Photo: Mikko Tiihonen, VTT, 2016.

Cold Climate Wind Power

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Beginning in 2022, the mission of Task 54, Cold Climate Wind Power, is to improve the large-scale deployment of cold-climate wind power in a safe and economically feasible manner.

The Task will centre around standardisation as well as gathering and disseminating information regarding wind energy in cold climates.

The main objectives for the term are to promote a holistic approach to the cold-climate market and expand from the turbine or wind farm level to a system-level view. This aims to make cold-climate wind more secure by reducing the risks and uncertainties involved. Additionally, to further standardise the field of cold-climate wind and to push for unified definitions, methods, and approaches in the cold-climate wind community.

In 2022, the Task was initiated, and work towards its first objectives was kicked off. This includes defining a performance envelope for blade heating systems, the goal of which is to define generic methods of evaluating the performance of blade heating systems and provide computational tools to simulate the operational envelope beforehand. Work has also started in creating a standard test procedure to test the performance of icing wind tunnels.

In October, Tasks 54 (Cold Climate Wind), 52 (Wind Lidar) and 41 (Distributed Wind), hosted a joint workshop in Vienna, Austria. The goal of the workshop was to identify common goals and activities shared by the three Tasks and what kind of collaboration would be possible between them to reach their respective goals.

Introduction

In 2020, IEA Wind Task 19 estimated that there are approximately 150 GW of installed wind capacity in low temperature and icing climates, making cold-climate wind the largest speciality wind market [1]. Most cold-climate installations consist of onshore wind facilities located in North and Central Europe and North America. Task 54 Cold Climate Wind Power was therefore created to provide tools and solutions to tackle the issues that arise from constructing and operating wind turbines in low temperatures and icing climates.

The goal of Task 54 is to make the production of wind power in cold climates safe, reliable, and profitable. The approach to reaching these goals includes gathering industry best practices, disseminating information and research results to the wider cold-climate wind community, and establishing best practices and common tooling and vocabulary for cold-climate solutions.

The Task is executed in close collaboration with industry participants either by seeking industry input to deliverables via workshops or via direct industry contribution towards Task deliverables. The evolution of cold-climate wind has historically been solution-oriented and industry-driven, with relatively quick adaptation of new technologies. Therefore, close collaboration with the industry is key for the Task to achieve the best possible reception for its work.

Progress and Achievements

So far, the progress of the Task is still in its early stages as this was the first year of its term. However, work has been started on several topics outlined in the Task work plan. The most significant progress has been made on items which help define the performance envelope of blade heating systems. Furthermore, a subtask has been formed which consists of a separate working group of Task members as well as representatives of industry and academia. The work plan for this working group has been refined.

Blade heating is a key technology in cold-climate wind to help alleviate the issues caused by atmospheric icing. However, physical limitations to blade heating performance pose a challenge. In certain atmospheric conditions, the heating power required to keep the blades ice-free can exceed the heating power provided by the blade heating system. These conditions are therefore outside of the operational envelope of the blade heating system. It is important to have information on the operational envelope of a blade

Table 1. Task 54 participants.

	COUNTRY	INSTITUTION(S)
1	**Austria**	Energieverkstatt Verein
2	**Canada**	Nergica
3	**Denmark**	DTU Wind and Energy Systems
4	**Finland**	VTT
5	**Germany**	Fraunhofer IFAM Mankiewicz Deutsche Windguard
6	**Switzerland**	Meteotest
7	**Norway**	Kjeller Vindteknikk
8	**Sweden**	WindREN Vattenfall
9	**Japan**	Nedo Komaihaltec

heating system when operating heated turbines, furthermore, when planning a site in cold-climate conditions. Additionally, knowledge of the limitations of operating conditions is relevant to both the site owner and operator as well as the blade heating system provider.

The goal of the work on performance envelopes of blade heating systems is to define generic methods to evaluate the performance of these systems and provide computational tools to simulate the operational envelope beforehand. The first steps in this project are to define terminology, common vocabulary, and metrics that can be used when discussing blade heating system performance. A review of existing literature showed that there is a lack of common methods for evaluating the performance of blade heating, making comparisons of different systems or the results of different studies challenging [2]. Defining performance metrics and vocabulary aims to help alleviate this problem in the future.

Another key cold-climate technology that is still lacking standardisation is the icing wind tunnel. Different technical approaches in construction can result in different icing conditions within the tunnel, making comparisons of test results between different tunnels difficult. A working group was formed from within the Task to design a test program that can be used to create comparable results from different sites. Task members have access to five separate icing wind tunnels. Therefore, the first goal is to perform a small set of experiments in each of them and verify that the results are comparable. Afterwards, the test program can be refined and published. The goal is to have the same set of experiments conducted in a wide variety of icing wind tunnels to help benchmark different sites and to verify that the results are comparable despite different technological solutions in wind tunnel construction and different calibration methods.

Highlight(s)

In October, Tasks 54 (Cold Climate Wind), 52 (Wind Lidar) and 41 (Distributed Wind) hosted a joint workshop in Vienna, Austria. The goal of the workshop was to identify where the three Tasks share common ground, common goals in their work plans and what kind of collaboration would be possible between the three Tasks.

The motivation for the workshop was inspired by the amount of overlap between the Tasks' work plans: Task 52 is working on the issues wind lidar measurements face in cold-climate conditions, including issues related to operation and deployment. There is furthermore a separate topic investigating lidar signals for ice detection that could be further explored. The collaboration between Task 41 and Task 54 is focused on the issues distributed deployments are facing in cold and icing climates. Established, field-tested technologies for cold-climate issues do exist, but most of these solutions are designed and deployed for large utility-scale wind turbines, and distributed deployments are often smaller and sometimes off-grid entirely. Further research is needed to see which of these solutions can be scaled down or otherwise adopted to distributed deployments. Similarly, icing condition assessment and ice throw risk assessment are relatively heavy processes that are feasible when building larger wind farms but are not always practical when planning distributed wind deployments. Hence, a more lightweight alternative is needed for that purpose.

The collaboration is expected to continue until the end of the current term of the Task(s).

Photo #1: Group photo of Task 41, 52 and 54 meetings.

Outcomes and Significance

One of the goals of Task 54 is to create a neutral ground when building community standards for technical problems related to cold climate wind. The work in building reference methods, tooling and defining vocabulary is all aimed towards this goal. A significant objective is to include various stakeholders in the development of Task research and deliverables, including members of the community, owners, operators, consultants, academic researchers, turbine manufacturers and other OEMs. This includes seeking input for reports and other publications, hosting industry workshops and being present at conferences and fairs.

The research field of cold climate wind is growing as new installations continue to be built onshore and, in the near future, offshore in areas affected by cold climates. The vocabulary and the solutions previously provided by IEA Wind TCP Task 19 have been widely adopted among the cold-climate wind community and are part of the standard toolkit for most people and companies working with cold-climate wind. Task 54 aims to continue this path.

Next Steps

The next steps of the Task 54 work plan are, among other topics, to collect information on the impacts that icing can have on electricity markets. Looking back at Winter 2023, this topic is especially relevant in Europe. Fluctuating energy costs, fluctuating balancing costs and the uncertainty in production caused by icing cause problems for many different players in energy markets. Tackling the icing-related uncertainty will also be another large topic to be opened in 2023.

References

[1] Karlsson, T. (2021). IEA Wind Task 19: Cold Climate Wind Market Study 2020-2025. Winterwind Conference 2021.
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