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Editorial: Towards Innovation in Next Generation of Wind Turbine Rotor Design

Wei Jun Zhu[1]*, *Wen Zhong Shen*[1,2] *and Taeseong Kim*[2,3]

[1]College of Electrical, Energy and Power Engineering, Yangzhou University, Yangzhou, China, [2]Department of Wind Energy, Technical University of Denmark, Kongens Lyngby, Denmark, [3]Wolfson School of Mechanical, Electrical and Manufacturing Engineering, Loughborough University, Loughborough, United Kingdom

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Editorial on the Research Topic

Towards Innovation in Next Generation of Wind Turbine Rotor Design

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David Howe Wood,
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***Correspondence:**
Wei Jun Zhu
wjzhu@yzu.edu.cn

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INTRODUCTION

The development of renewable energy is an inevitable response to the dual challenges of the energy crisis and global warming. In many countries, wind energy has become the most cost effective renewable energy relative to other energy sources. In order to reduce the cost of electricity, modern wind turbines are increasing in rotor size and unit power. The big wind turbines currently in the market are reaching 15 MW rated power and will be possibly increased to 20 MW in a few years. In such a scenario, the continued development in wind energy has led to large rotors that are much lighter and cheaper per kilowatt than before. The main innovations include higher tip speed, higher lift and thicker airfoils, resulting in more slender and lighter blades. In the meanwhile, the coupled effects of aeroelastic and aeroacoustic behaviour and modelling have become the key research challenges. Therefore, research in many aspects of wind energy innovation is important, such that the overall objectives of low cost of energy, high system reliability and environmental-friendliness can be achieved. Several rotor design concepts have emerged to satisfy the up-scale trend, but a crucial problem is managing the large inertial loads and aeroelastic response while retaining high aerodynamic efficiency. Further utilizations of wind energy research meet the critical challenge to continuously grow in size and continuously decrease in price per kilowatt.

CURRENT STATUS IN WIND TURBINE ROTOR DESIGN

This section gives a very brief review of the research history from the current state of art 5 MW machine towards the more challenging design of a 50 MW machine. The 5 MW reference wind turbine has been widely studied from rotor aerodynamic and structure design aspects (Buck and Garvey, 2015; Borouji and Nishino, 2019; Choi et al., 2019). As proposed in (Buck and Garvey, 2015), replacing the blades of a 5 MW wind turbine by a low induction rotor leaded to a reduction in capital cost per unit of annual energy production of over 2%. The same idea of low induction rotor was further employed in the design of a 10 MW wind turbine (Bak et al., 2013). For blade lengths reaching almost 100 m, it was noted that the conventional straight blade and upwind design concept can be further improved (Bortolotti et al., 2019; Sun et al., 2021). It turns out that a downwind non-aligned configuration might be a more interesting alternative (Bortolotti et al., 2019). More solutions for a 10 MW machine are given in (Sun et al., 2021) where different downwind/upwind/conning/pre-bending rotor configurations were studied in detail as sketched in **Figure 1**, where wind

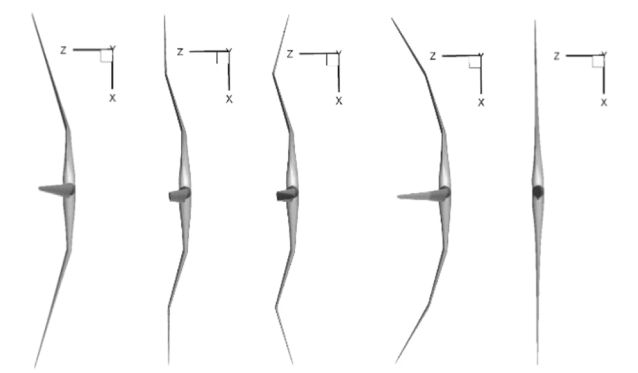

FIGURE 1 | Different conning and pre-bending configurations (Sun et al., 2021).

comes from the left hand side. Instead of combining various existing airfoils to build a large blade, the design and optimization process of airfoil shape can be integrated into blade design, which resulted in much higher aerodynamic performance of a 20 MW machine (Zhu et al., 2014). A redesign of a 13.2 MW machine up to 25 MW was achieved with a cone-wise load-alignment arrangement (Qin et al., 2020) which leaded to a useful baseline for further development and assessment of a 50 MW ultra-large machine (Yao et al., 2021), where a baseline 250 m blade was further optimized with a reduced weight of 25%. As also stated in (Veers et al., 2019), the science of wind turbine rotor design involves the world largest rotational machines, so the proposed design challenges are tremendous.

FUTURE RESEARCH NEEDS

Although this Special Issue has now closed, more research more research in advanced wind turbine rotor design technology is expected, as the goal of wind energy research is to help the technological development of new, environmentally-friendly and cost-effective large wind turbines.

AUTHOR CONTRIBUTIONS

The guest editor team has now completed the research topic management. WJZ mainly contributed on collecting abstracts, manuscripts as well as connecting the reviewers and authors. WZS and TK shared a lot of experience on finding reviewers and contributors who enhanced the influence of the topic.

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