



# Development and Deployment of a New Anti-ice Product – an OEM Perspective

Winterwind 2023, Åre

[Stephen Jude Buggy](#)

Specialist, Blades Protective Functions

24 March 2023

# Development of a New Anti-ice Product – an OEM Perspective

Hej allesammans!

**Who?**

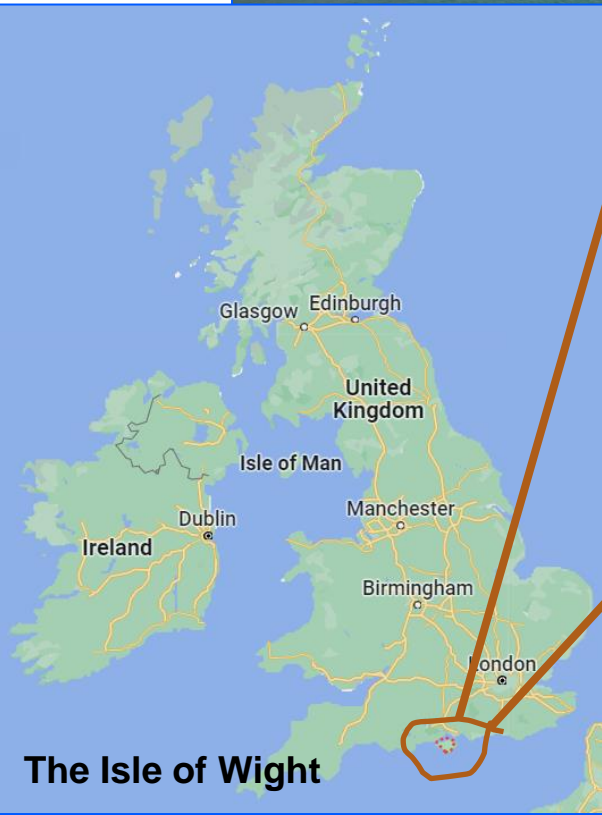
- Stephen Jude Buggy
- Specialist with the Blades Protective Functions Team

**Where?**

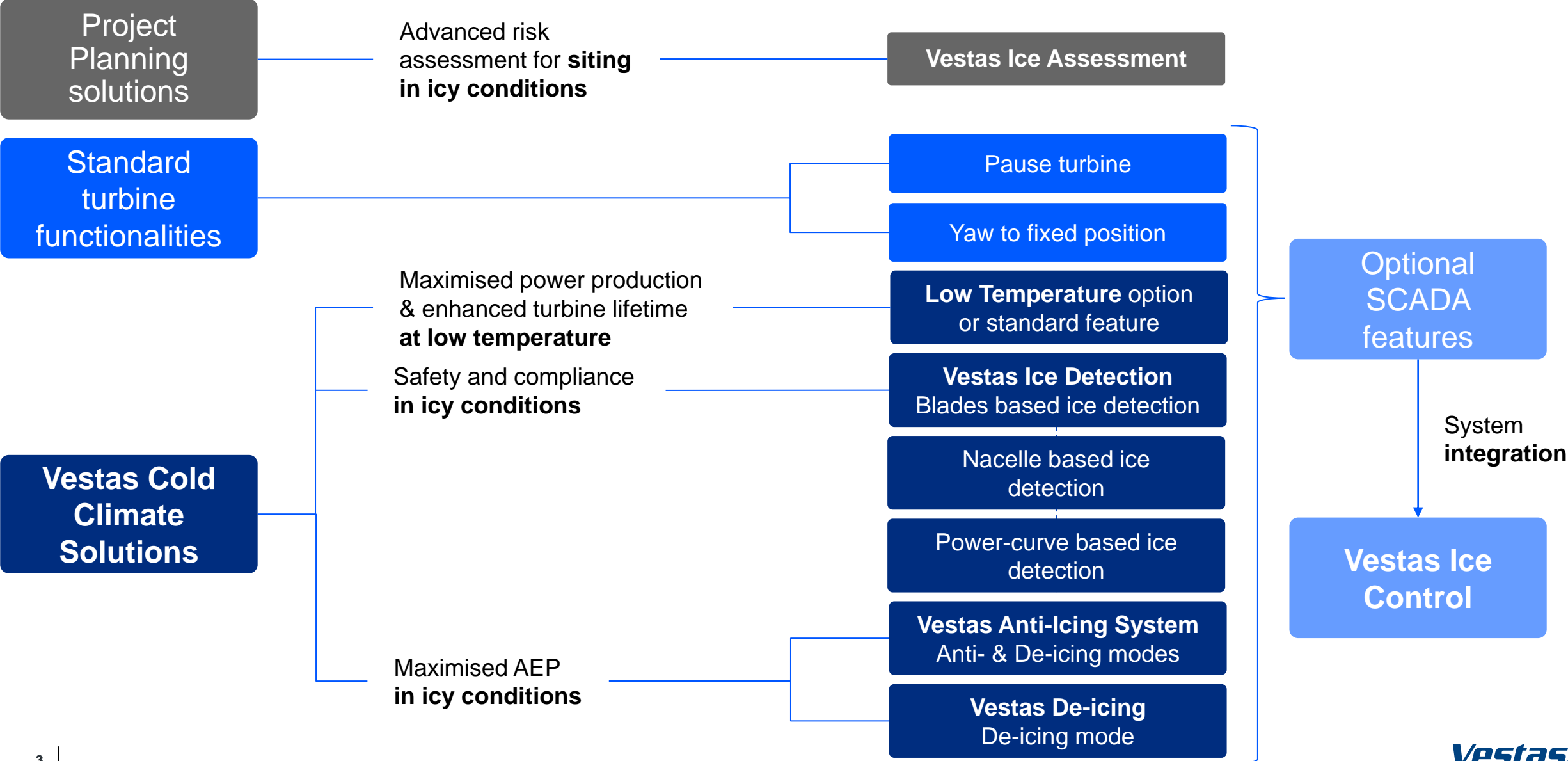
- Blade Design Centre – Vestas Technology UK

**What?**

- Vestas anti-icing
- Blade lightning protection system



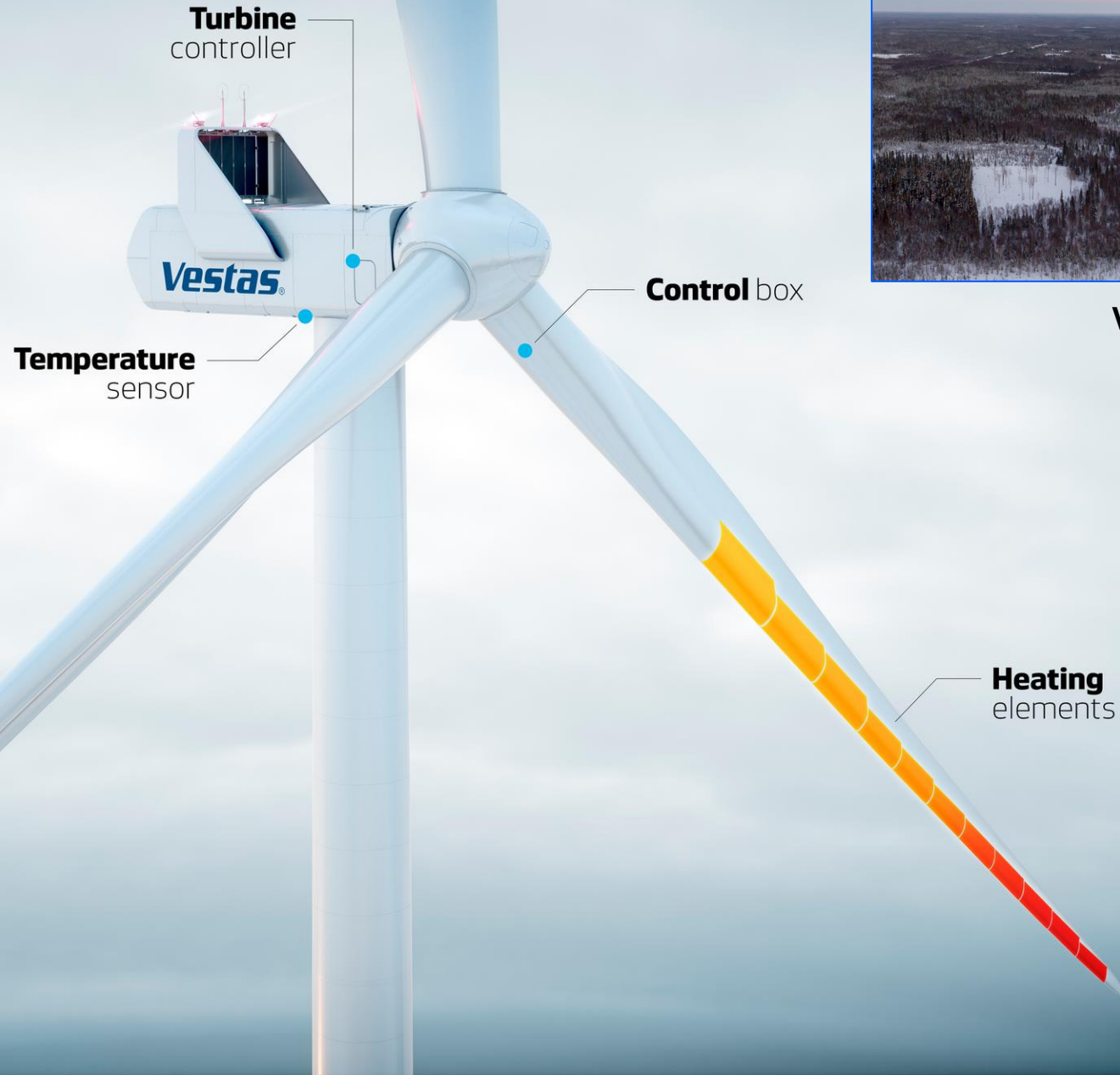
# Vestas Cold Climate Program



# Vestas Anti-Icing System™

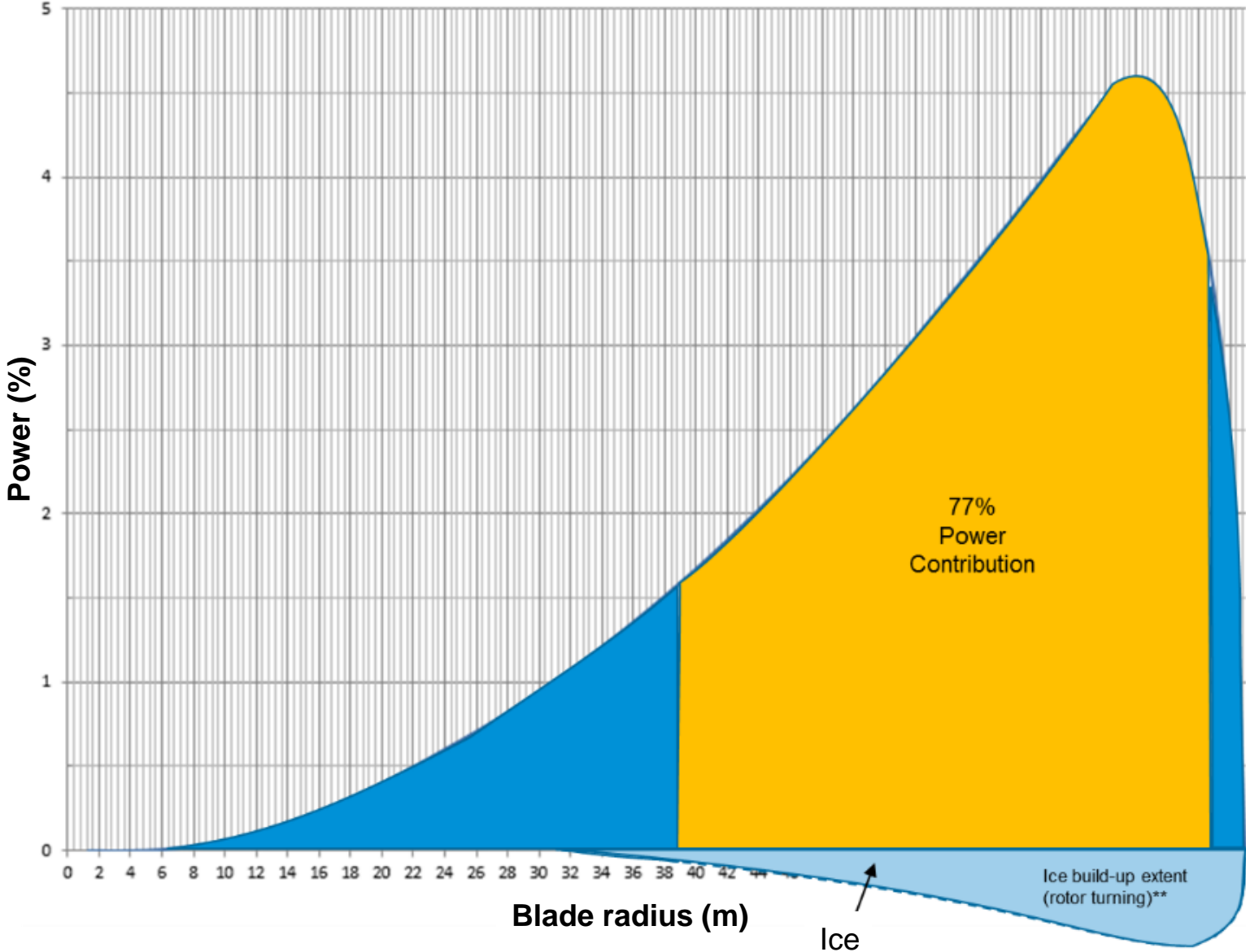
## Where and when it's needed

- **Automatic anti-icing mode** adaptive to climatic conditions for maximum **efficiency** to match the icing event
- **Targeted aerodynamic area**
- **Embedded heating system** in the laminate, close to the surface provides a **fast response time** with **no AEP impact**.
- **Optional control features** to match system performance to individual site conditions through SCADA
- Compatible with **Vestas Ice Detection™**



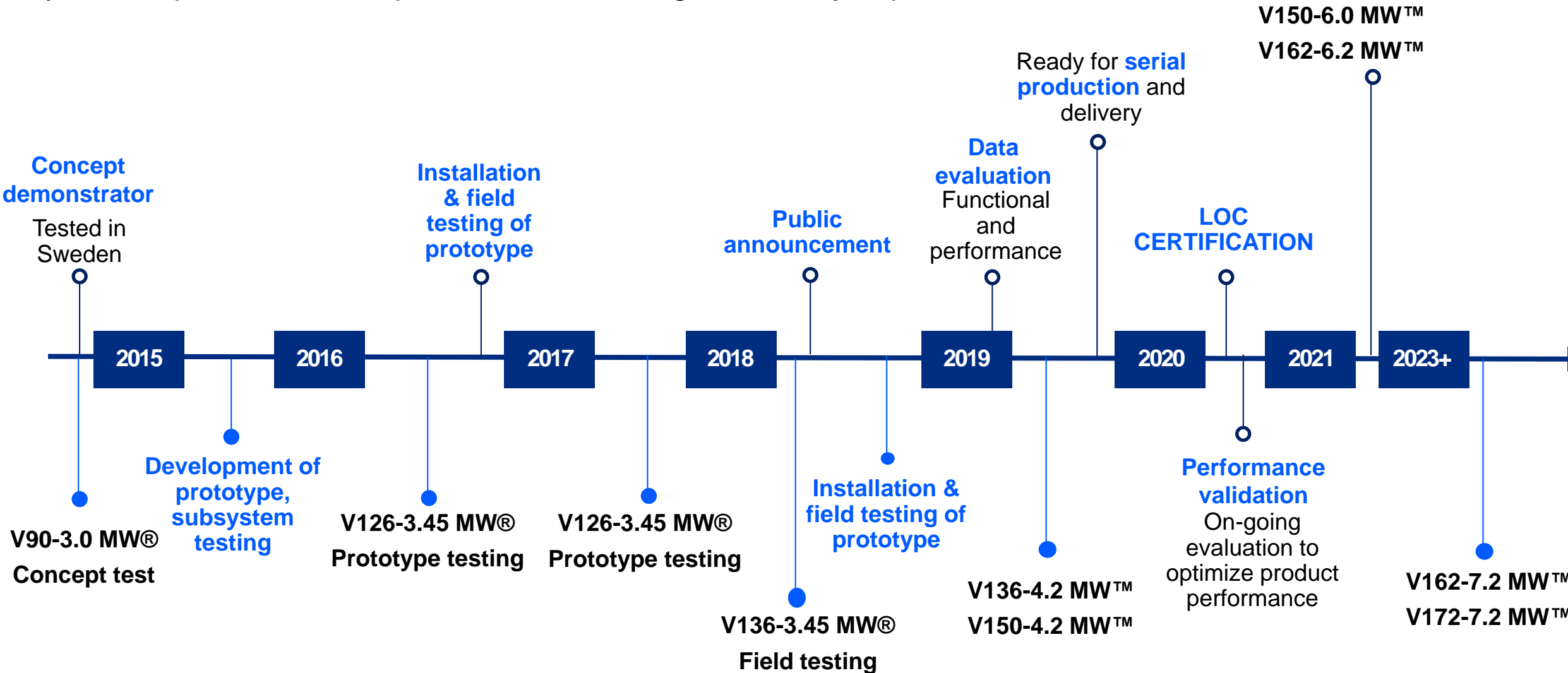
V136 VAS

# Targeted Aerodynamic Area



# Vestas Anti-Icing System™ timeline

8 years of product development to secure high reliability & performance

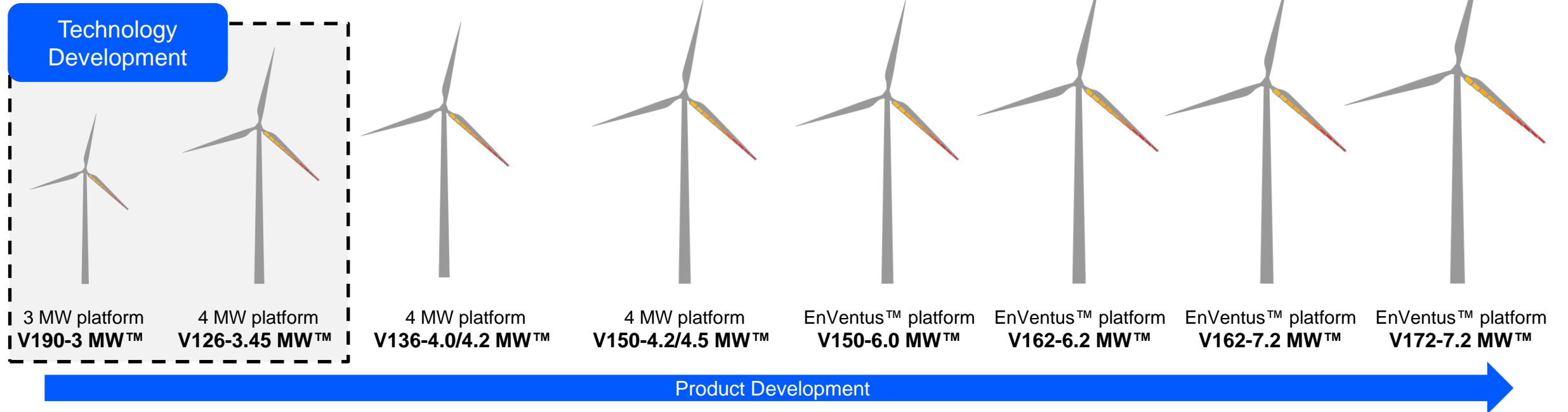


# Vestas Anti-Icing System™

A design applicable to multiple turbine variants

Designed to cover a **wide range of turbine configurations** the **Vestas Anti-icing system™** designs **apply a modular approach**

- Same component and circuit design and sizing
- Standard interfaces for modular hardware integration
- Shared software architecture, allowing for scalable configuration
- Common ice detection system

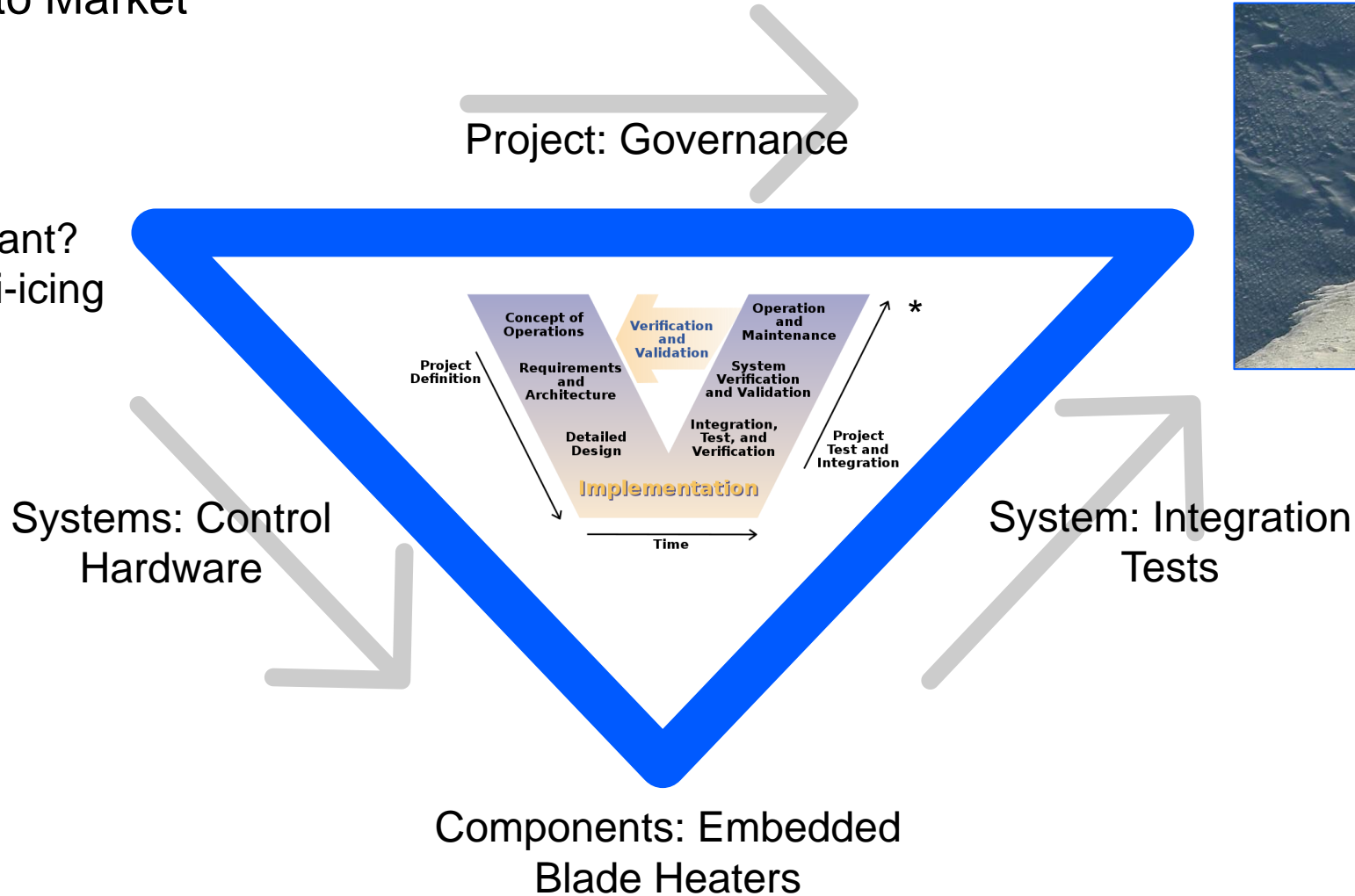


# The Design Challenge

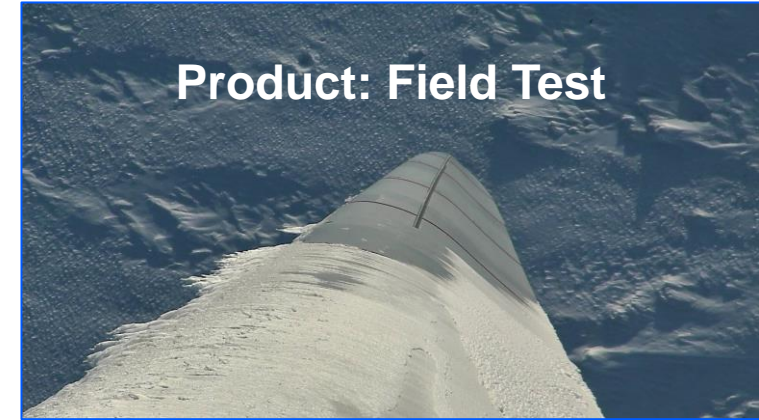
Vestas Way to Market



What do we want?  
Product: An anti-icing system



V90 test

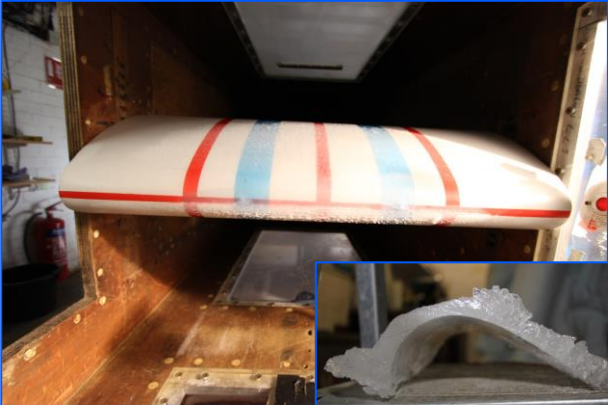




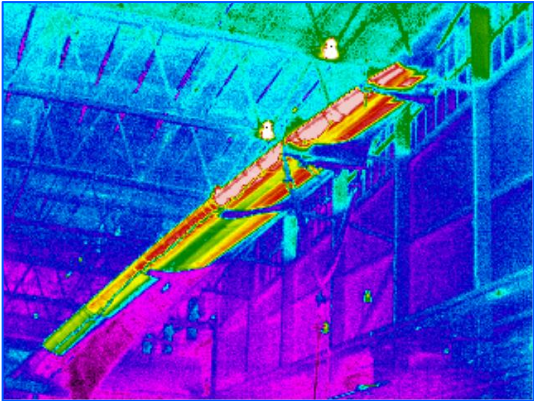
# The Design Challenge

## Component to Product

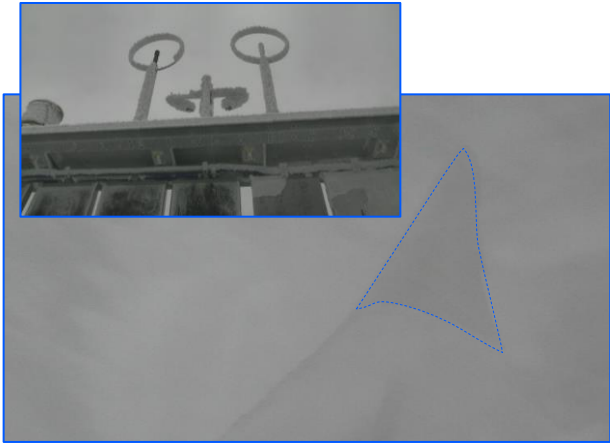
Components



Sub-Systems



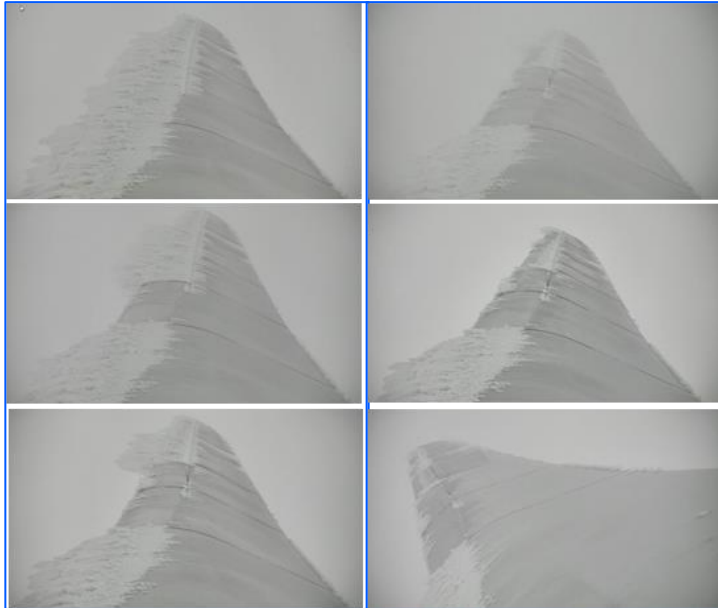
Product



# The Design Challenge

## Technology to Product

V90



V126



V136

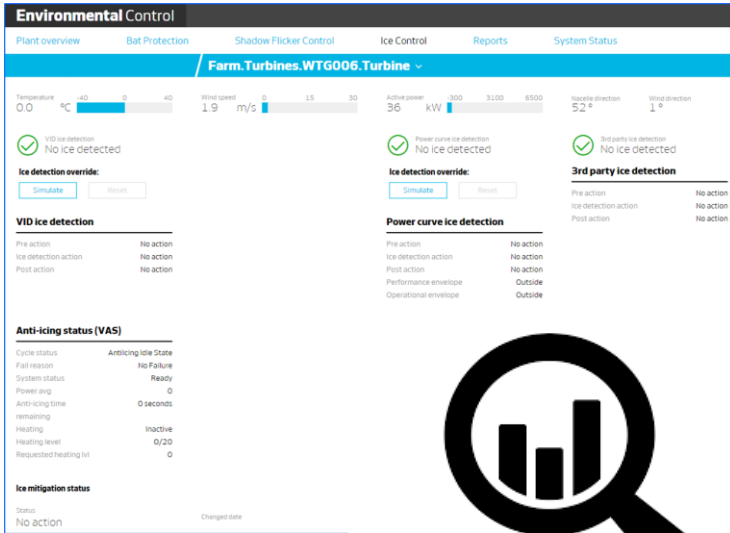


- Stand alone control
- Prototype materials
- First field experience

- Semi-integrated control
- Product level materials
- Lightning system robustness

- Fully integrated control
- Full product design
- Full blade lightning test

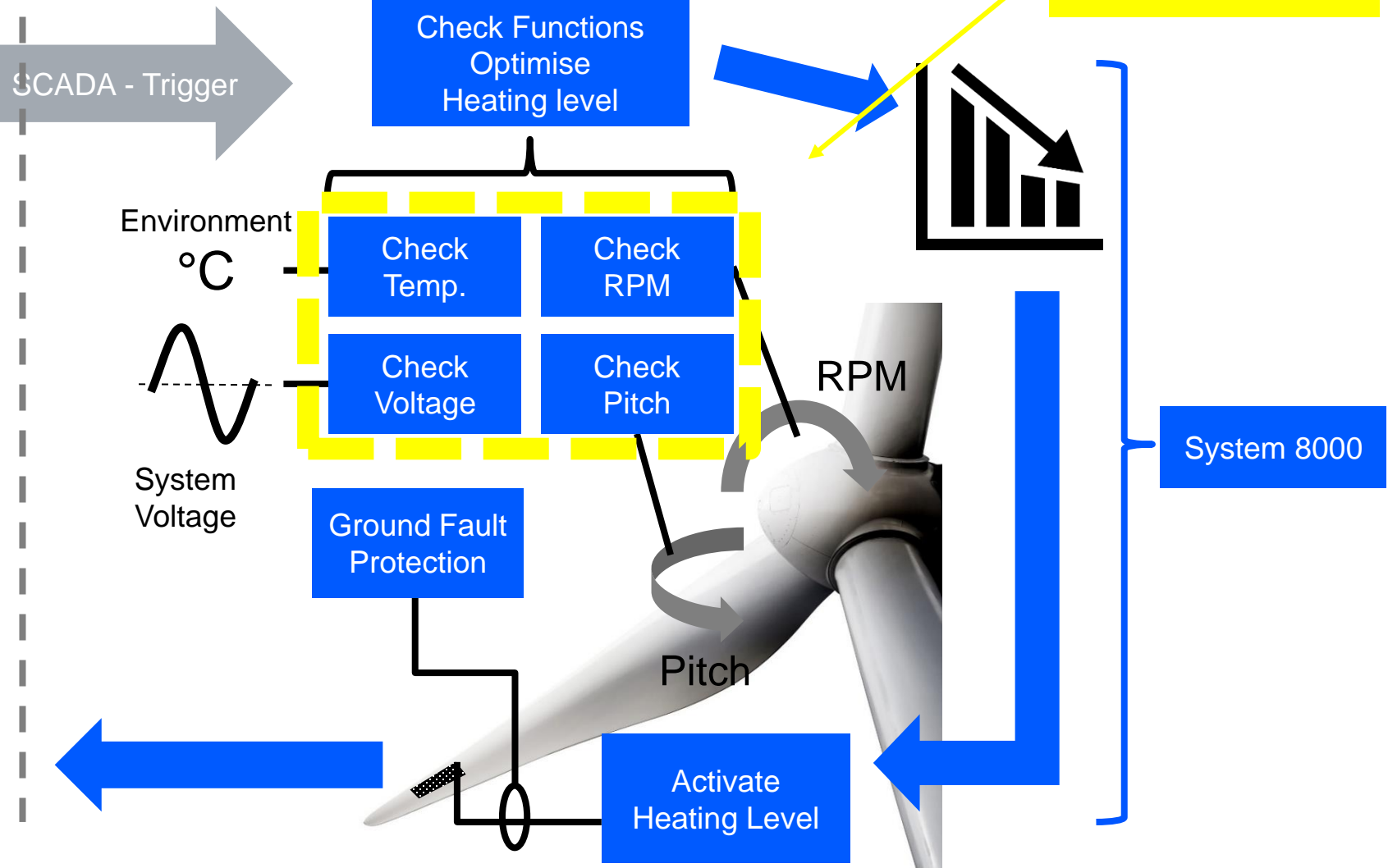
# Vestas Anti-Icing System Control Method

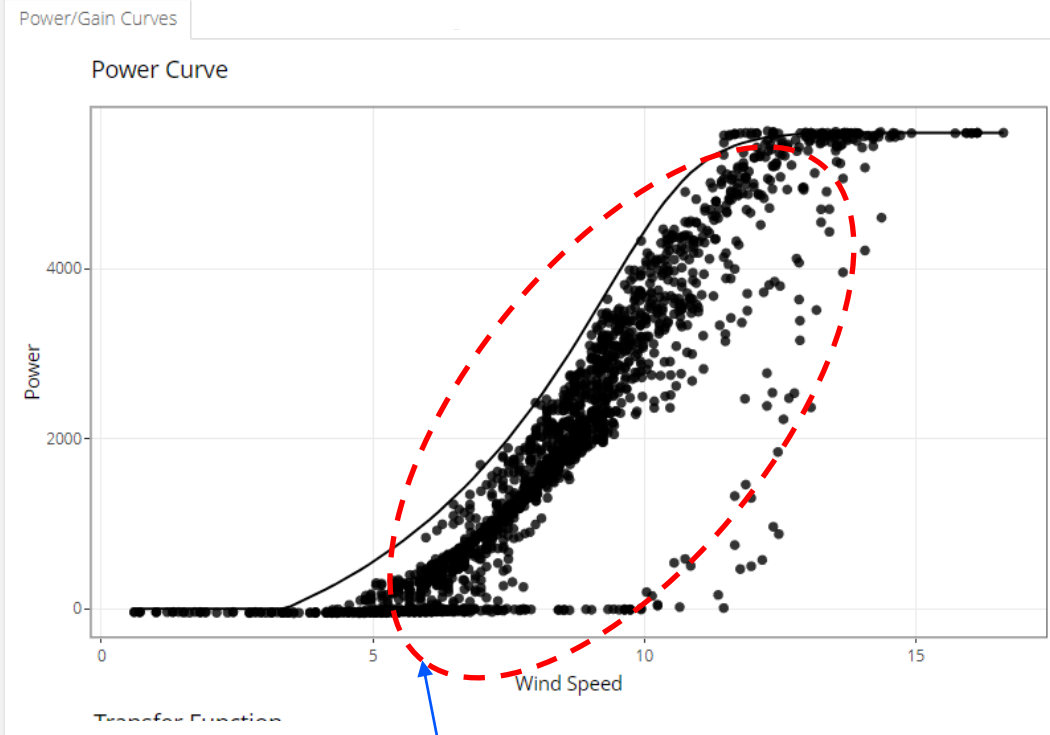
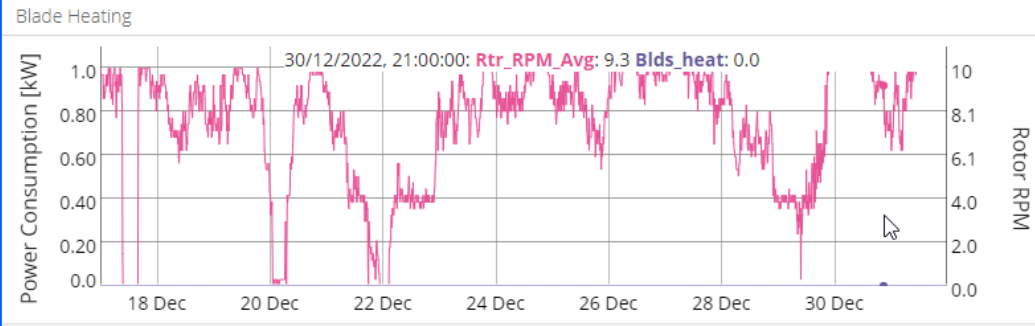
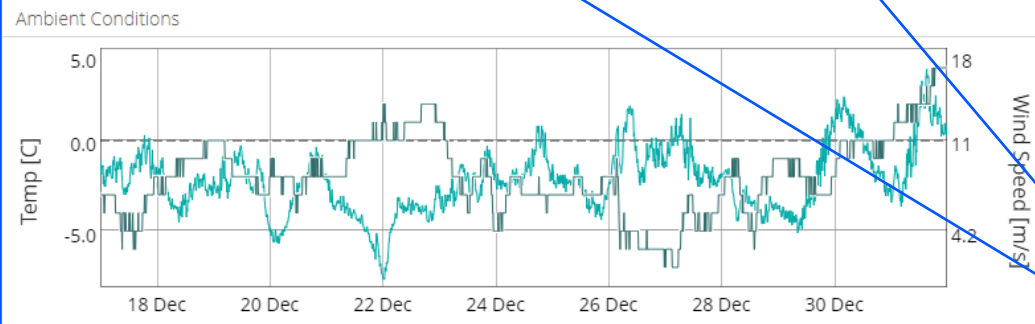
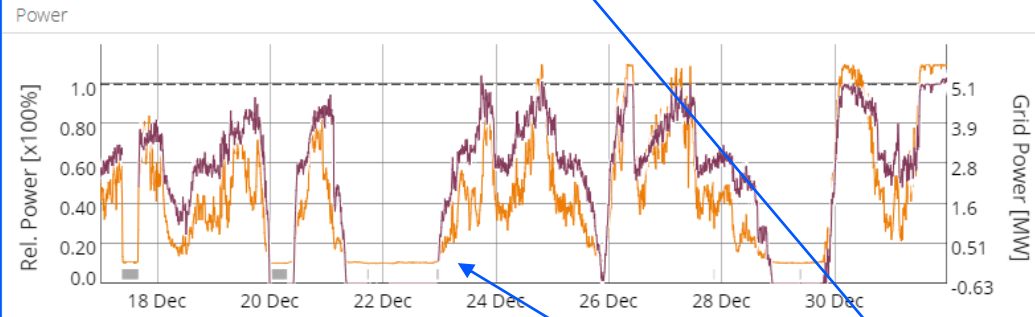
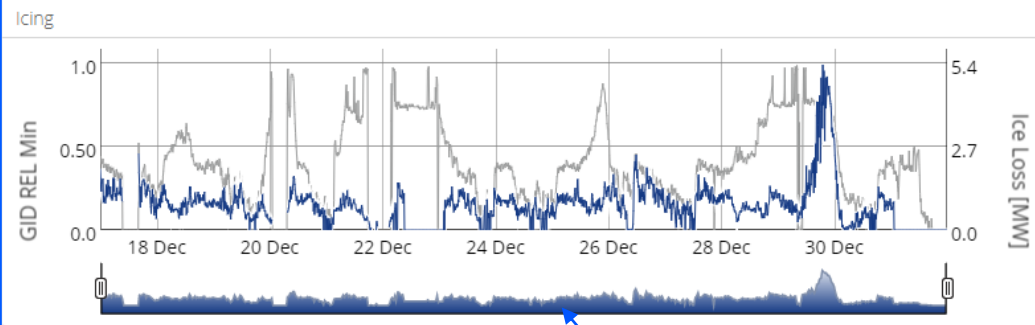


PCID - (Power Curve Ice Detection)

Check Power Curve  
Activate/Deactivate  
VAS

SCADA - Trigger

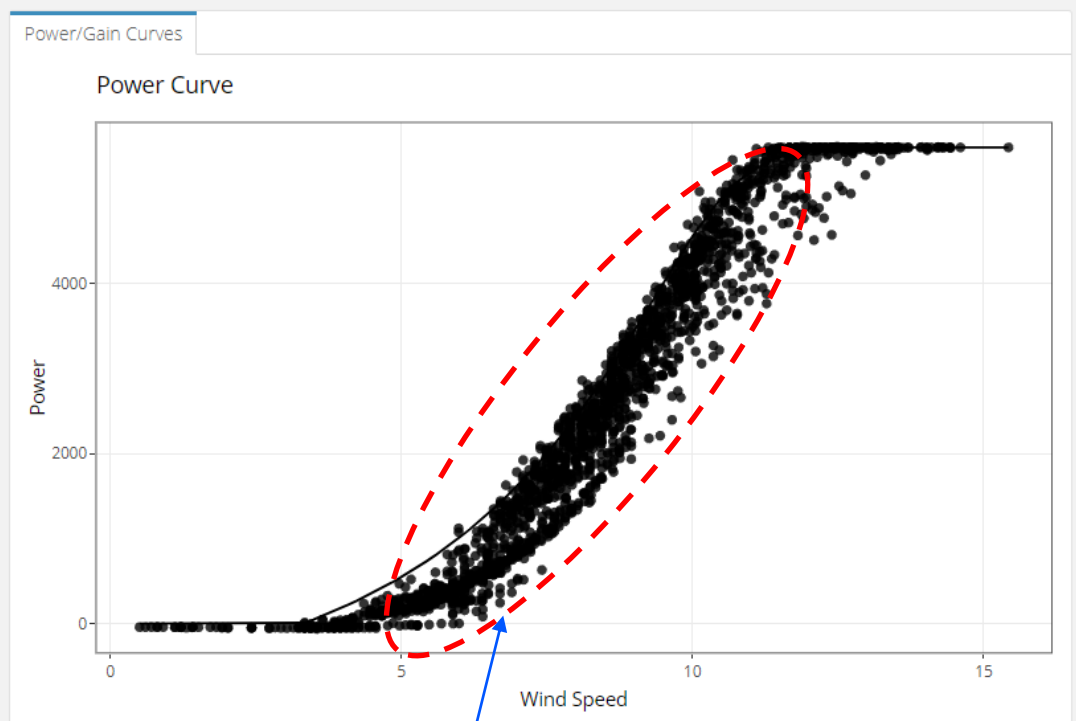
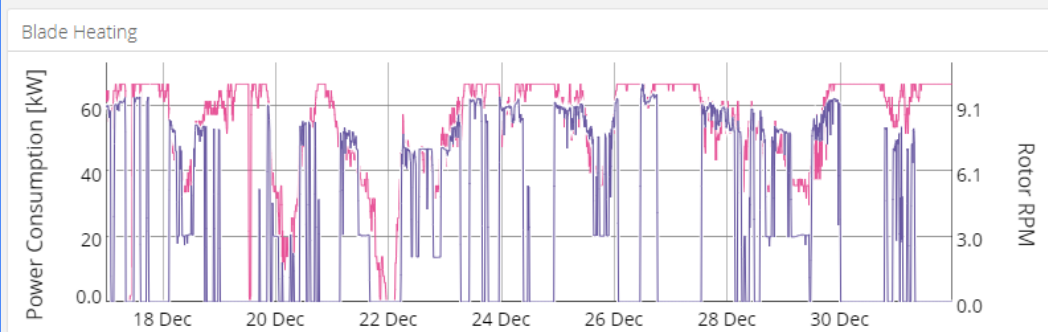
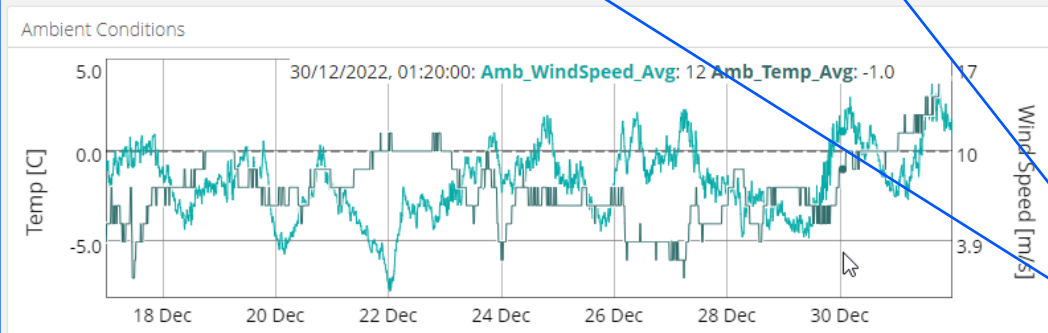
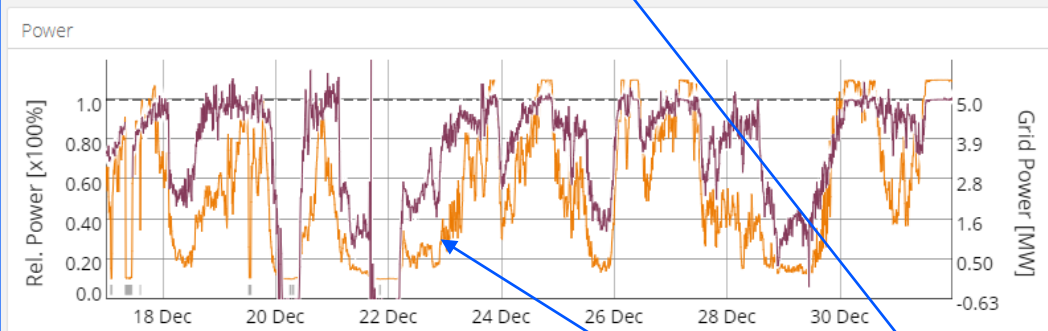
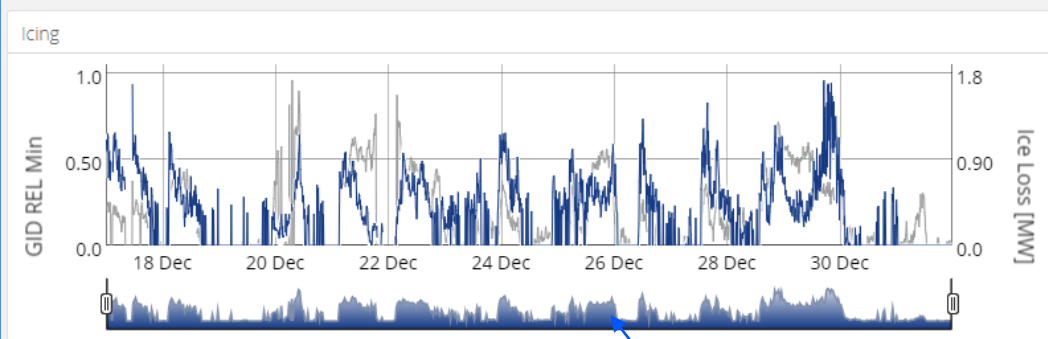




Impacted Power Curve

Impacted production during prolonged icing event

Nordics December 17-31 2022



Cleaner Power Curve

Improved production during prolonged icing event

Nordics December 17-31 2022

# Methods to Measure Ice Recovery?

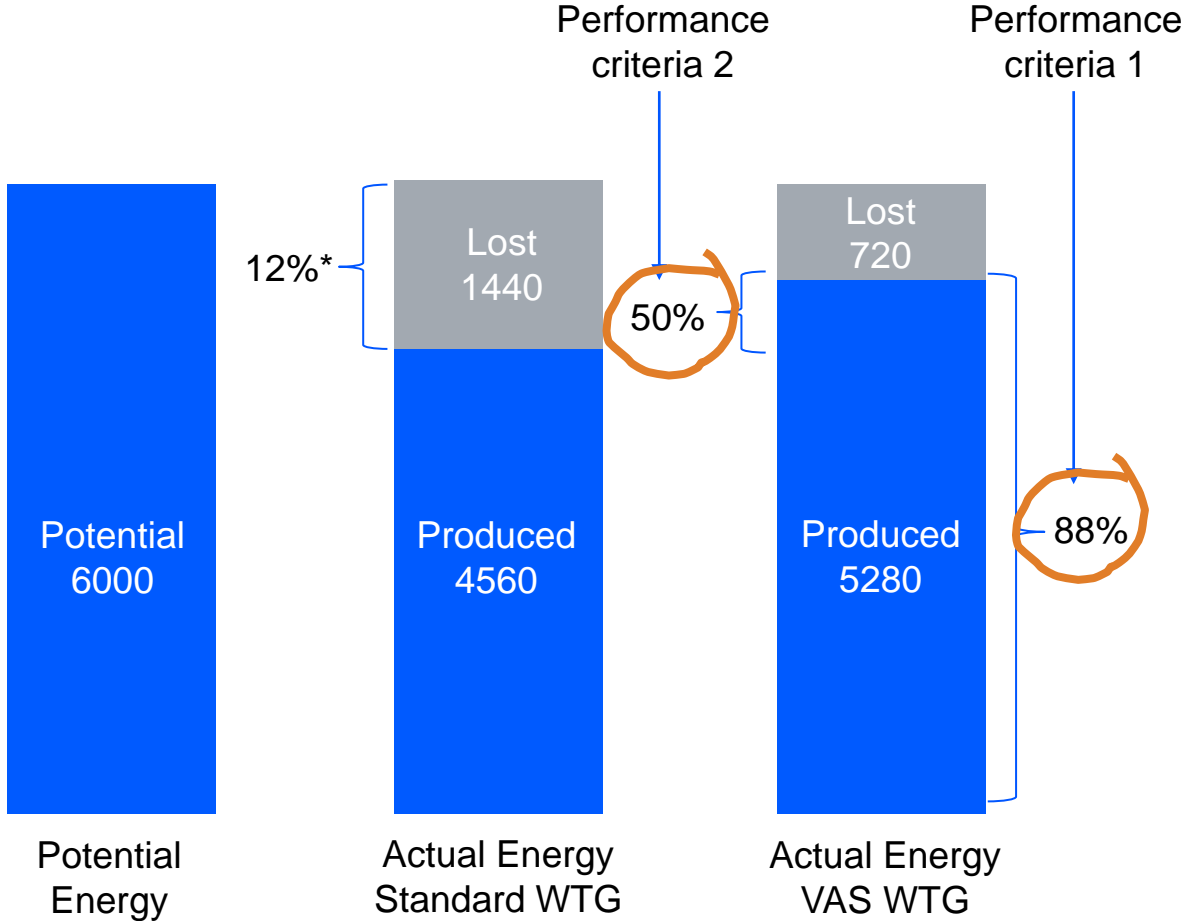
Table 1. Performance criteria calculation examples with high icing losses.

		WT 1 No IPS	WT 2 IPS	WT 3 IPS
Yearly gross energy production	MWh	12000	12000	12000
Yearly icing loss %	%	12%	6%	2%
Yearly icing loss	MWh	1440	720	240
Test period (T)	month	6	6	6
Actual Energy production during T (E <sub>A</sub> )	MWh	4560	5280	5760
Potential Energy production during T (E <sub>P</sub> )*	MWh	6000	6000	6000
<b>Performance Criterion Eq. 1</b>		76%	88%	96%
<b>Performance Criterion Eq. 2</b>		-	50%	83%

\*Assuming all energy production loss due to ice occurs during test period

Table 1 shows how the performance criterion from Equation 1 and 2 varies in result, depending on the IPS efficiency for turbines 2 and 3.

From: [IEA T19 Performance Guideline](#)



\*Ice loss over the year (24% loss over 6 months)

# Lessons Learned

2 key lessons learned so far....

## 1) Efficiency isn't everything

- Activate with maximum heat as quickly as possible.
- The original strategy targeted using the power as efficiently as possible by starting low and increasing the heating level and reacting to the impact on the power curve.

## 2) Keep the rotor running

- Activating standstill or de-ice cycles too soon proved to be impactful on overall system performance.
- Keeping the rotor spinning for as long as possible is better.

## 3) Detect ice quickly

- Activating as quickly as possible to early onset of icing conditions improves performance.

# Vestas Blades Protective Function Tack så mycket

---