location and size on distribution power system network," *Int. J. Power Electron. Drive Syst.*, vol. 9, no. 2, pp. 905–913, 2018, doi: 10.11591/ijpeds.v9.i2.pp905-913.

[119] W. Sun, C. Liu, G. He, K. Feng, and W. Zhao, "Optimization planning of distributed renewable generation based on long time series simulation," *Dianwang Jishu/Power Syst. Technol.*, vol. 39, no. 2, pp. 457–463, 2015, doi: 10.13335/j.1000-3673.pst.2015.02.025.

[120] P. Mohammadi and S. Mehraeen, "Challenges of PV Integration in Low-Voltage Secondary Networks," *IEEE Trans. Power Deliv.*, vol. 32, no. 1, pp. 525–535, 2017, doi: 10.1109/TPWRD.2016.2556692.