

> Nordex Advanced Anti-Icing System for N149/4.0-4.5

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6th February 2018

Agenda



- 1** **Advanced Anti-Icing System**
- 2** Validation of design and functionality
- 3** Yield improvement for customers

➤ New N149 comes with several innovations including Advanced Anti-Icing System



Main Innovations:

- Nominal power adjusted to site
- Acoustically optimized operating modes
- Advanced Anti-Icing System for larger rotor diameter

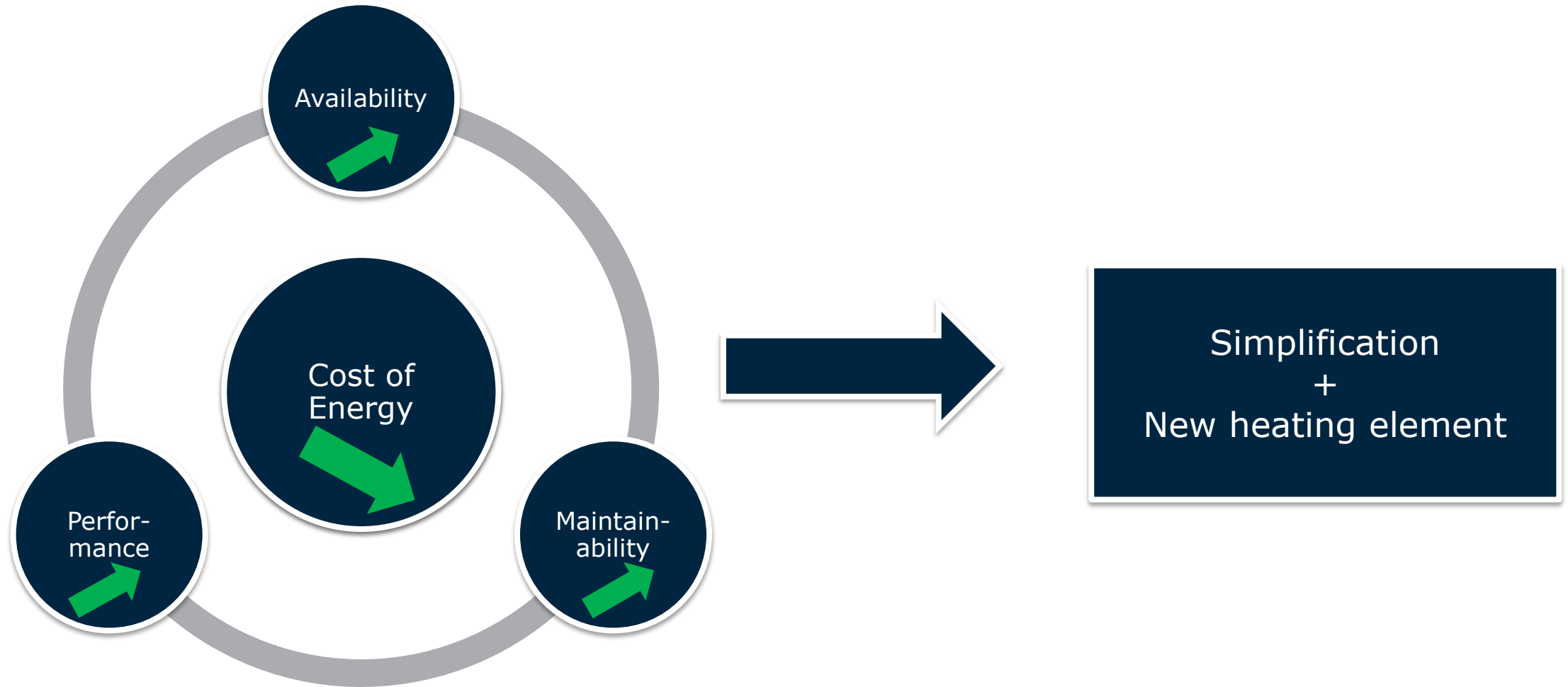
Advanced Anti-Icing System uses well proven concept of electrical resistance heating



Basic features:

- Electrical resistance heaters
- Heating aerodynamically relevant surfaces (leading edge)
- Low energy consumption – heating the surface rather than blade structure
- Fully operational during turbine operation
- Operates down to -20°C, even in severe icing conditions

Design goals for Advanced Anti-Icing System for N149

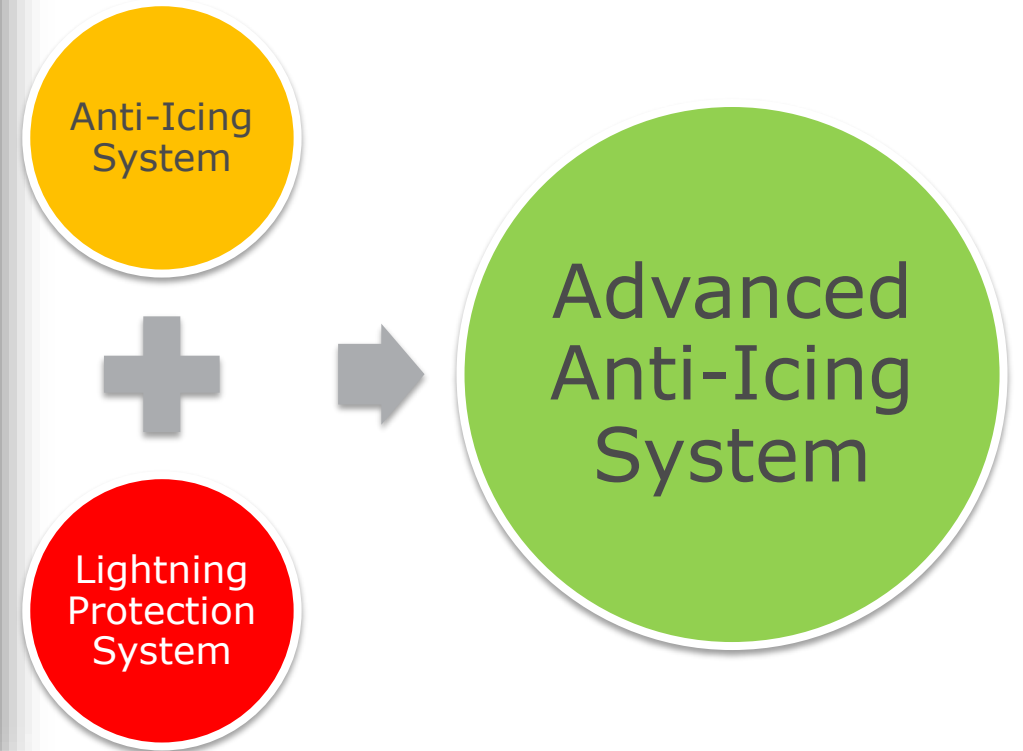




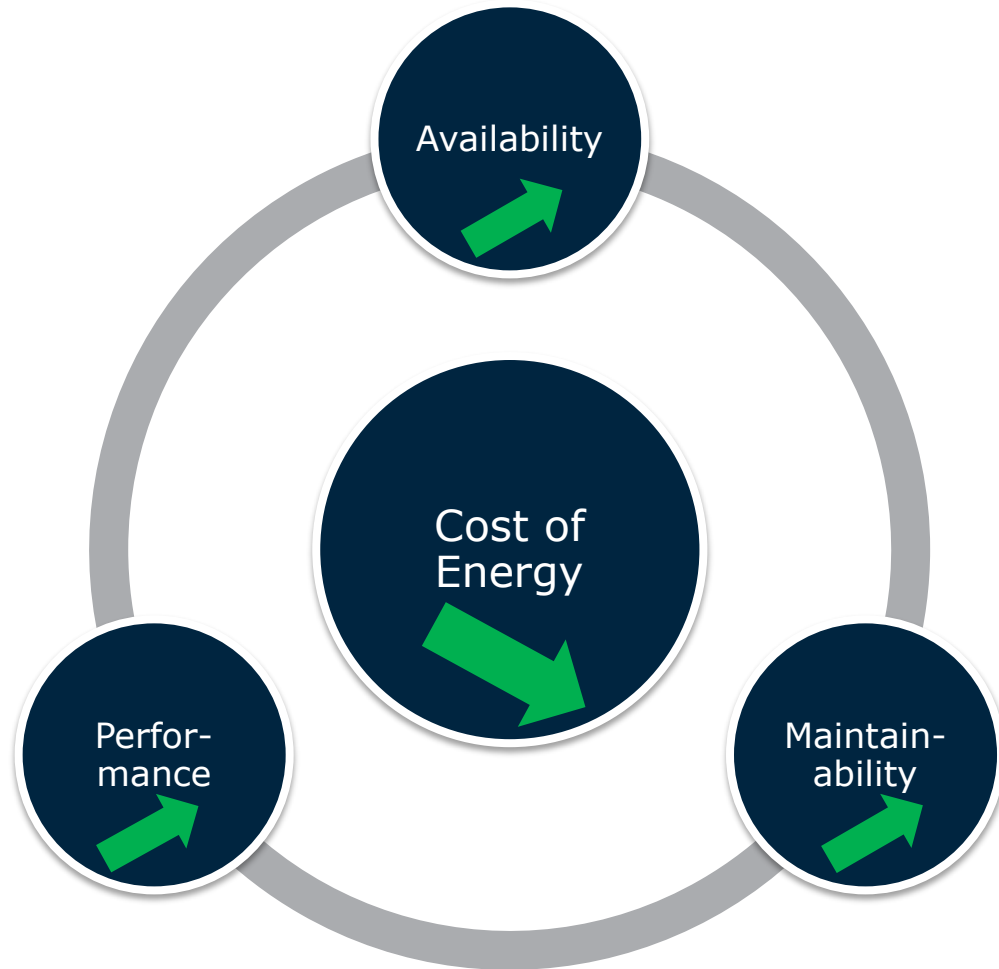
Anti-Icing System and Lightning Protection System are merged into one system



➤ New electrical resistance heater on leading edge



Benefits of Advanced Anti-Icing System



New benefits:

- Heating power/m² independent from geometry – optimized design for N149
- No additional components in/on blade (except connections at blade root)
- Heating element is segmented
- Manufacturing process much simpler
- Reduced maintenance effort

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➤ Structural design will be fully tested and certified

NR74.5 blade will be fully tested in static and dynamic tests incl. all additional loads for the AIS

- Dynamic flapwise – in preparation
- Dynamic edgewise – in preparation

➤ Static – in preparation

➤ Heating element



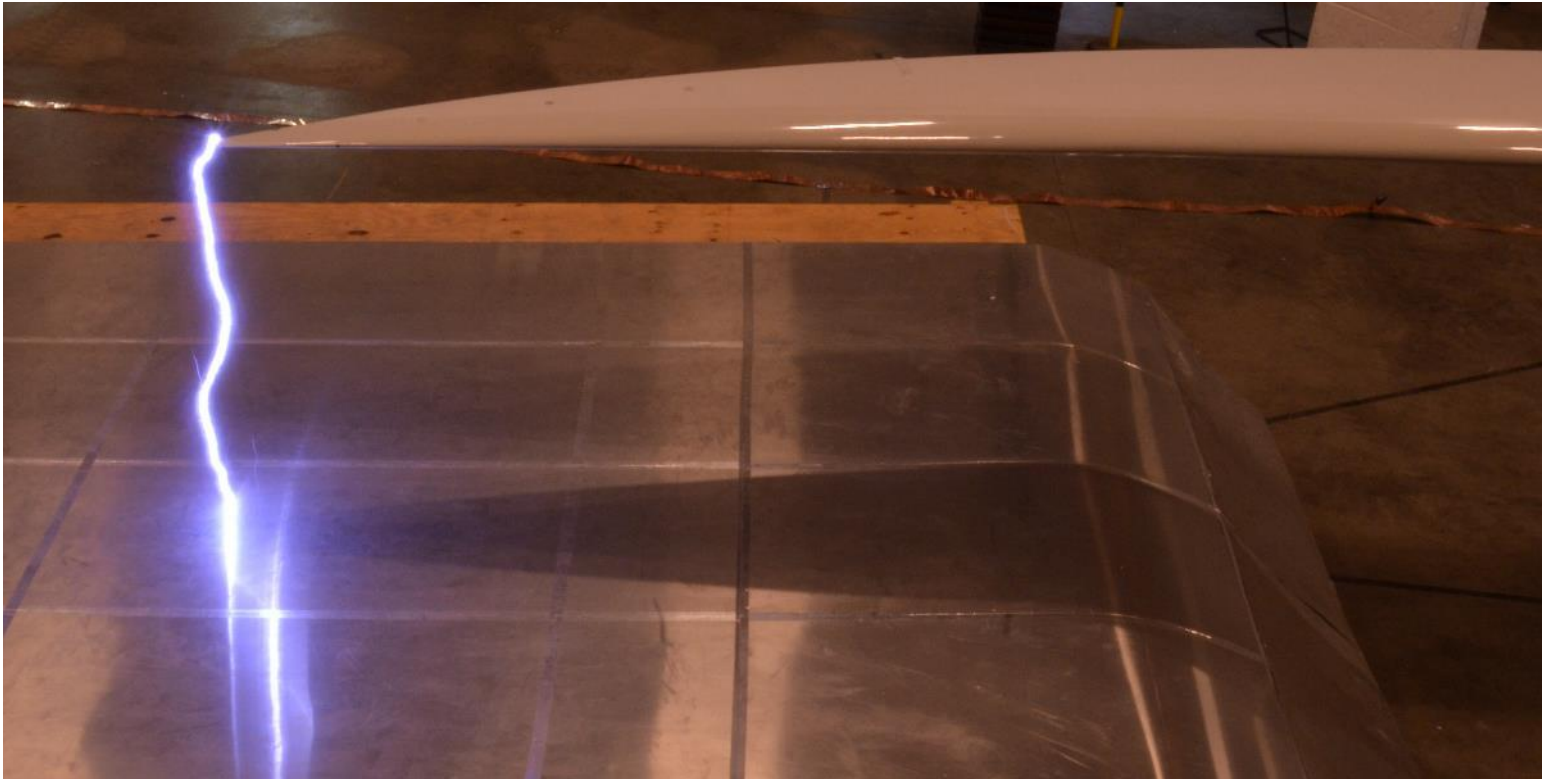
Picture: NR65.5



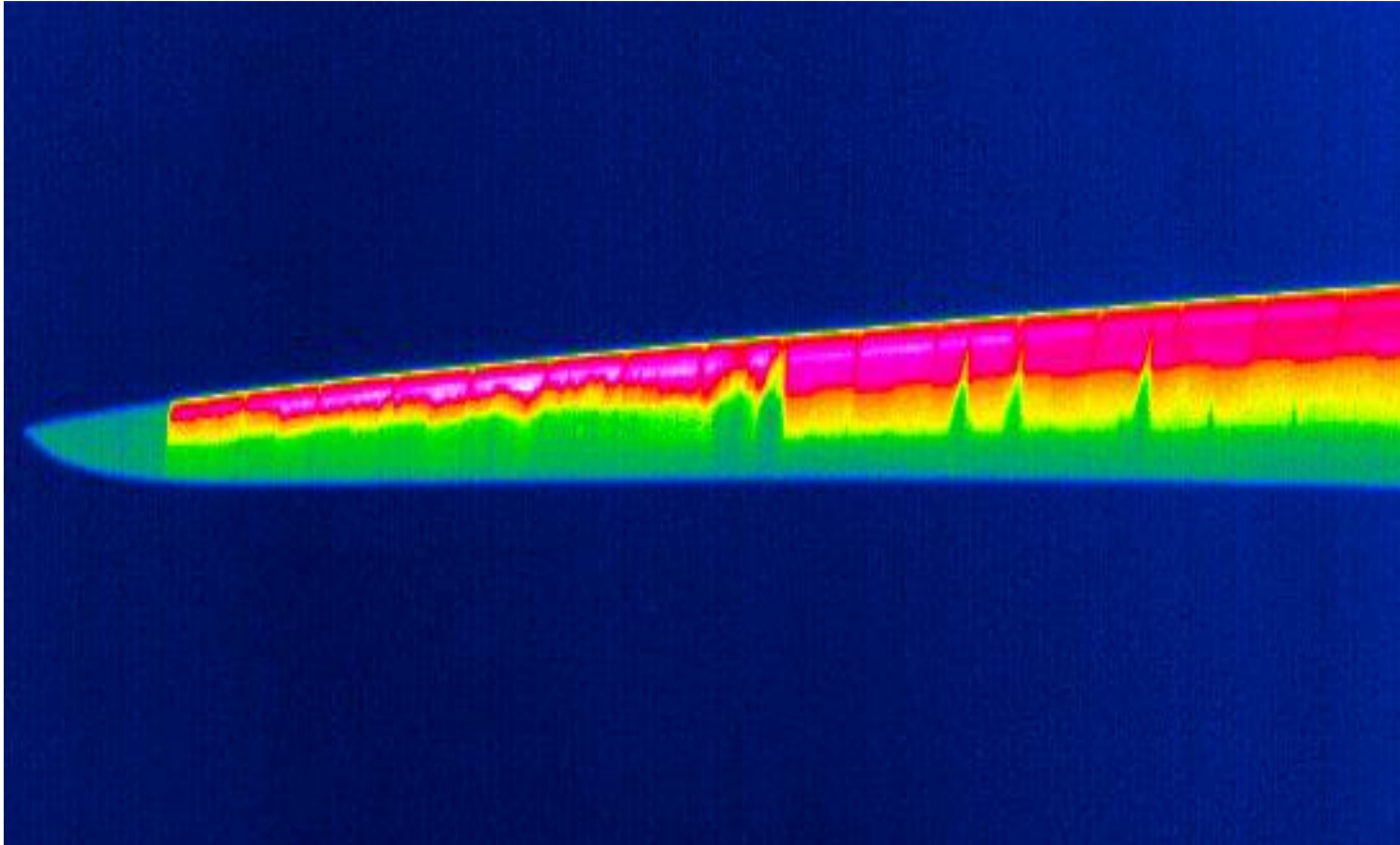
Lightning protection system of Advanced Anti-Icing System is fully tested by third party

- Initial leader attachment test ✓
- High current coupon tests ✓

- Current distribution test ✓



> New heating element has been tested in the field since 2014



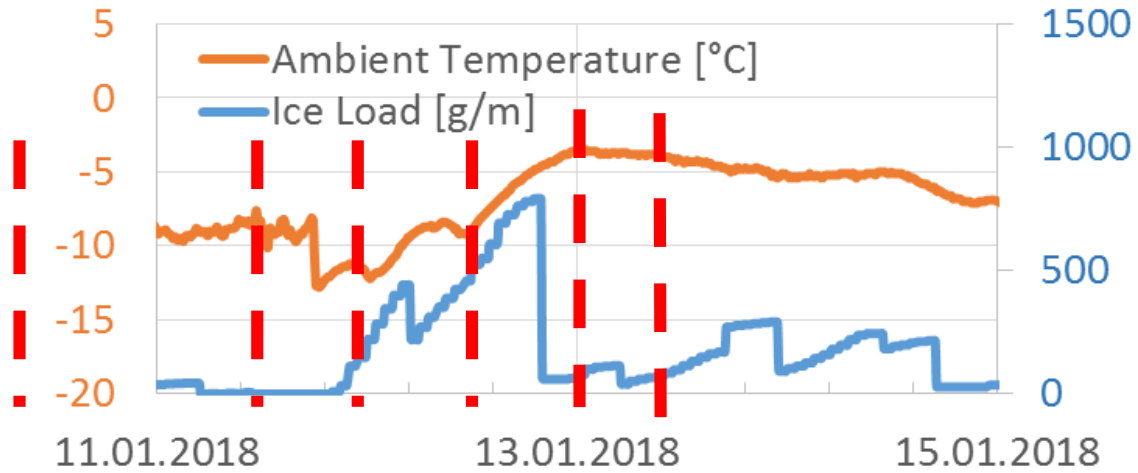
Prototypes:

- > 2014: N117 in Finland
- > 2016: N131 in Finland

Infrared picture taken during turbine operation.

Field experience during icing event – AIS operating at 33 % power for test reasons

All pictures taken with Anti-Icing System operating at 33 % power only!



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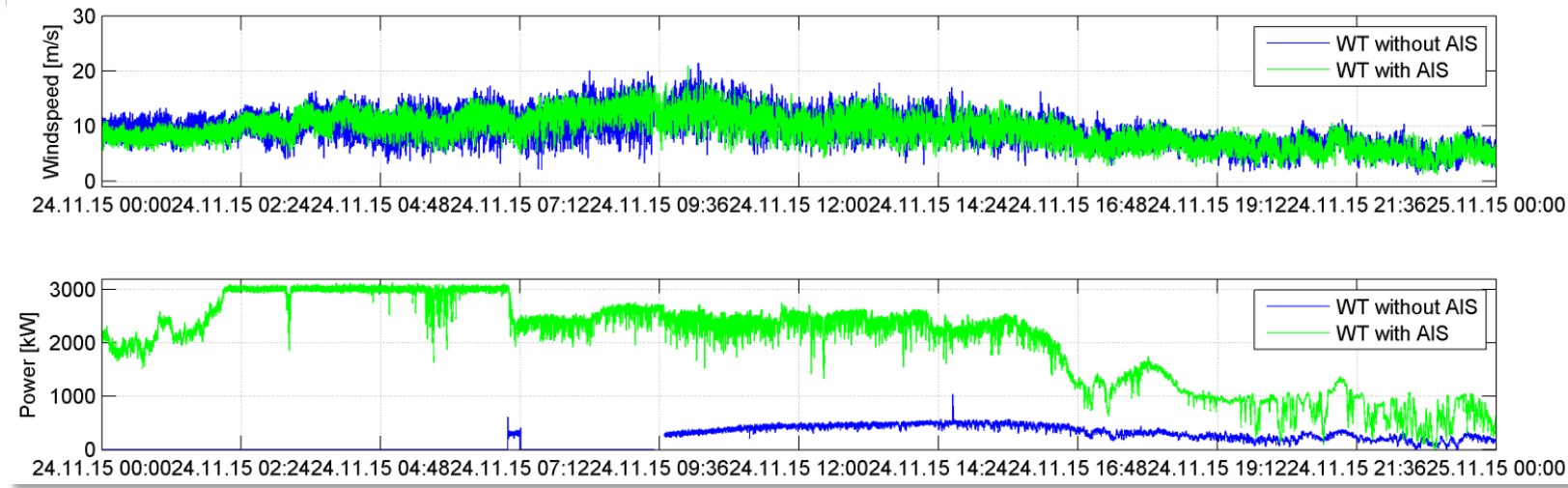


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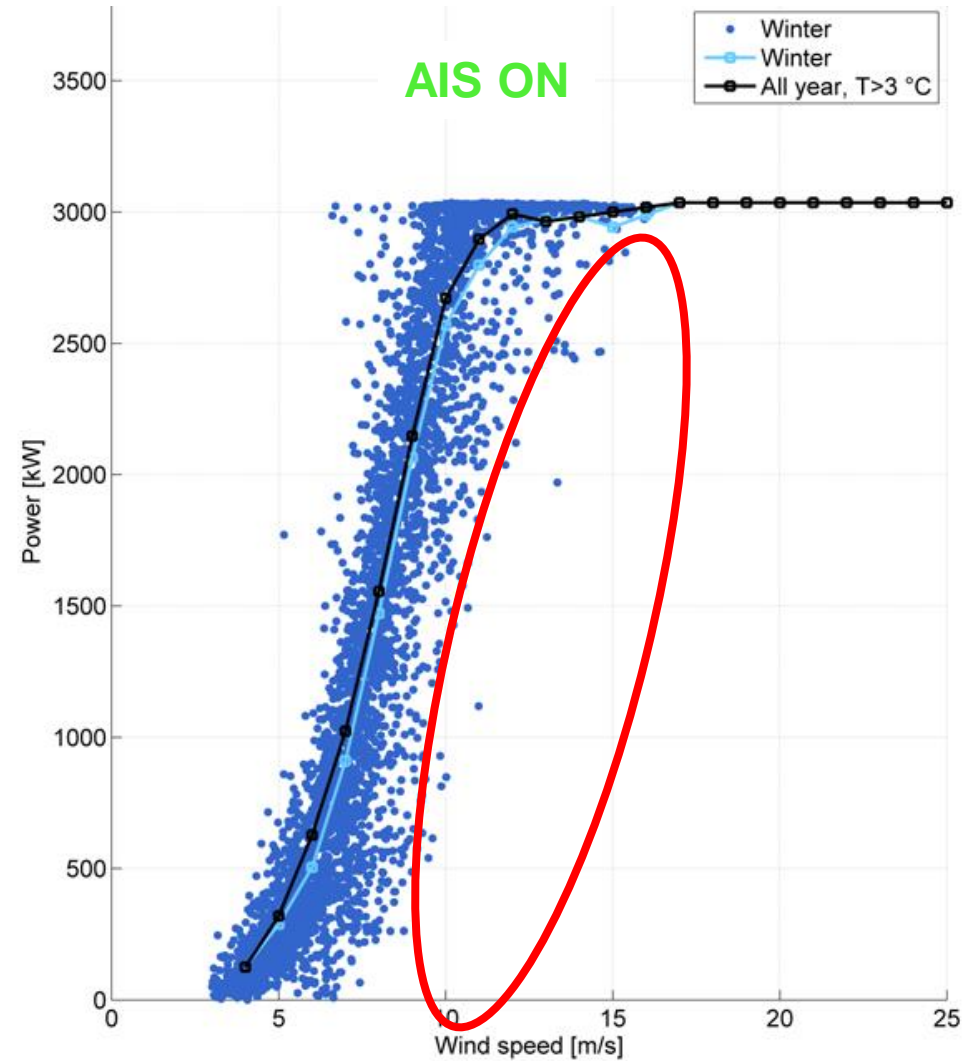
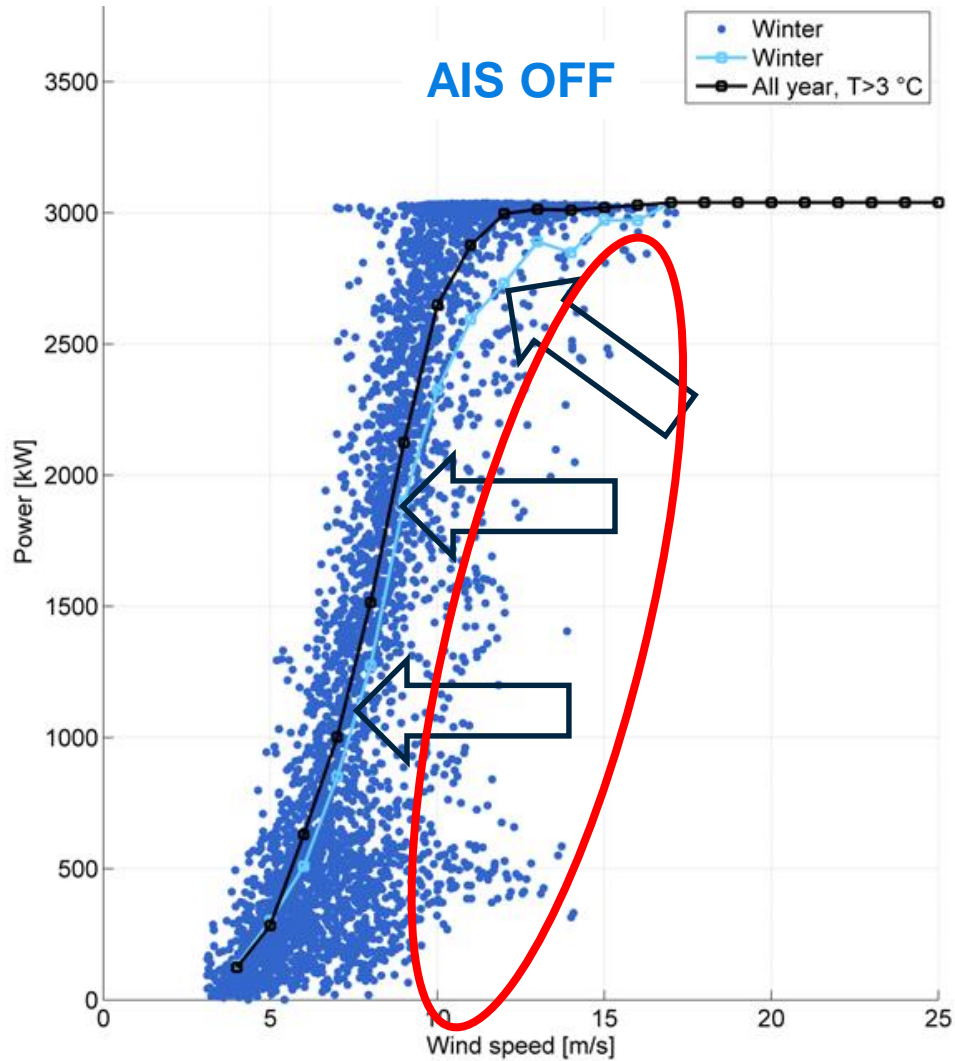
Field validation – Example of production gain in Lapland



- Winter 2015/2016
- N117, Sweden



Power curves reflect the yield improvement due to Anti-Icing System (AIS)



Summary

NORDEX Advanced Anti-Icing System for N149 ...

- ... is based on proven technology
- ... merges the Lightning Protection System and the Anti-Icing System into one optimized system
- ... has maximized robustness and minimized maintenance effort
- ... has been successfully tested in the field
- ... guarantees large yield improvement in icing conditions



**> Thanks for
your attention**

> Together on the same course

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