Wind Turbine Noise

With respect to the proposed Sugar River Wind Project

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Wind Turbine Noise - Overview

• Why listen to me? (qualifications)
• Wind turbine noise levels
  • dBA (audible)
  • low-frequency noise (LFN)
  • infrasound
• Wind turbine noise standards
• Noise from the proposed Sugar River Wind project
• Confidence in predictions
• Conclusions
• Entire 30-year career dedicated to the measurement, analysis, and mitigation (reduction) of environmental noise.

• Focus on wind turbine noise in the last decade.

• Consulted on wind turbine projects located in 14 states across U.S.

• Analyzed noise on over 40 wind projects.

• Measured noise on 10+ projects – spent many hours in the field at operating sites, much of it at night.

• Expert testimony; recognized expert by boards, courts, and colleagues.

• Not affiliated with proposed project or EDF.
Humans generally hear frequencies between 20 and 20,000 Hertz (Hz).

This is “audible noise” and is expressed using A-weighted decibels (dBA).

A-weighting replicates how the human ear is more sensitive to mid and high frequencies than to low frequencies.

Low frequency noise (LFN) is that from 20 to 200 Hz. Examples include bass music from car, a freight train, thunder. Expressed as C-weighted or octave band noise levels (dB).

Infrasound is that below 20 Hz and is produced by wind turbines, vehicles, ocean waves, etc. Expressed using one-third octave or FFT noise levels.
• From non-turbine sources, ambient noise levels range from about **20 to 120 dBA**.

• With no wind, traffic, insects/birds/frogs, or noise from resident/farming activities, ambient levels can be in the **20’s (dBA)**.

• Traffic produces a wide range of levels, depending mainly on proximity, and levels can range from **30 to 80 dBA**.

• Birds/insects/frogs produce levels in the **30 to 50 dBA** range.

• Wind can at times produce noise levels ranging from less than **35 to 70 dBA** as it blows through vegetation and against structures.
• With no wind, there is some residual noise produced by motors and cooling systems. Levels are in the low 30’s, dBA at a distance of ~1,500 feet from the nearest turbine (nearest residences).

• At ~8 mph at hub-height, the turbines begin to spin and “aerodynamic noise,” that produced by the blades, begins to become audible (30 to 40 dBA).

• At ~20 mph at hub-height, turbines reach maximum rotational speed, and produce their maximum noise emission (45 dBA).

• At wind speeds greater than ~20 mph the turbines do not spin any faster and do not produce any more noise (still 45 dBA).
Wind Turbine Noise – Audibility

Site 6 19-Oct-2018 18:00:00

Sound Pressure Level [dB(A)]

Power Production of Two Nearest Turbines

Power Generated [%]

August 6, 2019
Based on two months of measurements at a recent project in Illinois, turbines operated as follows:

- Off ~25% of the time,
- Partially ~60% of the time,
- Full ~15% of the time,
- Full but inaudible due to noise from the wind itself < 10% of the time.
• Wisconsin Admin. Code § PSC 128.14. requires 45 dBA or less at all non-participating residences.

• EPA (night) 45 dBA; WHO 2018 (annual avg. $L_{den}$) 45 dBA, Health Canada (46 dBA).

• Illinois ~47 dBA, Michigan 45 to 50 dBA, MN 47 to 50 dBA, Iowa often none, South Dakota 45 dBA.

• Previously permitted projects in U.S: 50+ dBA.
Wind Turbine Noise – Low Frequency

- LFN is that from 20 to 200 Hz.
- Typical sources include freight trains, conventional power plants, aircraft operations, bass music, and thunder.
- Quantified using octave band levels (dB) or overall C-weighted levels (dBC).
- ANSI S12.9 Part 4: “Generally, annoyance is minimal when octave-band sound pressure levels are less than 65 dB at 16, 31.5, and 63-Hz mid-band frequencies.”
- Hankard Environmental measurements show LFN less than 60 dB.
- Turbines LFN levels not linked to health effects.
• Infrasound is that from ~0 to 20 Hz.
• Wind turbines produce infrasound, but at levels orders of magnitude below human hearing thresholds.
• Infrasound is also produced by natural sources such as ocean waves, atmospheric disturbances, earthquakes, thunder, and wind blowing through vegetation and against houses.
• Infrasound produced by man-made sources, such as planes, automobiles, tractors, factories, and agricultural operations.
• No peer-reviewed or government study has linked wind turbine infrasound to health impacts (Health Canada, Japan, France, Germany, Australia, U.S. state studies, including Wisconsin).
• Lots of articles of speculation and fear-based stories on the www.
• ~60,000 operating wind turbines in U.S.
Wind Turbine Noise – Infrasound

Living Room and Outdoors at ShirleyR2 12/6/12 00:19:35-00:29:35

0.05 Hz Band SPL - dB

Frequency - Hz
Figure 7.1 Measured Project Sound Level Compared to Threshold of Hearing
Wind Turbine Noise – Sugar River Project
Hankard Environmental recently reviewed our noise measurement data at 28 locations on eight projects across U.S.

Determined loudest one-hour regularly occurring turbine-only noise level.

Compared these to predicted levels using the same modeling methodology employed on the proposed project.

On average the model predicts perfectly.

Occasional under-predictions of 1 dBA, as well as many over-predictions.

LFN levels generally less than 60 dB.

Infrasound not measured. International studies consistently show levels significantly less than human hearing threshold.
Sugar River Wind Project will be designed to a maximum level of 45 dBA at non-participating residences.

This level complies with State of Wisconsin requirements, as well as EPA and WHO standards, is in line with Health Canada results, and at the lower end of the range that projects across the U.S. have been and continue to be permitted and operated.

Actual turbine noise levels are less than predicted “loudest-hour” levels a majority of the time.

When producing full emissions, noise from turbines is often masked by noise from the wind blowing through vegetation.

Turbines not a source of significant LFN, turbine LFN levels meet stringent standards, and turbine LFN levels not linked to health effects.

Turbines not a significant source of infrasound, levels are well below hearing thresholds, and no demonstrated evidence of health impacts.