Sound propagation from wind turbines under various weather conditions

Conny Larsson
Olof Öhlund
Outline

• Human response to wind turbine noise
• Sound propagation effects
• Results
  – Long time measurements
  – Comparison with SEPA sound propagation model
  – Amplitude modulation
• Conclusions
Human response to wind turbine noise

Pedersen, Persson Waye 2004
Sound propagation effects

- Emission
- Spherical divergence
- Refraction
- Atmospheric absorption
- Turbulent scattering
- Immission
- Ground effect
Sound propagation effects

Low WT sound levels

High WT sound levels

Wind

Temp

Height
Measurement sites

Site Ryningsnäs
2 WTs
~ 400 m

Site Dragaliden
12 WTs
~ 1200 m

Photo: Hans Blomberg

Photo: Svevind
Results – Long time measurements

According to our measurements, the transmission loss (dBA) decreases with increasing horizontal distance from the turbine. The variability is indicated by an arrow, showing a 17 dBA change.
Results – Long time measurements

Wind

Horizontal distance from turbine (m)

Transmission loss (dBA)

104 dBA

34 dBA
Results – Long time measurements

Wind

Transmission loss (dBA)

Horizontal distance from turbine (m)

104 dBA

17 dBA
Comparison with SEPA model

Calculations with SEPA model

Transmission loss (dBA)

Horizontal distance from turbine (m)

104 dBA

31 dBA
Comparison with SEPA model

Ref. conditions ($v_{10m} = 8$ m/s downwind)

According to our measurements

Calculations with SEPA model

Mean diff. 1dBA

Transmission loss (dBA)

Horizontal distance from turbine (m)
Amplitude modulation (AM)

Night AM

Day No AM
Results – AM during 1 year

Propagation distance ~ 1200 m

AM more common during specific meteorological conditions!
Results – AM during 1 year

AM more common during specific meteorological conditions
Conclusions

- Weather conditions can give a 15 dBA variability in an expected WT sound level
- SEPA sound propagation model underestimates the "worst case" SPL with some dB.
- AM may increase annoyance and is more common during evenings and nights
  - Detected 20 % - 30 % of total time WTs operating depending on distance