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Editorial

Challenges and Perspectives of Wind Energy Technology

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1. Introduction

Wind power, as a vital renewable power source, has undergone rapid developments in recent years. Globally, 77.6 GW of new wind power capacity was connected to power grids in 2022, with the total installed wind capacity reaching 906 GW [1]. In Europe, 17% of electricity consumption was covered by wind power in 2022, while in Denmark, 55% of electricity consumption was supplied by wind turbines [2]. The levelized cost of energy (LCOE) of wind power is reducing and wind power is becoming a competitive energy technology.

In order to transform the energy system, completely replace the present fossil-fuel-based energy technology, and develop future sustainable and decarbonized energy systems, research is being conducted in order to further improve wind energy technology, to increase its utilization and economic performance, and to enhance the reliability of wind energy systems. This Special Issue, entitled "Challenges and Perspectives of Wind Energy Technology", presents some current technical challenges and promising solutions.

2. An Overview of Published Articles

After a rigorous review process, eleven manuscripts were accepted for publication in this Special Issue, including two reviews and one project report. The Special Issue covers a wide range of topics.

Offshore wind power offers the advantages of stable wind energy resources and a higher capacity factor than that of land wind turbines, in addition to not occupying land resources. Offshore wind power further avoids possible objections due to the visual and noise problems often faced by on-land wind turbines; therefore, it is anticipated that offshore wind power will be extensively deployed. However, offshore wind power requires a high level of investment in structure and power transmission, and has a high cost of operation and maintenance. Consequently, research on offshore wind power is required in order to improve its performance. This Special Issue includes three contributions (contributions 1, 2 and 3) related to offshore wind power technology, including one addressing new power electronic configurations for wind energy conversion systems (contribution 1), one addressing a DC collection system for offshore wind power plants and its impact on wind energy capture (contribution 2), and one proposing fault location technology for a HVDC transmission system for offshore wind power plants using an artificial intelligence approach (contribution 3).

Wind turbines have been widely installed in various natural conditions around the world; however, when under different conditions, some special considerations may need to be taken for their optimum utilization. This Special Issue presents some contributions that discuss wind conversion systems within various contexts. Contribution 4 analyzes the various factors that affect the applicability of wind power technology in Colombian Territory, while Contribution 5 presents a review with a specific design and thematic criteria, focusing on multidimensional sustainability challenges and onshore wind power generation in Northeast Brazil. Contribution 6, as a project report, describes a case study of grid-connected small wind turbines in urban areas.

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Furthermore, it has been found that some wind turbines experience special weather conditions that present significant challenges to the technology; as such, the relevant measures must be taken to ensure the reliability of the wind turbines. Contribution 7 analyzes the effects of icing on the aerodynamics and performance of a vertical-axis wind turbine using the CFD approach, while Contribution 8 presents research on wind power forecasting in a semi-arid region, utilizing machine learning methods to enhance the accuracy.

The exploration of new technology continues. With the potential of competing permanent magnet (PM) machines currently being widely employed in the wind industry, Contribution 9 reviews the application of non-conventional wind generators based on non-PM (wound-field) stator-mounted flux modulation machines. Meanwhile, Contribution 10 presents a framework of virtual testing workflows for wind turbines in order to support the virtual validation processes of the wind power system with increased complexity.

Contribution 11 investigates the supply of energy and water on islands, with regard to wind power. Two schemes of energy storage are considered; one is pumped hydro storage (PHS) and the other is a combined PHS and electrolyzer–hydrogen storage fuel cell system.

3. Conclusions

This compilation of publications is devoted to a diverse range of research activities in wind energy technology, addressing challenges and reflecting on new perspectives.

Wind power, as a vital energy source in future energy systems, is still evolving. As such, many challenges remain to be addressed, from large-scale applications in power grids and super grids to green hydrogen and synthetic hydrocarbon fuel systems, and from small urban wind turbines to microgrids on islands and in extreme conditions. New concepts and methodologies are emerging, from materials and components to wind power plants, from design tools to control systems, as well as artificial intelligence-based approaches. Dynamic and continuous changes in technologies are anticipated; thus, the current studies presented in this Special Issue should not only be seen as the results of investigations carried out by the respective researchers, but also as starting points, inviting researchers to conduct further studies in the future.

Conflicts of Interest: The author declares no conflict of interest.

List of Contributions

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