RIME ICE ON A WIND TURBINE BLADE. PICTURE COURTESY OF METEOTEST

TASK 19 REPORT 2020

Wind energy in cold climates

Roughly 20% of onshore wind has been installed in areas where atmospheric icing conditions or low operating temperatures affect the operation of the wind turbines. IEA wind TCP Task 19 was created to address the issues that arise from operating wind farms in cold climate and icing conditions.

TIMO KARLSSON,
VTT, FI

The mission of Task 19 is to *"enable large-scale deployment of cold climate wind power in a safe and economically feasible manner"*. The plan for the current term can be divided into three categories: Deployment of wind energy in cold climates, safety, and acceptance, and moving towards certification practices for cold climate solutions.

The goals of the term are represented by a diverse set of deliverables planned for the term. Focus of the work within the Task is developing guidelines and recommendations for the industry, with the long-term goal of pushing for further standardization of cold climate related technologies.

As a highlight of the year, Task 19 completed a new recommendation for *Performance warranty guidelines for wind turbines in cold climates*. The warranty guidelines document was developed in collaboration with a group of industry partners from all different sectors of the wind power industry: academic research organizations, consultants, turbine owners, and operators and wind turbine and ice prevention system manufacturers. This group of outside industry participants provided valuable feedback to the work developing these guidelines during the development process.

Introduction

Cold climate sites are attractive for wind power development due to several reasons: favorable wind conditions, higher outputs due to increased density in of cold air, availability of potential sites that can be developed onshore in low population areas to reduce social friction and for several Task 19 member nations due to local climates, developing wind power locally means having to deal with cold climate issues in everyday operations. IEA Wind TCP Task 19: *Wind Energy in Cold climates* was started to focus on the unique challenges that arise from low operating temperatures and atmospheric icing that occurs on cold climate sites.

The work of Task 19 is focused on the goal of supporting widespread deployment of wind power in cold climates at a scale in a safe and economically feasible way. The objective of the group is to collect and disseminate information about wind energy in cold climates, including project development, operation, and maintenance (O&M), health, safety, and environment (HSE) and recent research.

The current three-year term of the Task started in 2019 will last until end of 2021. The work during the term will focus on developing best practices for the cold climate wind sector, with a very specific focus on pushing towards standardization of test methods, vocabulary, and ways of working within the sector.

The Task works with different stakeholders in the wind industry: owners/operators, developers, turbine, and component manufacturers and consultants. Especially when developing guidelines and best practices, participation from industrial partners outside of the core of the Task has been very valuable.

Progress and achievements

At the Winterwind Conference 2021, several deliverables of this term were presented. Task 19 completed a review of the cold climate market size. [1] The aim of the study was to evaluate the size of the cold climate market as a fraction of the global wind power market. The method used in the study divided cold climate wind power into two subcategories: icing climate and low temperature sites. Low temperature here meaning sites where annual average temperature is below 0°C and minimum temperatures routinely drop below -20°C. Icing climate was defined as sites that experience meteorological icing at least 0.5% (44 hours) annually.

Within these definitions, the size of the onshore cold climate installation base today is estimated to be 156 GW globally. 119 GW of this is in icing climates, and 74 GW is in low-temperature climates. Some sites are classified in both categories. As a rule of thumb, icing is more common in Europe and North America, and most cold climate sites in Asia are in areas where icing is less common.

The study estimates that the growth of cold climate wind would continue during the next five years at an approximately 13 GW/year. Resulting in cold climate installation base of 224 GW in 2025 (Figure 1).

As a result of collaboration with Task 39, a preliminary study on the potential impact of blade icing on aerodynamic noise was presented at the Winterwind

TABLE 1. COUNTRIES PARTICIPATING IN TASK

Table 1. Task 19 Participants in 2020

	Country/Sponsor	Institution(s)
1	Austria	Energieverkstatt Verein
2	Canada	Nergica
3	China	China Aerodynamic Research and Development Center (CARDC)
4	Denmark	DTU Wind Energy
5	Finland	VTT (OA)
6	Germany	Frauenhofer IEE, Fraunhofer IFAM
7	Norway	Kjeller Vindteknikk
8	Sweden	WindRen, Vattenfall
9	Switzerland	Meteotest
10	UK	DNV

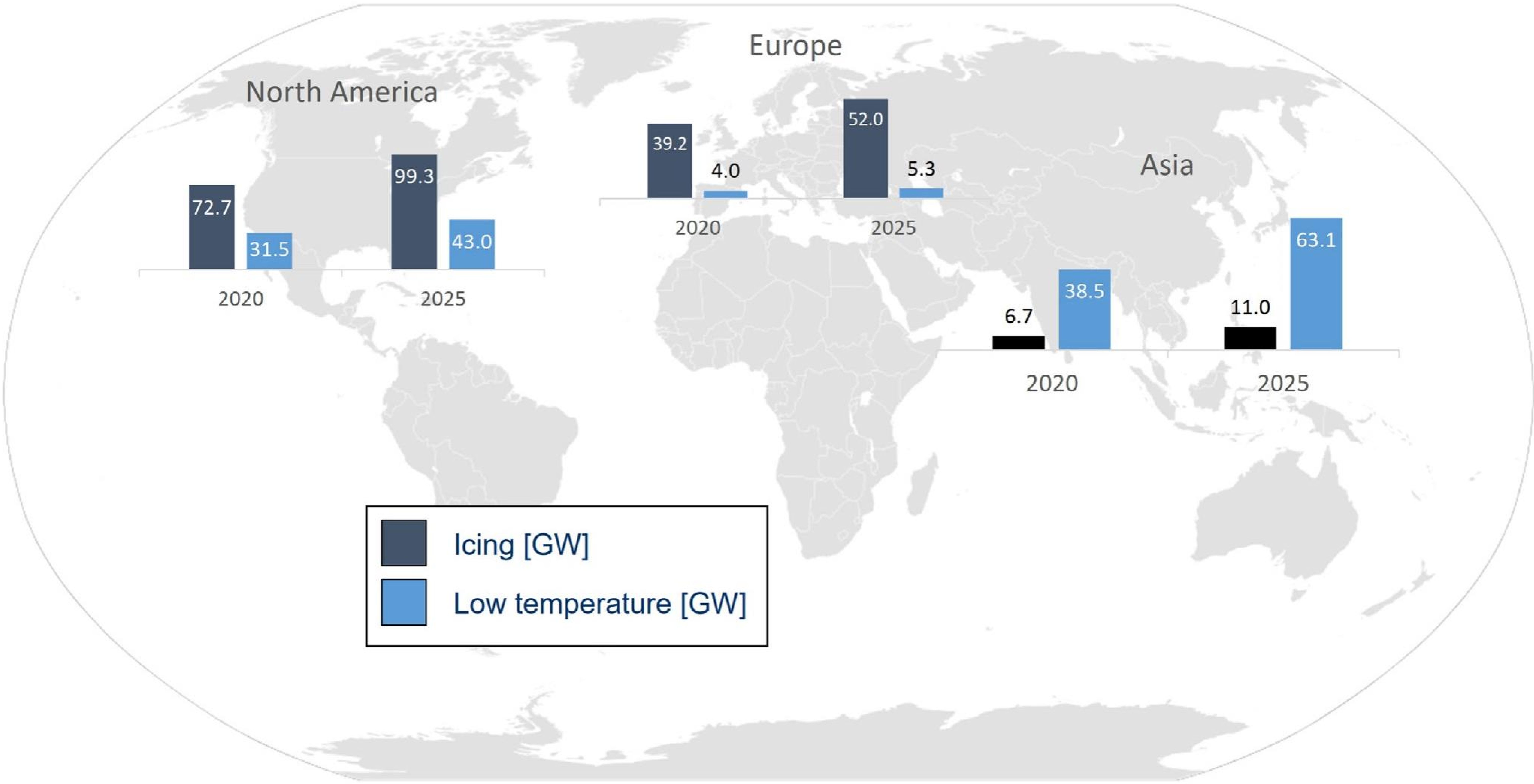

FIGURE 1: CAPTION: ESTIMATED SIZE OF THE COLD CLIMATE WIND INSTALLATION BASE IN 2020 (ACTUAL) AND IN 2025 (FORECAST) IN GW. CREDIT: IEA WIND TCP TASK 19.

Conference 2021.[2] The results of the study indicate that there can be a detectable increase in aerodynamic noise as result of leading-edge icing. The impact of icing can be large enough that it can be distinguished by human hearing. Hopefully, these preliminary results will lead to further collaboration between the Tasks on this topic.

Work continues in development performance evaluation guidelines for ice detection systems with the goal of being able to define methods to assess the accuracy and reliability of wind turbine ice detection systems and developing guidelines for testing of icephobic coatings. The guidelines of assessing the risk imposed by ice fall and ice throw for wind turbines will be updated as well during 2021.

Both the development of the icephobic coating test methods and the update of the ice risk assessment include a significant contribution from connected groups outside of Task 19. This industry participation has been a valuable contribution to the work in developing best practices and is also an important for adoption of recommended practices within the industry.

Highlight

Task 19 completed the Performance warranty guidelines for wind turbines in cold climates during 2020.[3] The motivation behind the development of the Performance warranty guidelines is that Task 19 sees wind turbine performance testing as a key driver for developing wind farms in cold climates and for developing necessary technologies for operating wind turbines in cold climates. Another important goal of the project was to develop a common procedure for performance testing that can be used as a backbone for a performance warranty that can apply also in icing conditions.

It is recommended that an ice protection system (IPS) be considered as a part of the turbine in cold climate conditions and if such a system exists it should also be considered to be part of the turbine when evaluating turbine performance. The recommendation in the guidelines is to consider the performance of the turbine as a whole and not just look at functionality of different subsystems.

The most important part of the turbine performance warranty is to define a test method, with a clear performance criteria within the operational envelope of the IPS. The IPS operational envelope refers to the atmospheric conditions in which the IPS can successfully operate.

The guidelines were developed in collaboration with industry stakeholders. First, a workshop was held in early 2020 with 35 participants from all sectors of the cold climate wind industry. The outcome of this workshop was then used to develop the test methods described in the final document. Further, a review group of volunteers from industry stakeholders was consulted during finalization of the guidelines.

Outcomes and significance

The most important goal in the work done by Task 19 revolves around reducing the risks involved in developing wind energy in cold climates. The work on developing guidelines for testing and curating the available technologies and pushing for recommended practices are all related reducing the economic risk in developing sites at cold climates by increasing awareness of the work of issues related to cold climate and the solutions available. The work on ice throw risk evaluation is looking at safety issues caused by wind and a way of promoting a good method for evaluating those risks in a transparent way.

The impact of the work of Task 19 is seen in the industry with a multi-year delay. But the terminology and method introduced by Task 19 have become staples within the cold climate community. One example is the Task 19 ice loss method [4] which since its initial release in 2017 has become a widely used method of estimating icing impacts on wind turbines, and the method described in the tool has become a commonly used method for power performance-based detection of icing events. The Task 19 ice classification is the most commonly used guideline for differentiation of icing condition within sites.

The work in Task 19 has been successful in promoting commonly used terminology and vocabulary within the cold climate wind community and in promoting best practices in solving the unique challenges caused by icing conditions and low temperatures.

Next steps

2021 is the final year of the current term of Task 19. During this year, the aim is to finalize 5 deliverables. Upcoming deliverables this term are:

- Task 19 guidelines for ice detector use
- Fact sheets on icing forecasts and ice maps
- Recommended practices for testing of icephobic coatings
- Recommended practices for ice throw and ice fall risk calculation
- Update on the recommended practices on wind energy projects in cold climates

In addition to these deliverables Task 19 continues to support the work in updating the IEC 61400-15 standard.

References

[1] Timo Karlsson, IEA Wind Task 19: Climate wind market study 2020-2025, Winterwind Conference 2021,

[2] Timo Karlsson, Franck Bertagnolio, Alexander Meyer Forsting, Icing impact on trailing edge Noise in Wind Turbines, Winterwind Conference 2021

[3]]Helena Wickman, Charles Godreau, Timo Karlsson, and Stefan Söderberg, "Performance Warranty Guidelines for Wind Turbines in Icing Climates," IEA Wind TCP Task 19 Technical Report, 2020.

[4] IEA Wind Task 19. (2019). T19IceLossMethod: Method for estimating icing losses from wind turbine SCADA data. Retrieved November 15, 2019, from https://github.com/IEAWind-Task19/T19IceLossMethod

Task contact

Timo Karlsson, Operating agent
timo.karlsson@vtt.fi
https://community.ieawind.org/task19/home