THE IMPORTANCE OF ACCURATE DETECTION FOR TURBINE ICE PREVENTION SYSTEMS

UNIVERSITÉ LAVAL

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Winterwind
INTERNATIONAL WIND ENERGY CONFERENCE

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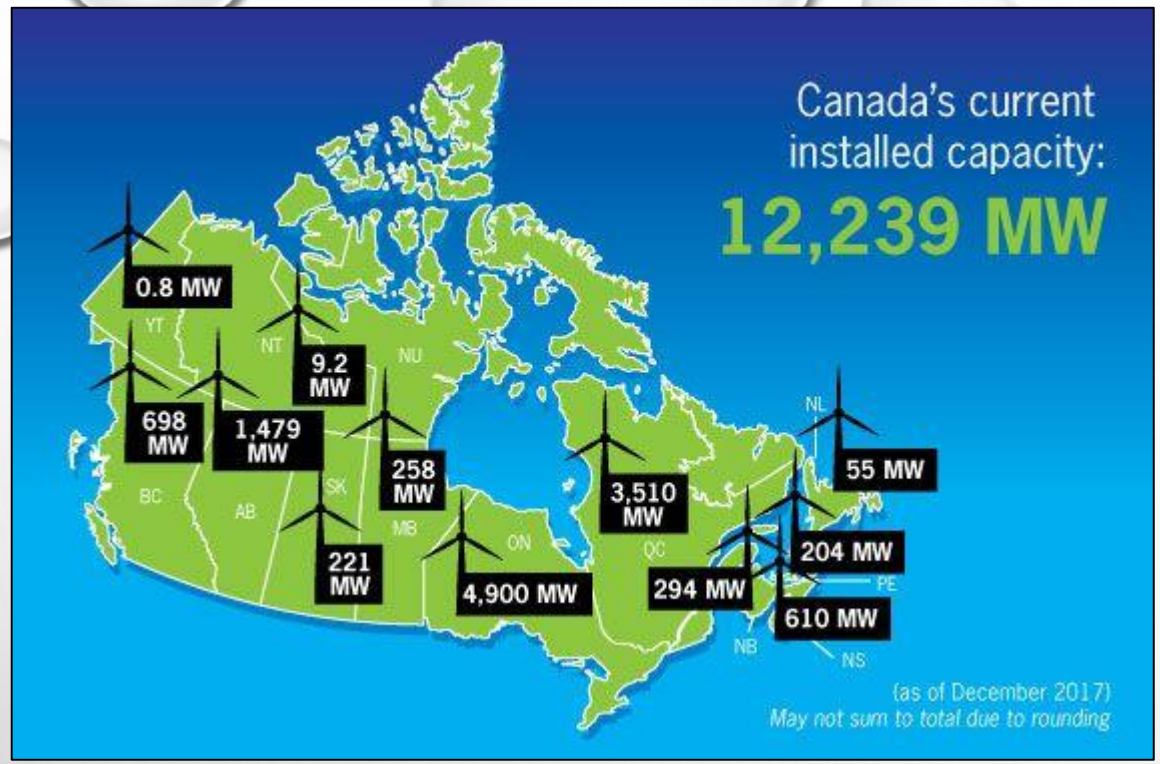
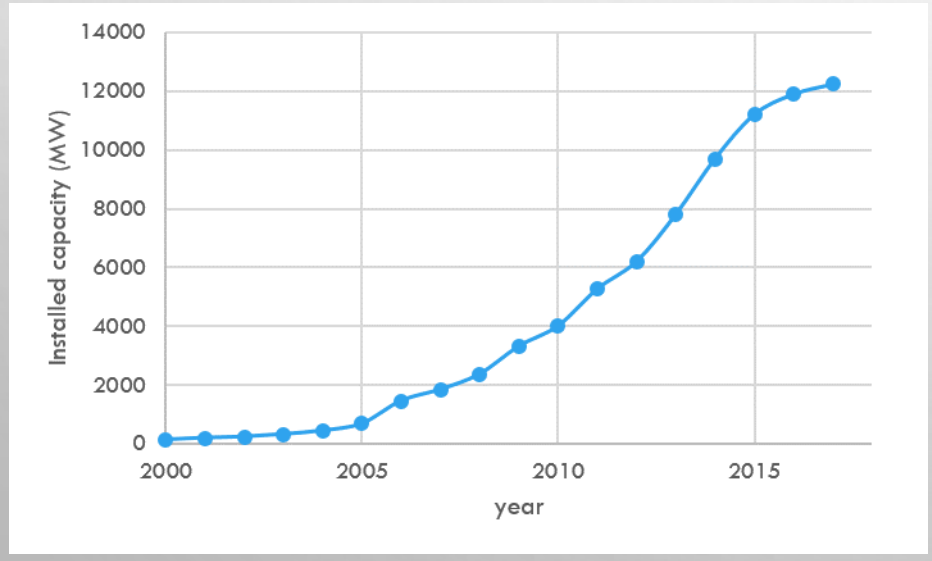
Wind power in Canada



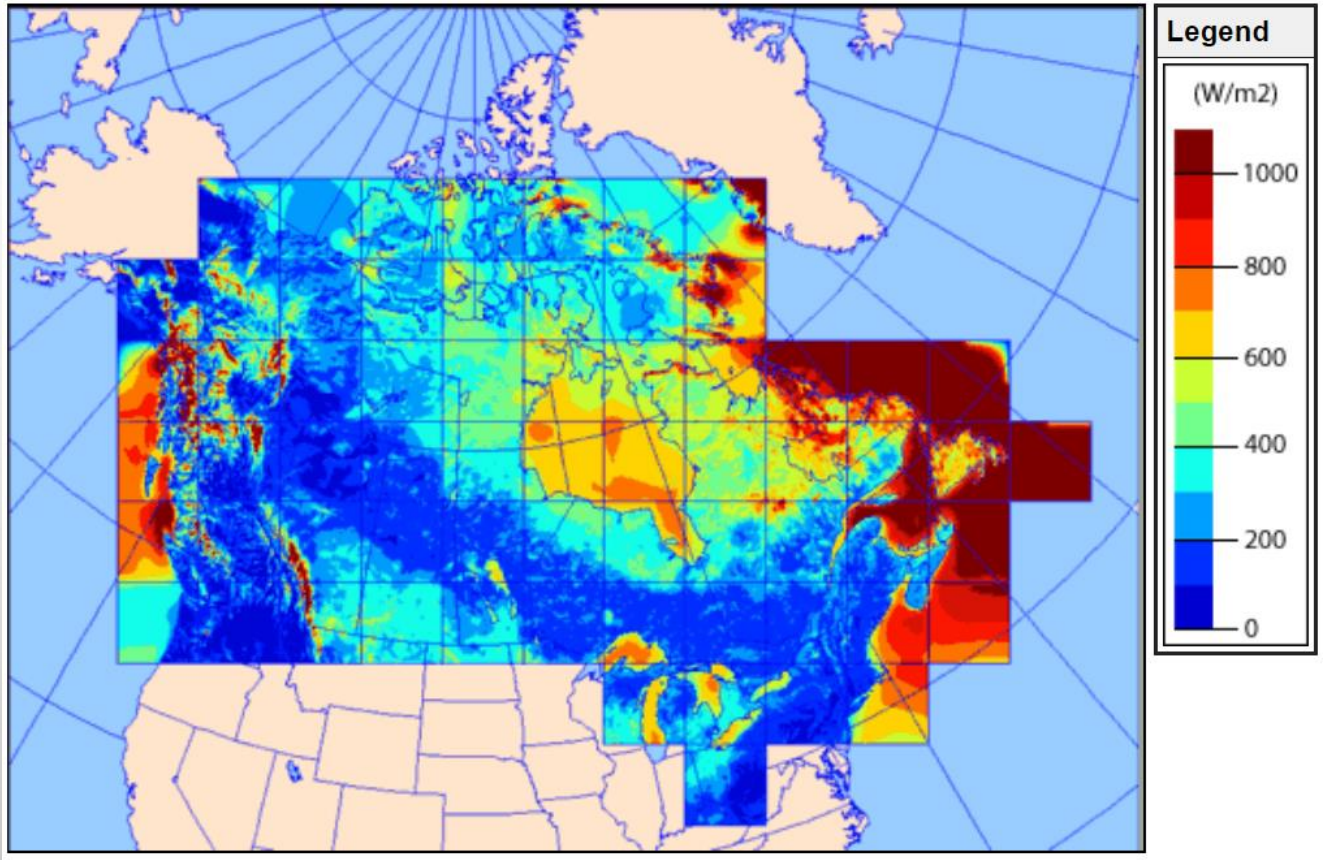


source: www.canwea.ca

≈ 6% of energy demand

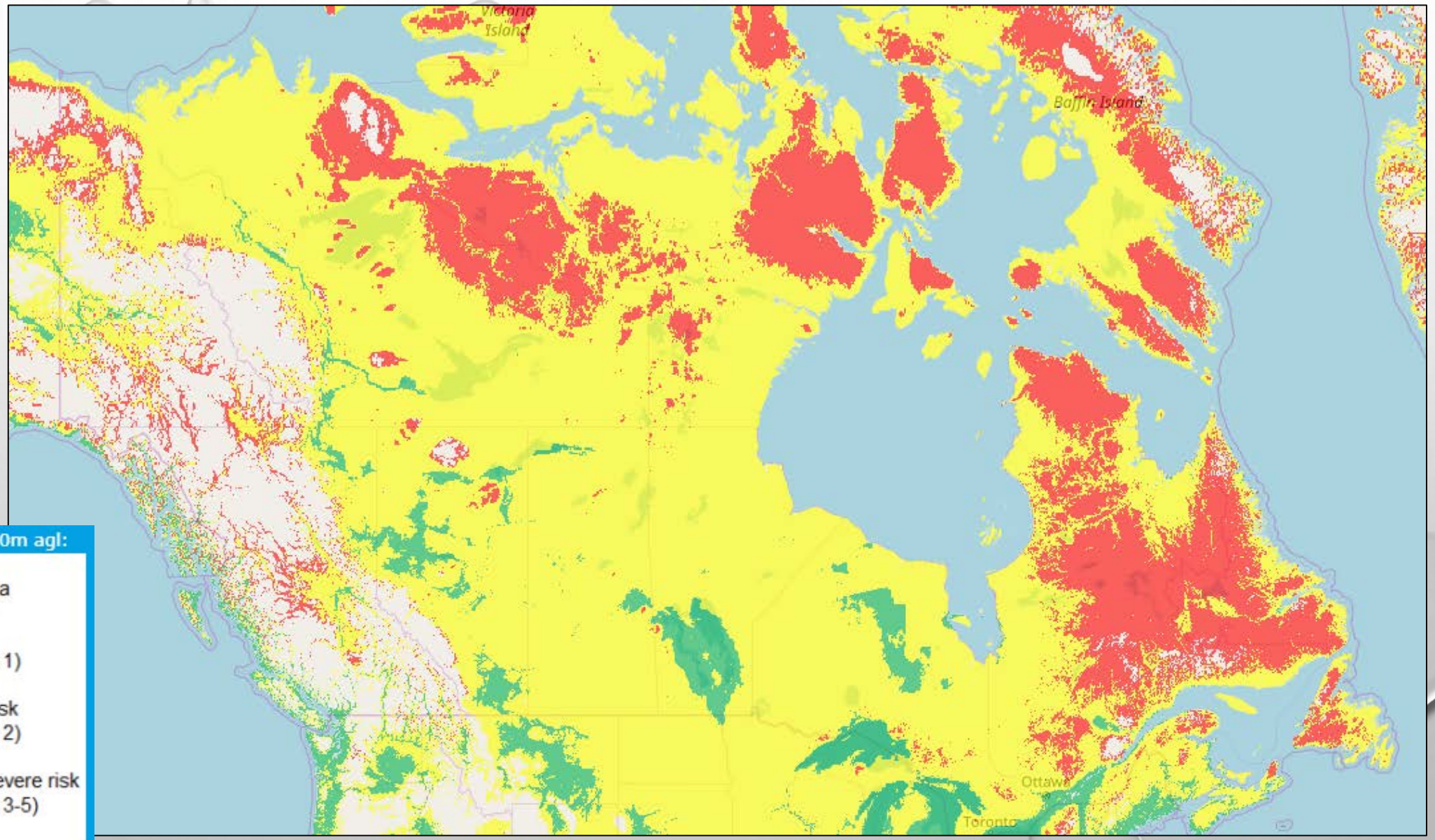
High wind potential

Cold temperature + atmospheric icing (glaze & rime)



source: http://www.windatlas.ca/maps-en.php

Canada ice map

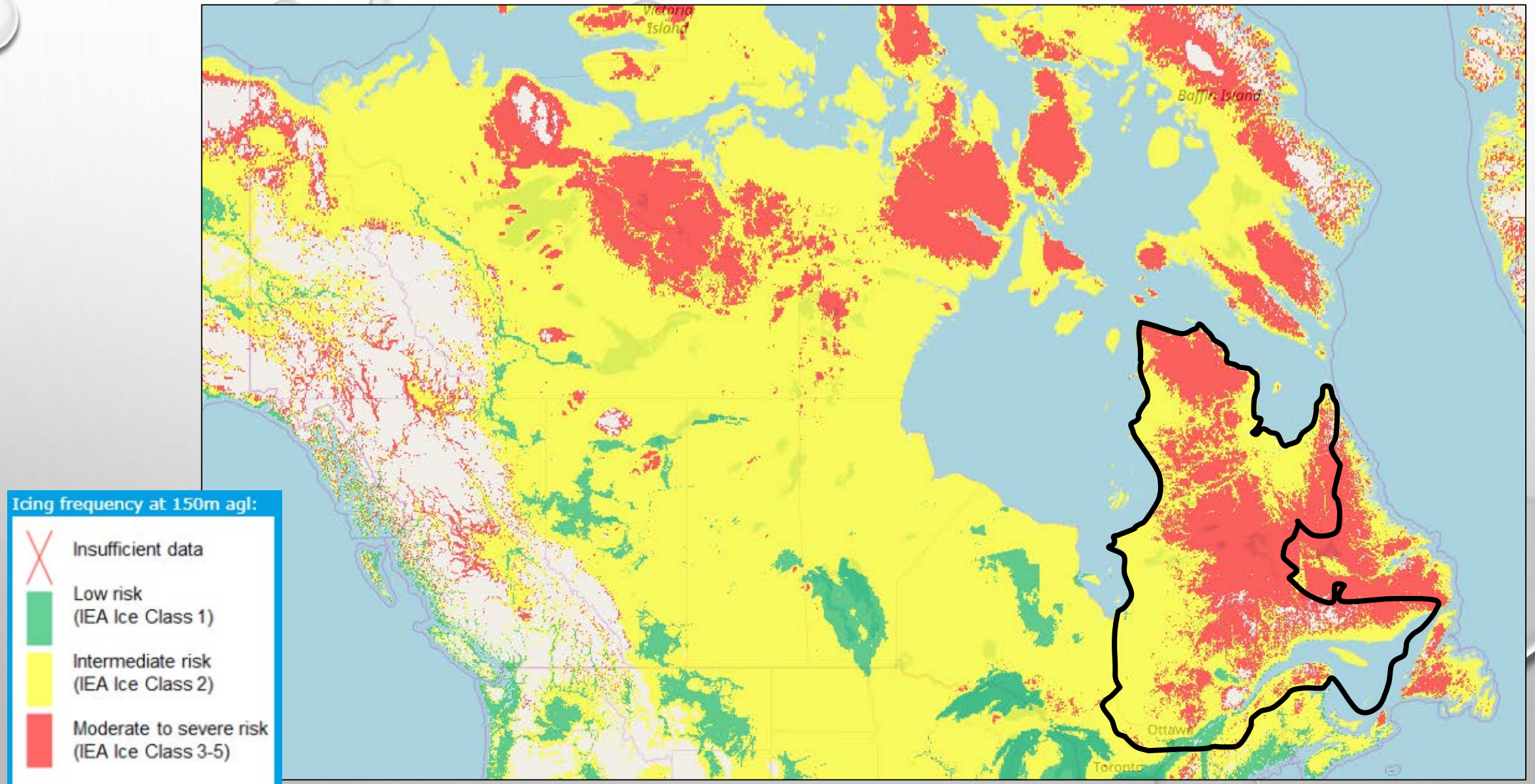


Icing frequency at 150m agl:

- Insufficient data
- Low risk (IEA Ice Class 1)
- Intermediate risk (IEA Ice Class 2)
- Moderate to severe risk (IEA Ice Class 3-5)

source: http://virtual.vtt.fi/virtual/wiceatla/

Canada ice map



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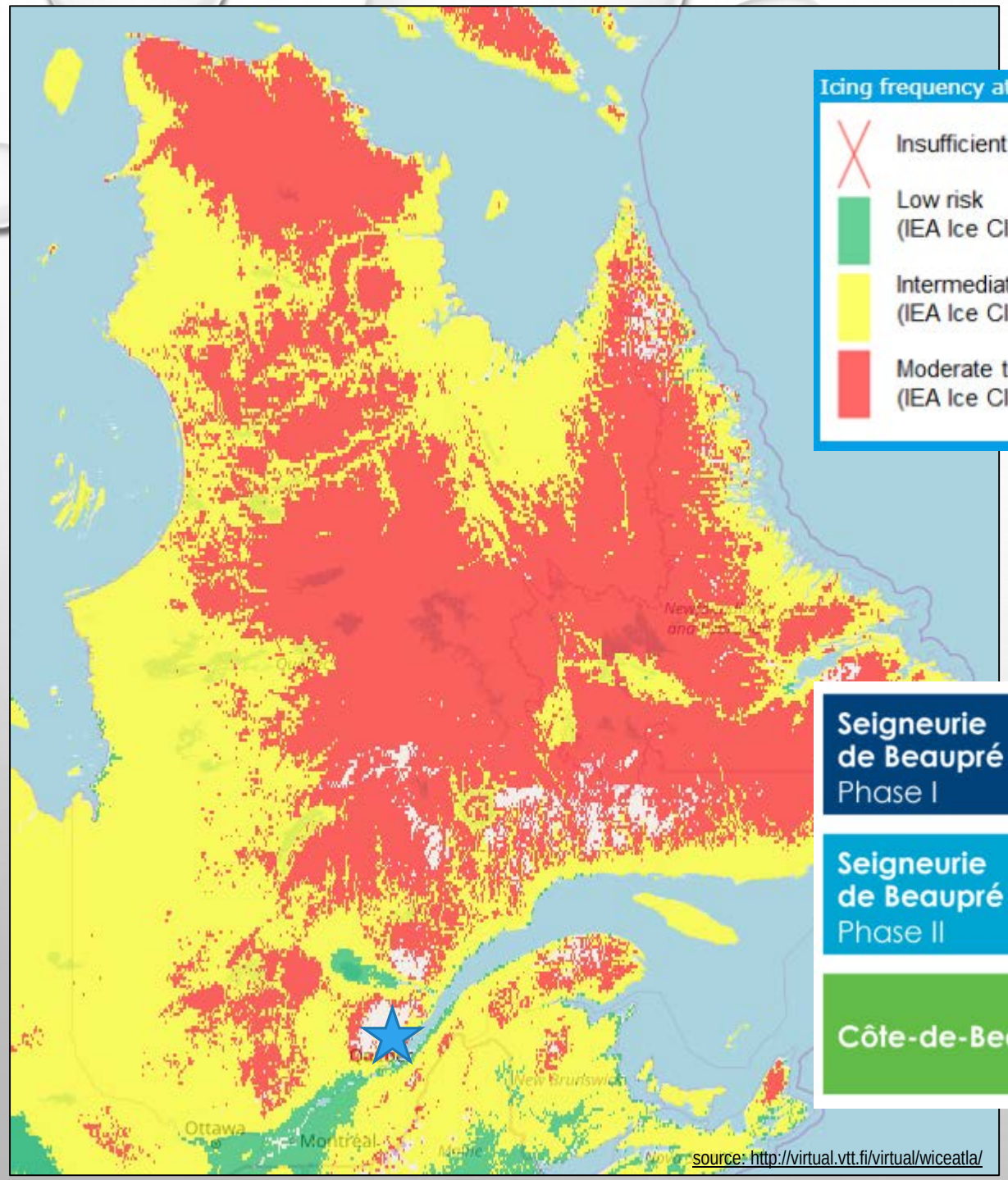
Wind energy research partnerships



source: http://virtual.vtt.fi/virtual/wiceatla/

★ Seigneurie-de-Beaupré

- High wind potential
- 164 turbines (364 MW)
- Servere icing; IEA class 4-5
- Enercon turbines equipped with IPS

	capacity	nb turbines	year	partners
Seigneurie de Beaupré 2 & 3 Phase I	272 MW	126	2013	BORALEX, GazMétro, VALENER
Seigneurie de Beaupré 4 Phase II	68 MW	28	2014	
Côte-de-Beaupré	24 MW	10	2015	BORALEX

source: http://www.seigneuriedebeaupre.com/parcs/fr/

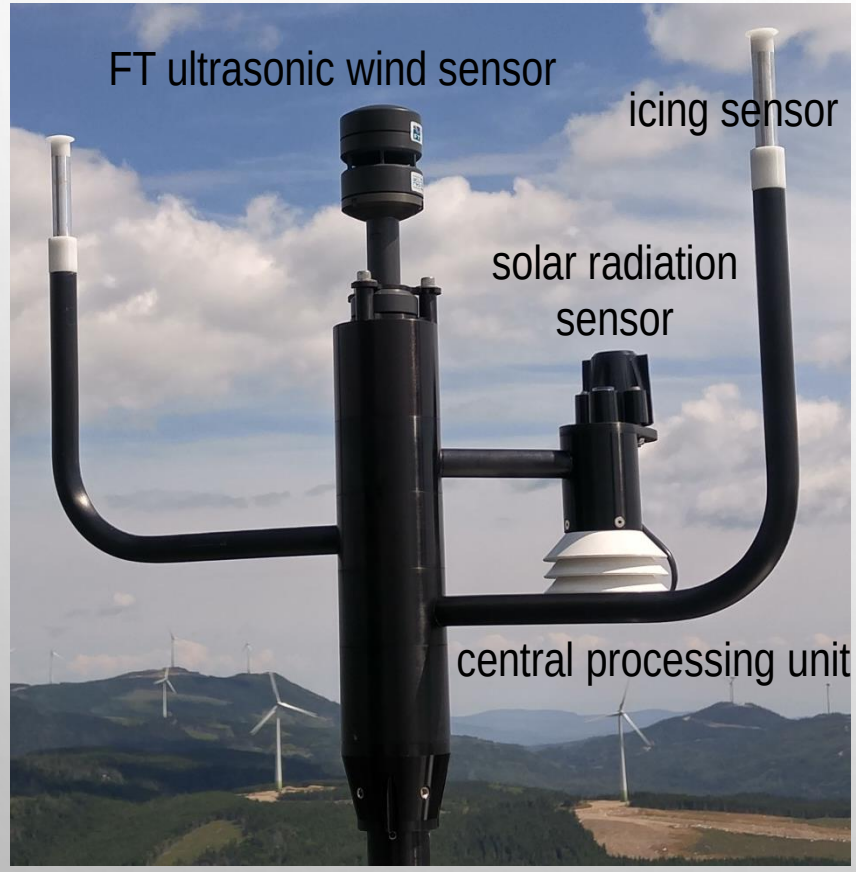
Project goals

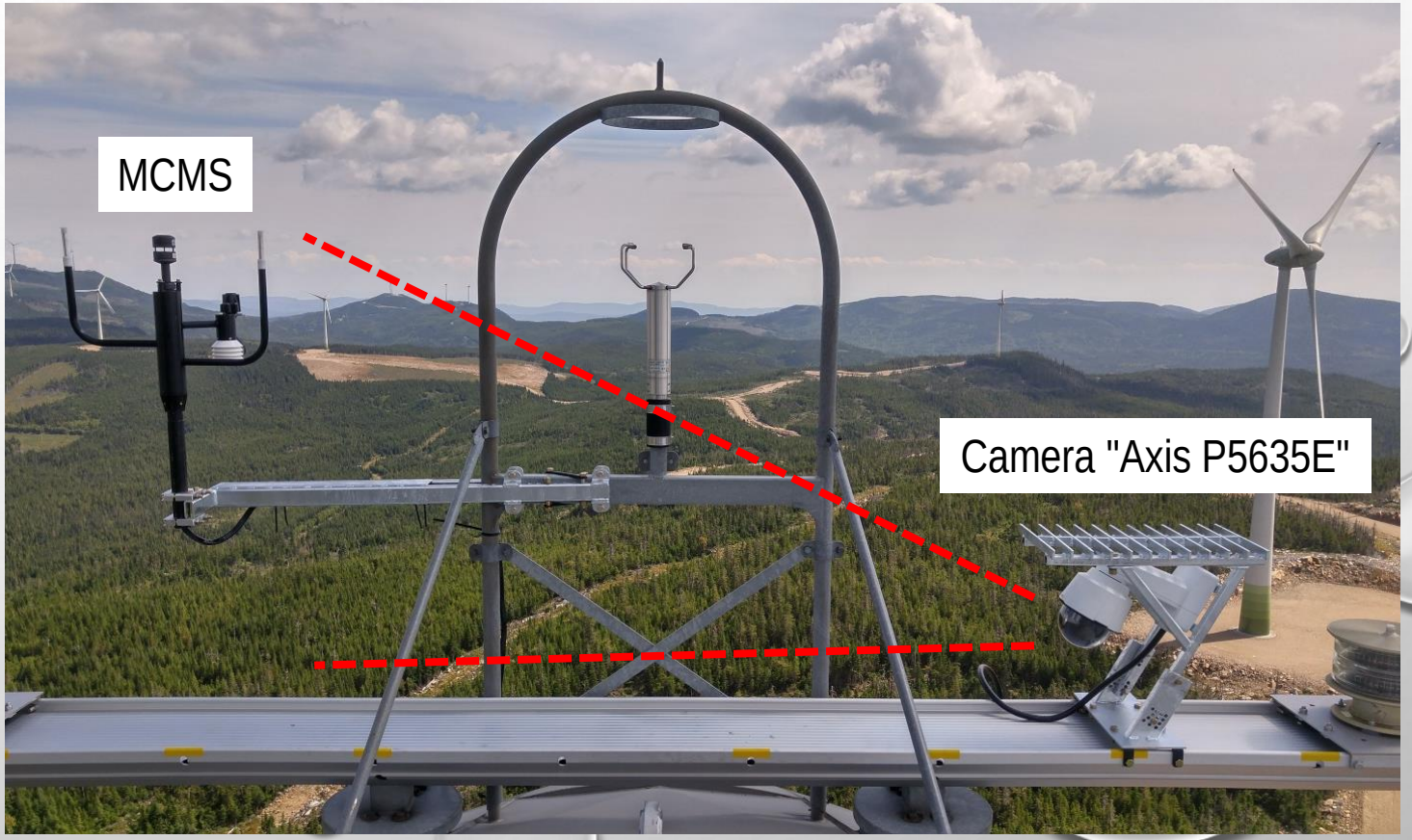
Improve power production in cold climate

- Study the behavior of wind turbines under severe icing conditions in Canada.
- Quantify the nature and severity of icing events at Seigneurie-de-Beaupré wind farm.
- Propose strategies and alternatives to improve net annual energy output.

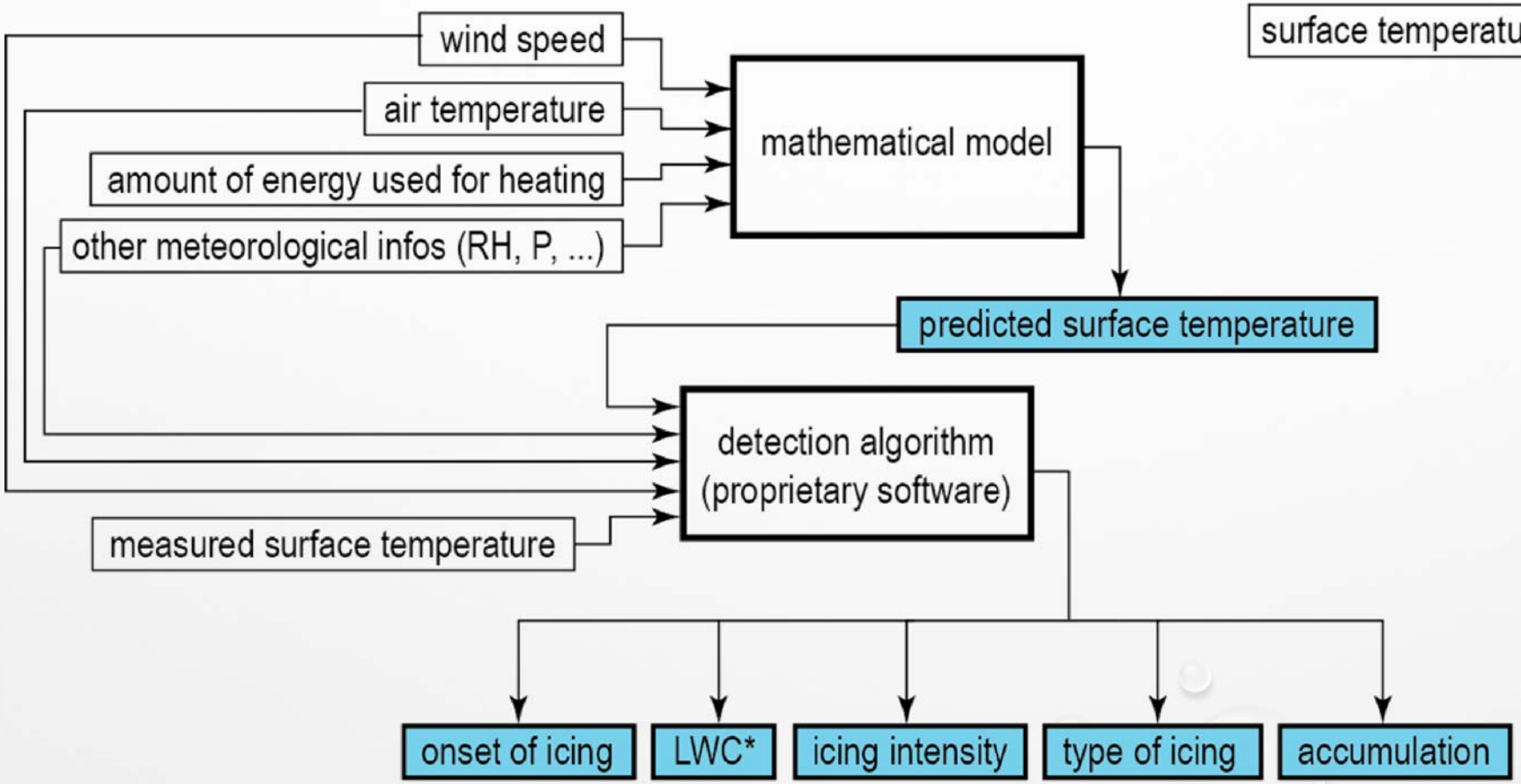
instrumental setup

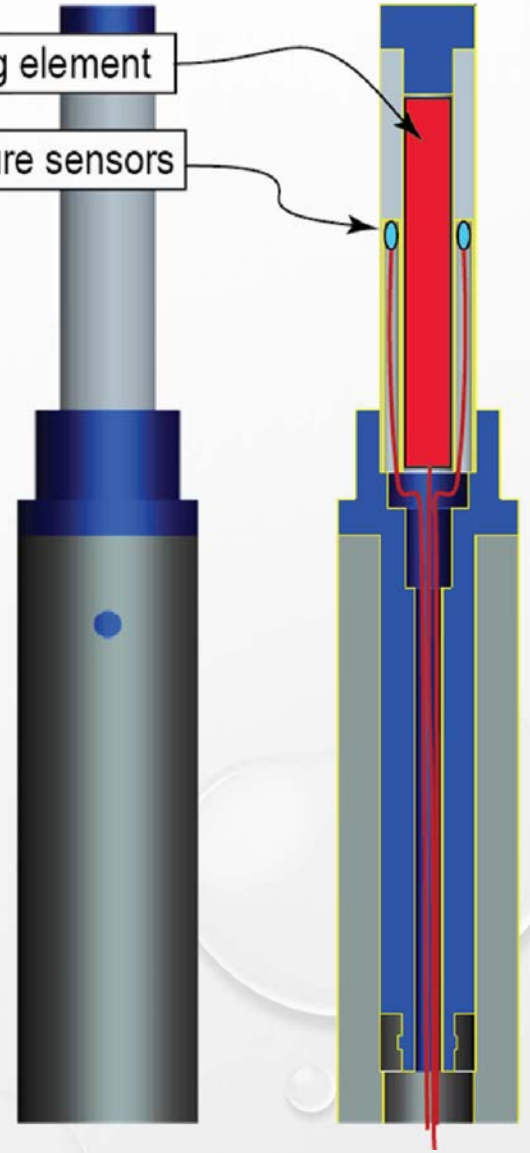
Université Laval's
Meteorological Conditions Monitoring System (MCMS)





MCMS ice detection operating principle





icing on the turbine as seen by the camera

Findings and observations

Meteorological conditions monitoring system

- fully customizable to suit client needs (measure and control)
- easily integrated into SCADA system (Modbus compatible)

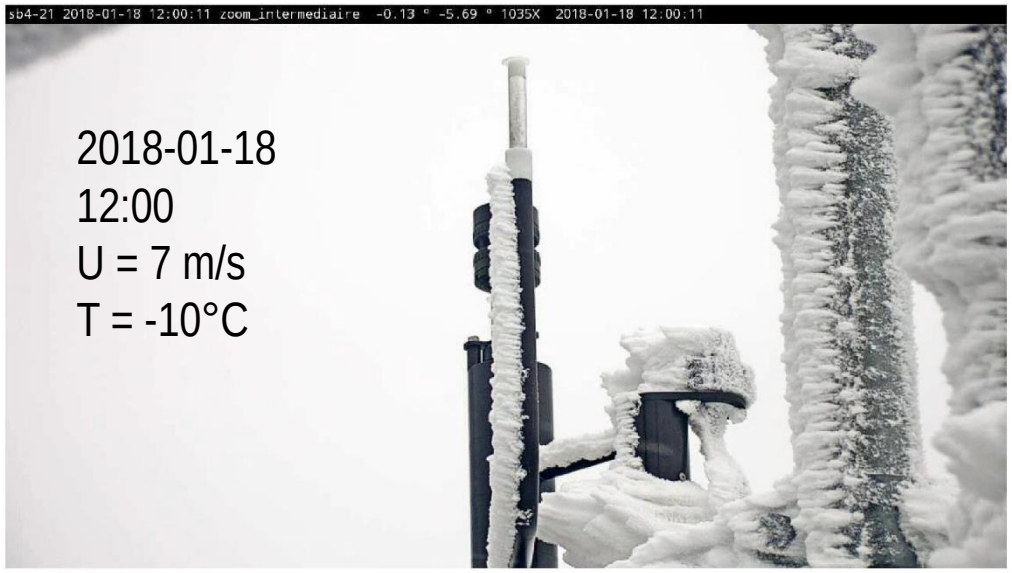
Camera (Axis P5635E-MkII)

- proved to be very valuable for the project
- install relay so that it can be remotely rebooted (seek "artic temperature control")

Enercon hot air deicing system

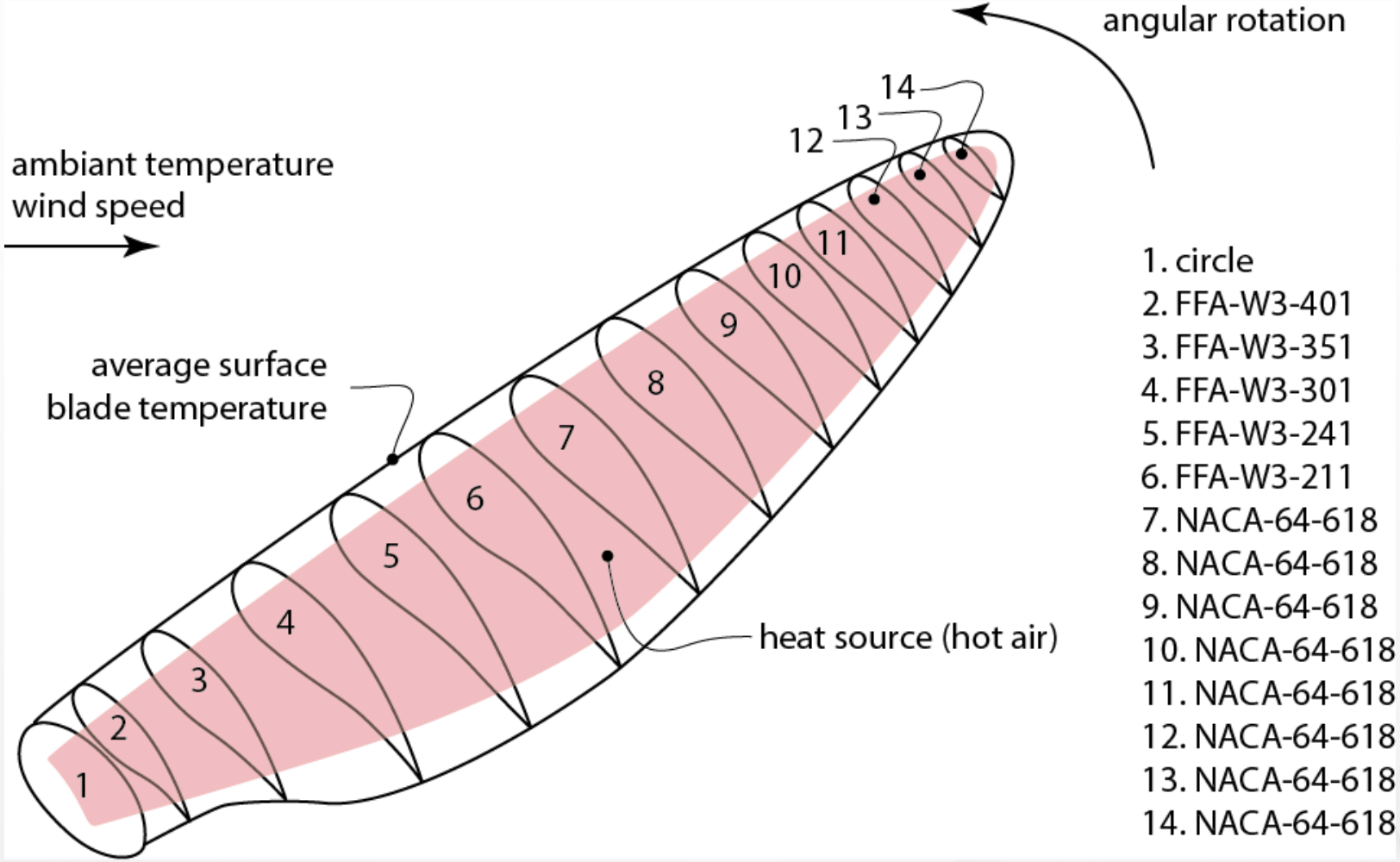
- ~25 kW/blade (insufficient in many occasions)
- ~1h to reach stationary conditions
- System is automatically turned off by Enercon when U > 12m/s (major issue)

Findings and observations: case study (2018-01-17 to 2018-01-21)



Findings and observations: insufficient blade heating

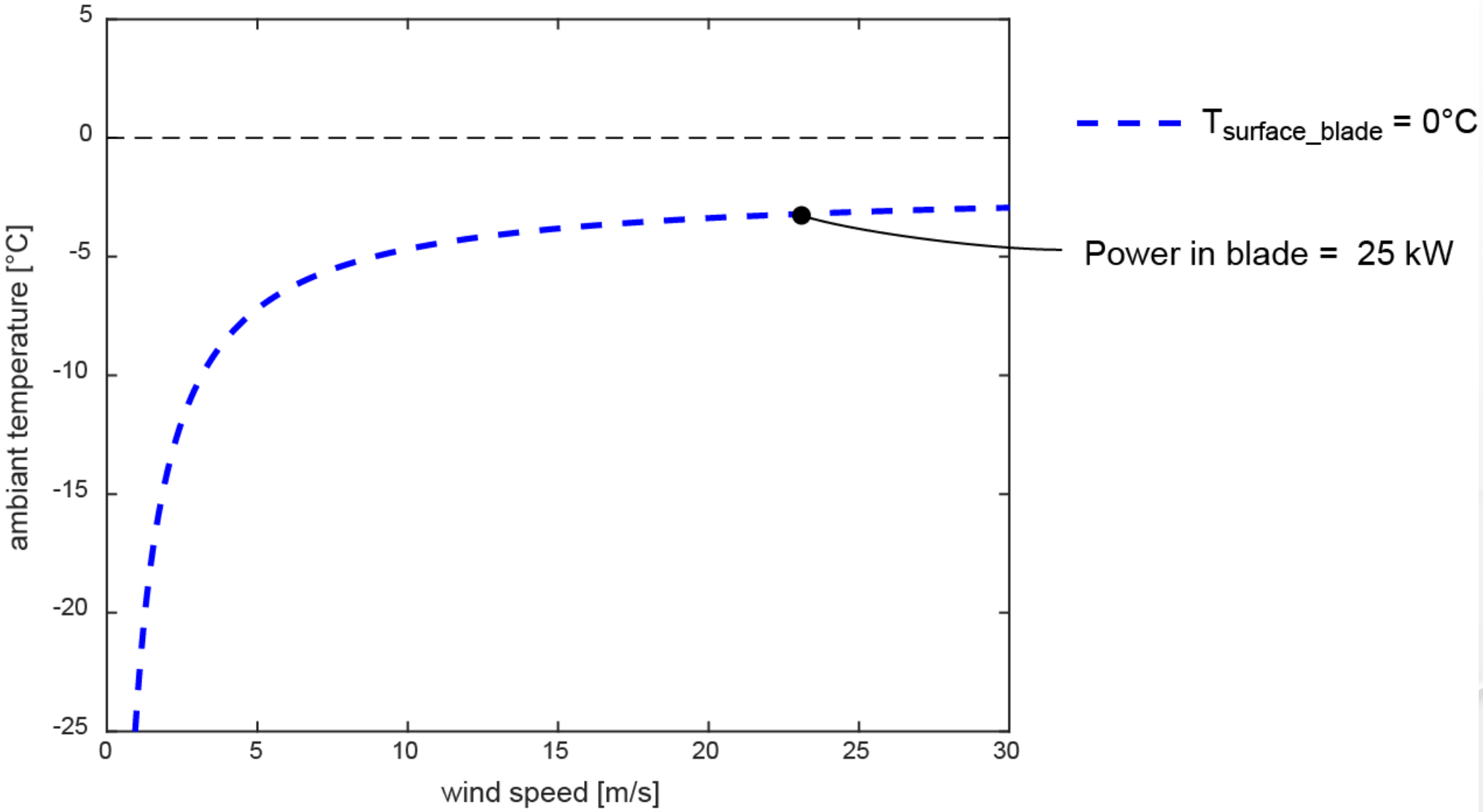
Limited blade heating power: thermal modelling of the blade



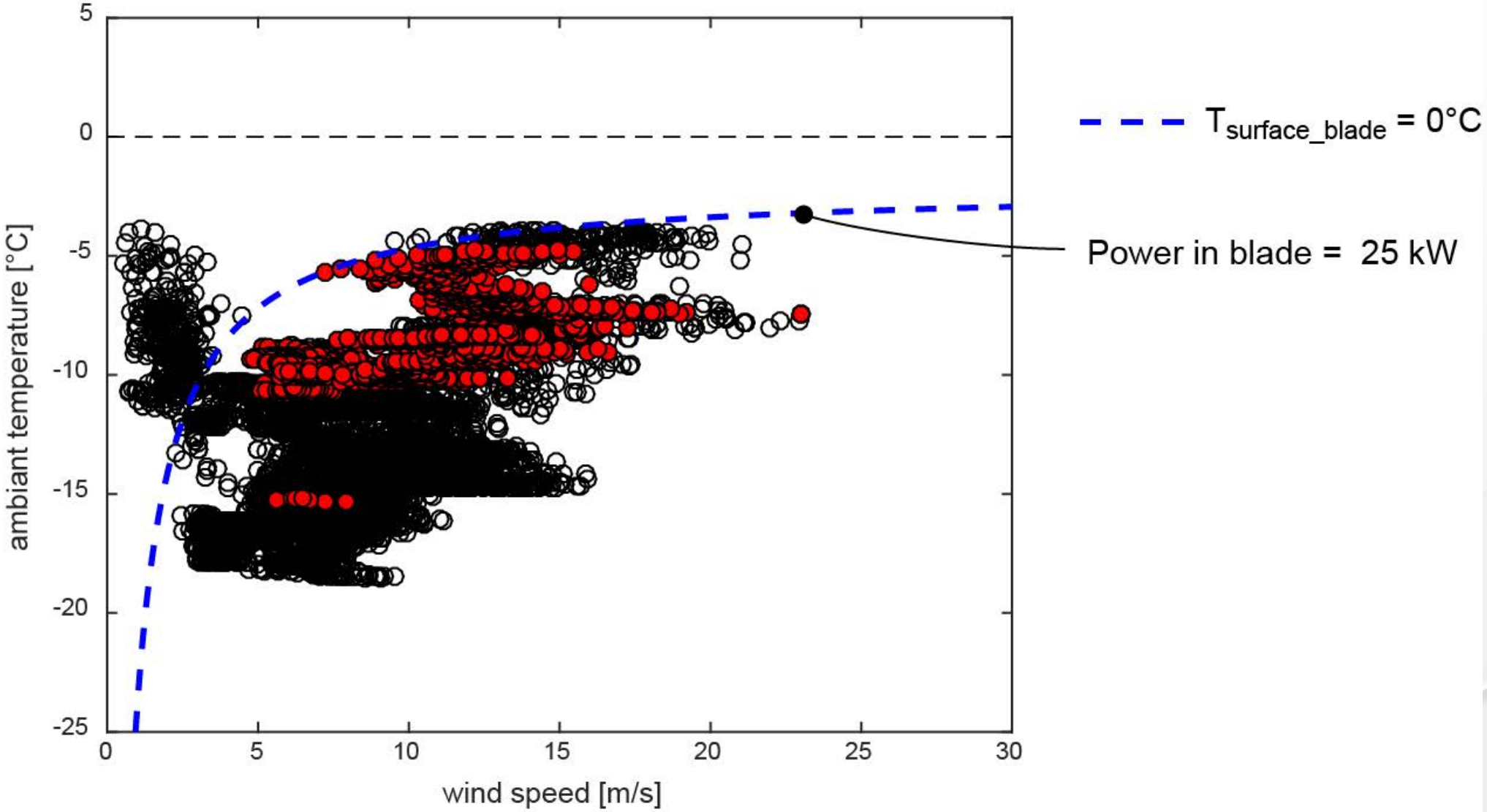
references:

Suke, P. (2014) *Analysis of Heating Systems to Mitigate Ice Accretion on Wind Turbine Blades*. M.A.Sc. Thesis, McMaster University.

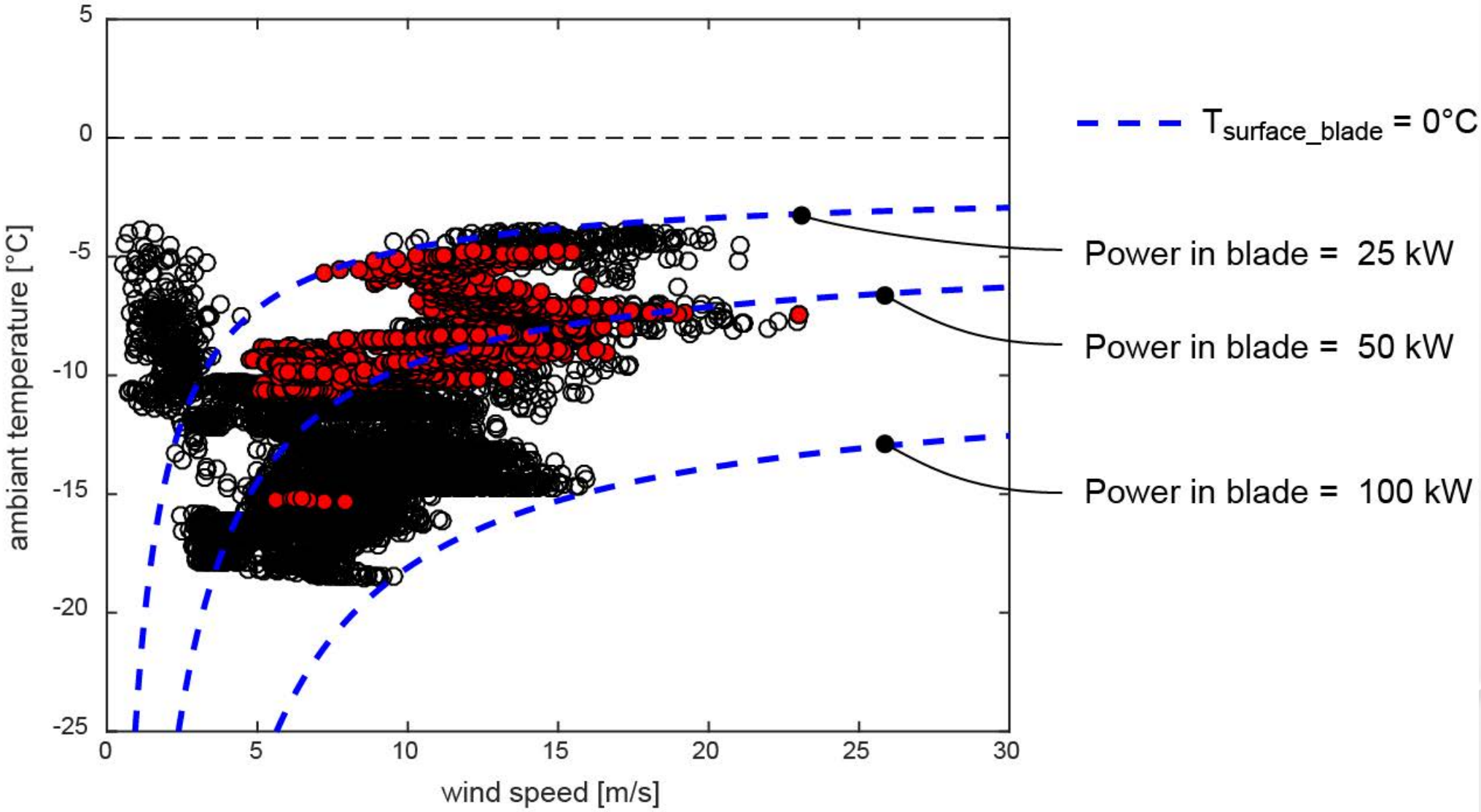
Limited blade heating power: thermal modelling of the blade



thermal model and case study (2018-01-17 to 2018-01-22)



Findings: limited blade heating power



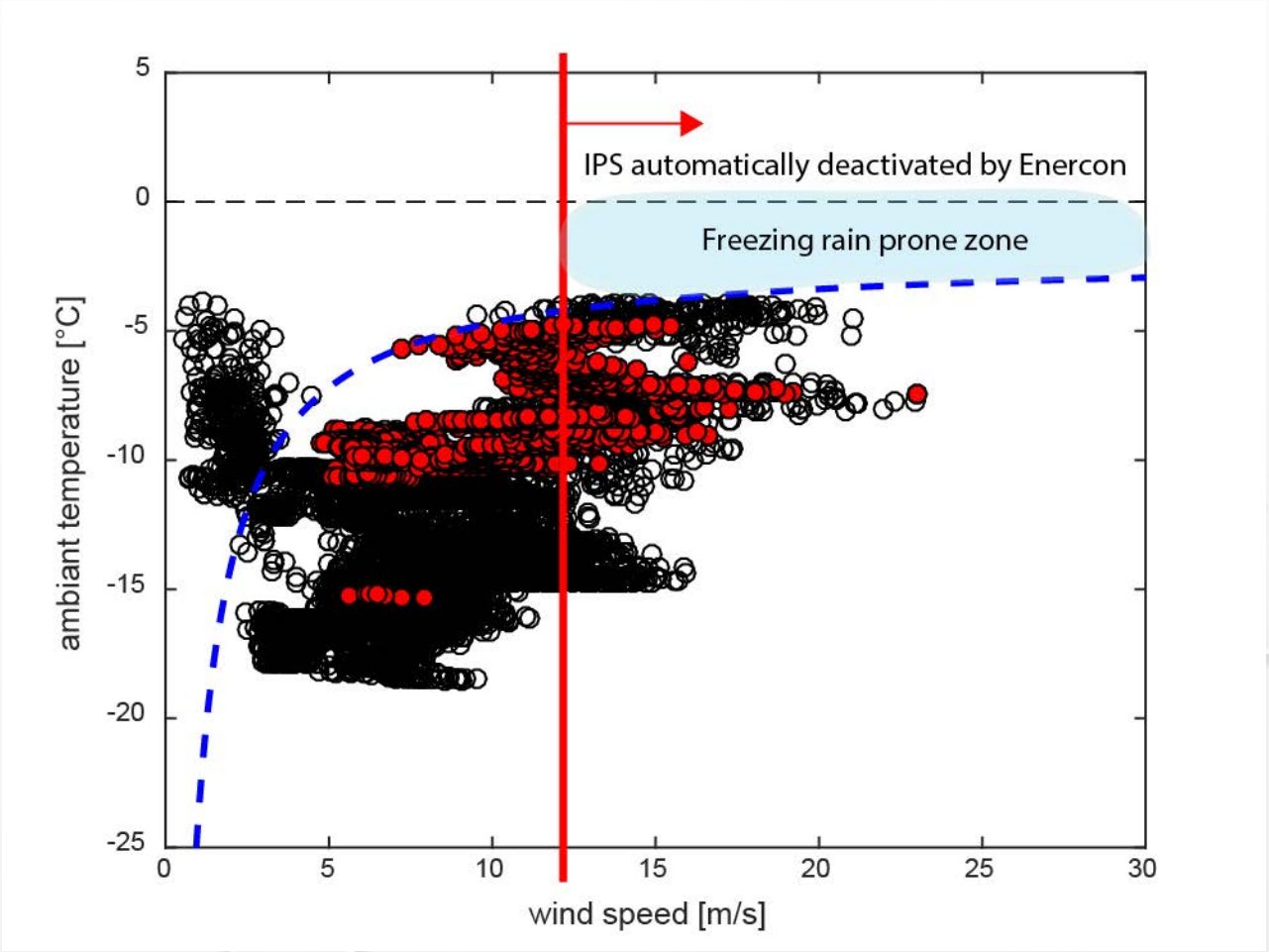
What's next?

Continue to improve wind turbine IPS control

- Early activation could yield gains but is offset by the limited heating power;
- Try to "unlock" Enercon's limitation based on wind speed;
- Avoid unnecessary heating!

Generate datasets to help wind turbine IPS designers

- Number of icing events, duration, estimated LWC, ...



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MERCI
THANK YOU
TACK