LEINE LINDE SYSTEMS

IPMS®

Timely ice detection for improved safety and higher energy yields.

Sample installation on a 3 MW wind turbine

IPMS®-Ice detection system
with network camera and humidity/temperature sensors

Conventional sensors trigger a warning after ice has already accumulated on the blades or nacelle. In contrast, IPMS® relies on predictive ice detection for wind turbines. This pioneering system detects imminent frost formation and, if responding as the situation warrants it, can prevent dangerous ice accumulation on the blades at an early stage. The advantage: Hazard to people and buildings due to ice shedding and falling, long-term production downtimes and the emergence of material fatigue are reduced to a minimum.

The IPMS®-Ice Prevention and Monitoring System – relies on the highly accurate humidity/temperature sensor technology commonly used in meteorology. The system includes a remote-controlled network camera that allows visual inspection of the rotor blades and turbine location, a feature which operating licenses often require. The operator can intervene remotely and no longer needs to make costly on-site visits. An additional reference sensor ensures that the IPMS® is operating correctly.

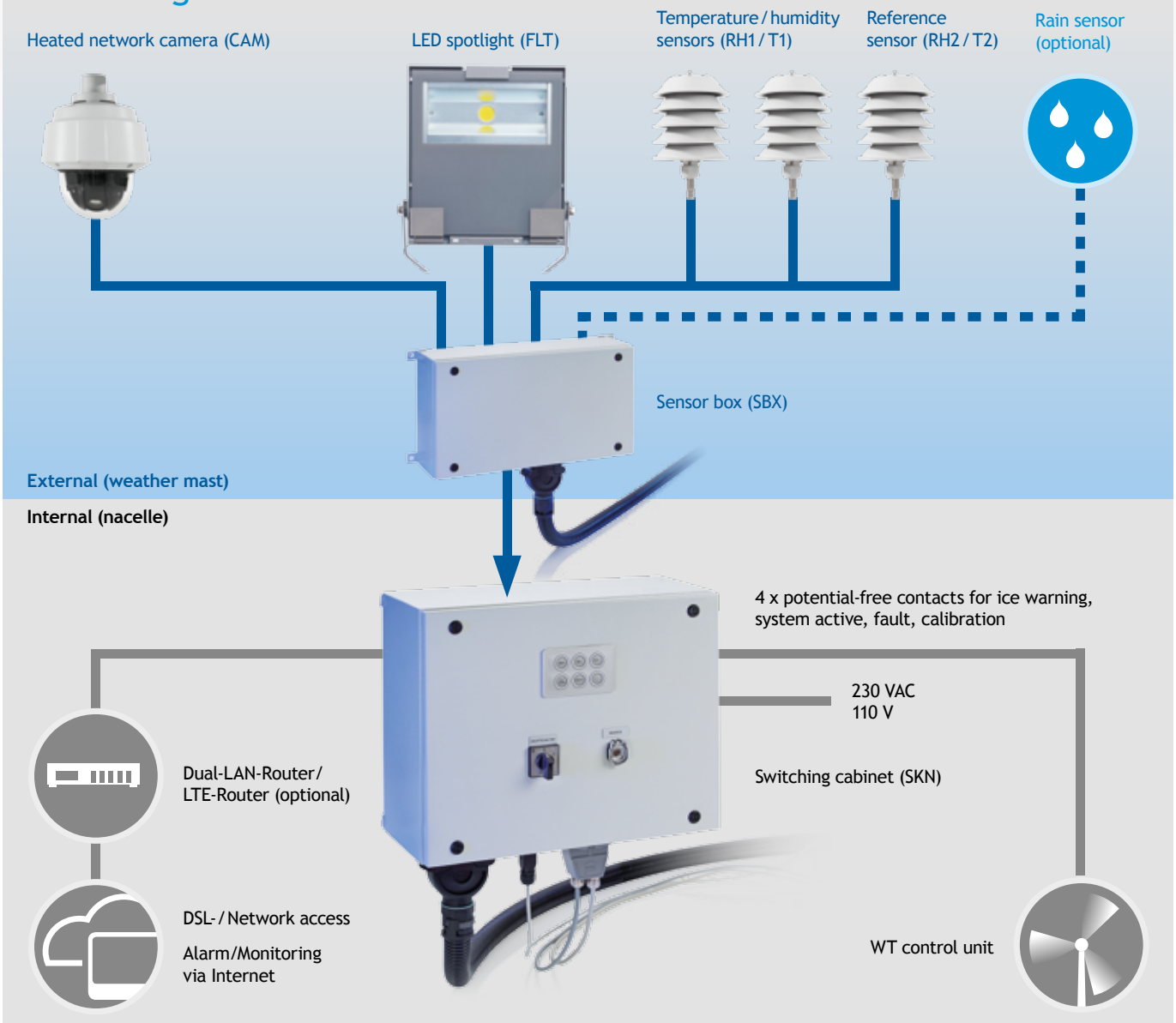
Operating principle

Permanent monitoring, early warning, automatic all-clear signal and live image

Whether retrofitted or integrated during wind turbine assembly in the manufacturer's plant: IPMS® monitors the weather conditions based on multiple parameters. The integrated, highly-accurate sensor system detects the risk of frost/ice formation at the installation site and automatically sends an e-mail notification. Including system status and current measurement data.

Now the owner or operator can use a PC or smartphone to analyze measurement data or perform a remote visual inspection via the heated network camera mounted to the roof of the nacelle. At any time day or night thanks to a remotely-controlled LED spotlight. The wind turbine can be switched off by the operator in manual mode or shut down automatically when the alert level configured in the IPMS® is triggered. IPMS® automatically sends a notification once safe, ice-free operation is possible again. The wind turbine operation can be approved remotely after a second visual inspection via the network camera.

Block diagram



Product

Proactive management for improved safety, higher availability and optimized energy yields

- Ice detection and early warning, even when the rotor blades are idle or there is no wind
- Yield losses are minimized by shutting down the system in time and restarting it early
- Can be retrofitted in installed wind turbines
- Installation on the nacelle roof/weather mast by the WT manufacturer in the plant or on-site by a WT service company
- Optimized operation for any rotor blade heaters that may be in place
- Existing sensors can be connected to IPMS®

- Reliable measurement of relative humidity, temperature and dew point via high-precision sensors and integrated probe heating
- Visual remote control with high-resolution live image via heated, professional network camera, includes spotlight for night operation with remote power switch
- Prevents the wind turbine being deactivated too early or too late via individually configurable parameters and optional customization for the specific turbine location
- Use of a third sensor for reference measurements
- Two operating modes allow the wind turbine to be switched on or off either automatically or manually
- Early warning of ice formation via e-mail notification to the owner/operator's PC or smartphone or other recipients
- Measurement and system status data saved in 1 minute intervals
- Self-diagnostic function; signaling via relay contact and information via e-mail after a reboot
- User-specific access authorization via four different access levels
- Detection of sleet via optional integrated rain sensor

Designs

Scope of delivery

The following components are supplied by LEINE LINDE SYSTEMS:

- Combined high-precision temperature / humidity sensor with integrated heating function and UV protection screen
- Reference sensor for temperature and humidity measurement, includes UV protection screen
- Professional, heated network dome camera with 30 x optical zoom and 360° horizontal / 220° vertical swivel
- LED spotlight for night operation, remote power switch
- Compact control cabinet (SKN) for installation in nacelle, includes build-in SPS, main power switch and service port
- Air-conditioned junction box (SBX) for sensor electronics for external mounting on the weather mast
- Plug-in system cabling (VKS 2) from SKN to SBX, 5 m or 10 m length
- Cables for connecting SBX to sensors / flood light / camera, 2 m or 5 m length
- Documentation, manual
- Mass storage device for data logging
- Visualization for configuration, operation and remote maintenance
- Integrated camera webserver

Additional features

Optional: Wind turbine support structure, overvoltage protection, project-specific connection cables, Roxtec roof outlets for VKS 2, rain sensor, LAN or LTE router

LEINE LINDE SYSTEMS GmbH can arrange installation, configuration and maintenance of the IPMS®.

Operating range

External: Sensor technology: temperature: −40°C ... 60°C, relative humidity: 0 ... 100%
Network camera: temperature: −40°C ... 55°C

Protection class

Internal: Compact control cabinet SKN: IP 54
External: Sensor box SBX: IP 64
Network camera: IP 66
LED spotlight: IP 66

Electrical connection

Power supply:	230 V/50 Hz or 110 V/60 Hz
Power consumption:	max. 600 W (10 A fuse on-site)
Connection to WT control unit:	4 x potential-free changeover contacts for ice warning, system active, fault, calibration statuses; switching load of 12 V/10 mA to 250 VAC/6 A

Additional external sensors and signals can be connected

Connection for external communication:
DSL/network connection (two IP addresses required for operation), optional 3G or 4G data connection available depending on location or optional fieldbus

Mechanical connection

Dimensions & weight (W x H x D):
Compact control cabinet (SKN): 500 x 400 x 210 mm, 18 kg
External sensor box (SBX): 550 x 300 x 160 mm, 11 kg
Network camera (CAM): 205 x 321 mm, 4 kg
LED spotlight (FLT): 233 x 319 x 85 mm, 2,5 kg
IPMS® sensors (RH1, T1, RH2/T2): 3 units, 105 x 122 (174) mm, je 0,5 kg each
Support structure (optional) on the weather mast: WT-specific

Visualization

Main side of visualization (example)

The remote monitoring, the transmission of the sensor data and the operation of the camera via an internet connection. With a viewer, a direct connection is established for the operation of the IPMS®. The viewer displays the content of the IPMS® electronics (server) on the local PC of the user (client) and sends in return keyboard and mouse movements to the electronics. The main messages and data are provided to the user clearly available. In the visualization the following menus are available: Home, metrics, configuration, alarms, system setup and recipes.

For the operation of the network camera (CAM) an Internet-capable browser (e.g. Microsoft Internet Explorer) is required, which accesses a camera embedded Web server.

Ice formation

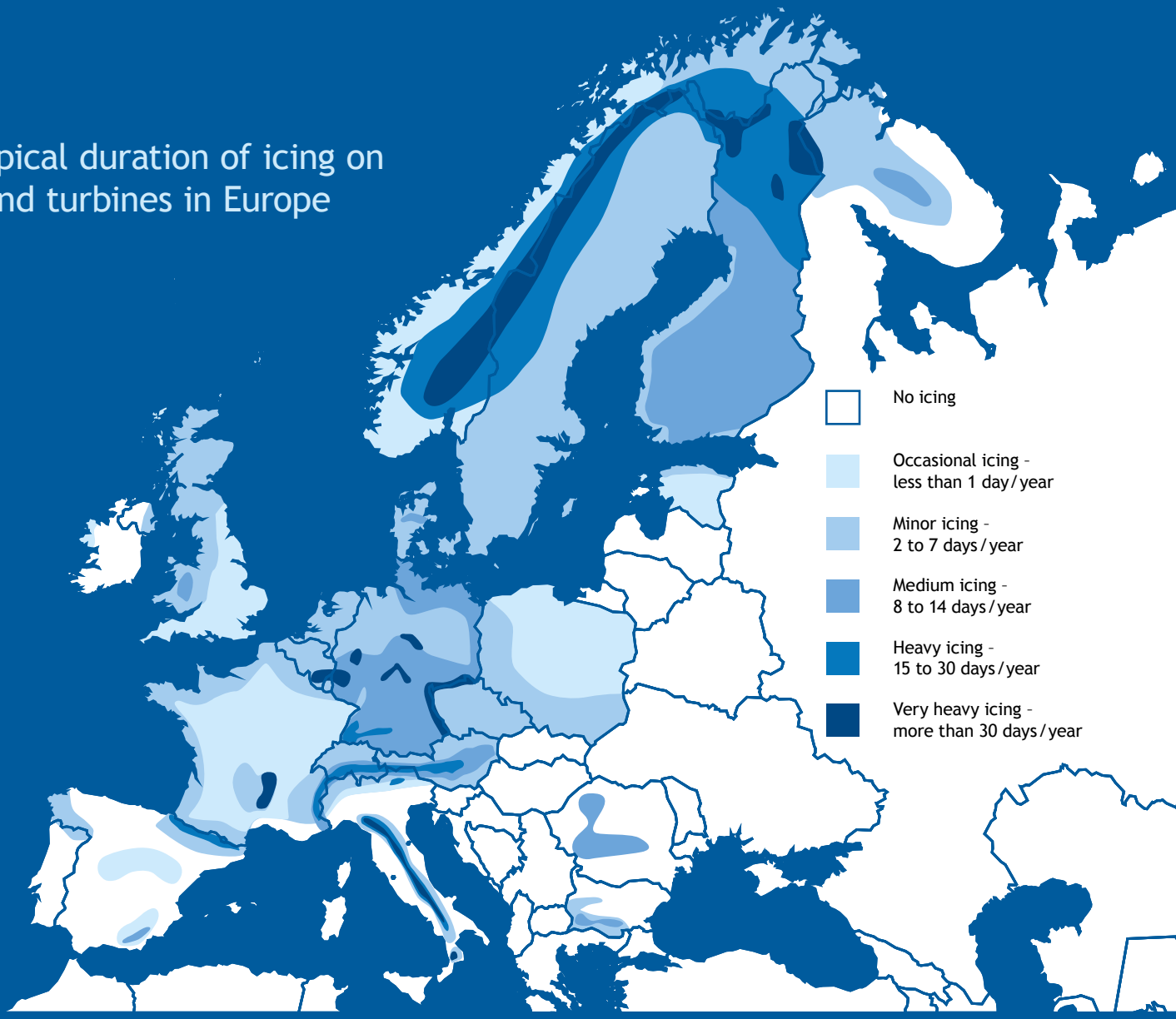
Dangers and risks of ice formation on wind turbines

Freezing temperatures combined with high humidity, fog, snow or rain: Unfavorable weather conditions like that can cause ice to form on the rotor blades and/or the nacelles of wind turbines (WT). In particular, centimeter-thick layers of ice frequently form quickly during freezing fog. And that has major consequences – not just for WT operations:

- Ice shedding or falling from wind turbines can endanger persons and service personnel in the vicinity, as well as nearby buildings or vehicles.
- Ice on the rotor blades reduces their aerodynamic and in general, this leads to automatic deactivation of the turbine and thus a loss in yield.
- Building codes or stipulations in operating licenses require that operators take preventive measures, which generally involve shutting down the turbine, and then visit the site before turning the turbine on again.
- Additional loads and imbalances due to ice can accelerate material fatigue, e.g. in the turbine drive train or the rotor blade.
- Waiting hours or days for better weather conditions can therefore result in yield losses that should not be underestimated.

In addition, the amount of ice on the rotor blades of running wind turbines can increase rapidly compared with the systems deactivated on time. As a result, wind turbines with little or no ice can also be reactivated and produce electricity much earlier.

Typical duration of icing on wind turbines in Europe



Source: WECO ice map 1991_1997

Freezing fog deposits

Freezing fog deposits is the collective term for precipitation deposits like white frost, rime, clear ice.

- They generally form when fog droplets freeze on largely vertical surfaces with surface temperatures below zero.
- They typically grow against the wind.
- Frozen fog deposits are a major source of risk in terms of material strain and can lead to heavy meteorological loads.

White frost: Type of frozen fog deposit; generally thin, fragile ice needles or flakes which are formed almost exclusively through sublimation and form only a loose bond with objects. Requirements for frost formation are high humidity (90% or more), low wind and temperatures below −8°C.

Rime: Granular, gray-white and very solidly bonded ice deposit with air bubble inclusions. Rime generally forms in foggy conditions at temperatures between −2°C and −10°C via rapid freezing of fog droplets on objects and via sublimation. High winds promote the formation of rime.

Clear ice: Smooth, compact, transparent and extremely solidly bonded ice deposit of indeterminate shape and with an irregular surface. Clear ice forms at air temperatures between 0 and −3°C via slow freezing of cooled fog droplets on objects and can grow to extremely heavy ice loads.

Source: Deutsche Wetterdienst DWD

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