A Comparison of Three Different Anti- and De-Icing Techniques Based on SCADA-Data

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Aim:

Compare the performance of three anti- and de-icing systems during winter 2014/2015

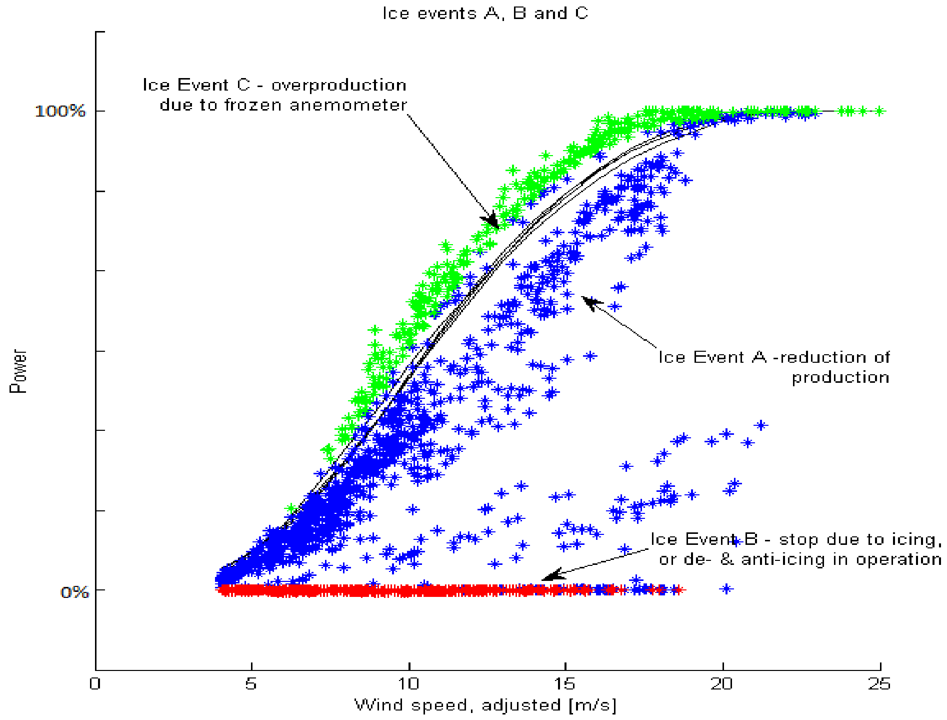
Studied systems:

-De-icing with heating resistances

- De-icing with warm air

- Anti-icing with heating resistances

Identification of ice events according to proposed standard from IEA task 19.



A – Loss in production

Start: 3 measurements: temperature <0 ^{O}C & <P10

Stop: 3 measurement >P10

B – Standstill + De-icing

Start: 3 measurements: temperature <0 ^{O}C, 1 measurement <P10 & 2 measurements standstill

Stop: 3 measurement >P10

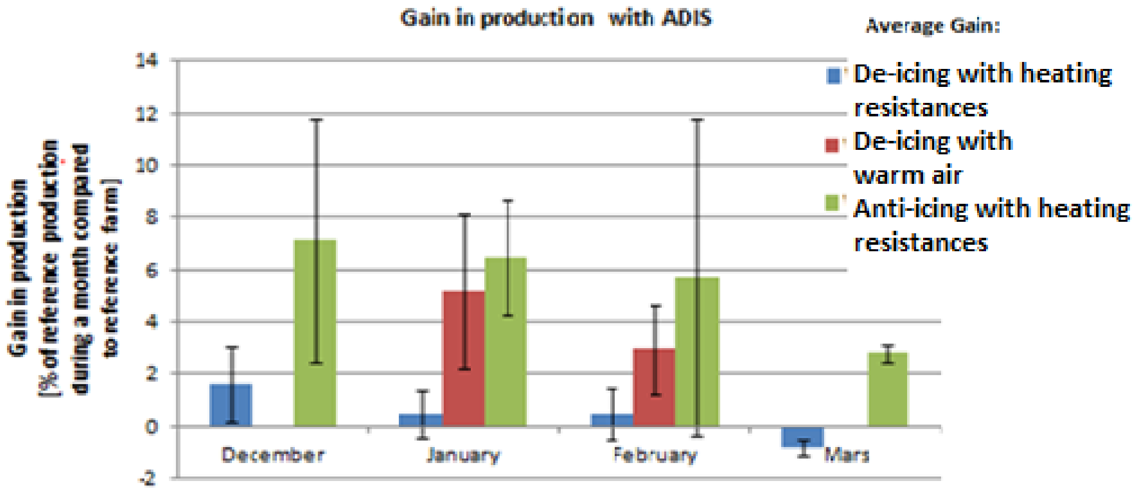
C – Overproduction

Start: 3 measurements: temperature <0 ^{O}C & >P90

Stop: 3 measurement <P90

Gain of the systems

Gain = Losses in reference farm – Losses in evaluated wind farm



Wind farm	1	3	5		1	3	5		1	3	5		1	3	5
Highest gain:	3,1		11,8		1,3	8,1	8,7		1,4	4,6	11,8		-0,5		3,1
Average gain:	1,6		7,1		0,4	5,2	6,5		0,4	2,9	5,7		-0,8		2,8
Lowest gain:	0,1		2,4		-0,5	2,2	4,3		-0,5	1,2	-0,4		-1,1		2,4

All three farms showed tendencies to improve the production. Impossible to quantify/ compare due to large uncertainties, available data.

-De-icing, heating resistances: little losses in reference wind farm

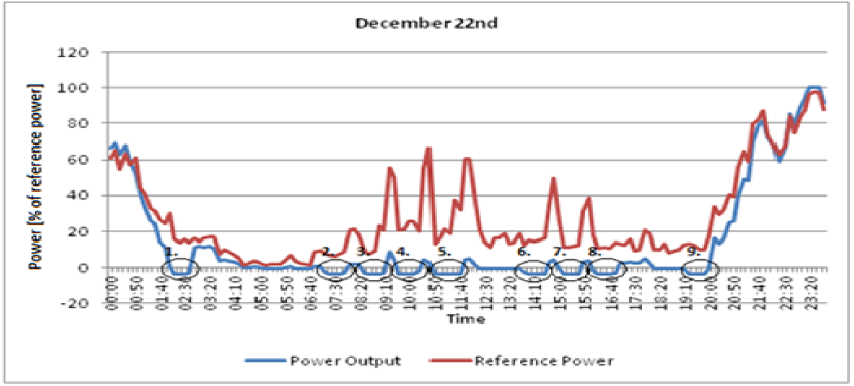
- De icing warm air: test period, few turbines & inconsistent operation

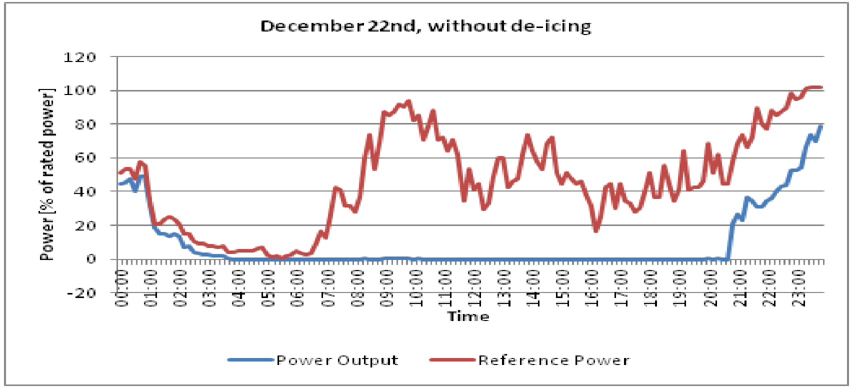
- Anti-icing heating resistances: Lack of information and data

** Energy for operation of the ADIS is not included for de-icing warm air & anti-icing heating resistances*

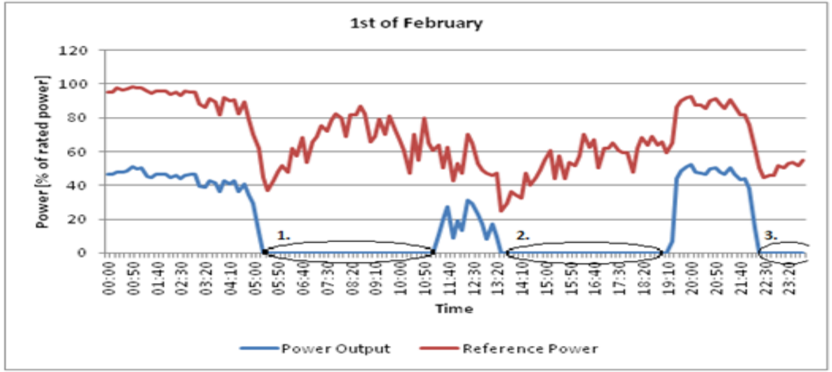
Examples – output during one day

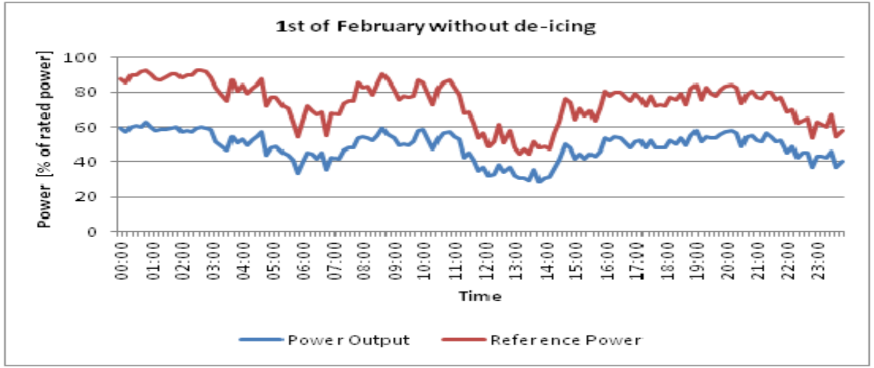
1. De-icing heating resistances 9 starts of the system, duration 40-60 min/cycle, 50 % losses (ref. farm 81 % losses, standstill 16h)





2. De-icing warm air 3 starts of the system, duration 6 h/cycle, 77% losses (ref. farm 34% losses, no stops)





Conclusions and Future work

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Operation of the systems during the studied time period

- All farms were subject to ice and losses due to ice
- All three farms showed tendencies to improve the production.
  (Impossible to quantify/compare due to large uncertainties, available data).
- Especially ***de-icing with heating resistances*** showed improvements during single ice events.
- Indications that ***de-icing with warm air*** was not sufficient. Because of system or test period?
- Too sparse information about the ***anti-icing system*** to make any conclusions
- Possible improvements of the systems regarding control, power etc?

Proposed standard

Strengths: WTG specific power curves
requirement of three following measurements to indicate starts/stops of ice event.

More information needed about smoothing, overlapping ice events and how to handle ADIS.

Future Work

Study longer time period (icing condition + statistical basis) and variation within summer months.

Possible improvements of the systems?