TAB 6

STATE OF CONNECTICUT
CONNECTICUT SITING COUNCIL

Petition of BNE Energy Inc. for a Declaratory Ruling for the Location, Construction and Operation of a 3.2 MW Wind Renewable Generating Project on New Haven Road in Prospect, Connecticut

Docket/Petition No. 980

February 14, 2011

Prefiled Testimony of Carl V. Phillips PhD

1. Please state your name, occupation, and address.

My name is Carl V. Phillips. I am health science researcher and author and director of Populi Health Institute, an independent public-interest research group I formed when I privatized my university research lab. My most useful contact information is cvphilo@gmail.com; my postal address is 221 W. Wayne Ave A4, Wayne PA 19087.

2. Please describe your credentials and professional background.

I am an expert in epidemiology and related health sciences, as well as scientific epistemology and methodology. I earned a PhD in public policy (with an emphasis on economics-based decision making) from Harvard University, completing a dissertation on environmental policy and economics. I then completed the Robert Wood Johnson Foundation Scholars in Health Policy Research postdoctoral fellowship at the University of Michigan. Later I did a second fellowship in philosophy of science at the University of Minnesota. Before I returned to school for my PhD and began my career in public health science, I worked in consulting, primarily analyzing energy and environmental policy issues. Prior to that I earned a Master's in Public Policy from the Kennedy School of Government at Harvard, and *summa cum laude* undergraduate degrees in math and history from Ohio State University.

I spent most of my career as a professor of public health, and my current academic-style research institute is a direct continuation of that. During my career as a professor, I taught at the schools of public health at University of Minnesota, University of Texas, and University of Alberta, the evidence-based medicine program at University of Texas medical school, the University of Alberta medical school, and Harvard's Kennedy School of Government. My teaching focused on two subjects: how to make optimal public policy decisions based on scientific evidence, and how to properly analyze epidemiologic data. This subject matter, as important as it is, is generally overlooked in health science and medical education, and students frequently reported that my teaching clarified their understanding of epidemiology, science more generally, and policy decision making for the first time in their educational careers.

My research during my academic career, and continuing in my private institute, has emphasized epidemiologic methods, environmental health, science- and ethics-based policy making, the nature and quality of peer review, and tobacco harm reduction. My work on epidemiologic methods focuses on recognizing and quantifying uncertainty, recognizing and correcting for biased analyses, and translating statistical results into decision-relevant information. My initial contributions in the area of quantifying uncertainty won several awards in the early 2000s and launched a new area of inquiry in the field.

3. How did you come to be involved in the present matter?

I was retained by Save Prospect Corp to provide testimony about the health effects of wind turbines on nearby residents.

4. Please describe your expertise and background as it relates to assessing those health effects.

I have spent substantial time in the last year reviewing what has been written about the health effects of wind turbines, including research and related background science, health reports, and testimony/analysis by industry, government, and independent scientists. I have extensively studied the epidemiologic evidence on the topic, including the formal scientific literature and the much more extensive information available in other forums, which I describe below. I have also contributed to some new analysis and have undertaken new research in the area, though no results from that are available yet.

Epidemiology is the study of actual health outcomes in people, and thus is the only science that can directly inform us about actual health risks from real-world exposures. Related biological and physical sciences often provide useful information about health risks, but they are ultimately trumped by epidemiology because real-world exposures and the human body and mind are so complex that we cannot effectively predict and measure health effects except by studying people and their exposures directly. My background in epidemiology methods, scientific epistemology, and optimal policy decision-making is the background that is needed for being able to evaluate bodies of health science literature and assess their worldly implications. Most people who work in or around epidemiology learn only how to conduct particular types of studies or how to technically interpret individual study conclusions in the simplest possible way, which does not provide the tools to sort out complicated controversies. My study and research have focused on the epistemology of epidemiology: how to understand what the available evidence tells us beyond what the authors of individual studies assert.

In addition, I have extensively reviewed research and other information, beyond epidemiology, that relates to the impacts and roles of wind turbines. My background in environmental economics and environmental health, with an emphasis on energy policy, provides important subject-matter background related to wind turbines, land use, and electricity generation.

Finally, I have reviewed the most prominent government and NGO reports on this matter and numerous reports by the wind energy industry and its consultants. I have conducted analyses and have written direct responses to the content of many of these reports when the authors have reached conclusions contrary to my own.

5. **Please summarize your scientific opinions about what we currently know about the health effects of wind turbines on nearby residents and the limitations of the currently available evidence.**

It is my learned opinion that there is ample scientific evidence that wind turbines sited near residences cause serious health problems for some people living in those residences. However, we do not have enough of the systematic population-based research that is needed to estimate the portion of the population that is vulnerable to the effects, the effects of exposure variables (e.g., how risk varies depending on how far away from a residence the turbines are), and the effects of other variables. In addition, we do not yet understand the pathways that lead from cause to effect.

It is possible to make rough estimates of the portion of the exposed population that will suffer serious health problems from turbines within one or two thousand meters of their residences, based on adverse event reporting and our limited systematic data: It is more than

trivial (that is, it is at least a few percent of the exposed population) but fairly clearly a minority. This is obviously a wide range, but it does exclude the possibility that the effects apply to only a few rare individuals, let alone the claim that there are no effects.

We would like to be able to better estimate this figure, especially as a function of intensity of exposure (distance from the turbines and other characteristics of the facility) and personal characteristics. We would especially like to know if particular types of people are at much higher risk. Moreover, we would like to have a better list of exactly which health outcomes are caused by the exposure; we have strong evidence about some, but others are more speculative. Additionally, it would be extremely useful to know which of the several candidate causal pathways (noise, shadow flicker, etc.) leads from the existence of the wind turbine to the health outcomes; without that knowledge, it is not possible to assess the options to mitigate the effects. However, the fact that we do not have as much such knowledge as we would like does not diminish the actual epidemiologic knowledge we have. That is, we know there is a serious problem, we just do not know exactly why it happens or how prevalent it is, let alone what steps (other than completely eliminating the exposure) could mitigate it.

If this were a pharmaceutical exposure, the manufacturer would have been required to do research to try to document the "side effects" and clear up these unknowns. Unfortunately, no entity with sufficient resources has been required to or has chosen to do that research for wind turbines, so the information can only trickle in as fast as various under-funded – often self-funded or community-funded – researchers can produce it. Still, even without sufficiently financed research and with the unknowns I have noted, one thing is quite clear from the science that has been done: There is no way that someone can claim that there is not evidence to support the claim that there are serious health effects.

6. Outline the evidence and analytic steps that led to these conclusions.

(a) There is substantial epidemiologic evidence of health effects on residents from nearby wind turbines, including numerous adverse event reports (case studies), many of which are case-crossover studies, and a few population-based systematic studies.

(b) When the nature of the situation and evidence is carefully considered, it becomes particularly convincing. It stands up well to criticisms and concerns that have been leveled at its validity.

(c) The health effects that have been reported are serious and have important implications for people's well-being. Attempts to dismiss these as "not real diseases" are inappropriate and contrary to widely accepted definitions of disease and health.

(d) The causal relationship between exposure and disease is quite plausible and requires no great imagination. Wind turbines produce audible noise, noise at sub-audible frequencies, and shadow and light flicker, and all of these affect people's minds and bodies. The noise and light are cyclic rather than constant, which can be particularly bothersome. We are not sure how much of the outcome results from particular causal pathways, but there is no reason to doubt the accuracy of the epidemiologic evidence based on a lack of plausible pathways.

7. **Describe the epidemiologic evidence that supports the claim that wind turbines cause serious health effects to nearby residents.**

The greater part of the evidence about individuals living near wind turbines takes the form of adverse event reports, also known as case reports. Many of these are individual stories that are self-published. Others have been collected more systematically, such as the WindVOiCe

collection from Ontario (Krogh et al. 2011), the scholarly book by Pierpont (2009), and in Harry (2007). Adverse event reporting is a cornerstone of identifying emerging health risks, since it is obviously impossible to constantly study every possible health risk in a more systematic way, waiting for health outcomes to appear. Pharmaceutical regulators rely heavily on clearinghouses they create for adverse event reports from drugs. The WindVOiCe report collection is an example of this same well-accepted kind of active-recruiting data collection system.

These adverse event reports provide useful information in several ways:

First, the reported health problems are similar across reports and are plausibly related to each other and the exposure. If people were complaining about a collection of seemingly unrelated ailments, it might suggest that they were simply blaming the turbines for coincidental problems. However, this is not the case. Instead, these outcomes consistently include a combination of the same list of related problems, including sleep disorders, general distress, and mood disorders, headache, fatigue, vestibular (balance) problems, and tinnitus. These problems exist at the border of the psychological and physical, and can all be caused by plausible effects of wind turbine exposure: stress reactions and/or vestibular disturbance. There are also a few reports of hypertension, though since this is difficult for individuals to monitor themselves it would be unlikely to appear in most adverse event reports.

Second, the sheer volume of adverse event reports suggests that the problems are not restricted to a few rare highly-susceptible individuals. It is impossible to make a very confident estimate based only on adverse event report collections, though pharmaceutical regulators attempt it, as best they can, as a matter of standard practice. We do not know what portion of the people experiencing the adverse events choose to volunteer the information in a form that is accessible to researchers and regulators (although this is typically very low); moreover, we do

not even know how many people are exposed. That said, the rate of volunteered complaints suggests that the prevalence of serious health problems is well above 1% of the exposed population. When communities or turbine operators actively solicit reports from a population of known size, several percent of the population in the monitored area (typically a fairly wide radius from the nearest turbine) make complaints.

Third, several of the case studies provide *case-crossover study* data, albeit without exactly the optimal data collection. The case-crossover study (Maclure 1991) is one of the most effective methods for assessing the transitory effect of a transitory exposure (which means in this context: occurring fairly soon after being exposed to turbine noise and disappearing fairly soon once the exposure is removed). It is a method for transforming the limited information that may come from a single case study to a controlled study with many observations. This study design is one familiar to all of us in our everyday lives: Impose the exposure at a time when the outcome of interest is absent and see if the outcome occurs; withdraw the exposure and see if the outcome disappears.

Many of the reports (personal testimonials and collected case series) recount the onset of distress beginning shortly after the activation of the turbines – that is, when the person crossed over from being unexposed to being exposed. Moreover, some residents have reported intermittent reductions in their health problems under certain conditions (when the turbines stop turning, or other effects of wind direction or speed), further supporting the conclusion. Finally, some of those who sought relief through physical (soundproofing) or geographic (moving their home) methods crossed back to unexposed and reported the results. While the cause-and-effect pattern might not be so obvious as the light switch experiment (because the appearance and disappearance of many of the effects would not be immediate), this is compelling evidence.

In addition to individual case-based data, there is a small collection of studies that use data gathered in a systematic way. There is a small collection of epidemiologic studies of people exposed to wind turbine noise in Europe by Pedersen and colleagues (2004, 2007, 2009, 2010). These studies suggest that some substantial portion of exposed individuals experience harms, some of which constitute health problems by any modern definitions of health. The studies have various limitations, but they provide a quantification of a nontrivial number of cases. Among the collections of cases that have been reported by advocacy groups or consultants working on previous regulatory cases, many are systematic studies though they may have been mischaracterized as non-systematic case series. It appears that no one has done a systematic review of such studies, so it is not possible to generalize about them. But as one example, Phipps (2007) presented a systematic study that provides further evidence of health effects, and I am aware of no examples that provide contrary evidence.

Most recently, Nissenbaum et al. (2011) surveyed residents living near turbines about most of the above-mentioned health conditions and compared them to similar people living further away. At the time of this writing the details of their research – which I have seen and commented on – are still confidential, but some of it has been reported in public forums so I am comfortable making some broad statements about it. The data appear to support most of the widely-stated hypotheses about the health effects of nearby turbines, and provided no contrary evidence. This study added a systematically-collected, population-based study with formally measured health effects to the types of evidence that already existed, and suggests that the portion of the population suffering the effects is much higher than the conservative estimates I present above. This is not to say that this one formal study provides definitive evidence, nor is it better evidence than we already had just because it was more systematic. But it does suggest that

the estimates based on adverse event reporting are extremely conservative (as they often are, since most adverse events are never reported). Moreover, this study shows that different types of evidence, gathered in different ways, tend to further support what the adverse event reports show.

Finally, observations about behavior and expenses endured provide further evidence of a causal relationship between turbines and health problems, as well as offering a measure of the magnitude of some of the problems. The reported adverse event reports suggest that a nontrivial number of residents who experienced severe problems concluded that the turbines were damaging their health with sufficient confidence to move their residence or retrofit the structure to try to block the noise. These are expensive actions that would not be taken by people who were suffering only minor problems or who had not made every effort to make sure the cause of their disease was indeed the turbines. Some case studies recount residents attempting to sell their properties but not finding buyers at a price they would accept, suggesting that potential buyers anticipated suffering health problems if they moved near the facility. Economists recognize that when there is data like this (called "revealed preference"), it is usually the most compelling evidence available.

The breadth and nature of the existing data make it more compelling than the sum of its parts. As with most complicated science, no individual piece of evidence is compelling. Similarly, gathering more similar information in the same way is often not compelling. In this case, we have different types of data, collected in different ways. Some of it is experimental (a case-crossover study is an experiment on oneself), some of it is systematic, and most of it is based on pre- and post-exposure experiences of particular individuals.

8. How do respond to claims by some commentators that there is no evidence that there are any health effects?

Commentators who have attempted to dismiss the entire body of evidence basically argue that most of it is not based on one of the two or three epidemiologic study types that they understand. They are apparently unaware of the importance of case-crossover studies and adverse event reporting in public health science. More generally they do not realize, or pretend to not realize, is that a huge portion of all knowledge, including formal scientific inference, is based on data that is not from studies designed according to certain standard approaches.

First-semester epidemiology students may only learn how to make sense of two types of studies, but experts in the field can do much better. It is fair to say that we wish we had particular forms of data, since some studies could tell us more than others. But failure to have the perfect data obviously does not mean we have no data. We simply need to be careful about only drawing the conclusions we can. This means that we can currently be confident that a nontrivial number of exposed people suffer serious health problems, but we cannot be confident that any particular mitigation measure or offset distance rule is sufficient to protect them.

It is perfectly reasonable to try to make a case that our existing knowledge does not provide convincing evidence of a claim, but when someone simply tries to convince the reader that most of that evidence does not even exist or has no content, it suggests that they do not feel like they can make that case. It is difficult to see how anyone could take seriously the assertion that there is no evidence to support the case.

9. What is the importance of the reported health effects from a public health perspective?

Psychological conditions and those with manifestations on both sides of the psych-physical border – a category that includes stress, depression, and many other ailments – probably account for the loss of more quality-adjusted life years than purely physical diseases, at least in the West and possibly even worldwide. Most accepted definitions of individual or public health include psychological health as part of the consideration, and usually refer to an overall state of well being rather than just an absence of a particular diagnosed physical ailment.

Legal and regulatory arenas often put greater emphasis on damage to someone's physical health, probably because it is easiest to measure. But unless physical damage causes unrelenting pain or the loss of the ability to communicate, it generally rates as much less important in terms of quality of life than psychological problems that affect mood or functionality. Indeed, research into quality of life suggests if people were allowed to experience both and choose between them, most would rather lose the use of an arm than to suffer constant insomnia or anger, or the inability to concentrate.

Some wind turbine proponents have tried to denigrate or dismiss the serious health problems that have been reported. They ridicule those who are suffering the health effects by making claims like "it does not bother me" or "the decibel level is no greater than that of the wind blowing through leaves" so you are just imagining it is a problem. They insinuate that because the effects are psychologically mediated that they are the suffering individual's own fault. Or they try to claim that the effects are "mere annoyance" (a claim that is based on intentionally misconstruing the jargon in the science literature, *annoyance*, which refers to a class of responses to noise that range from less serious to life-destroying). Among the more

bizarre claims is that people are suffering *symptoms*, but because there is no agreed upon term for the underlying disease, the suffering does not really count. All of these are obviously groundless, as should be obvious once attention is called to them. Moreover, they are insulting to the millions of people who also suffer the serious health problems like those that have been observed.

Other pro-industry commentators concede that people are indeed suffering, but that the observed problems are not really *health* problems, an arbitrary distinction that even if accepted would not diminish how much people are suffering. A major cost inflicted upon someone's psychological well-being matters, whether or not it has a disease designation, whether it does not seem to outside observers that it should be so bad, or even whether it is officially designated a health problem.

10. Should we doubt evidence that depends on people's own assessments of their exposures and outcomes?

That is a reasonable concern in some cases, but in this case the exposure-disease combination is relatively easy to study, including by individuals recounting their own experiences. This contrasts with more typical claims about health effects from noxious facilities. This is critical for understanding the evidence, so I will expand at some length:

In cases of environmental pollution there is often a fear of slow-developing diseases (especially cancer, for which we cannot even define a time of incidence – i.e., when the disease actually started – only of diagnosis) that occur seemingly at random because they have many causes, usually far in the past, that it is impossible to sort out a specific cause for a particular case. In such cases, when local residents claim "I got cancer because of the effluent from this

factory" the standard response is that it was inevitable that some people near the factory would get some cancer someday, and so it is impossible to make that causal conclusion. Indeed, to make any such conclusion it is generally necessary to systematically collect enough data on enough exposed cases, as well as on non-cases and an unexposed comparison group, so that statistical comparisons can be made. Contrast this epistemic situation with the case of a traumatic injury from a car crash: If following a crash a passenger in the car has a laceration on his head that he did not have a few minutes earlier, we would not hesitate to say, based on that information alone, that the crash caused the injury. Why? Because head lacerations do not slowly develop from unknown causes, appearing years later (like cancer); instead they are almost always diagnosed within seconds after a causal event occurs. Moreover, we can almost see the causal pathway in the form of the crash causing rapid deceleration which caused an impact between head and something in the car, and it is such impacts that cause trauma.

The case of the health outcomes that appear to be caused by wind turbines lies somewhere between the cancer and crash examples, but is rather closer to the latter. Unlike for the trauma case, we cannot fully envision the causal pathway. But the particular health problems and general distress that has been observed are not phenomena that, like cancer, often suddenly occur without any observable proximate cause; if the problem is new, the cause is almost certainly new. In addition, the sensory impact of nearby wind turbines is readily observable, like the car crash, and unlike chemical exposure. The reasonable expectation of a proximate explanation and ability to observe the turbine noise as the apparent cause make this case more like the car crash than the cancer. Some of the authors writing reports for the wind energy industry come from consulting groups that write a lot of reports for industry that argue, often correctly, "you can never know what caused those disease cases because you do not know

exactly when it was caused and there are many plausible causes other than our client's product/facility." But they have tried to import that exact claim to the present case where the observation is simply incorrect.

Though it is not quite so easy to observe the proximate cause of distress and the other psychological and physiological manifestations associated with wind turbines as it is to observe the crash as the cause of head trauma, a subject's own observations about his own case are still scientifically informative. This contrasts with most types of cancer, wherein neither the victim nor any clinician or scientist can offer a legitimate conclusion about causation, other than in the form of far-from-certain probabilities derived from statistical comparisons. Except for the very few cancers where we know the causes of almost every case (i.e., cervical cancer), a claim that "this exposure caused my (or this patient's) cancer" is never justified. But if someone claims "this noise is driving me crazy and keeps me from sleeping" we have good reason to believe him. For a more subtle exposure, like a relatively low decibel periodic noise, the conclusion is less certain than it would be for a loud party next door, but the individual's assessment still has substantial value. This is true even apart from the crossover data that an individual will naturally accumulate, so when combined with crossover data (either from actively moving away from the area or just the inevitable periods of low wind activity) and common intuition about how to reason based on crossover evidence, the individuals' assessments are even more compelling.

Thus, unlike the case of trying to detect an elevated incidence rate above some baseline level of a disease that has distant and uncertain causes – which is generally impossible absent formal studies that are specifically designed to do just that – the natural observations in this case are quite compelling.

11. Is it a problem, as some commentators claim, that most of the evidence is not "peer reviewed" studies?

Not really. A rule like, "only consider evidence published in certain journals" is reasonable for a debating league, since games played for fun always have arbitrary rules, and may be defensible in a stylized battle like a liability trial (though even then it is a formulaic substitute for really doing the science), but it is clearly not appropriate for policy decisions which are supposed to be made in the best interest of the public. Some of those who seek to deny the evidence tried to argue that the many adverse event reports should be discounted because they are not in a peer reviewed publication (though some of them actually are; Pierpont 2009 was peer reviewed). Apparently they somehow believe that peer review can improve the accuracy of someone's report about their experience, but that is simply not true.

Non-scientists often think that the peer review process offers some magical verification of analyses and data. But in health science, reviewers almost never assess these (they do not get access to the data, let alone to how it was collected; they see nothing more about the calculation methods than the reader sees, and thus cannot even check the work; see Heavner et al., 2009). Thus it should be obvious that even when adverse event reports are collected into journal articles (as they inevitably will be), the peer review process will do nothing to change the accuracy of the reports.

12. Is it important that many of the observed health effects are subjective (that is, they can only be measured by the person experiencing them)?

Yes, but not because this makes the effects less "real". Many important diseases are diagnosed and, indeed, defined based entirely on subjective experience, everything from suicidal depression to a minor headache. (It should be noted that in this case, there are objective measures of some of the effect, like inability to sleep.) To dismiss subjective experiences would be to dismiss the vast majority of what people genuinely care about in the world, as well as many fields of science and medicine. It is certainly true that the reported outcomes are much more difficult to measure than many other health outcomes. That, of course, is not a reason to ignore what we do know. We have to make the best of whatever form our data takes rather than declaring the data to be less than one might want and misconstruing that disappointment as complete ignorance.

The observations about subjectivity seem to be intended to downplay the importance of the experience. But the real challenge of many subjective effects is that context affects how much suffering they cause, and so only evidence about this specific experience is of much value: A minor trauma might cause a pain we just shake off while playing sports but the pain from such a trauma might be completely unpalatable if it occurs while sitting quietly at dinner, and if that pain were inflicted by someone walking by and hitting us on the head we might consider it even more painful and a criminal act. Many studies of the effects of noise on people take place in the workplace or short-term artificial settings where someone might find the stimulus tolerable and typical, whereas they would find it distressing if experienced constantly and at home. The challenge is not just that the experiences are different based on circumstance, but that none of these experiences is more legitimate than another. If the subjective experience of the resident at

home is different from the worker on the job or someone visiting the home to assess the effects, it needs to be dealt with as it is. Observing that sometimes people are able to ignore particular impacts without health effects might suggest intervention methods for reducing the impact, but the observation does not in itself reduce the effects.

13. Some residents living near turbines report health effects but most do not, and many studies have found that people can experience noise exposures with no ill effects; should this lead us to doubt the claims about effects?

No. Some observers appear to be confused by the heterogeneity of effects. But this is not at all unusual, and similar patterns can be observed for most any exposure-disease combination. For example, many heavy smokers never get cancer or suffer any other major disease that is often caused by smoking, but that does not lead us to doubt that smoking, even light smoking, gives some people lung cancer.

Some observers have had brief exposures to the noise and experienced no adverse effects, and perhaps concluded that the exposure would never bother them. This obviously does not constitute evidence that no one ever suffers from the effects; the individual in question might be immune while others are not. Moreover, he might be wrong about what would happen if he were exposed longer, since health problems caused by noise exposure tend to be cumulative, as is typical for other exposures that produce stress reactions. Stress-causing exposures (e.g., social harassment, pain, sleep deprivation, physical restraint) which may seem trivial for an hour can become torture after a week. Even exposures for eight hours per day (like workplace exposures) may have quite different effects than exposures that last all day and overnight. Some exposures that people intentionally seek controlled versions of for an hour or a workday-length period (hot

weather, loud music, exhausting exercise) cause stress reactions and health problems with unrelenting, uncontrolled long-term exposure. Something that is beneficial in one controlled form is harmful in other forms.

When effects are heterogeneous across people and across intensities of exposure, we can often find measurable characteristics that are associated with whether someone experiences the effect. A great deal of epidemiology is devoted to measuring these associations. Yet some of those who deny that wind turbines affect health seem to find such associations surprising or want to imply that the heterogeneity of effects suggests that the effects are less "real". Those authors may be making the mistake – common among people who do not understand complicated sciences like epidemiology – of thinking that if an outcome has one cause (personal characteristic) then another factor (noise) is not really the cause. In fact, the proper way to think of it (though it takes some getting used to) is that *both* the noise and the personal characteristics caused the disease (as did a multitude of other factors); if either one of them was absent then the disease would not have occurred. In ethical or policy discourse (as opposed to scientific analysis) we often reduce our list to causes that someone actively brought about (i.e., the causes someone is culpable for, not the ones that simply are). So, for example, a murder is not excused, and is not considered to not be the cause of the death, if his victim would have survived had he been stronger or closer to a hospital – those non-act-based personal and geographic characteristics *also* caused the death, but the murderer is still a cause and thus is guilty.

14. Is it biologically and physically plausible that wind turbines could cause the observed health outcomes?

It is clear that the physical effects – noise traveling through the air, noise/vibrations traveling through the ground, and flickering shadows and light – do reach the bodies of local residents, and noise and flickering do cause health problems under some circumstances. This observation alone, given that effects of noise and cyclical stimuli are so varied, unpredictable, and often downright strange, is sufficient to make health effects plausible. Additionally, various studies show that lower level sound and vibrations affect the body via the ear (hearing and vestibular systems), skull, skin, viscera, and other body parts. Some authors theorize that the health effects from wind turbines seem to result from impact on the vestibular system, while others are more inclined to suspect other sensory effects. Either of these could have secondary effects due to stress reactions that could cause many other harms.

15. How do you respond to claims that there is evidence that the noise or other impacts from wind turbines cannot cause health problems?

No such evidence is possible. A huge portion of what turbine proponents have written about the health effects – most of the studies of turbine acoustics, reviews of research about the effects of noise and flickering, and such – can be summarized by saying "hmm, we just cannot figure out why this exposure causes serious harm to people's health". Some researchers have directly countered this, providing evidence-based hypotheses about why. But the key response is simply that someone's inability to figure out why a well-documented phenomenon is happening hardly constitutes evidence that it is not happening. This would be true even if no scientist had any idea why the phenomenon was occurring, and it is certainly the case when the inability to

understand any reason why the phenomena might occur appears confined to those who would prefer that the phenomena did not exist.

The most charitable proper interpretation of the research that proponents incorrectly interpret as showing there must be no effect is that we would not have *predicted* there would be a health problem before it was observed. Prediction is useful, but obviously its value ends once we have an actual observation. The fact that last week's weather forecast predicted rain yesterday is not a helpful observation about what the weather was yesterday. It might be a useful observation about weather forecasting, though – i.e., the inability of the models to explain why there are health effects means that we do not fully understand the pathways. But of course, ignorance (about exactly what is happening) cannot constitute evidence (that nothing is happening).

With the exception of damage to hearing, noise causes problems via mechanisms that we do not fully understand. Similarly, flickering lights cause well-understood health problems under a few circumstances, but the reasons that they bother people in other circumstances are simply not known. The conclusion that we should reach from this is not "we have no evidence that turbine noise would cause health problems" but rather "we know so little about how noises cause health problems that we will have to defer to the epidemiology in assessing whether they are actually occurring", as well as "we should be quite cautious about imposing novel noises on people because they could easily have unpredicted effects." The scientific reasoning is not that if we cannot figure out how the physical impact causes a disease then there is not disease, but rather if there is disease then it would be useful to figure out how the exposure is causing it.

Not understanding the causal pathways does not keep us from knowing that there is a problem. However, it makes it almost impossible to claim "if we just do X there will be no problem." In other words, when industry proponents point out that we cannot figure out why

there is a problem, they are really arguing that we do not yet have any way of knowing what regulations are sufficient to eliminate the problem.

16. How do you respond to claims that wind turbines cause health problems only because nearby residents have the wrong attitude about them?

The first observation is that such claims propose alternative causal pathways, while conceding that turbines are causing health problems.

In one study (Pedersen and Waye 2004) a correlation was found between health problems and a negative opinion about the facilities. Some commentators have suggested that this means that the health problems are therefore less real, or perhaps even concocted due to other motives for disliking the facilities. It is theoretically possible that people who dislike the turbines for reasons that have nothing to do with their noise or light impacts could be lying about health problems, though it is difficult to understand what they do not like, if not the noise and light. Perhaps, the claim might go, they do not like the noise and light so much that they claim they are suffering health effects. But, again, why? At best they are wasting time, since experience shows there is little chance that complaints will cause an installed facility to be shut down, and at worst they are convincing potential buyers of their property to stay away.

Absent out-and-out lying, we still have the observation that health problems and opinions about the facilities are, at least sometimes, correlated. We should obviously expect to see this when all data is collected after the turbines are operating (which includes all the adverse event reports and most of the other studies): Anyone suffering health problems that they perceive to be caused by the turbines is going to have a negative opinion, and is likely to better recall any negative opinion they had before the facility was built. The causal pathway is quite plausible:

the impact of the turbine causes health problems, which then causes the sufferer to dislike the facility. Even if disposition data is collected before the turbines start operating, there is still a good chance of causation running from health concerns to disposition. People who recognize, from experience or other self awareness, that they are more likely to suffer health effects from noise pollution are among those who will most strongly object to the siting and have negative feelings about it. Indeed, it seems safe to predict that a larger than average portion of the population with those feelings will be near new facility sites, since local residents have chosen to live in quiet rural areas. It is certainly the case that the average resident will be more sensitive than people who self-select into noisy occupations (i.e., the people who are the subject of most studies of the effects of noise).

That said, it is not implausible that dislike of the facilities triggers or exacerbates health problems. Indeed, increase in distress caused by a stimulus due to frustration with having it imposed upon you, and not being able to do anything about it, is inevitable. But this is simply part of the causal pathway. That the pathway partially passes through local residents' dislike of the facilities is hardly an argument that the facilities are less damaging, though industry supporters sometimes suggest as much. The most charitable interpretation of the claim is basically, "people so hate having the audible, visual, and other effects of these facilities imposed on them so much that it ruins their health."

I observed in one recent regulatory proceeding the industry's consultants focusing on the argument that local residents have an irrational fear of the turbines, like the fears that have been documented about radiation or chemical pollution, and that they can just be educated out of this. However, there is no basis for claiming that people have the same attitude toward simple noisy mechanical objects that they have toward mysterious invisible threats like radiation. Equally

important, even if they do, there is absolutely no evidence that people can be "educated" into not being bothered by nearby turbines. If the industry can do this, they should be doing so in existing facilities, of course, rather than simply claiming it *could* be done as a basis for siting new facilities. But there is no evidence that they can or that they genuinely believe that they can. Unless it can be shown that this education reduces people's health problems, then the theory about the causal pathway is purely theoretical and represents a distinction without practical difference.

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Report (pg 6 and pg 10), "it is likely that more hoary and eastern red bat calls were recorded than were positively identified".

However, WEST then states that "two species with distinctive call sonograms are the hoary bat and the eastern red bat" and then generate tables and figures (Figures 6 and 7) that analyze these species separately and conclude that these bats comprised only 2.7% and 1.2% of the total bat calls in the project area.

Without continuous reinforcement of the caveat that these species have high overlap, the reader is left with the impression that these bats are uncommon at the project site (less than 4% of the total bat population), even though the call groups they belong to represent 81% of the total bat activity. In my opinion, one should not justify and use a conservative approach (such as species grouping) and then focus the majority of the analysis and interpretation using a non-conservative approach.

10. Do you have comments on the study duration reflected in WEST's report?

If so, please describe.

Acoustic sampling is typically conducted for the entire active season, which extends from spring (early to mid-April) through fall (late October). Surveys that I have conducted for this entire duration (in Vermont, New York, Pennsylvania, Massachusetts, and Virginia) usually show very little bat activity during the first and last weeks of the study, suggesting they do in fact capture the vast majority of the seasonal bat activity.

The study period identified in the WEST Interim Report (25 June -31 August, 2010) is characterized as representing "the majority of the maternity season in central Connecticut" (Tidhar et al. 2010). However, this is inaccurate.