

Do You Hear What I Hear?

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Noise Controversy Over Vinalhaven Wind Turbines Amps Up

Vinalhaven sits 15 miles off the coast and just over an hour's ferry ride from Rockland, but it has an old-fashioned sense of community rare on the mainland these days. Every driver waves as they pass and it's common for an islander to leave the keys in the truck in case anyone needs to borrow it.

It was with that sense of community that the islanders welcomed the three wind turbines to Vinalhaven last year. Not only did the turbines promise reliable electrical service, which was something long-term residents did not take for granted, but wind power would lower electric rates for everyone. Islanders turned out in strength last November to see the turbines started up, watch the 123-foot-long blades sweep the air and watch grade-school children do a windmill dance to the tune of "I'm a Little Tea-Pot."

Even with some initial start-up glitches, rates have gone down when averaged across the year (the estimated average rate is now five to six cents per kilowatt hour, with variations from month to month, according to Fox Island Electric Cooperative; the national average rate was 11.36 cents per kilowatt hour in 2008).

Most of the 1,200 or so residents on Vinalhaven approve of the turbines. But within days of start-up a handful of Vinalhaven residents who lived within a mile of the wind turbines on the North Haven Road reported noise problems.

Nine months later, people have taken sides. Fingers are being pointed. Frustration levels are rising. There are rumblings about complainers and how they should move off the island if they don't like it. There are accusations of misinformation and biased noise data collection.

Jeanne Bineau-Ames, whose house is near the swimming quarry in the middle of the island, summed it up.

"It's an island. We are only as strong as the smallest link. We have to work as a community," she said. Bineau-Ames lives far enough from the wind turbines not to hear them, has a relative on the board of the electric cooperative who strongly favors them, and sympathizes with those affected by the noise.

"I hate to see this go to mistrust and anxiety," she said. "We have to work at this. We have to work this out."

Sound Effects

Bothersome noise related to wind turbines is hardly new.

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Jim Cogswell, bottom, takes a lunch break from cutting brush on a gravel lane near the turbines, above. Cogswell favors the wind turbines, but noticed they are louder from a distance than they are up close.



Field bio-technician Mark DiGirolamo stands at the base of one of the Vinalhaven wind turbines. Photo by c. Parrish

"Wind turbine noise is becoming a bigger issue in the U.S.," said Patrick Moriarty, an aeronautical engineer for the National Renewable Energy Laboratory (NREL) in Golden, Colorado. NREL belongs to the U.S. Department of Energy and is the primary research and development site for energy efficiency and renewable energy, including wind power. Moriarty is a senior engineer at the lab.

"It's been a big issue in Europe for a while because their wind farms have been up longer and they are in more densely populated areas," Moriarty said.

In Maine, the Mars Hill wind farm in Aroostook County and the turbines in Freedom in Waldo County have elicited similar complaints by nearby residents who say the repetitive whump, whump, whump sound of the blades turning causes sleeplessness and anxiety. Some research suggests those symptoms could be related to low-frequency sound waves that impact people as a pressure wave.

Sound seems simple enough: you hear it or you don't; it's audible or it isn't. It turns out that sound is far from simple: not only can a noise that is alarmingly loud to one person be a minor note to another, but some people appear to be affected by low-frequency sound-the bass notes-while others aren't. And the really low frequency sounds (below 20 hertz), the inaudible sound waves, which elephants and whales use to communicate over long distances, can travel hundreds of miles without fading. It's this silent sound that may make birds and beasts aware of earthquakes and tsunamis ahead of any apparent danger, and it may be the cause of a laundry list of human complaints that include sleeplessness, anxiety, exhaustion and depression.

Or it may not be. The jury is out.

Dora Anne Mills, the medical doctor for the state of Maine, reviewed the medical and acoustics research on wind turbine noise and issued a 2009 report stating that the current research on health effects was inconclusive. Mills concluded there was insufficient evidence to change state noise compliance standards.

But the thing to understand, said Moriarty, is that the sound coming from the wind turbines is broadband noise; that is, it has all frequencies mixed together. It appears not to be the volume of the turbines, but the rhythmic nature of the noise, the whomp, whomp or whoosh, whoosh, whoosh-what Moriarty refers to as the modulation-that is problematic, but no one is really sure.

"Noise ordinances are now based on amplitude [volume]," said Moriarty. "Some people think modulation noise [repetitive, rhythmic noise] could be more annoying."

"It's an open question if noise regulations should be adjusted for modulation. It's at the bleeding edge of research at the moment and it's where technology and sociology overlap," said Moriarty.

That's cold comfort to some residents who live close to the wind turbines.

Britta Lindgren lives about a half mile down the Northhaven Road from the turbines.

"Initially, the animals went off their feed when the turbines started up. During the first few days after they started, I found an eider duck hiding in the corner of the porch, cowering. You never see eider ducks out of the cove. I've never seen that. During the first two or three weeks, it was really loud."

"The animals don't do that now. Truthfully, most of the time it's not a problem," said Lindgren, referring to the volume. "There are trees between us and the sound varies in intensity. It's a whomp, whomp, whomp sound."

They may not be so loud, but the sound pulses rhythmically. Lindgren believes the repetitive noise is what is creating sleep problems in her family and, she says, it isn't something that you just get used to, as some islanders have suggested.

"It feels like a constant wearing down," she said. "It's like when you have an itch. It's nothing to scratch it,

but then it keeps itching and you keep scratching and before you know it you have a hard, raw spot. It hurts. You're always aware of it."

A half mile in the other direction, Erin Creelman and her family are more acutely aware of the wind turbines. Their house sits on high ground across from them and all but one of the family members are having problems sleeping.

"We left our storm windows in this summer, and we have thermal panes," said Creelman. "We didn't put in the screens. We have a well-insulated house with wood panels and sheetrock. We have blown-in fiberglass. You can still hear them. You can feel them, really. It's a pressure thing more than a noise. It's like a whomp, whomp, whomp."

Creelman said she supported construction of the windmills and doesn't want them taken down; she wants the sound issues solved.

Lindgren agreed, but shook her head at the possibility of a solution.

"It's gotten quite divisive," said Lindgren. "How do you deal with that? I don't know."

Sally Wylie, another neighbor of the wind farm who lives less than a mile away from the turbines, didn't parse her words. She was thoroughly frustrated.

"They said it would sound like the humming of a refrigerator. That didn't seem so bad," said Wylie.

But Wylie said it isn't like a refrigerator.

"It sounds like a jetport," said Wylie, referring to the noise in the windy winter months. "It's unbelievable. It vibrates right through the house. It ricochets off the neighbors and comes back. It echoes."

The Neighbors & The Man Behind the Machines

"There are about 15 to 20 year-round houses located within three quarters of a mile of the turbines," said George Baker, who is the CEO of Fox Island Wind, a private enterprise that is a subsidiary of the Fox Island Electric Cooperative (FIEC) and that was formed to allow the wind turbines to be built.

Notably, the wind turbines have overwhelming support from Vinalhaven residents; only a handful of people are affected by the noise.

"I live with 4 a.m. lobster boats," said Donna Payne, who owns the Payne Homestead bed-and-breakfast in town. "These are the sounds of people going to work. That's what it takes to live on an island."

The wind turbines can't be heard in town.

"What noise?" said Pete Gasperini, when asked what he thought about the wind turbine noise. "We love them."

Carla Harris, who sat next to Gasperini at a public forum, agreed.

"We've gone up close to hear them and we've gone further away," said Harris. "This is not unbearable noise. It's like ambient sound."

Annette Philbrook also agreed.

"The old power plant made ten times more noise than these," said Philbrook.

Nans Case, a 20-year resident of Vinalhaven who lives in town, said she's a fan of the lower electric rates.

"My rates have gone down 25 to 30 percent," said Case. "That's something for someone on a fixed income."

But those who are bothered are really bothered. Some of those who live close to the turbines sought legal advice, citing bad faith on the part of Fox Island Wind in adhering to a tolerable noise level and in not addressing their concerns as a serious community issue.

Wylie is one of the neighbors who became vocal about the need to address the noise problem.

"We were big supporters of the project, but we were told the ambient noise would mask the sound of the turbines, so when the turbines were turned on, I was completely in shock," said Wylie. "I called George Baker and said, please, can you turn them down?"

"He said 'I can't do that. We have to study the sound

issue,'" said Wylie, who thought the impacts of the nearby neighbors were part of the equation for how the turbines should operate.

"We believed what they told us," said Wylie.

Now she thinks Fox Island Wind considers the neighbors a nuisance.

"We were totally naive," she said.

Wylie and others bothered by the turbine noise formed Fox Island Wind Neighbors (FIWN) and launched a website to share information.

"During the first two and a half months after the start-up, I spent hours every week talking to the neighbors," said Baker, who in addition to being the face of Fox Island Wind is a professor at Harvard Business School who has been on an extended leave of absence so he could serve as the vice president of Community Wind at the Island Institute in Rockland.

"I gave them a whole bunch of detailed financial information and technical information," said Baker. "Probably stuff I shouldn't have given. I told them I wasn't talking to my lawyers, because I knew if I did, my lawyers would say: 'Don't talk to them.' I didn't want it to be like that."

"I did tell them if they retained a lawyer, I'd have to talk to my lawyers and I knew what they would say," said Baker. Fox Island Wind's lawyers said what Baker expected: stop talking to the neighbors who retained legal counsel.

"There is no lawsuit. I desperately hope there isn't one. but we got into that lawyer thing and I hate it," said Baker. "So, no, I won't talk to them."

Wylie sees it differently. She says there is no intention to sue, nor was there, ever.

"We needed legal advice. Our lawyer advised us to keep working with the DEP and the community," she said. "To keep talking."

"There's an ethical question here," said Wylie. "Do you sacrifice the small part of the population or just focus on what the majority wants? Why didn't they just say, 'Guess what? This isn't really working. This is a lot louder than we thought and it's not a good thing.'?"

"We need to make it work," she said. "We're a community. We have a problem, but we're part of the community package. It's not like you can throw us out with the laundry."

Baker, whose unbounded enthusiasm for the Fox Island Wind project comes across without restraint, reined in when it came to talking about the noise controversy.

"I can't tell you how frustrated I am. I have an enormous stake in this. I'm not making a dime on this project, I hope that is clear," said Baker, who does not get a salary for being CEO of Fox Island Wind. Baker's Harvard Business School scholarship recently focused on negotiating and contracts that are built on trust and secured by the reputation of those involved, not on legal enforcement.

"I care deeply about getting this issue resolved, with community involvement," Baker said. "My reputation is at stake."

Compliance with State Sound Standards

The state of Maine has noise compliance standards that are pretty straightforward for windmills. When it comes to frequencies and decibels, they take their measurements from the middle range, with attempts to correct for the low-frequency part of the range.

Under Maine state law (Title 38, Sec. 343), wind turbines sited in a quiet location like Vinalhaven cannot operate any higher than 45 decibels at the property line of abutting landowners. Communities like Vinalhaven can adopt more restrictive local ordinances. Vinalhaven had a more restrictive noise ordinance, but voted it out in favor of the state standards.

"Sound is measured between May 1 and August 31, during the inversion period," said Becky Blais of the Maine Department of Environmental Protection. Blais monitors compliance for the Fox Island Wind site. Inversion is the term for when there is wind aloft and it is calm near the ground. The premise is that sound will carry farther during the summer inversion period; though, on the island, wind blows much harder in the winter.

"All we are measuring is state compliance," said Blais. The DEP asks Fox Island Wind to collect data using a DEP-approved method. That raw data and initial analysis is sent to DEP for further checking of accuracy and analysis. Complaints from neighbors, with specific time frames attached to the complaints so they can be correlated to sound collection data, also go into the mix for analysis.

The state, in essence, is measuring volume using a standard approach used by federal agencies for measuring industrial noise. They are not measuring low frequencies, which tend to travel farther and in lots of directions. Higher frequencies, in contrast, tend to travel in one direction for much shorter distances.

Fox Island Wind Neighbors takes issue with the state compliance standards of 45 decibels at the property line of an abutting property. They think it should be lower. Even so, FIWN wanted to determine for themselves if the turbines complied with existing state sound standards, so they took the initiative to collect their own sound data from an abutting property, starting this past April. It's a nonscientific study, but it does indicate that the turbines routinely exceed 45 decibels. FIWN shared their information with the Maine DEP in an effort to bolster their position that the turbines are louder than they should be.

Several sound studies have been done on Vinalhaven or are in the process of being conducted.

Study #1: Turning the Turbines Down

The Noise Reduction Operations (NRO) studies, which were undertaken at the request of Fox Island Wind last spring, included randomly turning down the turbines to see if there was any effect on nearby residents. Only nine participants submitted logbooks noting when they heard turbine noise and how they felt; but 200 responses came from those people.

Ben Hoen of the Berkeley National Laboratory at the Department of Energy was the principal researcher.

Hoen said the small sample size was, to some extent, offset by the number of responses received.

"There is no silver bullet when it comes to a solution here. It's all shades of grey," said Hoen. What the study did do was indicate that the complaints of sound effects, which were recorded with a date and a time, were correlated with wind speeds at the wind turbine site and at a buoy 10-15 miles away.

"The study method worked," said Hoen. "We hope to come back a second time. Ideally, you want every single person to participate."

Study #2: Cancelling Out the Noise

Conquest Innovations, an acoustics consulting firm based in Washington state, approached Baker of Fox Island Wind to see if they could set up an experimental study to attempt to fine-tune existing technology so it would work to cancel out the sound of the wind turbines.

Baker secured a \$12,000 matching grant from the Maine Technology Institute to kick off the experiment to explore the use of noise-cancellation technology on wind turbine sound.

"We've been looking at the full sound spectrum, with the focus below 250 hertz," said Steven Bradbury of Conquest Innovations. Active Noise Cancellation is based on recognized principles. Bose has used it in its noise-cancellation headphones and Honda has used it inside the cabin of some of its models to cancel out engine noise.

Bradbury explained how noise cancellation works.

"You ever been out on a boat? You know when two boat wakes come from two different directions... say, each wave is six inches high. When the crest of the two waves meet, they double and the peak is about 12 inches high. Now take the same two waves, but instead of the crest of one wave hitting the crest of an oncoming wave, it hits the trough."

Anyone who has crossed to Vinalhaven has seen it. When the crest of one wave hits the trough of an oncoming wave, the water briefly flattens out. The waves essentially cancel each other out, creating a momentary calm.

Sound waves are not exactly like water waves.

"But this is a great way to visualize what we are trying to do," said Bradbury.

Lower-frequency sound waves have crests that are farther apart than high-frequency waves; simply, they are less frequent. Think of the sound of the bass on the subwoofers coming out of a car passing on the road in the summer, with the music turned up high. The low-frequency sound comes right through the walls. It goes in all directions; the thumpa, thumpa, thumpa of the bass, until someone says out loud, "Jeez, can't that kid turn that down?"

The crests of the low-frequency waves are farther apart, thus giving Active Noise Cancellation (ANC) technology room to emit a sound that will flatten the wave. To cancel out three windmills will take three carefully calibrated speakers that are programmed to respond. The result: no more thumpa, thumpa, thumpa. ANC doesn't mask the sound wave; it meets it and gives the thumpa right back to it.

"We're pretty excited about this," said Bradbury. "The principles of active noise cancellation are proven. We know it works."

According to Bradbury, the direction and speed of the wind shouldn't make much difference in the effectiveness of noise cancellation.

"What isn't clear is whether the sound that is bothering people is just low frequency," said Bradbury. Noise cancellation won't work on high-frequency sound as effectively: the sound waves are too close together to

flatten out across large areas. They are also directional and don't go through house walls as effectively as low-frequency sound.

So, what happens if the bothersome noise is partially low-frequency and partially high-frequency sound waves? Or even a resonance effect created by extremely low frequency sounds essentially shaking the walls of a house and creating new sounds.

"It may not work," said Bradbury. It won't take much longer to find out. The sound data has been analyzed, a sound profile is being created, and Bradbury said a bench-top demo model will be ready in under two months.

Study #3: The Colorado Department of Energy Lab

On March 1 of this year, Baker requested that the National Research Energy Lab come out to Vinalhaven because he thought the lab could help FIW better understand the sound issues. NREL agreed and committed an initial \$30,000 to pay for the studies.

Moriarty of the NREL/DOE lab in Colorado and Ben Hoen of the Berkeley DOE lab in California have been looking into the effects of the wind turbines and trying to tie them to specific sound signatures. The data from the Noise Reduction Operation are their starting points, but they got a more complete assessment of impacts than the survey done by Fox Island Wind, said Moriarty.

"The idea was to be independent from Fox Island Wind and to maintain objectivity, " he said. "Of course, we wouldn't identify the people who spoke to us."

Moriarty stressed, again, that the turbines create broad- band noise across low to high frequencies.

"The noise is definitely related to speed. The dominant noise comes from the blades. The faster they spin, the louder they are, but the faster they spin, the more electricity they produce," said Moriarty, noting there will be a trade-off between reduced noise and electricity generation.

What NREL is looking for is specific symptoms or noise irritation (sleeplessness, irritation from loudness, etc.) at specific times, so they can tie them to the sound data. The NREL team plans to correlate that social data with a variety of other factors, including wind speed, turbine volume, humidity, inversions, and modulation.

What they found in their initial data collection on Vinalhaven was that noise annoyance didn't necessarily correlate with proximity to the turbines.

"There may be lots of sociological factors, from not wanting to be perceived as a bad guy in the community, to some people working away from home during the day while others are at home gardening. I think that was a big factor," said Moriarty.

Some other research questions have come up. How does proximity to the ocean, where the atmosphere almost traps the noise, come into play? Another is the base rock the turbines are built on top of.

"One question that came up at Vinalhaven is that the turbines are connected to granite. That's not very common anywhere in the world. It's a solid connection and it may be a more efficient transmitter of noise. Here in Colorado, we have the exact same turbine that is on Vinalhaven. You can hardly hear it. But the soil is very different here."

The next step will be to break down the sound signature and try to isolate the cause of the noise that annoys people at specific times.

"Is it the blades, the rotor? Is the reduced noise operation working the way it should? That's what we'll be looking at," said Moriarty. "Then we'll brainstorm mitigation potential, and costs and effectiveness. We

may recommend reducing speed; even more expensive is a new blade design. They may be able to reduce the operation so much and pay so much more for electric. Then we present it back to the community: Here's what we found. It's your island. What would you like to do?"

But what about the sounds that are so low they can't be heard? Called infrasound, the super low frequency sounds that register below 20 hertz.

Moriarty launched into a cautionary tale. A large experimental windmill was built in Boone, North Carolina, in the 1970s, with the wind at its back in order to maximize energy generation. But the low-frequency noise created pressure waves that were amplified by a number of factors.

"It created a pressure pulse low enough that you couldn't hear it, but it was similar to the resonance frequency of houses and the sound wave shook the houses and increased the amplitude. Body cavities have a similar resonance frequency, too, so people were getting seasick and dishes were falling off the walls."

"That's the number-one reason wind turbines are now designed to work upwind. Infrasound is much less of an issue. Recent measurements on infrasound of GE turbines on Vinalhaven found there isn't much infrasound coming from those turbines and they satisfy national standards," he said.

Moriarty said that everything he has seen on infrasound seems to indicate that the noise-related problems are not due to infrasound.

But noise problems are real and the industry is paying attention.

"Sound is a focus across the wind industry," said Melissa Rocker, the global communications manager for General Electric, who manufactured the wind turbines on Vinalhaven.

"We've been talking to Fox Island Wind since last November on how to reduce noise," said Rocker.

"Every site is unique, with different geographic conditions, weather conditions and ambient sound levels," she said. "GE is working on various technologies....When those technologies are ready, Fox Island would be a strong candidate for testing."

The Sculptor at the End of the Lane: Kitty Wales

Fred Granger, who works at a small quarry cutting granite for countertops and benches using a diamond-bit granite saw, hasn't been drawn into the conflict or paid much attention to the studies.

"I love them," he said of the wind turbines. He works in the shadow of the windmill blades and the sound of his granite saw is loud enough to drown out any turbine noise.

"They're beautiful machines that take air and make electricity," he said. "But I don't live on the island."

And then he walked past the numbered blocks of fine-grained granite to the edge of the North Haven Road and pointed down a long lane bordered by hay-scented fern and bayberry bushes.

"There's a sculptor lives down there," he said. "Close enough, but a little further away than the rest. She might be one to talk to. I don't know what she thinks of them. I don't know that she's been asked."

I started walking down the sunny lane, breathing in the summer island scent of sweet fern, hay-scented fern and wild roses. Jim Cogswell was clearing brush on the side of the lane a quarter mile in and stopped for a chat. Cogswell lives on the Pequot Road on the other side of the island.

"What do I think of them? Anything to get us to use less oil from the Arabs, I'm for them," said Cogswell. "It's funny, though. You can hear them from farther away than you can when you are right up close to them."

The sculptor at the end of the mile-long lane turned out to be Kitty Wales, who is on the island for five months. It's where she gets her sculpting work done; the rest of the year she teaches in Boston.

No one had asked her what she thought.

"The sound varies wildly," said Wales. "Some days I can't hear it at all. Other days it's this engine sound, whomp, whomp, and a rattling sound on a really bad day. Sometimes there is this low vibration. But I'm three quarters to a mile away and it's only when we are in the lee of the wind that I hear it."

"It's basically too close to residential, too close to homes...and it's done. For me, it's tolerable. I don't want it to affect my work, so I put it out of my mind as much as I can. I don't think they will be able to make it quieter, but they seem to be trying."

"Have you gone up the lane, with the pristine look of the bayberries and the hay-scented fern and there they are?" asked Wales. "Rising up in front of you? They are so beautiful. As a sculptor, I think they're amazingly cool."