

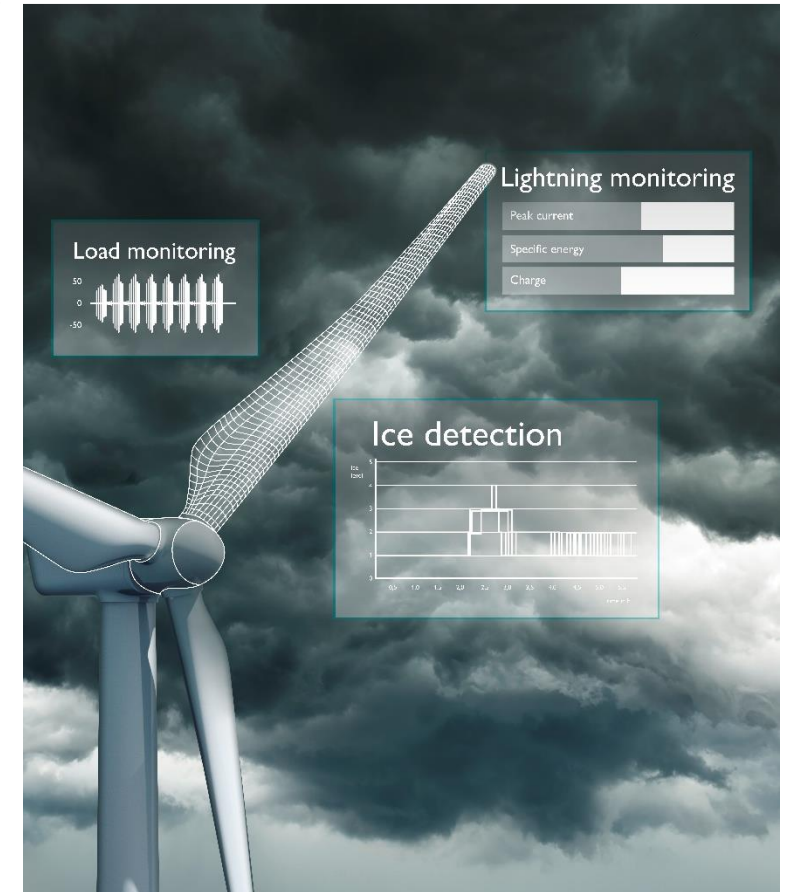
Welcome

Load Monitoring: The way to operate WTGs under Ice Conditions?

Rotor blade monitoring with Blade Intelligence

Agenda

- Phoenix Contact about us
 - Blade Intelligence
 - Test Turbine
 - Results
 - Outlook
-



Rotor blade monitoring with Blade Intelligence

Phoenix Contact about us

- **Founding year** 1923 in Essen, North Rhine-Westphalia, Germany
- **Turnover 2021** 2.97 bn. €
- **Number of employees 2021** 20,300 worldwide
- **Production sites** China, USA, Germany, Greece, India, Poland, Russia, Sweden, Switzerland, Taiwan/China, Turkey
- **Products** > 100.000 articles
- **Sales** Represented in more than 55 subsidiaries worldwide

Since Q2/2021 all Phoenix Contact operations globally are climate neutral

Phoenix Contact offers you creative solutions in the fields of connection technology, electronics and automation on the journey to a smart world.

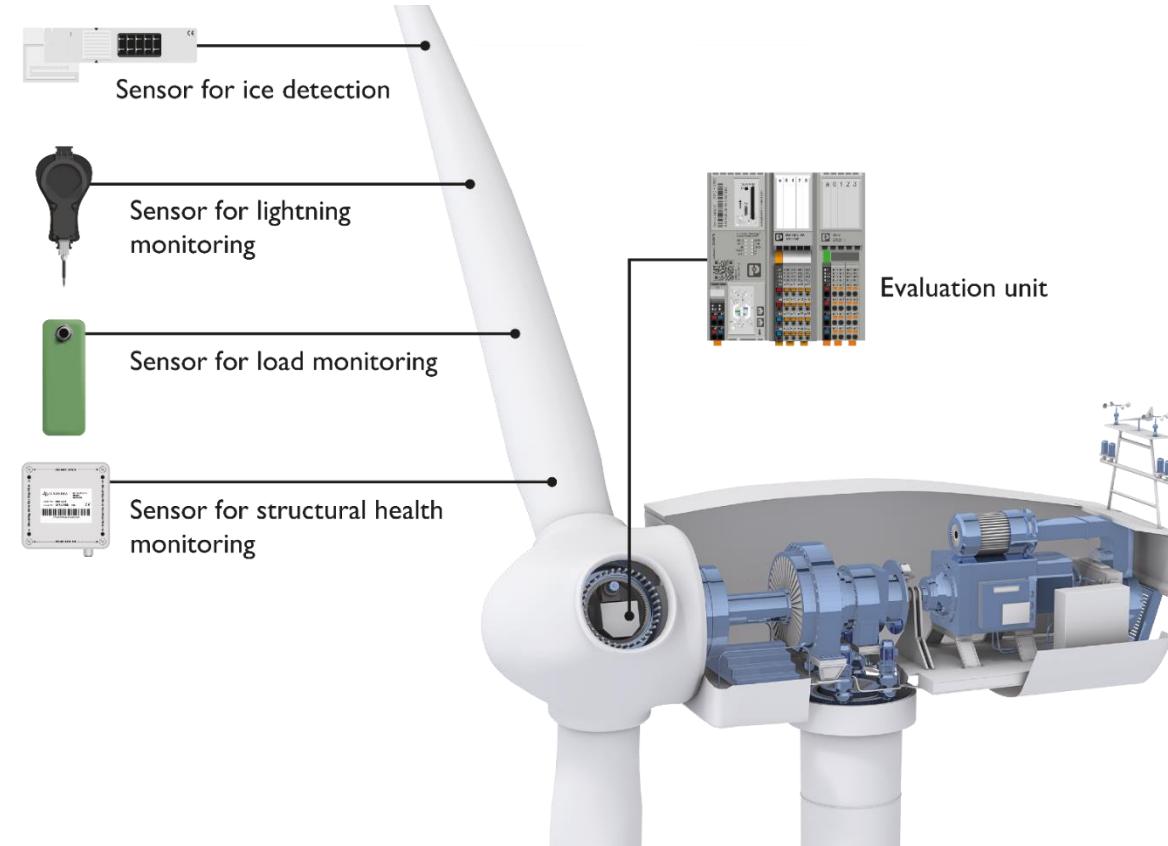
A privately held company founded in 1923 that is vertically integrated and independent in its entrepreneurial decision-making freedom.

Rotor blade monitoring with Blade Intelligence

Blade Intelligence

The modular design of this solution allows the individual solutions to be combined as needed **depending on the requirements.**

Sensors developed specially for installation on the rotor blade provide all the data necessary for processing in a **common evaluation unit.**



Rotor blade monitoring with Blade Intelligence

Blade Intelligence

More than

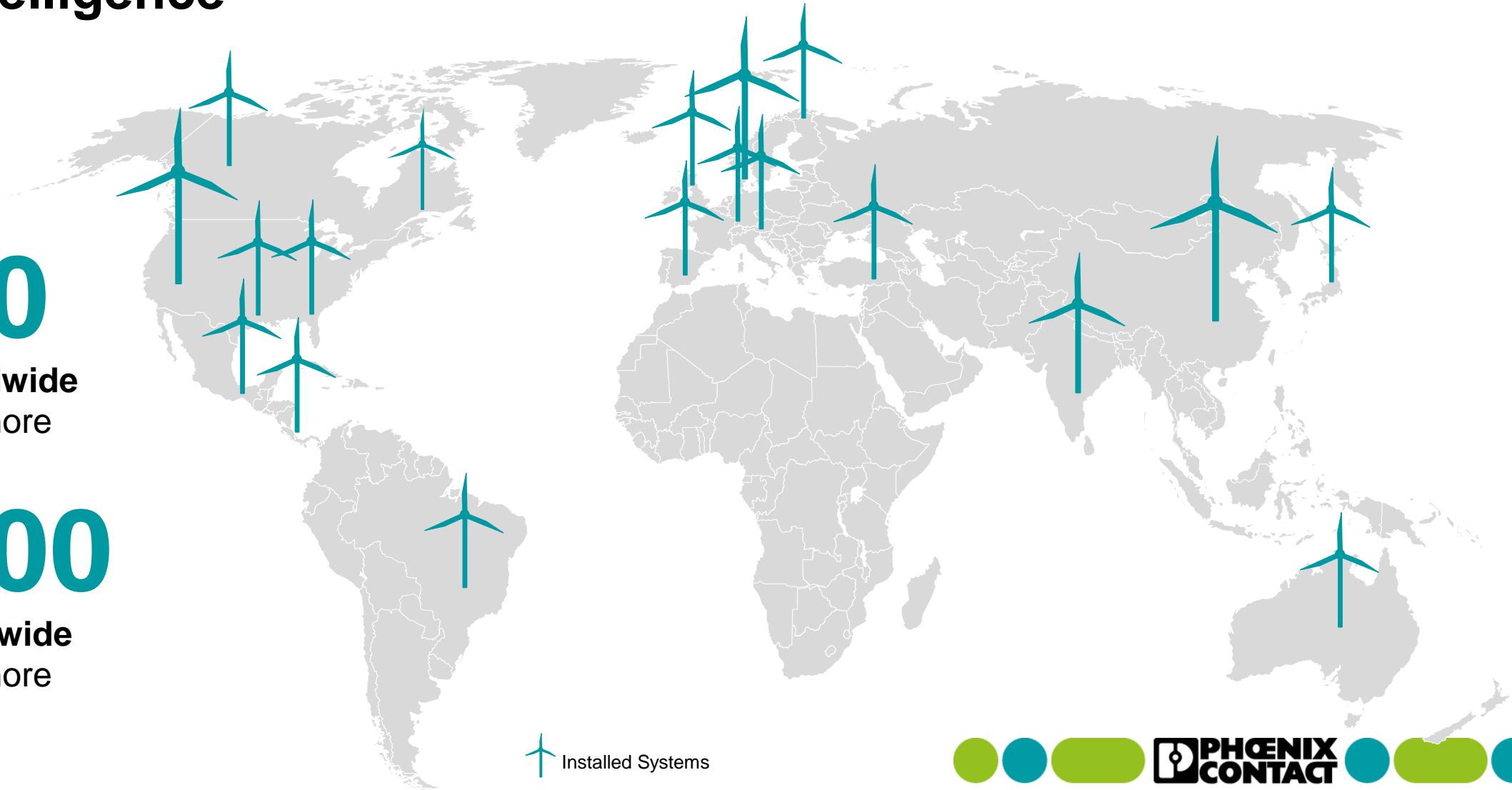
3.200


systems worldwide
onshore & offshore

More than

90.000

sensors worldwide
onshore & offshore

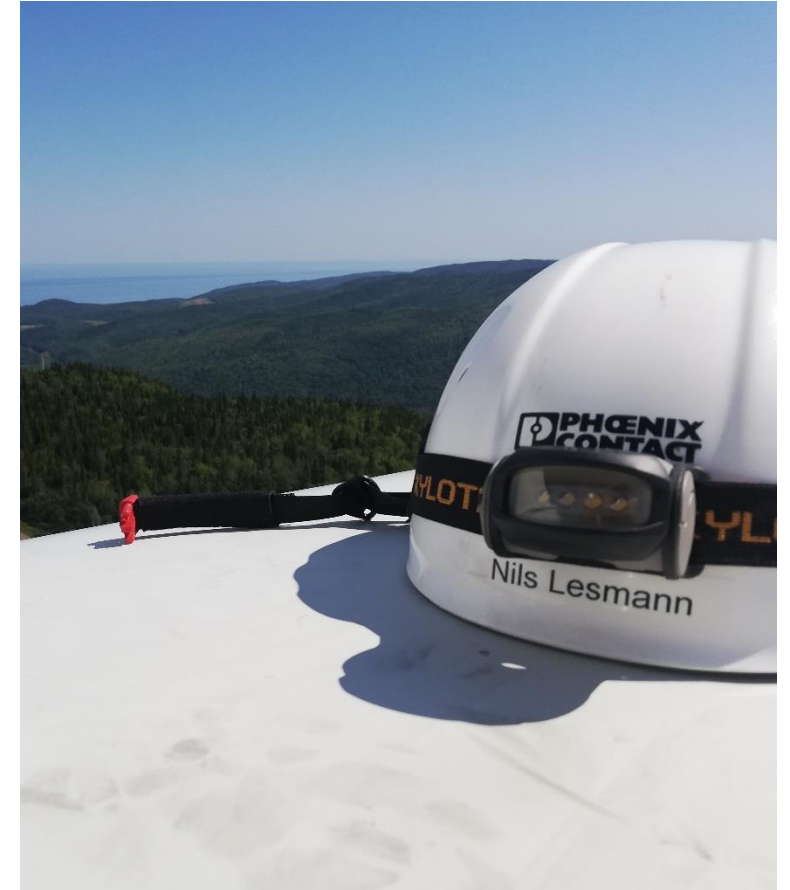


 Installed Systems

Rotor blade monitoring with Blade Intelligence

Project Scope

- Nergica uses Phoenix Contact Ice Detection System and Load Monitoring System on WTG 1 in Gaspe
- Enabling Operation with ice mode on existing WTG
 - No early shut down of the WTG
 - Run WTG with ice on the blades



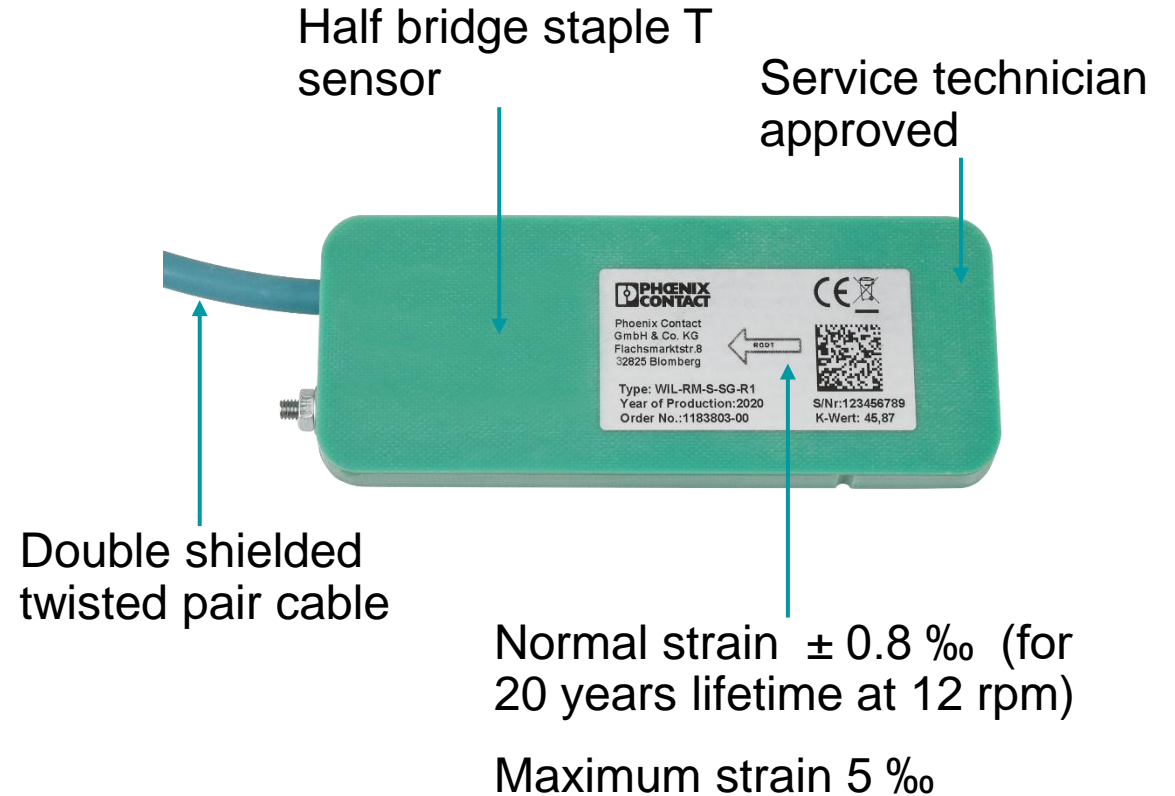
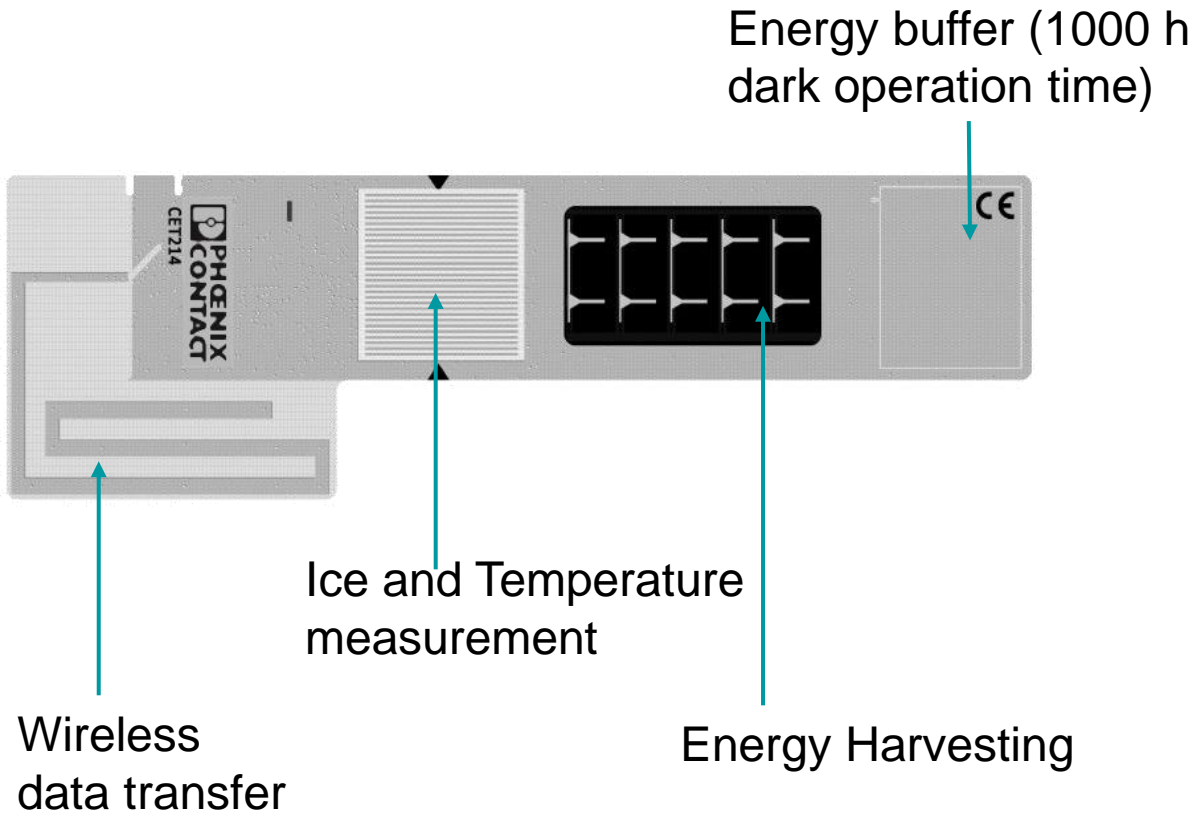
NERGICA

Renewable
Energy Research
and Innovation



Rotor blade monitoring with Blade Intelligence

Sensors Technology



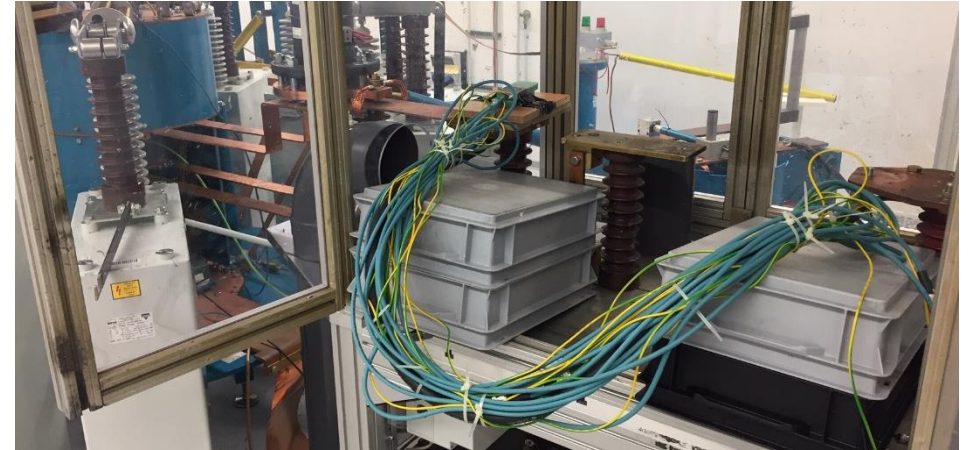
Rotor blade monitoring with Blade Intelligence

What about Lightning?

Sensors tested up to

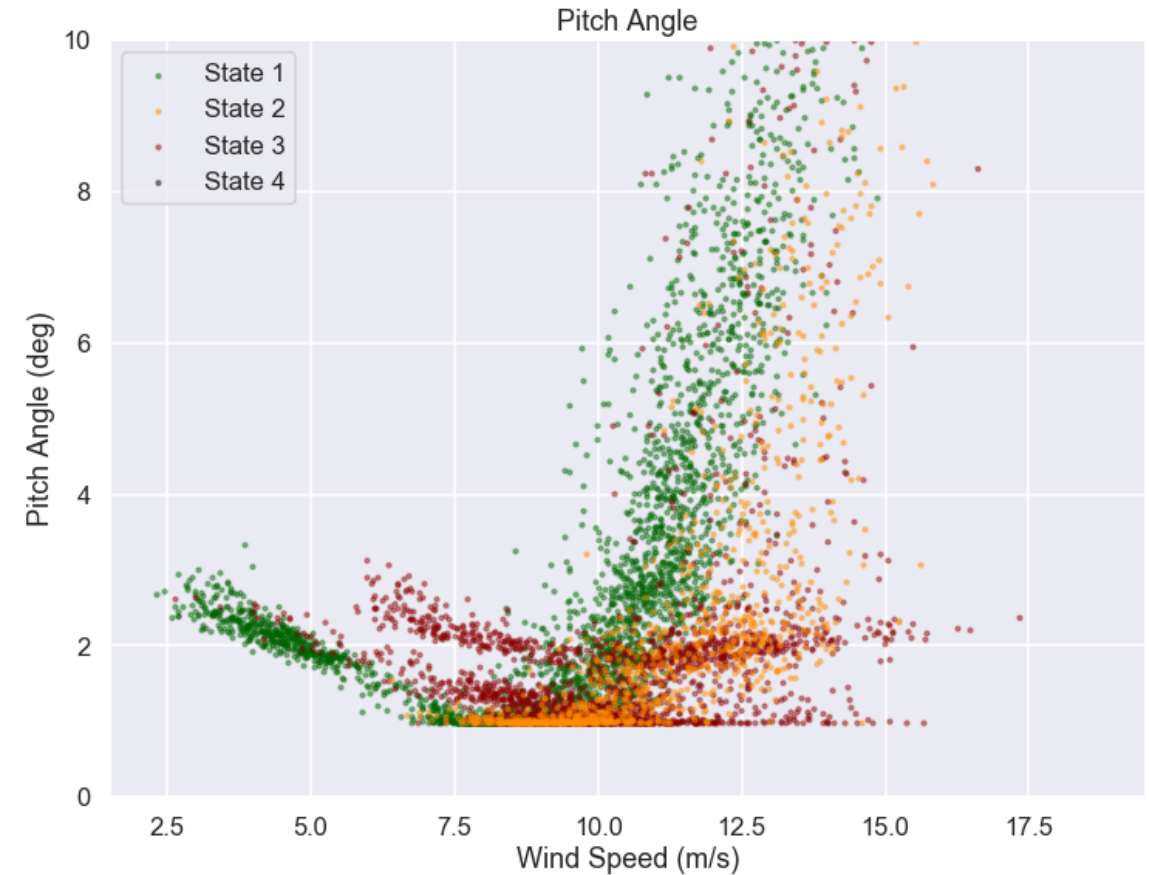
- 200 kA 8/20
- 100 kA 10/350

Lightning Impulses



Rotor blade monitoring with Blade Intelligence

Turbine Parameter under icing conditions



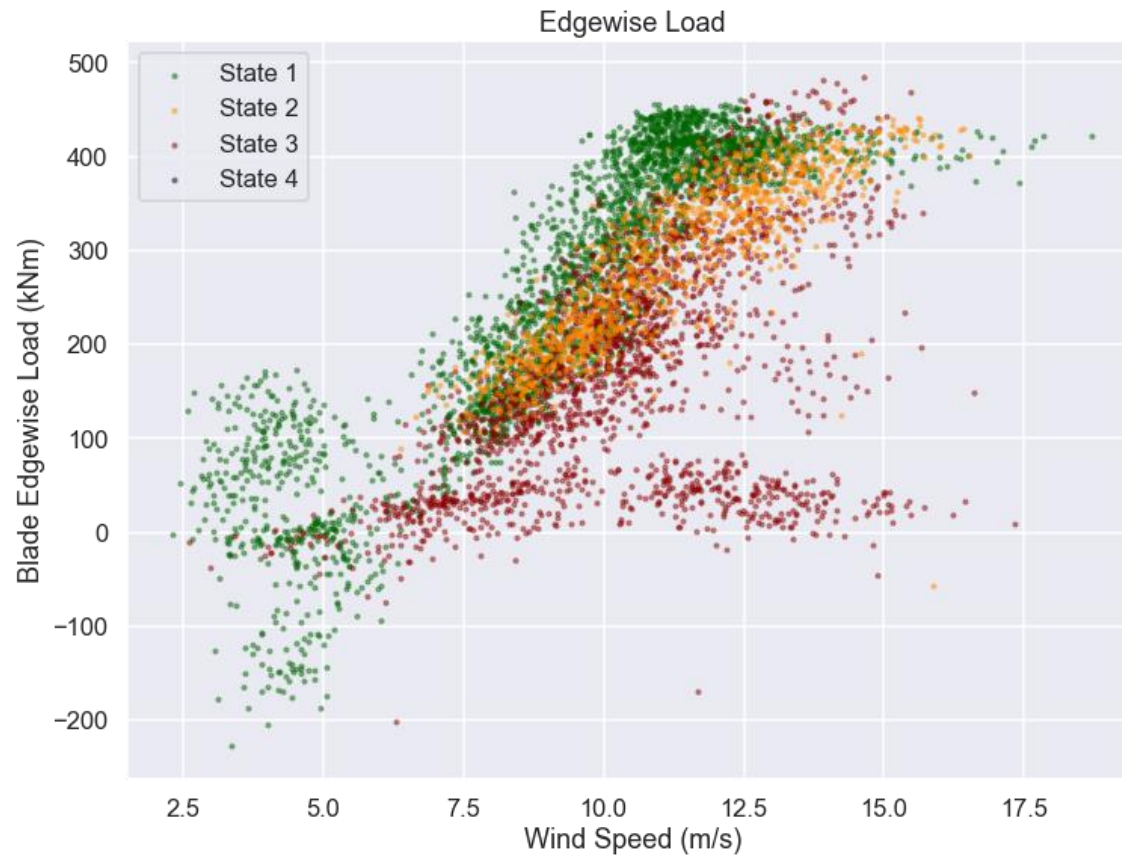
WindESCo



INSPIRING INNOVATIONS

Rotor blade monitoring with Blade Intelligence

Load Data under icing conditions



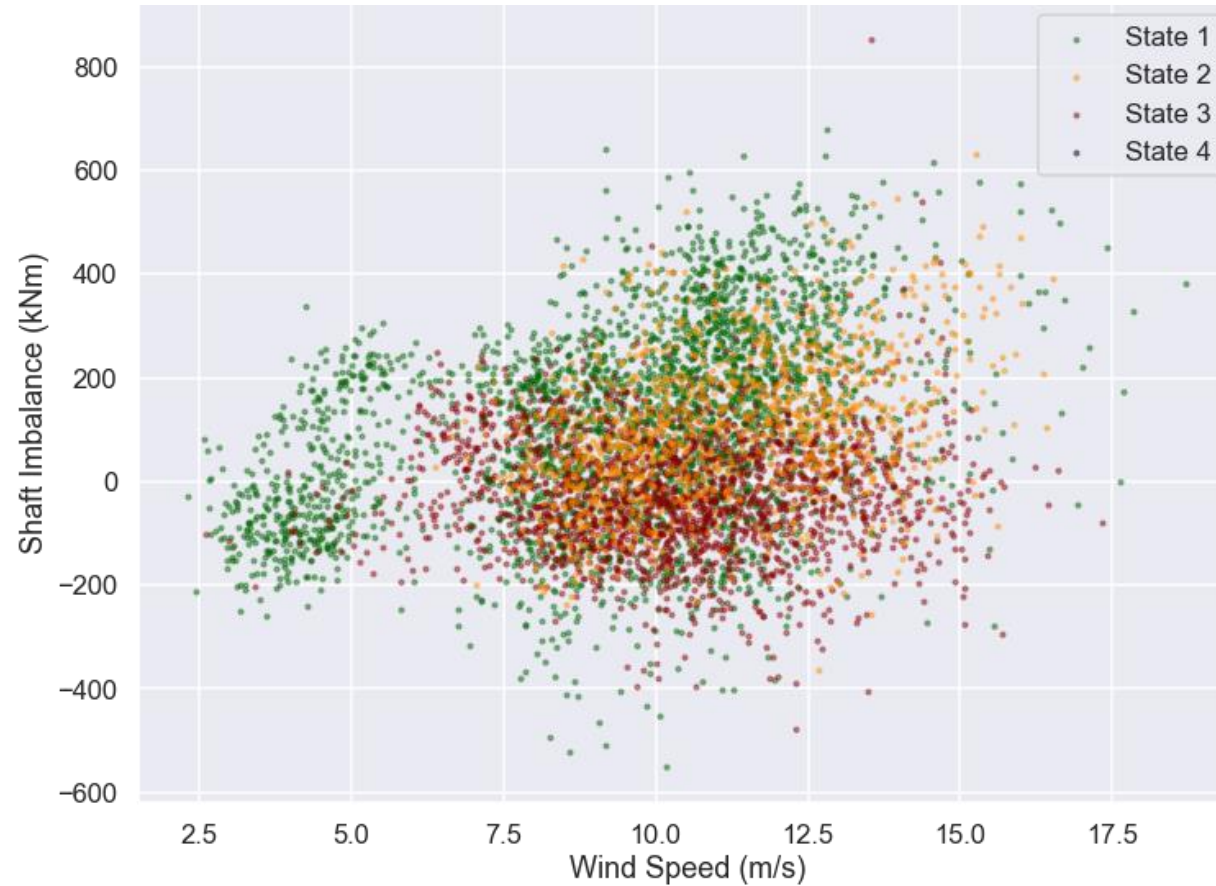
WindESCo



INSPIRING INNOVATIONS

Rotor blade monitoring with Blade Intelligence

Shaft bending under icing conditions

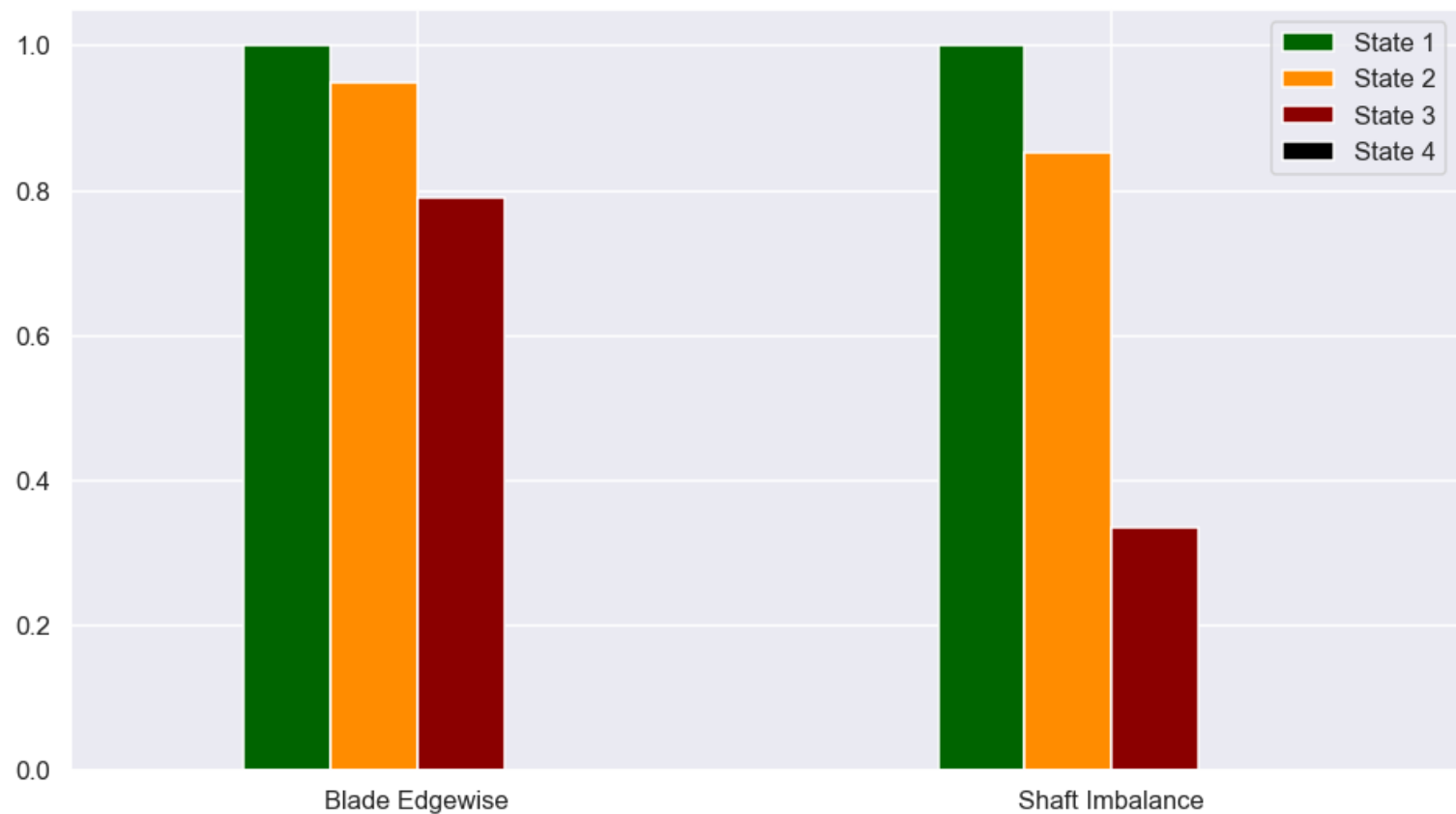


WindESCo



INSPIRING INNOVATIONS

Loads Vary with Ice Thickness



Rotor blade monitoring with Blade Intelligence

Icing Event on the 4th of April

WEC001 / HUBCAM1 / 10.8 degC / Day / 2021-04-04 17:34:59

NERGICA



NERGICA

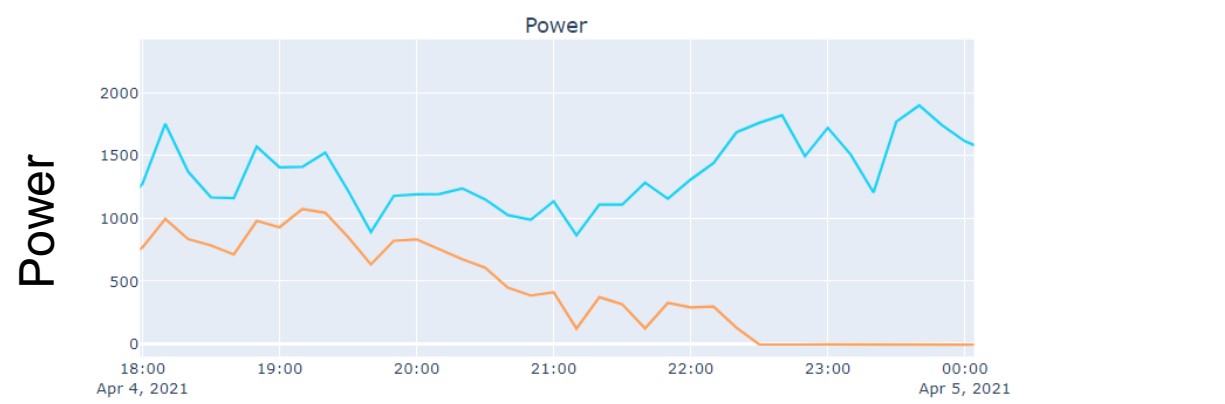
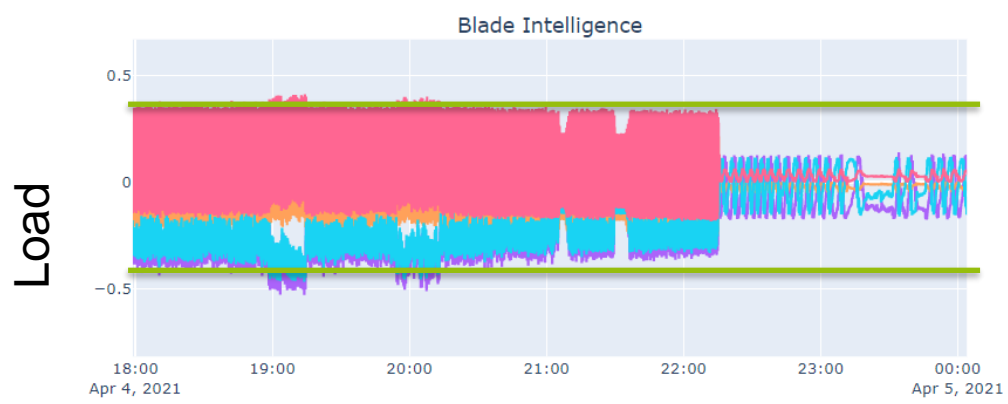
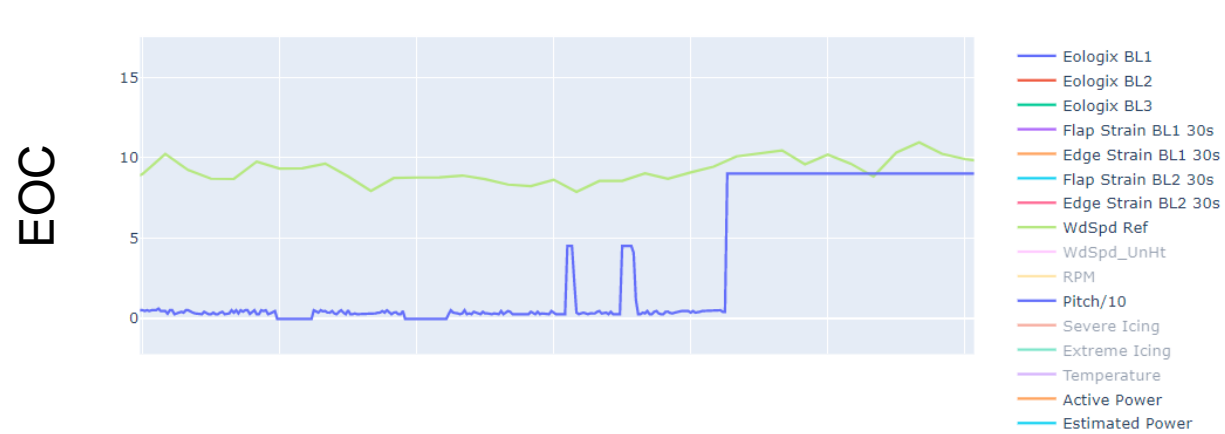
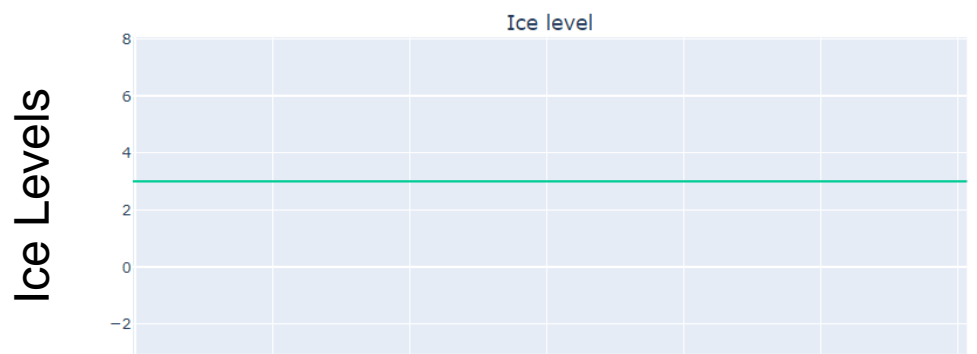
Renewable
Energy Research
and Innovation



**PHOENIX
CONTACT**
INSPIRING INNOVATIONS

Rotor blade monitoring with Blade Intelligence

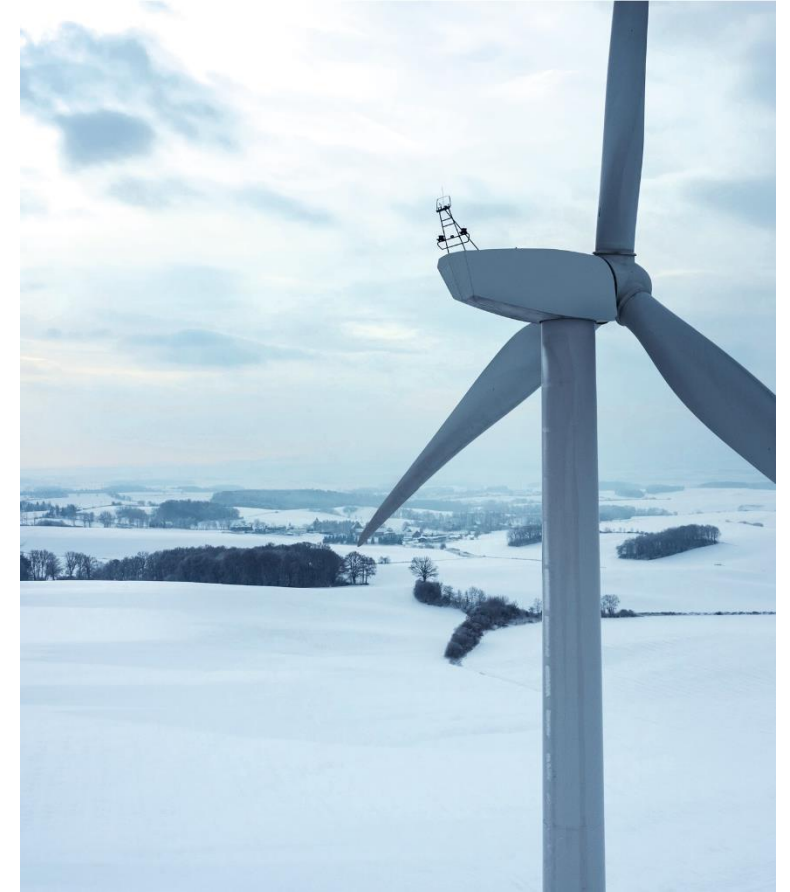
Load Behavior



Rotor blade monitoring with Blade Intelligence

Results

- Average ice load of 126 kg when Extreme Ice Mode is activated
 - Blade mass ~8100 kg
 - Extreme Ice Mode is based on aerodynamics
- No indication of that loads increased on the rotor prior to extreme icing stop
- Turbine operations would be increased by 245 h under ice load
- Gain of 107 MWh or 1,6% AEP



NERGICA

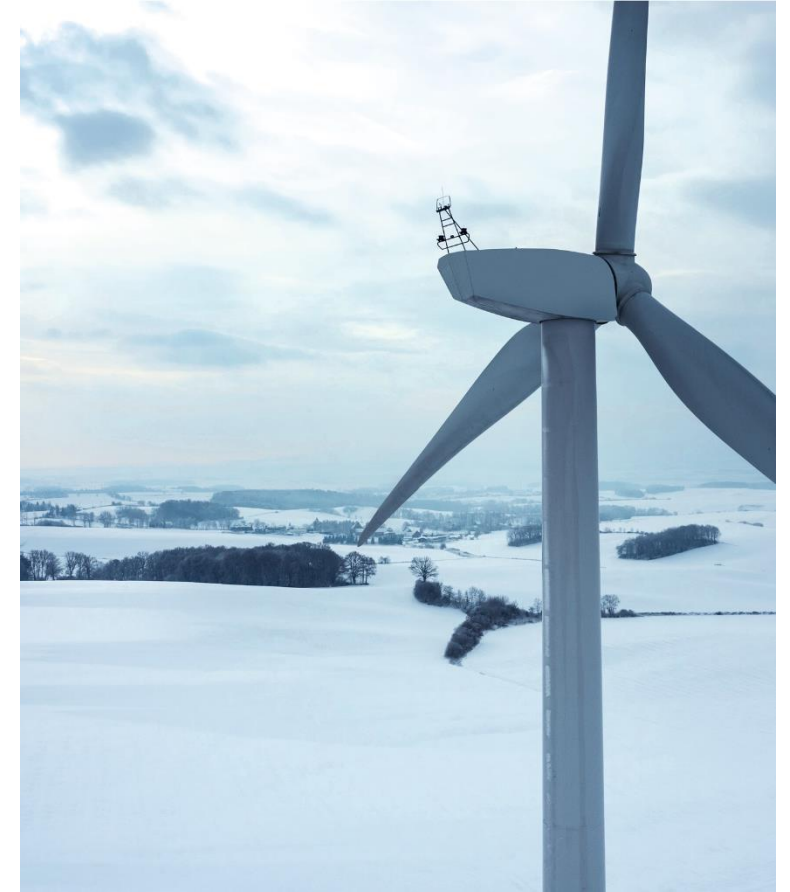
Renewable
Energy Research
and Innovation



Rotor blade monitoring with Blade Intelligence

Outlook

- Nergica and Phoenix Contact looking for Partners to start the research Project
 - Operators suffering high downtimes
 - Validating the test results
 - Load based ice detection instead of aerodynamic or impedance
 - Usage for turbines where the investment for heating system is too high



NERGICA

Renewable
Energy Research
and Innovation





Contact

Nils Lesmann

PHOENIX CONTACT Electronics GmbH

Team Lead | Global Industry Management Wind Power

Nlesmann@phoenixcontact.com

Phone +49 5281 946 - 2237

Thank you

more information on our [website](https://www.phoenixcontact.com)