Siemens Wind Power
Blade De-Icing

25 years of experience with turbines in cold climate

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Technology and Innovation
WinterWind 2013
So beautiful and at the same time so problematic

Operation affects in cold clime

Wind turbine
Aerodynamics
Loads
Materials
Control systems
Instrumentation

Safety
Unbalance
Fatigue
Noise
Ice throw
Ice fall

Economy
Energy production
Site prognosis
Life time
Maintenance
Repair

So beautiful and at the same time so problematic
Long experience with turbines in cold climate areas

Siemens (Bonus) first cold climate turbine.
Quebec in Canada 1986 - 65 kW

- Cold-resistant steel for turbine tower
- Heating elements for gearbox and hydraulic units.
- Sensors with integrated heating.

Siemens (Bonus) first turbine with de-icing.
Yukon Canada in 1994 1x150 KW

- Blade equipped with heating mats about 6” width
- Running along the entire length of the leading edge
- 1,700 watts for all three blades
Long experience with turbines in cold climate areas

Siemens (Bonus) Next generation with blade de-icing

16 installed turbine with blade de-icing
- Blade length 21 Meter
- Energy consumption around 50 - 65 kW

Scandinavia 1996 to 1999

Lammasoaivi
- 2 x Bonus 450kW (1996)
- 1 x Bonus 600kW (1998)

Olos
- 2 x Bonus 600kW (1998)
- 3 x Bonus 600kW (1999)

Suorva
- 1 x Bonus 600kW (1998)

Kotka
- 2 x Bonus 1MW (1999)

Pori
- 4 x Bonus 1MW (1999)

Vemhån
- 1 x Bonus 600kW (1998)
Siemens Think Tank

3 years ago started a Think Tank project in Siemens Wind Power.

We took all the knowledge from the past and built it into a new Siemens Blade De-icing system.
The SWP blade de-icing system consists of three elements:

1. Heating of blades
2. Ice detection
3. Control strategy for de-icing
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1. Heating of blades
2. Ice detection
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Ice detection methods

Further possible ice detection methods: frozen anemometer/wind vane, ice detectors on nacelle, drive-train blade vibrations, etc.
Power curve from reference turbine

Korpjället KFJ06 2305125

Active Power [kW]

Wind Speed [m/s]

Delce Off

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Power curve from turbine with de-icing

Power curve from korpfjället – deicing turbine

Korpffjället KFJ04 2305124

Active Power [kW]

Wind Speed [m/s]

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The SWP blade de-icing system consists of three elements:

1. Heating of blades
2. Ice detection
3. Control strategy for de-icing
Control strategy for Anti and De-icing

Know and unknown parameters

Design parameters
- Supplied heat
- Design of element
- Size of panels
- Placement of panels
- Sensors

Design of software
- Production (Optimize)
- Safety
  - People
  - Turbine
- Loads

Weather parameters
- Temperature
- Liquid water content
- Droplet diameter
- Wind Speed

Unknown factor – weather!
Production increase due to De-icing of turbines

Raftsjöhöjen
Kyrkberget
Korpfjället
Korpfjället 20 – 23 jan 2012

Power production in icy conditions

3 days of production with de-icing

![Energy Production Graph]

- De-icing
- 37 MWh
- 26 MWh
- 36 hours
Metrology installation on the nacelle

Metrology test station mounted at Korpället and Brahehus together with O2 and Gören Ronsten (Project manager on behalf of O2)

To learning and adjust the turbine controller for operating more efficient to improve energy production in cold climate
The blade de-icing system will be available for the main onshore turbines

**SWT-2.3-101**
- Rating 2.3 MW
- Rotor Ø 101 m (blade B49)
- Geared turbine
- De-icing system installed in early 2011

**SWT-3.0-101**
- Rating 3.0 MW
- Rotor Ø 101 m (blade B49)
- DD turbine
- De-icing system is available

**SWT-2.3-113**
- Rating 2.3 MW
- Rotor Ø 113 m (blade B55)
- DD turbine
- Wind parks with de-icing to be installed in 2012 and 2013

**SWT-3.0-113**
- Rating 3.0 MW
- Rotor Ø 113 m (blade B55)
- DD turbine
- De-icing system is available
Siemens Blade De-icing system

- Robust and proven technology.
- Power connections at the root end.
- Full retention of the aerodynamic profile.
- No effect on noise levels.
- Control system based on existing sensors.

Finished blade with De-Icing
Thank you for your attention!