An aerial photograph of a Nordex N163 wind turbine in a winter landscape. The turbine is the central focus, with its three blades extending outwards. The ground is covered in snow, and there are some trees and small structures visible in the distance. The sky is overcast.

# > Nordex Advanced Anti-Icing System for N163 Turbines

Nordex Group, April 2022

## Recap:

In 2020 we showed the successful field validation of the DELTA4000 Advanced AIS

**Comparison of CFD-Calculation and measured Data**

Heat transfer coefficient from CFD-Calculation

High  
Low

Infrared Images

Heat transfer coefficient calculated from infrared images

Position along blade

- Blade 1
- Blade 2
- Blade 3

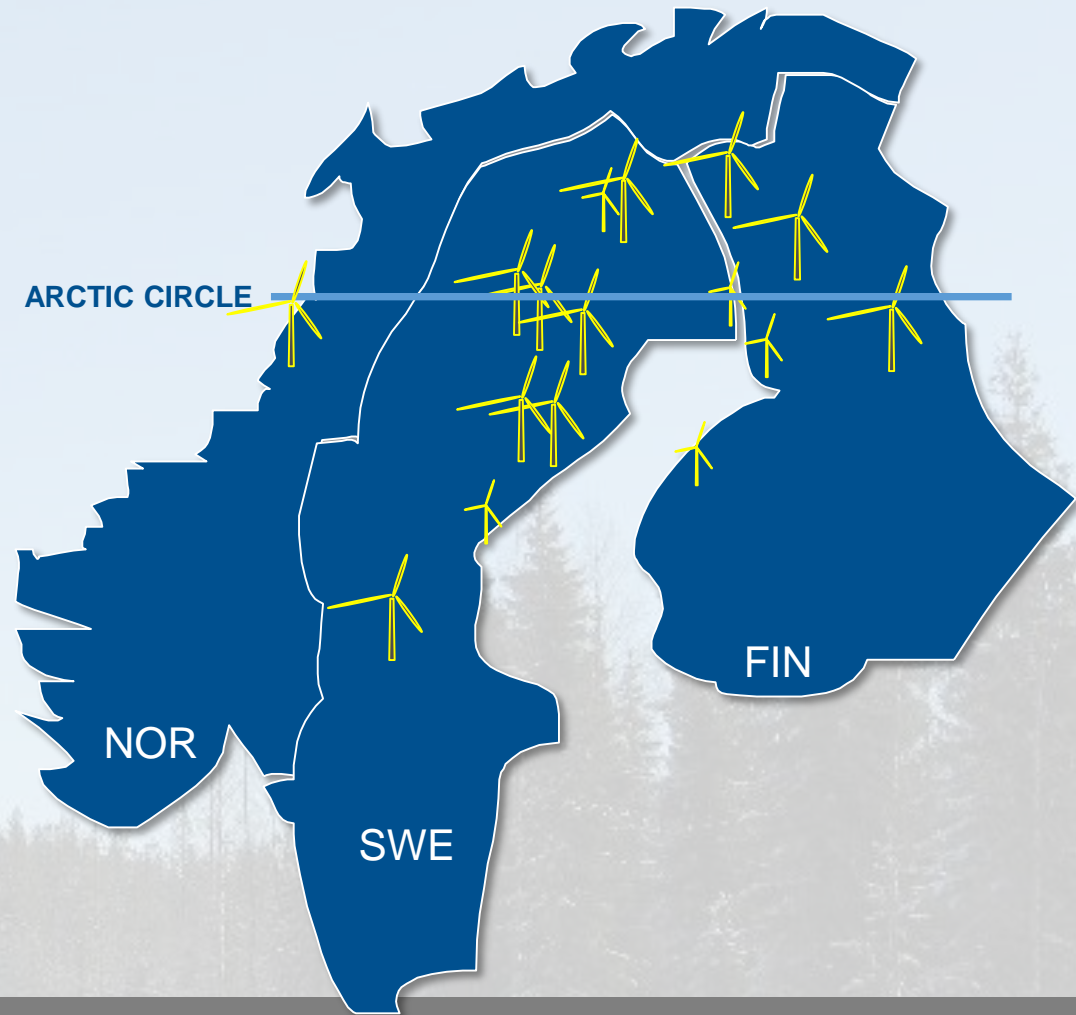
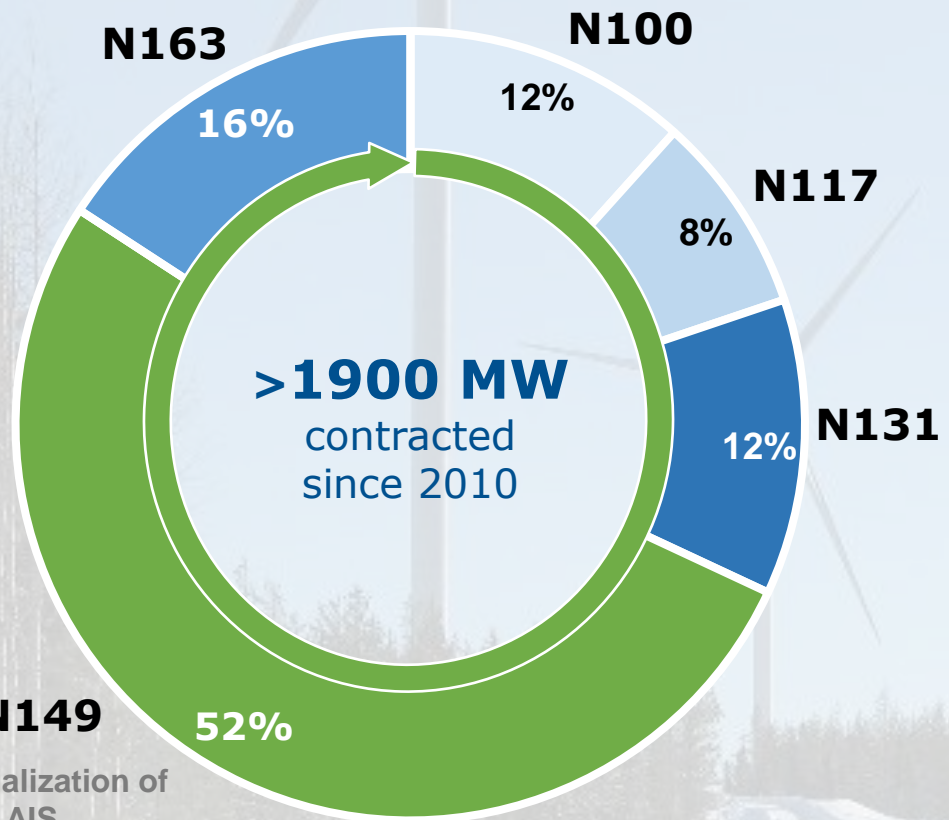
- Calculated behaviour of heat transfer coefficient is reproduced in the field measurements
- Higher scattering of values at the tip due to more turbulent air flow

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Advanced  
Winterwind Conference,  
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# Nordex has a LONG EXPERIENCE in developing and operating Anti-Icing Systems with different rotor sizes in severe Scandinavian icing conditions



> Commercialization of Advanced AIS

**CONTINUOUS IMPROVEMENT** based on more than 12 years operational experience

## In the change of time - 37 years of development

### N163/6.X



Nordex Group



159.761 Follower:innen

1 Monat • Bearbeitet •

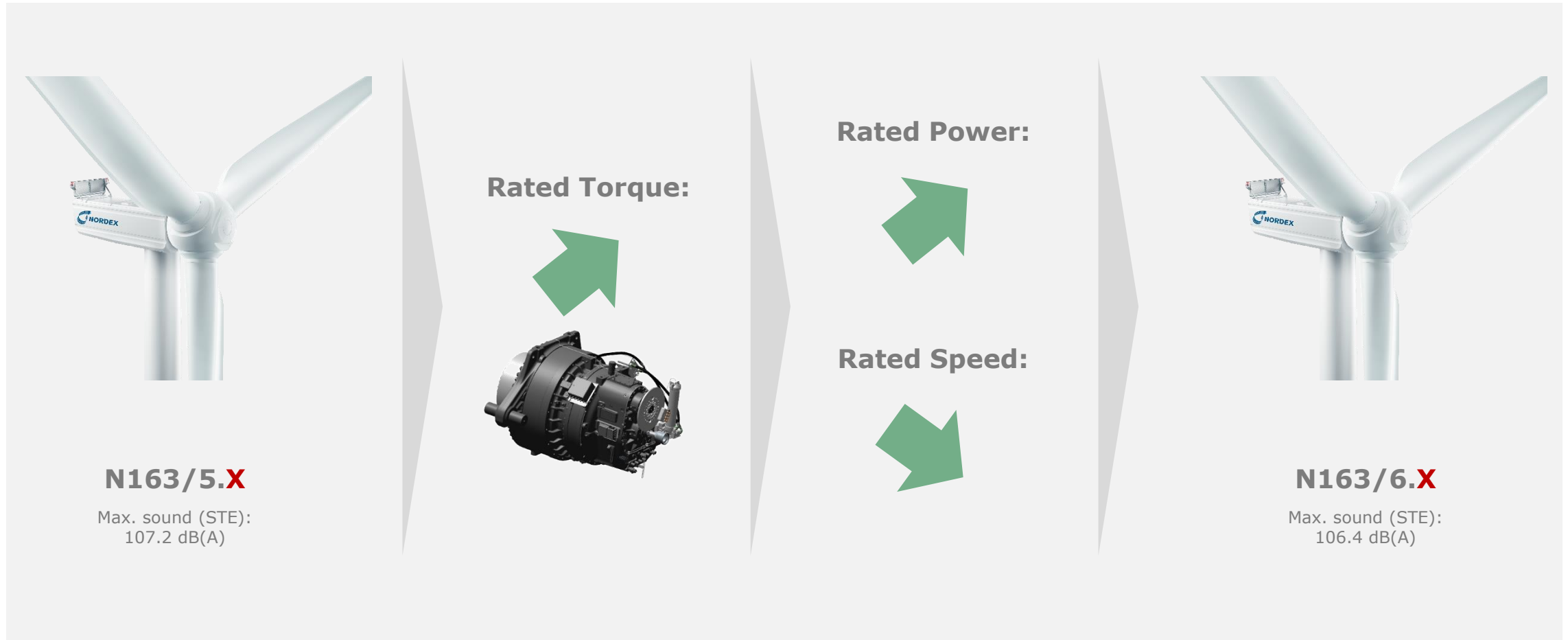


Size Matters – N163 vs N27

The picture shows the old nacelle of the N27/250 in the front. It is the turbine no. 1 – installed in Denmark in 1987 and operated until 2016. In the back our latest model of the Delta4000 platform, the N163/6.X. Impressive the development in size that we have taken in technology.

The N163 has a swept area of 20,870m<sup>2</sup>, this corresponds to a factor of 36 to the N27 which has 570m<sup>2</sup>. The N163 thus generates an energy yield that is more than 36 times greater than the N27. Nevertheless, the N163 is a flyweight with a tower head mass of around 290 t. If we were to work with the same level of knowledge as at the time of the N27, then a tower head mass of 600 t would be expected (36 x of the N27). The difference and the fact that the N163 is so "light" lies in our experience and knowledge that we have gained over time and that flows into today's turbines - always with a view to generating energy as cost-effectively as possible.

# > N163/6.X - An upgrade of the N163/5.X

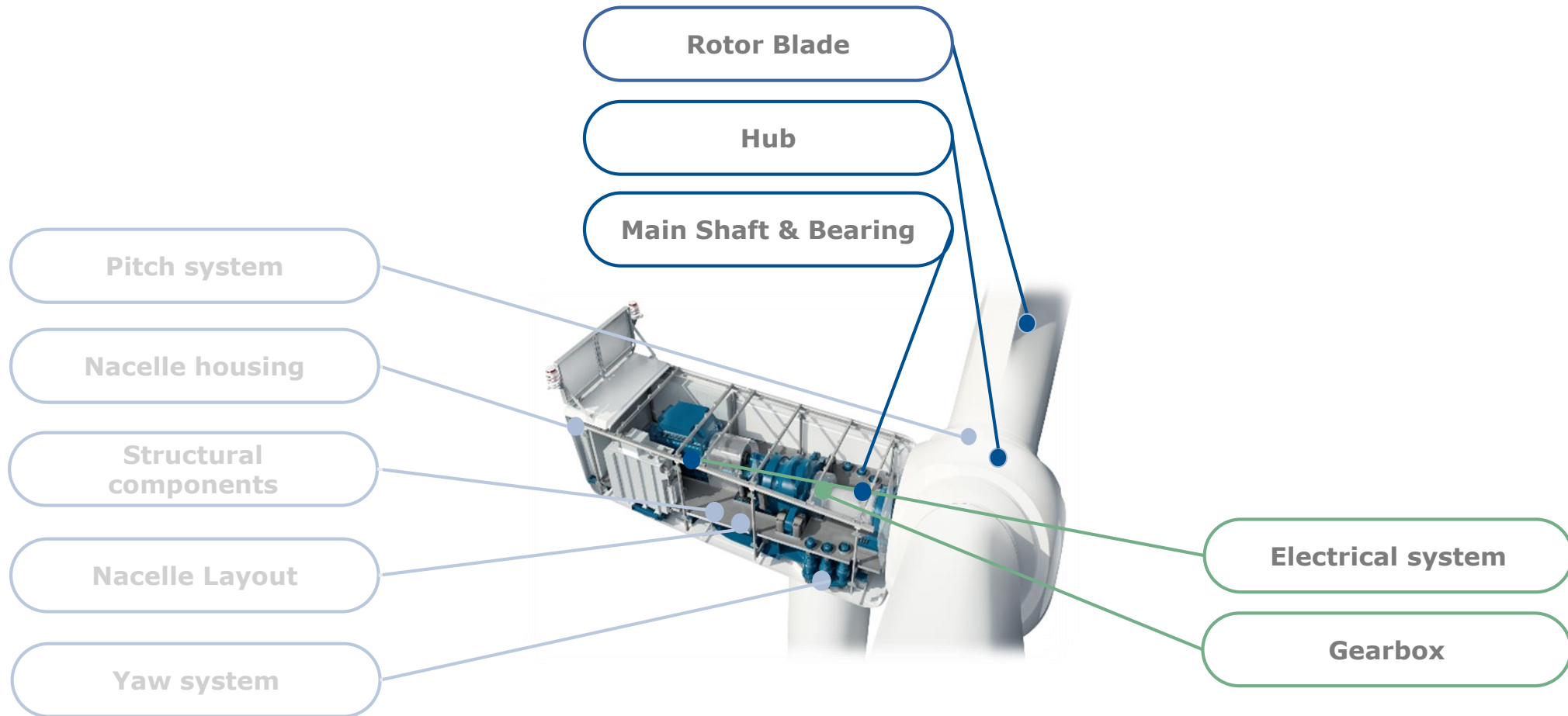


# > N163/6.X - Main changes compared to N163/5.X

## Utilized Delta4000 Components

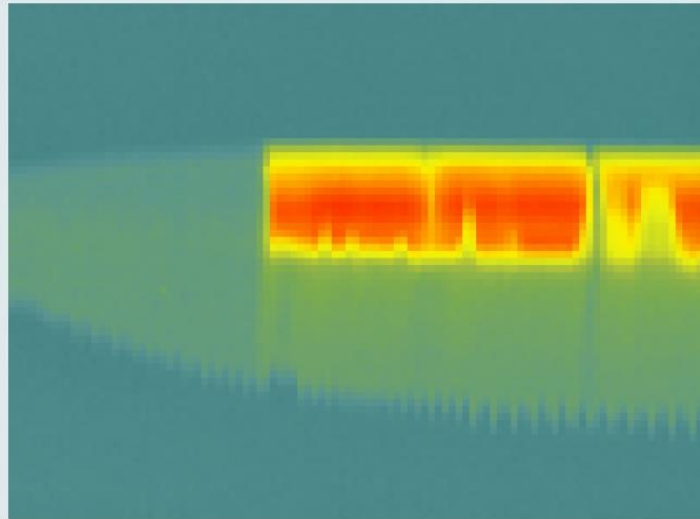
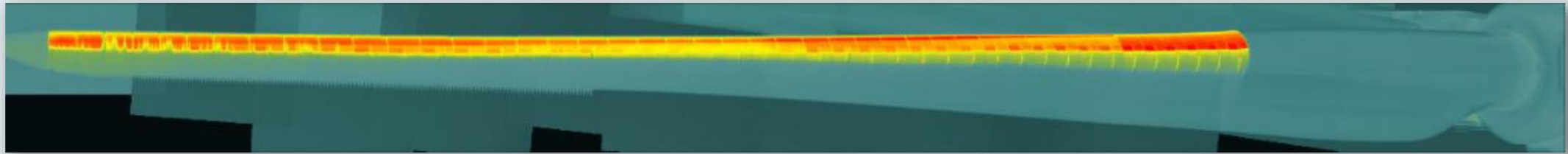
## Reinforced Delta4000 components

## Upscaled N163/6.X Components



## N163 AAIS Design remains mainly unchanged to N149

### AAIS conductor heating element

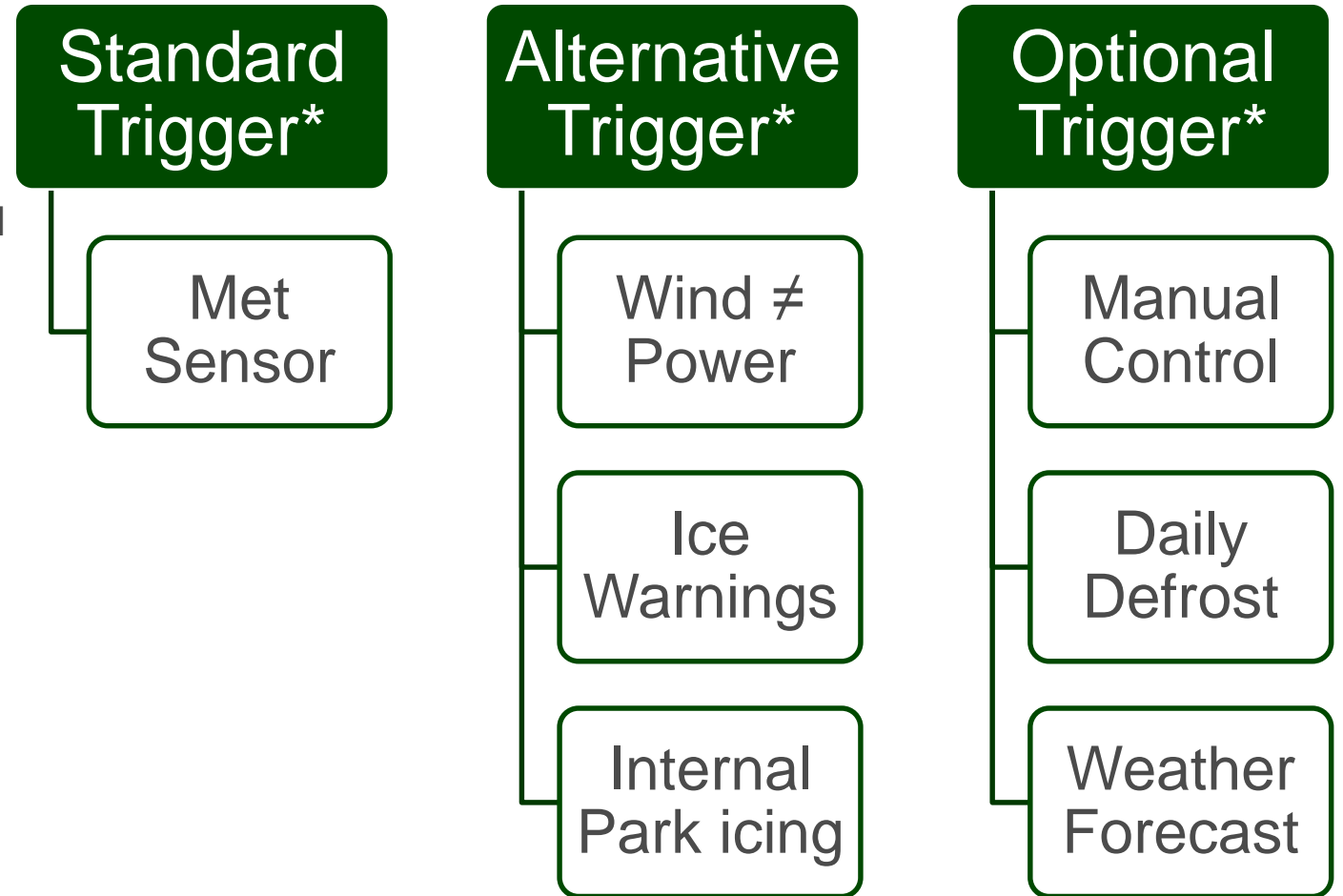


- Equal temperature along blade length
- Avoidance of ice accretion towards trailing edge

# What triggers the Anti-Icing System?

## Nordex follows a „Multi Sensor Approach“

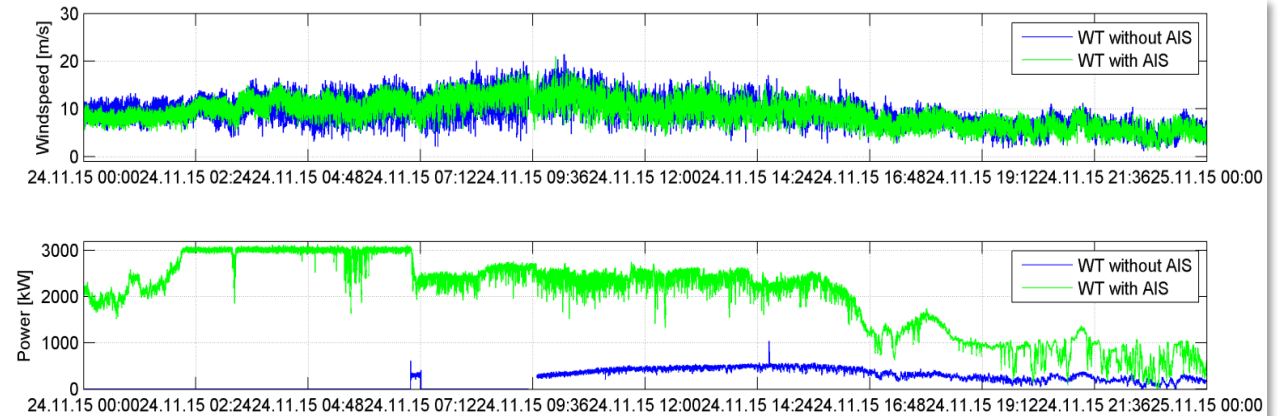
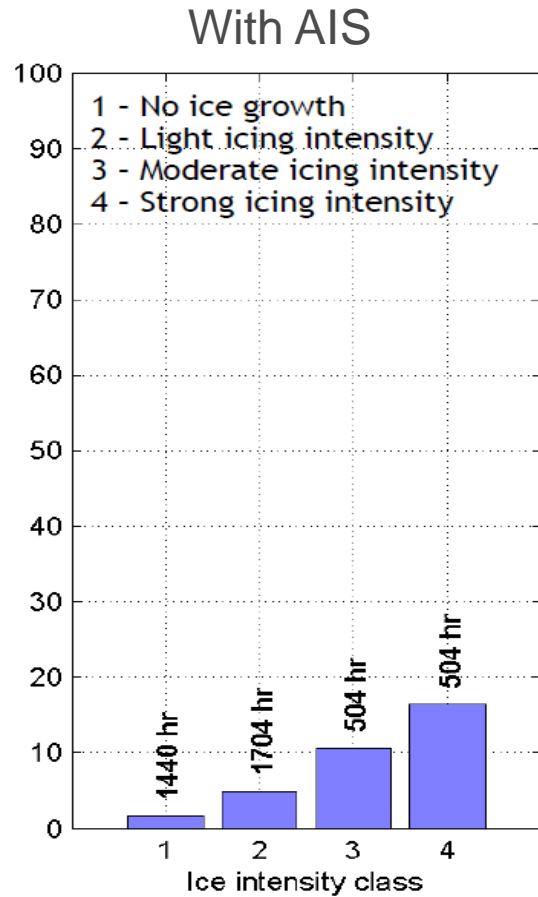
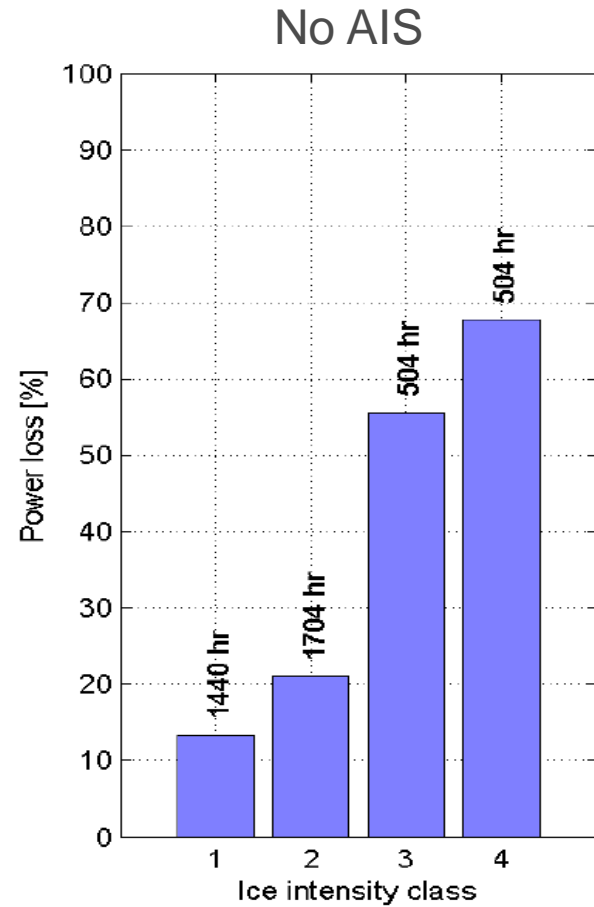
- Main trigger is the meteorological ice sensor which detects environmental icing conditions, aim is to pre-heat the blades before instrumental icing occurs
- Alternatively the AAIS can be triggered by:
  - Wind unequal power warning
  - Different failure messages attributed to ice
  - Park internal ice warning
- Further Triggers
  - Manual control
  - Daily Defrost
  - Weather Forecast (optional)



\* Pre-condition is T = +3°C to -20°C



# Benefits of an Anti-Icing System



➤ Significant ICING LOSS REDUCTION throughout the day

➤ Long term validation showed net icing loss reduction of ~80%

## Warranted Performance

### › Nordex provides an AIS Performance Warranty

#### Pre-conditions:

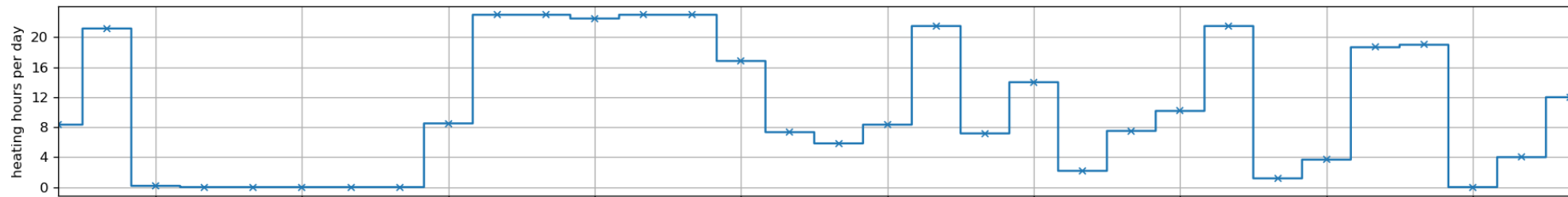
- ›  $T \Rightarrow +3^{\circ}\text{C}$  to  $-20^{\circ}\text{C}$
- › Active Icing Conditions (AIS active)
- › No limitations due to wind speed, humidity etc.

#### Warranted Performance:

- › Minimum 80% of AEP compared to AEP when no ice is present

#### Example:

One month of heating hours per day (example shows a January with many icing hours)



- › Cumulative 300 hours AIS was active = 80% of AEP (warranted)
- › The other 444 hours AIS was not active/no icing detected = 100% of AEP (warranted)
- › **Total warranted net AEP = 91.9%**



# NORDEX – your reliable partner for securing maximum energy yield in icy climates

## Nordex Anti-Icing System supports your business case

- › **Long cold climate experience and proven technology**  
around 1900 MW with AIS contracted over 12 years
- › **Anti-icing not De-icing**  
no shut down of the turbine, continuous operation
- › **Icing-prevention through smart algorithms**  
fight the ice before it accumulates on the blade
- › **Maximum performance and increased availability**  
even under severe icing conditions down to -20°C
- › **Robust, validated and 3<sup>rd</sup> party certified system**  
part of the IEC turbine type certificate, fully tested in-house
- › **80% performance warranty in case of active icing conditions**  
100% PC warranty at all other times
- › **Available for our latest Delta4000 series turbines**  
N163/5.X and N163/6.X



Picture: Havøygavlen Wind Farm

**> Thanks for  
your attention**

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