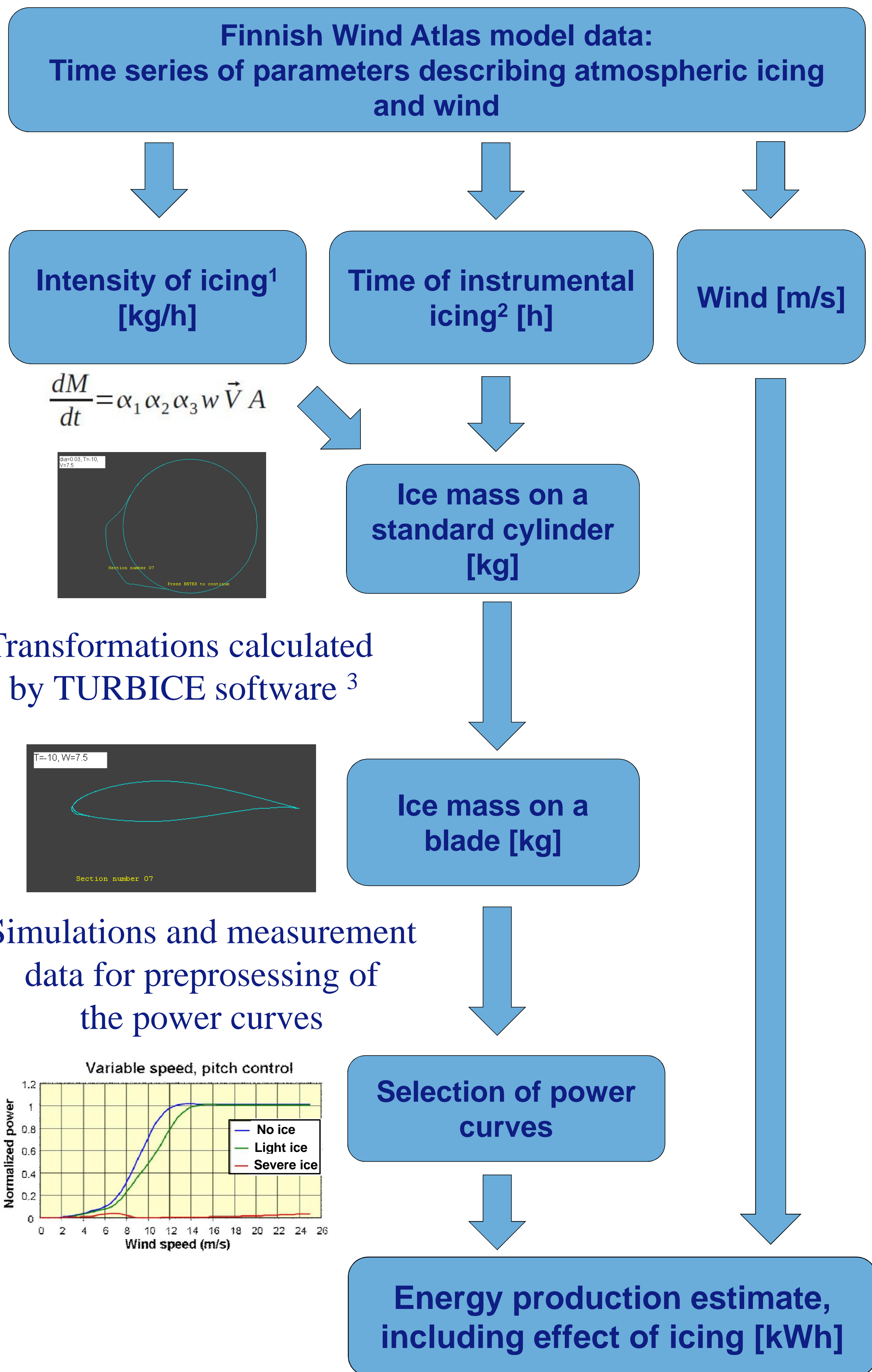


Energy production loss estimation method due to atmospheric icing of wind turbines

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Background

Most of the areas in Finland where wind power is planned to build several thousands of megawatts in the coming years, are affected by atmospheric icing. Icing of turbines poses risks of energy production losses and a risk of ice throws.

Due to the icing problems the Finnish Meteorological Institute (FMI) is making a Finnish icing atlas, where time of icing, average intensity of icing and estimation of energy production losses are presented. The atlas is planned to be ready in the fall 2011. VTT Technical Research Centre of Finland (VTT) is developing a method for estimating energy production losses for the icing atlas. The principle is presented here.

Method

The icing is calculated based on model data from AROME weather prediction model used by FMI. The ice accretion is modeled using the method described in ISO 12494 – Atmospheric icing of structures – standard¹, which is for ice accretion to stationary cylinder.

The corresponding ice accretion rate and the amount of ice on wind turbine rotor blades are calculated using an icing simulation software TURBICE³, which produce also the iced up blade profiles. As an example, in the fixed conditions: wind speed 7m/s, temperature -10°C, 10 g/m of ice on the standard cylinder gives more than 200 g/m ice on the rotor blade at the position of 85 % of blade radius of 3MW wind turbine, see Figure 1.



Figure 1: Iced and clean profile and ice mass (~200g/m), in the conditions similar than producing 10g/m ice on standard cylinder.

CFD simulations are used to get the degraded aerodynamic properties of blades and finally power performance simulations are used to generate the power curves. Measurement data is used to validate the power production simulations. The power production will be calculated based on wind data and representative power curves for iced up wind turbine. For simplicity of simulations, the icing is considered to be rime icing. Because of this, an additional degradations in power production estimate have to be considered if the temperature on the site under interest is commonly in the range where glaze icing occurs, because it is known to have more deteriorated effects than rime icing.

References:

- 1 ISO 12494 – Atmospheric icing of structures
- 2 COST 727: Atmospheric Icing on Structures Measurements and data collection on icing: State of the Art
- 3 Makkonen, L., Laakso, T., Marjaniemi, M., Finstad, K., Modellning and prevention of ice accretion on wind turbines, Wind Engineering Vol. 25 no. 1, 2001.

Work is going on

Results of the icing atlas and the energy production loss estimations will be published in the fall 2011.

Acknowledgements

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