Icing Loss Estimation: Practical Insights for Accuracy

Winterwind 2024 – 2024-03-20

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Icing losses estimation

- Often feels like a game of the Price is Right
- Everybody has their estimation: Owners, operators and 3rd parties
- But why is it complicated?

Why is it complicated?

- Data is incomplete and needs to be cleaned
- Other factors can influence the performance of the turbines

Why is it complicated?

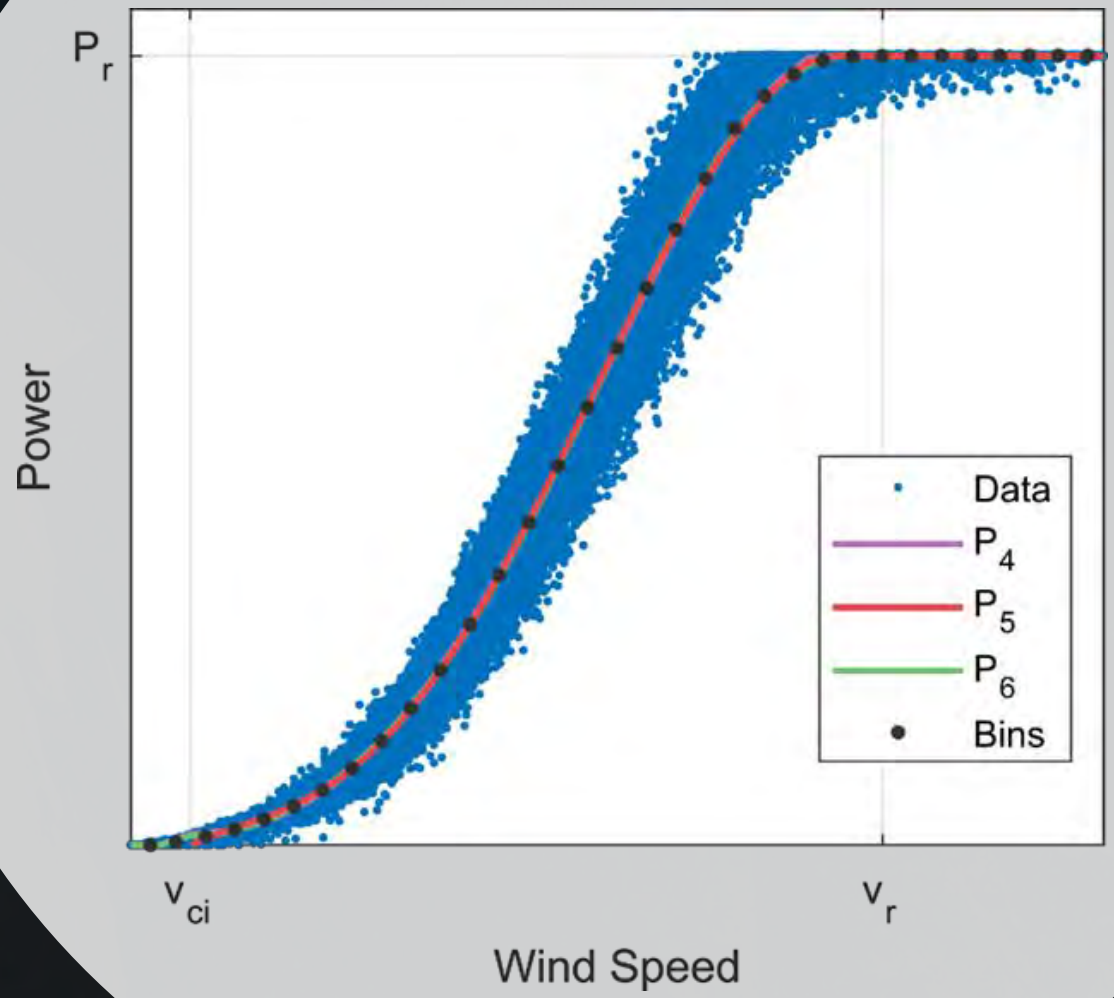
- Good tools like T19 Iceloss method exist
- Preprocessing and quality control are required
- Cannot use them blindfolded

What is needed?

Two steps are crucial to accurately estimate icing losses:

- Estimating the expected power
- Excluding external factors

Estimating the expected power

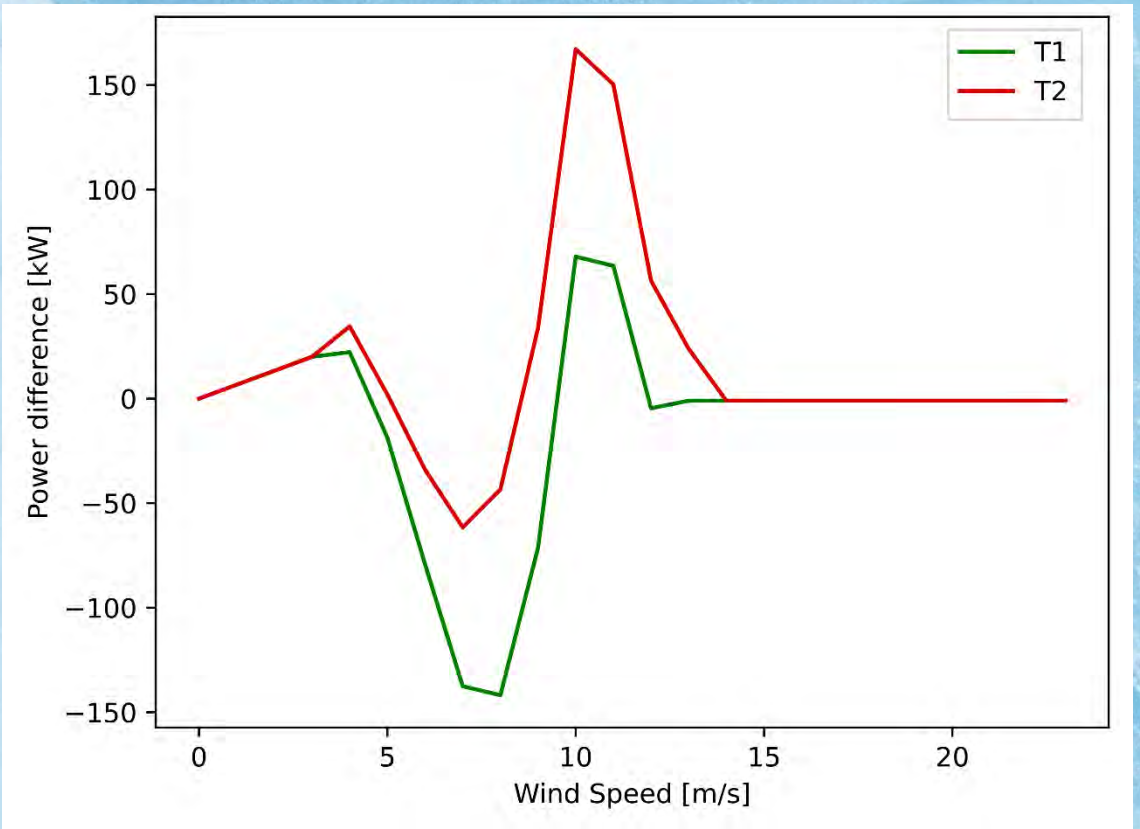


Roberge, P.; Lemay, J.; Ruel, J. & Bégin-Drolet, A. (2021) In situ estimation of effective liquid water content on a wind turbine using a thermal based sensor. Cold Regions Science and Technology 184 (2021) 103235https://doi.org/10.1016/j.coldregions.2021.103235

Estimating the expected power

Customizing power curves

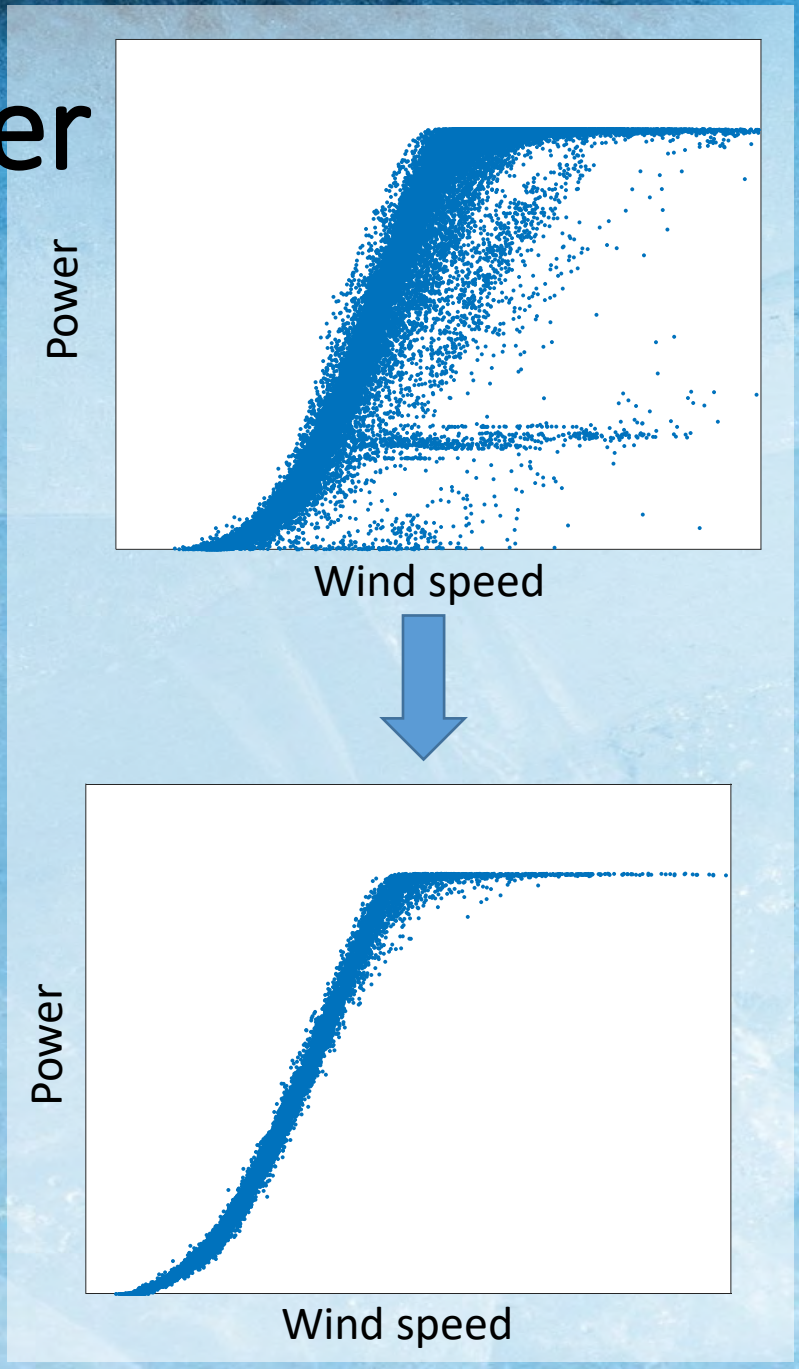
- Manufacturer's power curve is generic
- Specific power curves might be very different within a wind farm



Estimating the expected power

Build custom power curves

- Gather raw data
- Clean data set
- Avoid biases
- Use the power of timeseries



Estimating the expected power

Validate power curve

- Cumulative sum of losses during the summer
- Excluding faults and maintenance
- Expecting straight line
- Gives order of magnitude of “leaks”

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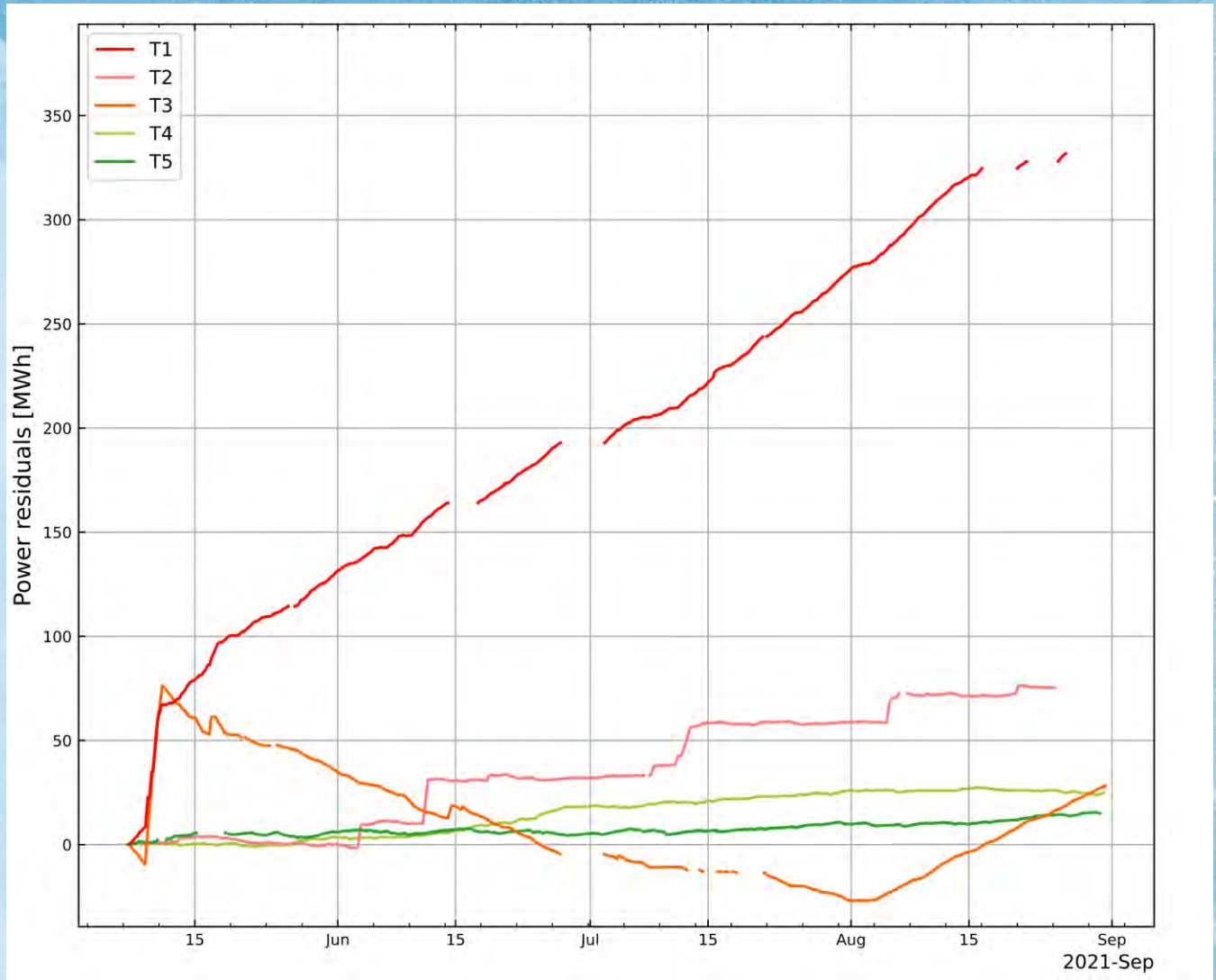

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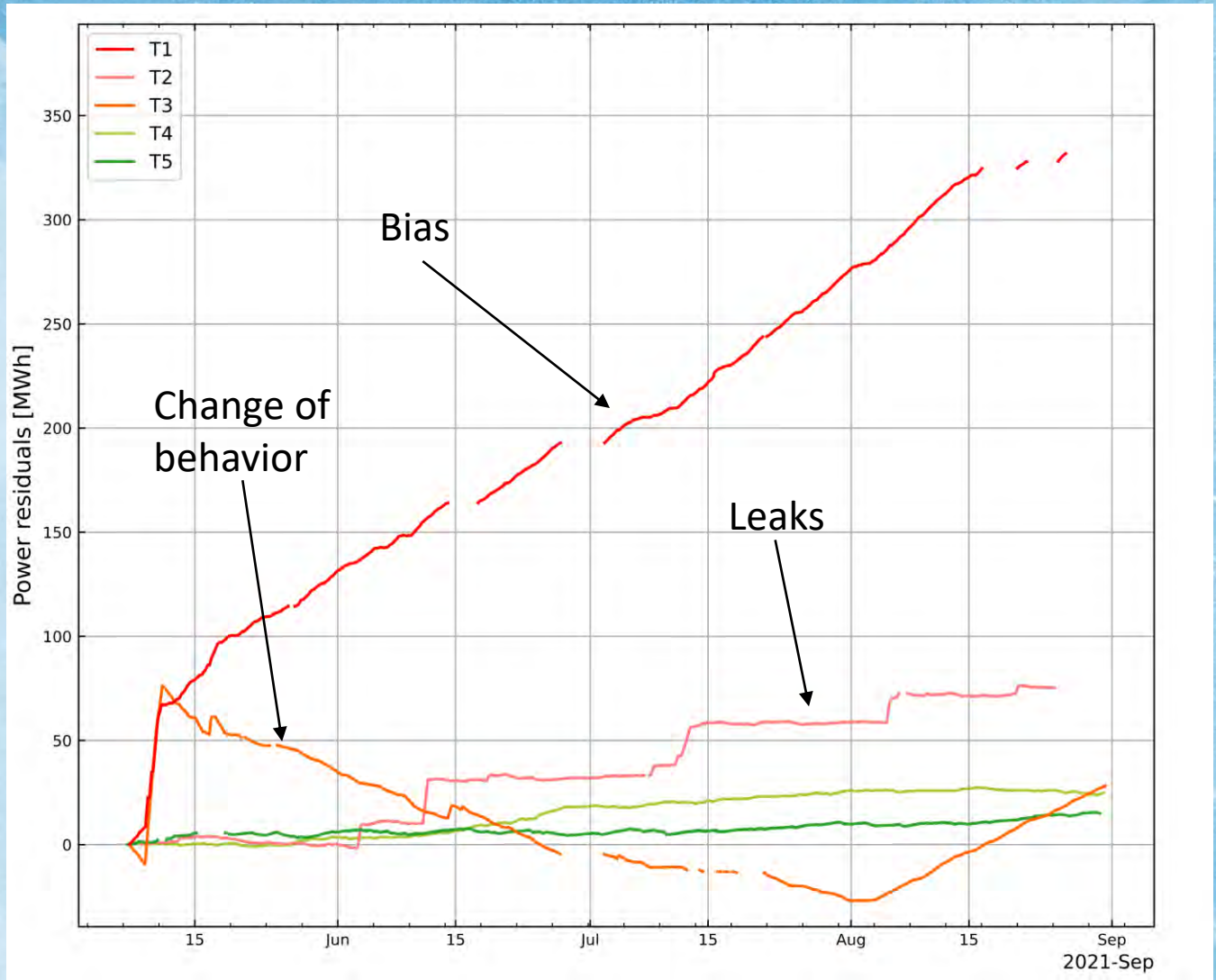

Excluding external factors

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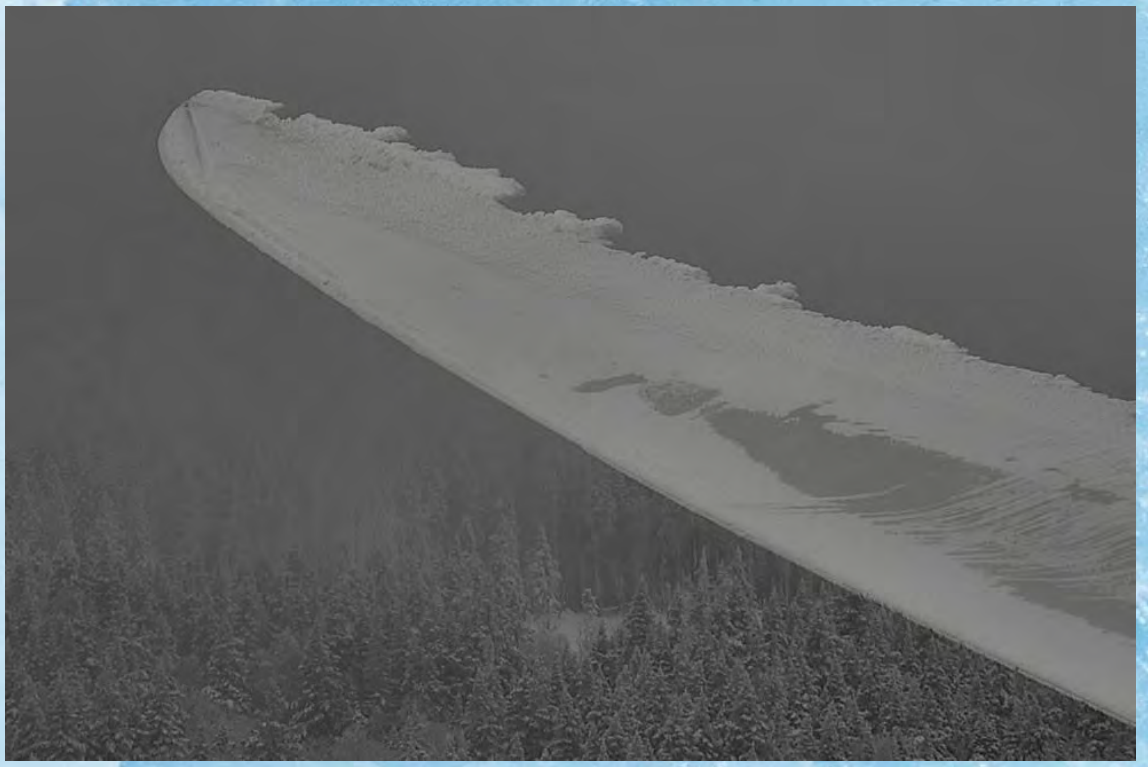
Separate icing from other variables

These variables include:

- Wind speed
- Wind orientation
- Temperature
- Maintenance or faults
- Curtailment



Excluding external factors

- A lot of curtailment and faults are not tagged
- Common solution: compute losses only during active icing status or stoppages
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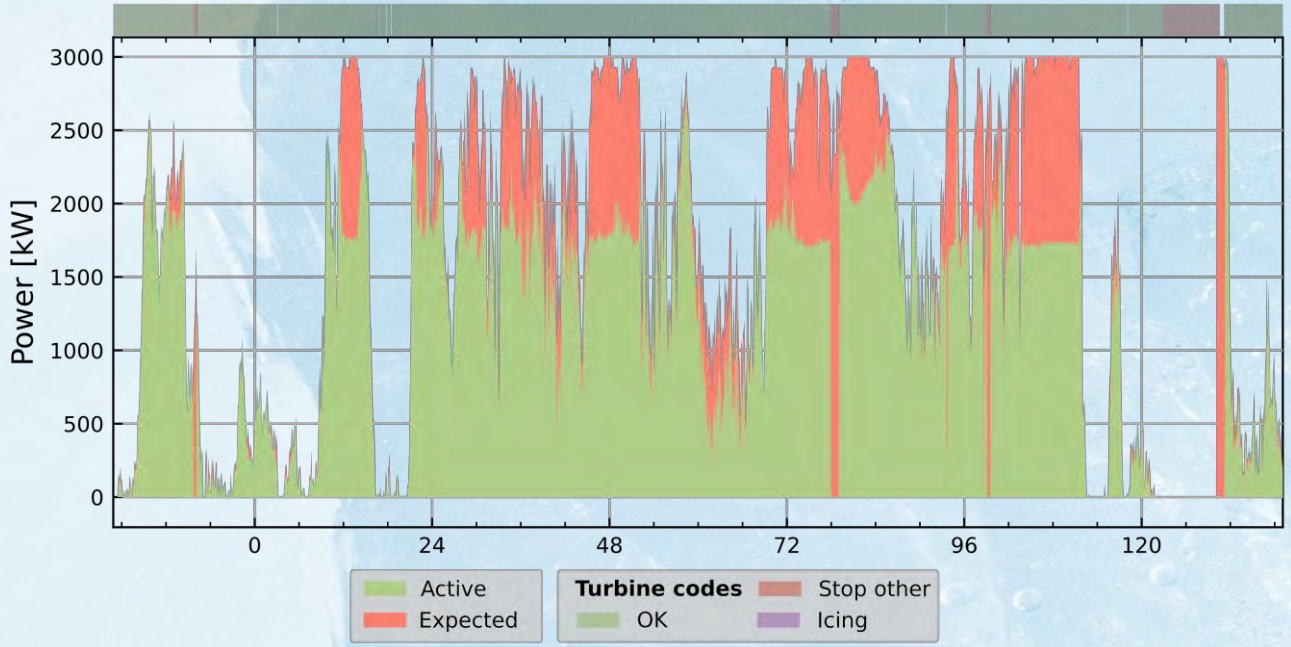
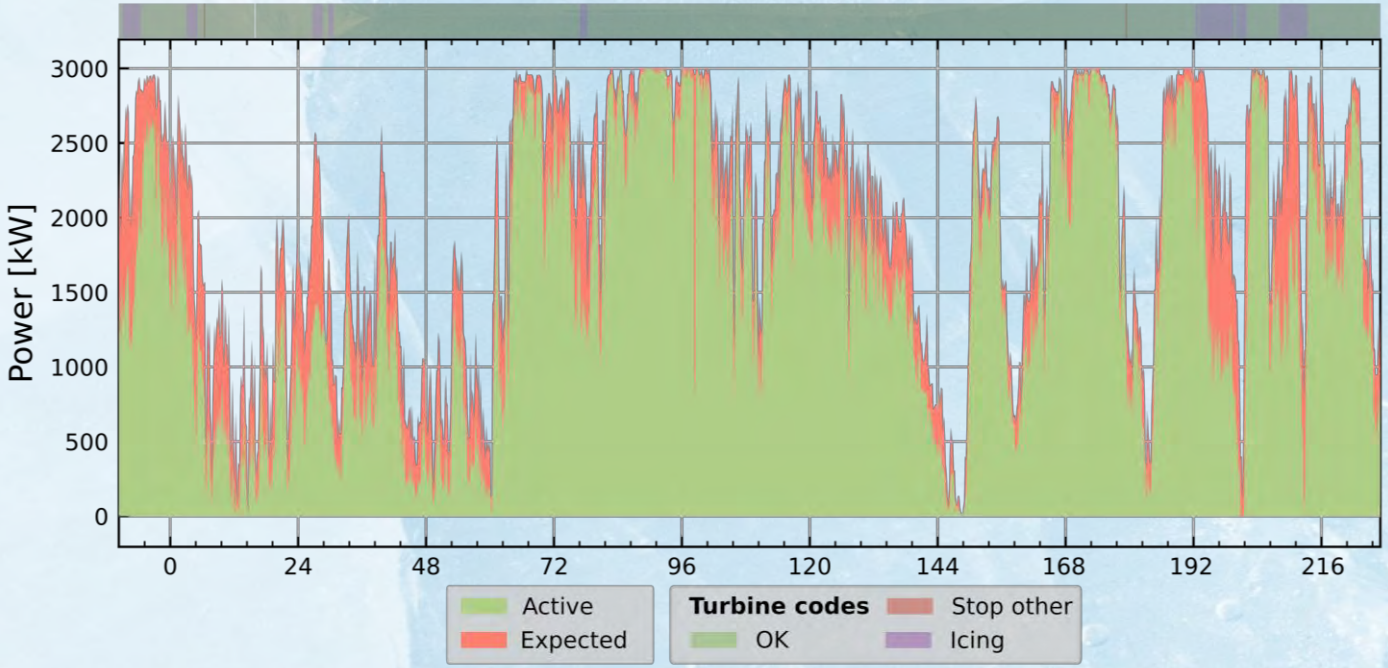


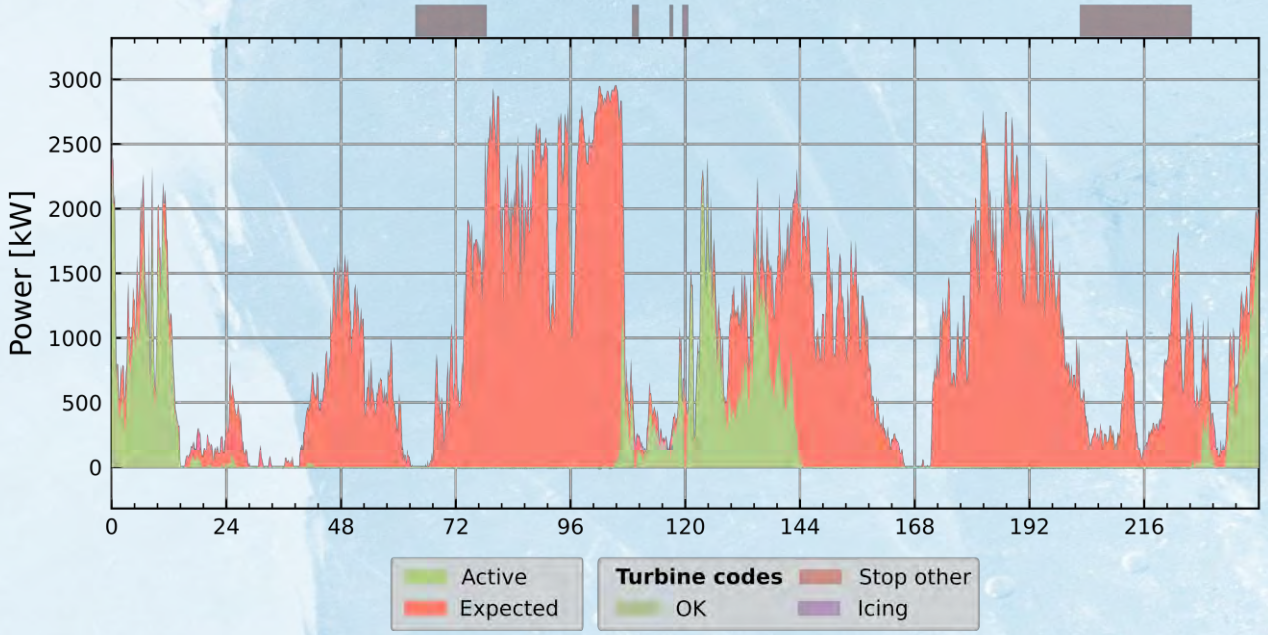
Excluding external factors

- Icing status not sensitive
- These periods can be significant
- Green = Produced
- Red = Expected
- Red visible = Loss
- Purple = Icing codes



Excluding external factors

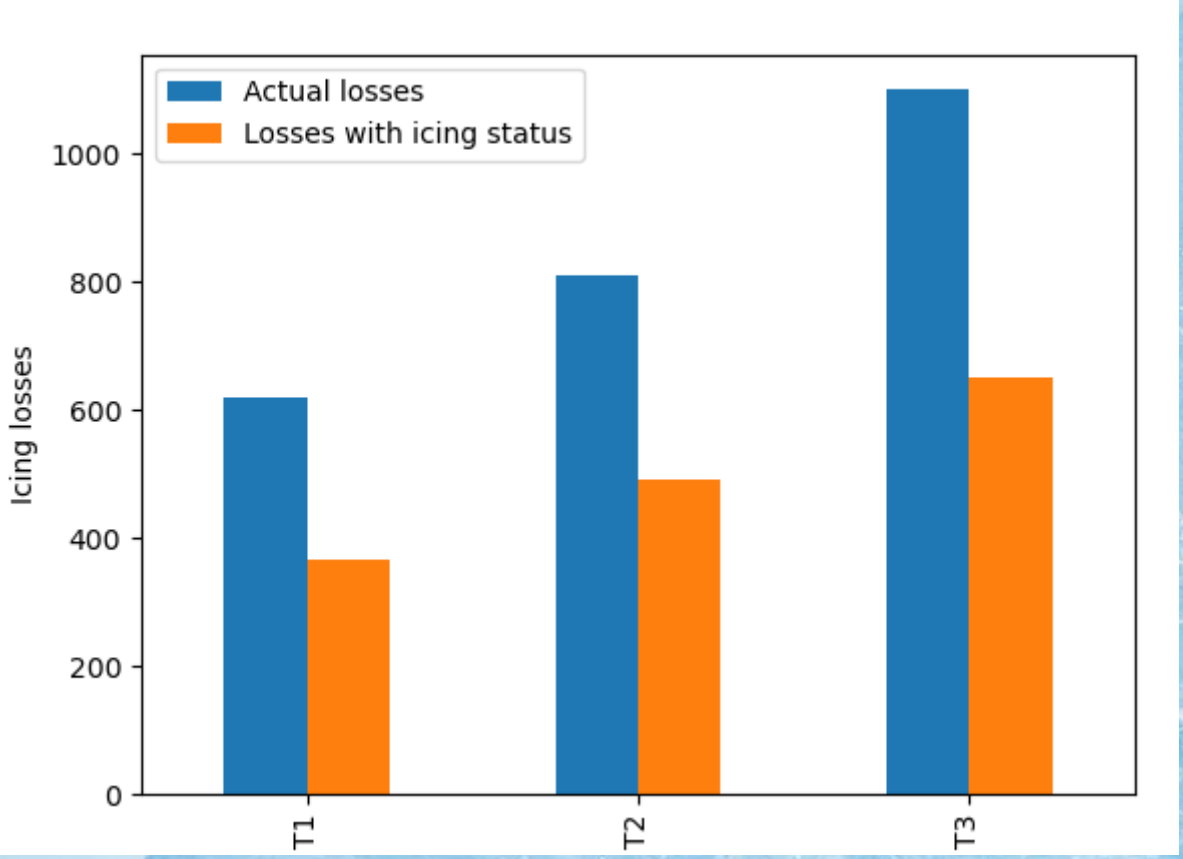
- Maintenance or faults codes during icing
- Overrides icing codes
- Icing stop before and after
- Underestimation of icing losses



Excluding external factors

Potential impacts

- Only using stoppage or icing code
- Underestimation of icing losses
- Example inspired on real data



Excluding external factors

Using the right metrics

- Isolate icing impact from wind
- Compare power production
- Compare the ratio of produced and expected energy

- Every turbine has its own set of conditions

Our methodology

Estimating the expected power:

- Data cleaning before power curves (algorithms)
- Timeseries validation

Excluding external factors:

- In house algorithm to identify icing periods
- Learn from every case, build algorithms
- Use good metrics

Conclusion

- Ice losses assessment requires long and rigorous process
- Data cleaning
- Accurate specific power curves
- Not relying only on turbine codes
- Validate with timeseries