IWAIS2015 16TH INTERNATIONAL WORKSHOP ON ATMOSPHERIC ICING OF STRUCTURES

Comparison of three different anti- and de-icing techniques based on SCADA-data

Sandra Kolar,
Uppsala Universitet/OX2 (52)

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


(Foto:OX2)

Sandra Kolar, UU in cooperation with OX2

Supervisor: Martin Löfstrand, OX2

Subject reader: Anders Goude, UU

Examiner: Petra Jönsson, UU

Aim:

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

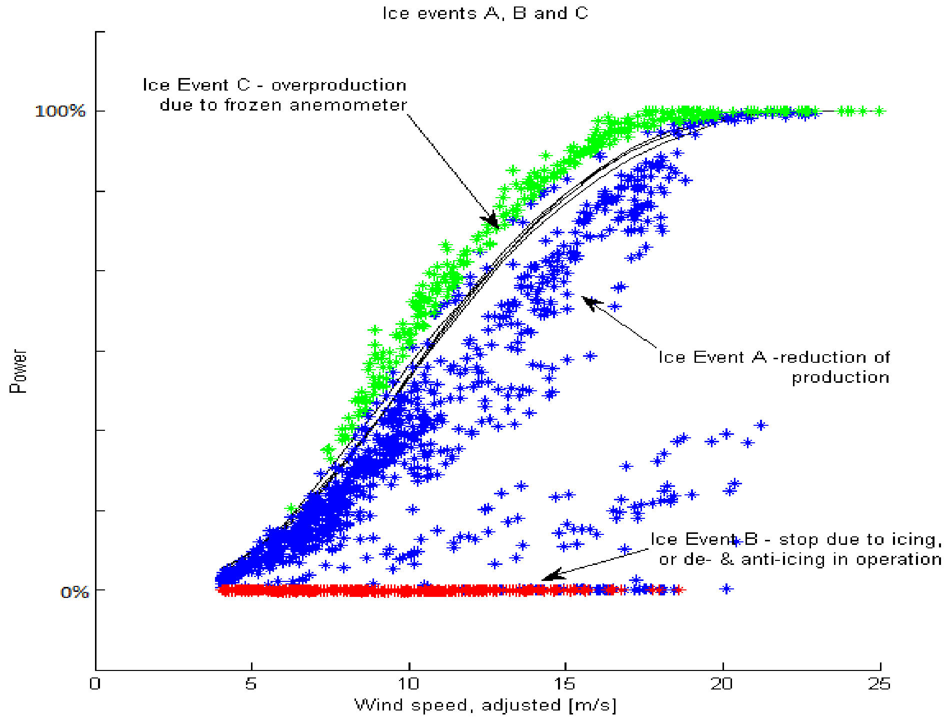
Studied systems:

-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

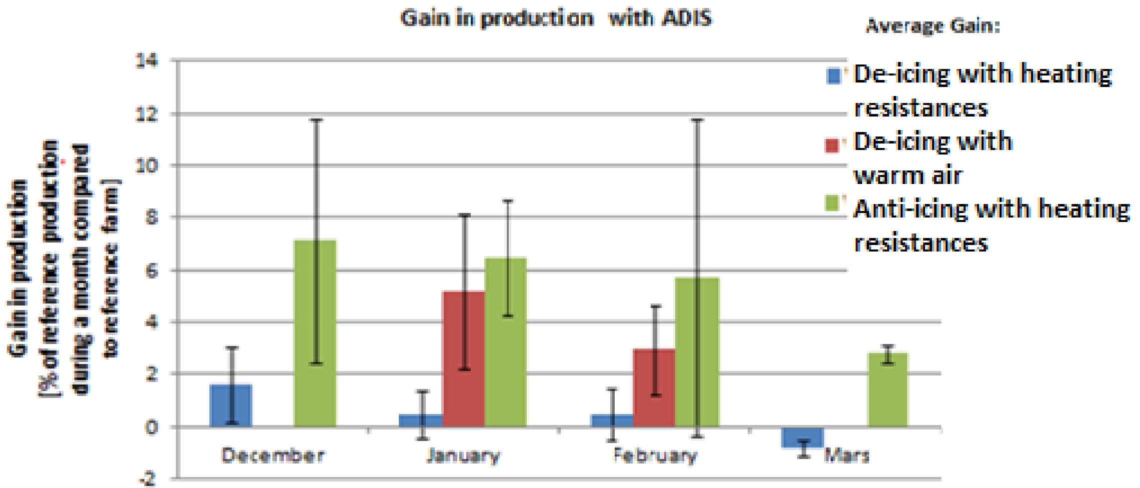
C – Overproduction

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

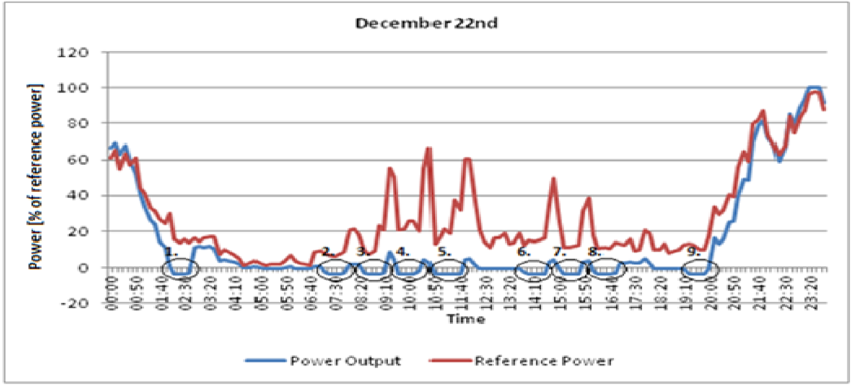
- Anti-icing heating resistances: Lack of information and data

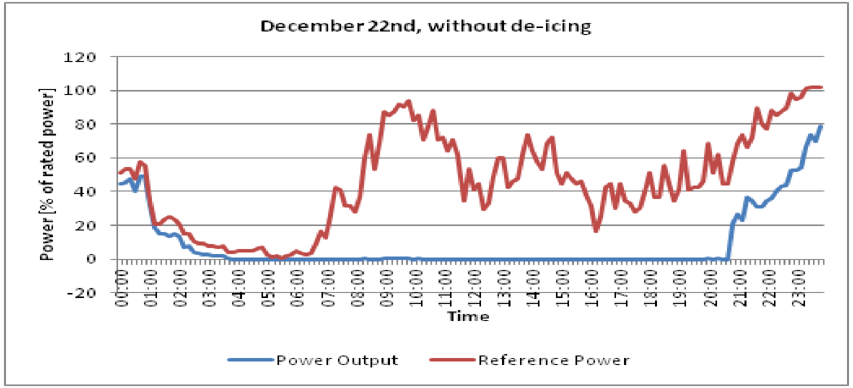
** Energy for operation of the ADIS is not included for de-icing warm air & anti-icing heating resistances*

Examples – output during one day

1. De-icing heating resistances 9 starts of the system, duration 40-60 min/cycle, 50 % losses

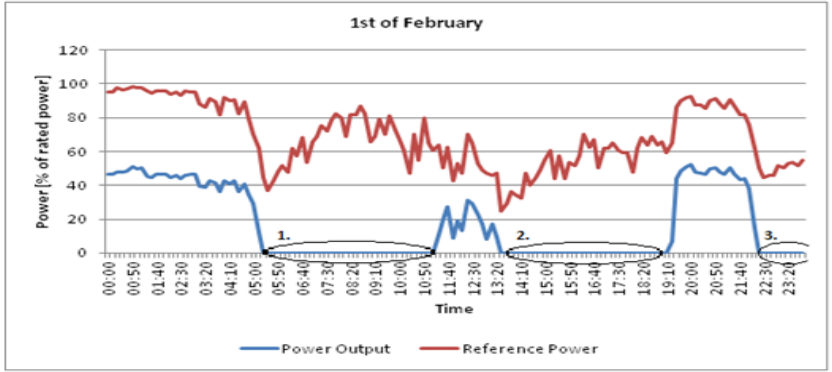
(ref. farm 81 % losses, standstill 16h)

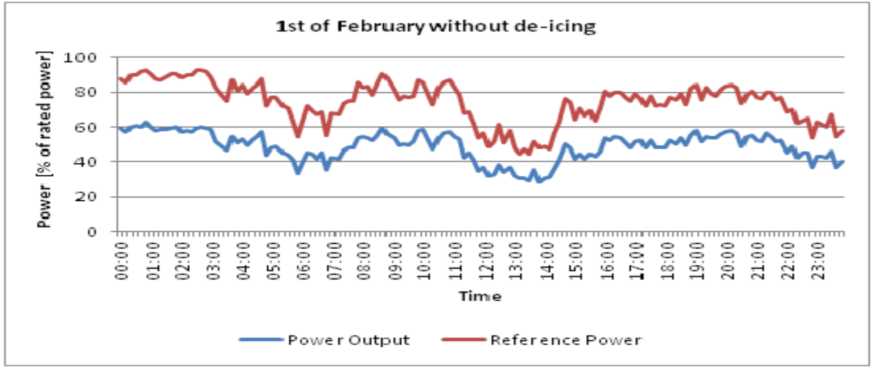




2. De-icing warm air 3 starts of the system, duration 6 h/cycle, 77% losses

(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?

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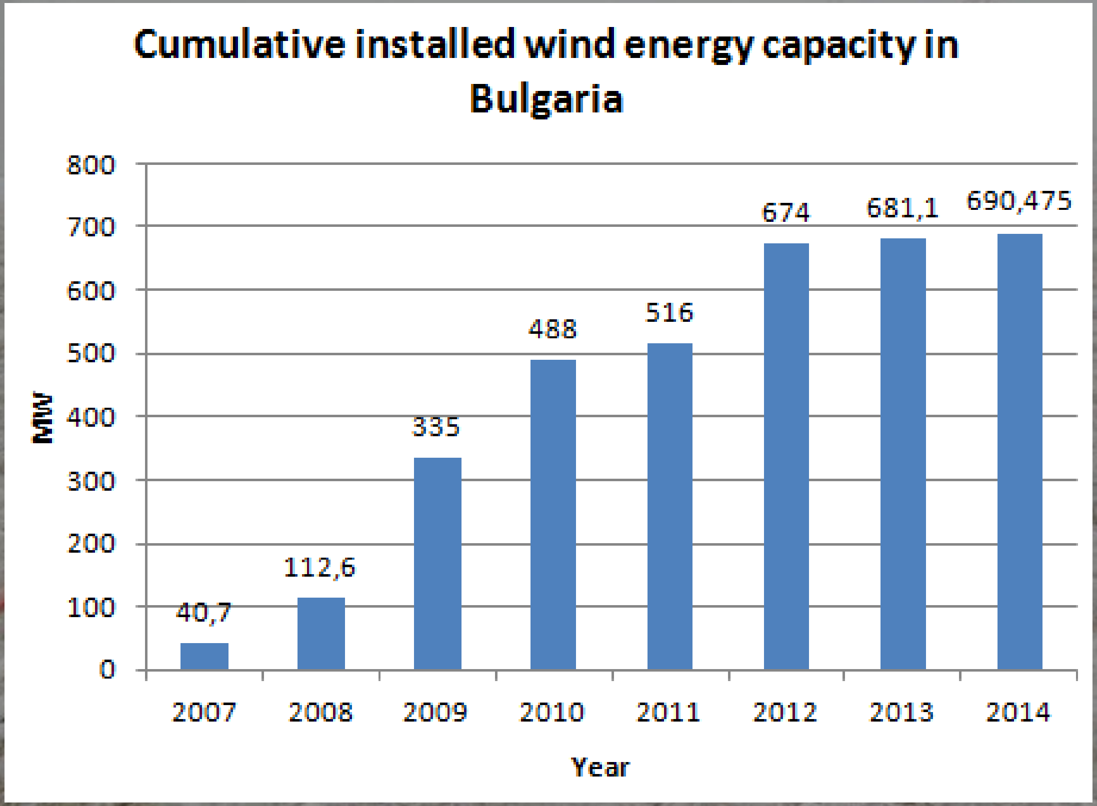
Review of icing related failures of wind masts in Bulgaria

Dimitar Nikolov, National Institute of Meteorology and Hydrology - Bulgarian Academy of Sciences (NIMH-BAS), Bulgaria (42)

REVIEW OF ICING RELATED FAILURES OF WIND MASTS IN BULGARIA

Dimitar Nikolov,
National Institute of Meteorology and Hydrology – Bulgarian Academy of Sciences

- Wind energy in Bulgaria has rapidly developed since 2008 and nowadays the amount of the energy from the installed wind turbines reaches more than 690 MW.



This paper summarizes the registered cases with failures of tall wind masts due to icing in different locations in the country since 2011.

- There have been 10 reported failures for the last 5 winters;
- Reported are only those cases where the equipment is insured – this means that the number of the collapses is higher;
- Three of these 10 cases were in high mountain regions and was caused by rime icing and strong winds;
- The other 7 cases were in plane regions and were caused by wet snow, freezing rains, rime ice as well as by combined processes.

Methods

- Four basic methods for assessment of the deposited ice and snow loads have been used:
  - the model of Makkonen for wet snow accretion (1989) - LM;
  - the model of Kathleen Jones for ice accretion in freezing rain (1996) - KJ;
  - the method of Ahti and Makkonen (1982) for rime icing, which is included in ISO 12494 - AM;
  - the height factor from ISO 12494 for estimation of the ice load at different heights above the terrain.

Comparison of some of the model estimations with the available measurements

- Unfortunately only in two of the cases there are some measurements of the ice depositions.
- The first of these cases is better documented. The case happened on 05-08.02.2012 and was caused by the combined influence of freezing fog and freezing rain.
- For the second case there is only one measurement of the ice thickness available. The process was freezing rain.

Case 1, 05-08.02.2012, NE Bulgaria

Model results for the radius of the deposition for case 1, assuming equal circular deposition, for different heights for the guy ropes (D-0.8cm) and for the main body of the mast (D-5cm); used models - KJ and AM and the height factor from ISO 12494.

Height, m	**Radius, cm** **(D_{gays} = 0.8 см)**	**Radius, cm** **(D_{mast} = 5 см)**
10	1.5	2.3
20	1.8	2.7
50	1.9	3.1
80	**2.2**	**3.7**
100	2.4	4.2

Good agreement of the estimation for height level 80 m with the measurements – see next slide.

Case 1, 05-08.02.2012, NE Bulgaria

- Measurements of the ice depositions – on the guy ropes (left) and on the main body of the mast (right) at height level of about 80 m.

Case 2, 01-02.12.2014, NW Bulgaria

- Type of the icing – glaze;
- Used model – KJ;
- Measured value – about 1.8 cm thickness but not equal distributed;
- Estimated value – 7.0 mm equivalent radial thickness;
- Model underestimates little the measured value in this case.

Conclusions

- This study is only illustrative with the purpose to demonstrate the possibility to use simple approaches for estimation of the ice loads on tall structures at different height above the terrain.
- The model results for the two cases with available measurements show relatively good results.

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The recognition and detection technology of ice-covered insulators under complex environment

Xin-bo Huang, College of Electronics and Information, Xi’an Polytechnic University, Xi’an 710048, P.R.China (10)

The Recognition and Detection Technology of Ice-covered Insulators under Complex Environment

Xinbo Huang, Juqing Li, Ye Zhang,Fei Zhang

College of Electronics and Information, Xi'an Polytechnic University,
Xi'an, 710048, P.R.China
huangxb1975@163.com

Abstract

In order to avoid the impacts of outer factors on the ice-covered insulators recognition, such as weather, seasons, outside illumination changes, acquisition time, image background and image contrast, a general algorithm which can recognize and detect the ice-covered insulator accurately in a complex environment is put forward in this paper. With the video monitoring device, the image information of insulators with or without covered ice can be acquired. The ice-covered insulator images under complex environment are regarded as the research objects.

Abstract

Morphological closing operation is conducted on the ice-covered insulator images firstly. Then the high frequencies in the image are removed by the Wavelet Domain. A kind of invariant background quotient image can be acquired by dividing the processed images and the original images, then after the camera calibration on the quotient images, the edge contours of insulators can be extracted using the wavelet edge detection method, and the icing thickness of insulator can be obtained by using template matching algorithm and geometric model.

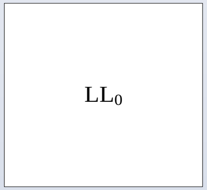
Abstract

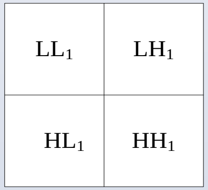
The method is verified in an artificial climate chamber, the results show that this method can eliminate the interference of the complex background weather, accurately identify icing insulators and calculate the insulator icing thickness. This method can be applied to recognition and detection of ice-covered insulators under complex environment.

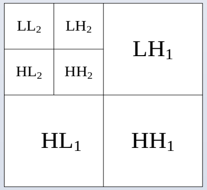
(1a) (1b) (1c)

(1a) Fog day
(1b) Cloudy day
(1c) Sunny day

Figure 1: The original color image

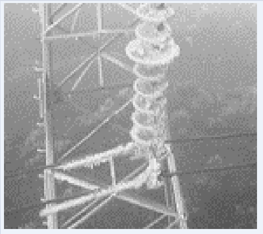


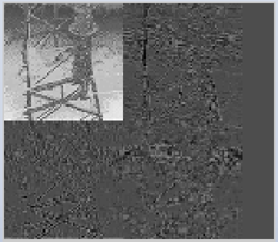


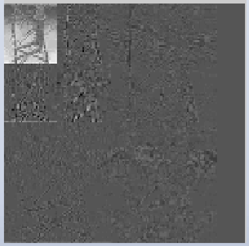


(2a) (2b) (2c)

(2a) Original image
(2b) A decomposition
(2c) Two decomposition







(2d) (2e) (2f)

(2d) Original greyscale image
(2e) A decomposition image
(2f) Two decomposition image

Fig.2: Wavelet transfor decomposition

(3a)

(3b)

(3c)

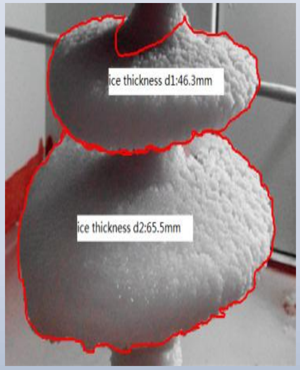
(3a)Fog day quotient image
(3b)Cloudy day quotient image
(3c)Sunny day quotient image

Fig 3: Image processing effects

In indoor condition, by simulating the insulator at a humidity of 80%RH and a temperature of -19.4°F under sunny day.

(4a)

(4b)



(4c)

(4a) No iced insulator
(4b) Iced Insulator
(4c) Ice thickness recognition

Fig.4: Recognition of insulator on sunny day

Thank you for your attention!