



Vestas De-icing System

Vestas Wind Systems A/S

Winterwind 2015

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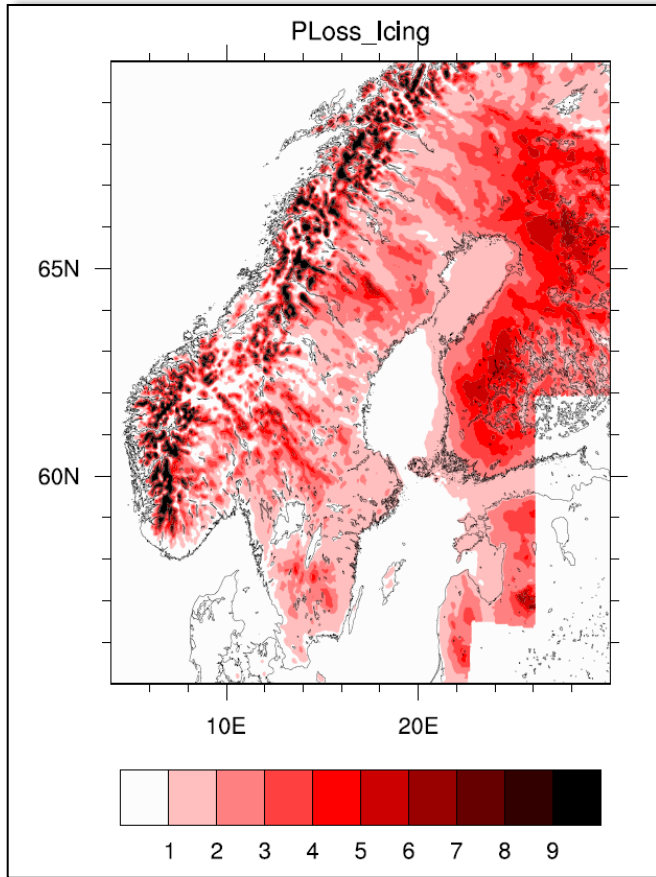
Agenda

1. Vestas icing Forecast
2. Vestas De-icing System
3. Testing of the De-icing system
4. Vestas Ice Detection

Vestas Icing Forecast

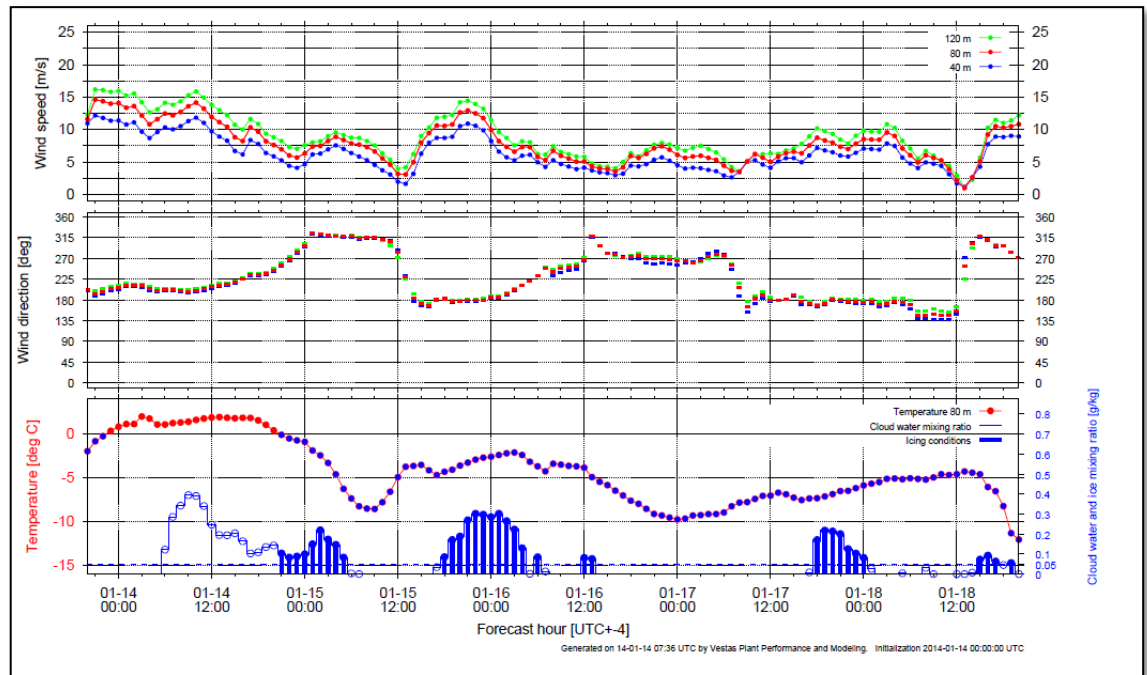
Vestas offers a range of forecast services

Production losses per year



- For investment decision

Hourly icing forecast

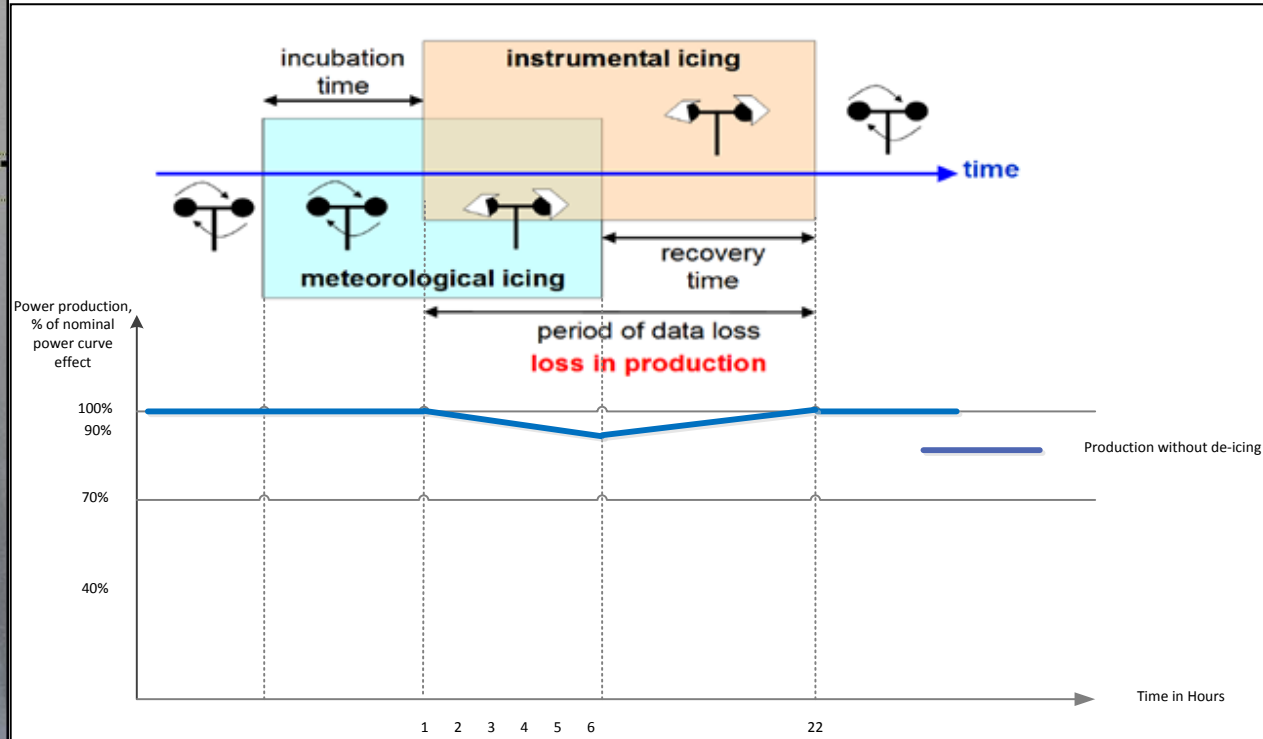
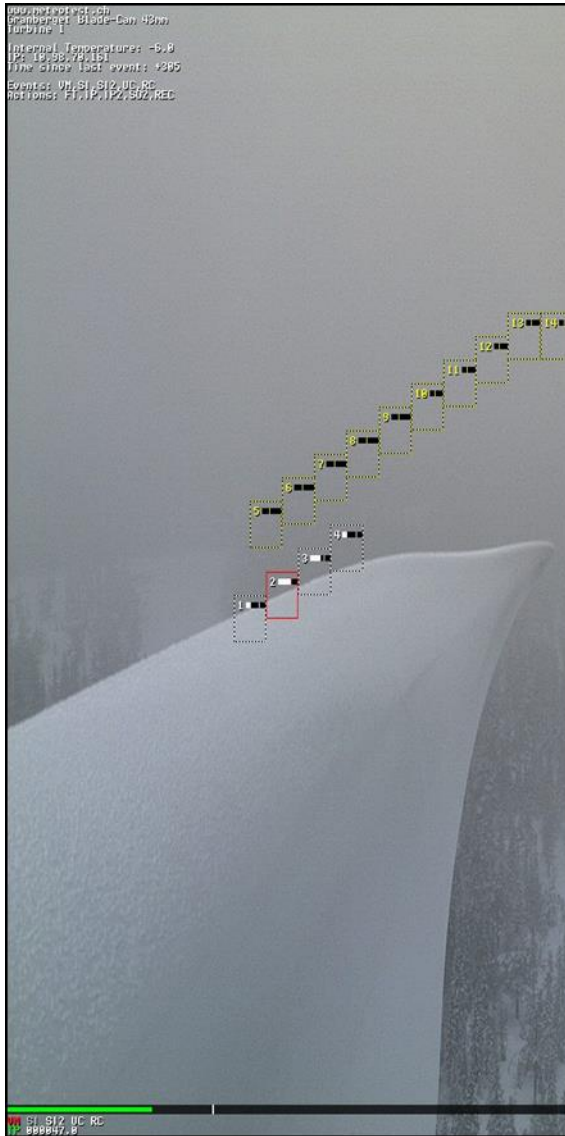


- For operational use

Icing Scenarios

Light icing

Conceptual illustration

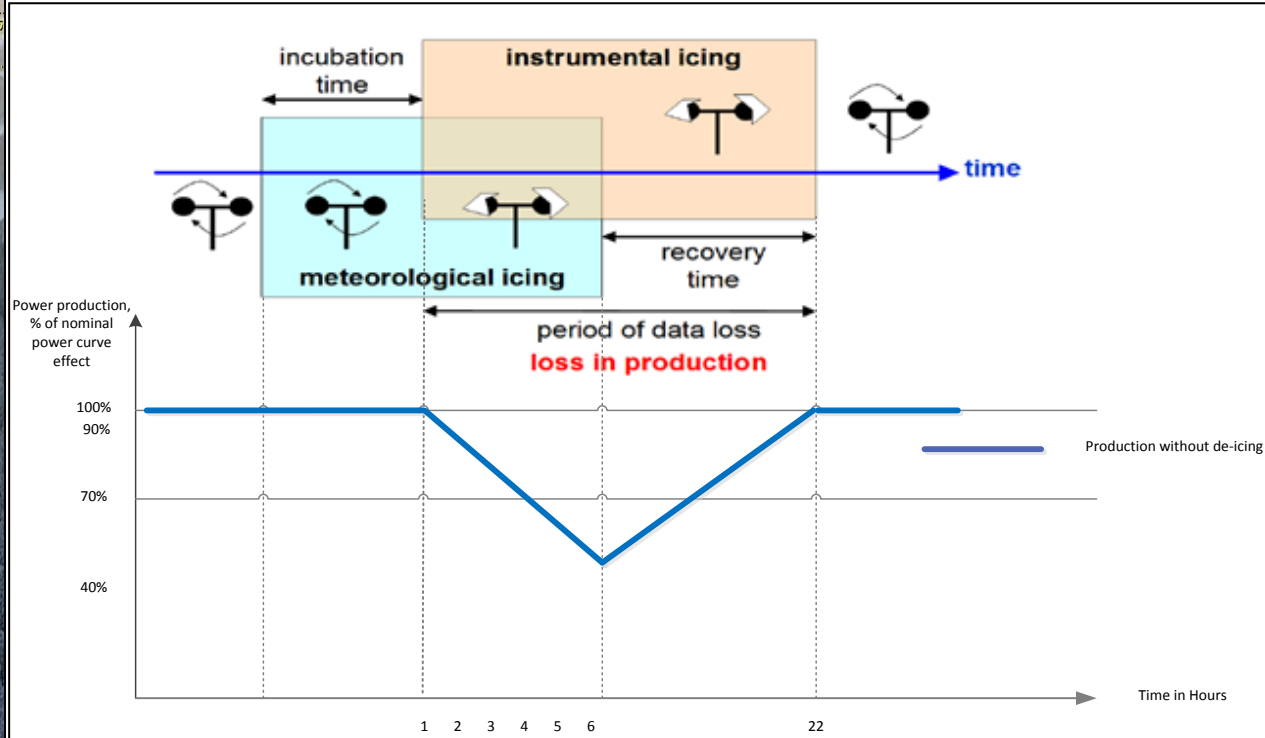
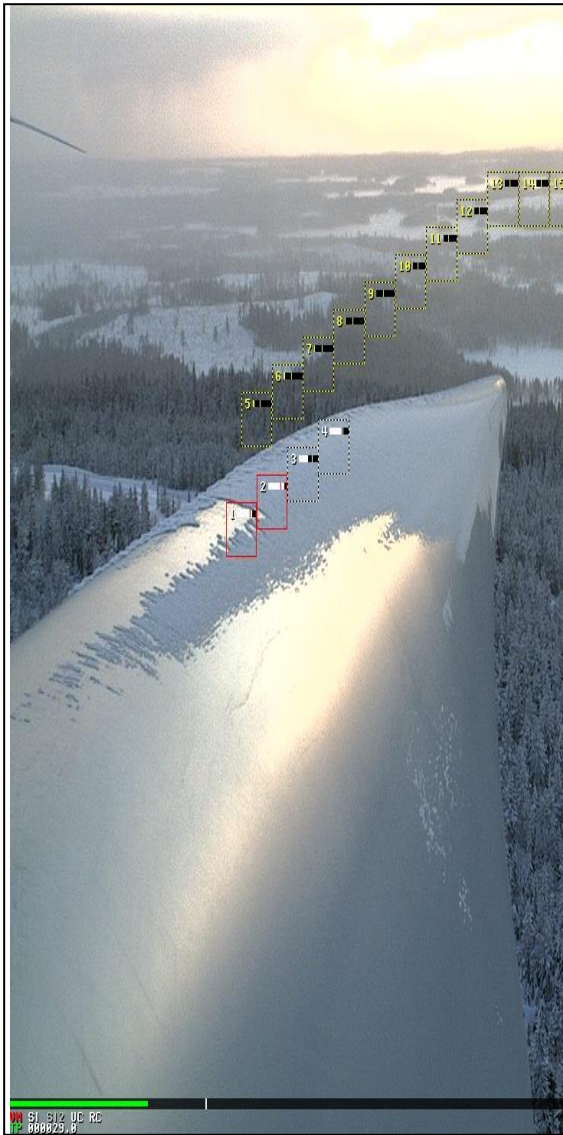


Source: "Wind Energy Projects in Cold Climates", IEA wind, May 22, 2012

Icing Scenarios

Moderate icing

Conceptual illustration

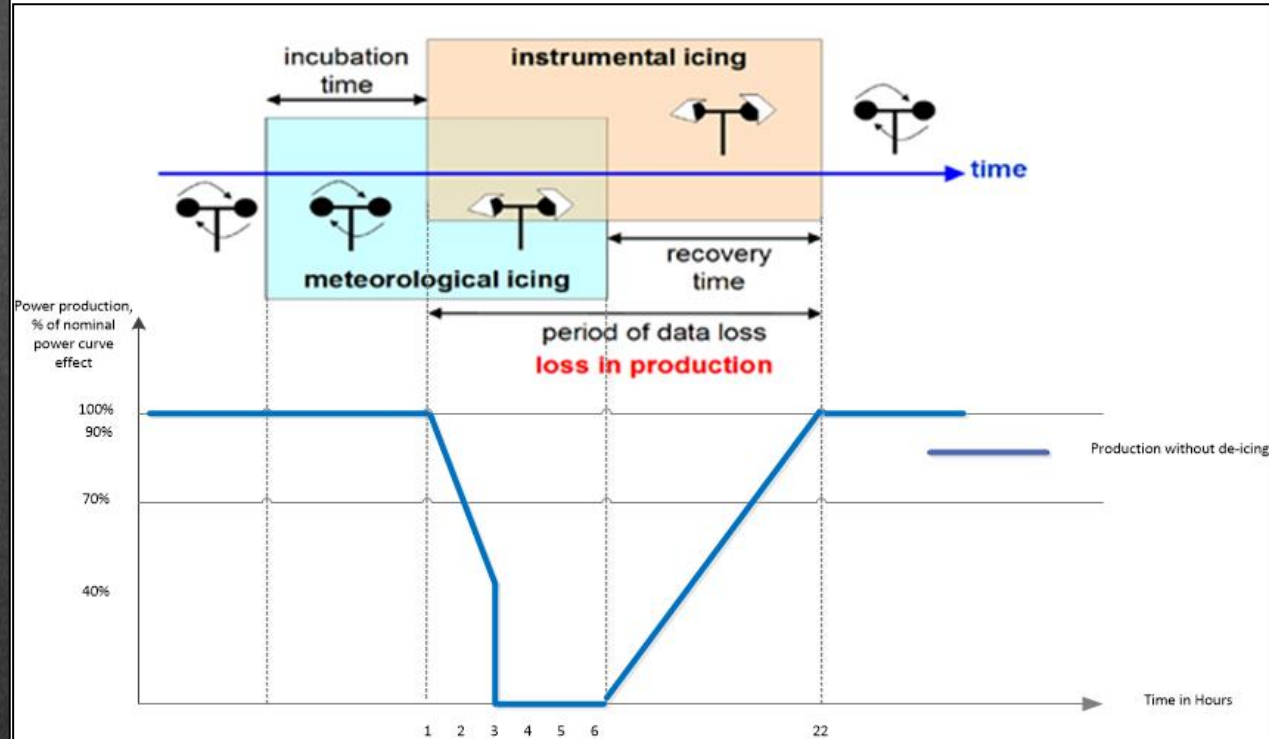
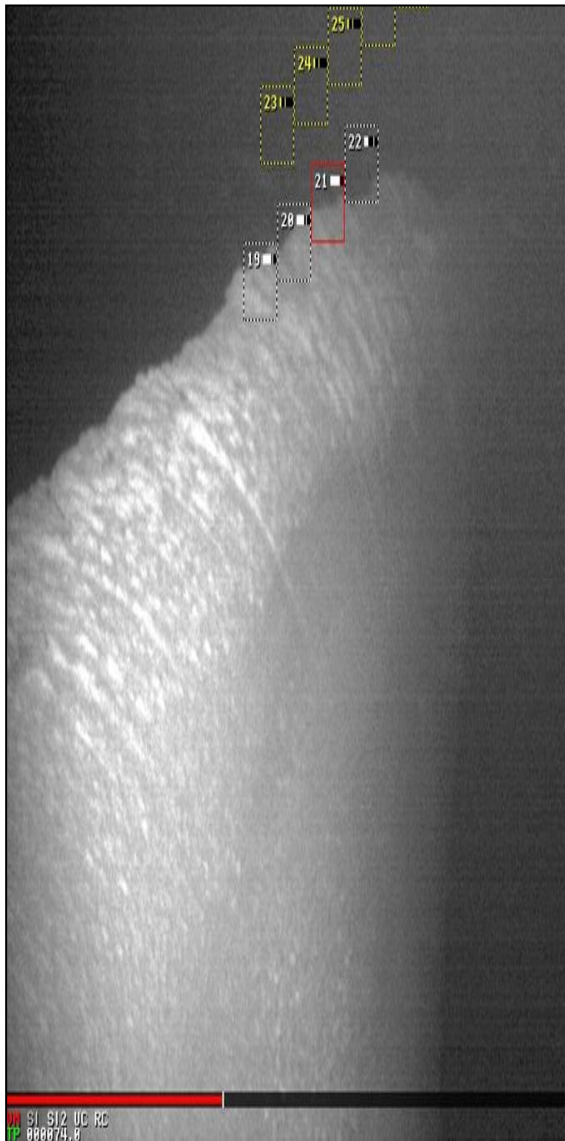


Source: "Wind Energy Projects in Cold Climates", IEA wind, May 22, 2012

Icing Scenarios

Heavy icing

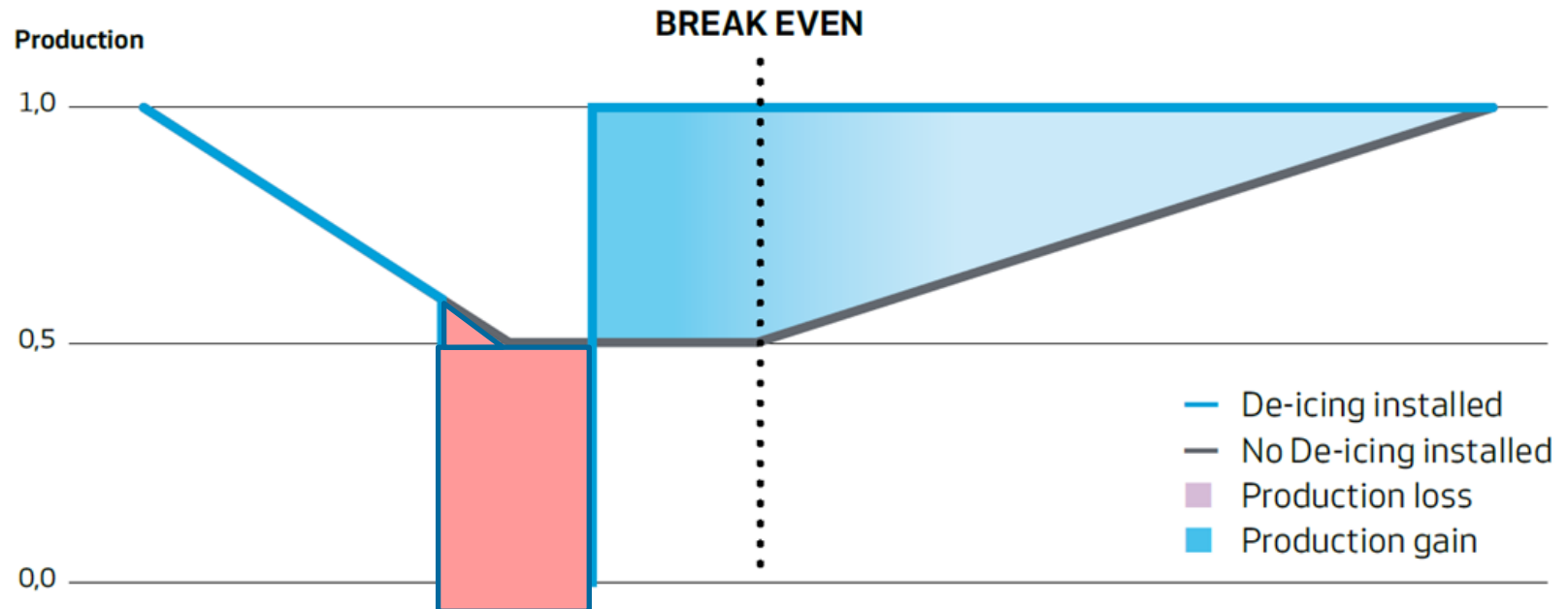
Conceptual illustration



Source: "Wind Energy Projects in Cold Climates", IEA wind, May 22, 2012

De-icing when it matters: Production focused trigger concept

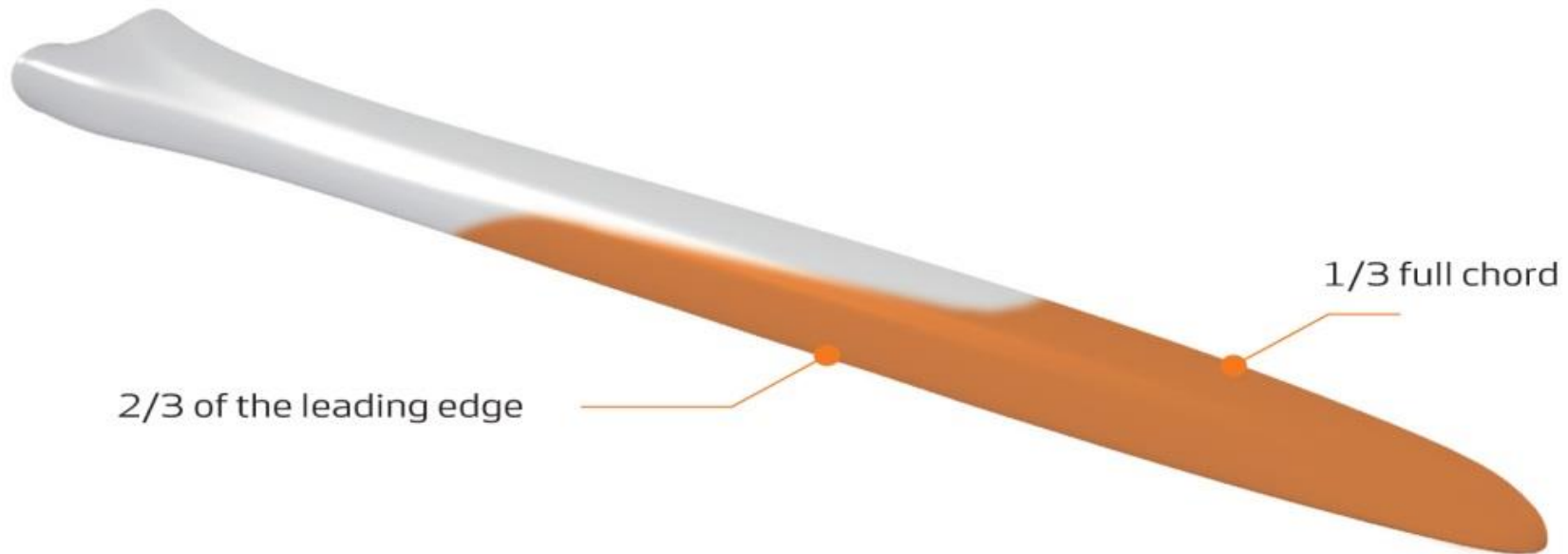
Break-even model integrated in de-icing trigger mechanism



- The break-even point is a setting in the control system, and can be tailored to the your de-icing strategy through SCADA
- Can be set to trigger at different wind speed
- Easy manually trigger option through SCADA to fit site/your needs

De-icing where it matters: Full retention of power curve

System performance



- Target area is the outer 1/3 of the blade, full chord & 2/3 of leading edge
- Fast recovery of production - min 90% on power curve
- Controlled de-icing cycle to reduce ice throw

Successfully improved power curve after de-icing

8 m/s and 0°, V112 Blade, Sweden

Blade after de-icing cycle



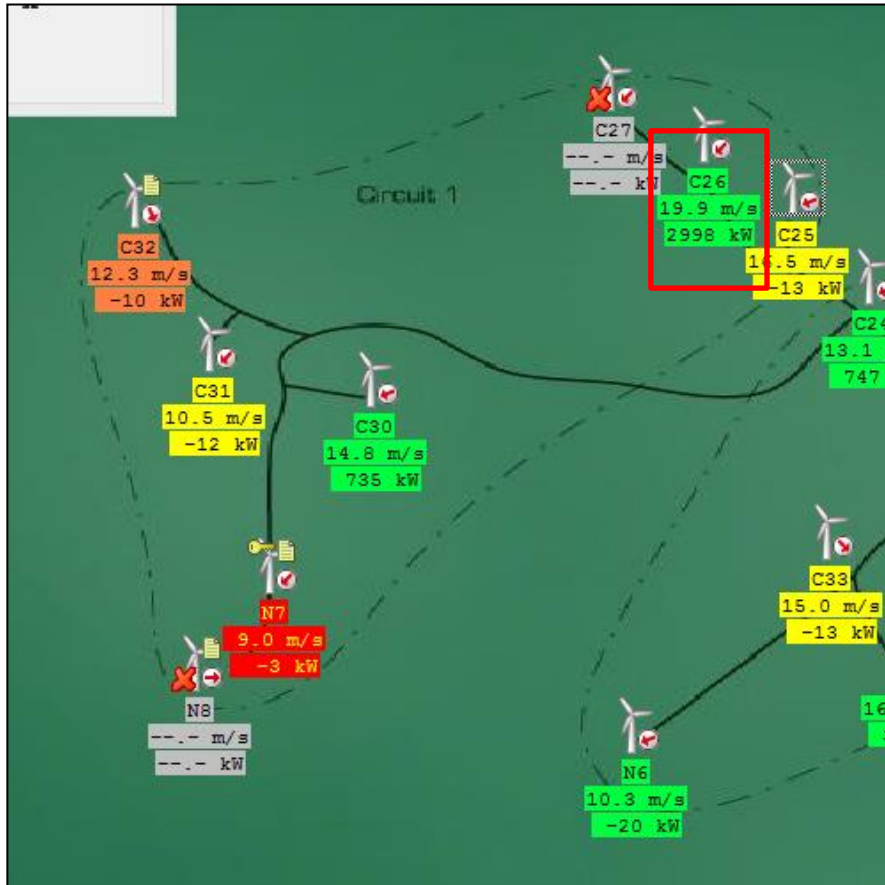
Blade from reference turbine



V90 concept demonstrator

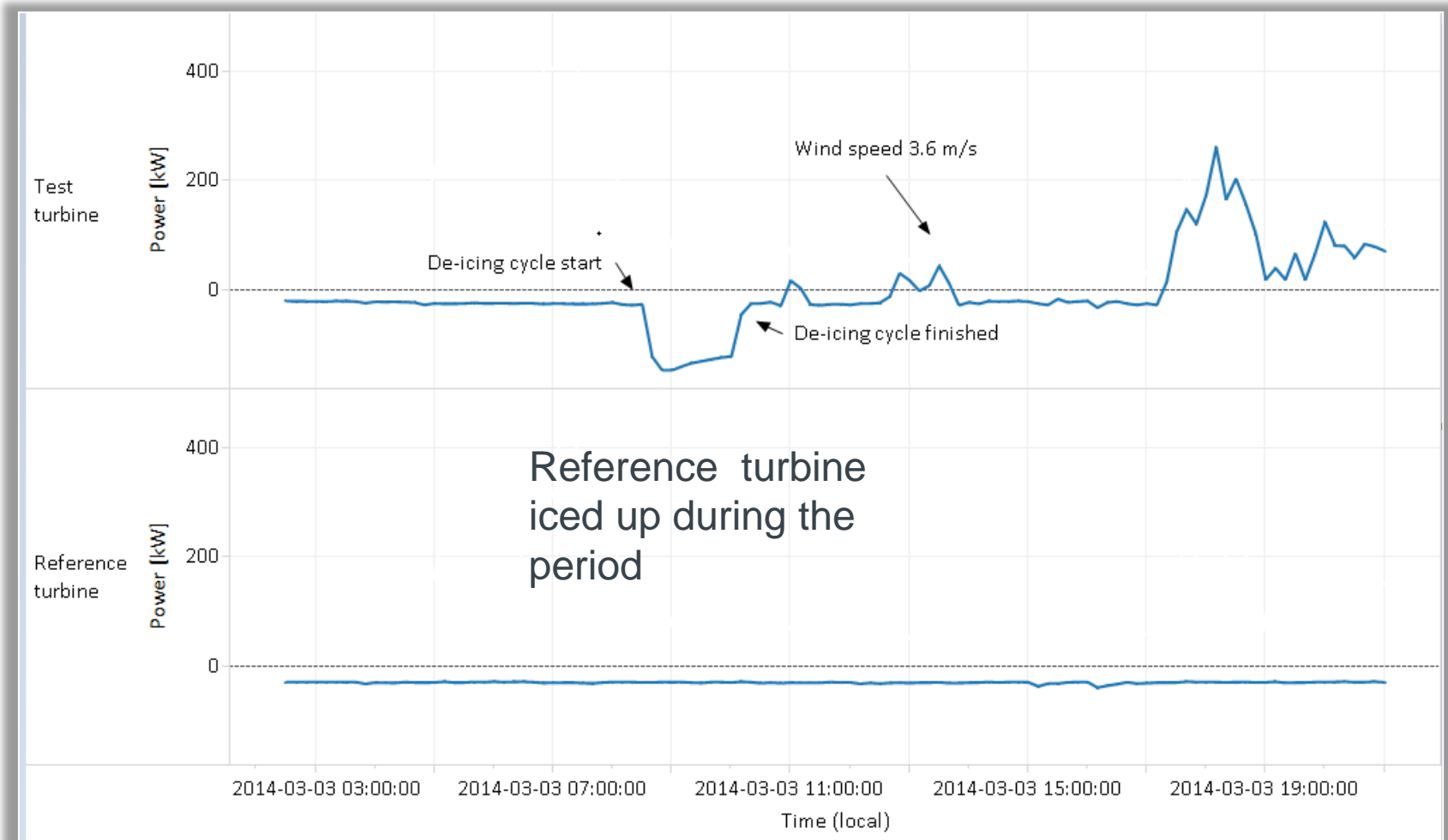
De-icing during operation – Week 52; 2014

- Turbine cut-in at 3.5m/s wind speed
- Turbine operating at minimum 90% power curve
- Canada



Successfully improved power curve after de-icing

Low wind test 3-4 m/s and 0°



Vestas De-icing System track record

What is being installed and when can the products be delivered

- 3 turbines have been tested in the winter season 2013-2014 (V90+V112)
 - In autumn 2014 the first commercial order of 30 V90-3.0 MW's with de-icing have been installed in Sweden
 - So far.... 39 V112 turbines is going to be installed in 2015 with de-icing which equals to a total track record of 72 De-icing turbines
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- Vestas De-icing System is available on V112-3.3 MW, V117-3.3 MW & V126 3.3 MW

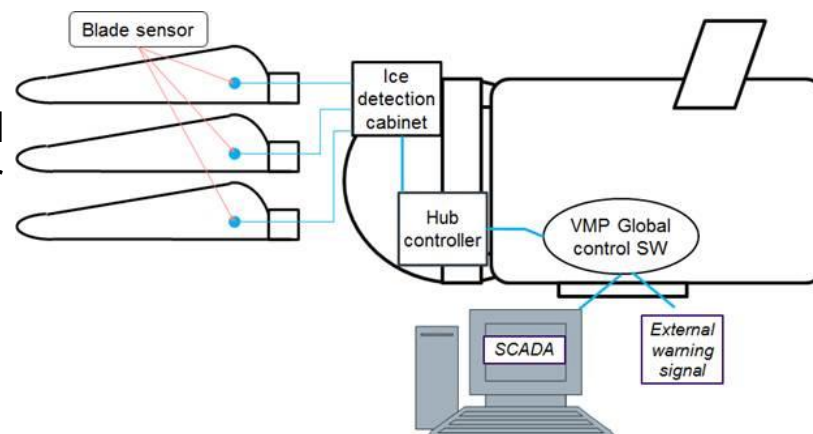
Vestas Ice Detection (VID)

Designed to reduce safety risk in icy conditions

Why Vestas Ice Detection?

- The VID offers a precise and reliable ice detector which reduce the risk of ice throws
- The VID contains an certified integrated automatic safe operational mode which shuts down the turbine when the certainty of ice is high, and allows for turbine restart, when certainty of ice free blades is achieved
- Designed to fulfil permits
- Fully integrated in the turbine operation
- Fulfils high level of requirements confirmed by a 3rd party statement that the ice sensor is “state of the art”
- Full visibility in SCADA and park level integration
- Available in Q4 2015 as a stand alone option on the 3MW product portfolio

Certified by



The Vestas logo is displayed in the top left corner of the slide. It consists of the word "Vestas" in a white, italicized, sans-serif font, followed by a registered trademark symbol (®). The background of the top half of the slide is a blue sky with wispy white clouds.

Wind. It means the world to us.™

Thank you for your attention

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