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IEA Wind Task 19: Standardization of pre-construction icing loss assessment in upcoming IEC 61400-15 standard

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Outline

- Kjeller and Task 19
- Motivation and background to IEC 61400-15
- Proposal for icing loss uncertainty standardization
- Case examples
- Summary

Task 19 meeting, Feb 2018, Gütsch, CH

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- Science based wind energy consulting
- Established 1998
- 33 employees
- Main office in Lillestrøm close to Oslo
- Other offices: Espoo, Stockholm, Stavanger and Kópavogur
- Main markets: Norway, Sweden and Finland

- Involved in Task 19 since 2001


Wind energy


Power lines


Bridges


Airports

IEA Wind TCP Task 19 – Wind Energy in Cold climates

Mission:

- Improve large scale deployment of cold climate wind power in a safe and economically feasible manner

Method:

- Gathering and disseminating information and research regarding wind energy in cold climates

International collaborative platform

Established under IEA (international energy agency)

Members from 10 Countries

Task Objectives & Expected Results

- Term 2019-2021:

Task 19 topics	Deployment of wind energy in cold climate	Towards standardized practices for cold climate solutions	Safety and acceptance
Motivation	Increase industrial awareness and interest	Bringing cold climate issues in guidelines and standards	Improving safety and removing cold climate specific barriers
Deliverables	Market study update 2020-2025 Fact sheet: icing forecast benefits IPS & retrofit presentation Available Technologies wiki	Finalize work with IEC 61400-15 "Site assessment" T19IceLossMethod: for IPS Performance warranty guidelines for IPS: testing details development Performance evaluation guidelines for ice detection systems Best practices for testing icephobic surfaces Recommended Practices report & fact sheet	Ice throw guidelines: uncertainty and turbine control Iced turbine sound emissions summary presentation
Dissemination	Web site, blogs Email newsletter LinkedIn, Twitter Workshops Free software Presentations at conferences		
Countries	ALL	ALL	AU, SU, CA

Pre-motivation: working with standards

Introduction to IEC 61400-15-2

Framework for assessment and reporting of the wind resource and energy yield

- Working group: +50 world-leading wind resource and energy yield experts from +10 countries (developers, financiers, consultants, OEMs…)
- Kick-off in 2013 (meeting#1 2014), Task 19 joined 2016 (meeting#6), latest meeting#20 in Jan2020
- **Not a "do like this" standard but provides a framework**

  -> unique structure for an IEC standard

- Separate Task 19 task force (Ville L., Mark Zagar/Vestas & Stefan Söderberg/DNVGL) have assisted in current text proposal on icing in addition to Task 19
- Best estimate for draft standard: Q4/2021, publish 2022 ->

Meeting#18, May 2019, @Seattle, US

This will be the most important standard to-date for the entire wind industry.

- Bob Sherwin, Convener, EAPC, US

IEC 61400-15 structure & icing

$$u_c = \frac{std}{mean}$$

- Standard separated to two documents:
  - 15-1: Provide standardized inputs for turbine loads calculations (100 %)
  - 15-2: Develop a standard uncertainty calculation method (60%)
- The 15-2 standard will not:
  - Tell how to perform an energy yield assessment (EYA) but rather how to assess the uncertainty of the chosen EYA method
  - Qualify or disqualify projects
  - Qualify or disqualify consultants/Independent Engineers

Loss	N of Sub-level (20)
Wakes	3
Availability	3
Electrical	2
Turbine Performance	4
Environmental	4
Curtailment	4

Uncertainty	N of Sub-level (26)
Historical Wind Resource	5
Project Evaluation Period Variability	3
Measurement Uncertainty	6
Vertical Extrapolation	3
Horizontal Extrapolation	3
Plant Performance	6

Proposal: Icing loss uncertainty drivers

Loss	Sub
Wakes	
Availability	
Electrical	
Turbine Performance	
Environmental	
Curtailment	

Uncertainty	Sub
Historical Wind Resource	
Project Evaluation Period Variability	
Measurement Uncertainty	
Vertical Extrapolation	
Horizontal Extrapolation	
Plant Performance	

Loss: Environmental	**Uncertainty: Plant Performance**	**IEC unc model & description**	***of loss***	***unc.***
Sub-level: Icing (assume 3.0% of AEP)	a) Quality and accuracy of method to estimate site icing conditions (met or inst icing at HH)	High: T+RH (>96%)	150 %	4.5 %
		Med: a) CBH + T from nearby met station b) valid. WRF model + ISO 12494 c) Validated icing map	80 %	2.4 %
		Low: Task 19 recom: +1yr mast meas.	20 %	0.6 %

Loss ± unc =

3.0 + 4.5 %
3.0 ± 2.4 %
3.0 ± 0.6 %

Proposal: Icing loss uncertainty drivers

Loss	Sub
Wakes	
Availability	
Electrical	
Turbine Performance	
Environmental	
Curtailment	

Uncertainty	Sub
Historical Wind Resource	
Project Evaluation Period Variability	
Measurement Uncertainty	
Vertical Extrapolation	
Horizontal Extrapolation	
Plant Performance	

Loss: Environmental	Uncertainty: Plant Performance	IEC unc model & description	*of loss*	*unc.*
Sub-level: Icing (assume 3.0% of AEP)	b) Long-term adjustment of short-term on-site icing assessment	High: <1yr icing meas./model. & no LTC	150 %	4.5 %
		Med: a) +2yrs onsite measurements b) valid. WRF model + ISO 12494 c) Validated icing map	50 %	1.5 %
		Low a) 5+years of icing measurement on-site b) min 1-year ice meas. & LTC, LT reference: b.1) valid. weather model + ISO 12494 b.2) CBH + T from nearby met station	20 %	0.6 %

Loss ± unc =

3.0 + 4.5 %
3.0 ± 1.5 %
3.0 ± 0.6 %

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Proposal: Icing loss uncertainty drivers

Loss	Sub
Wakes	
Availability	
Electrical	
Turbine Performance	
Environmental	
Curtailment	

Uncertainty	Sub
Historical Wind Resource	
Project Evaluation Period Variability	
Measurement Uncertainty	
Vertical Extrapolation	
Horizontal Extrapolation	
Plant Performance	

Loss: Environmental	Uncertainty: Plant Performance	IEC unc model & description	*of loss*	*unc.*
	c) Knowledge of the turbine/site control strategy	High: a) no IPS and not considered or no knowledge b) IPS with low track record	50 %	1.5 %
		Med: a) no IPS and preli controller specs designed according to IEC-1 ed 4 icing DLC b) IPS with medium track record	30 %	0.9 %
		Low: a) no IPS and full knowledge & SCADA data verifying icing control strategy b) IPS with long track record	10 %	0.3 %

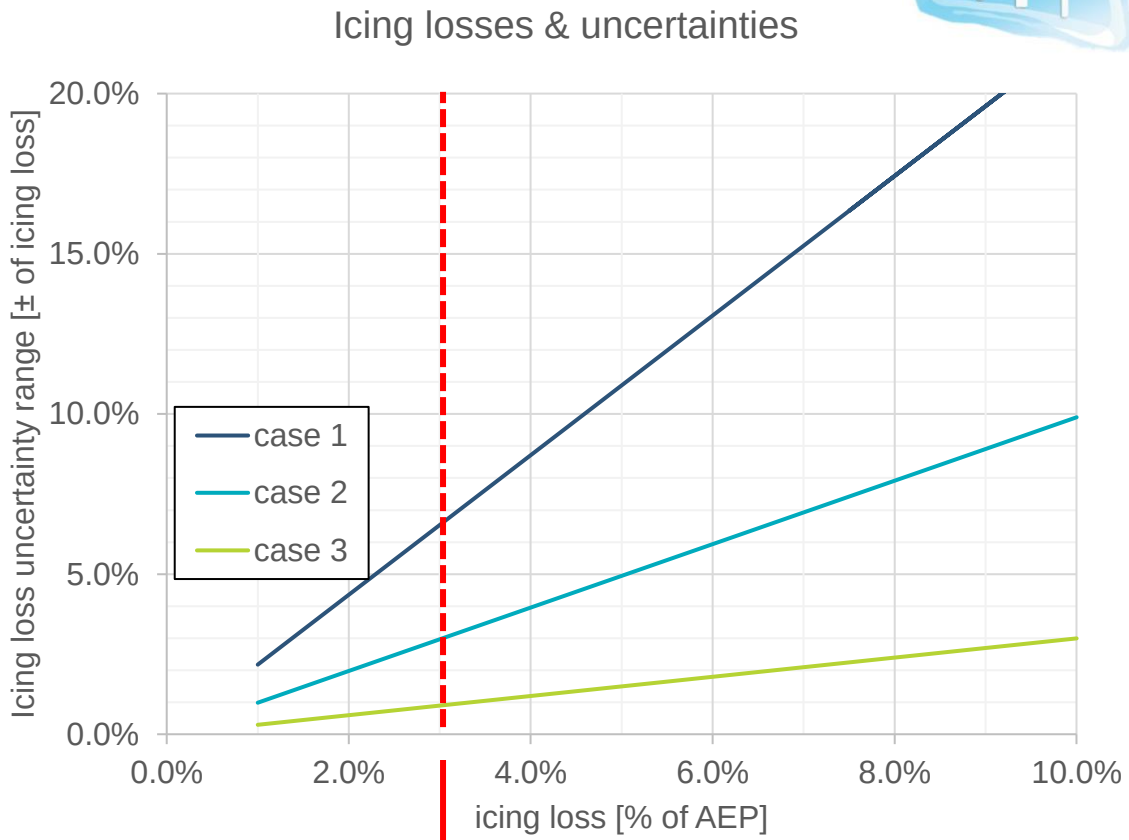
Loss ± unc =

3.0 + 1.5 %
3.0 ± 0.9 %
3.0 ± 0.3 %

AEP = Annual Energy Production
T = Temperature
RH = Relative humidity
CBH = Cloud base height
LTC = Long-term correction
IPS = Ice Protection System
DLC = Design Load Case

3 case examples using IEC uncertainty model

#	Case description	Unc. A	Unc. B	Unc. C
1	T+RH, no long-term correction, no turbine knowledge	High 150 %	High 150 %	High 50 %
2	Regional icing map, valid. IEA ice class uncertainty range, some turbine knowledge	Med 80 %	Med 50 %	Med 30 %
3	T19 best practices: 1yr site ice meas, WRF long-term correction, no IPS but full knowledge about turbine ice control strategy	Low 20 %	Low 20 %	Low 10 %



$$u_c = \sqrt{u_1^2 + u_2^2 + .. + u_n^2}$$

Case 1: 3.0 + 6.5 %
Case 2: 3.0 ± 3.0 %
Case 3: 3.0 ± 0.9 %

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Summary & Conclusions

- Upcoming IEC 61400-15-2 is one of the most important standards for the wind industry
- Upcoming IEC 61400-15-2 is not a “do like this” standard so it is very different from all other IEC standards, but IEC 15-1 standard is “do like this”
- Icing losses are considered, **draft IEC icing loss uncertainty model is very important for markets without extensive icing loss knowhow to focus on essentials and to give a simple IEC model as a tool for the wind industry**
- Other than IEC model uncertainties can be used if scientific evidence & model validation is available

Next steps

- Gather feedback from WinterWind2021 on the draft icing loss uncertainty drivers -> Task 19 & IEC task force to agree on change proposals
- Draft full standard ready in 2021 (optimistic), published in 2022 ->

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Thank you!

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