
Borealis Wind
Winterwind 2020
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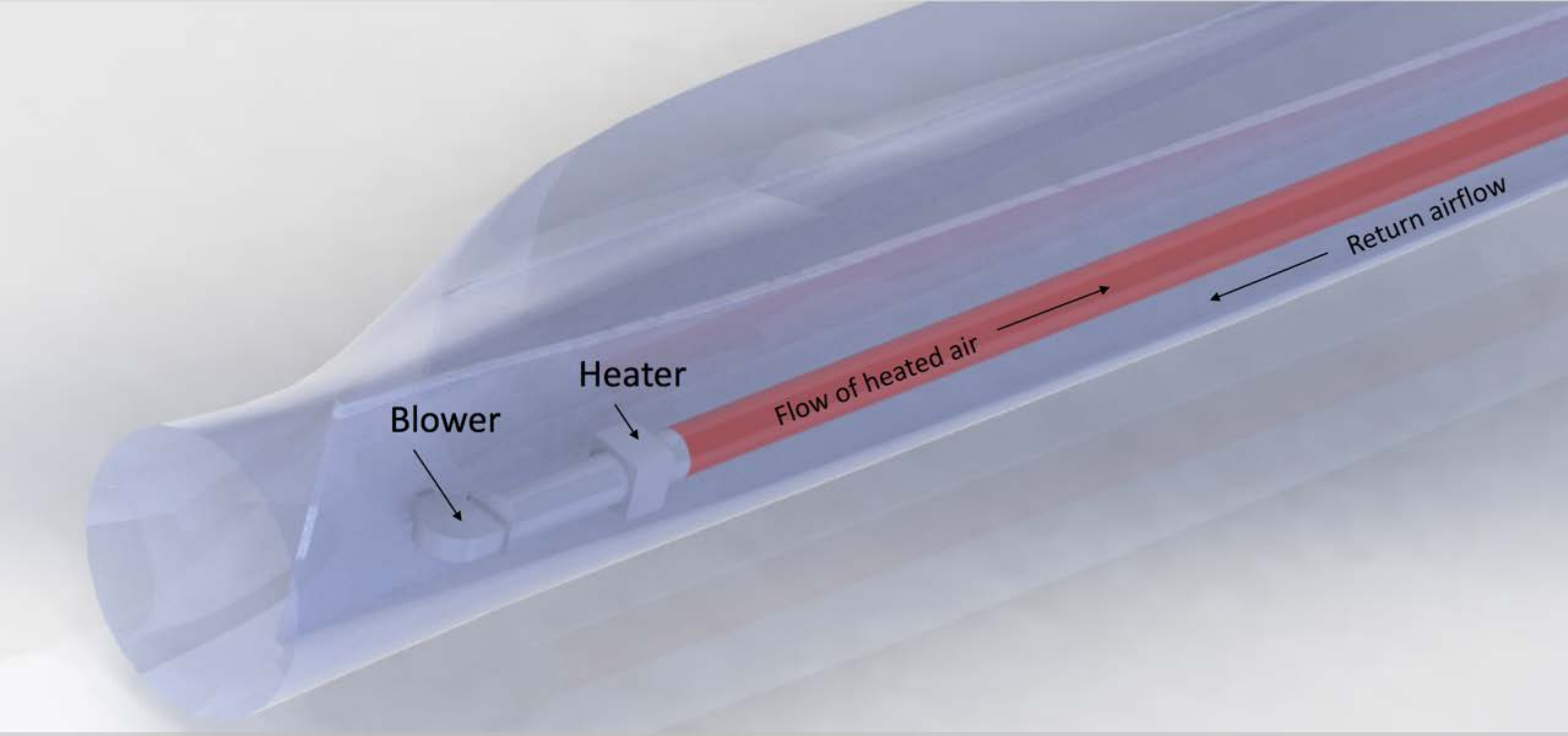
Problem:
Icing is the leading cause of revenue loss for cold climate wind farms

Our Goal:
Provide a simple retrofit system that can reduce icing loss by at least 70%

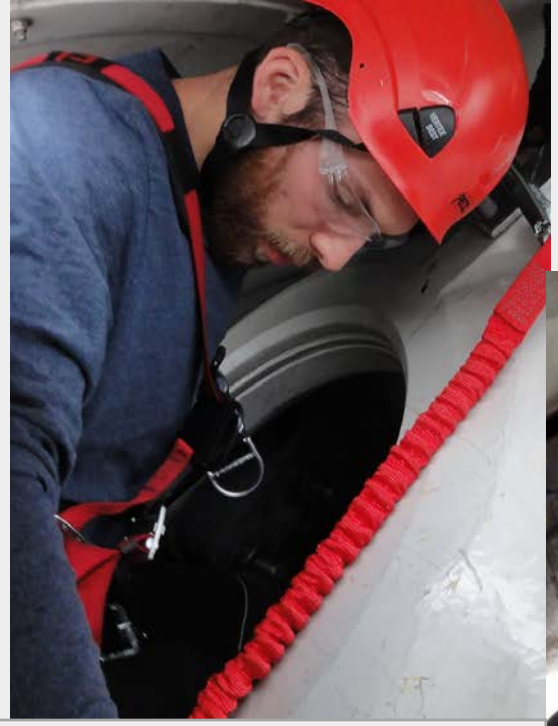


Borealis Ice Protection System

Installation

- 9 days to retrofit the Borealis System
- Schedule is designed to have the turbine operational overnight
- All materials are sized so they can be easily passed into the blade
  - Less than 50 cm x 50cm in cross section
  - Less than 70 lbs.

Each Day



7 am	Safety meeting
8 am	Climb, Crane-up materials
9 am	Pin blade horizontally and pass materials into the blade
10 am – 5pm	Planned work
6 pm	Clean up, move materials out of blade
7 pm	Return turbine to operation

	1	2	3	4	5	6	7	8	9
Team 1	Install duct and electrical panel in Blade A, B, C			Install blower and heater in Blade A, B, C			Run cable from the hub to the heating system in Blade A, B, C		
Team 2	Mount hub and nacelle panel		Run Cable from nacelle to hub		Mount tower electrical panels		Run cable up tower		Slip ring

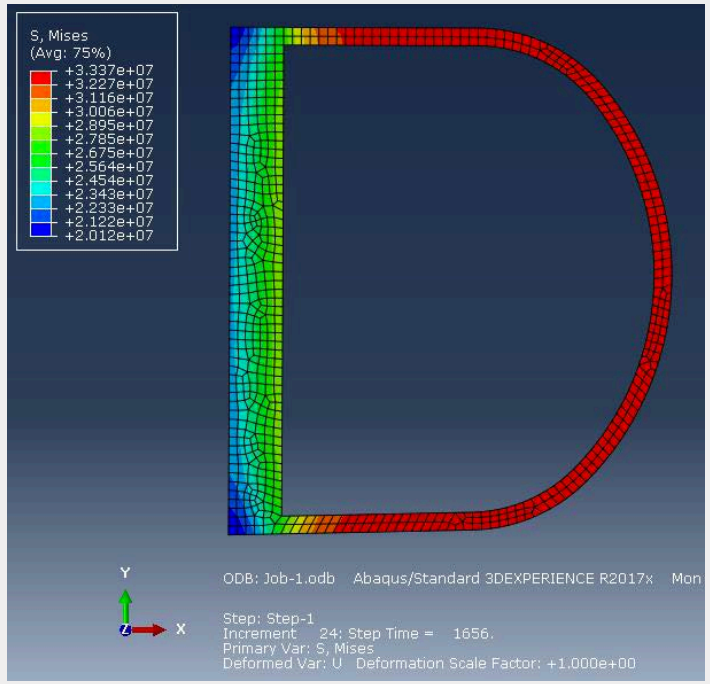
Optional Feeder Circuit

Install Procedure

Risk Mitigation

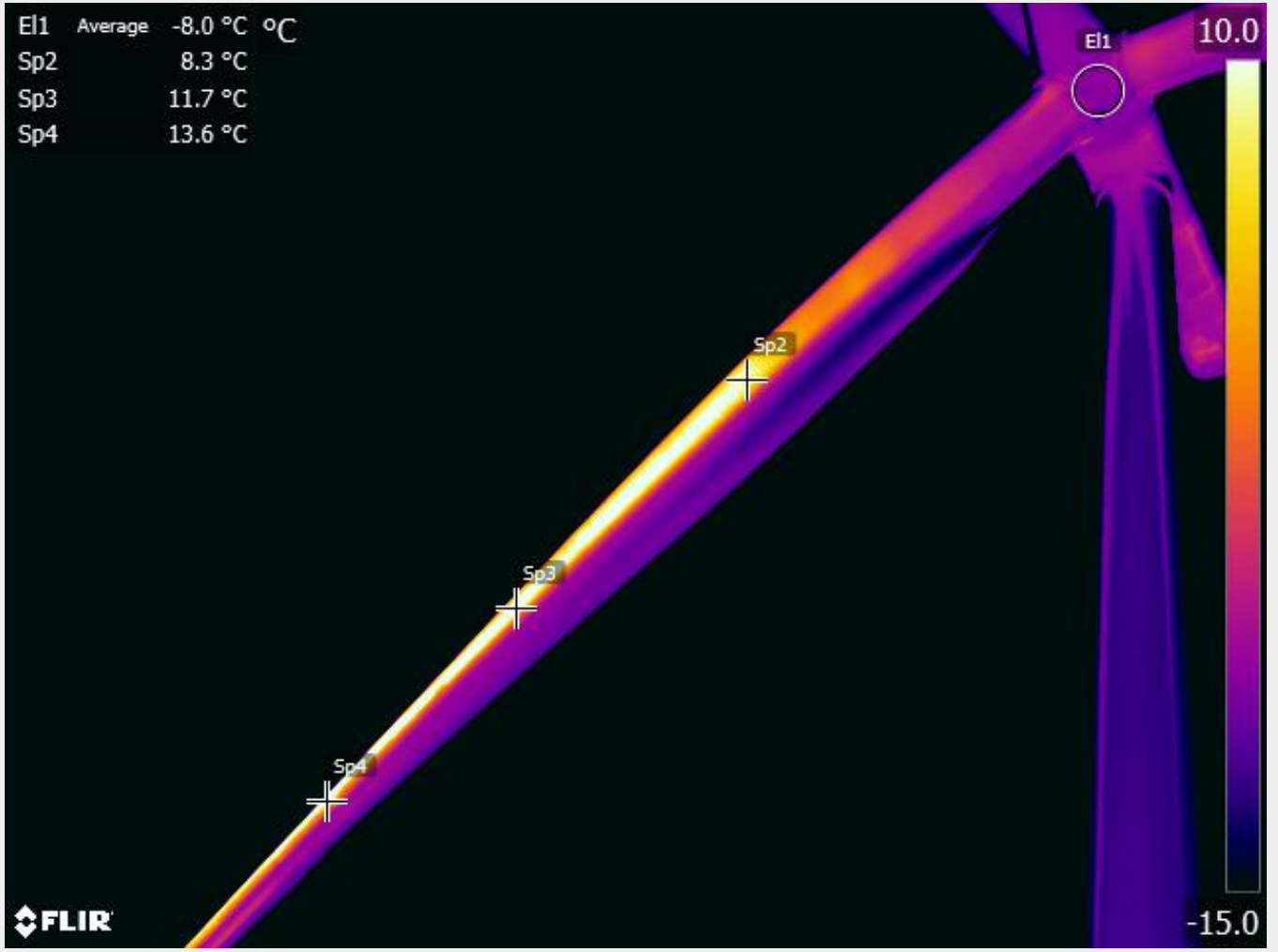
- Load testing with the University of Maine, Advanced Composites and Structures Center
- Thermal impact analysis with the Composites Research Network and University of Waterloo
  - Physical testing and improvement of the model are ongoing
- Strain much less than the strain limit defined by IEC 61400-23

https://composites.umaine.edu/wp-content/uploads/sites/20/2016/07/UMCompositesCenter-WindBladeTesting_rev3-1.pdf

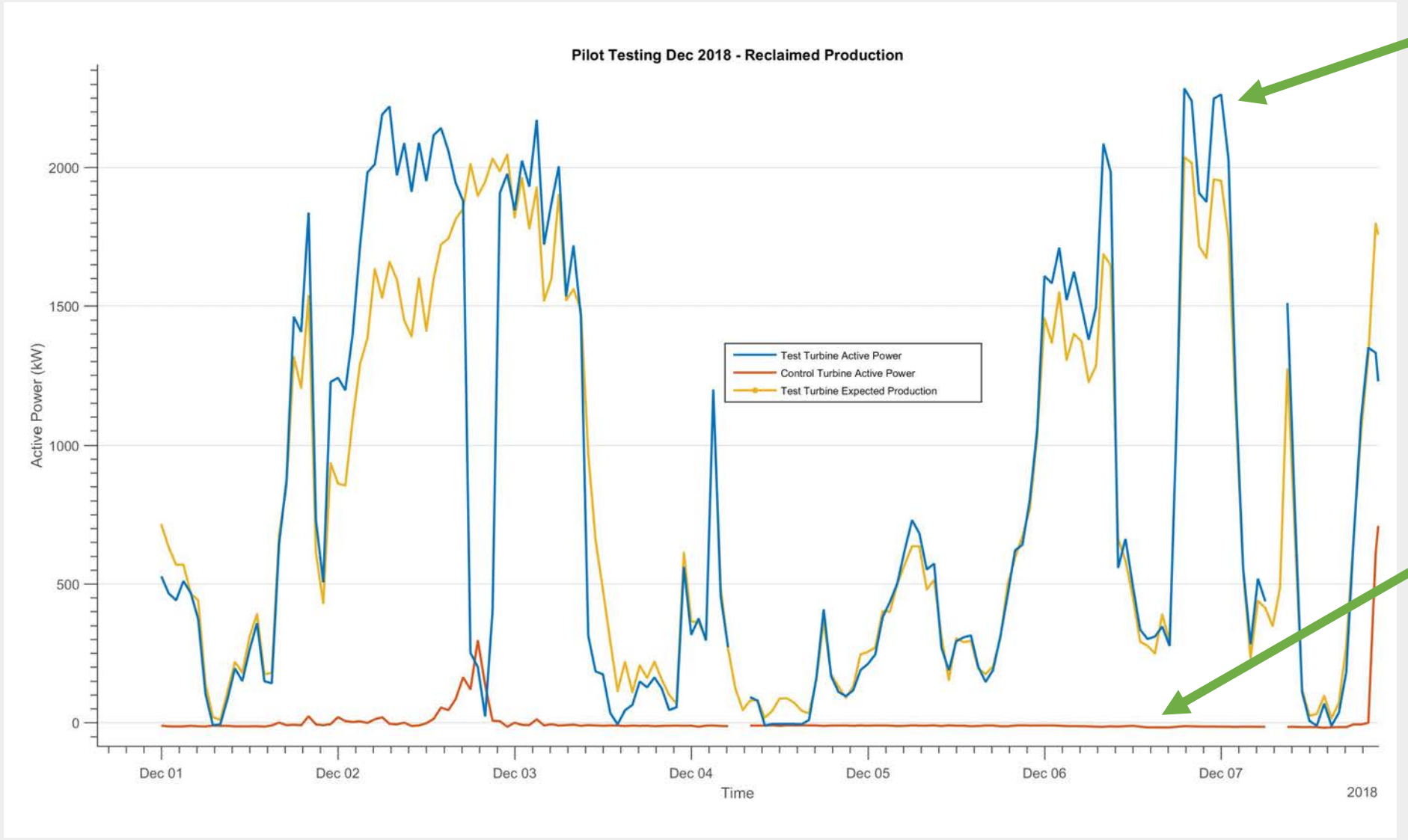


Infrared Photo of blade with Borealis IPS

Ambient Temperature	-7°C
Wind Speed	6 m/s
Blade Internal Temperature	32°C
Blade External Temperature	11°C



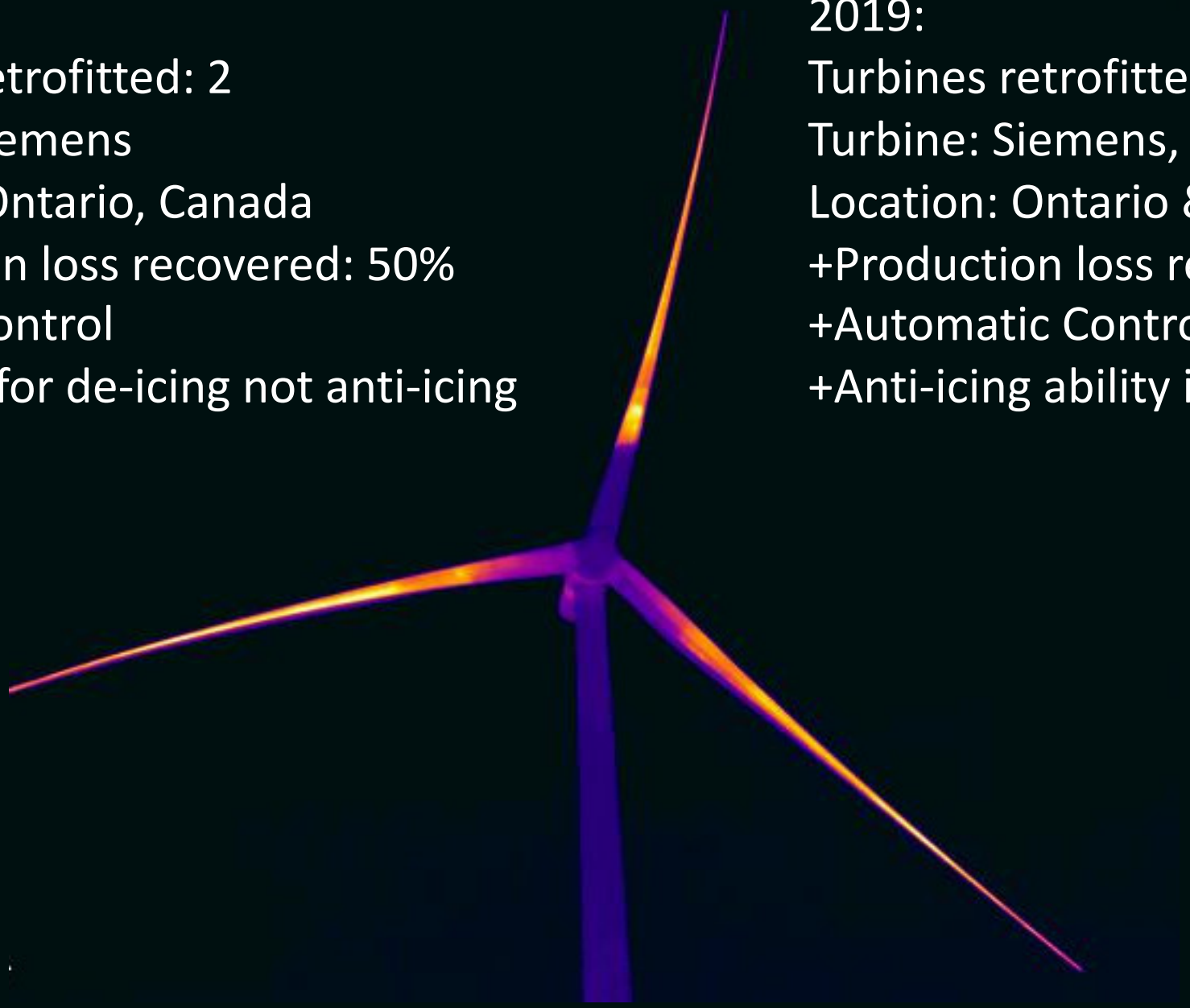
Icing Event Performance



Turbine **with** the Borealis System

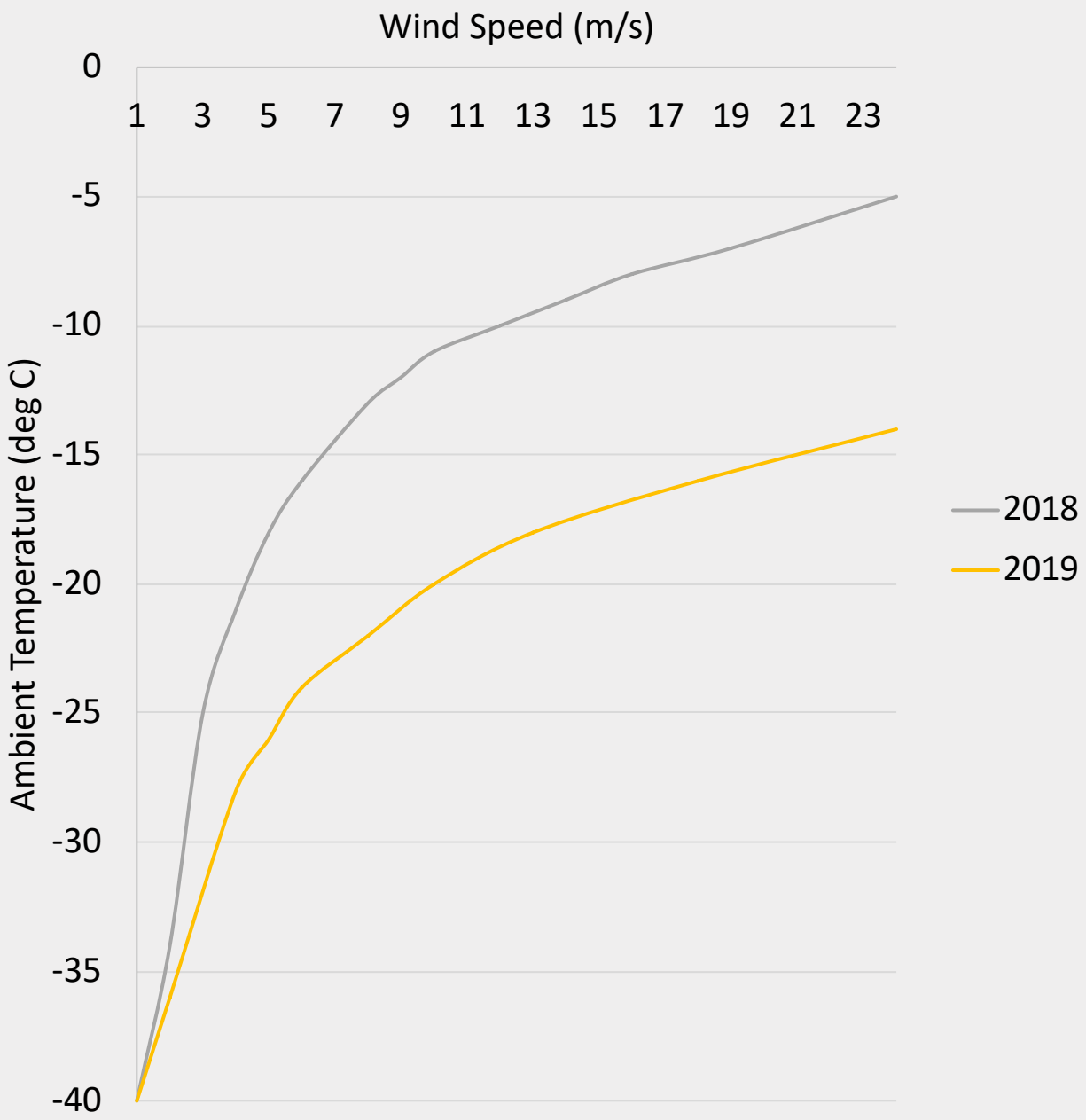
Turbine **without** the Borealis System

2018:
Turbines retrofitted: 2
Turbine: Siemens
Location: Ontario, Canada
+Production loss recovered: 50%
-Manual Control
-Designed for de-icing not anti-icing

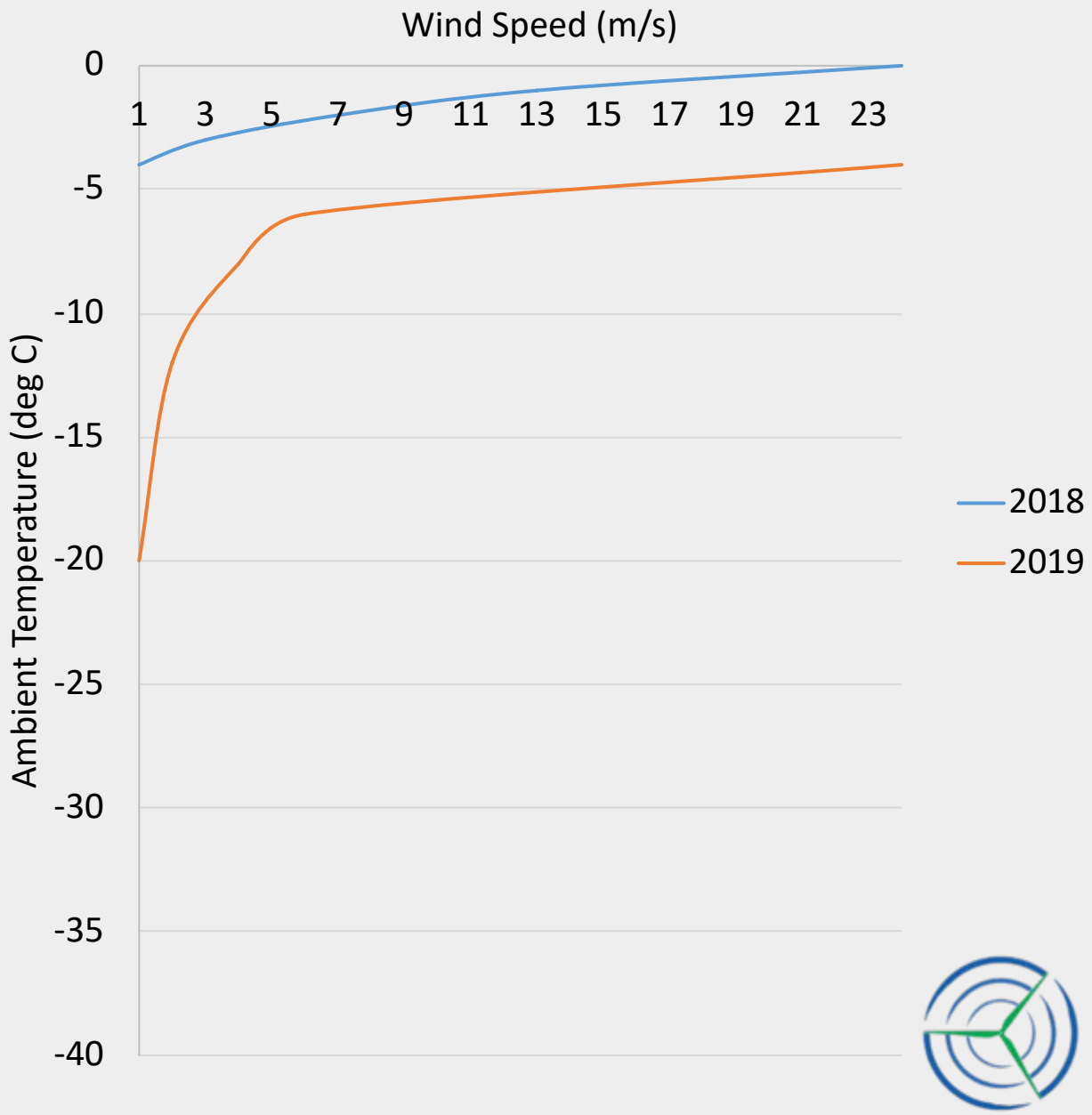


2019:
Turbines retrofitted: 6
Turbine: Siemens, Senvion
Location: Ontario & Quebec, Canada
+Production loss recovered: TBD
+Automatic Control
+Anti-icing ability improved

De-icing Ability



Anti-icing Ability



Summary

Borealis Ice Protection System:

9-day installation time

2018: Reclaimed 50% production loss with V1 of the system

2019: Improved anti-icing ability, Automated control system

6 new installs in 2019 in Canada

Borealis Wind is seeking:

- interested customers outside of Canada to help validate the system in other icing climates
- manufacturing and installation partners outside of Canada

Note: For installs in 2020 order by end of March

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