

Wind Turbines and Public Health

Published November 2022



Utility-scale wind energy is the largest source of renewable electricity generation in the United States with over 70,000 wind turbines deployed across the country, capable of generating 139 gigawatts of clean, reliable electricity, which is enough wind power to serve 43 million American homes. Over the past 20 years, wind energy deployment has received broad levels of support from the public and is perceived by most residents as providing an array of economic and environmental benefits.

Hundreds of thousands of people around the world live near and work in proximity to operating wind turbines with no ill health effects.

As discussed more in this paper, credible, peer-reviewed scientific data and various government reports in the United States, Canada, Australia, and the United Kingdom – and other university and government scientists and researchers now totaling more than 100 – soundly discredit the claim that wind farms cause negative health impacts.

Over 20 years of research into the impact of wind turbines on human health indicates that wind turbines when constructed properly at the permitting authority's approved setback distances do not pose a risk to people's health. In fact, university researchers, government scientists, and medical and public health authorities have published over 100 peer-reviewed scientific studies on health and living in proximity to wind turbines. These studies have investigated the wide range of purported negative health claims with respect to wind turbines including sound, low frequency noise and infrasound, shadow flicker, and electromagnetic field emissions (EMF). Furthermore, independent health experts have conducted comprehensive reviews of the existing research and repeatedly conclude that wind turbines do not pose a threat to public health.

Nonetheless, some community members are concerned that wind turbines may cause adverse health effects to those who live in proximity. Despite the overwhelming amount of data contradicting negative health impacts, opponents of wind energy continue to falsely claim that wind turbine sound, shadow flicker, and EMF harm human health. In fact, misinformation about wind energy is so prevalent that it routinely appears in official correspondence and state and local siting regulations. And the misinformation itself can contribute to harmful impacts through the "nocebo effect", which is the opposite of the placebo effect. It describes a situation where a negative outcome occurs due to a belief that the action will cause harm.

Sound and Health: The Facts

The early spread of misinformation based on anecdotal health concerns and risks of living near wind turbines caused public apprehension and spurred the Massachusetts Department of Public Health in 2012 to convene a committee of expert scientists, engineers, physicians, and public health experts to evaluate the merits of the reported human health effects related to the exposure to sounds from operating wind turbines. The findings of the study were particularly conclusive, stating that there is no evidence for a set of health effects from exposure to wind turbines that can be characterized as "Wind Turbine Syndrome" (WTN).¹

To date, the most comprehensive multi-disciplinary, multi-million-dollar field study (including surveys and objective health measurements as opposed to relying solely on self-reported symptoms) was conducted by Health Canada (the Canadian equivalent of the U.S. Department of Health and Human Services). Health Canada found that self-reported sleep issues,

When in operation, wind turbines emit sound from the rotating blades passing through the air. The dominant sound emitted from wind turbines is often described as a "swishing" or "whooshing" sound. Wind turbines emit sound over a wide frequency range, including low frequency noise and infrasound. While low frequency sound levels may be heard, infrasound near wind turbines does not exceed hearing thresholds, which at these levels, studies show does not cause health issues. In some instances, the mechanical sounds (e.g., cooling fans, generators, and gears that rotate the turbine into the wind) may also be audible, but typically less so than the whooshing sound. Even so, you can have a conversation at normal volume at the base of a wind turbine, and the sound is reduced as you get further from the turbine.

illnesses, and stress were “not found to be associated with WTN exposure.” Health Canada has published a series of peer-reviewed scientific publications over the past eight years consistently concluding that living adjacent to wind turbines does not pose a public health risk.²

Most recently, in April 2022, the Ohio Department of Health (ODH) released a review and summary of the available scientific literature regarding wind turbines and public health between 2004 and 2018. ODH concluded that **“there is no significant body of peer-reviewed, scientific evidence that clearly demonstrates a direct link between adverse physical health effects and exposures to noise (audible, LFN, or infrasound), visual phenomena (shadow flicker), or EMF associated with wind turbine projects.”**^{3,4}

Furthermore, studies show that infrasound from wind turbines does not directly impact the vestibular system. Several recent studies on sleep disturbance have also concluded that there is no compelling evidence supporting the association between wind turbine sound exposure and sleep disturbance.^{5,6,7}

Shadow Flicker and Health: The Facts

Shadow flicker occurs when rotating wind turbine blades pass between the sun and an individual’s home, casting a periodic shadow that may result in a flickering phenomenon. **Numerous health studies have concluded that shadow flicker does not cause negative health impacts to those living in proximity to wind turbines and does not increase risk of seizures in the small percentage of people with photosensitive epilepsy.** Approximately 1.2% of the U.S. population has active epilepsy⁸ and even fewer with epilepsy have photosensitive epilepsy.⁹

The panel of experts commissioned by the Massachusetts Department of Public Health¹⁰ concluded that there is no scientific evidence to suggest that shadow flicker negatively affects human health and that shadow flicker from wind turbines does not pose a seizure risk since shadow flicker from modern commercial wind turbines occurs at “flash” frequencies between 0.3 and 1 Hertz, whereas photosensitive epileptic seizures are triggered by flash frequencies between 5 to 30 Hertz or flashes per second.¹¹ For more information on Shadow Flicker and Wind Turbines, please see ACP’s fact sheet: [Wind Turbines and Shadow Flicker: Facts and Proven Mitigation Strategies](#).



A recent study by the Lawrence Berkeley National Lab reviewed people’s perception of wind turbines and shadow flicker. The study found that only a small portion of the population near turbines experience any shadow flicker and “annoyance to shadow flicker was most strongly correlated with perceptions of wind project aesthetics and general annoyance to other (non-turbine) factors. Shadow flicker exposure was not a significant predictor of shadow flicker annoyance when subjective factors were included.” The conclusions of the study indicate that shadow flicker annoyance is primarily a subjective response to other factors, such as the appearance of wind turbines and the individual’s attitude towards the wind turbines.^{12,13,14}

EMF and Health: The Facts

Public concern over potential health effects from EMF is not new. There is extensive research over multiple decades on EMF and health by the academic community, government health agencies and scientists, and medical agencies. However, despite the wealth of scientific evidence not supporting a causal link between EMF and health issues at the levels of exposure typically encountered by the public, there has been increased concerns raised at public meetings and legal proceedings about exposure to EMF from wind turbines and associated electrical transmission. As with wind turbine sound and health effects, the concerns raised by wind energy opponents are not based on actual measurements of EMF exposure surrounding existing wind energy projects but appear to follow from worries from internet sources and a misunderstanding of the science.¹⁵

A study conducted at a wind project in Ontario Canada measured magnetic fields exposure to nearby homes in proximity to wind turbines, substations, and several buried and overhead collector and transmission lines.¹⁶ The study found that magnetic field levels in the vicinity of wind turbines are lower than levels that people are exposed to on a daily basis in homes, offices and schools, and much lower than exposure people receive from many common household electrical devices, such as televisions, hair dryers, cell phones, laptop computers, or other portable wireless devices. The researchers’ findings are consistent with measurements conducted during a 2011 study at one of the largest wind turbine energy parks in Bulgaria (Israel et al. 2011), which found that EMF levels were four orders of magnitude lower than the levels known to cause harm to human health according to the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guideline.¹⁷

Furthermore, the Ohio Department of Health upon reviewing the peer-reviewed scientific literature published between 2004 and 2019 came to the same conclusion that “information to date does not indicate a public health burden from electromagnetic fields generated by any part of a wind turbine or wind farm.”¹⁸

As noted, there are over 70,000 wind turbines operating across the U.S. and to date, there is no indication that those with pacemakers have been negatively affected.

Conclusion

Wind energy reduces the reliance on traditional, combustion-based electricity generation which in turn provides air-quality, pollution reduction, and greenhouse gas emission benefits. Reducing harmful air pollutants has a beneficial impact on pollution related respiratory illnesses such as asthma, lung cancer, and chronic obstructive pulmonary disease (COPD). Between 2007 and 2015, wind-generated electricity avoided as many as 3,000 to 12,000 premature deaths according to researchers from the Lawrence Berkley National Laboratory,¹⁹ and in 2021, wind energy avoided over 318 million metric tons of carbon (CO₂) emissions, approximately 228 thousand metric tons of nitrogen oxide (NOx) emissions, and approximately 221 thousand metric tons of sulfur oxide (Sox) emissions that leads to air pollution and climate change.

Hundreds of peer-reviewed scientific studies conducted on health effects and wind turbines clearly demonstrate that there is no direct link between adverse physical health effects and exposures to wind turbine sound (audible, low frequency noise, or infrasound), shadow flicker, or EMF associated with wind turbines and associated infrastructure.

For more information or for any questions, please contact Hilary Clark at hclark@cleanpower.org.

-
- 1 Massachusetts Department of Public Health. 2012. Wind Turbine Health Impact Study: Report of Independent Expert Panel. Accessed at: [Final Expert Panel Wind Turbine Report 1 11 2012 \(mass.gov\)](#).
 - 2 Health Canada. 2013 - 2018 -. Wind Turbine Noise and Health Study: Scientific Journal Publications. Accessed at: [Scientific Journal Publications - Canada.ca](#).
 - 3 Health Canada. 2014. Wind Turbine Noise and Health Study: Summary of Results. <https://www.canada.ca/en/health-canada/services/health-risks-safety/radiation/everyday-things-emit-radiation/wind-turbine-noise/wind-turbine-noise-health-study-summary-results.html>.
 - 4 Ohio Department of Health. Wind Turbines and Wind Farms: Summary and Assessments. April 12,2022. Accessed at: [ODH+Wind+Turbines+and+Farms+Summary+Assessment_2022.04.pdf \(ohiodnr.gov\)](#).
 - 5 Michaud, D. S., Keith, S. E., Guay, M., Voicescu, S., Denning, A., & McNamee, J. P. (2021). Sleep actigraphy time-synchronized with wind turbine output. *Sleep*, 44(9), zsab070. Accessed at: <https://doi.org/10.1093/sleep/zsab070>.
 - 6 Tessa Liebich, Leon Lack, Gorica Micic, Kristy Hansen, Branko Zajamšek, Claire Dunbar, Bastien Lechat, Hannah Scott, Nicole Lovato, Felix Decup, Duc Phuc Nguyen, Peter Catcheside, The effect of wind turbine noise on polysomnographically measured and self-reported sleep latency in wind turbine noise naïve participants, *Sleep*, Volume 45, Issue 1, January 2022, zsab283, Accessed at: <https://doi.org/10.1093/sleep/zsab283>.
 - 7 Hübner, G., Pohl, J., Hoen, B., Firestone, J., Rand, J., Elliott, D., & Haac, R. (2019). Monitoring annoyance and stress effects of wind turbines on nearby residents: A comparison of U.S. and European samples. *Environment international*, 132, 105090. Accessed at: <https://doi.org/10.1016/j.envint.2019.105090>.
 - 8 Center for Disease Control and Prevention (CDC). 2020. Epilepsy Data and Statistics. Accessed at: [Epilepsy Data and Statistics | CDC](#).
 - 9 Epilepsy Society. Wind turbines and photosensitive epilepsy. Accessed at: [Wind turbines and photosensitive epilepsy | Epilepsy Society](#)
 - 10 Massachusetts Department of Public Health. 2012.
 - 11 Epilepsy Foundation. [Photosensitivity and Seizures | Epilepsy Foundation](#).
 - 12 Haac, Ryan & Darlow, Ryan & Kaliski, Ken & Rand, Joseph & Hoen, Ben. (2022). In the shadow of wind energy: Predicting community exposure and annoyance to wind turbine shadow flicker in the United States. *Energy Research & Social Science*. 87. Accessed at: <https://doi.org/10.1016/j.erss.2021.102471>.
 - 13 Hoen, Ben, Jeremy Firestone, Joseph Rand, Debi Elliott, Gundula Hübner, Johannes Pohl, Ryan H Wiser, Eric Lantz, Ryan Haac, and Ken Kaliski. "Attitudes of U.S. Wind Turbine Neighbors: Analysis of a Nationwide Survey." *Energy Policy* 134 (2019).
 - 14 Haac, T. R., Kaliski, K., Landis, M., Hoen, B., Rand, J., Firestone, J., Elliott, D., Hübner, G., & Pohl, J. (2019). Wind turbine audibility and noise annoyance in a national U.S. survey: Individual perception and influencing factors. *The Journal of the Acoustical Society of America*, 146(2), 1124. Accessed at: <https://doi.org/10.1121/1.5121309>.
 - 15 McCallum, L. C., Whitfield Aslund, M. L., Knopper, L. D., Ferguson, G. M., & Ollson, C. A. (2014). Measuring electromagnetic fields (EMF) around wind turbines in Canada: is there a human health concern? *Environmental health: a global access science source*, 13(1), 9. Accessed at: <https://doi.org/10.1186/1476-069X-13-9>.
 - 16 Ibid.
 - 17 McCallum et al. 2014 and Ohio Department of Health 2022.
 - 18 Ohio Department of Health, 2022.
 - 19 LBNL. The Health and Environmental Benefits of Wind and Solar Energy in the United States, 2007-2015 - <https://emp.lbl.gov/publications/health-and-environmental-benefits>.