BOOK OF ABSTRACTS

Winterwind

INTERNATIONAL WIND ENERGY CONFERENCE 2017

WHERE
THEORY
MEETS
PRACTICE

Program

MONDAY 6 FEBRUARY

6 FEB

OUTSIDE SESSION ROOMS

09:15	Departure from Stadshotellet
09:35–13:00	Pick up at the airport
13:00–17:00	**Field trip**
17:00–19:00	Arrival back to Stadshotellet

FESTVÅNINGEN

IEA Task 19 workshop – Ice throw, Rolv Erlend Bredesen, Kjeller Vindteknikk, Norway (52)

IEA Task 19 workshop on Ice throw, Dag Haaheim, Statkraft, Norway (53)

18:00–20:00 **Registration**
Poster set up

TUESDAY 7 FEBRUARY

7 FEB

08:00–10:00 **Registration**

10:00–11:30 **SESSION 1 • VERANDAN**

Inauguration and keynote 1

Chairs: Jeanette Lindblad and Göran Ronsten

- **Global status and future outlook of renewable energy with a focus on wind,** Christine Lins, REN21, France (11)
- **High-resolution simulations of freezing drizzle and freezing rain events and comparisons to observations,** Gregory Thompson, National Center for Atmospheric Research, USA (22)
- **IEA Task 19 – Long-term visions for cold climate,** Ville Lehtomäki, VTT, Finland (23)

11:30–13:00 **LUNCH**

12:30–12:55 **POSTER PRESENTATIONS**

- **A review of MERRA-2 data in Scandinavia,** Gemma Daron, DNV GL, United Kingdom (43)
- **Internet of Things gives cost effective monitoring solutions,** Patrik Jonsson, Combitech, Sweden (21)
- **Changing the oil in a cold climate – OBV 4406,** Larissa Lärneklev, Energiservice Skellefteå, Sweden (55)

13:00–14:30 **SESSION 2–4**

VERANDAN

Forecasting, cloud physics, aerodynamics

Chairs: Nadine Rehfeld & Gregory Thompson

- **Numerical simulation of ice accretion on an airfoil,** Matilda Ronnfors, Lund University, Sweden (15)
- **ICE CONTROL – Measurements and probabilistic forecasting of icing events in Austria and Germany,** Lukas Strauss, University of Vienna, Austria (20)
- **Cold climate requirements compared to other non-standard markets,** Jos Beurskens, SET Analysis, The Netherlands (56)
- **A novel approach for combining measurements and models for icing predictions,** Emilie C. Iversen, Kjeller Vindteknikk, Norway (37)

FESTVÅNINGEN

HSE (Health, Safety and Environment)

Chairs: Hannele Holttinen & Dag Haaheim

- **Experimental investigation of risk from ice throw and ice shed,** Markus Drapalik, University of Natural Resources and Life Sciences Vienna, Austria (3)
- **ICETHROWER – mapping and tool for risk analysis,** Jenny Lunden, Pöyry Sweden (13)
- **IEA Task 19 – IceRisk: Review of current knowledge and the way forward in risk assessments associated with ice throw from wind turbine blades,** Rolv Erlend Bredesen, Kjeller Vindteknikk, Norway (28)

BOVIKEN

Operational experience

Chairs: Kristina Conrady & Ville Lehtomäki

- **New recommended practises for low temperature and icing climate conditions,** Kai Freudenreich, DNVGL Renewables Certification, Germany (12)
- **IEA Task 19 – Low temperature compliance testing of wind turbine applications,** Pieter Jan Jordaens, Sirris / OWI-Lab , Belgium (10)
- **Modeling the dynamic behavior of wind farm power generation,** Beanán O'Loughlin, AWS Truepower, USA (41)
- **Estimating icing losses at proposed wind farms,** Till Beckford, DNV GL, United Kingdom (27)

14:30–15:30 **BREAK**

15:00–15:25 **POSTER PRESENTATIONS**

- **WIceAtlas public website,** Simo Rissanen, VTT, Finland (35)
- **Comparison of icing measurements from nacelle-mounted and blade-mounted ice sensors with icing simulations on a wind turbine blade,** Tatu Muukkonen, Labkotec, Finland (38)
- **Hotspot resistant blade heat system,** Greger Nilsson, Blade Solutions, Sweden (25)

15:30–17:00 (17:30) **SESSION 5–7**

VERANDAN

Wind turbine manufacturers

Chairs: Christine Lins & Sven-Erik Thor

- **Introduction for Dongfang low-temperature wind turbine,** Ke Chen, Dongfang Electric Corporation, China (1)
- **ENERCON – reliable energy production during the winter months,** Katharina Roloff, Enercon, Germany (45)
- **Siemens – Improving performance and reliability in cold climate,** Lennart Frølund, Siemens Wind Power, Denmark (7)
- **Nordex Anti-Icing System on N131 wind turbines – development and validation,** Konrad Sachse, Nordex Energy, Germany (48)
- **Vestas R&D within cold climate,** Brian Daugbjerg Nielsen, Vestas Wind Systems, Denmark (51)

FESTVÅNINGEN

De-/anti-icing including ice detection & control

Chairs: Carla Ribeiro & Emilie C. Iversen

- **Measuring in cloud water droplets – the real cause of icing,** Timo Arstila, University of Oulu, Finland (18)
- **Standardizing ice detector tests in icing wind tunnel,** Tuomas Jokela, VTT, Finland (17)
- **So where exactly is the ice – how many sensors does a turbine need?,** Michael Moser, eologix sensor technology, Austria (42)
- **IEA Task 19 – Evaluation of ice detection systems for wind turbines – first experiences from field test,** Saskia Bourgeois, Meteotest, Switzerland (8)

BOVIKEN

Pre-construction site assessment

Chairs: Jenny Longworth & Kai Freudenreich

- **Probabilistic long term correction of production losses due to icing,** Magnus Baltscheffsky, WeatherTech Scandinavia, Sweden (29)
- **IEA Task 19 - Blind icing map validation,** René Cattin, Meteotest, Switzerland (9)
- **IEA Task 19 – IceLoss – 10 years of experiences with calculation of production losses caused by icing,** Øyvind Byrkjedal, Kjeller Vindteknikk, Norway (32)

17:30–19:00 **MINGLE AND POSTER PRESENTATIONS IN EXHIBITION HALL**

19:00– **DINNER AND ENTERTAINMENT**

WEDNESDAY 8 FEBRUARY

8 FEB

08:30–10:00 **SESSION 8 • VERANDAN**

Keynote 2

Chairs: Saskia Bourgeois & Göran Dalén

- **Wind Energy in Cold climates – one of many niche markets requiring technical adaptations,** Jos Beurskens, SET Analysis, The Netherlands (56)
- **Grid challenges to wind deployment,** Hannele Holttinen, VTT, Finland (14)
- **Wind power in cold climate in the global energy landscape,** Stefan Gsänger, World Wind Energy Association WWEA, Germany (47)

10:00–10:30 **BREAK – POSTER PRESENTATIONS**

- **How to extend the life time of wind turbine gearboxes,** Stefan Bill, REWITEC, Germany (31)
- **Features of design of high-penetration wind-diesel power plants for villages in the Arctic regions of Russia,** Elistratov Viktor, Peter the Great St.Petersburg Polytechnic University, Russia (44)
- **Application of a SCADA data monitoring methodology,** Bojan Alavanja, Nordex Acciona Windpower, Sweden (50)

10:30–12:00 SESSION 9–11

VERANDAN

Market, research, offshore

Chairs: René Cattin & Øyvind Byrkjedal

- **IEA Task 19 - Cold climate wind power market study 2016–2020,** Timo Karlsson, VTT, Finland (24)
- **Site specific simulations of sea ice and wave loads on offshore wind turbine support structures,** Simo Rissanen, VTT, Finland (33)
- **Overview of challenges associated with offshore wind farms in cold climates,** Pieter Jan Jordaens, Sirris / OWI-Lab, Belgium (34)
- **New Swedish Energy Agency research programme within wind energy,** Pierre-Jean Rigole, Swedish Energy Agency, Sweden (49)

FESTVÅNINGEN

De-/anti-icing including ice detection & control

Chairs: Katharina Roloff & Rolv Erlend Bredesen

- **Identification of ice build-up and corresponding control optimisation,** Oscar Hugues-Salas, DNV GL, United Kingdom (19)
- **A novel meteorological conditions monitoring system for icing detection purposes on wind turbines: operational experience in Canada,** André Bégin-Drolet, Université Laval, Canada (6)
- **Recent ice wind tunnel test results and correlations with surface characteristics,** Nadine Rehfeld, Fraunhofer IFAM, Germany (4)

BOVIKEN

Environmental Impact Assessment (EIA)

Chairs: Jenny Lunden & Fredrik Lindahl

- **Experience with de-icing systems, noise and vibrations evoked by ice accretion,** Daniel Brenner, Weidmüller Monitoring Systems (WMS), Dresden, Germany (39)
- **Impact of snow on sound propagating from wind turbines,** Kristina Conrady, Uppsala University, Sweden (16)
- **Acoustic monitoring for ice detection and wind park maintenance,** Timo Mämmelä, APL Systems, Finland (40)

12:00–13:15 LUNCH

12:45–13:10 POSTER PRESENTATIONS

- **Detection of atmospheric icing conditions via cloud information,** Juha Paldanius, Vaisala Oyj, Finland (54)
- **Uncertainty quantification for wind power forecasts in cold climates,** Jennie P. Söderman, Uppsala University, Sweden (26)

13:15–15:00 SESSION 12 • VERANDAN

GRAND FINALE – The way forward

Chairs: Willy Silberstein

- **Stefan Gsänger,** Secretary General of World Wind Energy Association (WWEA), member of the steering group of the IRENA Coalition for Action and adviser to governments and international organisations.
- **Tomas Kåberger,** Professor at Chalmers Univ of Technology, Göteborg and Executive Board Chairman of Renewable Energy Institute, Tokyo
- **Christine Lins,** Executive Secretary of REN21, the Renewable Energy Policy Network for the 21st Century. Secretary-General of European Renewable Energy Council (2001–2011)
- **Ville Lehtomäki,** VTT Technical Research Centre of Finland. Operating Agent of International Energy Agency (IEA) Wind Task 19 "Wind Energy in Cold Climates" and coordinator of cold climate sub-committee in the revision of IEC 61400-1 ed3->ed4 "Design requirements for wind turbines" standard.

14:15–14:35 Summary of Conference

- **Hannele Holttinen,** VTT
- **Gregory Thompson,** UCAR

14:35–14:45 WWEC2017 presentation and final words

- **Ulla Hedman Andrén,** Director of Operations Swedish Windpower Association and Project Manager Winterwind International Wind Energy Conference. Member of WWEC2017 organizing committee.

Abstract #: 52 (Oral), session 00_1

R&D areas/s: 11. Other

IEA Task 19 workshop - Ice throw

Rolv Erlend Bredesen, Kjeller Vindteknikk, Norway

Saskia Bourgeois (Meteotest, CH), Dag Haaheim (Statkraft, NO)

Ice throw from the blades of a wind turbine is a crucial H&S issue. It is important to examine ice throw in the planning phase and also during operation.

Areas of potential ice throw should be calculated and the proximity of developed areas, roads, and tourist infrastructure such as, for example, ski slopes, lifts, footpaths and parking areas must be taken into account when placing the turbines.
In this workshop we address the state-of-the-art knowledge related to ice throw from wind turbines and the key questions regarding ongoing and future work:
- Current knowledge based on latest work at Kjeller, Meteotest and others
- Existing ice throw data bases
- IceThrower: project within Swedish Energy Agency research program
- Recommendation for risk mitigation (Dag Haaheim)
- National Guidelines from Norwegian ministry (work in progress)
- IEA Wind Task 19: update of Recommended Practices
- Presentations of IEA Wind Task 19 (subtask): partners working on guidelines for ice throw.

Web site:

Short biography: Rolv Erlend Bredesen holds a M.Sc. in Computational Science and Engineering from the University of Oslo from 2005. In 2004 and 2005 he was an exchange student at the University of Washington, USA studying mesoscale modeling with the WRF model. His main expertise is within fluid mechanics, computer programming, and wind farm development. He has a long experience applying WRF to wind farm development and lately worked extensively with ice risk analyses. He is participating as the Norwegian member in the IEA Task 19 expert group on wind power in cold climates for the working period 2016-2018. This work includes creating international guidelines for the safety issue related to ice throw from wind turbines.
As a hang glider pilot he makes the most of the vertical wind component, be it mechanical lift induced by the terrain or the weaker thermals below convective clouds, to soar in the air.

BACK

Abstract #: 53 (Oral), session 00_2

R&D areas/s: 06. Health, Safety and Environment (HSE) incl. noise

IEA Task 19 workshop on Ice throw

Dag Haaheim, Statkraft, Norway

Rolv Erlend Bredesen (Kjeller Vindteknikk, NO), Saskia Bourgeois (Meteotest, SU), Dag Haaheim (Statkraft, NO)

Ice throw from the blades of a wind turbine is a crucial H & S issue. It is important to examine ice throw in the planning phase and also during operation.
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Current knowledge based on latest work at Kjeller, Meteotest and others
Existing ice throw data bases
IceThrower: project within Swedish Energy Agency research program
Recommendation for risk mitigation (Dag Haaheim)
National Guidelines from Norwegian ministry (work in progress)
IEA Wind Task 19: update of Recommended Practices
Presentations of IEA Wind Task 19 (subtask): partners working on guidelines for ice throw

Web site: http://statkraft.com/energy-sources/wind-power/

Short biography: H&S Coordinator

BACK

Abstract #: 11 (Keynote day 1), session 01_1

R&D areas/s: 11. Other

Global status and future outlook of renewable energy with a focus on wind

Christine Lins, REN21, France

Christine Lins (Executive Secretary REN21, Austria)

2015 was a record year for renewable energy installations. Renewable power generating capacity saw its largest increase ever, with an estimated 147 gigawatts (GW) added. Modern renewable heat capacity also continued to rise, and renewables use expanded in the transport sector. Distributed renewable energy is advancing rapidly to close the gap between the energy haves- and have-nots.
These results were driven by several factors. First and foremost, renewables are now cost competitive with fossil fuels in many markets.
In addition, government leadership continues to play a key role in driving the growth of renewables, particularly wind and solar, in the power sector. As of early 2016, 173 countries had renewable energy targets in place and 146 countries had support policies. Cities, communities and companies are leading the rapidly expanding "100% renewable" movement, playing a vital role in advancing the global energy transition.
Additional growth factors include better access to financing, concerns about energy security and the environment and the growing demand for modern energy services in developing and emerging economies.
What is truly remarkable about these results is that they were achieved at a time when fossil fuel prices were at historic lows, and renewables remained at a significant disadvantage in terms of government subsidies. For every dollar spent boosting renewables, nearly four dollars were spent to maintain our dependence on fossil fuels.
Early 2017 REN21 will present a new edition of the Renewables Global Futures Report for which over 150 energy experts from all around the world were interviewed on the question on whether a 100 % renewable energy supply by mid-century is feasible and realistic or not.

Web site: http://www.ren21.net

Short biography: Christine Lins was appointed as Executive Secretary of REN21, the Renewable Energy Policy Network for the 21st Century, in July 2011. REN21 is a global public-private multi-stakeholder network on renewable energy regrouping international organizations, governments, industry association, science and academia as well as NGOs working in the field of renewable energy. REN21's Secretariat is based at UNEP in Paris/France.
Christine Lins came to REN21 from the European Renewable Energy Council, the united voice of Europe's renewable energy industry, where she served as Secretary-General for 10 years from 2001 - 2011. Previously, Ms. Lins worked in a regional energy agency in her home country, Austria. She has a Masters degree in international economics and holds more than 20 years of working experience in the field of renewable energy and energy efficiency.

Abstract #: 22 (Keynote day 1), session 01_2

R&D areas/s: 01. Forecasting, cloud physics, aerodynamics

High-resolution simulations of freezing drizzle and freezing rain events and comparisons to observations

Gregory Thompson, National Center for Atmospheric Research, USA

Gregory Thompson (NCAR, USA)

The Weather Research and Forecasting (WRF) model is used to simulate large scale and severe winter icing events at high resolution. Output from the model was compared to observations and specific application of model data to icing of wind turbines and other ground structures is investigated. WRF simulations utilized the Thompson and Eidhammer (2014) microphysics scheme and shows very promising capability to predict widespread as well as more isolated events of ground icing. The latest version of the scheme has begun using explicitly predicted water droplet number, which produces realistic drop size distributions. Size and number of drops are important variables in determining the rate at which ice accumulates on ground objects. A real-time application that includes time-lag-ensemble averages of HRRR variables is now available over the continental U.S. and will be discussed at the conference.

Web site: http://staff.ucar.edu/users/gthompsn

Short biography: Developer of a cloud microphysics parameterization for use in high resolution numerical weather prediction models, primarily the Weather Research and Forecasting (WRF) model. The scheme is run in real-time in the Rapid Refresh (RAP) model with 13-km grid spacing and the High Resolution Rapid Refresh (HRRR) model with 3-km spacing. Extensive background in application to aircraft and ground icing applications. Personal interests include photography and triathlons.

BACK

Abstract #: 23 (Keynote day 2), session 01_3

R&D areas/s: 11. Other

IEA Task 19 - Long-term visions for cold climate

Ville Lehtomäki, VTT, Finland

Geert-Jan Bluemink (VTT, Finland)

Cold climate markets are growing +12GW/a between 2016-2020 making it the largest "special" climate market in wind energy today (IEA Wind Task 19, 2016). However, the cold climate wind community (research and industry) faces several challenges. Based on IEA WIND Task 19 Winterwind surveys form 2015-2016, missing standards have been seen as one of the main barriers for cold climate wind power. But what do standards actually require as input? Answer: high quality scientific research. Standards are not made by requesting for them, they are made from systematic and long-term research activities in international context with innovative and ambitious industry partners. And right now, the international context in missing as only national activities exist in the absence on international, cold climate specific calls.
These are the kick-off, opening words for the Task 19 session answering the following questions:

- What are the pre-requirements in order to make an international standard for cold climate?
- What networks for cold climate exists, what are their roles?
- What is the process from idea to standards?
- How to fund international R&I projects for cold climate?

These questions will also be answered and discussed in the Task 19 panel session.
References
IEA Wind Task 19. (2016, July 29). Emerging from the cold. (WindPower Monthly) Retrieved August 22, 2016, from http://www.windpowermonthly.com/article/1403504/emerging-cold

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

Short biography: Mr. Lehtomäki has been part of VTT Technical Research Centre of Finland Ltd in Wind Power team since 2009. He has a Master's degree on mechanical engineering on product development from Helsinki University of Technology. Currently as Senior Scientist, his everyday work focuses on coordinating and developing new projects and technology innovations mainly in the field of cold climate wind power. He specializes in icing effects on blades, iced wind turbine dynamics, ice detection and pre-construction icing loss assessments. He is the Operating Agent of International Energy Agency (IEA) Wind Task 19 "Wind Energy in Cold Climates". He is the coordinator of cold climate sub-committee in the revision of IEC 61400-1 ed3->ed4 "Design requirements for wind turbines" standard. He is also working with IEC 61400-15 ed1 "Energy yield assessment" standard regarding cold climate effects.
He is on a mission to transform cold climate wind power into a mainstream market.

BACK

Abstract #: 15 (Oral), session 02_1

R&D areas/s: 01. Forecasting, cloud physics, aerodynamics

Numerical simulation of ice accretion on an airfoil

Matilda Ronnfors, Lund University, Sweden

Matilda Ronnfors (Lund University, Sweden), Robert-Zoltan Szasz (Lund University, Sweden), Johan Revstedt (Lund University, Sweden)

Numerical simulation of ice accretion on an airfoil
Matilda Ronnfors, Lund University, Sweden
Wind turbines are sensitive to cold climate because of ice accretion. The ice will make the power production decrease and in some cases even stop completely. The ice can also be thrown away as large blocks due to the centrifugal force which can be a hazard for those in the area. The wind power industry is also facing the acoustic problem of noise which is connected to the ice accretion. Reliable predictions, with good CFD methods, of the ice accretion on wind turbines is important because of the problematic real life measurements.
The objective of this study is to show results from numerical simulations of the ice accretion on an airfoil and comparing them to wind tunnel experiments [1]. The CFD program used is OpenFOAM which is an open source program and the ice accretion model used is based on Makkonen [2]. In the Makkonen model the ice is calculated from the water concentration in the air, the relative velocity, the projected area of the airfoil relative to the wind direction and three factors that account for the sticking efficiency, the collision efficiency and the accretion efficiency.
In the work presented here the simulations are focused on ice accretion on an airfoil with an angle of attack of 3º and 9º respectively. The two angles are chosen to show the differences when the flow is separated from the airfoil or not. This study is concentrated on the mass of ice that is accreted on the airfoil and the shape of the ice.
[1] Hochart, C.,Fortin, G. and Perron, J., 2007, "Wind Turbine Performance under Icing Conditions", Wind Energ. 2008; 11:319-333, Wiley Interscience.
[2] Makkonen, Lasse, 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: http://www.energy.lth.se/english

Short biography: I am a PhD student in Fluid Mechanics at Lund University. My greatest interest is my summer cottage in Småland!

BACK

Abstract #: 20 (Oral), session 02_2

R&D areas/s: 01. Forecasting, cloud physics, aerodynamics

ICE CONTROL – Measurements and probabilistic forecasting of icing events in Austria and Germany

Lukas Strauss, University of Vienna, Austria

Lukas Strauss, Stefano Serafin, Manfred Dorninger (University of Vienna, AT), Alexander Beck, Christoph Wittmann (Zentralanstalt für Meteorologie und Geodynamik (ZAMG), AT), Saskia Bourgeois, René Cattin (Meteotest, CH), Thomas Burchhart (VERBUND Hydro Power, AT)

Forecasts of wind power production loss caused by icing weather conditions are produced by a chain of physical models. The model chain consists of a numerical weather prediction model, an icing model and a production loss model. Each element of the model chain is affected by significant uncertainty, which can be quantified using targeted observations and a probabilistic forecasting approach.
In this contribution, we present preliminary results from the recently launched project ICE CONTROL, an Austrian research initiative on measurements, probabilistic forecasting, and verification of icing on wind turbine blades.
ICE CONTROL includes an experimental field phase, consisting of measurement campaigns in a wind park in Rhineland-Palatinate, Germany, in the winters 2016/17 and 2017/18. Instruments deployed during the campaigns consist of a conventional icing detector on the turbine hub and newly devised ice sensors (eologix Sensor System) on the turbine blades, as well as meteorological sensors for wind, temperature, humidity, visibility, and precipitation type and spectra. Liquid water content and spectral characteristics of super-cooled water droplets are measured using a Fog Monitor FM-120. Three cameras document the icing conditions on the instruments and on the blades.
Different modelling approaches are used to quantify the components of the model-chain uncertainties. The uncertainty related to the initial conditions of the weather prediction is evaluated using the existing global ensemble prediction system (EPS) of the European Centre for Medium-Range Weather Forecasts (ECMWF). Furthermore, observation system experiments are conducted with the AROME model and its 3D-Var data assimilation to investigate the impact of additional observations (such as Mode-S aircraft data, SCADA data and MSG cloud mask initialization) on the numerical icing forecast. The uncertainty related to model formulation is estimated from multi-physics ensembles based on the Weather Research and Forecasting model (WRF) by perturbing parameters in the physical parameterization schemes. In addition, uncertainties of the icing model and of its adaptations to the rotating turbine blade are addressed.
The model forecasts combined with the suite of instruments and their measurements make it possible to conduct a step-wise verification of all the components of the model chain – a novel aspect compared to similar ongoing and completed forecasting projects.

Web site: http://imgw.univie.ac.at/en/research/general-meteorology-and-climatology/projects/ice_control

Short biography: Lukas Strauss is a Postdoc scientist at the Department of Meteorology and Geophysics of the University of Vienna. Prior to joining the ICE CONTROL project, he did a PhD on mountain-wave-induced atmospheric turbulence. Lukas has mostly worked with measurement data from research aircraft, Doppler lidars and met masts but has also strived to provide insight in their mesoscale context using high-resolution numerical weather prediction models. His recent work helps him accept for good there is no escaping from forecast uncertainties for the serious meteorologist.

BACK

Abstract #: 37 (Oral), session 02_4

R&D areas/s: 01. Forecasting, cloud physics, aerodynamics

A novel approach for combining measurements and models for icing predictions

Emilie C. Iversen, Kjeller Vindteknikk, Norway

Bjørn Egil Nygaard (KVT, NO), Øyvind Byrkjedal (KVT, NO), Øyvind Welgaard (Statnett, NO)

Modeling and prediction of production loss due to icing has been limited by the lack of reliable measurements of the driving meteorological parameters. Here we present a novel approach for collecting these parameters with a newly developed icing sensor in combination with conventional meteorological instruments.
The ongoing research project FRonTLINES is focused on innovation within icing monitoring and icing measurements, as well as further development of numerical icing models. The tools will be applied both for design purposes and for monitoring power lines under operation, including forecasting of potentially critical events. The innovation gained in the project is however, also applicable for wind energy site assessment as well as production forecasting at sites exposed to severe icing climate.
The measurement program comprises three test sites, all located in exposed mountain areas in western and southern Norway. The Instrumentation used at the test sites are:

- A newly developed ice load sensor (KVT Ice-Troll)
- An improved heated web camera system for reliable ice monitoring
- Real-time ice load measurements in overhead line test spans
- Real-time ice load measurements in operational high voltage transmission lines
- Meteorological measurements of all relevant parameters, including a laser precipitation monitor (distrometer)

In this presentation we will show the latest results and experiences from the ice load sensor ("KVT Ice-troll") from two winter seasons in operation. The sensor is constructed according to the ISO description of a standard reference object, and the new design has allowed for forced rotation of the cylinder in combination with automatic load monitoring. The forced rotation ensures a smooth buildup of ice on the instrument, which makes it possible to derive the icing intensity in accordance with the ISO standard.
Meso scale models are often used for the icing assessments in wind farms; for the estimation of potential icing losses and for risk analysis related to ice throw. Such icing assessments are often limited by uncertainties in one of the key driving ice accumulation parameters, i.e. the supercooled cloud liquid water content. With the measured icing intensity from the ice load sensor and the meteorological data we show how this parameter can be derived and used for an improved validation of the models.
Furthermore, we show how the measured and derived parameters can be used to model ice accumulation on other structures. Modeled ice loads are compared with actual measured ice loads in a test span in addition to ice loads measured on an operational transmission line.
The work represents one step further in the knowledge regarding measurements of important meteorological variables to validate and further develop numerical icing models to be used in the context of both overhead transmission lines and wind energy production.

Web site: http://vindteknikk.no/

Short biography: Emilie C. Iversen has been working as a researcher at the University of Oslo (UiO) for one year and at Kjeller Vindteknikk for two years. At UiO she was working on a research project led by Kjeller Vindteknikk, developing a time-dependent model for the estimation of power production from wind farms. Later she has been involved in research on ice prediction using numerical models, and the development of a state-of-the-art methodology for estimating design loads on overhead transmission lines for Statnett, the main grid operator in Norway. She has also carried our a vast amount of icing assessments for the design of the transmission line network in Norway. She has a background in Meteorology (B.Sc. from Bergen University) and Climate Change (M.Sc. from University College London).

BACK

Abstract #: 3 (Oral), session 03_1

R&D areas/s: 06. Health, Safety and Environment (HSE) incl. noise

Experimental investigation of risk from ice throw and ice shed

Markus Drapalik, University of Natural Resources and Life Sciences Vienna, Austria

Wolfgang Kromp (BOKU-ISR, Austria)

Public risk caused by thrown or even only shed ice remains a recurring problem in wind turbine siting which has been addressed in various publications. When in doubt, expert assessments were needed. These were either based on rules of thumb or on ballistic models. Until recently, the latter used the simple assumption of three dimensional free fall with air resistance and an added term for surrounding wind. Some models are refined using e.g. logarithmic wind profiles but usually air lift is assumed to be negligible.

This assumption has been cast doubt on by Biswas et al in 2012 [1], who utilized a model including air lift for ice throw, leading to maximum throw distances of 350 m. As pointed out by Krenn [2], even detailed knowledge of aerodynamic properties leaves open problems like the choice of wind average time and thus the impact of gusts.

In order to investigate the difference between calculation and reality full scale ice drop experiments have been performed. In a first attempt several hundred wooden cuboid test specimen have been created and dropped under various conditions. Ground distributions and camera footage of single falling test specimen indicate that under appropriate conditions an ice fragments gathers sufficient rotational speed along a principal axis and is thus stabilizes its direction relative to the global reference frame and allows for significant lift.

For further tests, observations of natural icing and ice shed from turbine blades have been made. Stereo photogrammetric imagery was used to reconstruct the trajectories of shed ice. Although large uncertainties remain, the several observed trajectories were roughly exponentially flattened, indicating lift forces.

Due to the limited control over natural icing, additional experiments have been conducted using artificial ice fragments modeled after 3D scans of natural fragments. These were dropped from wind turbine hubs, the fragments were filmed in close-up und stereo photographs were made. Comparison of the rotational speed of the fragment with the trajectory was used to create a model for ice fragment fall distances. The influence of the grade of detail of the artificial ice fragments was examined.

[1] Biswas, S.; Taylor, P. & Salmon, J. (2012), 'A model of ice throw trajectories from wind turbines', Wind Energy 15(7), 889--901

[2] Krenn, A. (2016), 'Standardised Methodology for Ice Throw Risk Assessments', presentation at Winterwind 2016

Web site: http://www.wau.boku.ac.at/risk/

Short biography: Having graduated in physics at the University of Vienna in 2009, Markus Drapalik has been working since at the Institute of Safety, Security and Risk Sciences (ISR) at the University of Natural Resources and Life Sciences, Vienna. His main focus are possible risks of wind turbine usage, which is also the topic of his PhD thesis. Contributing in ISR projects, he acquired skills in general security and safety topics, risks of nuclear power generation as well as risks of renewable energy generation. His spare time he likes to spend with his family and his horse, preferably trail riding.

Abstract #: 13 (Oral), session 03_2

R&D areas/s: 06. Health, Safety and Environment (HSE) incl. noise

ICETHROWER – mapping and tool for risk analysis

Jenny Lunden, Pöyry Sweden

Bengt Göransson (PöyrySweden AB, SE), Erik Aretorn (Dala Vind AB, SE), Ylva Odemark (Vattenfall AB, SE), Jonas Sundström (Skellefteå Kraft AB, SE), Björn Montgomerie (ProgramoGrafik HB, SE)

With increased wind farm development in Scandinavia in areas with cold climate conditions, ice drops and ice throws from wind turbines is an area with increased health and safety focus. The risk of being hit by ice lumps while visiting wind farms during the winter season is uncertain and there is lack of deeper understanding on how to estimate and apply safe distances.
This project aims to strengthen the knowledge of the ice throw risk in Sweden and to develop a practical tool for calculation of ice throw distribution in a wind farm and the associated risk. The ICETHROWER project consists of two parts, a field study, and the development of one physical and one statistical model to simulate ice throws and estimate the risk. Three wind farm operators, Dala Vind, Vattenfall Vindkraft and Skellefteå Kraft participated in the field study were information such as throwing distance, physical data of the ice fragments as well as meteorological parameters was collected in a data base. Ice data was collected during three winter seasons, between 2013 and 2016. The data is used in the development of a statistical simulation model and for verification of the existing Swedish aerodynamic model KASTIS developed by ProgramoGrafik and Vattenfall.
The project is supported through a grant by the Swedish Energy agency in the program Wind power in Cold Climate ("Vindkraft i Kallt Klimat").

Web site: http://www.poyry.com/sectors/energy/renewable-energy/wind-power

Short biography: Dr. Jenny Lundén is a meteorologist with research background in atmospheric modelling, focusing on the high Arctic including effects of climate change. The last seven years Jenny has been working with wind power and she has large experience in wind resource assessment, wind farm design and energy yield estimates for both Swedish and international wind power projects as well as with technical due diligence. Jenny also works as project manager and take great part in internal development of wind services and in-service training and also teaching/lecturer in wind energy and meteorology.

BACK

Abstract #: 28 (Oral), session 03_3

R&D areas/s: 06. Health, Safety and Environment (HSE) incl. noise, 08. Market potential, finance, risk assessment and mitigation

IEA Task 19 - IceRisk: Review of current knowledge and the way forward in risk assessments associated with ice throw from wind turbine blades

Rolv Erlend Bredesen, Kjeller Vindteknikk, Norway

Arve Sandve (Lloyds' Register, Norway)

Introduction
A general methodology to assess risks related to ice throw from turbines and falling ice debris was presented in [1] and applied on wind farms and turbines, tall masts, and fjord crossing power lines in Norway. Operational forecasts of risk zones relevant for maintenance purposes for the wind farm Stamåsen in Sweden has also been presented [2]. A review is given on ongoing and suggested improvements to the IceRisk-model as well as on the risk assessment methodology.
Conclusion
We present an applicable method, which enables identification of where and how the best risk reducing measures are to be applied. The risk can be presented using the suggested standardized method of risk communication. (see figure in [4]). Ongoing improvements to the IceRisk model are listed in [4].
Key questions for ongoing and future work:

- What is the largest ice accretion expected in the wind farm and what is the maximum throw distance associated with this ice accretion?
- At which ice load is the turbine influenced in the form of a penalty on the performance and rotational speed. What is the reduced rate of further ice accretions on the blade?
- What is the long-term size and density distribution of ice accretion on a blade for a site specific turbine?
- How much energy is absorbed on impact for snow/ice debris of varying density?
- How effective are detection, deicing and anti-icing systems with respect to the prevention of buildup of dangerous ice amounts?
- How effective are de-icing systems with respect to not attempting start-ups when dangerous ice amounts are still present after a failed deicing cycle?

Learning objectives
The furthest ice throw distances suggested by ballistic models have not yet been confirmed, however with increasing empirical evidence we expect the safety distances to be addressed with a higher level of certainty. Uncertainties and simplifications still exist in the presented IceRisk methodology, though with incremental improvements and increasing empirical evidence the precision in such analyses will increase. The advantages of using the presented assumptions are evident: 1) the method enables comparison of the risk related to falling and thrown ice, between sites and different installations and 2) the method could be applied by others in the community to compare with their own models and experience, especially regarding the size of and risk level associated with the ice throw risk zones around turbines. Such a scrutiny is welcome and wanted as the community improves the awareness and knowledge with respect to the safety issue.
Bibliography
[1] R. E. Bredesen and H. Refsum, “Methods for evaluating risk caused by ice throw and ice fall from wind turbines and other tall structures,” in IWAIS 2015. 16th International workshop on atmospheric icing of structures. ISBN 978-91-637-8552-8.
[2] R. E. Bredesen, “Ice risk forecast system for operational wind farms,” in WinterWind, 2016.
[3] Wadham-Gagnon et al., 2015. IEA Task 19 - Ice Throw Guidelines. Winterwind 2015.
[4] R. E. Bredesen, H. Farid, M. Pedersen, D. Haaheim, S. Rissanen, G. Gruben and A. Sandve, “IceRisk: Assessment of risks associated with ice throw from wind turbine blades (PO.339). https://windeurope.org/summit2016/conference/allposters/PO339.pdf,” in WindEurope Summit, Hamburg, 2016.
[5] D. Wahl, P. Giguere, 2006. G.E. Energy. “Ice Shedding and Ice Throw — Risk and Mitigation. ”

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

Short biography: Rolv Erlend Bredesen holds a M.Sc. in Computational Science and Engineering from the University of Oslo from 2005. In 2004 and 2005 he was an exchange student at the University of Washington, USA studying mesoscale modeling with the WRF model. His main expertise is within fluid

Abstract #: 28 (Oral), session 03_3

R&D areas/s: 06. Health, Safety and Environment (HSE) incl. noise, 08. Market potential, finance, risk assessment and mitigation

mechanics, computer programming, and wind farm development. He has a long experience applying WRF to wind farm development and lately worked extensively with ice risk analyses. He is participating as the Norwegian member in the IEA Task 19 expert group on wind power in cold climates for the working period 2016-2018. This work includes creating international guidelines for the safety issue related to ice throw from wind turbines.
As a hang glider pilot he makes the most of the vertical wind component, be it mechanical lift induced by the terrain or the weaker thermals below convective clouds, to soar in the air.

BACK

Abstract #: 12 (Oral), session 04_1

R&D areas/s: 05. Wind turbine manufacturers - cold climate solutions, test centers

New recommended practises for low temperature and icing climate conditions

Kai Freudenreich, DNVGL Renewables Certification, Germany

Kai Freudenreich (DNVGL, DE), Michael Steiniger (DNVGL, DE), Gireesh Kumar Vasanta Kumari Ramachandran (DNVGL, DK)

1. Introduction
This presentation gives an overview about state-of-the art guidelines for design and certification of wind turbines for Low Temperature Climate (LTC) and Icing Climate (IC) conditions. Dependent on the intended areas for wind farm development, LTC and/or IC effects need to be considered for wind turbine design and certification. The term Cold Climate (CC) conditions combines LTC and IC conditions, see [1]. However, LTC and IC require separate considerations.
LTC conditions correspond to temperatures below the normal environmental conditions as stated in the applicable standards or guidelines used for certification, see [2] and [3]. Commonly, -30°C is recommended for the lower operational limit of the turbine and -40°C for the lower extreme ("survival") limit, compared to normal conditions with -10°C and -20°C limits, see [3] and [4]. LTC areas are defined as to show temperatures below -20°C (in average over many years) at more than 9 days per year. Frequent icing may not occur.
IC is defined as atmospheric icing, leading to rime and glace ice accretion on the wind turbine and its components [1]. It may also occur in the normal temperature range. IC areas are defined to show frequent atmospheric, typically for more than 168 hours per year, [5].
2. Approach
DNVGL has recently developed two separate recommended practises (RP) in order to provide principles, technical requirements and guidance for design and documentation. They serve as a solid basis for LTC and/or IC type, component and project certification.
The "RP - Extreme temperature conditions for wind turbines" [2] has been issued by DNVGL in 2016 and addresses wind turbines at both extreme high and low temperature conditions.
This RP covers e.g. the following topics:
- definition of external conditions including site assessment
- design loads
- control and protection system: sensors, braking system, cold start procedures and manuals
- rotor blades and mechanical components: changed material properties, damping, drive train losses and lubricant characteristics
- electrical components: changed pitch and yaw system response, energy storage characteristics and grid connection
- cooling and heating devices
- support structures (steel and concrete) including corrosion protection

The "RP - Icing on wind turbines" [5] is presently under development at DNVGL and will be issued until mid of 2017.
This RP covers e.g. the following topics:
- external icing conditions as ice mass accretion and imbalance of the rotor, aerodynamic influences, icing duration and definition of a wind turbine ice class
- design loads
- site assessment
- control and protection system including ice detection, effects on sensors, possible controller instabilities
- de-icing and anti-icing systems
- energy production and noise level
- ice accretion on support and exposed structures as working plattforms, helihoists, boat landings
- spray ice on offshore structures
- ice throw

3. Conclusions
DNVGL provides two Recommended Practises as sound engineering guidance for design and certification of wind turbines under LTC and/or IC conditions. A separate RP on Sea ice will be published in the future.
3. References
[1] "Available Technologies of Wind Energy in Cold Climates", IEA Wind Task 19, 2016
[2] "Recommended Practise - Extreme temperature conditions for wind turbines", DNVGL-RP-0363, DNVGL, 2016

Abstract #: 12 (Oral), session 04_1

R&D areas/s: 05. Wind turbine manufacturers - cold climate solutions, test centers

[3] "IEC 61400-1 CDV (draft) International Standard "Wind turbines – Part 1: Design requirements", IEC, 2016
[4] "Standard - Loads and site conditions for wind turbines", DNVGL-ST-0437, draft, DNVGL
[5] "Recommended Practise - Icing on wind turbines", draft, DNVGL

Web site: https://www.dnvgl.com/energy/generation/renewables-certification/index.html

Short biography: Kai Freudenreich has been working in the wind industry for more than 15 years. He is currently a Principal Specialist at the Certification Body DNV GL in Hamburg. He studied mechanical engineering at Ruhr-Universität Bochum in Germany and received his PhD at the Royal Institute of Technology in Stockholm, Sweden. After designing work at a wind turbine manufacturer, he is working in the department of Loads, Site Conditions and Electrical Engineering at DNVGL. His fields are loads, tropical cyclone conditions, cold and icing climate conditions and standards. He is member of the IEC TC 88 MT01 committee editing IEC 61400-1 and the project group editing the German Guideline for Wind Turbines.

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Abstract #: 10 (Oral), session 04_2

R&D areas/s: 05. Wind turbine manufacturers - cold climate solutions, test centers

IEA Task 19 - Low temperature compliance testing of wind turbine applications

Pieter Jan Jordaens, Sirris / OWI-Lab , Belgium

Bastiaan Reymer (Sirris / OWI-Lab, BE) , Christof Devriendt (VUB / OWI-Lab, BE) and Pieter Jan Jordaens (Sirris/ OWI-Lab, BE).

As the deployment of wind energy in cold climate regions is growing, OEM's and component suppliers are looking into optimization projects and new designs features in order to make sure their machinery is capable of surviving and reliably working in such harsh environments. Due to good wind conditions at such locations, an increased air density, low population densities, and new technological solutions for operating in low temperatures and icing environments, the cold climate wind power market is gaining momentum. As this market is increasing, so does the awareness of the challenges associated with this environment.
Developers, OEM's and component suppliers have become aware that the standard temperature specification is not sufficient for operations the cold climate market, certainly not those where temperatures can go down to -40°C. New features as gearbox heating, the use of different materials and lubrication systems, anti- and de-icing technology etc… have been introduced for this niche market. During the design process of such cold climate technology, testing and validation of these new features early in the design is essential. OWI-Lab therefore has set-up a large climatic test chamber in order to functionally test and validate electrical, hydraulic and mechanical systems in a controlled environment. So called climate chamber tests, are standard validation tests in other industries like automotive, off-highway and aerospace applications that also need work in low and icing environments. The challenge for wind turbine applications with respect to test facilities for cold climates are the large dimensions and weight of components, the needed cooling power and the needed power requirements to set-up functional tests that simulate the environment in the best possible way. OWI-Lab has developed different test approaches and test bench set-ups for electro-mechanical machinery that can be found in the wind turbine. Components as gearboxes, transformers, power converters, lubrication systems, de-icing technology have been tested in the climatic test facility during extreme low temperatures. Based on the experience in the field, and in the lab one can summarize that certain machinery needs special attention. Start-up events after grid fall for example. The rotating elements in a gearbox, pitch or yaw system or generator for example can be at risk because of insufficient lubrication and/or differential thermal expansion of its components. Viscous and stiff lubricants can affecting oil flows put exceptional load on pumps for example, leading to certain failures. The test methodology and lessons learned regarding operations and testing at cold temperature will be presented to underline the importance of cold climate tests in the validation process.
The presentation will provide insights in the behavior of certain critical components in low temperatures, its cold start-up performance and potential failure modes which have to be taken into account. A state-of-the-art with respect to low temperature adaptations will be presented and best case practices from 3 years of testing in the climate chamber will be explained by case examples. All cases can be linked to the topics included in the new DNV-GL recommended practices report on 'extreme temperature conditions for wind turbines', in order to link standards to results in practice. A first case will deal with the cold-start-up of gearboxes and will show results from a test campaign in which a new low temperature lubricant was introduced. A second case will deal with the behavior and potential issues on wind turbine transformers in cold conditions. A third case will explain the full size testing of a mid-sized wind turbine in the climate chamber.

Web site: http://www.owi-lab.be

Short biography: Pieter Jan joined Sirris – Belgian collective technology center - in 2010 as a project engineer. His first task was to set-up and roll-out OWI-Lab, the Belgian wind energy research, development & innovation platform from scratch. After setting up certain R&D and test investments, he focused on developing the R&D and test services of OWI-Lab as business developer. Main goals is to support academic research topics and industrial needs on topics as reliability, environmental testing, big data, SHM, and operations and maintenance in wind farms.
His main responsibility deals with OWI-Lab's climatic test lab in which (large) wind turbine components and assemblies are tested for cold, icing, tropical and hot climate conditions. In cooperation with the

R&D areas/s: 05. Wind turbine manufacturers - cold climate solutions, test centers

university of Brussel (VUB) he also works on topics as structural health monitoring (SHM) and big data for wind turbine applications.
He holds a Master's degree in Electro-Mechanical Engineering obtained at the KU Leuven (faculty of engineering technology) and graduated at the same institute following an additional International Postgraduate Program in Entrepreneurial Engineering.
Pieter Jan is also member of the IEA wind research group - Task 19 that is focusing on international research on cold climate wind turbine technology. He’s main focus with respect to this working group is the topic of testing.

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Abstract #: 41 (Oral), session 04_3

R&D areas/s: 03. Pre-construction site assessment, measurements, models and standards, 04. Operational experiences incl. performance optimization, production losses and repairs

Modeling the dynamic behavior of wind farm power generation

Beanán O'Loughlin, AWS Truepower, USA

Philippe Beaucage (Lead Research Scientist AWST, US), Nick Robinson (Director of Openwind AWST, US), Michael Brower (President and Chief Technical Officer AWST, US), Brian Kramak (Senior Project Manager Hydro-Québec, CA), Julien Choisnard (Hydro-Québec, CA), Slavica Antic (Hydro-Québec, CA)

Time-series energy modeling represents the next frontier of wind plant design and energy estimation. Its potential advantages over existing methods based on static frequency distributions include capturing a wider range of dynamic wind characteristics such as shear and turbulence, more accurate wake simulations, and better estimation of losses that depend on time and prior conditions, such as icing and directional and environmental curtailment. Modifications were made to the Openwind software to implement a full time-series energy estimation model. Advances were made possible through the analysis of SCADA data from 18 operational wind farms on the Hydro-Québec (HQ) system, part of a project funded by HQ to support grid operations, integration and reliability. Effort was devoted to understanding the time-varying plant losses related to wakes, availability, environment, and electrical systems and developing ways to model them. Particular attention was paid to icing losses, which are severe in Quebec. An ice loss model was developed and calibrated to observed icing losses by means of a Generalized Additive Model. Historical time series of wind power production and associated plant losses were generated for the 1979-2015 period. The long-term, hourly meteorological time series were created with the Weather Research and Forecasting (WRF) model initialized by the ERA-Interim reanalysis data set. The meteorological time series were then converted into wind power generation in Openwind, taking into account plant losses on an hourly basis. All plant losses were tracked separately and at the turbine level, providing the ability to make detailed comparisons with actual operation. Strong agreement is observed between the actual and modeled net power generation even though icing-related losses add to the complexity.

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

Short biography: Beanán O'Loughlin joined AWS Truepower as a Senior Renewable Energy Analyst in 2016 and he now leads a team of analysts working on pre-construction energy assessments. He holds an MSc in meteorology from University College Dublin, and began his career in wind working as a wind analyst for SSE Renewables in the UK and Ireland. Prior to joining AWS Truepower, he worked as an engineer for Enercon GmbH, managing site suitability studies in Northern Europe and East Asia/Oceania. He presented at the Anti-Icing conference in Bremen in 2016 and likes to keep fit by playing some traditional Irish sports.

BACK

Abstract #: 27 (Oral), session 04_4

R&D areas/s: 03. Pre-construction site assessment, measurements, models and standards, 04. Operational experiences incl. performance optimization, production losses and repairs

Estimating icing losses at proposed wind farms

Till Beckford, DNV GL, United Kingdom

Carla Ribeiro, (DNV GL, United Kingdom)

An update of DNV GL's empirical methods for estimating Icing losses at proposed wind farms
Till Beckford (DNV GL, UK)
During past Winterwind conferences, DNV GL has presented findings from the analysis of operational data from 20 wind farms in the Nordic region, along with meteorological data from over 70 measurement masts. These datasets have been analysed and used to derive empirical methods for predicting annual icing losses at proposed wind farms – based on either anemometer data or DNV GL's Icing Map of Sweden.
For this year's conference, DNV GL shall present findings from the analysis of further operational and pre-construction data conducted over the past year, increasing the geographic and temporal spread of the dataset and thereby the robustness of the methods.
In addition, DNV GL shall conduct further analysis on the above dataset to offer additional insights into the characteristics of icing at wind farm sites and of the impact of different turbine and wind farm configurations.

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

Short biography: Till has been working at DNV GL for the past 4 years since graduating from university. At DNV GL Till has been part of the Project Development department focusing on the Scandinavian and Finnish markets and undertaking pre-construction and operational energy assessments. In conjunction with this work, Till has taken a leading role in developing DNV GL's understanding of icing in cold climates and the methods used to predict these losses. Till made his Winterwind presenting debut at the 2015 conference and in his spare time enjoys playing music and sport.

BACK

Abstract #: 1 (Oral), session 05_1

R&D areas/s: 05. Wind turbine manufacturers - cold climate solutions, test centers

Introduction for Dongfang low-temperature wind turbine

Ke Chen, Dongfang Electric Corporation, China

Xu Guangyu (Dongfang Electric Corporation, China)

Dongfang Electric Corporation Limited has been keeping close watch on cold climate wind turbine technology advancement in recent years. The DF110 low temperature type wind turbines equipped with de-icing system have been put into operation in the wind farm in Nordic area. Before that a lot of test and data analysis work has been carried out on the prototype machine equipped with de-icing technology in the test wind farm in China. Some related progress has also been achieved in such field as control algorithm and lighting protection technology for the de-icing system. At the same time, Dongfang has been making continuous effort in the ice detect technology too, which makes the de-icing system work more effectively.

Web site: http://www.dongfang.com.cn/index.php?s=/Home/Article/lists/category/63/tab/2

Short biography: Project management for the wind turbine.

Abstract #: 45 (Oral), session 05_2

R&D areas/s: 02. De-/anti-icing including ice detection & control incl. standards, 03. Pre-construction site assessment, measurements, models and standards, 04. Operational experiences incl. performance optimization, production losses and repairs, 05. Wind turbine man

ENERCON – reliable energy production during the winter months

Katharina Roloff, Enercon, Germany

Katharina Roloff (Enercon, Germany)

ENERCON is one of the leading companies in wind energy, with a worldwide capacity of 40 GW. Since its founding in 1984, ENERCON has provided the production, construction and maintenance of wind turbines. ENERCON focuses on research and development, always searching for new and improved solutions to the challenges of the wind industry. Among these challenges we find sites with low temperatures and/or icing conditions. The energy potential is typically higher in the winter, caused by the higher density of the wind and the occurrences of higher wind speeds. At a site with significant icing conditions, the standstill times of the turbine due to icing can cause major energy losses. To tackle this problem, ENERCON developed a hot air rotor blade heating system. The first prototype was installed in 1996, and the rotor blade heating system has since then been thoroughly tested and improved, and the optimization of the system continues also in the future. Another important aspect is the detection of icing; ENERCON has developed an in-house technology using deviations in the power output caused by ice accretion on the aerodynamically optimized rotor blades. This is a well-functioning system which has been investigated and approved by the German certification company TÜV Nord. A second challenge at these sites can be the occurrence of low temperatures, which can bring the wind turbine components to their limits. In order to avoid energy losses due to low temperatures, ENERCON has developed a cold temperature package which ensures full production down to -30°C, and reduced production down to -40°C. This can be achieved by using specialized materials for e.g. the safety ladders, cast parts, lubricants for pitch and yaw gears and other adjustments.

Web site: http://www.enercon.de/en/home/

Short biography: Katharina Roloff works as a coordinator of the icing research within ENERCON. Examples of her tasks include icing measurements, wind measurements under icing conditions, ice detection and energy loss due to icing on the rotor blades. Her technical background she has from Gottfried Wilhelm Leibniz Universität in Hannover, where she did a master of science in meteorology followed by two years as a researcher in the field of aircraft icing (associated with several relevant collaborations and internships).

BACK

Abstract #: 7 (Oral), session 05_3

R&D areas/s: 05. Wind turbine manufacturers - cold climate solutions, test centers

Siemens - Improving performance and reliability in cold climate

Lennart Frølund, Siemens Wind Power, Denmark

Lennart Frølund (Siemens Wind Power, Denmark)

Siemens Wind Power has delivered blade de-icing for wind turbines since 1994, and since then more than 300 turbines with blade de-icing have been installed globally. In cold climate environments, where the conditions are highly variable and localized, intensive and large scale testing is important to obtain valid results. Therefore the installed systems are continuously subject to thorough testing and analysis, to gain knowledge on performance and reliability. The knowledge gained has made it possible to optimize the cold climate systems even further; tuning parameters, upgrading designs, and generally improving reliability and performance.
Siemens Wind Power delivers efficient, proven and guaranteed solutions for cold climates, ensuring the best possible energy production from any given site.

Web site: http://www.siemens.com/global/en/home/markets/wind.html

Short biography: Lennart Frølund
Lennart is a product lifecycle manager in Siemens Wind Power, managing cold climate solutions and features for the Onshore market.
Lennart is a graduate of Aarhus University, School of Engineering, where he received a BA in Mechanical Engineering, followed by a postgraduate in Business Engineering.
After graduation, Lennart launched his career at Siemens Wind Power in Denmark, where he began his specialization working with wind turbines. That led to 3 years in different positions, within the technology development department of Siemens Wind Power. After having acquired a well-rounded base of technical and project management knowledge, Lennart moved into a position with a wider scope, as product lifecycle manager for cold climate solutions and features.
Lennart is living in the city center of Aarhus, where most of the time is spent with family and friends, enjoying the city culture or mountain biking the nearby forests. Beside that, Lennart is a very active person, having a passion for sailing and surfing. After having spent years skippering sailing yachts in the Mediterranean, Lennart have invested in his own boat, now cruising the Scandinavian harbors together with his girlfriend.

BACK

Abstract #: 48 (Oral), session 05_4

R&D areas/s: 05. Wind turbine manufacturers - cold climate solutions, test centers

Nordex Anti-Icing System on N131 wind turbines – development and validation

Konrad Sachse, Nordex Energy, Germany

Danela Jacob (Nordex Energy GmbH), Ines Runge (Nordex Energy GmbH), Jochen Birkemeyer (Nordex Energy GmbH)

Since 2010 Nordex has been offering an Anti-Icing System (AIS) for its N100 wind turbines. In 2013 prototypes of the N117 have been installed and in 2015 Nordex did the next step, which was bringing the N131 with AIS to market.
Besides the adaption of the AIS to the longer blade all components of the AIS such as heating element, sensors and switch cabinets for power supply, signal processing and control have been optimized to achieve a safe, reliable and efficient operation and to further reduce the maintenance effort. A simplification of maintenance procedures could be achieved, which leads to reduced operating costs of the system. Nevertheless the key features of the Nordex AIS remain 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 AIS for N131 wind turbines, the heat distribution as well as the lightning protection system have been intensively studied and qualified during inhouse testing, simulations and together with third party institutes. 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 2014 he was appointed Senior Engineer for the Nordex Anti-Icing System.

BACK

Abstract #: 51 (Oral), session 05_5

R&D areas/s: 05. Wind turbine manufacturers - cold climate solutions, test centers

Vestas R&D within cold climate

Brian Daugbjerg Nielsen, Vestas Wind Systems, Denmark

Brian Daugbjerg Nielsen

Vestas will present the cold climate solutions package, the Low temperature which have been installed since the kW platform, the journey to Hot Air de-icing, why it was selected, how it was designed, how it have been tested to a commercial product. Field testing and latest learnings will presented, and what the focus will be in the short term. Vestas furthermore offers icing forecasting, and it will be elaborated what learnings have been from this, and how this correspond to field data, and what considerations Vestas is doing.
On the commercial side Vestas will elaborate on what the buyers vs suppliers perspective are, and conceptual warranty road map could look like, and what the enablers are to these.
Ice throws is an increasing concern in the cold climate and Vestas will elaborate on mitigation strategies and what which R&D initiatives could aid, but also how the balance could be between a production based vs safety based site. Furthermore R&D test will be presented to show how future ice detection system will bring to the industry and how this can be integrated into site requirements.

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

Short biography: Senior Product Manager at Vestas. Responsible for product options: Commercial leading and managing options, drive road map and Go to Market plans. Been in Vestas since 2006. Started out in Sourcing based in Lem, From 2007-2009 expat in R&D facility, UK Isle of Wight to integrate sourcing into blade development programs in an early stage. Moved back to DK in 2009 working with category management for sourcing. Moved to Aarhus in 2012, and started as a product manager, working from the Vestas HQ. Been heavily involved with cold climate developing De-icing system. Holds an MSc in Industrial Marketing & Purchasing from Copenhagen Business School.

BACK

Abstract #: 18 (Oral), session 06_1

R&D areas/s: 01. Forecasting, cloud physics, aerodynamics, 02. De-/anti-icing including ice detection & control incl. standards, 03. Pre-construction site assessment, measurements, models and standards

Measuring in cloud water droplets - the real cause of icing

Timo Arstila, University of Oulu, Finland

Ville Kaikkonen (University of Oulu, Finland), Timo Kananen (University of Oulu, FI), Anssi Mäkynen (University of Oulu, FI)

Icing causes challenges for wind power industry in cold climates. The most common reason for ice accretion on wind turbine blades is in cloud icing where cloud droplets hit the cold blade and freeze there. Cloud droplets are water droplets that are too small to rain down. The intensity of icing depends on liquid water content of air (LWC), median volume diameter (MVD) of droplets, relative wind speed and temperature. The reliable determination of LWC and MVD in real environment has been a challenge up to these days.

We have created a measurement technique, called ICEMET, that can measure LWC and MVD directly in real environment. On the basis of this technique we built a sensor system for proof of concept measurements on winter 2015-2016. For the location we chose a harsh fell environment in Finnish Lapland. Based on the experiences of these PoC-measurements we designed a 2nd generation sensor for this coming winter 2016-2017 to be placed on the nacelle of a wind turbine. The new ICEMET-sensor has now been presented in Wind Energy Hamburg fair and tested in VTT's icing wind tunnel in Espoo, Finland. The installation to the wind turbine takes place on November 2016 in Eastern Finland.

ICEMET measurement system consist a droplet sensor together with data transfer and cloud computing facilities. The sensor is based on an optical method that utilizes computational imaging. It produces images of droplets and together with wind speed LWC and MVD can be calculated. Results can be read on-line in nearly real time and they provide precise information when the icing period starts (before the ice formation), how severe it is and exactly shows when the icing risk is over. The whole system is possible to get relatively cost effective. Data combined to present weather data, icing of an arbitrary shaped object can be modeled and predicted.

By solving this long lasting challenge to measure LWC and MVD reliably in the field, we believe to help wind power manufacturers to improve their anti-icing and de-icing practices, weather modelers to improve their icing models and icing forecasts, site assessors to make relevant evaluations of potential wind farm sites. Our measurement system will certainly has a role as a reference for the traditional icing sensors and other indirect icing measurements. Also real world LWC and MVD measurements will give accurate input for icing model simulations.

In this presentation we will present promising results of the PoC-measurements from the winter 2015-2016 made with 1st generation sensor and compared them to traditional icing sensor data. We will also present characterization measurements of the icing wind tunnel test section with new 2nd generation sensor in October 2016. Hopefully we can also offer some first results from the wind turbine installation from the winter 2016-2017.

Web site: http://www.oulu.fi/icemet

Short biography: Timo Arstila has joined the Industrial measurement group in the University of Oulu in 2012. The research group has developed optical measurement techniques e.g. for snowflakes and rain droplets but now also for cloud droplets. Mr. Arstila has worked as a project manager in the ongoing ICEMET-project. His personal interest is swing dancing and other partner dancing, specially Lindy Hop.

BACK

Abstract #: 17 (Oral), session 06_2

R&D areas/s: 02. De-/anti-icing including ice detection & control incl. standards

Standardizing ice detector tests in icing wind tunnel

Tuomas Jokela, VTT, Finland

Ville Lehtomäki (VTT Technical Research Centre of Finland, Finland)

Cold climate markets are growing +12GW/a between 2016-2020 making it the largest "special" climate market in wind energy today (IEA Wind Task 19, 2016). However, the cold climate wind community (research and industry) is still facing challenges in one fundamental area: ice detection. While other industries and even wind industry for "normal climates" have best practices and testing methods for full- (eg blades, gearboxes etc) and sub-system level solutions (eg pitch motors, yaw motors, wind sensors etc), the cold climate community strongly believes in full-scale on-site "winter season" thinking. On-site testing is very important but it is not the only solution for testing new products. The "we live from winter seasons" thinking in the cold climate community in expensive, slow and ultimately results into slow R&I cycles for new products.

By learning from other industries and "normal climate" branches within the wind industry, the cold climate community needs to radically increase the controlled environment testing of new solutions in laboratory conditions. VTT has developed together with industry partners Vattenfall, Statkraft and Labkotec standardized testing conditions for stationary (met mast or on top of turbine nacelle) ice detectors in icing wind tunnel. By using the VTT Icing Wind Tunnel, we can emulate real-life icing conditions and reproduce the conditions for almost any ice detector. By controlling the liquid water content, wind speed, temperature and icing time, VTT Icing Wind Tunnel can emulate icing severities from light to extreme icing. New N=5 key performance indicators (KPI) have been developed in order to compare ice detectors with each other and for comparing new product versions with older products. Icing Wind Tunnel results from following sensors will be presented:

- ISO 12494 standard rotating cylinder Ø3cm L=50cm
- Labkotec LID-3300ID ice detector
- Vaisala relative humidity sensor
- Vaisala shaft heated cup anemometer
- Vector unheated cup anemometer
- Vector wind vane

Testing is ultimately a win-win case for ice detector manufacturers and end-users. Ice detector manufacturers can test new solutions in identical conditions accelerating new R&I solutions for their products and end-users will have more information to compare different ice detectors to each other in order to select the right sensor for their needs.

The results will be used as part of IEA WIND Task 19 work and implemented to Task 19 Recommended Practices 2019 revision.

References

IEA Wind Task 19. (2016, July 29). Emerging from the cold. (WindPower Monthly) Retrieved August 22, 2016, from http://www.windpowermonthly.com/article/1403504/emerging-cold

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

Short biography: Tuomas Jokela
Date of Birth:
2.12.1974, Helsinki, Finland
Education:
06/2010 - Helsinki University of Technology (M.Sc), mechanical engineering
11/2000 - Mikkeli Applied Univesirty (B.Sc), measurement and instrumentation
Working at VTT Ltd:
I have been working at VTT Ltd as a Research Scientist from 6/2010. My tasks have been related to different measurements issues, for example metmast and lidar measurements related projects. I have also been working with the icing wind tunnel related customer driven development projects. I have also taken care of the working safety issues in our team.

BACK

Abstract #: 42 (Oral), session 06_3

R&D areas/s: 02. De-/anti-icing including ice detection & control incl. standards

So where exactly is the ice - how many sensors does a turbine need?

Michael Moser, eologix sensor technology, Austria

Thomas Schlegl (eologix, Austria), Michael Moser (eologix, Austria)

We present a study on turbine icing and de-icing detected and quantified by eologix' sensors under the aspect of both the automated turbine stop due to icing as well as the automated re-start.
Typically, authorities require a turbine to stop upon the detection of a certain amount of ice, whereas for the "ice free" detection, currently, the threshold of iced measurement points on the blades is required to be zero. This means that there is a hysteresis-type difference between a turbine not yet iced enough to be stopped and a turbine still iced too much to allow for an automated restart.
In our presentation, we will explain that in detail, show the difference in terms of the amount of ice and present field data from various locations and turbine types.

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

Short biography: Michael Moser is one of the founders of eologix sensor technology gmbh, a young company focusing on smart wireless sensors. Since 2014, he is managing director of the company. From 2007-2013, he was a research assistant at Graz University of Technology.
He holds an M.Sc. in electrical enginnering and sound engineering and a PhD in electrical engineering. His personal interests include playing the piano and cycling.

BACK

Abstract #: 8 (Oral), session 06_4

R&D areas/s: 02. De-/anti-icing including ice detection & control incl. standards

IEA Task 19 - Evaluation of ice detection systems for wind turbines – first experiences from field test

Saskia Bourgeois, Meteotest, Switzerland

René Cattin (Meteotest, Switzerland), Ulla Heikkilä (Meteotest, Switzerland)

Atmospheric icing has a significant impact on the operation of wind parks. To reach an optimal performance, a turbine must be able to detect ice on the rotor blades immediately when it occurs. It must also provide an "ice-free" signal when normal operation can be resumed.
We present an independent overview of ice detection systems commercially available. The study was initiated and financed by the VGB PowerTech. A report for the VGB member was published in 2016 which gives a summary of the working principle and operational experiences of the ice detectors.
There are two different types of ice detection systems: nacelle-based and rotor blade-based systems. Nacelle-based systems measure instrumental icing and therefore do not represent the icing conditions on the rotor blade.
Ten nacelle-based systems have been evaluated. The Labkotec and the Goodrich have the highest technical maturity and the most systems in use. They are also the only certified systems. Several independent field studies exist for most systems. These studies show that all systems have their shortcomings.
Four blade-based systems and the power curve method have been evaluated. The power curve method is applied very frequently. The Bosch Rexroth BladeControl system has by far the most systems in use. The other three systems are very new on the market.
The evaluation study was the basis for designing a unique field test for the blade based systems. All four blade systems will be installed and evaluated on the same turbine on a site in Sweden. The field test will be carried out during the winters 2016/17 an 2017/18. Data from the ice detectors will be validated against webcam images and SCADA data. We will present first experiences from the field test.

Web site: https://meteotest.ch/geschaeftsbereich/vereisung

Short biography: Saskia Bourgeois has been working at Meteotest for ten years. She is a project manager, focusing on site assessments in complex terrain and cold climate. Currently Saskia is also involved in three different research projects dealing with ice detectors, icing prediction and production losses due to icing.
Since five years she is head of the wind energy group at Meteotest.

Abstract #: 29 (Oral), session 07_1

R&D areas/s: 03. Pre-construction site assessment, measurements, models and standards

Probabilistic long term correction of production losses due to icing

Magnus Baltscheffsky, WeatherTech Scandinavia, Sweden

Stefan Söderberg (WeatherTech, Sweden)

One important part of the model chain used for pre-construction site assessment of production losses due to icing is the long term correction. A site assessment study typically involves short term high resolution modelling of icing, to describe the local icing conditions, combined with long term coarse resolution modelling to describe the interannual variability of icing. Atmospheric icing and production losses due to icing have been found to vary significantly from year to year making the site assessment very sensitive to the long term correction method.
This work examines the potential of using an analog ensemble method (AnEn) to create probabilistic long term corrected time series of icing and production losses due to icing. The AnEn uses the time period where both high and coarse resolution model data is available to find analog weather situations to each point in time where only coarse resolution data is available. This set of analogs is used to create a probabilistic estimation of what the high resolution model would have shown if the data had been available.
The AnEn is compared to traditional long term correction methods and the benefits of using a probabilistic approach are explored.

Web site: http://www.weathertech.se

Short biography: Magnus joined WeatherTech in 2010 after completing his MSc in Meteorology adding new skills in running numerical mesoscale models. He has been involved in several wind power related R&D projects and delivered consultancy services such as preconstruction wind resource and icing climate studies. Magnus has more than 8 years of experience in running WRF.

Abstract #: 9 (Oral), session 07_2

R&D areas/s: 03. Pre-construction site assessment, measurements, models and standards, 04. Operational experiences incl. performance optimization, production losses and repairs

IEA Task 19 - Blind icing map validation

René Cattin, Meteotest, Switzerland

Andreas Krenn (Energiewerkstatt Verein, AT), Pieter Jan Jordaens (SIRRIS OWI-LAB, BE), Matthew Wadham-Gagnon (Technocentre éolien, CAN), Niels-Erik Clausen (DTU, DK), Ville Lehtomäki (VTT, FI), Zouhair Khadiri-Yazami (Fraunhofer IWES, DE), Göran Ronsten (Windren, SE), Neil Davis (DTU, DK)

In 2011, the IEA Ice Classification was introduced in the report "Recommended Practices for Wind Energy in Cold Climates" elaborated by IEA Task 19 "Wind Energy in Cold Climate. This allowed for the first time to classify a wind park site based on the frequency of meteorological icing (ice build-up) or instrumental icing (ice persistence). The site classification consists of five classes. For each class, an indication of the related power loss is given.
In 2016, an ice class validation study has been elaborated and presented at Winterwind. In this validation study, data pairs of instrumental icing versus power loss were collected from different operators of wind farm around the world and compared to the site classification. The study shows the effects of inter-annual variation and of different operation modes and ice protection systems. The presentation will show an update of the evaluation study with more new data pairs.
In addition, the validation data will be used to carry out a blind icing map validation. More and more icing maps are available for different countries and regions. They promise to be a very useful decision tool in order to define if a site is affected by icing or not and to choose the right technology for the site assessment from the beginning. However, the results may vary strongly between different icing maps and there is still a lack of validation data for icing maps in general.
In order to close that gap, the corresponding value from at least one icing map (e.g. WIceAtlas) will be collected for each data pair of instrumental icing versus power loss. If available, the information from several global, national and regional icing maps will be used for the same spot. Based on this data set, it will become possible to rate the accuracy of icing maps in different regions of the world and thus their suitability for site assessment.

Web site: https://meteotest.ch/

Short biography: René Cattin is a Geographer working at Meteotest. He works in Cold Climate since almost 15 years. Since 2009 he is the Swiss member of IEA Task 19. He was involved in a large number of Cold Climate projects such as "Alpine Test Site Gütsch" or "Test Site St. Brais". It is his 9th participation in Winterwind, the first first time was in 2008. Outside the office, he is very interested in Rock Music.

Abstract #: 32 (Oral), session 07_3

R&D areas/s: 01. Forecasting, cloud physics, aerodynamics, 03. Pre-construction site assessment, measurements, models and standards

IceLoss - 10 years of experiences with calculation of production losses caused by icing

Øyvind Byrkjedal, Kjeller Vindteknikk, Norway

Øyvind Byrkjedal (KVT, Norway), Johan Hansson (KVT, Norway)

Kjeller Vindteknikk has for more than a decade worked extensively on developing methods to predict production losses in wind farms due to icing and have estimated the icing losses at more than 100 different wind farm projects.

Over the years, and by the cooperation and development within various research projects (Energimyndigheten – Vindpilotprosjektet, Nordic Energy Research – IceWind, Vindforsk – ProdOptimize, Norges Forskningsråd – FRonTLINES) the knowledge about the meteorological conditions that causes icing has increases as well as the knowledge and operational experiences on how the wind turbines respond to the icing has increased. Kjeller Vindteknikk has combined this knowledge into the IceLoss model.

The IceLoss model is based upon a meteorological description of the wind and icing conditions at the wind energy site with calculations in the time domain. By validation of the meteorological parameters we have shown that the model is able to estimate the time periods when icing is occurring at the different sites (e.g. [1], [2], [3], [4], [5]). Comparisons with observed ice loads have also shown the model's ability to calculate the amount of icing that can be expected. ([6],[7],[8]).

Important development of the IceLoss model was enabled after operational data started to become available from several wind farms in icing conditions in Sweden. 'Vindpilotprosjektet' funded by Energimyndigheten gave an important contribution in the development by enabling a study of the connection between the modeled meteorological conditions and the observed power losses experienced at the site ([6],[9],[10]). In this project operational data from 7 wind farms operating under icing conditions was made. This project showed that there was a significant correlation between the observed energy losses in the wind farms and the modeled ice load.

One of the challenges of predicting the icing losses for a wind farm was found to be the operating strategy of the wind turbines. Whereas in some wind farms the turbines are able to continue energy production with iced up blades. Other wind farms were found to stop when ice was detected on the blades [11]. The IceLoss model can be set to model the production losses under different operating strategies including de-icing and anti-icing operations.

Based on detailed studies of the production losses experienced at 25 wind farms in Sweden operating under icing conditions it has been found that the IceLoss model is able to predict the timing of icing situations, the length of the icing situations and the energy losses experienced. This knowledge is used in the calculation of icing losses in new wind farms as well as for the operational forecasting of icing and energy losses for wind farms in the Nordic countries [9].

References:

[1] Byrkjedal & Åkervik (2009): Vindkart for Norge. NVE oppdragsrapport 9/2009.
[2] Harstveit et al. (2009): Validation of Regional In-Cloud Icing Maps in Norway, IWAIS 2009
[3] Byrkjedal (2008): Regional mapping of icing conditions from meso-scale model data, Winterwind 2008.
[4] Tallhaug (2010): En Norsk iskartlegging for Vindkraftbruk, Winterwind 2010
[5] Byrkjedal (2013): Icing map of Sweden, Winterwind 2013
[6] Byrkjedal Ø (2012) Mapping of Icing in Sweden – On the influence from icing on energy production, Winterwind 2012
[7] Byrkjedal et al (2016). New advances in icing measurements and icing predictions, Wintewind 2016
[8] Kringlebotn et al (2015) Monitoring and forecasting ice loads on a 420 kV transmission line in extreme climatic conditions, IWAIS 2015.
[9] Byrkjedal et al (2015) Development of operational forecasting for icing and wind power at cold climate sites, IWAIS 2015
[10] Hansson (2016) Methods for estimation of occurred icing losses in operational wind farms, Winterwind 2016
[11] Byrkjedal (2013) On the uncertainty in the AEP estimates for wind farms in cold climate, Winterwind 2013

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

Abstract #: 32 (Oral), session 07_3

R&D areas/s: 01. Forecasting, cloud physics, aerodynamics, 03. Pre-construction site assessment, measurements, models and standards

Short biography: Byrkjedal has been working in Kjeller Vindteknikk since 2007, and is currently the R&D manager of Kjeller Vindteknikk. Byrkjedal has a background as a meteorologist and holds a phd in meteorology from the University of Bergen, Norway.
He has been working in the field of meteorological icing during the past 10 years, and has lead the development of the Norwegian wind- and icing atlases and has also created wind and icing atlases for Sweden and Finland. Byrkjedal has also developed a methodology to estimate power losses due to icing based on operational power data from several Swedish wind farms, and is now leading the FRonTLINES project which is aiming to develop new tools for the assessment of icing on overhead power lines.

BACK

Abstract #: 56 (Keynote day 2), session 08_1

R&D areas/s: 08. Market potential, finance, risk assessment and mitigation

Wind Energy in Cold climates - one of many niche markets requiring technical adaptations

Jos Beurskens, SET Analysis

Jos Beurskens, (SET Analysis, NL)

Offshore issues dominate present day's wind energy research and development agendas. Considering the worldwide potential for wind energy and its geographical distribution, one will come to the conclusion that there is an unbalance between research and development requirements and (public) R&D priorities. During this presentation the various application areas will be identified and an indication of development needs will be given. The emphasis will be on cold climate issues. Also synergies between cold climate requirements on the one hand and generic research and offshore research will be touched upon.

Web site:

Short biography: Jos Beurskens headed the Renewable Energy and Wind Energy Units of the Energy research Centre of the Netherlands (ECN) from 1989 to 2005 and is a scientific advisor at ECN since. He was the scientific director of he Netherlands' first offshore wind energy R&D programme "We@Sea", 2004 - 2010. At present he has his own consultancy, SET Analysis. He is a guest scientist at the Delft University of Technology, the Netherlands.

Throughout his career, Mr. Beurskens has been extensively involved with various industry associations involved in renewable energy. He was a founding member of the European Wind Energy Association (EWEA), on the Board of which served for more than 15 years. He was one of the founders of the International Meeting of Test Stations (IMTS), the European Academy of Wind Energy (EAWE) and the European Renewable Energy Centres Agency (EUREC). He has chaired the Executive Committee of the Wind Energy programme of the International Energy Association (IEA) and has been retained as an advisor to the European Commission and several national governments on R&D programmes in the field of wind energy.

He is chairman of the Scientific Advisory Board of ForWind (universities of Oldenburg, Bremen and Hannover, Germany) and a member of the Scientific Advisory Council of the Hanse Wissenschaftskolleg, Delmenhorst, Germany. Beurskens served on the Steering Committee of the European Wind Energy Technology Platform and was chairman of WG Wind Power Systems.

Jos Beurskens received the honour of Wind Energy Pioneer of the British Wind Energy Association in 1995. In 2008 he was awarded with the Poul la Cour's prize, which was presented to him by Mr. Janez Potočnik, EU Commissioner for Science and Research. In November 2009 Mr. Beurskens received the Honorary Doctor's Degree at the University of Oldenburg, Germany, for his work on initiating European research in the field of wind energy.

As a co-author Jos Beurskens contributed to several books.

BACK

Abstract #: 14 (Keynote day 2), session 08_2

R&D areas/s: 11. Other

Grid challenges to wind deployment

Hannele Holttinen, VTT, Finland

Hannele Holttinen (VTT, Finland)

Presentation will show the challenges with wind integration: long term planning of transmission grid adequacy, and installed power capacity adequacy, as well as managing increased variability and uncertainty. Implications to icing and cold climates for these challenges are briefly discussed. Additionally, power system and electricity market value of wind power will be highlighted with high shares of wind energy. Cold climate opens opportunities using a wind resource that is usually not deployed before, thus enlarging the area for wind energy generation and increasing smoothing impacts, and value of large scale wind.

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

Short biography: Dr Hannele Holttinen (female), is Principal Scientist in Smart Energy and Systems Integration research area at VTT Technical Research Centre of Finland (MSc in 1991, PhD in 2004, Helsinki University of Technology; docent 2014, Aalto University, Finland). She has worked for VTT since 1989 in different fields of wind energy research. Since 2000, her main interest is the impact of wind on power systems and electricity markets and she has worked in several EU as WP leader (WILMAR, Tradewind, REserviceS) as well as Nordic funded (Icewind; Climate and Energy) and national research (FLEXe research programme WP leader) and foreign assignments on grid integration. She acts as Operating Agent of the IEA international collaboration on power system operation with large amounts of wind power (IEA WIND Task 25) since 2006 and was active in EU Wind Energy Platform TPWIND 2007-14, ETIP Wind 2016-. She chaired IEA Implementing Agreement on Wind Energy in 2011–2012. She worked for IEA Paris for 4 months in 2012-13 and was a visiting scientist in IREC Barcelona (3 months) in 2015 and LNEG Lisbon (5 months) in 2015-16. She has co-authored more than 100 publications including 20 journal articles.

Abstract #: 47 (Keynote day 2), session 08_3

R&D areas/s: 08. Market potential, finance, risk assessment and mitigation

Wind power in cold climate in the global energy landscape

Stefan Gsänger, World Wind Energy Association WWEA, Germany

n/a

The latest figures and the global status of wind power will be presented, including global figures of the end of the year 2016. These figures will show that wind power is today a pillar of the global energy supply, whose share is now exceeding 20% in many countries and regions. Worldwide, around 500 GW of wind power contribute today close to 5% of the global electricity demand.
Based on the general trend towards a more domestic energ supply and on the Paris agreement which defines to phase out fossil fuels by 2050, wind power has bright prospects for the years to come. The main challenge is now to design appropriate, integrated 100% renewable energy solutions for all purposes, including for various climate zones. The general potential of wind power in cold climate zones will be presented, including general political, economic and social strategies to harvest these potentials. An important element of such strategies have to participatory approaches to include local population and make them beneficiaries of wind power developments.

Web site: http://www.wwindea.org

Short biography: Stefan Gsänger has managed the World Wind Energy Association since its foundation in 2001. Under his direction, WWEA has become the voice of the wind sector worldwide, with members in more than 100 countries. WWEA attained Special Consultative Status at the UN.
Mr Gsänger is member of the managing committee of the International Renewable Energy Alliance, the executive committee of the Global 100% Renewable Energies campaign, the international steering committee of REN21, the steering group of the IRENA Coalition for Action, and adviser to governments and international organisations.
Mr Gsänger co-chaired 15 World Wind Energy Conferences, and has been an invited speaker at conferences in 40 countries. He published numerous articles, is editor of the yearbook Wind Energy International, the WWEA Bulletin and the Small Wind World Report.
In 2011, Mr Gsänger received the International Community Power Award of the Ontario Sustainable Energy Association.

Abstract #: 24 (Oral), session 09_1

R&D areas/s: 08. Market potential, finance, risk assessment and mitigation

IEA Task 19 - Cold climate wind power market study 2016-2020

Timo Karlsson, VTT, Finland

Ville Lehtomäki (VTT, Finland)

Wind power deployment in cold climate conditions is growing rapidly. Cold climate sites are attractive due to high wind speeds, increased production due to low temperature. In cold climate areas wind farms can be built on remote locations away from populated areas. In Europe, the best sites to build large onshore wind power installations are in cold climate areas.
In 2013 IEA Wind Task 19 published the first global cold climate market study in BTM World Market Update report 2012[1]. Forecast horizon of this study was at the end of 2015. The new market study presented here will compare the current estimated market size to the previous forecast and offer a new forecast until 2020.

The study looks at two different and partially overlapping markets: icing and low temperature sites. Icing sites are locations where icing can cause issues for wind power operations. Low temperature sites are sites are cold sites that are not necessarily in icing conditions. The term cold climate site is used to refer to both icing and low temperature sites.

The new forecast is based on multiple different datasources: first historical weather observations and measurements of in-cloud icing were used to produce a map of icing conditions around the world at 150m above ground level [2]. Then a global reanalysis dataset was used to estimate the geographical size of the low temperature market [3]. A global wind turbine database was then used to estimate an IEA ice class for every onshore wind power site in the world. [4]

The forecast for the size of the global cold climate wind market in 2020 was then calculated based on the onshore wind market growth estimates from BTM World Market Update 2016. [5]

The method made it possible to produce an estimate and a forecast for cold climate wind capacity on a country level. The methods used in the study are presented along with the results.
REFERENCES
[1] Navigant Research,2013.World Market Update 2012, Chicago, Illinois: Navigant Research, ISBN: 978-¬-87-¬-994438-¬-4-¬-0
[2] VTT. Wind Power Icing Atlas – WIceAtlas, http://www.vtt.fi/sites/wiceatlas
[3] MERRA: MODERN-ERA RETROSPECTIVE ANALYSIS FOR RESEARCH AND APPLICATIONS, https://gmao.gsfc.nasa.gov/reanalysis/MERRA/
[4] http://www.thewindpower.net/index.php
[5] BTM and Navigant Research. 2016. International Wind Energy Development: World Market Update 2015. Denmark, U.K. and California, USA: Navigant Consulting.

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

Short biography: Timo Received his M.Sc. degree form Aalto University in 2012, from the School of electrical engineering, with speciality in automation and control engineering. He has been employed at VTT since 2011 working as a research scientist in VTT Wind power technologies group. During his time at VTT Timo has been working on numerous R&D projects related especially to wind power in cold climates. These include ice detection method development, ice assessment, production data analysis and ice prevention system development.

BACK

Abstract #: 33 (Oral), session 09_2

R&D areas/s: 09. Offshore - access, foundations, artificial islands

Site specific simulations of sea ice and wave loads on offshore wind turbine support structures

Simo Rissanen, VTT, Finland

Jaakko Heinonen (VTT, Finland)

The Baltic Sea features a potential for large capacity wind farms because of relatively high and constant wind velocities. Mostly shallow coastal areas enable cost-efficient foundation and grid connection. However, in the northern sea area - Gulf of Bothnia - the sea freezes annually. Sea ice loads and ice-induced vibrations due to drifting ice field introduce the most significant uncertainties in the support structure design for offshore wind turbines.
FAST (Fatigue, Aerodynamics, Structures and Turbulence) aeroelastic simulation code was used to investigate structural performance of offshore wind turbines. The structural model was based on the NREL offshore 5-MW baseline wind turbine. The magnitude and time variation of ice and wave loads depends on various factors, like the thickness and velocity of the ice as well as the size and shape of the structure [1][2]. Especially turbine location has a huge impact to dynamic behavior and optimization of support structures as ice, wave and wind conditions and water depth differs. In this study focus was in defining local wave and ice conditions and comparing loads using turbulent wind field.
References:
[1]: S. Rissanen and J. Heinonen, Simulations of drifting sea ice loads on offshore wind turbine support structures, in Winterwind Åre, 2016
[2]: J. Heinonen and S. Rissanen, Numerical Comparison of Drifting Sea Ice and Wave Loads on Different Offshore Wind Turbine Support Structures, in WindEurope Summit Hamburg, 2016.

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

Short biography: Mr Rissanen has been a Research Scientist at VTT Technical Research Centre of Finland between 2003 and 2006 and again since 2011. His work focuses on dynamic modelling of wind turbines, ice load analysis, ice assessment, and icing effects on blades. He has worked on several national and international research projects related to dynamic modelling of wind turbines and ice load analysis.

BACK

Abstract #: 34 (Oral), session 09_3

R&D areas/s: 09. Offshore - access, foundations, artificial islands

Overview of challenges associated with offshore wind farms in cold climates

Pieter Jan Jordaens, Sirris / OWI-Lab, Belgium

Bastiaan Reymer (Sirris/OWI-Lab, Belgium), Christof Devriendt (VUB/OWI-Lab, Belgium)

This presentation will address specific challenges faced with the combination of the 'offshore environment' and the 'cold climate environment'. To date, the majority of the wind farms in so called 'cold climate areas' are located land based (onshore). A recent market study by IEA Task 19 shows that at the end of 2015, 127,5GW of installed wind power capacity is located in region where low temperatures and icing evens occurs. It is expected that 185,5GW wind power capacity in cold climates will be installed by 2020. These numbers do not take into account the combination of offshore sites which that are located in cold climate areas. Due to the rising interest of nearshore and offshore wind farms in the North sea and the Baltic sea, also certain offshore wind farms will be affected by topics as icing and low temperature effects. First experiences in this regard show that during wintertime in certain offshore wind farms new challenges come up with respect to the resource assessment, foundations, access, operations & maintenance and health & safety.
Due to the remote location of most offshore wind farms assets, the need for robust and reliable technology is a must in order to keep the development and O&M costs at a minimum. In offshore cold climates, or arctic offshore wind farms, additional attention is needed towards different topics that are either affected by icing or cold temperatures.
Ice loads on the foundation structure for example involve an increase in design loads which are typically higher than loads induced by waves, wind or currents. In general this means using larger and more robust foundations structures. On the other hand, in order to keep the development costs within allowable range, the industry tries to overcome overdimensioned foundation structures. During the operational lifetime on the other hand, another potential issue are ice-induced vibrations on the support structure. A technique of structural health monitoring will be explained as measure to monitor such events.
Another topic with regard to icing is the topic of 'splash ice'. In the development phase of an offshore wind farm splash ice can induce challenges to floating lidar systems for example. Such systems are commonly used to date in 'normal climate' offshore wind farm for the resource assessments. An overview of challenges for Floating lidars in cold offshore environments will explained. During the operation lifetime, splash ice can also restrict access to the turbine boat landings and affect the vessel operations in wintertime. New access tools might be needed in the future to visit cold climate offshore wind farms in wintertime due to ice. Examples and best case examples from other industries like the shipping industry with similar challenges will be explained.
Low temperatures also pose challenges to the machinery itself. Materials and lubrication fluids are affected by cold temperature and certain electro-mechanical equipment used in the wind turbine needs to be adapted for such environments.
The presentation will also include low-temperature and icing compliance testing examples as a measure to mitigate risks and ensure reliable operations in such conditions. Experiences in the regard form offshore oil & gas and the shipping industry in cold climate will be used as an example of good practice. Examples related to the DNV-GL offshore standard – 'Winterization for cold climate operations' and the recommended practices report 'Extreme temperature conditions for wind turbines' will be explained in the presentation in order to show developers, OEM's, suppliers and O&M crews that certain potential issues with respect to low temperature and icing can be mitigated early in the development process.

Web site: http://www.owi-lab.be

Short biography: Pieter Jan joined Sirris – Belgian collective technology center - in 2010 as a project engineer. His first task was to set-up OWI-Lab, the Belgian wind energy RD&I platform and it's testing infrastructure. After that, he focused on developing the R&D and test services of OWI-Lab as business developer to support academic research topics and industrial needs on topics as reliability, testing, SHM, big data, and operations and maintenance in offshore wind farms. The majority of his time he's involved with developments in OWI-Lab's climatic test facility where the effect of arctic cold, icing, hot -and tropical climates are tested on wind turbine applications. He's also active in techology watch with respect to wind energy in general.

BACK

Abstract #: 34 (Oral), session 09_3

R&D areas/s: 09. Offshore - access, foundations, artificial islands

He holds a Master's degree in Electro-Mechanical Engineering obtained at the KU Leuven (faculty of engineering technology) and graduated at the same institute following an additional International Postgraduate Program in Entrepreneurial Engineering.
Pieter Jan is also member of the IEA wind research group - Task 19 that is focusing on international research on cold climate wind turbine technology.

BACK

Abstract #: 49 (Oral), session 09_4

R&D areas/s: 11. Other

New Swedish Energy Agency research programme within wind energy

Pierre-Jean Rigole, Swedish Energy Agency, Sweden

Pierre-Jean Rigole (Swedish Energy Agency), Linus Palmblad (Swedish Energy Agency), Andreas Gustafsson (Swedish Energy Agency)

The Swedish Energy Agency works for a sustainable energy system in Sweden, combining ecological sustainability, competitiveness and security of supply.
The Swedish Energy Agency supports research and development about the supply, conversion, distribution and use of energy. Within the wind sector the Agency has a financing budget of about 60 MSEK supporting research and innovation, demonstration and implementation and communication activities.
In June 2016, the Government, the Moderate Party, the Centre Party and the Christian Democrats have concluded an agreement on a common road map for a controlled transition to an entirely renewable electricity system, with a target of a 100 % renewable electricity production by 2040. Wind power is expected to play an important role towards that goal. The Swedish government has set up a planning framework of 30 TWh wind power in 2030, and in 2014 the production already reached 16.5 TWh in 2015. In order to coordinate its actions to support research within the wind sector, the Swedish Energy Agency has adopted a strategy pointing out three prioritised areas: Wind in Swedish conditions, sustainability, and electrical network integration. Wind in Swedish conditions implies supporting activities to installation and operation of wind turbines in cold climate, in forest environment and in the Baltic Sea, pinpointed areas for their significant innovation potential.
Following the strategy work, the agency is preparing the launch of a new research programme within wind energy. The programme is not yet officially approved, therefore the talk will present the current status in the preparation of the programme including the aim and objectives, research topics, and coordination with other programmes within wind energy at the agency.

Web site: http://www.energimyndigheten.se/

Short biography: Prior to working as the Swedish Energy Agency, Pierre-Jean was Director of Technology at Finisar Sweden, part of Finisar Inc. the world's largest supplier of optical communication products. Prior to Finisar Sweden he was the CTO and founder of Syntune, a company developing and selling widely tunable semiconductor laser diodes. Syntune was acquired by Finisar in May 2011.
Pierre-Jean has a Ph.D. on widely tunable laser diodes from the Royal Institute of Technology (KTH) in Stockholm, Sweden. He holds a M.Sc. degree in Sustainable Technology from KTH and a M.Sc. degree in Engineering Physics from the École Nationale de Physique de Marseille, France.
During his spare time Pierre-Jean is enjoying spending time with his family and friends and practicing bicycling.

BACK

Abstract #: 19 (Oral), session 10_1

R&D areas/s: 02. De-/anti-icing including ice detection & control incl. standards

Identification of ice build-up and corresponding control optimisation

Oscar Hugues-Salas, DNV GL, United Kingdom

Oscar Hugues Salas (DNV GL, United Kingdom), Martin Evans (DNV GL, United Kingdom)

It is well known that wind turbines located in cold climates are subjected to ice formation on their blades. Ice on blades can cause degradation in rotor aerodynamic performance and added mass. Reduced aerodynamic performance impacts power capture and risks stall, while added mass changes the structural frequencies and can introduce imbalances, both of which increase structural loads.
Traditionally, ice detection methods are split into three categories: meteorological systems, external monitoring systems and SCADA based systems. Meteorological systems use equipment to measure, for example, temperature, humidity, wind speed, liquid water content in the air and icing duration to deduce the presence of ice. External methods use rotor mounted sensors and use monitoring systems for observing the rotor response. Finally, SCADA based methods use power threshold curves for statistically comparing power curves of turbines with and without ice in order to infer the presence of ice. Once ice accretion is detected or assumed, thermal solutions or intermittent operation of wind turbines are common fixes in the industry. However, they either raise the capital cost of the turbine or reduce the turbine capacity factor when numerous shutdowns occur.
In this work we demonstrate ice detection based on signals from sensors that are already typically available to the turbine controller: nacelle anemometer and accelerometers, blade root or tower mounted strain gauges, generator speed and torque sensors and pitch angles. These signals are not available to SCADA at the required sample rates. The vector of measurements is processed in such a way that future measurements can be predicted. The prediction process is an algorithm known as an observer.
Iced blade scenarios are modelled with modified aerodynamic and mass properties. A bank of observers is created offline; each is numerically tuned to one of these icing scenarios. The observers are then employed in parallel online. The observer with the lowest error between predictions and measurements is selected and the conditions are inferred from that choice.
For each modified blade, in addition to a tuned observer, an optimised controller is also created. One controller is activated at any time, dictated by the observer selection. In whole, the proposed system identifies the most likely icing state from a predefined set, then selects the most suitable controller to handle those conditions. The cost of energy benefits of this system are studied with respect to a set of representative cold weather wind farm sites.

Web site: http://dnvgl.com/energy

Short biography: Oscar Hugues-Salas is a Senior Engineer working in the Control Engineering Section of DNV GL - Energy for over 6 years. His experience covers: wind/floating/tidal turbine modelling and simulation using Bladed, control algorithm design, energy capture and performance optimisation, analysis of non-linear dynamic structures, development of methods for reducing loads in different turbine components, site specific load analysis, onshore and offshore wind turbine loads calculation and assessment of load cases, R&D projects including LIDAR assisted control, Individual Pitch Control, Floating Turbine Control and Wind Turbine Ice Accretion Detection and Controller Optimisation.

Abstract #: 6 (Oral), session 10_2

R&D areas/s: 02. De-/anti-icing including ice detection & control incl. standards, 04. Operational experiences incl. performance optimization, production losses and repairs, 05. Wind turbine manufacturers - cold climate solutions, test centers

A novel meteorological conditions monitoring system for icing detection purposes on wind turbines: operational experience in Canada

André Bégin-Drolet, Université Laval, Canada

André Bégin-Drolet (Université Laval, Canada), Jean Ruel (Université Laval, Canada), Jean Lemay (Université Laval, Canada), Sébastien Goupil-Dumont (EDF-EN, Canada), Sébastien Trudel (EDF-EN, Canada)

Wind energy production in cold climate (CC) is very challenging but many sites located in CC offer high energy density and are now being assessed and harvested [1]. Nowadays ice prevention systems (IPS) can be installed on wind turbines to cope with the adverse effect of icing found in CC [2]. In order to properly operate IPS, adequate ice detection methods must be used. However, atmospheric icing is very difficult to monitor and to quantify due to the nature of the different incarnations it can take (freezing rain, rime ice, glaze ice). Many ice detection techniques have been proposed in the past [3] and can be divided into two main categories: nacelle based approaches and blade based approaches [4]. The most popular ice detection methods include double anemometry (nacelle based approach) and power curve deviation (blade based approach). However, those preferred methods do not properly detect the onset of icing. Moreover, it is difficult to quantify the accumulation as well as the severity of icing events and those methods cannot be used to detect precisely the end of an icing event, a crucial information when IPS are used.

To address these issues, a Meteorological Conditions Monitoring System (MCMS) was developed by a team of researchers at Université Laval in Canada. This novel sensor consists in the integration of: an ultrasonic heated anemometer, an ambient temperature probe, a relative humidity sensor, a barometric sensor, a solar radiation sensor and several custom-built thermosensitive probes designed for the measurement of parameters associated with icing conditions encountered in the wind energy sector. Complex algorithms have been developed to adequately estimate the meteorological and instrumental icing, the duration of the icing events, the liquid water content, the accumulation of ice and the severity (intensity) of icing on a given site. This kind of information can be very useful for wind turbine operation in CC, whether or not they be equipped with IPS.

In 2015, a partnership between Université Laval and the EDF-EN Canada, a leader in renewable energy production, led to the installation of a MCMS at Rivière-du-Moulin wind Park, the largest wind energy facility in Canada (350 MW) under a single power purchase agreement and located in CC where icing events occur frequently. The MCMS was installed on a turbine equipped with a hot air IPS. The main objective of this research project was to study the operational performances of wind turbines equipped with IPS and operated under severe icing conditions. Several case studies were investigated and are presented. Based on the observed data as well as the performances of the wind turbine, it is clear that the MCMS is a novel system that can be used advantageously by wind farm operators as well as by turbine manufacturers to maximize the annual energy output.

References:

[1] Lehtomäki, V. et al. (2016) Wind Energy in Cold Climates Available Technologies – report. IEA Wind Task 19 July 2016. 120p.

[2] Battisti, L. (2015) Wind Turbines in Cold Climate – Icing Impacts and Mitigation Systems. Springer International Publishing. 341p. doi: 10.1007/978-3-319-05191-8

[3] Homola M.C., Nicklasson P.J., Sundsbø P.A. (2006) Ice sensors for wind turbines. Cold Reg. Sci. Technol. 46: 125–131. doi:10.1016/j.coldregions.2006.06.005.

[4] Cattin, R. & Heikkilä, U. (2016) Evaluation of ice detection systems for wind turbines – final report. Meteotest, VGB Research Project No. 392.

[5] Bégin-Drolet A, Ruel J, Lemay J. (2013) Novel meteorological sensor for anemometer heating purposes - Part A: proof of concept. Cold Reg. Sci. Technol. 96: 45-52. doi:10.1016/j.coldregions.2013.09.007

[6] Bégin-Drolet A, Ruel J, Lemay J. (2013) Novel meteorological sensor for anemometer heating purposes - Part B: integration into a single sensor. Cold Reg. Sci. Technol. 96: 53-68. doi:10.1016/j.coldregions.2013.09.006

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

Abstract #: 6 (Oral), session 10_2

R&D areas/s: 02. De-/anti-icing including ice detection & control incl. standards, 04. Operational experiences incl. performance optimization, production losses and repairs, 05. Wind turbine manufacturers - cold climate solutions, test centers

Short biography: André Bégin-Drolet is a professor of mechanical engineering at Université Laval. Pr. Bégin-Drolet research focuses on designing mechatronic systems used as sustainable development tools and a large portion of his work is oriented toward improving wind power production in cold climate where atmospheric icing is prevalent. His research led him to the design of a smart sensor adapted to measure 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 sailor who loves to perform in both inshore and offshore regattas.

BACK

Abstract #: 4 (Oral), session 10_4

R&D areas/s: 02. De-/anti-icing including ice detection & control incl. standards

Recent ice wind tunnel test results and correlations with surface characteristics

Nadine Rehfeld, Fraunhofer IFAM, Germany

Nadine Rehfeld, Björn Speckmann and Andrej Stake (all Fraunhofer IFAM, Germany)

Ice wind tunnel tests are an important tool to evaluate the performance of anti-icing and de-icing technologies. These tests also help to understand icing phenomenon on different surfaces under the relevant icing conditions. Physical and chemical surface characteristics can be determined and results are used to improve the development of passive icephobic coatings. Furthermore, relevant surface parameters can be detected that significantly support active anti-icing and de-icing technologies, including heating devices and mechanical actuation.
Fraunhofer IFAM is addressing these topics in several research and development projects. An ice wind tunnel test facility is available that supports coating developers in their formulation work. Furthermore, surface characterization techniques, ice-related lab tests, and cooperation with further icing research groups give the opportunity to make progress in the field of coatings. With the available infrastructure important questions regarding e.g. reliable and feasible application processes and durability of icephobic effects can also be addressed in the future.
The presentation includes recent results on studies related to correlations between surface characteristics and icephobic effects of coatings. Different test regimes are being compared and assessed regarding their significance for industrial applications. This shall allow the view on future needs and potentials of icephobic coatings.

Web site: http://www.polo.fraunhofer.de/en/alliance/institutes/fraunhofer-ifam.html

Short biography: Nadine Rehfeld has worked in the Paint Technology group at the Fraunhofer IFAM in Bremen, Germany, since 2008. She is a biology graduate and started working on anti-microbial coatings for aircraft applications in 2006. After joining the Fraunhofer IFAM she has specialized in multifunctional coatings. Since 2009, she has been responsible for R&D activities related to anti-icing technologies and coordinated, amongst others, the international JediAce project dealing with ice protection systems for aircraft applications.

BACK

Abstract #: 39 (Oral), session 11_1

R&D areas/s: 02. De-/anti-icing including ice detection & control incl. standards, 04. Operational experiences incl. performance optimization, production losses and repairs

Experience with de-icing systems, noise and vibrations evoked by ice accretion

Daniel Brenner, Weidmüller Monitoring Systems (WMS), Dresden, Germany

Dr. John Reimers (Weidmüller Monitoring Systems GmbH (WMS), Germany)

The experience of a blade mounted ice detection system at turbines with De-Icing-systems of different techniques and manufacturers will be presented. The De-icing system may change the behaviour of the blade vibration, e.g. a hot air fan reduces the blades stiffness by increasing the blades temperature.
With over 1500 active rotor blade condition monitoring systems out in the field and more than 4000 operational years of data and experience on icing events, the detection of ice on the rotor blades as well as deviations of the blades, the whole rotor or even the drivetrain have been gathered.
Examples from the field will be shown about noise problems evoked by resonance of blade natural vibrations which were excited by the drivetrain. Additionally defects in the pitch system and delamination of the blade protection film have successfully been discovered.
With the online visualization of icing events including quantitative measures about the amount of ice, the operator of a turbine knows if the ice is still accumulating or already melting.
This information helps to judge e.g. if a restart of a turbine is useful or if it is too dangerous to approach the turbine.
The BLADEcontrol system is also examined in several benchmark tests with other ice detection systems like in a comparison performed by Eolien in Canada.
Finally examples of imbalances invoked by asymmetric distribution of the ice mass among the three blades after ice has been thrown off of one blade will be shown to illustrate the negative influence of the operation of iced turbines with respect to vibration problems leading to lifetime reduction.

Web site: http://www.weidmueller.com/int/products/electronics-and-automation/measuring-and-monitoring-systems

Short biography: As head of Monitoring at Bosch Rexroth Monitoring System GmbH in Dresden, Germany, Dr. Brenner and his team continuously monitor over 1500 turbine rotors of various manufacturers in different regions and climates.
Dr. Brenner studied electrical engineering in Dresden and worked for BMW in Munich during his diploma thesis. He graduated as PhD in mechanical engineering at the University of Magdeburg about the lifetime of wind turbine gearboxes. During the last 6 years he was responsible for the development of condition monitoring methods for wind turbine rotor blades.
Since 1st of November The company had been renamed to Weidmüller Monitoring Systems GmbH and Mr. Brenner kept his position.

BACK

Abstract #: 16 (Oral), session 11_2

R&D areas/s: 06. Health, Safety and Environment (HSE) incl. noise

Impact of snow on sound propagating from wind turbines

Kristina Conrady, Uppsala University, Sweden

Anna Sjöblom (Uppsala University, Sweden), Conny Larsson (Uppsala University, Sweden)

Simultaneous acoustic and meteorological measurements, as well as daily snow observations, at a wind farm in northern Sweden are analysed for two snow seasons. The purpose is to examine the meteorological influence on sound propagating from the wind turbines, and to evaluate if the site is representative for other sites as well. Measurements of these types are crucial, since significant knowledge gaps exist in the implementation of the complexity of the atmospheric boundary layer (ABL) in sound propagation models, especially for conditions in cold climates. It is known that processes in the ABL in cold climates differ from those in warmer zones, for instance due to a snow cover. It has been shown previously that there is an effect of snow on sound propagating from wind turbines, as well as other sound sources, but neither the effect of different snow conditions nor the impact of snow on trees has been fully investigated yet. The results show that there is a difference between different snow conditions, and that snow has an attenuating or amplifying effect on sound from wind turbines. Furthermore, the vertical wind speed and temperature gradient influence the effect. Hence, the impact of snow on sound propagation cannot be generalised as just a damping effect, and has to be taken into account when planning and maintaining wind farms.

Web site: http://katalog.uu.se/organisation/?orgId=X35:30

Short biography: I did my bachelor's degree in meteorology at the University of Hamburg in 2010 and moved to Svalbard for one year, where I took Arctic related courses in meteorology, oceanography and glaciology. Afterwards, I started my master studies in meteorology at the University of Hamburg and wrote my thesis in cooperation with the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research. I worked with Atmospheric concentration of black carbon in the western Arctic and attended a flight campaign in the Arctic. Currently I am doing a Ph.D. in meteorology at Uppsala University where I investigate processes in the atmospheric boundary layer with implications for sound propagation in cold climates.

I am fascinated by nature in general, and in particular by the Arctic. To make sure that I will not be cold in the cold climates, I am knitting warm stuff whenever and wherever it is possible.

Abstract #: 40 (Oral), session 11_3

R&D areas/s: 02. De-/anti-icing including ice detection & control incl. standards, 06. Health, Safety and Environment (HSE) incl. noise

Acoustic monitoring for ice detection and wind park maintenance

Timo Mämmelä, APL Systems, Finland

Antti Leskinen (APL Systems, FI), Timo Mämmelä, (APL Systems, FI), Roy Hjort, (APL Systems, FI)

The Scandinavian winter poses technical challenges for wind turbines. Extreme conditions, especially icing on the blades, stresses the blades and affects production of the wind turbines.
Icing effects aerodynamic properties of the blade. This causes turbulence on the surface of the blade and reduces the production capability. Power curve has been used commonly used to detect icing events. Detection of the icing incidents is based on long term monitoring the sound profile of the turbine. Acoustic properties of turbine blade changes when ice starts to build-up. Change of the sound is caused by the turbulence that ice creates. These turbulences change the spectrum of the sound and by detecting these changes with automated spectrum analysis in real time, icing events can identified. These changes are reoccurring so automated alarms can be created, which then can be used to trigger e.g. de-icing. Similarly, other changes on wind turbine can be found from changes the acoustic emissions of wind turbine.
Acoustic detection of icing and other changes on the blade conditions have not largely been used. Reasons for that have been that requirements for equipment used in these harsh conditions have not been available and automated detection of the different sound related incidents need fast and fully automated sound analysing system integrated to the noise monitoring system.
AuresSound® have been developed for Nordic conditions and have been used in wind park sound emissions monitoring for several years in very harsh conditions. AuresSound® Ice detection and premaintenance application can be installed in any wind park without a need to stop production.

Web site: http://www.apl.fi

Short biography: Timo Mämmelä have been working with APL Systems for four years in environmental noise emission monitoring in variety of business sectors. Timo has also been closely involved on the development of the acoustic monitoring application for wind parks. Previously Timo have been working in different positions on environmental monitoring and R&D positions in pharmaceutical industry.

BACK

Abstract #: 43 (Poster), session 13_01

R&D areas/s: 03. Pre-construction site assessment, measurements, models and standards

A review of MERRA-2 data in Scandinavia

Gemma Daron, DNV GL, United Kingdom

Gemma Daron (DNVGL, United Kingdom)

The availability of reliable and consistent long-term reference data is key for defining the long-term wind regime at a proposed wind farm site. Reanalysis products have been widely used within the wind industry for several years, given their global coverage and public availability. The MERRA dataset, in particular, has been shown to provide robust correlations to site measurements across the Scandinavian region.
In February 2016 the MERRA dataset was discontinued by NASA and replaced by MERRA version 2, which incorporates new measurements and an updated assimilation model. This prompted an investigation of the performance of the new dataset as a source of long-term reference data. Analysis of correlations between site measurements and MERRA-2 (at the 50 m height) reveals that the correlations are significantly worse at some sites across the Scandinavian region, when compared to the original MERRA dataset.
In this presentation, we will explore possible reasons for this change in performance, and present results using alternative reference data, including MERRA-2 data on pressure levels and DNV GL's Virtual Met Data product. We will show examples where these products give an improved representation of the long-term wind regime, providing an alternative to the use of conventional MERRA-2 data products.

Web site: http://blogs.dnvgl.com/energy/author/gemma-daron

Short biography: Gemma has worked in the wind energy industry for 9 years, primarily in the field of wind resource and energy production assessments. In this time, she has conducted assessments for many gigawatts of proposed and operational wind farm projects in Europe and sub-Saharan Africa. She is also a regional specialist for DNV GL's Virtual Met Data service, which involves running mesoscale models to produce long-term wind time series and wind maps, and has delivered of several country-wide wind speed maps. Gemma graduated with a BSc in Meteorology from the University of Reading, UK, in 2007. As part of this, she also spent a year studying at the University of Oklahoma, USA. Gemma is a keen runner and photographer.

Abstract #: 21 (Commercial poster), session 13_02

R&D areas/s: 02. De-/anti-icing including ice detection & control incl. standards

Internet of Things gives cost effective monitoring solutions

Patrik Jonsson, Combitech, Sweden

Björn Ollars (Combitech, Sweden)

High quality monitoring equipment such as sensors and loggers are usually expensive. The cost is related to the quality of the equipment and the cost is growing exponentially as the quality demands increases.
At many monitoring tasks there is a need of cost effective monitoring solutions. It is often difficult to find a low cost solution that is reliable and flexible enough to suit specific measurement needs.
If the highest reliability demands can be omitted, very cost effective monitoring solutions can be built using todays Internet of Things (IoT) equipment. The IoT principle solves the problem with lower quality by using many systems, so that at any time some systems should be up and running. By utilizing small, low cost and low power computers such as Arduino, BeagleBone and Raspberry running Linux operating systems, it is possible to develop high end monitoring applications with almost the same performance as a modern laptop. Only a few years ago, loggers where built up using proprietary operating systems and application software. This made the loggers expensive and impossible to add 3rd party drivers and applications. Today's IoT systems are using standard operating systems and the development of new software and drivers for new hardware is supported by a huge number of people that drives the open source community forward at a great speed.
Combitech has a vast knowledge of building low cost monitoring systems that greatly improves the customers possibility to increase their knowledge of weather, sounds and status of other equipment. Ice detection systems and associated equipment can advantageously be handled by IoT solutions. By carefully choosing IoT computer platforms and sensors it is possible to develop monitoring solution at a much lower cost than traditional monitoring solutions, while still maintaining high quality systems. Some of our demanding customers for these cost effective IoT systems are Skistar and SCA.

Web site: http://www.combitech.se/Koncept/Utvecklingsmiljoer/Information-of-Things/

Short biography: Patrik Jonsson has a Ph.D. in electronics and has performed research in how to discriminate between a surface covered with water, ice or snow by utilizing near infrared light, filters and advanced computer models. Today he works at combitech with improving their monitoring system solutions. One of his may interests are hunting in the Swedish mountains.

BACK

Abstract #: 55 (Commercial poster), session 13_04

R&D areas/s: 07. Inspection, maintenance and repair

Changing the oil in a cold climate - OBV 4406

Larissa Lärneklev, Energiservice Skellefteå, Sweden

Energiservice Skellefteå

The need to change the oil in a gearbox can occur during the cold season. One problem is to transport oil to the turbine. Another problem is to deal with oil on both technical and working environment and of course environmentally friendly way. Energiservice in Skellefteå has therefore developed a methodology and tools to perform oil changes in a cold climate. 4406 stands for an ISO code. This means that the new oil is treated to a specified level of purity which turbine manufacturer requires before it is filled in the gearbox. The function of the quality work has fulfilled with the tool as Energiservice has developed. During the development of the new tool has placed great emphasis on the environment. With this method, it shortens the stopping time of the work, which means a direct economic benefit for the owner.

Web site: http://www.es.se/

Short biography: Not available

BACK

Abstract #: 35 (Poster), session 13_045

R&D areas/s: 08. Market potential, finance, risk assessment and mitigation

WIceAtlas public website

Simo Rissanen, VTT, Finland

Ville Lehtomäki (VTT, Finland)

The cold climate wind energy market is expanding rapidly due to its excellent wind resources. However, in cold climate sites icing causes productions losses which increases uncertainty in project profitability. Therefore it is important to perform icing assessment in parallel with wind resource assessment.
WIceatlas (Wind power icing atlas) [1] is based on weather observations, terrain elevation and reanalysis data. Observations are from ~4500 weather stations around the world. Only stations with more than 20 years of data with 70% availability are used in WIceatlas and therefore long term average and interannual variation of icing can be calculated. Site measurements are still considered to be the best and most reliable source of information to assess icing conditions but are often too short duration to predict losses over the lifetime of a wind power project. WIceAtlas can be used together with site measurements to define icing severity during measurement campaign compared to long term average.
In 2016 VTT launched public version of WIceAtlas with restricted pixel and icing severity resolution. In this presentation public website and methods behind the map will be presented.

References:
[1]: Rissanen, Wind Power Icing Atlas (WIceAtlas) – icing map of the world, Winterwind 2015 presentation

Web site: http://www.vtt.fi/sites/wiceatlas

Short biography: Mr Rissanen has been a Research Scientist at VTT Technical Research Centre of Finland between 2003 and 2006 and again since 2011. His work focuses on wind power in cold and icing climate and dynamic modelling and simulation of wind turbines. He has worked on several R&D projects related especially to ice mapping, ice assessment, wind turbine modelling and icing effects on wind turbines.

Abstract #: 38 (Commercial poster), session 13_05

R&D areas/s: 02. De-/anti-icing including ice detection & control incl. standards

Comparison of icing measurements from nacelle-mounted and blade-mounted ice sensors with icing simulations on a wind turbine blade

Tatu Muukkonen, Labkotec, Finland

Jarkko Latonen (Labkotec, Finland)

Labkotec presents research results from icing wind tunnel tests in correlation to simulations with a wind turbine blade. Behavior of ice detectors and accumulation of ice on wind turbine blades have been studied in different types of icing conditions, namely freezing rain, moderate/light in-cloud icing and harsh in-cloud icing. Accordingly, the VTT Pre-Certification has also been updated.
Labkotec is currently developing blade-mounted ice detectors and the nacelle-mounted ice detector LID-3300IP Type 2. The very first blade-mounted ice detector prototype was installed to a wind turbine blade in 1994. The ice detector was integrated on to the turbine to optimize blade heating and to minimize ice accumulation on the blade. That knowledge has been the baseline during the recent years for the development of new generation blade-mounted ice detectors. Today, Labkotec is working on a production prototype and is aiming to start production soon.
Development on nacelle-mounted ice detector LID-3300IP Type 2 has been focusing on functional safety aspects. Comparing to the current product, LID-3300IP, functional safety classification of LID-3300IP Type 2 has been further improved based on customer needs. Improved safety aspects include, for example, safety relays where relay position is constantly monitored. Also a separate safety processor is applied to double check information inside the ice detector. All other features, like event log file with accurate time stamps, are available. The event log improves customer experience. History of user entries, parameter changes and improved diagnostics and troubleshooting can be easily seen from the event log. Currently, Labkotec is testing production prototype and is aiming to start production in 2017.
As Labkotec is developing two new products, functional safety analysis has been carried out in both cases according to the standard ISO 13849-1. Functional safety characteristics like Diagnostic coverage (DC), Mean time to failure (MTTF), and Mean time to dangerous failure (MTTFD) have been calculated. In both new products, functional safety classification (PL value) will be further improved, even if the current technology has shown millions of hours of operating time without critical faults.

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

Short biography: Working on ice detection R&D and customer related applications for about five years as Project Manager and about two years as Product Manager

BACK

Abstract #: 25 (Commercial poster), session 13_06

R&D areas/s: 02. De-/anti-icing including ice detection & control incl. standards, 07. Inspection, maintenance and repair

Hotspot resistant blade heat system

Greger Nilsson, Blade Solutions, Sweden

Greger Nilsson (Blade Solutions, Sweden)

Blade heat systems have major impacts on arctic wind turbines' energy production. The dominating types of heating systems are convection systems with fans inside the blade or direct conduction systems. The direct conduction systems incorporate heating element consisting of carbon fibre mats attached around the blade´s leading edge. Carbon fibre based systems have the advantage that they can be activated during production, with the leading edge being heated to prevent build-up of ice crust.
However, a major drawback of carbon fibre based heat systems is their sensitivity to hotspots. The blades, and the leading or outer edge in particular can be subjected to physical impacts e.g. from ice or extreme electrical currents from lightning strikes. These events may lead to point defects on the heat mats, and hotspots form as the electrical current re-directs itself around the defects. The hotspot temperatures are often much higher than the rest of the heating system, sometimes exceeding the degradation temperature of the thermoset matrix (e.g. epoxy/polyester), resulting in hotspot growth and eventual blade failure.
The purpose of this presentation is to demonstrate a new carbon fibre based blade heat system with increased hotspot resistant. The new blade heat system has been tested in the laboratory as well as at arctic conditions in a wind park. The new blade heat solution reduces temperature increase around a hotspot significantly. Similar damage in the new system results in 1/3 temperature increase in a hotspot compared to regular system. With less heat build-up, chances are that the hotspot growth is contained which in turn means less down-time and repair cost. Neither the lab tests or the field trials have demonstrated reasons for concerns or drawbacks of using the new system. Instead, the tests suggest that the new system is ready for commercial introduction.

Web site: http://www.bladesolutions.se/

Short biography: Owner of Blade Solutions, former composite researcher, Lic. in composite engineering, MSc in mechanical engineering. Catamaran sailing.

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Abstract #: 31 (Commercial poster), session 13_07

R&D areas/s: 04. Operational experiences incl. performance optimization, production losses and repairs, 07. Inspection, maintenance and repair, 11. Other

How to extend the life time of wind turbine gearboxes

Stefan Bill, REWITEC, Germany

Stefan Bill (REWITEC GmbH, Germany)

REWITEC is an independent, medium-sized business that develops innovative nano- and micro-particle-based lubricant additives and markets these in Wind Turbine applications around the world. When applying the products, treated machinery, gearboxes and bearings can run with reduced friction, reduced temperature and great reliability and durability due to reduced abrasion and wear.
In the wind sector in particular, the service life of systems is of central importance, since any renewal or replacement of system components entails a substantial investment. Many well-known manufacturers and operators of wind turbines appreciate the efficacy of the products and use them on a regular basis. Even scientific tests and reports show that using REWITEC products increases smooth running and reduces wear in main gears. Adding DuraGear W100 specially developed for the wind industry can extend the life of all moving parts right through to the scheduled repowering, without having to make an additional investment in a gearbox.
The special high-temperature grease GR400 has also been applied to pitch, generator and main bearings and azimuth and pitch gears. The results, like the extended service life of components, removal of previous damage and the positive impact on bearings and their CMS data, convince not only owners, operators and commercial managers but also those companies involved in the service and maintenance business.
Evaluation of life time improvement
Using the REWITEC provided specific gear and bearing surface roughness measurements with and without treatment, 3rd party Sentient Science ran two cases for each of several critical components (intermediate pinion bearing, planetary bearing and intermediate pinion gear). Aside from the surface roughness differences Sentient Science assumed that all other model input parameters including bearing and gear loads, metallurgical and material properties, and oil viscosity remained unchanged from Sentient Science´s Winergy 4410.2 prognostic model. Sentient Science used its proprietary six-step prognostic modelling process to evaluate life of the two different surface finishes. REWITEC used these tests to provide Sentient Science with the surface finish data of the components with and without REWITEC DuraGear W100 treatments.
To take the influence of microasperity into account for determination of probabilistic fatigue life, Sentient Science mixed EHL (elastrohydrodynamic) solver utilizes simulated surface roughness profiles in an explicit deterministic calculation of surface tractions. Surface traction refers to the pressures transmitted between two surfaces through a lubricant.
Outcome: We can directly determine the performance of a given surface finish during the generation, sustainment, and/or failure of an EHL film at the contact zone.
DigitalClone predicts that a Winergy 4410.2 damaged gearbox treated with REWITEC DuraGear W100 has a significant improvement in life than untreated gearbox and representative turbine operating conditions. Specifically, for bearings, REWITEC´s DuraGear W100 treatment is expected to improve the overall contact fatigue life by a factor of 3.3. For gears, REWITEC´s DuraGear W100 treatment is expected to improve the overall fatigue life by a factor of 2.6.
REWITEC main application are gears and bearings in wind turbines, steel-, mining production, industrial and marine industry.
Latest University test results have proven 43 % less friction, 20 % less temperature and 54 % less roughness on a 2 disc test assembly bench. Sentient's DigitalClone technology predicts that Winergy 4410.2 gearboxes will exhibit a significant improvement in life compared to untreated gearboxes – under field representative operating conditions, REWITEC's DuraGear W100 treatment is calculated to improve bearing life by a factor of 3.3 and overall gear life by a factor of 2.6. This life extention upgrade solution allows for a ROI up to 49 % and a payback within 8 months and more.

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

Short biography: Dipl.-Ing. Stefan Bill
53 years, married, 2 children

Abstract #: 31 (Commercial poster), session 13_07

R&D areas/s: 04. Operational experiences incl. performance optimization, production losses and repairs, 07. Inspection, maintenance and repair, 11. Other

- 1985–1988 Studies of Electronics, University Giessen/Friedberg (Germany), Graduate Engineer
- 1988-2002 Sales Manager LTI Drives GmbH, Lahnau, Germany
- 1999 Studies of Economics, St. Gallener Business School, Switzerland
- 2002-2004 Business Unit Manager Motors&Drives ABB Automation Products, Mannheim, Germany
- Since 2004 Executive Partner REWITEC GmbH, Lahnau. Responsible for International Accounts, R&D

REWITEC was Finalist of the 28th Innovations Award of the German Economy 2007
Finalist 1st HUSUM WindEnergy Award 2009
Winner of Industry prize 2014 in the category – BEST OF 2014 for the product DuraGear
Finalist of the Wind Energy Award 2016 as supplier of the year

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Abstract #: 44 (Poster), session 13_09

R&D areas/s: 03. Pre-construction site assessment, measurements, models and standards, 04. Operational experiences incl. performance optimization, production losses and repairs, 08. Market potential, finance, risk assessment and mitigation

Features of design of high-penetration wind-diesel power plants for villages in the Arctic regions of Russia

Elistratov Viktor, Peter the Great St.Petersburg Polytechnic University, Russia

Denisov Roman (SPbPU, Russia), Konishchev Michail (SPbPU, Russia)

Currently the development of energy infrastructure of the Arctic and Far Eastern regions of Russia is one of the main priorities of «The energy strategy of Russia's development to 2030». Most of these areas are located in areas of decentralized energy supply. The total installed capacity of diesel power plants (DPP) working in the northern regions are more than 500 thousand kW. DPPs produce about 2.5 billion kW·h, which requires the consumption of about 1 million tons of diesel fuel per year. Delivery of diesel fuel in these regions is carried out in the "northern" delivery. DPPs are characterized low reliability, long life of service, they consume expensive long-imported fuel, and therefore the unit cost of electricity generated by diesel power plants is 0.22-2.23 $/kW·h.
In the article the concept of a reliable energy infrastructure based on wind and diesel power plants (WDPPs) is offered, as the best option to replace diesel fuel consumption. In order to improve the accuracy of determining the share of the replacement fuel the method of wind resource assessment in the areas with shortage of weather and natural climate information is developed. The method is based on a three-level approach. Each level corresponds to a more accurate model of the wind flow: meso- and microscale modeling and more accurate assessment of the spatial distribution of the wind resource. In order to create an effective and competitive energy supply system for northern conditions Russia the multi-level method of determining the optimal composition, parameters and operating modes of an autonomous WDPP is designed. The method is based on an assessment of equipment losses in harsh conditions. Measures of adaptation for elements of structures and installations of wind turbines, which reduce losses from underproduction of energy in the northern regions of Russia by 10-20%, are analyzed and proposed. An intelligent system of energy management and distribution based on active networks for adaptive architectures is developed to ensure the work of WDPPs with high penetration level.
The proposed solutions are applied to several WDPP projects operating in Russia in the Arctic Circle. The effect of the optimization of the composition, parameters and modes of operation of the power plant is estimated to save 169 thousand liters of diesel fuel, which is more 100k $/year. Additionally it can reduce CO_2 emissions of 600 tons/year.

Web site: http://ice.spbstu.ru/
https://translate.google.se/translate?sl=ru&tl=en&js=y&prev=_t&hl=sv&ie=UTF-8&u=http%3A%2F%2Fice.spbstu.ru%2F&edit-text=

Short biography: Doc. of Sc., Prof., Director of Science-education center «Renewable energy sources»
Research interests: renewable energy, system engineering based on RES, wind power.
Publications: more 180.
H-index: 12.

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Abstract #: 50 (Oral), session 13_11

R&D areas/s: 04. Operational experiences incl. performance optimization, production losses and repairs, 07. Inspection, maintenance and repair

Application of a SCADA data monitoring methodology

Bojan Alavanja, Nordex Acciona Windpower, Sweden

Bojan Alavanja, Supervisor Prof. Jens N. Sørensen (DTU, DK), Examiner Prof. Simon-Philippe Breton (Uppsala University, SWE)

Reliability of wind turbine components and maintenance optimisation are among the critical aspects of wind power development closely related to profitability and future development. The main reason for research in these areas is lowering the cost of energy production for wind power, specifically important in offshore environment. Continuous monitoring of specific wind turbine components can be valuable for wind farm operators and, subsequently, wind farm owners. Also, health assessment of critical components can be useful in estimating the possibilities for life extension of wind turbines. Expensive Condition Monitoring Systems (CMSs) are not always available, particularly in older wind farms, and additionally installing CMSs on wind turbines is not always economically feasible. However, most of modern wind turbines are equipped with the Supervisory Control And Data Acquisition (SCADA) system which is recording 10-minute average values of parameters that depict operation of the turbine. That being said, SCADA data contains a vast amount of information that can be used for analysis of wind turbine components health. Therefore, this project will present an application of previously published methodology for SCADA data condition monitoring on real wind farm data. The goal of this project is to investigate on the possibilities of the SCADA monitoring methodology and what can be the added value of the application for wind farm operators, owners and other stakeholders.
The methodology for condition monitoring through SCADA data was applied on real data gathered from two wind farms in Germany and one in the Netherlands. During the project the methodology had to be modified in order to ensure the best possible industrial application. Results of the project showed that the SCADA data condition monitoring approach is not capable of predicting failures. However, the technique has been proven successful for detecting the changes of trends in dependencies of working parameters, specifically monitoring parameters related to the turbine generators. Continuously monitoring the dependencies of working parameters can be used as an additional source of information for maintenance scheduling and assessment of components health. The approach presented in this paper can be valuable to asset managers and wind farm owners.

Web site:

Short biography: My name is Bojan Alavanja and I am a recent graduate of Wind Power Project Management at Uppsala University, Campus Gotland.
My academic background is in electrical engineering with a focus on electrical power systems. During my bachelor studies I gained valuable knowledge regarding renewable energy sources, electrical machines, power transformers, electrical grid, etc. Subsequently, during my master studies I have been studying more broadly about technology, project management and economic aspects of wind power. I can confidently say that I have a broad knowledge regarding wind power development and a good understanding of wind turbine technology and the wind industry.
My master thesis project was based on wind turbine reliability and the key performance indicators of operating wind farms. Main goal of my master thesis was to develop a methodology for extracting valuable information about wind turbine health and performance, using available SCADA data and alarm logs. The project was driven by the fact that the majority of currently operating wind farms are not equipped with the advanced and expensive condition monitoring systems.

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Abstract #: 54 (Commercial poster), session 13_12

R&D areas/s: 01. Forecasting, cloud physics, aerodynamics, 02. De-/anti-icing including ice detection & control incl. standards, 03. Pre-construction site assessment, measurements, models and standards, 04. Operational experiences incl. performance optimization, produ

Detection of atmospheric icing conditions via cloud information

Juha Paldanius, Vaisala Oyj, Finland

Ville Lehtomäki (VTT, FI), Timo Karlsson (VTT, FI)

"One of the biggest obstacles wind projects in cold climates face is blade icing. Ice throw is an obvious health and safety hazard and thus its mitigation has been taken very seriously from the beginning. However, what is less understood is the impact of blade icing on production losses and how to anticipate these losses prior to project construction. While estimating blade icing certainly adds to the complexity of an already complex development cycle, further research is important as these events cause operators to lose millions of dollars each year. Here again, remote sensing technology may provide a tool to overcome this challenge.
Atmospheric icing is defined as the period of time where atmospheric conditions exist for the accretion of ice or snow on structures, which are exposed to the atmosphere, to occur. In general, the different types of atmospheric icing that impact wind turbine development are in-cloud icing (rime ice or glaze) and precipitation icing (freezing rain or drizzle, wet snow).
Icing process is divided into three categories: meteorological-, instrumental- and rotor icing. All of which are measures of time. Meteorological icing refers to the time during which meteorological conditions are favorable to icing, there is liquid water and the temperature is below zero Celsius. Instrumental icing refers to the time ice stays on the instruments (by definition an unheated cup anemometer) once it has started to form. Rotor icing refers to the time ice stays on the rotor blades once it has started to form. Due to differences in dimension, shape, flow velocity and vibrations, Instrumental icing is not equivalent of rotor icing.
Detection of favorable icing conditions can be done by detecting presence of liquid water and temperature. Obtaining temperature information is relatively straight forward but direct detection of liquid water content from air requires very expensive and complicated lidar system. Which has made people to look other alternatives for detecting icing conditions either direct detection of icing or developing models to forecast the phenomena.
Idea of using presence of clouds as a proxy for presence of liquid water was introduced few years ago by VTT. This study shows that reliable cloud measurement combined with temperature information provides good proxy of identifying icing conditions. In the study cloud base information was collected by using standard Vaisala CL31 ceilometer and icing alarms were created basis of ceilometer and temperature data. The icing alarms were compared to turbine instrumentation icing alarms and turbine SCADA data.
Results of the study show excellent agreement between overall cloud proxy icing data and true icing information also giving matching IEA ice classification of the tested sites. This validates the method of using cloud information as proxy to icing conditions. Time series comparisons of icing events show good agreement on specific icing events. The methodology needs further development to fine tune site parameters for best possible performance. But already as is it produces reliable and reproducible results about atmospheric icing.
"

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

Short biography: Short biography: Juha Paldanius has worked over 20 years on environmental and meteorological measurements globally. Over the past 10 years he has focused on weather information systems used by hydro-, wind-, nuclear– production and power transmission industries. Currently he works as application manager for surface weather instrumentation in Vaisala.

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Abstract #: 26 (Oral), session 13_14

R&D areas/s: 01. Forecasting, cloud physics, aerodynamics

Uncertainty quantification for wind power forecasts in cold climates

Jennie P. Söderman, Uppsala University, Sweden

Heiner Körnich (SMHI, SE), Anna Sjöblom (UU, SE), Hans Bergström (UU, SE)

Next-day forecasts of icing on wind turbines are needed for the estimation of wind power production and safe operations. The modelling chain for icing related production losses usually starts with a numerical weather prediction model. The forecasted meteorological parameters are then used as input to the icing model and further into the production loss model. The production losses are estimated from the icing intensity and ice load with an empirical model. These forecasts are uncertain owing to errors in the meteorological initial conditions and model formulations, in the employed ice growth models, and in the production loss models. Therefore, a sensitivity study is performed where we examine how sensitive the forecasted icing and wind power production are to changes in uncertain model parameters. Given the most sensitive parameters, we can construct an ensemble of icing and production models. We will use uncertainty quantification methods to create an improved uncertainty estimate for wind power forecasts in cold climate.

We will examine the performance of this setup for a case study during winter 2011/12. The mesoscale ensemble prediction system HarmonEPS, based on the numerical weather prediction model Harmonie/AROME is used for the meteorological parameters. The ensemble prediction system consists of 11 members and has been run for up to +42 hours for a two week period in the winter 2011/2012 with a horizontal resolution of 2.5 km over a Swedish domain of 1100x1600 km2. Observations from several Swedish wind farms are used to validate the performance of the forecasting setup.

Web site: http://katalog.uu.se/organisation/?orgId=X35:30

Short biography: PhD student in second year at Uppsala University in a project sponsored by the Swedish Energy Agency (Energimyndigheten).

BACK