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

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Wind power in Canada

- Relatively young market;
- More than 7000 MW installed in the last 5 years (1438 MW/year);
- 7th in the world for installed capacity;
- 5% of Canada's electricity demand;
- Largest wind energy facility: 350 MW.

Canada’s current installed capacity: 11,205 MW

(source: www.canwea.ca)
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

- overly cautious approach
- greedy approach

**Consequences**
- Increase downtime
- Production losses
- Financial losses

**Ice projections**
- Excessive loading
- Increase failure rate

**Short term**
- Production losses

**Long term**
- Financial losses
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)

**Ice related features:**
- meteorological icing detection;
- type of icing;
- estimation of LWC;
- estimation of icing severity;
- estimation of accumulation.

**Meteorological data:**
- air temperature;
- wind speed/direction;
- relative humidity;
- barometric pressure;
- solar radiation.
MCMS ice detection operating principle
MCMS ice detection operating principle

- Wind speed
- Air temperature
- Amount of energy used for heating
- Other meteorological info (RH, P, ...)

Mathematical model

Predicted surface temperature

Detection algorithm (proprietary software)

Measured surface temperature

Onset of icing
LWC
Icing intensity
Type of icing
Accumulation

Heating element
Surface temperature sensors
Research partnerships

- Université Laval
- Wind Energy TechnoCentre
- Rivière-du-Moulin (EDF): 350 MW
- Caribou Wind Park (Engie): 99 MW
- 4 MW
MCMS at Rivière-du-Moulin

Rivière-du-Moulin wind park:
- Canada's largest wind energy facility;
- installed capacity: 350 MW;
- 175 turbines (MM82 and MM92);
- lowest temperature measured by MCMS at RDM: -32°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
1st case study - March 28-29, 2016
1st case study - March 28-29, 2016
2\textsuperscript{nd} case study - December 22-23-24, 2016
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12440 kWh
~US$1000
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.
• Correlate measurements with ice projections.
• Improve the MCMS design and accuracy.
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MERCI
THANK YOU
TACK