The relationship between chord length and rime icing on wind turbines

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Business from technology

Backround of the work

Large blades should accrete relatively less ice during a similar icing encounter than small blades [1], because of larger leading edge radius.

This phenomena was proposed, [2], as a possible reason for low production losses at Nygårdsfjell wind park in northern Norway, which consist of three 2,3 MW pitch controlled Siemens wind turbines.

Method

The study was made by using TURBICE icing model, which is a comprehensive numerical ice accretion model that accretes ice on a two-dimensional airfoil in a potential flow field perpendicular to the airfoil axis (see picture below).

Atmospheric conditions

Wind speed (m/s)	10
MVD (µm)	12, 15, 17, 20, 30
LWC (g/m3)	0.2
Temperature (°C)	-10
Simulation time (min)	120

These atmospheric conditions results rime ice.

Medium Volume Diameter (MVD) was only variable between simulations.

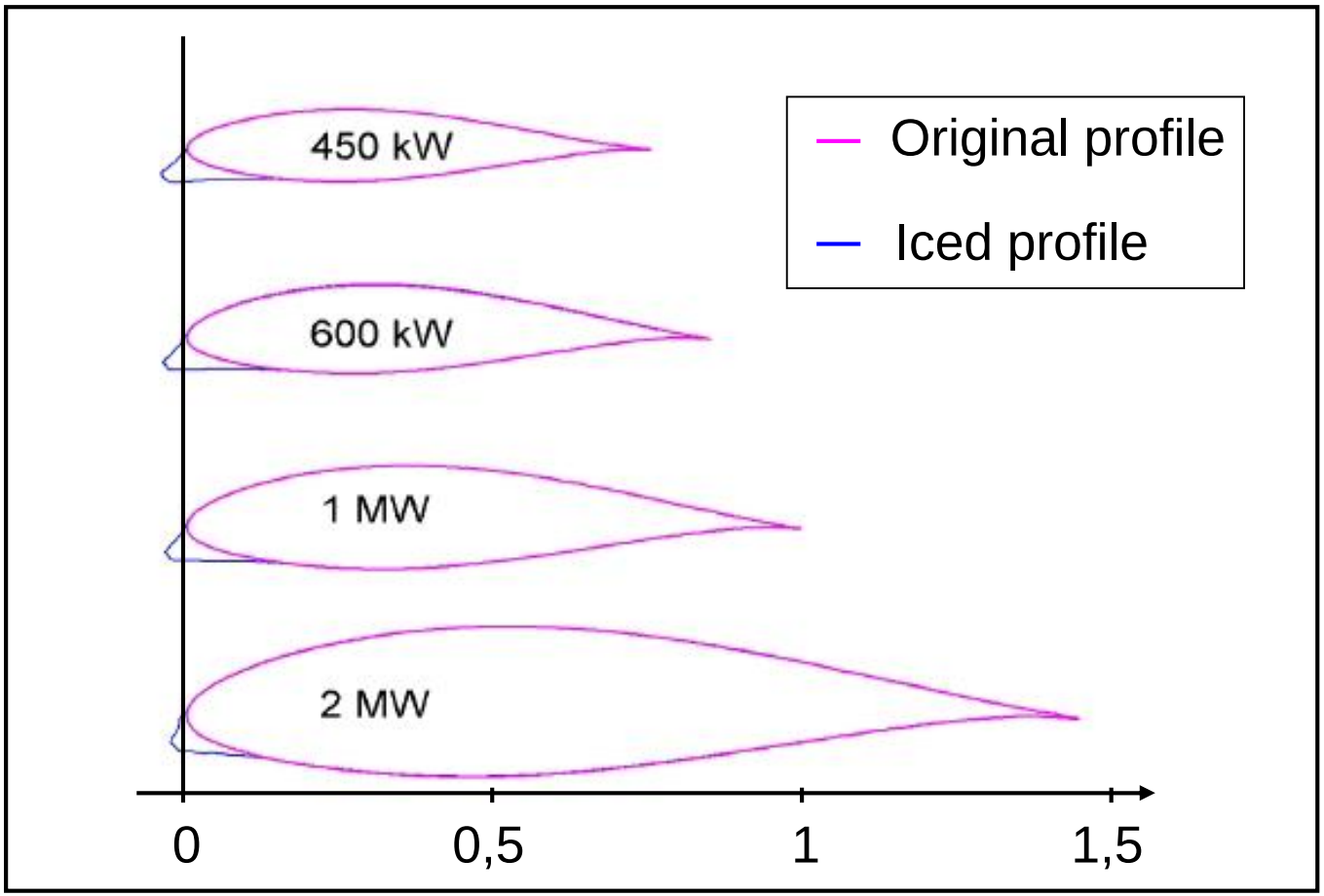
Only the case with 15 µm is shown in results.

Turbine details

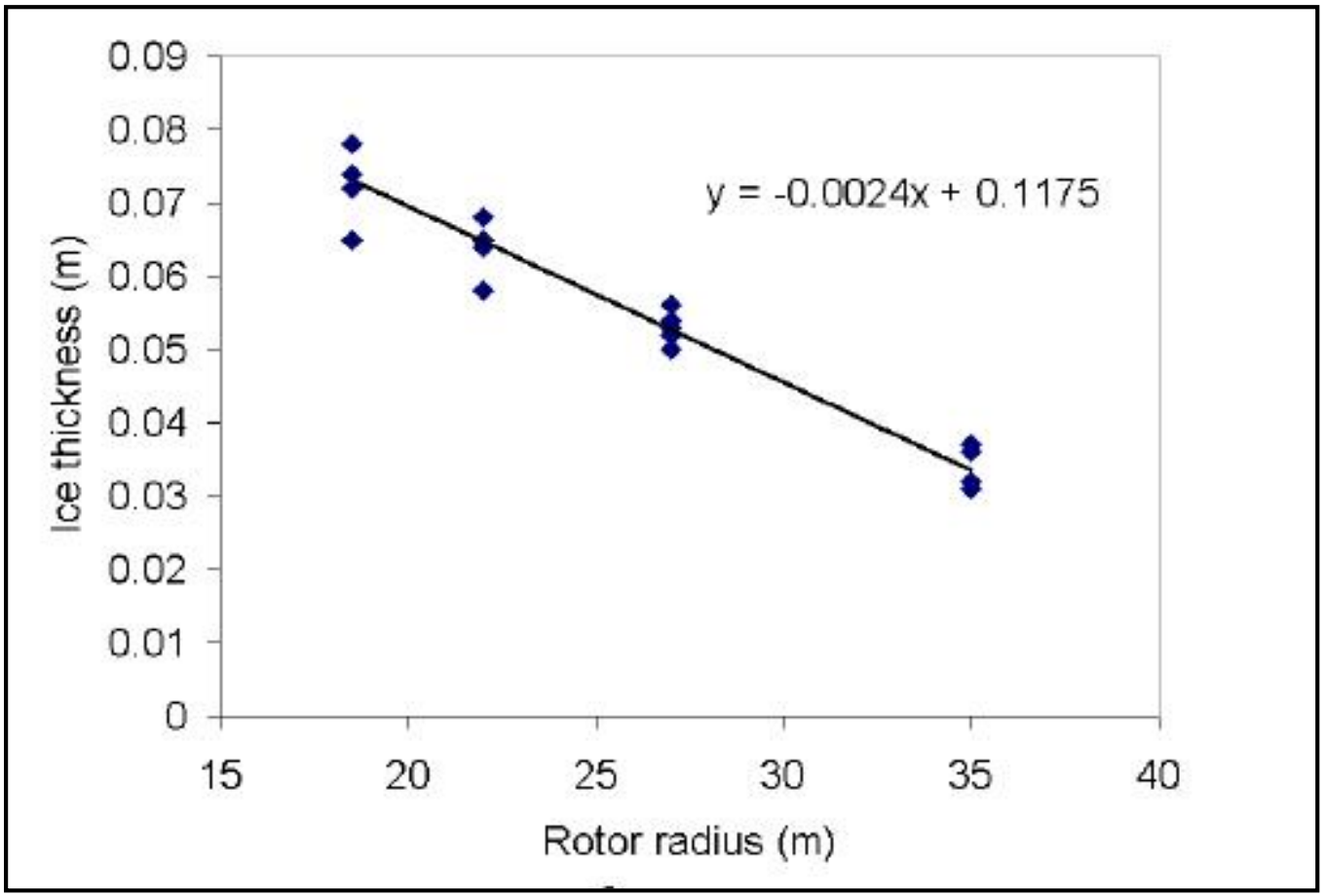
Power	450kW	600kW	1MW	2MW
Airfoilname NACA	63215	63417	63417	63416
Rotation speed (rpm)	30	27	22	18
Chord length (m)*	0.75	0.84	0.99	1.44
Relative speed (m/s)	50	53	54	57
Simulation radius (m)	16	19	23	30

*Simulation position was ~85 % of rotor radius.

Results 1/2: Blade profiles



Results 2/2: Ice thickness on leading edge



Conclusions

The simulations indicate that dry rime icing is less severe for larger wind turbines both in terms of local ice mass and in terms of ice thickness.

Future studies should deal with

- Glaze icing
- Larger turbines
- Wind tunnel experiments to derive aerodynamic changes due to ice accretion

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References

1. R. W. Gent, N. P. Dart, and J. T. Cansdale. Aircraft icing. Philisophical Transactions of The Royal Society of London A, 358:2873–2911, 2000.
2. Matthew C. Homola, Per J. Nicklasson, Per A. Sundsbø, and Arne E. Holdo. Experiences from icing at Nygårdsfjell wind park. In Proceedings of the EWEC 2008. www.ewec2008.info.