

▶ Experiences with IPS icing losses and Iceloss 2.2

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IceLoss

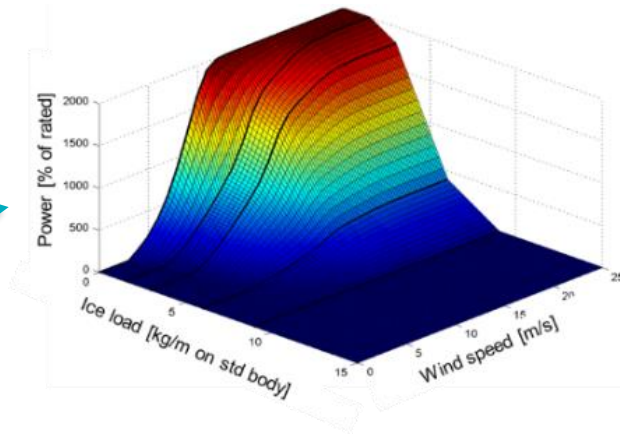
- ▶ A state-of-the-art-model developed by Kjeller Vindteknikk (KVT) for calculating:
 - ▶ ice accumulation on the turbine blades
 - ▶ icing losses
- ▶ Based on WRF meso-scale weather model
- ▶ First IceLoss analysis 2009
- ▶ IceLoss 2.0 update 2018-2020
- ▶ Preliminary IceLoss 2.2



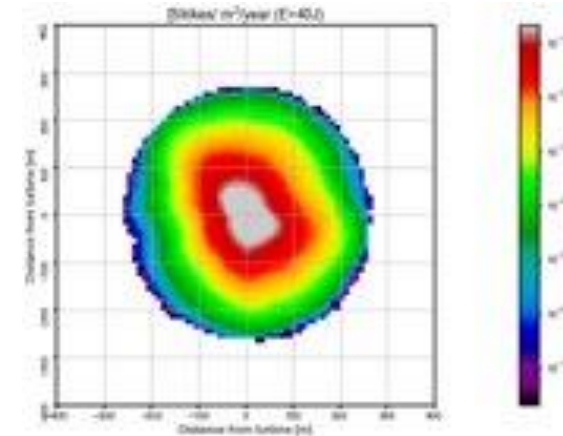
IceLoss applications

- ▶ Pre-construction icing losses
- ▶ Ice throw risk
- ▶ Post construction icing loss (long-term correction)
- ▶ Forecasts (both loss and risk)

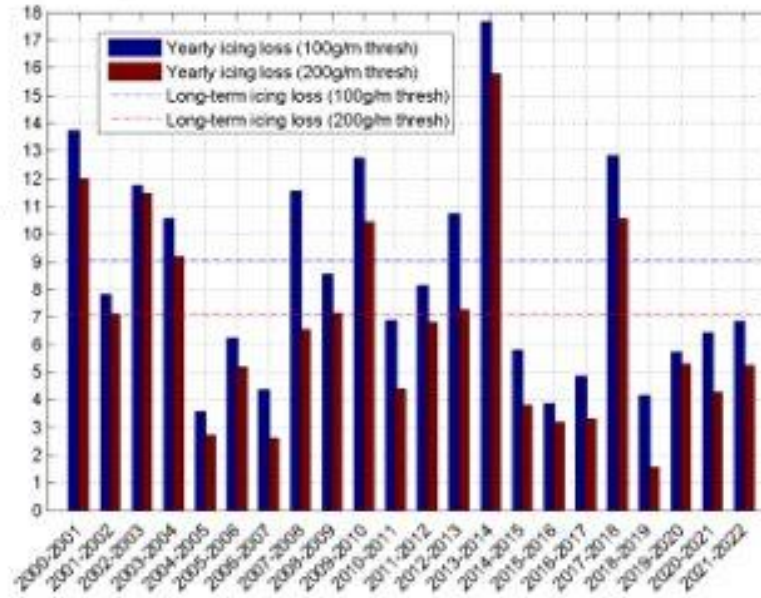
IceLoss



IceRisk



PCPA

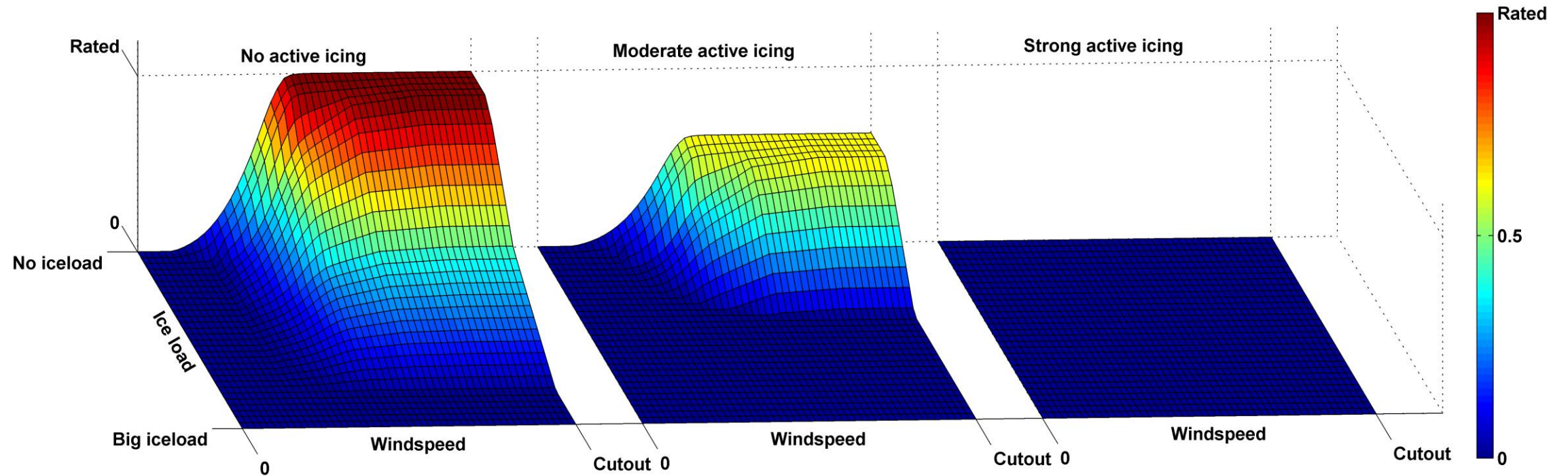


Forecast



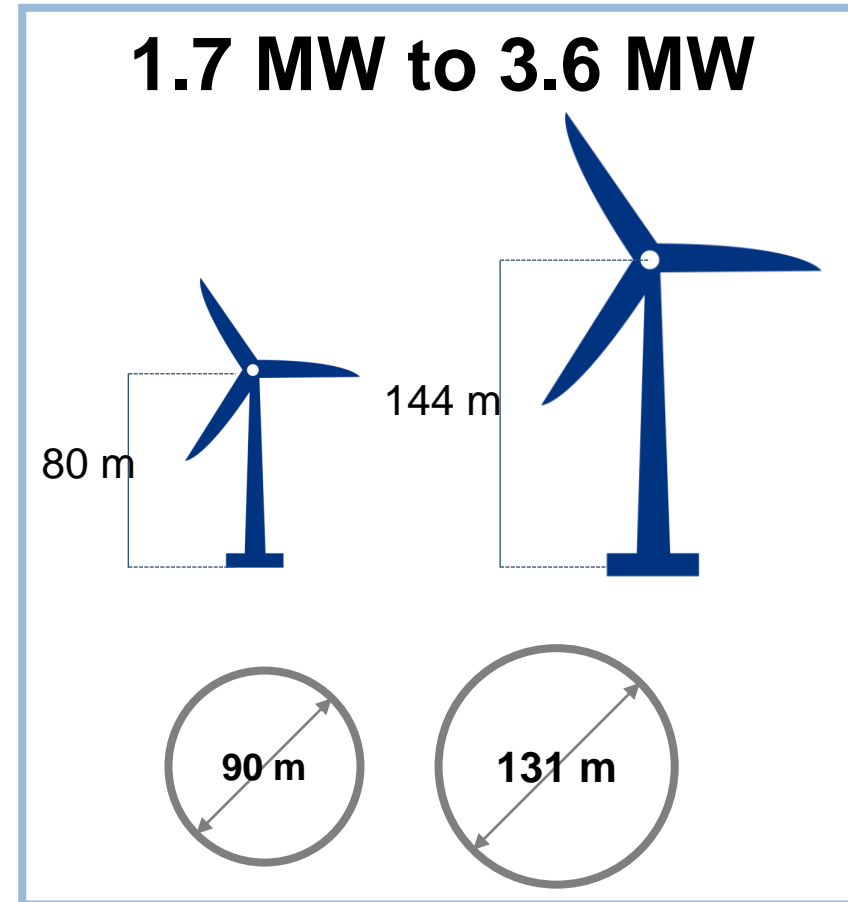
IceLoss calibration

- ▶ SCADA icing loss based on Task19 method
- ▶ Long-term icing losses
- ▶ 3D power curve



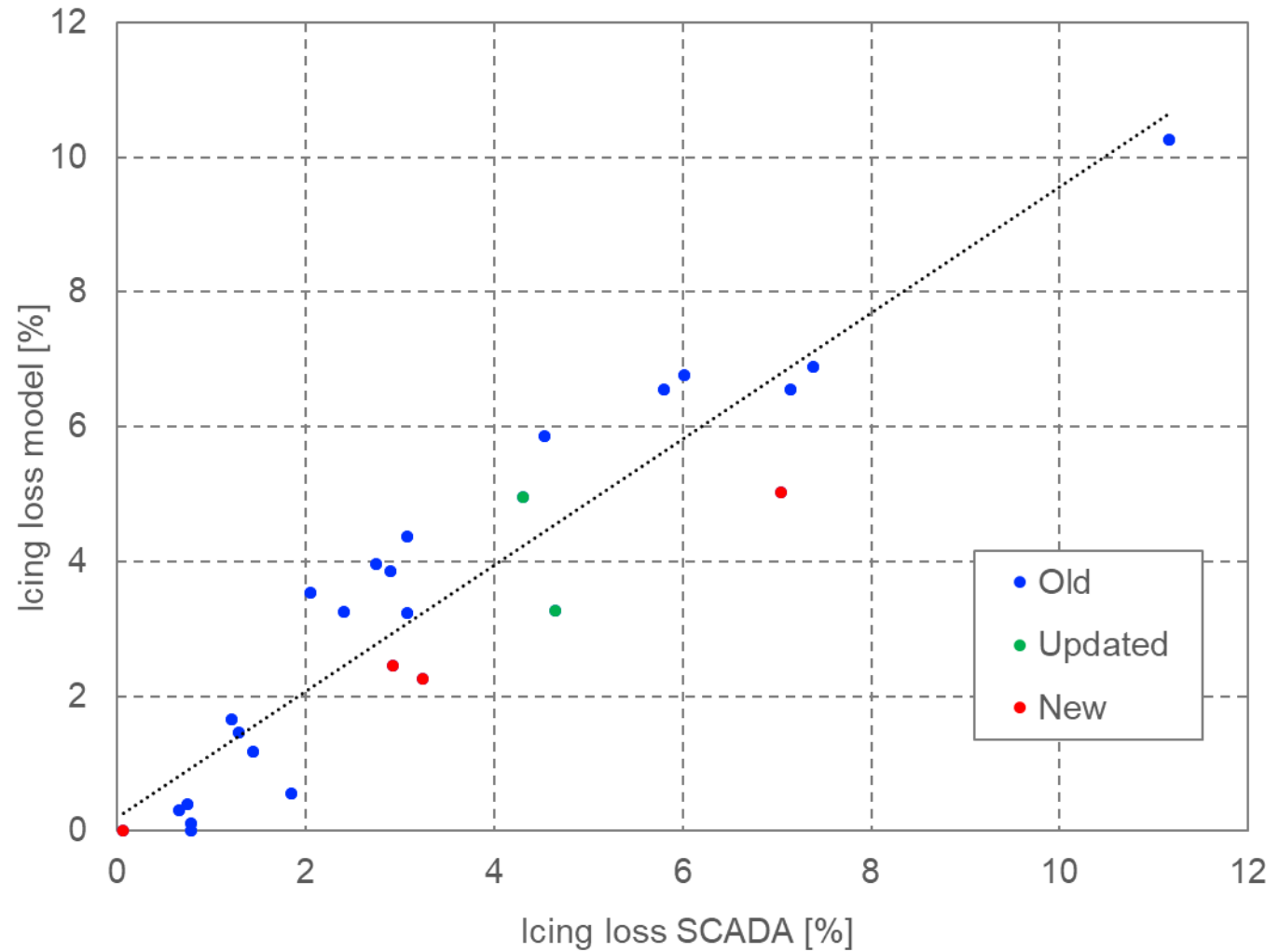
Calibration dataset

- ▶ 26 wind farms
- ▶ 430 WTGs
- ▶ 4 OEMs
- ▶ Sweden, Norway, Finland
- ▶ No IPS
- ▶ Historical icing loss <1 % to > 10 %
- ▶ > 2100 WTG years
- ▶ Analysed period per site 1-8 years



IceLoss 2.2 validation

- ▶ 4 sites added
- ▶ Updated SCADA analysis in 2 sites



IPS model calibration

- ▶ Post-construction production/icing analysis
 - ▶ > 10 sites
 - ▶ 5 OEMs
 - ▶ Anti-icing and de-icing
 - ▶ Electrothermal, hot air and special winter operation mode
- ▶ 6 sites used in IPS model calibration

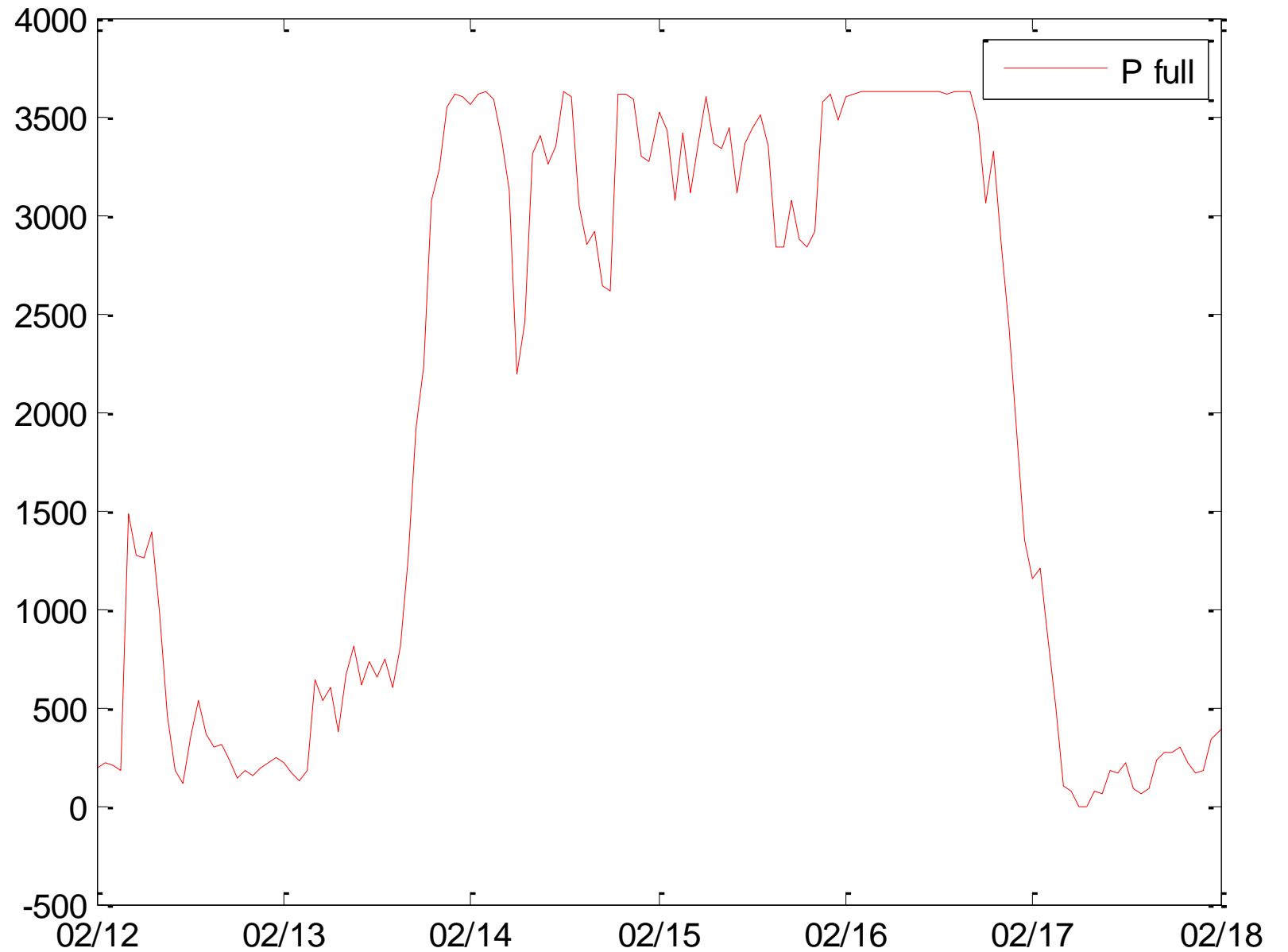


IPS model

- ▶ Turbine type specific IPS model
- ▶ Based on:
 - ▶ IPS documentation
 - ▶ KVT IPS performance analysis
 - ▶ Track record
- ▶ Uncertainties

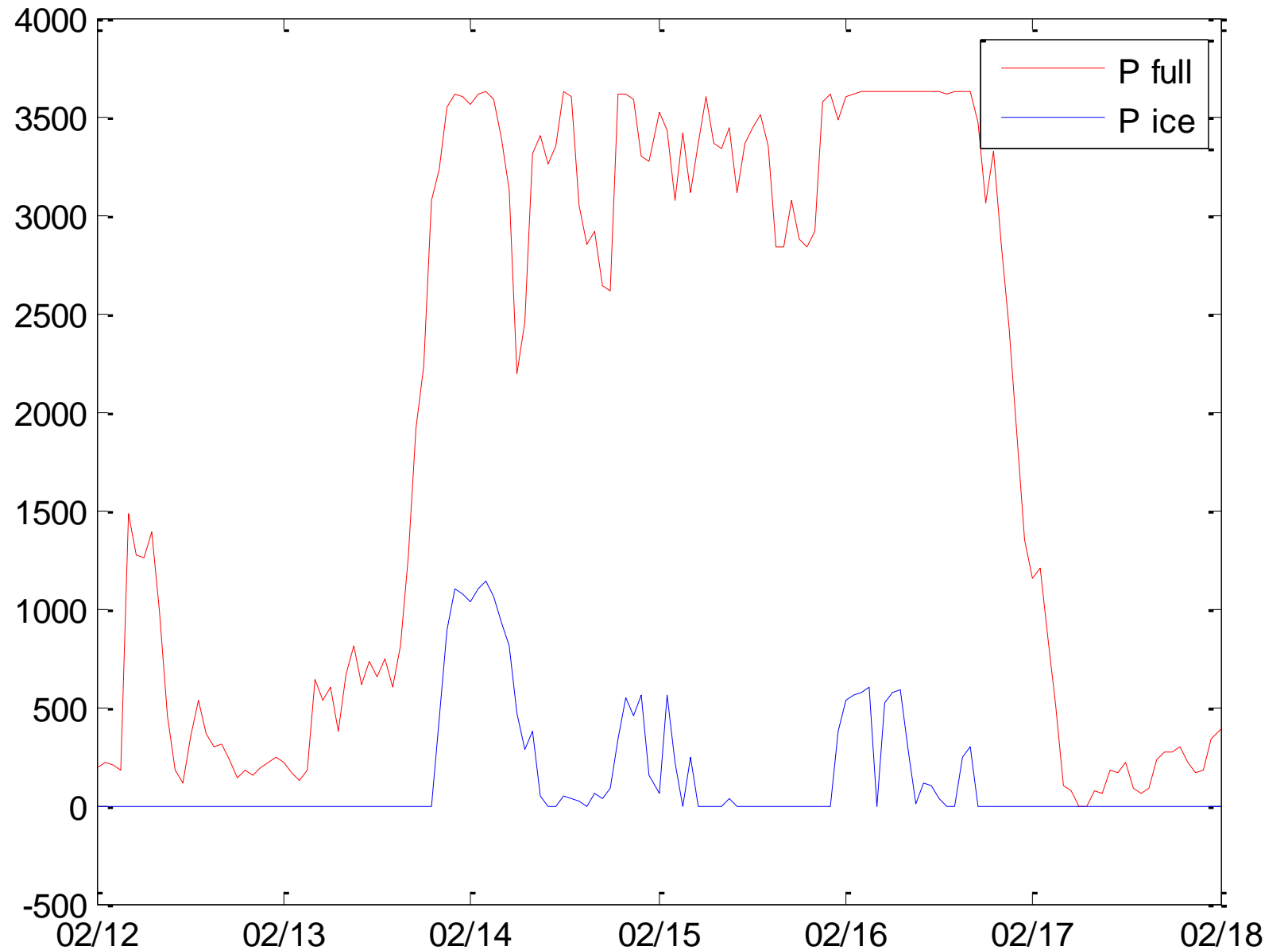
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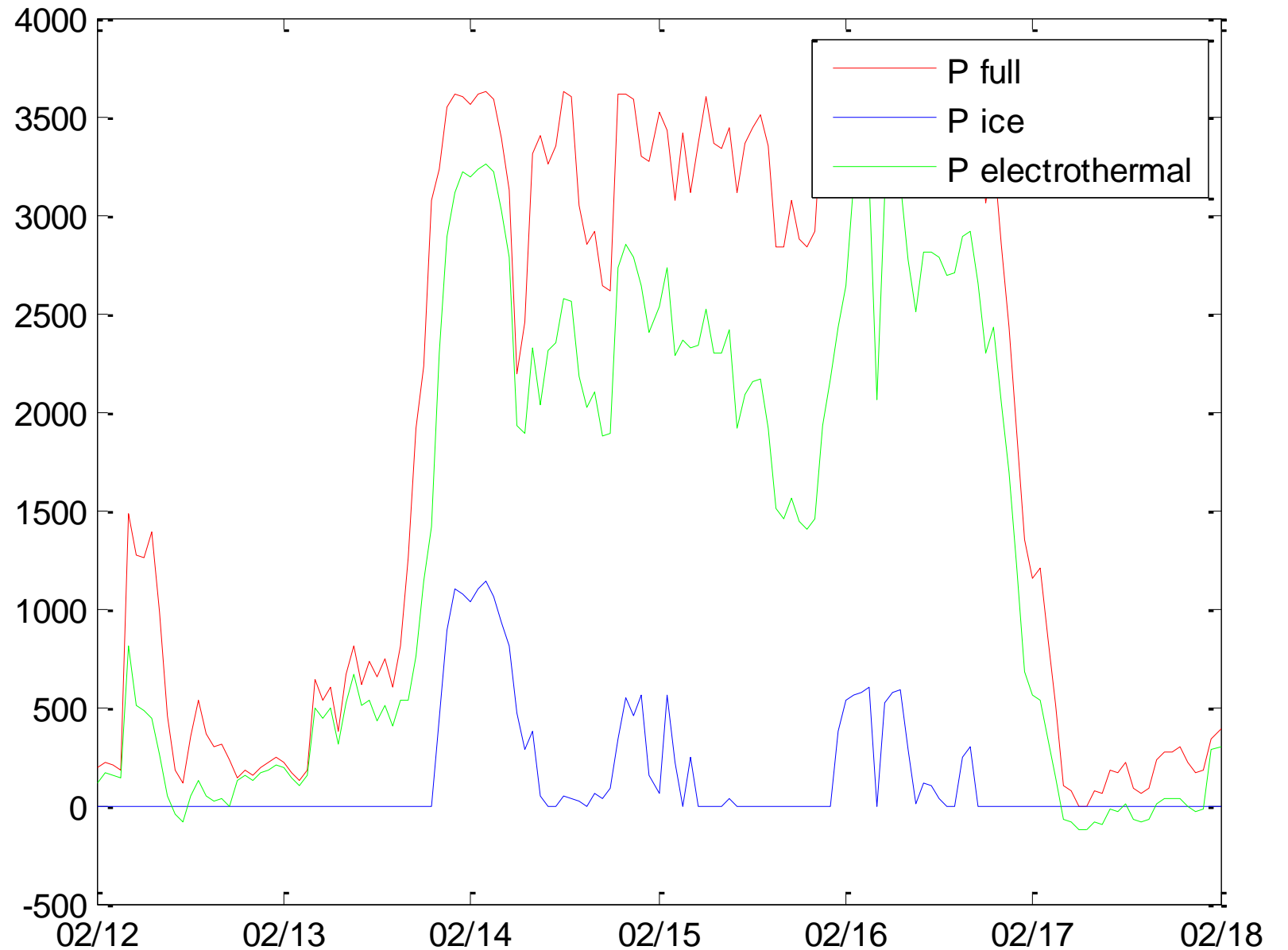
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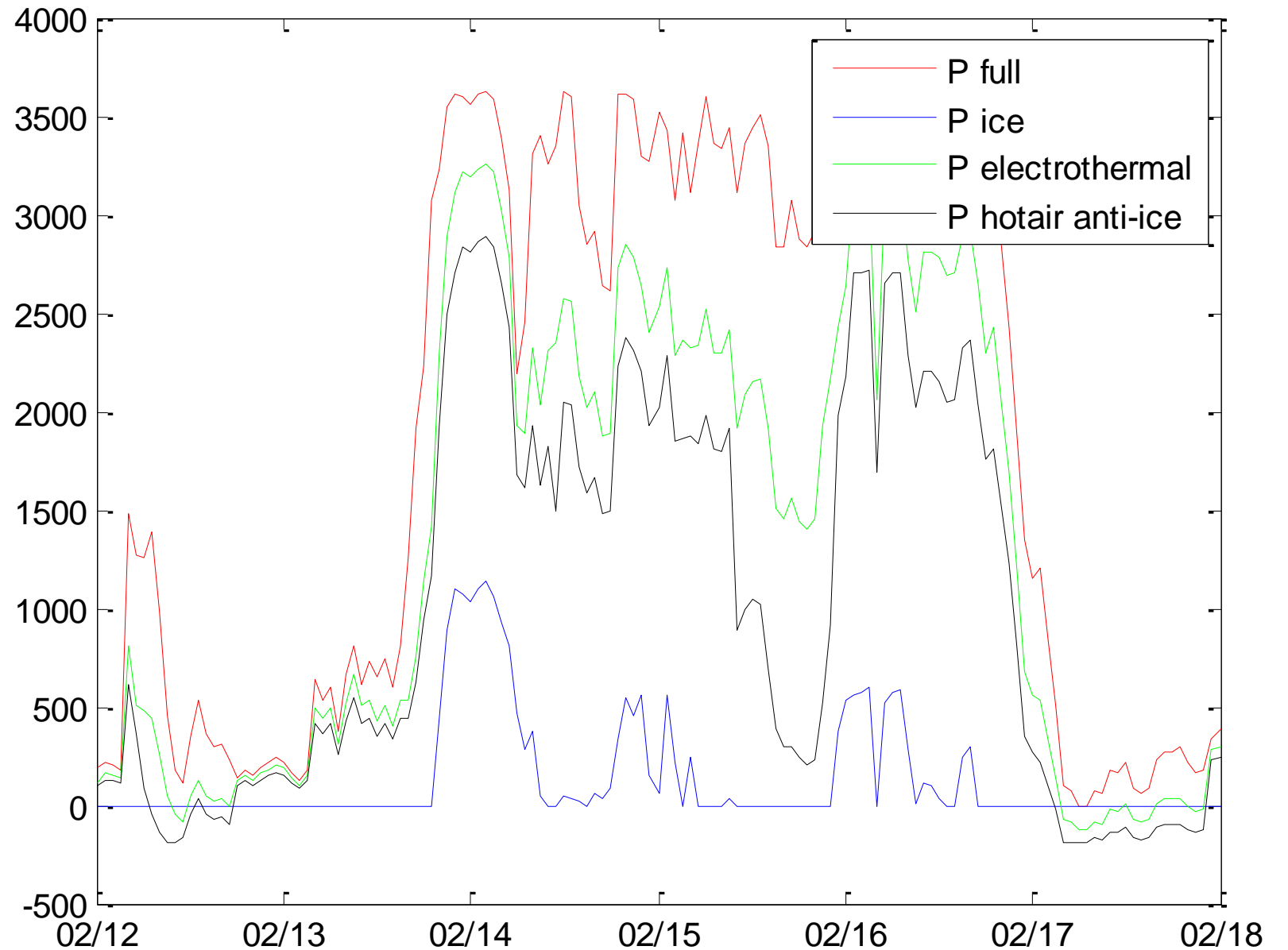
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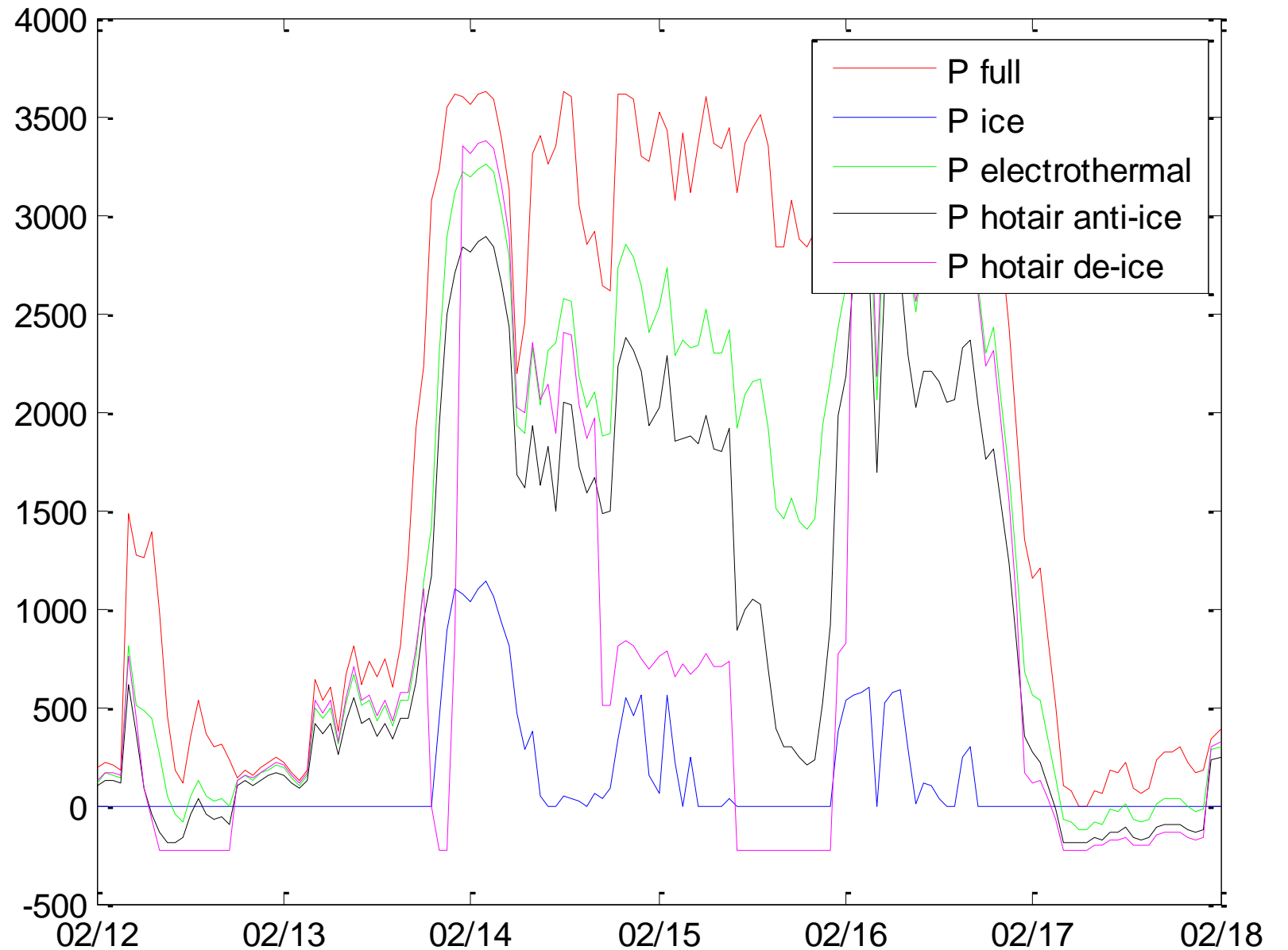
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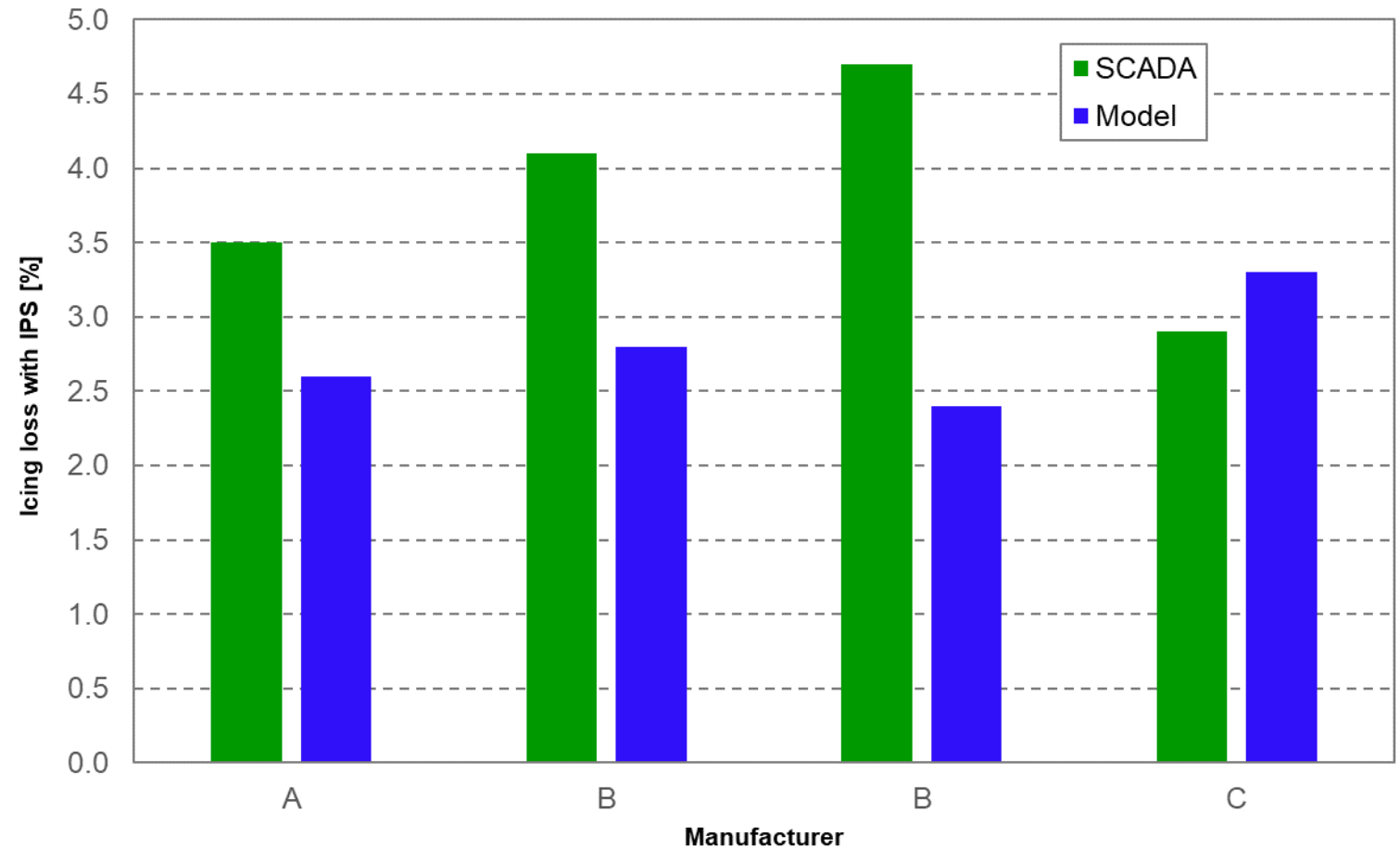
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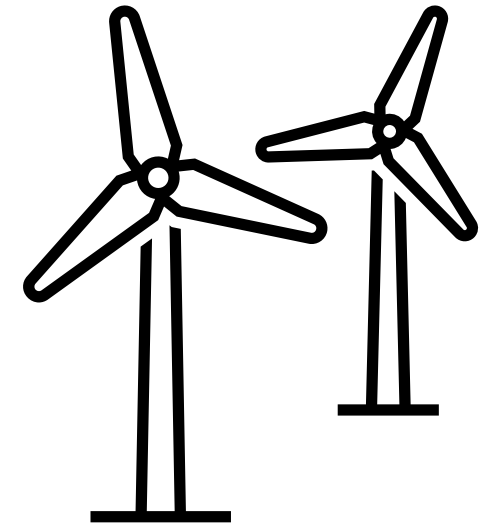
IPS Loss validation

Manufacturer	IPS type
A	Electrothermal 1
B	Hot air
C	Electrothermal 2



Take-aways:

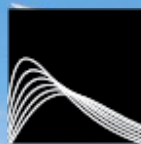
- ▶ IceLoss updated -> average WTG size increased, more accurate results for large turbines
- ▶ IPS specifications are optimistic?
- ▶ After tuning, modelled IPS icing loss uncertainties still higher than without IPS



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Thank you!



KJELLER

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En del av Norconsult

