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The Windmill Meteorology of New Hampshire (Is it 200' or 2200'??) 25 June 2014

SUMMARY:

The current procedures for determining the suitability of a site for a wind farm do not, and cannot, provide the relevant, post construction, information for the neighborhood surrounding the prospective site. Existing weather stations do not measure, and hence cannot portray, the weather hundreds of feet above a multi-thousand foot hill. The idea of "modeling" a hill is itself an oxymoron. No two hills are any more alike than two snowflakes. The final step in the process, entering unrepresentative weather data into an oxymoronic model, is the height of folly. It only pretends to produce a relevant answer. The SEC needs to require that developers discard this approach and instead turn to real, measured, weather data, taken above real hills and ridges.

BACKGROUND:

New Hampshire has a special topography and meteorology found in few other places in the world, Mount Washington being our "poster boy". This special combination of topography and meteorology requires a special approach to the siting of wind turbines in New Hampshire, very different from siting turbines elsewhere.

The only usable sites for wind farms in New Hampshire are the tops of hills and ridges. But siting decisions for wind farms on the tops of hills and ridges require first, the acknowledgement that a 200' tower on a 2000' hill is functionally equivalent in many respects to a 2200' tower on flat land, and requires analysis and treatment more like a 2200' tower! The visual appearance, the shadow flicker, the noise, the frequency and severity of icing and other safety characteristics are quite different from those of a 200' tower on flat land. However, there are no models used to calculate the environmental degradation of the surrounding neighborhood that reflect these unusual real-world effects. In fact, using a model to calculate the effects of a turbine on a hill or ridge is an oxymoron. No two hills are any more alike than two snowflakes! The fundamental requirement for developing a model is that the subjects to be modeled have similar characteristics. Are there two similar hills or ridges, in New Hampshire or elsewhere?

In place of models, and in deference to the individual characteristics of each hill, there needs to be an absolute requirement for a well-designed program of meteorological measurements prior to any approval, and this measurement program must include the special meteorology of the selected hilltop. A comparison of the weather observations at Concord and Mount Washington is breathtaking! No wind farm developer would ever use the weather from Mount Washington, and for obvious reasons. The Site Evaluation Committee should not allow the weather in Concord to be used either, and for the very same reasons! The Mount Washington Observatory has established weather observation sites on many areas of the mountain down from the summit, to determine how the weather changes with altitude. They have informed me that they would be interested in assisting a wind farm developer in setting up meteorological sites at mid-altitude sites on the mountain similar in altitude to those at which projected turbines would operate. The idea of a single Meteorological tower, placed at a "convenient" site on the hill cannot collect the data to determine the effects on its neighbors.

The hills are always selected to maximize the financial return to the developer, the turbines will remain for a lifetime, the environmental effects need to be well known prior to any approval. Developers know this but keep it quiet, taking advantage of hills, always stressing the height of the turbine above the top of the hill, when the relevant number is the height above the surrounding landscape.

DETAILS:

Aesthetics: Simple geometry shows that a 200' turbine on an isolated 2000' hill appear similar to a 2200' turbine on flat ground. The beauty of New Hampshire, the reason it's a tourist destination for summer visitors, hikers, campers, fishermen, etc., is not because we have big Walmarts, but because we don't. Instead, we offer the natural beauty of our mountains, lakes and rivers, unspoiled by other distractions. If we keep adding windmills in an ultimately futile effort to "save our environment", we will have destroyed its natural beauty in the process. Every hiking trail, every vista, will have windmills as its salient viewpoint. We see our hilltops and mountaintops from every highway in the state. Maybe we could we put up "scenic area" signs to alert the drivers to these “scenic windmills”, like we do for other landmarks!

Sound Propagation: The intensity of the sound generated by a turbine is dependent on the wind speed and the wind shear, both of which reach their maximum at night. The area to which this noise is broadcast, and its intensity, are dependent on the temperature stability, which is highest at night. The ambient noise level in most/all of New Hampshire is lowest at night. The high correlation of these effects means that their effects cannot be calculated by using averages of any of them. Any calculation, and most importantly any measurement of any one of them, to be used in the discussion of sound levels around the site, must be done at times of, and ONLY at times of, the maximum correlation of all of them. Measurements at other times to determine the "worst case" noise are irrelevant! When these factors combine, as they often do on clear nights, they form a duct which restricts the dispersal of sound, and directs it preferentially into a channel along the ground, just as an air controls the flow of air in a building. If this duct forms, as it would in many New Hampshire valleys, the hills on both sides further restrict the dispersal of the noise. Finally, putting a water body, which is highly reflective of sound, on the bottom of this channel would allow the noise to carry, with little loss for long distances from the turbine. (The extreme example of the effect of topography is an echo)

An comparison of noise complaints against the concurrent meteorology would be very interesting.

Icing Frequency: There are few, if any, weather stations on elevated, isolate hills and ridges, with Mt. Washington the notable exception. It's expected however, that icing frequency and intensity will be many times higher on such hills and ridges compared to the frequency at the weather stations on low ground. This is both because of the temperature decrease with altitude, but more because of the increased strength and frequency of the wind. The moving blades act to increase the effective wind passing over the blades, and increase the accumulation rate of the icing. It is also well known that the arrival of southerly winds, along with thawing temperatures which cause any icing to melt, come to the higher elevations in winter before they arrive at the lower elevation sites, at which most weather stations are located, and for which weather forecasts are tailored. These effects will ensure that icing, and ice throwoff, will be a substantial problem on the hills and ridges, a problem for which no data will be available to calculate either the frequency of their occurrence or severity, nor for forecasting their occurrence ahead of time.

Throw Area: It is obvious to anyone who has watched the actions of birds near hills and ridges, that the birds utilize the substantial updrafts and downdrafts on all sides of such obstructions. The occurrence of updrafts is dependent on the time of day, the wind speed and direction, and the cover on the ground below. In this light, the throw area of ice and other debris will be difficult to calculate, but will very surely be substantially enhanced over the throw area around turbines on flat land. Birds can "sail" long distances, but only in preferred directions from hills, depending on the wind speed and its direction.

Shadow flicker: The calculation of shadow flicker, its frequency, and its intensity are both very sensitive to the astronomy, meteorology and topography of the site of the turbine and the affected nearby areas. The astronomical, or trigonometric, calculation is straightforward, PROVIDED however that the calculation includes the topography of both the hill and the receptors. The angle of the sun affects both the "flash strength" (the contrast between the sunlight and shadow) and its flicker frequency. The flash strength of the flicker depends on the intensity of the sunlight compared to its shadow. The frequency of the background cloud cover depends on both the real cloud cover in the background, and a correction factor for the low angle at which it is seen. Both the intensity of the sunlight and the frequency of background cloud cover are very dependent on the elevation angle of the sun above a calculated "flat" horizon. These two parameters are extremely dependent on the height of the turbine above the surrounding affected land. A turbine on an elevated hill or ridge will not only intercept MUCH stronger sunlight, but will necessarily be seen against a MUCH reduced cloud cover background. The first arises because the intensity of the sunlight goes from a dull red on the horizon to a blinding yellow only a few solar diameters above the (flat) horizon. The second arises because of the apparent decrease of cloud cover as the angle which the clouds subtend opens up as you look higher up in the sky. Both of these are major effects, and each by an order of magnitude. The "cloud cover correction factor" for isolate hills is not even in the same ballpark with that applicable to flat land, and changes for every affected site around the turbine. In addition, turbine blades on hills will move the locus of the shadowing blades southward, toward an apparent lower sun angle. A turbine sitting higher in the sky increases both the chance of a non-cloud background and its higher elevation moves the point of impact more to the south, with many neighbors experiencing flicker every day for many weeks continuously around the winter solstice. Not to be ignored is how owners, or potential owners, who plan to build after the installation, are affected. Do such "future builders" forfeit their chance to build on an affected site if they are not considered at the time of the wind farm approval? Don't we have to assume every site around the prospective wind farm deserves consideration?

(Multiple turbines guarantee multiple flickers, with the extreme coming from a row of turbines orthogonal to the sun/viewer axis, and producing almost daily flicker somewhere)

Modeling: No two hills are alike; in their shape, their wind, their weather, and their reaction to their weather, their sound characteristics, their shadowing of the surrounding areas, their view from near and far, their icing frequency and the characteristic wind associated with their icing events, their throw area, and their shadow flicker. Models are not only inadequate, but misleading, giving an apparent result, but with completely unknown uncertainties. Determining, a priori, the likely effects of these 50-year decisions, requires a carefully designed, and adequately carried out, program of measurements of the relevant parameters, both meteorological and environmental, and including the variations of the noise and icing under a wide variety of different weather conditions. These measurements will reveal the enormous range of both the weather and its effects on both the turbine and its neighbors. Random measurements in "nice" weather are a sham.

The SEC should require any developer who uses "private" weather data, and/or a model, in his proposal to produce both the data and the model, with sufficient explanation so that an independent meteorologist can analyze and evaluate both?

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I am a professional meteorologist, with BS, MS and PhD degrees, all in meteorology, from MIT. I was a researcher for 30 years at the Air Force Geophysics Laboratory, spent 14 years presenting the weather on Channel 7 in Boston, was CEO of the largest weather data distributor in the world. I testify in court and before government bodies, and have lived in Stoddard NH for 19 years.

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