

An aerial photograph of a wind farm in a winter landscape. The foreground shows a close-up of a white wind turbine blade. The middle ground is filled with a dense forest of evergreen trees covered in snow. In the background, several wind turbines are visible against a clear blue sky with a few wispy clouds. The overall scene is bright and clear, suggesting a sunny day in a cold climate.

# Siemens Cold Climate Strategy

Improving output in harsh conditions

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# Agenda

- Siemens Wind Power Blade De-Icing
- Experience
- Next Steps & Challenges





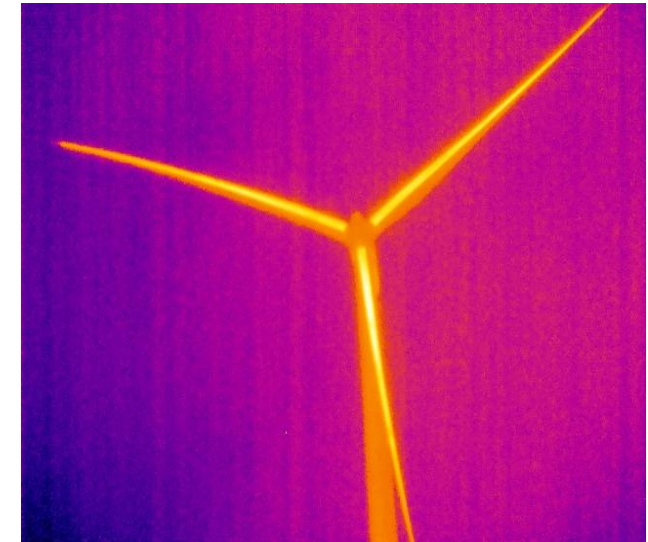
## Reliable and efficient solution for removing ice

### Siemens Wind Power De-icing Strategy

- Ice detected (through power curve deterioration, ice detection sensor or low torque ice detector).
- The turbine is stopped, in static or idle mode.
- De-icing is activated on all three blades.  
(single blade activation is also possible)
- After x min, the nacelle yaws into the wind.
- Once the turbine is producing again, de-icing is deactivated.

#### Parameters for blade de-icing

Temperature	+5°C to -15°C
Liquid water content	0 - 60 g/m <sup>3</sup>
Droplet diameter	0 - 60 µm
Wind Speed	0 - 25 m/s



SWT-2.3-101 de-icing activated



SWT-2.3-101 de-icing activated

# Integrated design offers distinct advantages

## Designing toward minimum risk...

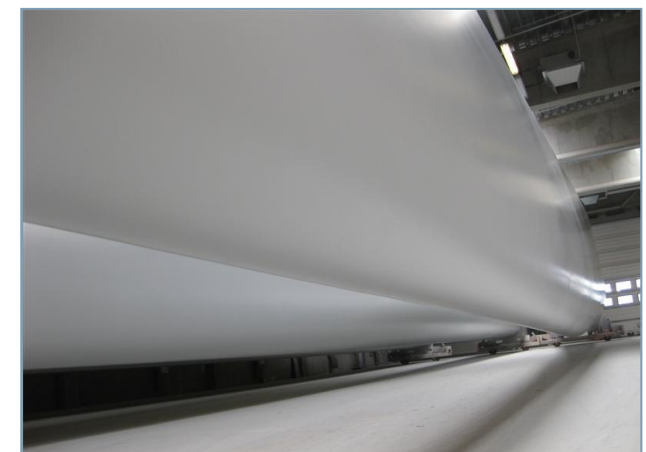
- Heating elements secured from contamination, loading, loosening, and displacement
- No wiring on the outside of the blade, reducing risk of lightning strikes
- Factory assembled system, increasing reliability while minimizing risk of transport damage

## ...and optimized performance

- Heating element adjacent to surface for optimized heat transfer and minimum power losses
- Full retention of the aerodynamic profile
- No effect on noise levels



*Blade with mounted carbon layer*



*Finished blade with de-icing*

# Agenda

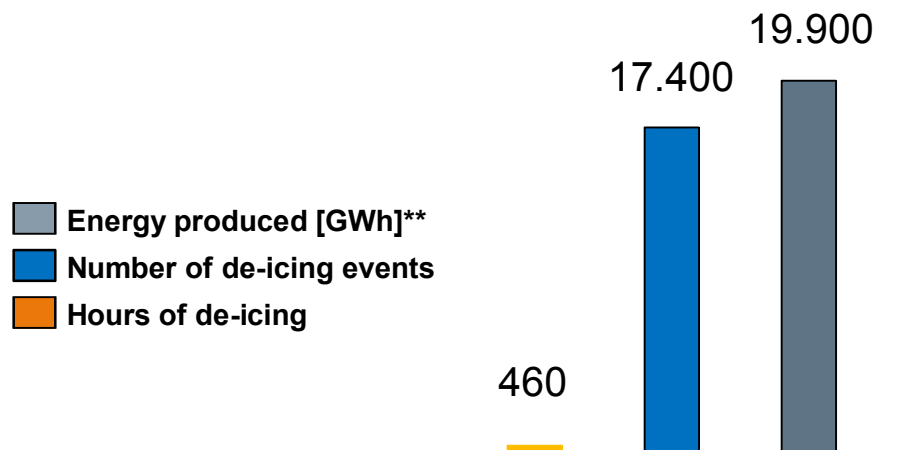
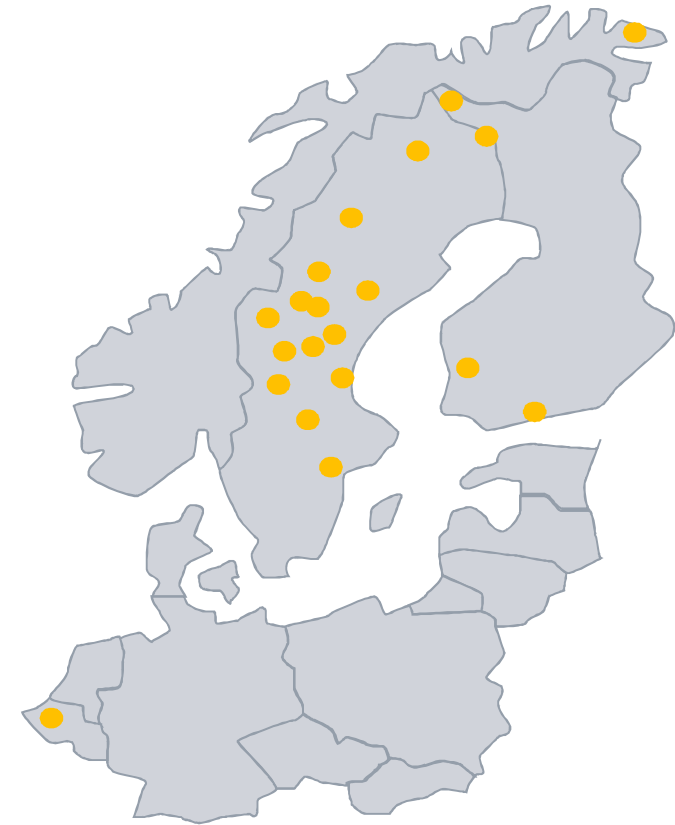
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# Going from niche to industrialized solutions with high volume, lower cost, and improved quality

## Installed and contracted projects\*

- Previous platforms: 18 units (1994 -1999)  
Bonus 150kW, Bonus 450kW, Bonus 600kW, Bonus 1MW
- Geared platform: 61 units (2011 - 2013)  
SWT-2.3-101
- Direct Drive platform: 227 units (2013 -2015)  
SWT-2.3-113, SWT-3.0-101, SWT-3.0-113, SWT-3.2-113



\* Accumulated numbers during winter 2013 and 2014

\*\* Gigawatt-hour

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# Increasing production and availability in icing conditions

## Operation with Ice

- Functionality that extends the range of operation in cold climates.
- Finds the optimal operational set-up through pitch angle and speed-power modifications.
- Increases production and availability without compromising operational safety.





# How can we increase owner value?

## Current owner value of blade de-icing

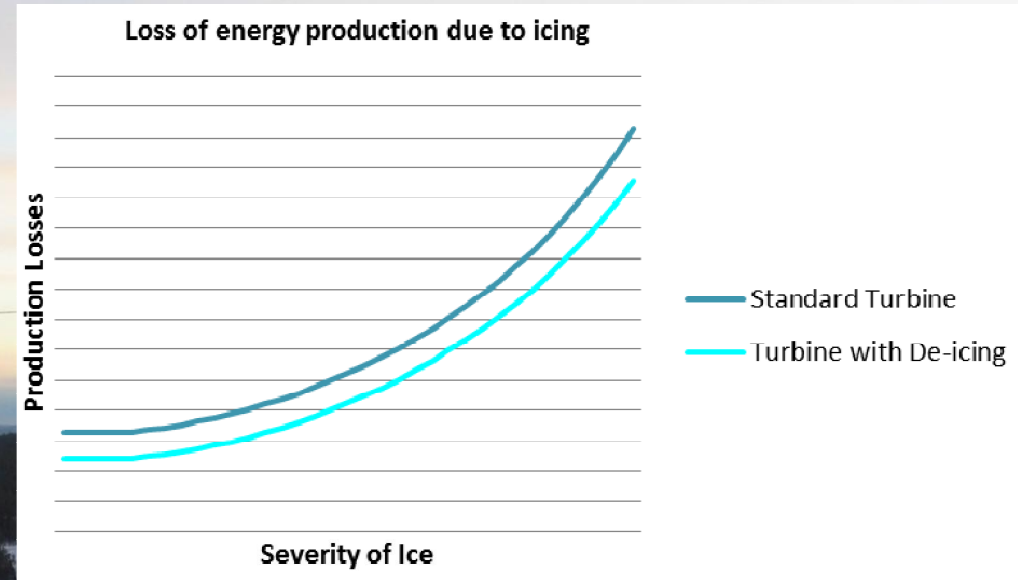
- Allows operation in harsh climatic conditions
- Increases energy production (reduces losses)
- Decreases repair costs

## How can we add value?

- Increase knowledge of ice characteristics and behavior
- Standardized methods of describing icing conditions, de-icing systems and de-icing efficiency
- Performance Availability Warranty



**Reduce owner risk of contingency**



## Increasing owner's benefit may increase contractor 's risk

### Performance Availability Warranty

#### Present

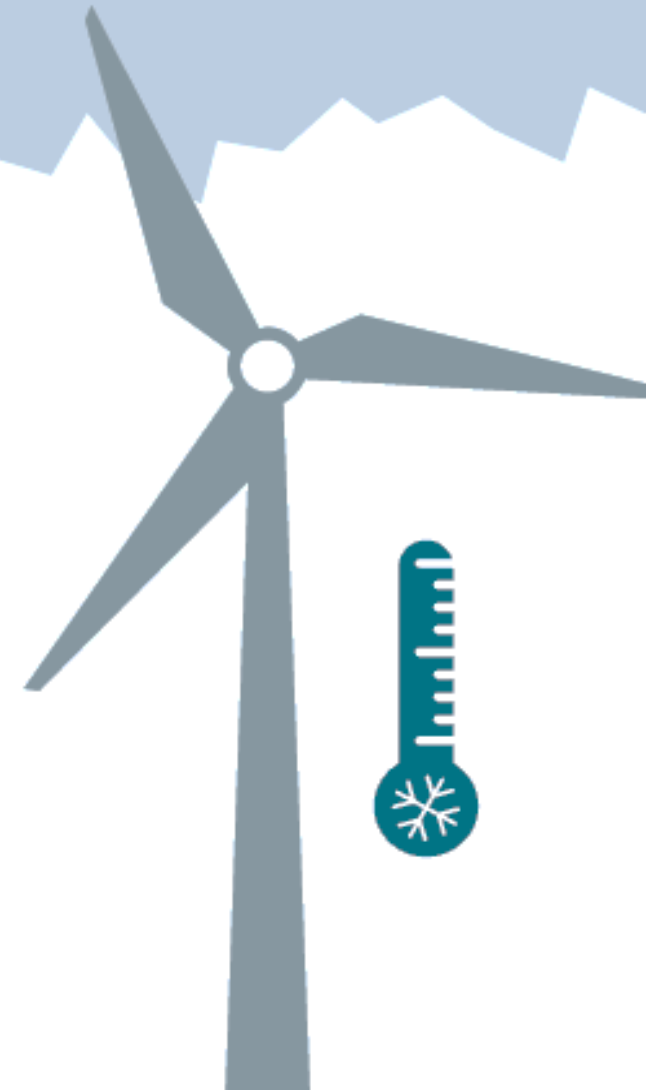
Warrant the functionality of the de-icing system

#### Challenges to address:

- Many variables to consider (e.g. wind speed, temperature, air moisture)
- Little knowledge of ice characteristics and behavior
- No standardized way for evaluating icing conditions

#### Future

Find methods to warrant performance of de-icing system (e.g. in terms of decreased downtime caused by icing, increased energy production or decreased energy loss)







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Thank you for your attention

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