NERGICA Renewable Energy Research and Innovation

The natural progression of the TechnoCentre éolien

Wind Turbine Rotor Icing Detectors Performance Evaluation

Charles Godreau, P.Eng., M.Eng.
WinterWind 2019
Umeå, Sweden
February 6, 2019

Rotor Icing

Ice formation on the wind turbine blades

Degrades aerodynamic performance

Estimated losses of 100 M$ per year in Canada

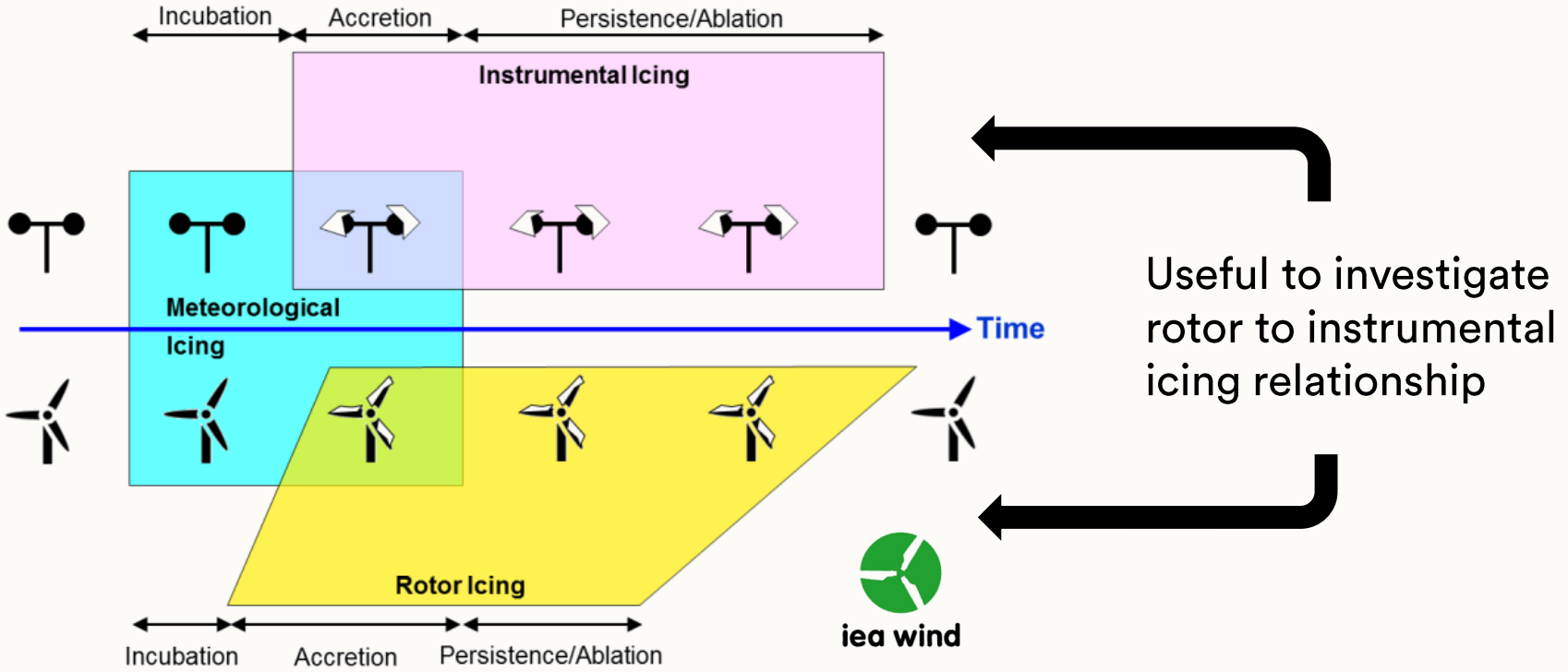
Is a significant health and safety issue

Rotor Icing Detectors

Rotor icing detectors measure icing directly on the wind turbine blades

Common method for detecting rotor icing: power curve

Main limitation: does not work at standstill



Useful to investigate rotor to instrumental icing relationship

Definitions related to icing [1]

Rotor to instrumental icing relationship

Wind turbine blade ice accretion: A correlation with nacelle ice accretion

Nicolas Jolin*, Dominic Bolduc, Nigel Swytink-Binnema, Gabriel Rosso, Charles Godreau

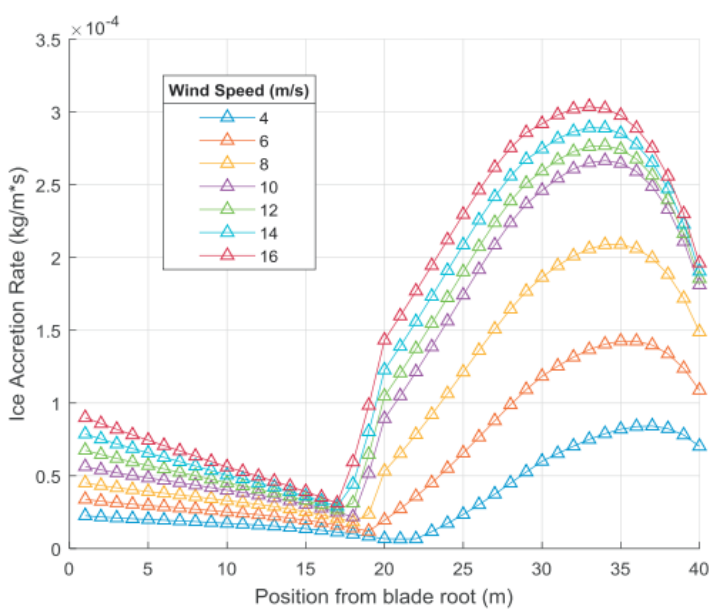


Fig. 6. Modelled ice accretion rates along the blade length.

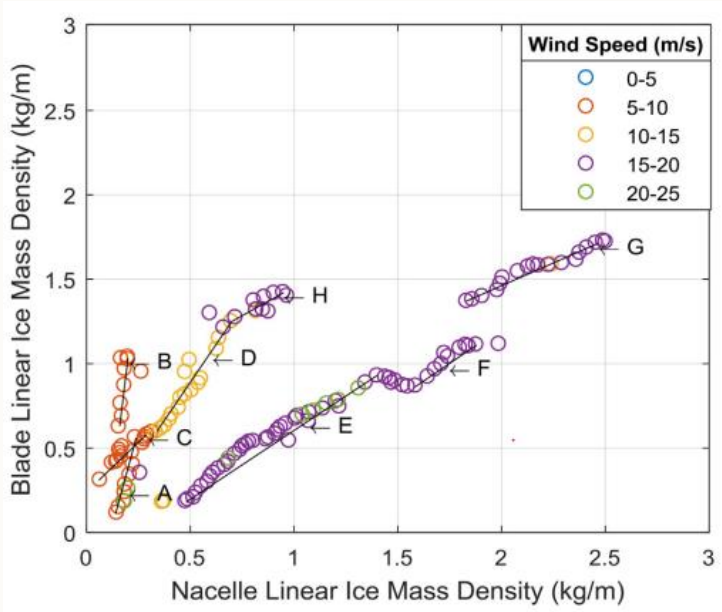


Fig. 11. Blade and nacelle linear ice mass densities for an operating turbine over different wind speeds.

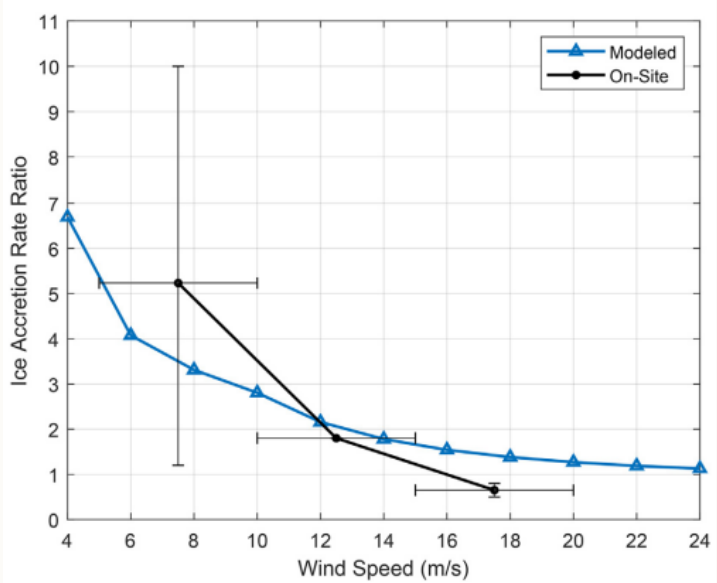
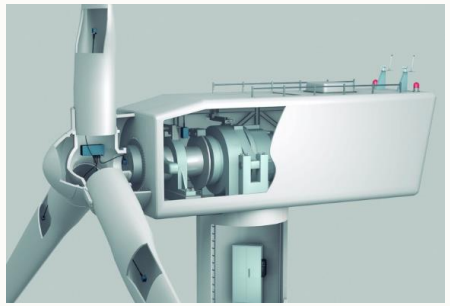


Fig. 12. Modelled and on-site Relation between blade and nacelle ice accretion rates.

Four commercially available technologies



Weidmüller

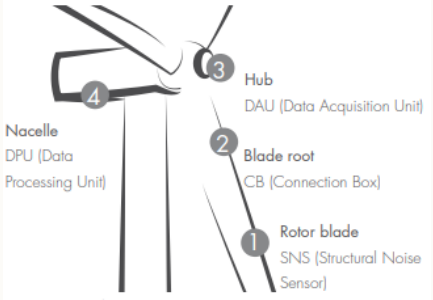
BLADEControl

[1, 2, 3]

fos4X

Rotor Ice Control

[1, 2, 4]



Wölfel

IDD.Blade

[1, 2, 5]

eologix sensor technology

[1, 2, 6]

All certified components by DNV-GL

No independent performance study completed yet

How do they perform ?

Towards performance assessment standardization

Research ➡ Industry Adoption ➡ Standard

In line with IEA Wind TCP Task 19 Objectives

iea wind

Performance Evaluation Guidelines for
Ice Detection Systems coming in 2020

The experiment

Commissioning of the rotor detectors*: 2015-2017

↓

Nergica study over winter 2017-2018

↓

Compare the performance of three rotor ice detectors*

Propose two reference methods

Define 4 Key Performance Indicators (KPI)

Senvion MM92 2.05 MW
Nergica Test Site
Gaspé, Canada

*Tested rotor icing detectors

Weidmüller fos4X eologix sensor technology

Not tested Wölfel

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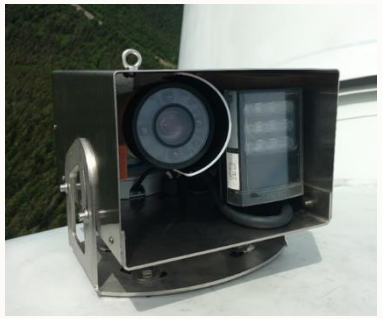
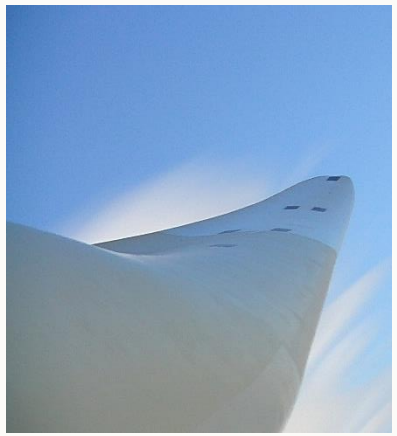
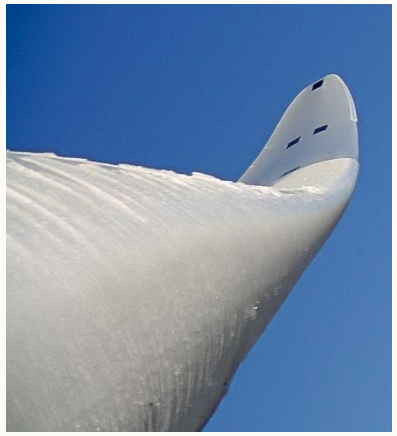
Reference icing severity

2 Hub Cameras





0 – No Ice

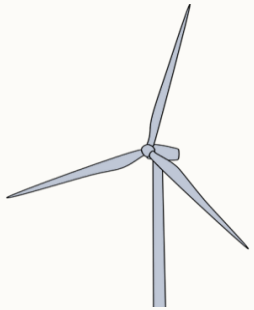


1 – Light Icing

2 – Medium Icing

3 – Severe Icing

Wind Turbine Control System*



Normal Operation

Anemometer Icing

Reduced Performance

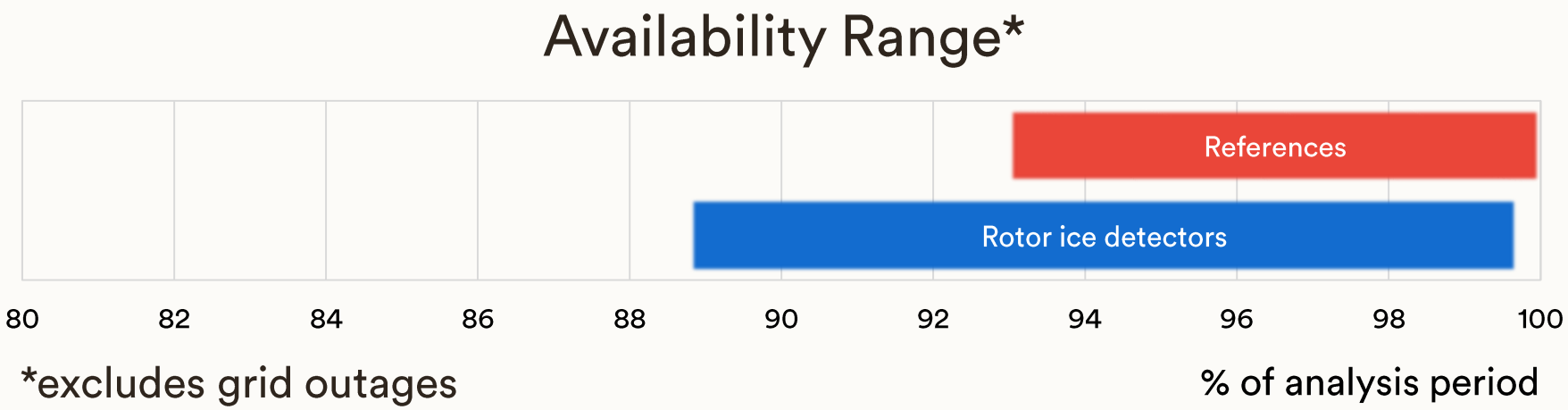
Turbine Stopped

*Turbine is not required to stop has soon has icing is detected

KPI and Results

Availability

Is the system able to detect icing ?



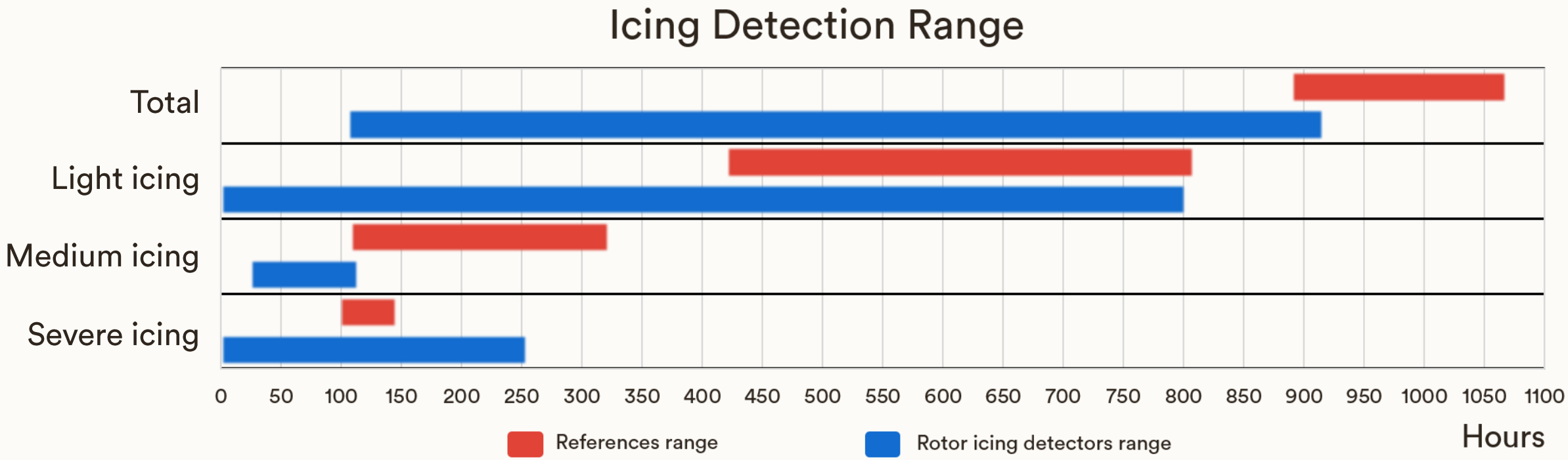
KPI and Results

Icing Time

Is the system detecting all icing events?

Icing Severity

Does the system indicate the right amount of icing?



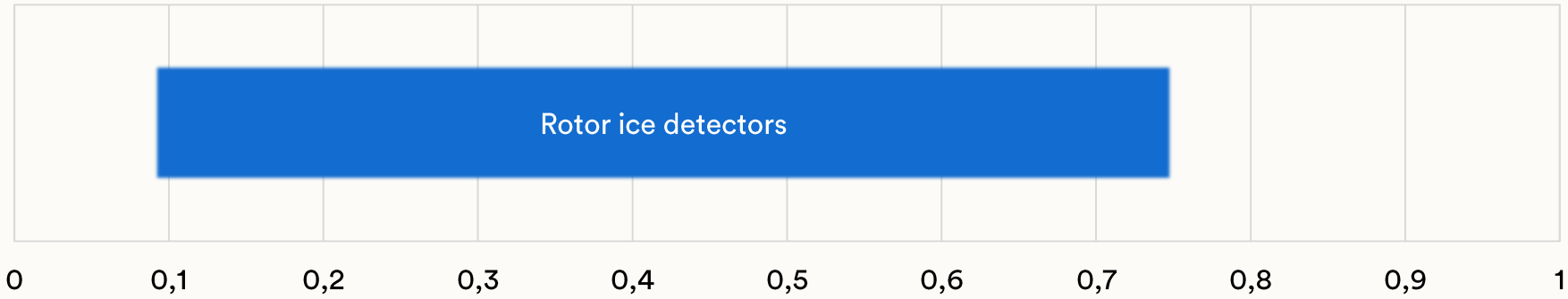
KPI and Results

Time Accuracy

Is the icing detected at right time?

Skill Scores H: Hit rate F: False alarm rate KSS: H - F

KSS Range – Total icing detection*



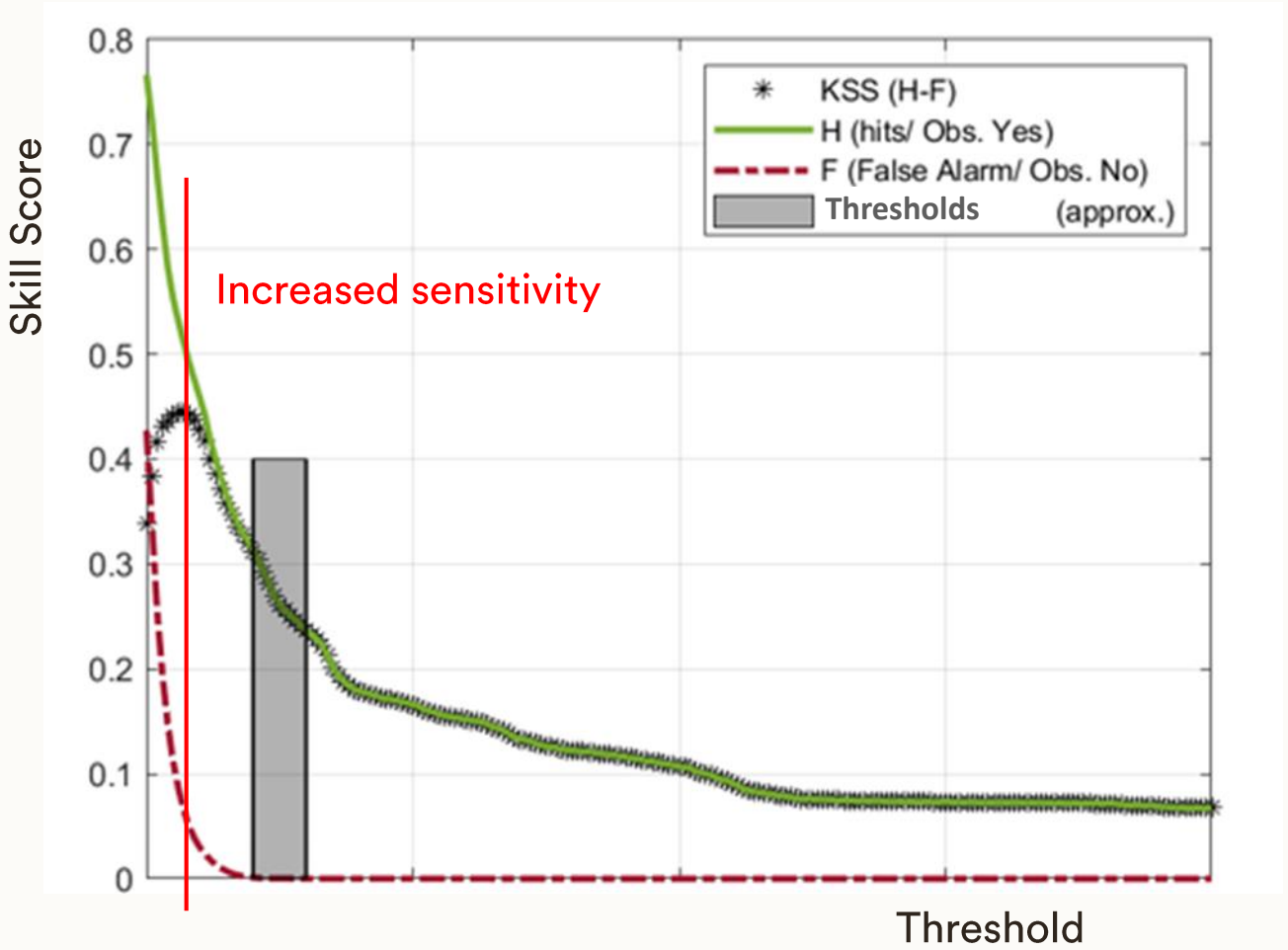
*False alarm rate negligible for all detectors

KPI and Results

Time Accuracy

How thresholds affect detection?

Skill score variation against threshold settings



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Conclusions

Rotor icing detectors show good availability

High variability in icing detection due to different thresholds/technologies used

Detector selection depends on application and required sensitivity

Other metrics to be considered:
- Cost (system + installation + maintenance)
- Durability

Full study coming out in March 2019

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Nos principaux partenaires financiers

Développement économique Canada pour les régions du Québec
Canada Economic Development for Quebec Regions
Québec

References

[1] IEA Wind TCP Task 19, “Available Technologies for Wind Energy in Cold Climates”, 2018.

[2] R. Cattin and D.U. Heikkilä, “Evaluation of ice detection systems for wind turbines”, Meteotest, Bern, 2016.

[3] Weidmüller, “Rotor blade monitoring with BLADEcontrol”. [Online].
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[4] fos4X, “fos4Blade - open sensor platform for rotor blades of wind turbines - fos4X”. [Online].
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[5] Wölfel, “Ice Detection | Wölfel”. [Online].
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[6] Eologix, “Eologix Sensor Technology | wireless temperature and icing sensor system for rotor blades.” [Online].
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