Book of Abstracts - Abstract number order

Winterwind 2020

INTERNATIONAL WIND ENERGY CONFERENCE

WINTERWIND
INTERNATIONAL WIND ENERGY CONFERENCE 2020
Feb 3-5 2020, Åre, Sweden

Monday Feb 3

Winterwind 2020 Program per 2020-01-29

Time	Outside session rooms	Solskog	
09:00 - 12:00		Swedish Windpower Association and RISE - Workshop on blockage, Martin de Maré, RISE Research Institutes of Sweden (57) Global Blockage Offshore/Onshore - Reality or Myth ?, Jan-Åke Dahlberg, Vattenfall Vindkraft AB, SE (56)	By invitation and application only via this link: https://forms.gle/3VPzjCeMhYxYL6g46
10:00 - 18:00	Field trip		
14:00 - 18:00		Task 19: Performance warranty guidelines for wind turbines in icing climates workshop at Winterwind 2020, Helena Wickman, Vattenfall (49)	By invitation and application only via this link: https://forms.gle/4iXGREGjcngDVzAf7
18:00 - 20:00	Registration and Poster Setup		
19:00 - 20:00		Introduction to Winterwind 2020 Program and Modern networking	

Tuesday Feb 4

Time		Arenan	Solskog	Snöljus
08:00 - 09:00	Registration, Exhibition and Modern networking			
09:00 - 10:00	**Session 1**	**Opening session** **Moderators: Jeanette Lindeblad and Fredrik Lindahl** Welcome! - Jenette Lindeblad and Fredrik Lindahl, Swedish Windpower Association A short introduction, Göran Ronsten, Program coordinator A European Outlook on the prospect of Onshore Wind - Global importance with regional benefits, Sandra Grauers, Vattenfall (51) Open Innovation Contest, Tanja Tränkle, RISE (50) **Innovate to survive, Siemens Gamesa** **Open Innovation Contest**		
10:00 - 11:00	**Break and Modern networking**			
10:30 - 10:55	**Poster presentations** Reliable ice detection with different measuring methods, Daniel Schingnitz, Weidmüller Monitoring Systems GmbH, GER (60) Six presentations from Open Innovation Contest			

11:00-12:30	Sessions 2 - 4	**Modelling** **Chairs: Daniela Roeper, René Cattin**	**Forecasting** **Chairs: Sandra Grauers, Sven-Erik Thor**	**Icing losses and ice throw** **Chairs: Rebecka Klintström, Anders Wickström**
		Large Eddy Simulation of Icing Conditions Impacting Wind Farms in Heterogeneous Land Use, Erik Janzon, Department of Earth Sciences, Uppsala Universitet, Sweden (11)	Improvements to the WRF microphysics, Emilie C. Iversen, Kjeller Vindteknikk (5)	The impact of liquid water content on thermal ice protection systems efficiency , André Bégin-Drolet, Université Laval (18)
		Predicting production loss due to ice accretion, Johan Revstedt, Dept. of Energy Sciences, Lund University, SE (16)	Forecasting of icing for wind energy applications, Øyvind Byrkjedal, Kjeller Vindteknikk, NO (38)	Task19 - Ice Loss Tool, Timo Karlsson, VTT (15)
		Parametric analysis of wind turbine icing in cold regions, Ifrah Mussa, Kingston University, United Kingdom (45)	How might climate change affect repowering?, Charles Godreau, Nergica, CA (8)	windThrow: an open source toolbox for ice throw simulations, Hamid Sarlak, Denmark (23)
		Improved flow modelling at cold climate sites through novel land-surface data from satellite sources , Morten Lybech Thøgersen, EMD International A/S, DK (40)	Minimise your business risks with your own biodiversity strategy, Åsa Abel, Ecogain AB, SWE (55)	On the communication of the ice throw hazard to the public, Rolv Erlend Bredesen, Kjeller Vindteknikk, NO (44)
		Discussion	Discussion	Discussion

12:30 - 14:00	Lunch and Modern networking

14:00 - 15:30	Session 5 - 7	**Modelling and forecasting** **Chairs: Ifrah Mussa, Johan Revstedt**	**Uncertainties – development, life cycle, end-of-life** **Chairs: Helena Wickman, Hamid Sarlak**	**Testing and innovation** **Chairs: Åsa Abel, Rolv Erlend Bredesen**
		Validation of turbine specific modelled ice losses, Stefan Söderberg, DNV GL, SE (31)	Cost of uncertainty in project development, Jenny Longworth, Kjeller Vindteknikk AB (29)	Climatic chamber testing and verification in cold climate, Mattias Viktorsson, RISE (12)
		Validation of, and findings from, the IceLoss 2.0-project, Johannes Lindvall, Kjeller Vindteknikk, SE (36)	Circular streams from GFRP composite waste, Richard Sott, RISE (14)	Pile Foundation Prototype Execution and Applicability for Scandinavia, Miguel Turullols, Nabrawind Technologies SL (Spain) (13)
		A CFD benchmark study of ice accretion on a wind turbine blade and a comparison to the ice accretion of a rotating blade cylinder model, Johannes Lindvall, Kjeller vindteknikk, SE (37)	Improve Wind Project Lifecycle Cost of Energy in Cold Climates, Albert Bosch, VORTEX FdC, SL (6)	Ice and snow management innovations for critical infrastructure , Ville Kaikkonen, University of Oulu (32)
		Offshore wind farm at icy conditions – Tahkoluoto, Jaakko Kleemola, Suomen Hyötytuuli Oy, FI (54)	Wind farm blockage onshore: what drives the loss?, Till Beckford, DNV GL, UK (28)	Storage of electricity in molecules, Finn Daugaard Madsen, Siemens Gamesa Renewable Energy A/S (3)
		Discussion	Discussion	Discussion

15:30 - 16:30	Break and Modern networking

16:30 - 18:00	Session 8 - 10	**Structural monitoring** **Chairs: Tanja Tränkle, Till Beckford**	**Ice detection** **Chairs: Frida Godet, Øyvind Byrkjedal**	**Ice Protection Systems I** **Chairs: Jenny Longworth, Finn Daugaard Madsen**
	Modern networking	Blade defect forecasting, Anders Røpke, Wind Power LAB (4)	Icing intensity evaluation based on ice detector measurements, Jarkko Latonen, Labkotec Oy, FI (43)	Experimental investigation of an infrared de-icing system for wind power application in cold climate, Sofia Sollén, Luleå University of Technology (48)
		Towards tracing a rotor surface's 3D trajectory over time, Michael Moser, eologix sensor technology gmbh (42)	The impact of light ice masses on expected wind power production, Florian Rieger, fos4X GmbH (21)	Performance Maps for Ice Mitigation Operational Strategies, Dimitar Stoyanov, Coventry University (33)
		Effect of heavy rotor blade icing to lifetime consumption of tower and foundation, Carsten Ebert, Woelfel Wind Systems (46)	Blade based ice detection IDD.Blade – efficient operation in cold climate, Bernd Wölfel, Wölfel Wind Systems GmbH (47)	Measuring the Wind in Cold Climates - a real world summary of Lidar performance, Wulstan Nixon, United Kingdom (10)
		Siemens Gamesa effective blade repair solution at cold temperatures, Mert Satir, Siemens Gamesa Renewable Energy, Ireland (30)	Optimizing Windturbine heaters with blade based ice detection Systems, Nils Lesmann, Phoenix Contact, GER (1)	Case study; Controlled environment in up-tower blade repairs, Ville Karkkolainen, Bladefence, FI (53)
		Discussion	Discussion	Discussion

18:00 – 19:30	Mingle, poster presentations in exhibition hall and Modern networking
19:30 – 23:59	Dinner and entertainment

Wednesday Feb 5

Winterwind 2020 **Program per 2020-01-29**

Time	Session	Arenan	Solskog	Snöljus
09:00 - 10:00	**Session 11** **Open Innovation Contest awards**	**O&M** **Chairs: Anne Mette Nodeland, Martin de Maré** Slowly, slowly, we'll reach our goal!, Sébastien Trudel, EDF Renewables, Canada (52) Highlights from CanWEA's operations and maintenance summit 2020, Charles Godreau, Nergica, CA (41)		
10:00 - 11:00	**Break and Modern networking**			
11:00 - 12:30	**Session 12-14**	**Manufacturers** **Chairs: Åsa Elmqvist, Stefan Söderberg**	**Ice protection systems II** **Chairs: Emilie C. Iversen, Jan-Åke Dahlberg**	**O&M activities and strategies** **Chairs: Liselotte Aldén, Lars Jacobsson**
		Vestas Cold Climate solutions, Karl Gregory, Vestas Wind Systems A/S, DK (27)	Megaterends in blade heating, Petteri Antikainen, Wicetec, Fi (26)	Wind turbine operations in northern Siberia, Masafumi Yamazaki, Kanagawa Institute of Technology, Japan (25)
		Evaluation of Vestas De-icing System, Alexander Stökl, Energiewerkstatt e.V. (2)	A new type of anti icing system – development/application/demonstration, Sven-Erik Thor, Lindskog Innovation AB (19)	Control of tower bolt connections and the challenges related to cold climate conditions, Anders Wickström, RISE Research Institutes of Sweden (20)
		Siemens Gamesa ice accretion modelling and its impact on the aerodynamic performance and AEP, Esteban Belmonte, Siemens Gamesa Renewable Energy, SP (35)	Installation of Retrofit Hot Air De-icing Systems, Daniela Roeper, Borealis Wind, Canada (9)	**From Open Innovation Contest**
		Nordex advanced Anti-Icing System for N149 wind turbines, Konrad Sachse, Nordex Energy GmbH, DE (7)	Ice protection systems and retrofits: Performance and experiences, Charles Godreau, Nergica, CA (39)	Advanced operational analytics with machine learning, Till Beckford, DNV GL, UK (34)
		Discussion	Discussion	Discussion
12:30 - 13:30	**Lunch and Modern networking**			
13:30-15:00	**Session 15**	**What do we need now?** **Moderator: Tomas Kåberger**		
		Should I heat or should I not? - Smart operation of wind turbines in Cold Climate, René Cattin, Meteotest, CH (24)		
		World Energy Outlook 2019 – Wind Offshore long-term perspectives: Opportunities and uncertainties, Yasmine Arsalane, World Energy Outlook Directorate of Sustainability, Technology and Outlooks International Energy Agency (58)		
		Dialogue: Yasmine Arsalane (IEA) and Sandra Grauers (Vattenfall)		
14:40-14:50		A decade of expansion ahead, Tomas Kåberger, Renewavle Energy Institute, InnoEnergy, Chalmers (59)		
14:50-15:00		**Final words** **Fredrik Lindahl**		

R&D areas/s: 02. Health, Safety and Environment (HSE) incl. ice throw and noise, 10. De-/anti-icing including new technologies, ice detection & control incl. standards

Optimizing Windturbine heaters with blade based ice detection Systems

Nils Lesmann, Phoenix Contact, GER

Nils Lesmann

Phoenix Contact Blade Intelligence System ist capable to detect ice thicknesses and temperatures direct on the rotorblade. The sensors detection ice thicknesses <1mm to detect ice build up. The sensor itseld is working self-sufficent on the rotorblade, equipped with a PV module and batteries to ensure 1000h dark operation time. The sensors are applied to the blade surface communicating wireless with the base stations PLC.
In combination with the new Phoenix Contact PLC generation it is possible to detect ice build up on the blade and let those collected data running on the PLC. The PLC is capable to run the Matlab Model from the heater system to ensure a gigh efficient use of the heater system itself.
At some experimental turbine there has been a significant correspondence between light ice build and the power curve. Aim of the presentation should be to show those values and the Phoenix Contact solutions to solve those.
In addition to the ice measurement the Blade Intelligence can be equipped with an Lightning Monitoring and a Load Monitoring System to collect all relevant WTG Data in one system.

Web site:

Short biography: Working for 11 years as Phoenix Contact, 7 in the wind business now as Project Manager for the Blade Intelligence System

R&D areas/s: 01. O&M experiences incl. performance optimization, production losses

Evaluation of Vestas De-icing System

Alexander Stökl, Energiewerkstatt e.V.

Alexander Stökl (Energiewerkstatt, AT)

The presentation focuses on the evaluation and the assessment of the Vestas de-icing system based on operational records from two heated wind turbines of the type Vestas V112 – 3.3 MW on a site in the northern part of Upper Austria. Six wind turbines of the type Vestas V90 – 2 MW without blade heating are situated in the immediate vicinity and serve as a base-line for comparison.
The selected site is, in several ways, well-suited for the evaluation of the Vestas de-icing system. First, it shows a comparatively high number of icing events (corresponding to IEA icing class 3) placing high demands on the performance of the blade heating and allowing for meaningful statistics. And, second, the wind farms in this area also contain a number of turbines without a de-icing system. This comparison among a larger number of wind turbines – two with, and six without blade heating and sited in immediate vicinity – gives a broad statistical basis and thus allows the deduction of well-based conclusions.
The evaluation of the operational records shows that the blade de-icing system reduces the ice-related turbine downtime for this site by 57%. Regarding production this means a reduction of the ice-induced losses between 44% (conservative estimate) and 51% (best estimate). These numbers already include the energy consumption of the blade heating system. On the other hand, it has been observed that the total number of icing-related turbine stops for turbines with blade de-icing is more than twice as high than for turbines without blade heating.
Besides that, it can be concluded that usually the utilization of the Vestas blade heating system leads to an ice-free rotor blade, even though subsequently new ice may form under continuing meteorological icing conditions. The total energy balance of energy production and energy expended for blade heating is generally clearly positive, also for phases with repeated cycles of de-icing and new ice formation and at moderate wind speeds. Overall for the investigated site, the limited heating capacity of the blade de-icing system represented no serious limitation. For about 87% of the time when icing occurred, wind and temperature conditions were within the specified operational limits (Vestas Wind Systems A/S, 2015) of the de-icing system.
The results of this study, specifically the reduction of icing-losses by about 50%, can also serve as a basis for an economic evaluation of blade de-icing systems. Such an evaluation is, however, only sensible with reference to a specific project, i.e. a particular wind turbine and a particular site.

Web site:

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, interrupted by a two years stint in the wind energy business at AMSC WindTec. In 2018 he has joined Energiewerkstatt e.V. where he now primarily focuses on wind energy research projects.

R&D areas/s: 09. Environmental Impact Assessments (EIA), 15. National strategies, research programs, grid access, system services and new developments

Storage of electricity in molecules

Finn Daugaard Madsen, Siemens Gamesa Renewable Energy A/S

Finn Daugaard Madsen (Siemens Gamesa)

Abstract for WinterWind Sweden
Speaker: Finn Daugaard Madsen - Innovations manager at Siemens Gamesa Renewable Energy
Title: Storage of electricity in molecules
In a fossil-free world, we only have solar, hydro and wind as carbon free source and we need to be able to store large volumes of energy over days and weeks. Today there is talk of batteries and other types of storage, but if we need large amounts of energy it must be stored in a chemical storage carrier.
To get from electricity to chemical storage you need to produce hydrogen in large quantities and this can be done from electrolysis as you know in the physics room - (two eclectic conductive rods in a glass with water and a little salt) today this is done in electrolysis stacks with capacities of 250 kw and up to megawatts, and in the future we are talking about gigawatt systems.
Hydrogen can support the business case for renewables, by providing an alternative revenue stream that is not dependent on a grid connection (particularly relevant in remote areas), and by being used for load-balancing. As the electrolysis process requires large amounts of cheap electricity, it is most cost-effective when there is much wind power in the grid and power prices are low.
By using water electrolysis and renewable electricity, hydrogen production can be made completely carbon-free and scalable with no limiting scarce resources restraining it. Hydrogen can be burned in a hybrid gas turbine, used directly in hydrogen cars or buses, but it can also function as a building block to create electro fuels such as green ammonia, or methanol or methane, if there is a carbon source connected to the process.
In the mid term, electro fuels can be used for both energy storage and as an alternative to heavy fuel oil powering large vessels. In the long run, it is expected to be the next generation's CO2 neutral fuel.
The audience will gain insights into how the low price levels of wind power combined with recent price drops in electrolysis equipment have the potential to make electro fuel production commercially possible, and how this could fundamentally change both the energy and transportation sector as we know it.

Web site:

Short biography: Finn Daugaard Madsen
Current Position: Innovation Manager, Siemens Gamesa Renewable Energy A/S
Experience and Education
Years of Experience in wind: 10+ years
Years of Experience in Project management 25 + years
Education:
2017 Pasteur Program, Harvard Business School
2006 Diploma of leadership
2005 Diploma in Management
2003Diploma in Engineering Business Administration
2002 International project management
2001 Pathfinder
1985 Mechanical engineer
1982 Auto elektro mekaniker
Employment History

2014 -	Innovation Manager	Siemens Gamesa
2010-2014	Innovation Manager	Siemens Wind Power
2008-2010	Think Tank Manager	Siemens Wind Power
2007-2008	Key Account Manager	Primo Danmark
1985 - 2007	Project director	LEGO System

R&D areas/s: 01. O&M experiences incl. performance optimization, production losses, 03. Inspection and repair, 05. Market potential, finance, risk assessment, bankability and mitigation, 07. Forecasting, cloud physics and aerodynamics, 14. Big Data, AI, digitalization and machine learning applied to cold climate challenges

Blade defect forecasting

Anders Røpke, Wind Power LAB

Morten Handberg, (Wind Power LAB, DK), Charlotte Hasager,(DTU Wind, DK), Kristian Pagh Nielsen, (DMI, DK)

Environmental conditions cause blade defects to develop and add downtime during the turbine lifetime. Icing, rain, lightning and wind and turbulence all add to the degradation of the blade surface and structure.
Icing will accelerate surface degradation by causing expansion in surface cavities. If the turbine is allowed to continue operation with icing on the blade in the tip area, additional and often asymmetric loads cause increased fatigue loads.
Repairs are costly and exceed the net-cost of a blade at 1-2 million EUR per blade over the lifetime. New types of wind turbine blades and new repair materials are foreseen but at present no unique solution has had a break-through to eliminate leading edge erosion. Thus, the strategic relevance of continuously monitoring the condition and predicting the repair of the existing fleet of wind turbines will be of utmost importance.
To achieve this, it is necessary to first establish the quantification of how a series of environmental parameters influence blade degradation and defects through artificial intelligence method.
Specific objectives:
• To establish comprehensive environmental parameters database for Europe.
• To utilize the novel insights to develop the forecasting tool on blade degradation defining the specific defects and the need for repair, in a given environment.
• To market the forecasting tool as service including site specific blade design requirements and site specific OPEX blade repair planning for new wind farms and planning future repair campaigns for blades in operation
The project is supported and funded by Innovation Fund Denmark. Wind Power LAB(WPL) insights in wind industry, operator perspective and cost of blade repairs is essential to support the project, together with the technical knowledge at Technical University of Denmark Wind Energy(DTU) and Danish Metrological Services(DMI).
DTU and DMI will lead the first part of the project on gathering environmental condition at predefined geographical areas. DTU will collect the data in a database. DTU will then develop a model of environmental parameters and establish of a sufficient geographic grid. The following work packages will link field data from blade defects to the model.
DTU and WPL will then use the weather model and pair the results with the AI detected blade defects at sites in the selected regions. This will provide a combined AI that can correlate weather and defect data and provide a statistical view of defect development at a local site level.
WPL will then build the blade defects forecasting tool into a web platform and use it as an added service to WPL blade defect assessment service. WPL will then be able to offer defect prediction as a service to the general wind industry, primarily to owners and operators.
The proposed risk mitigation will be supported by the results from the project, as a degradation speed linked to the specific environment of the turbine is considered. From this the client will be able to plan for relevant blade defect repairs, fully motivated by both the current state of the turbine and the degradation rate for similar turbines in similar environments.
After sufficient model development of environmental parameters and establishment of a sufficient geographic grid, the following work packages will link field data from blade defects to the model. This is the first step towards implementing the results from the proposed project.
Project outcome for recipients Developers, Owners and Utilities will be benefit from getting a tool able to generate an OPEX budget based on blade specific defect data and weather forecasting from local site data. The repair industry and its affiliated companies will indirectly benefit from the forecasting tool as it will enable long term planning of defect and give basis for long term contracts on blade repairs.

Web site: https://windpowerlab.com/

R&D areas/s: 01. O&M experiences incl. performance optimization, production losses, 03. Inspection and repair, 05. Market potential, finance, risk assessment, bankability and mitigation, 07. Forecasting, cloud physics and aerodynamics, 14. Big Data, AI, digitalization and machine learning applied to cold climate challenges

Short biography: Mr. Anders Røpke. holds a master´s degree in Geoinformatics and a master´s degree in Environmental Engineering. He specialises in the offshore wind power industry with specific focus on wind farm operation, data analysis, development and implementation of cutting-edge technologies in wind farm management, stakeholder engagement, strategy and business development, and execution of business improvement projects.

Mr. Røpke has practical experience with complex business challenges and improvement potentials within the wind power industry. During his employment with DONG Energy (now Ørsted), Mr. Røpke was the project manager on a large-scale cross-organisational data and business improvement project on wind turbine blade inspection and defect detection with 50+ project participants and stakeholders, spanning back office and multiple wind farm sites. As project manager, he was responsible for scoping and delivering all phases of the project to the operational organisation, including steering committee management.

As Lead Business Developer at DONG Energy, Mr. Røpke was responsible for elaborating and monitoring the implementation of business development strategies, developing technical and business concepts, including roadmaps, and screening and analysing concept offerings.

In 2016, Mr. Røpke established Wind Power LAB ApS with the aim to develop an automated defect detection algorithm to help analyse and assess wind turbine blades, initially. By means of cloud computing and a defect detection algorithm, based on a global data set of wind turbine blades, Wind Power LAB is able to provide customers with a quick, automated and high precision analysis and assessment of wind turbines blades quality assured by a team of experienced and professional blade specialists

Personal interest: Family skiing in Sweden! Thank you for the location!

R&D areas/s: 07. Forecasting, cloud physics and aerodynamics

Improvements to the WRF microphysics

Emilie C. Iversen, Kjeller Vindteknikk

Gregory Thompson (NCAR, USA), Bjørn Egil Nygaard (KVT, NOR)

This presentation will show results from research on improved prediction of melting level and mixed precipitation in the Thompson microphysics scheme in WRF, which will improve predictions of snow-to-rain mixing ratios, precipitation amounts at the surface as well as wet snow icing.
In dry air snow can exist as dry snowflakes for several degrees of positive air temperature, and hence zero degree air temperature is not a good measure of melting level. Given that there is a difference in fall speed of dry- and melting, wet snowflakes, a correct determination of melting level is important for a correct prediction of the amount of precipitation reaching the surface. Below melting level the exchange rate of heath between the air and the snowflake (melting degree) is important for the snowflake fall speed and vice versa, and hence a correct representation of fall speed of melting snow is also important to obtain good predictions from numerical weather prediction (NWP) models.
Melting snow will eventually become sticky, which might be problematic for structures in the way that it adheres to them and creates ice sleeves. Wet snow icing has shown to be particularly problematic for overhead transmission lines, with events causing tower collapses and power outages in many countries. Obtaining precise predictions of wet snow is important to prevent costly damages of infrastructure, as well as for human safety.
It is hence important that the relevant NWP models incorporate a microphysical scheme with a good representation of precipitation in the melting layer, without being too computationally expensive to run in real-time. The Thompson microphysics scheme has been explicitly developed and tested for forecasting winter precipitation as part of the WRF model (Weather Research and Forecast model). The scheme is viewed to be perhaps the best real-time, bulk scheme for icing forecasting due to the specific development towards in-cloud aircraft icing. Less attention has though been devoted to wet snow icing, which most often occur close to the ground. This presentation will show results from research on improving the Thompson microphysics scheme with respect to the representation of melting snow.

Web site:

Short biography: I have a bachelors in Meteorology from Uni. Bergen and a Masters in Climate Change from UCL (London). I have worked at Kjeller Vindteknikk (KVT) as a consultant for about 4 years, mainly with climatic load assessments, with specific focus on icing, research and development. As of August 2018 I am doing a PhD at Uni. Oslo, while still employed at KVT. My PhD is part of a big research project, ICEBOX, initiated by Norway's TSO, Statnett, where the goal is to develop a toolbox for icing measurements, modelling, monitoring and forecasting. In the first quarted of 2019 I spent time at NCAR, Colorado working with developers of the WRF code as part of my project. In the second part of the project I will investigate the effects of climate change on the occurence of icing, and estimate future loads. Personal interests are snowboarding and splitboarding (climbing mountains on a "split board" = skis which you put together to a snowboard to run down), music and travelling.

R&D areas/s: 07. Forecasting, cloud physics and aerodynamics, 14. Big Data, AI, digitalization and machine learning applied to cold climate challenges

Improve Wind Project Lifecycle Cost of Energy in Cold Climates

Albert Bosch, VORTEX FdC, SL

Albert Bosch (VORTEX, Spain), Gil Lizcano (VORTEX, Spain), Pau Casso (VORTEX, Spain)

New innovative cold climate indicators have become available for O&M in the wind industry in the last years. One of this indicators is Vortex ICING 10-years time series.
Detailed hourly information will become an essential tool for the wind industry in cold climate regions causing time-collapsed averaged data to become obsolete. Available new technologies as well as computational power increase, make possible the creation of cold climate related variables time series and thus, a deeper analysis can be executed regarding the performance of wind farms on such cold regions.
From mesoscale cold events detection to microscale ice accretion calculation, the generation of long term meteorological icing time series has become now a reality which leads to a new approach when analyzing the project lifecycle, specially regarding the energy cost estimation.
Modelled icing averaged indicators at each turbine location allow to focus on:
- Wind Speed Histograms during Icing Episodes for icing losses,
- Wind Direction Roses during Icing Episodes by sectors,
- Icing hours per year for annual estimation, as other cold climate indicators related to extreme temperature and maximum density events.

Modelled icing time-series at each turbine location allow to deeper analyze:
- Daily profiles analysis,
- Cost of energy evaluation per time slots,
- Service and repair scheduling,
- Long term performance optimization
- Flag indicators testing.

As a conclusion, long-term icing time-series introduction is an open door to other recent technologies like machine learning. Training long-term SCADA data with icing time-series give a huge amount of new information for cold climate wind farms far from a simple matching comparison.

Web site: https://vortexfdc.com/

Short biography: Albert Bosch, Wind Meteorologist at Vortex since 2016.
Skilled in Data Analysis, Communication, Meteorology, Data Science, GIS, mesoscale modeling, project manager and programming. Research professional with a Master of Science - MS focused in Meteorology from Universitat de Barcelona, Spectral energy annalist of wind data, Icing project developer and measured data calibration for models. Part of the Vortex Team on the Global Wind Atlas project by the World Bank Group with Vortex and DTU Wind Energy.
Interested in life outside big cities and camper vans.

R&D areas/s: 06. Wind turbine manufacturers – cold climate solutions, test centres, turbines and components

Nordex advanced Anti-Icing System for N149 wind turbines

Konrad Sachse, Nordex Energy GmbH, DE

Ines Runge (Nordex Energy GmbH), Stefan Magnus (Nordex Energy GmbH), Nils Lehming (Nordex Energy GmbH)

Since 2010 Nordex has been offering an Anti-Icing System (AIS) for its various wind turbines. In 2018 Nordex has done the next step, which was introducing the advanced AIS for the N149/4.0-4.5. This year the system was adapted for the new N149/5.X turbine.
The advanced AIS for the N149/5.X offers very high performance for heavy icing conditions using the new heating element technology that was introduced together with the N149/4.0-4.5. The new technology improves the robustness of the system while reducing the complexity and allowing the system to continue operation in case of local defects.
Maximizing the reliability and achieving highest maintainability were two of the main development goals for the advanced AIS. Nevertheless the key features of the Nordex AIS remained unchanged: the AIS is fully operational during turbine operation, it provides high energy deposition on the blade surface to minimize ice formation even in strong icing conditions and the turbine availability and production can be significantly increased.
The components of the advanced AIS have been intensively tested and qualified regarding the heat distribution as well as the lightning protection system since 2013. A brief overview of test results and field experiences will be presented.

Web site: http://www.nordex-online.com

Short biography: Mr. Konrad Sachse was born in 1983 and received his Diploma of Physics in 2008. He then worked in the field of nanotechnology research and had the chance to visit research institutes all over the world. Since 2013 he has been working on the Anti-Icing System in the blade engineering department at Nordex Energy. In 2019 he was appointed Expert Engineer for the Nordex Anti-Icing System.
Konrad loves playing the drums and being on stage with his rock bands.

R&D areas/s: 07. Forecasting, cloud physics and aerodynamics, 08. Pre-construction site assessment, measurements, models and standards

How might climate change affect repowering?

Charles Godreau, Nergica, CA

Marilys Clément (Nergica), Nigel Swytink-Binnema (Nergica)

Nergica is halfway through a multi-year project with climate modelling experts Ouranos and multiple Canadian grid operators. We are looking at the effect of climate change on wind energy potential across North America from 1950 until 2100.
Two Representative Concentration Pathways (RCPs) were simulated: RCP 4.5 (global emissions peak in 2040 before declining) and RCP 8.5 (worst-case “business-as-usual” scenario and emissions continue to rise). Within the 150 years simulated, three climate periods have been identified:

- Historical reference period: 1981-2010
- Horizon 1 (short-term / first repowering): 2031-2060
- Horizon 2 (long-term / second repowering): 2061-2090

Simulation results for both Horizons using each RCP will be compared with the Historical period. Focus will be on comparing Horizon 1 to the Historical reference period. This will be the period of most interest as we enter our first repowering efforts in Canada.
The effects of climate change on Annual Energy Production (AEP) will be evaluated by factoring in changes to wind speeds as well as changes to icing. Wind speed effects are evaluated using a power curve, and icing and power losses are modelled using Nergica’s model GPEO. In addition, changes to wind direction will be quantified, as this is a significant factor in wind turbine siting.
The presentation will cover a description of the project and methodology but will focus on preliminary results of the simulations. Maps of changes will be shown for key regions within North America. These changes could include the following: annual icing days, severe icing amounts, average wind speeds, dominant wind directions, and AEP. Lastly, future steps will be outlined for the final two years of the project.

Web site:

Short biography: As a specialist in meteorology as it relates to wind power in cold climates, Marilys leverages her know-how in atmospheric physics to skillfully overcome the inherent challenges in wind energy production in cold climates and complex terrain. Although her initial focus area of theoretical climate change research has since evolved to encompass a search for concrete solutions such as renewable energy integration, she remains deeply drawn to climate-related issues.
As a research and innovation project manager, she has had the opportunity to lead and take part in numerous research projects aiming to improve modelling for wind energy. In addition to developing an ice and energy loss model (GPEO), Marilys has also made noteworthy contributions to several projects related to the processing, analysis and evaluation of climatic and meteorological models.
Marilys holds Bachelor’s and Master’s degrees in atmospheric sciences from the Université du Québec à Montréal.

R&D areas/s: 10. De-/anti-icing including new technologies, ice detection & control incl. standards

Installation of Retrofit Hot Air De-icing Systems

Daniela Roeper, Borealis Wind, Canada

Daniela Roeper (Borealis Wind, Canada)

Cold climates are ideal for wind energy production, but wind turbine icing results in significant reductions in energy production around the world and revenue loss of $250 million per year in Canada alone. Borealis Wind has developed a retrofit Hot Air de-icing system to remove and prevent ice accumulation on wind turbine, called the Borealis Ice Protection System ("IPS"). The installation process of the Borealis system is unique to the market because there is no need to use cranes to remove the blades, no need for rope access, and no lost production overnight. The device consists of a heating system which is installed inside the leading edge of the blades where it can efficiently remove ice and remain protected from the harsh environment. It focuses heat to the crucial areas of the blade to increase the reliability, efficiency, and safety of existing wind turbines in cold climates, thereby removing barriers for the development and adoption of wind energy. Borealis works closely with the wind farm owners and operators to tailor the device to their environment, turbine model, and technical team. The Borealis IPS is currently installed at several wind farms in Canada. The installation starts with the specialized design of the components, which must be able to be brought inside the blade without performing modifications to the turbine. Once the components are in the blade the installation is performed to allow air circulation all the way to the very tip of the blade, although only 1/3rd of the blade is accessible to the install team. Finally, it is structured so that the turbine is able to operate overnight each night, during the installation process. Once the mechanical installation is complete the turbine is commissioned, and the system is ready to operate. This process normally takes about 1 week per turbine.

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

Short biography: Daniela is a mechanical engineer with a passion for the environment. While still completing her undergraduate degree from the University of British Columbia, Daniela founded Borealis Wind, a startup that provides a blade de-icing retrofit for wind turbines, improving their reliability as well as increasing production. The system has been validated through pilot testing in Canada. The innovative system can be installed up-tower without removing the blades of the turbine, saving significant installation and maintenance costs.

R&D areas/s: 08. Pre-construction site assessment, measurements, models and standards

Measuring the Wind in Cold Climates - a real world summary of Lidar performance

Wulstan Nixon, United Kingdom

Wulstan Nixon (ZX Lidars, UK)

A number of multipoint wind measurement campaigns have been carried out in harsh sub-arctic conditions across three high elevation sites in Scandinavia. A mix of fixed low height heated masts and co-located, plus roaming Lidars have been deployed to mitigate mast ice risk, allow the collection of full rotor diameter wind conditions and give adequate coverage of measurement points across large and complex sites.
Co-located mast and Lidar datasets showed excellent levels of correlation, exceeding current best practice accuracy criterion. Data loss from masts due to icing conditions was significant and the co-located Lidar data highlighted cup icing periods not captured by typical QC methods. The Lidar datasets were used for finance grade investment decisions in the region.

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

Short biography: Wulstan has been working for ZX Lidars for over 5 years helping to improve wind measurement best practice in some of the harshest conditions. As a keen advocate for Lidar technology Wulstan is supported by a large group of dedicated scientists and R&D professionals striving to realise the potential of Lidar technology in reducing costs and uncertainties at all stages of Wind Farm development and operation.

R&D areas/s: 07. Forecasting, cloud physics and aerodynamics

Large Eddy Simulation of Icing Conditions Impacting Wind Farms in Heterogeneous Land Use

Erik Janzon, Department of Earth Sciences, Uppsala Universitet, Sweden

Heiner Körnich (SMHI, SE), Johan Arnqvist (Uppsala Universitet, SE), Anna Rutgersson (Uppsala Universitet, SE)

Wind turbines located in cold climates and in elevated terrain are often at risk of ice accretion when supercooled water droplets within clouds interact with the surface of the turbine blade structure. The accurate forecast of generation losses during these icing events is necessary for the operation of wind farms. In order to accurately predict wind generation losses, meteorological input is required from numerical weather prediction (NWP) models that are in turn required to resolve the complex interaction between the surface and the atmosphere—more specifically the wind, temperature and clouds within the atmospheric boundary layer. Surface-boundary layer interactions are sub-grid scale processes within operational NWP models and must be parameterized. To further add to the complexity wind farms are often located within regions of heterogeneous land use, which can hinder accurate representation of the surface in the NWP model. The impact of the land-use on the low-level clouds can potentially be important for the forecasting of icing and related power generation losses. This study will explore the validity of the surface model in a Large Eddy Simulation (LES) using the MesoNH research model at 50 m horizontal resolution. Surface-Atmospheric interactions of heat, moisture, and momentum will be analyzed for different patterns of tree cover with the aim of determining the impact of heterogeneous land use on icing conditions.

Web site:

Short biography: Erik Janzon is a meteorology PhD student from the United States in the Department of Earth Sciences at Uppsala Universitet. Erik completed his Bachelor's degree in Meteorology in 2009 at Northern Illinois University and his Master's degree in Atmospheric Science in 2012 at the University of Wisconsin-Madison. Prior to moving to Sweden, Erik worked as a weather forecaster for real-time energy trading at Avangrid Renewables and as a fundamentals meteorologist at Portland General Electric in Portland, Oregon USA. In his spare time, Erik plays the electric guitar.

R&D areas/s: 06. Wind turbine manufacturers – cold climate solutions, test centres, turbines and components, 10. De-/anti-icing including new technologies, ice detection & control incl. standards, 12. Laboratory and full-scale testing, small wind turbines

Climatic chamber testing and verification in cold climate

Mattias Viktorsson, RISE

Mattias Viktorsson

Environmental Engineering environments - The potential, and the various challenges with testing and verification in climate chambers with focus on cold climates and icing.

Web site: https://www.sp.se/en/index/services/Climate_simulations/Sidor/default.aspx

Short biography: With 20 years of experience in environmental engineering with a focus on simulation temperature, sun, ice and high humidity. I have combined my expert role at RISE with in recent years also working as a generalist to helping companies to innovate and grow internationally. In my spare time I like to play golf, to be a magician and spending time with my family.

R&D areas/s: 04. Construction of wind farms in cold climates (preparations, foundations and installations)

Pile Foundation Prototype Execution and Applicability for Scandinavia

Miguel Turullols, Nabrawind Technologies SL (Spain)

Arocena, Ion (Nabrawind); Rodriguez, Emilio (Nabrawind); Esparza, Arantxa (Nabrawind); Turullols, Miguel (Nabrawind)

Whereas the standard tubular towers they all share the same gravitational foundation, Nabrawind suggests a pilot foundation for its Nabralift tower which means several advantages.
This is possible thanks to the specific characteristics of the Nabralift tower. To sum up, Nabralift is a hybrid steel tower with a three legs steel structure in the bottom part and a tubular tower in the top one. Due to this combination, Nabralift is compatible with a pile or anchor rock foundation. This kind of foundation does not only contribute to significantly reduce the cost of the very same foundation, but also the quantity of concrete.
Therefore, the first advantage is that the pilot foundation reduces the cost of the foundation by a 60% when comparing with a gravitational foundation.
Nevertheless, and especially when referring to cold climates, there are some specific benefits that need to be described.
First of all, when using this kind of pile foundation there is a real possibility of heating the concrete. This technique just requires 80m3 of concrete, a small amount of concrete that can be heated. This means to lay the foundation in winter would be possible.
Secondly, fulfilling the piles just takes one hour. Suck a quick maneuver increases the operational time in autumn and spring, when the temperature fluctuates from below to above zero degrees.
All in all, a pile foundation represent some interesting advantages that might help to increase the operational time for the installation of wind turbines.

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

Short biography: Miguel Turullols have worked in the wind industry for the last two years. He is currently the Marketing Manager in Nabrawind Technologies.
Previously, he had developed a career as a Trade consultor, working in the Embassy of Spain in Zagreb (Croatia) for two years and in the Mission of Spain to the United Nations in New York for another year. Before that, he worked in several media in Spain, covering politics and economics. news.
He first studied Communication in the University of Navarre. After that he completed his background with a Master Degree in International Relationships and then a Master of Business Administration.

R&D areas/s: 15. National strategies, research programs, grid access, system services and new developments

Circular streams from GFRP composite waste

Richard Sott, RISE

Richard Sott, Cecilia Mattsson, Magdalena Juntikka and Tanja Tränkle (RISE)

GFRP waste is a growing global environmental problem since the waste from wind, boat, automotive and construction industries go to landfill or incineration. Our project aim is to take a larger perspective on the problem: End-of-Life and manufacturing GFRP waste should be recycled through solvolysis/HTL in order to generate new circular material flows. To lay the grounds for future implementation of the solvolysis technology in a circular value chain, material flows from industries such as wind power, boat and construction industries need to be mapped and future recycled products and value chains will be evaluated regarding their profitability and impact on the environment.
Today, the more valuable carbon fiber composites are recycled by chemical recycling and pyrolysis, where the plastic parts of the composite are utilized for generating energy to the process. However, it's not possible to use same process conditions for GFRP recycling since the glass fiber are more sensitive to chemicals and heat. In addition the cost of virgin glass fibres is low and therefore no incentive for profitable recycling exits. Our aim is to modify the solvolysis process condition and use lower temperatures (250-400 ºC) and utilizing catalysts for achieving separation between fiber and plastic part in the thermoset linked three-dimensional composite structure. In order to create circular high-quality product streams from both glass fibres and the plastic components, the goal is to produce fine chemicals or plastic building blocks that can be used for repolymerization, and glass fibres that can be reused in new composite materials.
To lay the grounds for future implementation of the technology in a circular value chain, material flows from industries such as wind power, boat and construction industries needs to be mapped, and possible future recycled products and value chains will be evaluated regarding their profitability and impact on the environment. An interdisciplinary perspective must be taken to tackle this GFRP recycling problem, where composite manufacturers and users, recycling industry and potential new players must meet and generate new innovative circular streams from GFRP composite.

Web site: https://www.ri.se/sv/richard-sott

Short biography: Researcher at RISE - Chemistry and Materials with current focus on recycling of composite materials from windmill turbine blades. Background from pharmaceutical industry and research in organic synthesis. Interested in anything that concerns replacement of fossil based materials to biobased plastics, analytical chemistry and recycling of plastics. Personal interest in any possible outdoor Winter sport.

R&D areas/s: 01. O&M experiences incl. performance optimization, production losses

Task19 - Ice Loss Tool

Timo Karlsson, VTT

Timo Karlsson (VTT, FI)

When installing and operating wind turbines in cold climates, the turbine blades can be affected by icing. Icing has an impact on blade aerodynamics and causes production losses. The magnitude of production losses varies depending on the site and the turbine model.
There is no real standard definition what kind of impact in production constitutes an icing event. Task 19 has proposed one way to standardize this. In 2015 a software implementation of this method was published for the first time. The software uses a standard statistical definition of an icing event and can be used to estimate the magnitude of icing losses posthumously from production data.
The method for detecting icing is based on computing an acceptable variance from summer time production and using this as lower limit for ice detection. The tool is using the turbine rotor as an ice detector and calculates specific limits for each turbine every time its run.
The tool has been recently updated to include some new features and at the same time the development and release process has been changed. The development is now more open and welcoming to outside contributions and instead of making big release every now and then, the new development process allows continuous improvement of the tool in an open and collaborative way. [1]
The new additions allow new kind of analysis, including analysis of heated turbines and estimation of effectiveness of ice detection.
Originally, when the tool was developed there were three goals:

1. Have a tool to compare site to each other
2. Validate the IEA ice classification
3. Compare the effectiveness of blade heating systems to non-heated turbines on cold climate sites

The presentation looks into how well these goals have been achieved and what still needs to be done. Experiences from the first few years of the tools availability will be shared in the presentation, what went right, what went wrong, what was achieved, what could be improved.
Some usage tips and best practices for the usage of the tool will be presented and the future evolution of the tool will be discussed.
[1] https://github.com/IEAWind-Task19/T19IceLossMethod

Web site: https://www.vttresearch.com/services/low-carbon-energy/wind-energy

Short biography: My background in industrial automation and I have M.Sc. degree from Aalto University School of electrical engineering. I've been at VTT since 2011 working as a research scientist focusing in wind power and cold climate issues. During this time at I've been working on numerous R&D projects in wide variety of topics including ice detection method development, ice assessment, production data analysis and ice prevention system development.
Currently I'm also the operating agent of IEA Wind Task 19.

R&D areas/s: 11. Onshore turbines, aerodynamics, loads and control

Predicting production loss due to ice accretion

Johan Revstedt, Dept. of Energy Sciences, Lund University, SE

Johan Revstedt (Lund University, SE), Robert Szasz (Lund University, SE), Stefan Ivanell (Uppsala University, SE)

The power output from wind turbines in cold climate is in winter time affected by ice accretion on the turbine. Accounting for this when estimating the potential power output at a prospective new site is important. This can be done in several ways. One method is to make estimates based on wind measurements with anemometers and the number of hours these are affected by ice. One can make empirical estimates based on the connection between terrain height and production losses.
However, these methods are often limited in both space and time to the area and time span of data collection. More advanced methods utilize mesoscale atmospheric models together with, for example the Makkonen [1] model for the ice build-up.
The model we are developing for predicting production losses is based on a modelling chain from mesoscale simulation of the atmospheric conditions via CFD simulations of the ice accretion to CFD of the full iced turbine, in the latter case using the actuator line model.
In the present state of this project we are collecting aerodynamics data for a wind turbine blade from a certain icing event. This includes detailed flow simulations during ice accretion at several sections of the turbine blade. From these sections we extrapolate aerodynamic data to the whole blade. As a model turbine we use the NREL 5 MW turbine.
We will present data from how the blade of this turbine is affected by icing for at least one icing event. Up to now we have only considered rime ice but results from our recently developed glaze ice model will also be presented. Furthermore, using a CFD based technique for ice accretion one will have to address the large separation in time scales between the ice accretion process and the flow. Hence, to get results in a reasonable time one has to scale the time of the accretion process.
Our results indicate that decreasing the time scale of ice accretion by a factor of 1000 still gives reasonable results in terms of ice load and ice distribution on the blade. Future work will present results bridging the gap from mesoscale simulations, i.e., give model input to ice accretion modelling, all the way to rotor simulations including load assessment.
Acknowledgements: This work is financed by the Swedish Energy Agency, project no. 47053-1.
Computational resources are provided by SNIC (Swedish National Infrastructure for Computing).
References:
1. Makkonen, L., 2000, “Models for the growth of rime, glaze, icicles and wet snow on structures”, Philosophical Transactions of The Royal Society London A 2000 358, pp. 2913-2939.

Web site: https://www.fm.energy.lth.se

Short biography: Professor Revstedt got his master degree in mechanical engineering in 1996 and a PhD in fluid mechanics in 1999 at Lund University, Sweden. He is since 2011 professor in Fluid Mechanics at the department of Energy Sciences, Lund University. His main research interests are multi-phase flow, fluid-structure interactions and wind turbine aerodynamics. He has been involved in several research projects concerning wind turbine aerodynamics, some including ice accretion and aeroacoustics. Among his extracurricular activities one may mention a keen interest for swimming.

R&D areas/s: 10. De-/anti-icing including new technologies, ice detection & control incl. standards

The impact of liquid water content on thermal ice protection systems efficiency

André Bégin-Drolet, Université Laval

Patrice Roberge (Université Laval, Canada), Jean Ruel (Université Laval, Canada), Jean Lemay (Université Laval, Canada)

In cold climate and especially in eastern Canada where the icing season span roughly from mid-September to early May, ice related losses can reach a substantial percentage of the annual energy production, thus leading to important financial losses for operators. Wind turbine thermal Ice Protection Systems (IPS) are now widely available and are designed to heat a given surface of the blades for the purpose of preventing or removing atmospheric icing. However, it has been observed that wind turbines equipped with IPS still suffer important icing losses. Over the last couple of years, we have developed a semi-empirical model to explain the inefficiency of the IPS under standard meteorological conditions. This model was used to generate what has been called IPS performance envelope, a tool that can be used to characterize the efficiency of IPS. The IPS performance envelope is a concept used to predict the behaviour of a wind turbine and, in its simplest form, relies only on 2 external parameters that are widely available: wind speed and air temperature. Lately, we have observed, during field tests, that the IPS systems are also greatly impacted by the liquid water content (LWC). Hence, even though IPS performance envelopes can be a very useful tool for wind turbine designer as well as for wind energy developers and operators, it is also very important to consider the LWC when trying to assess or predict the behaviour of IPS. In this presentation, we will give a brief overview of the research we are doing in Canada regarding icing detection, characterization of IPS and improvement of wind energy in cold climate as a whole. We will show, using field measurements, the impact that LWC can have on IPS efficiency and the importance of measuring LWC on a given wind test site. Finally, we will also address the importance of establishing partnerships between academia and industry.

Web site: http://www.gmc.ulaval.ca

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

R&D areas/s: 10. De-/anti-icing including new technologies, ice detection & control incl. standards

A new type of anti icing system – development/application/demonstration

Sven-Erik Thor, Lindskog Innovation AB

Jonas Sundström (Skellefteå Kraft AB), Kjell Lindskog, Sven-Erik Thor (Lindskog Innovation AB). Sweden.

This presentation will describe the development of a new type of anti-icing system. The presentation will focus on the general characteristics of the system and description of the different subsystems as well as the experiences from operation on a wind turbine.
The goal of the project was as follows:
1. Development of heating modules, including manufacturing technology.
2. Develop methods and models for controlling the heating modules
3. System integration
4. Apply system on a wind turbine
5. Performance test in icing climate on a wind turbine

The system has been installed and been in operation on a wind turbine owned by Skellefteå Kraft AB.
The project has been managed and financed by Lindskog Innovation AB. Financial support from Energimyndigheten and Skellefteå Kraft AB is greatly acknowledged.

Web site:

Short biography: His long career includes; being head of wind RD&D at Vattenfall before his retirement. Participating in a number of EU projects on wind energy. Being a member of EU TpWind Steering Committee and services to the European Commission to evaluate proposals for framework programs. Has been Operating Agent for IEA Task 11.
Presently working with Lindskog Innovation AB regarding the development of de/anti-icing systems.
On his free time, he enjoys woodworking and taking care of the summer house.
https://www.linkedin.com/in/sven-erik-thor-a6124115/

R&D areas/s: 01. O&M experiences incl. performance optimization, production losses, 03. Inspection and repair, 04. Construction of wind farms in cold climates (preparations, foundations and installations), 08. Pre-construction site assessment, measurements, models and standards, 15. National strategies, research programs, grid access, system services and new developments

Control of tower bolt connections and the challenges related to cold climate conditions

Anders Wickström, RISE Research Institutes of Sweden

Magnus Evertsson, Chalmers, Professor in Machine Elements, Head of Division Product Development
Jonas Nilsagård, TensionCam, Inventor

Inaccurate tightening bolt connections is a problem on wind turbine towers. The tightening operation is difficult. The tightening load must not be too low or too high. It is necessary to pay particular attention to the choice of the tightening tool, the process and the control method.
Most often the tightening is conducted with a torque wrench. The real preload, which is applied to the bolt by torque, depends on the friction coefficient in threads and the friction coefficient of the contact surfaces between nut and structure. The "useful" part of the torque is generally only 10–15% of the total torque. Even using a sophisticated wrench tool giving a high precision torque and having low friction coefficients, the accuracy of the final tightening load cannot be better than ±20%.
The pretension might therefore not be equally distributed among the bolts in the same joint. The practical conditions might be different from the hypothesizes at the design stage. The calculations of bolted joints needs to take these uncertainties into account.
There is an ongoing research project within SWPTC. The aim is to develop knowledge and deeper understanding of the tower bolt joints in general and more specifically control of bolt pretension.
The Swedish company TensionCam has invented and developed a concept, where the tightening load is determined by measuring displacements at bolt head or nut by an existing fingerprint sensor. Different locations and patterns have been tested. The resolution, about 1 micrometre, and accuracy have been validated by both FE-calculations and workshop tests at RISE.
This new technology makes it possible to check that the tightening force of each and every bolt is correct both after assembly and over time.
Winter conditions and lack of pretension control had severe impacts on the erection of the V112 turbines at Lemnhult in December 2015. If the pretension of the tower bolt joint would have been accurate, the accident would not have occurred.
There are additional challenges related to winter and cold climate conditions:
The optimal type of lubricant might differ depending on the ambient temperature.
Material properties of the foundation might change in extreme coldness.
The foundation ageing might be affected.
Ice on contact surfaces during tightening
All of these aspects might have an impact on the bolt pretension over time.
With a simple and rapid technology for checking the pretension, these aspects can be further evaluated. Therefore, involved partners hope to get an extension of this successful SWPTC project in order to also address the cold climate aspects of bolt pretension in towers and foundation.
With hope of getting the opportunity to tell more at the conference.

Web site: https://tensioncam.com/

Short biography: Wind turbine design since 1988, Kvaerner, ScanWind, GE.
Independent wind turbine consultant at Scandinavian Wind.
Official wind turbine expert at Statens haverikommission and its investigation of the V112 accident in Lemnhult
Since last year, employed at RISE.

R&D areas/s: 01. O&M experiences incl. performance optimization, production losses, 10. De-/anti-icing including new technologies, ice detection & control incl. standards, 14. Big Data, AI, digitalization and machine learning applied to cold climate challenges

The impact of light ice masses on expected wind power production

Florian Rieger, fos4X GmbH

Florian Rieger (fos4X GmbH), Luis Vera-Tudela (fos4X GmbH)

Wind power production in cold climates is affected by the formation of ice on rotor blades. In consequence, efforts in the industry have been focused on its detection. The goal is twofold, first to mitigate the risk of damaging the turbine structure as well as third-parties and, second, to minimize wind power production lost in the process. It is a risk-reward trade-off.
A previous investigation on the performance of various rotor-mounted ice detection systems has shown their overall high technical availability (Nergica, 2019). It has also shown that vibration-based systems limit the occurrence of false detection, as it is the case for fos4X Rotor Ice Control. This is achieved by using a threshold for ice-mass detection. This approach also implies a lower rate of detection when there is light icing. Thus, it is of interest to explicitly relate the amount of ice-mass to the power loss expected.
In this publication we evaluate field measurements to assess the impact of light icing on expected power production. Data sets gathered from fos4X Rotor Ice Control installations include time-series for electrical power produced, ice-mass, ice warnings and ice alarms. We include a statistical expectation for power production in ice-free periods to account for the lost power when there is light icing events. We describe how varying the threshold impacts on the expected power loss.
The utility function serves as baseline to discuss threshold selection in terms of expected power production. Since manufacturers guarantee power curves, this is also relevant to help market participants to find a fair expectation of power production under light icing. Furthermore, varying the threshold implies a change in false detection, which is discussed in qualitative terms to weight the interests of other market participants

Web site: https://www.fos4x.de/

Short biography: Florian is the main data scientist on ice detection at fos4X GmbH. He holds a master in electrical engineering from the Technical University of Munich, where he currently deepens his technical expertise by pursuing a PhD.

R&D areas/s: 02. Health, Safety and Environment (HSE) incl. ice throw and noise, 09. Environmental Impact Assessments (EIA)

windThrow: an open source toolbox for ice throw simulations

Hamid Sarlak, Denmark

Assistant professor, DTU Wind Energy

Latest developments on DTU's ice throw aerodynamic model will be presented. Compared to the original, research based version (see Sarlak, H. and Sørensen, J.N., 2016. Analysis of throw distances of detached objects from horizontal-axis wind turbines. Wind Energy, 19(1), pp.151-166.), the new revision includes a graphical user interface and a Python-based Monte Carlo simulation toolbox is integrated into the aerodynamics module (Fortran) to perform massive simulations with varying input parameters. Latest improvements and challenges in developing the toolbox will also be presented. The code will be released to the research community at the Winter Wind conference.

Web site: https://dk.linkedin.com/in/hamid-sarlak

Short biography: Hamid is an assistant professor of fluid mechanics at the department of wind energy at the Technical University of Denmark. Hamid has a previous background in ocean engineering and his current research involves turbulence modeling, CFD, hydrodynamics, and experimental aerodynamics.

R&D areas/s: 14. Big Data, AI, digitalization and machine learning applied to cold climate challenges

Should I heat or should I not? - Smart operation of wind turbines in Cold Climate

René Cattin, Meteotest, CH

Paul Froidevaux (Meteotest, CH), Ulrich Langnickel (VGB PowerTech, DE), René Cattin Meteotest, CH)

Today, electricity prices are low. As a result, there is a lot of pressure on wind turbine operators to maximize the production of their wind farms. The focus is on minimizing production losses and standstill times. At the same time, digitalization offers many new opportunities in the field of wind energy. Huge amounts of data from operating wind turbines are available in real time and turbines become more and more connected. In particular, the interaction between wind farms and servers located anywhere becomes more and more a standard.
Wind energy under icing conditions itself has also made a lot of technical progress in the past years: Ice detection has strongly improved and by today, various robust systems for blade based ice detection are available on the market. Ice protection systems (blade heatings) are today being offered by almost all OEMs.
However, the removal of blade icing still remains a technological challenge and the success of a blade heating attempt strongly depends on external conditions such as ambient temperature and wind speed (performance envelope). Moreover, the success of a blade heating event might be pragmatically assessed in terms of net production gain, rather than in terms of ice removal. The production gain depends on the temporal evolution of wind speed and ice cover in the hours or days following a heating event. Typically, all this information is by today not yet taken into account by the control systems.
Ideally, a smart control of the blade heating should consider external conditions for the present and for the near-future, i.e. it should combine real-time data with weather forecasts for efficient nowcasting. Nowadays, weather forecasts for wind speed or ambient temperature, as well as for icing, have reached an accuracy which allows to consider them for turbine control. This includes automatic decision making without the need of human interpretation of the forecasts.
In summary, there are a lot of suitable technologies and information sources available to optimize operation of wind turbines under icing conditions. However, all these advantages are not yet applied in an intelligent manner, a wind turbine operating under icing conditions is to some extent still "stupid". As of today, a blade heating is typically activated immediately when ice is detected at the blades, instead of controlling it in a predictive way by taking into account all available information. In other words, the optimal time to heat the blades depending on the current and forecasted external conditions must be put into focus.

There is a large potential to improve the operation of wind turbines by introducing a smart turbine control. This presentation will be of conceptual nature and outline the current technological state of the art as well as potential benefits and ways forward towards a real-time smart turbine control under icing conditions.

Web site: https://meteotest.ch/

Short biography: René Cattin holds a master degree in Geography. He works at Meteotest for almost 19 years. Since 2018, he is the CEO of Meteotest. He has been active in cold climate and wind energy since more than 15 years and was the Swiss representative of IEA Task 19 from 2009 to 2016. Outside the office, he is husband, father of three kids, a local green politician and always interested in rock music.

R&D areas/s: 01. O&M experiences incl. performance optimization, production losses

Wind turbine operations in northern Siberia

Masafumi Yamazaki, Kanagawa Institute of Technology, Japan

Ken'ichi Iwai(Komaihaltec Inc., Japan), Masao Hosomi(Komaihaltec Inc., Japan), Shigeo Kimura(Kanagawa Inst. of Tech., Japan)

In Tiksi, the Sakha Republic of northern Siberia, three wind turbines were installed. Tiksi is located in the area where the electricity is off the grid and has been depending on diesel power generation for a long time. Diesel power system often faces the high cost of the transportation of fuels. From this point of view, wind turbines are expected to contribute to reducing those costs as well as alleviating the load on the diesel power generator.
Tiksi experiences extremely low temperature climate in witer. All the three wind turbines are manufactured by a Japanese company, Komaihaltec Inc., designed to withstand below -30 degrees in Celsius. In addition to turbine's specification, icing on wind turbines also should be considered in cold climate. This report aims to provide information gathered through operating experiences.

Web site: https://www.linkedin.com/in/masafumi-yamazaki-541076b4/

Short biography: Masafumi Yamazaki is a Master student at Kanagawa Institute of Technology and a trainee at National Institute of Advanced Industrial Science and Technology (AIST). He received Bachelor's degree in Applied Physics from Tokyo University of Science in 2013. He has contributed to icing problems on various kinds of objects internationally. In addition to wind turbines, commercial aircrafts, multi-copters, and anemometers are of those.

R&D areas/s: 10. De-/anti-icing including new technologies, ice detection & control incl. standards

Megaterends in blade heating

Petteri Antikainen, Wicetec, Fi

Lasse Hietikko & Tomas Wallenius, Wicetec

The cold climate wind market has matured to very serious utility scale business, with utility scale requirements. The presentation is describing few trends which are making appropriate ice prevention more important than ever before.
When the turbines are getting bigger and higher, the icing is increasing exponentially due to increased frequency when blade is hitting the clouds. At the same time, the turbines are getting cheaper, requiring light weight structures, which are more sensitive to different disturbances, for example icing. The long blades also introduce different constraints with different heating technologies.
More and more turbines are being built to icing climate, in bigger units, for example Markbyggden with a plan for 4 GW. This introduces a big interest for security of supply in a severe icing periods.
Other economic concerns rise, fulfilling production requirements of PPA's. What is the cost, if you need to buy electricity with the top prices instead of selling?

Web site: https://wicetec.com

Short biography: Petteri has worked 25 years with cold climate wind. 2014 he co-founded Wicetec, a company dedicated to Ice Prevention for wind turbines.
Before Wicetec, he has developed tools and methods for cold climate including standards in National and International standardization committees, SESKO and IEC MT12-1. He has a M. Sc. in Technical Physics at HUT, Finland. Petteri worked as principal scientist at VTT, Technical Research Centre of Finland. He has also been a board member in Finnish Wind Power Assosiation.

R&D areas/s: 10. De-/anti-icing including new technologies, ice detection & control incl. standards

Vestas Cold Climate solutions

Karl Gregory, Vestas Wind Systems A/S, DK

Karl Gregory (Vestas), Brian Daugbjerg Nielsen (Vestas)

Vestas will present the cold climate solutions package available to the market. 1) Low Temperature: Low temperature operational ranges and turbine product adaption. 2) Icing mitigation solutions: A)Vestas turbine in icing conditions - Production impact due to icing and how Vestas Turbines reacts to the icing. B) Anti-icing – moving into mass production, most recent field data and next steps. C) Ice detection solutions – how the operational strategy can be tailored to fit high regulative ice throw sites to less regulative, and what can be combine in order to enable the most optimum operational strategy.

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

Short biography: MSc Aerospace '85-'87 Cranfield University, BEng, Civil Engineering '81-'85 Univerisity of Bradford.
2010 till now, Vestas, Senior specialist 2010 till now. Main focus on cold climate solutions
1997-2010 GKN Aerospace Chief Engineer (propulsion)
1992-1997 Team leader, rolls Royce Deutschland

R&D areas/s: 08. Pre-construction site assessment, measurements, models and standards

Wind farm blockage onshore: what drives the loss?

Till Beckford, DNV GL, UK

Till Beckford (DNV GL, UK), Christiane Montavon (DNV GL, NL

When modelling turbine interactions within arrays, the wind industry typically only considers wake losses, whereby a specific turbine only affects turbines located downstream of its position. In practice, turbine interactions also include lateral as well as up- and downstream interactions, which altogether contribute to the resistance (aka blockage) that the wind farm induces on the background flow, deflecting some of the flow above and around the wind farm. A consequence of this is that the turbines operating on the upstream edge of the wind farm are exposed to wind speeds which are slightly different (usually reduced) from the so-called freestream conditions, as measured by a mast before the wind farm is in operation.
Since the adoption of blockage effects by DNV GL in 2018, further research and the acceptance in the industry, particularly offshore, has increased culminating in the recent (at the time of writing) announcement by Ørsted of their own blockage model and downgrading of their expected long-term production forecast /1/.
Questions however remain over the applicability of blockage effects onshore, and in particular, the influence of forestry and terrain, such as that seen in the Nordic region. Do forestry and terrain effects introduce more mixing in the atmosphere, and thereby mitigate blockage effects? Are these effects negligible in relation to the driving factor in wind farm blockage calculations, turbine density?
In order to answer these question, DNV GL has undertaken CFD simulations of a range of generic wind farms with variable levels of forestry and terrain, in order to represent typical onshore wind farms in the Nordics. Through this, the important relationships between these factors and the turbines are investigated and empirical relationships suggested. These enables improved predictions of turbine interaction blockage effects at typical Nordic wind farm projects to be made.
In addition, the influence of atmospheric stability on the magnitude of blockage effects is considered, along with the height of the boundary layer and the influence this can have on onshore and offshore blockage calculations.
In viewing this presentation, delegates will gain an important understanding of the driving factors for blockage effects at Nordic wind farm projects, along with how this may change when looking offshore. This understanding is vital in empowering industry stakeholders to make well informed decisions and understand the risks in predictions of long-term energy yield.
References
1. https://orsted.com/en/Company-Announcement-List/2019/10/1937002

Web site: https://www.dnvgl.com/energy/index.html

Short biography: Till has been working in the renewable energy sector with DNV GL since 2012. Working in the Renewable Energy Analytics department, Till focuses on undertaking analyses of wind farms throughout their life cycle – from project development through to operational analytics. In his current role, Till leads a team of engineers serving the Nordic & Baltic markets and is the technical lead for DNV GL's pre-construction services. Till has worked on some of the largest wind farms in northern Europe and has extensive experience in Cold Climate projects. Till has a Masters in Mechanical Engineering from the University of Bath. Outside of work you can find Till enjoying music or keeping fit!

R&D areas/s: 05. Market potential, finance, risk assessment, bankability and mitigation

Cost of uncertainty in project development

Jenny Longworth, Kjeller Vindteknikk AB

Ville Lehtomäki

This presentation will show how uncertainty in wind measurements and the resulting uncertainty in expected wind farm annual energy production (AEP) impacts the wind farm purchase price near financial close. The purchase price analysis was done by a big equity investor based on a statistical analysis of historical wind farm transactions. A cost-benefit analysis is performed by Kjeller Vindteknikk on how to mitigate the wind measurement uncertainty by different methods and solutions. Solutions to mitigate uncertainties before and after wind measurements are presented.
It is recommended that project developers make AEP uncertainty reduction a #1 priority in project development as this proves to be cost effective. Active, early intervention including corrective measures during wind measurement campaigns are financially viable ways to reduce AEP uncertainties.

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

Short biography: Jenny Longworth has been working in the wind industry since 2005 at a number of different wind energy consultancies and project developers such as Sgurrenergy, SSE and Vattenfall with wind energy analysis as well as wind turbine procurement. She joined Kjeller Vindteknikk AB as Managing Director in September this year. Jenny has a master's in mechanical engineering from Luleå University of Technology and a MSc in Renewable Energy Systems Technology from Loughborough University and she is also active in the research centre Stand Up for Wind.

R&D areas/s: 03. Inspection and repair

Siemens Gamesa effective blade repair solution at cold temperatures

Mert Satir, Siemens Gamesa Renewable Energy, Ireland

Mert Satir (Siemens Gamesa Renewable Energy, IE), Maria Azzurra Riezzo (Siemens Gamesa Renewable Energy, DK)

Siemens Gamesa has a long history and vast experience in servicing turbines in cold climates around the world and has been a pioneer in developing innovative solutions to improve the performance and serviceability of turbines in cold climates. Cold weather makes blade repair a challenge both technically and logistically. Ordinary lamination solutions like wet lamination are just not up to the task. Not suitable for winter – or humid – conditions, these can only be applied in temperatures over 15°C, and carry the risk of an incorrect mixing ratio, and have a long curing cycle – even up to 5 hours. To overcome these challenges, Siemens Gamesa has introduced the innovative Siemens Gamesa UV Curing Laminate Repair System. An efficient, proven concept that responds directly to the inefficiencies of other blade repair lamination solutions, thanks to its UV lamp curing solution allowing the repairs to be done at lower temperatures and higher humidity conditions. Greatly simplified lamination with less operator dependency results in substantial reduction in processing time and simplified logistic set-up. This ensures a repair cost reduction by 20-30%. This presentation explains this innovative, cost and time-efficient repair solution that helps to keep the turbine blades operating optimally.

Web site: https://www.siemensgamesa.com/en-int

Short biography: Mert Satir is the Product Marketing Manager in Siemens Gamesa Renewable Energy, covering North, Central and East Europe and Middle East region. He has a BSc degree on Naval Architecture and Marine Engineering and a MSc degree on Sustainable Energy and Green Technologies. Prior to his current work, he worked at various roles in Wind Energy in Project Management and Sales Bid Management at locations such as Denmark, USA, Germany and Ireland. Currently based in Dublin, Ireland, he is working to help shape the product portfolio. Maria has a bachelor's degree in Industrial Engineering and a master's degree in Material Engineering from the University of Salento. She recently joined Siemens Gamesa as a material specialist. She is mainly focused on the qualification of new structural materials. In the past, she was involved in research projects about structural composite material within the aeronautical sector.

R&D areas/s: 08. Pre-construction site assessment, measurements, models and standards

Validation of turbine specific modelled ice losses

Stefan Söderberg, DNV GL, SE

Till Beckford (DNV GL, GB), Carla Ribeiro (DNV GL), Alan Derrick, (RES Ltd, GB), Min Zhu (RES Ltd, GB)

In recent years technical innovations and improved understanding of challenges in cold climate areas has allowed the development of large wind farm projects in regions where severe icing conditions can be expected. One of the challenges has been, and still is, to accurately predict the expected energy loss due to icing.
The tool DNV GL use to estimate production losses due to icing is called WICE [1,2,3,4]. WICE includes a site-specific mesoscale modelling study using the state-of-the-art mesoscale model WRF [5], modelling of ice accretion on a turbine blade, a machine learning model to predict production losses due to icing and methods to long term correct the model results. The model chain has previously been validated in an internal study [4].
Recently DNV GL undertook a blind test for RES. RES is the world's largest independent renewable energy company with a portfolio of over 16 GW. In the study, 6 wind farm projects were included. The projects were located in different parts of Sweden, providing a good geographical spread within the country. Icing loss estimates were generated using WICE. Timeseries with hourly data for each individual turbine was provided by DNV GL and then compared to the observed losses in the operational data by RES. In the analysis an overall good agreement between WICE and SCADA derived losses was found.
As the performance of icing loss modelling continues to improve, the possibility presents itself for the use of icing modelling in the optimisation of wind farm designs, as opposed to limiting icing modelling to the estimation of energy losses. This optimisation may entail the specification of Ice Protection Systems only at the more severely effected locations, or the placement of turbines themselves.
To this end, the work presented here, includes an in-depth analysis of the turbine by turbine icing loss predictions in the blind test, and is augmented by the analysis of turbine specific losses from previous internal DNV GL WICE validations. From this it is shown that WICE performs well in capturing icing loss variation within wind farms, offering the potential for better wind farm designs. The presentation shall discuss where WICE does well, where there is room for improvement, and what the next steps are to enable developers of wind farms in Icing Climates to optimise their projects.
References:
[1] Söderberg, S., M. Baltscheffsky, and H. Bergström, 2013: Estimation of production losses due to icing - a combined field experiment and numerical modelling effort. EWEA 2013, Wien, Austria.
[2] Baltscheffsky, M. and S. Söderberg, 2013: Estimation of Production Losses Due to Icing – Development of methods for site assessment and forecasting. Winterwind 2013, Östersund, Sweden.
[3] Söderberg, S. and M. Baltscheffsky, 2014: A novel model approach to test de-icing strategies and de-icing efficiency. Winterwind 2014, Sundsvall, Sweden.
[4] Söderberg, S, J. Collins, T. Beckford, and C. Ribeiro, 2019: WICE 2.0 – The new generation of ice loss models. Winterwind 2019, Umeå, Sweden.
[5] Skamarock, W. C.; J. B. Klemp; J. Dudhia; D. M. Gill; M. Duda; X.-Y. Huang; W. Wang; and J. G. Powers (2008): A Description of the Advanced Research WRF Version 3. NCAR Technical Note.

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

Short biography: Stefan has worked in the wind industry since 2006. In DNV GL Stefan is and expert in numerical mesoscale modelling and icing climate studies. Prior to DNV GL, Stefan founded and worked in WeatherTech Scandinavia developing services based mesoscale model data such as wind resource mapping and estimates of production losses due to icing.
In the Renewable Energy Analytics Team, Stefan is Technical Lead responsible for the development and application of mesoscale modelling techniques in wind and solar resource assessment, working together with DNV GL's global pool of specific energy assessement challenges affecting the NEMEA (North Europe, Middle Easts and Africa) region, such as production losses due to icing, wind flow modelling and wakes offshore, among others.

R&D areas/s: 07. Forecasting, cloud physics and aerodynamics, 10. De-/anti-icing including new technologies, ice detection & control incl. standards, 15. National strategies, research programs, grid access, system services and new developments

Ice and snow management innovations for critical infrastructure

Ville Kaikkonen, University of Oulu

Ville A. Kaikkonen (University of Oulu, FI), Eero O. Molkoselkä (University of Oulu, FI), Harri J. Juttula (University of Oulu, FI), Katri M. Kukkola (University of Oulu, FI), Mikko Rintala (Lapland University of Applied Sciences, FI), Yijun Shi (Luleå Un

The Ice Proof Arctic - Innovations for ice and snow management –project aims to increase the number of actors involved in innovation activities in the Interreg North Program area by developing and validating solutions to reduce damages caused by ice and snow loads on various structures. The project aims for new innovations for reliable and cost effective risk management of snow and ice for critical infrastructure such as power grids, wind power production and large-scale buildings. The project includes the field test validations of multiple new innovations originating from both the commercial partners and the research units in the fields of cold climate wind power production, icing condition detection and measurement, power line ice load de-icing, and rooftop snow load monitoring and management systems. The project increases the cross-border co-operation between the companies and research institutes located in the northern parts of Norway, Sweden and Finland through cross-linked actions and public workshop events. This 3-year project started in October 2019 and is done in close collaboration with companies Rajakiiri Oy, Statnett FS, Global Boiler Works Oy, Dimense Oy, Koillis Mittaus Oy, Kjeller Vindteknikk AS, Wind Controller JV Oy, Nordic Cai Project Consulting AB and by four research groups from the University of Oulu, the Lapland University of Applied Sciences, the Luleå University of Technology and the Arctic University of Norway.

Web site:

Short biography: M.Sc.(tech.) degree in electronics, currently finalizing PhD work in the field of photonics on image based rain and snow measurements. Past research activities on different kind of optical environmental measurements. Spend my free time with my family and double basses playing jazzy and classical music.

R&D areas/s: 01. O&M experiences incl. performance optimization, production losses, 06. Wind turbine manufacturers – cold climate solutions, test centres, turbines and components, 08. Pre-construction site assessment, measurements, models and standards, 10. De-/anti-icing including new technologies, ice detection & control incl. standards

Performance Maps for Ice Mitigation Operational Strategies

Dimitar Stoyanov, Coventry University

Jonathan Nixon(CU,UK)

The study looks at determining how a wind turbine should perform for three alternative operational ice mitigation strategies during extreme and harsh in-cloud icing. Complete shutdown, anti-icing and tip-speed-ratio derating are evaluated for two icing events with ambient temperatures ranging between -30 and -5°C. Two anti-icing approaches are investigated; protecting the whole surface of the blade section and impingement zone protection only. The effectiveness of the ice mitigation strategies is evaluated by means of performance maps, which display what the reduction of the produced energy over a period of time would be depending on the choice of ice mitigation strategy. The considered time of operation is 24 hours, while the chosen wind turbine is NREL 5MW reference wind turbine. The ice simulations are completed using lewINT ice accretion software to generate the ice shapes for the extreme and harsh icing case with durations of 1 and 4 hours. The reduced aerodynamic performance is obtained using the predictive capabilities of XFoil and blade element momentum theory.

Tips-speed ratio derating was estimated to reduce the maximum possible ice induced energy losses by 35% during the extreme icing condition in comparison to the reference operational strategy, while the estimated reduction for the harsh icing conditions was 70% at an ambient temperature of -5°C, which reduced with lower temperatures.

Keeping the whole surface of the blade at 5ºC was found to require 0.5-2.6% of the daily energy production for the extreme icing case, while the maximum icing losses vary from 2.6-8.4% over the temperature region. During the harsh icing event, the ani-icing of the whole blade was found to be effective for ambient temperature between -10 and -5°C, leading to less than a 4% reduction of the daily energy generation, while the maximum losses from not utilising any strategy ranged from 12–15.5%. The anti-icing of the impingement region was found to be the optimal solution for both icing events, requiring less than 0.5% of the daily energy generation. The margin between maximum achievable losses and the energy required to heat the protected area can be used to establish design limits for the second anti-icing approach, which will allow wider protected zone and/or increase of blade surface temperature.

The operational shutdown reduced the daily energy loss by 30% during the harsh icing event at an ambient temperature of -5°C, while assuming wind turbine operational recovery 1-hour post-icing event. For the rest of the operational conditions, the alternative strategies are suggested.

The study shows also the importance of modelling ice melting, shedding and abrasion from wind as the expected reduction of the energy was estimated to vary between 0.5 to 4% of the daily energy production for 1-hour long extreme icing event, while for a 4-hour harsh icing event the variation was between 15.5% to 1.7%.

The results outline a framework for evaluating different ice mitigation strategies and set out to establish design limits for anti-icing systems. It was shown that the current approach visualise the potential effect of each ice mitigation strategy and its advantage is that it allows for the comparison of various possible ice mitigation techniques providing their ice mitigation properties are translated to reduction in the daily/annual energy losses. By investigating a potential wind site using this approach, it will be possible to select a combination of optimal operational strategies ensuring improved energy generation during the icing periods. The proposed framework will be beneficial for manufacturers in identifying regions of interest for high fidelity analysis on ice mitigation systems and techniques. In addition, the choice of suitable cold climate packages and wind turbine operational set of sequences would be eased for wind turbine operators when wind energy projects are being developed for Cold Climate regions.

Web site: https://www.researchgate.net/profile/Dimitar_Stoyanov4

Short biography: Dimitar Stoyanov is a third year PhD candidate in Coventry University, UK. After finishing his MSc in Aerospace Engineering in Coventry University, he started a PhD project on Wind Turbine Operation in Icing Conditions. The project aims to establish a method, which can help wind

R&D areas/s: 01. O&M experiences incl. performance optimization, production losses, 06. Wind turbine manufacturers – cold climate solutions, test centres, turbines and components, 08. Pre-construction site assessment, measurements, models and standards, 10. De-/anti-icing including new technologies, ice detection & control incl. standards

turbine operators to choose which is the best ice mitigation strategy or set of ice mitigation strategies for a specific Cold Climate location and wind turbine.
Following a journal article in Renewable Energy journal and a book chapter in Renewable Energy and Sustainable Buildings book, the project is set out to finish in the next four months when the complete output will be available to the research community.
Personal interest to Dimitar Stoyanov are CFD, aerodynamic, MATLAB programming routines and numerical analysis.

R&D areas/s: 01. O&M experiences incl. performance optimization, production losses, 14. Big Data, AI, digitalization and machine learning applied to cold climate challenges

Advanced operational analytics with machine learning

Till Beckford, DNV GL, UK

Sarah Barber (DNV GL, UK), Thomas van Delft (DNV GL, UK)

The operational management of renewable energy assets is an area for optimisation and opportunity; where improved practices can bring significant financial benefits for projects. This trend is driven by the increased consolidation of operators and the growing size of portfolios, both in terms of numbers and geographic spread. Advanced machine learning techniques, in collaboration with large high quality SCADA datasets, has enabled DNV GL to develop new tools for the analysis of operational data which improves both the accuracy and efficiency of analytics.

In the past year, DNV GL has been developing two tools using machine learning techniques and this presentation shall demonstrate these and the expected improvements available to operators of wind farms in the Nordics.

The first application of these techniques is power curve performance analysis, where the benefits of human experience and automation are combined into a single model. The presentation shall demonstrate the ability of the model to capture abnormal turbine performance, including icing conditions. This allows for the robust and efficient quantification of icing losses, which has been demonstrated to be variable with existing tools and is an essential component in performance management, in particular when undertaking Ice Protection Systems warranty tests.

Furthermore, through the development and training of the model, DNV GL has amassed a large database of operational turbine data, derived from the over 65 GW of wind farm operational data analysed by DNV GL. Through the analysis of this, interesting findings comparing the operation of different turbine types in cold climate conditions are revealed. This offers a greater understanding of turbine operations, from which smarter decisions can be made.

The second application of machine learning is in drivetrain condition monitoring. Here, DNV GL has applied machine leaning techniques to turbine SCADA data to develop a model predicting impending component failures. The presentation shall show the driving factors in the model and the implications of operating in cold climate environments.

In conclusion, from this presentation delegates shall gain an understanding of the uses of machine learning in operational analytics, along with an appreciation of the benefits in using large high-quality turbine SCADA datasets. This shall engender further discussion in the industry about what these datasets can show and be used for, and where machine learning can be intelligently used to improved turbine operations in cold climates and worldwide.

Web site: https://www.dnvgl.com/energy

Short biography: Sarah Barber is DNV GL's Global Service Line Leader for Asset Operations and Management, focusing on advisory services for operational solar and wind plants. Sarah joined DNV GL in 2008 and has worked in renewable energy technical advisory for nearly 17 years. Her experience includes both solar and wind energy, from single projects to global portfolios. Examples of her current and past work include: advising renewable asset owners in transactions and strategy decisions, monitoring for wind and solar farms, long-term energy production assessments, developing operational energy analytics, and project management of due diligence for large operational renewable portfolios. She has experience in many roles including as a Team Lead, Technical Lead, and Key Account Manager. She has degrees in Chemistry and Renewable Energy Systems. Outside of work, Sarah is an enthusiastic cyclist and also enjoys hiking and camping.

R&D areas/s: 06. Wind turbine manufacturers – cold climate solutions, test centres, turbines and components

Siemens Gamesa ice accretion modelling and its impact on the aerodynamic performance and AEP

Esteban Belmonte, Siemens Gamesa Renewable Energy, SP

Esteban Belmonte, Gabriel Ovejero, Marta Barreras

Siemens Gamesa Renewable Energy (SGRE) has more than 20 years of experience with wind turbines working under Cold Climate conditions around the world. Our cold climate expertise ensures that we understand the impact of operating the turbines on icing climate conditions and we overcome the challenges associated with ice accretion.
The presentation will show the blade airfoils modification based on different ice accretion models and their deteriorated aerodynamic performance based on CFD analysis. Various ice conditions and wind speeds are taken into account for the development of such models covering different blade sections.
The information provided by the ice accretion models are used to predict AEP losses of SGRE wind turbines at a specific site. Load simulations allow SGRE to analyze which loads/components are affected by ice formation and to achieve an optimal operation of the turbine during icing by use of advanced control strategies. Main benefits are the recovery of AEP losses and the extension of operating range in ice events.

Web site:

Short biography: Esteban Belmonte de Udaondo is currently working at Siemens Gamesa Renewable Energy in Onshore Technology Development department as the Project Manager for the cold climate solutions. Since graduated as a Mechanical Engineer he has been working in wind power industry for more than 15 years in different areas such as R&D and certification and he has been involved in broad range of areas from technical tasks to group and project management. He has supplemented his education with Project Management Professional granted by the Project Management Institute (PMI).

R&D areas/s: 08. Pre-construction site assessment, measurements, models and standards

Validation of, and findings from, the IceLoss 2.0-project

Johannes Lindvall, Kjeller Vindteknikk, SE

Johannes Lindvall (KVT, SE), Leon Lee (KVT, SE), Øyvind Byrkjedal (KVT/Norconsult, NO)

IceLoss 2.0 is a research project partly funded by the Swedish Energy Agency that has been running since 2018 and that will be delivered in spring 2020. The overall goal with the project is to increase the knowledge of production losses due to icing and to develop a next generation IceLoss model, which will be able to provide wind power project developers, investors and banks with better estimates of the production losses due to icing on the turbine blades.

Wind farm owners have contributed with SCADA data to the project and a database with historical icing losses from about 400 WTGs from 24 wind farms (~2000 WTG years) spread over Sweden, Norway and Finland has been created. This database is used to calibrate and validate the IceLoss 2.0 model but also to compare losses from different wind farms and different turbine types when subject to similar icing conditions.

In this presentation the focus will be on the calibration and validation processes of the IceLoss 2.0 model. Parts of the SCADA icing loss database will be dedicated to optimizing the modelled icing loss on turbine level to get as close match as possible to the historical losses. The simulated variables used in the calibration process are wind speed, accumulated ice load on a rotating blade cylinder and the icing intensity. SCADA data independent from the calibration process, are then used for the validation of the IceLoss model. The presentation will discuss the challenges of the calibration process and show the results of the validation study.

The presentation will also display the benefits of the IceLoss 2.0 model for estimating a long-term icing loss for a wind farm in operation by applying the optimization methodology to the historical SCADA data of a single wind farm.

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

Short biography: Johannes holds a PhD in atmosperic sciences from Stockholm University and continued with research on boundary layer clouds at NASA Jet Propulsion Laboratory and Stockholm University before joining Kjeller Vindteknikk in 2013. At Kjeller Vindteknikk, Johannes works with commercial and R&D-projects. At the moment, the majority of his hours are put into the IceLoss 2 research project, which aims to develop Kjeller Vindteknikk next model for predicting production losses due to icing. Johannes is also a United States champion in floorball, which means nothing.

R&D areas/s: 07. Forecasting, cloud physics and aerodynamics

A CFD benchmark study of ice accretion on a wind turbine blade and a comparison to the ice accretion of a rotating blade cylinder model

Johannes Lindvall, Kjeller vindteknikk, SE

Leon Lee (KVT, SE), Ville Lehtomäki (KVT, FI), Johannes Lindvall (KVT, SE), Richard Hann (NTNU, NO), Johan Revstedt (LTH, SE), Muhammad S. Virk (UiT, NO)

This presentation will show results from a Computational Fluid Dynamic (CFD) benchmark study that has been done as part of the research project IceLoss 2.0, partly funded by the Swedish Energy Agency. IceLoss 2.0 is an upgraded version of Kjeller Vindteknikk's (KVT) IceLoss algorithm, which is used to analytically predict long-term and short-term production loss estimates due to ice on wind turbines using modeled weather data.

Five different CFD model setups has been used to simulate ice accretion on the 3.4 MW onshore research turbine developed within IEA Task 37. The simulations were done for three pre-defined meteorological cases and performed in co-operation with the Arctic University of Norway (UiT), Lund University (LTH) and Norwegian University of Science and Technology (NTNU). A total of 30 different simulation runs was performed.

The Makkonen standard cylinder ice accretion model, originally developed for estimating ice loads on power lines, has proved to be useful within the wind industry on estimating icing losses. Although widely used, the model is limited to the fact that it models ice on a cylinder with the mean wind speed fed in as droplet collision velocity. In a study by Davis et al. (2014), the inputs to the Makkonen model was modified to better represent a rotating turbine blade and it was shown to have a better skill score than the standard cylinder model. KVT has developed a Blade Cylinder model based on this as part of the IceLoss 2.0 project and has performed calculations equivalent to the benchmark CFD simulations to make it comparable in this study.

It is seen that all CFD models give approximately the same amount of ice mass, although the ice shapes have some differences, especially for the more extreme meteorological cases. The chosen droplet distribution also has a significant impact on the estimated ice loads. Although the simulated ice loads of the KVT Blade Cylinder model is of the same magnitude as the CFD models, it shows buildup of larger ice loads in general. Due to a reduction in accretion coefficient (alpha3) in the blade cylinder model, the icing intensity remains the same although the collision speed increases for the different blade sections. This is not the case for the CFD calculations where an increase is seen for the outer blade sections also under the extreme icing case.

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

Short biography: Johannes holds a PhD in atmosperic sciences from Stockholm University and continued with research on boundary layer clouds at NASA Jet Propulsion Laboratory and Stockholm University before joining Kjeller Vindteknikk in 2013. At Kjeller Vindteknikk, Johannes works with commercial and R&D-projects. At the moment, the majority of his hours are put into the IceLoss 2 research project, which aims to develop Kjeller Vindteknikk next model for predicting production losses due to icing. Johannes is also a United States champion in floorball, which means nothing.

R&D areas/s: 02. Health, Safety and Environment (HSE) incl. ice throw and noise, 07. Forecasting, cloud physics and aerodynamics

Forecasting of icing for wind energy applications

Øyvind Byrkjedal, Kjeller Vindteknikk, NO

Johannes Lindvall (KVT, SE), Rolv Bredesen (KVT, NO)

Operational short-term icing forecasts have been carried out for 22 wind farms in the Nordic countries for the last 2-3 winter seasons. This presentation will show the results from the validation of the icing forecasts for these wind farms.
Better knowledge combined with the possibility to forecast turbine icing events has the potential to improve on the safety for the personnel working in the cold climate wind farms and can be used for the planning of service and maintenance in the wind farm. In addition it can be used to inform other parties about when it is safe to visit the wind farm area. Short term forecasting of turbine icing can also be beneficial for power forecasting and potentially as a supplementary signal for the operation of blade heating systems.
Kjeller Vindteknikk's operational forecasts consist of the WRF model using GFS forecasts as input source. The forecasts are run for a 48 hour period 4 times daily. The horizontal resolution of the WRF model is 4 km x 4 km. In three of the wind farms in the Fosen project in Trøndelag, Norway, these forecasts are now publicly available through Fosen Vinds home page (fosenvind.no).
To validate the forecasts a study has been carried out where the operational icing forecast was compared to period where icing was found to influence the energy production at 22 wind farms. The observed icing periods was found using the IEA Wind Task 19 method for calculating icing losses from SCADA data. The results show that the for the most exposed wind farms the forecasts correctly predict 70-90 % of the icing situations detected from the SCADA data.
Since there is also some uncertainty in identifying icing by the use of power data from SCADA we also illustrate this uncertainty by choosing one of the turbines in the wind farm as a predictor of icing for the rest of the turbines. The results show that typically 70-90% of the icing episodes in the wind farm are captured using the one turbine as a predictor. This is on the same level as was found for the icing forecasts. However, with a lower false alarm rate compared to the icing forecasts.
For one of the wind farms two different ice detection instruments located at the turbine nacelle was also available and showed that not all icing events found from SCADA was captured by the instruments. The instruments also detected several episodes that was found not to influence the energy production in the wind turbine. The operational icing forecasts was found to better predict icing on the rotor compared to icing on the instruments.

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

Short biography: Øyvind has a background from meteorology with a PhD from the University of Bergen, Norway. He has been a consultant in Kjeller Vindteknikk for the past 13 years and developed the tools used for icing loss assessment at Kjeller Vindteknikk today.
He currently has the position of R&D manager of Kjeller Vindteknikk and has been in charge of several research projects within wind energy and within icing climate.

R&D areas/s: 10. De-/anti-icing including new technologies, ice detection & control incl. standards

Ice protection systems and retrofits: Performance and experiences

Charles Godreau, Nergica, CA

On behalf of IEA Wind Task19

This presentation from IEA Wind TCP Task 19 (T19) will consist of a review of the publically available performance results from various ice protection systems (IPS) and retrofits. The collection of results will highlight the range of performance results, the metrics used and the scope of the studies published and push the discussion on how can IPS performance be compared from one system to the other. The presentation will also include the results of an industry survey conducted by T19 aimed at collecting and sharing experiences and operational knowledge of IPS and retrofits.

Web site: https://nergica.com/

Short biography: As a specialist in assessing wind turbine performance in cold climates as well as icing detection/protection systems, Charles possesses strong skills in data analysis for operational turbines as well as for developing, planning and implementing research projects. He has participated in a number of conferences and represents Canada in the International Energy Agency's Task 19 working group on wind energy in cold climates. In his free time, he enjoys white water canoe, splitboarding and improv theater.

R&D areas/s: 08. Pre-construction site assessment, measurements, models and standards

Improved flow modelling at cold climate sites through novel land-surface data from satellite sources

Morten Lybech Thøgersen, EMD International A/S, DK

Merete Badger (DTU, DK), Henning Skriver (DTU, DK), Rogier Floors (DTU, DK), Ebba Delwik (DTU, DK), Lasse Sveningsen (EMD, DK), Kenneth Grogan (DHI-GRAS, DK), Yavor V. Hristov (VESTAS, DK), Mark Žagar (VESTAS, DK), Anders Sommer (VATTENFALL, DK)

Setup and calibration of a land-surface model are the important first steps by wind-analysts to simulate the flow over a wind farm site. Accurate land-surface data play a key role and includes land-cover characteristics such as terrain roughness, elevation as well as tree heights and leaf-area density. These are the main inputs to modern flow models to derive accurate predictions of the energy-yields over the whole modelling domain for the potential wind farm area. Cold climate sites are often located in forested areas with semi-complex or complex orography and establishing the land-surface models at the required accuracy may prove a challenge, as maps and aerial imagery are not up-to-date or the full site may be inaccessible during site-inspections. An additional complication for cold-climate sites is the significant variation of land-cover characteristics over the seasons. A consequence is inaccurate and incomplete land-surface models which result in errors propagating down the full flow model chain resulting in non-optimum/erroneous results.

A solution to this issue result from the recently deployed Sentinel satellites and their raw data which are distributed via the Copernicus joint European Union infrastructure project. Here hundreds of petabytes of raw data with Earth observations are available at a resolution down-to 10-meters - with most locations on the globe being revisited once every few days. These data – and other national and international data services enable the development of unique sets of novel land-surface products describing the land-surface conditions in high temporal and spatial resolution with unprecedented accuracy and are fully up-to date.

A major achievement has been to develop a model that can derive leaf area-index, tree-type and tree height from the available Sentinel satellite data sources – along with the possibility to calibrate with LiDAR data to achieve best

possible accuracy. This product has been evaluated at 10 sites around the globe. Preliminary investigations promise improved predictions and reduced uncertainty. This is achieved both via a physical parameterization within the flow modelling and with the new data sources. When combined with a time-varying flow modelling approach it is possible include also the seasonal land-surface variation to model the seasonal variations at cold-climate sites with unprecedented accuracy in time and space.

The work presented is supported through the InnoWind project – an R&D project with partners from the industry and academia: Vattenfall, Vestas, DHI-Gras, EMD International and the Technical University of Denmark. Innovation Fund Denmark has co-funded the project.

Web site: http://www.innowind.dk

Short biography: Morten Lybech Thøgersen is the head of the Wind R&D Department at EMD International A/S – and is currently leading a team of 5 R&D specialists - along with being the project manager for a number of external and internal R&D projects. He has specialist knowledge within topics like MCP, wakes, turbulence, IEC classification and probabilistic methods. Morten oversees the high-performance computing efforts at EMD and its links to the windPRO software. Morten came to EMD in early 2001 and he has been working with software development, consultancy services and R&D. Prior to that, Morten was employed as a scientist at Risø National Laboratory (now DTU Wind Energy). His interests are within probabilistic methods and wind modelling as well as project management using Agile methods. At home, he enjoys the time with his family - and to sail, scuba-dive and snowboard.

R&D areas/s: 01. O&M experiences incl. performance optimization, production losses

Highlights from CanWEA's operations and maintenance summit 2020

Charles Godreau, Nergica, CA

In collaboration with the Canadian Wind Energy Association (CanWEA)

CanWEA's Operations & Maintenance (O&M) Summit is the largest annual wind operations event in Canada. With an expected attendance of over 300 wind energy professionals from across Canada and the United States, the CanWEA O&M Summit serves as a critical meeting ground where key stakeholders come together to learn from one another and discuss the latest opportunities and challenges facing this rapidly growing sector. As wind fleets expand and age, the sector's knowledge base advances and strengthens resulting in an array of new options and support services for operators to strategize and improve their business.

The Canadian wind industry is intensely focused on leading edge innovation at sites across the country. For this reason, the 2020 O&M Summit theme will be "Solutions Focused". The program will center on topics that have clear linkages to improved wind energy operations within the diversity of Canadian wind sites. Facing challenges head on, speakers will target solutions that work and serve a direct purpose. With health and safety running as an integrated element to all content, sessions will be as local and technically sound as possible.

The technical topics covered during the conference will be: Advanced control strategies, multi-technology, advanced inspections, approaching end of financed life and forces of nature.

With the cold climate focus in mind, Charles Godreau, will present the highlights from the conference held the week just before Winterwind. Fresh O&M innovations from across the pond!

Web site: https://canwea.ca/events/canwea-operations-and-maintenance-summit-2020/

Short biography: As a specialist in assessing wind turbine performance in cold climates as well as icing detection/protection systems, Charles possesses strong skills in data analysis for operational turbines as well as for developing, planning and implementing research projects. He has participated in a number of conferences and represents Canada in the International Energy Agency's Task 19 working group on wind energy in cold climate. Charles has been contributing to CanWEA's activities as a member of the O&M Caucus' Cold Climate Health & Safety committee and as an active member of the O&M Summit program committee. In his free time, he enjoys white water canoe, splitboarding and improv theater.

R&D areas/s: 01. O&M experiences incl. performance optimization, production losses, 10. De-/anti-icing including new technologies, ice detection & control incl. standards

Towards tracing a rotor surface's 3D trajectory over time

Michael Moser, eologix sensor technology gmbh

Theresa Loss (Graz University of Technology, AT), Michael Moser (eologix, AT), Thomas Schlegl (eologix, AT)

While in cold climates icing has still one of the biggest negative impacts on the energy yield of wind turbines, wind fields over complex terrains and forests - typical locations for wind power in cold climates such as Alpine regions or northern Scandinavia - also contribute to significant uncertainties and losses, not only during winter time.

Research is being carried out to extend our blade-based icing and temperature measurement technology with 6 degrees-of-freedom acceleration sensing units. Using measurement data obtained from integrated micro-electro-mechanical systems (MEMS) and given the exact location of the sensing units on the blade's surface, the 3D trajectory of each sensing unit in space can be derived. By means of a mesh of sensing units, this allows for tracking the surface in 3D over time without the necessity to collect data from the turbine's SCADA system.

In combination with the mechanical model of the blades, this information can be useful for detecting and assessing various scenarios which have in common the effect of a decreased production as well as an impact on the turbine components' lifetimes. At the end of the day, 3D motion tracking also allows for estimating loads and mechanical strain over each blade.

Applications include but are not limited to detection and measurement of both pitch and yaw angle misalignment (including shear winds), excessive blade vibration and blade integrity issues.

In the full paper, we will present pitch angle estimations which have been recorded under load (i.e., during production) obtained from enhanced sensors retrofitted to the blade surface.

Web site: http://www.eologix.com

Short biography: Michael Moser studied Electrical Engineering and Sound Engineering at University of Music and Performing Arts Graz and Graz University of Technology. Between 2007 and 2013, he was a research assistant at the latter, where in 2013 he completed his PhD thesis focusing on energy harvesting and icing detection on electrical power transmission lines. Since 2014, he is managing director of eologix sensor technology. When he finds time, he still likes to play the piano.

R&D areas/s: 10. De-/anti-icing including new technologies, ice detection & control incl. standards

Icing intensity evaluation based on ice detector measurements

Jarkko Latonen, Labkotec Oy, FI

Tatu Muukkonen (Labkotec, FI)

Labkotec Ice Detectors have already been used in the wind industry for roughly 20 years. The first sensors were originally designed to start blade heating, however the main concern of many of the users over the years has been to prevent ice throw. Both applications seem to be equally important nowadays.
During the recent years, discussions about health and safety issues as well as wind turbine performance optimization in icing conditions have increased, raising the interest for more advanced utilization of ice measurement data.
This presentation will describe a case study how Labkotec Ice Detector measurement data was used to evaluate icing intensity.
Data from several icing tests at the VTT Icing Wind Tunnel have been analyzed to create a method to categorize icing events into different icing intensity classes, namely mild, severe and extreme.

Web site: https://www.labkotec.fi/en

Short biography: Jarkko Latonen studied at the Tampere University of Technology and holds a master's degree in electrical engineering. He has worked 17 years for Labkotec, being actively involved in wind industry and ice detection for about 15 years. Currently he's responsible for R&D and product management as the CTO of Labkotec.
Jarkko used to coach ice hockey for junior teams of hockey club Tappara. Nowadays he's more into jogging and cross-country skiing.

R&D areas/s: 02. Health, Safety and Environment (HSE) incl. ice throw and noise

On the communication of the ice throw hazard to the public

Rolv Erlend Bredesen, Kjeller Vindteknikk, NO

Øyvind Byrkjedal (KVT, NO)

With regards to the ice throw hazard surrounding wind farms in cold climate there has been a standardization on how to describe and evaluate the risk [0]. The current community knowledge regarding the risk has been described [1] and the Norwegian guideline [1][2] gave easily understood advice on typical measures.
However there are still inherent uncertainties in the analyses [3] and there is a challenge in finding the suitable measures for site specific decisions made under uncertainty. This is can be a challenge when communicating the risk further.
The talk touches on the topics of what to do after a risk assessment is carried out, what does the risk assessment not tell you, and what are the limitations of risk assessments. (IPS systems etc.).
Examples on how to establish and maintain the dialogue with relevant stakeholders for a wind farm (e.g. service personell, forrest workers, reindeer herders, local community and those opposed to local wind farms) is given together with presentation of relevant information campaigns [4][5] and alert systems for the task of informing the public [6].
[0] International Recommendations for Ice Fall and Ice Throw Risk Assessments (2018. IEA Wind RD&D Task 19.https://community.ieawind.org/task19/viewdocument/international-recommendations-for-i?CommunityKey=b1ba65c9-bf79-4b55-98cd-cf324c26f76f&tab=librarydocuments
[1] Bredesen et al. (2017). Understanding and Acknowledging the icethrow hazard. Journal of Physics. https://iopscience.iop.org/article/10.1088/1742-6596/926/1/012001/pdf
[2] National Norwegian Guidelines: Ice-throw hazard (2018)
https://windren.se/WW2018/03_2_24_Bredesen_Norwegian_guidelines_regarding_the_risk_of_icethrow_for_the_public_Pub_v2_draft.pdf.
Norwegian guideline:
https://www.nve.no/nytt-fra-nve/nyheter-konsesjon/nyveileder-for-handtering-av-faren-for-iskast-fra-vindturbiner/
Norwegian Framework for wind power, report on icethrow: https://www.nve.no/Media/6951/iskast.pdf
[3] An ongoing cross comparison of the Icethrower database with 10 years of SCADA and meteorological forecast data.
https://windren.se/WW2019/05_01_Bredesen_A_cross-comparison_of_the_IceThrower_database_with_10_years_of_SCADA_and_meteorological_forecast_data_-_What_can_we_learn_pub_v2.pdf
[4] Application of Risk Management and Barrier Management for Structures in Cold Climate. IWAIS 2019, Iceland. https://iwais2019.is/papers
https://iwais2019.is/images/Papers/063_IWAIS_Paper_LR_KVT_rev2.pdf
[5] https://austri.no/sikkerhetsavstand-til-vindturbiner/
[6] https://www.fosenvind.no/vindparkene/iskastvarsel/

Web site: http://vindteknikk.com

Short biography: Rolv Bredesen is Kjeller Vindteknikk's expert on IceRisk assessments and the current Norwegian representative in IEA Wind Task 19 - expert group on wind energy in cold climates. His considered safe hobbies are speed-riding, hang-gliding, motorcycling as well as rock climbing.

R&D areas/s: 07. Forecasting, cloud physics and aerodynamics

Parametric analysis of wind turbine icing in cold regions

Ifrah Mussa, Kingston University, United Kingdom

Ifrah Mussa (Kingston University, UK), Prof. Jian Wang (Kingston University, UK), Dr. Yujing Lin (Kingston University, UK)

Ice accretion on wind turbine is one of the core challenges for renewable wind energy development in cold climates. Therefore, in order to continue exploiting these cold regions for clean energy growth, it is important to understand the icing process on wind turbine blades. Research conducted on aircraft icing can be very beneficial in this respect. However, even though a substantial amount of knowledge and understanding can be employed from aircraft icing investigations, it cannot completely represent icing on wind turbine blades. There are a range of parameters which can influence wind turbine ice shape and size. Some of these parameters are site dependent climatic variables including ambient temperature, wind speed and icing time; while others are meteorological variables such as Liquid Water Content (LWC), Median Volumetric Diameter (MVD) and humidity. Since all of these parameters collectively play a significant role in the icing process, it is vital to investigate their individual effect on wind turbine blade icing by conducting a parametric analysis which can help better understand the underlying physics of the ice formation process for different types and densities of ice, the amount of heat required to de-ice the blades and the to design an effective operational strategy to get the maximum power output.
This study uses numerical techniques to investigate the effects of different parameters on wind turbine blade icing by monitoring some of the main characteristics of ice including: ice shape, mass, thickness and location. The method employed to conduct this study is as follows. First, NREL Phase VI wind turbine blade was selected for the analysis which is composed of S809 aerofoil from root to tip. The icing parameters investigated were: angle of attack, wind speed, temperature, LWC, MVD and icing time. The icing conditions selected for this study were based on a wind farm site in Smóla. Prior to starting the flow and icing simulations, an optimized code for Blade Element Momentum Theory (BEMT) was established on Matlab with tip and root loss corrections. This was important to determine the relative velocity and local angle of attack for a range of cross sections along the blade length. Following this, five cross sectional locations were selected for the parametric analysis which best represented the wind turbine blade. The parametric analysis was then conducted starting with ANSYS Fluent flow simulations followed by ANSYS FENSAP-ICE simulations for ice prediction using single shot technique.
Results proved that BEMT plays a significant role in conducting a quasi-3D numerical analysis on wind turbine blade icing and reducing the computational time. Ice profiles obtained from parametric study revealed that the ice shape, mass, thickness and location is highly influenced by the icing variables tested. The effects of each variable must be taken into consideration while designing an anti-/de-icing system for wind turbine blades. A linear growth in ice accumulation was observed from the blade root to blade tip which further highlighted the critical area of the blade that has the most degrading effect.
The current paper presents early phase of parametric study with single shot. Future work includes a comprehensive study with additional variables that were beyond the scope of current research. It would further include multi-shot simulation results, which is a time iterative icing process on FENSAP to predict icing. A three dimensional wind turbine blade icing simulations would also be presented.

Web site:

Short biography: Ifrah is a third year PhD student at Kingston University. She completed her undergraduate degree in Aerospace Engineering (MEng) from Kingston University in 2017. She recently completed a six months PhD placement in China where she observed icing experiments. Personal interest: travelling

R&D areas/s: 11. Onshore turbines, aerodynamics, loads and control

Effect of heavy rotor blade icing to lifetime consumption of tower and foundation

Carsten Ebert, Woelfel Wind Systems

Manuel Eckstein (Wölfel Engineering GmbH + Co. KG, Germany)

Wind turbine towers are exposed to various loads such as high wind, additional loads due to imbalances due to heavy blade icing or pitch angle errors and incorrect operational modes. These loads affect the operating costs as well as the lifetime of the components. Nevertheless, the majority of all existing wind turbines have normally large – but unknown – reserves with respect to their lifetime.
With an efficient and intelligent monitoring concept, these loads can easily be recorded and analyzed with respect to operational mode, lifetime and predictive maintenance. An accelerometer at tower top supplemented by an inclination sensor in the tower base combined with a numerical model is used to measure the vibrations and to derive the loads in any segment of the tower.
In this presentation, we would like to focus on the effects of rotor blade icing and show how different mass distributions and aerodynamic effects increase the stresses of the tower. It can be shown that the fatigue loads differ from ice-free operating modes. The effects to lifetime consumption are illustrated. Operators can use these efficient load measurements to record the real actions and to objectively evaluate and assess the structural condition of their asset. It is possible at any time to compare the real loads with the loads from the design and from the certification as well as to forecast the remaining service life.
In a validation survey, the presented concept has been investigated with respect to validity and precision. With additionally installed strain gauges, the mathematically derived loads are compared and evaluated with respect to the loads measured by the strain gauges directly. It is shown that the concept is very suitable for lifetime prediction and various load analyses (e.g. influence of retrofitted components).
In this context, the following will be presented: sensor and monitoring concept; insight in mathematical method; calculation of ice loads and influence to tower vibrations; lifetime consumption depending on degree of icing and lifetime prediction

Web site: https://www.woelfel.de

Short biography: Carsten Ebert is civil engineer (Dr.-Ing.) and 43 years old. He has been working for Wölfel Wind Systems since 2008 and is CTO of the company. He has an extensive knowledge in structural dynamics, especially in the field of structural health monitoring based on vibration measurements. At Wölfel, he is responsible for the development of products for the structural monitoring of rotor blades, towers and foundations. Since 2013, he is a member on advisory board of VDI-Guideline 4551, a German guideline for the condition monitoring of offshore wind foundation structures.

R&D areas/s: 10. De-/anti-icing including new technologies, ice detection & control incl. standards

Blade based ice detection IDD.Blade – efficient operation in cold climate

Bernd Wölfel, Wölfel Wind Systems GmbH

Timo Klaas (Wölfel), Carsten Ebert (Wölfel)

Since the efficiency of wind turbines (WT) is primarily reflected in their possibility to produce energy at any time, the down times of WTs due to "conventional" inspections for damage or ice detection are costly and unwelcome for WT investors.

Especially the danger of ice throw from rotor Blades has to be avoided for personal safety reasons. Furthermore, the ice on rotor blades can cause severe damage to the wind turbine itself. Not only to the rotor blades, but also other parts of the structure, e.g. gear box and the tower are more affected by higher loads and imbalances.

For this reason the Wölfel Group has developed a wide product line-up with vibration-based SHM systems for damage and ice detection in rotor blades, foundation and tower monitoring (onshore and offshore), load monitoring, vibration reduction systems, etc., to give wind turbine operators the opportunity to reduce the number of WT inspections and increase availability and yield.

The centerpiece of this paper is the presentation of the latest innovations and developments around SHM systems:

In this context the following will be presented:

- The importance of ice and damage detection on rotor blades
- New hardware concept: Have a look into the future
- Additional blade monitoring features such as damage detection, rotor blade imbalance and pitch angle monitoring
- Increase of energy output: summer vs winter operation
- Smart data: How to use advanced data analytics to gain new findings

Web site: http://www.woelfel.de

Short biography: Timo Klaas is educated as an industrial engineer (B. Eng), 32 years old and lives in Hamburg. He is working for Wölfel Engineering and is leading the sales department for all systems related to wind energy.

R&D areas/s: 10. De-/anti-icing including new technologies, ice detection & control incl. standards

Experimental investigation of an infrared de-icing system for wind power application in cold climate

Sofia Sollén, Luleå University of Technology

Sofia Sollén (Luleå University of Technology), Jennifer Pettersson (Vattenfall AB).
Lavan Kumar Eppanapelli (Luleå University of Technology), Johan Casselgren (Luleå University of Technology), Jan Ukonsaari (Vattenfall AB), Pär Attermo (Vattenfall AB).

Icing of wind turbine blades poses a great challenge for wind farms in cold climate and this challenge is addressed using various traditional de-icing practices, which require significant cost to operate. Thus alternative and potential solutions are needed to improve wind power production in cold climate. The present study is focused on an experimental method to investigate the effectiveness of a new de-icing system that consists of infrared heaters. Two types of heaters were selected based on wavelength, input power and investment cost. Due to experimental limitations, test blades covered with soft rime ice were prepared using snow machines in a controlled indoor testing facility. Individual heaters and combinations of the heaters were tested with respect to distance from a section of a real wind turbine blade and ambient temperature.
This presentation is focused to the experimental methods used during the experiments simulating ice accumulation at wind turbine blades together with results showing the possibilities to implement an infrared de-icing system. The project was initially proposed by Vattenfall AB and were performed in a collaboration with Luleå University of Technology in the spring of 2019.

Web site:

Short biography: Sofia Sollén and Jennifer Pettersson graduated as sustainable energy engineers at Luleå University of Technology in 2019. Their specialization is wind and hydro power and together they performed their master thesis including an experimental investigation of a new de-icing system for wind turbine applications. Today Jennifer is working as a research engineer at Vattenfall R&D focusing on wind turbines in cold climate and Sofia has just started as a PhD student in experimental mechanics at Luleå University of Technology. Both Jennifer and Sofia enjoys the nature and spends a lot of time outside hiking or skiing.

R&D areas/s: 10. De-/anti-icing including new technologies, ice detection & control incl. standards

Task 19: Performance warranty guidelines for wind turbines in icing climates workshop at Winterwind 2020

Helena Wickman, Vattenfall

Charles Godreau (Nergica), Timo Karlsson (VTT) and Stefan Söderberg (DNVGL)

There are a number of different Ice Protection Systems and other turbine operational strategies available on the market today for mitigating icing effects on wind turbines. Wind farm development in cold climates is becoming more mature, but there is still work to be done. Further developed performance warranties plays an important role in ensuring that icing risks can be quantified and handled.
The IEA Wind Task 19 will therefore host a workshop on performance warranty guidelines for wind turbines in icing climates. The workshop will be held at the Winterwind conference in Åre, Sweden on February 3rd, 2020 from 14:00 to 17:30.
The main objectives of the workshop are:
- To establish a common language for wind turbines in Icing Climate;
- To establish an outline for Performance Warranties;
- To discuss test methods for Performance Warranties in Icing Climate and move towards fewer and standardized warranty options and test methods;
- To discuss the benefit of having a warranty in pre-construction energy and risk assessments;
- To share experiences on both icing and ice mitigations;
- To align Cold Climate industry expectations on the above.

The results from the workshop will be used in the update of the Task 19 "Performance Warranty Guidelines for Wind Turbines in Icing Climates" report to be published in Q4:2020. The workshop will be chaired by Helena Wickman (Vattenfall), Charles Godreau (Nergica), Timo Karlsson (VTT) and Stefan Söderberg (DNVGL) representing IEA Task 19 subtask on "Performance warranty guidelines for wind turbines in icing climates ".
This will be an invitation only or by request workshop, targeting cold climate experts working across Northern Europe and North America.
Please complete the following questions via the link below
https://forms.gle/4iXGREGjcngDVzAf7
by 17th of January 2020 if you are interested in attending the workshop, so that Task 19 can get in touch with you. Due to limited seats in the workshop, Task19 will select attendees based on their potential contribution to the workshop and remaining seats.

Web site: https://community.ieawind.org/task19/home

Short biography: Helena Wickman (Vattenfall), Charles Godreau (Nergica), Timo Karlsson (VTT) and Stefan Söderberg (DNVGL) representing IEA Task 19 subtask on "Performance warranty guidelines for wind turbines in icing climates "

R&D areas/s: Open Innovation

Open Innovation Contest

Tanja Tränkle, RISE

Tanja Tränkle

Winterwind's arena for new ideas within research and product development! You pitch your very own idea and will get instant feedback from the community as well as the possibility to network with the market players you need to get on board. We'll make sure you'll meet a fair-minded jury and have the chance of being rewarded with more than just honour.

Web site: https://www.ri.se/sv/richard-sott

Short biography: Researcher at RISE

R&D areas/s: Keynote

A European Outlook on the prospect of Onshore Wind - Global importance with regional benefits

Sandra Grauers, Vattenfall

Sandra Grauers

Onshore wind is one of the main pillars of the decarbonisation of society. Electricfication is the key tool for the transformation of the Industry and Transport sectors, which will drive a highly increasing demand for renewable electricity moving forwards. Sweden is currently the Onshore market in Europe with the largest volume of projects in construction. What is making Nordic countries attractive now and in the future?
Vattenfall is a key Onshore player in Northern Europe, with 1 GW in construction and a development pipeline of around 5 GW. Stakeholder management and local acceptance is evermore important. In the presentation I will share some reflections and best practice examples around the regional benefits and potential of windfarm projects.

Web site: http://vattenfall.com/

Short biography: Sandra Grauers

R&D areas/s: 15. National strategies, research programs, grid access, system services and new developments

Slowly, slowly, we'll reach our goal!

Sébastien Trudel, EDF Renewables, Canada

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For many years, the industry has been working towards improving the operation of wind turbines in cold climate and icing environments. Along the way, obstacles, challenges and unexpected outcomes have paved the way to the development of new technologies such as de-icing systems, and of new products such as anti-icing coatings or better ice detectors. In many ways, our common path on this adventure is similar to leaving for a Himalayan expedition to climb one of the highest peaks on the planet.
The magnitude of the endeavor looking from the starting point can be overwhelming, and the overarching goal can only be reached by setting smaller, intermediate objectives. The path to the end might be clear for some of us, but it will likely be foggy, hesitant and uncertain for the rest of us. But, we have to keep moving forward, one step at the time, knowing that challenges and obstacles will appear on the way, and that with confidence we will overcome them.
In this presentation, we will see how climbing mount Manaslu in Nepal, the 8th highest summit on the planet, can be a reflection on how we can approach challenges in our personal and professional life.

Web site:

Short biography: Sébastien Trudel graduated as a civil engineer in 1998. After a few years in the industrial waste management business, he went back to school to complete a Master's degree in Environmental sciences. His thesis assessed renewable energy potential worldwide. For now more than 15 years, he has been involved in the development of onshore wind projects in North America, working as a resource assessment analyst, and then manager. With EDF Renewables since 2009, he has been specifically involved in the assessment of pre-construction icing losses, and the assessment and testing of various anti-icing and de-icing technologies on turbines operating in eastern Canada. As of last year, he was promoted to manager of offshore wind and metocean analysis, involved in the offshore measurement campaigns and layout optimisation work.
In his personal life, Sébastien is an avid hiker, trekker and mountaineer, going out to the mountains whenever possible. He has climbed mountains everywhere from Alaska to Argentina, Europe, India and Nepal. His latest significant achievement was reaching the summit of Manaslu at 8163m last September.

R&D areas/s: 01. O&M experiences incl. performance optimization, production losses, 03. Inspection and repair

Case study; Controlled environment in up-tower blade repairs

Ville Karkkolainen, Bladefence, FI

Ville Karkkolainen (Bladefence, FI)

Rotor blade repairs have traditionally been very difficult, sometimes even impossible, in cold climate areas, especially during winter time. Often repairs require a summer like conditions, as conventional blade repair systems generally require an ambient temperature of more than +15 Celsius and a maximum RH of 60% to work properly. In the case of more significant issues, a de-mounting of the blade might be needed for on-ground repairs under controlled weather environment.
We present a novel approach, developed in co-operation with a major OEM during the 2018 repair season, where a rapid and safe skylift access is combined with a controlled environment for blade repairs. This controlled environment, or a habitat, will enable the usage of conventional blade repairs materials in conditions which typically have completely prevented blade repairs. Although habitats have been used in the industry before, this is the first of its kind where the flexibility and speed of skylift access is combined with a controlled blade repair environment.
Experiences and data gathered during actual on-site repair operations shows that the usage of a controlled environment significantly reduces weather related downtime, lowers costs, increases repair quality and expands the works scope that can be completed during a repair season. Controlled environment also enables permanent repairs to be carried out during cold climate season, reducing the number of temporary repairs which should then be repaired again during the summer season.

Web site: http://www.bladefence.com

Short biography: Ville Karkkolainen is the CEO of Bladefence North America. Prior to this position, for six years, he was the co-founder and managing director of Bladefence Ltd., based in Helsinki Finland. During this period the company grew to become one of the leading independent blade service providers in Europe. Ville has been an active speaker in dozens of industry events and a promoter of advanced blade repair procedures and pre-emptive blade maintenance programs. Outside of wind energy he is an enthusiastic Harley-Davidson rider.

R&D areas/s: 13. Offshore and near offshore – access, foundations incl. artificial islands

Offshore wind farm at icy conditions – Tahkoluoto

Jaakko Kleemola, Suomen Hyötytuuli Oy, FI

Jaako Kleemola

The presentation is describing the Tahkoluoto offshore wind farm technology and conditions at Pori, Finland. Cold climate and frozen sea makes offshore wind energy production challenging. Winter time construction, service and operation has severe disadvantages. Location offers also benefits like Kokemäki river, ports, grid connections, positive local attitude sea bottom properties and wind conditions. The foundation design is presented. The monopile was not possible to use at Tahkoluoto because of the hard sea bottom. The icing loads was necessary to take account in load calculations. The main information from construction phase and the project management is described. The site has been operating now two and half year. Information how the service is carried out and possible risks are shared.

Web site:

Short biography: Jaakko Kleemola, Doctor of Science (Tech.), is Director of Technology at Suomen Hyötytuuli Oy. Since 2009 he has been working at wind energy sector in many different roles starting from Group Manager of wind turbine gearbox manufacturer to his current role as Technology Director at wind turbine owner. Prior to this, working at university and industrial side has given him a very strong and broad technical background starting from individual EHL contacts to largest power train systems. His current responsibilities include to improve production capabilities and tools for example by offering better productions energy forecasts or developing predictive maintenance algorithm for monitoring. His doctoral theses is from Tampere University of Technology (2010).

R&D areas/s: 09. Environmental Impact Assessments (EIA), 15. National strategies, research programs, grid access, system services and new developments

Minimise your business risks with your own biodiversity strategy

Åsa Abel, Ecogain AB, SWE

Åsa Abel (Ecogain AB, SWE)

The UN's scientific panel IPBES has made it apparent that biodiversity loss is as serious for humanity as climate change. As a consequence, the demand for legislation requirements on species and ecosystems will continue to increase, and the green risks for businesses will change.
"Those who have not started to work with biodiversity face great challenges."
This was one of the conclusions at the OECD's branch conference in June 2019 on mining and environmental issues in Skellefteå. The mining and energy sectors are not so different.
In this seminar you will gain insights and hear about good examples from other businesses on how you can proactively deal with future risks and opportunities regarding the UN's global goals 14 and 15 both dressing biodiversity. The seminar will demonstrate how your business can establish a strategy for addressing a crucial societal issue, support your communication and future-proof your business.

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

Short biography: Åsa works as business area manager at Ecogain. Based on the UN's global goals for sustainable development, she assists with businesses' requirements and challenges with regard to responsible land use and biodiversity.
Åsa is highly experienced at providing strategic and solution-based advice at the leadership level, both within private businesses and public organisations. Ecogain's clients appreciate her ability to lead them towards set goals, identify risks and provide solutions in a way that leads to sustainable development and strengthens their trademark.
Åsa is an ecologist from Linköping University, which she has combined with courses in business economy and wind power project development. Åsa has a master's degree in wind power development from the wind power engineering college on Gotland.
Her master's thesis focused on how turbulence unevenly increases the maintenance requirements in a wind farm. Turbulence and biodiversity in all its forms fascinate her.

R&D areas/s: 08. Pre-construction site assessment, measurements, models and standards, 12. Laboratory and full-scale testing, small wind turbines

Global Blockage Offshore/Onshore - Reality or Myth ?

Jan-Åke Dahlberg, Vattenfall Vindkraft AB, SE

Jan-Åke Dahlberg, Vattefall Vindkraft AB, Stockholm, Sweden
Antonio Segalini, KTH Mechanics, Stockholm, Sweden

Global Blockage Offshore/Onshore - Reality or Myth ?
Is it likely that the presence of a wind farm will affect the wind flow, not only downstream of the park, but also upstream in such a way that the turbines in the front row are exposed to a wind flow that is lower than the free wind?
If so, how do the conditions differ between offshore and onshore?
This issue has been intensively discussed lately. I myself have been thinking a lot about this issue. It was therefore of great joy when my former employer, Vattenfall Vindkraft AB, about 7 years ago gave me the opportunity to explore this phenomenon more deeply.
With a long background as a researcher in the field of wind energy with experience from measurements on turbine models in wind tunnels, it seemed natural to use these skills in the attempts to investigate this phenomenon under well controlled conditions.
I will present the outcomes of two comprehensive wind tunnel studies of blockage effects in wind farms. The results unquestionably demonstrate the existence of global blockage (GB). The measurements were conducted in wind tunnels with smooth floor, i.e. low surrounding roughness, representative for offshore conditions.
The results from the measurements have been used to further validate the numerical tool ORFEUS. Results from calculations with ORFEUS show good agreement with corresponding measured data. Results from ORFEUS calculations representative for onshore condition with high surrounding roughness will be presented.
I will also give examples on how Global Blockage effects have been taken into account, in a few large offshore projects, where I took part.
In addition to the GB material, I will present results from experiments with active yaw control, i.e. methods to control the direction of the wake by yawing the upstream turbine and thereby minimize wake interference with the downstream turbines.

Web site: https://www.kth.se/profile/segalini

Short biography: Jan-Åke Dahlberg has since 1975, when he finished his studies at the Royal Institute of Technology, worked on all kinds of research projects in the field of wind power.
Special areas of interest have been performance of individual turbines as well as entire wind farms.
For the past 10 years he has worked at Vattenfall Vindkraft AB, with wind analyzes and production assessments for large offshore wind farms.
Meanwhile at Vattenfall, he worked on experiments with small wind turbine models in wind tunnels to demonstrate and map the existence of the so-called global blockage, i.e. the slowing down of the free air-inflow, merely caused by the presence of the entire wind farm.

R&D areas/s: 08. Pre-construction site assessment, measurements, models and standards

Swedish Windpower Association and RISE - Workshop on blockage

Martin de Maré, RISE Research Institutes of Sweden

Martin de Maré and Tanja Tränkle (RISE, SE)

Measurements indicate that the wind speed upstream of a wind turbine situated in the front row a large wind farm, is lower than the corresponding wind speed upstream a solitary wind turbine. This effect is commonly referred to as wind farm blockage (however it can also be seen as some combination of more detailed effects such as the combined induction zones of the wind turbines in the wind farm, upstream effects of the wind farm induced change in surface roughness and changes in the mesoscale flow induced by the windfarm).
The typical onshore wind farm differs from the typical offshore wind farm in a number of ways that may affect the size of the wind farm blockage effect. Such differences may include the number and the size of the installed wind turbines as well as the chosen hub heights, a higher surface roughness onshore and terrain features within and around the wind farm.
Various models are used in order to estimate production losses that originate from the wind farm blockage effect for onshore wind farms. The estimated losses are varying to an extent that is heavily influencing the bankability of a wind farm project. Industry players are therefore in need of ensuring a common understanding and definition of what is included when quantifying wind farm blockage effect.
RISE, in cooperation with the Swedish Windpower Association, is therefore inviting to a discussion and workshop on Wind Farm Blockage Effect for onshore wind farms. The workshop will be held at the Winterwind conference in Åre, Sweden on February 3rd, 2020 from 09:00 to 12:00. The workshop aims
- to establish a common language for the wind farm blockage effect;
- to establish an outline for the main influencing parameters;
- to discuss possible verification activities towards improved modelling;
- to share experiences on the wind farm blockage effect onshore;
- to align production loss forecasting due to wind farm blockage effect onshore within the industry.
This will be an invitation only or by request workshop, targeting experts working within the field of quantifying production losses caused by wind farm blockage. Please complete the following questions via the link below
https://forms.gle/3VPzjCeMhYxYL6g46
by 17th of January 2020 if you are interested in attending the workshop. Due to limited seats in the workshop, we will select attendees based on their potential contribution to the workshop and remaining seats.

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

Short biography: Before joining RISE in 2018 Martin de Maré worked with siting at Ørsted. Prior to that he persued an industrial PhD at Risø DTU within the field of wake and turbulence modelling, and before that he worked with power performance at Vestas Wind Systems.

R&D areas/s: 15. National strategies, research programs, grid access, system services and new developments

World Energy Outlook 2019 – Wind Offshore long-term perspectives: Opportunities and uncertainties

Yasmine Arsalane, World Energy Outlook Directorate of Sustainability, Technology and Outlooks International Energy Agency

World Energy Outlook Directorate, IEA

Offshore wind is a rapidly maturing renewable energy technology that is poised to play an important role in future energy systems. In 2018, offshore wind provided a tiny fraction of global electricity supply, but it is set to expand strongly in the coming decades into a $1 trillion business. Turbines are growing in size and in terms of the power capacity they can provide. That, in turn, is delivering major performance and cost improvements for offshore wind farms.
This new World Energy Outlook special report provides the most comprehensive analysis to date of the global outlook for offshore wind, its contributions to electricity systems and its role in clean energy transitions. The report is a deep dive into offshore wind, giving a snapshot of where the market, technology and policies stand today – and mapping out how they may develop over the next two decades. It draws on a state-of-the-art geospatial analysis of the world's offshore wind resources and explores the implications of the technology's growth for global environmental goals and energy security.

Web site: http://iea.org/

Short biography: Ms. Yasmine Arsalane is a Senior Energy Analyst at the International Energy Agency (IEA) within the Directorate of Sustainability, Technology and Outlooks. She contributes to the World Energy Outlook (WEO), the IEA's flagship publications dedicated to global energy projections. She focuses more specifically on the modelling and analysis of long-term trends for the power sector.

R&D areas/s: 15. National strategies, research programs, grid access, system services and new developments

A decade of expansion ahead

Tomas Kåberger, Renewavle Energy Institute, InnoEnergy, Chalmers

Renewable Energy Institute, InnoEnergy, Chalmers

Falling costs makes expansion beyond the traditional electricity sector possible. This will remove many perceived challenges.

Web site:

Short biography: Tomas Kåberger is affiliate professor of Renewable Energy at Chalmers University of Technology in Göteborg, Sweden, and Industrial Growth Executive at InnoEnergy. He is also spending a quarter of his time in Japan as executive board chair of Renewable Energy Institute in Tokyo.
He is a member of the Royal Swedish Academy of Engineering Sciences and of the Swedish Association of Energy Economists.
Industrially professor Kåberger has held leading positions in companies working with automotive biofuels, combustion technology, solar- as well as wind-energy. Currently he serves as a non-executive director of Vattenfall as well as on boards or advisory boards of some small energy technology companies. He has been on the boards of several national and international industrial federations in renewable energy.
He was appointed by the Swedish government to the Energy Commission that provided the final review of the electricity re-regulation introducing competition in 1995, and several other committees on energy issues. From 2008 to 2011 he served as Director General of the Swedish National Energy Agency. Currently he serves as a member of the Swedish Climate Policy Council.
From 2007-2011 he was a member of a task force of China Council on International Cooperation on Environment and Development elaborating on a Low Carbon Industrialization Strategy för China. From 2008-20018 he was visiting professor at Zhejiang University. From 2016 hes serves as senior advisor to GEIDCO in Beijing.
During 2011-2012 he headed the Swedish delegation to the International Renewable Energy Agency in Abu Dhabi, and served as vice chairman of the IRENA Council during 2012.

R&D areas/s: 10. De-/anti-icing including new technologies, ice detection & control incl. standards

Reliable ice detection with different measuring methods

Daniel Schingnitz, Weidmüller Monitoring Systems GmbH, GER

Daniel Schingnitz (WMS, GER)

A reliable ice detection by BLADEcontrol as a blade based system can be relaized by different sensor variants. Latest evaluations show that sensors located close to root of the blades generated same results like common acceleration sensors which are installed inside the blades at a lengths of approx. 1/3 of the blade. Both sensor variants identify identical frequency ranges and ensure a reliabe ice detection, even during standstill of the turbine. Beside this, it can be stated that turbines equipped with BLADEcontrol located in cold climate regions recognized approx. 83 ice events on average per year with a lengths of more than 1 hour. A comparative view of icing at single wind farms show that turbines show different icing behavior. In some cases first and last ice alarms wihtin one wind farm differ in 3-5 hours. In case not all turbines in the wind farm are equipped with a separate ice detection system, this fact cause significant energy loss by heating wihtout ice on the blades. The example shows that amortization of blade based ice detection systems can be realized after approx. 3 years. In summary it can be stated that reliable blade based ice detection with BLADEcontrol can be realized with acceleration as well as close to root sensors. Evaluation of ice-caused downtimes of turbines in cold climate regions confirm that a separate equipment of all turbines by a bladebased ice detector leads to an optimal reduce of turbine downtimes due to icing!

Web site: http://weidmueller.com/

Short biography: From 2007 to 2016 I was working at university of Dresden in the field of environmental engineering. During this time I also did my PhD in environmental engineering. While working at the university, I was head of different working groups dealing for specific regional as well as international projects (i.e. in China, Russia, Brazil, Jordan.
Since October 2016 I am working for Weidmüller Monitoring Systems GmbH (WMS) in the field of marketing and sales. WMS is producer and distributor of BLADEcontrol Ice Detection as well as Condition Monitoring Systems and global market leader in blade based monitoring of rotor blades of wind turbines. Beside knowing about functionality of the systems I strongly support customers in case of installation requirements and monitoring background.
As local member of the sales team I am responsible for German customers. Beside this I am focused as a key account manager on highly relevant OEMs for WMS. In addition, I am responsible for market development of WMS in Asian countries, especially in China.
Personal interests: hiking, football, my two kids :-)

R&D areas/s: 10. De-/anti-icing including new technologies, ice detection & control incl. standards

Optical ice-sensing surface

Patrice Roberge, Laval University, CA

Patrice Roberge, Jean Lemay, Jean Ruel, André Bégin-Drolet (all from Laval University, CA)

What is the burning need the innovation solves?: This technology offers a simple low-cost way to assess the instrumental icing status of a surface. Such information is crucial to use proactively ice protection systems. Also, current ice sensing technology is still evolving and adapting to the many challenges faced. The existent ice detectors can be divided in to separate categories: the direct measurement sensors with a working principle based on the interaction with the icing conditions in the air (i.e. meteorological icing) and the indirect measurement sensors relying on the ice accretion effect (i.e. instrumental icing). Even though they are accurate in most occasions, indirect sensors present a lower sensibility and a higher latency time in addition to be more prone to large ice accretion altering their working principle. On the other hand, direct measurements are vulnerable to non-sticking icing conditions. Ice sensors would benefit from being paired with a simple low-cost sensor to increase the quality of the measurements.
Who will benefit from your innovation?: Wind farm operators and owners or anyone who needs an easy way to assess the icing status of a surface to trigger an action.
Description of the innovation:This technology relies on the well-known total internal reflection principle and allows a fast and reliable instrumental icing detection. The system is composed of a waveguide embedded in the surface, an emitter, a receptor and a simple electronics. This surface could also be used with indirect sensors to add redundancy or increase sensibility, with direct sensors to assess the state of instrumental icing or even to detect locally the presence of ice on a blade section to heat only the neighboring surfaces. The variation of the surface signal over time can also give indications of the event type (i.e. rain, freezing rain or in-cloud icing). This process of detecting the event type could also be automatized using machine learning. The beauty of this technology is that it can be packaged in a multitude of ways to facilitate its implementation and make it less cumbersome as possible.
What is needed for the idea to a) accelerate? b) to go-to market and c) how much capital is initially needed to move forward?: a) More icing events to gather data.
b) International partners
c) Zero, the product in its current form is ready to install
What kind of partners are you looking for? Are you missing expertise, would you like to have a mentor, are you looking for investors?: We are looking for industrial partners who wants to have information on the icing status of their wind turbine.

Web site: http://ulaval.ca/

Short biography: Patrice is currently doing his master's degree in mechanical engineering at Laval University in André Bégin-Drolet's lab. He has been working on the operation of wind turbines in cold climates for 4 years where he had the chance to contribute in the development of an ice detection device. He has authored and co-authored four scientific publications. He completed his bachelor's degree in physical engineering with a distinction mention. He was awarded the prestigious undergraduate student research award form the Natural Sciences and Engineering Research Council of Canada three times, the NSERC Alexander Graham Bell Graduate Scholarship and the FRQNT scholarship for his master's degree as well as the Université Laval's leadership and sustainable development award. He is a very curious person that loves to learn and understand the why and the how of the everyday phenomena. He is passionate about skiing snowshoeing and trekking.

R&D areas/s: 10. De-/anti-icing including new technologies, ice detection & control incl. standards

Borealis De-icing System

Daniela Roeper, Borealis Wind

Daniela Roeper (Borealis Wind, Canada)

Simple retrofit de-icing system
Who will benefit from your innovation?: Wind farm owners
Description of the innovation:Borealis Wind has developed a retrofittable hot air blade de-icing system. The system uses a blower, heater and flexible duct to circulated heated air in the blade, to prevent and remove ice formation. The system has undergone 1 winter of testing at a Canadian wind farm and will now be installed at 3 additional wind farms for winter 2019/2020.
What is needed for the idea to a) accelerate? b) to go-to market and c) how much capital is initially needed to move forward?: Borealis Wind is seeking interested pilot customers outside of Canada to help validate the system in other icing climates. Borealis Wind is also seeking manufacturing and service partners in Europe.
What kind of partners are you looking for? Are you missing expertise, would you like to have a mentor, are you looking for investors?: Borealis Wind is seeking sales, manufacturing and service partners in Europe.

Web site: http://borealiswind.com/

Short biography: Daniela is a mechanical engineer with a passion for the environment. While still completing her undergraduate degree from the University of British Columbia, Daniela founded Borealis Wind, a startup that provides a blade de-icing retrofit for wind turbines, improving their reliability as well as increasing production. The system has been validated through pilot testing in Canada. The innovative system can be installed up-tower without removing the blades of the turbine, saving significant installation and maintenance costs.

R&D areas/s: 01. O&M experiences incl. performance optimization, production losses, 10. De-/anti-icing including new technologies, ice detection & control incl. standards, 11. Onshore turbines, aerodynamics, loads and control

Fibersail shape sensor (Shaping the Structures of Tomorrow))

Pedro Pinto, Fibersail, NL

Pedro Pinto (Fibersail, PT) Carlos Oliveira (Fibersail, PT) Pedro Ferreira (Fibersail, PT)

Fibersail enables wind turbines to be controlled by loads on blades in order to optimize performance, availability and lifetime while reducing O&M costs by implementing predictive maintenance and inputs for de-icing on/off.
Who will benefit from your innovation?: Wind turbine Owners/Operators are able to increase output while reducing O&M costs.
Wind turbine Manufacturers are able to design more efficient and critical turbines reducing the weight of rotors while controlling the blades through loads and tip/tower clearance precise measurements.
Description of the innovation:Fibersail is an independent shape sensor based on fiber optic technology designed to measure shape and deformations of wind turbine blades. The sensor is composed by a fiber glass composite beam with parallel arrays of FBGs fixed to the interior of each blade. Strains from the composite beam are then converted into curvature and deflection while the blade is bending. The system is designed to be incorporated during the manufacturing process or retroffited into existing blades.
What is needed for the idea to a) accelerate? b) to go-to market and c) how much capital is initially needed to move forward?: a) To accelerate we need to find a partner to test and pilot our technology and retrofitting procedure on operational wind turbine and the failure mode diagnosis algorithm. b) For the go-to market we need to demonstrate the value creation on operational wind turbines through an operation pilot. c) We are looking for 250k to support the tests and operational pilot.
What kind of partners are you looking for? Are you missing expertise, would you like to have a mentor, are you looking for investors?: We are looking for a blade testing center to test and benchmark our technology, a mentor to guide on the go-to market strategy and business model validation, and finally once we can prove the value creation we will be looking for investors.

Web site: http://fibersail.com/

Short biography: Background on Software Engineering and Management, Business Developer and founder of Accedo Technologies, Olympic Sailing Coach with participation at Beijing and London Olympics.
Being an Entrepreneur, with skills on Software design and expert on wind as professional sailor and coach, gave me the right tools to develop an innovative shape sensor, firstly idealized for increasing performance of sails and then updated for blade monitoring.

R&D areas/s: 01. O&M experiences incl. performance optimization, production losses, 07. Forecasting, cloud physics and aerodynamics, 14. Big Data, AI, digitalization and machine learning applied to cold climate challenges, Dynamic line rating

AmpacityBrain

Sebastian/Kateryna Haglund El Gaidi/Morozovska, Greenlytics, SE/Heimdall Power, NO

Sebastian Haglund El Gaidi (Greenlytics, SE), Kateryna Morozovska (Heimdall Power, NO)

Wind power is a great technology! It is safe, it is clean and getting cheaper and cheaper. However, because of it intermittent nature, it only produces when the wind blows, making it challenging to integrate into the power system.

Historically, the grid has been over-dimensioned to handle extreme conditions, hot temperature and low wind days contributing to heating of equipment. As more and more wind power comes online, the grid infrastructure needs expensive upgrades or replacements to be able to function properly, even in case of extreme conditions.

What if we could use the grid in a smarter way and thereby operate it safe even without expensive capital investments. All this is possible with the AmpacityBrain system. The AmpacityBrain continuously sensors the current state of an overhead power line and uses weather forecasts to predict future line heating and sag.
Pitch deck: https://drive.google.com/open?id=1u-5kuyAcr8PX8LW14RC6SeAkgt5oqOIH
Who will benefit from your innovation?: Our service would allow DSOs to provide cheaper grid connection to the wind farm owners buy connecting new wind turbines to already existing power lines by using dynamic line rating. By reducing the initial investment cost for connecting wind farm we would contribute to lowering electricity price for renewable energy and make it more accessible. The information will also be available to power traders allowing them to take more informed trading decision and avoid additional fees.
Description of the innovation:Our technology combines the benefits of dynamic line rating with predictive forecasting in order to provide support to DSOs, wind farm operators and power traders for making more informed, cost efficient and secure decisions in day to day operation. By dynamically rating the power lines, additional wind power capacity (either from a newly built wind farm or from the additional turbines, in case of wind farm expansion) can be fitted into the grid without any more infrastructure.
The operative system will use probabilistic forecasting of power line capacity and wind from to provide additional information to DSOs of how much of the available wind power will be possible to dispatch. In addition to that, the system will communicate the risk based decision from the DSO to wind farm operator about the necessary curtailment hours. Power traders will also be able to use the service to know how much of the wind power curtailment is expected for day ahead trading.
What is needed for the idea to a) accelerate? b) to go-to market and c) how much capital is initially needed to move forward?: What we need in order to accelerate the development of the idea is a few early adopters. Wind power producers and DSOs that are enthusiastic about piloting new technologies to find out how it can help tackle their challenges. The business model depends on both wind power producer and DSO agreeing contractually on how curtailment should be done for the dynamic line rating, so this is crucial. The idea can be evaluated in a pilot in less than 6 months.
After the pilot we will most likely need to adjust some minor issues with the technology and business model according to our learnings. After a period of 3 months, to make adjustments, the technology will be ready for go-to-market internationally. However, the business model might need to be adapted for market conditions outside of European regulations.
We need around 500 kSEK to make the pilots and bring the technology to market.
What kind of partners are you looking for? Are you missing expertise, would you like to have a mentor, are you looking for investors?: Currently this project is a partner project between two startups Greenlytics AB (Stockholm, Sweden) and Heimdall Power AS (Oslo, Norway). We are looking for pilot customers (DSOs and wind farm operators) to validate our joint concept. If we can get help from a well-connected mentor in the industry that would be great! The help we need is mainly on the business side but it will also be important to get insight from domain experts working with the pilot customer.

Web site: http://greenlytics.io/

R&D areas/s: 01. O&M experiences incl. performance optimization, production losses, 07. Forecasting, cloud physics and aerodynamics, 14. Big Data, AI, digitalization and machine learning applied to cold climate challenges, Dynamic line rating

Short biography: Kateryna Morozovska is a PhD student at KTH Royal Institute of Technology. Kateryna's research is focused on using dynamic rating for integration of renewable energy resources to the grid. Kateryna has a background in electrical power engineering and wind energy. Since 2019 she is working for Heimdall Power as an expert in the field of Dynamic Line Rating.
Sebastian Haglund El Gaidi is one of the co-founders of Greenlytics, a weather analytics company targeting the energy industry. Sebastian has a background in engineering and previously worked as a power trader at a big utility company in Sweden.

R&D areas/s: 07. Forecasting, cloud physics and aerodynamics, 08. Pre-construction site assessment, measurements, models and standards, 10. De-/anti-icing including new technologies, ice detection & control incl. standards

ICEMET - icing under control

Ville Kaikkonen, University of Oulu, FI

Katri Kukkola (University of Oulu, FI), Eero Molkoselkä (University of Oulu, FI), Anssi Mäkynen (University of Oulu, FI)

The lack of cloud liquid water content (LWC) and median volume diameter (MVD) data in turbines currently forbids the calculations of icing rates for different blade types and speeds. Also, the methods based on sensing the already formed ice on surfaces are fundamentally always more or less late in sensing the icing events. By measuring directly the cloud droplets, both the start and end of an icing event can be precisely determined. In addition, the droplet data can be used to calculate icing rates for all turbine structures during different icing conditions.

Who will benefit from your innovation?: Wind energy producers, turbine manufacturers and designers, meteorologists, weather and icing model developers, icing assessments, wind energy traders.

Description of the innovation:The ICEMET –system is a novel icing condition measurement system to be installed on wind turbines and met masts. The operation principle is based on digitally imaging cloud droplets, ice crystals and any other particles found in the air. The recorded images are computationally analyzed to determine the liquid water content and droplet size distributions of the icing clouds. The use of image data for measuring icing conditions results in reliable measurement, where ice crystals and other particles in the air are discriminated for accurate icing condition measurements. The data provided by ICEMET-system is used to calculate the icing rates of different blade profiles or any other arbitrary shaped structures. The ICEMET-sensor is designed for use in icing conditions. It has anti-icing heating, and it has been successfully tested in varying icing conditions both in icing wind tunnel and in actual operational environment; installed on a wind turbine nacelle for 1.5 years.

What is needed for the idea to a) accelerate? b) to go-to market and c) how much capital is initially needed to move forward?: a) more ICEMET-installations to get the attention and convince of the market on the new type of a product, b) cost cut-down scaling, c) thing move forward all the time, capital would increase the speed of course.

What kind of partners are you looking for? Are you missing expertise, would you like to have a mentor, are you looking for investors?: We would benefit of a mentor with strong expertise in wind energy production in icing climates. To scale the invention to mass market investors are needed.

Web site: http://@oulu.fi/

Short biography: M.Sc.(Tech.) degree in electronics, currently finalizing PhD work in the field of photonics
on image based rain and snow measurements. Past research activities on different kind of optical environmental measurements. Spend my free time with my family and double basses playing jazzy and classical music.

R&D areas/s: 10. De-/anti-icing including new technologies, ice detection & control incl. standards

Early information of potential Iceing and measuring of icing events

Markus Rhomberg Freytag, Österreich

Sommer Michael (SOMMER Gmbh Austria).

Wind parks need to know when there is potential icing, icing events, how thick the ice build-up is and quite important when an icing event stops.
As earlier they know that there is a potential event coming up as faster they can react in for example switch on the heating system (if available).
When an icing event happens it's quite important to understand how (fast) it is being build up,
Total ice thickness and when the ice thickness stops to build up. Here the decision can be made if the Turbine has to stop.
Further to understand if there is potentially additional build-up of ice coming or if conditions changed and it will melt.
Here the service team can be informed to go to the side and start up the wind turbine again.
Who will benefit from your innovation?:
Beneficent party's are Wind park owners and Service companies. By shortening the downtime of the System and extending the live time of the windfarm efficiency rate can be increased and also
The service schedule can be better planed.

Description of the innovation:New approach to measure ice and potential ice.
IDS-20 Ice detection sensor can inform in a very early stage of potential icing "in the air".
In the split second when a icing even accrue this can be measured very precise starting with
0.01mm and the complete icing circle can be observed very accurately. Further total ice-build up
Can be measured up to 80mm.
On the other hand, end off icing-events and information of no further icing potential can be used for initiating inspection and restart of the turbines.
Efficiency of the turbines and increase of lifespan are results by using the date available from the sensor.
The combination of getting the information when to stop, start with knowing future tendency of
Icing potential give the client a big advantage in running the Wind-park.

What is needed for the idea to a) accelerate? b) to go-to market and c) how much capital is initially needed to move forward?: Current procedures to certify sensors for ice detection are not suitable for our new approach using different technology. Opening the certification process and allowing new technology to be certified is the base to be able to provide new solutions.
What kind of partners are you looking for? Are you missing expertise, would you like to have a mentor, are you looking for investors?: We are looking for willing partys to use the IDS-20 ice detection for feeld trials and based on that suport the certification of this sensor.

Web site: http://sommer.at/

Short biography: Born in Austria in 1971 and after finishing engineering school (Electronic and Communication)
and part time university for Marketing and Management I was since active in sales, technical sales
And business development in the Oil, gas, power and environmental sector. After 20 years overseas I came back with my family to Austria and finally settled in the middle of the Alps.
Having still the possibility to he world, traveling and seeing different cultures customers still exits me all the time.