So where exactly is the ice – how many sensors does a turbine need?

Michael Moser | eologix sensor technology gmbh, Graz, Austria
Winterwind 2017 | 6. - 8.2.2017 | Skellefteå, Sweden

eologix: history

02/2011 first Winterwind participation
08/2014 eologix sensor technology gmbh is founded
12/2014 first measurement system commercially used by e.on
12/2015 measurement systems mounted to 20 wind turbines world wide
03/2016 Phoenix Contact joins eologix as a minority shareholder
12/2016 measurement systems on 42 wind turbines in commercial use
01/2017 11 people in team (thereof 7 engineers)

Partners:

Selected Turbine Locations 2016

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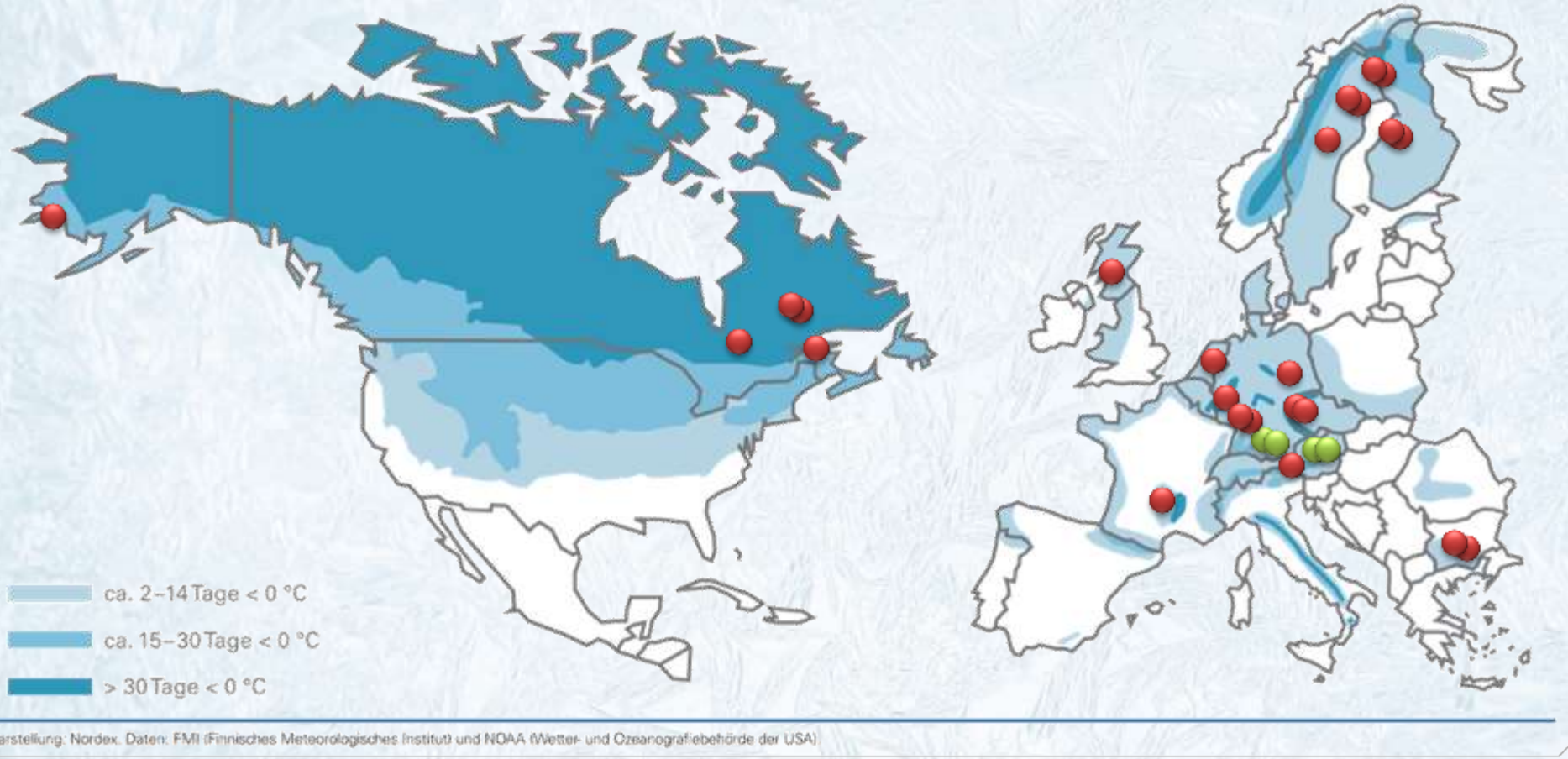

- Wind turbine
- Wind farm

Technology

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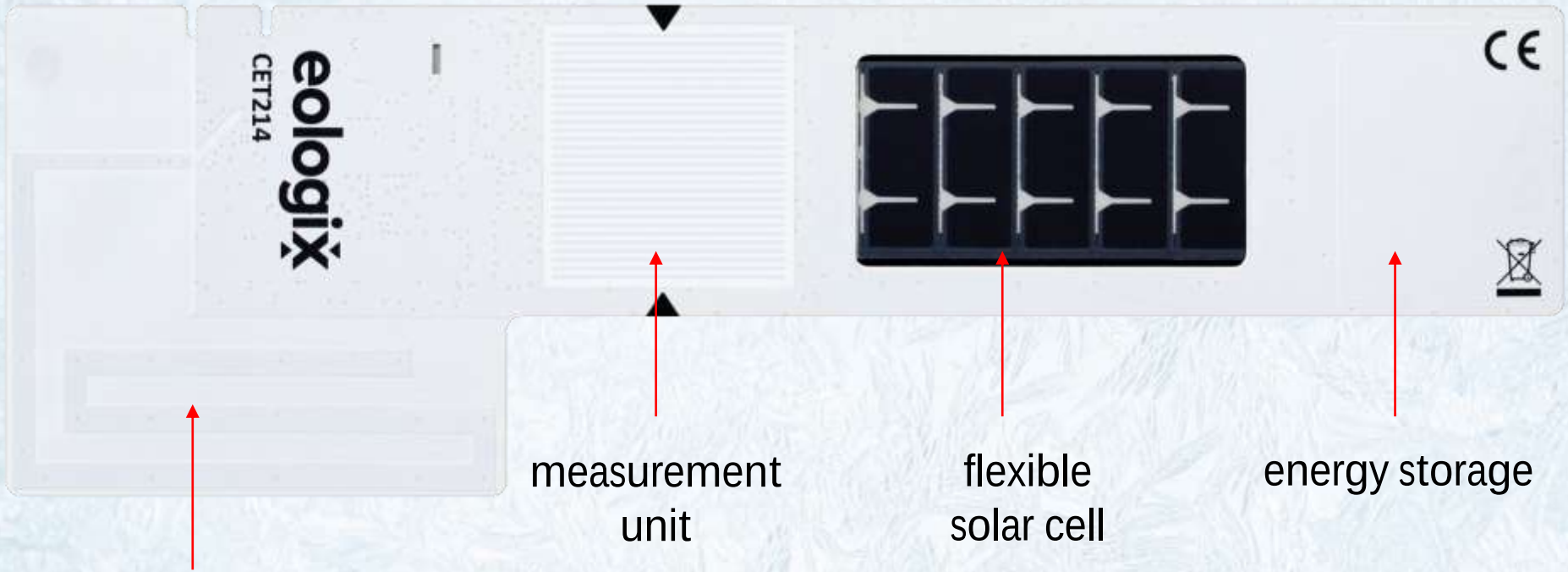

wireless communication

measurement unit

flexible solar cell

energy storage

System Design

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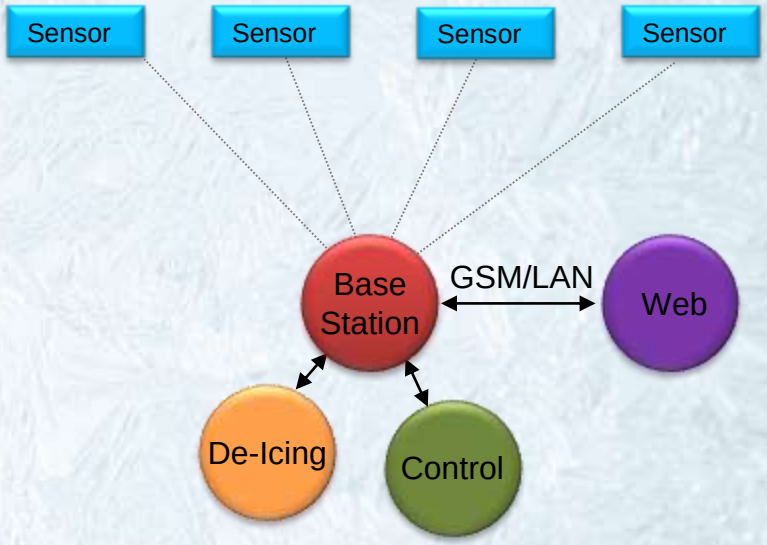
Sensors

- wireless
- flexible and thin (<2mm), adhesive
- ice detection on blade surface
- temperature measurement in each sensor

Base Station

- data collection and processing
- data output to turbine control
- raw data output to online system (web)
- location: nacelle or ground



Mounting: rope access (retrofit)

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Mounting: during turbine construction

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Surface States

dry, free surface

very thin layer
(<1mm) or wet

ice > 1-2mm

ice > 10mm

Temperature measurement: ± 0.25°C (each sensor)

Use Cases

Control:

- Ice detection for "ice stop" (**eologix SAFE**)
- **"Ice free" detection** for automatic restart (eologix RESTART)

Monitoring:

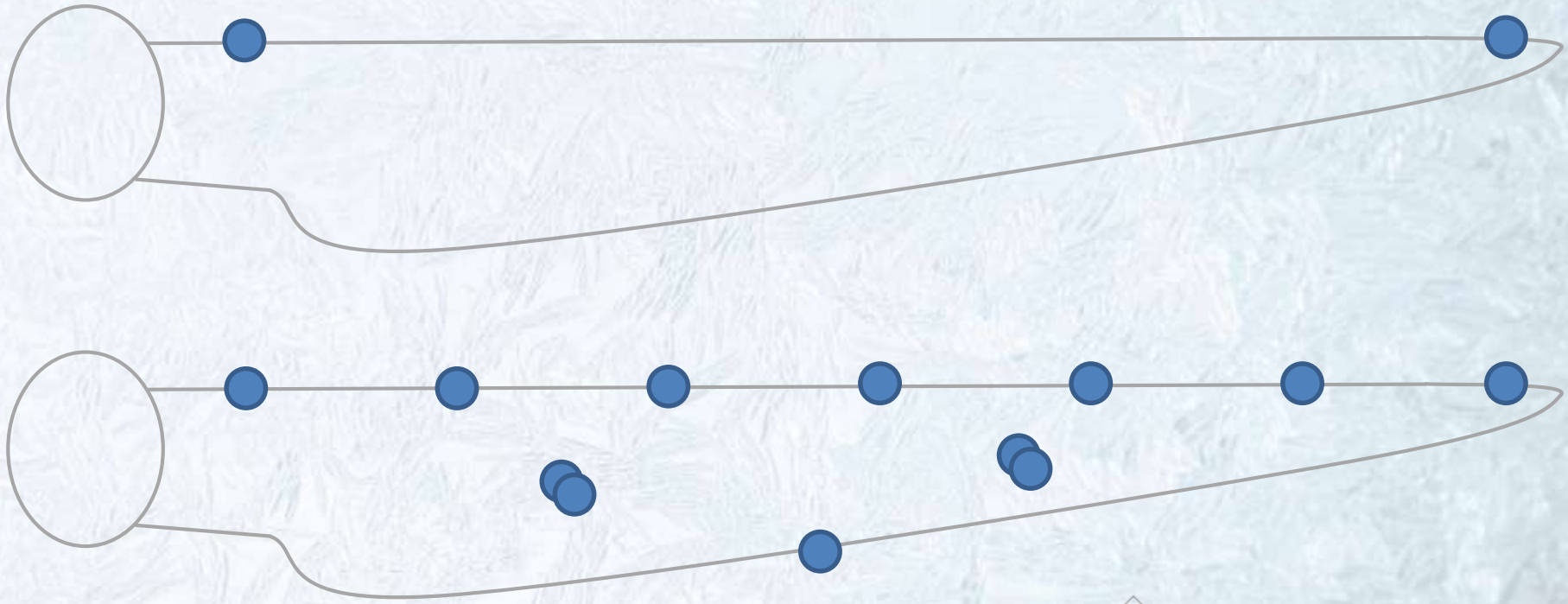
- Evaluation of de-icing equipment
- Temperature data acquisition

RENEWABLES CERTIFICATION
DNV·GL
Certificate no.
CC-GL-IV-1-00526-0

Typical Sensor Configurations

SAFE
- blade tips (>90%)
- blade root (<10%)
- total: 6 sensors

RESTART
- blade tips
- blade root
- leading edge
- blade flanges (suction and pressure side)
- trailing edge



Turbine #1, Event #1
Germany, ~120m rotor, Jan. 2017

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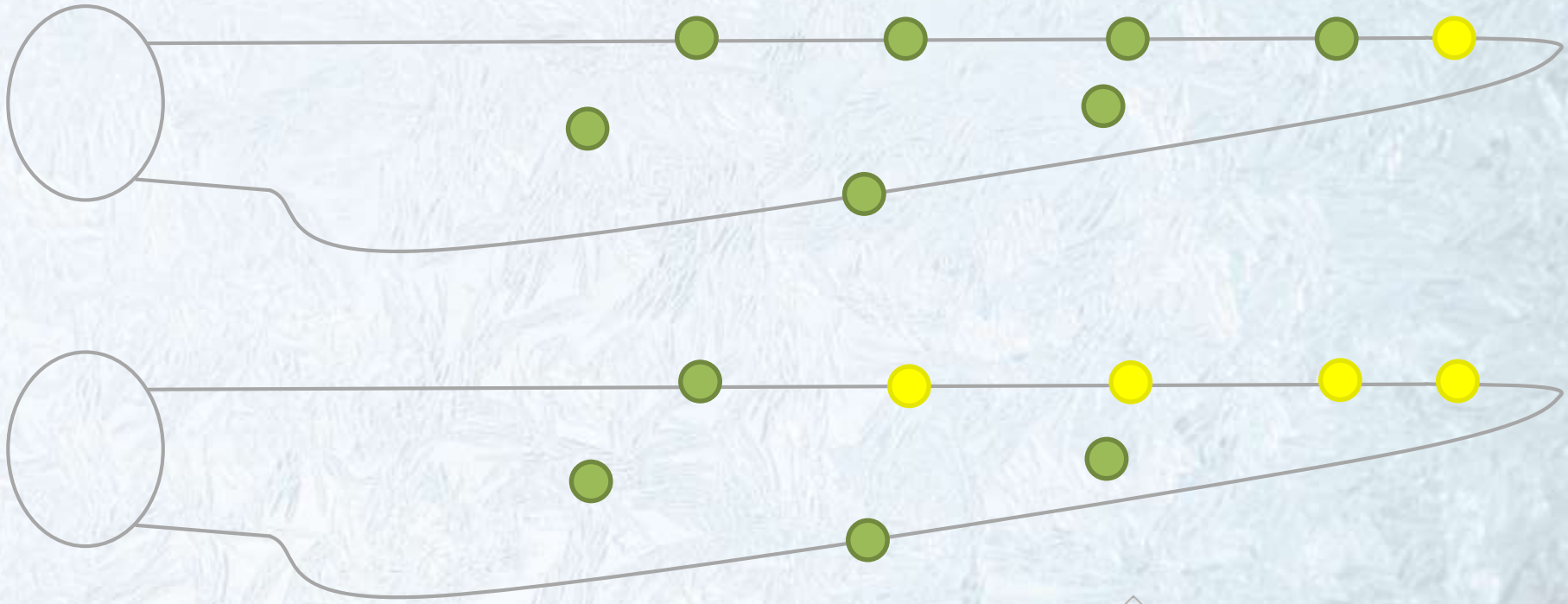
Icing in rotation

Early icing
- icing starts from tip

Maximum status
- outer half of leading edge affected by ice
- safety stop



Turbine #1, Event #2
Germany, ~120m rotor, Jan. 2017

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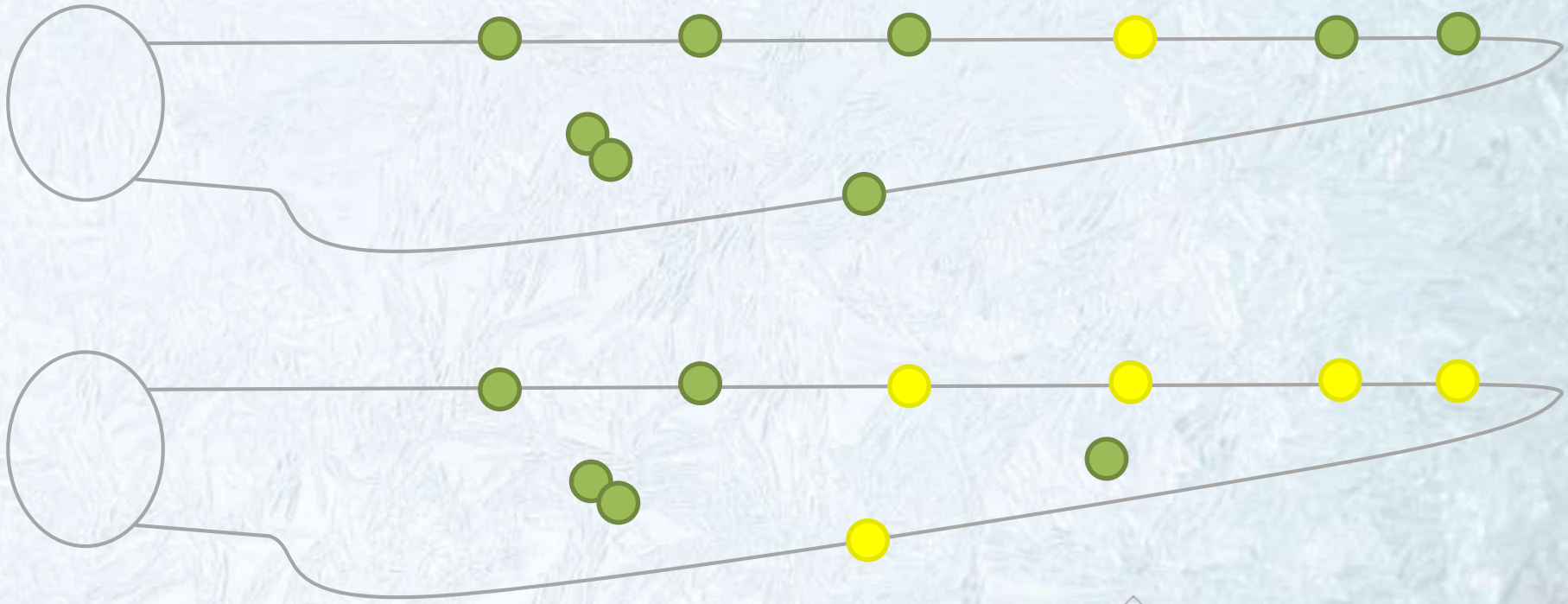
Icing in rotation

Early icing
- large part of blade is at Level 2

Maximum status
- outer half of leading edge affected
- trailing edge affected
- safety stop



Turbine #2, Event #1
Sweden, ~90m rotor, Feb. 2017

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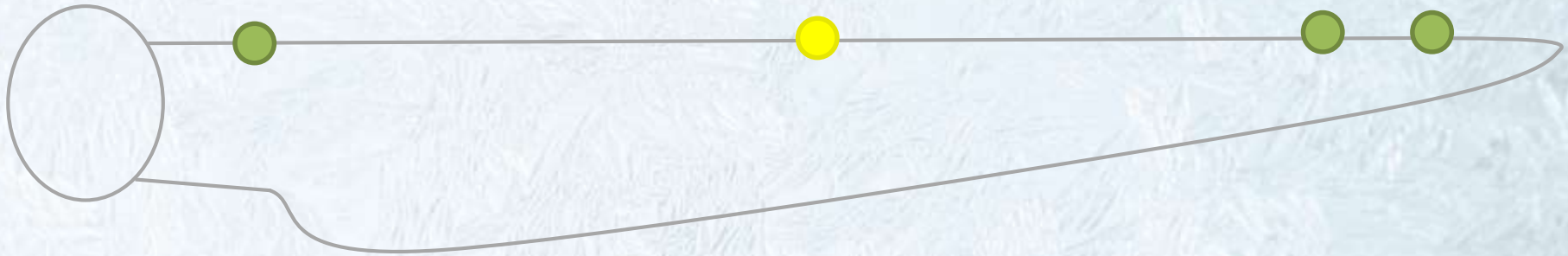
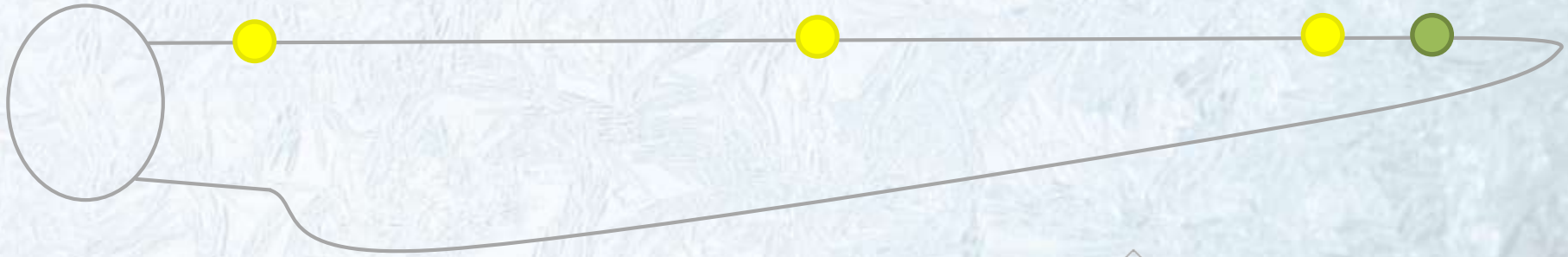
Icing in standstill

Early icing
- all sensors are affected, most ice is at blade center



Maximum status
- whole leading edge affected except tip
- safety stop



Turbine #3, Event #1
Austria, ~100m rotor, Feb. 2017

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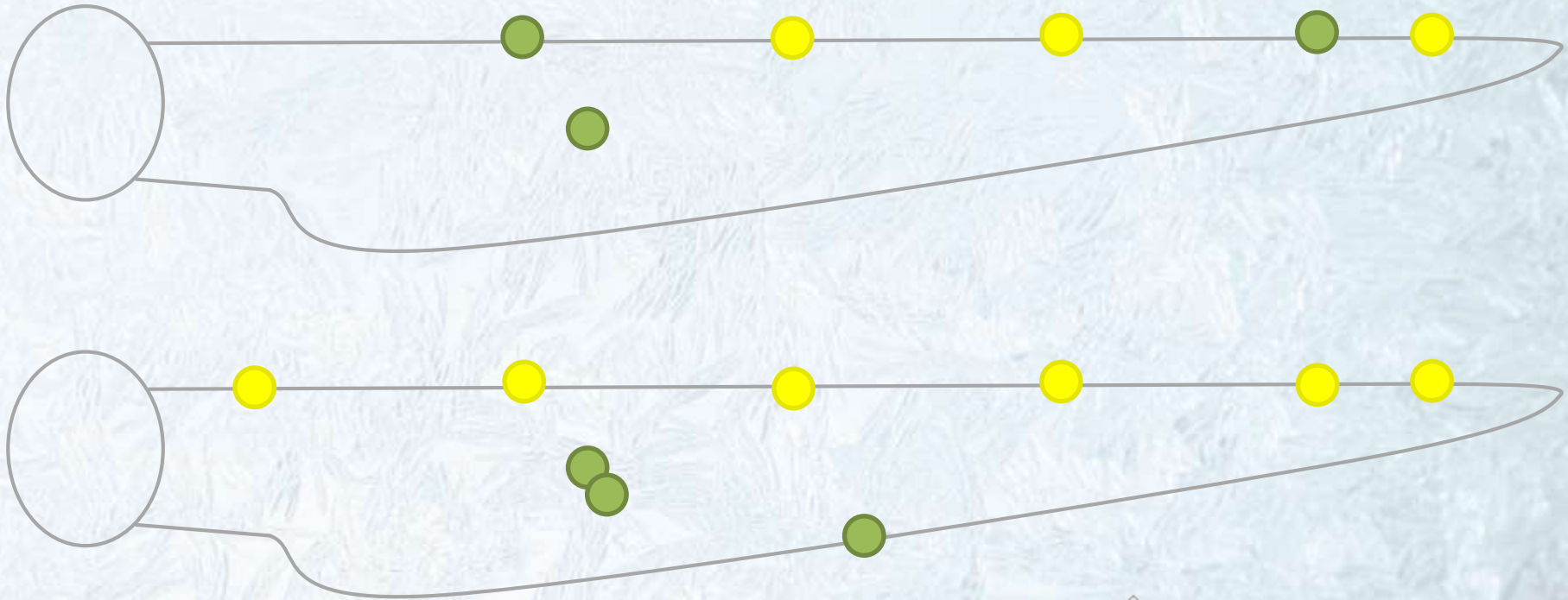
Icing in rotation

Early icing
- tip more affected than root,
  but not uniformly

Maximum status
- whole leading edge affected
- safety stop



Turbine #3, Event #2
Austria, ~100m rotor, Oct. 2016

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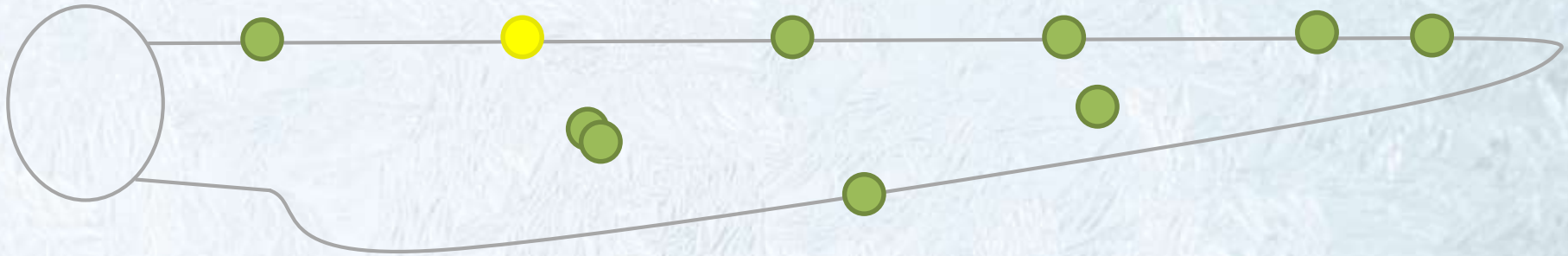
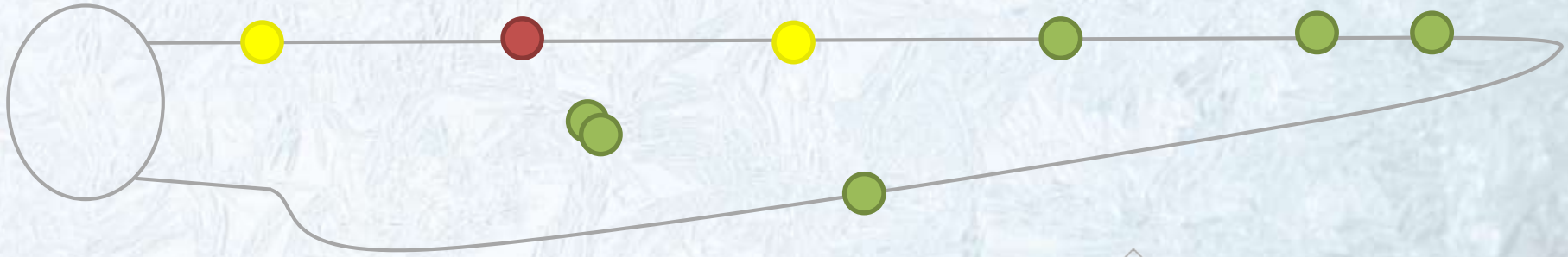
Icing in rotation

Early icing
- nearly all sensors affected, but only one point iced



Maximum status
- leading edge close to blade root most affected (>10mm), not tips
- safety stop



Summary

Differences in icing distribution can be observed between

- different turbine types
- same turbine type at different sites
- same turbine at same site during different weather conditions

General results

- icing tends to start from blade tip and leading edge, but this is not a general rule
- in winter 2016-2017, blade flanges were never affected by relevant icing
- trailing edge may be a point to watch, especially when anti-/de-icing is used but trailing edge not covered

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Thank you for your attention!

Visit us at our booth in the exhibition area!