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# A NOVEL METEOROLOGICAL CONDITIONS MONITORING SYSTEM FOR ICING DETECTION PURPOSES ON WIND TURBINES: OPERATIONAL EXPERIENCE IN CANADA



**UNIVERSITÉ  
LAVAL**

André Bégin-Drolet, ing., Ph.D.  
Jean Lemay, ing., Ph.D.  
Jean Ruel, ing., Ph.D.

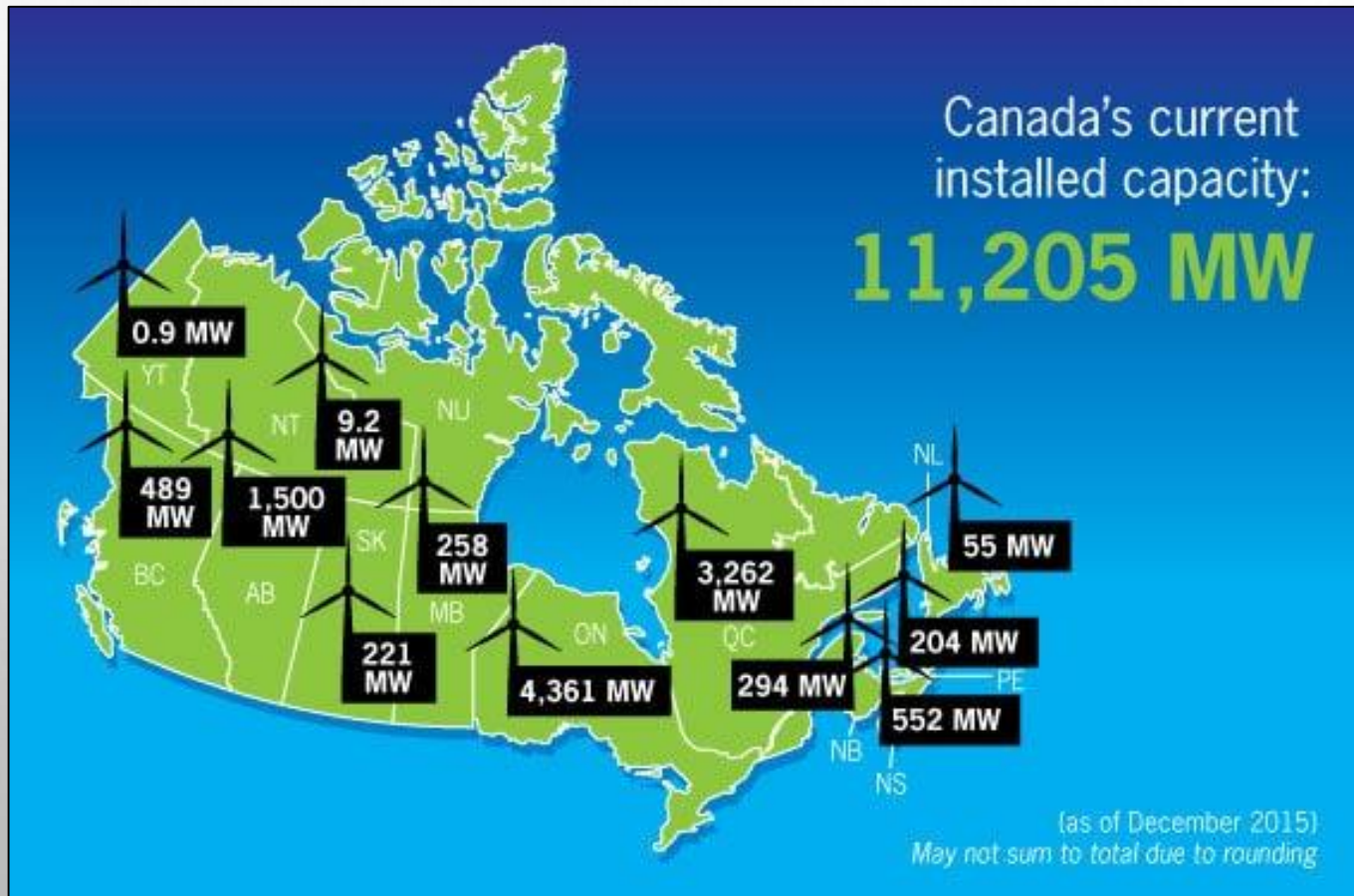


**edf**  
energies nouvelles

Sébastien Trudel, ing., M.Sc.  
Sébastien Goupil-Dumont, ing.

 **Winterwind** FEB 6-8  
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# Wind power in Canada



source: [www.canwea.ca](http://www.canwea.ca)

- Relatively young market;
- More than 7 000 MW installed in the last 5 years (1 438 MW/year);
- 7<sup>th</sup> in the world for installed capacity;
- 5% of Canada's electricity demand;
- Largest wind energy facility: 350 MW.

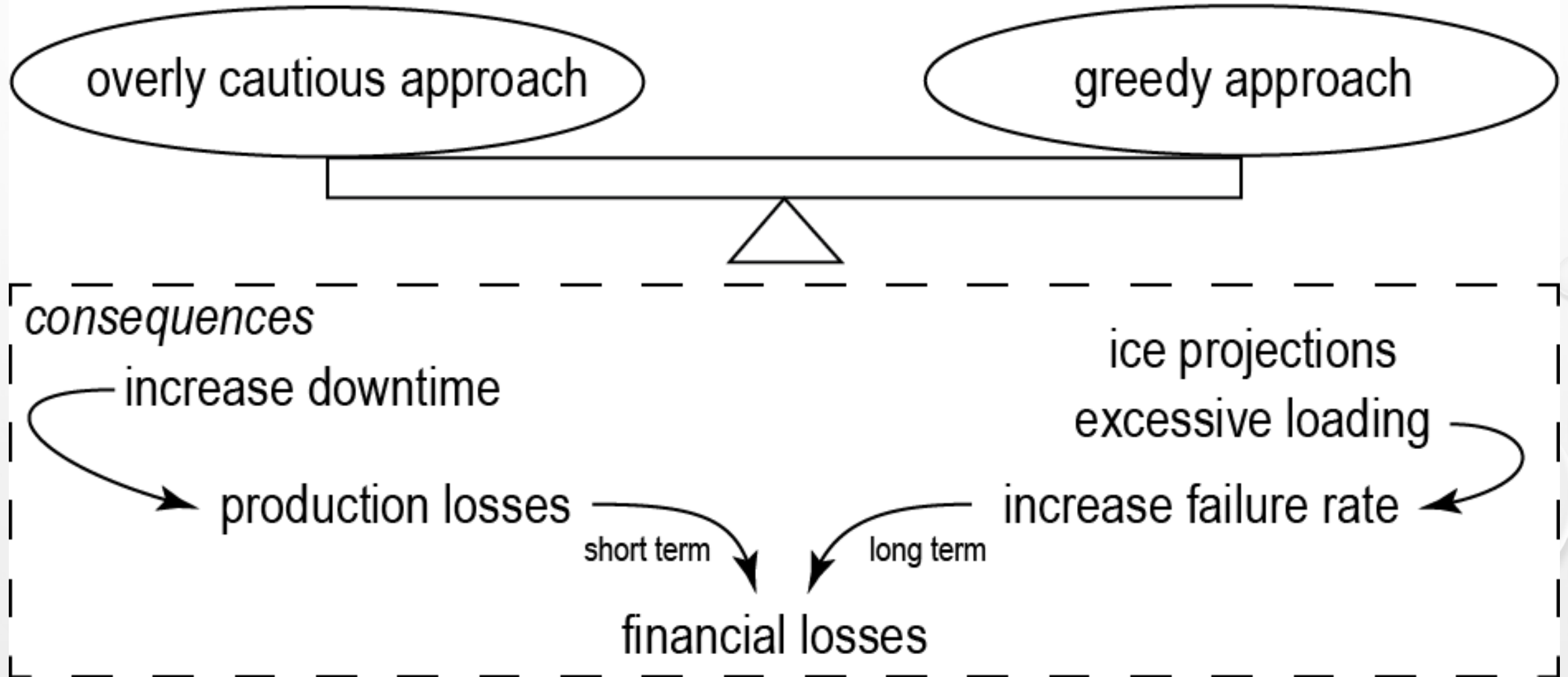
# Cold climate in Canada: a major issue



- Eastern Canada most affected by atmospheric icing;
- Estimated annual cold climate production losses of 142M\$ (Lacroix, Winterwind 2013);
- Other issues associated with atmospheric icing:
  - excessive turbine loads;
  - health/safety;



# Turbine operation in cold climate: all about the right balance



# Our research goals

WHAT:

*PUSH THE BOUNDARIES OF HUMAN DEVELOPMENT IN THE NORTHERN ENVIRONMENT BY DEVELOPING INTELLIGENT SOLUTIONS TO MINIMIZE THE SOCIO-ECONOMIC CONSEQUENCES ASSOCIATED WITH COLD CLIMATES.*

HOW:

*DEVELOP SENSORS AND STRATEGIES, IN PARTNERSHIP WITH VARIOUS USERS, BASED ON REAL-TIME KNOWLEDGE AND INFORMATION.*

# Meteorological Conditions Monitoring System (MCMS)



## Meteorological data:

- air temperature;
- wind speed/direction;
- relative humidity;
- barometric pressure;
- solar radiation.

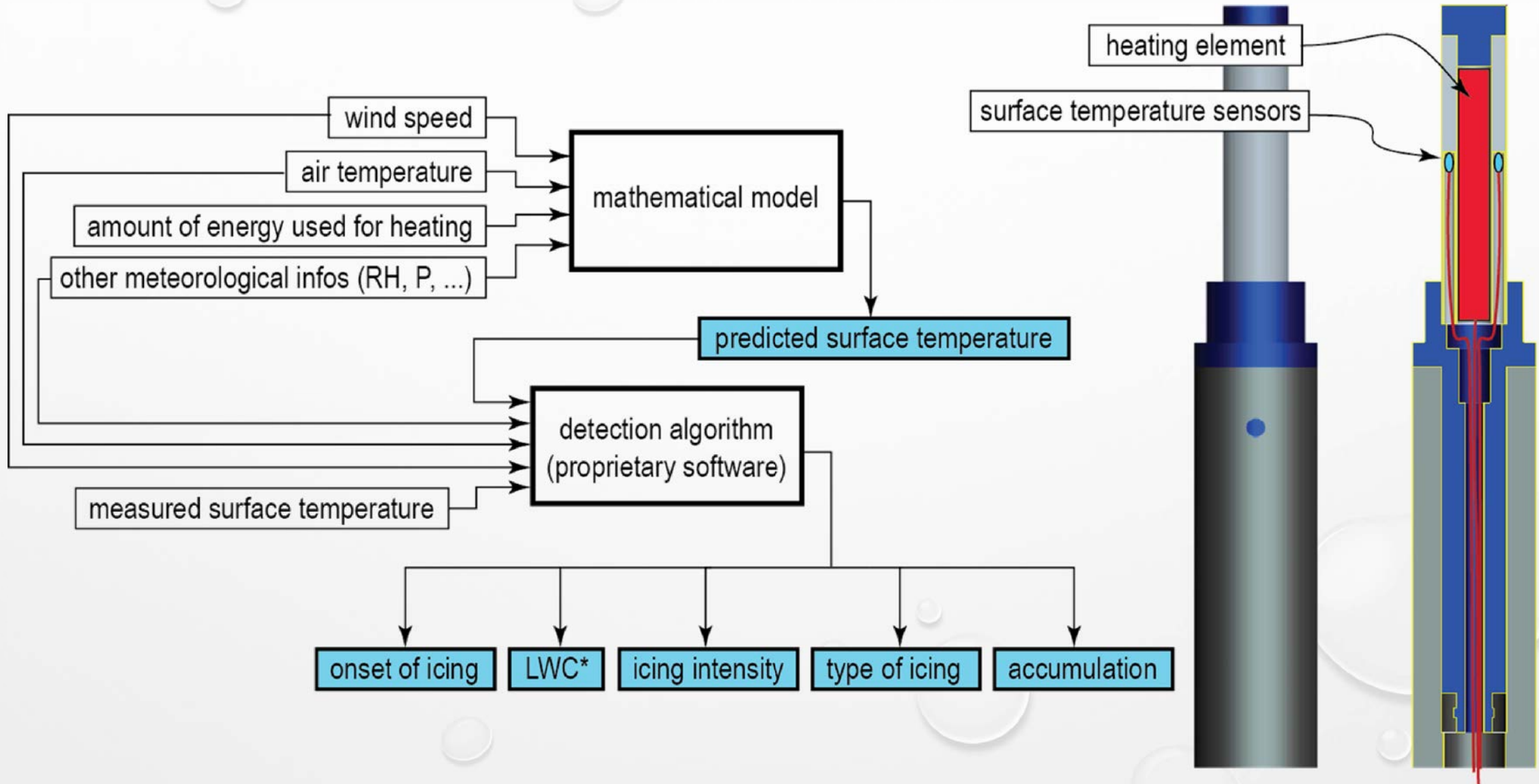
## Ice related features:

- meteorological icing detection;
- type of icing;
- estimation of LWC;
- estimation of icing severity;
- estimation of accumulation.

# MCMS ice detection operating principle



# MCMS ice detection operating principle





# Research partnerships



# MCMS at Rivière-du-Moulin



Rivière-du-Moulin wind park:

- Canada's largest wind energy facility;
- installed capacity: 350MW;
- 175 turbines (MM82 and MM92);
- lowest temperature measured by MCMS at RDM:  $-32^{\circ}\text{C}$ .

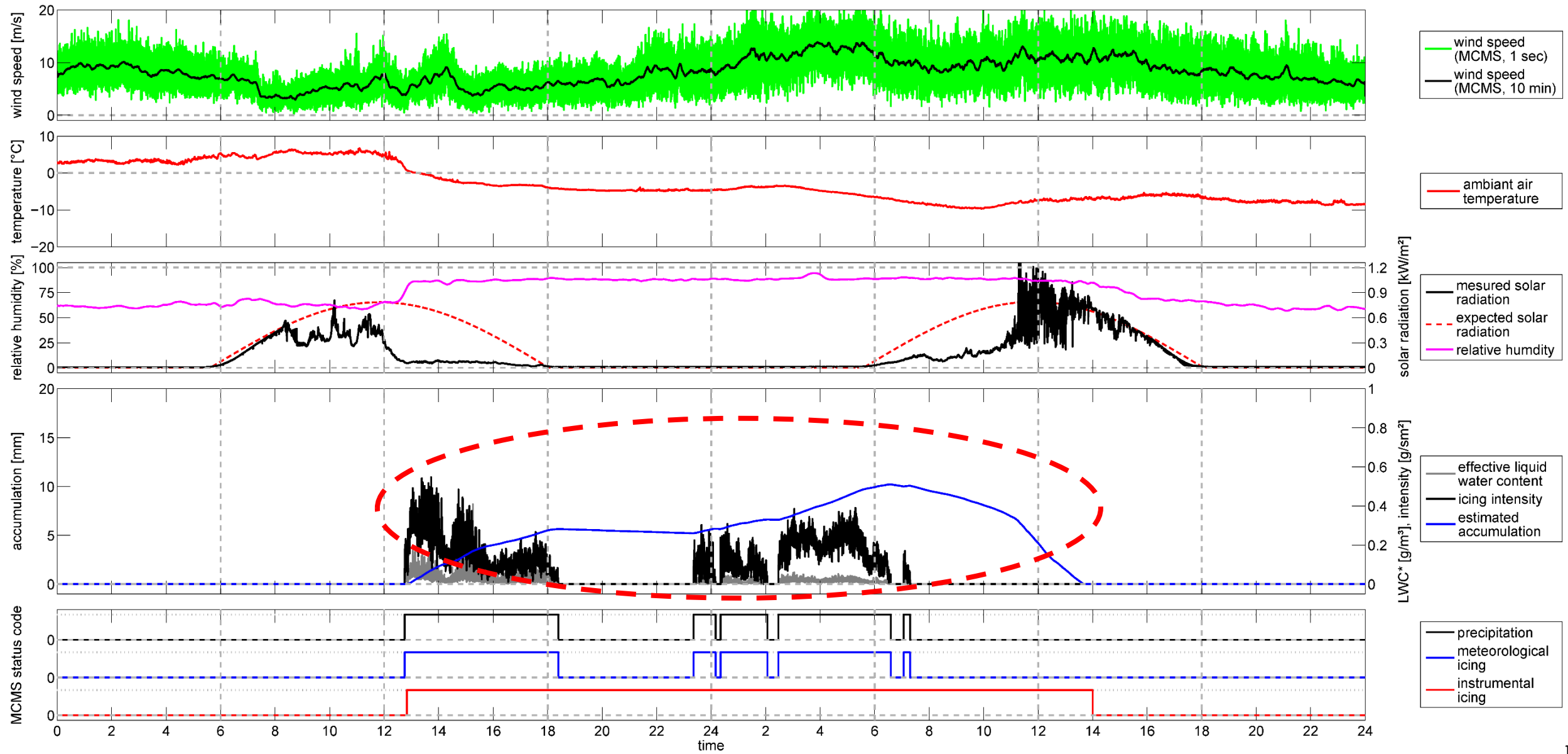
Research outputs:

- real-time monitoring of MCMS;
- monthly reports containing MCMS and SCADA data (power production and status code);
- develop/propose ice mitigation strategies.

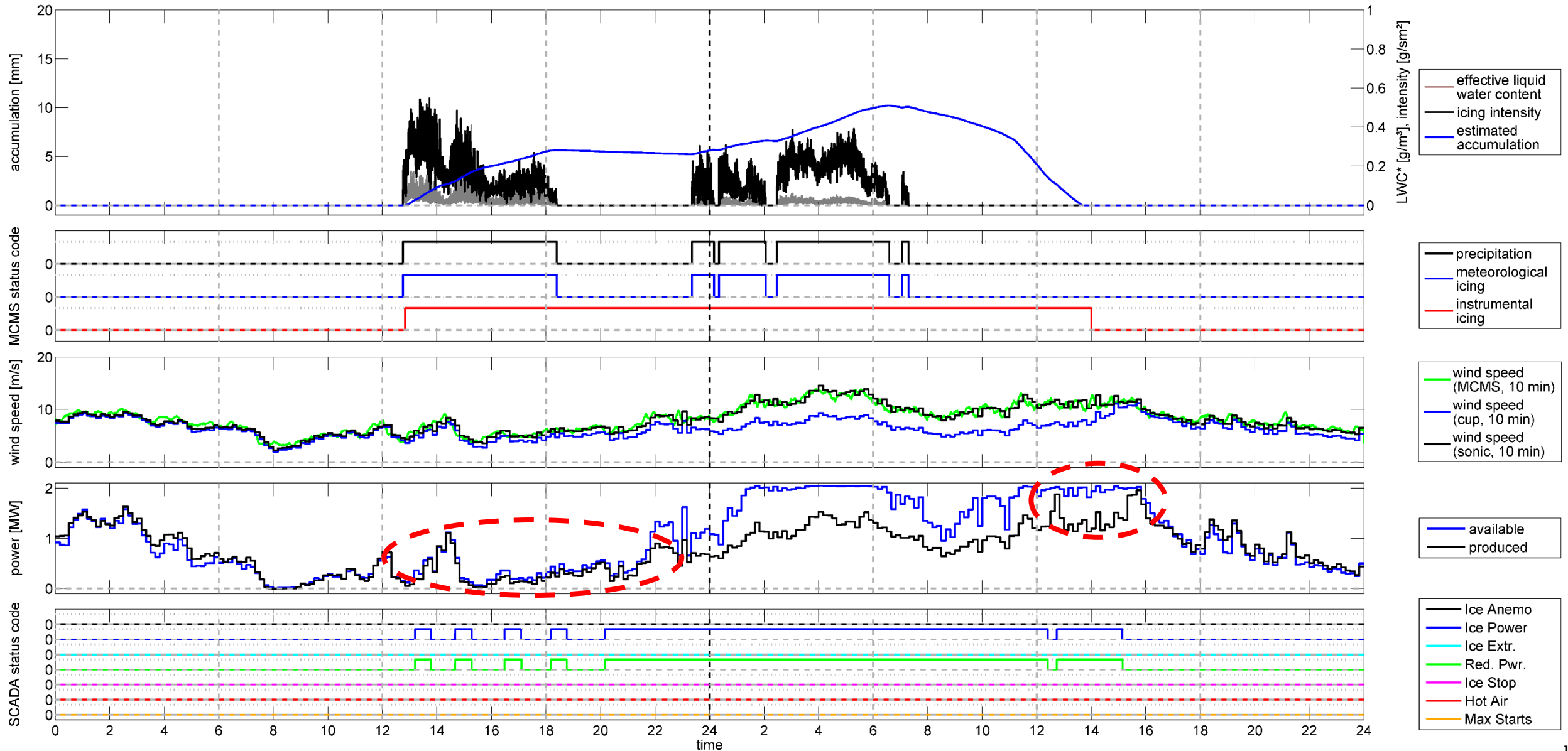
# case study: Rivière-du-Moulin



# 1<sup>st</sup> case study - March 28-29, 2016



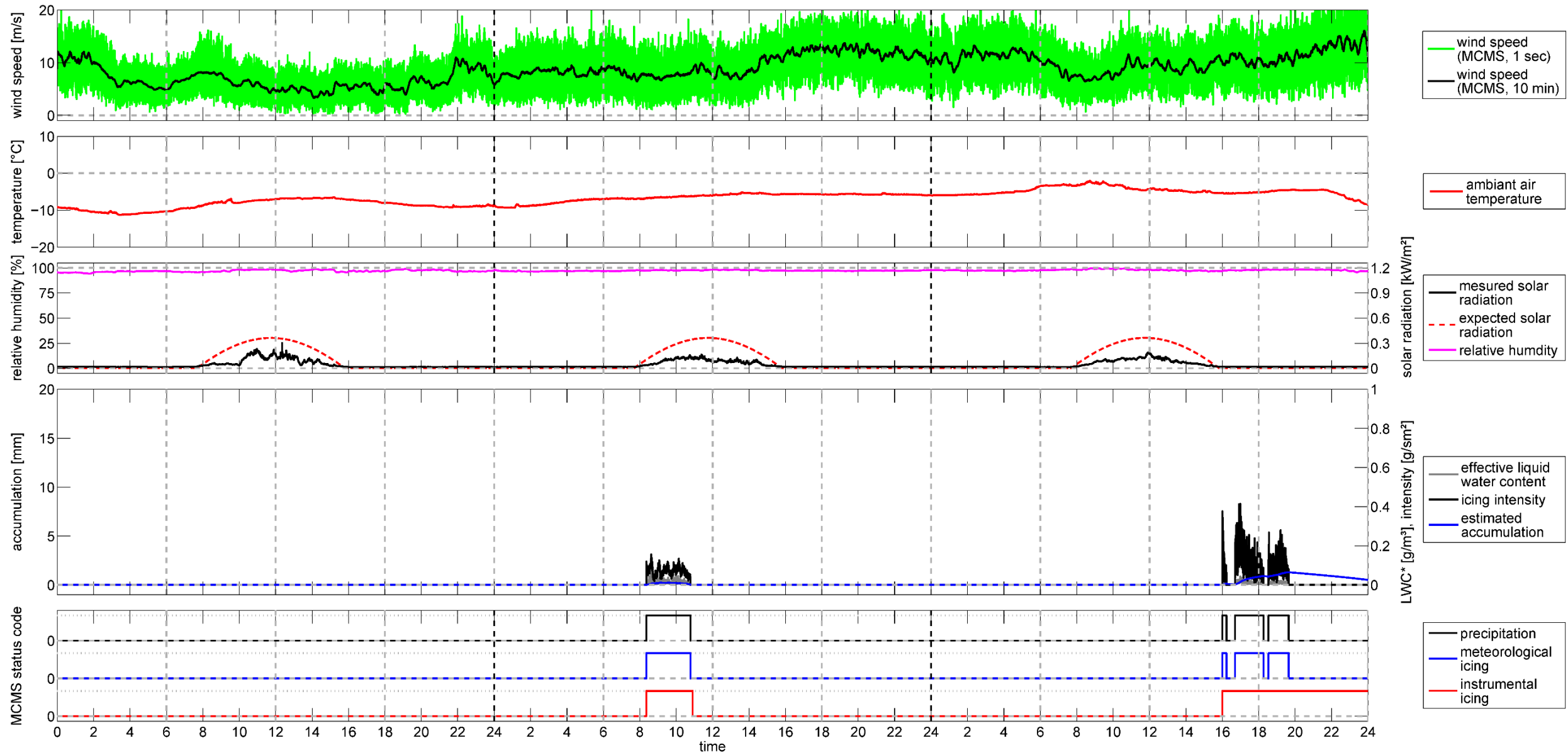
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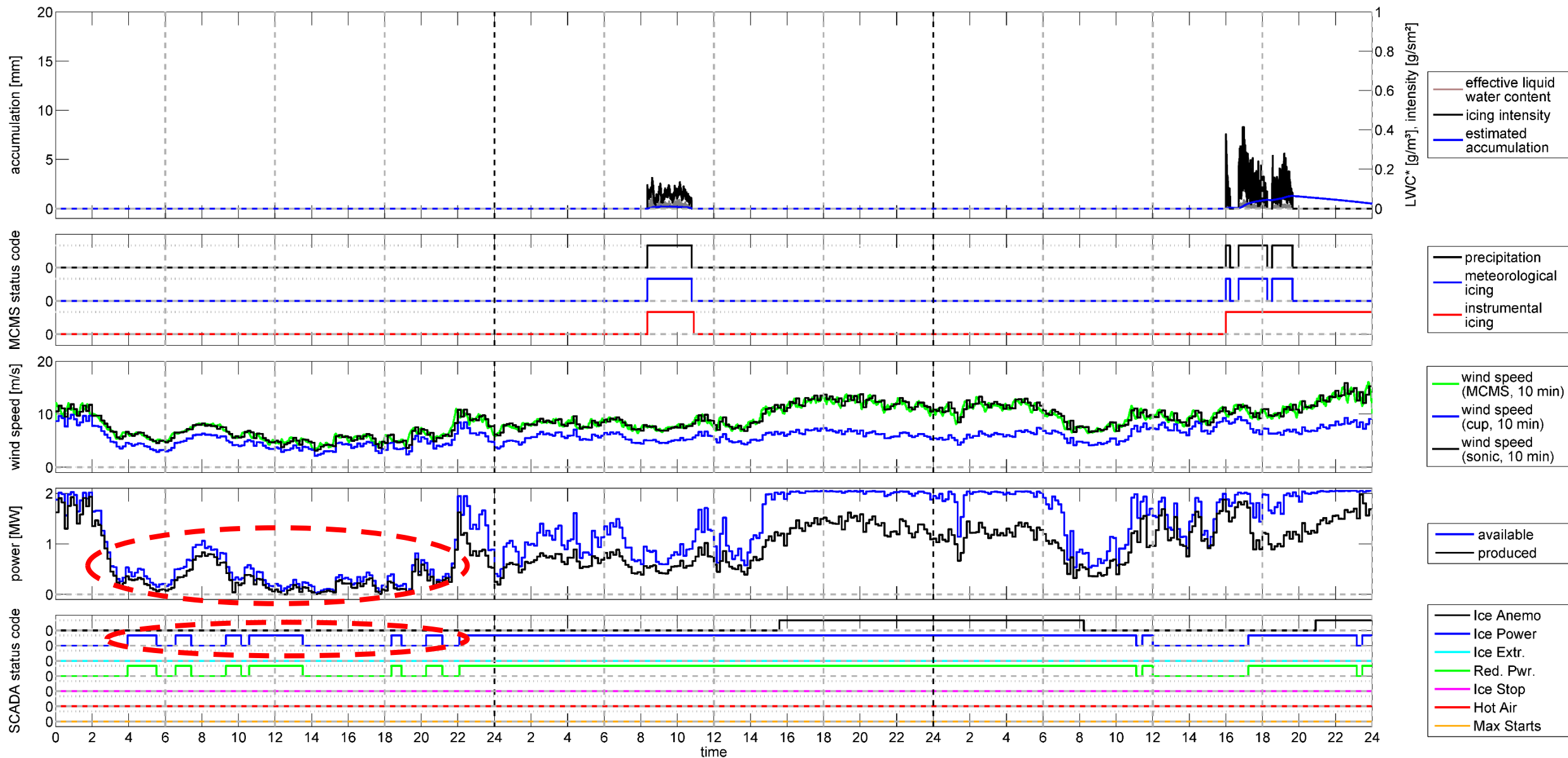
# 2<sup>nd</sup> case study - December 22-23-24, 2016



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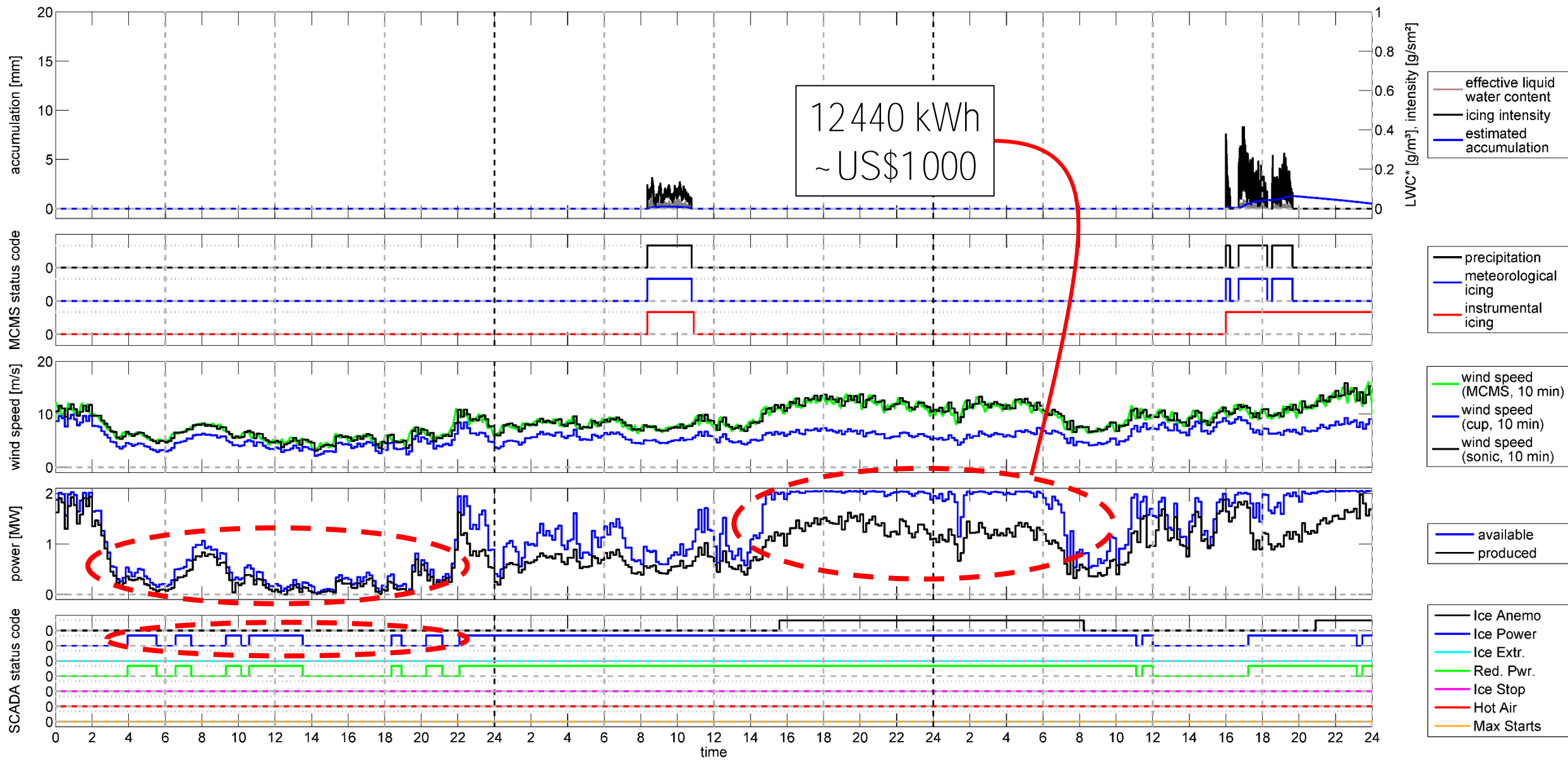


# 2<sup>nd</sup> case study - December 22-23-24, 2016





# 2<sup>nd</sup> case study - December 22-23-24, 2016





# Perspectives

## industry:

- Make the MCMS available to the industry.
- Integrate MCMS data to SCADA systems.
- Use MCMS as a control element.
- Improve safety near WEC.
- Increase annual energy production!

## academic research:

- Correlate nacelle based measurement with ice accumulation on blades.
- Full winter assessment (2016-2017).
- Correlate measurements with ice projections.
- Improve the MCMS design and accuracy.





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## Contact information

André Bégin-Drolet, ing., Ph.D.  
Professor – Université Laval  
[andre.begin-drolet@gmc.ulaval.ca](mailto:andre.begin-drolet@gmc.ulaval.ca)

1065 ave de la médecine  
Québec (Québec)  
G1V 0A6  
Tél. : +1 418 656-2131 x3271

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THANK YOU  
TACK