Winterwind 2026

Sundsvall, SE

Feb 2-4

Program and

Book of Abstracts

Version

2025-11-05

Program committee

Erika Dahlin, Statkraft, SE
Franziska Gerber, Meteotest, CH
Charles Godreau, Nergica, CA
Göran Ronsten, WindREN, SE
Daniela Roper, FabricAir, CA

https://winterwind.se/

Start time	Monday Feb 2 Welcome to Wintwerwind 2026!		Tuesday Feb 3 Day 2		Wednesday Feb 4 Day 3	
08:00			Exhibition and registration 08:00 - 09:00		Exhibition and registration 08:00 - 08:30	
08:30					Ice Protection Systems(18) 08:30 - 09:30 Moderator: Lisa Ek Keeping Blades Ice-Free: Inside the Vestas Anti-Icing System, Stephen Jude Buggy, Vestas Technology, UK (6) Practical retrofit process for wind turbine ice protection systems, Paulius Sarapnickis, FabricAir, LT (36) Field Validation Nordex Delta4000 Anti-icing System, Nils Lehming, Nordex, SE (18)	
09:00			Ice throw (7) 09:00 - 10:00 Chairs: Sensitivity analysis and recommendation of wind turbine risk assessment parameters, Alper Sevim, DNV, DE (13) Improving Site-Specific Wind Turbine Icing Estimates for Risk Assessment, Gerlinde Jung, F2E Fluid & Energy Engineering GmbH & Co. KG, DE (16) A novel multisource approach for handling icing risk for personell working in the wind farm, Sigmund Guttu, Norconsult, NO (35)	Icing measurements 1 (8) 09:00 - 10:00 Chairs: SCADA, Icetek IC-1 and Ceilometer - Agreement or discrepancies?, Franziska Gerber, Meteotest, CH (22) Quantitative metrics for icing events severity assessment, Charles Godreau, Nergica, CA (19) From Landline phones to Smartphones: Rethinking Icing Measurements for the Site Assessment of Modern Wind Farms, Patrice Roberge, Icetek, CA (20)		
09:30	Site visit to Jenåsen				Break 09:30 - 10:15	
09:45	Bus departure from hotel				Poster session 4 (19), 09:40 - 10:10 Chair: A new market reality for the wind power industry calls for active approach, Lisa Eklund, W3 Energy, SE (43)	
10:00		Hydrogen seminar (1) 10:00 - 12:00 Moderator: Björn Aronsson	Break 10:00 - 11:00			
10:15			Poster session 1 (9), 10:15 - 10:45 Chair: Powering a neutrino telescope with renewables at Summit Station in Greenland, Vera Schorbach, Hamburg University of Applied Sciences, DE (10) Coatings for wind and solar: ice and hail protection in winter environments, Matiss Sivins, Phazebreak Coatings, LT (37)		Pre-construction (20) 10:15 - 11:15 Chairs: Digital forest intrution valuation using drones and AI, Roger Öhlund, Conifer Vision, SE (9)	Turbine control (21) 10:15 - 11:15 Chairs: Cold Climate Operation (CCO): A software-based solution for ice loss mitigation in Vestas wind turbines, Torben Tvedebrink, Vestas, DK (26)

Time						
					WICE 2.5 – Model update and validation of the DNV atmospheric icing model in North America and the Nordics, Luis Baquero, DNV Energy Systems GmbH,	Centralizing Intelligence: Using IceBrain to Transform Icing Data into Operational Insight, Dave Tremblay, Icetek, UK (39)
11:00				Plenary session (10) 11:00 - 12:30 Moderator: Lisa Ek Keynote: Synergies in Atmospheric Icing: From UAVs to Wind Energy Systems, Richard Hann, Norwegian University of Science and Technology NTNU, NO (3)	Machine learning-based estimation of ice loss for pre-construction wind energy yield assessments, Sabin Stefanov, IDCORE (Industrial Doctoral Centre for Offshore Renewable Energy), UK – a collaboration between University of Edinburgh, University of Strathclyde, Swansea University, University of Exeter and the industrial partner Wood Group. (28)	Operational envelopes for the design, sourcing, and operation of IPS, Dylan Baxter, FabricAir, CA (14)
11:15	Welcome to Jenåsen!	Panel discussion		Risk and insurance challenges of operating wind and solar farms in cold climates, Jan Willem Hoogenboezem, Marsh (38)	Lunch 11:15 - 12:30	
12:00		Lunch on your own 12:00 - 13:00		IEA Wind Task 54: Global cold climate wind market size, Timo Karlsson, VTT, FI (24)		
12:30				Lunch 12:30 - 14:00	Closing session - A cross section (23) 12:30 - 14:00	
13:00		Grid seminar (2) 13:00 - 14:45	IEA Task 54 seminar (3) 13:00 - 17:00		Moderators: Lisa Ek, …	
13:25		Moderator: Lisa Ek Using Dynamic Line Rating to minimize curtailment of Wind power connected to rural power networks, Magnus Lindström, Griddiagnoze, SE (40)	Moderator: Patrice Roberge WORKSHOP: IEA Task 54: Wind turbine and blade heating performance subtask, IceLossMethod 2.0 and new site Icing classification update, Patrice Roberge, Icetek, CA (21)	Poster session 2 (11), 13:25 - 13:55 Chair: Using Dynamic Line Rating to minimize curtailment of Wind power connected to rural power networks, Magnus Lindström, Griddiagnoze, SE (40)	Unraveling hidden losses and new areas of focus for wind power in cold climates, Simon Grenholm, W3 Energy, SE (34) Summary of workshop: IEA Task 54: Wind turbine and blade heating performance	

Time						
		How different flexible consumers influence the performance of Windfarms in SE2, Lukas Pfeiffer, Gridmetry, DE (41)		How different flexible consumers influence the performance of Windfarms in SE2, Lukas Pfeiffer, Gridmetry, DE (41)		Summary of seminars: Hydrogen, Grid & Storage Summary of Winterwind 2026 Welcome to Winterwind 2027 in...
14:00		Panel discussion		Drones (12) 14:00 - 15:00 Chairs: Session title (TBD): From Drones to Wind Turbines: Shared Challenges in Atmospheric Icing", Richard Hann, Norwegian University of Science and Technology NTNU, NO (4) Inhousing blade inspections with drones, Kaspars Litavnieks, Perceptual Robotics, UK (7) Micro-CT imaging of icing on wind turbines, drones and marine structures, Sönke Maus, Norwegian University of Science and Technology NTNU, NO (15)	Icing measurements 2 (13) 14:00 - 15:00 Chairs: Heat only when it matters: Wireless sensors for precision blade heating, Thomas Schlegl, eologix-ping, AT (33) The influence of heavy icing on blade edgewise vibrations (BEV), Daniel Brenner, Weidmüller Monitoring Systems GmbH (WMS), DE (2) Modelling and predicting wind turbine performance in cold climates, Torben Tvedebrink, Vestas, DK (25)	
14:45		Break 14:45 - 15:00	Break 14:45 - 15:00			
15:00		Storage seminar (4) 15:00 - 17:00 Moderator:: Lisa Ek Integrating BESS into Operational Wind Farms – Practical Lessons from Sweden's Hybrid (Wind + BESS) in cold climate, Daniel Eliasson, Ramboll, SE (29)	IEA Task 54 seminar (5) 15:00 - 16:15	Break 15:00 - 15:45		

Time				
15:45	Back at the hotel		Forecasting losses (15) 15:45 - 17:00 Chairs:	Lidar measurements (16) 15:45 - 17:00 Chairs:
16:00				
16:15	Panel discussion		Icing Forecasting for Wind Energy, Karl Thunell, rebase.energy, SE (1) Predicting energy production and icing losses in operating wind farms with AFRY DAPS – physics-based and data-driven modelling, parameterization and weather forecasts, Helmi Uusitalo, AFRY Finland Oy, FI (11) Machine Learning or Deep Learning? The Role of Ice Sensors and Weather Forecasts in Wind Turbine Icing Prediction, Jonathan Nixon, Coventry University, UK (31) Physical models versus machine learning methods in day-ahead icing forecasts, Mona Kurppa, Kjeller Vindteknikk/Norconsult, FI (23)	Performance evaluation of pulsed vertical profiling lidars in clean air alpine environments, Hazem Rabhi, VAISALA, FR (8) Availability of wind-LiDAR measurements at alpine locations, Alexander Stökl, Energiewerkstatt, AT (12) IEA Wind Task 52: Advancing Wind LiDAR in Cold Climates, Sara Koller, Meteotest, CH (17)
17:00			Exhibition break 17:00 - 18:00 Poster session 3 (17), 17:15 - 17:45 Chair: Integrating BESS into Operational Wind Farms – Practical Lessons from Sweden's Hybrid (Wind + BESS) in cold climate, Daniel Eliasson, Ramboll, SE (29) Future Trends and Economic Impact of Icing Losses in Wind Energy, Jennie Molinder, Kjeller Vindteknikk, part of Norconsult, SE (42)	
18:00	Opening session (6) 18:00 - 19:00 Moderators: Lisa Ek and Per Olofsson The benefits of icing forecasts in day-ahead and intraday markets: a theoretical case study from Finland, Pia Isolähteenmäki, Kjeller Vindteknikk/Norconsult, FI (27)		Leisure time 18:00 - 19:00	
19:00	Dinner on your own 19:00 -		Conference dinner 19:00 - 23:59	

R&D areas/s: A) Wind

Icing Forecasting for Wind Energy

Karl Thunell, rebase.energy, SE

Karl Thunell (rebase.energy, SE)

Balancing the power grid is a delicate act - too much or too little generation can trigger costly imbalance costs. That's why market participants must nominate their electricity supply and demand. For wind power producers, this is no small feat: forecasts depend heavily on weather, and in cold climates, the additional uncertainty of turbine icing can tip the balance even further. Ice build-up on blades alters their aerodynamics, causing significant production losses - sometimes constituting up to 25% of a wind farm's total imbalance volume.

rebase.energy has developed an icing production loss forecasting system that uses weather data from multiple meteorological institutes. It runs two forecasting models in parallel - one that factors in icing conditions (ice-aware) and one that does not (ice-blind). The difference between the two is a real-time measure of the expected loss due to icing. The ice-aware model leverages advanced predictors such as vertical temperature profiles to improve accuracy.

This approach isn't just theoretical - it has been operationally deployed for more than five Nordic energy traders and is in active use with many more during the current 2025/2026 winter season. By anticipating icing-related losses before they occur, the Rebase Platform helps wind power producers reduce uncertainty, imbalance costs, and keep turbines spinning even in the harshest winter conditions.

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

Short biography: Kalle has worked in the energy industry since graduating from KTH in 2017, both at large players within the EV industry, before joining rebase.energy in 2022 as the chief commercial officer. He likes to work hard and play hard, and likes going to events, catching up, meeting, and discussing with energy industry peers. In his free time, he likes to do hybrid training - running and lifting weights!

R&D areas/s: A) Wind

The influence of heavy icing on blade edgewise vibrations (BEV)

Daniel Brenner, Weidmüller Monitoring Systems GmbH (WMS), DE

Sebastian Bitzer (WMS, DE)

Today's turbines, with longer and more slender blades, experience heavy vibrations in the edgewise direction. Such vibrations lead to subsequent damages to other turbine components, such as the mainframe. Some customers felt that turbines which are required to shut down in the case of icing in accordance with the wind park permit often suffer less from BEV. Therefore, we examined windfarms with and without regulatory requirements regarding the number of BEV events at different amounts of icing. Especially turbine operation during heavy icing with a multiple amount of the permissible ice thickness and mass showed clear recommendations.
The data of almost 100 turbines over two winter seasons have been taken into account.
The evaluation demonstrates at which amount of icing BEV occur more often and how the threshold values should be set to avoid subsequent damages to the turbine even if no regulatory ice shut-down requirements are in place.

Web site: https://weidmueller.com/

Short biography: As Head of Monitoring at Weidmüller Monitoring System GmbH in Dresden, Germany, Dr. Brenner and his team continuously monitor over 6000 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 16 years he has been responsible for the development of condition monitoring methods for wind turbine rotor blades.

R&D areas/s: F) Drones/helicopters, Ice protection systems

Keynote: Synergies in Atmospheric Icing: From UAVs to Wind Energy Systems

Richard Hann, Norwegian University of Science and Technology NTNU, NO

Richard Hann (NTNU, NO)

Unmanned aircraft and wind turbines share the same icing challenges; this keynote highlights synergies, shared research questions, and future opportunities for collaboration.

Icing on unmanned aerial vehicles (UAVs) is a relatively new but rapidly growing research field, driven by the increasing use of drones for logistics, surveillance, environmental monitoring, defense, and novel concepts such as airborne wind energy. Although UAVs differ from wind turbines in size and operation, they share many of the same fundamental challenges posed by atmospheric icing. Both systems are exposed to icing at low altitudes close to the ground, require autonomous detection and operation in adverse conditions, and depend heavily on reliable forecasts of when and where icing will occur. Equally, both must employ energy-efficient ice protection systems (IPS), where even small improvements can translate into significant gains in endurance, safety, and sustainability.
Addressing these challenges demands a combination of innovative technologies and robust infrastructure. Smart algorithms that can adaptively operate IPS are needed to minimize energy consumption while ensuring sufficient protection. Similarly, advanced simulation tools are essential to predict icing losses and their impact on performance. These tools must be tightly coupled with experimental validation, linking numerical predictions to experiments in both controlled facilities and real-world environments. Dedicated experimental facilities capable of reproducing representative icing conditions are therefore indispensable for developing, testing, and optimizing the next generation of icing mitigation technologies. This keynote will explore these synergies between UAV and wind turbine icing research, highlighting ongoing and future opportunities for cross-domain collaboration. Shared research questions range from how to design efficient IPS and optimize operational strategies, to how to improve icing forecasts and quantify performance degradation across scales. Special attention will be given to airborne wind energy, which uniquely unites the challenges of both UAVs and wind turbines in a single system. By examining these intersections, the presentation will point toward a joint research agenda that can accelerate progress and deliver solutions with broad industrial and societal relevance.

Web site: www.uavicinglab.com

Short biography: Dr. Richard Hann is the Director of the UAV Icing Lab at the Norwegian University of Science and Technology (NTNU) and the Aerodynamics Lead at UBIQ Aerospace. With over a decade of experience in the field, Dr. Hann is a world-leading expert on UAV icing, having authored more than 40 publications on the topic. He earned his degree in aerospace engineering from the University of Stuttgart in Germany in 2013 and went on to complete his PhD on the topic of UAV icing at NTNU in 2020. Dr. Hann’s research focuses on developing innovative methods for predicting and mitigating the effects of icing on emerging and disruptive aircraft such as UAVs, urban air mobility, and eVTOL aircraft. Dr. Hann's is the co-chair of the NATO RTO Task Group AVT-388 – Operation of UAVs in Icing Environments. He is a member of the AIAA Atmospheric and Space Environments Technical Committee, the AIAA Ice Prediction Workshop, and the SAE AC-9C Aircraft Icing Technology Committee.

R&D areas/s: F) Drones/helicopters

Session title (TBD): From Drones to Wind Turbines: Shared Challenges in Atmospheric Icing”

Richard Hann, Norwegian University of Science and Technology NTNU, NO

Richard Hann (NTNU, NO)

Icing on unmanned aerial vehicles (UAVs) is a relatively new but rapidly growing research field, spurred by the expanding use of drones for logistics, surveillance, environmental monitoring, and novel concepts such as airborne wind energy. Although UAVs differ from wind turbines in size and operation, they share many of the same fundamental challenges posed by atmospheric icing. Both systems are exposed to icing at low altitudes close to the ground, require autonomous detection and operation in adverse conditions, and depend heavily on reliable forecasts of when and where icing will occur. Equally, both must employ energy-efficient ice protection systems (IPS), where even small improvements can translate into significant gains in endurance, safety, and sustainability.

Addressing these challenges demands a combination of intelligent technologies and robust infrastructure. Smart algorithms that can adaptively operate IPS are needed to minimize energy consumption while ensuring sufficient protection. Similarly, advanced simulation tools are essential to predict icing losses and their impact on performance. These tools must be tightly coupled with systematic validation, linking numerical predictions to experiments in both controlled facilities and real-world environments. Dedicated experimental facilities capable of reproducing representative icing conditions are therefore indispensable for developing, testing, and optimizing the next generation of icing mitigation technologies.

Beyond being affected by icing themselves, UAVs also offer unique opportunities as tools for cold climate wind energy. Drones can be deployed for inspection of iced turbine blades, validation of icing forecasts, atmospheric measurements in and around wind farms, and monitoring the performance of ice protection systems under operational conditions. This keynote will explore these synergies between UAV and wind turbine icing research, highlighting ongoing and future opportunities for cross-domain collaboration. Special attention will be given to airborne wind energy, which uniquely unites the challenges of both UAVs and wind turbines in a single system, offering a powerful testbed for joint solutions with high industrial and societal relevance.

Web site: www.uavicinglab.com

Short biography: Dr. Richard Hann is the Director of the UAV Icing Lab at the Norwegian University of Science and Technology (NTNU) and the Aerodynamics Lead at UBIQ Aerospace. With over a decade of experience in the field, Dr. Hann is a world-leading expert on UAV icing, having authored more than 40 publications on the topic. He earned his degree in aerospace engineering from the University of Stuttgart in Germany in 2013 and went on to complete his PhD on the topic of UAV icing at NTNU in 2020. Dr. Hann’s research focuses on developing innovative methods for predicting and mitigating the effects of icing on emerging and disruptive aircraft such as UAVs, urban air mobility, and eVTOL aircraft. Dr. Hann's is the co-chair of the NATO RTO Task Group AVT-388 – Operation of UAVs in Icing Environments. He is a member of the AIAA Atmospheric and Space Environments Technical Committee, the AIAA Ice Prediction Workshop, and the SAE AC-9C Aircraft Icing Technology Committee.

R&D areas/s: A) Wind, AI

WICE 2.5 – Model update and validation of the DNV atmospheric icing model in North America and the Nordics

Luis Baquero, DNV Energy Systems GmbH, DE

Luis Baquero, (DNV, DE)

In the context of increasing onshore wind capacity worldwide, with much of this development occurring in cold climates, understanding the impact of icing on energy production has become increasingly important. While cold climate regions such as the Nordics have long been a focal point for addressing ice accretion on wind turbines, there is a growing need to extend this understanding to other regions with diverse cold climatic conditions and to improve and validate industry tools that can cover all market regions.

DNV has utilized the WICE 2.0 model to estimate onshore wind production losses. This model chain integrates site-specific mesoscale modeling using the WRF model, ice accretion modeling for specific turbine types, and a machine learning model trained on high-resolution operational data from wind farms located in harsh cold climate conditions in the Nordics. This approach allows the translation of project-specific climate conditions modeled with WRF, project-specific ice accretion, and, when available, local measurements into ice production loss estimates and long-term correction methods for model results. The WICE 2.0 model has been validated in the Nordics and applied across diverse climatic and operational contexts worldwide, including the USA, Canada, Central Europe, the Balkans, and some countries in the Middle East, demonstrating strong performance.

Building on these experiences, DNV has introduced the new WICE 2.5 model, an update from WICE 2.0, and extended its validation using atmospheric, terrain, and operational data from non-Scandinavian regions to improve accuracy in diverse locations. This includes data from various representative sites in North America and Northern Europe, extending the prediction capabilities of WICE 2.5 to distinct climatic, operational, and topographic conditions. Furthermore, the forcing WRF dataset was updated from ERA-Interim to ERA5, and the estimation of icing losses in the training data was improved by combining IEA Task 19 and DNV's methodologies.

Results showed that training the model with region-specific operational, climatic, and topographic data, and better icing labelling on the training data led to more accurate predictions of energy losses due to icing compared to the previous model trained solely with Nordic data. Consequently, the uncertainty in loss predictions can be reduced when the model is trained with data representative of the intended application region. The model can also continuously improve based on further validation and operational data.

This presentation will introduce the WICE model, following by the model update done in 2025, present validation results, and offer an outlook for ongoing and future improvements efforts to ensure the model's applicability across global markets.

Web site: https://www.dnv.com/services/wice-icing-loss-assessment-157379/

Short biography: Luis is a Senior Engineer at DNV in the Northern Europe Project Development and Engineering Team, with 14 years of professional experience in the energy sector. He began his career as an Electrotechnical, Data Analyst Engineer, and project management in the oil and gas industry, earning a master's degree in Oil Industry Management in Chile during this period.

Over the past seven years, Luis has focused on the energy transition, leveraging his expertise in data analysis, software development, and project management to support the shift from fossil fuels to renewable energy. In 2020, he completed a Master of Science in Renewable Energies in Germany with a merit thesis about using machine learning for wind speed vertical extrapolation.

Since joining DNV, Luis has specialized in analyzing wind farm operational data to assess its performance and forecast energy yields. He leads the Icing Climate Assessments group, developing advanced analytical

R&D areas/s: A) Wind, AI

tools for onshore wind farms in cold climates and supporting turbine and ice protection system manufacturers with validation works.
In addition, Luis is actively involved in innovation projects, driving digitization within his team and developing software for wind farm analysis aligned with German regulatory frameworks. He has also contributed to research groups, specializing in data analysis and machine learning for solar and wind technologies.

Outside of work, Luis enjoys bikepacking on his gravel bike, bouldering and has recently taken up kickboxing. During his stay in Sweden for WinterWind 2026, he will take his first experience skiing hoping to make it back home without too many bruises.

R&D areas/s: A) Wind

Keeping Blades Ice-Free: Inside the Vestas Anti-Icing System

Stephen Jude Buggy, Vestas Technology, UK

Vestas, UK

The Vestas Anti-icing System (VAS) is designed to mitigate ice formation on Vestas wind turbines operating in cold, ice-prone environments where icing can negatively affect annual energy production. Integrated into specific turbine models—such as the V162 6.5MW—VAS targets the key aerodynamic areas of the blades to target achieving ice-free surfaces, thereby minimising aerodynamic losses and improving energy output.
VAS utilises sensor-free electrothermal heating elements embedded within the blade structure to actively remove ice. The operation and monitoring of VAS are fully embedded in the turbine's control system, and it is automatically triggered via SCADA-based plant control (IceControl). Activation is based on ice detection technologies such as Power Curve Ice Detection (PCID), Global Ice Detection (GID), or Vestas Ice Detection (VID). Manual activation is also available to meet specific operational requirements.
This presentation outlines several design features of VAS, including its built-in redundancy, lightning protection, and potential performance gains through faster ice detection methods. It also reviews the metrics used to assess system performance and discusses some of the challenges associated with interpreting these indicators.

Web site: https://www.linkedin.com/in/judebuggy

Short biography: Stephen Buggy, PhD, CEng, MIET
Stephen Buggy is a Chartered Engineer with over two decades of experience in renewable energy and power systems. As Functional Lead at Vestas, he drives the development of cold climate wind turbine solutions, including blade heating and condition monitoring technologies deployed worldwide. His expertise spans power and control systems, mechanical and aerothermal design, SCADA integration, and functional safety.
Stephen holds a PhD in Optical Fibre Sensors from Cranfield University and has authored multiple patents and publications in monitoring and control systems. Outside of engineering, he enjoys trail running, sea swimming, and spending time with his family.

R&D areas/s: F) Drones/helicopters

Inhousing blade inspections with drones

Kaspars Litavnieks, Perceptual Robotics, UK

Kevin Lind, LT

Wind turbine blade inspection in cold climate conditions presents unique operational challenges including icing conditions, reduced accessibility, harsh weather windows, and increased safety risks for personnel. This presentation introduces Perceptual Robotics' autonomous drone inspection system (Dhalion) and its proven deployment across various cold climate wind farms, demonstrating how intelligent automation addresses these specific challenges.

Our patented self-service autonomous system integrates high-resolution imaging (45-50MP), LiDAR sensing, and RTK positioning to conduct comprehensive blade inspections in winds up to 12 m/s. The system's key innovation lies in its ability to operate effectively in challenging Nordic conditions while reducing inspection time from traditional methods to approximately 20 minutes per turbine, achieving 10 turbines per person-day productivity.

The presentation will share operational data from deployments in cold climate environments, demonstrating:

50% reduction in inspection costs through team upskilling and automation
14% increase in damage detection rates compared to manual methods, critical for identifying ice-related damage
48-hour turnaround for AI-processed inspection results enabling rapid response to weather-related damage
Validated performance across multiple turbine models in sub-zero conditions

Our AI/ML processing pipeline automatically classifies damage types and severities, with particular emphasis on ice impact damage, erosion patterns specific to cold climates, and lightning protection system integrity. The Repair Now Ratio (RNR) algorithm prioritizes repairs considering factors such as damage progression rates, accessibility windows, and proximity-based repair grouping to optimize maintenance campaigns.

Looking forward, we will discuss our offshore roadmap including autonomous landing on vessels. The integration of this technology represents a significant advancement in maintaining wind assets in harsh climates while ensuring personnel safety and operational efficiency.

Web site: www.perceptual-robotics.com

Short biography: I am from Latvia, Riga. Bachelor degree in small business management. For the last 10 years have been working as a business development manager for companies resolving process automation with robotics and new technologies. Last 4 years I have been working in wind industry starting in company from Latvia - Aerones as a global development team lead in expanding their business globally regarding preventive maintenance of wind turbines with robotic solutions. Year ago I joined Perceptual Robotics from UK that is a technology company providing solutions to take WTG inspections back in owners and asset manager hands rather than outsourcing it. We already have a wide portfolio customers in Sweden, thanks also to previous Winterwind events. It will be my 5th event.

R&D areas/s: A) Wind

Performance evaluation of pulsed vertical profiling lidars in clean air alpine environments

Hazem Rabhi, VAISALA, FR

Hazem Rabhi (Vaisala, FR)

Vertical profiling lidars are extensively used in the wind energy industry for wind resource assessment and turbine control [1]. Wind measurements using Doppler lidars depend on the presence of sufficient aerosols in the atmosphere to provide backscatter for the laser signal [2]. In clean air conditions, where aerosol concentrations are low, the lidar signal return is weakened. This reduction in backscatter can significantly affect data availability and data quality, and it can also limit the maximum measurement range of the lidar.
This study evaluates the data availability of the WindCube v2.1 XP compared to two standard WindCube v2.1 units at two alpine sites in Austria characterized by complex terrain, high altitude (800 m and 1800 m), low aerosol concentrations, snow cover, and low temperatures. The first test, conducted from November 2024 to March 2025 at 800 m altitude, demonstrated that the WindCube v2.1 XP achieved significantly higher range-resolved data (RSD) availability than the standard units. The second test, conducted from March to May 2025 at 1800 m altitude, showed that the WindCube v2.1 XP provided slightly improved RSD availability at higher measurement heights. These results indicate that the WindCube v2.1 XP offers enhanced performance in clean air, alpine environments, supporting its suitability for wind energy applications in challenging atmospheric conditions.

[1] Gunter, W. S. (2019). Exploring the feasibility of using commercially available vertically pointing wind profiling lidars to acquire thunderstorm wind profiles. Frontiers in Built Environment, 5, 119. https://doi.org/10.3389/fbuil.2019.00119

[2] Shangguan, M., Qiu, J., Yuan, J., et al. (2022). Doppler wind lidar from UV to NIR: A review with case study examples. Frontiers in Remote Sensing, 2, 787111. https://doi.org/10.3389/frsen.2021.787111

Web site: https://www.vaisala.com/fr

Short biography: My name is Hazem RABHI, and I am an engineer with dual engineering diplomas in instrumentation and electrical engineering, as well as a master’s degree in electrical energy. With advanced skills in data science and machine learning, I am passionate about data and energy. I currently work as a Science and Application Engineer for Wind Energy at VAISALA, where I apply my expertise to create sustainable and innovative solutions. Outside of work, I enjoy cinema, jogging, and fitness training.

R&D areas/s: F) Drones/helicopters, Digital forest intrution valuation

Digital forest intrution valuation using drones and AI

Roger Öhlund, Conifer Vision, SE

Jonas Granström, Conifer Vision, SE

Conifer Vision AB is a Swedish software company offering an innovative digital solution for valuing and measuring forest areas using drones and AI. The solution fully supports standards like Skogsnorm 2018 and Swemin.

Conifers solution removes the main bottleneck of traditional forest measurement - an inefficient process that relies on manual surveying, causing results to vary in both time and accuracy depending on the forest's complexity. Instead, Conifer uses drones to efficiently capture aerial images covering the entire project area and then advanced AI image analysis detects and measures every tree, delivering precise metrics such as tree height, crown diameter, density, DBH, and volume for each site.

Key benefits:

• Complete solution: drone scanning, automated analytics, and comprehensive forest valuation reporting for each site.

• Fast and precise: One drone can survey forest areas of any size up to 400 times faster than manual methods, measuring every tree over 0.3m height with high accuracy.

• Cost-effective: significantly reduced cost with less risk than manual methods.

• Efficient project planning: high resolution digital forest models and terrain models covering the entire project footprint, including infrastructure and site layout.

• Environmental transparency: aerial images and documentation offers clear evidence of environmental impact and minimizes future risks.

• Risk minimization: Transparent documentation of forest status at the time of valuation eliminates future disputes with landowners and stakeholders.

• Validated performance: Conifer's system already tested and used for land valuation in other major infrastructure projects, such as transmission corridors.

Web site: www.conifervision.com

Short biography: The forest has been a part of Rogers family for generations and Roger himself is an enthusiastic forest owner with a great interest in forest management. His strong interest in forestry lead to the founding of Conifer Vision in 2019.

As founder of Conifer Vision Roger is the driving force behind Conifer's AI-platform and forest analysis frameworks adapted for forest analysis and valuation. In collaboration with clients such as Svenska Kraftnät, Boliden, Billerud, SCA, Sveaskog and Norra Skog Roger has been responsible for delivering digital solutions regarding planting, clearing, thinning, felling, valuation and carbon credits. Roger is also involved in Conifers collaborations with university and research organizations like the Swedish agricultural university (SLU), Skogforsk, Skogstekniska klustret and Mistra Digital Forest.

Roger holds a master's degree in engineering physics and a bachelor's in space technology. He has held leading roles in business development, technology, and sales at Ericsson, Tieto, and Skellefteå Kraft where he was responsible for evaluating business opportunities related to renewable energy and hydrogen, as well as to drive the growth of renewable energy production and develop sustainable strategies for the future.

R&D areas/s: A) Wind

Powering a neutrino telescope with renewables at Summit Station in Greenland

Vera Schorbach, Hamburg University of Applied Sciences, DE

Anna Nelles (DESY, DE), Allan Hallgren (Uppsala University, DE), Dirk Heutelbeck (Hamburg University of Applied Sciences, DE), Pascal Schriefer (Friedrich-Alexander-University Erlangen-Nuernberg, DE), Nils Heyer (Uppsala University, SE), Nils Bingefors (Uppsala University, SE), Eric Oberla (University of Chicago, US)

In this abstract we introduce our research project which is just at the very beginning.
The Radio Neutrino Observatory in Greenland (RNO-G) is located at Summit Station at a height of 3231m (72° 36′ N, 38° 25′ W). Its main purpose is the detection of high energy neutrinos coming from yet unknown cosmic ultra high energy sources, such as accretion in supermassive black holes at the center of a galaxy.
At the moment, the telescopes consists of 8 stations reaching 100m deep into the ice. Upon completion it will have 35 stations with a spacing of 1.25km between each other. Powering the antennas with cables from Summit Station is not possible, so each station must produce its own electric power of about 25W.
The energy concept consists of 240 W of photovoltaics, a battery storage of 5.2kWh deep cycle gel batteries, and a wind turbine which must still be optimized because of icing. [1]
So far, two different wind turbines have been tested on the site: two Savonius tandem turbines with a power of max. 60W [2] and a horizontal axis turbine with a power of 500W.
Despite the favourable wind speeds [3], no turbine has been able to produce sufficient power during winter. Because of the high latitude of 72°, solar power is also suffering in winter so that the telescope is almost down for half of the year.
The current idea is to develop an active anti-icing system. This is quite challenging as there are very strict EMC requirements to fulfil as the turbine should not produce any EM-waves which may disturb the telescope.
Actually Summit Station is quite an attractive site from a wind speed point of view. . However, temperature in winter can easily be below -50°C [1].
From a wind turbine perspective it is most special that our main focus is not energy yield. Instead it is simply keeping the turbine in operation. For this project it would be acceptable if the major amount of energy yield from the turbine is used for the anti-icing system as we only require a mean power of 25W for each antenna of the telescope. The outcome of our project will certainly not be a candidate for the mass market of small wind turbines but very attractive for many remote locations under extreme conditions where icing is an important problem.

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Web site: https://haw-hamburg.de/

Short biography: since 2016 professor for wind energy and virtual product development at HAW Hamburg
2012-2016 research associate at HAW Hamburg and PhD in Engineering at University of Wuppertal: PhD topic: teeter end impacts on two-bladed wind turbines
2011-2012 PhD scholarship from Pro Exzellenzia Hamburg
2009-2011 M.Eng.,RenewableEnergySystems HAW Hamburg
2003-2009 Development Engineer for Fuel Cell and Electric Vehicles at Daimler, Sindelfingen
1999-2002 B.Sc. Mechanical Engineering at Baden-Württemberg Cooperative State University

R&D areas/s: A) Wind, E) Offshore

Predicting energy production and icing losses in operating wind farms with AFRY DAPS – physics-based and data-driven modelling, parameterization and weather forecasts

Helmi Uusitalo, AFRY Finland Oy, FI

Helmi Uusitalo (AFRY, FI), Riku Suutari (AFRY, FI)

Prediction errors in operating wind farms can cause significant challenges in wind power production, such as increased costs and grid stability issues, especially during icing events in cold climates. These challenges in icing loss forecasts often occur simultaneously across multiple wind farms, leading to problems with energy availability and high imbalance costs, due to unexpected icing losses.

According to AFRY's development, wind farm production and icing losses can be accurately predicted for the following day using advanced physics-, research-, and data-based modelling techniques. Normal production simulation methods rely on historical production and measured weather data of the wind farm, real-time measured SCADA data, weather forecasts, quantile regression and weather calibration models, to achieve accurate intraday and next day production forecasts.

Ice formation can be categorized into in-cloud and precipitation icing, including different icing types such as glaze, rime ice and wet snow [1]. Icing types affect the conditions and severity of icing events in wind farms, making it essential to consider their impact on production losses separately in forecast models. Especially during glaze events, ice formation may halt wind farm production entirely, making it crucial to focus on the points of ice release in forecasts - i.e. the exact timing when ice detaches from turbine blades, significantly affecting production.

AFRY's development of wind farm icing modelling [2] enables accurate icing loss forecasts by applying ice accretion physics [3], historical SCADA data, weather forecasts, and parameterization, considering ice-release points and different ice types. Development approach combining physics and data-based parameterization solutions makes it possible to optimize forecast simulation models allowing the consideration of specific wind farm specifications, turbine types, collision, sticking and accretion properties of turbine blade surface materials, local weather conditions, and potential ice prevention systems.

With AFRY's production and icing forecast approaches, forecast errors can be considerably reduced by accurately forecasting normal production and predicting nearly all icing events. This enables reliable forecasts, improved grid stability, and avoidance of high regulating costs in energy markets. Despite the complex nature of icing phenomenon and its connection to various weather conditions, years of development have resulted in accurate production and icing loss forecasts for all types of operating wind farms.

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Web site: https://afry.com/en/service/afry-daps

Short biography: Helmi Uusitalo (M.Sc.) from AFRY's Wind & Solar Development and Engineering unit has a background in Engineering Physics (Advanced Energy Technologies) from Aalto University. She has developed wind farm icing modelling in her Master's Thesis (Analysis and Modeling for Predicting Icing Losses in Finnish Wind Power Production, Aalto University, 2022) and continued the icing and production forecast modelling development in AFRY after completing her studies. Prior to AFRY, Helmi worked in University of Helsinki in Institute for atmospheric and Earth system research studying new particle and droplet formation in atmosphere. Helmi has experience of many years from wind power analyses, R&D areas/s: A) Wind, E) Offshore

measurements and modelling, as well as development related to icing and turbine operational data. Helmi has long been very interested in wind power forecasts and icing being one of the most complicated phenomenon in wind power production, that is difficult to predict. The challenge has led her to a development journey to better simulate, understand, and predict the effects caused by ice accretion and breakage from the wind turbines.

R&D areas/s: A) Wind

Availability of wind-LiDAR measurements at alpine locations

Alexander Stökl, Energiewerkstatt, AT

Alexander Stökl & Claas Rittinghaus (both Energiewerkstatt, AT)

Wind-LiDAR measurements at alpine sites can be severely affected by low availability, in particular during winter. This is most likely caused by clean-air conditions at greater elevations stemming from the lack of vertical mixing processes in the stable atmosphere conditions prevalent during wintertime.
The presentation will discuss results from a comparison of availability from Austrian sites at alpine locations with sites in more even terrain at lower altitudes. In this comparison, the availability at the mountainous sites in winter was on average less than 50%, whereas at flatland sites the availability remained in the order of 90% throughout the year.
To investigate the effect of the measurement principle of the LiDAR measurement on the availability, a measurement campaign at an Austrian alpine site with a parallel operation of both a continuous wave LiDAR and a pulsed LiDAR was carried out. This campaign also provided additional insight, as the measurement period coincided with several Sahara dust events, where air masses from north Africa caused episodes with very high aerosol concentration.
These studies have been performed as part of the Austrian participation to IEA Wind TCP Task 52 (formerly Task 32).

Web site: energiewerkstatt.org

Short biography: Alexander Stökl earned his PhD in astrophysics and has worked in this field for many years, mostly on fluid dynamics and numerical methods.
In 2018 he joined Energiewerkstatt, where his responsibilities include risk assessments and wind energy research projects.
His research interests in wind energy focus on the specific challenges facing the Austrian Wind energy. This includes meteorological icing on wind turbines and wind-LiDAR measurements at alpine sites.
His personal interests include aviation and he holds a private pilot's license.

R&D areas/s: A) Wind

Sensitivity analysis and recommendation of wind turbine risk assessment parameters

Alper Sevim, DNV, DE

Lennart Hawmann (DNV, DE), Christoph Schmidt (DNV, DE), Ferhuda Birge (DNV, DE)

Wind energy is a key driver of the global renewable energy transition, with installed capacity growing rapidly each year. Despite being a mature and advanced technology, turbine failures cannot be completely eliminated. Furthermore, increasing rotor diameters and hub heights expand the potential impact area for ice throw and ice fall. As wind farms are often located near existing infrastructure or inhabited areas, it is essential to assess the associated risks and determine whether they remain within acceptable limits. Several standards and guidelines, such as IEC 61400-31 "Wind energy generation systems – Part 31: Siting risk assessment" [1], IEA Wind TCP Task 19 -International Recommendations for Ice Fall and Ice Throw Risk Assessments [2], Handboek Risicozonering Windturbines [3], and the Wind Turbine Manual – Guidelines for the Risk Calculations of Wind Turbines [4], provide models and recommendations for evaluating potential failures and their impacts in the vicinity of turbines. However, parameter settings for these simulations often rely on the assessor's experience and judgment, which can lead to significant variability in results.

To address this, we developed a software for wind turbine risk assessments and conducted a sensitivity analysis for various turbine failure and ice throw scenarios, examining their influence on hit probability, effective range, and impact distribution. Model parameters were adapted based on publicly available data [5], research projects, and field observations [6]. Based on these findings, we developed recommendations for parameter settings across different failure scenarios, aiming for conservative yet realistic outcomes to support robust and reliable risk assessments.

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Web site: www.dnv.com

Short biography: Alper Sevim has over a decade of experience in the wind turbine industry, with a strong technical focus on rotor blade development, structural and aerodynamic optimization, and system validation. He has held engineering and research roles at a leading wind turbine manufacturer and the Fraunhofer Institute for Wind Energy Systems, contributing to advanced blade projects such as Smart Blades, which explored bend-twist coupling for load reduction. His expertise includes sensor integration, data analysis, FEA-based design, and innovative monitoring solutions, supported by publications and patent activity. He has also been involved in the development of aircraft detection lighting systems for wind turbines, enhancing acceptance and compliance in wind farm operations. Currently, he works as a Senior Consultant at DNV and serves as a lecturer at the Hamburg University of Applied Sciences, reflecting his continued commitment to advancing wind energy technology. Outside of work, Alper is an avid cyclist who enjoys exploring new routes and staying active on two wheels.

R&D areas/s: A) Wind

Operational envelopes for the design, sourcing, and operation of IPS

Dylan Baxter, FabricAir, CA

Dylan Baxter (FabricAir, CA)

A common challenge in cold climate wind energy is how to compare, test, and operate different Ice Protection Systems (IPS) on different sites, in different weather, and on different turbine models. The "operational envelope" is one way to describe IPS performance. In this work, we expand the envelope concept and show how it can give several important insights depending on how the data is viewed.

We use our in-house model together with real data from Canadian turbines before and after they were equipped with the Borealis IPS. First, we look at average and local leading-edge blade temperatures for turbines at idle and at full RPM with the IPS running at full duty cycle. Then we reverse the analysis to ask: what RPM is needed for blade temperatures to reach important thresholds under full duty operation? We also study how IPS duty cycle levels interact with turbine RPM to meet those thresholds, which tells us how much power the IPS will consume under different conditions. Finally, we explore other less common and less developed results, such as how long it takes to remove ice during idle and the potential risk of ice throw.

The same dataset can support many users. IPS designers can use envelopes to adapt systems for new turbines or sites. OEMs can use them to refine "give-up" and "retry" control logic and connect with icing sensors. Asset managers can use them to estimate IPS power use at their site and to predict turbine output during and after icing events.

By presenting operational envelopes as a clear and repeatable tool, this work gives the wind energy community a shared way to compare IPS performance, set realistic expectations, and make better technical, financial, and operational decisions in cold climate projects.

Web site: https://www.linkedin.com/in/baxterdylan/

Short biography: Dylan Baxter, P.Eng., is an engineering leader with over 10 years in the wind industry, specializing in the design, optimization, and operation of Ice Protection Systems (IPS). As a founding member of the BorealisWind product, his experience spans R&D in electrical, mechanical, controls, and SCADA systems, as well as analytics, safety (HSE), operations, and organizational leadership. He has led multidisciplinary and international teams to deliver end-to-end solutions for cold-climate wind turbines. Outside of work, he enjoys backcountry skiing in the winter, backcountry camping in the summer, and spending the rest of his time traveling or renovating his home.

R&D areas/s: A) Wind, F) Drones/helicopters

Micro-CT imaging of icing on wind turbines, drones and marine structures

Sönke Maus, Norwegian University of Science and Technology NTNU, NO

Sönke Maus (NTNU, NO)

Icing and ice adhesion are major safety issues for onshore and offshore operations and practical solutions to deal with icing problems in everyday life are well established. Examples are the chemical treatment of manned aircrafts prior take-off, safety procedures as reaction to snow and ice on roads, and the incorporation of icing forecasts into many standard weather forecasting models. For other, relatively young applications, in particular icing on wind turbines, drones and offshore structures, there is still need for experimental and theoretical development. A challenge in these fields is that, depending on the environmental conditions and velocities of operation, ice with quite different microstructure and properties may form. To establish icing prevention and removal standards one needs to understand the interaction of this microstructure with the surfaces on which it grows.

3D micro-CT tomography (µ-CT) has emerged as a powerful method for 3D material characterization, and is now increasingly used to study the 3D details of ice growth and formations. Very recently it has also been demonstrated as a useful tool to image icing on airfoils, wind turbines and offshore structures. In the present talk I will give an overview of such imaging activities at the Norwegian Centre of Nanoscale X-ray Tomography (NEXT, X-ray hub at NTNU) and show 3D micro-CT observations of icing structure under a variety of conditions, including frost damage in concrete, the formation of marine sea spray ice, drone icing in a wind tunnel. A recent highlight is the application of synchrotron-based time-lapse tomography, a technique that allows the 3D imaging of ice growth with a few seconds temporal resolution. These experiments provide novel insights into droplet and spray ice growth on different surfaces (alumina, PVC, anti-icing coatings) and help to understand icing, ice adhesion and its dependence on ice microstructure and growth conditions. I propose and discuss future applications of these methods for future development of anti-icing materials and icing prevention for drones, wind turbines and offshore structures.

Web site: https://www.ntnu.no/ansatte/sonke.maus

Short biography: I am genuinely interested in ice, its physics and role in the environment. Educated as physical oceanographer (University of Hamburg, Germany) I have approached sea ice from the ocean and based on topics related to sea ice physics in the climate system. For my Phd (University Bergen, 2007) I studied sea ice microstructure and crystal growth to improve the understanding of sea ice properties on a fundamental level. During the following years as Researcher and associate Pofessor (University Bergen, 2007-2013) I started working with X-ray imaging of ice and snow, in the lab and at synchrotron radiation facilities. This research has always been guided by the challenge to incorporate micro-scale sea ice physics into larger scale models of ice-atmosphere-ocean interaction, climate and engineering applications.

In the coming years I had a short break from research as a consultant (2013-2014, www.sea-ice.no) and have since 2015 been working at the Department of Civil and Environmental Engineering (IBM) of the Norwegian University of Science and Technology (NTNU). Here I extended my expertise to applied engineering problems where ice and sea ice microstructure is relevant, e.g. sea-ice-oil interaction, sea spray icing, frost-concrete interaction, as well as sea ice microphysics related to Arctic climate (MOSAiC expedition, https://mosaic-expedition.org/). I am currently coordinating the MICROSPRAY project (Microstructure of sea spray ice, RCN-Norway, 2020-2025, with industrial partners like Equinor), where synchrotron-based results have opened new paths in understanding the formation and properties of sea spray ice.

My personal interests are hiking, cross-country skiing, music and cooking. I am engaged in disseminating ice and climate research to school kids and the general public, and convinced that human being in the richer states of the world need to change consumption and life style to create a better and sustainable world.

R&D areas/s: A) Wind

Improving Site-Specific Wind Turbine Icing Estimates for Risk Assessment

Gerlinde Jung, F2E Fluid & Energy Engineering GmbH & Co. KG, DE

Rebecca Bode (F2E, DE), Daniela Schumann (F2E, DE), Yannick Külper (F2E, DE), Thomas Hahm (F2E, DE)

Assessing the risk that ice throw and ice fall from wind turbines pose to people and society requires reliable, location-specific estimates of icing conditions.
The site-specific frequency of icing events, the resulting ice mass that builds up on the rotor of a wind turbine and the potential number of ice fragments shed from the turbine are key parameters for any robust risk assessment. These factors directly influence the results of ice throw modeling and, consequently, the definition of safety zones, operational strategies during icing conditions, and the development of effective mitigation measures.
Various methods are currently used to determine site-specific icing frequencies and to translate them into turbine-specific estimates of ice mass on the rotor and/or the potential number of ice fragments falling from the wind turbine. However, widely used approaches in risk assessment exhibit several limitations, for example an insufficient consideration of the full range of relevant meteorological variables that influence ice formation at a specific site and hub height.
In this work, we introduce a new approach for estimating wind turbine icing, in order to enhance the quality of risk assessments.
We determine general icing conditions for Central Europe, based on data from the New European Wind Atlas (NEWA) (Dörenkämper et al., 2020). The NEWA dataset is derived from long-term mesoscale meteorological simulations using the Weather Research and Forecasting model (WRF), equipped with an icing module based on the Makkonen ice growth model (Makkonen, 2000).
By combining NEWA data on ice accretion on a Makkonen cylinder with generalized assumptions regarding rotor blade geometry and limited observational data (e.g. IEA, 2022), we develop a robust method for estimating ice mass and fragment numbers for use in ice throw risk assessments.
We further discuss the improvements, advantages, and remaining uncertainties of our method, and evaluate its performance through comparisons with standard approaches in selected case studies.

Web site: www.f2e.de

Short biography: Gerlinde Jung is a meteorologist working as a consultant at Fluid & Energy Engineering (F2E) located in Hamburg, Germany. She studied Meteorology at the University of Innsbruck (Austria) and received her PhD from the University of Augsburg (Germany). After working for almost 20 years in climate research she moved into industry to actively contribute to the energy transition. Her research topics ranged from land-atmosphere feedback mechanisms and the impact of climate change on hydrology in West Africa over the global transport of air pollutants to plaeoclimate research of the late Miocene. As a consultant at F2E, she focuses primarily on risk assessment related to ice throw/fall and component failure.

R&D areas/s: A) Wind

IEA Wind Task 52: Advancing Wind LiDAR in Cold Climates

Sara Koller, Meteotest, CH

Sara Koller (Meteotest, CH)

The IEA Task 52 focuses on the Large-Scale Deployment of Wind LiDAR. Wind LiDARs are a crucial measurement technology in the wind industry, used for applications like energy yield assessments, power performance measurements, or as a permanent wind measurement on operational sites. Therefore, reliable, year-round operation of LiDARs is essential.
The LiDAR in Cold Climate working group has two primary objectives: improving LiDAR data availability in cold climates and detecting icing with LiDAR. The group addresses the following key questions:

- What causes low data availability in cold climate regions?
- How can data availability be increased in these regions?
- Are LiDARs suitable for detecting meteorological icing?
- Is it possible to estimate ice classes from LiDAR data?

Data availability can sometimes drop to as low as 30% in the winter season, compared to 90% during the summer at the same location. However, applying artificial intelligence, physics-based methods, or making mechanical modifications to the laser can increase data availability by up to 40%. Progress has also been made in meteorological icing detection with wind LiDARs by using ceilometers to analyze cloud phases. The results of this three-year project will be presented at the Winterwind 2026 conference.

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 worked in the wind department at Meteotest in Switzerland. In 2020, she was appointed head of the Wind & Ice team. Meteotest represents Switzerland in IEA Tasks 54 and 52, where Sara is an active member of the LiDAR in Complex Terrain working group and leads the LiDAR in Cold Climate working group for Task 52. With 16 years of experience, wind in all its aspects has been her primary focus. In her second life, Sara is a performance artist.

R&D areas/s: A) Wind

Field Validation Nordex Delta4000 Anti-icing System

Nils Lehming, Nordex, SE

Nils Lehming (Nordex, SE & DE)

Nordex has accumulated 16 years of experience in installing and operating wind turbines equipped with rotor blade Anti-Icing Systems (AIS). Over the past 16 years, we have presented performance data from earlier AIS generations used on the 2.5 MW and 3.X MW turbine platforms. This presentation marks a significant milestone, as we now share the first performance results from our Delta4000 series turbines featuring the latest AIS technology.
Although the first AIS-equipped Delta4000 turbine was commissioned in 2019, a robust performance evaluation requires several years of operation to ensure a meaningful sample size. The current analysis includes data from six wind farms in Finland, comprising a total of 46 turbines—specifically, the N149/4.X and N163/5.X models. The results provide valuable insights into the effectiveness and reliability of the new AIS generation under demanding cold climate conditions.

Web site: https://nordex-online.com/

Short biography: Nils Lehming is a Senior Product Manager at Nordex SE, specializing in the development of onshore wind turbine platforms. With over 20 years of engineering experience across automotive and renewable energy sectors, he currently manages the Delta 3.X MW and Delta4000 4.X/5.X MW product portfolio. His work includes innovations such as the Advanced Anti-Icing System (AIS) for rotor blades. Nils holds engineering degrees from the Polytechnic University of Lübeck and the Milwaukee School of Engineering.
One of Nils personal interests is sailing and classic cars.

R&D areas/s: A) Wind

Quantitative metrics for icing events severity assessment

Charles Godreau, Nergica, CA

Charles Godreau (Nergica, CA)

Icing events affecting wind farm operation come in various categories of severity. Some are mild events, leaving only a few millimeters of icing on the blades, while some others can leave over 50 millimeters of icing and disrupt the energy production for days. With the wider adoption of wind energy in cold climate regions, severe icing events have affected the energy price when the wind energy supply was compromised.

In recent years, Nergica has been gathering icing events data at its research site in Gaspé, Quebec, Canada, while comparing it with the energy production of its wind farm. Several quantitative indicators have been compared to identify which ones are correlating with severe production losses.

To tackle some of the current challenges with wind energy in icing climates, those retrospective indicators have been compared to 48 h ahead forecast data to identify the signature of severe icing events before they happen. This type of information can inform pre-emptive control strategies as well as day-ahead energy trading decisions.

The same data has also been leveraged to document the ice shedding mechanism to help the development of optimized ice-phobic coatings.

The presentation will cover the experimental data gathered, compare quantitative metrics to icing losses, discuss the identification of severe icing events in forecast data and provide insights on the ice shedding mechanism.

Web site: https://www.linkedin.com/in/charles-godreau/

Short biography: Charles Godreau specializes in wind turbine performance assessments in cold climates as well as icing detection and protection systems. He possesses strong skills in data analysis for operational turbines as well as for developing, planning and implementing research project. He notably represents Canada in the International Energy Agency’s Task 54 working group on wind energy in cold climates and is an active member of Winterwind's program committee. In his free time, he enjoys improv and splitboarding.

R&D areas/s: A) Wind

From Landline phones to Smartphones: Rethinking Icing Measurements for the Site Assessment of Modern Wind Farms

Patrice Roberge, Icetek, CA

André Bégin-Drolet (Université Laval, CA)

In the last decades, double anemometry has been the standard way to do icing impact estimation during site assessment by measuring instrumental icing. It was reliable, straightforward, and good enough for its time, like a landline phone. But wind turbines have changed, with blade heating and ice operation modes now common, we need methods that can keep up.
Double anemometry only shows how long ice stays on sensors. That doesn't always reflect what happens on the rotor, where heating systems often remove ice much faster than nature clears the instruments.
Meteorological icing, on the other hand, tells us something more useful. By measuring the liquid water particles in the air, it gives a direct read on both icing risk and heating efficiency. It is a major improvement, more like the smartphone of site assessment.
Adding these kinds of measurements to field campaigns helps capture local effects that models alone can miss. In this presentation, turbine performance is compared to both instrumental icing from double anemometry at nearby masts and meteorological icing measured by state-of-the-Art sensors. This presentation explores why it is time to hang up on outdated methods and dial into a new standard of precision for the site assessment process of modern wind projects.

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 10 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 now works at Icetek as the Lead Data Scientist where he helps operators understand precisely why their assets are struggling in icing conditions and provides solutions to improve their performance. 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 football, skiing, snowshoeing and trekking.

R&D areas/s: A) Wind

WORKSHOP: IEA Task 54: Wind turbine and blade heating performance subtask, IceLossMethod 2.0 and new site Icing classification update

Patrice Roberge, Icetek, CA

Timo Karlsson (VTT, FI), Michaël Morin (Nergica,CA), Jennifer Pettersson (Vattenfall, SE), Charles Godreau (Nergica, CA), Jennie Mollinder (Kjeller, SE), Marie-Cecilie Pederson (EMD, DK), André Bégin-Drolet (Université Laval, CA)

The assessment of production losses from icing is a vital part of different processes for wind energy in cold climates. Accurate loss assessments are critical for tracking asset performance, evaluating icing solution performance, validation of site assessment studies and much more.
In 2016, IEA Wind Task 19 (now Task 54) released the IceLossMethod, a public tool for assessing historical production losses due to icing. Its goal was to provide a standardized approach for comparing losses across sites, validating IEA ice classes, evaluating Ice Protection System efficiency.
The method uses SCADA data and power curve analysis, following three steps:
1. Define a reference power curve with non-iced data.
2. Identify icing event start/stop times.
3. Calculate production losses for each event.

The method is now widely applied internationally, with many adaptations and studies based on it.
Building on this experience and the feedback that we received from last year's workshop, IEA Task 54 is preparing the IEA Wind IceLossMethod 2.0, inviting users and experts to share insights on improvements, adaptations, and threshold settings.
The main challenges addressed, and features added are:
- Refactoring the code (Numpy arrays to Pandas DataFrames) to make it easier to modify. This is done in a modular way where different modules can be added or subtracted.
- Adding an importation module to help the transition from specific files to a formatted input. This part includes a UI to make it more accessible.
- Streamlining the data filtering process to allow iterative processes of filtering
- Add modules to evaluate the quality of the data set and power curve.
- Allow users to share additional modules to the open source code to bonify the use cases (Repository on GitHub).
- Keep the features available in the old version, the main logic of the code would remain the same. The focus is to improve data quality and indicators of potential issues.
- Allow multi-turbine/wind farm calculation.
- Speed up calculations.
- Clear and simple documentation that will allow any user to use the code.
- Structured timeseries output with icing events flagged and other intermediary steps visible to allow users to make deeper analysis.

The workshop will end with an open discussion about the upcoming redefinition of IEA Icing classification. The goal is to gather ideas and focus points to work on for the revision of the ice classes that will happen in the next year.

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

Short biography: The mission of Task 54, Cold Climate Wind Power, is to improve the largescale deployment of cold-climate wind power in a safe and economically feasible manner.

R&D areas/s: A) Wind

SCADA, Icetek IC-1 and Ceilometer - Agreement or discrepancies?

Franziska Gerber, Meteotest, CH

Franziska Gerber, Fabian Umbricht, Sara Koller (Meteotest AG, CH)

Icing in complex alpine terrain is a challenge for wind energy. There are different techniques available to detect and measure the icing conditions. However, measuring icing remains difficult. To improve the understanding of the icing conditions in the cold climate of the Alps in Switzerland an Icetek IC-1 sensor was installed on a wind turbine. In addition to the Icetek IC-1 sensor a Vaisala CL61 Ceilometer was installed in the vicinity of the turbine.

The data is analyzed to characterize the icing conditions in the alpine cold climate which allows to improve the understanding of the wind turbine behavior. The combination of SCADA data, Icetek IC-1 sensor data and ceilometer data allows to compare different icing measurements and to validate various approaches. Discrepancies are investigated through image analysis of a webcam installed on the turbine. Overall, the study provides valuable insights into different icing measurement techniques and their pros and cons.

Web site: https://meteotest.ch/

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 spends time with her family most preferably in the nature.

R&D areas/s: A) Wind

Physical models versus machine learning methods in day-ahead icing forecasts

Mona Kurppa, Kjeller Vindteknikk/Norconsult, FI

Mona Kurppa (Kjeller Vindteknikk/Norconsult, FI), Christoffer Hallgren (Kjeller Vindteknikk/Norconsult, SE), Sigmund Guttu (Kjeller Vindteknikk/Norconsult, NO)

In cold climates, icing on wind turbines is a major source of production losses, second only to wake effects. Accurate forecasting of icing losses during operation is essential to predict energy imbalances and minimize economic costs in energy trading in the winter months.

Traditional icing models are typically built on top of numerical weather prediction (NWP) models. These models face challenges due to limited spatial resolution, complex local topography, and imperfect parametrizations -- especially in cloud microphysics schemes. Icing is inherently more difficult to model than wind, as it involves sensitive microphysical processes where small changes in temperature or humidity can determine whether ice accumulates on turbine blades.

At Kjeller Vindteknikk/Norconsult, we have extensive experience in physical modelling of turbine icing. Traditionally, the power loss due to icing has been calculated using a three-dimensional power curve that considers the effect of ice mass and icing intensity on the turbine blade to the power production. This method we call the reduction matrix method. Our recent developments include implementing a machine learning (ML) method to model power loss. While the reduction matrix implements static historical relationships, the ML approach dynamically learns from data, capturing complex patterns that physical and linear models may miss. By integrating ML techniques with physical models and the reduction matrix method, we aim to create hybrid models that utilize the strengths of both approaches.

Our IceLossForecast provides intraday and day-ahead icing forecasts to support stakeholders in the power market. It uses downscaled NWP data from the global GFS and ECMWF weather models. The downscaled forecasts provide high-resolution capabilities and advanced microphysics schemes, forming a strong foundation for physical modelling. IceLossForecast employs an ensemble approach to address forecast uncertainty related to, for instance, the cloud positioning and hub-height air temperatures. This ensemble helps quantify the range of possible outcomes and improves robustness.

To further enhance accuracy, IceLossForecast incorporates real-time SCADA data from wind turbines. This allows the model to tune forecasts based on observed turbine performance. ML techniques are particularly well-suited for this task, as they can continuously learn from new data and refine predictions. The integration of SCADA data exemplifies how ML can complement physical models by improving responsiveness to changing atmospheric conditions.

IceLossForecast has demonstrated improved day-ahead wind energy production estimates for individual wind farms, national electricity price areas, and grid operators in cold climates.
In my presentation, I will compare physical and ML-based modelling approaches, discuss their respective benefits and limitations, and demonstrate how site-specific SCADA tuning and ML techniques can be integrated into an existing icing production loss modelling chain. We will also explore the requirements for a robust icing model, current challenges, and future development plans.

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

Short biography: Mona Kurppa works as a Senior Advisor and Team Leader at Kjeller Vindteknikk, part of Norconsult, where she combines her scientific background with a passion for renewable energy and data. After earning her PhD in Atmospheric Sciences from the University of Helsinki in 2020, she entered

R&D areas/s: A) Wind

the renewable energy field to explore her passion for wind and green energy. Her technical work focuses on icing forecasting. When she’s not working, Mona enjoys biking, running, and discovering the world with her two kids.

R&D areas/s: A) Wind

IEA Wind Task 54: Global cold climate wind market size

Timo Karlsson, VTT, FI

Timo Karlsson et al (VTT, FI)

Cold climate conditions are increasingly popular locations for onshore wind. Good wind conditions, sparse population and higher efficiency provided by colder temperatures mean that these locations remain attractive for wind installations also in the future.

The true size of the cold climate market can be interesting to many people and companies in the industry. Understanding the market potential in different countries can be crucial for estimating market needs and planning future R&D and marketing efforts. For future prospects recognizing the trend of development can also be useful.

The actual size of the cold climate market can be estimated using weather data and icing atlas type tooling. The estimate is based on known wind turbine locations and estimations of icing conditions. The estimate is built using the VTT icing atlas, ERA5 reanalysis data and information of existing wind turbine installations. Since the focus is on existing markets the study will produce ana estimate on the onshore market size.

In 2020 IEA Wind Task 19 made a market study of the size of the cold climate market that included a forecast until 2025.[1] The finding s of this years' market size estimate will be compared to the forecast from 2020 and the accuracy of the previous forecast will be evaluated. Looking back on the previous market studies will also allow identifying of potential trends. Such as if the cold climate wind market has grown faster or slower than the general onshore wind market.

Future growth estimates can be done by using the estimate of the current market size and various forecasts of wind power market growth in relevant, earlier recognized cold climate markets. The growth forecast is based on published reports from WindEurope, GWEC and others.

In addition to the estimation of the size of the global cold climate wind market in 2025, an estimate of the growth of the market will be presented. Most relevant areas will be identified based on these results on a country-by-country basis.

References:
[1] Karlsson, T. (2021). IEA Wind Task 19: Climate wind market study 2020-2025. Winterwind 2021.

Web site: http://iea-wind.org/task54/

Short biography: Timo has more than a decade of experience in cold climate wind, mostly at VTT. During his time at VTT Timo has been working on numerous R&D projects related especially to wind power technology development. These projects have covered developing signal processing tools for wind turbine performance assessment and automatic ice detection, etc. He has been the Operating Agent of the IEA Wind research task on cold climate wind since 2017. He has a degree in electrical engineering.

R&D areas/s: A) Wind

Modelling and predicting wind turbine performance in cold climates

Torben Tvedebrink, Vestas, DK

Dan Beltoft (Vestas, DK), Anne Lund Christophersen (Vestas, DK)

Vestas turbines are designed to operate in diverse weather conditions, including cold climates where ice accumulation on blades can reduce performance. To quantify potential production losses, Vestas developed a site- and turbine type-specific Ice Assessment model, used for siting and after-sales campaigns.

Using SCADA data from over 8000 turbines across 650+ parks in North America, Scandinavia, and Southern Europe, we annotated 10-minute production and sensor data to identify icing hours (instrumental icing conditions) and ice losses (production loss due to icing). This annotated dataset is aggregated by park and winter season.

The Vestas Climate Library provides hourly weather time series at 3x3 km resolution, based on WRF simulations driven by ERA5 reanalysis. Covering global landmasses and nearshore areas from 2000 onward, Vestas Climate Library includes 50 surface and 25 height-varying variables. From this, we derived an ice growth model, tuned to match SCADA-derived icing hours. Ice severity is categorized into four bins, from mild to severe, based on accumulated ice growth.

For each turbine variant relevant to cold climates, we simulated blade aerodynamic polars under four common icing scenarios using a commercial ice accretion tool and CFD. These simulations reflect the observed degradation in SCADA data. The resulting ice affected Cp-curve quantify aerodynamic losses under varying ice and wind conditions.

The Vestas Ice Assessment model is based on a statistical model trained and evaluated on a subset of more than 400 of the ice annotated parks. The model expresses the ice caused power production loss in terms of differences between the turbine's baseline (non-iced) Cp-curve and the ice severity specific Cp-curves. Site and ice severity specific wind speed distribution was obtained from VCL, which combined with the difference in Cp-curves was used to predict the ice caused production losses.

The same framework evaluates the benefit of enabling Cold Climate Operation (CCO), which adjusts blade pitch to prevent stalling and improves aerodynamics under icing. CCO-specific Cp-curves are simulated to assess performance degradation under this strategy. The resulting Ice Mitigation Ratio (IMR) quantifies the value of CCO for a given site.

Model validation shows that 84% of parks fall within ±1 %-point of observed relative ice losses, and 95% within ±2 %-points. Visual comparisons of empirical and model-based power curves confirm similar degradation trends. Vestas Ice Assessment is available to customers through Vestas siting engineers and sales teams.

Web site: https://vestas.com/

Short biography: Torben Tvedebrink is a Data Science Specialist in Vestas Modelling and Analytics. He holds a PhD in statistics from Aalborg University, where he worked as an Associate Professor before joining Vestas in 2022. Before joining Vestas he worked in the area of forensic genetics, using statistical models to evaluate forensic evidence in crime cases. When Torben is away from the keyboard, he likes to spend time with his family, travel, cook and watch football.

R&D areas/s: A) Wind

Cold Climate Operation (CCO): A software-based solution for ice loss mitigation in Vestas wind turbines

Torben Tvedebrink, Vestas, DK

Dan Beltoft (Vestas, DK), Anne Lund Christophersen (Vestas, DK), Sara Siniscalchi Minna (Vestas, DK), Fabio Spagnolo (Vestas, DK)

Icing conditions pose a significant challenge to wind turbine performance, leading to reduced aerodynamic efficiency, increased mechanical stress, and substantial energy production losses. Vestas' Cold Climate Operation (CCO™) is a software-based control solution designed to mitigate these losses in ice-prone regions without requiring additional hardware investments.

CCO dynamically adjusts turbine control parameters—particularly pitch settings—based on real-time rotor icing detection. This enables turbines to maintain production during icing events, optimizing energy output and reducing downtime. Field tests conducted across multiple Northern European sites between 2020 and 2022 demonstrated an average Ice Mitigation Ratio (IMR) of 6.5% to 11.5%, with some sites achieving even higher recovery rates under favorable conditions.

Validated by third-party assessments and endorsed by DNV, CCO is compatible with a wide range of Vestas platforms and is particularly effective for sites with moderate ice losses (>2%)

Web site: https://vestas.com/

Short biography: Torben Tvedebrink is a Data Science Specialist in Vestas Modelling and Analytics. He holds a PhD in statistics from Aalborg University, where he worked as an Associate Professor before joining Vestas in 2022. Before joining Vestas he worked in the area of forensic genetics, using statistical models to evaluate forensic evidence in crime cases. When Torben is away from the keyboard, he likes to spend time with his family, travel, cook and watch football.

R&D areas/s: A) Wind

The benefits of icing forecasts in day-ahead and intraday markets: a theoretical case study from Finland

Pia Isolähteenmäki, Kjeller Vindteknikk/Norconsult, FI

Pia Isolähteenmäki (Kjeller Vindteknikk/Norconsult, FI), Ville Lehtomäki (Kjeller Vindteknikk/Norconsult, FI), Mona Kurppa (Kjeller Vindteknikk/Norconsult, FI)

Recently, accurate forecasting of wind power production has become increasingly critical for efficient market participation and grid stability as wind power continues to gain a larger share in the Nordic electricity system. In cold climates, wintertime turbine icing can cause significant production losses as ice accumulation on turbine blades reduces aerodynamic properties of blades. While icing is already considered in many production forecasts, the question of how well these icing loss forecasts perform is becoming increasingly relevant.

While forecast accuracy is commonly assessed using statistical metrics such as Mean Absolute Error or Bias, in the context of icing-related wind power production losses, it is equally crucial to consider what matters most to the end user – namely, the forecast's ability to support reliable bidding, minimize imbalance costs, and reflect actual financial impacts . In this theoretical case study, we focus on the Finnish electricity market and analyze the monetary costs of icing-related production losses for market participants with two distinct strategies – whether they act on the day-ahead market only or also in the intraday. We compare wind power production forecasts with and without Kjeller Vindteknikk's IceLossForecast and calculate the cost of forecast errors.

The results indicate that implementing IceLossForecast to the power production forecast could have reduced the cost of forecast errors by 10 % under both market strategies: day-ahead only and combined day-ahead and intraday participation. During the studied period, moments of pronounced imbalance price volatility revealed how sensitive the economic outcomes are to forecast accuracy. In such cases, being on the opposite side of the general market imbalance provided particularly beneficial, with potential gain far exceeding the average result. In summary, this study highlights the importance of evaluating forecast performance not only through statistical accuracy but also through its practical implications for market operations and profitability.

Isolahteenmaki, Pia. Assessing benefits of icing loss forecast in wind power forecasting. Master's thesis, Aalto University, 2025. https://urn.fi/URN:NBN:fi:aalto-202508196542

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

Short biography: Pia Isolähteenmäki works as an advisor at Kjeller Vindteknikk. She holds a double master's degree in Meteorology and Energy Technology and has seven years of experience as an operational meteorologist. Her work has also included research on future climate icing conditions in the Nordics. Pia is particularly interested in energy systems and markets, and in how a better understanding of weather and climate can support more efficient and sustainable energy production and consumption. Outside of work, she is an enthusiastic orienteer who enjoys challenging terrains and night races.

R&D areas/s: A) Wind

Machine learning-based estimation of ice loss for pre-construction wind energy yield assessments

Sabin Stefanov, IDCORE (Industrial Doctoral Centre for Offshore Renewable Energy), UK – a collaboration between University of Edinburgh, University of Strathclyde, Swansea University, University of Exeter and the industrial partner Wood Group.

Sabin Stefanov (IDCORE, UK)

Ice accretion on wind turbine blades is a leading cause of energy losses in cold climates. Notably, previous studies have identified icing as the most significant contributor to energy loss in such environments - surpassing losses due to operational interventions and high winds (Jesus Maria Pinar Perez, 2016). Additionally, the occurrence and impact of icing on energy yield are governed by complex and nonlinear physical processes (Fahed Martini, 2021), making ice loss estimation particularly challenging. This uncertainty carries significant implications for wind energy development, complicating strategic decisions such as site selection and the evaluation of de-icing system viability.

To address this, a data-driven model has been developed to estimate ice-related production losses using only meteorological data. Unlike traditional approaches that rely on variables such as liquid water content and droplet size - parameters that are rarely measured and difficult to model (Bengt Sunden, 2015) - this method relies on accessible inputs that can be estimated under lower uncertainty - specifically temperature, relative humidity, wind speed, and precipitation. Additionally, the ice-induced energy loss is computed according to the International Energy Agency Task 19 standard (Timo Karlsson, 2014), enabling consistent comparisons across sites.

The problem itself was approached as a machine learning regression task, where meteorological time series and their derived statistics served as input features, and the target output was the ice-induced energy loss. Multiple model architectures were evaluated using operational data from six wind farms located in Scandinavia. Among these, LightGBM emerged as the best-performing model, demonstrating strong predictive accuracy with deviations within 40% of measured losses across all sites. Although further benchmarking against established methodologies is needed, these findings highlight the model's promising potential.

By leveraging standardised ice loss metrics and readily available meteorological inputs, the proposed framework offers a practical and scalable method for assessing expected energy yield losses at prospective sites. This therefore reduces uncertainty in cold-climate assessments and supports better investment decisions.

References:

Bengt Sunden, Z. W., 2015. On Icing and Icing Mitigation of Wind Turbine Blades in Cold Climate. Journal of Energy Resources Technology.

Fahed Martini, L. T. C. M. A. I., 2021. Review of Wind Turbine Icing Modelling Approaches. energies.

Jesus Maria Pinar Perez, F. P. G. M. D. R. H., 2016. Economic viability analysis for icing blades detection in wind turbines. Journal of Cleaner Production.

Timo Karlsson, V. T. T. W. J. M., 2014. Production Loss Estimation for Wind Power Forecasting. Winterwind.

Web site: https://www.idcore.ac.uk/

Short biography: I hold an integrated Master's degree in Aerospace Engineering from the University of Bristol, where I studied aerodynamic modelling, wind turbine fundamentals, and general engineering. After completing my degree, I joined the IDCORE programme (Industrial Doctoral Centre for Offshore Renewable Energy), where the first year provided focused training on the challenges and principles of both onshore and offshore wind turbines.

My expertise in machine learning was developed during an internship at the UKRI Node for Trustworthy Autonomous Vehicles, where I worked on controller strategies for drones operating in high-disturbance environments using reinforcement learning. Since June 2025, I've been working in partnership with Wood Group, applying machine learning models to wind energy challenges. My current research includes developing and integrating an ice loss model for pre-construction yield assessments, as well as applying machine learning to wind energy forecasting and failure detection.

Outside of engineering, I'm deeply passionate about marine biology and ocean ecosystems. I nurture this interest by reading scientific literature, watching documentaries, and immersing myself - quite literally - through scuba and free diving, including along the rugged coastlines of Scotland where I live.

R&D areas/s: A) Wind, C) Energy storage

Integrating BESS into Operational Wind Farms – Practical Lessons from Sweden's Hybrid (Wind + BESS) in cold climate

Daniel Eliasson, Ramboll, SE

Daniel Eliasson (Ramboll, SE), Vane Aminga (Ramboll, SE)

As Sweden's renewable energy landscape evolves, developers are increasingly retrofitting battery energy storage systems (BESS) into existing wind farms to boost flexibility, grid stability, and revenue potential. While this trend is gaining momentum, practical experience remains limited, especially when working within live operational sites and cold climate conditions.

This abstract draws on Ramboll's role as Owner's Engineer (OE) for two pioneering Swedish large scale BESS projects, developed by international clients. Both projects have involved adding large-scale BESS to operational wind farms, a process that brought new layers of complexity compared to new built standalone wind or BESS projects.

Key topics will include:

- Working safely within live wind farm operations while maintaining production.
- Aligning legacy infrastructure with modern storage systems.
- Managing grid compliance and signal integration for wind + BESS.
- Planning around winter weather logistics and equipment constraints.
- Navigating multi-stakeholder coordination across borders and cultures.

By sharing these insights, Ramboll aims to provide developers, operators, and grid stakeholders with practical guidance to de-risk and accelerate future hybrid wind + BESS integrations in Sweden and beyond.

Background
Daniel's experience comes from acting as Owner's Engineer (OE) for two northern located hybrid wind + BESS projects in Sweden: Client 1. Both projects involve adding large BESS to existing, operational wind farms, not new builds. Integrating BESS into running wind farms is relatively new and requires new methods, coordination, and specialized knowledge. The OE is expected to have a broad experience, be able to switch between different threads, grasp the unseen as early as possible and act as a local expert for international clients.

Web site: www.ramboll.com

Short biography: Daniel Eliasson has more than 15 years experience from renewable energy in roles ranging from site manager to project manager and originally a technician. He is tech-savy and has hands on experience few can compete with. He has used his competence within onshore wind globally but specifically in cold climate being based in Umeå. During the last year he has been the site manager for many projects in the northern Sweden but also doing work for the international market.

R&D areas/s: A) Wind

Machine Learning or Deep Learning? The Role of Ice Sensors and Weather Forecasts in Wind Turbine Icing Prediction

Jonathan Nixon, Coventry University, UK

Abhishek Kallarappayi (Coventry University, UK), André Bégin-Drolet (Université Laval, Canada), Charles Godreau (Nergica, Canada)

Atmospheric icing on wind turbine blades remains a major barrier to reliable wind energy production in cold climates, reducing annual yields by up to 20%. In addition to production losses, ice shedding from blades creates safety hazards for personnel and infrastructure, prompting mandatory curtailments. Reliable forecasting of icing formation would allow operators to anticipate events before losses occur, preventing blade damage, reducing downtime, and improving the accuracy of day-ahead energy trading.

Predicting icing accretion is challenging because it depends on diverse atmospheric and turbine operating conditions, as well as microphysical parameters such as liquid water content (LWC) and droplet size, which are difficult to measure. These variables can fluctuate rapidly and are only partially observed by SCADA and conventional weather stations. Prior studies have largely been restricted to very short horizons using limited data sources, leaving a gap between research model capabilities and the operational needs of wind farm operators.

This research presents the first systematic benchmarking of machine learning (ML) and deep learning (DL) models for icing prediction across multiple horizons and input configurations. The models integrate SCADA signals, meteorological measurements, turbine-mounted icing sensors, and weather forecasts. We compare ML ensembles (Random Forest, Extreme Gradient Boosting, and Light Gradient Boosting Machine) with a convolutional neural network–long short-term memory (CNN-LSTM) model. Models are evaluated at 1-, 6-, and 24-hour horizons using high-frequency turbine data recorded at 1-second resolution. To assess the contribution of different data sources, we test three input configurations: Class A (SCADA + historical weather), Class B (Class A + icing sensor), and Class C (Class A + forecasted weather including LWC). Performance is measured using the F1 score, which balances precision (avoiding false alarms that cause unnecessary shutdowns) with recall (catching as many real icing events as possible).

Random Forest emerged as the best-performing ML model, and with Class C inputs, it performed as well as CNN-LSTM across all horizons, achieving high F1 scores at 1, 6 and 24 hrs. Crucially, Random Forest runs far faster than CNN-LSTM, making it highly suitable for real-time deployment. Ablation analysis demonstrates that including icing sensor data significantly improves short-term (1 hr) forecasts, raising F1 considerably. At the day-ahead horizon, incorporating weather forecast data (Class C) is essential for maintaining a high F1 score.

These findings demonstrate that enriched input data matter more than model complexity. ML ensembles, when supplied with icing-relevant measurements and forecasts, can rival deep learning performance while remaining interpretable and computationally efficient. This enables proactive turbine control in the short term and more reliable energy trading and scheduling at longer horizons, reducing losses and enhancing safety in icing-prone climates.

Web site: https://pureportal.coventry.ac.uk/en/persons/jonathan-nixon

Short biography: Dr Jonathan Nixon is an Associate Professor at Coventry University specialising in renewable energy, systems modelling, and artificial intelligence (AI). His research develops AI-driven methods to improve the performance, reliability, and resilience of clean energy technologies.

A major strand of his work focuses on wind energy in cold climates. He has developed approaches for icing prediction, anti-icing strategies, and adaptive turbine operation, integrating machine learning and optimisation to improve turbine performance. He leads a Royal Society international exchange programme with Université Laval and Nergica (Canada) on intelligent wind turbines and represents the

R&D areas/s: A) Wind

UK on the International Energy Agency Task 54 (Cold Climate Wind). His earlier work included a British Council-funded collaboration with the China Aerodynamics Research and Development Center (CARDC), addressing the multidisciplinary issues of turbines in cold environments.

Beyond his wind energy research, Dr Nixon applies AI-based modelling and optimisation to a wide range of renewable energy challenges. He has contributed to major projects across Europe, Asia, Africa, and North America, with funding from the British Academy, Innovate UK, EPSRC, UNICEF, and the British Council. His work on energy access in refugee camps in Rwanda and displaced communities in Nepal has included deploying solar microgrids, smart street lighting, and digital monitoring systems. He also led the Solar Energy Transitions (SET) project, advancing the design of solar-battery e-cooking systems in sub-Saharan Africa, and is working with UNICEF on smart climate-resilient water pumping solutions.

These initiatives demonstrate how advanced modelling and AI tools can be applied across technologies and geographies—from improving cold-climate wind turbine performance to delivering community-focused energy access solutions in some of the world's most challenging environments.

R&D areas/s: A) Wind

Heat only when it matters: Wireless sensors for precision blade heating

Thomas Schlegl, eologix-ping, AT

Michael Moser (eologix-ping, AT)

Conventional blade heating systems operate with preset control strategies that often result in unnecessary energy consumption, delayed activation, or insufficient de-icing. Direct measurements on the blade surface reveal a very different picture than ambient models alone can provide. This work presents a wireless sensor-based precision heating concept designed to improve energy efficiency and response time of blade heating systems through localized, data-driven decision-making.
A network of wireless surface sensors was deployed on two operational wind sites in Sweden. Each sensor continuously measured blade surface temperature and ice accretion indicators, transmitting real-time data to a central controller. Instead of using ambient temperature, nacelle icing or ambient icing models as proxies, heating was activated selectively based on actual on-blade conditions. The system was tested during the 2025–2026 winter season in both stand-alone and SCADA-integrated configurations.
Preliminary results show up to 82% reduction in heating energy use compared to fixed-cycle operation, while maintaining or improving de-icing time. The wireless architecture eliminated the need for additional cabling or blade modification, enabling retrofit deployment. Additionally, localized sensing revealed significant thermal variability across blade zones, suggesting further optimization potential through zonal heating control.
The study concludes that wireless sensor-driven heating activation is a viable pathway toward smarter, more efficient ice mitigation strategies on wind turbines. Future work will focus on predictive activation models and integration with turbine-level power performance metrics. In the full presentation, we will give detailed insights on the actual turbine performances.

Web site: www.eologix-ping.com

Short biography: Thomas Schlegl is Co-Founder and CEO of EOLOGIX-PING, driving innovation in wind energy through blade health monitoring. After earning his PhD in sensor technology in Graz and Stanford, he co-founded EOLOGIX, introducing wireless sensors to tackle wind turbine blade issues. In 2023, he led the merger with Australia's Ping Services, creating EOLOGIX-PING and the industry's first platform combining on-blade sensors with acoustic monitoring. With 10+ years of experience and multiple patents, Thomas inspires through action, shaping a safer, more reliable, and sustainable future for wind power by turning proactive monitoring into a global standard.

R&D areas/s: A) Wind

Unraveling hidden losses and new areas of focus for wind power in cold climates

Simon Grenholm, W3 Energy, SE

Simon Grenholm (W3 Energy, SE)

The energy market in northern Sweden is constantly evolving, and so should our view on icing and wind power in cold climates.

Operating wind turbines in icing conditions is a challenge, where production losses may be substantial if they are not mitigated properly. Ice losses are like an iceberg, where digging deeper will unravel unknown matters of great importance to both operational and financial results. This presentation will summarize well-known and lesser-known ice losses, and show pathways towards more robust and well-optimized ice protection systems. It will also highlight the importance of setting individual wind turbines in a broader context, interacting with energy system components and mechanisms on both a smaller and larger scale.

Among well-known issues are the direct production losses when ice aggregates on the turbine blades and reduces performance. Lowering production losses is a matter of installing systems that use effective ice protection technologies; but also, to organize maintenance and repair resources for a high availability, so that the investments are fully utilized.

Also known are the fluctuating energy prices. With a rising share of wind power in the total energy supply, wind conditions and icing have an increasing influence on the energy market. Consequently, when there is less wind and during icing events, spot prices and balancing costs are higher. These high energy prices add additional importance and values to robust and effective ice protection systems, with a multiplying effect on the direct production losses.

What is less discussed is the electric losses between turbines and substations, and their non-linear pattern. When the amount of transmitted energy decreases, the transmission losses in percentage increases rapidly. Therefore, during low wind speed and icing, the percentage of electricity produced that is lost in transmission is much higher than otherwise. This hidden ice loss adds another multiplying effect on the importance of the already highly valued ice protection system.

The broader picture implies new views on both design, operation, transmission, hybrid solutions and consumption patterns. For the wind turbines and ice protection systems, this will push for a general shift from focusing on maximum annual energy yield, towards low wind speed and icing scenarios. Despite its challenges, wind power in cold climates has an important role to play in the energy ecosystem up north. Thanks to the generally high wind speed and high air density during winter months, the annual production pattern of wind power offers a great match to the overall annual consumption pattern.

Web site: www.w3e.se

Short biography: Simon Grenholm works as a Business Intelligence and Performance Analyst at W3 Energy, with a specialization in ice protection 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. He likes being out in the wild, and especially fishing.

R&D areas/s: A) Wind

A novel multisource approach for handling icing risk for personell working in the wind farm

Sigmund Guttu, Norconsult, NO

Sigbjørn Grini (Norconsult, Norway)

Previous projects and experience have shown that the state-of-the-art operational ice risk forecast for the public has a limited relevance for the operating personnel in their daily planning and routines. Using a multisource approach, a more detailed and accurate forecast can help to make more informed and strategic decisions on when to access certain wind turbines and areas of a wind farm. In an on-going research project supported by the Norwegian Research Council and Norwegian wind farm operators, we have developed a web-based forecast system tailored to the needs of the operating personnel in a wind farm.

To develop the forecast system, we utilize an improved icing model representing snow and ice forming both on the nacelle and the blade. The icing predictions are performed for each wind turbine, which is further corrected using SCADA-data and a machine-learning model trained on camera images from the wind farms, contributing to improved model performance.

The web-based forecast system designed specifically for operating personnel in a wind farm involves icing forecasts on timescales from current day to one week ahead. Camera images mounted on the nacelle visualize the current icing situation. The forecast system distinguishes between various risk sources, through risk area annotations based on calculations representing both icing on blade, tower, and nacelle.

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

Short biography: Sigmund Guttu has a background within meteorology. He has a doctoral degree within Climate Sciences from the University of Oslo. In 2021, he started in Norconsult AS (former Kjeller Vindteknikk) and has touched upon various topics within meteorology. Within wind energy, Sigmund is involved in operational forecasts, both related to production losses and icing risk. Of personal interest, he wants to highlight cross-country skiing, football and music.

R&D areas/s: A) Wind

Practical retrofit process for wind turbine ice protection systems

Paulius Sarapnickis, FabricAir, LT

Daniela Roeper (FabricAir, LT)

Retrofitting an ice protection system into existing turbines poses practical challenges in access, space, and integration. The BorealisWind IPS consists of fabric ducting, running to the tip of the blade, blower, heater and electrical panel, all which are designed to be installed as a retrofit up-tower. This requires planning for the limit space and access points, routing around structural features, and interfacing with turbine power and control systems. This presentation will show our retrofit process built from 7 years of field experience. Lessons learned also include optimal sequencing of tasks, crew coordination, and specialized tooling for confined spaces. Together, these insights have improved the efficiency and reliability of retrofit installations and can inform future work on turbine retrofits.

Web site: www.borealiswind.com

Short biography: Paulius Šarapnickis is the Director of Global Installation & Maintenance at FabricAir, overseeing installation and retrofit projects for fabric duct and ice protection systems worldwide. With a background in environmental engineering and over a decade at FabricAir, he focuses on improving installation efficiency and field reliability. In his spare time, he enjoys hunting and the outdoors.

R&D areas/s: A) Wind, B) PV, Robotics

Coatings for wind and solar: ice and hail protection in winter environments

Matiss Sivins, Phazebreak Coatings, LT

Aaron Dupuis (US)

Every year, icing causes millions in losses for the wind energy industry. As wind turbines grow in size, ice removal becomes more complex and the lost MWh become even more costly. Heated blades can slow the formation of ice, but they require energy to use and have maintenance issues of their own. Perhaps, then, the answer is not ice removal, but ice 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 12,000 blades around the world.

NEINICE helps improve turbine energy output during winter storms, reduces recovery time following such events, and diminishes 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 the successes we've seen in helping owners and operators improve turbine performance. By reducing ice buildup before removal is necessary, NEINICE also helps lower maintenance costs, prevent ice throw, protect blade integrity, promote worker safety, and ensure that profitability remains high for owners and operators.

Further, Phazebreak has recently entered the world of solar with the development of NEUSHIELD, an impact-resistant, self-cleaning, and antifungal coating. NEUSHIELD has been labratory tested and proven to resist impacts comparable to some of the largest hail stones present in cold environments, while it's hydrophilic properties encourage the easy removal/prevention of snow and ice formation on properly angled PV surfaces.

To this end we will present data on the following:
Turbine output data comparing the performance in MWh of coated vs uncoated turbines.
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
In-field data from over 12000 coated blades over the last 4 years
Labaratory data showing NEUSHIELD's effectiveness on solar panels

Web site: www.phazebreak.com

Short biography: Matiss Sivins is Director of Business Development and Sales (US) at Phazebreak Coatings, Inc. Before joining the Phazebreak team, Matiss worked as a Business Development Manager at Aerones, working with clients to maintain turbines with Aerones' ground breaking robotic technology. He is a graduate of University of Arkansas - Fort Smith, and is a talented basketball player.

R&D areas/s: A) Wind, B) PV

Risk and insurance challenges of operating wind and solar farms in cold climates

Jan Willem Hoogenboezem, Marsh

Jan Willem Hoogenboezem

Recent events and long-running cold-climate site failures show that operating renewable energy assets in cold or variable climates requires more than a nominal "-40°C" design line on a spec sheet.
Case Study A:
One multi-turbine site experienced 50+ wind turbine generators (WTGs) offline for months due to widespread bearing seal failures. The seals, specified to operate to −40°C, failed at temperatures within that limit. The manufacturer redesigned seals, and most turbines are back in service, but claims and warranty issues remain unresolved.
Case Study B:
Operators face losses from ice accretion on blades and masts, especially when large ice chunks fall and damage equipment at turbine bases. The February 2021 Texas freeze highlighted risks of geographic assumption errors: many turbines lacked cold weather protection, causing mass shutdowns, energy shortfalls, and economic losses.
Primary risk themes:
• Design spec ambiguity and geographic assumption error: A stated lower bound (e.g., −40°C) is insufficient if specs, test conditions, or installation differ from site reality.
• Component failure modes: Seals, bearings, and lubricants behave differently under transient cold, ice loading, and freeze–thaw cycles.
• Icing and falling ice hazard: Blade ice causes production loss, structural damage, and safety risks at site perimeters.
• Fragility of active systems: Anti-icing systems relying on site power or grid supply may fail when most needed.
Insurance and claims implications:
These events generate complex claims: physical damage, extended business interruption, third-party losses, and protracted OEM warranty disputes. Insurers face inconsistent contract language on "cold climate suitability," disputes over latent design defects versus maintenance lapses, and aggregated exposures when many assets fail simultaneously. Some cases link systemic risk to grid reliability, expanding contingent business interruption exposures.
High-level recommendations — operators:
1. Reassess design limits with independent forensic reviews comparing vendor specs to site environmental conditions; document assumptions explicitly.
2. Prioritize critical retrofits using risk-based triage (ice hazard mapping, production value, safety zones) to justify blade heating, coatings, or seal upgrades.
3. Implement operational mitigations: exclusion zones for falling ice, automated ice detection, staged shutdown protocols, remote monitoring, and pre-positioned spare parts.
4. Clarify contracts: tighten O&M and procurement language to define environmental suitability, test evidence, acceptance criteria, and warranty timelines.
High-level recommendations — insurers and underwriters:
1. Update underwriting models to reflect site-specific cold risks and correlated grid exposures; include scenario testing for widespread freezes.
2. Clarify coverage boundaries: explicitly address wear vs. defect, retrofit obligations, and contingent business interruption aggregation in policies.
3. Incentivize mitigation: offer premium credits or parametric products for winterization measures and provide collaborative risk engineering support for retrofit prioritization.
4. Develop claims playbooks: establish fast-track technical triage teams, pre-agreed forensic protocols, and joint OEM/insurer/owner dispute resolution frameworks.
The path to resilient renewables in a changing climate is practical and collaborative. Operators, OEMs, and insurers should convene immediate site-specific risk reviews, prioritize retrofits that materially reduce exposure, and embed clearer warranty and insurance terms in future contracts. This approach will reduce downtime, limit contentious claims, and support a reliable, low-carbon power system that works when needed most.

R&D areas/s: A) Wind, B) PV

Web site: https://marsh.com/

Short biography: Jan-Willem Hoogenboezem
Renewable Energy Leader Europe

Years in the industry / Marsh
Jan-Willem began his career in insurance in 1999 and (re)joined Marsh in 2021.

Current Responsibilities
Jan-Willem is the Renewable Energy Leader for Europe.

Skills and experience Jan-Willem is experienced in allocating risk and in negotiating insurance provisions in supply and installation contracts, plus design and broking of on and offshore renewable energy insurance programs.

Brief career history Jan-Willem has over 25 years' experience in the power and renewable energy sector. The first 10 years he worked as an underwriter for engineering lines. In 2009 Jan-Willem joined Marsh as a Client Executive primarily servicing clients in the Renewable Energy sector. From 2015 until end of 2019, he led the Energy department of Aon in the Netherlands.
In 2020 Jan-Willem re-joined Marsh and became Offshore Wind Leader for Continental Europe. Since January 2022 Jan-Willem is the Renewable Energy Leader for Europe.

Interest
Mountain biking, CrossFit, Motor racing.

R&D areas/s: A) Wind

Centralizing Intelligence: Using IceBrain to Transform Icing Data into Operational Insight

Dave Tremblay, Icetek, UK

Dave Tremblay (Icetek, UK)

Operating wind turbines in cold climates can be complex, and making operational decisions often gives operators headaches as they must juggle numerous parameters such as IPS availability, triggering strategy, turbine control settings, and meteorological conditions. Icing events are intricate and complex, each with its own unique characteristics, making it difficult to generalize solutions. Operators need not only reliable IPS systems but also integrated tools that allow them to observe, understand, and optimize every aspect of the performance chain in real time.
IceBrain, Icetek's new software platform, provides operators with a complete picture of what is happening in the field, enabling them to make informed, data-driven, and even automated decisions. By combining operational and meteorological data with visualization tools, data-crunching algorithms and automated routines, IceBrain helps alleviate the complexity of cold-climate turbine operation. Working in tandem with Icetek's IC-1 sensor, it leverages high-precision, real-time meteorological measurements, including the Liquid Water Content data into action, supporting operators in tackling everyday challenges.
By presenting real-world operational case studies of issues faced every year by all operators, this presentation will demonstrate how the centralization of data, coupled with SCADA and visual support, mitigates and often solve pains and challenges by offering educated recommendations and support, moving from reactive to proactive actions and adaptations that generates measurable gains in production and reduces headaches and frustration for operators.

Web site: www.icetek.ca

Short biography: Dave is acting as CRO for Icetek since March 2024, becoming a shareholder at the same time. He holds an MBA and worked in finances and M&A for over 20 years before becoming an entrepeneur and investing in several companies. At Icetek, Dave is responsible for customer service, building relationship with wind park operators and OEM and support the team's continuous development of ice detection sensors and software application. When he's not spending time with his family, he enjoys playing flag football and working around the house.

R&D areas/s: Dynamic line rating

Using Dynamic Line Rating to minimize curtailment of Wind power connected to rural power networks

Magnus Lindström, Griddiagnoze, SE

Jens Sperens (Griddiagnoze, SE)

Abstract—Elia, the Belgian TSO, is aiming to minimize curtailment of wind power plants connected to its 70kV rural network to the absolute minimum by using Dynamic Line Rating in combination with advanced flow simulation. This combination allows Elia to use its network assets to their real time maximum, without increasing risk and decreasing the security of supply.
In situations like the one described below, where it's possible to control the flow in near real-time via curtailment it becomes possible to use all of the extra capacity available via Dynamic Line Rating. On average more then 30% extra capacity is available but this figure can easily increase to 100% extra capacity as soon as there is more then 4 m/s wind perpendicular to the line.

Web site: www.griddiagnoze.com

Short biography: I have been working with monitoring and digitalization in both ABB/Hitachi and now in Griddiagnoze. Our goal is to contribute to a resilient network for both producers and utilities.

R&D areas/s: C) Energy storage

How different flexible consumers influence the performance of Windfarms in SE2

Lukas Pfeiffer, Gridmetry, DE

Lukas Pfeiffer (Gridmetry, DE)

The increasing penetration of variable renewable energy sources challenges the operational stability and market performance of power systems. In Northern Sweden's SE2 bidding zone—characterized by high wind generation, limited transmission capacity to the south, and growing congestion—the integration of flexible electricity consumers emerges as a potential stabilizing mechanism. This study quantitatively assesses how distinct types of flexible demand—battery energy storage systems (BESS), hydropower, and flexible data centers—affect both the technical and economic performance of wind farms in SE2.

Using high-resolution wind production, electricity price, and imbalance data from 2023–2025, we develop a dynamic co-optimization model linking generation, consumption, and reserve market participation. The model represents the physical ramping and state-of-charge constraints of BESS, reservoir dynamics of hydropower, and adaptive load control strategies of data centers capable of modulating computational demand within seconds. Each flexibility type is evaluated with respect to:

Curtailment reduction,

Price volatility mitigation,

Imbalance cost reduction, and

Incremental revenue to the wind producer under current and hypothetical market designs.

Results indicate that short-duration BESS primarily enhance intra-hour balancing, reducing windfarm imbalance penalties by up to 35 % under high-volatility scenarios but offer limited annual revenue due to short energy capacity. Hydropower flexibility, when co-optimized with wind generation, provides the most efficient balancing resource, increasing average windfarm market value by 5–8 % while stabilizing local prices. In contrast, flexible data centers—whose electricity demand can vary by 30–50 % within 10 s without violating service-level constraints—demonstrate a distinct economic synergy: by shifting computation to low-price periods, they create a de-facto downward hedge for wind producers, improving realized capture prices and nearly eliminating negative-price episodes in the simulation.

A scenario analysis combining all three consumer types shows a significant cumulative reduction in wind curtailment and an significant overall increase in windfarm profitability depending on the correlation between wind output and demand flexibility. Sensitivity tests reveal that locational grid constraints and reserve market price signals critically determine the distribution of benefits among actors.

The study concludes that integrating geographically proximate, dynamically controllable consumers—especially data centers and distributed BESS—offers a cost-effective complement to traditional hydro flexibility in SE2. Policy frameworks that recognize these consumers as active balancing resources could accelerate renewable integration while maintaining system efficiency.

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

Short biography: With more than eight years of experience in the data center and digital asset industry, Lukas Pfeiffer works at the intersection of energy systems, technology, and infrastructure innovation. He is the Founder of Gridmetry, a company pioneering the integration of data centers into the electricity grid as flexible, grid-supporting assets. By transforming data centers from passive consumers into active participants in the energy market, Gridmetry enables the monetization of renewable overcapacity, provides real-time curtailment capabilities, and delivers ultra-fast frequency response where the grid needs it most.

R&D areas/s: C) Energy storage

Before founding Gridmetry, Lukas Pfeiffer served as Managing Director of Crypto Oxygen, where he led corporate development, M&A, and the design and construction of large-scale Bitcoin mining facilities across several countries. This role strengthened his expertise in energy markets, digital assets, and industrial-scale infrastructure, laying the foundation for his current work on demand flexibility and system stability.

Driven by a deep commitment to the energy transition, his mission is to turn the challenges of grid volatility into opportunities — creating economic and environmental value for both the energy system and the businesses that depend on it.

R&D areas/s: A) Wind

Future Trends and Economic Impact of Icing Losses in Wind Energy

Jennie Molinder, Kjeller Vindteknikk, part of Norconsult, SE

Mona Kurppa (KVT, FI), Emilie Claussen Iversen (KVT, NO), Pyry Pentikäinen (KVT, FI), Jennie Molinder (KVT, SE), Ville Lehtomäki (KVT, FI)

The economic impact of icing on wind energy production has become increasingly relevant, as observed discrepancies between annual energy losses and corresponding financial losses highlight the need for additional evaluation methods. To address this, an economic module has been developed for Kjeller Vindteknikk's IceLoss simulation tool. This module estimates icing-related losses in EUR, based on the recent years's historical spot market prices, enabling a better view of the financial consequences of icing events.

In addition, IceLoss has been extended to incorporate climate model data, allowing for simulations of future trends in icing losses under changing climatic conditions. This capability provides a broader picture when assessing long-term impacts on wind energy production in cold climates.

Together, these developments support both technical and economic evaluations of icing losses. For example, they enable more informed decisions regarding the implementation of ice protection systems (IPS), by balancing expected future losses against the potential cost savings such systems may offer.

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

Short biography: Jennie Molinder is a meteorologist who has done a PhD focusing on modelling of icing related production losses. She has been working at Kjeller Vindteknikk for the past 5 years, mainly focusing on icing related projects and pre- and post-construction analyses. In her spare time, Jennie likes to travel, build a lot of lego and do crocheting.

R&D areas/s: Asset Management

A new market reality for the wind power industry calls for active approach

Lisa Eklund, W3 Energy, SE

Lisa Eklund (W3 Energy, SE), Malin Tuomas (W3 Energy, SE), Emma Fjällvide (W3 Energy, SE)

The wind power industry is facing a new reality with changing market conditions, price volatility, and increased risk exposure. A passive strategy is no longer an option for long-term financial sustainability. Ensuring long-term sustainability requires a proactive approach, where financing, risk management, pricing strategy and contractual framework are fully integrated.

This presentation explores strategic considerations for navigating in a volatile market.

We explore

- Why risk mitigation through pricing strategies and optimized contractual structures is essential for profitability and long-term financial sustainability.

- How active participation in the market strengthens the strategic capability of both owners and operating organizations.

The aim is to inspire new thinking among investors, operators, and decision makers on how financial and technical perspectives can be integrated – not just to survive market volatility, but to actively benefit from it.

Web site: https://www.w3e.se/

Short biography: Lisa Eklund is a Financial Asset Manager at W3 Energy, a leading independent asset management company in the renewable energy industry. With more than 12 years of experience in the power system and deep knowledge of how its components interconnect, combined with strong expertise in financial governance and operations, she will share perspectives on how an active management approach can strengthen financial resilience and compliance in an evolving market landscape.