Solution for cold climate to secure production of wind park

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WWD-1 operational in Finland
Temperature -25 C

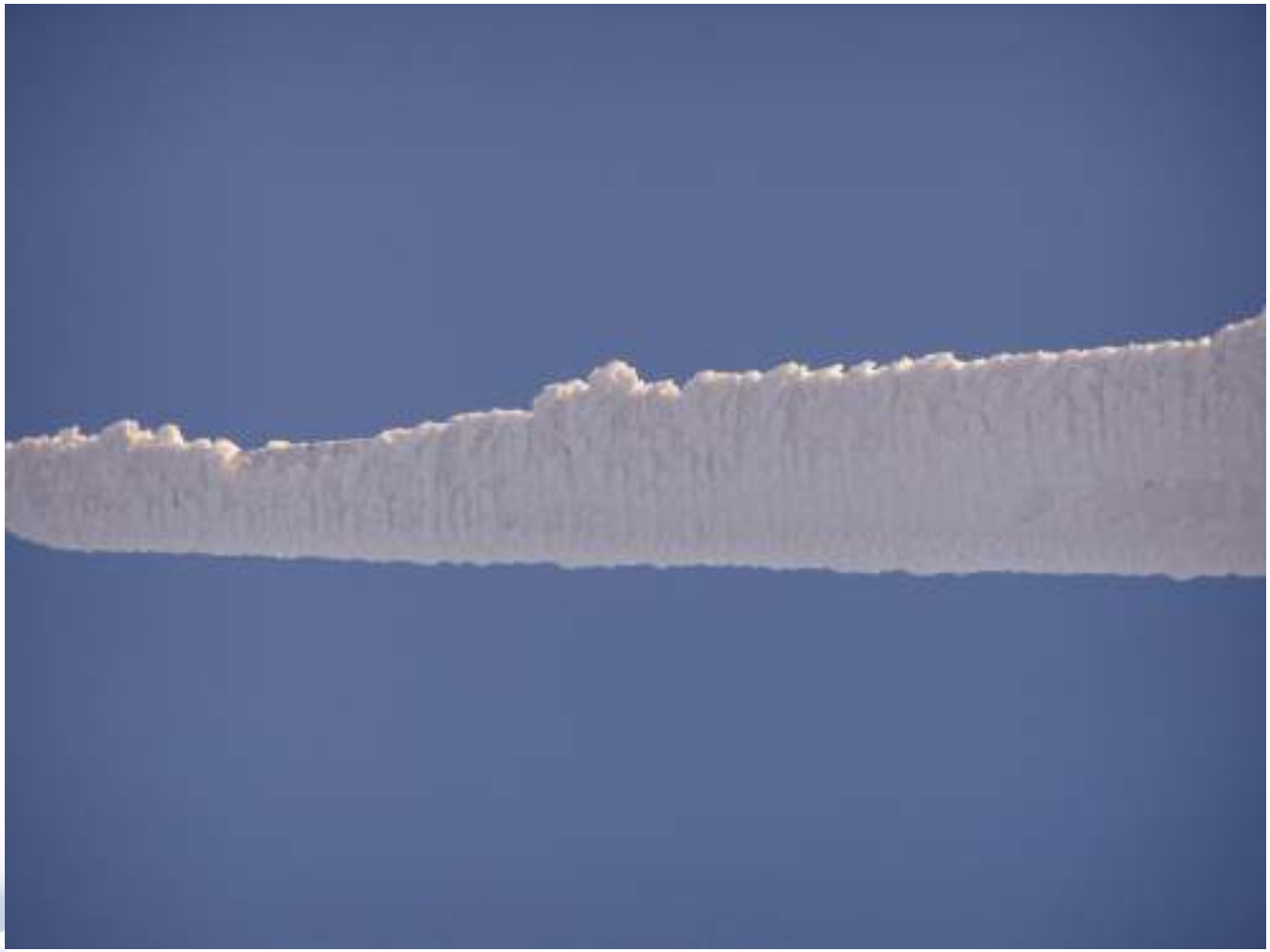
Solution for cold climate to secure production

Success keys

- **Algorithms /sensors when to heat**
- **Power supply to hub and from hub to blades**

WWD3 operational in Estonia

Icing and snow on blade



Situation without blade heating -> no production

Algorithms to switch power on

Why wind park needs sufficient algorithms to switch power on?

- **Like in Sweden & Finnish Lapland, ice can occur 7 months of year (from October to May)**
- **Heating always on -> waste of energy (money)**
- **Heating on after when blades are all ready on ice, stops turbine and take much time to start again -> waste of energy (money)**
- **Prior experiences has shown that further research is needed**

Detection of ice and icing conditions

1 Needed sensors for algorithms:

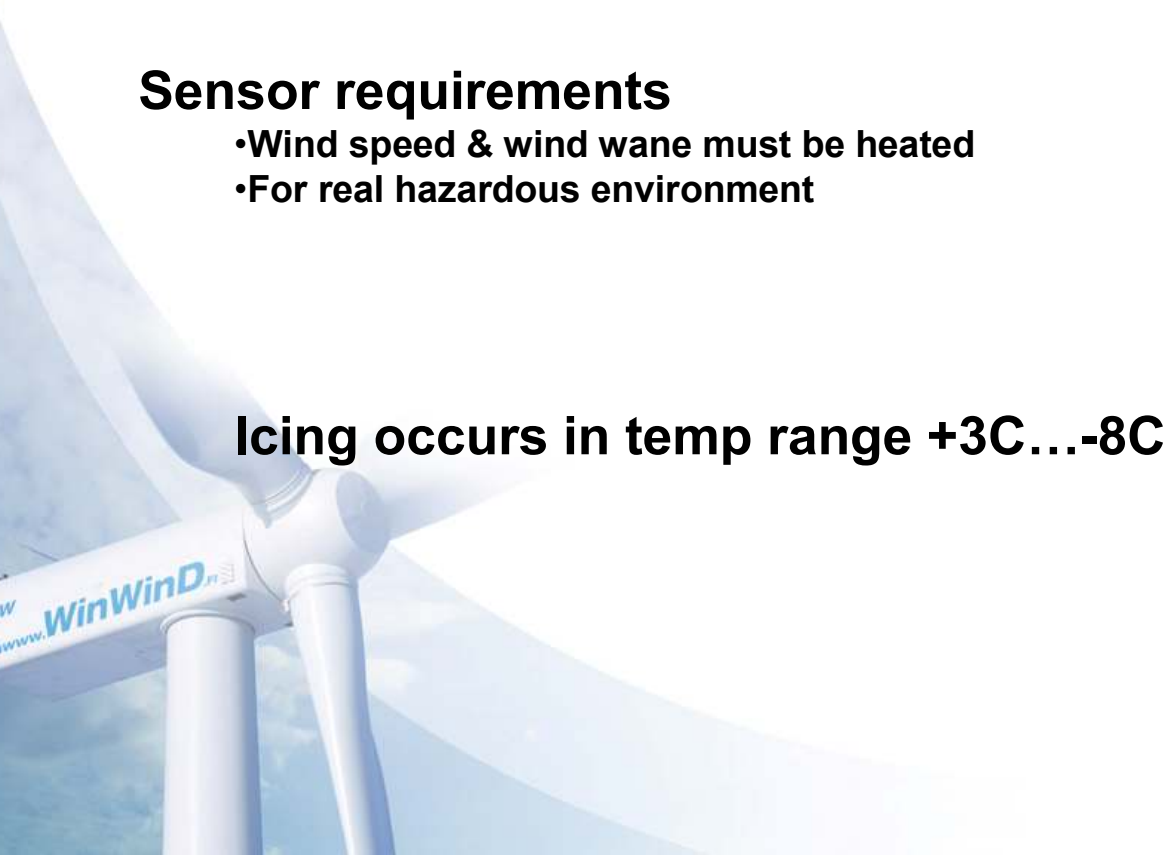
- Temperature
- Pressure
- Humidity
- Wind speed
- Rotor unbalance

2 Ice detecting system

Sensor requirements

- Wind speed & wind wane must be heated
- For real hazardous environment

Icing occurs in temp range +3C…-8C



WinWinD

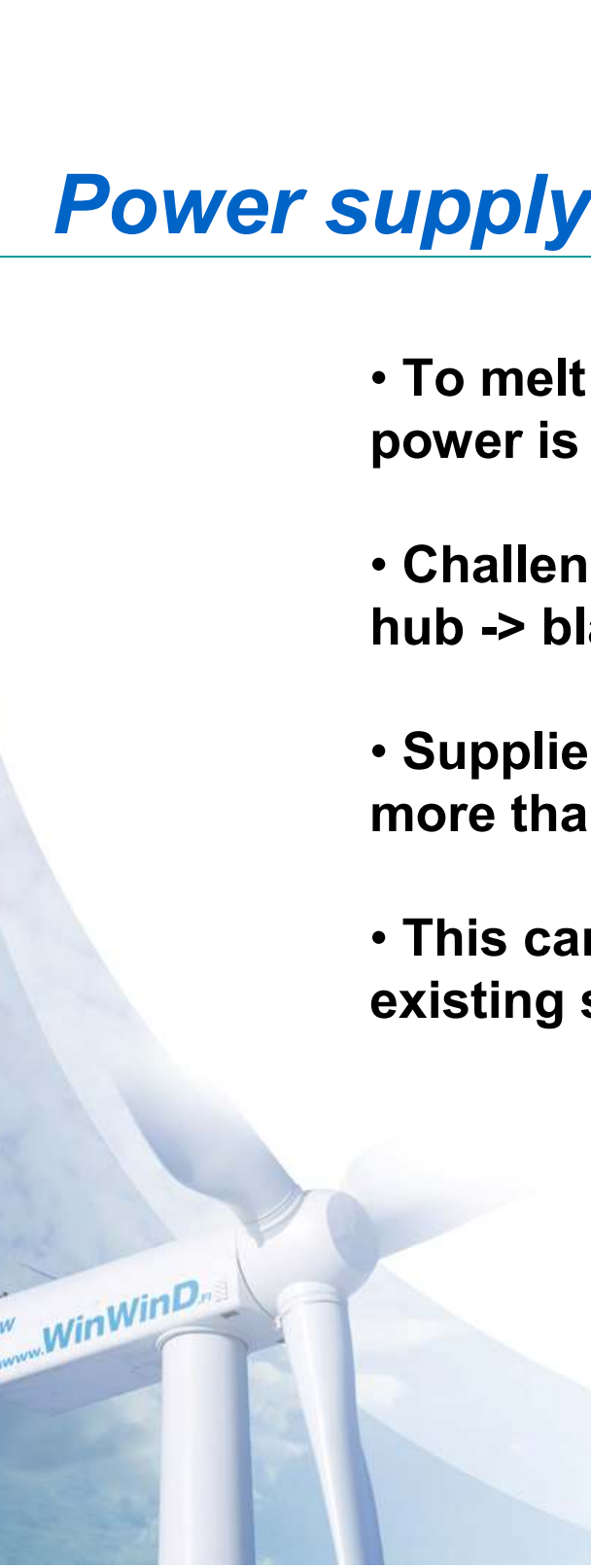
Power supply to hub for blades

- To melt ice out of blades, then sufficient amount of power is required >100kW

- Challenge is to get enough power trough shaft to hub -> blades

- Suppliers can supply from 25kW up to 600kW, more than 190kW needs special solution

- This can be done with special design, even with existing standard turbine



Conclusions

- Make all needed “Arctic model” changes for your turbines
- Use proper sensors
- Make proper algorithms for switch heating on