Benefit and expected gains with use of de-icing technologies

Agenda

- **My background and mission**
- **Why explore wind power in cold climate?**
- **Skellefteå Krafts choice of anti/de-icing technology**
- **Presentation of the Mawic project**
  - Skellefteå Kraft together with Fortum run this project
  - Results up to now
- **Conclusion**

My background

Ph.D Student Manufacturing Systems Engineering 1999-2004

MW-Innovation 2005-2010

- Development and evaluation of anti/de-icing technology with support from Swedish Energy Agency together with O2 and Kelly Aerospace.

Consultant since April 2010 with a mission for Skellefteå Kraft

My mission for Skellefteå Kraft

Evaluation of existing de-icing technology/system in actual projects for their wind power exploration in cold climate.

Analyze report and provide Skellefteå Kraft with latest information about ongoing interesting project etc.

Update and supply Skellefteå Kraft with latest technology level/ stage about anti/de-icing.

Project manager MAWIC project

Why explore wind power in cold climate at high altitude?

Wind speed increase by 0,1 m/s per 100 m of altitude for the first 1000 m.

In areas with cold climate, available wind power is approximately 10% higher than other regions due to the increased air density at lower temperatures.

It can be a challenge!

Icing on wind turbine blade

Small amounts of ice significantly reduce the aerodynamic properties.

Mechanical failures due to increased load or unsymmetrical distribution of the ice.

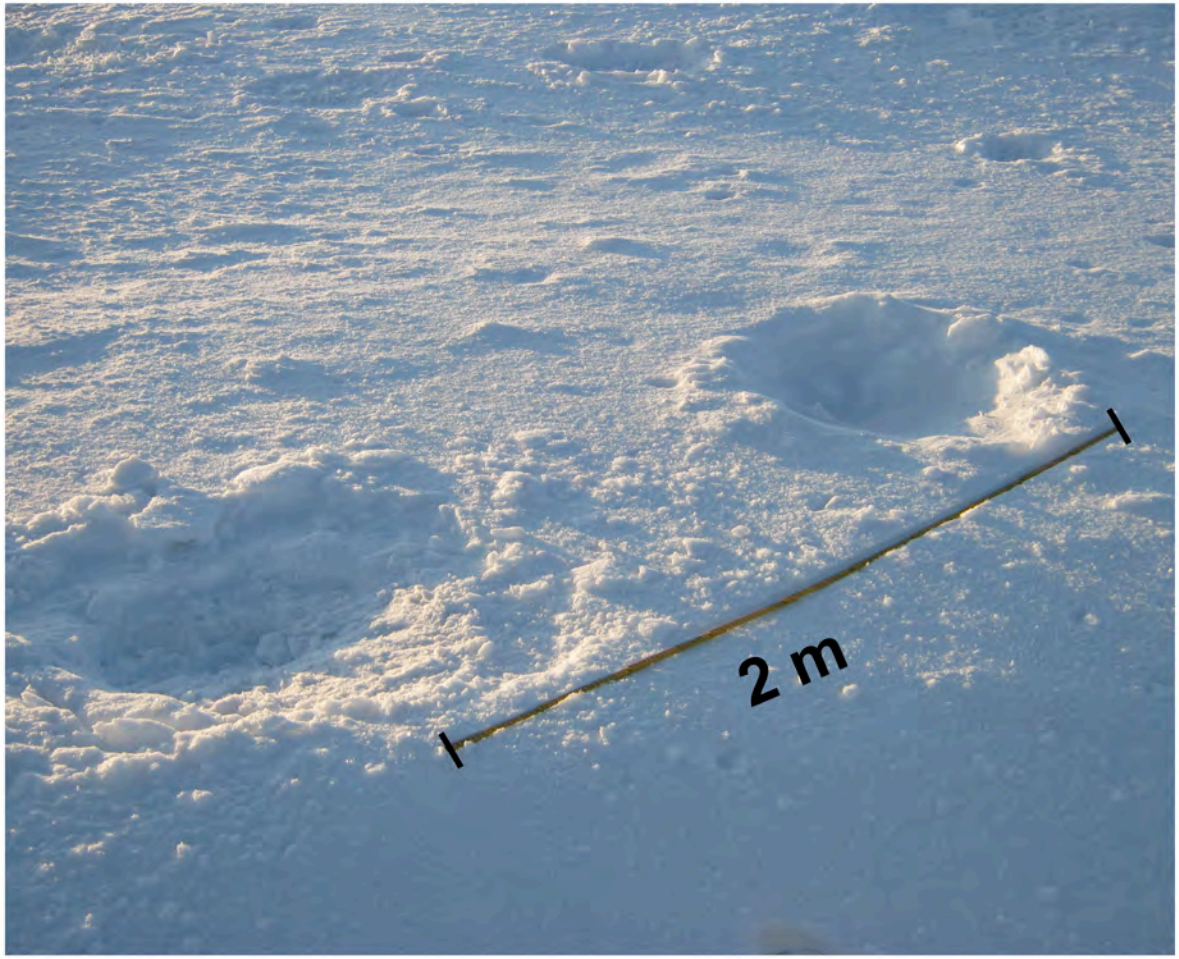
Damages on bearings and gear boxes.

Causes noise

Safety risks, ice thrown.

Damage on a service building roof from ice throw.

Ice throw



Final choice of anti-icing technology

- Autumn 2010 Nordex installed the first N100/2500 turbines with anti-icing in Jokkmokksliden, the forerunner project to Blaiken. The wind turbine manufacturer tested and optimised the system in cooperation with Skellefteå Kraft on the basis of three different prototype system and one reference turbine.
- One system, laminated carbon fiber below coating.
- The other systems, external installation peel and stick.
- The final choice was the system that is laminated into the blade. The heaters and electrical connections are more protected compared to the other technical solution. Best in evaluation test.
- Skellefteå Kraft now continuing with own studies, together with Fortum for development of control algorithms, etc. for wind power in cold climate in the MAWIC project.

Measurments Analysis Wind Power for Icy Climates

MAWIC Project

Fortum

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MAWIC Project

The objective of this project is increased knowledge and experience of maintenance on turbines equipped with anti and de-icing system for improvement and optimization of control algorithms with focus on lowest possible life cycle costs.

MAWIC

Skellefteå Kraft and Fortum supports and run the project together.

Measurements from three sites.

– Uljabuouda 2010, 10 WTG

– Jokkmokksliden 2011, 12 WTG

– Blaiken (2015 under construction, 90 WTG)

MAWIC

Measurement period 01-11-2011 to 31-03-2012.

Continuously measurement and analysis of:

- Wind Speed
- Wind direction
- Air pressure
- Humidity
- Temperature
- Ice load

MAWIC

Measurement period 01-11-2011 to 31-03-2012.

Other measurement and observation

- Energy production and consumption in the de-icing system. The study sites Uljabuouda, and Jokkmokksliden are recorded. (Blaiken is excluded, under construction)
- Mesoscale model (Blaiken)
- Noise observation (Uljabuouda when maintenance personal visit site)
- IR camera will be installed, blade monitoring at Uljabuouda WTG 7.

Results and observations

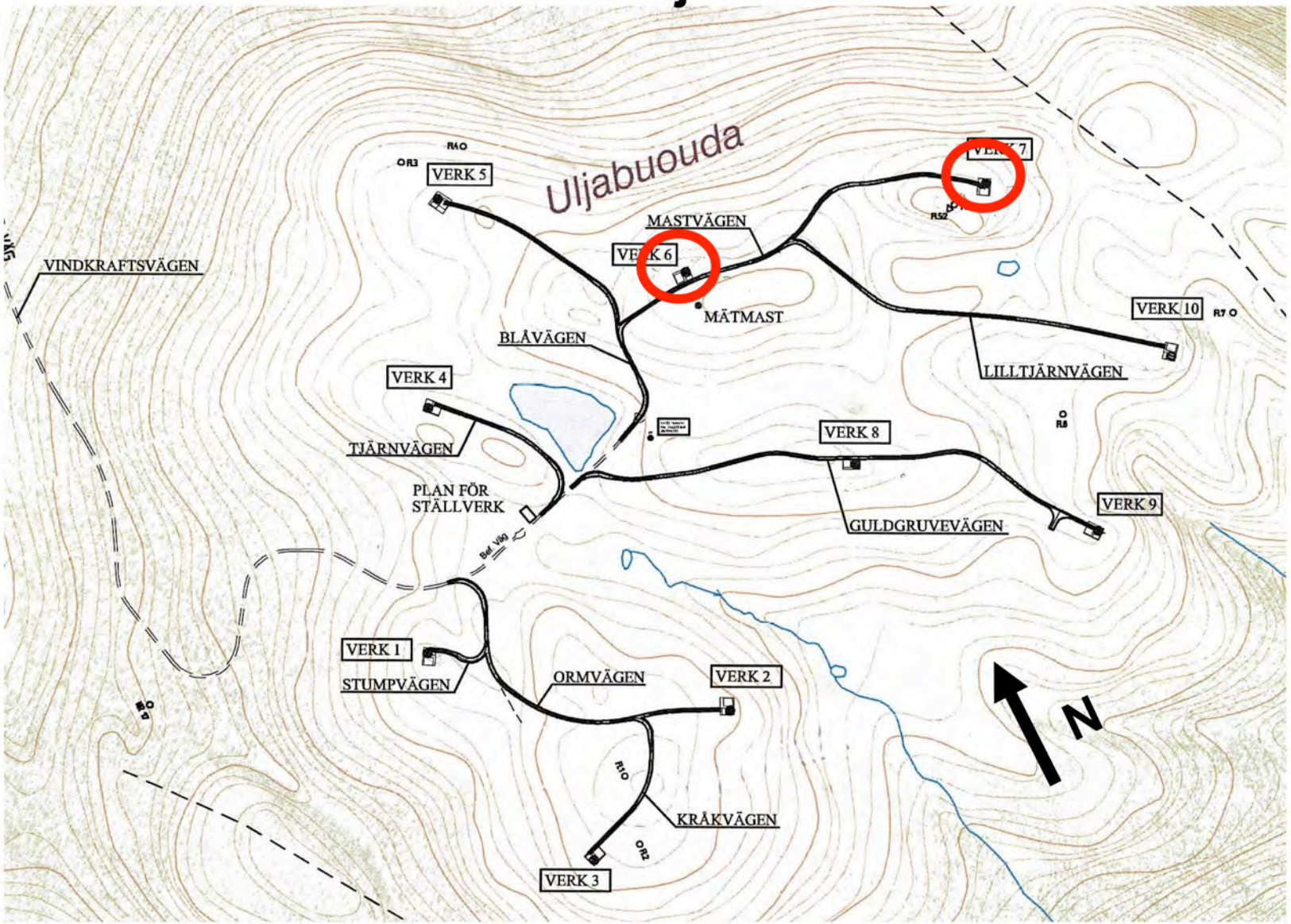
Based on observations at Uljabuouda Nov – Dec 2011

WTG 6 - 10 are the turbines included in this study, with focus on WTG 6 and 7.

The de-icing system at WTG 6 has been disabled deliberately for longer periods for a direct comparison of the power production against the other turbines with enabled de-icing system.

- It seems to be a connection between icing and noise
- Energy savings for this period was estimated to 19 000 EUR/ WTG with use of de-icing system.
- Three icing events has been observed in the period Nov-Dec
- Interesting observations are done especially around December 23-24 at Uljabuouda.

Site Uljabuouda



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Disabled de-icing system

- De-icing system at WTG 6 was disabled from December 8th until December 23rd at Uljabuouda.
- Good Weather forecast for wind power production upcoming holidays
- Until December 22, production losses estimated to 19 000 EUR/WTG.
- A decision was made to activate the de-icing system at WTG 6 between 9:00 and 17:00 Dec 23rd to reduce the energy losses over the upcoming holiday.

Icing

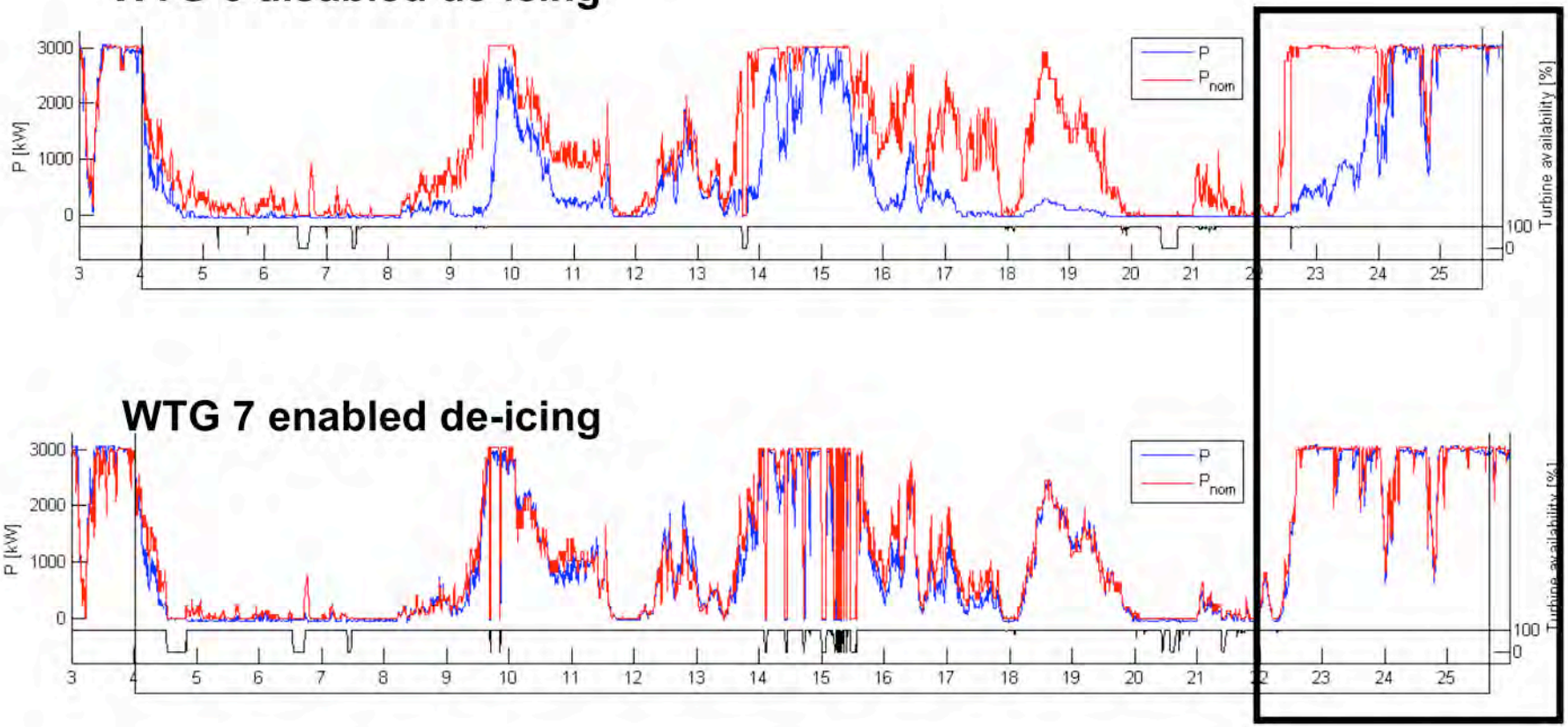
Severe icing on rotor blades reported from site Uljabuouda at Dec 22.

Note the difference of ice accretion between the turbines.

Difference, disabled and enabled de-icing system at Uljabuouda Dec 22

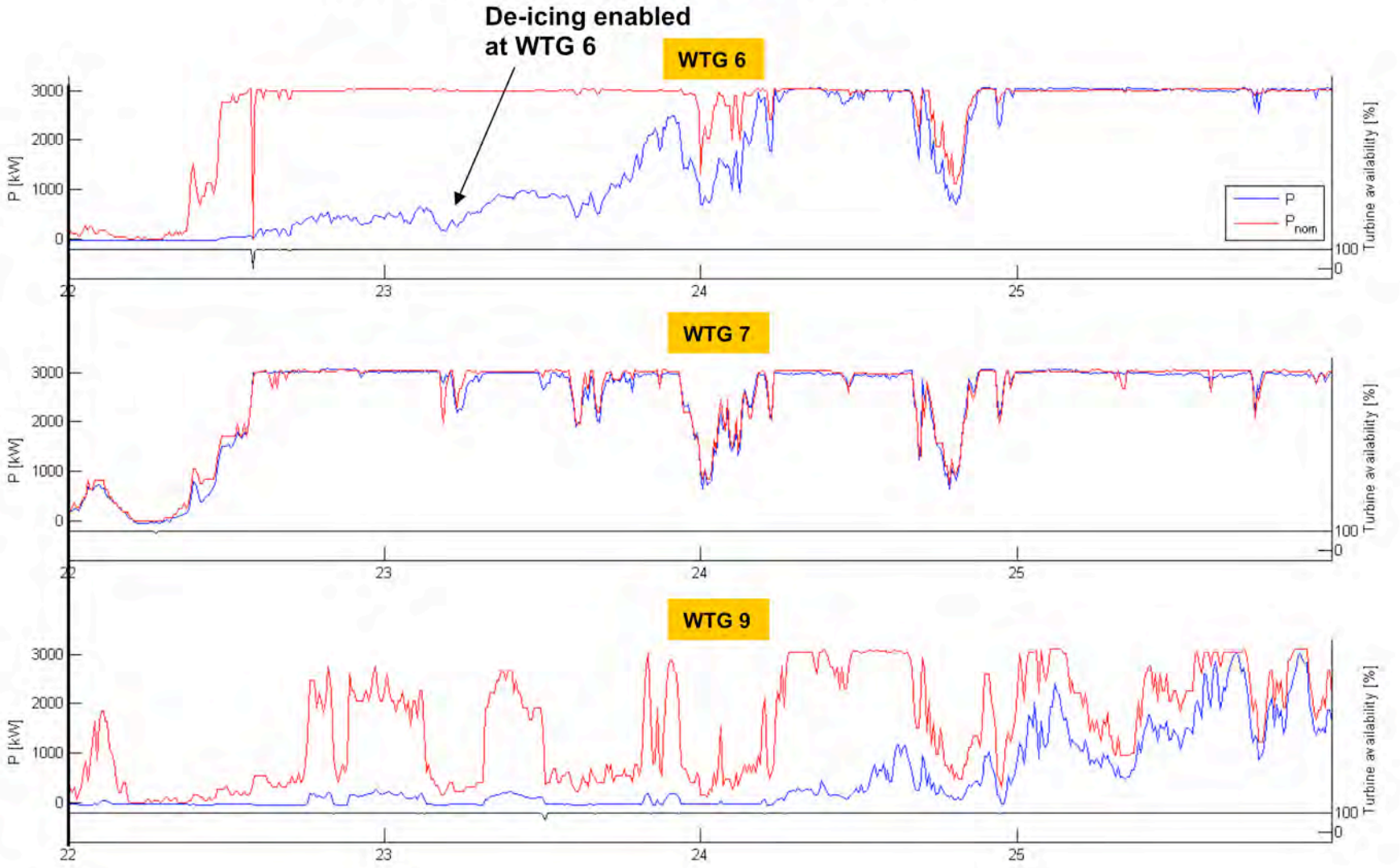
Icing event Dec

WTG 6 disabled de-icing



WTG 7 enabled de-icing

Icing Event Dec 22 - 26



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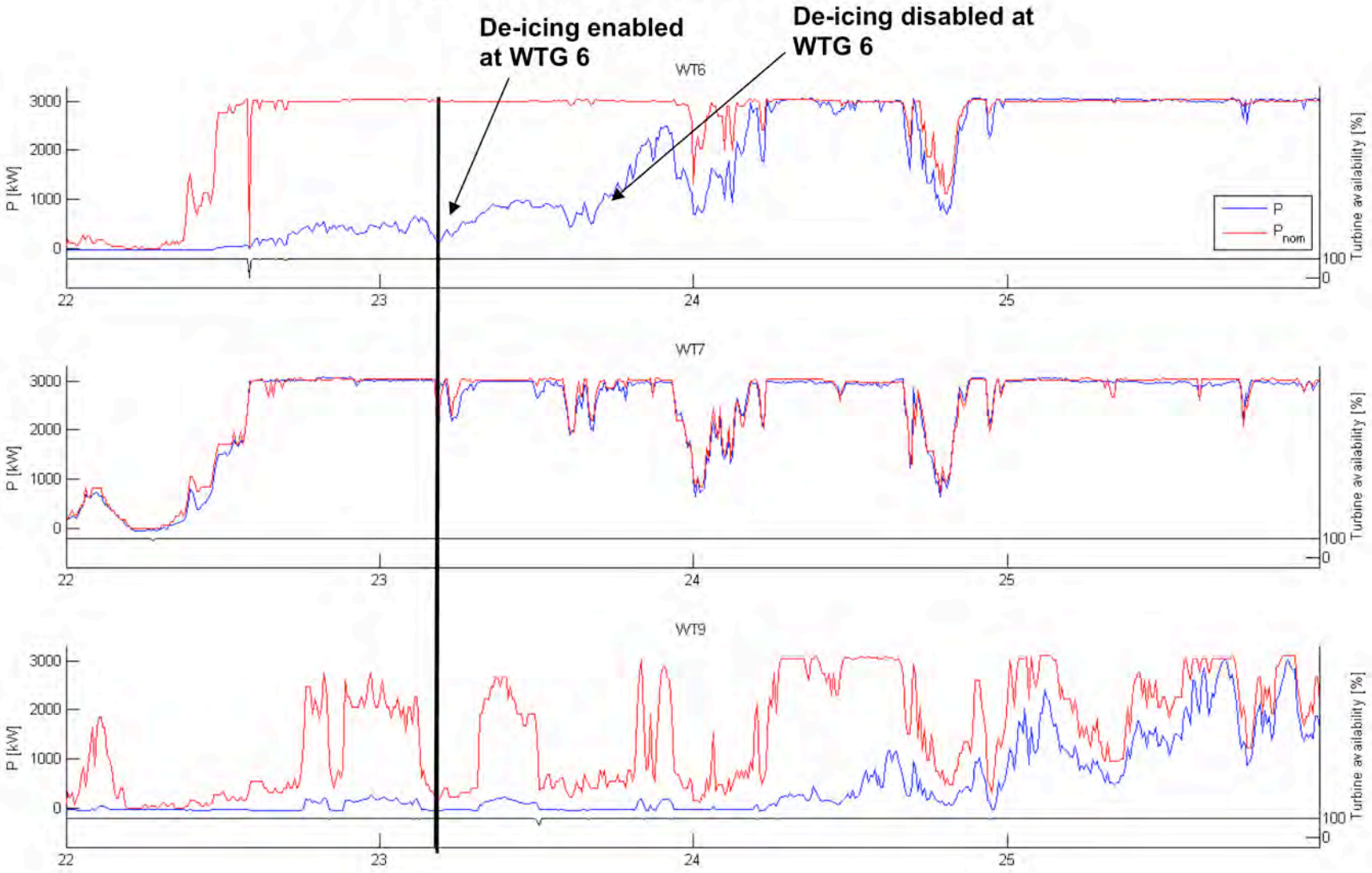
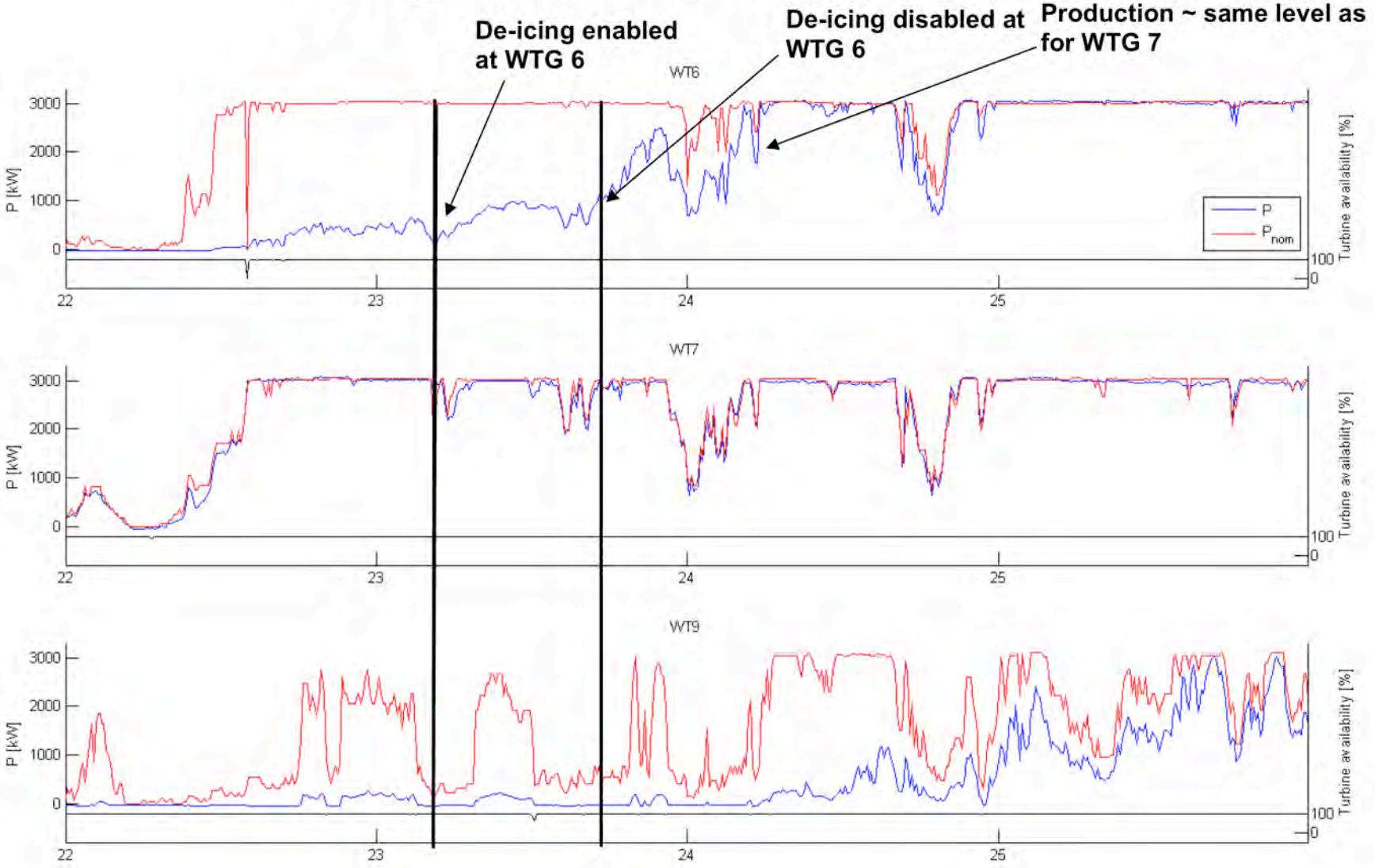
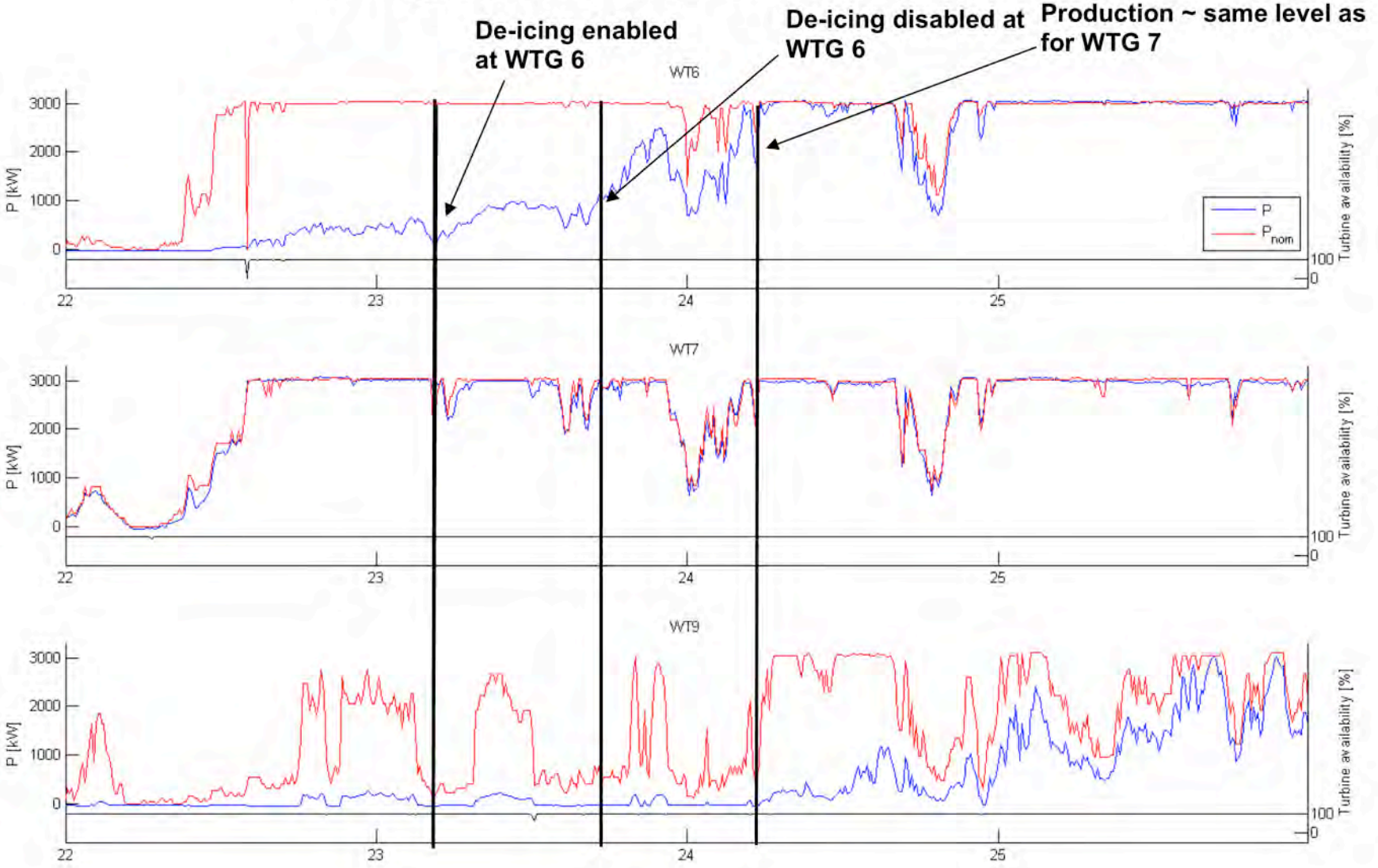
Icing Event Dec 22 - 26



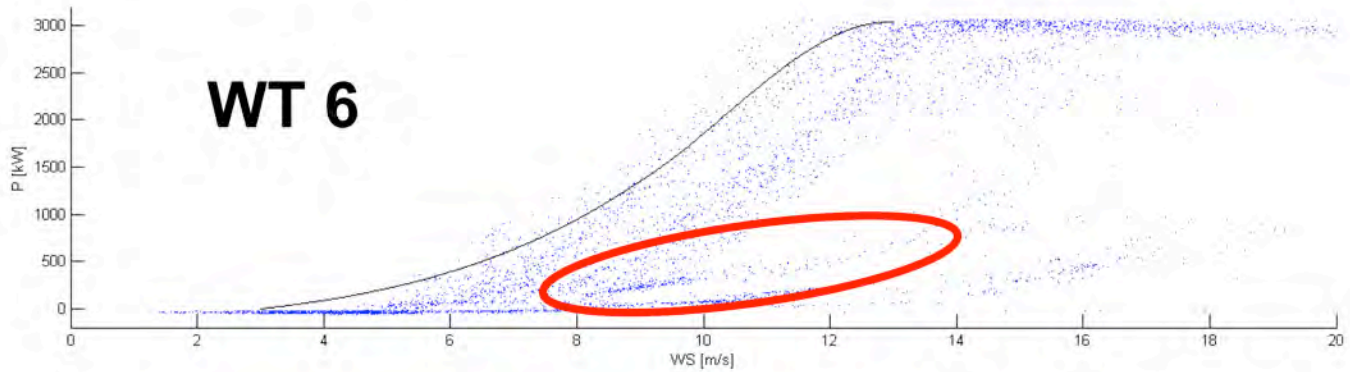
Icing Event Dec 22 - 26

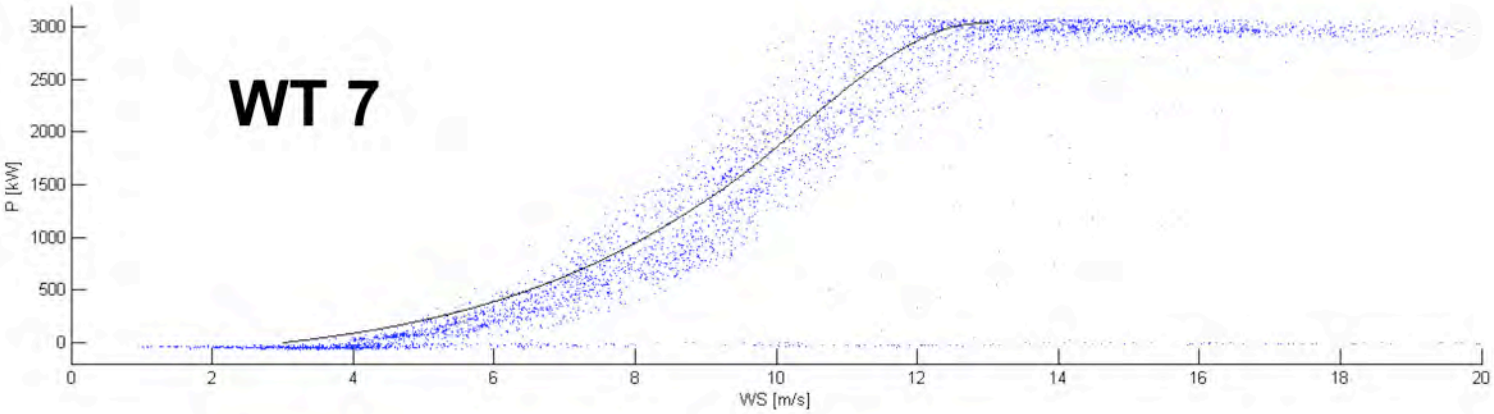


Icing Event Dec 22 - 26



Power output December for WT 6 - 7





Conclusion

- Anti-icing is necessary
- Significant energy savings
- Icing generates noise
- System not perfect
- System improvement needed

Thank you for your attention

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