KJELLER VINDTEKNIKK
En del av Norconsult

Forecasting of icing for wind energy applications

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Fosen Vind

Om Fosen Vind | Vindparkene | Utbyggingen | Nyheter og media | Iskastvarsel

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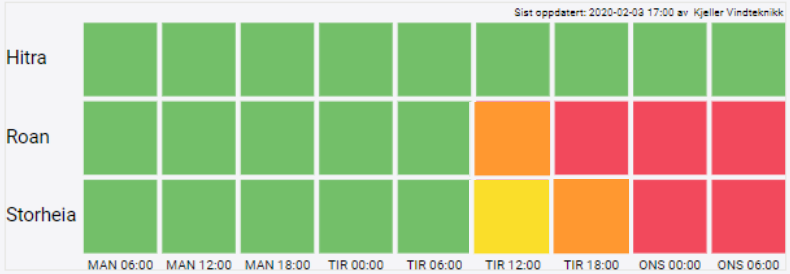
Iskastvarsel

Basert på meteorologiske data beregnes sannsynligheten for iskast i de forskjellige vindparkene.



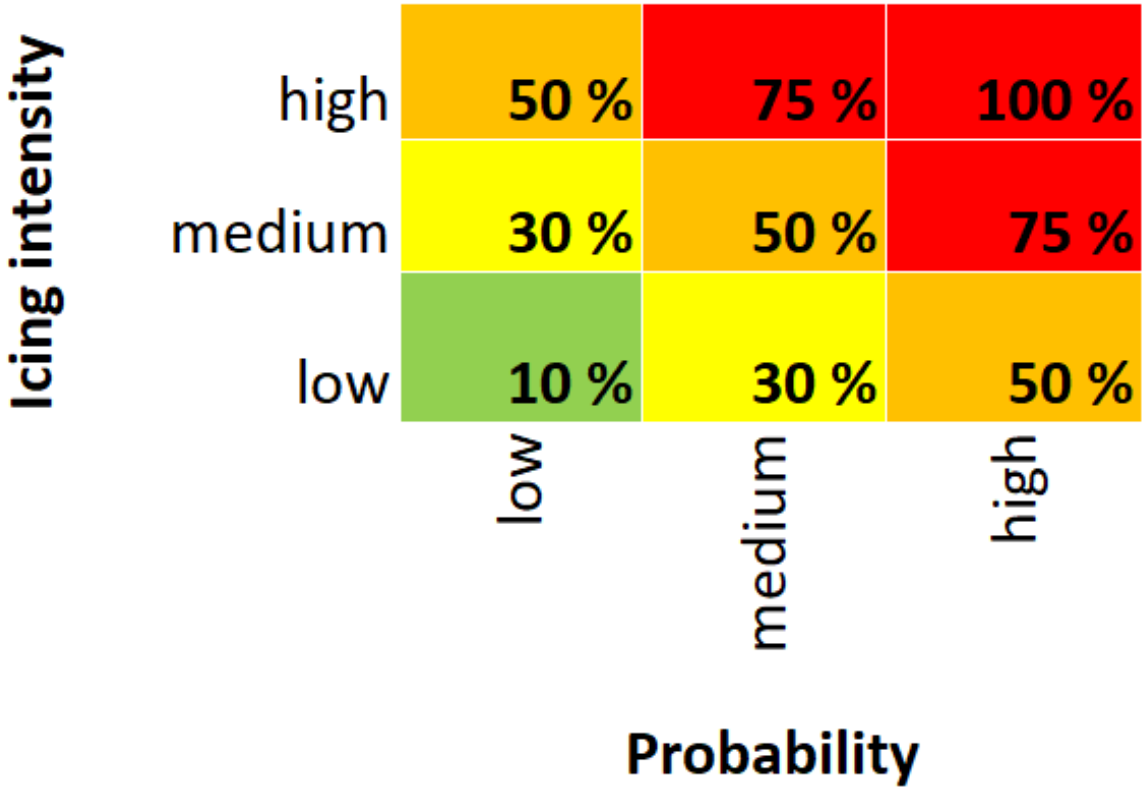
Ingen data
Minimal sannsynlighet
Lav sannsynlighet
Medium sannsynlighet
Høy sannsynlighet

Basert på meteorologiske data beregnes sannsynligheten for iskast i de forskjellige vindparkene. Disse beregningene gjøres fire ganger i døgnet. Hver blokk i diagrammet representerer derfor sannsynligheten i neste 6 timers intervall.

Se forøvrig informasjon om iskast under hver vindpark. Variasjon i geografisk plassering, høyde over havet og nærhet til sjøen gjør at forholdene og

Vindparkene

- Roan vindpark →
- Storheia vindpark →
- Kvenndalsfjellet vindpark →
- Harbaksfjellet vindpark →
- Geitfjellet vindpark →
- Hitra 2 vindpark →
- Driftsfasen
- Jobber i vindparkene →
- Iskastvarsel



Application and users of icing forecasts

- **Safety – risk of ice throw / ice fall**
  - Reindeer hearders

Application and users of icing forecasts

- **Safety – risk of ice throw / ice fall**
  - Hikers
  - Skiers

Application and users of icing forecasts

- **Safety – risk of ice throw / ice fall**
  - Service personell
  - Snow removers

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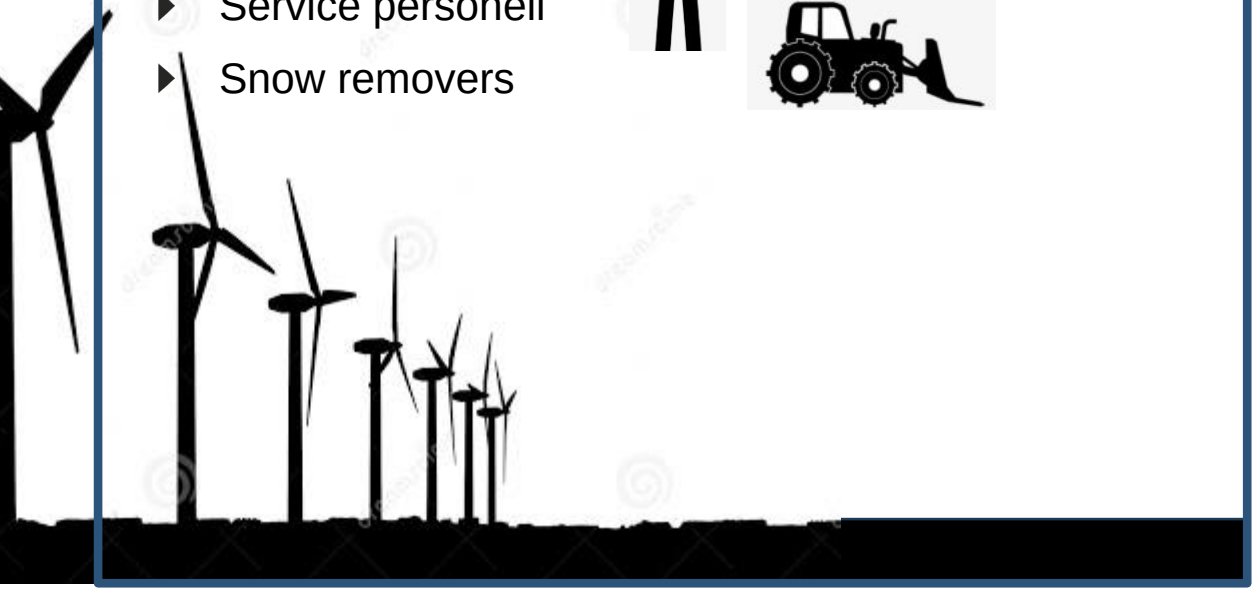


- **Power losses**
  - Energy trading
  - Development of blade heating systems

About the model simulations

Hindcasts

- Hindcasts are carried out to create historical data
- Hourly data from 1979 until recently
- Updated on a daily or monthly basis

Forecasts

- Forecasts calculate forward in time
- Time periods are 2 days ahead and 5 days ahead
- Updated 4 times daily for 2 day forecast
- Updated once daily for the 5 day forecast

WRF

- Weather Research and Forecast
- Forecast and hindcast use the same model configuration
- The validation work presented is carried out using the hindcast data.

Validation of icing forecasts

- 24 wind farms
- 401 turbines
- 5 years per turbine (average)
- Sweden, Finland and Norway

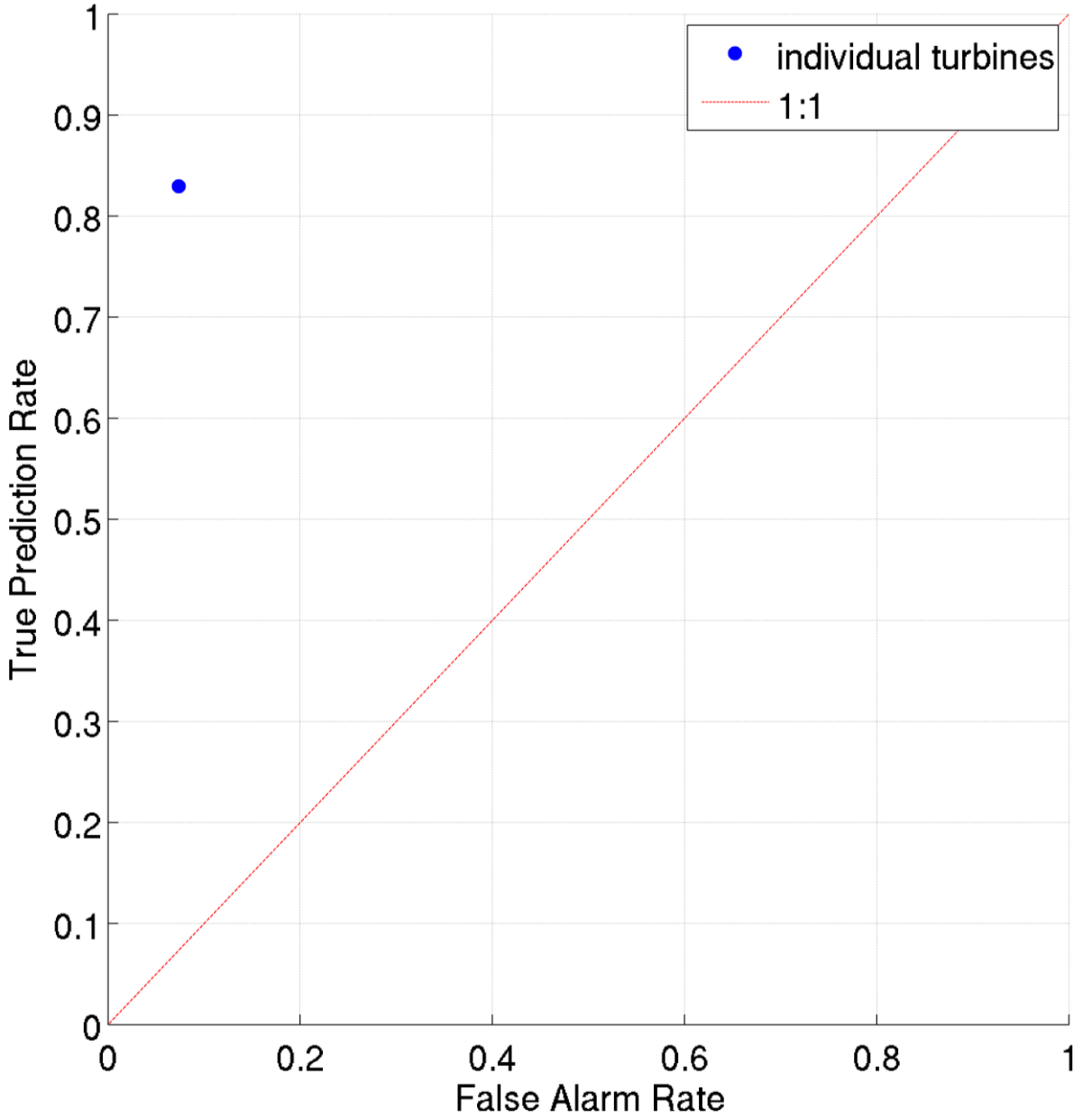
- Database developed in the IceLoss 2.0 project funded by Energimyndigheten

		Observation	
		Ice	No ice
Model	Ice	a	b
	No ice	c	d

- True prediction rate: a/(a+c)
- False alarm rate: b/(b+d)

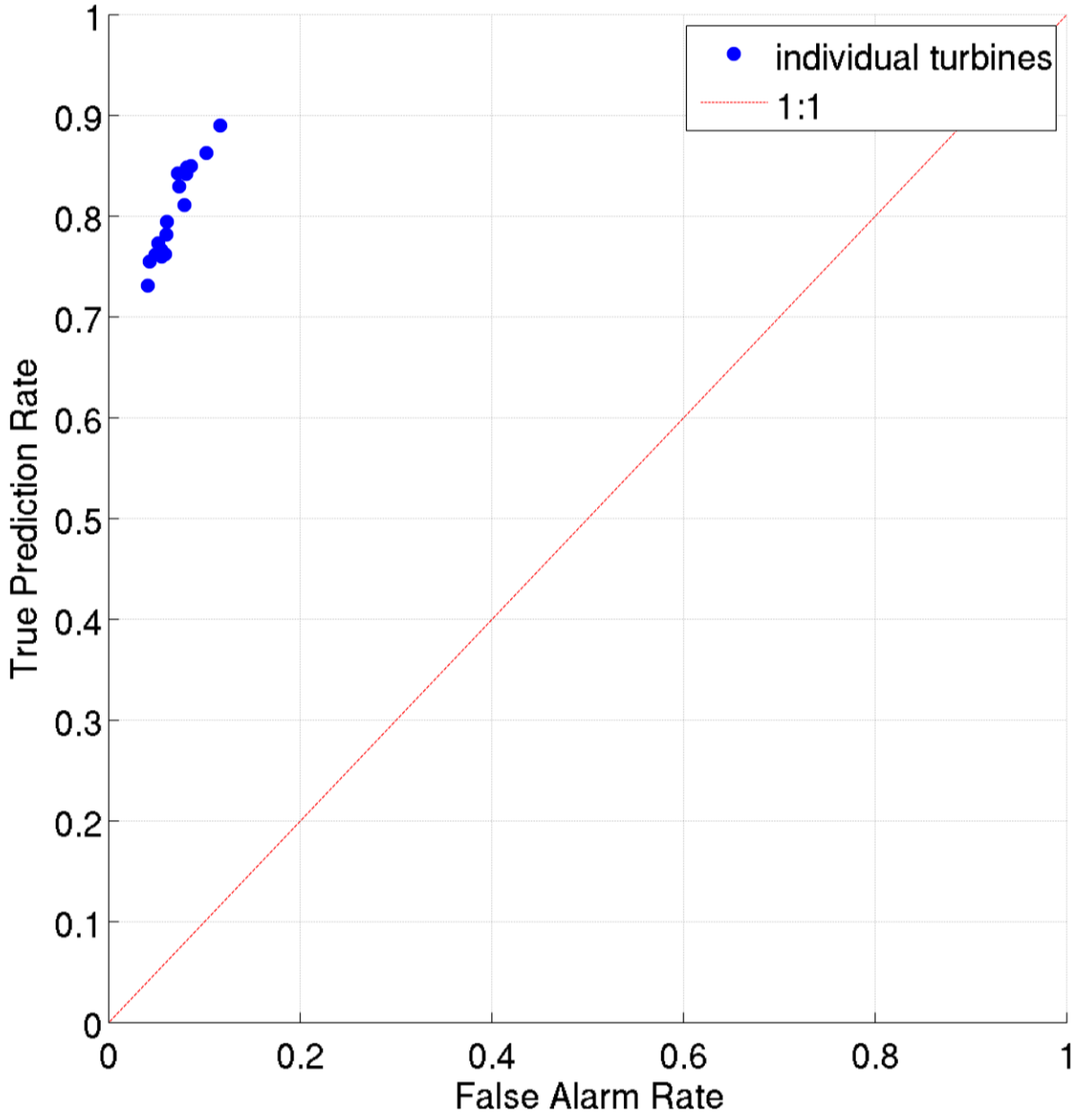
Validation of icing forecasts

- One wind turbine is used to predict icing at the other turbines in the wind farm
- Icing periods are estimated from SCADA by deviations from the power curve



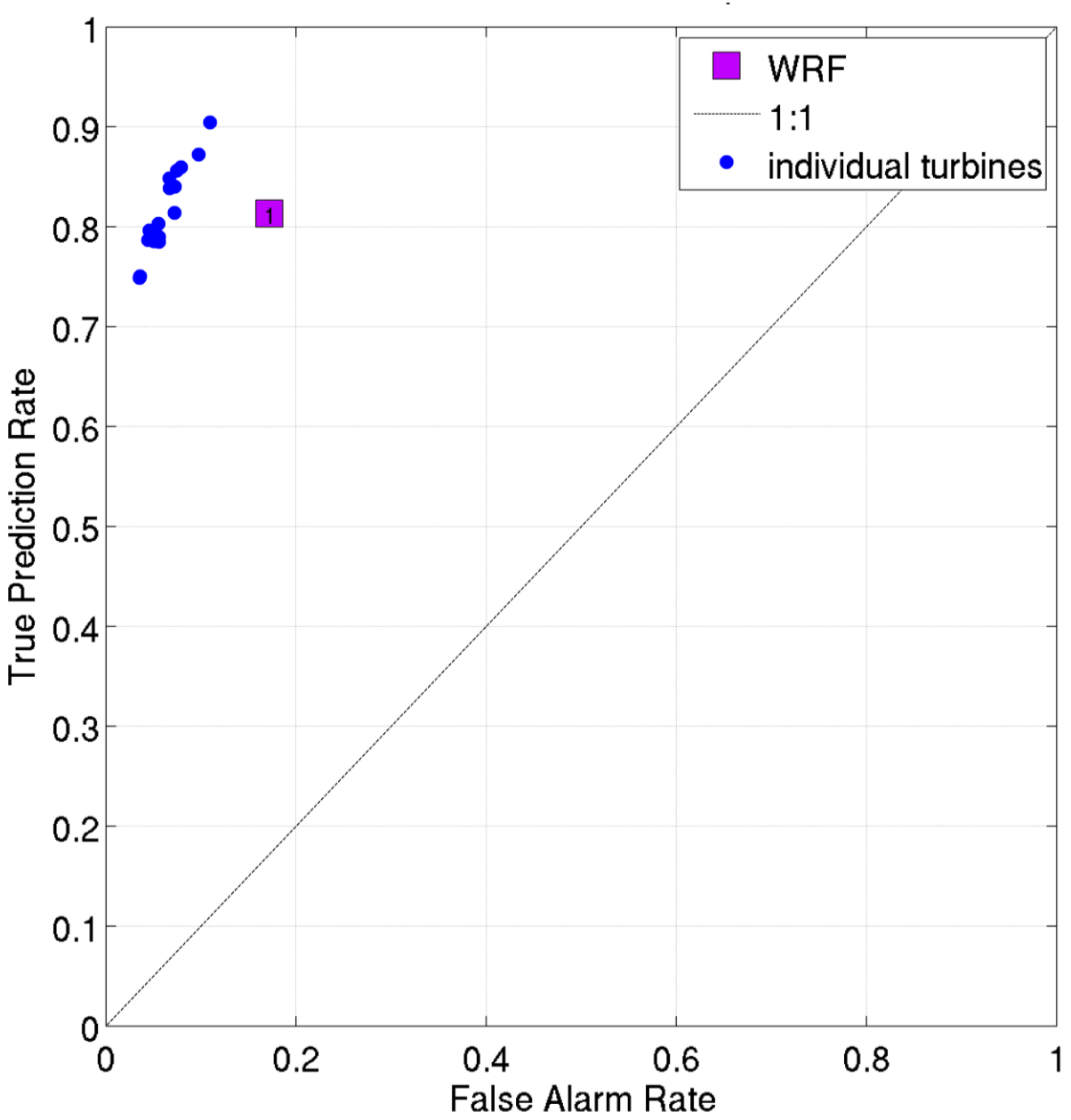
Validation of icing forecasts

- All turbines in the wind farm is used to predict icing for the other turbines.
- Icing periods are estimated from SCADA by deviations from the power curve



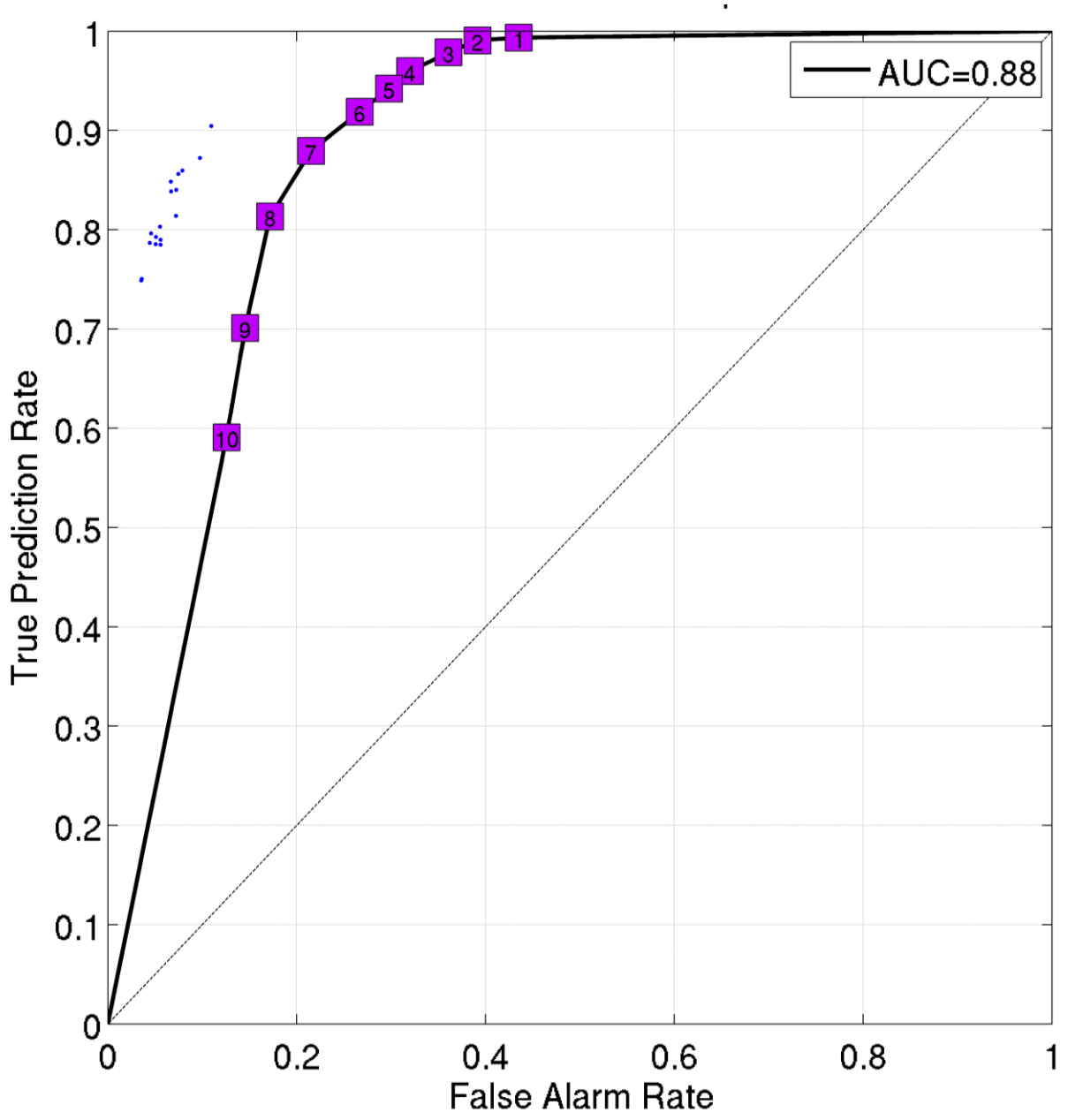
Validation of icing forecasts

- All turbines in the wind farm is used to predict icing for the other turbines.
- Icing periods are estimated from SCADA by deviations from the power curve
- Icing calculation from WRF for the same windfarm



Validation of icing forecasts

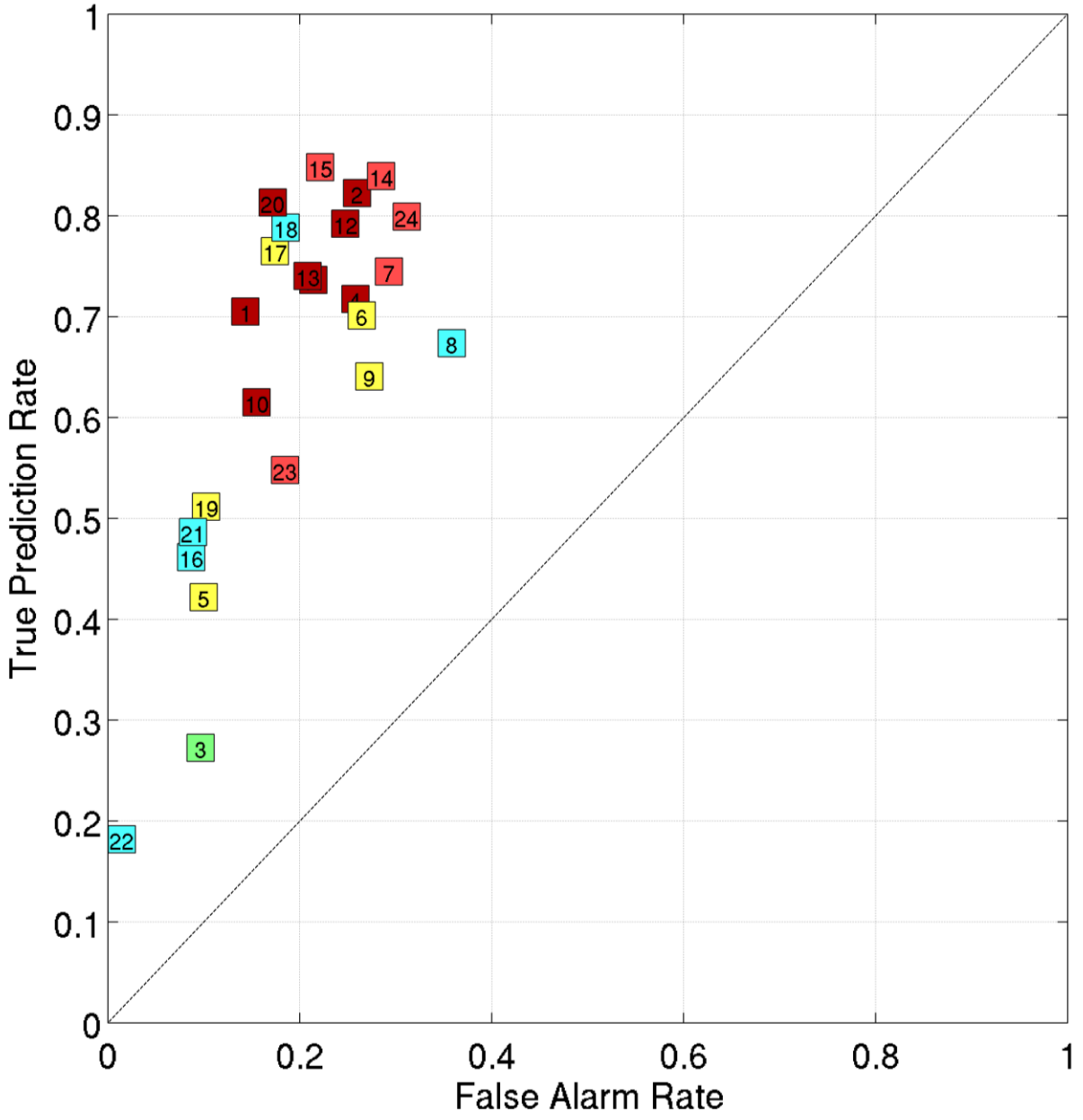
- All turbines in the wind farm is used to predict icing for the other turbines.
- Icing periods are estimated from SCADA by deviations from the power curve
- Icing calculation from WRF for the same windfarm
- Calculation using different sensitivities in the WRF icing model:
  - Change to the amount of icing
  - AUC, Area under curve



Results from 24 windfarms

- Icing calculations from WRF for the 24 windfarms
- The colors denote the IEA Icing class

IEA Ice class	Meteorological icing	Instrumental icing	Icing loss
	% of year	% of year	% of gross annual production
5	>10	>20	> 20
4	5-10	10-30	10-25
3	3-5	6-15	3-12
2	0.5-3	1-9	0.5-5
1	0-0.5	<1.5	0 - 0.5



Summary

- Calculation of icing periods for 24 wind farms are shown.
- Icing is better predicted at sites of higher icing classes.
- The calculations are calibrated toward the specific site to optimize the forecasts depending on the user needs.

New R&D project will develop this further

- Ongoing icing projects have supported the study:
  - IceLoss2.0 funded by Energimyndigheten
  - NoIce4Wind funded by the Norwegian research council

- The work will continue in a new research project funded by the Norwegian research council and industry partners:
  - Wind energy in icing climates

Kjeller Vindteknikk

Owned by: Norconsult

- High expertise within meteorology, measurements and wind energy
- Established 1998
- 32 employees
- Turnover 2018: ~6.5 M EUR
- Offices: Lillestrøm, Stockholm, Espoo
- Main markets: Norway, Sweden and Finland

Wind energy

Power lines

Bridges

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