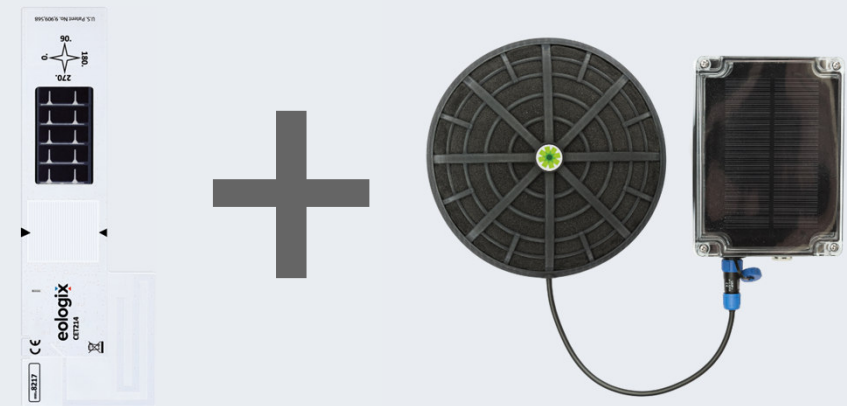# Safety aspects and risks of preventive heating during production

Doris Schadler | Winterwind 2024, Åre, Sweden

eologix & Ping Services

Why preventive heating during production operation?

Accumulation of ice during production operation

→standstill due to ice

→start heating

📉 Negative balance

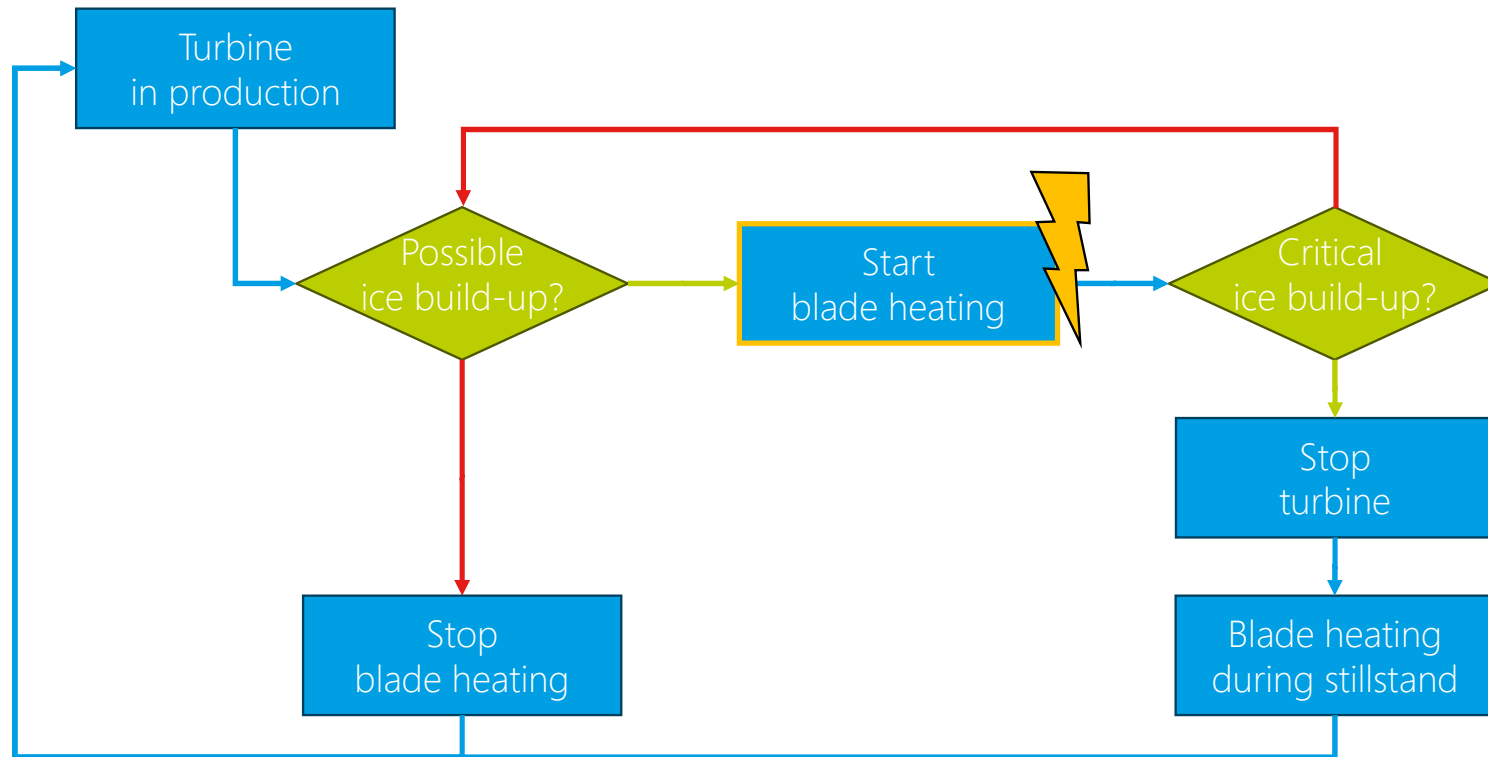→start heating

→turbine in production operation

📈 Positive balance

Are there any possible risks?

Preventive heating

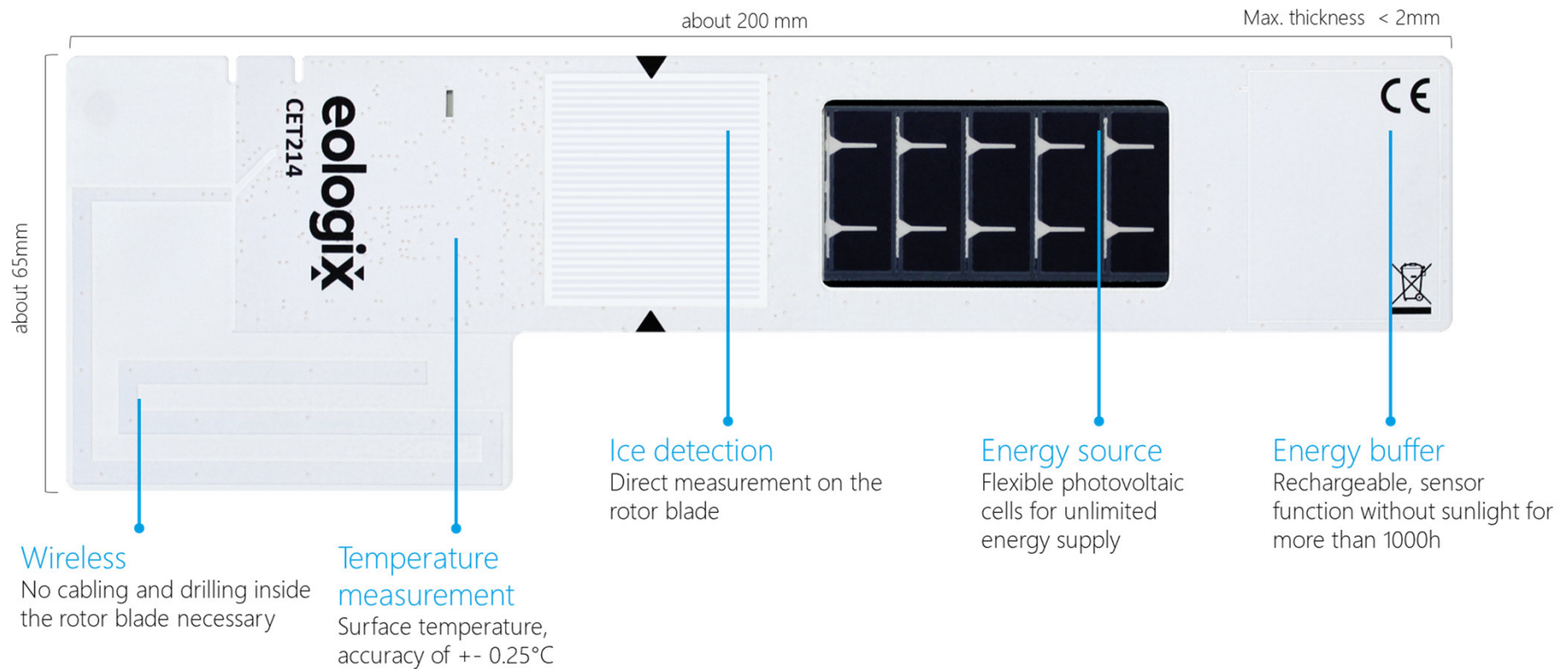during production operation WITH risks

Major risk

Insufficient differentiation between critical and possible ice build-up

- delayed start of heating

- water between blade and ice

- risk of ice throw

- danger for human being

- criterion for preventive heating of blades (based on temperature only) is not sufficient

Measurement system

about 200 mm

Max. thickness < 2mm

about 65mm

CET214

eologix

Ice detection
Direct measurement on the rotor blade

Energy source
Flexible photovoltaic cells for unlimited energy supply

Energy buffer
Rechargeable, sensor function without sunlight for more than 1000h

Wireless
No cabling and drilling inside the rotor blade necessary

Temperature measurement
Surface temperature, accuracy of +- 0.25°C

Product solutions

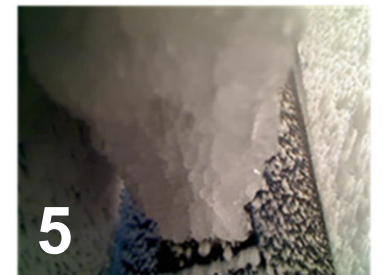Stop at ice accumulation
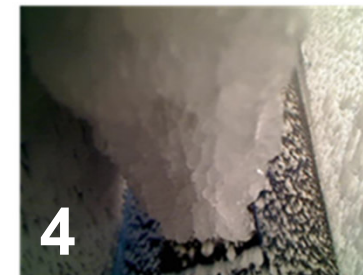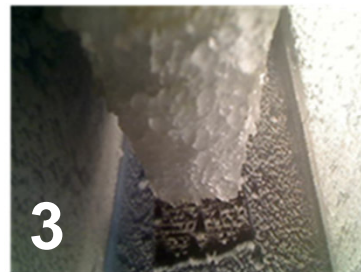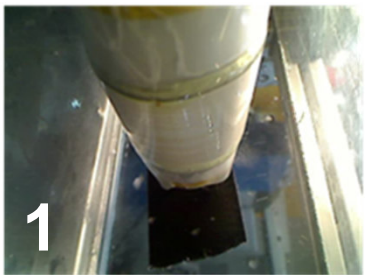eologix :safe

Automatic restart
eologix :restart

– detect safety-relevant, i.e. critical ice build-up
– activate or deactivate blade heating systems during standstill

Ice levels

– Ice and temperature measurement at each sensor

– Accurate detection of ice accumulation

– 5 levels of surface condition:
  – Level 1 = free sensor surface
  – Level 2 = "activity" (moisture, water, hoar frost, etc.)
  – Level 3 = ice with a thickness of more than ~1-2 mm
  – Level 4 = ice with a thickness of more than ~10 mm
  – Level 5 = ice with a thickness of more than ~15 mm

Ice build-up levels

Possible ice build-up	Light ice build-up	Critical ice build-up
Conditions: Any 1 sensor reports ice with a thickness of more than 1–2 mm, *and* temperature <2°C Secondary condition: - Previous condition was not "Light ice build-up" Effects: Turbine: in production operation Blade heating: active	Conditions: Any 1 sensor reports ice with a thickness of more than ~10 mm, *and* <66% of active tip sensors report ice with a thickness of more than 1-2 mm, *and* temperature <2°C Effects: Turbine: in production operation Blade heating: not active	Conditions: Any 1 sensor reports ice with a thickness of more than ~15 mm, *and/or* 2 adjacent sensors report ice w/ thickness of more than ~10 mm, *and/or* >66% of active tip sensors report ice with a thickness of more than 1-2 mm Effects: Turbine: stop Blade heating: standstill-process

Preventive heating

during production operation WITHOUT risks
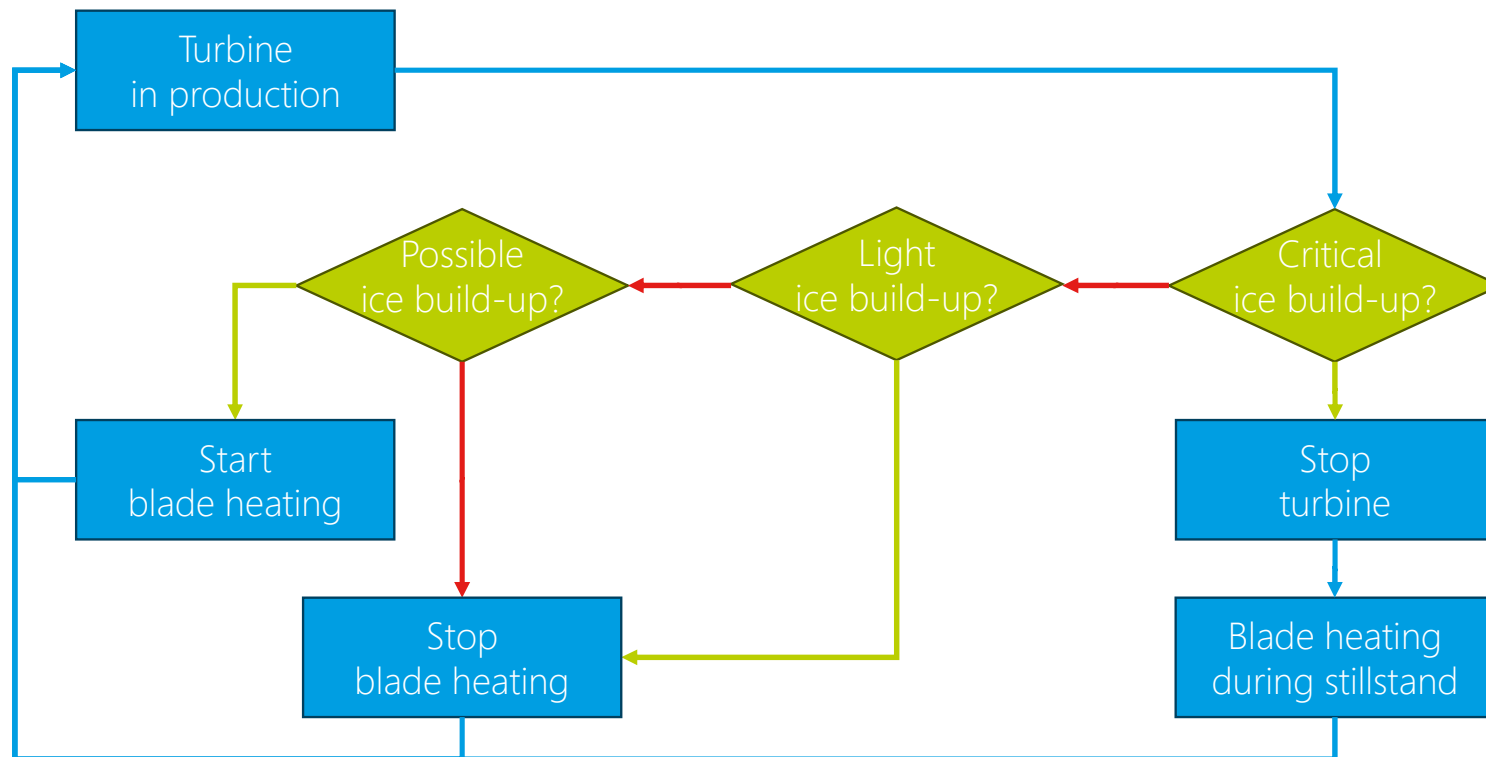
Other additional risks

Cause:
Non-uniform temperature curve across the blade profile

Error:
Sensor positions are not representative for heating process

Source: https://www.rechargenews.com/wind/vestas-launches-new-wind-turbine-blade-anti-icing-system/2-1-268313

Countermeasure:
Attach additional sensors at the trailing edge in case of leading edge heating

Other additional risks

Cause:
Incorrect signal levels or incorrect combination of signal levels lead to incorrect assignment to the "Possible ice build-up" or "Critical ice build-up" condition

Error:
Parameterization error (heating control)

Countermeasure:
Automatic plausibility test or implementation of a commissioning test based on forced signal levels

Product solutions

Stop at ice accumulation
eologix :safe

Automatic restart
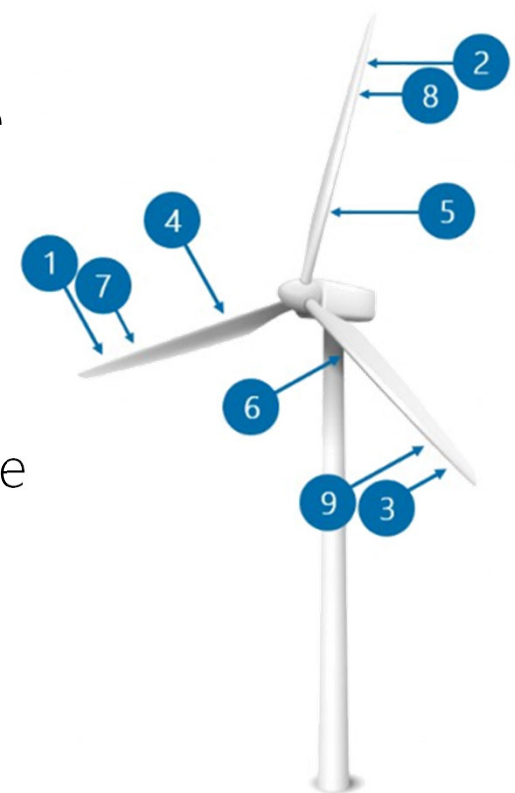eologix :restart

Preventive heating
eologix :heat

- detect safety-relevant, i.e. critical ice build-up
- activate or deactivate blade heating systems during standstill
- preventive heating during production operation

eologix:heat

Hardware configuration:

1. Heating systems with <u>even heat distribution</u> along the profile (e.g. warm air heating):
9 sensors (per blade: 2 sensors on the blade tip, 1 sensor on the root)

2. Heating systems with <u>uneven heat distribution</u> along the profile (e.g. leading edge heating):
15 sensors (per blade: 2 sensors on the blade tip in the leading edge area, 2 sensors on the blade tip in the trailing edge area, 1 sensor on the root)

Expert opinion by TÜV Nord

Benefits of preventive heating
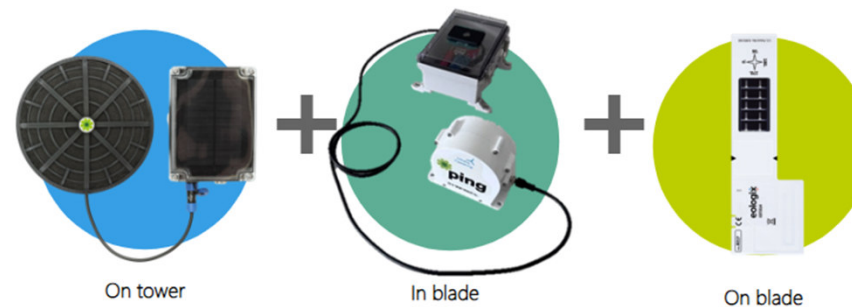
using eologix:heat

– Ice level available for every position ➔ accurate system

– No historical (weather) data required ➔ works right from the start

– No access to SCADA data required ➔ autonomous

– Independent (of the location) of the turbine ➔ universally applicable

– Retrofittable for any (blade heating) system ➔ customizable

– Additional feature for ice detection and restart ➔ no additional costs
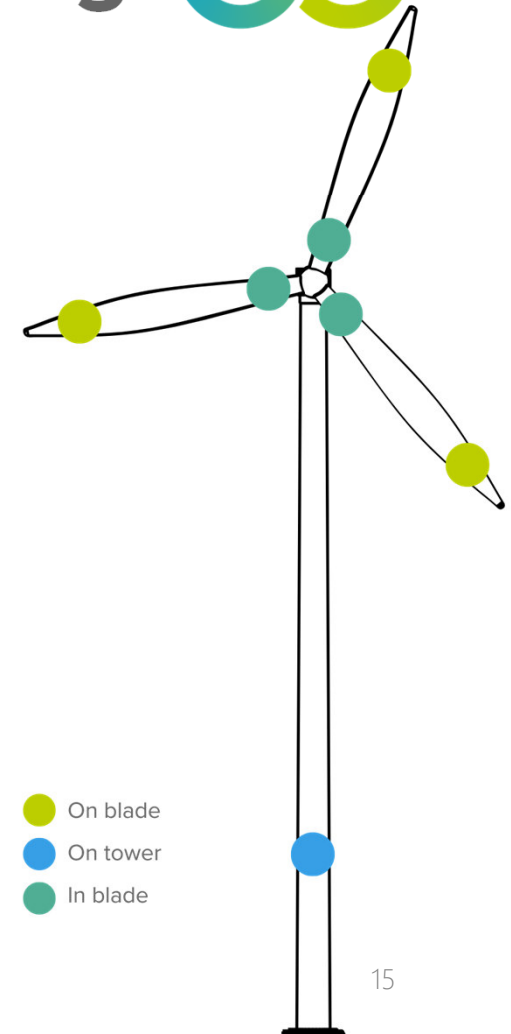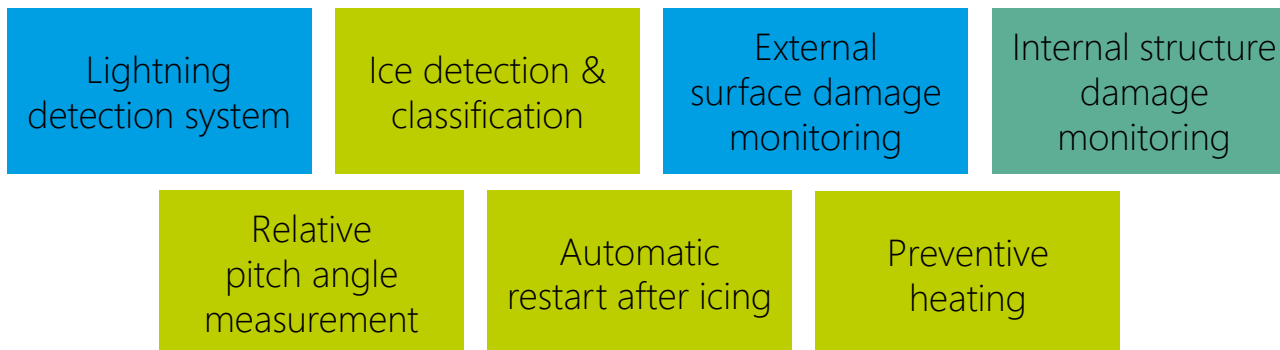
Continuous blade health monitoring

Intelligent fusion of vibrational, acoustic and other sensor technologies coupled with the latest advancements in data analytics & science

- ✓ Sensor fusion and high reliability
- ✓ Open & independent
- ✓ Simple installation
- ✓ Modular & retrofittable

On tower   +   In blade   +   On blade

Our applications

Lightning detection system	Ice detection & classification	External surface damage monitoring	Internal structure damage monitoring

Relative pitch angle measurement	Automatic restart after icing	Preventive heating

- On blade
- On tower
- In blade

Any questions?

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