



# Ice sensor for rotor blades

## The innovation for your installation

### Danger of icing

Even in moderate climate areas icing of wind turbines is well known.



**Ice formation on windmill rotor blades**

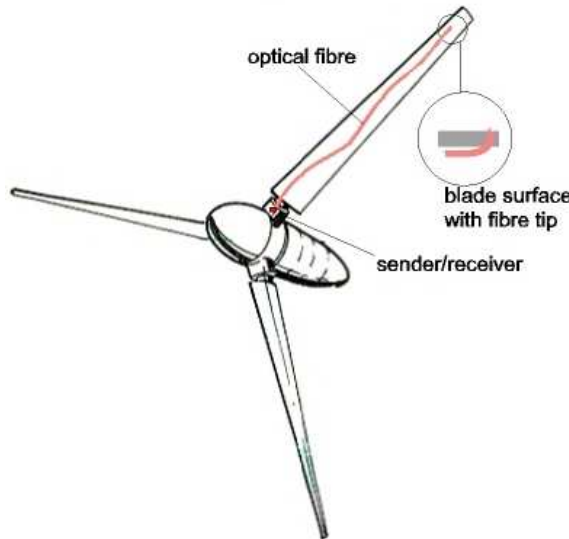
Icing causes standstills and profit cuts. The aim always has to be minimum standstills and maximum reduction of risk potential caused by ice fall. This can only be guaranteed by a secure ice detection at the *direct location of ice formation*, i.e. at the rotor blade itself.

Currently available ice sensors use different techniques for ice detection, but NOT in the blade itself (e.g. heated/unheated anemometers), or are inaccurate (temperature measurement in the hub etc. does not correspond to actual ice formation on the blade). Vibration analysis is possible during rotor operation only.

The innovative concept of the **ice sensor** is the fully direct and continuous measurement of ice formation in the blade, at any possible (user defined) location in the blade. This technique monitors the rotating as well at the stationary blade and allows an immediate reaction when icing occurs. It enables both the immediate stop and secure re-start of the turbine after standstill.

### Idea – The measurement system

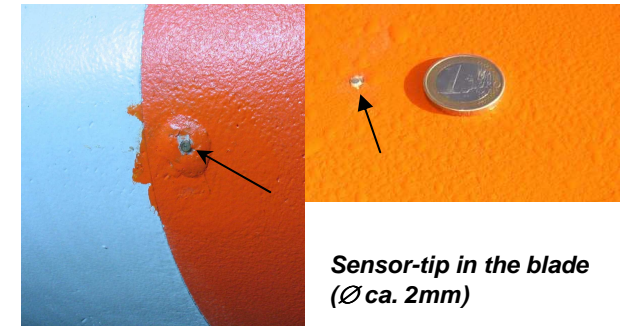
Basis is the current-free measurement using infrared light via optical fibers. For practical reasons these are laminated into the blade during manufacturing.



### Location of sensor components in the turbine

The basic unit consists of a *sending/receiving* part located in the rotor basis and up to 3 optical fibers leading to any selectable measurement point in the blade.

Only the flush mounted fibre tip ( $\varnothing$  2 mm) is in contact with the blade's outside surface for ice detection.



### Technique - Functionality

Infrared light is absorbed differently by water and ice. This can be used for ice detection. Infrared light is sent continuously through the blade's optical fiber. When icing occurs on the sensor tip, the signal changes characteristically and allows a secure ice warning. This signal is transmitted by radio from the blade to the central unit in the power house. From there it is passed via relays or RS-232 to the control system. This "ice yes/no" signal allows the plant operator a situation conform reaction.

Especially in high humidity areas, like near-coast or offshore, in clouds or fog, icing danger is even higher due to adiabatic effects even at temperatures slightly above 0°C. This makes simple temperature measurement an inadequate mean for ice warning.

Vibration analysis is useless during standstills. Due to distances of over 100m between adjacent rotor blade tips, totally different atmospheric conditions may occur in the same installation.

*Only a direct measurement in the blade gives the information of the real icing condition!*

### System concept:

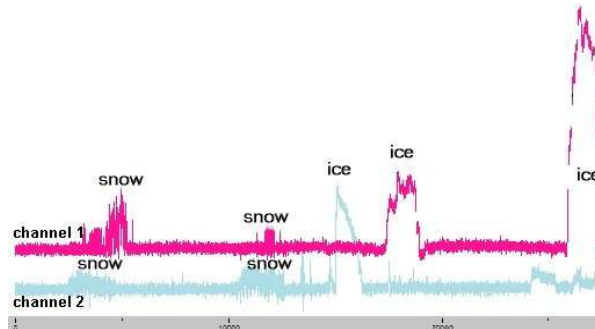
- Control unit in blade basis, grid-bound power supply
- 3 sensors (optical fibers) per unit lead to different locations in the blade and are laminated into the blade (e.g. blade upper/bottom side, leading edge)
- Several blade modules applicable (e.g. to monitor all blades)



**Control unit with sensor fiber**

- Data transmission from blade module to central unit via radio (easy information retrieval possible, standstills avoidable/reducible), applicable as bus system
- RS-232-connection for on-site inspection

- Bus coordination, analysis and communication with installation's operation system via receiver/analysis unit in the powerhouse
- Signals: ice and error via relays, details via RS-232
- Remote maintenance possible if data connection by operator is provided



**Measurement of ice formation on different rotor blades of the same installation**

The ice sensor provides a continuous monitoring of your installation. This is especially helpful with difficult accessible turbines, e.g. offshore or in mountain regions.

### Requirements

The integration of the sensor components (installation of blade module in the rotor blades) is optimally done during blade manufacturing. The blade module requires only a 24V DC/230V AC power connection in the blade's root. The system is maintenance-free, in case of malfunctions/service the sending/receiving unit can be exchanged unproblematically.



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