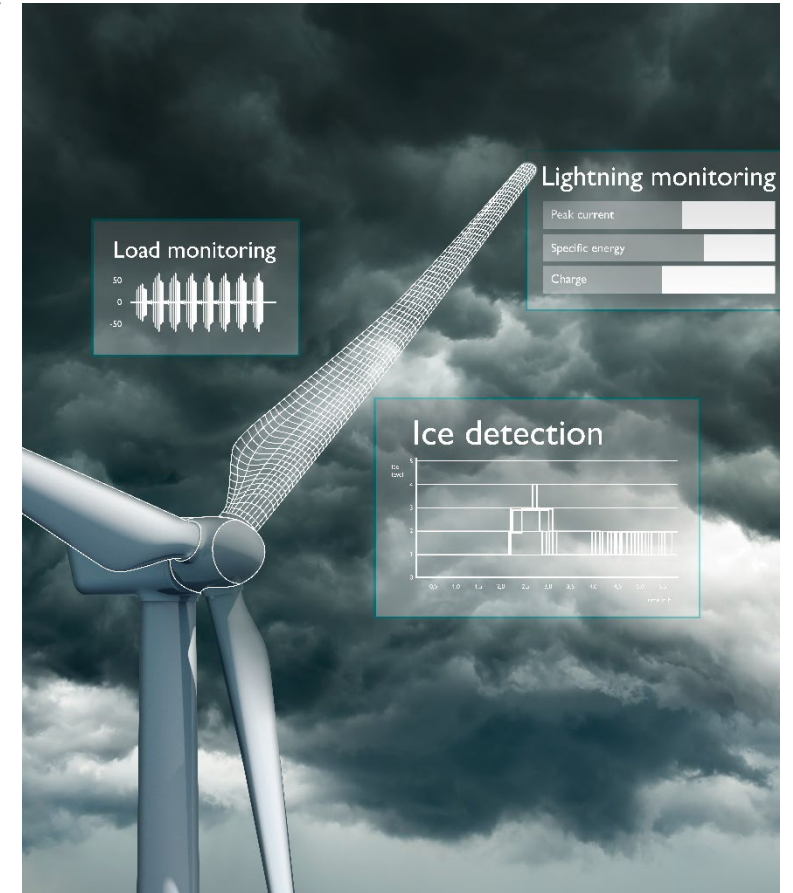


Welcome

Blade Intelligence

Agenda

- Short presentation of Phoenix Contact
- Sensor Systems
- Measurement of ice on the blade surface
- Conclusion



Blade Intelligence

Short presentation of Phoenix Contact

Load monitoring



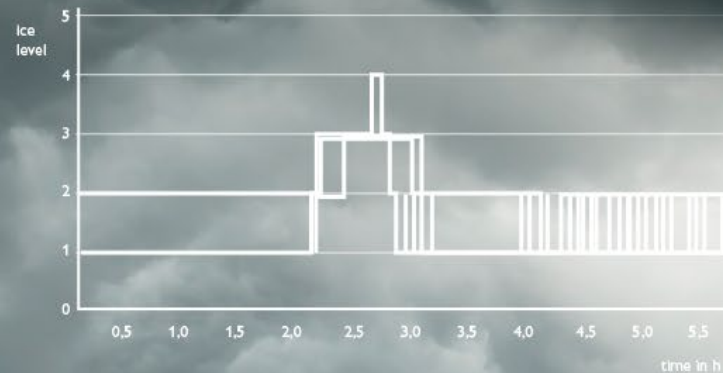
Lightning monitoring

Peak current

Specific energy

Charge

Ice detection



Phoenix Contact GmbH & Co. KG



> 2.6 Billion €

Turnover

> 17.500

Employees

> 65.000

Products

4

Vertical Markets



Phoenix Contact, HQ Blomberg



„Medium sized family business“



Energy



Process



Infra-structure



Factory Automation



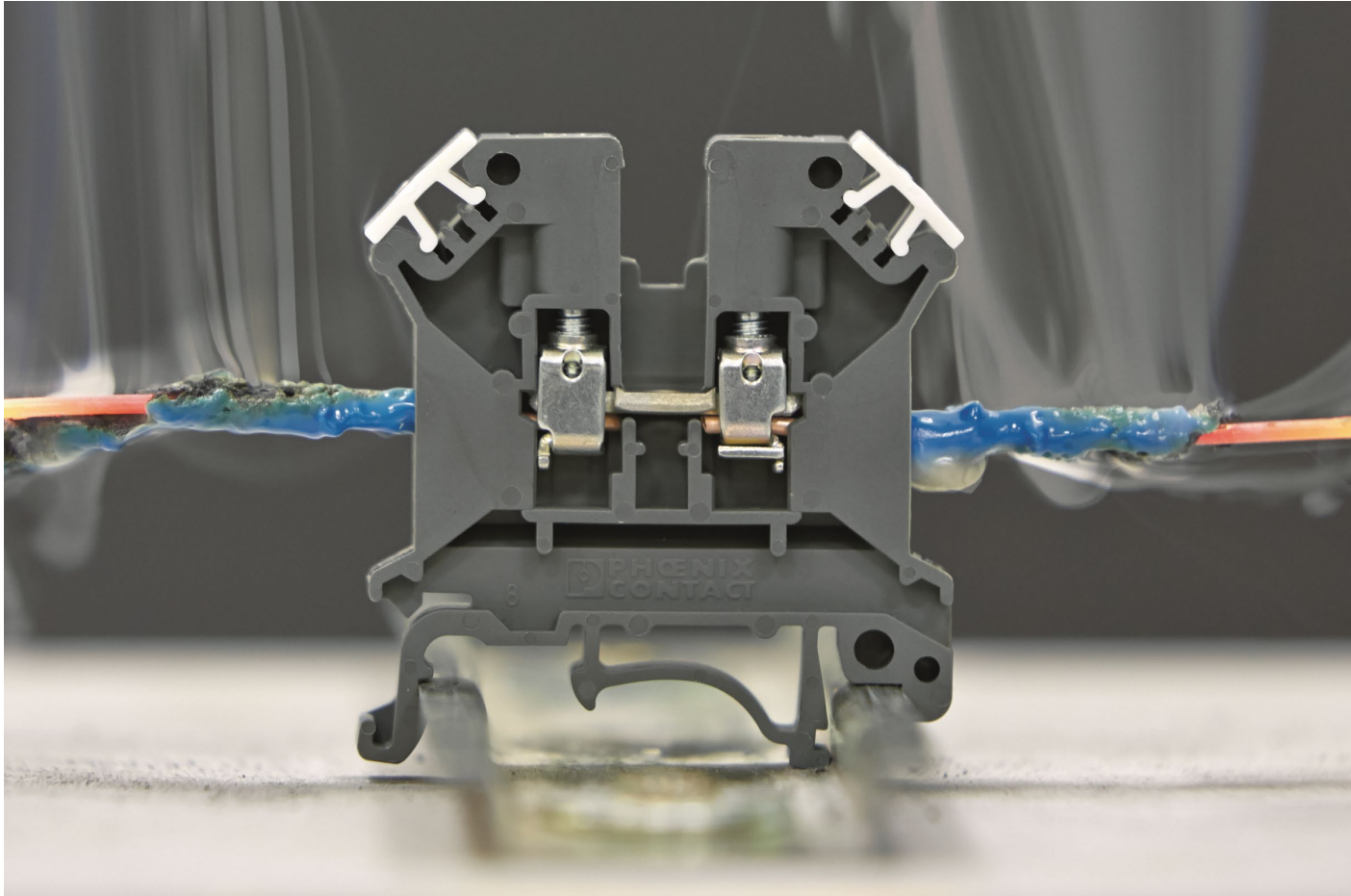
> 50 International Locations



Phoenix Contact, HQ Bad Pyrmont

Solutions for wind power

Phoenix Contact in Wind Industry



Phoenix Contact in Wind Industry



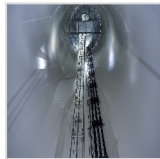
Connecting and wiring



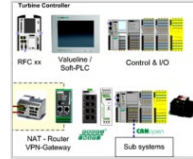
Power & interface



System Protection



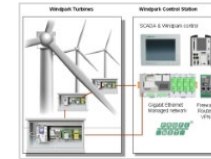
Lighting Solutions



Control Technology



Software for turbine control



System communication

Electrical installations

Operational Control

Condition Monitoring

Machine Safety

Load Monitoring



Lightning Monitoring



Ice Detection



Safety Components



Integrated Safety



Safety Services



Blade Intelligence

Sensor systems

Load monitoring



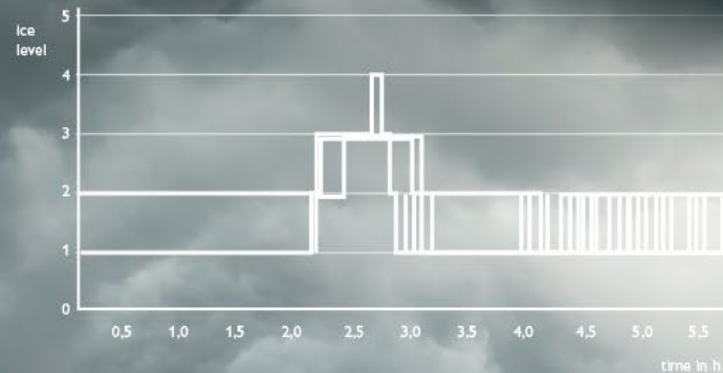
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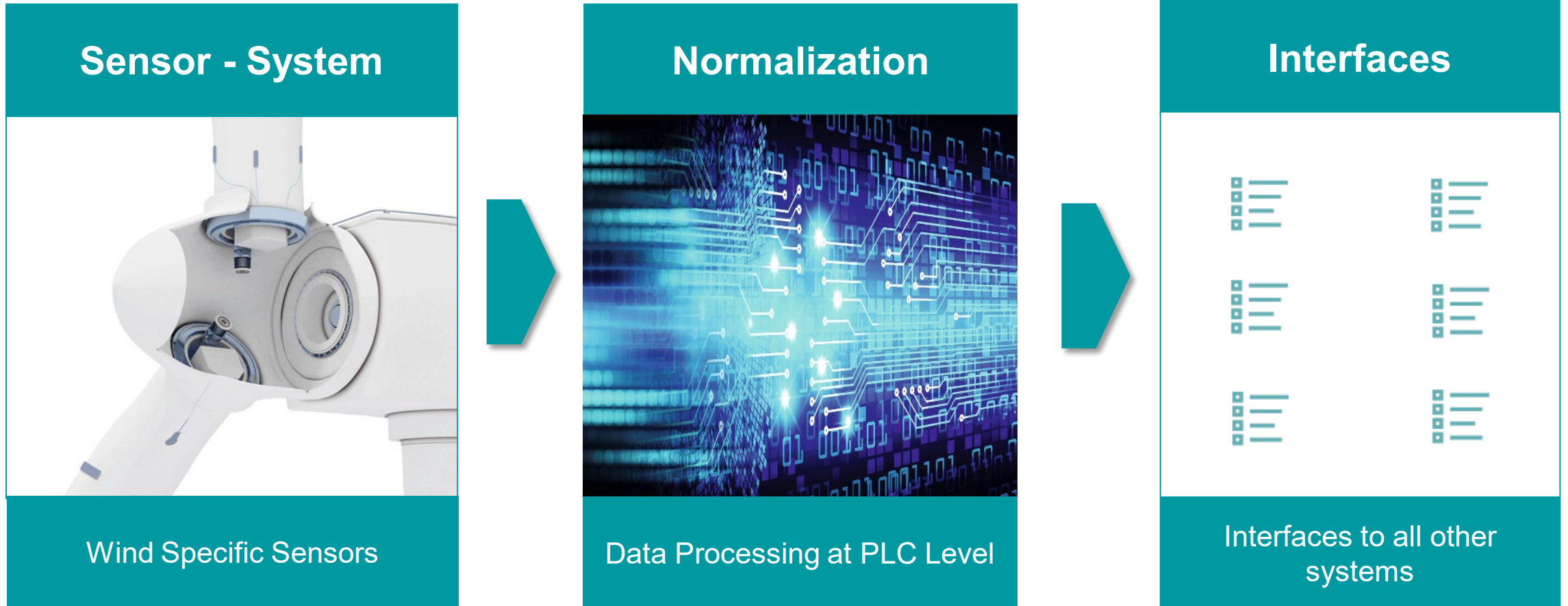
Charge

Ice detection



Blade Intelligence

Our solution



Wind specific sensors

Load Monitoring



Copper connection as approved and price competitive solution

Lightning Monitoring



Fibre optical for galvanic decoupling

Ice Detection



Wireless connection to measure ice where it is

For every application the best connection technology

Blade Intelligence

Track record

Over 1700 systems world wide
onshore and offshore

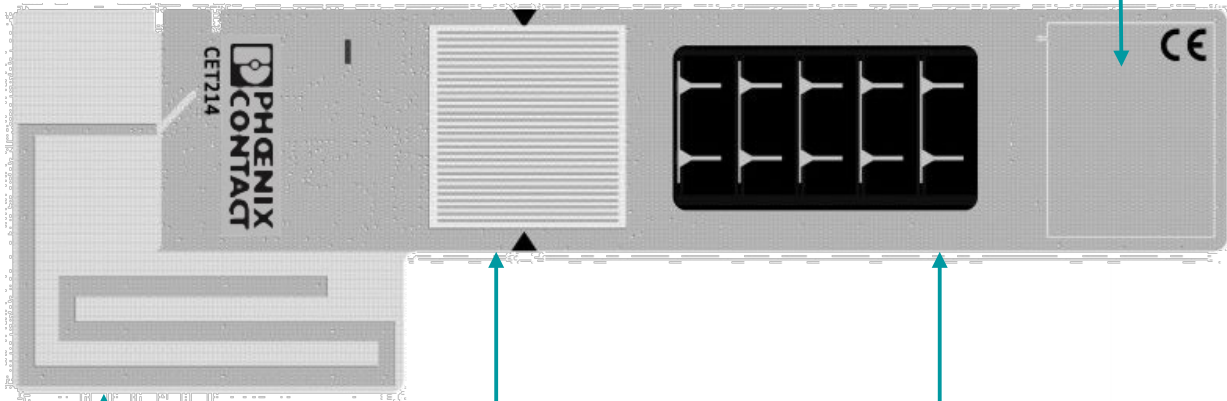


Blade Intelligence

Ice Detection where ice occurs

In cooperation with **eologix**
sensor technology

Energybuffer



Wireless
data transfer

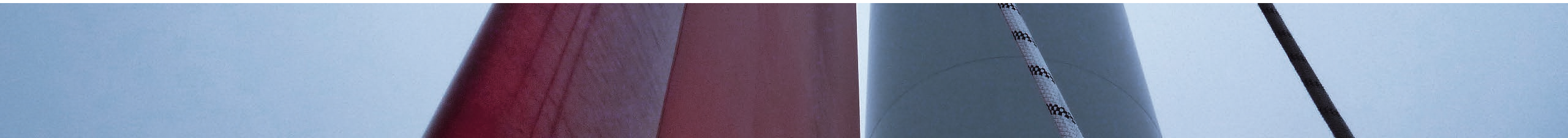
Ice- and Temperature
measurement

Energy Harvesting





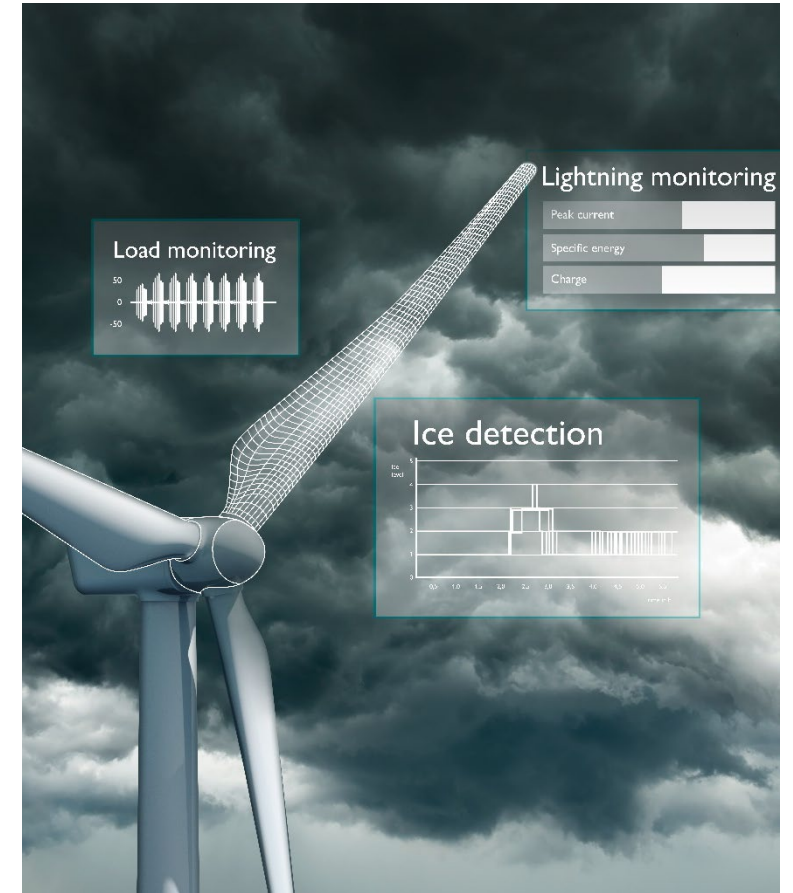
But why should I measure ice and temperature on the blade surface?



Why measuring on the blade surface?

- No initializing process at turbine start up → Simplified initializing
- No turbine controller information needed → Simplified integration

To measure ice when it builds up



Benefits of ice measurement outside the blade - Experiment



Ice detection sensors

Ice detection base unit

Load analysis



Power

How and when does icing effect power production?

Loads

Are loads reasonable and/or manageable during an icing event?

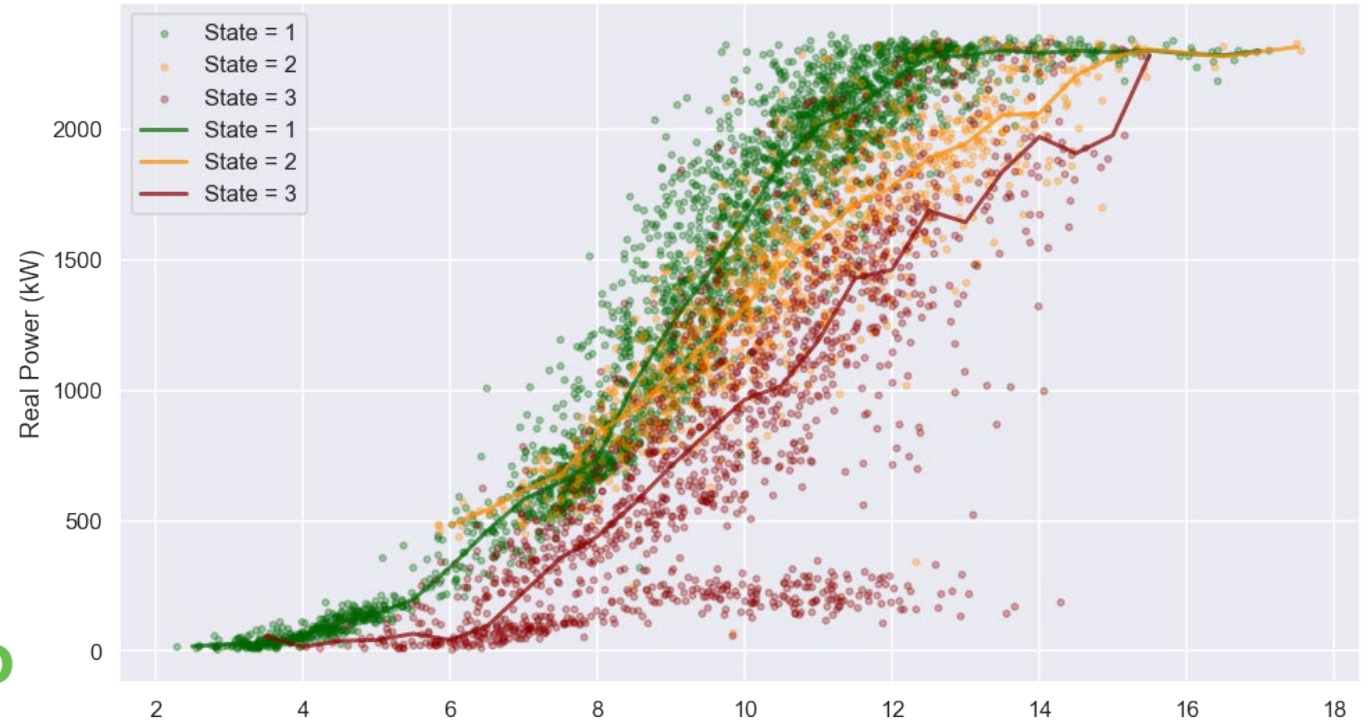
End of icing

How can the end of an icing event be detected?



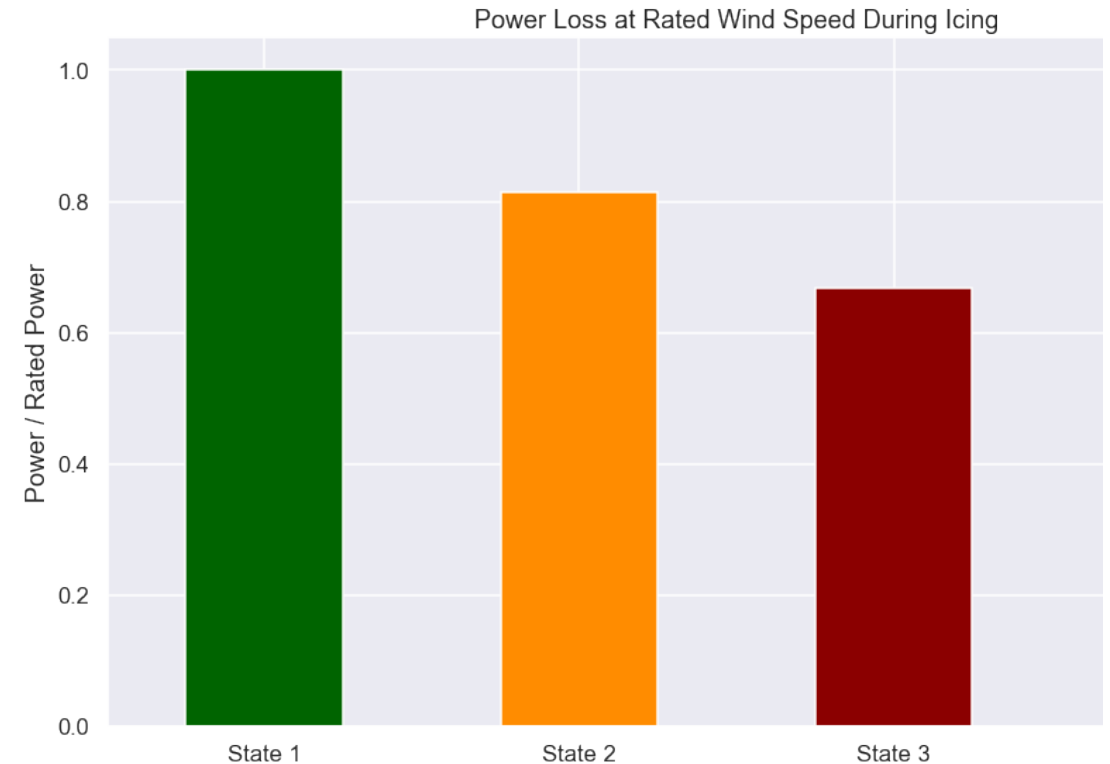
Benefits of ice measurement outside the blade

- Level 1: No Ice ■
- Level 2: < 1 mm ■
- Level 3: 2 – 10 mm ■



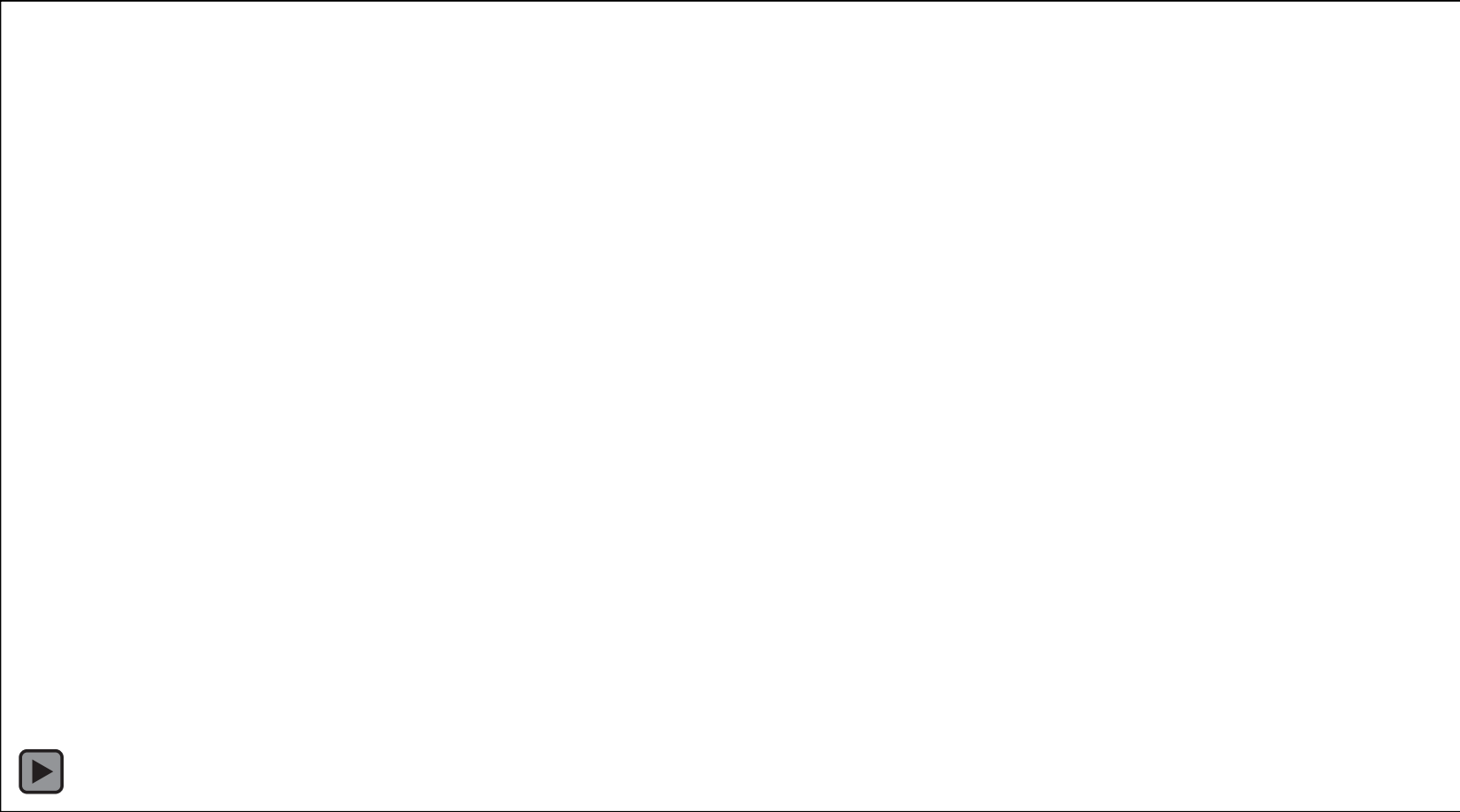
Benefits of ice measurement outside the blade

- Icing effects the power curve
 - Beginning at level 2
 - Level 3 has a big effect on the turbine performance



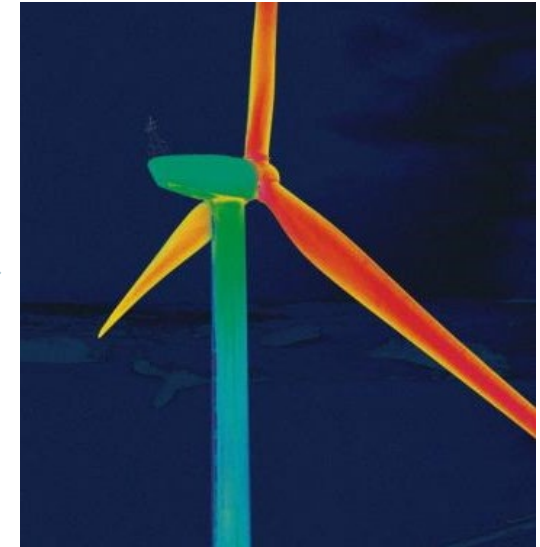
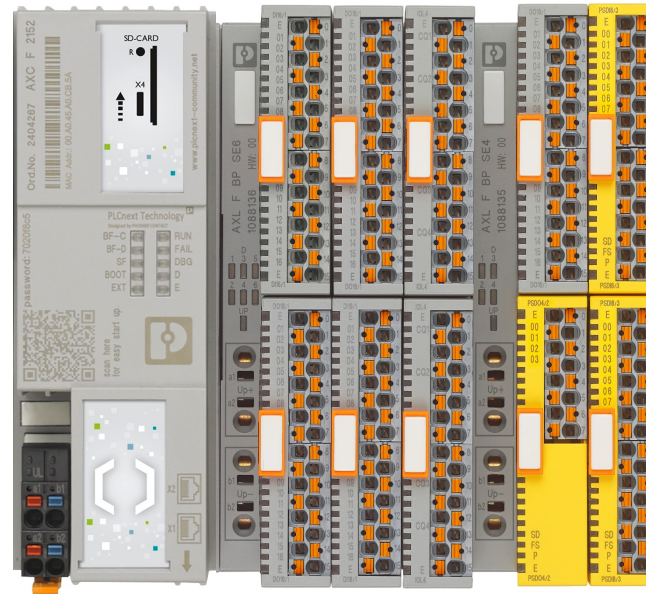
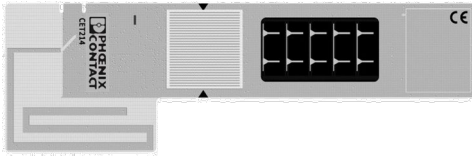
Blade Intelligence

Measuring Ice



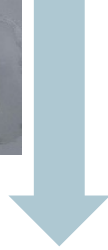
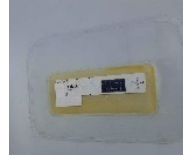
Blade Intelligence

Open Ice detection control

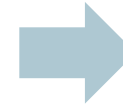


Blade Intelligence

Synchronize mobile with Blade Intelligence



Sensor ID	Radius	Distance TE	Direction	Installed
1111	5	95	0	✓
222	15	95	0	✓
3333	20	90	180	✓
4444	45	90	0	✓
2439	25	95	0	✓



- Owner
- Service Provider
- Manufacturer
- Phoenix Contact

Blade Intelligence

Conclusion

Load monitoring



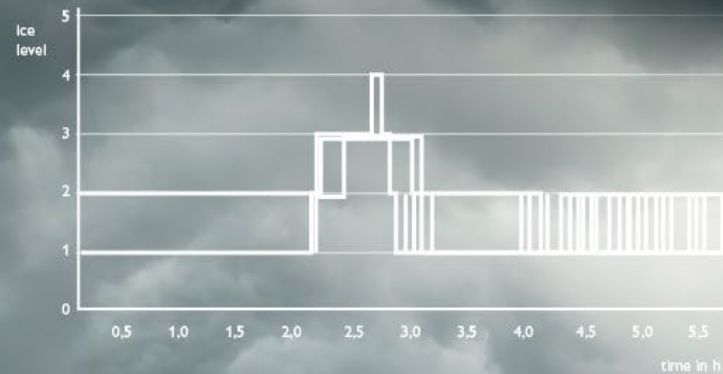
Lightning monitoring

Peak current

Specific energy

Charge

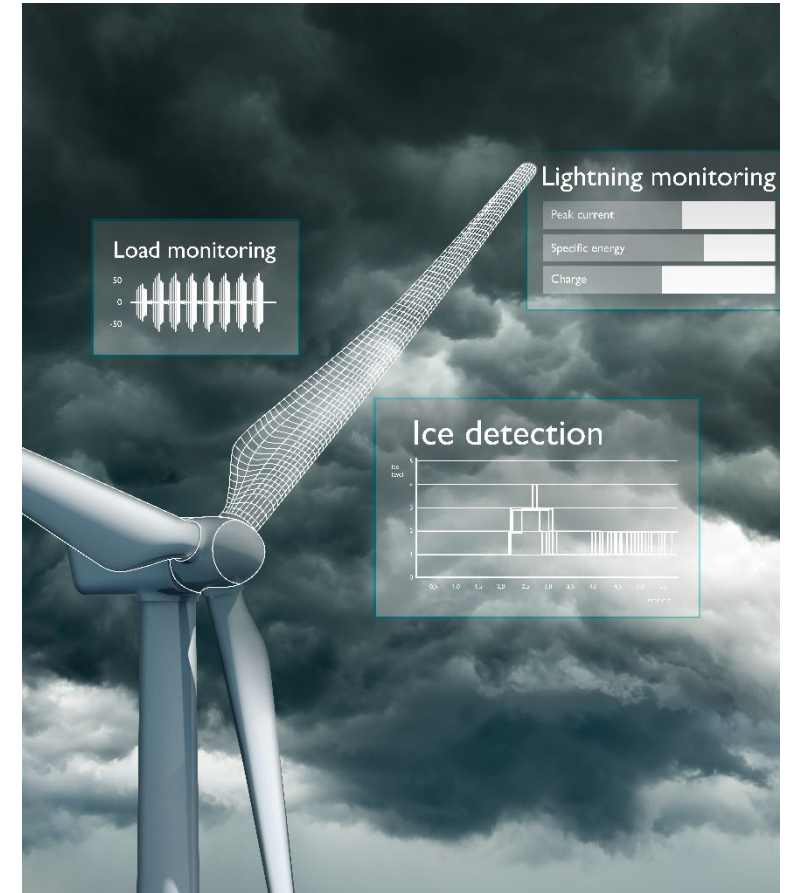
Ice detection

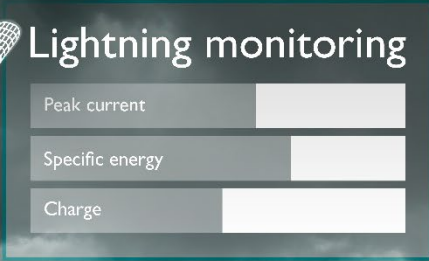
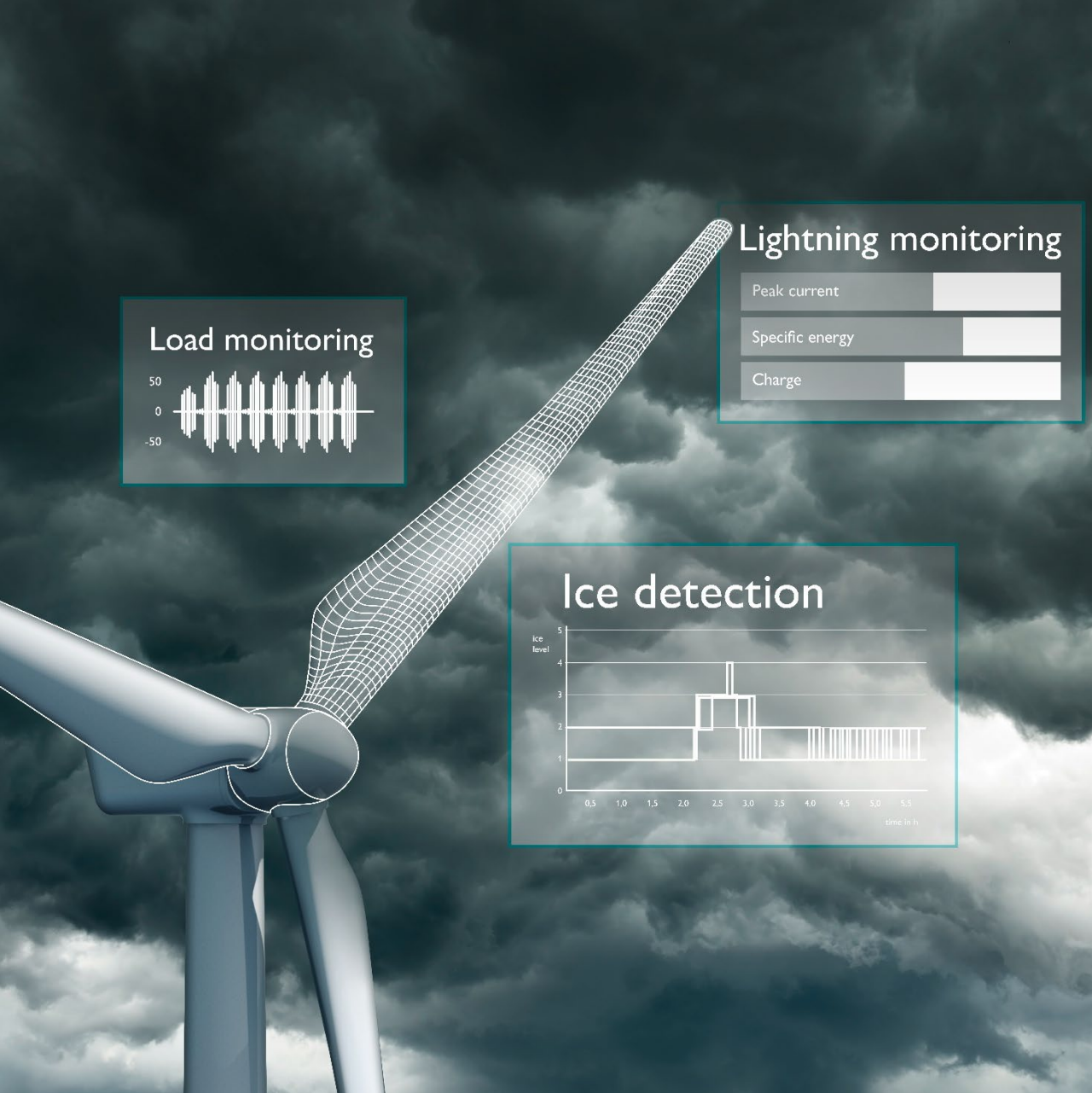


Blade Intelligence

Conclusion

- Detect ice when it starts growing
- Open control platform for measurement and control e.g. heaters
- One system for three different measurements
- Ice detection as an app in the PLCnext Store





Thank you

Blade Intelligence