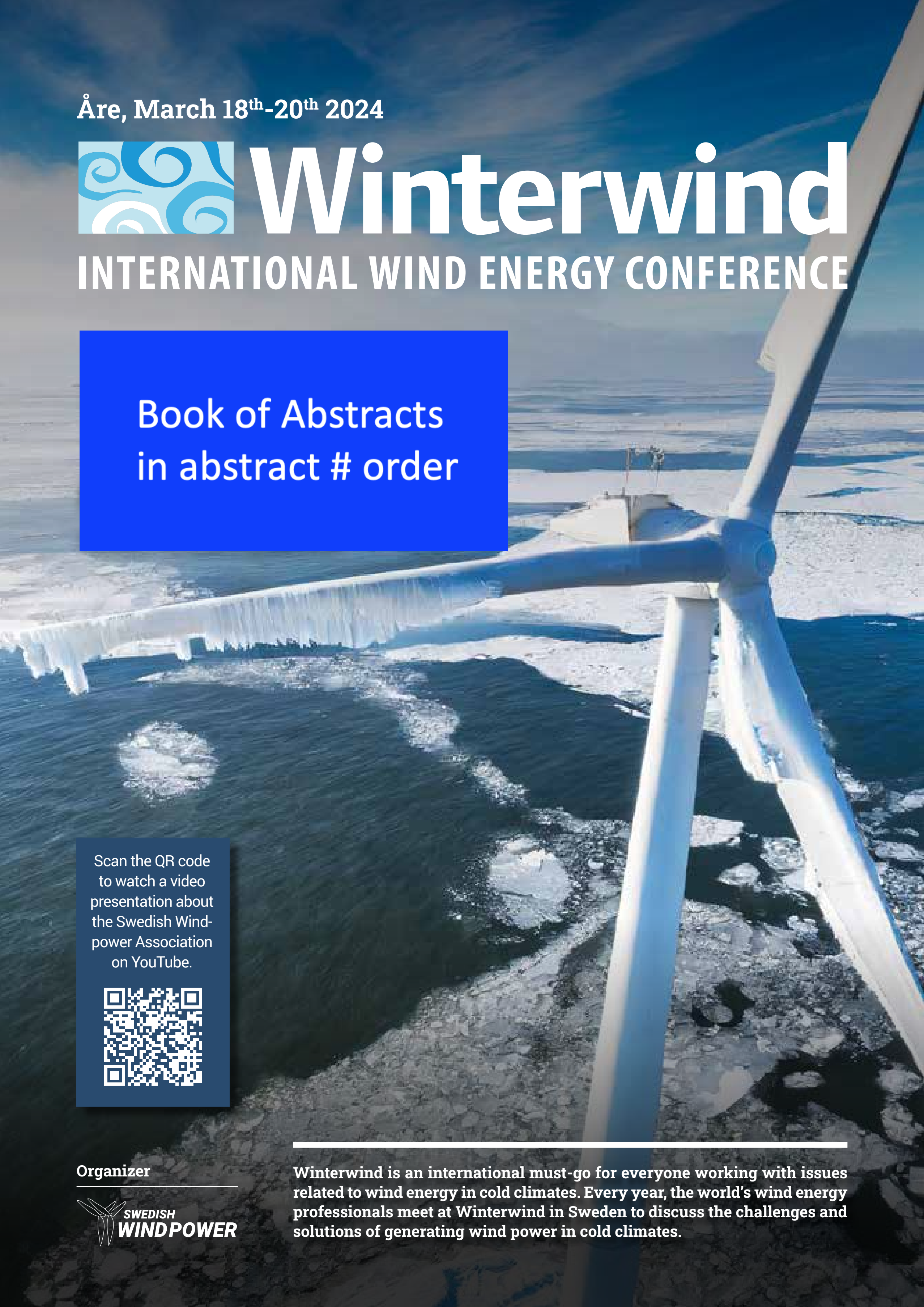

Åre, March 18th-20th 2024

Winterwind

INTERNATIONAL WIND ENERGY CONFERENCE

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Organizer

SWEDISH WINDPOWER

Winterwind is an international must-go for everyone working with issues related to wind energy in cold climates. Every year, the world's wind energy professionals meet at Winterwind in Sweden to discuss the challenges and solutions of generating wind power in cold climates.

R&D areas/s: B) Technology

Data management and real-time algorithm deployment for advancing anti-icing rotor blade heating in wind turbines

Georg Fritze, AIT Austrian Institute of Technology, AT

Georg Fritze (AIT, AT), David Gruber (AIT, AT), Martin Gruber (VERBUND Green Power, AT), Simon Kloiber (VERBUND Green Power, AT), Franziska Gerber (Meteotest, CH), Paul Froidevaux (Meteotest, CH), Michael Sedlmayer (University of Vienna, AT), Radu Bot (University of Vienna, AT),

The adverse effects of icing on wind turbines reduce their efficiency, resulting in significant energy losses and increased balancing power costs. To approach these hurdles, an intelligent, real-time rotor blade heating algorithm to mitigate or prevent icing-related losses is proposed. Specifically, the barriers to real-time implementation and validation of an intelligent blade heating algorithm are presented, as well as several solution approaches and their implications. The presented findings are based on the ongoing research initiative "Smart Operation of Wind Turbines under Icing Conditions" (SOWINDIC) that is funded by the FFG - Austrian Research Promotion Agency.

The aim of SOWINDIC is to develop a real-time algorithm to optimize the control of wind turbine's rotor blade heating system to enable an increased energy yield in cold climate conditions. The novelty of SOWINDIC's approach rests on the utilisation of a multitude of data sources. This involves turbine data, meteorological measurements on-site, data from an ice detection system mounted on the rotor blade, as well as local weather forecasts. Given an algorithm that uses a such a multitude of input data to decide whether activating the rotor blade heating of a wind turbine is smart or not – which is a non-trivial question on its own – several practical aspects must be resolved for deploying the algorithm in real-time. These encompass interfacing with data sources, determining on-site or intermediate server integration, defining execution environment requirements, managing changing data formats from diverse firmware versions, establishing execution triggers, and ensuring seamless data flow between remote sensors, sensor systems of different manufacturers, and centralized databases.

The SOWINDIC approach tackles these questions and takes regulatory restrictions like only a manually and on-site activated blade heating is permitted as well as technical hurdles like a missing turbine interface to trigger the rotor blade heating via a retrofitted algorithm into account. SOWINDIC fosters a custom modular communication framework based on ZeroMQ and MessagePack while utilising software containerisation for hardware independence and enabling the use of a multitude of programming languages at the same time. Additionally, a tailored retransmit strategy for each data source guarantees gap-free data transmission to a remote PostgreSQL data archive. Although not optimal for real-time data availability, this runtime environment executes the algorithms remotely and automatically informs the maintenance personnel on-site if activating the rotor blade heating is effective and energy efficient.

Finally, three wind turbines, each equipped with an ice detection system, are used to illustrate the requirements and challenges of evaluating the real-world optimisation potential of a sophisticated rotor blade heating algorithm in the field.

Web site: https://www.ait.ac.at/

Short biography: Completed a bachelor's degree in Hardware Software Design and a master's degree in Embedded Systems at University of Allied Sciences Upper Austria from 2013 to 2019. Subsequently, engaged in extensive research and development at AIT Austrian Institute of Technology GmbH since 2019, specializing in the domains of control and automation technology. Emphasizing expertise in real-time capable algorithm development and deployment, with a particular focus on optimizing industrial plant performance at the field level.

R&D areas/s: B) Technology, D) Construction, E) Operation, maintenance and forecasting

WORKSHOP: How turbine design may reduce ice fall risks for personnel

John M. Gitmark, Kjeller Vindteknikk/Norconsult, NO

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Many of us are familiar with the risk of ice throw and ice fall from turbines in cold climate, and it is especially critical for personnel working in the wind farms. In a current research project, Kjeller Vindteknikk (Norconsult), together with partners, are looking into design solutions to reduce the risk.

Your input is very valuable, and we are therefore arranging an interesting workshop. By attending, you will gain unique insight into the challenges and needs in the industry, as well as being a part of shaping future solutions!

Everyone is welcome, and the workshop is especially relevant if you are familiar with any one of these topics:

• Turbine design,
• Wind farm operation,
• Turbine service,
• Meteorology,
• Risk of ice,
• Wind farm planning,
• Authority regulation.

The focus on the workshop will be on how different designs can be used to reduce the risk, including turbine design, modifications, add-ons, or other relevant solutions. The goal of the workshop is to obtain ideas that are applicable, practically achievable, and cost-effective. We believe that with a good variety of people with different knowledge and experience, we will have a good platform for result-focused discussions.

The background:
The risk for ice fall is the topic in a research project by Kjeller Vindteknikk together with partners (Statkraft, Zephyr, Fred. Olsen Renewables, Hydro Energi and The Norwegian Meteorological Institute). The main goal of the research project is to develop tools and methods to increase safety related to ice throw and ice fall in wind farms. More details about the research project, SVIV, can be read on Kjeller Vindteknikk's web page (https://www.vindteknikk.com/services/research/sviv/).

This workshop will give valuable input to a work package in the research project regarding design solutions. The final goal of this part is to deliver a report based on research findings in collaborations with participants such as turbine suppliers, wind farm operators and regulatory authorities. The long-term vision is that this work can contribute to safer work environment for wind farm personnel and create focus on ice risk.

Web site: https://www.vindteknikk.com/news/sviv-workshop/

Short biography: John M. Gitmark is an advisor at Kjeller Vindteknikk, Norconsult, where he has been working for about four years. His work is primarily within wind power, with a focus on the risks associated with ice throw and ice fall in wind farms. He has conducted numerous risk mitigation analyses and held several courses for educating personnel in wind farms on how to take precautions and reduce risk.

He holds a Master of Science degree in Mechanical Engineering, with a specialization in energy, process, and fluid flow. His master's thesis was on wind tunnel wake measurements behind wind turbines in yaw. Before joining Kjeller Vindteknikk, he spent three years working on the design and delivery of industrial refrigeration systems for fishing vessels, where he is an inventor of a patented solution.

R&D areas/s: B) Technology, D) Construction, E) Operation, maintenance and forecasting

Outside of work, John enjoys outdoor activities such as hiking, skiing, paddling, and climbing. He also enjoys jigsaw puzzles, and the coolest gadget at home is the self-made automatic tomato plant watering machine.

R&D areas/s: E) Operation, maintenance and forecasting

The economic costs of icing and the potential of icing forecasts

Mona Kurppa, Kjeller Vindteknikk, FI

Jennie Molinder (Kjeller Vindteknikk, SE), Ville Lehtomäki (Kjeller Vindteknikk, FI)

The regulating-power prices and their fluctuations have increased notably in the Nordics within the last few years. Therefore, ice-induced wind energy production losses may have become more expensive for the wind energy producers if they have had to buy the missing production from the imbalance market. Icing-related production losses are expected to further increase in the near future with the technology trend of building bigger wind turbines closer to low level clouds. To reduce the ice-induced economic costs in the wind energy production, operational icing loss models are needed.
We at Kjeller Vindteknikk have developed a physical icing forecast model, IceLossForecast, for day-ahead applications. IceLossForecast calculates the icing on turbine blades and subsequent production losses for each hour for the next 48 hours. The model uses our in-house mesoscale WRF (Weather Research and Forecasting) forecasts as input data. In addition to the deterministic model simulations, IceLossForecast includes ensemble simulations to assess uncertainties and the probability of icing by altering, for instance, the cloud base height and the location of clouds.
To assess the change in the economic costs due to icing, a case study was performed for a wind farm of typical type and size in the western part of Finland. The study showed that the icing related costs have increased within the last 6 years, but also that icing can lead to additional income in case of temporal market disruptions. IceLossForecast managed to reproduce up to 76% of the icing events and using the model output, the costs of icing would have been up to 23% lower

Web site: 0

Short biography: Ms Kurppa works as a Senior Advisor at the science-based consultancy company Kjeller Vindteknikk Oy (Finnish office). After earning her Doctoral degree in Atmospheric Sciences from the University of Helsinki in 2020, she entered the renewable energy field to explore her passion for wind and green energy. Her technical work focuses on wind energy topics such as icing loss evaluations, energy yield assessments and wind measurement analyses.

R&D areas/s: B) Technology

Development platform for the ice design of offshore wind turbines in the Gulf of Bothnia

Maria Tikanmäki, VTT Technical Research Centre of Finland, FI

Maria Tikanmäki, VTT Technical Research Centre of Finland Ltd., Finland

There are many ongoing development projects for large-scale wind farms in the Gulf of Bothnia. Compared to other seas where the wind energy has been harvested for a long time, the Gulf of Bothnia has specific environmental conditions because the sea freezes every year. It is well known from other type of offshore structures in cold climate that the sea ice introduces the major uncertainties in the support structure design. Experience of offshore wind turbines in very limited, but we know that special attention should be given for slender-like structures, because ice-induced vibration may take place. In addition, ice ridges can interact with the structures almost everywhere in the Gulf of Bothnia creating a high load on sub- structures. This presentation introduces an ice load portal, which is a development platform for feasibility studies find a suitable to location of the wind farm and for the preliminary design of support structures. Ice load design portal simplifies and speeds up the preliminary design process for offshore wind farms. The design portal integrates all necessary information (site-specific environmental data, structural design, and environmental loads) into a single tool. This study demonstrates the functionality of the ice load design portal with selected case studies.

Web site: https://www.vttresearch.com/en/ourservices/arctic-marine-technology-and-offshore-wind-power-freezing-sea-areas

Short biography: Dr. Jaakko Heinonen is principal scientist at VTT Technical Research Centre of Finland Ltd. He has more than 20 years' experience of research in Arctic technology. He has led several Arctic research projects. Ice loads due to drifting sea ice on offshore structures is one of his main research topics, especially to understand the challenges caused by ice ridges on support structures. His recent research activities have focused on structural performance of offshore wind turbines in ice-covered sea areas in close collaboration with the industry world-wide.
Dr. Heinonen has a background as mechanical engineer and graduated 2004 as Doctor of Science from Technical University of Helsinki (nowadays Aalto University).

R&D areas/s: B) Technology

Low temperature autonomous calibration of blade-based ice detection systems

Daniel Brenner, Weidmüller Monitoring Systems, DE

Kirsten Larson (Weidmüller Monitoring Systems GmbH, GER)

Vibrational blade-based ice detection systems measure the blades' natural vibration to judge if there is critical ice accretion on the blades. If the measured frequency deviates above a defined threshold value from the expected ice-free frequency, an alarm signal is raised to protect the environment of the turbine from dangerous ice throw.

The value of the ice-free frequency not only depends on the blade type but, due to productional tolerances for example in blade mass and stiffness, it also depends on characteristics of each individual blade.

The existing solution to automatically calibrate the frequencies and, therefore, to compensate for productional tolerances, uses only the data gathered above +5°C because the blades are certain to be free of ice above this temperature.

However, in the case of turbine commissioning during the winter season, there is a potential risk for a delay in the calibration and commissioning of the ice detector.

Therefore, a new method of ice detector calibration based on the comparison between generated power and expected power curve has been developed.

This method has been implemented on several turbines of different turbine types.

The presentation illustrates how the amount of ice influences the generated power and how this information can accurately be used for calibration and commissioning, for example of the Vestas Ice Detector.

The presentation demonstrates the benefits for the owners and operators of the turbine.

Web site: 0

Short biography: As Head of Monitoring at Weidmüller Monitoring System GmbH in Dresden, Germany, Dr. Brenner and his team continuously monitor over 4000 turbine rotors of various manufacturers in different regions and climates.

Dr. Brenner studied electrical engineering in Dresden and worked for BMW in Munich during his diploma thesis. He graduated with a PhD in mechanical engineering from the University of Magdeburg where he studied the lifetime of wind turbine gearboxes. During the last 14 years he has been responsible for the development of condition monitoring methods for wind turbine rotor blades.

R&D areas/s: B) Technology, E) Operation, maintenance and forecasting

Navigating uncertainties in the energy market: ice accretion, wind turbines, bidding strategies, and the quest for perfection

André Bégin-Drolet, Université Laval, CA

André Bégin-Drolet (Université Laval, CAN)

In the ever-evolving landscape of the wind energy sector, questions abound regarding the influence of environmental factors on the efficiency and reliability of wind turbines whether they be equipped or not with ice protection systems. One pressing enigma revolves around the impact and prediction of ice accretion on turbine surfaces in cold cold climate. This presentation delves into a realm of uncertainty, exploring the intricate questions surrounding ice accretion and whether these uncertainties could reshape market bidding strategies within the wind energy sector.
This presentation might raise more questions than providing answers to this complex problem as we embark on a journey of inquiry, seeking to unravel the complexities of ice accretion mechanisms on wind turbines and its associated effects. Can we truly comprehend the intricate interplay of aerodynamics, turbine behaviour, and economic implications when ice takes hold? Field observations set the stage for raising questions, as researchers strive to develop a nuanced understanding of the elusive ways in which atmospheric icing affects turbine performance. Can computational simulations contribute to reducing the uncertainty and providing a competitive advantage in unregulated markets?
Amidst these uncertainties, the economic aspect ventures into uncharted territory. Could there be a silver lining in the unpredictability of ice accretion? Is it feasible to incorporate such enigmatic insights into market bidding strategies? Are fixed power purchase agreements (PPAs) a stalwart shield against the unpredictability of unregulated markets? Who ends up assuming the costs of uncertainty associated with icing in regulated markets? Could wind farm operators gain a competitive edge by adapting their bidding strategies to navigate the frosty challenges? What potential financial benefits await those who dare to optimize turbine performance through alternative operation strategies in icy conditions, especially in unregulated markets? Should energy system operators provide incentives to operators under fixed PPA so that they enhance their production? Should operators request guaranties from turbines OEM for their ice protection systems? Can OEM provide such guaranties and under which conditions? Can we decipher the intricate physics of ice accretion on wind turbine surfaces, considering variables like temperature, humidity, liquid water content, wind speed, and turbine parameters? How does the elusive impact of ice accumulation play out on aerodynamic efficiency and overall energy production of wind turbines? Can we bridge the gap between theoretical models and the unpredictable reality? Can strategic market bidding truly turn ice-related challenges into competitive advantages? In the face of uncertainties surrounding ice accretion, what innovative risk mitigation strategies can be developed?
While contemplating these questions, this presentation will also touch upon the broader aspiration of perfect market integration for the wind energy sector. What would be needed for such integration? Do we need real-time monitoring technologies, advanced predictive modeling, and a comprehensive understanding of market dynamics? Can perfect integration be achieved through a harmonious balance between regulatory frameworks, technological advancements, and adaptive strategies that account for "unpredictable" elements such as icing events? And last but not least, what is the place of artificial intelligence in this context?
This presentation opens the door to a world of inquiry and questions surrounding the impact of ice accretion on wind turbines aim to provoke thoughts, reflections and discussions.

Web site: 0

Short biography: André Bégin-Drolet is a full professor of mechanical engineering at Université Laval in Canada. His research, in the wind energy sector, focuses toward improving wind power production in cold climate where atmospheric icing is prevalent. His research led him to the design of a patented smart sensor, the Meteorological Conditions Monitoring Station (MCMS), adapted to measure meteorological conditions in cold and icy environment. Moreover, he is very interested in developing methods to improve the production of wind energy in icing conditions using this novel instrument. In 2020, he launched the spinoff company Icetek with purpose to help the wind energy in cold climate to improve its performance. Wind is also part of his hobbies as he is an active racing sailor who loves to perform in both inshore and offshore regattas.

R&D areas/s: B) Technology, E) Operation, maintenance and forecasting

Smart control for blade heating systems – physics or machine learning?

Franziska Gerber, Meteotest, CH

Paul Froidevaux (Meteotest AG, CH), Michael Sedlmayer (University of Vienna, AT), Radu Bot (University of Vienna, AT), Martin Gruber (VERBUND Green Power, AT), Simon Kloiber (VERBUND Energy4Business, AT), David Gruber (AIT Austrian Institute of Technology GmbH, AT), Georg Fritze (AIT Austrian Institute of Technology GmbH, AT)

Icing of wind turbines is a challenge for operators, particularly during the winter season when energy demand reaches its peak. Turbines may lose a significant amount of their power, or even have to be stopped, because of blade ice, either for safety reasons or due to operational restrictions, even when wind conditions favor power production.

Therefore, to reduce icing stops and icing losses, blade heating systems are in use. However, these systems cannot prevent or remove icing under all conditions. To control blade heating systems in the most efficient way, i.e. reducing production losses due to blade ice while minimizing heating costs, the timing of heating events should be wisely chosen. Heating costs consist of costs for heating energy and production lost during forced stops during active heating as required by some of the blade heating technologies and local regulatory constraints.

Within the research project “Smart Operation of Wind Turbines under Icing Conditions” (SOWINDIC), a real-time algorithm to optimize the usage of ice protection systems is developed. On one hand, an algorithm on the basis of physical considerations predicts the best heating time based on local weather forecasts and current atmospheric conditions, taking into account the heating efficiency and by predicting the power production over a certain forecasting horizon for different heating scenarios (different timing of active blade heating). On the other hand, a second algorithm is proposed based on machine learning techniques. This algorithm predicts (1) the probability of a forced turbine stop due to icing (i.e. an “ice stop”) occurring in the next 30 minutes and (2) the probability that one heating cycle of active blade heating at the time of icing would be successful. The concepts of the algorithms and some first results will demonstrate the current state of the research, highlight the capabilities of both approaches and discuss current flaws.

Web site: 0

Short biography: Franziska Gerber was always interested in snow and ice, which was part of her work throughout the years. Snow distributions and small-scale wind fields in complex terrain were the topic of her PhD at EPFL Lausanne and the WSL Institute for Snow and Avalanche Research SLF (Davos). She continued her work at SLF Davos on blowing snow over Antarctica as a PostDoc. In April 2021 she joined the wind and ice team at Meteotest AG, where she extended her horizon to icing of wind turbines. When not at work she can be found on skis in winter, hiking or cycling in summer or chasing shuttles on the badminton court throughout the year.

R&D areas/s: B) Technology, E) Operation, maintenance and forecasting

Navigating icy waters: decoding wind turbine success with the ice index

Patrice Roberge, Icetek, CA

Patrice Roberge (Icetek, CA)

Imagine you're steering ships through icy waters. Just counting how many times those ships bump into icebergs does not really tell you how well they're handling the icy challenges. To truly understand their performance, you would need to know the density of icebergs in the area. Operating wind turbines in cold climates is quite similar; merely looking at yearly icing losses won't give you the full story of how well turbines and anti-icing solutions are doing.

This is where the Ice Index comes in, it is a tool defined to paint a clearer picture of how often icing happens on a wind farm. The ice index relies on cloud base height measurements at meteorological stations. This strategy has the advantages of being based on publicly available data and to have been proven helpful to define ice frequency maps. In this case, the measurements are not used to focus on the amount of icing, they are used to illustrate how it changes over time.

Using this methodology, it was possible to define monthly and yearly ice indices that tells whether the period was icier or milder in general compared to the usual weather. The validity of this methodology was verified using the data from six wind farms within 160 km of the meteorological station where the cloud base height was measured. A good agreement was observed between the ice index and the losses observed at those wind farms.

The Ice Index becomes valuable in various scenarios. It serves wind farm operators in performance assessment, helping them evaluate the impact of icing on turbine efficiency and energy production. For grid management, system operators can use the Ice Index to understand and manage potential fluctuations in energy supply due to icing. During the site evaluation phase, wind farm developers can leverage the Ice Index to reference their measurements to assess the suitability of a location for wind turbine installation in cold climates. Finally, in the realm of research and innovation, scientists and engineers can use the Ice Index to advance our understanding of icing phenomena and develop improved ice detection and mitigation technologies.

The Ice Index can be though as a map for ship captains. It doesn't just count how many times ships face ice; it helps captains understand how effective their strategies are at avoiding trouble. Similarly, the Ice Index goes beyond counting yearly icing losses; it tells the tale of how turbines and anti-icing solutions fare the cold climate.

This presentation is based on research made at Université Laval.

Web site: www.icetek.ca

Short biography: Patrice completed his Ph.D. in mechanical engineering at Université Laval under the direction of André Bégin-Drolet. He has been working on the operation of wind turbines in cold climates for nearly 8 years where he had the chance to contribute to the development of an ice detection device. He has authored and co-authored over 15 scientific publications. He is a very inquisitive person that loves to learn and understand the why and the how of the everyday phenomena. He is passionate about skiing, snowshoeing and trekking.

R&D areas/s: E) Operation, maintenance and forecasting

The Costs and Benefits of Blade Heating, Validated with Field Data

Daniela Roeper, BorealisWind, Division of FabricAir, DK

Daniela Roeper (BorealisWind, Division of FabricAir, DK)

Blade heating systems, or ice protections systems, have costs related to maintenance, power consumption and potential turbine downtime, but they also have benefits, such as increased power production, increased safety, and reduced wear/damage to the wind turbine. Using field data that we have collected at BorealisWind over the past 6 years, I would like to present the costs and benefits ice protection systems, to help people assess what the real return on investment will be by installing a system like this, and which wind farms it might make sense for.

Web site: www.borealiswind.com

Short biography: Daniela is a mechanical engineering and entrepreneur from Canada. In 2016 she founded Borealis Wind, a company which developed a retrofit blade heating system which she took from and idea to commercialization. Borealis Wind was acquired by the Danish company, FabricAir, in 2023 and they are now scaling the availability of the technology globally. Daniela is now the VP of the BorealisWind product line at FabricAir.

R&D areas/s: B) Technology

Performance of ice protection systems

Ines Runge, Nordex Energy SE Co. KG, DE

Konrad Sachse (Nordex Energy SE & Co. KG, DE)

The development, production, project planning and service of onshore wind turbines has been the core competence and passion of the Nordex Group with its more than 9,000 employees worldwide for over 35 years. However, our current focus is on turbines in the 3 to 6+ MW class. The Group's comprehensive product portfolio offers individual solutions, both for markets with limited space and for regions with limited grid capacity.

Nordex has a long experience in developing and operating Anti-Icing Systems with different rotor sizes in severe Scandinavian icing conditions. Maximizing reliability and achieving the highest level of maintainability were two of the main development goals for the advanced AIS. However, the key features of the Nordex AIS have remained unchanged: the AIS is fully operational during turbine operation, it provides high energy deposition on the blade surface to minimize ice formation even in severe icing conditions, and turbine availability and production can be significantly increased. In this presentation, I will share some thoughts on evaluating the performance of ice protection systems.

Web site: www.nordex-online.com

Short biography: Ms. Ines Runge works as a Senior Engineer in the Blade Engineering department at Nordex Energy. She has a PhD in mechanical engineering. After starting her career at an automotive supplier, she has been working on the Nordex anti-icing system since 2011. In addition to system design, she is also responsible for prototype evaluation. Ines enjoys long walks with her dog and baking cakes for her family.

R&D areas/s: B) Technology

The challenge of detecting the liquid water content with ceilometer and Wind LiDAR

Sara Koller, Meteotest, CH

Sara Koller (Meteotest, CH)

So far it was only possible to estimate the probability of icing at one or several heights at a met mast before a wind turbine was built. Cameras, heated and unheated anemometers as well as temperature measurements have been used for this purpose. One of the objectives of IEA Task 52: Large-Scale Deployment of Wind LiDAR is the attempt to replace met masts with LiDARs in wind energy applications. Many studies and efforts are being made to solve the problems encountered in LiDAR practice, for example in complex terrain and cold climate. As production losses, increased load, risk of failure and noise emissions, as well as safety issues due to ice throw and fall are challenges for the operation of wind farms in cold climate, ice detection with LiDAR becomes an inevitable task. However, a satisfactory solution for ice detection with LiDAR that works in all different types of cold climate does not yet exist.
First results of a method for detecting icing with LiDAR were not entirely satisfactory. Although all icing periods were detected, they were drastically overestimated. The criteria of temperatures below 0°C and cloud cover, which are measured by the meteorological station and the LiDAR, are not sufficient to reliably identify icing, as the information on the liquid water content of the cloud is missing. In the meantime, a concept for calibrating Wind LiDAR with ceilometer is developed. The ceilometer CL61 by Vaisala is not only capable of profiling the cloud, boundary and aerosol layer but also allows a straightforward identification of liquid and ice clouds, precipitation type and melting layer, and has an improved potential for monitoring aerosols, smoke, dust, and volcanic ash thanks to depolarization ratio profiling. Meteotest has started a collaboration with Vaisala to combine knowledge of icing with laser expertise. The aim is to provide a tool to determine the liquid water content of clouds and thus to detect icing not only at one height, but at the entire rotor plane of a wind turbine.
From December 2023 to the end of March 2024 the ceilometer will be installed at two sites in cold climate in Switzerland. Both sites dispose of a 100m meteorological mast equipped with heated and unheated anemometers, temperature sensors at different heights, a camera filming an unheated anemometer and a Wind LiDAR. A Windcube V2.1 from Vaisala is installed at the first site and a ZX300 from ZX Lidars at the second site. In collaboration with Vaisala and the two LiDAR manufacturers we will analyse the icing events and try to find a way to calibrate the Wind LiDAR. The measurement setup and the first results of the icing detection will be presented at Winterwind 2024.

Web site: www.meteotest.ch

Short biography: Sara Koller holds a Master's degree in Environmental Geosciences from the University of Basel. Since 2009, she has been working in the wind department at Meteotest in Switzerland. In 2020, she became head of the Wind & Ice team. Meteotest represents Switzerland in IEA Tasks 54 and 52, at which Sara is active in the LiDAR in Complex Terrain working group and leads the LiDAR in cold climate working group of Task 52. Wind in all its aspects has been her topic for the last 14 years, although every time she works in the field she regrets that she is not working in the solar energy department. In her second life, Sara is a performance artist.

R&D areas/s: B) Technology, E) Operation, maintenance and forecasting

Maximizing wind energy output: Robotic ice-phobic coating application

Kaspars Litavnieks, Aerones, LV

Janis Klavins (Aerones, LV)

Aerones presentation is about ice phobic application on wind turbine blades. To apply it preventievly and maximize the electricity production time.

Web site: www.aerones.com

Short biography: I have been working in wind industry for 2 years as the senior business development executive. Before that I was more than 8 years in engineering and process automation for different industries.

R&D areas/s: B) Technology

Simplify operation in cold climate

Nils Lesmann, Phoenix Contact, DE

Nils Lesmann (Phoenix Contact, DE)

Different operations, different applications, different use cases need different controllers!
Sure?
Ice detection, structural health monitoring, load sensing and lightning monitoring is already possible on a PLCnext technology PLC from Phoenix Contact.
Those systems are also available as an App from the Phoenix Contact Appstore. But how could this work on my application or operation.
The presentation should show some use cases and examples for using Phoenix Contact Technology including third party software and applications running a more efficient Wind Turbine in cold climates

Web site: https://www.phoenixcontact.com/wind

Short biography: Nils Lesmann is working more than a decade in the wind industry for Phoenix Contact. Starting with the bachelor thesis on surge and lightning protection for small wind turbines getting graduated as application engineer.
After that Nils Lesmann was plattform responsible for the Blade Intelligence System and recently moved to the dark site in sales as Business Development Manager for Wind Power.

R&D areas/s: A) Policy and Market

IEA Wind Task 54: Icing impacts on electricity grids and markets

Timo Karlsson, VTT Technical Research Centre of Finland, FI

Timo Karlsson (VTT Technical Research Centre of Finland, FI)

The electricity system can be seen as a complex system that contains the energy market and its underlying mechanisms but also the transmission grid, all the power plants connected to the grid as well as the electricity consumers.

The role of wind power in the grid is to act as a power producer, electricity consumers as well as electricity traders then rely on availability of wind power to do their business.

Icing at wind turbine level causes production losses due to worsening aerodynamics. The magnitude and duration of these losses are, based on current state of the art, hard to predict. The losses at turbine level will cause a number of issues further up the operation chain of the electricity system.

Icing impacts in the electricity system can be seen at multiple levels: losses at wind turbine will create uncertainty at the wind farm level, for example the uncertainty of production forecasting will increase due to increased incing induced uncertainty at turbine level. Increase in uncertainty at a wind farm will mean that bids to electricity markets might not be accurate resulting in increased uncertainty at the markets, increased balancing requirements and costs. Market operators, who buy or sell electricity rely on accuracy of forecasting to some degree as well.

Increased uncertainty of wind power production means that there is a requirement for balancing power that might need to be scaled as wind power penetration increases. Increased balancing requirements put additional pressure on the market and power plant owners as well.

Icing is usually a regional phenomenon, so large-scale icing events can cause multiple wind farms to experience losses at the same time. These kinds of large, regional icing events can increase the pressure that icing events put on the electricity market. It also means that geographical clustering of the wind power production capacity can increase the system-wide effects of icing.

To reduce these effects the impacts of icing need to be understood better at all levels. Solutions can start from the turbine level as well. If the impact of icing is minimal or at least predictable and icing events are well foretasted, the uncertainty related to available production capacity of wind power during icing events can be reduced significantly.

Technical solutions such as control system modifications and blade heating can be used to make the behavior of wind turbines more predictable during icing events. Improved operational forecasting and icing measurements can be used to prepare for these effects as well.

Icing impacts on different aspects of electricity markets are presented as well as available solutions to reduce icing induced uncertainties. A description of icing impacts at different levels of the electricity system is presented. The solutions discussed are well known tested solutions that can be applied at different levels in the electricity system by market players in their operations.

Web site: https://www.iea-wind.org/task54

Short biography: Timo has a decade of experience in working with cold climate wind power related research and development mostly at VTT. The projects Timo's been working on at VTT have covered a wide variety of topics: icing detection method development, pre-construction icing assessment, ice mitigation and blade heating system development and production data analysis. Currently he's also the head of IEA Wind task 54 "Cold Climate Wind Energy", an international expert group. He has a Master's degree from Aalto university school of electrical engineering.

R&D areas/s: B) Technology

On the importance of control for the performance of ice protection systems and wind turbines

Tomas Wallenius, Wicetec, FI

Markus Heinonen (Wicetec, FI)

Ice protection system performance plays a key role on a wind turbine performance in winter conditions. Especially crucial it is when electricity is sold to power markets during low to medium wind speed periods. Low wind production increases the market price, thus the value of the production on those periods becomes higher than production in high wind periods. Icing of turbines causes additional challenges: if not being able to produce the forecasted and sold wind production, losses can come from high balancing power costs or from not being able to sell electricity while the prices are high and profits could be made. Therefore it is beneficial to equip turbines with efficient ice protection systems.

But often when ice protection system performance is discussed, main focus is on the blade heating power and the operational weather envelope, meaning the conditions where the system could be capable of operate. However, even a powerful blade heating system can be like a too powerful car on an icy road on the hands of a non-rally driver, if the control of turbine with such system is overlooked.

This presentation explains some of the challenges of ice protection system control, focusing on ice detection, correct timing of heating, self consumption, and control effects of wind turbine. Also, the performance evaluation methods of ice protection system equipped wind turbines are discussed; currently widely used method to define icing only based on power curve is likely to cause bias to evaluation. Methods to avoid the bias are presented. The presentation will be supported by practical examples of field data from Canada and Scandinavia from turbines equipped with ice protection systems.

Web site: https://wicetec.com

Short biography: Tomas Wallenius is a co-founder and chief technology officer of Wicetec Oy, a company developing wind turbine blade heating system technology founded 10 years a go, as a spin-off from VTT Technical Research Centre of Finland. Tomas has worked in wind industry more than 15 years, always engaged in wind energy in winter conditions. Prior moving to industry side, he was a senior scientist at VTT and took care of Operating Agent duties of IEA Wind Task 19 - Wind Energy in Cold Climates working group and was a wind turbine power performance analyst as a part of accredited testing laboratory team. Tomas holds a Master's degree in mechanical engineering (major subject applied thermodynamics) from Technical University of Helsinki. Outside work life, and besides family life, he restores his beloved tiny little night fire red classic Mini car.

R&D areas/s: C) Development and financing, EIA

CLIMB - A new standard for valuing biodiversity

Åsa Abel, Ecogain AB, SE

Ruaridh Hägglund, (Ecogain, SE)

CLIMB is a new model for calculating, valuing and compensating for biodiversity. Ecogain has developed the model together with several major players in Swedish industry, with the support of Swedish Mining Innovation.

At a time when six of the nine planetary boundaries are crossed, it is more important than ever to be concrete and to act. By making the tool free and accessible to everyone, CLIMB contributes to informed decisions and a sustainable future.

CLIMB is a tool for Nordic conditions that calculates biodiversity within a geographical area. CLIMB has been developed for such quantification to primarily be applied in case of land use change, i.e. in industries such as energy, material extraction, infrastructure and urban planning. CLIMB is developed to support informed land use decisions in line with EU and global biodiversity targets and new frameworks in finance and accounting.

Web site: https://climb.ecogain.se/

Short biography: Åsa Abel is the head of Ecogain's Nature Intelligence Business Area, she's a visionary who bridges the gap between technology and ecology. Grounded in the UN Sustainable Development Goals, Åsa adopts a holistic view of responsible land use. She has navigated complex strategic landscapes in both the private sector and politically controlled organizations. With a degree in ecology from Linköping University, enriched by studies in business administration and management, Åsa embodies the qualities of a modern, multifaceted leader. Based in Malmö, Skåne, she's a driving force for sustainable change in Sweden and beyond.

Åsa fancy a good cross-country ski-trip, and enjoy camping in snowcovered landscapes.

R&D areas/s: C) Development and financing

Early assessment on wind power projects and reindeer husbandry

Carly Smith, Ecogain AB, SE

Victor Kingstad (Ecogain, SE)

On early stages the importance of soil lichens for reindeer foraging can be assessed from remote sensing. Knowledge on low/high abundance of soil lichens, indicate low or high risk related to part of the local impact. The early assessment is not a complete reindeer husbandry investigation, but give an early signal.

Ecogain has developed a method for soil lichen prediction, where the importance of soil for reindeer foraging can be assessed from remote sensing. Soil lichens are an important resource for the reindeer's winter grazing. Ecogain has developed a model to make a prediction of the conditions for the occurrence of soil lichen based on data on natural geographical conditions.

The method is continuously validated in the field. With the model, we examine a larger area than the project area, in order to capture the land for a winter grazing reindeer group.

A complete reindeer husbandry investigation is carried out in accordance with the wind power industry's handbook for fact-based reindeer husbandry investigations, which Ecogain has produced. It is an adequate basis for an EIA.

Web site: https://svenskvindenergi.org/rapporter/vindkraftsbranschens-handbok-for-faktabaserade-rennaringsutredningar

Short biography: • Carly Smith supports companies in identifying socially and ecologically sustainable business models. She is currently working with energy companies from Sweden, Norway, Finland, Germany, and France on complex land use issues in Northern Sweden. Carly was a driving force in the development of the Swedish Wind Energy Association’s handbook for reindeer husbandry impact assessments. She has previously advised the government in business and sustainability policy, including reviewing the environmental permitting process in Sweden and its competitor countries. Carly is a political scientist and economist with extensive international work experience in the business and sustainability sector.

R&D areas/s: E) Operation, maintenance and forecasting

Intensity estimate - a step further from on/off to how much?

Tiina Kuula, Labkotec, FI

Tiina Kuula (Labkotec, FI)

Labkotec Oy have provided ice detectors for wind industry over 20 years. Recently discussions about health and safety issues as well as wind turbine performance optimization in icing conditions have significantly increased, raising the interest for more advanced utilization of ice measurement data. For many users right-time usage of blade heating is important, however nowadays the users are focused on preventing ice throw, ice warning but as a very first from Labkotec time from now on, utilization of intensity estimate.

Icing intensity, indicating ice mass growth rate, has a significant influence to the area safety and energy production. Intensity estimate gives a more accurate method to analyze phenomena called icing and to have better understanding of weather conditions. Ice detection measurement data provides us more advanced way to evaluate icing event. This is a step further from on/off to how much ice accumulates in the wind power plant. The new, more accurate way to handle icing intensity estimate gives four-steps from light to extreme icing conditions.

One important way to use ice measurement data is to prevent ice fall and ice throw accidents to happen. Area safety and personal safety are increased by informing, but also by warning in real time during icing conditions, warning lights based on the control of Labkotec Ice Detectors or any other as capable ice detection methods. Especially because the number of power plants is strongly increasing and because there are more and more power plants in areas where people go for walks. Using all these three possibilities, ice detection, intensity estimate and ice warning lights we see wind energy safe and more sustainable clean energy player in the society.

Web site: www.labkotec.fi

Short biography: Experienced professional with a strong technical background in international business for more than 20 years. Focused on business development to boost growth, performance, and productivity in a human way for very practical level to strategic top executive level. Chair in Technical Task Force, Finnish Wind Power Association.

In her free time, she enjoys hiking, handcraft, and ice-swimming. Has a license to bake.

R&D areas/s: A) Policy and Market, E) Operation, maintenance and forecasting, Govermental Administration perspective

Co-existence of wind farms and winter navigation – Maritime perspectives on offshore wind energy

(TBC) Emelie Persson Tingström, Swedish Maritime Administration, SE

Emelie Persson Tingström (Swedish Maritime Adminstration, SE), Ulf Siwe (Swedish Maritime Adminstration, SE)

Co-existence of wind farms and winter navigation – Maritime perspectives on offshore wind energy

The national need for increased green energy, and the current political climate, call for a considerable increase in the establishment of off shore wind energy. Shipping also has a desire for greener energy resources, however shipping also sees a potential conflict of interest regarding the use of the maritime domain. This is especially true in areas with winter navigation. The lack of deeper knowledge on how offshore wind parks affect the ice conditions and shipping operations calls for increased studies and extended dialogue in the matter of maritime spatial planning.

The Swedish Maritime Administration and the Finnish Transport and Communications agency are leading the Policy Area on Maritime Safety and Security within the EU Strategy of the Baltic Sea Region. The potential conflicts of co-existing shipping and wind energy have been raised by several countries in the Baltic sea Region.

The Policy Area would like to visit the Winterwind conference, to share the Swedish and Finnish perspective on the needs of shipping and winter navigation in order to co-exist in a safe manner. We would also like to demonstrate the current situation and how traffic in the Bay of Bothnia varies, by showing track of ships from normal and hard winters the past years.

Web site: https://www.eusbsr.eu/pa-safe-about

Short biography: Emelie has a background in Business and Marketing as well as a HR degree from Uppsala University Sweden and National University of Ireland Galway. After 7 years in marketing she transferred to Research and Innovation in the maritime field. For the past 8 years she has been working in and contributing to the creation of national and international research and innovation projects focusing on making the maritime domain safer, more efficient and environmentally friendly.

Emelie is currently working as Policy Area Coordinator of the Policy Area on Maritime Safety and Security within the European Union Strategy for the Baltic Sea Region. Within the Policy Area and its stakeholders the co-existence of offshore wind energy and the needs of shipping has been an area of increased interest.

Ice, snow and water has always been personal interests with hobbies such as synchronized ice skating, skiing and sailing.

R&D areas/s: C) Development and financing

Modelling icing losses in complex terrain – uncertainties and solutions

Marie Cecilie Pedersen, EMD International, DK

Morten Lybech Thøgersen (EMD International, DK)

Wind power production has moved into more complex terrain, and this also applies for wind power in cold climates. The typical models for production loss assessment established over the past one and half decade consists of three steps: 1) a site-specific meteorological model configured for icing, 2) modelling of ice accretion on a standard object or simplified wind turbine blade and 3) translation of modelled icing into a production loss [1]. As stated, the methodology is driven by meteorological models, which are most often run with a horizontal spatial resolution of kilometres. At EMD, the in-house icing model (EMD-WRF OD ICING) [2] is driven by an icing configuration of the Weather Research and Forecasting model (WRF). The horizontal spatial resolution used is 3x3 km2 and a typical production loss assessment for a site would be based on the WRF grid point closest to e.g., a meteorological mast (met mast) or the centre of the site. The WRF grid point holds a certain elevation above sea level and icing will be modelled as a default for fifteen heights in the vertical direction above ground level. Icing maps of e.g., annual energy production losses or meteorological/instrumental icing can be made based on interpolating the modelled icing at the WRF grid point to the elevation of the site area, using a representative elevation map. Specific wind turbines losses can be interpolated similarly. However, for complex sites, one WRF grid point might not be representative for the production loss assessment. This is due to a high elevation difference over the site and because the cloud water content varies a lot over short distances.

In this study we present a methodology for production loss assessment due to icing in complex terrain based on multiple WRF nodes, where we introduce uncertainty maps, ice downscaling profiles and a temperature bias correction. Applications of the methodology are shown by a case-example and comparing previous cases to SCADA losses.

References

[1] M. C. Pedersen, T. Ahsbahs, W. Langreder and M. L. Thøgersen, "On the modelling chain for production loss assessment for wind turbines in cold climates," Cold Regions Science and Technology, vol. 216, p. 103989, 2023.

[2] EMD, "EMD-WRF On-Demand ICING," EMD International A/S, [Online]. Available: https://help.emd.dk/mediawiki/index.php/EMD-WRF_On-Demand_ICING. [Accessed 8 12 2023].

Web site: 0

Short biography: Marie Cecilie Pedersen is a wind energy R&D specialist at EMD International A/S in Denmark. She started working with wind power in cold climates in 2014 during her Industrial PhD. studies. Her competences stretch from micro-scale modelling of icing accretion on structures using Computational Fluid Dynamics (CFD) to preconstruction production loss assessment for wind power in cold climates and ice throw modelling. Marie is passionate about wind power, energy and environment and the “green energy transition”. Marie holds a PhD. (2018) and a M.Sc. in Energy Technology from Aalborg University.

R&D areas/s: C) Development and financing, Hybridization

Wintersolar: Similarities and differences between developing solar and wind power in cold climates

Sigbjørn Grini, Kjeller Vindteknikk, part of Norconsult, NO

Mina Elise Holter (Kjeller Vindteknikk, NO)

We know that winter climates brings both opportunities and challenges for wind energy. As the costs for solar energy are rapidly decreasing and the demand for more clean energy is increasing, solar energy has peaked the interest of energy developers. Here, wind developers have an advantage since there are several lessons learned for developing wind energy in cold climates that can be used for solar energy development. In addition, solar energy can be developed in the wind farm area using the same infrastructure. However, there are also important differences between developing these two technologies, especially related to cold climates.

For instance, while wind turbines face issues with icing, standard solar panels might experience reduced or no energy production due to snow coverage. If snow covers the ground and not the panels, however, it will drastically increase power production by reflecting sunlight, using bifacial solar panels. If this is not accounted for in development and operations, substantial gains in production can be left out.

For wind energy yield (EYA) assessments, a good estimate of the wind resource is key. Mesoscale modelling is used in conjunction with measurements to a assure a bankable EYA. For solar energy the process is similar, but there are some main differences in both cost and uncertainty.

For a hybrid solar and wind power project, sizing and location can be challenging due to grid limitations and ice throw and ice fall from the turbines onto the panels. What are general rules of thumb what are key elements to consider when developing hybrid projects in cold climates?

In this work, we will use our experience with consulting solar power development in cold climates to highlight similarities and differences between developing wind and solar energy such that wind energy professionals know how they can use their knowledge as an advantage to contribute to successful solar energy and hybrid projects.

Web site: www.vindteknikk.com

Short biography: Sigbjørn Grini is a Team Leader at the science-based consultancy department Kjeller Vindteknikk in Norconsult AS being responsible for solar energy and operational services. He holds a master's degree in environmental physics and Renewable Energy specializing in quality control of measurement solar data and a PhD in Solar Energy. Having a profound interest in programming and data, he seeks to apply an extensive use of quality data and processes to enable more successful wind and solar energy projects in cold climates. On his spare time, he is an avid tennis player.

R&D areas/s: E) Operation, maintenance and forecasting

Advanced Predictive Analysis of Icing Events and Power Loss for Wind Parks

Li Bai, ConWX, DK

Li Bai (ConWX, DK)

Icing events in the cold climate areas lead to large power production loss for wind turbines, thus affecting the wind power forecasts and energy trading. Our work presents a comprehensive analysis of icing event forecasts and associated power loss forecasts, employing data-driven machine learning algorithms and engineering methodologies.

Our approach utilises ensemble machine learning methods based on SCADA data regarding individual turbines within a park and numerical weather prediction models. We focus on data modeling from feature engineering, automatic feature selection to optimal robust model selection, empowered by data analysis for imbalanced datasets between icing and non-icing events and skewed distribution for power loss.

Our models have been evolved with different datasets located in different areas along the time. The predictive model for icing events and power loss forecasts, validated against historical data sets, shows a notable increase in accuracy year by year. The current models provide 5% improvement on accuracy for icing event forecasts and 20% improvement for power loss forecasts using normalised root mean squared error (NRMSE) compared to the previous models. The results not only offer vital insights for assets owner of wind park, utility companies and energy grid operators but also contribute to enhancing emergency preparedness and response strategies.

Web site: https://www.linkedin.com/in/li-bai-21834559/

Short biography: With a grounding in renewable energy forecasting and energy market design, my academic path began with a Ph.D. from the University of Pisa in Italy. There, I dedicated myself to understanding the complexities of renewable energy systems and market structures. Following this, I spent 1.5 years at the Technical University of Denmark as a postdoctoral researcher, where I expanded my knowledge into district energy heat forecasting and local market design.

Presently, I am part of the team at ConWX in Copenhagen, where for nearly two years, I have been contributing to renewable energy forecasting and icing forecasts. My role involves applying the insights and skills I have gained over the years to enhance the efficiency and sustainability of energy solutions. Throughout my career, my aim has been to deepen the understanding of renewable energy forecasting and support their thoughtful integration into our markets.

R&D areas/s: B) Technology

Strides in ice mitigation: How NEINICE icephobic coating is evolving

Aaron Dupuis, Phazebreak Coatings, US

Aaron Dupuis (Phazebreak Coatings, US)

The industry standard solution to ice build-up on wind turbine blades is focused on ice removal - heated blades, helicopter-aided spray removal, and risky uptower maintenance operations. Phazebreak believes the best way forward is to change the conversation from removal to prevention.
For this reason, Phazebreak has developed NEINICE icephobic coating for use on wind turbine blades as well as common leading edge protection (LEP) systems. Used in the field since 2018, the patented NEINICE formula has been deployed on over 9,000 blades around the world. NEINICE's phase change material (PCM) formula helps to improve turbine energy output during winter storms and reduces recovery time following such events, while also diminishing the risk of severe ice throw.
Phazebreak has recently reformulated NEINICE, doubling the coating's icephobic capabilities and increasing the activated pot life. In addition, the formula has become more environmentally friendly and compliant to regulatory bodies: a tin catalyst and all PFAs have been removed.=
This presentation focuses on successes we've seen in helping owners and operators improve turbine performance: By reducing ice build-up before removal is necessary, NEINICE also helps lower maintenance costs, protect blade integrity, promote worker safety, and ensure that profitability remains high for owners and operators.
To this end we will present data on the following:
Turbine output data comparing the performance in MWh of coated vs uncoated turbines. (including a case study illustrating actual revenue increase)
Robotic application procedures and efficacy
Real-world data on the lifecycle of the coating and best re-application procedures
Materials from ice adhesion tests demonstrating an increase in efficacy

Web site: phazebreak.com

Short biography: Aaron Dupuis has been with Phazebreak Coatings for 2 years, in which time he has risen to be Director of Marketing. His passion for renewable energies and a green future have driven his interest in state-of-the-art clean power solutions such as NEINICE.

R&D areas/s: C) Development and financing

How does cold climate impact WTG performance aside from icing?

Ben Buxton, K2 Management, SE

Neil Atkinson (K2 Management, GB)

Operational losses due to blade icing are not the only impacts on WTG yield for cold-climate projects.

Cold-climate sites are frequently subject to high shear and low turbulence intensity (TI) conditions, thus WTGs are often operating outside the valid conditions of the power curve. We have observed that this leads to yields below expected levels compared to idealised conditions often used in pre-construction estimates.

There is no clear consensus in the industry how to predict this impact. Since 2017, K2 Management has routinely calculated the impact at every site using a three-dimensional turbine performance matrix based on the parameters of normalised wind speed, rotor wind speed ratio (shear) and TI. This method is fully validated and is populated using WTG production data and wind measurements from wind farms around the globe, encompassing over 70 WTGs, covering a full range of wind flow conditions, WTG types and geometries. Ultimately, it provides an accurate indication of the impact that real-world wind conditions have on turbine performance.

By using wind data measured on site, K2 Management considers the time-varying physical effects of shear and TI patterns on the WTG output to better predict the true yield of the wind farm. We have shown that accounting for site-specific WTG performance moves the estimated P50 closer to the observed yield in operational data. With losses often ranging from 2 to 4% observed in cold-climate sites, the effect of wind conditions in cold climates on real-world WTG performance cannot be overlooked. This approach is vital for accurate pre-construction energy yield assessments that are suitable for bank financing.

Web site: https://www.k2management.com/

Short biography: Ben Buxton has worked in the wind industry since 2010 and holds a master's degree in Engineering. He has worked across diverse markets around the globe in both consulting and project developer roles. At K2 Management, Ben is a Senior Specialist within Analysis Services, undertaking and providing support to the wind farm analysis team and in due diligence. He is moreover responsible for coordinating graduate training across the global team. Driven by an interest in both the details of the data and the big picture of the project, he enjoys using his experience in the technical attention required in wind farm development from analysis to design to contractual matters.

Ben counts food (eating and cooking) as one of his passions and enjoys travelling.

R&D areas/s: E) Operation, maintenance and forecasting

Will we experience less ice induced losses in 2050?

Emilie C. Iversen, Kjeller Vindteknikk, NO

Pyry Pentikäinen (Kjeller Vindteknikk, FI)

Atmospheric icing on wind turbines is dependent on freezing temperatures, moisture in the form of cloud droplets, and wind. With an increasingly warmer world it is intuitive to think that the occurrence of icing on wind turbines will decrease. But with warming also comes more moisture. Melting temperatures and hence ice-free periods will occur more frequently in the future, but when icing conditions occur it may be that the icing is more severe. Future projections of temperature and moisture content are also different between different regions, and the future icing climate depends strongly on crossings of the 0°C isotherm at specific wind farm locations. Hence, it is not given how future icing losses will evolve at the local scale.

Here we show a continuation from last year's presentation, which was focused on extreme values of ice loads (mostly relevant for dimensioning of structures), to present projections of future icing frequency and severity, more relevant for power production losses. The projections are based on two climate models and three future scenarios of greenhouse gas emissions, regionally downscaled over Norway, Sweeden and Finland. The icing projections will be used to make inferences about changes in ice induced production losses in Norway, Sweeden and Finland towards 2050.

Web site: www.vindteknikk.no

Short biography: Emilie is a meteorologist who has worked on the topic of atmospheric icing and meteorological modelling for almost 10 years, through consultancy work at Kjeller Vindteknikk and several large research projects. She completed her Doctoral degree in this field in 2022, which also contained research on climate change impacts on icing. The complex topic of climate change is of specific interest to her, and particularly how it will affect our winter climate in the years to come. This is also of high relevance for her spare time passions, snowboarding and split boarding.

R&D areas/s: B) Technology

Determining heating power and control strategy required to optimize ROI if an IPS

Dylan Baxter, BorealisWind, FabricAir, CA

Dylan Baxter (BorealisWind, FabricAir, CA)

This presentation will review the optimization processes of determining the required heating power for an active IPS. It will look at the sites icing conditions, blade size/composition, and financial returns to maximize the performance of the IPS for the site. It will compare the benefits of increasing the heating capacity and power consumption, or waiting for the severity of the icing event to decrease. It will also look at methods to prevent a net negative power situation for the site, where the heating systems are running but the site is down due to icing.

Web site: www.borealiswind.com

Short biography: Dylan is a mechanical engineer with a background in fluid dynamics and thermodynamics. He is the Director of Technology for the BorealisWind IPS, and is one of the inventors of the technology. He has been involved in the simulation, design, installation, maintenance and monitoring the BorealisWind IPS, and intimately understands the benefits and drawbacks of the technology. Dylan is passionate about wind energy, and improving cold climate wind energy using ice protection systems.

R&D areas/s: E) Operation, maintenance and forecasting

Developments in Standardization: Test Methods for Anti-Icing Properties of Rotor Blade Coatings

Ute Dr. Bergmann, TU Dresden, DE

Ute Bergmann (TU Dresden), Florian Feil (AMETEK Atlas Material Testing Technology), Florian Korinth (DIN Standards Committee NAB), Nadine Rehfeld (Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM), Reinhard Hertrampf (RENOLIT SE)

Rotor blade coatings, especially at the leading edge of the blade, must withstand many environmental stress factors, such as rain, icing, sand, insects, dirt, solar radiation and others. Some of these stress factors become especially critical, due to the movement of the blade with high velocity like the tendency to stick ice. More and more coating and film systems based on different strategies are developed to avoid or minimize icing on these planes and many different individual strategies to characterize their functionality were designed. Unfortunately, these different methods impede a comparability and measurability of the supplied anti icing strategies so far.

ISO/TC 35/SC 9/WG 32 “Coating Materials for Wind-Turbine Rotor Blades” is active in the development and adoption of standards related to testing the properties of rotor-blade coatings. The working group published documents on general test methods for rotor blade coatings, possibly damaged by hail, soiling, UV. This presentation is aimed at current activities, especially methods of determination and evaluation of ice adhesion. In focus of this proposal are the activities of the working group on one concept and one draft to measure the ice adhesion properties of coating systems and surface of rotor blade coatings.

Web site: https://tu-dresden.de/ing/maschinenwesen/ifww/biomaterialien/forschung/korrosion-und-oberflaechen

Short biography: Since 15 years Mrs. Dr. Ute Bergmann is the head of the group “Corrosion and Surfaces” on the chair “Biomaterials” on the Institute of Material Science on the Technical University of Dresden/ Germany. Research topics of the group are surface functionalization, corrosion processes, material degradation, and insurance claims etc. Her group has worked on anti-icing solutions for surfaces for the last 15 years, where problems like coating development are just as much in focus as the development of characterization methods to analyze and rank their properties. Dr. Bergmann works in teaching and gives lectures on corrosion, surface treatment and material selection, and manages the laboratories of corrosion and icing of the Institute of Materials Science. Furthermore, Dr. Bergmann works voluntarily on the standards committee of „Coating Materials for Wind-Turbine Rotor Blades“ ISO/TC35/SC 9/WG 32. Before that, she worked at the Institute for Safety Research of the Research Center Dresden Rossendorf HZDR.

Mrs. Bergmann studied materials science on the Technical University of Kiev and completed her engineering doctorate on the subject of the development of an in-situ method of crack propagation measurement on the Technical University of Dresden in 2001. She is a member of the German Society of Corrosion Protection and of the German Society of Materials Science.

R&D areas/s: A) Policy and Market

The cost of icing in different electricity markets

Petteri Antikainen, Wicetec, FI

Petteri Antikainen (Wicetec, FI)

The costs due to icing is varying hugely depending on market areas.

The direct cost of lost production is always on the producer. This is simple and the same in all the markets. How to deal with the consequences ie. balance and intraday power is different depending on market area. Within market areas there are also differences of risk sharing models, which are based on contract terms between the parties.

In this presentation the markets are divided to three different categories: a) pay-as-produced, where the cost of balance is carried by someone else than producer; b) where all the cost are on producer, base load contract type; c) in between of two previous.

When looking into a), the situation is simple from the perspective of producer. All you can produce shall be bought with the agreed price. The loss due to icing is direct AEP loss only. The problem of balance power is on someone else, for example on system operator, buyer or taxpayer.

On market b), producer is responsible for all the costs, matching the predicted and sold but missing production in intraday and balance markets.

Case c) is most interesting. How costs are shared between producer, buyer, balance service provider, etc. How much individual producer has other assets which can compensate the need to buy from intraday and balance markets. The compensation with other assets is not costless but can bring relief from extreme prices. The cost of balance services has also rapidly increased. The variation of risks and business opportunities is huge.

The problem of icing costs is especially the case in low wind situations when prices are high. Even light icing can easily cause production losses to be on level of 50-70%. This level of losses can be seen on power curves of individual turbines, but often also being the difference of predicted and realized wind production in complete market area. Examples of individual turbines and Finnish market area shall be presented.

This complicated equation has no simple solution. There are naturally year-by-year variations, but also significant variation during the lifetime of project when markets are changing. However, in this presentation a simple method to estimate the real icing costs in different markets shall be presented.

Web site: wicetec.com

Short biography: Petteri has worked 30 years with cold climate wind. 2014 he co-founded Wicetec, a company dedicated to Ice Prevention for wind turbines.
Before Wicetec, he has developed tools and methods for cold climate including standards in National and International standardization committees, SESKO and IEC MT12-1. He has a M. Sc. in Technical Physics at HUT, Finland. Petteri worked as principal scientist at VTT, Technical Research Centre of Finland. He has also been a board member in Finnish Wind Power Assosiation.

R&D areas/s: B) Technology

Mesoscale-to-microscale flow modelling in cold climate (WRF-to-CFD)

Narges Tabatabaei, DNV Sweden, SE

Narges Tabatabaei (DNV, SE), Barriatto, Leonardo (DNV, BR), Christiane Montavon (DNV, UK), James Bleeg (DNV, UK)

Planning and building a new wind farm is a major undertaking in harsh climates. Investors and other stakeholders need reassurance that risk has been mitigated when it comes to cold climate. Accurate wind flow modelling is a key step in optimizing wind farm design, reducing uncertainty in energy production forecasts, and maximizing returns. Flow modelling options roughly breakdown into two options: mesoscale and microscale.

Mesoscale models solve the governing equations of atmospheric flow over a much larger horizontal scale than microscale models. The Weather Research and Forecasting model (WRF) is a mesoscale numerical weather prediction system that is suitable for running simulations with horizontal grid spacing down to 1-2 km. WRF models have historically been used to predict flow over terrain. In the last ten years, however, the capability to represent wind farms has been added. The main disadvantage of WRF as it is used in wind energy, and of mesoscale models more generally, is that it is unable to reliably resolve the flow down to many of the scales that are important in wind farm flow. To address this issue, mesoscale models are sometimes coupled with reduced-order microscale models, but these models are unable to capture some of the key physics influencing flow through a wind farm.

Microscale computational fluid dynamics (CFD) models are capable of resolving the key physics down to turbine scale. However, uncertainty in the inflow boundary conditions, specifically in their representativeness of the actual atmospheric conditions at the site being simulated, translate directly to uncertainty in the results of the CFD analysis. This shortcoming is an issue in most regions where wind farms are developed, including those in cold climates where boundary layers are frequently thinner, which in combination with larger modern turbines, makes it extra important to simulate atmospheric conditions within and above the boundary layer that are consistent with the actual local conditions.

The presentation describes an effort to effort to improve the representativeness of CFD inflow boundary conditions by deriving them from WRF output. Using WRF to inform CFD boundary conditions should lead to the simulation of conditions that are more representative of the actual atmospheric conditions at the site. Deriving the inflow vertical profiles from WRF is expected to increase the representativeness of the profiles relative to alternative practices and thus increase prediction accuracy. Results from the proposed approach are validated against observations related to wakes, blockage, and flow over terrain at four wind farms, offshore and onshore. While obtained results show promise, we also discuss where steps can be taken to further improve this WRF-to-CFD approach.

This research marks a significant stride towards bridging the gap between mesoscale and microscale CFD simulations, contributing to more accurate wind flow predictions, and bolstering confidence among stakeholders in the planning and execution of wind farm projects.

Web site: https://www.dnv.com/services/computational-fluid-dynamics-3814

Short biography: Narges has more than 10 years of experience in CFD simulations of turbomachinery. She has also worked with aerodynamics investigations in different applications, as well as the algorithm development for modeling the various flow systems. Narges is a senior engineer who has been working in different industries and research groups, with expertise in fluid mechanics. She received her doctoral degree from Luleå university of technology with the doctoral thesis on icing effect over wind turbine performance. Important part of her work includes the CFD developments as a part of her PostDoc in KTH Royal Institute of Technology.

R&D areas/s: E) Operation, maintenance and forecasting

Wind power icing loss forecasting and evaluations against T19IceLossMethod

Mihai Chiru, rebase.energy and Modity, SE

Henrik Kälvegren (Rebase, SE), Sebastian Haglund (Rebase, SE), Emelie Bäckström (Modity, SE), Kruno Kuljis (Modity, SE)

Power grids need to be continuously balanced in order to avoid grid frequency deviations and maintain safe operating conditions. Because of this, power market participant are asked to provide dayahead nomination of electricity supply and demand. This can be tricky for wind power that depends heavily on uncertain weather conditions. Imbalances as compared to dayahead nomination result in imbalance fees paid by the market participant. For wind power in cold climate this challenge is even more pertinent since ice formation might occur on wind turbine blades, which result in production losses by altering their aerodynamic properties. Icing production losses can correspond to as much as 25% of the total imbalance volume for a wind farm.

We have developed a icing production loss forecasting model based on weather forecast data from multiple weather forecast institutes. The developed model consist of two separate forecasting models, one that predicts with ice-contextual information and one without. The difference of these models can be seen as a measure of the expected ice production loss. For model predicting with ice-contextual information, several predictor features were developed including vertical temperature profiles. The model has been tested during the 2023-2024 winter season and was able to predict 6 out of 8 icing events.

Web site: https://www.rebase.energy/

Short biography: Mihai has a background in data science and energy modelling. He is committed to develop and apply machine learning models that can accelerate the energy transition. In his free time, Mihai enjoys swimming and hacking old computer programs.

R&D areas/s: Forecasting and Trading

Economical effects of icing - a case studie

Sten Lillienau, Centrica Energy, SE

Kristian Skjødt Pedersen (Centrica Energy, SE), Asger Arnklit (Centrica Energy, SE)

Icing effect the economy and profitability of a wind park in a number of ways. 1. Higher imbalance costs due incorrect production forecasts for day-ahead market and challenges in trading out the correct imbalances on the intraday market. 2. Income losses due to less production and spot revenues, especially since the spot prices typically are higher in winter. 3. Effects of on the hedged volumes. Costs for volume and profile risk gets higher.

In the case study we calculate the economic effect from all three components.

Web site: https://centricaenergy.com/

Short biography: Sten Lillienau has wide industrial background from the renewable sector, among others covering forest industry, heat pumps and renewably produces power. Likes endurance sports and new music.

R&D areas/s: E) Operation, maintenance and forecasting

Icing loss estimation : practical insights for accuracy

Olivier Fortin-Moreau, Icetek, CA

Olivier Fortin-Moreau (Icetek, CA)

Achieving precise estimates for icing losses in wind turbines requires careful consideration. Depending solely on turbine status codes, often linked to manufacturer power curves, may overlook subtle performance nuances. The strategy of only considering icing stoppages, even with turbines with sensitive controls strategies, may lead to a severe underestimation since turbines can experience underproduction before a complete stop.

Additionally, be attentive to factors like turbine curtailment, not encompassed by status codes, as they contribute to overall losses. Relying exclusively on statistical metrics may present a skewed picture; incorporating time series representations validates data and enhances understanding.

Precision in estimating icing losses unveils the complexity of wind turbine performance. Beyond standard metrics, understanding nuanced issues like underproduction and turbine status codes is crucial. This goes beyond numbers, emphasizing the importance of a comprehensive view for better wind energy solutions.

Web site: https://icetek.ca/

Short biography: With a decade of experience as a mechanical engineer, I spent eight years working on projects across various disciplines at Université Laval. During this period, I collaborated with several wind farms that were experiencing problems caused by meteorological icing. In 2020, I co-founded Icetek, a pioneering firm addressing challenges related to ice accumulation in wind farms. My expertise encompasses designing and installing measurement equipment, conducting fieldwork, performing in-depth analyses of production data.
My commitment to sustainable development is evident in my active involvement in the wind energy sector. This dedication underscores the crucial importance of adopting a global perspective when designing informed energy solutions. Beyond my professional activities, I am a fervent advocate of winter pursuits, particularly skiing. This personal enthusiasm not only brings me joy but also contributes to my nuanced understanding and appreciation of the subtleties inherent in cold weather conditions, providing valuable insights that complement my professional endeavors.

R&D areas/s: E) Operation, maintenance and forecasting

IceRisk tool for Safe Operation of Wind Power in Winter Climate

Rolv Erlend Bredesen, Kjeller Vindteknikk - part of Norconsult, NO

Rolv Erlend Bredesen (Kjeller Vindteknikk -part of Norconsult, NO)

The main objective of the Norwegian research program "Safe Operation of Wind Power in Winter Climate" is to increase the safety for wind farm service personnel and the public. We want to achieve a reduced risk from ice throw, safe working environment in the wind farm and safe traffic through wind farm areas. This is done through the development of methods and tools to monitor, estimate, and forecast ice risk, sharing of experiences and discussion of common challenges and optimal measures within the industry.

The program is lead by Kjeller Vindteknikk with research partner the Norwegian Meteorological Institute and industry partners Statkraft, Hydro Energy, Fred Olsen Renewables, and Zephyr. The program is supported by the Research council of Norway

In this presentation we present an early version of a planning tool for the design of the wind farm layout with respect to risks as well as an extended forecast system meant for skilled personnel (based on the existing IceRiskForecast).

In cold climates it is of particular importance to optimize the wind farm layout and consider design implications already in the planning phase of a wind farm. Key questions regarding risks in the design phase is often overlooked because project developers are not aware of the challenges facing project operators. This can lead to missed opportunities for inherently safe design early on when making suitable adjustments to the project is cheaper. IceRisk analyses have typically and historically only been ordered for considering third party risks, and often at a time after other design choices already have been made.

The IceRisk tool which typically is used together with timeseries of meteorologically modeled parameters describes the risk in the time dimension. Already at the planning stage of wind farm development the following questions can be addressed:

- How often will the turbines be approachable/available for service personnel in a safe way.
- Where should service buildings be located.
- Relative placement of roads with respect to turbines and hazard zones.
- What is the running cost of wtg's being inaccessible for weeks during winter.
- Should we require safer design of nacelle roofs / heat exchanger, what is the available offers from the wind turbine manufacturers with regards to safety.
- How effective are measures meant for optimizing the production in regards of reducing the actual risk on the ground.

This forecast system will consist of a map showing the risk across the wind farm on a turbine level, where the wind direction and wind speed is taken into account. In addition, the extended forecast service will enable wind farm personnel to calculate the risk along routes specified by the wind farm personnel. An option to simulate the change of risk caused by stopping any turbines along the route will also be included.

We suggest to create simple tables spanned by hour and turbines, enabling service technicians to make informed day-to-day decisions on e.g. the following:

1) Whether to allow turbine access today.
2) Whether to allow drive-by with a vehicle for accessing other turbines/service building.
3) Judge which turbines that are available for service/visit. Should service be delayed?
4) Is it safe to perform snow clearance?
5) What is the risk associated with an evacuation or rescue from a turbine (or area) if an accident occurs or a vehicle gets stuck inside the windfarm.

As the research project develops, it is expected that for each turbine the risk onto the service road for driving by will be presented as well as the risk for walking and entering each specific turbine.

R&D areas/s: E) Operation, maintenance and forecasting

The categories of risk presented may at the end of the research project include:
i) ice throw from an operating turbine vs ice fall from blade of an idling/stopped and yawed/wind-oriented turbine,
ii) ice throw/fall of wet-snow from inner third of blade,
iii) wet-snow falling from tower,
iv) ice-blocks/icicles falling from the nacelle.

Web site: https://www.vindteknikk.com/services/wind-energy/icerisk/

Short biography: Rolv Bredesen has a background in mathematical modelling and computational science and is an expert on wind, icing and risk assessments at Kjeller Vindteknikk – part of Norconsult. He has participated in the IEA Wind's (TCP) expert group on wind energy in cold climates (Task 19/54) since 2016, and has recently participated as one of two Norwegian contributors of the IEC technical committee nr 88 to create an international standard for wind turbines within the topic of Siting Risk Assessment. The standard IEC TS 61400-31:2023 was published recently in November 2023 .
Rolv Bredesen has a long experience especially with ice throw risk assessment and has contributed to National Norwegian Guidelines (2018, NVE) as well as the updated international guidelines IEA Wind TCP Task 19's recommendations (2nd edition 2022).

The standard can be found following this link:
https://lnkd.in/d5QbcTdv

More information on IceRisk can be found here:
https://lnkd.in/dzMFqrqt

A previous presentation on IceRisk forecast system by the author can be found here:
https://windren.se/WW2016/2_2_3_Bredesen_IceRisk_forecast_system_for_operational_wind_farms.pdf

His considered safe hobbies are speed-riding, hang-gliding, motorcycling as well as rock climbing.

R&D areas/s: C) Development and financing

Exploring cold-climate wind-energy modelling and ice-mapping with the new Copernicus European Regional Analysis (CERRA) dataset

Morten Lybech Thøgersen, EMD International, DK

Marie Cecilie Pedersen (EMD, DK); Lasse Svenningsen (EMD, DK), Thorkild Guldager Sørensen (EMD, DK)

The Copernicus European Regional Analysis (CERRA) is a high-resolution reanalysis dataset provided by the European Copernicus programme [1] through an open-data license. It's delivered through a contract with the Swedish Meteorological and Hydrological Institute (SMHI), with Meteo-France and the Norwegian Meteorological Institute as subcontractors. For wind-energy analysts operating in cold-climate regions, CERRA may prove particularly useful as it delivers the parameters needed for general ice production loss modelling. In this case-study, we are investigating the CERRA dataset by using it as forcing into the EMD-WRF OD ICING model [2, 6]. The aim is to map its applicability for local, national, and regional ice-loss prediction within the pan-European domain covered by CERRA.

The CERRA model provides data at a 5.5km resolution. It uses initial conditions and boundary conditions provided from ERA5 reanalysis data [3] for downscaling to its 5.5km spatial resolution and hourly temporal resolution. CERRA makes extensive use of remote sensing data, local observations, sea-ice records, and sea-surface temperature fields. CERRA is based on the HARMONIE-ALADIN data assimilation system and applies a 3D variational analysis (3D-VAR). The assimilation is run with 8 cycles per day. The numerical weather prediction model used is HARMONIE–ALADIN, providing a valuable alternative to the commonly used WRF model for wind-energy modelling [4, 5, 6, 7]. As such, CERRA may provide a valuable and cost-efficient contribution to uncertainty modelling, first- and second-opinion analyses for cold-climate production loss modelling for wind-turbines.

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[3] ECMWF: Climate Reanalysis and ERA-5. [Online]. Available: https://climate.copernicus.eu/climate-reanalysis. [Accessed 2023-12-08]
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[5] P. S. S. Thorsson and H. Bergström: Modelling atmospheric icing: A comparison between icing calculated with measured meteorological data and NWP data. Cold Regions and Science Technology, vol. 119, pp. 124-131, 2015.
[6] M. C. Pedersen, T. Ahsbahs, W. Langreder and M. L. Thøgersen, "On the modelling chain for production loss assessment for wind turbines in cold climates," Cold Regions Science and Technology, vol. 216, p. 103989, 2023.
[7] Ø. Byrkjedal, J. Lindvall, L. Lee and S. Rissanen: Development and calibration of state-of-the-art icing loss estimates using a new meteorological dataset. In Winterwind 2021. [Online, 2021].

Web site: https://www.emd-international.com/

Short biography: Morten Lybech Thøgersen, a passionate advocate for renewable energy and the Head of Software Development Department at EMD International A/S in Denmark (EMD), is at the forefront of windPRO software development. His love for Agile methods in software development is evident in his commitment to creating user-friendly software that integrates data and models to deliver significant end-user value. Currently leading a team of 15 talented software developers, Morten's research interests are deeply rooted in applied methods. These include data analysis, probabilistic methods and loads, global reanalysis data, GIS and land-surface data, machine learning, big data, and high-performance computing. His expertise in these areas is particularly relevant to the modelling of renewable energy in cold climates.

R&D areas/s: C) Development and financing

Before joining EMD back in 2001, Morten contributed to the scientific community as a researcher at Risø National Laboratory, now known as DTU Wind Energy. His work there laid a solid foundation for his current role and continues to inform his approach to software development and data analysis. Outside of his professional life, Morten is a devoted family man who enjoys spending time with family and friends. An avid sports enthusiast, he can often be found running or engaging in various water sports, whether in the frozen or liquid state, including sailing, scuba diving, kite surfing, and snowboarding. His love for these activities, particularly those in cold climates, mirrors his professional interest in cold climate modelling of renewable energy.

R&D areas/s: E) Operation, maintenance and forecasting

Snow and ice forecast based on machine learning

Johan Casselgren, Luleå Technical University, SE

Torbjörn Gustavsson (Pileus Scandinavia, SE)

According to the IEA (International Energy Agency), the war in Ukraine and the growing concern about accelerating climate change have led to a very large increase in investments and expansion of wind farms. Because energy production via wind is more efficient in cold climates than in warm ones (connected to the fact that air has a higher density at low temperatures), many new wind farms are located in our Nordic countries. However, wind power production in cold environments has the disadvantage that snow and ice accumulate on the turbine blades decreasing the efficiency to a very high degree.

In order to prevent snow and ice accumulation, de-icing and detection systems have been developed, but these systems have been shown to perform poorly, especially in terms of detection before large amounts of snow and ice have accumulated on the turbine blades. Accumulation of snow and ice on the blades also has another effect linked to safety. When the ice/snow melts, there are major risks regarding the working environment at and around the wind turbines. Based on the above, one can clearly identify a large and growing need for a new, improved technology for snow and ice detection that is both more accurate and can give a warning even in the case of small accumulations.

At Luleå University of Technology, for several years now, research has been carried out regarding snow and ice and its impact on various structures. An important focus of this work has been to develop new techniques to be able to measure and record, for example, when snow or ice begins to accumulate and how quickly the build-up takes place. Especially for wind turbines and the growth of snow and ice on the turbine blades, an optical technology has been developed. This technique has proven to be very fast and accurate in capturing snow and ice growth. The technology has been validated in the field and developed especially in terms of accuracy for current state and forecasting. These tests have been carried out with various actors such as Statkraft and Vattenfall both for development purposes but also above all to be able to demonstrate the technology.

This presentation will focus on describing the advantage with this technology and what is the next step in the development of this technology.

Web site: https://www.ltu.se/staff/j/johcas-1.12652

Short biography: Johan Casselgren is associated professor at Luleå university of technology

R&D areas/s: B) Technology, E) Operation, maintenance and forecasting

"Performance envelopes of blade heating systems" - A subtask of IEA Wind TCP Task 54 "Cold climate wind power"

Claas Rittinghaus, Energiewerkstatt, AT

Charles Godreau (Nergica, CA), Patrice Roberge (Icetek, CA), André Begin-Drolet (Université Laval, CA), Daniela Roeper (Borealis Wind, CA), Franziska Gerber (Meteotest, CH), Paul Froidevaux (Meteotest, CH), Taeseong Kim (DTU, DK), Nadine Rehfeld (Fraunhofer IFAM, DE), Tomas Wallenius (Wicetec, FI), Jennifer Pettersson (Vattenfall, SE)

This abstract is a proposal for a workshop to be conducted on the first day of the conference.
The IEA Wind TCP Task 54 subtask on performance envelopes of blade heating systems comprises participants from seven different countries (AT, CA, CH, DE, DK, FI, SE) including blade heating systems manufacturers, consultants, research institutes and universities. In a previous workshop at the 2023 Winterwind conference, the subtask introduced its work plan and roadmap on how to improve on the uncertainties in developing and operating wind energy projects in cold climate regions relying on blade heating systems. From site assessment through operational control to forecasting electricity production, assessing the performance of blade heating systems and incorporating it into the individual processes at hand during the stages of project development, deployment and operation is key to increase efficiency and decrease uncertainty. The selection of a suitable blade heating system with respect to site-specific meteorological conditions as well as the technical validation of the system's performance during commissioning of a turbine are examples that can decrease unexpected losses and thereby increase the overall profitability of a project. The same goes for accurate power forecasting incorporating blade heating system performance as another example along the project lifecycle that can at the same time also create a positive effect on electricity grid stability, the volatility of the electricity market in general and the balancing power market in particular. Hence, the targets of the subtask are well in line with next year's main theme of the conference "The real cost of ice induced losses and balancing of power".
The subtask aims to advance the knowledge base and to provide tools for improving the aforementioned processes. The activities branch into:

- Collecting and hosting a database of icing events from different regions of the world for researchers, manufacturers and operators to access and use for their respective applications.
- Creating and publishing a model code for the computation of a generic blade heating system performance envelope based on meteorological icing event data.
- Defining and validating a procedure for the site-specific validation of the performance envelope of a blade heating system.

The upcoming workshop will focus on results from the first two bullet points. Participants shall then use the combinations of individual icing event data and modelled performance envelope based upon the data to discuss the applicability of the results to their line of work and to identify potential missing pieces to the respective incorporations.
Furthermore, an outlook will be given on the work in progress with respect to the third bullet point. Defining a reference procedure for validating blade heating systems in the field will require further research to be conducted outside of the Task 54's work. The subtask hence focusses on outlining the key points of the validation procedure and compiling requirements for the respective research.

Web site: 0

Short biography: Claas Rittinghaus earned his diploma in physics at the University of Bielefeld, Germany. After 10 years of working as a product manager for Phoenix Contact in Blomberg, Germany, he joined the Energiewerkstatt in Friedburg, Austria, in 2021 as a project manager in research and consultancy services. As Austrian participant of IEA Wind TCP Task 54 specifically icing topics are in his focus. He is a mountain enthusiast, in summer as in winter, and enjoys hiking, climbing, bouldering, downhill skiing and ski touring. Another passion of his is music, especially playing the guitar and singing.

R&D areas/s: B) Technology, E) Operation, maintenance and forecasting

A field study on acoustic ice detection on wind turbine towers

Eike Lueken, eologix-Ping, AT

Eike Lueken (eologix-Ping, AT), Jon Cooper (eologix-Ping, AT), Michael Moser (eologix-Ping, AT)

Operating wind turbine blades under icy conditions requires optimisation between safety, damage prevention, and maximum energy generation while limiting the energy consumption of the anti-icing or de-icing systems, if present. As widely known, neither a too early shutdown nor a too late shutdown are acceptable for operators.

The available ice detection systems are diverse and range from meteorologic to instrumental measurements analysing sound, vibration, eigenfrequencies, impedance, power curves, optical inputs, etc. Thecharacteristics of sensitivity, accuracy, continuity, automation, ease of installation and integration vary significantly between the systems. However, the factor of sensitivity (early-stage detection of ice) seems to be of utmost importance for two of the most critical use cases for ice detection.

In the present work, we will show results in tower-based acoustic monitoring of early icing and compare the data from dozens of wind turbines in the field, showing promising results on a novel, easy method to monitor icing on turbine blades.

Web site: https://www.eologix-ping.com/

Short biography:

R&D areas/s: A) Policy and Market, E) Operation, maintenance and forecasting

Safety aspects and risks of preventive heating during production

Doris Schadler, eologix-Ping, AT

Doris Schadler (eologix-Ping, AT), Harald Hohlen (eologix-Ping, AT), Michael Moser (eologix-Ping, AT)

In wind turbines, signals from blade based detection systems are already being used to decide whether to activate or deactivate blade heating systems. However, their use is currently limited to heating the blades during standstill. In addition to being used for blade heating control, the provision of signal levels is primarily used to detect safety-relevant, i.e. critical ice build-up. If the conditions for critical ice build-up are met, the system is stopped. By stopping the system, it is ensured that only ice fall but no ice throw can occur.

A risk assessment was carried out together with a renowned certification body to ensure that preventive heating does not cause ice throw through the blades during production operation. The risk analysis as part of the risk assessment showed that a distinction must be made between the two conditions "Possible ice build-up" and "Light ice build-up" in production operations in order to avoid an increased risk of ice throw.

Possible ice build-up refers to conditions in which further ice build-up on the leaves can be avoided, delayed or reduced during production operation with activation of the blade heating. Slight ice build-up refers to conditions in which operation of the system is still possible without activating the blade heating.

In our presentation, we will show that the operation of the wind turbine without additional risk of ice throw can also be ensured in the event of preventive heating during production operation with the aid of the signal levels of blade surface based ice detection systems.

Web site: www.eologix-ping.com

Short biography: After earning her PhD in mathematics at Graz University of Technology in 2022, Doris Schadler entered the wind energy world to explore her passion for data analysis. As a Data Analyst and Algorithm Designer at eologix-Ping, she is involved in the development of algorithms for ice detection, pitch angle monitoring and ice prediction for wind turbines. Besides analyzing data, she likes to walk her dog, Nora, and in winter she enjoys snowboarding.

R&D areas/s: B) Technology, E) Operation, maintenance and forecasting

Strategies and tools for designing and optimizing wind farms for prosperous operation in cold climates

Simon Grenholm, W3 Energy, SE

Simon Grenholm (W3 Energy, SE)

Designing ice mitigation systems and planning for wind farms in cold climates may lead to a focus on minimizing energy ice losses, summarized as annual kilowatt hours. But optimizing for a prosperous project economy and contributing to a stable and renewable national energy supply may require other optimizing strategies and designs.

This presentation will take ground from a set of real-life icing situations. Based on W3 Energy experiences from monitoring and optimizing wind farms in northern Sweden, light will be shed on different perspectives of wind turbine icing, from both technical and economic views.

As a result of wind power now contributing significantly to the national electricity supply, the spot market energy prices have an increasing correlation to wind speed and ice conditions. This becomes particularly clear in situations with low wind speeds, where turbines tend to lose production capacity at the same time as spot prices are rising sharply.

No single design or strategy will master all circumstances, but some questions and analyzing tools are worth extra focus.

Among important questions are: Designing for a high energy yield at high wind speed or for a high revenue yield at low wind speed? Hot air system, electro-thermal heating mats or no ice mitigation system at all? What is a sufficient level of blade heating power, at initial turbine design and in operative scenarios?

Among useful analyzing tools are: Visualizing via stacked views, frequency views and via farm aggregated views. Plotting both energy losses and revenue losses in time series and in wind speed graphs. Plotting and performing regression analyses on energy and revenue losses as function of ice mitigation system availability.

Through a balanced evaluation of pros and cons with different options, a site-specific design can be developed, and operating strategies systematically optimized.

Web site: www.w3e.se

Short biography: Simon Grenholm works as a Business Intelligence Analyst at W3 Energy, with a specialization in ice mitigation systems, software development and data analyses. He has graduated from Luleå University of Technology with a Master of Science in Environmental Engineering, with a focus on renewable energy sources. He also has a long-time experience as a software developer for the construction industry. Simon is passionate for a living planet and a sustainable development.

R&D areas/s: B) Technology

Improving bearing life in harsh environment

Peter Schmidt, SKF

Peter Schmidt (SKF Renewable Energy, SE)

Improving bearing life in harsh environment

Peter Schmidt, SKF Renewable Energy

Operational reliability of wind turbines is essential to provide a cost-efficient energy output. Bearings are expensive to exchange because the main shaft and, in some cases, also the rotor must be taken down. However, wind turbines in cold locations experience many different conditions like imbalance due to ice, cold startup temperatures etc. which has a detrimental effect on the bearing performance. SKF has developed a new bearing design which tackles the know issues affecting bearings operating in cold locations. Due to the new design, material and manufacturing process, the bearing can obtain up to 90% longer life within the same boundary conditions. Prior to market release several large size bearings was extensive tested in SKF's test laboratory. After experts' approval of the test results, the bearing rating was approved by DNV/Germanischer Lloyd.

Web site: www.skf.com

Short biography: Short Biography:
Peter Schmidt has worked at SKF for 20 years in various positions focusing on bearings in the wind turbine drive train. Today Mr. Schmidt supports the major Danish manufactures with bearing application expertise.