Icing of wind turbines

The effect on noise emission

WinterWind 2013

Innovation by experience

Personal introduction

- Peter Arbinge - ÅF Sound and Vibration
- Acoustics consultant:
  - wind turbines
  - industries
  - infrastructure
- Noise measurements and calculations
- Graduated from KTH in 2012
- Master's project and thesis:

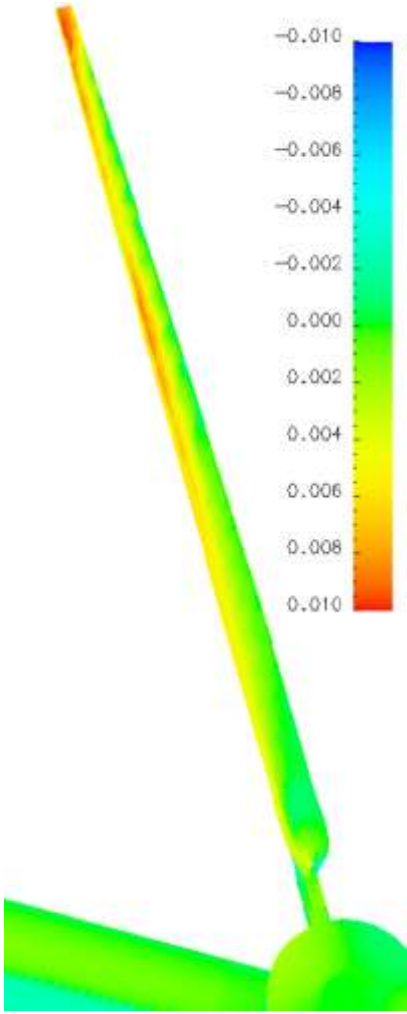
"The effect on noise emission from wind turbines due to ice accretion on rotorblades"

Project introduction

- ÅF Consult and Vattenfall
- Measurements in-situ and analyses
- On one wind turbine (WT) in cold climate
- December 2011 to March 2012
- Detect anomalies due to ice accretion
  - Sound emission level
  - Power production
  - Atmospheric conditions: Wind, temp. etc.
- Time synchronized measurements

Icing and sound
Previous research

- No previous “in-depth” investigations of a real case of wind turbine icing and effects on sound
- Laszlo Fuchs, KTH (2011)
  - Modeling
  - Simulation
    - Ice accretion
    - Possible effects on sound
  - No quantitative analysis



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Measurement object

- Vestas V90-1,8 (2,0) MW.
- Guaranteed sound level 104 dBA
- Stor-Rotliden wind farm
- Altitude of 570 meters above sea
- Site features
  - Low pine forest
  - 1.5 meters of snow!

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Measurements
Standard IEC 61400-11

- Measurements of sound pressure levels “close” to the WT
  - Long term measurement – microphone on stand
  - Short term measurement – microphone on wooden board

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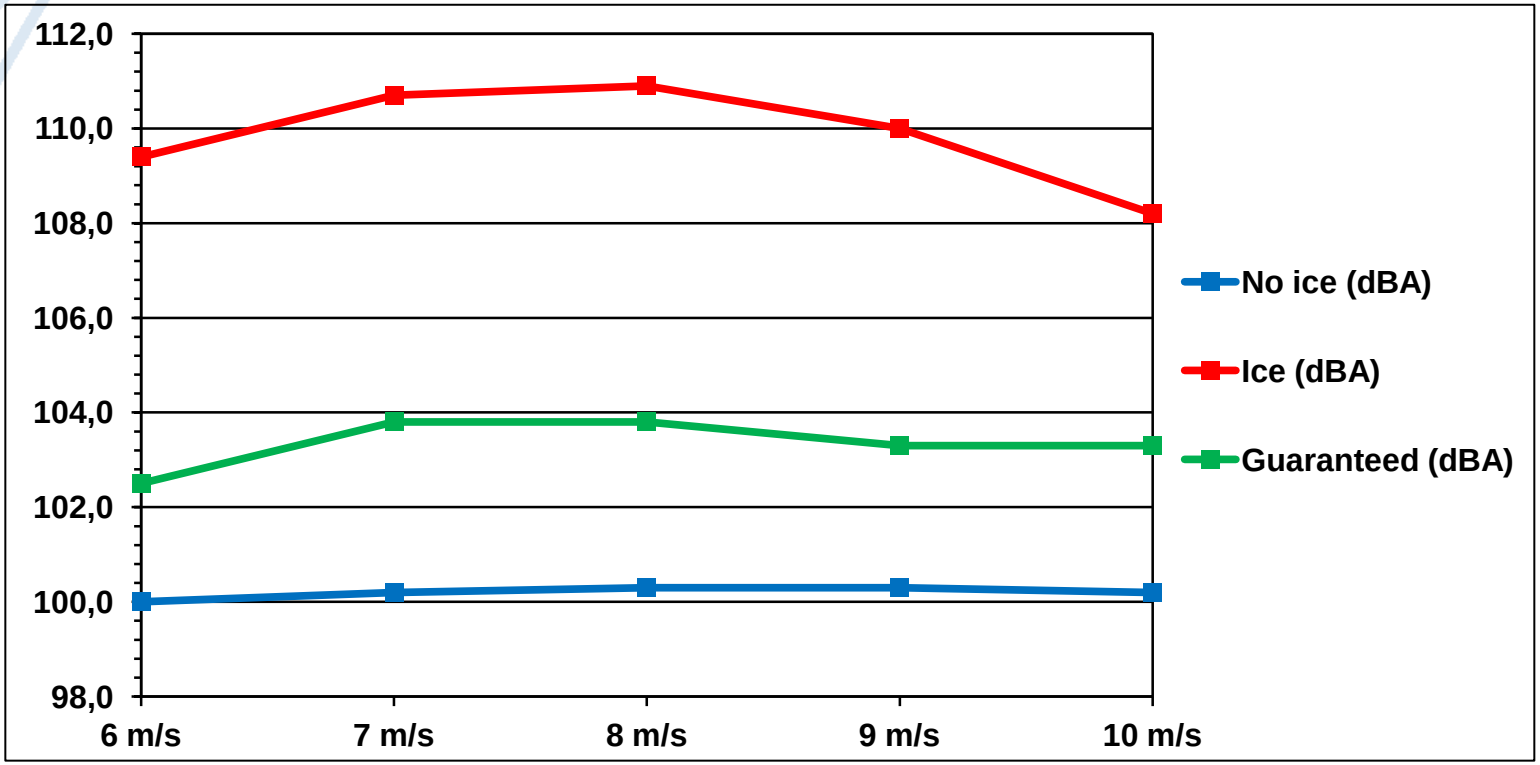
Avg. increase in sound level



- 104 dBA guaranteed noise level (Vestas V90 1,8 MW)
- No ice, 4 dBA under guaranteed level
- With ice, 7 dBA over guaranteed level

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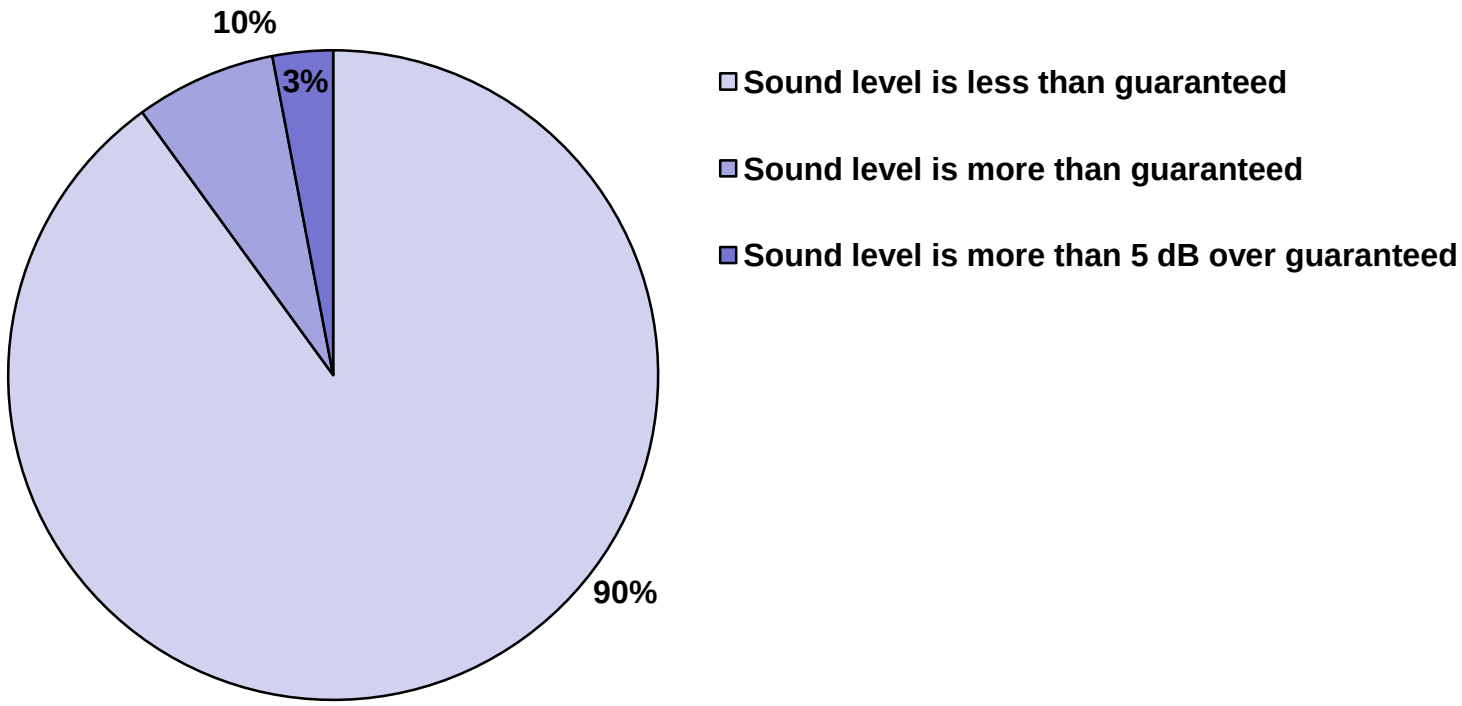
Sound levels in % of winter



- Winter is time period of December to March
- Sound levels over 104 dBA for approx. 11 days (10 %)

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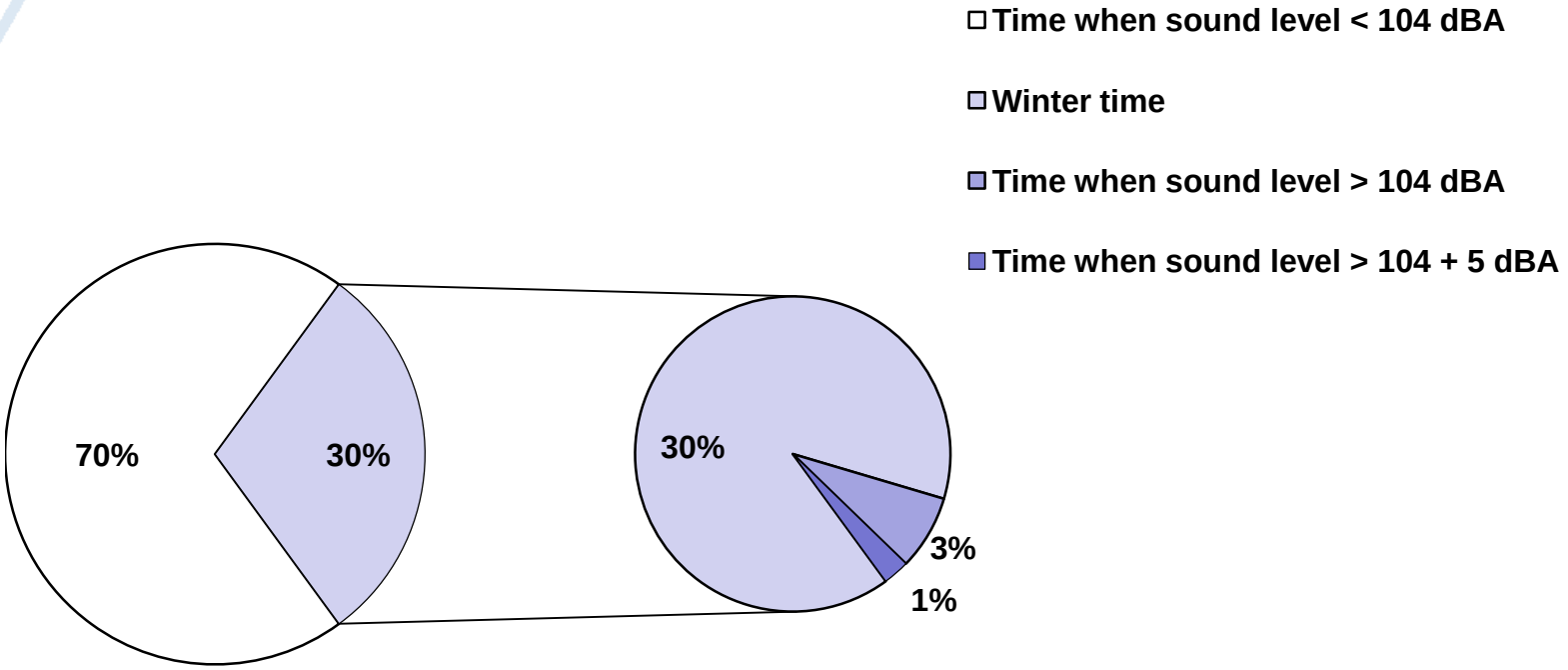
Sound levels in % of year



- Sound levels over 104 dBA for approx. 11 days (3 %)
- Sound levels over 104 + 5 dBA for approx. 3 days (1 %)

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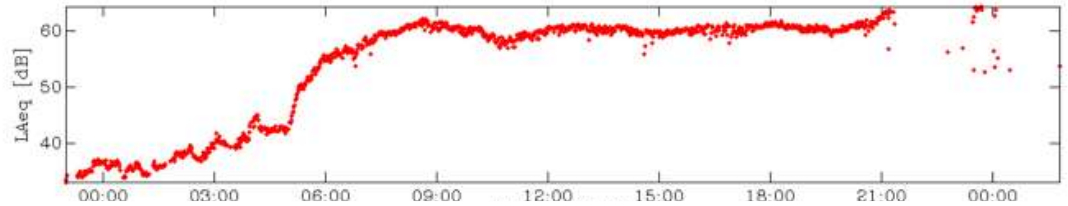
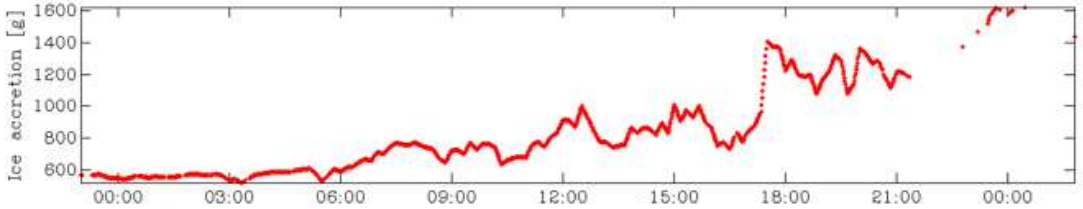
Ongoing icing of WT

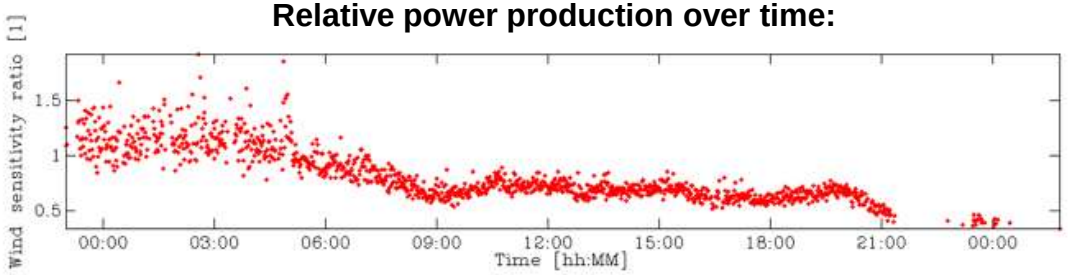
Sound level over time:



Ice accretion over time:



Relative power production over time:



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Summary of project

- WT sound level increase
  - Average 11 dB over all icing events
  - Increase even at small amounts of ice
  - Violation of guaranteed level approx. 11 days per winter
- Possible measures to be taken
  - De-icing of rotor blades
  - Production halt
- Future work – further investigations
  - Sound level over “long” distances, e.g. at nearby residents
  - Influence of snow on ground
  - Ice measurements

THANK YOU!

VATTENFALL

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