

Borealis Wind

Hot Air Blade De-icing Retrofit – Field Test Results

Winterwind 2019

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Founded in 2014

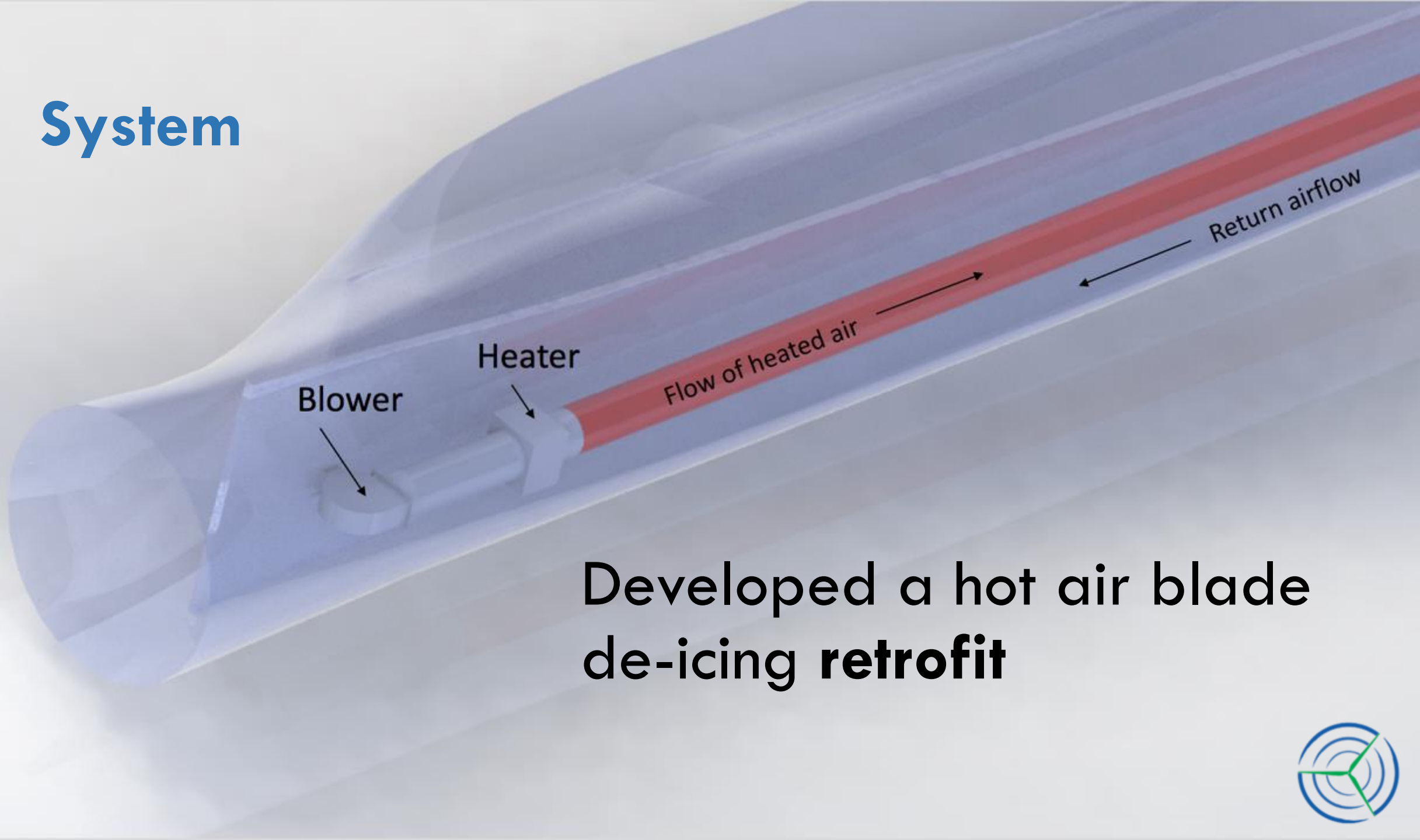
First site visit in October 2014

Goal

Develop a blade de-icing retrofit that is **simple to install and maintain** while still effective



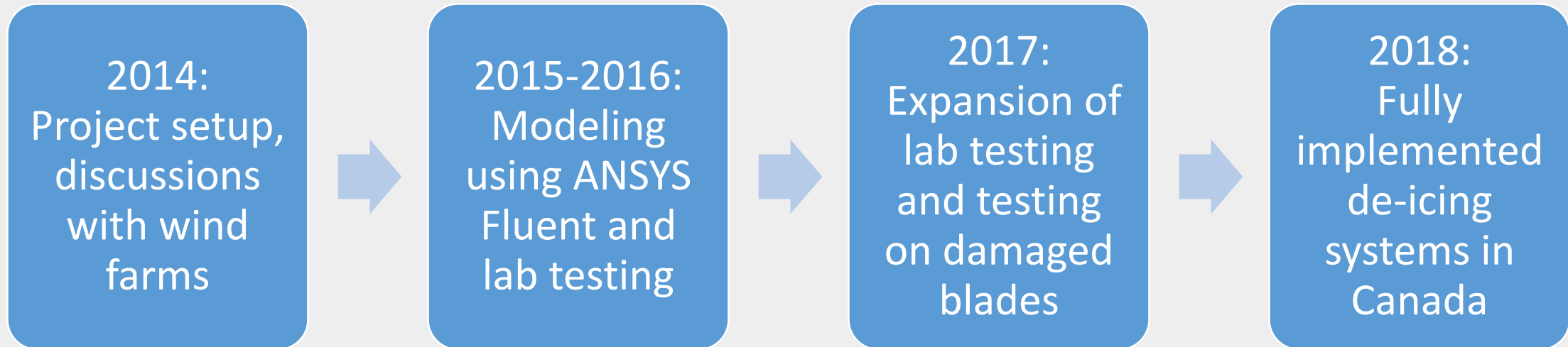
System



Developed a hot air blade de-icing **retrofit**



Timeline



Field Test Results

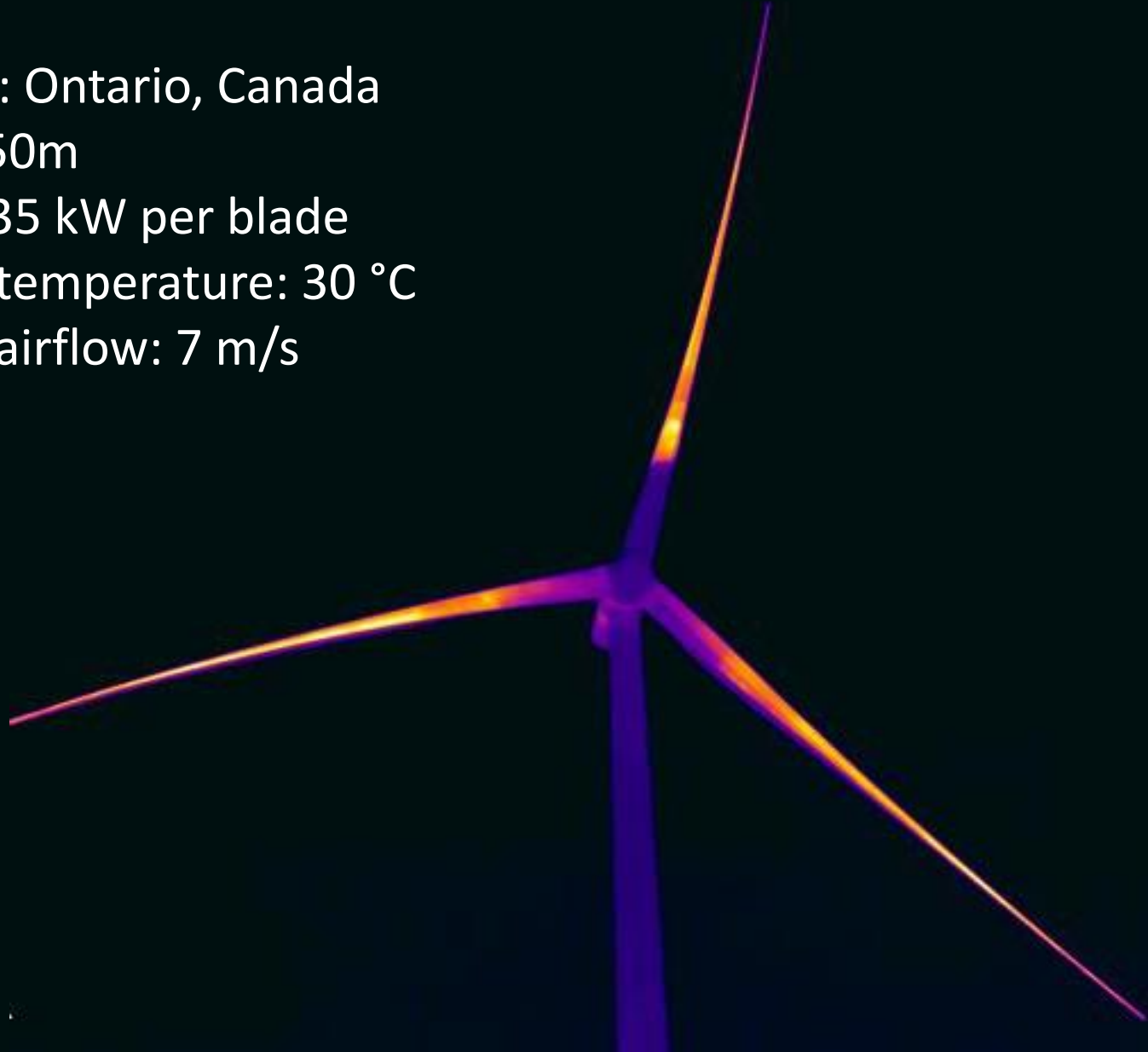
Location: Ontario, Canada

Blades: 50m

Heater: 35 kW per blade

Internal temperature: 30 °C

Internal airflow: 7 m/s



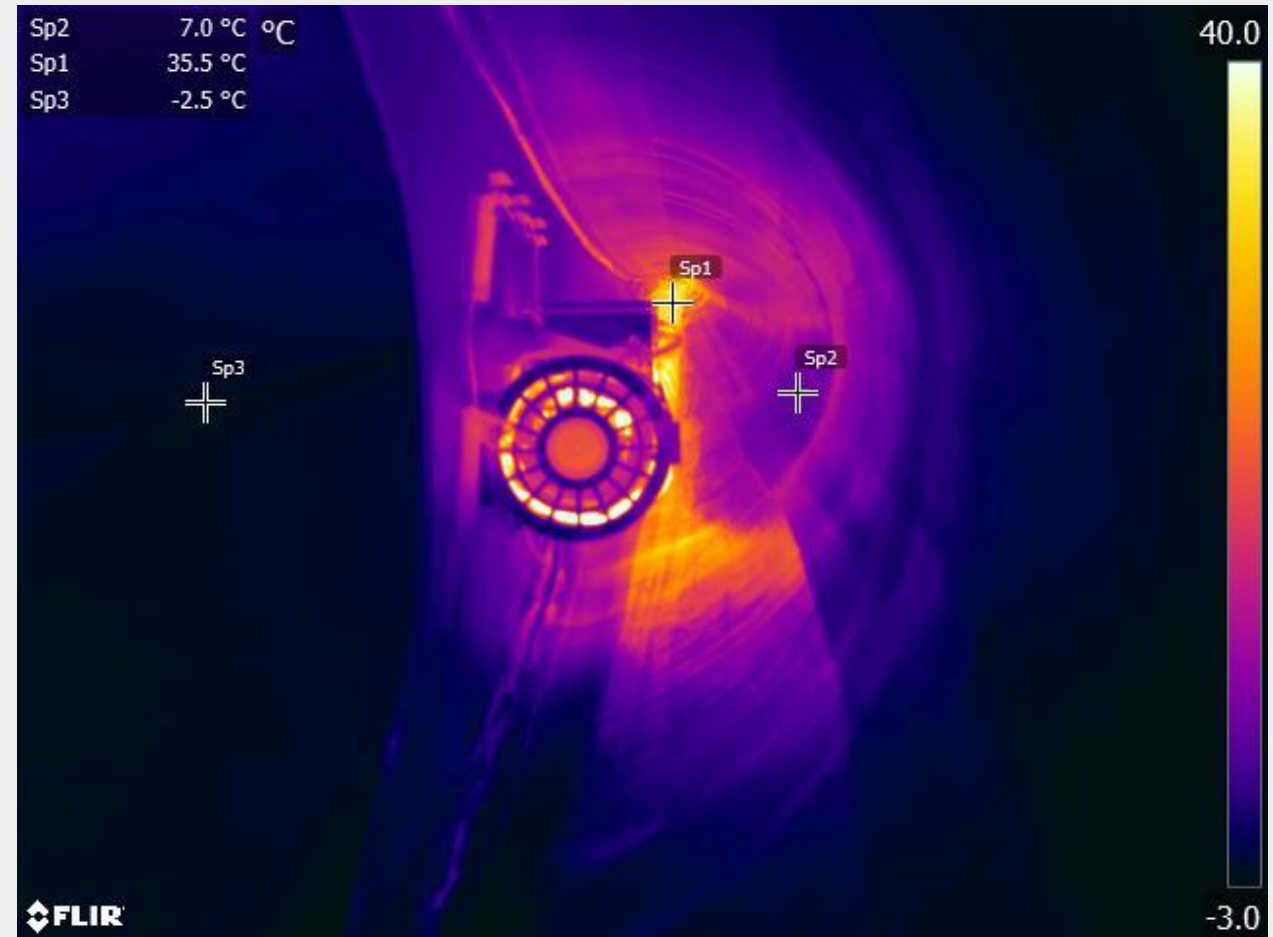
Installation

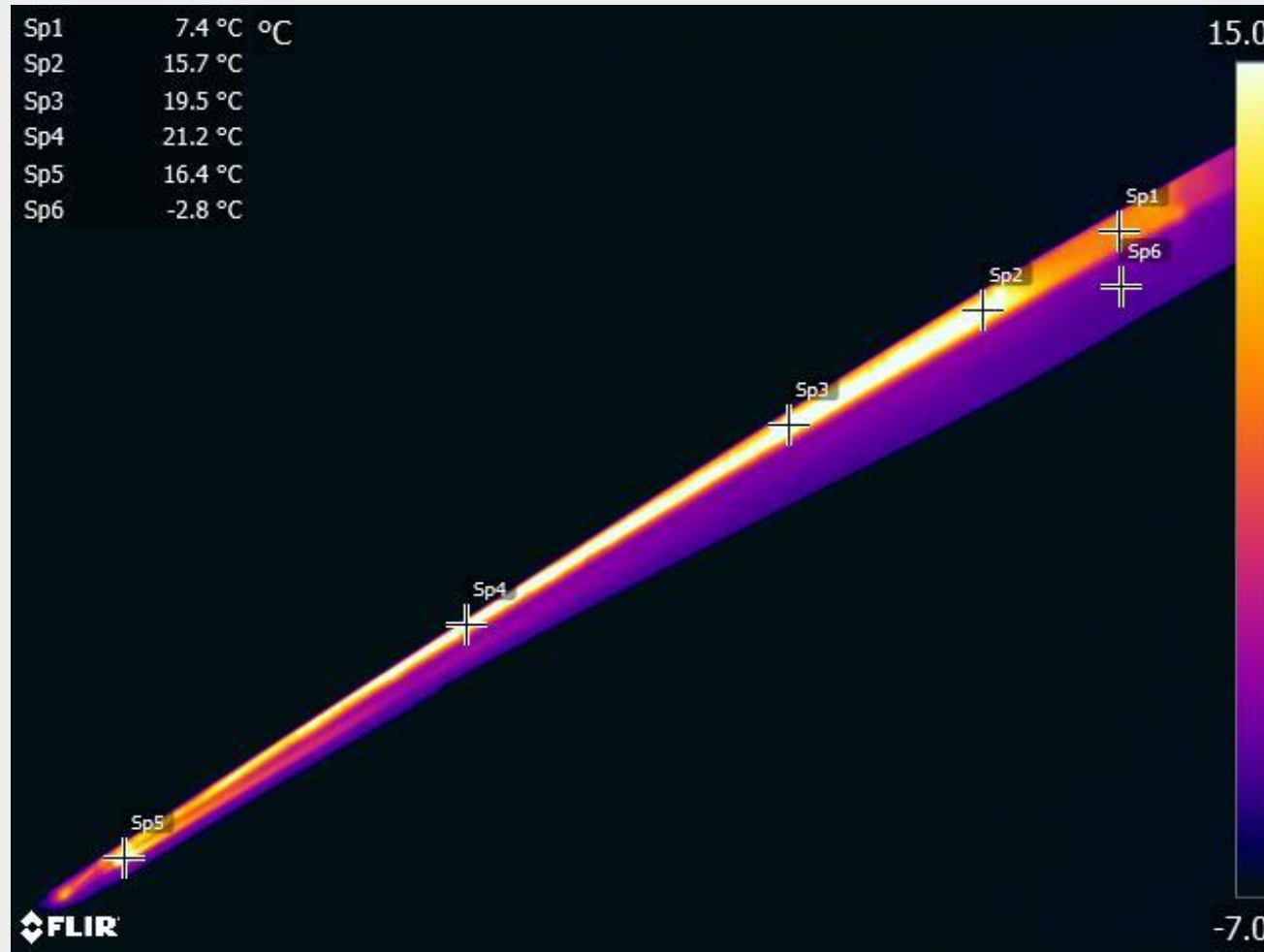
Time to Install:

- Current: 9 working days
- Components are small, can be carried into the blade
- Assembled inside the blade
- No rope access, cranes or platforms
- Goal: 5 working days

Turbine Downtime:

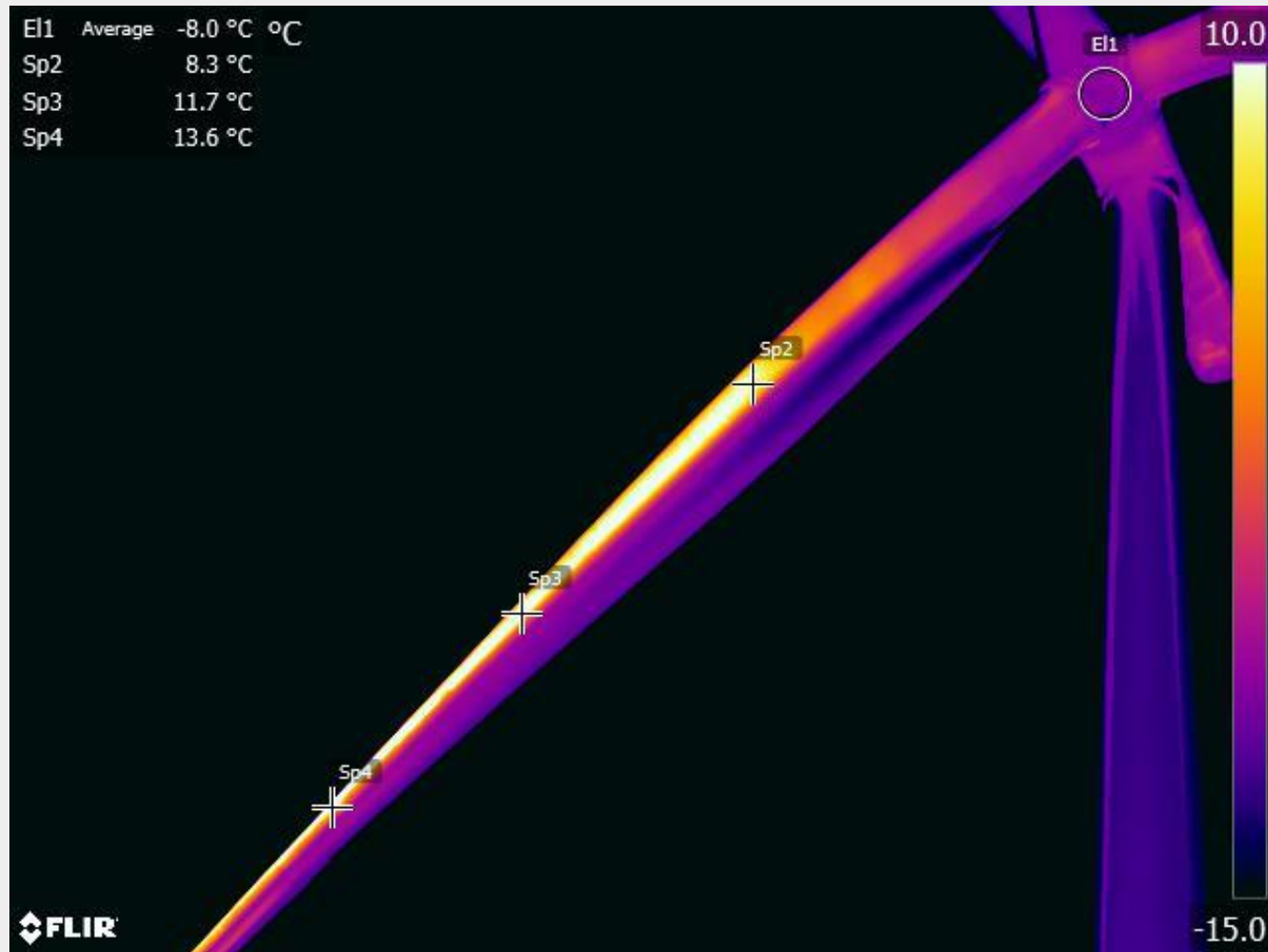
- Down during working days, operational overnight





	Modelled	Measured
Ambient Temperature (°C)	-2	-2
Wind Speed (m/s)	2.2	1.2 to 3.2
Blade Surface Temperature (°C)	14.5 to 20.0	15.7 to 21.2 (+/-2)





	Modelled	Measured
Ambient Temperature (°C)	-7	-7
Wind Speed (m/s)	5.8	4.8 to 6.8
Blade Surface Temperature (°C)	6.3 to 12.9	8.3 to 13.6 (+/-2)



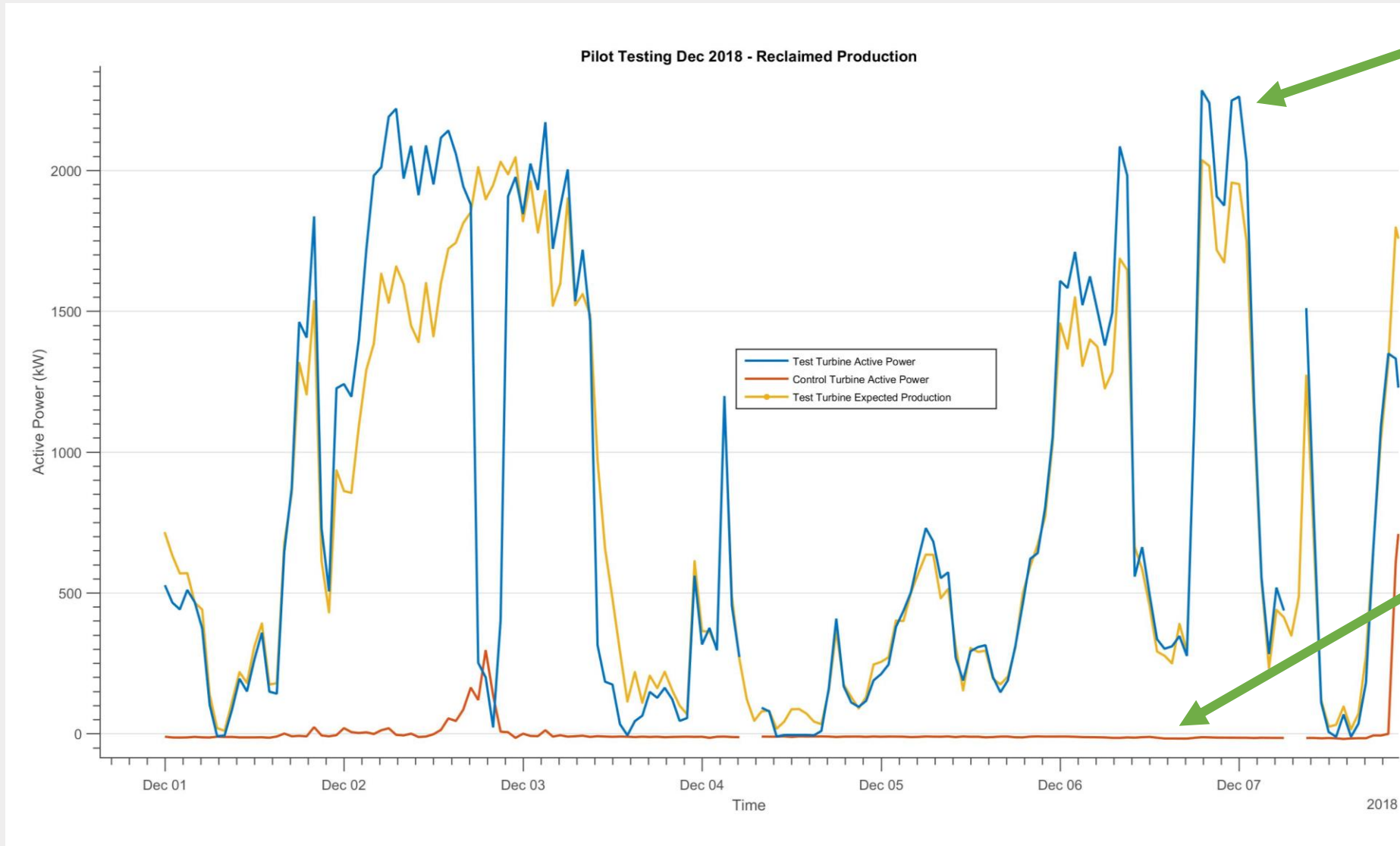
Preliminary Performance Analysis

Date	Turbine	Percent Reclaimed Production
November 2018 (predominantly anti-icing)	Turbine 1	30%
	Turbine 2	19%
December 2018 (predominantly de-icing)	Turbine 1	82%
	Turbine 2	69%
Total	Turbine 1 & 2	62%

- Manual control system has allowed us to reclaim **62%** of production
- Automatic control system is beginning operation February 11th
- Next Steps: work with a 3rd party to review data



Icing Event Performance



Turbine **with** the Borealis System

Turbine **without** the Borealis System



Advanced Composites and Structures Center

University of Maine

- Purpose:
 - Simulate the loads created by the de-icing system and measure the resulting strains



The Advanced Composites and Structures Center is an ISO 17025 accredited testing laboratory with 15 years of experience testing blades to IEC 61400-23.

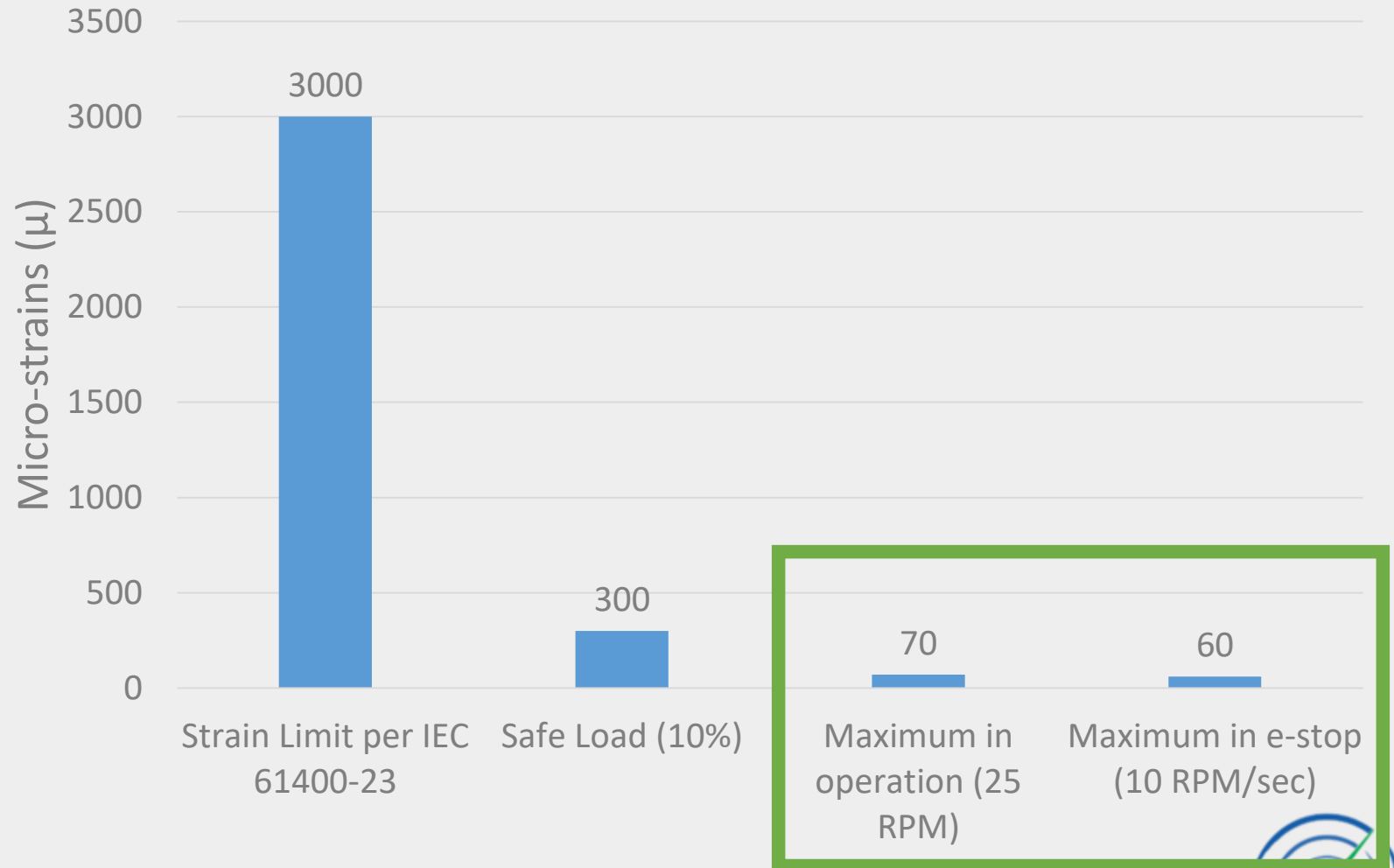
https://composites.umaine.edu/wp-content/uploads/sites/20/2016/07/UMCompositesCenter-WindBladeTesting_rev3-1.pdf



Test Results

Strain Comparison

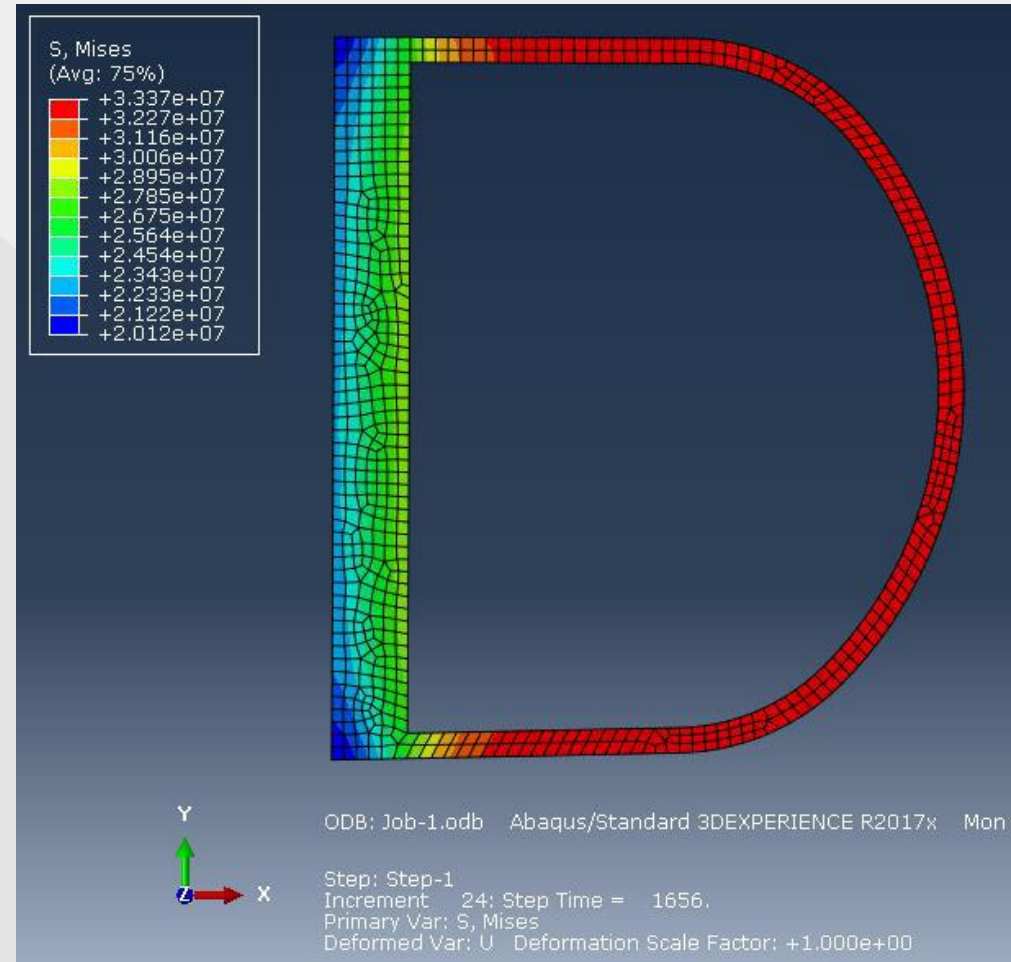
Maximum strain measured was **70 μ** at the blower during 25RPM operation, **much less than the safe load**



Composites Research Network (CRN)

University of British Columbia

- Purpose:
 - Model the thermal stress due to a temperature gradient
- Next steps:
 - Determine blade material properties from blade samples
 - Determine stress due to heating
 - Thermal cycling testing



Next Steps

- Obtain certification
- Complete analysis on thermal impacts on the blade
- System performance analyzed by a 3rd party
- Release 15-25 early commercial systems for install in summer 2019
- Currently raising funding for scale-up



Borealis Wind

- Hot air blade de-icing retrofit
- 1-week to install (no cranes, platforms, rope access)
 - 62% reclaimed over November and December
 - Releasing 15-25 systems for installation in 2019
 - Currently raising funding for scale-up

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