Global Warming is a Real Threat, Wind Power as a Safeguard
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Introduction

Among the four tested blades, GOE 447 outperformed the other three airfoils, that’s why it’s opted for further simulations.

Results

Numerical power of various airfoils

The main reason that enables thinner and curved airfoils of generating higher power is its ability to create higher pressure difference between the suction and pressure sides of the blade. The average pressure difference between the suction and pressure side of the NACA 64(3)618 at root and tip sections is 400 and 2000 Pa, respectively. Meanwhile, for the GOE 447 blade is 550 and 4500 Pa.

Numerical power of different blades

Adding both tubercles and winglets to the GOE 447 baseline blade design improved the turbine power output. More power improvement is obtained by the blade with tubercles than the blade with winglet. The amount of improvement is maximum at the turbine rated wind speed (5.5% for tubercles design, while 5% for winglet), while this amount decreases at the medium wind speed (4.7% for tubercles design, while 4.4% for winglet). Finally, the difference in power improvement of both tubercles and winglets diminishes at low wind speed (both designs improve power by 4.2% more than the baseline).

Conclusions

- Airfoil type has a significant effect on pressure distributions around the blades, and the rate of the tip-vortices generation, hence the airfoil design strongly impacts power coefficients.
- Given that TSR is fixed at 1, at all wind speeds, thinner and more curved airfoils (NACA 6412 and GOE 47) produce more power than thicker and less curved ones (NACA 64(3)618).
- GOE 447 outperforms the other three airfoils at all wind speeds. Moreover, adding tubercles and winglets to the baseline GOE 447 generates more power. At 12.5 m/s, winglet and tubercles produce 5% and 5.5% more power. At 10 m/s, winglet and tubercles produce provide 4.4% and 4.7% more power. At 7.5 m/s, both winglet and tubercle blade designs generate 4.2% higher than the baseline power.

Future work

- Different tubercles and winglet configurations will be tested at wider range of wind speeds to investigate the effect on power output.
- Different blade materials should be tested to make sure that the proposed thinner airfoil operation will be safe under all operating wind conditions.
- Since noise level is one of the challenges that faces the wind power expansion, the operation of the proposed airfoils should be tested for the resultant noise level.

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Literature cited


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