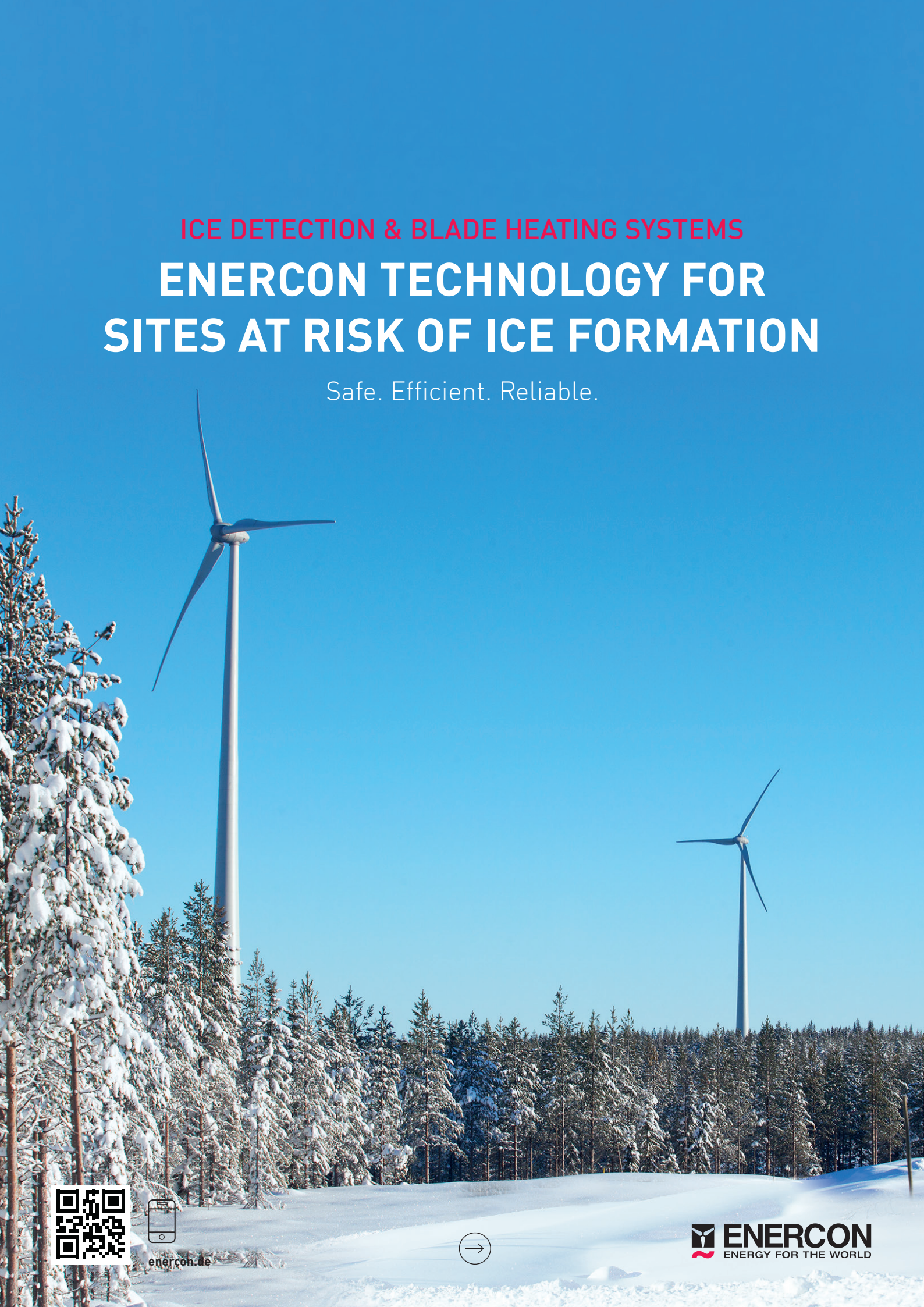
ICE DETECTION & BLADE HEATING SYSTEMS

ENERCON TECHNOLOGY FOR SITES AT RISK OF ICE FORMATION

Safe. Efficient. Reliable.



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ENERCON
ENERGY FOR THE WORLD

ENERCON
EFFICIENT & SAFE TECHNOLOGY WHERE THERE IS A RISK OF ICE FORMATION

Extreme climate conditions like those at Cold Climate sites demand flexibility and specialised technological solutions. In the winter months in particular, it is entirely possible that ice formation will also occur on rotor blades at other sites. This is caused by high air humidity at outside temperatures around freezing and colder. Ice formation can lead to loss of yield or may even cause a standstill of the wind turbine. ENERCON's sophisticated ice detection technology has been working to counteract this since 2004. It helps to reduce any downtime and losses of yield to a minimum.

ENERCON ice detection system

All ENERCON wind energy converters are equipped with an ice detection system as standard, which is based on a specially developed and patented characteristic curve analysis method. During operation, the ice detection system compares current operating data such as wind, power and blade angle with the recorded long-term mean values. Ice build-up on the wind energy converter changes the aerodynamic properties and the WEC is stopped. The thawing time is determined by the outside temperature. Once this period has elapsed, the wind turbine is restarted. If called for by the particular site, automatic restart following icing can be deactivated. In this case, the operator/owner restarts the machine manually after having carried out a visual inspection.

ENERCON ice detection technology has won over many customers due to its high level of reliability, something which has been confirmed by independent institutes such as Meteotest. In addition to the characteristic curve analysis method, ENERCON also offers further independent ice detection systems for sites more susceptible to ice formation.

SIGNIFICANT REDUCTION
IN ICING-RELATED YIELD LOSS THANKS TO BLADE HEATING SYSTEM

ENERCON blade heating system

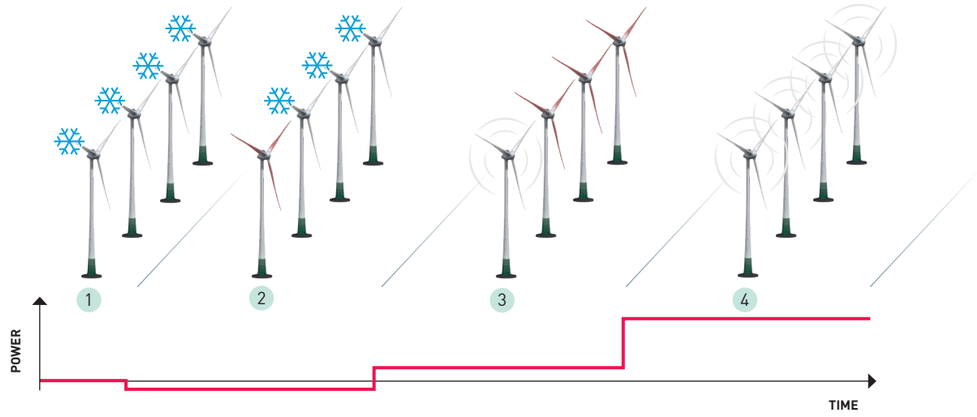
The optionally available ENERCON blade heating system shortens thawing time. A fan heater installed in the blade root is activated and starts heating the air inside the rotor blade using air recirculation. The temperature of the blade surface warms up to above 0°C and the ice build-up melts off.

At sites with a low risk potential, it is also possible to automatically activate the blade heating system while the wind turbine is running thanks to ENERCON's ice detection technology. Thin layers of ice are thawed off at an early stage thus reducing downtime. If ice continues to build up on the rotor blades during extreme weather conditions despite the blade heating system being switched on, the wind turbine is stopped.

Various research stations with ENERCON wind energy converters in the Czech Republic and Sweden were able to successfully verify that the ENERCON blade heating system is highly efficient. Although the wind turbine's energy consumption increases with use of the blade heating system, the considerable additional yield showed that the losses resulting from icing could be reduced thanks to the blade heating system.

ENERCON SCADA power consumption management

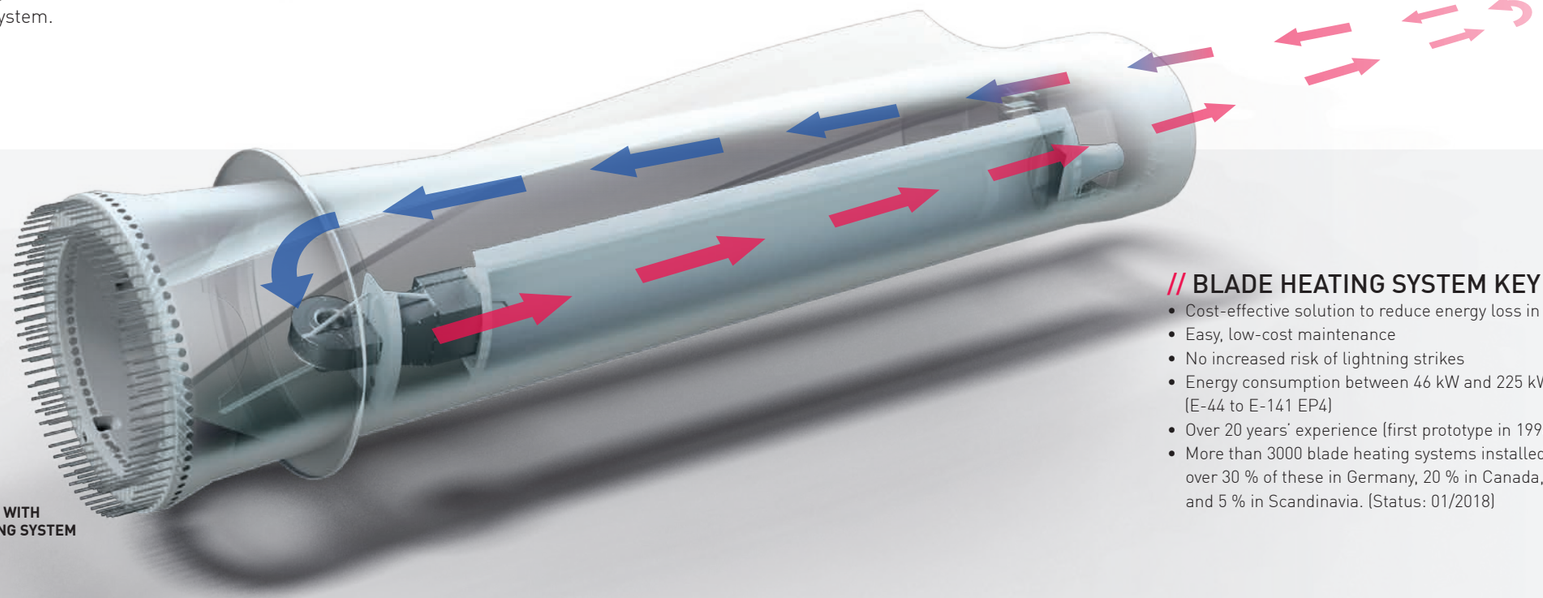
ENERCON SCADA power consumption management enables restriction of the power consumption of ENERCON wind energy converters at the network connection point to an individually configurable value. The additional costs resulting from the power consumption can thus be reduced to a minimum. This is particularly useful where large electrical consumers such as the blade heating system are concerned, as the blade is often heated while the wind energy converters are at a standstill, and affects the whole wind farm.



STAGE 1: All WECs in the wind farm are iced up
STAGE 2: Restricted power consumption for one WEC to thaw the blades
STAGE 3: Thawed WEC restarts and powers the blade heating system of the other three WECs using its own energy (without further power consumption from the grid)
STAGE 4: All WECs are thawed and back in operation

Risk minimisation in the case of ice formation

On top of its ice detection technology, ENERCON has also developed software certified by Deutsche WindGuard to support in evaluating the risk of ice shedding and ice throw from wind turbines. To ensure risks are also minimised when ice formation occurs during wind farm operation, ENERCON offers optional ice warning lights along with site-specific nacelle positioning and restart strategies following icing.



INNER BLADE WITH BLADE HEATING SYSTEM

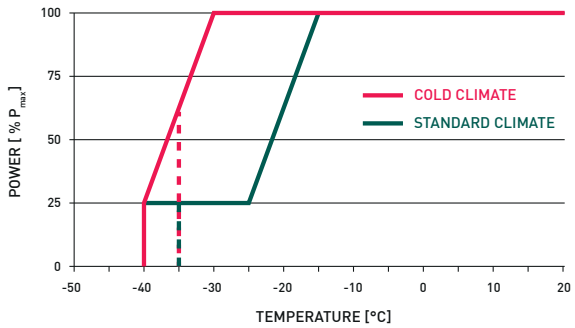
// BLADE HEATING SYSTEM KEY FACTS

- Cost-effective solution to reduce energy loss in the long term
- Easy, low-cost maintenance
- No increased risk of lightning strikes
- Energy consumption between 46 kW and 225 kW (E-44 to E-141 EP4)
- Over 20 years' experience (first prototype in 1996)
- More than 3000 blade heating systems installed worldwide, over 30 % of these in Germany, 20 % in Canada, 14 % in Austria and 5 % in Scandinavia. (Status: 01/2018)

ENERCON Cold Climate package

ENERCON wind energy converters are equipped with a special Cold Climate package at Cold Climate sites* where temperatures are far below freezing. This includes components that are modified in the areas of machine construction (e.g. adjustments made to steel, concrete or lubricants) and electronics, which enable reliable operation at sites with extreme climate conditions.

The power curve of ENERCON wind energy converters with Cold Climate features remains unaffected at temperatures down to -30 °C. Below this temperature, maximum wind energy converter power is reduced linearly to 25 % until a temperature of -40 °C is reached. At temperatures lower than this the wind energy converter is stopped, although it remains ready for operation. The wind energy converter is restarted as soon as the temperature has risen to -35 °C.



* Sites where the temperature measures below -20 °C for at least an hour on more than 9 days every year or with an annual average temperature of < 0 °C.

COLD CLIMATE SITE – RAGLAN MINE IN CANADA:
45 % of the annual energy yield is generated at temperatures below -15 °C

Photo:
Tugliq Energy / Justin Bulota

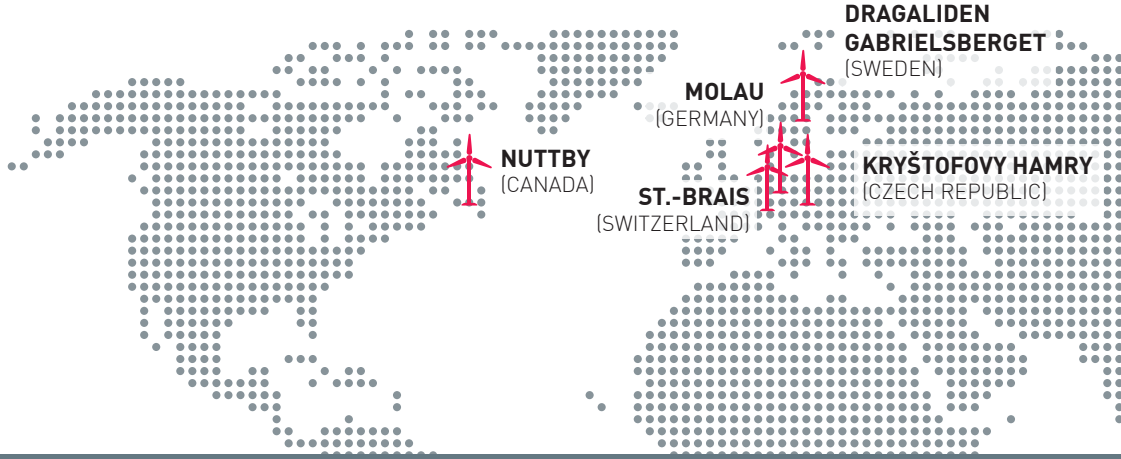
IEA ICE CLASSIFICATION
FOR SITES WITH ICING RISKS

IEA ice class (no.)	Meteorological icing (% of year)	Instrumental icing (% of year)	Production loss (AEP in %)		Validation (Site)
			without blade heating system	with blade heating system in operation	
5	> 10	> 20	> 20	> 4	-
4	5-10	10 - 30	10 - 25	1.5 - 5	Krystofovy Hamry Dragaliden Gabrielsberget
3	3-5	6 - 15	3 - 12	0.5 - 3	St. Brais Nuttby
2	0.5-3	1 - 9	0.5 - 5	0 - 1.5	Molau
1	0-0.5	< 1.5	0 - 0.5	< 0.5	-

Energy yield gain
per year on tested WECs with blade heating system in operation

DRAGALIDEN 10 %**
KRYŠTOFOVY HAMRY 6 %**
MOLAU 4 %**
NUTTBY 3 %

** Verified by Meteotest



FURTHER INFORMATION CAN BE OBTAINED FROM ENERCON SALES
ENERCON GmbH • Vertireb • Dreekamp 5 • 26605 Aurich • Tel. +49 49 41 - 927 - 0 • vertrieb@enercon.de