THE acoustic ecology INSTITUTE
. . . listen . . .
News/Issues | Science | Resources | Soundscapes | About Us | Join Us

45 Cougar Canyon Santa Fe NM 87508 505.466.1879
acousticecology.org jim@acousticecology.org

Prepared by Jim Cummings in December 2010 for the San Miguel County Commission

Wind Farm Noise: Community Response Considerations

Introduction

This information packet is not intended to over-emphasize noise complaints, but rather to provide clear information that can foster informed conversation about wind farm siting regulations. As you'll read below, it appears that noise can affect a significant proportion of people living within a mile or so of wind turbines. In the US, setback requirements are rarely more than a half-mile, and it not uncommon to have setbacks as small as 1000-1800 feet. At the same time, however, the vast majority of US wind farms are built far from existing homes, with no non-participating landowners within a mile or two (or much more), which is of course the best option for avoiding noise issues.

It appears to AEI that a half-mile setback is clearly not enough if the goal is to avoid noise impacts on residents, whereas a one-mile setback will likely offer protection from significant noise disturbance in most situations. Ridge-top turbine placement may require larger setbacks, since residents below are likely to be protected from wind noise, so that the turbines noise is more noticeable at greater distances. To address audible low-frequency noise, which can in some locations travel more than a mile, and protect individuals with physiological conditions that may make them more sensitive to low-frequency noise, larger setbacks are likely necessary. Some acousticians and health professionals that I respect are encouraging setbacks of 1.25-1.5 miles to more fully minimize problems (i.e., so that the closest residents experience only very occasional barely audible noise), and others recommend setbacks of two or three miles to assure turbines will always be completely inaudible at homes. The recommendations of your local task force, and the generally supportive comments of your noise consultant, reflect this view, which represents a totally valid approach that would assure wind development has no acoustic effect on local residents.

The following pages provide a quick overview that summarizes the basics on wind farm noise levels and community response rates. I consider this to be a fair and objective representation of what is happening within a mile or so of wind farms, based on engineering studies and mainstream research. None of what is included here is based on personal, subjective reports of wind farm neighbors, though I do encourage you to take such reports to heart as well; in many cases, people who supported their local wind farm have been surprised at the impact of the noise, and their reports are reliable representations (I could refer you to ones I especially respect). There is no black and white answer to these questions; you will need to decide how much grey your communities are comfortable with.

The Acoustic Ecology Institute works to increase personal and social awareness of our sound environment, through education programs in schools, participation in conferences and workshops, and our internationally recognized website, AcousticEcology.org, a comprehensive clearinghouse for information on sound-related environmental issues and scientific research. Our over-arching goal is to help find pragmatic ways to bridge the gaps between extreme positions voiced by advocacy-oriented organizations, and so to contribute toward the development of ethical public policies regarding sound.

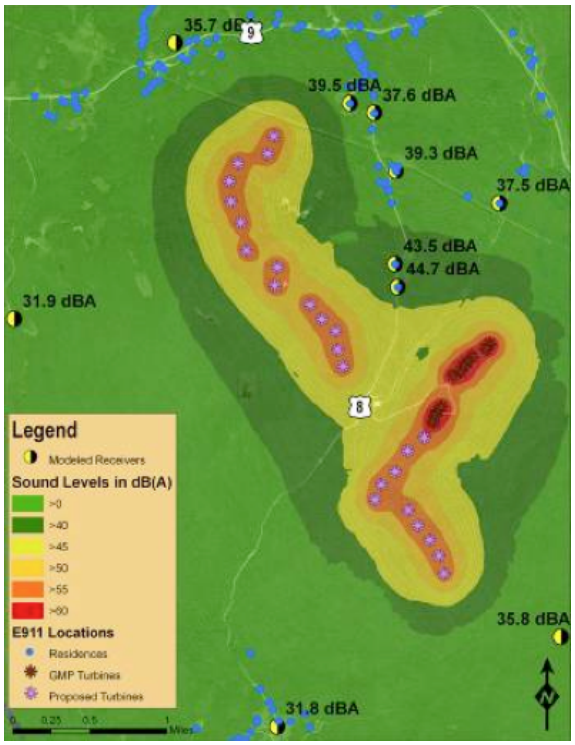
AEI Executive Director Jim Cummings is an editor and writer with a focus on science, the environment, and public policy. He has twice been a plenary speaker at the Alberta Oil and Gas Noise Control Conference, was a member of the Canadian Department of Fisheries and Oceans expert committee on seismic survey mitigation practices, and has presented at many international conferences including Effects of Noise on Aquatic Life (Ireland), Acoustic Communication in Animals (Oregon), and the 8th Wind and Wildlife meeting (Denver). In 2008, he guest edited a special ocean noise double issue of the *Journal of International Wildlife Law and Policy*.

See also AEInews.org (use search box to find news and research on topic of interest)
And AEI's 2009 year-in-review on wind farm noise issues: http://aeinews.org/archives/695

How Noisy Are Wind Turbines?

Since modern turbine design has greatly reduced mechanical noise from the turbine gearboxes, the main source of noise is the air off blade edges. Turbine blades move at over a hundred miles an hour at their tips, and the **rated sound power level for large turbines is generally a hundred decibels or a bit more, roughly equivalent to a leafblower**. This is why the sound is easily audible for several hundred feet at least, and somewhat audible out to a half-mile or mile.

While most wind farms are far enough from homes that noise is not an issue, when building in or around existing communities, sound modeling is used to predict likely sound levels in a particular location, based on topography, the local wind regime (direction and intensity of winds), and the wind farm layout. The final turbine layout often aims to put as many turbines as possible into the local landscape, while keeping them just far enough from homes to meet the local or state noise limits, which vary by location from 35dB to 50dB. A 45dB limit often leads to setbacks of 1750 feet, or about a third of a mile (though recordings indicate that sounds often peak a bit higher at times).



This typical official wind project "noise map" (from Ken Kalinsky's presentation in a DOE-sponsored New England Wind Energy Education Project webinar last July) shows 40dB at locations 1800-3700 feet from turbines, and 45dB at locations from 1700-2900 feet. Such maps, as well as repeated reports from neighbors, affirm that turbines are often audible to over a half mile, and at times to a mile. *(See next page for a discussion of annoyance rates at various sound levels.)*

It is important to recognize that night-time ambient noise levels in rural areas are often 25dB or lower; so, it's easy for wind farms to become a new and dominant acoustic presence. All too often, wind developers tell local planning boards that the turbines will be inaudible, which is rarely the case, or always masked by nearby wind in ears and trees, which is has proven to be less reliable than expected (partly because turbine sounds tend to be lower frequency than wind in bushes).

Any sound more than 5dB over ambient will be noticeable, while an increase of 10dB is perceived as twice as loud as current background, and is considered likely to trigger complaints.

So, how noisy *is* 40 or 45dB? Here we enter the murky world of comparing the sounds of very different things. Certainly, 45dB is not what most of us normally consider to be a loud sound. But as just mentioned, it may be much louder than what someone is used to hearing when working in their garden or playing outside with their kids. 40db is sometimes compared to the sound of a refrigerator or steady light traffic on a road a hundred feet away. While of course these things are not intensely loud, it's not hard to imagine that, **for many people who live out in the country, the sound of a humming refrigerator in their backyard or bedroom, or the sudden appearance of steady traffic noise would seem loud in that context, and be disruptive to their sense of home and place**.

What cannot be sidestepped is that wind farms are large-scale machines. They *will* have an impact on the area around them. While it's not "the end of the world," neither is it "no big deal." The changes are real, and the impacts will vary from person to person. The closer they are built to homes, the more problems will arise. All this is really quite easy to see in other communities, and equally obvious to our common sense. **The siting decisions will determine how many locals will be bothered.**

Community Response: How Many People Really Are Bothered?

While in some situations, the sound from turbines can be drowned out by nearby wind noise, or may be perceived as a gentle whooshing noise that people find easy to accommodate, turbines often generate a pulsing noise, which is much harder to ignore or acclimate to, making it a major source of complaints. Perceptually, the problem is that any pulsed or irregular sound will tend to cause more disturbance (similarly, waxing and waning of sound intensity over the course of a day or night, as wind speeds change, is harder to ignore than steady noise, as from a distant highway).

While noise complaints have arisen in many communities, the rhetoric on both sides of the issue tends to distort the situation: community groups imply that everyone is being driven to distraction, while industry groups claim that only a few malcontents who never wanted a wind farm are complaining. Strangely, **there have been very few solid surveys of community responses to wind turbine noise—but those that we have give us a pretty good sense of what to expect.**

A series of large surveys around wind farms in Denmark and Sweden asked people to rate their annoyance at the sound on a scale of 1 to 5 (1=cannot hear, 2=hear but not annoyed, 3= slightly annoyed, 4=rather annoyed, 5=very annoyed). They found that in rural areas, around 5% of people were annoyed (4 or 5 on the scale) as soon as the sound became audible, between 30 and 35dB. As sound moved past 35dB, a higher proportion was annoyed (15-20%). At sound levels of 35-40dB, a quarter to a third were annoyed, and **when sound hit 45dB, just under half the people hearing these levels in rural areas were rather or very annoyed**. Clearly, as noise rises above 35dB, noise is affecting far more than a few disgruntled neighbors.

Similar results were obtained in a study by Christopher Bajdek, presented at NOISECON 2007, a noise control industry conference. Bajdek included two key maps that charted dB measurements and the percentage of residents who were "highly annoyed" by wind farm noise: **44-50% of people under a half mile away were "highly annoyed" (over a third within a half mile had been awakened by turbine noise)**; as in Scandinavia, only as sound levels drop below 40dB do annoyance levels drop substantially; as sound drops below 35dB (around a mile from nearest turbines), annoyance drops to 4% and less.

These patterns seem to match those found in most of the towns where noise issues have cropped up around wind farms. In many communities, a third to half of those within a half mile, or in the 45dB range, get quite upset, while another half of those in these areas are relatively unperturbed. A further study by the Scandinavian team dug into this disparity and found that **in rural areas, annoyance is tied to what they term "place identity," or the reason one chooses to live in a rural area**. While residents who are actively working the land and are used to the steady presence of the sounds of machines are generally unbothered by wind turbines, residents who are not full-time farmers value peace and quiet around their homes, and are very likely to be upset at even relatively faint sounds of turbines. **This is a key factor for rural communities to consider as they determine the proper setbacks or noise limits for their particular residents.**

> *Note:* the response rates cited above give us a sense of how many of those people living *close* to wind farms will be likely to be negatively affected. Of course, in any community, most of those who can see or hear the turbines are further away, and will be more apt to hear sounds of less than 35dB, or to be too far away to hear them at all. Thus, industry spokesmen can accurately say that only a very small proportion of the overall community is complaining or will be negatively impacted. Still, one of the things that local councils and communities need to accept is that if wind farms are built closer than a mile from homes, that it is likely that some of these people will find their quality of life diminished; in the worst cases, some may feel they can no longer live in their home (this is rare, but has happened in several projects, almost always at homes within a half mile of a turbine). **Each community needs to make their own assessment of whether this trade-off of some residents' tranquility is something they want to accept in order to allow more flexible siting options for wind farms.**

***For more detail on community responses**, see my presentation to the New England Wind Energy Education Project webinar, which includes many helpful charts and detailed references: http://aeinews.org/archives/972*

Other issues related to noise

Health Effects

This is certainly a hot-button issue. Several state and industry reports have pointed out that there is no solid evidence that the noise levels around wind farms have any "direct, causal" health impacts. This is true enough, as far as it goes: 45 or 50dB sound doesn't cause physiological damage or trigger symptoms like high blood pressure. But all these studies sidestep the question of indirect effects, as well as the question of whether some people with pre-existing health conditions may be more sensitive to noise (especially low-frequency noise) at low levels.

The most common triggers for negative health effects near wind farms are not the noise levels directly, but sleep disruption and general stress and discomfort in reaction to the noise, even when the noise is not objectively "loud." **In most communities, health effects are reported by a minority of those bothered by the noise** (around a third), though in Mars Hill, Maine, where the turbines are on a ridgeline above many homes, the vast majority of those within a mile reported impacts on their physical and mental health.

The **World Health Organization recommends a maximum year-round outside nighttime noise average of 40db** to avoid sleep disturbance and its related health effects. Their report notes that only below 30dB (outside annual average) are "no significant biological effects observed," and that between 30 and 40dB, several effects are observed, though generally modest, with the chronically ill and children being more susceptible. At levels over 40dB, "Adverse health effects are observed," and "many people have to adapt their lives to cope with the noise at night. Vulnerable groups are more severely affected." For sounds that contain a strong low frequency component, which is typical of wind turbines, WHO says that the limits may need to be lower than 40 dBA to not put people at risk. They note that a child's autonomous nervous system is 10 to 15 dB more sensitive to noise than adults. Even for adults, health effects are first noted in some studies when the sound levels exceed 32 dBA, 10-20 dBA lower than the levels needed to cause awakening. While recommending the use of the average level, the report notes that some instantaneous effects occur in relation to specific maximum noise levels, but that the health effects of these "cannot be easily established." While the WHO recommendations are good to note, the year-long average may be difficult to obtain, as it would require longer-term sound monitoring than is usually budgeted for by industry, states and counties, or neighborhood groups. For more on the WHO guidelines, see http://aeinews.org/archives/429

Noise Measurement Averaging

When the "experts" begin talking about noise, they throw around terms that can make most people's eyes glaze over. A key factor is that noise is generally measured over a period of time, and then characterized in various statistical shorthands, each of which can clarify different aspects of sound fluctuations and daily patterns. Some examples:

- L_{eq}/LA_{eq} ("equivalent" sound level averaged over a given period of time, i.e., as if it were the same throughout; will be lower than the loudest sounds and higher than the quietest times)
- L_{90}/LA_{90} (sound is louder than this 90% of the time; represents the generally quietest times)
- L_{10}/LA_{10} (sound is louder than this only 10% of the time; represents generally loudest times, excluding extreme transient noises like a car passing close to the microphone)

A crucial decision when writing regulations meant to protect citizens from noise during quiet times of day or night is choosing the time period that both turbine noise and existing ambient background noise will be averaged over. Day-long averages or 12-hour averages (both of which generate simpler data that's easier to work with in planning), can lead to noise standards that do not represent the quietest ambient or loudest turbine conditions, which is exactly when turbine noise can be an issue. A highly precautionary approach is hourly (or even ten-minute) averages throughout the day or night, with limits based on the quietest period. At the least, day, evening, and late night should be averaged separately, with noise limits either varying by period (tied to the L_{eq} in that period, or to the quietest short span, e.g. hour or 10 minutes, in a period); this would create a lower limit at night than in the day, without guessing at what level will be problematic in the particular location. In addition, consideration of dBC sound level better reflects low-frequency components.