Improved Efficiency of Wind Farms by Alternating Mast Height

Malene Vested

DTU Wind energy, Technical University of Denmark

INTRODUCTION

This project is experimental and investigates the performance of twelve model wind turbines in a wind tunnel. When wind turbines are placed in a wind farm, the power production falls dramatically, because the wind turbines create wakes and thereby 'shadow' each other. This projects aims to improve the efficiency of wind farms, by giving the wind turbines alternating mast heights. In this way the wake-to-wake interaction is decreased which leads to a better performance of the wind farm as a whole.

WHY IS IT A GREEN PROJECT?

This is a green project because it aims to optimize the performance of wind farms. In order to face a greener future society, it is essential to become less dependent on fossil fuels in the electricity generation and here wind energy represents one alternative. However, if wind energy is to become an important contribution to the generation of electricity worldwide, it is necessary to optimize wind farms bot onshore and offshore. Today, wind turbines placed in a wind farm produce much less power than single wind turbines placed remotely from each other. This is because the wind turbines in front 'shadow' the subsequent wind turbines, such that the front row of wind turbines extracts the biggest share of the energy in the wind. This project investigates if alternating mast height could be one of the steps to meet this challenge in wind farm efficiency.

HOW WAS THE STUDY CARRIED OUT?

The study is experimental and was carried out at the wind tunnel facility at Portland State University, Oregon, USA. The experimental set-up consists of twelve model wind turbines, only differing in mast height of either 12cm or 18cm, placed in rows of four by three wind turbines. To investigate the effect of alternating mast height, five different configurations were tested in the wind tunnel: One configuration with all same mast height and four with alternating mast heights. The power production was measured in the five configurations by the use of a torque sensing system installed in each model wind turbine. Additionally, the velocity field was investigated by the use of stereographic Particle Image Velocimetry.

CONCLUSION

In this study, we have found that by alternating the mast height, the efficiency of the model wind farm is increased between 20-40%. This result suggests that the shadowing effect is less pronounced in a model wind farm with alternating height. This was supported by the stereographic Particle Image Velocimetry results, which show a decreased wake-to-wake interaction in the configurations with alternating mast height. In other words, alternating mast height in a wind farm can lead to bigger wind farm efficiency and could bring us one step closer to a future still more based on green energy.