



MORTEN E. HANDBERG | +45 51 92 29 57 | MEH@WINDPOWERLAB.COM

Cost Effective De-icing Repairs

SUPPORTING the WIND industry

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We know blades.

OPERATIONAL EXPERTISE

Expertise takes work, study, and daily practice – trust many years of effective HSE driven operations in the energy sector.

CONSISTENT DELIVERY

A combination of innovative technology, advanced tools and expert application allows us to provide a superior product.

INDUSTRY KNOWLEDGE

Combined years of industry knowledge will ensure your deliverables and enable proper financial decision making.

Damage from ice on blades

Situation

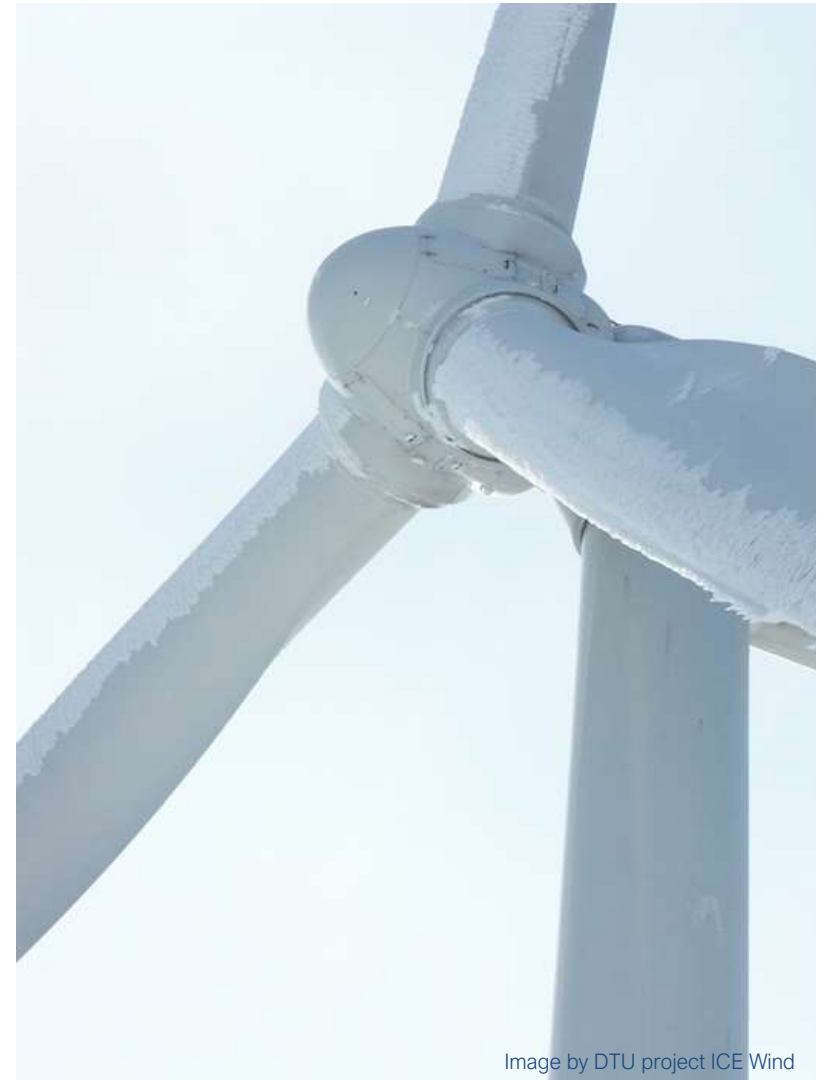
Texas 2021

The sudden and unexpected need of a deicing system

Cold climate turbines

The need of a functioning deicing system

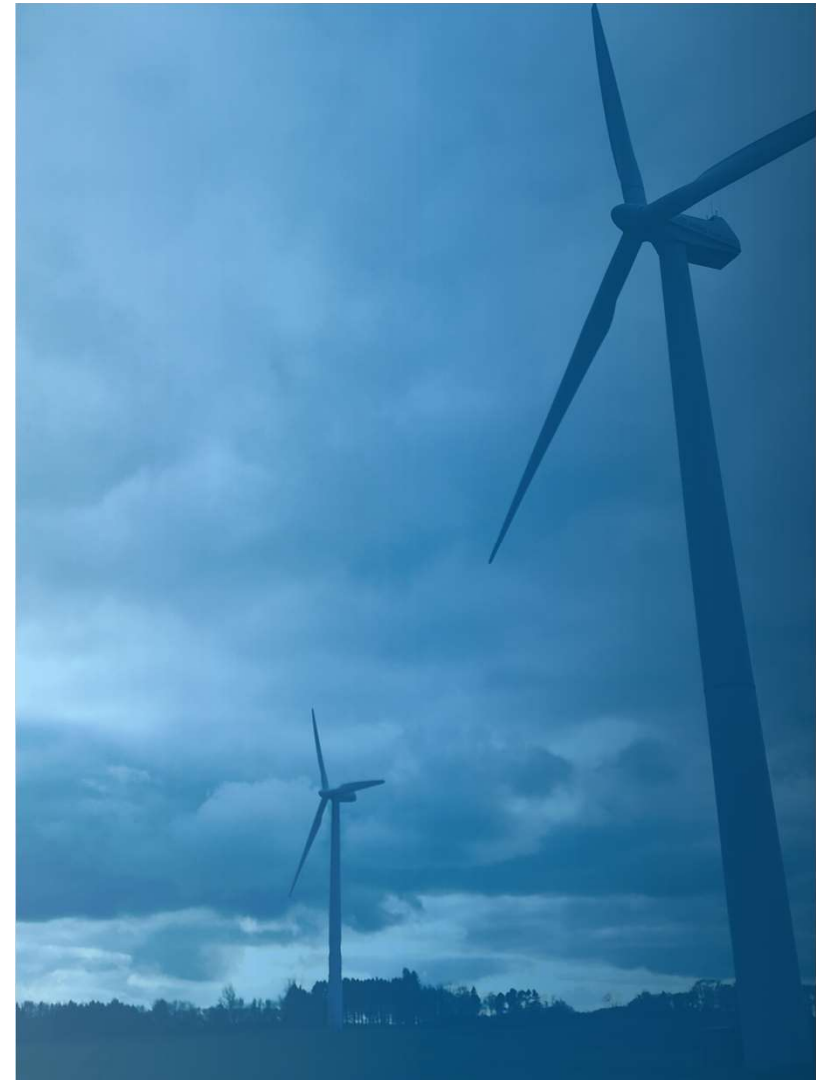
We need a deicing system to mitigate risk of lost production



Carbon Electric Resistance

- Biax ply laminate running along LE center on blade PS and SS
- Efficient system to heat blade surface during icing events
- System input between 25-60kW

Blade De-Icing effect pr kvm – 50m blade	
input effect kW	60
CFRP length m	96
CFRP width m	0,6
Area m ²	57,6
Effekt kW pr m ²	1,04



Damage from ice on blades

Complication

Texas 2021

The sudden and unexpected need of a deicing system

Cold climate turbines

The need of a functioning deicing system

Failing deicing systems lead to lost production and potentially severe blade failures

But why do they fail?



QC of post production blade condition



Avoid unnecessary repairs by

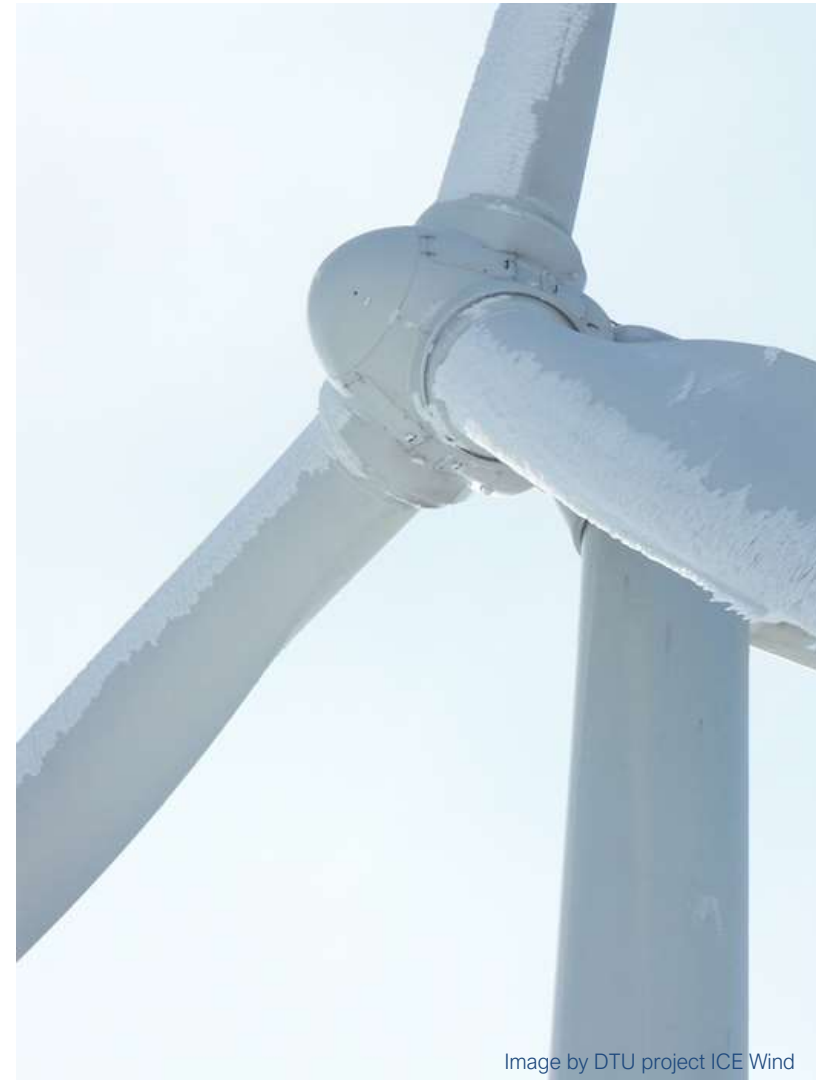
- Inspect de-icing systems against OEM factory condition specifications
 - Acquire report on system functionality test



Operating in Cold Climates

Complication

When de-icing systems fail in wind farm operation

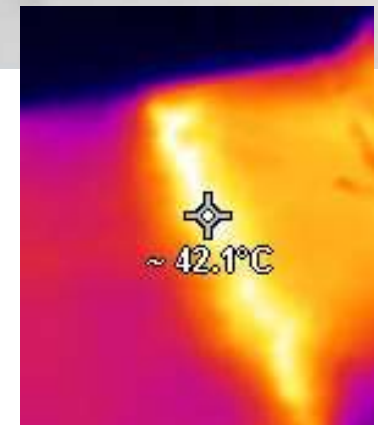


De-icing defects

Common damages in the Carbon Ply

- **Wrong lightning attachments**
Striking the De-Icing system that with sufficient energy can cause an immediate delamination between the blade surface and the carbon ply.
- **Transport**
Impact/scraping on the blade surface can cause tremor or removal of carbon fibers.
- **Fatigue**
Delamination cause by inadequate adhesion or air inclusion between carbon ply and blade surface.

Any of the above damages will reduce the local deicing area where the heat is distributed, causing a hotspot in the remaining healthy area and a cold spot in the damaged area.



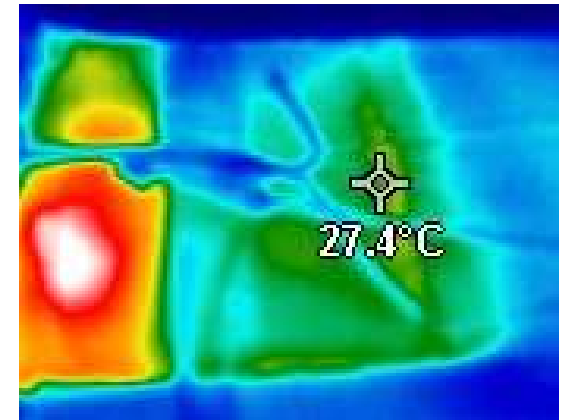
De-icing defects

Consequences of defect

Blade De-Icing effect pr. m healthy laminate	
input effect W	600
CFRP length m	1
CFRP width m	0,6
Area m ²	0,6
Effekt kW pr m ²	1

Blade De-Icing effect pr. m 75% width reduction	
input effect W	600
CFRP length m	1
CFRP width m	0,15
Area m ²	0,15
Effekt kW pr m ²	4

- High spike in local heat distribution can damage laminate if the temperature increases above 80dgr
- In severe events it can render the system inoperable due to risk of fire damage in the hotspot



Operating in Cold Climates

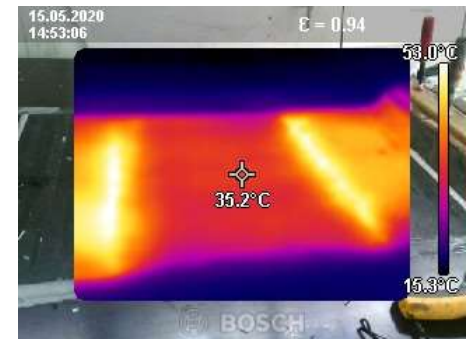
How to avoid blade replacement due to De-icing failure

On-site Repairs

Repair of Carbon De-icing



- Must enable heat transfer over the entire width of the carbon ply
- Effects of heat transition zones must be minimal
- Any hotspots must not exceed 80 degree during max-load on the system



3 TAKE AWAYS



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- How do I avoid blade defects that origin from production?
 - What can I do if a damage is detected in my de-icing system?
 - What do I need to be aware of an operation of my turbine during icing conditions?



Turbine owner perspective

Lightning damages on de-icing systems

Carbon based De-icing systems can be repaired

Validated cost-effective method for in field repairs

Mitigate risk of stopped turbines during winter season due to icing, as consequence of malfunctioning de-icing systems





Thank you!

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