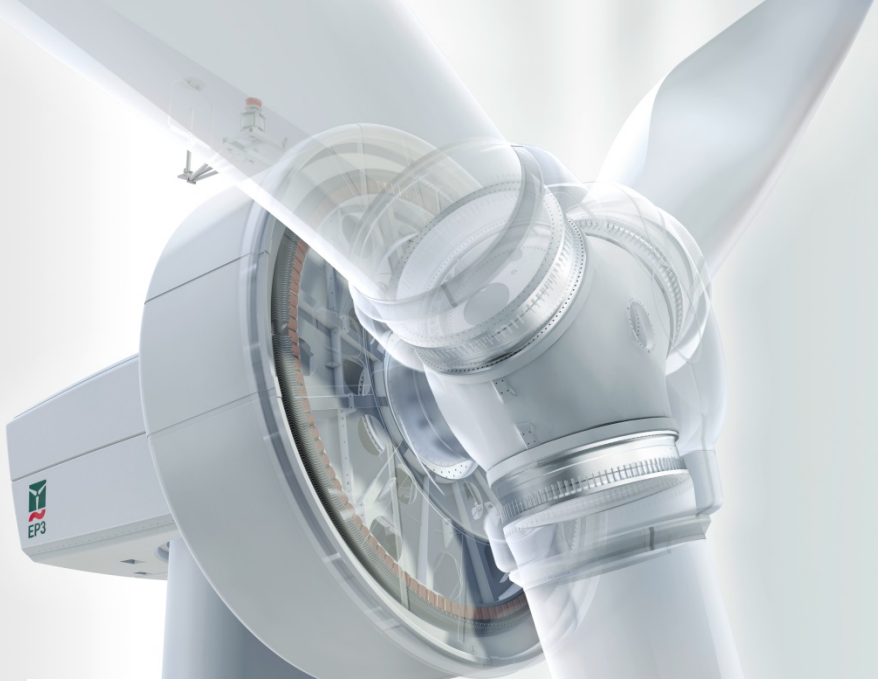

Safe turbine operation in icy conditions

Winterwind 2021-04-21
Eva Sjögren

ENERCON
ENERGY FOR THE WORLD

AGENDA

1. Overview
2. Safe turbine access
3. Safe turbine operation: ice detection and de-icing
4. Different countries – different regulations
5. Summary and conclusions

1 OVERVIEW

OVERVIEW

THE BEAUTIFUL SWEDISH WINTER

Photo: Magnus Junti, Enercon

THE NEED OF GREEN ENERGY IN NORTHERN SWEDEN

”The Light in the North”

Dagens Industri

- Hybrit
- H2 Green Steel
- Northvolt

+ lots of other high electricty intensive industries

Source: https://www.hybritdevelopment.se

Source: https://northvolt.com/about

WHERE DO WE COME FROM?

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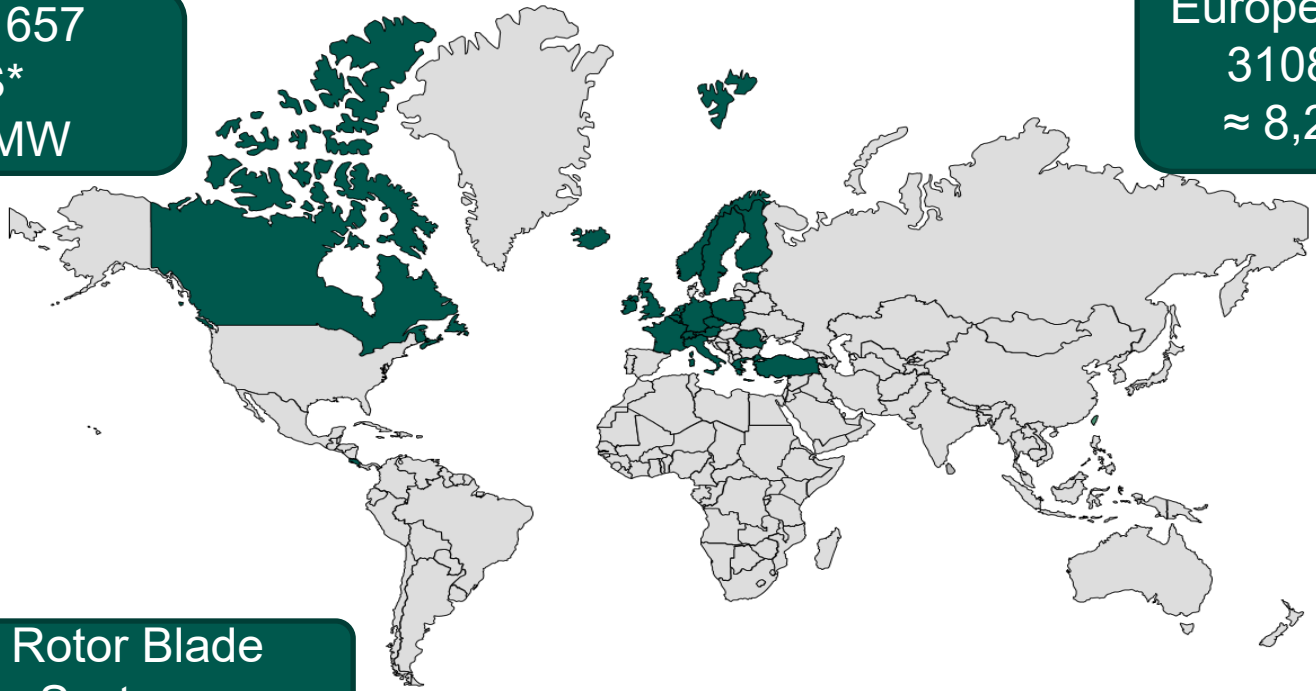
Canada: 657
RBHS*
≈1,500 MW

Europe + Turkey:
3108 RBHS
≈ 8,200 MW



*RBHS= Rotor Blade Heating Systems

THE WORK OF ENERCON

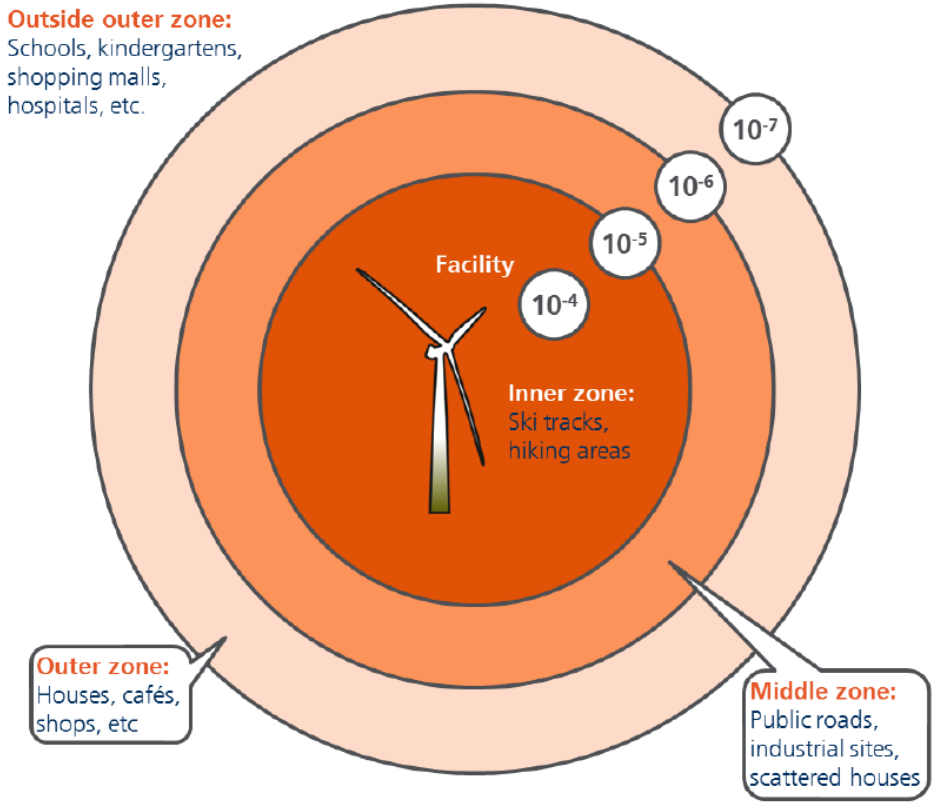
ENERCON
ENERGY FOR THE WORLD

- We are part of the **IEA Wind TCP TASK 19**
- We are part of the **Icing and Cold Climate Safety Sub-Committe**
- We are a member of the **Working Group for Environment and Safety** within the Swedish Wind Energy Association
- We carry out our own in house research since many years at the **WRD Center in Aurich, Germany**

2 SAFE TURBINE ACCESS

SAFE TURBINE ACCESS

DIFFERENT ZONES



Source: IEA Wind TCP Task 19, International Recommmendations

SAFE TURBINE ACCESS

ENTERING THE INNER ZONE

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Photo: Magnus Junti, Enercon

SAFE TURBINE ACCESS

ENTERING THE SITE

Photo: Magnus Junti, Enercon

SAFE TURBINE ACCESS

ENTERING THE WIND TURBINE

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Photo: Magnus Junti, Enercon

THE RISK OF ICE THROWS

The ice throw zone or the maximum throwing distance can be represented by the red circle of Figure 3.

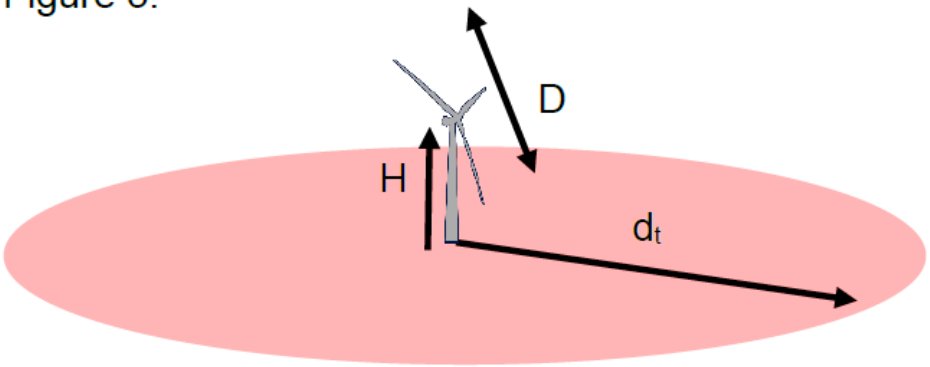


Figure 3: Maximum throwing distance area

$$d_t = 1.5 * (D + H)$$

d_t = Maximum throwing distance (m)
D = Rotor diameter (m)
H = Hub height (m)

Source: Best Practices for Wind Farm Icing and Cold Climate Health&Safety page 7

SAFE TURBINE ACCESS

THE ENERCON CHECK LIST

1. Turbine Approach with icing Conditions

1.1 Primary analysis
1.2 Second analysis

2. Iced Turbine

ICING CONDITION

Tab.1. How to evaluate the presence of ice, how to assess its stability, when is it safe to enter a turbine, how to position and approach the turbine, and how to deploy ice protection devices.

1. Turbine Approach With Icing Condition		**Yes**	**No**
1.1. Primary analysis		**(check the box)**	
Do any ice detection methods suggest the presence of ice?			
Is the operating state related to icing?			
Has snow, freezing rain, or fog occured in the last 24 hours?			
Has the temperature been below 3° C during precipitation?			
Has the previous work team seen iced turbines?			

If you answered "YES" to one of the question, the wind turbine is probably iced. Go to section 2. Iced Turbine.
If you answered "NO" to all questions, go to section 1.2 Second Analysis.

1.2. Second Analysis. *Stop vehicule outside of the ice throw zone, observe turbine with binoculars:*	**Yes**	**No**
Is ice visible on the blades or on the nacelle?		
Does the turbine make unusual continious noise?		
Are there ice pieces or ice shed impacts in the vicinity of the turbine?		

If you answered "YES" to one of the question, the wind turbine is probably iced. Go to section 2. Iced Turbine.
If you answered "NO" to all questions, Turbine is probably free of ice. ***Proceed to work.***

2. Iced Turbine. *Remotely stop the turbine. Stay outside the turbine's ice throw zone (approx. 300 meters).*	**Yes**	**No**
Is the turbine entirely visible?		
Has ice accumulated only on the rotor?		

If you answered "NON" to one of the two question, ***Stop work and contact your supervisor.***
If you answered "YES" to the two questions, remotely, place the rotor on the opposite side of the access door and observe with binoculars:

Is ice falling from the blades, rotor, nacelle, or tower? (Observe 15 minutes)		
Is wind direction placing the access door downwind of the blades?		

If you answered "YES" to at least one of the questions, ***Stop work and contact your supervisor.***
If you answered "NO" to both questions, ***Proceed to work.***

Stay away from the blades	Do not approach alone
Get as close as possible with the vehicle	Deploy ice-protection device if applicable
Name a spotter that continuously observes for shedding ice	Continuously observe for shedding ice
One person should leave the vehicle and ensure that the way is safe and clear for the others (leave the door open)	
Minimise the amouth of time outside	
Once everyone is inside, drive vehicle back to parking area immediately	
Repeat the same steps to exit the turbine	

Name of the technician:		Date
Signature:		
Name of the technician:		Date
Signature:		
Name of the technician:		Date
Signature:		
Name of the technician:		Date
Signature:		

SAFE TURBINE ACCESS

OTHER RISKS…

Photos: Lars Bergman, Enercon

3 ENERCON Ice Detection and Rotor Blade Heating System

ENERCON POWER CURVE ICE DETECTION METHOD

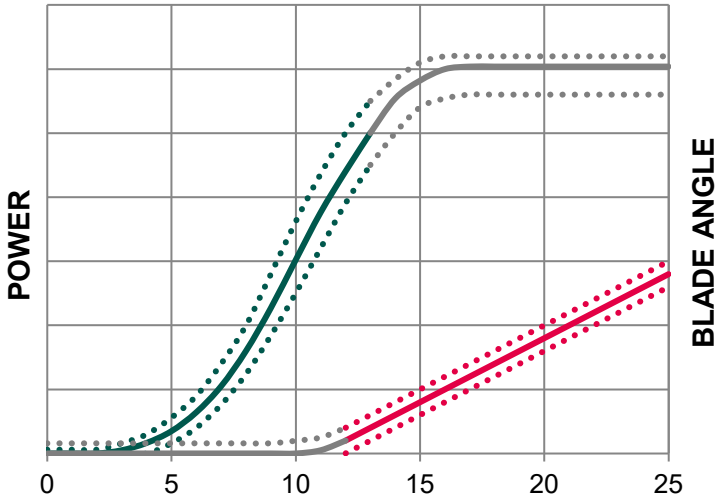
For detecting ice: deviations from characteristic curves are monitored for temperatures below 2°C.

GREEN GRAPH – POWER CURVE METHOD

Deviations from the power curve compared to the current wind speed are detected and registered as ice on the rotor blades

PINK GRAPH – BLADE ANGLE METHOD

Deviations from the blade angle curve compared to the current wind speed are detected and registered as ice



TÜV Nord Report about the functionality of the ENERCON ice detection method (Rev. 6)

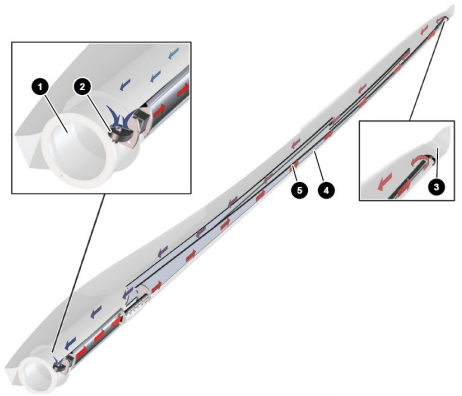
ROTOR BLADE HEATING SYSTEM

Heating during:

1.) Standstill

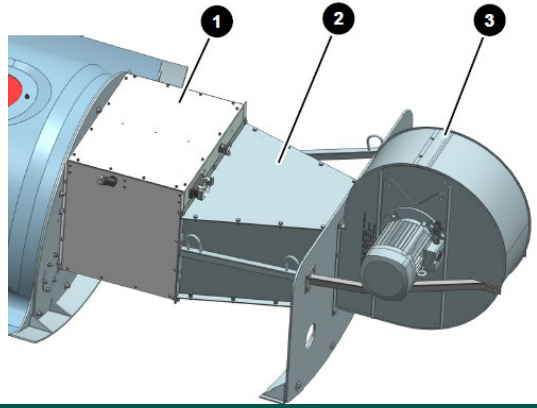
-> allowed in automatic mode on customer demand,

but without additional risk assesment



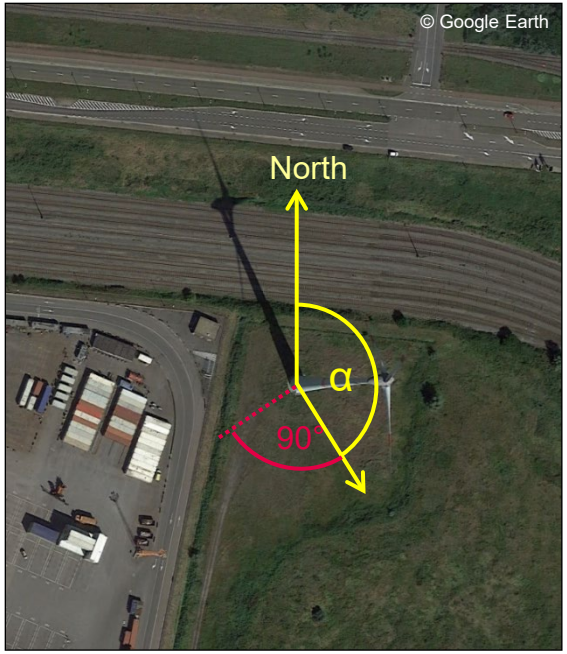
2.) Turbine in operation

-> only possible if site is classified as uncritical for ice throw in certification/individual external ice assessment



NACELLE ALIGNMENT DURING ICING CONDITIONS

- To minimize the risk of falling ice in the immediate vicinity of roads or paths, it is possible to position the rotor of the WEC to a specified azimuth angle α
- Due to the risk of moisture ingress, the nacelle may only be positioned until a certain wind speed has been reached
- Nacelle positioning only recomended if required in building certificate



SITE-SPECFIC RISK ASSESSMENT

- Safe operation of WEC must be secured by ENERCON (acc. to the Machinery Directive 2006/42/EC)
- Standard parameters of the ice detection system and the RBHS enable safe operation (acc. to TÜV Nord report)
- Any deviation from the standard parameterization for critical parameters represents a potentially increased risk and must only be carried out with a site-specific risk assessment by a third party which classifies the risks as acceptable or in compliance with the building permit
- Who is responsible?
- In addition, country-and region-specific requirements have to be observed

4 DIFFERENT COUNTRIES DIFFERENT REGULATIONS

SWEDEN

- Swedish Work Environment Authority
- The Work Environment Act
- Conditions on blade heating systems in permits?!
- Conditions on warning signs regarding ice throws?!

FINLAND

- Maankäyttö-ja rakennuslaki (132/1999 'MRL')
- The Occupational Safety & Health Act (738/2002)
- Environmental Protection Act (527/2014)
- Building permits don’t determine an icing prevention system of any kind
- The windfarm owner must warn for possible ice throw or such hazardous risks by visual signs

GERMANY & AUSTRIA

Germany:

- BimSchG requires at least one ice detection method to secure a turbine stop under icing conditions

- Different regulations in German states, e.g. one state demands an ice detection system which is able to detect the ice immediately at the blades also at standstill to secure a safe restart

Austria:

- Two independent ice detection systems are required to stop the turbine in case of ice built-up

CANADA

- Each province and territory has their own regulatory requirements regarding occupational health and safety
- Canadian Centre for Occupation Health and Safety (federal legislation) and each province and territory's equivalent (provincial/territorial legislation)
- By law, the employer must provide the employee with a safe and healthy workplace. It is also the supervisor's responsibility to ensure that employees understand how to safely conduct their work. It is the employee's responsibility to work safely [19].
- [19] Government of Canada, "Cold Weather Worker Safety Guide." 2005.

Source: Best Practices for Wind Farm Icing and Cold Climate Health & Safety

CANADA – WORKING IN COLD CLIMATE

Canadian Centre for Occupational Health and Safety (CCOHS)

1. The right way is the safe way of doing the job. Follow instructions and ask questions
2. Know potential hazards
3. Know safety rules for specific jobs
4. Follow emergency procedures
5. Report all injuries
6. Know emergency equipment
7. Use personal protective equipment
8. Learn special safety procedures
9. Understand seasonal safety
10. Lock out and tag all energy sources of all machinery and equipment under repair
11. Wear proper clothing
12. Off-the-job safety is equally important

Source: Best Practices for Wind Farm Icing and Cold Climate Health & Safety

5 SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

STATUS QUO AND THE FUTURE

ENERCON
ENERGY FOR THE WORLD

- We – the world - need more green energy then ever before
- We need wind energy when the electricity demand is high at winter times
- We need safe work methods for our service technicans
- We need reliable systems to (i) detect ice and (ii) de-ice the blades
- For the future; we need even more R&D, knowledge sharing, and not least - more Winterwind Conferences ☺

THANK YOU, TACK, DANKE!

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ENERGY FOR THE WORLD

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