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Editorial

Advances and Challenges in Solar PV Systems' Performance

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The increase in the dissemination of renewable energies constitutes a new energy model that can be used to face the global challenges derived from the reduction in fossil fuels to limit the effects of global warming. In this framework, photovoltaic (PV) energy is playing a significant role in decarbonization policies worldwide. PV installations are growing every year; in particular, around 175 GW was commissioned worldwide in 2021, and the cumulative installed capacity at the end of 2021 reached 942 GW [1].

This editorial paper intends to highlight examples of recent advancements in different topics closely related to PV systems' performance through a number of research and review papers recently published in *Energies*. As the editor, has been pleasant to review and highlight some of the current developments in this topic; we received many interesting contributions, as PV systems' performance is a very active area of research. Therefore, as a way to illustrate the last recent activities and contributions in the field, a number of papers were selected, and here, their main findings are briefly commented upon.

The extensive growth of PV highlights the need for research into the degradation and fault detection of PV systems to improve their stability and performance. In this context, the development of robust methods for the detection and classification of faults and anomalies in PV systems is desirable. The literature contains several different techniques used to classify faults. A new and recent classification method is presented and discussed in [2].

The influence of data averaging and temporal resolution in PV-batteries systems for self-consumption is explored in [3]. A study was conducted by averaging the measurements of data related to 3 min of generation and demand to 15, 30 and 60 min. The coarse resolution of data affected the discharge of the storage system and may have also produced cable overload during over-generation. A coarse temporal resolution can also undersize the power of a converter, which regulates the recharge of batteries, reducing self-consumption.

Floating PV is emerging as a suitable solution to reduce water losses due to evaporation, prevent algae proliferation, and at the same time, generate energy. In particular, canal-top PV plants offer notable benefits in terms of both evaporation reduction and energy generation performance. In general, PV systems installed in water reservoirs and ponds are usually floating, while PV systems in canals and channels are fixed. An innovative study regarding a techno-economic analysis, including a study regarding the impact of temperature on a canal-top PV system's efficiency in Egypt, was performed and is described in [4].

The forecasting of solar irradiance and power constitutes a vast topic that has been gaining accuracy through the use of multiple techniques developed in recent years [5]. A complete overview of applications and state-of-the-art models for both solar irradiance and PV forecasting is presented in [6]. In the case of time-series forecasting (solar irradiance or PV power time series), machine learning and statistical methods have been investigated extensively. Recently, the use of convolutional neural networks (CNNs) in PV output forecasting has been very successfully used. The comparison of these CNN techniques with traditional regressive or autoregressive models showed that the former performs better in terms of different forecasting horizons (1 h, 1 day or 1 week) [7].

Despite the fact research and development has already been carried out regarding PV tracking technology, new innovations and improvements can still be realized. Often-

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times, solar tracking systems constitute an essential part of a PV facility, and good knowledge of the different driving and control systems is very important in designing a plant. A very comprehensive and detailed review of solar tracking systems is found in [8]. The prevalence of single-axis and dual-axis PV systems is increasing significantly more than that of fixed PV systems. In addition, the most commonly used control systems rely on combinations of microprocessor- and sensor-based systems. Sensor-based tracking is more accurate than tracking carried out using systems based on sun position algorithms.

PV penetration in the urban context is increasing significantly and is foreseen to play a crucial role in cities. The concept of nearly zero-energy buildings (nZEB) requires specific policies in energy efficiency that are being included in the European Directive on Energy Efficiency. In this context, building integrated photovoltaics (BIPV) technologies are recognized as a solution to the incorporation of properly renewable energies in cities. BIPV systems have a dual purpose: they serve as constructive elements, and they generate energy at the same time. Thus, BIPV technologies have high potential, but they also have technical, social and economic barriers that must be overcome. Module customization considering aesthetic and technical aspects is going to facilitate the use of BIPV systems. The integration of hidden colored PV modules in architecturally sensitive areas is investigated in the work of Pelle et al. [9]. This is a complex subject, as this integration must preserve the historic and natural value of a building. The work of Pelle et al. highlights the need to better investigate the wide range of colored BIPV technologies regarding electrical behavior. The customization process could lead to modifications in the electrical behavior of a module due to the presence of one or more colored layers which cause the reflection or absorption of a portion of the solar spectrum (in the visible range) that would otherwise be converted into electricity, causing a reduction in the module's yield [9].

In order to conclude this short editorial, I would like to emphasize the advancements and challenges in spreading the use of PV systems in coexistence with urban, water body, agricultural and other land uses. This high level of dissemination requires large amounts of effort to be focused on the research and development of different PV systems and solutions. This short paper intends to offer evidence of that assessment through a number of research and review papers regarding the topic recently published in *Energies*.

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References

1. IEA-PVPS. Snapshot of Global PV Markets. 2022, pp. 1–23. Available online: www.iea-pvps.org (accessed on 1 August 2022).
2. Bharath Kurukuru, V.S.; Blaabjerg, F.; Khan, M.A.; Haque, A. A novel fault classification approach for photovoltaic systems. *Energies* **2020**, *13*, 308. [CrossRef]
3. Burgio, A.; Menniti, D.; Sorrentino, N.; Pinnarelli, A.; Leonowicz, Z. Influence and impact of data averaging and temporal resolution on the assessment of energetic, economic and technical issues of hybrid photovoltaic-battery systems. *Energies* **2020**, *13*, 354. [CrossRef]
4. Alhejji, A.; Kuriqi, A.; Jurasz, J.; Abo-Elyousr, F.K. Energy harvesting and water saving in arid regions via solar pv accommodation in irrigation canals. *Energies* **2021**, *14*, 2620. [CrossRef]
5. Sengupta, M.; Habte, A.; Wilbert, S.; Gueymard, C.; Remund, J. *Best Practices Handbook for the Collection and Use of Solar Resource Data for Solar Energy Applications*, 3rd ed.; Report IEA-PVPS 16-04:2021; National Renewable Energy Laboratory: Golden, CO, USA, 2021.
6. Lorenz, E.; Heinemann, D. 1.13—Prediction of Solar Irradiance and Photovoltaic Power. In *Comprehensive Renewable Energy*; Sayigh, A., Ed.; Elsevier: Oxford, UK, 2012; pp. 239–292. ISBN 978-0-08-087873-7.
7. Suresh, V.; Janik, P.; Rezmer, J.; Leonowicz, Z. Forecasting solar PV output using convolutional neural networks with a sliding window algorithm. *Energies* **2020**, *13*, 723. [CrossRef]
8. Seme, S.; Štumberger, B.; Hadžiselimović, M.; Sredenšek, K. Solar photovoltaic tracking systems for electricity generation: A review. *Energies* **2020**, *13*, 4224. [CrossRef]
9. Pelle, M.; Lucchi, E.; Maturi, L.; Astigarraga, A.; Causone, F. Coloured BIPV technologies: Methodological and experimental assessment for architecturally sensitive areas. *Energies* **2020**, *13*, 4506. [CrossRef]