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Editorial: Distributed solar PV applications

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Editorial on the Research Topic
Distributed solar PV applications

Solar photovoltaic (PV) power generation has become the most economical way of generating electricity. Various drivers, including increase in competition in energy generation markets, large scale production, and technological advancements, have significantly reduced the cost of electricity produced from solar PV over the last decade. While most solar PV developments have primarily emerged at the utility scale, distributed solar PV systems—rooftop-mounted or integrated into buildings or structures—have become a crucial component of sustainable energy policies worldwide, even though with a wide variance among countries. Undoubtedly, producing energy from distributed solar PV can play a fundamental role in achieving emission targets, meeting the increasing global energy demand, and making power systems more resilient and affordable. Furthermore, distributed solar PV generation has the additional benefits of reducing electrical losses and the congestion in transmission lines. The development of economically attractive battery storage systems and the increasing demand for electric vehicles (EVs) further accelerate their applications. However, the expansion of distributed solar PV is expected to bring about enormous disruptions to traditional electricity systems, creating both opportunities and many challenges in the energy markets. These challenges extend to operators, regulators, generators, new entrants, networks, and also impact the overall economy of a country. Hence, the development and management of distributed solar PV generation systems require complex and multidisciplinary solutions.

Among the important challenges are regulatory barriers and inconsistencies in policymaking, financial barriers and complexities in obtaining financing, informational and behavioral barriers in raising awareness, providing information, and influencing customer decisions, as well as important technical challenges either at the plant level or grid connection level. The Research Topics aim principally to respond to these important challenges that distributed solar PV faces.

With the increasing utilization of solar PV power plants, optimizing solar power generation has become crucial to reduce system operational costs and enhance efficiency. Various techniques have been proposed in the literature to ensure maximum PV power output under varying conditions. One of the most significant approaches is maximum power point tracking (MPPT), employed due to the non-linear behavior of PV power plants. However, under changing environmental and partial shading conditions, standard MPPT methods may yield unexpected results. The study, "*Backstepping-based real twisting sliding mode control for photovoltaic system*," authored by Ullah et al. proposes an MPPT control strategy for the PV-battery system, aiming to extract the maximum available power by tracking PV voltage. Additionally, the authors introduce a direct sliding mode control for a battery-integrated buck-boost converter for voltage regulation. The proposed MPPT strategy is tested against variations in irradiance, temperature, and load, and simulation results highlight its superior tracking performance, reduced chattering, and oscillations compared to existing models. The results are then a potential viable alternative to reduce operational costs and improve de efficiency of solar power generation.

In another study titled "*A MATLAB-based modeling to study and enhance the performance of photovoltaic panel configurations during partial shading conditions*," authored by Ali et al. the objective is to propose a different methodology for addressing another important technical challenge in PV solar applications—namely partial shading conditions. Shading poses a considerable challenge, resulting in significant power output reductions, multiple power peaks in the P-V characteristics, decreased efficiency, and a shortened lifespan. The causes of shading include factors such as adjacent buildings and trees, which can be managed during installation, as well as unpredictable elements like clouds, snow, temperature variations, and others. To tackle this issue, the study introduces the Magic Square View (MSV), which involves a physical rearrangement of PV modules within a Total Cross Tie (TCT) interconnection scheme, effectively dispersing shadows across the entire photovoltaic array. The results highlight that the proposed method has improved the power output of the PV array, especially with Long and Wide shading patterns, leading to a notable power enhancement shading pattern.

Finally, the research article "*Analysis, monitoring, and mitigation of power quality disturbances in a distributed generation system*" authored by Ravi and Kumar responds to the challenges of solar PV integration at the grid level. Despite the numerous benefits of distributed generation, there are a number of challenges associated with integrating it to the grid. One of the challenges is a technical issue primarily linked to power quality. Various power quality problems impact the grid, including voltage disturbances, swells, harmonics, load shedding, and others. These complications significantly affect industrial, commercial, and residential customers. Additionally, these factors also influence measurement instruments and monitoring systems. Due to these challenges, there is a growing need to analyze, monitor, and mitigate power quality disturbances in a distributed generation system. The main research purpose of this article is to fill this gap conducting a comprehensive analysis of power quality problems, critically reviewing mitigation and control techniques such as Distribution Static Compensator (DSTATCOM), Dynamic Voltage Restorer (DVR), Unified Power Quality Conditioner (UPQC), and Uninterruptible Power Supply (UPS).

In summary, these papers collectively present different and complementary techniques used to address important challenges in the integration of solar PV generations into the power system. This compilation represents a valuable contribution to the literature and provides researchers working on improving the performance of solar PV generations, whether at the plant level or within the grid, with a valuable resource to enrich their research.

Author contributions

SN: Conceptualization, Investigation, Writing–original draft, Writing–review and editing. AC: Writing–original draft, Writing–review and editing. CA: Writing–original draft, Writing–review and editing. CG-H: Writing–original draft, Writing–review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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