

**Action Plan
for
Investigating Noise Issues at Fox Islands Wind Project**
September 23, 2010

Background

A few neighbors living near the three-turbine, 4.5-MW Vinalhaven, Maine wind power facility, which began operations in late 2009, have complained that noise from the turbines is unwelcome and annoying. Fox Islands Electric Collaborative (FIEC), a 2,000-member electric cooperative and owner of the facility, hopes to reach a workable solution with these neighbors. FIEC believes that understanding all mitigation options available, with their associated costs, will greatly improve its ability to find workable solutions to satisfy the greatest number of community members. To that end, FIEC has explored options such as a noise reduced operation (NRO) mode for the turbines. Exploring alternative noise reduction options, such as adding insulation in the nacelle, making alterations to the blades, and installing active noise cancellation devices in homes require the cooperation of outside engineers and experts, which, to date, has not been readily available to FIEC.

Also important to note, although the issues on Vinalhaven involve a relatively small number of individuals, they are not unique. Other communities that have installed turbines face similar complaints and similarly lack understanding of potential solutions. Further, communities that are considering building new wind facilities are looking to Vinalhaven to see if noise mitigation is possible, before moving forward with their proposals. Therefore, investigating the noise issues on Vinalhaven will not only assist FIEC to find solutions, but will also be applicable to other communities in the U.S.

Objective

To help Vinalhaven and FIEC better understand the noise issues and possible mitigation strategies, a collaborative effort is proposed among GE Wind, the U.S. Department of Energy, the National Renewable Energy Laboratory, and Lawrence Berkeley National Laboratory to analyze data collected by FIEC and its agents. The objectives of the analysis are to:

- 1) **Identify Sources:** Identify the noises that are most bothersome and their sources.
- 2) **Identify Mitigation Options:** Identify possible mitigation options to reduce these noise levels and their related costs.
- 3) **Present Findings:** Present the findings of this research to FIEC and the community in a form that can be understood by as many of the community members as possible.

Approach

The research approach has four guiding principles:

- *The research team is unified in its mission.*
- *The research team will approach the problem and possible solutions in an unbiased, impartial, and transparent way so that the community, to the degree possible, will “buy in” to the process and trust the results.*
- *The research team will realize that a perfect understanding of the problem and its solutions is not possible, but hopefully through this effort a better understanding is possible.*
- *The research team will NOT recommend possible solutions but will present options to FIEC and the community for FIEC to consider.*

To meet the objectives listed above, the following work will be conducted:

Identify Noise Sources

Local residents describe the noise using a variety of descriptors that are sometimes difficult to trace back to a source or sources at the turbine. This part of the research will attempt to link the neighbors' description of the sounds (via logs and/or interviews) and the source of the sounds (via analysis of the recordings, sound, and meteorological data collected during the same period, and engineering expertise). Another important element of this research is to link the reported frequency (number of occurrences) of the disturbing noise by the neighbors to similar numbers of occurrences in identifiable engineering units in the data. Finally, it is imperative to explore the degree to which the complaints are synonymous among neighbors, and when they are not. The research to identify noise sources will include three parts: neighbor data collection, correlation with recorded sound, tracing sounds to forcing functions, and will specifically include:

1. Collect data on noise from neighbors
 - a. Use neighbor observation logs filled out in February 2010 for NRO experiment.
 - b. Supplement with more broadly distributed FIEC observation logs for nearby residents.
 - c. For residents who do not fill out logs, ask FIEC to contact them and collect summary data (e.g., “How often in the past 2 weeks were you highly annoyed by the turbines?”) to ensure that all residents (a census) within a certain distance (e.g., 1.5 miles) are represented in the sample.
2. Correlate neighbor data with recorded sound
 - a. Attempt to identify time-stamped, logged annoying wind sound occurrence (e.g., "thumps", “sneakers in a dryer”, "squeaks", etc.) in sound recordings via direct dialogues with neighbors while recorded sounds from the same period are played back to identify and characterize actual sound response in time and frequency domain.
 - b. If necessary to separate noise components, attempt to identify unique sound characteristics in sound data (“sound signature”) that might be identifiable

elsewhere in the data using signal processing, filtering and synthetic reconstructions to verify that these observations are connected to specific noise “features “ that are measurable.

3. Tracing sounds to forcing functions
 - a. Search data for these characteristics to determine how frequently and during which conditions (e.g., wind direction, high shear) they occur.
 - b. Connect to actual turbine responses and identify components from where each sound feature originates. Detailed operational characteristics of the turbines will be needed from GE to indentify sound -producing mechanisms and devices.

Identify Mitigation Options

A variety of mitigation options exists at the turbine, which include, but are not limited to, slowing down the turbines at night, increasing the cut-in wind speed, adding additional insulation to the nacelle, and changing the tip and/or trailing edges of the blade to decrease aeroacoustic sound. All of these come at a cost. Some are expensive yet potentially have limited impact on the frequency of annoyance; for others, the opposite may be true. Better information about these specifics will potentially allow the community to make a more informed decision as to how to move forward.

This part of the research will have two parts, determine what mitigation options are available given the sources identified in the previous task, and estimate the cost of such a solution if possible. More specifically:

1. Identify mitigation options
 - a. Use the data from the Identify Noise Sources task that link to individual sources to identify possible mitigation strategies.
 - b. Estimate likely reduction in sound levels at residences and changes of frequency of occurrences.
2. Estimate the cost of mitigation options
 - a. Through discussion with GE, estimate costs of mitigation options.

Present Findings

Presenting the findings from this research in a form that will be readily understood by the community as a whole will be essential to the process. To that end, a highly readable yet short research summary will be prepared along with a presentation of the findings so that community members can ask questions of the team representatives. This phase of the research includes:

1. Write summary of findings.
2. Present findings to community in panel format.