Report 2023

Task 54

Cold Climate Wind Power

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The goal of Task 54 is to promote the large-scale deployment of wind power in cold and freezing climates.In practice, this means developing tools and collecting industry best practices to reduce the risks involved. These risks can be economical, due to uncertainty or safety risks caused by turbine icing.

The Task aims to create a holistic view of the entire cold climate market to not only understand the issues freezing and cold temperatures cause at the individual turbine level, but also the specific challenges that cold climate conditions pose for wind power operations at the electricity system level. The main approach is to push for further standardisation of methods and tools and to promote proven solutions which will define industry best practices for common problems within the field of cold climate wind.

In 2023, an industry workshop was held to discuss the performance evaluation and validation of blade heating systems, with the goal of finding a reliable, realistic method to validate the performance of such systems. In addition, development of several tools continued which

included a reference implementation of an ice throw simulation tool and a blade heating simulation model. A test campaign in icing wind tunnels was started with the goal of cross-validating icing conditions in participating test facilities. An overview of the impacts of icing on the wider electricity market was prepared and presented at Winterwind 2024.

Introduction

Many cold climate areas are ideal for wind power development, due to abundant wind resources and sparse populations leading to easier siting. Electricity consumption in these areas also increases in wintertime, further solidifying the business case. Cold weather poses specific challenges, mainly due to icing on the turbine blades and other structures. Most cold climate wind sites are located in North and Central Europe and North America, and in some areas in Asia.

Task 54 was established to tackle the problems related to freezing conditions. The goal of the Task is to provide tools and reference methods for the industry to solve cold climate issues and to collect knowledge for industry best practices for wider dissemination. In addition, Task 54 seeks to make production of wind power in cold climates safe, reliable, and profitable. In short, Task 54 aims to reduce cold climate-related risks in the wind industry.

Direct collaboration with the industry is vital to the Task. Industry collaboration occurs either in the form of workshops or as direct, in-kind contributions from the industry toward the deliverables of the Task. Historically, cold climate wind has been notably industry-driven and solution-oriented. New technologies have been introduced to the field reasonably quickly and best practices in the industry are often established based on shared experiences. Due to the solution-oriented nature of cold climate wind, close collaboration with the industry is a prerequisite for successful operation of the Task.

Progress and Achievements

Understanding icing as a phenomenon is integral to solving cold climate-related issues. For wind power in cold climates, this applies especially to in-cloud icing. The key facilities for this kind of research are icing wind tunnels, in which experiments are conducted and will play an important role in the development of sensors, icephobic coatings, and other technologies that mitigate cold climate and icing issues. Additionally, for their importance in basic ice research. Task 54 has organised an effort to create a benchmark for icing wind tunnels to compare results from different locations. The mission is to verify whether different wind tunnels will produce similar results, when icing conditions are known. Performing the same experiment in multiple locations would thus result in similar outcomes. The first round of testing, involving ice growth tests and droplet size measurements, has now been completed. The end goal of these experiments is to increase the repeatability and reliability of icing wind tunnel experiments, and to validate the wind tunnels against one another.

A study was completed which investigated the operations of wind turbines in extreme cold environments, adjustments that would need to be implemented, and how different operational strategies can help increase availability at really low temperatures. However, the results are not yet available to the public. Work also continues to develop methods to quantify icing-related uncertainty during siting pre-construction. These tools

Table 1. Countries participating in Task 54.

COUNTRY	INSTITUTION(S)
Austria	Energieverkstatt Verein
Canada	Nergica
Denmark	DTU Wind and Energy Systems
Finland	VTT
Germany	Frauenhofer IFAM, Mankiewicz, Deutsche Windguard
Switzerland	Meteotest
Norway	Kjeller Vindteknikk
Sweden	WindREN, Vattenfall
Japan	Nedo, Komaihaltec

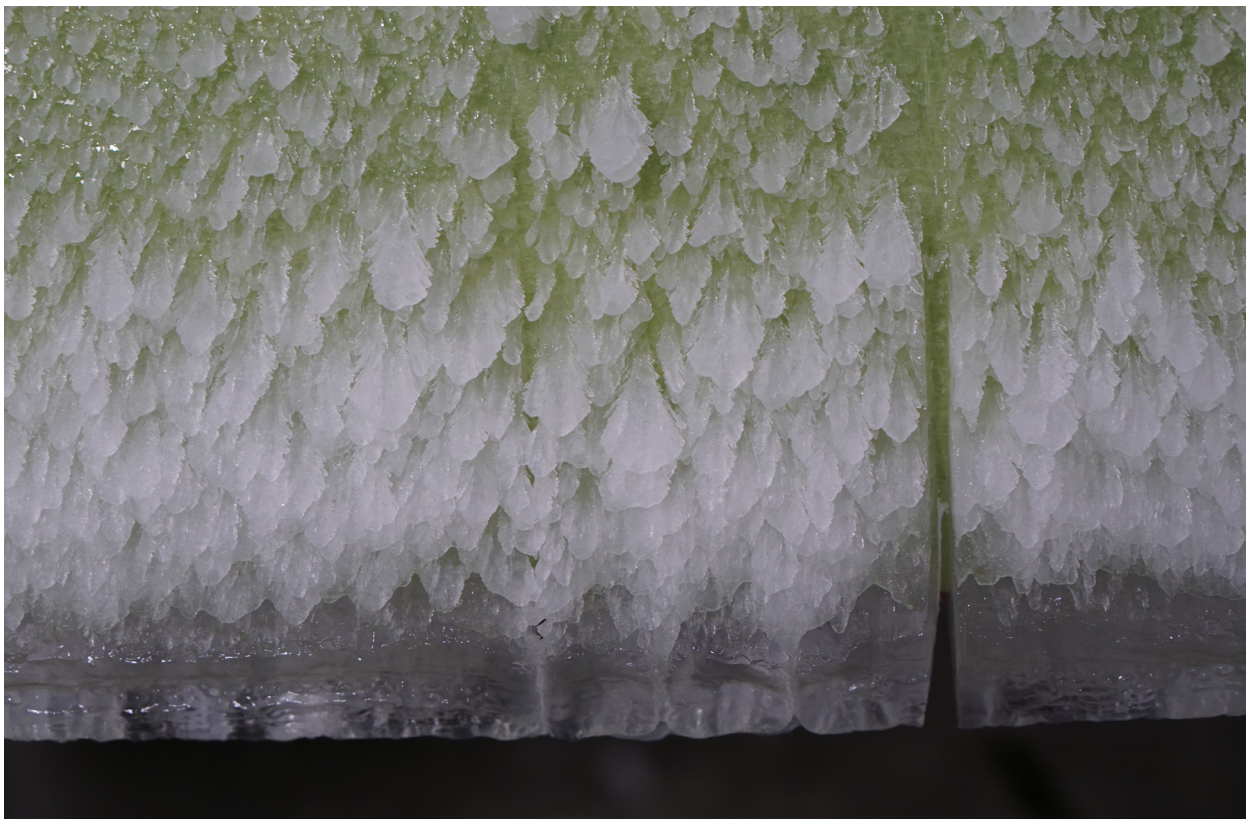

Photo 1: Ice accretion on a blade profile in an icing wind tunnel.

are vital to understanding siting-related uncertainties and reducing the uncertainty of production estimates when planning new projects.

Finally, a collaboration on ice throw has been initiated with the goal of testing different ice throw models for ice throw risk assessment. Ultimately, Task 54 aims to release a reference model for ice throw simulations during 2024.

Highlight(s)

Task 54 has been running an effort to develop methods and tools to better evaluate the performance of blade heating systems. Blade heating is a key technology to counter issues caused by blade icing. Commercial blade heating solutions are available through both third- and first-party options. However, there is a lack of standard terminology and evaluation methods. Task 54 aims to help remedy this.
Task 54 has developed the concept of a performance envelope for a blade heating system to help understand the environmental conditions that govern the performance of heated blades. The Task has furthermore developed a simple model of a heated blade and built a reference software implementation of this model. In addition, a proposed method for evaluating the performance of a blade heating system has been developed in collaboration with the industry.

A highlight of this collaboration are the workshops hosted in conjunction with the Winterwind conference, where around 50 participants from industry and academia were present. During the workshops, industry participants evaluated the feasibility of the proposed solutions and provided valuable feedback on their usability. Additionally, an initiative to collect information on icing events was launched. Task 54 is seeking anonymised data on meteorological icing conditions, preferably in wind power contexts, which could be made available to researchers. This data will be anonymised to the degree requested by the data owner. In the short term, this data will support the further development of methods to evaluate blade heating models and the performance envelope.

Outcomes and Significance

The main goal of all Task 54 activities is to reduce the risks associated with cold climate wind operations. Whether it be the financial risk posed by uncertainty in operations and power production, or the safety risk caused by potential ice throw and ice fall from the turbine structures, Task 54 activities aim to better understand those risks and provide tools to reduce them.

The availability of these tools, as well as data from icing events, will help the industry to be prepared to deal with issues caused by cold climate conditions. Tools developed under the Task 54 umbrella are often used by Task members in their day-to-day work. Promotion of these tools via cold climate wind events,

conferences, and industry workshops remains important to drive the adoption of these solutions to promote best practices in the industry. Growth of wind energy in cold climate areas appears to remain steady in the immediate future. Projects are becoming larger in scale, wind penetration in energy systems is increasing, and projects are moving closer to populated areas or other industries such as factories and ports. Managing cold climate risks is therefore still important to all players in cold climate wind in the future.

Next Steps

During 2024, Task 54 aims to make a reference ice throw simulation tool publicly available, release a reference procedure for blade heating system evaluation, and provide a reference implementation of the model for a heated blade. Additionally, the results of the wind tunnel experiments will become publicly available. The results of the call for contributions on icing data will be released for public availability. During 2024, Task 54 will start work on a roadmap for research needs in cold climate wind.

References

[1] Karlsson, Timo: Icing impacts on electricity grids and markets, Winterwind 2024.
https://windren.se/WW2024/03_3_17_Karlsson_IEA_Wind_Task_54_Icing_impacts_on_electricity_grids_and_markets_Pub_v1.pdf

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