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Optimizing Conductive Heating for Rotor Blade Anti-Icing

Using Wireless Blade Sensors

30 January 2025

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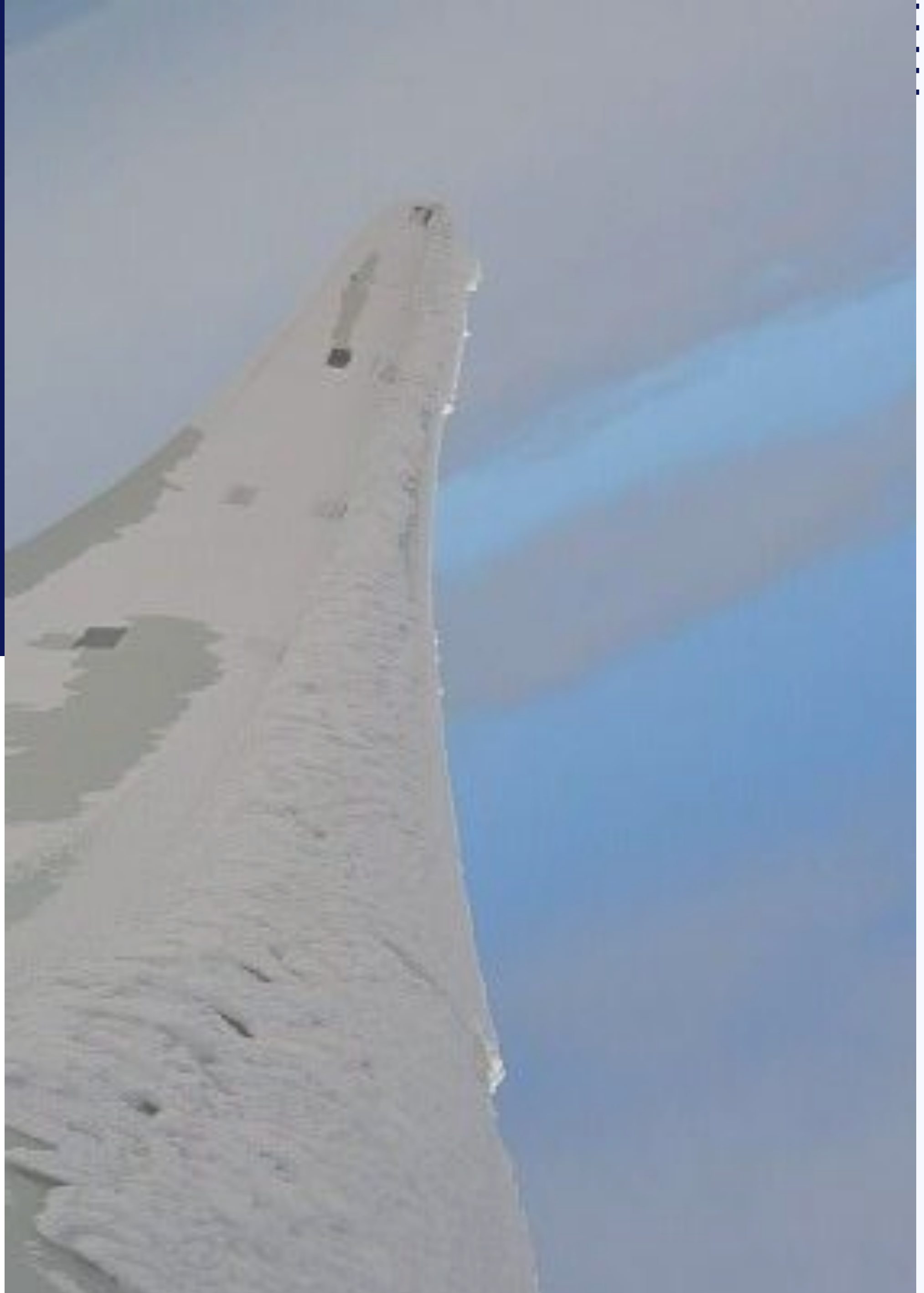

Source: Wind Power Engineering Development

The Anti-Icing Challenge

Blade heating systems are not controlled efficiently.

Conventional ice detections methods can be inaccurate and cause excessive costs.

The activation/deactivation of the blade heating is timed inefficiently.

This results in unnecessarily

i. high energy costs (excessive heating).

ii. lower yields (iced-blades).

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The Anti-Icing Solution

Precision Heating

High precision ice detection, measured accurately directly on the blade surface

Ice thickness measurement

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Case Study: Precision Heating

Swedish Windfarm **(Jämtland)**

Equipped with Anti-Icing **(Conductive Blade Heating)**

2024/2025 Winter

Objectives:

1. Replace the original nacelle-based ice detection with High Precision Wireless On-Blade Sensors
2. Reduce blade heating operational costs by avoiding wasteful heating cycles.

Simple Retrofit

- Retrofitted within ~ 1 day
  - Self-adhesive
  - Solar panel & Cold climate battery
  - Wireless communication
- Fully integrated into the turbine controller
- No additional data from the turbine necessary
- Replaces the nacelle-based ice-detector and controls the blade heating system directly

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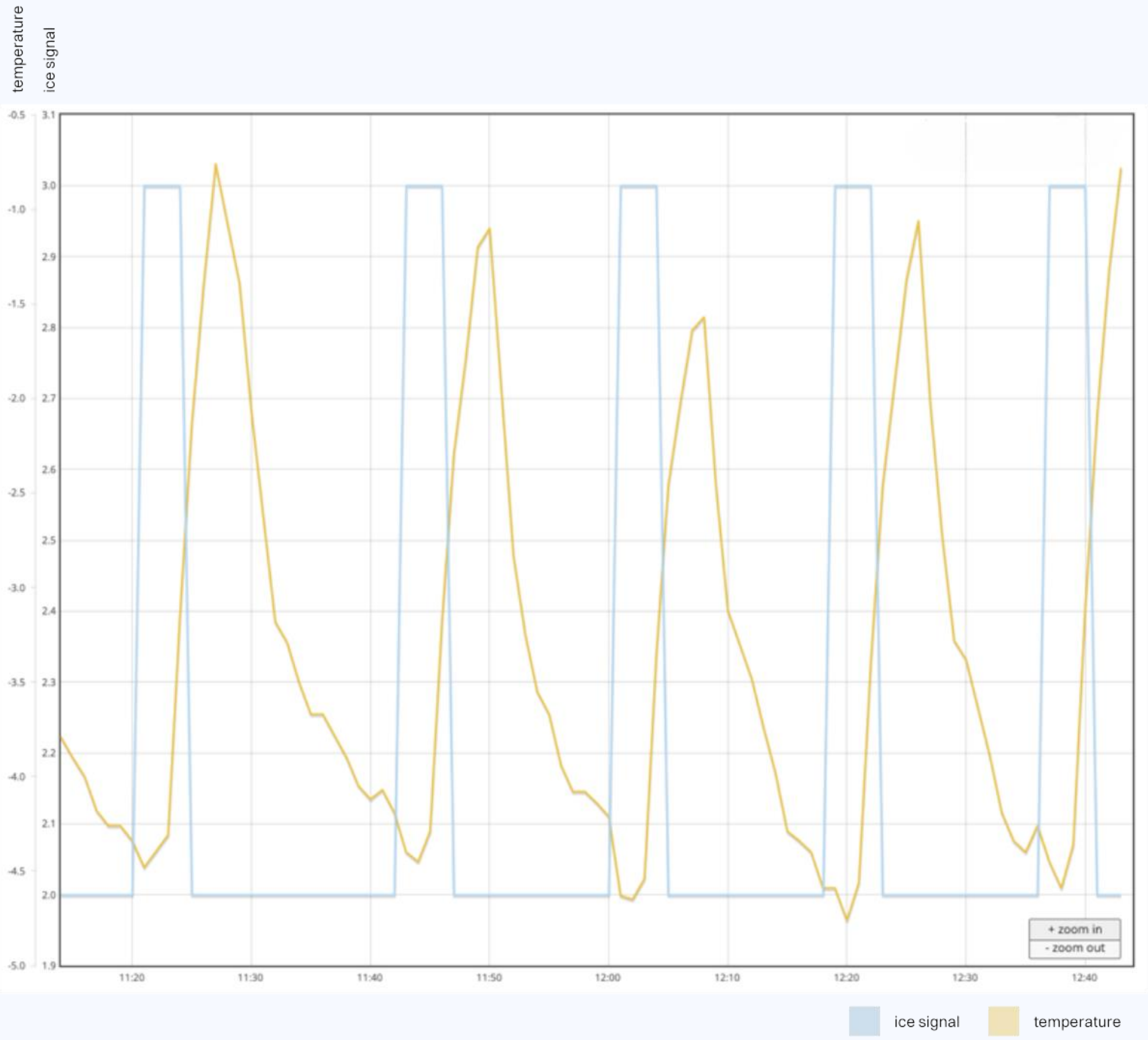
Successful Anti-Icing

Blade Heating is activated only if ice has formed

- > 1mm (level 3)

Blade Heating turns off again once ice is gone

- Most energy efficient mode



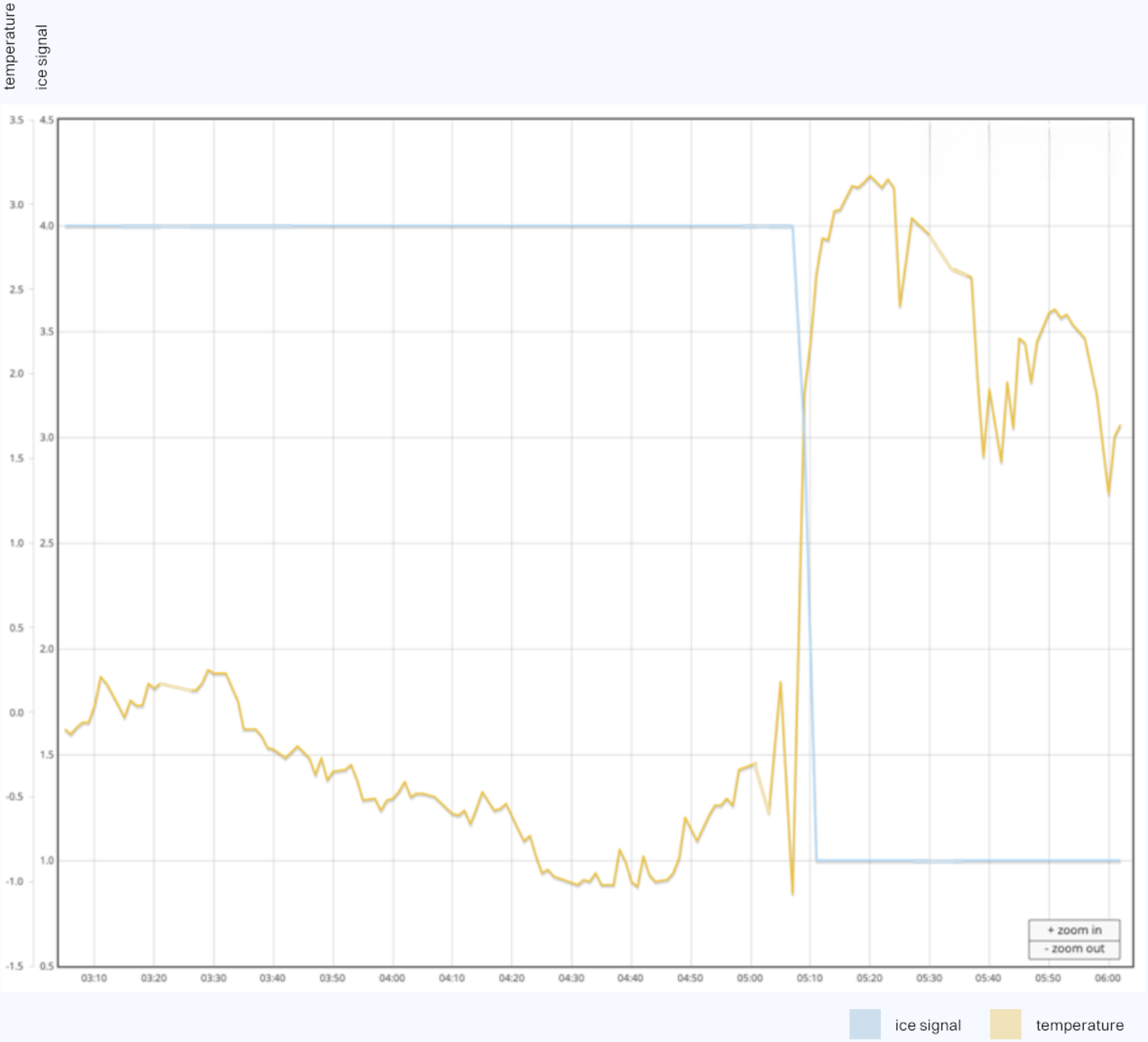
Successful De-Icing

Blade Heating is always off when the turbine is stopped / wind speed is < 5 m/s

- In this case 10-15 mm of ice accumulated on the blade

Blade Heating is able to melt down the ice quickly

- **> 10 mm of ice is gone in ~ 10 minutes**



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Conclusion: Precision Heating

Most accurate and efficient

Retrofittable with ease

Replaces nacelle-based ice detection

Keeps the blades ice-free

Cost benefit of up to 50 % estimated.

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Wireless blade sensor (WBS)

Less than 2 mm thick, wireless, flexible and energy-autonomous, retrofittable

Base station

Connected to customer’s system it receives measurement data from the sensors via antennas

Antenna

Two different antenna options (panel antenna or rod antenna)

The Anti-Icing Challenge

Solved!

Precision ice detection with wireless sensors directly on the blade surface.

The activation/deactivation of the blade heating is timed perfectly.

This results in unnecessarily

i. Lowest energy costs (precision heating).

ii. highest yields (ice-free blades).

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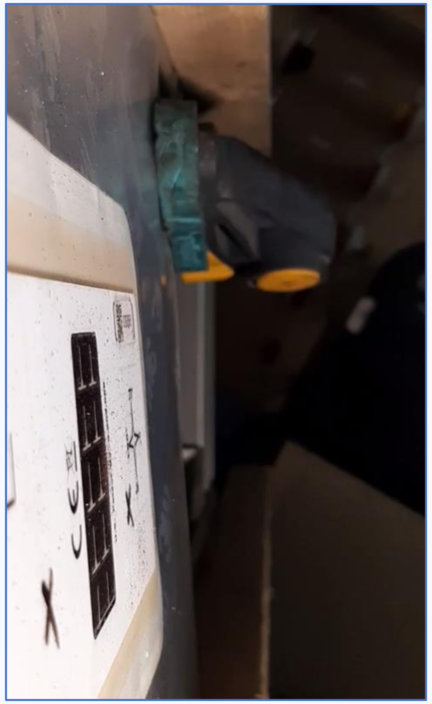

Reliability

Tested & Proven

Our ON-BLADE technology: Continuously enhanced through rigorous testing for proven field reliability.

Continual Enhancement

- Ultra efficient solar panel & high-capacity battery
- Lightning & impact protection
- Based on hundreds of sensors in the field

Tested Reliability

- Wind and ice tunnel
- Climate chamber (2 weeks, -35 °C, darkness)
- Hail gun shots
- Lightning strikes