

Original Questions:

1. What does the scientific literature say about the health/mental effects of shadow flicker? [See response below.](#)
2. What are the effects of people who experience shadow flicker in a home? [See response to question C1.](#)
3. Is there a safety hazard if turbines cast shadow flicker over a road or highway? [See response below.](#)
4. What are the scientifically documented effects of shadow flicker on those living and working in proximity to wind turbines? [See response to C1.](#)
5. Have the people who will be living near these windmills been informed of the side-effect called ‘shadow flicker’? This is the constant shadow/light/shadow/light that is very visible (and annoying) inside a home when the home is in the shadow of the windmill. [Comment not question.](#)
6. How much of each day and at what distance would a resident living or employee working in proximity to a wind turbine experience shadow flicker? [See response to question C8.](#)
7. How many hours are appropriate for shadow flicker on a residence? [See response to questions C1 and C8.](#)
8. When there is a “flicker” problem that affects someone’s domicile, typically how many days a year does this occur, and for how long each day? [See response below.](#)
9. What will be done to protect owners and homes and land from the “flicker” effects of the wind turbines? [Project specific.](#)
10. What kind of liability does the developer have if blade throw or failure causes damage to life or property? [See response below.](#)
11. For a turbine with a hub height of 330 feet, and a total blade tip height of 485 feet, what is the theoretical limit for ice throw? [See response to question C12.](#)
12. Ice throw in northern climates is an issue. How do you calculate a safety zone to prevent injuries from ice throw? [See response below.](#)
13. Has the icing effect been taken into account during our long winters? [Needs further clarification, but see response to question C12.](#)
14. Does living with a wind turbine really affect people’s health and safety when compared with normal, everyday environmental factors? [See response to A11 and A27.](#)
15. Please present honest and truthful studies that these turbines can be harmful to health of humans and people. Those studies are out there, please present both sides. Will you show both sides of the coin? Flicker effect, noise, sleep deprivation, etc. [Comment not question.](#)
16. The health hazards as we get older are a real concern for us, plus the shadows and sound that these will generate. Please don’t ruin this quaint little town. (Arcadia) [Comment not question.](#)
17. Why does the wind industry continually try to discredit the physicians and audiology professionals studying wind turbine syndrome? [Comment not question.](#)
18. How does the township board plan to deal with “competing experts” – conflicting testimony regarding medical impacts? [Beyond scope of project. Project/township specific.](#)
19. If there’s a turbine fire and it causes a wildfire and destroys property can the developer be held responsible? [See response below.](#)
20. Who is responsible for any ecological, physiological, or medical consequences of wind? [Beyond the scope of this project.](#)
21. What is the speed (MPH) of the blade tips at maximum revolution for a 495 foot turbine? [See response below.](#)
22. What is the maximum wind speed that contemporary turbines are designed to withstand? [See response below.](#)
23. Are the fumes toxic if one of these catches fire? [See response below.](#)
24. Can the township require that utility grid systems have fire suppression systems since there is no fire equipment that will reach that high? [See response below.](#)

25. The wind industry says that wind turbines do not cause health effects, numerous doctors and studies provide evidence of health impacts. Should the wind industry use residents as guinea pigs or should definitive medical studies be completed before wind developers are allowed to be built? **Comment not question, but see response below to question C14.**
 26. Re: Ethics of the Wind Industry in regards to the dismissal and denial of any ill effects on people living within the wind project footprint. This is a fundamental public health issue. Rather than be responsive and better understand exactly what the effects are in order to determine appropriate siting the wind industry in general seems to be taking the stance that there are no ill effects. It cannot be ignored that people do have problems associated with living in close proximity to large wind facilities. An in-depth and scientific inquiry needs to be pursued regarding rural wind farms and health effects. How can a community or an individual help to initiate such an inquiry? **Comment not question, but see response below.**
 27. What types of insurance and how much per turbine should the township require for the wind developer to carry? **See response below and response to D9 for general information about township insurance.**
 28. What percentage of people living within 1500 foot of a large industrial turbine reported sleep loss? **See response below.**
 29. The ordinance should specify that Duke or subsequent owners will reimburse the township and its residents for any costs associated with handling any turbine-related emergencies – e.g. fires started in turbines, etc. **Comment not question. Project specific.**
 30. Do industrial wind turbines interfere with emergency communications? **See response below.**
 31. What would the impact of the wind turbine-generated noise be on people, pets, and wildlife? **See response below.**
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Questions and Responses:

These questions may have been recategorized and reorganized. Some may have been sent to another “theme” area (this will have been explained in red under the “Original Questions” section). In other cases two or more questions will be answered with one response.

C1. What does the scientific literature say about the health/mental effects of shadow flicker?

Response: Shadow flicker is a relatively well-understood wind energy phenomenon. When rotating turbine blades cast a shadow over a building, the changing in light intensity is called shadow flicker. This usually occurs for a period in the evening or morning when the sun is at a low angle in the sky. Shadow flicker does not occur on cloudy days or when the turbine is not operating. Shadow flicker has been a longstanding concern in Northern European countries like Norway, Sweden and Finland where the high latitude and low sun angle exacerbate the effect.

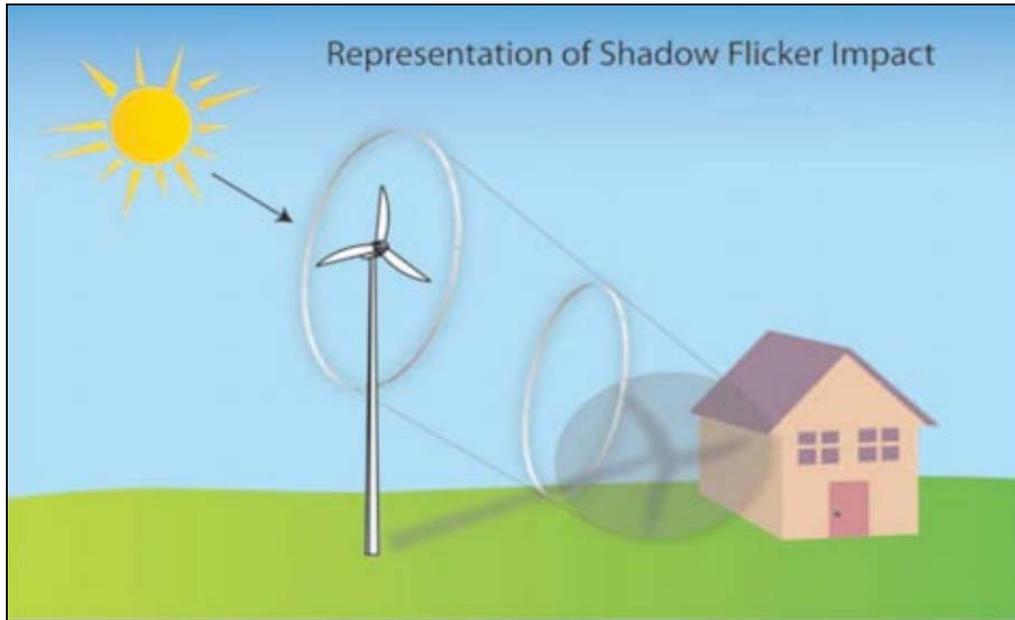


Image Credit: American Wind Energy Association

Shadows that fall on a home may be disruptive and constitute a nuisance. It is a common concern that shadow flicker may induce seizures in people with epilepsy, but the frequency of the flickering effect is too slow to cause a reaction. Various epilepsy advocacy groups, including the British group Epilepsy Action, have not found evidence that wind turbines, especially larger wind turbines, could induce a seizure. Current research suggests that the risk to human health from shadow flicker is quite minimal. For other health effects, see response below to question C14.

There are several ways to mitigate the effect of shadow flicker. Because the area affected by shadow flicker can be reliably calculated (because the position of the sun and the height of the turbine are known on any given day), developers can choose wind turbine locations that will not cause extensive shadow flicker on a dwelling, usually at least 1000 feet from a dwelling. When the shadow of a wind turbine does fall on a dwelling, it usually does so for a short period of time, often no greater than 30 minutes in the worst case scenario. This means that the wind turbine could be turned off during periods when shadow flicker becomes a nuisance. In addition, physical barriers, including trees, can be used to mitigate the impact.

For additional information, see the section on shadow flicker in the National Academy of Sciences publication, "Environmental Impacts of Wind Energy Projects". This is accessible at http://books.nap.edu/openbook.php?record_id=11935&page=160

Also see questions C3 and C8 for more about shadow flicker.

C3. Is there a safety hazard if turbines cast shadow flicker over a road or highway?

Response: If a turbine is close to a highway, the movement of the large rotor blades and possible resulting flicker can distract drivers when they drive beneath the shadow. However, we did not discover evidence of a documented death as a result of distracted driving near wind turbines. This risk can be reduced by increasing the distance between turbines and roads. In Ireland, for example, it is recommended that turbines be setback roads at least 300 meters, or about 1000 feet, from public roads.

For more on shadow flicker, see questions C1.

- C8. When there is a “flicker” problem that affects someone’s domicile, typically how many days a year does this occur, and for how long each day?

Response: The duration of shadow flicker varies greatly depending on a dwelling’s proximity to a wind turbine, latitude, weather patterns (including frequency of days when it is both windy and sunny at the same time) and any barriers blocking the shadow of the turbine. Shadow flicker does not occur when the sky is cloudy, there is no wind, or at night. In worst case scenario planning, a dwelling could be impacted by shadow flicker for up to a half an hour per day for several weeks during the winter when the sun is low in the sky.

Wind developers can use modeling software to calculate where the shadow of wind turbines is likely to fall. During the siting process or the preparation of an environmental impact assessment, developers can use this information to site wind turbines in a way that minimizes shadow flicker for residents.

Ottawa County, Michigan, has issued a model wind ordinance that local governments can choose to adopt or modify. The model ordinance requires wind developers to analyze shadow flicker to determine where the shadows would fall and for how long over the course of one year. It also mandates that shadow flicker on an occupied building not exceed 30 hours per year.

For additional information, see the section on shadow flicker in the National Academy of Sciences publication, “Environmental Impacts of Wind Energy Projects”. This is accessible at http://books.nap.edu/openbook.php?record_id=11935&page=160

For more on shadow flicker, see question C1.

- C10. What kind of liability does the developer have if blade throw or failure causes damage to life or property?

Response: The developer has full liability based on tort or personal injury due to negligence, and possibly on the basis of a nuisance condition to adjacent landowners.

- C12. How do you calculate a safety zone to prevent injuries from ice throw?

Response: “Icing” of wind turbine blades occurs under specific meteorological conditions where a layer of ice, called “rime,” forms on an exposed surface, such as the blades of a tall wind turbine. Ice throw potential is calculated using blade length, hub height, blade shape, and rotor speed and will vary based on these parameters. Risk for injuries from ice throw is at its greatest when the turbine is at rest and construction workers are working around the base of the turbine. A British study calculated that the risk of being hit by ice throw while within 230 meters (750 feet) of a wind turbine is slightly greater than the risk of being struck by lightning within that same area. This ice throw study was completed by a British renewable energy consulting agency. This is accessible at <http://easthavenwindfarm.com/filing/feb/ehwf-ml-reb4.pdf>.

Modeling software programs calculate the zone in which ice throw may occur. During the siting process and/or the preparation of an environmental impact assessment, developers can use this information to site wind turbines in a way that minimizes this risk to nearby residents and property.

- C19. If there's a turbine fire and it causes a wildfire and destroys property can the developer be held responsible?

Response: Yes, if negligence and tort liability, or nuisance conditions get out of control and cause damage.

- C21. What is the speed (MPH) of the blade tips at maximum revolution for a 495 foot turbine?

Response: The maximum speed of the blade tips varies greatly for large-scale wind turbines from about 130mph to 230mph depending on the size of the turbine. The tips of the blade will always move many times faster than the inner edge of the wind turbine blades. The maximum blade tip speed for each model is

controlled because after a certain wind speed the wind turbine will “cut-out” and will change position to minimize risk of a wind turbine being knocked over. (For more on cut-out speed, see question C22). The maximum speed of the blade tips in miles per hour can be calculated by multiplying the rotor diameter (in meters), by pi (π), by the maximum revolutions per minute, all divided by 26.82 (a conversion factor).

C22. What is the maximum wind speed that contemporary turbines are designed to withstand?

Response: All modern wind turbines are designed with “cut-in speeds”—the wind speed at which the turbine blades begin to rotate and produce electricity, typically around 10 mph—and “cut-out speeds”—the wind speed at which the turbine automatically stops the blades from turning and rotates out of the wind to avoid damage to the turbine, usually around 55 to 65 mph. It is extremely rare for wind turbines to be knocked over by high wind speed. The cut-out speeds vary by manufacturer and turbine model. That information is widely available but depends on the particular turbine model.

C23. Are the fumes toxic if one of these catches fire?

Response: Accidents involving fire in modern wind turbines may occur in the nacelle (where the gear box and generator are), on the tower of the turbine and in a transformer substation on the ground near the wind turbine. The greatest source of fire risk to wind turbines is after lightning strike, but technical malfunctions can also contribute to a turbine fire. Wind energy companies and developers are particularly motivated to reduce fire risk because an accident can result in months of lost revenue and damage the reputation of the company.

We did not come across any definitive statistics on turbine fires. In 2009, the Caithness Windfarm Information Forum, seeking to catalog all wind turbine related accidents, estimated that there had been 122 reported wind turbine fires in the history of modern wind energy. This may be an underestimate of the actual number of fires because many may go unreported.

The primary flammable fluid in wind turbines is hydraulic braking fluid. On large wind turbines there may be up to 750 liters (200 gallons) of this fluid in the nacelle of the wind turbine. While it is likely that inhalation of burning hydraulic fluid or any other fire smoke would be harmful to human health, the height of most wind turbines makes it unlikely that anyone besides a maintenance worker would come into direct contact with the smoke from a turbine fire.

For more information, see this Fire Protection guide from a German wind turbine insurance agency, available at www.imia.com/downloads/external_papers/EP43_2009.pdf

An article in Wind Systems magazine describes wind turbine fire risk and various suppression systems that exist. This article can be found at www.windsystemsmag.com/article/detail/136/turbine-fire-protection

For more about fires in wind turbines, see question C24.

C24. Can the township require that utility grid systems have fire suppression systems since there is no fire equipment that will reach that high?

Response: As discussed in the response to question D1, townships have broad authority to regulate in areas related to the public health, safety, and welfare, so long as the regulations are reasonable and not preempted by state law. If a township determines that wind turbines impose an additional or unusual fire-related risk, they could adopt additional reasonable regulations addressing the risk so long as the regulations did not directly conflict with state regulations or fall within in a subject matter that is already heavily regulated by the state.

Most wind turbine manufacturers build a fire suppression system into the design of a wind turbine without a specific law requiring that it be done. There are many designs of fire suppression systems in wind turbine models and the particular system used will depend on the size, type and manufacturer of the turbine. These systems usually both detect the presence of a fire and automatically release a fire suppressant, such as carbon dioxide gas, into the nacelle of the turbine. A description of wind turbine fire risk and various suppression systems available can be found at: www.windsystemsmag.com/article/detail/136/turbine-fire-protection.

Local and state governments can also train their fire fighting forces in correct protocol for responding to a wind turbine fire. An example of a memo released in the province of Ontario, Canada can be found here: www.ffao.on.ca/documents/content_310.doc.

For more about fires in wind turbines, see question C23.

C26. Re: Ethics of the Wind Industry in regards to the dismissal and denial of any ill effects on people living within the wind project footprint. This is a fundamental public health issue. Rather than be responsive and better understand exactly what the effects are in order to determine appropriate siting the wind industry in general seems to be taking the stance that there are no ill effects. It cannot be ignored that people do have problems associated with living in close proximity to large wind facilities. An in-depth and scientific inquiry needs to be pursued regarding rural wind farms and health effects. How can a community or an individual help to initiate such an inquiry?

Response: The research team cannot speak to the ethics surrounding the development of wind energy projects. To date, there has been no large scale epidemiological study comparing the health of people who live near wind turbines with that of people who do not (See question C14). Such a study could be conducted by a research team through funding either from an academic center, foundation or a federal source like the National Institutes of Health. The results of such a study would likely be published in a peer-reviewed academic journal, which would mean the study would likely adhere to strict methodological and ethical codes and therefore produce more reliable results.

The American and Canadian wind industry associations commissioned a study to investigate the peer reviewed literature on the direct, physiological impacts of the sound levels themselves (in essence, it was addressing the idea of Wind Turbine Syndrome). This 2009 study by a group of medical doctors and acoustical experts found that there is no evidence that the audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effects. That study is available at http://www.awea.org/learnabout/publications/upload/awea_and_canwea_sound_white_paper.pdf

C27. What types of insurance and how much per turbine should the township require for the wind developer to carry?

Response: The insurance should cover personal and property damage claims, and exclusions in the policy should be very carefully studied. Limits should be as high as the potential damages to persons or property with an estimate of the number of people in homes or working or traveling within area of risk to determine the cap for aggregated claims (eg. \$3-5 million per person, \$10-15 million per incident).

C28. What percentage of people living within 1500 foot of a large industrial turbine reported sleep loss?

Response: There is competing evidence about the impact of large scale turbines on sleep loss. To date, there has been no large scale epidemiological study comparing the sleep disturbances of people who live near wind turbines and people who do not (See question C14). There are calls from various organizations to undertake such a study.

The World Health Organization's "Night Noise Guideline Report," compares sources of noise (not including wind turbine noise) and their sleep and health effects: www.euro.who.int/data/assets/pdf_file/0017/43316/E92845.pdf.

There are anecdotal accounts of sleep loss that have been reported by residents living near some wind turbines. Sleep loss is one of the symptoms addressed by Nina Pierpoint in her volume “Wind Turbine Syndrome”. Dr. Pierpoint’s book reports that two-thirds of her test group, fourteen out of twenty-one individuals, presented “disturbing symptoms”. Pierpoint’s website can be accessed at <http://www.windturbinesyndrome.com/>

Other sleep experts, associated with Dr. Pierpoint, have claimed that low-frequency vibrations of large scale wind turbines is more disruptive to sleep than traffic, aircraft and industrial noise.

C30. Do industrial wind turbines interfere with emergency communications?

Response: Electromagnetic interference (EMI) is where the towers or blades of a wind turbine change the direction or block entirely the transmission of signals from TV stations, cell phone towers, military or other radar and potential emergency communication that travels along these pathways. A disruption to communication due to EMI could clearly be a hazard in the event of an emergency situation. Different types of communication are affected differently by the presence of wind turbines. AM and FM radio and cell phone signals are not significantly affected by the presence of wind turbines, but TV broadcasts, point-to-point (“direct link”) radio transmission, and radar can all be disrupted by the presence of wind turbines. Due to the fixed nature of these types of transmission, however, careful siting can avoid the majority of potential EMI and also avoid disruption of emergency communication and other transmission.

For a more detailed explanation of electromagnetic interference, see the section on this topic in the National Academy of Sciences publication Environmental Impacts of Wind Energy Projects (from page 169), accessible at http://books.nap.edu/openbook.php?record_id=11935&page=169#p20012f909970169002.

C31. What would the impact of the wind turbine-generated noise be on people, pets, and wildlife?

Response: The environmental effects of wind turbine noise are controversial, complex and inconclusive. New research on the topic is emerging. For more information, see section A on Sound/Noise and section B on Wildlife.

These sources provide basic information on the science behind wind turbine noise as well as the policies and controversy surrounding it:

- The Acoustic Ecology Institute has produced one fact sheet and two full-length reports concerning Wind turbine Noise:
 - Wind Turbine Noise Fact Sheet:
www.acousticecology.org/docs/AEI%20Wind%20Turbine%20Noise%20FactSheet.pdf
 - “Wind Farm Noise 2011, Science and Policy Overview”:
www.acousticecology.org/wind/winddocs/AEI_WindFarmNoise2011.pdf
 - “Wind Farm Noise: 2009 in Review”:
www.acousticecology.org/docs/AEI_WindFarmNoise_2009inReview.pdf
- Grand Valley State University’s Wind Brief #2, describes the potential noise and health affects of wind turbines: www.gvsu.edu/wind/project-documents-3.htm
- The Minnesota Department of Health produced a report of the Public Health Effects of Wind Turbines, which gives more information about sound created by wind turbines and its affect on humans: <http://energyfacilities.puc.state.mn.us/resource.html?id=24519>
- “Environmental Impacts of Wind Energy Projects,” and online book, has a chapter about noise, which gives more detail about the level and type of noise that wind turbines produces: http://books.nap.edu/openbook.php?record_id=11935&page=157