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Editorial: Advances in wind turbine rotor design

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Editorial on the Research Topic
Advances in wind turbine rotor design

The global transition to sustainable energy has placed wind power at the forefront of renewable energy technologies. As the demand for clean and efficient energy sources escalates, the role of wind turbines in the global energy mix continues to expand. According to the report from the Global Wind Energy Council (GWEC), wind energy installations have rapidly increased, with 2023 marking the highest year in history, recording 116.6 GW of new installation, a 50% increase from the previous year (GWEC, 2024). GWEC expects the wind energy market to continue growing by 9% annually. Among the key components of wind energy systems, the rotor plays a pivotal role in harnessing the kinetic energy of wind and converting it into mechanical power. The design and optimization of wind turbine rotors, therefore, remain pivotal in improving energy capture, reducing costs, and enhancing the overall performance and reliability of wind energy systems. The improvement of technologies and the scaling-up capabilities of wind energy systems have led to a reduction in costs and an increase in capacity factors. Between 2010 and 2020, the global weighted average levelized cost of electricity for onshore and offshore wind projects decreased by 56% and 48%, respectively (IRENA, 2024). As demand for efficiency, reliability, and scalability increases, the evolution of rotor design has become critical in advancing the performance and competitiveness of wind energy systems.

This Research Topic, Advances in Wind Turbine Rotor Design, brings together leading researchers and innovators to address the multifaceted challenges and opportunities in rotor technology. The collection encompasses state-of-the-art methodologies, novel materials, advanced aerodynamic modeling, and groundbreaking structural designs that redefine the boundaries of rotor performance. The key themes emerging from this collection are the active and passive flow devices, advances in wind turbine rotor design, computational fluid dynamics analysis, innovation in wind turbine blade design, interaction of wind turbine array, power augmentation device, numerical and analytical analysis, wind turbine aerodynamics and aeroelasticity, and wind-wake interaction of turbine rotor.

From the collection, regarding blade aerodynamics, Wood and Golmirzaee introduced a revised blade element/momentum theory for wind turbines operating in high-thrust conditions, improving the modeling of wake behavior and aerodynamic loads, validated through numerical simulations and experimental data. Oehme et al. explored thermographic detection techniques to identify and locate unsteady flow separation on wind turbine rotor blades, highlighting their potential for enhanced performance monitoring and early detection of aerodynamic issues. Chen et al. developed a new blade structure design methodology by combining the improved Non-Dominated Sorting Genetic Algorithm (NSGA-II) with Thin-Walled Beam Theory (TWBT) and Classical Laminate Theory (CLT). The parametric models of spar caps based on the production process were successfully applied. For offshore wind turbine application, research by Huo et al. investigated the performance of a novel floating offshore wind turbine mooring system designed for shallow water, employing experimental methods to evaluate its dynamic behavior and structural stability under various conditions. Ji et al. conducted a numerical investigation into the effect of initial flatness divergence on maximum stress and fatigue damage in the ring flange connections of fixed-bottom and floating offshore wind turbines. In the vertical axis wind turbine application, Zhang and Hu experimentally studied the static aerodynamic performance of straight-bladed vertical axis wind turbines without intermediate support axes or support bars. Finally, a review article by Lee et al. analyzed various design concepts for vertical-axis wind turbines, examining their structural and aerodynamic features, operational performance, and suitability for different wind energy applications to guide future innovations.

In summary, this Research Topic highlights studies on flow and aerodynamics, material selection and evaluation, wind turbine performance assessments, and a review of recent design concepts for wind rotors. As wind power continues to grow, the insights presented in this collection will play a significant role in advancing the field.

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References

GWEC (2024). Global wind report 2024. In *Wind energy technology*. Available at: https://gwec.net/global-wind-report-2024/.

IRENA (2024). Wind energy. *IRENA: energy transition*. Available at: https://www.irena.org/Energy-Transition/Technology/Wind-energy.