Winterwind

INTERNATIONAL WIND ENERGY CONFERENCE

THIS YEAR

DANIEL GUSTAFSSON
WIND POWER IN SWEDEN

BLADE DAMAGE

DE-ICED BLADES IN ICING CLIMATES

ICING ALSO IN "WARM" CLIMATES

ROTOR BLADES
THE GEARBOXES OF THE FUTURE

Conference program **2016**

COLD CLIMATE WIND ENERGY SOLUTIONS

Editorial

t is with great pride that we welcome you to Åre. This is the eighth time that we arrange Winterwind, THE conference on wind power in cold climates.

Just over 15 years ago, in October 2000, I participated in the spectacular inauguration of Anja, Vesta's very first de-ic wind turbine, in Åre. Kallbygdens Ekonomiska Förening had invested in a Vestas V66 at Gråsjön. We have seen major developments since then, and large wind farms have been established in similar climates.

Cold climate environments are challenging for many, no less so for wind power. A constant identification of opportunities and the development of technology and innovations are keys to success. Yngve Bergqvist, founder of the Icehotel in Jukkasjärvi, once said: "If you can build an hotel of snow and ice in a village 200 kilometres above the Arctic Circle, which strikes the world with amazement, nothing is impossible". That may well be true.

In many parts of the world, the wind power industry has been hit by the economic crisis, just like all other industries – but the construction of wind turbines continues. Renewable energy is the future, and there will always be attractive sites for it. Many of those sites are located in cold climate areas. Not only does this pose great demands on technology and service, but it also affects the utilisation of capacity in such areas during winter. Nonetheless, those areas have great potential, with regard to both wind conditions and construction opportunities.

We aim to educate the industry and drive developments forward, to facilitate the roll-out in those areas. We will start by listening to the exciting speakers who have gathered here in Åre, and we hope that there will be many interesting meetings and an open dialogue. We also hope that you will leave the conference with new knowledge and expectations and full of renewable energy.

There are many reasons to feel optimistic about the future.

Jeanette Lindeblad
Chairman, Swedish Windpower Association

Content

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30 year Anniversary!

Swedish Windpower Association celebrates its 30-year anniversary, which we will celebrate in connection with the Annual meeting in Kalmar 12-13 May 2016.

We will begin on 12 May with a study tour to Kårehamn offshore park hosted by E.on and in the evening we have an anniversary dinner in Kalmar Salen. On May 13 we continue with an exhibition and conference sessions on the theme; Wind Power development in a 30 year perspective and focus on the future.

We offer exhibitions stands and sponsor packages!

Get a discount if you book our packages during Winterwind.
You'll find us at stand No 2, in the reception area. More info about the event and booking on our website. Invitations will be sent out to our members!

Welcome to celebrate Swedish Windpower Associations 30 year's anniversary!

Let's Connect!

Linkedin, is where you stay in touch with colleagues, clients and friends between conferences.

Facebook, here you'll find photos from the conference, discussions and trivia.

winterwind.se, at our website you can download the presentations and sign up for the Winterwind newsletter.

Instagram & Twitter, keep yourself updated **@WinterwindEvent**

World Wind Energy *Conference & Exhibition*

Every year World Wind Energy Association, WWEA, invites in cooperation with local Wind Energy Associations, the Windpower Community from around the world to join the World Wind Energy Conference. WWEC2016 takes place in Tokyo, Japan.

WWEC2017 in Sweden

WWEC2017 will be held in Malmö, Sweden, with Swedish Windpower Association as host. If you are interested in sponsor opportunities please contact Ulla Hedman Andrén at

ulla@svensk-vindkraft.org

Wallmans show

Expect the unexpected. Wallmans aim to surprise, entertain and exceed your expectations!

The show's stars, who will also be your waiters, will be your personal guides on a journey through decades of music, while you enjoy the flavors of a well composed surprise menu. Welcome to a sparkling night for all senses!

Check-in your Question for the final session!

Help us shape powerful questions for the Ask & Share* session!

At the final session we will gather Windpower Manufacturers for questioning. Take the opportunity to ask them a question - it can be something you are considering already or a matter that comes up during the conference days in Åre. Post your question at the bulletin board, and Check it out at the final session!
Keep an eye out for the check-in bulletin board at Holiday Club.

**Safe and reliable operation in cold climate conditions – today and in the future. 13.45–14.45 at Arena.*

Job Corner

Take the opportunity to present your company and the job opportunities that you offer, during Winterwind! As exhibitor or sponsor you have the possibility to present your company at the Job Corner. You will reach both senior professionals who are seeking for new challenges and students. The Job Corner is located in the reception area at Holiday Club. Send your vacancies to **info@svensk-vindkraft**

Note: Job ads must specify were/how to apply or a contact person incl. contact information, as we do not handle any documents at the booth.

We support Gula Båtarna, Yellow boats

We do not share any gifts to our presenters this year. Instead, we donate money to those who need it better, and this year the money goes to the Yellow boats that save lives on the Mediterranean.

http://gulabatarna.se

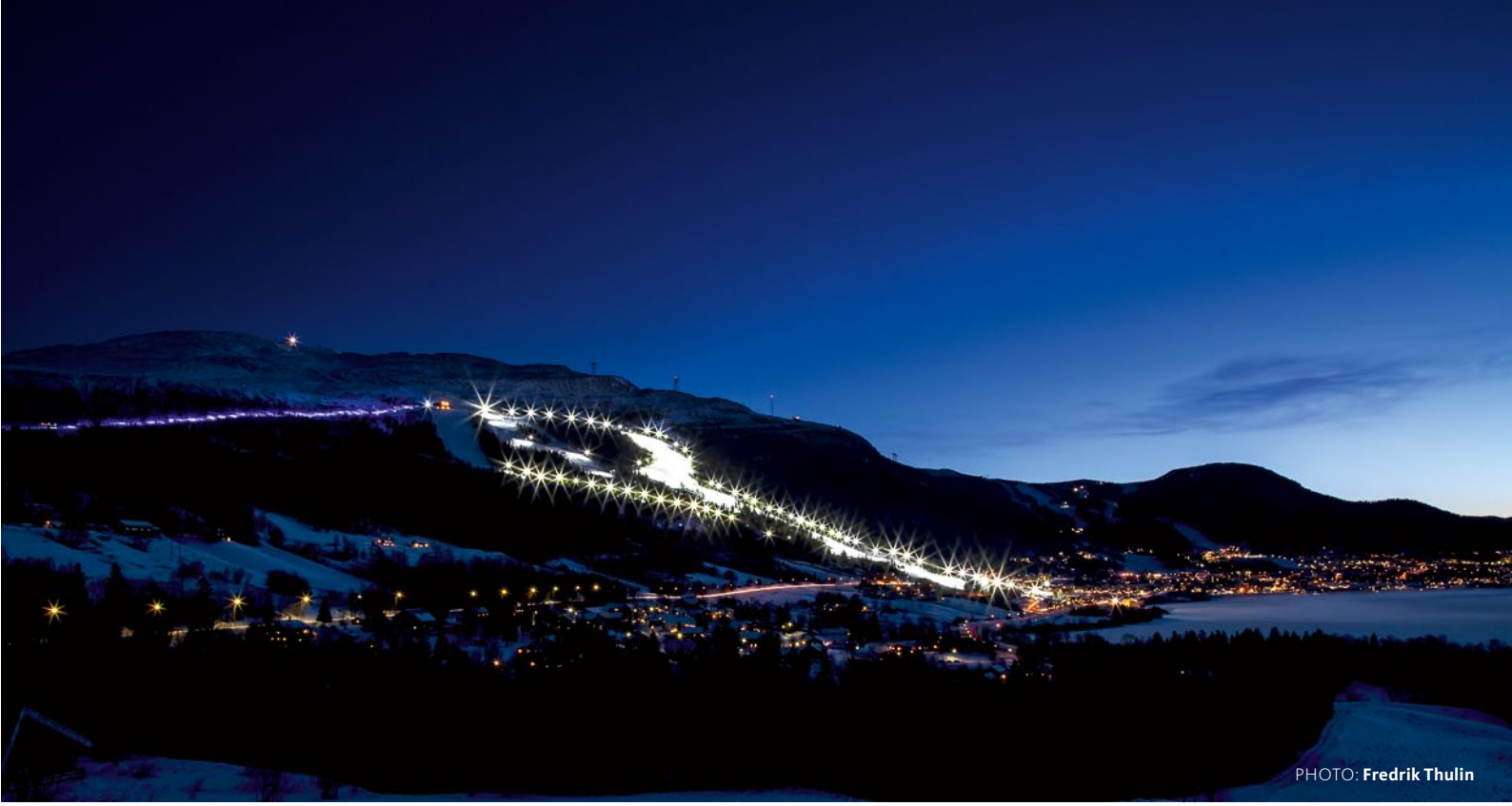


PHOTO: **Fredrik Thulin**

Why are we in Åre, at Winterwind 2016?

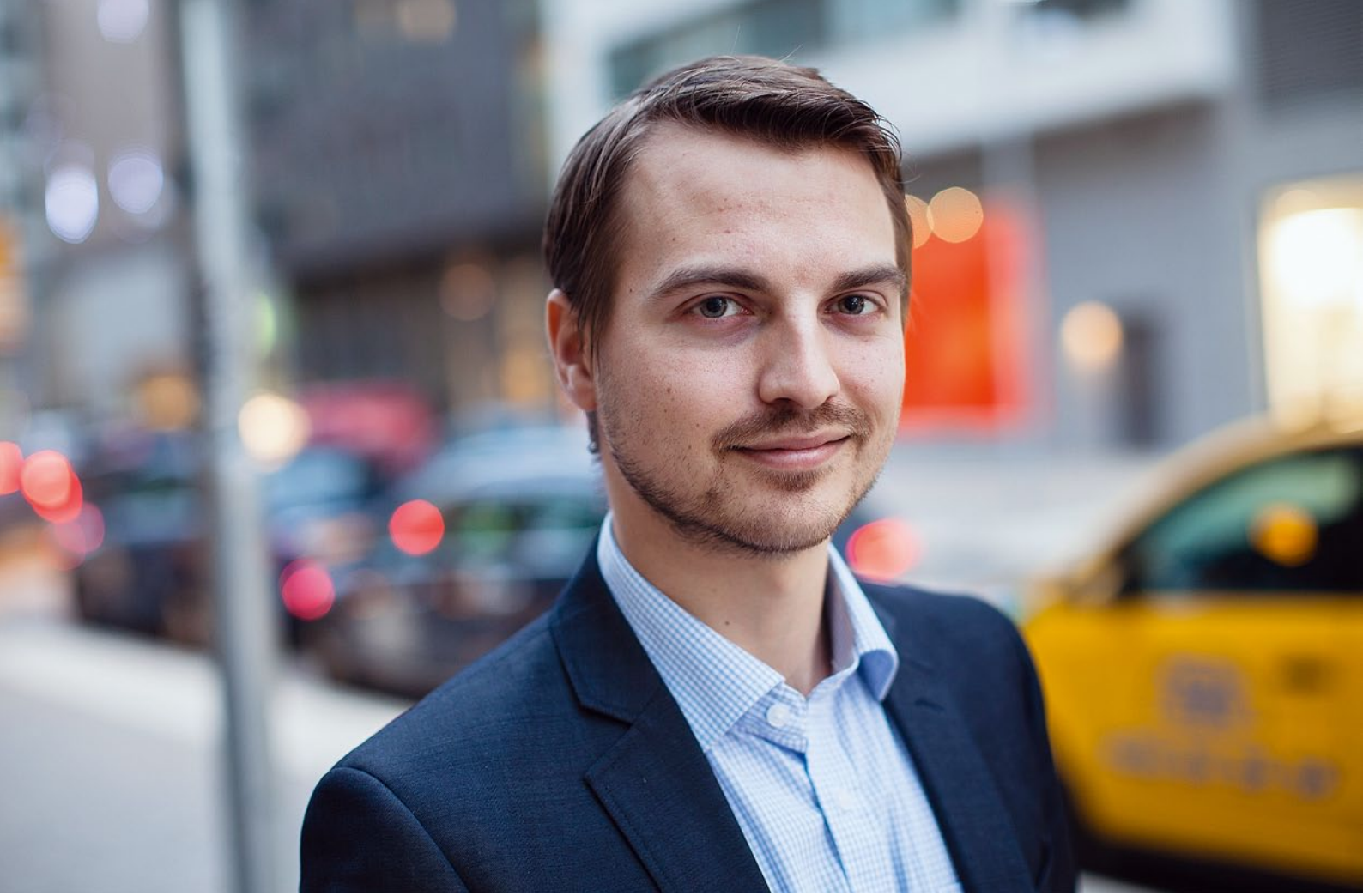
Boreas I, held in Finland 1992, was the first scientific wind energy conference dealing with icing and low temperatures. We've come a long way since and the industry can now provide adapted technologies to master the environments in some of the most demanding locations in the world. Wind Turbines have been deployed in deep frozen Antarctica, on the Alaskan permafrost and as large-scale installations in Canada, the US and Scandinavia. Working conditions for the staff servicing these wind turbines can be challenging. In Alaska's small turbines with lattice towers, the technician has a mere 15 seconds to fasten a bolt with one bare hand before it gets too cold. He'd better not drop the glove before climbing down.

In Antarctica, tubular towers provide shelter and facilitate access to the nacelle and blades. Drifting snow enters every unsealed opening. The Swedish Work Environment Authority has indicated a possible, forthcoming requirement to keep a temperature of at least 20°C in the blades during maintenance and repair work. While the industry might find this requirement surprising, challenging and even impossible to fulfil today, it ought to be feasible in blades equipped with hot air-based de-icing systems, where "only" power and airflow need to be limited.

Wind turbine blades have grown in size lately, thanks to research and development in design and materials. A large rotor diameter now enables a single, onshore wind turbine to produce in excess of 10 GWh annually at capacity factors from 35% and up. Active de-icing systems are readily available from many wind turbine manufacturers, and it's important to be aware of the capabilities and limitations of these systems. Hydrophobic coatings are intriguing. While the search for the holy grail continues, I've yet to see a study that shows a functioning, passive ice-repellent surface. In cold climates, the blades are exposed to accelerated erosion and falling ice and consequently need to be optimised, taking cold climate requirements into account. Thin shells in the vicinity of the leading edge are not ideal to withstand crushing forces, and heating foils make repairs more difficult, if not impossible during winter conditions.

Many cold climate challenges remain to be solved. Together, here at Winterwind 2016, we'll have a chance to improve the cost-efficient large-scale utilisation of wind energy in cold climates. ●

Göran Ronsten, Program coordinator Winterwind 2008–2016. On behalf of the Swedish Wind Power Association



With a sense for ice

In the doldrums. That's how Daniel Gustafsson describes the current situation for wind power in Sweden. As Vattenfall's project manager for wind power in cold climates, he still keeps his head cool.

TEXT: **Marie Feuk** PHOTO: **Alexander Ruas** TRANSLATION: **Johanna Liljenzin**

Icing of rotor blades, security issues and production losses caused by icing. Daniel Gustafsson faces plenty of challenges. The price on electricity plummeted in the last three years to the low levels of the 1990s, and investments in wind power declined significantly last year, but he isn't overly concerned about it.

– Despite of the current electricity price, Vattenfall will continue to invest, at the same rate and higher. The company has a long-term view of profitability, and the cost of building wind power has dropped.

The energy giant plans to invest SEK 50 billion on renewable energy sources over the next five years, according to its new strategic direction, says Daniel Gustafsson. It has a clear strategy that involves taking a leading role in the transition to a renewable energy system, by phasing out fossil energy production; coal-fired power plants will be sold and additional wind turbines will be built.

This long-term strategy aims to provide 15 terawatt-hours of wind energy per year by 2020, which is roughly double compared to 2015, according to Daniel Gustafsson. He is convinced that wind energy is the energy source of the future, especially in cold climates, despite the fact that the electricity price is so low at present that it has become necessary for some wind farms to make write-downs.

– The challenge is to produce wind energy at reasonable costs.

Even if the current investments in wind energy in the northern parts of Sweden are affected by icing – which has an effect on both production and safety – there is still great interest in investing in wind power in cold climates. Winter

is simply the best season for wind power. At low temperatures, the density and energy content of wind is higher, leading to increased energy production.

–Also, it's considerably windier in the winter. The colder it gets, the better the output from the power plants, if all other conditions are alike.

In 2008, as a technology student at KTH Royal Institute of Technology, Daniel Gustafsson wrote his master thesis at Vattenfall. The thesis dealt with measuring wind using sodar technology and verifying the measurements based on the results derived. Right after graduation, he was hired by the company as a wind analyst, a job that involved estimating the size of the production and which problems might arise in projects that Vattenfall considered purchasing.

It was challenging for the new graduate to begin his work on wind power in cold climates. According to Daniel Gustafsson, at the time when he was hired, no one had a good understanding of how climates subject to icing affected production losses in wind power plants.

–No one at Vattenfall had a decent method of calculating the effects of icing, and no consultants knew how to make assessments with limited uncertainty.

Eventually, Daniel Gustafsson got some help. At Vattenfall's electricity distribution, it had been established that icing caused relatively big problems in the area where the wind farm was located, indicating that icing in the area was linked to a clear risk of production losses.

–But it wasn't known at the time that icing in an average year causes a loss of approximately ten percent. There may even be times when the entire wind farm must be shut down due to icing.

Daniel Gustafsson has worked hard to make turbine manufacturers accept their share of the responsibility for icing, with the aim of limiting production losses to a few percentages. Siemens, which supplied the turbines to Vattenfall's wind farm Juktan, has also provided performance guarantees for the de-icing system.

Another cornerstone in addressing the problem with icing is cooperation with colleagues in other countries.

–We have a cooperation project with colleagues in the Netherlands, regarding ice detection. It involves special methods for measuring ice, from reviewing standardised turbine data to adding special vibration sensors in the blades.

Daniel Gustafsson's prime reason for accepting the job of finding solutions for wind power in cold climates wasn't only the excitement or the challenges involved in mastering the problems. His choice was based on his wish to help saving the world.

–Saving the environment is necessary for a tolerable life on earth. The western world must deal with climate refugees and flooding, and that's why I have this job.

His interest in technology and environmental issues arose already in secondary school. He became a vegan a few years back, not only for ethical reasons, i.e. not killing animals, but also because it's climate-friendly. He doesn't own a car, he doesn't consider himself to be a big consumer, and he tries to live as environmentally friendly as possible. His conscience is still made to suffer from time to time, as he can't completely avoid air travel – particularly not at work.

–But I try to take the night train whenever I can", he says.

Daniel Gustafsson doesn't hold a share in a wind turbine, but he is about to become a part owner in an altogether different wind project. Svarte Petter (Black Pete or "be left holding the baby") is a thirty feet sailing boat, and he is about to pay for his share in it.

–I like sailing, but I have no idea what model Svarte Petter is.

To allow wind energy to contribute to a fossil-free society, municipalities and county councils need to be more understanding, according to Daniel Gustafsson. Each time the permit for a new wind power plant is declined, conditions become harder and costs increase.

-It's our job to convince municipalities and county councils to give us reasonable permits and make them understand the effects of turning down wind energy.

According to Daniel Gustafsson, it isn't unreasonable to bring the whole world on-board the train to a society based on 100 percent renewable energy.

–Wind power is the key to phasing out of fossil energy until 2040. But we need the political will.

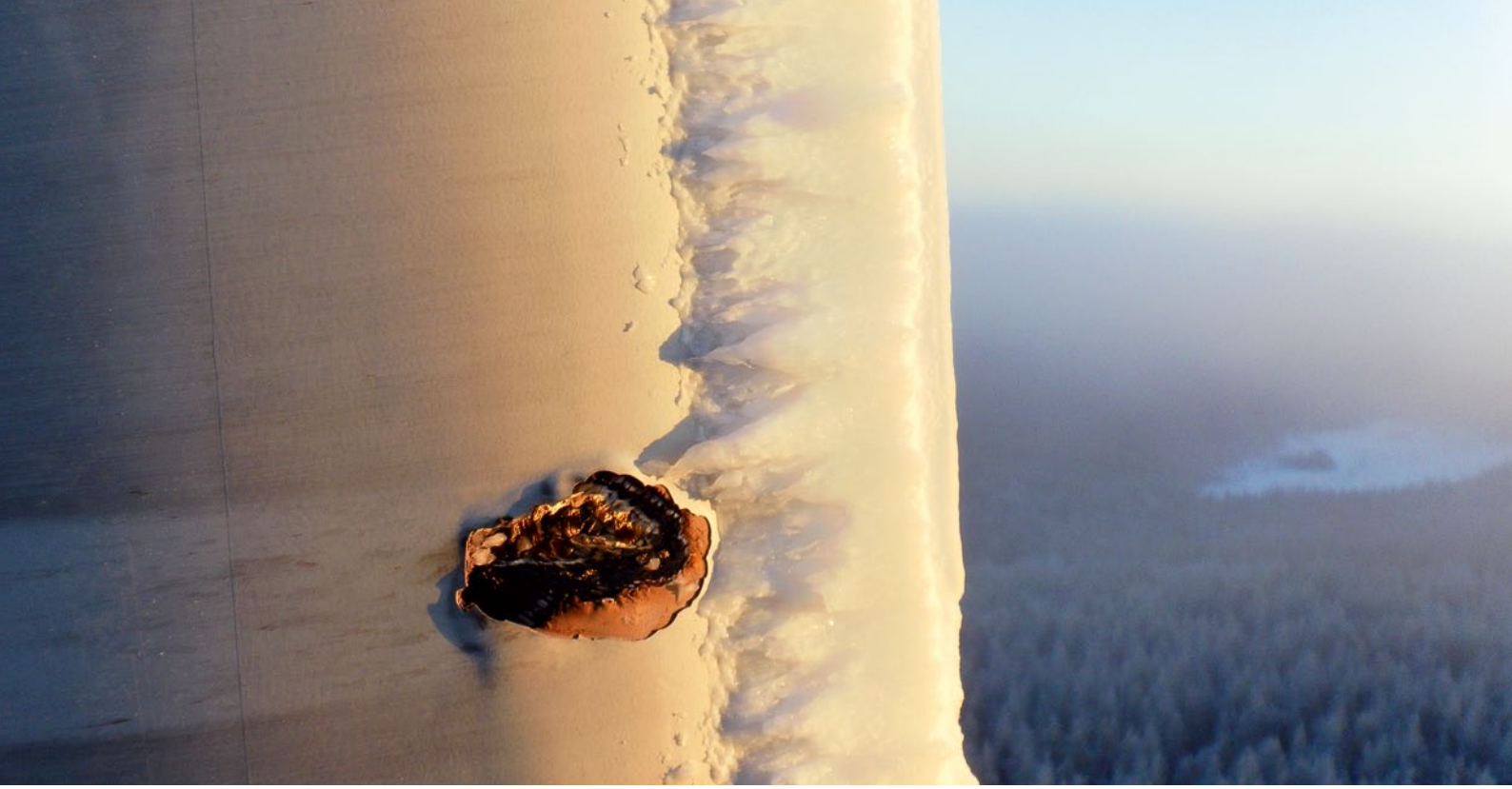
Otherwise, there is a risk that Daniel Gustafsson, and the rest of us, are left to deal with Black Pete (be left holding the baby). ●

PROFESSION
Project manager for the development of wind power in cold climates

CAREER
MSC from KTH Royal Institute of Technology in vehicle engineering, with a specialisation in energy systems. He was hired by Vattenfall in Solna seven years ago, right after graduation. He began his career as a wind analyst, which involved making calculations for projects that Vattenfall considered acquiring.

MARITAL STATUS
Cohabitation in a tenant-owned apartment on Kungsholmen in Stockholm. He doesn't hold a share in a wind turbine, but he purchases wind energy from Vattenfall.

AGE
30 years



How to detect blade damage

To detect damage to a turbine blade, you need to look carefully, either by being close to the blade or by inspecting it remotely, with a camera.

TEXT: **Jan Lothigus** PHOTO: **Greger Nilsson** TRANSLATION: **Johanna Liljenzin**

Like a mountaineer on a mountain wall, the blade inspector lowers himself down with rope and harness from the hub, down along the blade, which has been placed in a vertical position. This is called rope access, and it's a method that allows the blade surface to be inspected in search of defects, which can then be documented. The benefit of the method is that only minimal equipment is needed. But if the wind is more than moderate, it's better to await calmer weather.

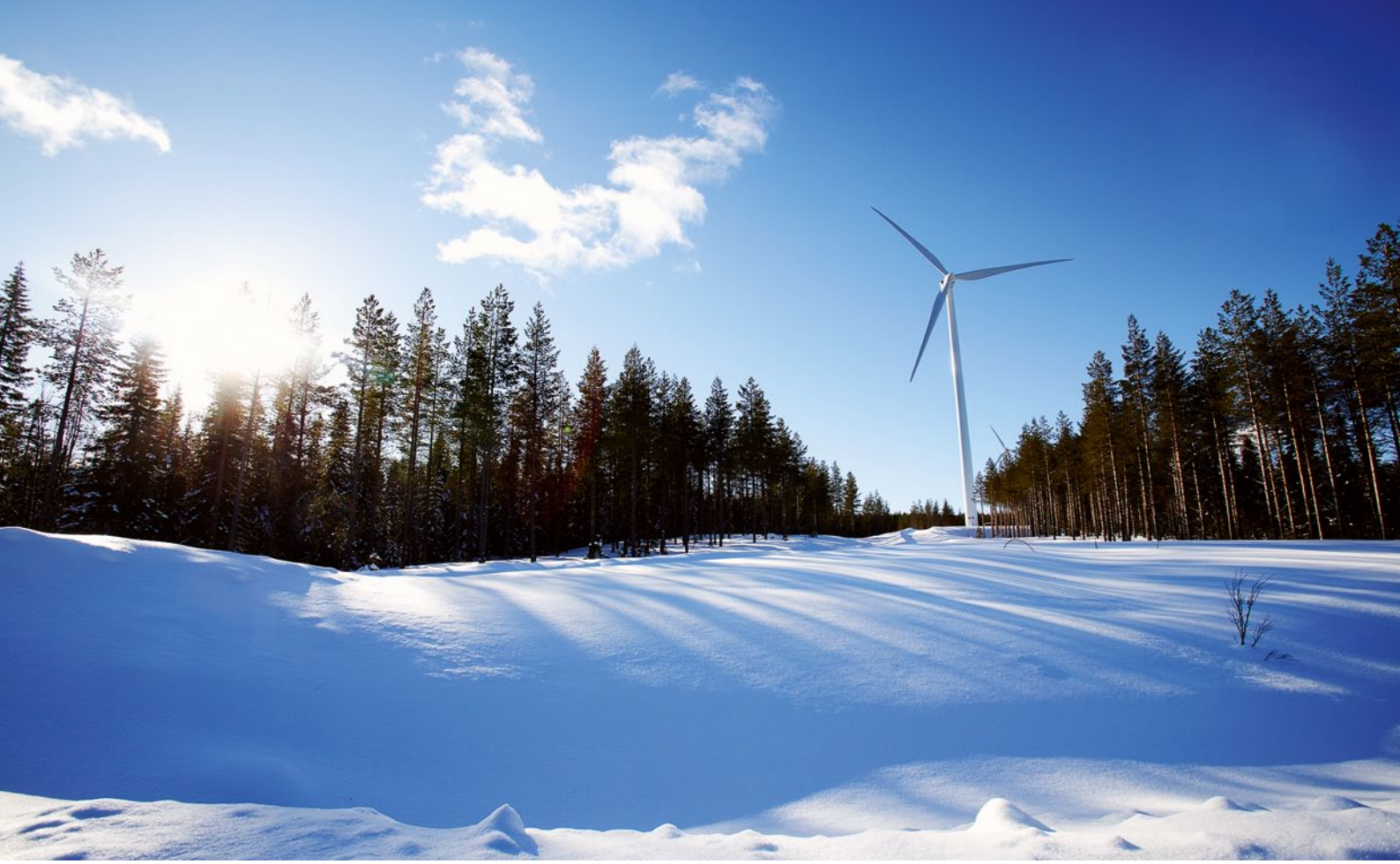
According to Jörgen Svensson at Skellefteå Kraft, rope access is unsuitable in cold weather, for safety reasons. If someone would get stuck up there on the rope, he risks freezing to death before it's possible to sort out the equipment needed to bring him or her down. Finnish Bladefence Oy, with Europe-wide operations, are specialised in blade inspections and repairs. They always use mobile aerial work platforms to reach the blades.

"In a cold climate, we always recommend repairing damage in connection with the inspection. If you wait, you risk that the damage propagates further. Repairs that would take one hour to carry out immediately may require a full day's work if you wait a year, says Ville Karkkolainen, Managing Director of Bladefence. "It's simple and cheap to inspect a turbine blade with a camera drone."

But if you find suspected damage, you still need to send someone up there in a rope or on a aerial work platform to inspect it. You might find that a bird has feasted on blueberries and left an imprint, says Thomas Mannelqvist, head of wind turbine maintenance at Skellefteå Kraft AB.

Braendler Engineering in Copenhagen, Denmark, has developed a system that makes it possible to photograph and analyse pictures of damage. The system allows for systematic follow-up on the status of individual blades over time, similar to when a dentist uses a computer to monitor a patient's dental status from one year to the next. Other information about the blade can also be recorded in the system, such as results from other forms of inspection and data regarding repairs that have been carried out.

Are there other methods for inspecting turbine blades? Yes, it's possible to establish the scope of the damage using ultrasound. According to Orla Sørensen at Blade Care Consulting in Esbjerg, Denmark, some blade defects can even be heard from the ground, when the blades sweep past. But it takes a trained ear to do so.



De-iced blades are a must in icing climates

There is great potential for wind power in cold climates, but icing on turbine blades is a major problem. Icing reduces the production of power, and several methods are therefore being developed to remove ice and prevent it from forming.

TEXT: **Jan Lothigius** PHOTO: **AnnaKarin Drugge** TRANSLATION: **Johanna Liljenzin**

With 126 wind turbines, Skellefteå Kraft AB is one of the largest operators of wind power in cold climates. According to the company's estimates, it would have lost up to 40 percent of the production between October and April without de-icing systems.

In Norrland in Northern Sweden and in the northern parts of Finland and Norway, icing of wind turbines is a considerable problem. But icing also appears and causes production losses further south. There are several methods for addressing the challenges caused by icing.

Vestas has chosen to carry out de-icing by blowing hot air through channels in the turbine blades. The turbine's monitoring system notices when the actual energy production deviates from the expected production (wind speed, power, temperature, etc). A certain deviation is accepted, but if the production loss is expected to exceed the loss during a de-icing stoppage, the de-icing process is initiated. The rotor stops and hot air is blown through the blades, one at a time. The de-icing process takes approximately two hours.

Nordex and Siemens have chosen solutions primarily aimed at preventing icing: carbon fibre mats embedded in the front edge of the blades are heated using electricity. The de-icing process is activated when a measuring instrument

on the nacelle indicates that there is a risk of icing.

Chinese Dongfang Electric Corporation uses a combination of front edge heating and hot air blown through the blades. Dongfang's turbines differ from the Vestas turbines in that they can be heated with hot air also during operation. But functioning de-icing systems do not only involve heating – it also matters how the heating is controlled, which surface coating has been used on the blades, and if it's possible to operate the turbine in a way that allows the blades to shake off ice.

Gamesa**,** another major manufacturer of wind turbines, has also developed a system built to withstand cold climates. This system has been tested in a wind turbine in Torneo in Finland.

Gamesa has developed a patented surface treatment based on nano technology that supposedly makes it more difficult for ice to stick on the surface. Like Dongfang, Gamesa has systems for blowing hot air (with 80kW heat power) in the blades combined wtih electrical heating of the front edge of the blade. The company has also developed a system for optimal operation even if a certain amount of ice has formed, by adapting the pitch of the blade. By changing the pitch, it's possible to remove ice also from other parts of the blades than the front edge.

The inspection and maintenance of turbine blades in cold climates is subject to particular challenges. The blades risk damage from falling ice, and the de-icing system may also suffer damage that must be repaired. And this is in addition to the type of damage to turbine blades and need of measures that also affect wind turbines located in the south.

Thomas Mannelqvist is head of wind turbine maintenance at Skellefteå Kraft. Typical damage to the blades involve damage from lightning, impact – most likely from falling ice –, cracks in joints and shearing next to the root of a blade. But it's rare that damage to the blades is so severe that the operation must be stopped. Most repairs can therefore be carried out in the summer, when the weather is fair and the low energy price-mitigates the cost of production losses.

If required, certain repairs can still be carried out in cold weather – if it isn't too cold. Carbon fibre mats are mostly subject to impact (from falling ice) and damage from lightning. Damage from an impact on the front edge may cause the heating mat to generate heat unevenly, giving rise to hotspots. Too much heat in one place can damage the underlying epoxy composite, so it isn't possible to use the de-icing system in case of a potentially harmful hotspot.

In collaboration with Skellefteå Kraft, the company Blade Solutions has developed a method to repair the carbon fibre mats used to heat the front edge of the blade. The repairs restore the carbon fibre mat and its conductive capabilities, so that the heat is evenly distributed over the entire surface.

Greger Nilsson, the head of Blade Solutions, explains that it's possible to repair damage using composites and epoxy, cured by UV light, also in cold weather. Greger Nilsson and his colleagues can carry out such repairs hanging in ropes from the hub. A stroke of lightning in a turbine blade can also damage the heating mat. Even if the blade contains a lightning conductor, the energy from the lightning may still find its way through the conducive heating mat. One comfort is that thunderstorms are considerably less common to the far north, compared to Southern Europe, for example.

How ice is formed

Certain combinations of temperature and atmospheric humidity cause ice to form on the front edge of the blade. This appears mostly in temperature zones ranging from +3 to -7°C (yes – even above zero!). Ice formation also depends on atmospheric humidity, the presence of drops of water, the size of such drops and several other factors. The ice destroys the effective laminar flow of air around the blade, thus reducing the power of the wind power plant, which in some cases must be shut down completely.

Ice can also form on the trailing edge, but this doesn't affect the functionality of the turbine to the same degree. Ice can also form on other parts of the blade, such as when a de-icing system causes ice to melt on the front edge, or when the turbine stands still. If ice is distributed unevenly on the turbine blades, imbalances may also cause the plant to shut down.

TECHNOLOGY AT THE FOREFRONT

At the Frauenhofer Institute IPA in Stuttgart, the next generation system for the prevention of ice formation on turbine blades is under development, with financing from the European Union's framework programme for research and development. The de-icing system aims to prevent icing so quickly and efficiently that there is no timefor ice to form.
Such a system, if and when it can be commissioned, will have two main benefits:

- Power production can continue, without production losses, as the blade's aerodynamic properties remain intact
- The risk of damage to the blades and the de-icing system caused by falling ice will be eliminated.

Several tiny detectors will be placed along the front edge of the blade. As soon as a detector indicates that ice has formed, that specific part of the front edge will be heated. The heating mats will be built of electrically conducive layers of carbon nanotubes, that are only a few micrometres thick.

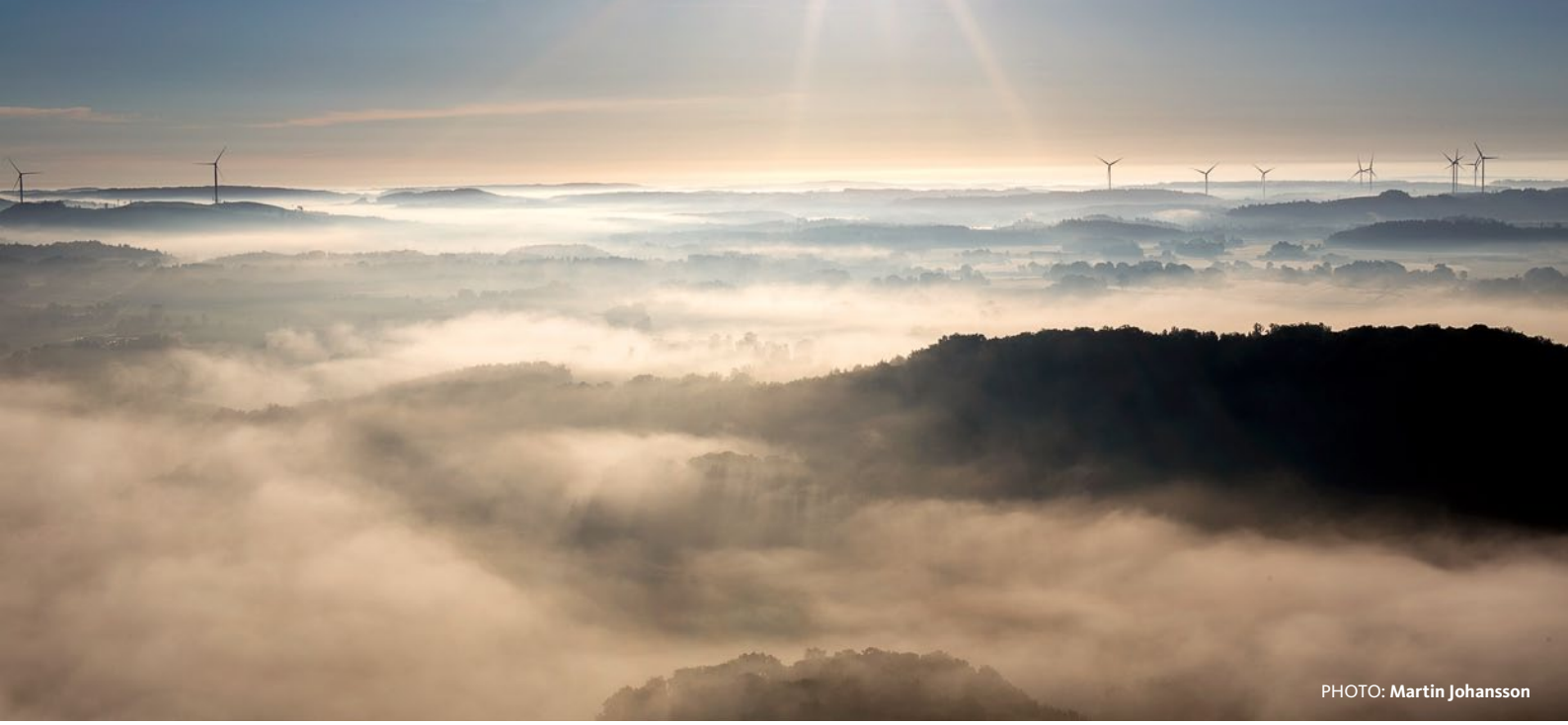


PHOTO: **Martin Johansson**

Icing also in "warm" climates?

Icing of wind turbines mostly occurs in clouds, when supercooled droplets of water hit the leading edges of the blades and form ice that attach to the surface. The power output decreases, the noise increases and the surroundings get risky.

Today most manufacturers offer equipment for "de-icing" and "anti-icing". The former means simply deicing of wind turbine blades, normally at stand-still. In the latter case, the equipment keeps the blades of an operating wind turbine free from ice. Methods generally in use today utilize heat, either from electrical resistive heating elements embedded in the blade surface or from an electrical heating blower, circulating hot air inside the blades.

A functioning method for the indication of ice is to continuously compare actual power with the normal power at that wind speed. Another method, claimed to be faster by the originator Bosch Rexroth, is to monitor the eigenfrequency of the turbine blade. Some hundred kilogram's of ice covering the surface of a turbine blade will lower the frequency, according to the basic laws of physics. This can be measured by using accelerometers inside the blades. In this way, it is also possible to detect ice on a wind turbine in stand-still.

There is a general rule of thumb for calculating the maximal distance for the risk of being hit by ice thrown from an operating wind turbine. That is to multiply the sum of hub height and turbine diameter with a constant of 1,5. In one case the maximal distance was calculated to be 300 meters. The probability for a person to be hit at that distance was one in 40 million years. Close to the tower the probability increased to one in 40 years. So far there is no reported case of any human being hit by ice from a wind turbine, although it is known that cars have been damaged.

The general opinion so far has been that challenges associated with icing of wind turbines appear in the Swedish inland, approximately from Dalarna and northwards, especially in hilly terrain.

A new mapping produced by Kjeller Vindteknikk discloses a slightly different picture: the highest risk (more than 5 per cent of the time) appears on the highest mountain ridges of the Scandinavian mountain chain and on the northern inland ridges. But the mapping also reveals that there is a 3 per cent risk of icing (10 days per year) in large areas of southern Sweden and in the remainingnorthern inland.

This means that problematic icing may occur in larger areas than hitherto anticipated. In addition, the wind turbines increase in height, making them spend more hours in clouds, with more icing as a consequence.

Today there are Swedish operating wind turbines reaching a height of 200 meters, and turbines of 240 meters that emerge on the drawing board. Yearly losses of 20 per cent have been reported.

This icing of turbine blades may appear to be a problem for the majority of future, ever-growing wind turbines. Also at sites where the risk earlier was deemed to be quite small. ●

ABOUT THE PRESENTER

Staffan Engström, consultant has been in the wind turbine business since 1975. Author of "The Story of Swedish Wind Power" (in Swedish), ISBN 978-91-7611-109-3

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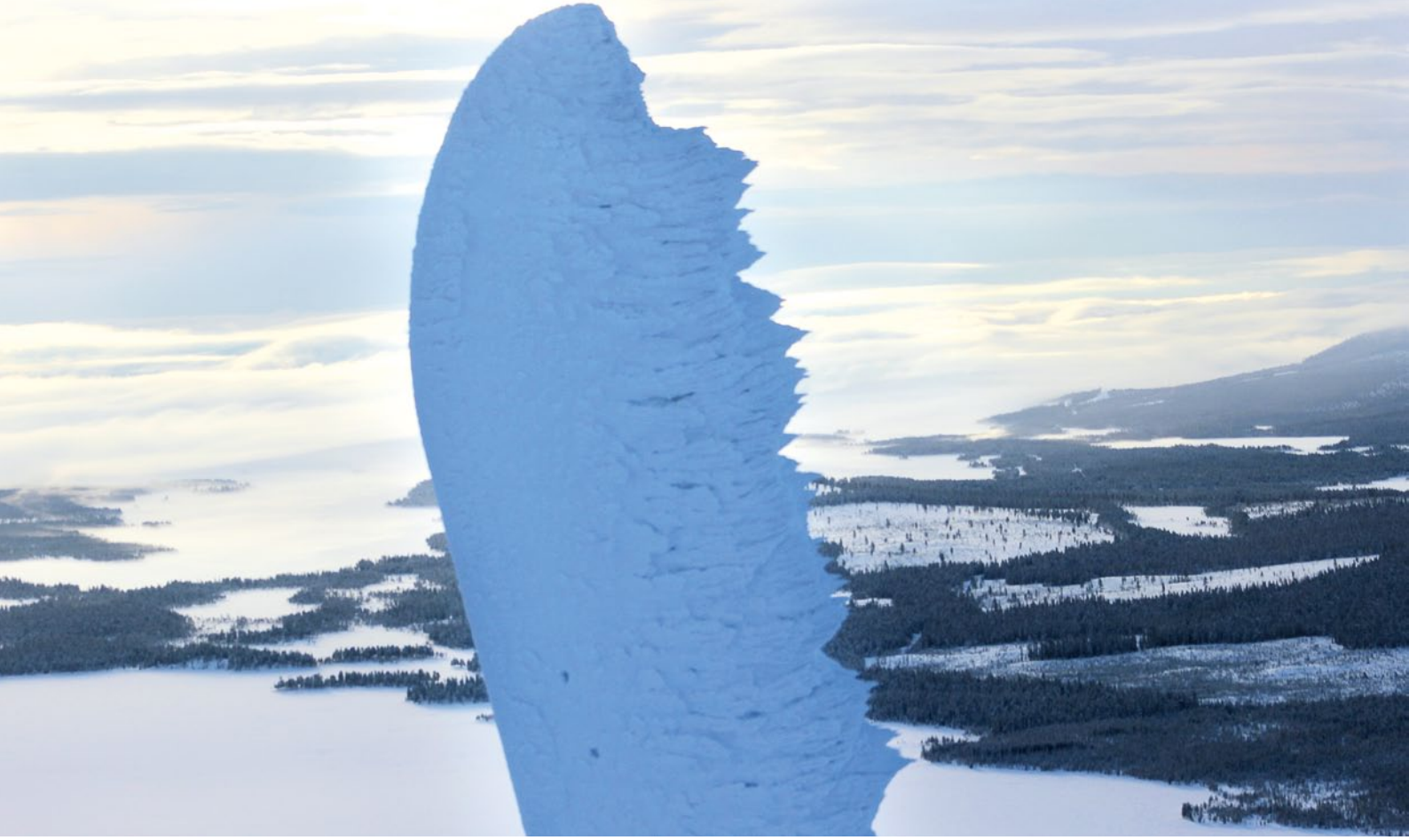

Rotor blades

– the gearboxes of the future?

For 25 years, wind turbine gearboxes have been a cause for concern for owners and insurance companies alike.

TEXT: **Göran Ronsten** PHOTO: **Hans Gedda** TRANSLATION: **Johanna Liljenzin**

Turbines equipped with gearboxes have a lower acquisition cost compared to turbines with direct drives, but the repair and replacement of gearboxes entail significant one-off costs. Also, unplanned replacements often cause long standstills, with ensuing production losses.

Blades must not be optimised without regard for operations in cold climates

We now see signs that blades may rival gearboxes as the single most expensive component from a repair and maintenance standpoint. A reason for this is that the increasingly long blades have been optimised without due consideration for cold climate conditions. The leading edges of the blades erode more when precipitation takes solid form, and many of the new blades used in cold climates have too thin a shell. They simply can't withstand falling ice.

Minor blade damage may require extensive repairs

Seemingly minor blade defects must be sanded up in size to ensure exposure of a sufficiently large area – for example, 4 cm – of each damaged layer, and of the innermost unharmed layer. If a small defect penetrates to the tenth layer, over 40 cm may need to be exposed in the most critical directions. The repair may be as long as one metre, but depending on the local load distribution, it may not be as wide.

Repair methods must be improved

Blade repairs currently require a minimum surface temperature of +5°C. Consequently, only minor blade repairs, where the blade surface can be heated locally, can be carried out in late autumn, winter and early spring. Minor repairs can be carried out with workers suspended from

ropes. Some major repairs require the work to be carried out on a platform. The most extensive repairs require the blade to be removed or even replaced.

De-icing is necessary for a variety of reasons

The first large Swedish wind farms in a cold climate were built in 2004 (Råshön) and 2005 (Aapua). The blades are not equipped with de-icing systems, so the farms sometimes stand still for weeks on end due to icing on the blades.

Competition harms collaboration

The wind power industry is young and competition has lead to increasing confidentiality. Far-reaching collaboration on safety issues, such as seen within the transport sector, has only partially reached the wind power industry. There is no public reporting on breakdowns, incidents and accidents, unlike in public transport in general and air travel in particular. There used to be no collaboration at all on the dimensioning of wind power plants in cold climates, until recent years, as the latest revision of the standard on the design of wind power plants, IEC 61400-1 is about to be adopted. Unfortunately, proposals for stricter requirements that would benefit the end customers have often been opposed by manufacturers, as they may lead to costs in the short term.

Standardisation efforts are important

Sweden only participates in the work on the international IEC standards for wind power in exceptional cases. Before the deployment of wind power gained momentum, after the adoption of the country's first wind power bill in 2006, standardisation work was in part publicly funded. If you take it to the extreme: Each individual foreign manufacturer engaged by a Swedish or foreign wind power developer for the construction of wind turbines and large wind farms must currently devise unique solutions, as no requirements are included in the standards. For example, the future standard for wind farm optimisation, IEC 61400-15 "Site energy yield assessment", has received no Swedish funding. In an ideal world, manufacturers would use the standardisation work to defend their patents, just like they do in the telecom, vehicle and pharmaceutical industries. Sweden has no manufacturers of its own, and other Swedish players within the wind power industry will not fund standardisation work, unless Vattenfall is tasked with this in its next appropriation directions.

Blades become increasingly advanced, leading to increasingly difficult and expensive repairs

Ever since the financial crisis in August 2008 (but not before then), manufacturers have had to listen to customers' requests for adapting wind turbines to climates affected by icing. These days, most manufacturers can supply blades with de-icing systems. The two methods currently used are either based on a heated foil or on hot air circulated in the leading edge of the blade. For blades equipped with heated foil, special, and therefore more expensive, repair methods are required to repair the foil and electrical joints under the blade surface.

The foil, which rapidly heats the surface of the blade alone, should at sufficient power density be capable of handling severe icing, while consuming little energy. The hot air solution, which requires the heating of a larger part of the blade, is more energy-intensive and cannot handle as severe icing as the foil.

Hot air has three advantages: (a) the tip of the blade, which is often hit by lightning, can be de-iced; (b) there is no need to modify the material of the blade to make the leading edge conducive; and (c) lightning damage is no more expensive than usual to repair.

Blade heating based on circulating hot air has two disadvantages: (d) the highest temperature that the blade can be exposed to, combined with the slow heat transfer from the inside to the outside, limits the de-icing abillity; and (e) when a large part of the blade is heated, this may cause self-induced icing, if dry snow melts and refreezes on the blade. ●

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[1] The cost of gearboxes is primarily driven by the torque that each step of the gearbox is designed for. As the first step in a gearbox takes approximately 70% of the torque, single step gearboxes as used in Multibrid (in Sweden, WinWind) are not that much cheaper than conventional gearboxes, which can be used with conventional generators.
In addition to the risk of ice throw, rotor blade icing may also cause noise levels to rise by 10 dB(A).

MONDAY 8 FEBRUARY - OUTSIDE SESSION ROOMS

8 FEB

11.00–20.00

Site visit to Mullberget
Hosted by: Mullbergs Windfarm and Siemens

19.00–21.00

Registration
Stand & poster set up

TUESDAY 9 FEBRUARY

9 FEB

08.00–10.00

Registration

10.00–11.30 SESSION 1

ARENA

Inauguration and keynote presentations

Chairs: Jeanette Lindblad and Göran Ronsten

- **North Asia driving the wind industry**
  Sebastian Meyer, Azure International, CN
- **The European Commission's "WinterPackage" and the latest developments regarding cooperation and market integration of renewable energy**
  Dörte Fouquet, BBH, EREF, DE
- **Moving forward in a frosty market**
  Daniel Gustafsson, Vattenfall Wind Power, SE

11.30–13.00 LUNCH & EXHIBITION

12.30–12.55 POSTER PRESENTATIONS

01. **Reliable ice detection for rotor blades to increase availability and yield of wind turbines** — Bernd Wölfel, Wölfel Wind Systems, DE
02. **In Situ Instrument AB - your overall partner when it comes to measuring wind in any environment —** Emil Lindblom, In Situ Instrument, SE
03. **Airborne de-icing solution for wind turbines** — Hans Gedda, Alpine Helicopter, SE

13.00–14.30 SESSION 2

ARENA

Forecasting, cloud physics, aerodynamics

Chairs: Anna Coulson Sjöblom and Hans Bergström

- **Benchmark study of icing forecasts. Do they really add a value?**
  Ben Martinez, Vattenfall R&D, SE

SOLSKOG

HSE (Health, Safety and Environment)

Chairs: Ylva Odemark and Dag Haaheim

- **Integrated approach to safety and asset performance in cold climates**
  Arve Sandve, Lloyd's Register Consulting, NO

SNÖJUS

Inspection and repair

Chairs: Helena Wickman and Sven-Erik Thor

- **Assessing the likelihood of hail impact Damage on Wind Turbine Blades**
  Hamish Macdonald, University of Strathclyde, GB

- **Ice detection methods and measurements**
  Matthew Wadham-Gagnon, TechnoCentreéolien, CA
- **Towards validation of microphysics schemes in numerical weather prediction models for icing applications**
  Magnus Baltscheffsky, WeatherTech Scandinavia, SE
- **On-site measurement from cold Climate - possibilities and applications towards validation of CFD model**
  Marie Cecilie Pedersen, Vattenfall Vindkraft, SE

- **Uncertainty quantification for wind power forecasts in cold climates**
  Esbjörn Olsson, SMHI, SE
- **IceRisk forecast system for operational wind farms**
  Rolv Erlend Bredesen, Kjeller Vindteknikk, NO

- **Blade heat system repair, part II**
  Greger Nilsson, Blade Solutions, SE
- **Quantifying the impact of ice accretion on turbine life for typical Scandinavian sites using numerical modelling**
  Ricard Buils Urbano, DNV GL - Energy Advisory, GB

14.30–15.30 BREAK – POSTER PRESENTATIONS & EXHIBITION

04. **Optimizing wind and icing** — Case Finland, Simo Rissanen, VTT, FI
05. **Cost effective system for ice throw detection** — Najeem Lawal, Mid Sweden University, SE
06. **A study of maintenance performance indicators for the European offshore wind farms in cold climate regions** — Mahmood Shafiee, Cranfield University, GB

15.30–17.00 SESSION 3

ARENA

Resource assessment, measurements and models

Chairs: Katja Hynynen and Ben Martinez

- **An experimental study on the use of nanosecond-pulsed dielectric barrier discharge plasma actuators for de-icing of aerospace structures**
  Jakob Van den Broecke, Delft University of Technology, NL
- **Frozen anemometers and bias in the wind resource**
  Lasse Johansson, Sweco, SE
- **Mast measurements in cold climate challenges and recommendations**
  Sónia Liléo, Sweco, SE
- **New advances in icing measurements and icing predictions,**
  Øyvind Byrkjedal, Kjeller Vindteknikk, NO

SOLSKOG

De-/anti-icing including ice detection &control

Chairs: Marie Cecilie Pedersen and Till Beckford

- **Wet-snow production and snowing wind tunnel test for snow accretion and prevention**
  Kengo Satoh, Snow and Ice Research Center,National Reserch Institute for Earth Science and Disaster Prevention, JP
- **Prediction of production losses in cold climates and ice protection system design by computational fluid dynamics**
  Massimo Galbiati, EnginSoft, IT
- **Assessment of de-icing and anti-icing technologies in ice wind tunnel**
  Nadine Rehfeld, Fraunhofer IFAM, DE

SNÖJUS

IEA TASK 19 & PANEL DISCUSSION

Chairs: Carla Ribeiro and Sebastian Meyer

- **Overview of IEA wind Task 19 results from 2013-2015**
  Ville Lehtomäki, VTT, FI
- **IEA Task 19, standardised methodology for the elaboration of the ice throw risk assessments**
  Andreas Krenn, Energiewerkstatt, AT
- **Validation of the IEA Task 19 ice site classification**
  René Cattin, Meteotest, CH
- **Classification based approach for Icing detection**
  Zouhair Khadiri-Yazami, Fraunhofer IWES, DE
- **Panel discussion:** What should IEA Task 19 take into account when working with the new draft standard IEC 61400-15 "Site energy yield assessment" in 2016-17?
  Ville Lehtomäki, VTT, FI

17.00–19.00 MINGLE IN EXHIBITION HALL

19.00– DINNER AND ENTERTAINMENT NOTE. WALLMAN SHOW STARTS AT 7PM

WEDNESDAY 10 FEB

10 FEB

08.30–10.00 **SESSION 4**

ARENA

Strategier EM/Vattenfall/Canada

Chairs: Ville Lehtomäki and Jos Beurskens

- **A Look at wind turbine performance in Canadian icing climate**
  Dominic Bolduc, TechnoCentre éolien, CA
- **The Swedish Energy Agency strategy within wind energy,**
  Pierre-Jean Rigole, Swedish Energy Agency, SE
- **An overview of Vattenfall's research within turbine icing – Yesterday, today and tomorrow**
  Ylva Odemark, Vattenfal, SE

SOLSKOG

De-/anti-icing including ice detection & control

Chairs: Nadine Rehfeld and Matthew WadhamGagnon

- **An approach in using guided waves for ice detection on wind turbines**
  Siavash Shoja, Chalmers University of Technology, SE
- **Combined effect of the heating and the superhydrophobic coating on the deicing capability of the ultrasonic wind sensor**
  Tomofumi Saito, Kanagawa institute of technology, JP
- **Performance of two nacelle-mounted ice detectors: a case study**
  Katja Hynynen, Lappeenranta university of technology (LUT), FI
- **Wind turbine ice detection systems testing**
  David Futter, Uniper Technologies Ltd, UK
  Real-World icing distribution analysis based on data from surface sensors
  Michael Moser, eologix sensor technology, AT

10.00–10.30 **BREAK - POSTER PRESENTATIONS & EXHIBITION**

07. **Ice detection via advanced infrared image analysis —** Mikko Tiihonen, VTT, FI
08. **Monitoring systems for harsh climate —** Patrik Jonsson, Combitech, SE
09. **Recent development on blade mounted and nacelle mounted ice detectors, —** Tatu Muukkonen, Labkotec, FI

10.30–12.00 **SESSION 5**

ARENA
Production experience, losses

Chairs: Rebecka Klintström and Jakob Van den Broecke

- **Update of DNV GL's empirical icing map of Sweden and methodology of estimating icing losses using further Nordic wind farm data**
  Till Beckford, DNV GL, GB
- **Methods for estimation of occurred icing losses in operational wind farms, measurements and modelling**
  Johan Hansson, Kjeller Vindteknikk, SE
- **A roadmap for understanding the performance of numerical weather prediction based models for predicting long-term wind farm production losses due to ice accretion on blades**
  Daran Rife, DNV GL, US

SOLSKOG
DOM (Deployment, Operations and Maintenance)

Chairs: Sónia Liléo and Andreas Krenn

- **Swedish Wind Energy Association's view on wind energy in cold climates**
  Bengt Göransson, Dag Haaheim, Pöyry Sweden AB, SE / Statkraft Sverige AB, SE
- **Forecasting wind turbine icing: the value of icing forecasts trading on the day-head energy market**
  Jon Collins, DNV GL, GB
- **Applications of iced wind turbine noise simulations**
  Richard Hann, Richard Hann Consulting, DE

SNÖJUS
Standards and Offshore

Chairs: Anne Mette Nodeland and René Cattin

- **Validation of icing atlases based on SCADA data**
  Timo Karlsson, VTT, FI
- **Pre-certification of cold climate instruments and coatings**
  Tuomas Jokela, VTT, FI
- **Simulations of drifting sea ice loads on ofshore wind turbine support structures**
  Simo Rissanen, VTT, FI

12.00–13.30 **LUNCH & EXHIBITION**

13.00–13.25 **POSTER PRESENTATIONS**

10. **Decommissioning of wind farms – ensuring low environmental impact —** Liselotte Aldén, Uppsala University, SE
11. **Doing a meso-scale re-analysis using the WRFmodel – does it matter for the resulting icing climatology which version of WRF you use? —** Hans Bergström, Uppsala University, SE
12. **Determination of the actual ice mass on wind turbine blades; Measurements and methods for avoiding excessive icing loads and threads —** Daniel Brenner, Bosch Rexroth Monitoring Systems (BRMS), Dresden,DE

13.30–15.00 **SESSION 6**

ARENA – PANEL DISCUSSION AND SUMMARY
Safe and reliable operation in cold climate conditions – today and in the future

Chairs: Åsa Elmqvist and Anders Järvelä

Five short presentations prior to panel discussion

- **ENERCON. Experiences with wind energy turbines in icing conditions**
  Anne Mette Nodeland, ENERCON, DE
- **Vestas cold climate offerings to cope with icing conditions**
  Brian Daugbjerg Nielsen, Vestas, DK
- **Siemens. Improving output in harsh conditions**
  Annike Skovgaard Sørensen, Siemens Wind Power, DK
- **Nordex anti-icing system on N131 wind turbines – development and validation**
  Andreas Beyer, Nordex Energy, DE
- **Dongfang experience in low temperature wind turbine de-icing**
  Honghua Zhong, Dongfang Electric Corporation, CN

- **Summary (assisted by Jos Beurskens and Sven-Erik Thor)**
  Daniel Gustafsson, Dörte Fouquet, Vattenfall, SE/BBH EREF, DE

Meet our Exhibitors

Some of the industries most interesting companies ranging from contractors, operators and specialists – all eager to show their latest innovations.

Vattenfall AB – Powering the transition to renewables. Climate change associated with greenhouse gas emissions is seen as the greatest environmental challenge facing humanity. Today's energy system is a large contributor to overall emissions of greenhouse gases. Our strategy: To be among the leaders in developing environmentally sustainable energy production by reducing the company's CO_2 exposure and transforming the production portfolio towards more renewable production.

The Swedish Energy Agency works for a sustainable energy system, combining ecological sustainability, competitiveness and security of supply. The Agency finances research for new and renewable energy technologies, smart grids, and vehicles and transport fuels of the future. The Agency supports commercialization and growth of energy related cleantech.

STV is manufacturing tracked vehicle for heavier loads that is perfectly suitable for service and maintenance at the wind mill park. These types of tracked vehicles are extremely suitable in sensitive environments, and can be used on both bare ground, marshes, swamps and as over snow vehicles. With the most modern engines they also meet the environmental requirements of our customers. Maintenance work in winter climate may be associated with the risk of falling ice. Our Ice ArmorTM has met great interest from our customers. With it installed, staff can travel safely at the wind mill park.The vehicles can be equipped with platforms, cranes, fuel tanks and work shop modules to make your service and maintenance easy. STV has delivered tracked vehicles all over the world to work in the most demanding conditions.

The Nordex Group is one of the leaders in multi-megawatt wind power systems. The product range of Generation Gamma (N90/2500, N100/2500, N117/2400) and Generation Delta (N100/3300, N117/3000, N131/3000) comprise turbines for strong, medium and light wind sites. Solution-driven innovations, a dense service network, preventive maintenance, anti-icing system and end-to-end modernization are also part of the company's offer. Nordex has installed a total of around 6,500 turbines with an aggregate capacity of more than 11,500 MW all around the world.

ENERCON products are known for their innovative technology, outstanding reliability and excellent returns on investment, worldwide. With its tried and tested drive system, constant technological sophistication and high quality standards, the company has been setting benchmarks in the wind energy industry for 30 years now. Currently, the product catalogue includes turbines ranging from 800 kW to 7,500 kW. ENERCON has already installed more than 24,800 turbines worldwide with a total rated power of more than 39.2 gigawatts.

Gill Instruments is a world leader in the design and manufacture of meteorological solutions based on their highly successful ultrasonic anemometer range.
Gill has over 25 years experience in producing sensors for Wind Speed and Direction using their 2d and 3d platforms, with more complex Weather Monitoring Systems based around the MaxiMet and MetPak platforms. Gill products are renowned for their rugged design and excellent long-term reliability in a wide range of harsh and inhospitable environments where ultrasonic technology is deployed in order to take advantage of enhanced accuracy, reduced maintenance and calibration on the basis of no moving parts.

Jemtska and JK Park Management is a full-service partner for companies who are establishing wind farms. Our owner is Skanska and Jämtkraft, so we have all the necessary experience and expertise for project managing and building your wind farm. We will coordinate all the contracts and control the subcontractors to work in a safety manner. We are responsible for all the Civil and Electrical works and of course H&S. Jämtkraft Park Management provides comprehensive solutions and helps you with everything you need for your Wind park and for problem-free ownership. Come to stand no.22 and we´ll tell you more how we can make your project come true.

VTT Technical Research Centre of Finland Ltd is the leading research and technology company in the Nordic countries. We develop new smart technologies, profitable solutions and innovative services. Wind power is an important part of VTT's R&D in energy and we have over 20 years of cold climate experience. Our activities cover the whole value chain from resource assessment, system integration, wind turbine technology to wind power production and O&M. We serve the needs of our customers through direct contract research and development, but also through active national and international R&D collaboration with universities, research centres and industries.

Wicetec is a company established 2014 to sell the proven Finnish wind turbine blade ice prevention system. Wicetec wraps the technology and Finnish cold climate experience of 25 years to an effective package to deliver "winter ride-through" feature for your wind farm. The turbibes will be in operation without icing losses. 500MW of wind power is currently operating equipped with the technology.
➔ www.wicetec.com

Energiservice. We are an independent service provider of strategic and operational maintenance in wind, water, power grids and industries. Energiservice takes care of your strategic and operational maintenance so you can concentrate on your core business. We have extensive experience in preventive maintenance and work across the entire process, from optimisation to operational services and

emergency preparedness. At new installations and renovations, we can offer project management, design and drawing services. We can also take care of the entire project.With more than one hundred employees we have a broad expertise and our service portfolio includes a number of special services including thermography, vibration analysis, machine analysis, alignment and balancing, industrial climbing and high voltage maintenance. Our clients range from major power utilities to smaller industrial companies.

SIEMENS

Siemens is one of the world's leading suppliers of offshore and onshore windpower solutions, including services throughout the entire life cycle of the wind turbines.
Nearly 13,000 wind turbines around the globe with a total capacity of 21 GW help to provide the world with clean, renewable energy.
Siemens has long experience of working with turbines in cold climate areas. Welcome to our booth where we will tell you more about our solutions.

DNV·GL

DNV GL in the Energy Industry. In DNV GL we unite the strengths of DNV, KEMA, Garrad Hassan and GL Renewables Certification. DNV GL's 2,500 energy experts support customers around the globe in delivering a safe, reliable, efficient, and sustainable energy supply. We deliver world-renowned testing, certification and advisory services to the energy value chain including renewables and energy efficiency. Our expertise spans onshore and offshore wind power, solar, conventional generation, transmission and distribution, smart grids, and sustainable energy use, as well as energy markets and regulations. Our testing, certification and advisory services are delivered independent from each other. Learn more at **www.dnvgl.com/energy**

LEINE LINDE SYSTEMS

Leine Linde is in the German DR. J. HEIDENHAIN group of companies, your main point of contact for renewable energies, especially for wind power. We are a daughter company of Swedish Leine & Linde AB.
We supply Slip rings for pitch and generators, ADSR®, Encoders (absolute, incremental, optical, inductive, magnetic), Ice detection IPMS®, Temperature-, Humidity- and Condensation Sensors, Pre-assembled Cables + Leads, Pitch motors, Functional Safety, FSR®, EnDat and Resolver worldwide to a lot of wind turbine manufacturers, their sub suppliers, independent service companies, project developers and turbine owners. Visit us on www.ll-systems.com

Total Wind Service AB

Total Wind Service AB är ett företag specialiserat på nyckelfärdiga lösningar inom transport, installation, service, underhåll och leverans av reservdelar till vindkraftverkTotal Wind har dotterbolag i 11 länder på tre kontinenter och erbjuda tjänster i hela världen. Svenska huvudkontoret finns i Veddige utanför Varberg förnärvarande är vi 18 anställda.

EMPOWER
Building a Smarter Society

Empower is a forerunner in providing comprehensive Wind Power Services. They cover the entire life span of wind farms from development to construction, maintenance and service. For example, development stage engineering, cold climate specialized wind measurement deliveries, turnkey construction services, scheduled and corrective maintenance and project management services are parts of our service scope. With our long-term and extensive experience we can adapt our services according to our customers' needs as a comprehensive service integrator or service provider. In addition to Wind Power Services Empower has also extensive experience in Grid and Telecom Engineering and Construction Services. These can be included in all our Wind Power Life Cycle Packages.

BLADEFENCE®

Bladefence is a specialist for wind turbine blade condition analysis, repairs and maintenance. The company utilises advanced skylift equipment and UV-curing blade repair method in its operations. In combination, these enable operations in harsh weather conditions, cutting-edge efficiency and minimise turbine downtime. The company was certified by Germanischer Lloyd for blade repairs in 2012 as the first company in the Nordic countries.

BUILDING TRUST Sika®

SIKA CORPORATE PROFILE Sika is a specialty chemicals company with a leading position in the development and production of systems and products for bonding, sealing, damping, reinforcing and protecting in the building sector and the motor vehicle industry. Sika has subsidiaries in 91 countries around the world and manufactures in over 160 factories. Its approximately 17,000 employees generated annual sales of CHF 5.6 billion in 2014.

fos4X
fiber optic measurement

fos4X's fos4IceDetection system measures the vibrations at the tip of the rotor blade which leads to a very reliable detection of smallest amounts of ice on the rotor blade. It operates even after a shutdown of the wind turbine and at very low wind speeds – hence an automatic restart is feasible.

Alpine HELICOPTER

Alpine Helicopter Sweden AB. With a helicopter and hot water, Alpine Helicopter AB has made it their business idea to de-ice the blades rather than waiting for thaw. Until now, there has been no other alternatives than to wait for the ice to melt if the wind turbine isn't equipped with a de-icing system.

WeatherTech

WeatherTech Scandinavia AB offers qualified consultancy services such as customized wind and weather related reports, icing studies and weather forecast services for the power industry and actors on the energy market. We have broad meteorological competence from university and wind industry including many years of experience from modelling atmospheric processes.

dc Danske Commodities

Danske Commodities offers complete solutions for production management of wind farms. We are an independent, international energy commodities trader and provide an array of energy-related services. Founded in 2004, we now operate in 30+ countries bringing passion, building trust and creating value in every market we enter.

IN SITU
miljömätningar mark · vatten · luft

In Situ Instrument AB is an innovation-oriented company that develops and delivers measurement systems for environmental measurements in soil, water and air. We provide technical solutions including installation, monitoring, maintenance and repairs, all according to the customer's specific needs. Our products and solutions are based on world-leading technology and are developed in close cooperation with customers, leading providers and research institutions.

Exhibitors

Eologix sensor technology gmbh was founded in 2014. The company develops innovative sensors for smart surfaces. The first product was launched in early 2015 and is a thin, autonomous and retrofittable sensor for icing detection in for wind turbines. The patented solution can be used to reduce stand-still times as well as to effectively control anti- and de-icing equipment. Due to the easy mounting process on the rotor blades, it can be used for all types of wind turbines, also as a retrofit solution.

FORCE Technology provides highly specialised engineering solutions. Our services cover the entire life cycle of the wind turbine from top to bottom and almost any technical area relating to the wind industry. We supply critical services such as design recommendations, inspection, failure investigation and analysis, chemical analysis and metallurgical examinations.

FT Technologies are the leading manufacturer of ultrasonic wind sensors for turbine control. At Winterwind we are introducing our new 75m/s FT742 sensor with improved accuracy. Featuring our patented Acoustic Resonance technology our small, tough wind sensors are easily heated, help to improve output and reduce costly turbine down-time.

NEAS is an independent international energy asset management company with activities in power, gas and related commodity markets throughout Europe, both physical and financial. We are one of the leading partners on the northern Europe market with a portfolio over 5000 MW, offering balancing and trading of power and certificates.

Vindkraftcentrum. Our mission is that the large investments made – as much as possible – should benefit the population in the forms of jobs and businesses. We identify the possibilities and facilitate contacts.

- Company database – 2700 addresses
- Matching tools
- Industry knowledge
- Business development
- Business advise
- Inspirational meetings, seminars, fairs
- Website, newsletter

Factual information to the public and decision makers

Vindval collects and provides scientific knowledge of wind power's impacts on humans and nature. The program is a cooperation between the Energy Agency and the Swedish EPA.

Vindforsk is a technical research programme run by the Energy Agency in cooperation with the Swedish industry. The project's aim is to increase knowledge and strengthen the Swedish wind power industry's knowledge base.

Statoil Lubricants is a European organization with operations in Scandinavia, Poland, the Baltics and Russia. Our lubricants business covers everything from research and development to production and sales. We offer a complete range of products and services for all types of industries. The entire operation is certified according to environmental and quality standards ISO 9001:2008 and ISO 14001:2004. From 1 October 2015 Statoil Lubricants is a part of Fuchs Petrolub.

Nibe Wind Components – Heating solutions and equipment for wind turbine erected in cold climates. Heating blankets for blade repair as well as nacelle fan heaters and other related heating products for maintenance on site, is our focus! NWC offer all kind of heaters for cold climate turbine applications. Ask us!

Rope Access Group provides contract services in wind power industry with the help of IRATA® industrial climbing, rope access and offers a wide range of training courses, whether you are a wind technician, subcontractor or rescue personnel. We have offices in Solna (Stockholm), Gothenburg, Malmö, Östersund and Piteå.

Connected Wind Servicesis Europe's strongest independent service provider for wind turbines. For more than 25 years, our multi-brand, multi-skill approach, combined with local competencies, has been the foundation for providing wind turbine operators and owners with unrivalled reliability and service.
We adapt to individual needs and are focused on the full lifecycle of wind turbines. Our reputation is built on efficiency, flexibility and safety within wind turbine service and maintenance, gear refurbishment and replacement, and retail of spare parts.
We deliver integrated, high-value services that help maximize yield and protect assets – providing all you need from a single point of contact.

EnginSoft specializes in computational fluid dynamics and ice accretion, we support wind turbine manufacturers and wind farm operators to predict turbine performance and wind farm power output in icing conditions.
The use of advanced simulation technology is fundamental for development of ice protection systems based on electro-thermal and hot air heating. EnginSoft Nordic are known as "Key partner in design process innovation" for many of the Nordics most well-known businesses. Come to our booth to learn more.

VAISALA

Vaisala. When you fully understand your environment, you make confident, accurate decisions. As experts in weather for 80 years, Vaisala is committed to helping you understand the risks associated with the impact of weather. With the acquisitions of 3TIER and Second Wind, Vaisala has created an integrated suite of renewable energy assessment, forecasting, asset optimization, and measurement solutions to help customers around the globe make the right decision when it comes to weather. With this combination, Vaisala offers products and services for all phases of a wind project.

NÄTVERKET FÖR VINDBRUK
www.natverketforvindbruk.se

Jämfrakt has more than 125 years´ experience of producing energy from renewable sources. Jämtkraft works with every stage of the process from construction of wind farms to operating, controlling and monitoring windturbines and internal networks. Jämtkraft group offer a professional range of full asset management services including balancing, trading and hedging of power, EL certificate and GoO:s.

Swedish Windpower Association

Promoting the development of windpower in Sweden and internationally.

Swedish Windpower Association is primarily representing wind power owners but is to open to all. We are an established referral organization with over 30 years of experience in wind power and with more than 1,500 members. The association publish annually; Tidningen Svensk Vindkraft, the leading trade publication in Sweden. The association is active in Sweden as well as internationally, promoting the development of windpower. A non-profit and apolitical association.

SUPPORT OUR WORK, BECOME A MEMBER!

Swedish Windpower Association is an active participant in the debate on windpower conditions and development in Sweden. As a member do you support our work against politicians, authorities and other stakeholders. For more info about our members benefits and how to become a member, visit our booth during Winterwind or our website: **www.svensk-vindkraft.org/bli-medlem**

- We promote trends in technological development, completely front edge.
- We are active through referrals to influence improved economic and financial conditions.
- We cooperate with authorities, institutions, organizations and industry.
- We continuously attempt to learn something new that will benefit the members.

OUR FOCUS AREAS

1. **EDUCATION**
2. **ACCEPTANCE**
3. **MEMBER VALUES**
4. **COLD CLIMATE**
5. **NEXT PRACTICE**

Swedish Windpower Association is a member of World Wind Energy Association. **WWEA** is a global association embracing the wind sector worldwide, with more than 600 members in around 100 countries. WWEA works for the promotion and world-wide deployment of wind energy technology.

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www.svensk-vindkraft.org


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