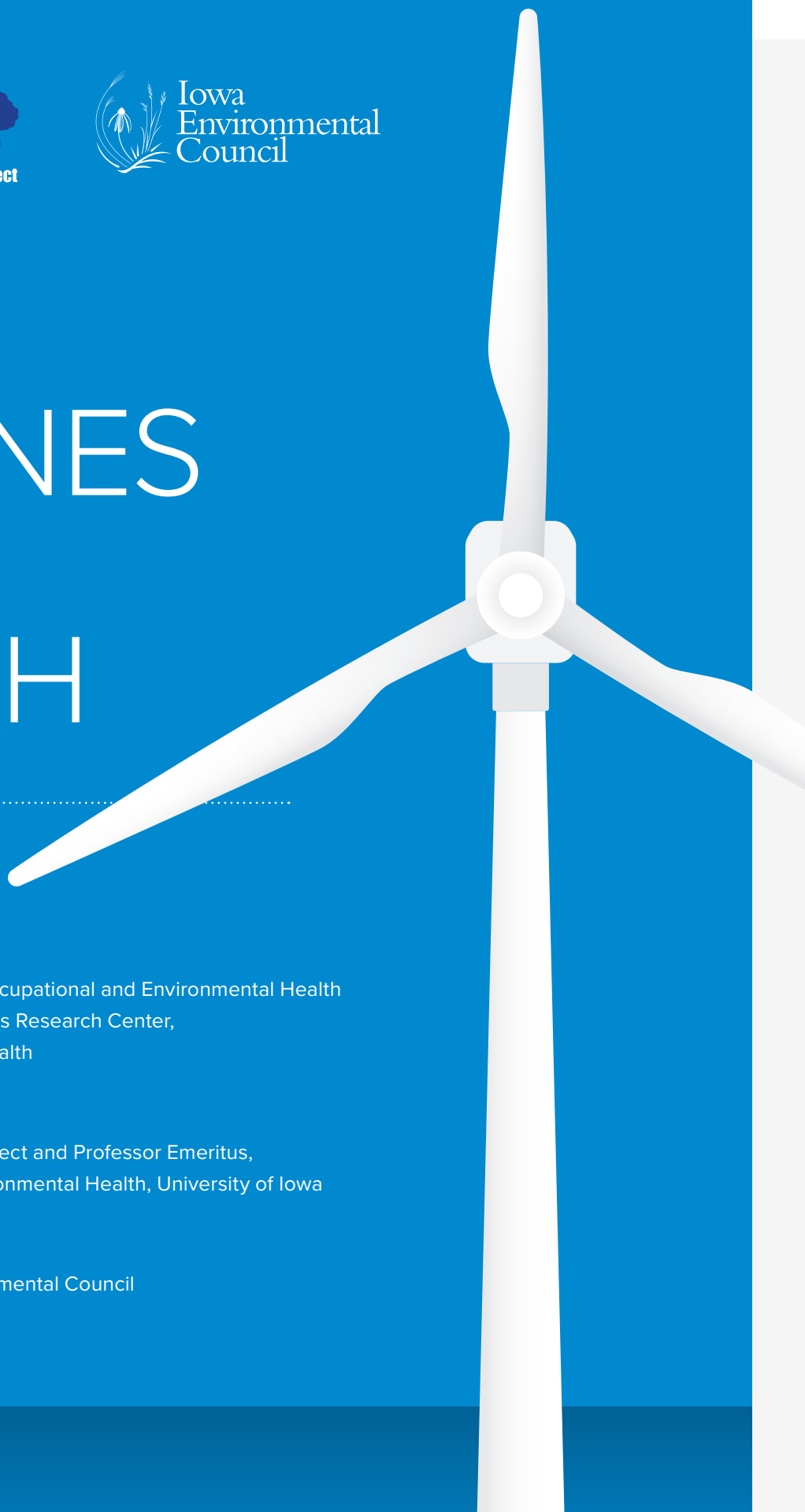




WIND TURBINES AND HEALTH



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INTRODUCTION

Wind produced electricity has made an extraordinary expansion. In just over 20 years, global wind electricity generating capacity has increased almost 100 fold (6,100 megawatts (MWs) in 1996; 539,123 MW in 2017).¹

While Asia, Europe, and North America all contain countries that lead in wind-produced electricity (China, Germany, U.S.), just 10 countries are responsible for more than 80 percent of all production.² Specific states within the United States are responsible for the majority of production. Iowa has 10 times the capacity of neighboring Wisconsinⁱ and five times the capacity of better wind-resourced Nebraska.³

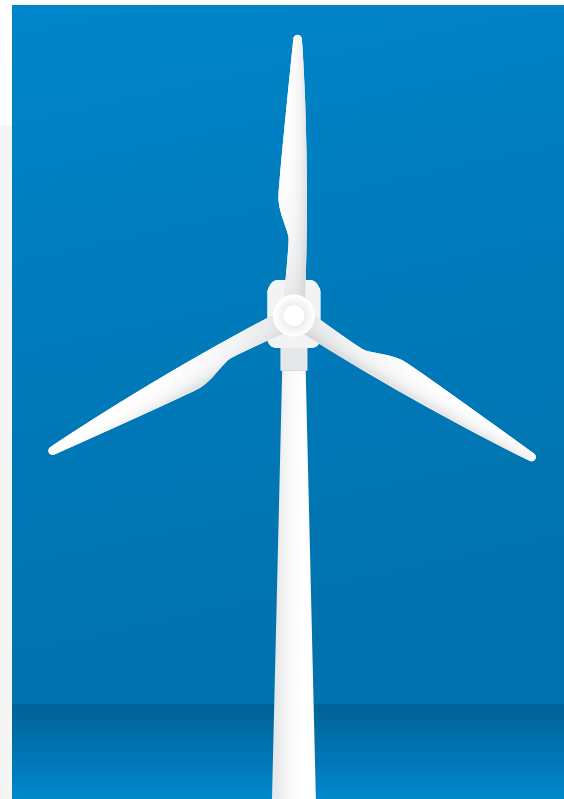
Internationally and within the United States, the availability of renewable resources (e.g., wind, solar, hydro, geothermal), the cost of renewables compared to traditional generating sources, and government policy drive the amount of renewable electricity produced. Citizen support also impacts the development of renewable energy and such support is influenced by public perceptions about the benefits and risks related to wind power, the largest source of new renewable electricity in the U.S.

This joint statement from the Environmental Health Sciences Research Center at the University of Iowa College of Public Health, Iowa Policy Project, and the Iowa Environmental Council summarizes the results of the best research available and concludes that there is little scientific evidence that sound from wind turbines represents a risk to human health among neighboring residents.

HOW TO RESEARCH HEALTH EFFECTS

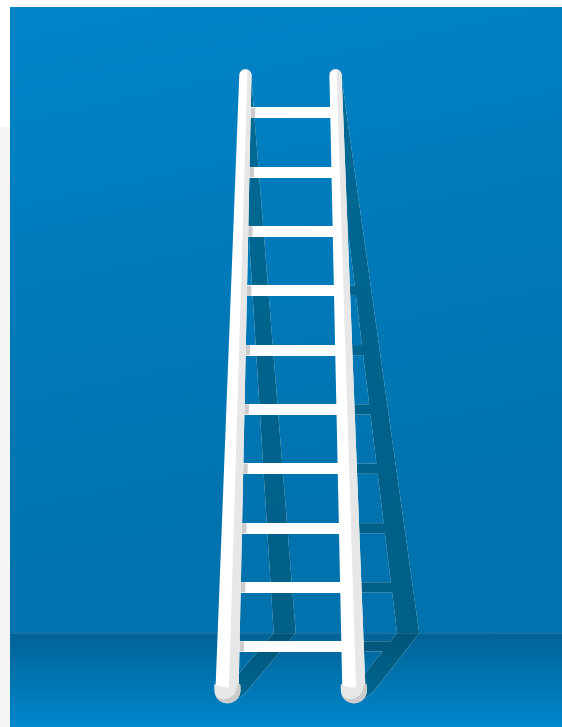
Any new technology often must answer to the various effects its expansion may have on both economics and health. Frequently human and environmental health are treated as external to the economics of decisions regarding power generation. This leads to a discounting of the health impacts of fossil-fuel-based power generation that cause a substantial burden to citizens. Science can answer questions about potential harm from emerging technologies and thus help policy makers make sound decisions. Most will agree that economic progress should not introduce health problems to an area. To find if problems exist with wind electricity production, well-constructed scientific studies, rather than local conversations, should be our guide.

ⁱ Wisconsin in 2017 had 746 MW of wind power capacity while Iowa had 7,312 MW. Wind energy produced 37 percent of Iowa's electricity, while in Wisconsin the amount was just 2.3 percent.



A basic concept from the science of public health requires that a human health risk be a true hazard and that there is exposure to that hazard. As an example, working on a ladder can be hazardous, but first one must climb the ladder. Wind turbines produce sound pressure, but if the frequency is at or below the threshold of human perception and the sound pressure level is low at area residences, there is little or no exposure to cause human health problems.

There have been a modest number of studies of wind turbines and health — some published in peer-reviewed scientific journals with strong reputations, others found on websites or published with no expert review. The source, extent of peer review, and scientific quality must determine the weight scientists and policy makers give to any study.



REPUTABLE REVIEWS OF WIND TURBINE EXPOSURES AND HAZARD POTENTIAL

Two authoritative peer-reviewed, critical reviews have been done on the topic of wind turbines and health.ⁱⁱ Perhaps the most thorough review on the subject was published in 2015 by the Council of Canadian Academies. That organization “is an independent, not-for-profit organization that supports independent, science-based, authoritative expert assessments to inform public policy development in Canada.”⁴ The Council review summarized here was written by an expert panel of nine university professors and an engineering firm CEO and was extensively peer reviewed.

The expert panel started by looking at a wide range of relevant peer-reviewed journal articles, web pages, legal decisions, and the grey literature (non-peer-reviewed publications such as websites) on wind turbine health effects. They compiled a list of 32 symptoms and health conditions referenced in this literature and found that the health effects most commonly blamed on turbine sound include: annoyance, sleep disturbance, and stress-related conditions.⁵ The authors used this list as a starting point to assess whether there are any causal links between exposure to wind turbine noise and health impacts. Next, they reviewed the available literature to evaluate the claims.

ⁱⁱ Critical review articles are articles written by content experts to evaluate the state of the science and weigh the evidence regarding a particular hazard.

The expert panel's evaluation of the scientific evidence regarding various complaints led to the following overall conclusions:

- Current evidence is **sufficient** to establish a causal relationship between a person's exposure to wind turbine noise and feelings of **annoyance**.ⁱⁱⁱ
- Current evidence is **limited** for a causal relationship between exposure to wind turbine noise and **sleep disturbance**.^{iv}
- Current evidence is **inadequate** to determine whether there is a link between exposure to wind turbine noise and **stress or other health outcomes**.^v
- There is **evidence of no causal relationship** between **hearing loss** and exposure to noise at any distance at the sound pressure levels that are associated with wind turbines.^{vi}

While the expert panel found sufficient evidence the wind turbines can cause annoyance, they also noted that current evidence is not sufficient to establish whether the level of annoyance is related to the visual impact of the turbines or other factors such as personal attitudes. Studies completed so far do not measure noise independently from these factors. There is also a lack of data about baseline levels of annoyance without the turbines, the size of the annoyance effect, and how the impact changes in different wind and weather conditions.⁶

There is also a question in the scientific literature about the magnitude of citizen concern and about how that compares to energy production from alternative sources. According to one of the papers evaluated by the expert panel, noise complaints between the years 2007 and 2011 in the Province of Alberta were fewer than complaints about other energy activities such as oil and gas operations.⁷

The second critical review, published in 2014, is by Robert J. McCunney, a professor at the Massachusetts Institute of Technology (MIT) and several others.⁸ The authors state that their work received funding from the Canadian Wind Energy Association but that the funder “did not take part in editorial decisions or reviews of the manuscript.” MIT conducted an independent review of the work and determined there was academic independence and the work was without bias.

This review found no evidence that people residing close to wind turbines experience disease outcomes but did find that some people experienced annoyance with the turbines or turbine noise, similar to the

iii “Sufficient” evidence of a causal relationship means that a relationship was found and that chance, bias, and confounding factors can be ruled out with reasonable confidence.

iv “Limited” evidence of a causal relationship means a causal association was considered by the Panel to be plausible, but that chance, bias, and confounding factors could not be ruled out with reasonable confidence.

v “Inadequate” evidence of a causal relationship means that the available studies lack the quality, consistency, or statistical power to lead to a conclusion about whether a causal relationship exists.

vi “Evidence of no causal relationship” means that several adequate studies covering the full range of exposure consistently show no association between exposure and effect at any level of exposure.

findings in the Council of Canadian Academies review. However, this review also found that the percent of participants expressing annoyance varied across the studies they reviewed.⁹

CONFOUNDING FACTORS

When people experience symptoms of compromised health, yet there is not enough evidence to find more than annoyance and no other health effects, it is reasonable to look for other explanations, including confounding factors. Confounding factors are things that can “muddy” the results of otherwise well-designed scientific studies. One such factor is the “nocebo effect.” Related to the similar-sounding placebo effect, the nocebo effect comes into play, in this case, when people are predisposed to believe they will experience health consequences from wind turbines coming to their area.

Nocebo effects were investigated in both the reputable reviews used in our research. Both the McCunney review and the report of the Council of Canadian Academies cite a paper by Fiona Crichton and colleagues (2014) in the physiology literature.¹⁰ Crichton and her team did not work in the field measuring noise levels but used students to replicate the experience of people living near wind farms. The study looked at infrasound, which is “sub-audible,” or produced in a frequency range below what can be heard by humans. Proponents of negative health effects from wind turbines have often pointed to this sub-audible sound as causing problems.

The study divided 54 university students into two groups who attended a session at the listening room of the Acoustic Research Center at the University of Auckland, NZ. One group was exposed to sub-audible infrasound for 10 minutes. The other group was exposed to silence. All participants then viewed one of two short videos, one describing dangers of infrasound and the other describing benefits of wind power and the lack of health problems. A second 10-minute listening session followed. Those who had seen the provocative video, taken from material readily found on the internet, found that their symptoms and the severity of those symptoms increased, whether or not they were actually subjected to sub-audible infrasound. The conclusion of the Crichton paper should be a suggestion to policy makers deciding on the location of wind farms.

nocebo

[noh-**see**-boh]

noun

A detrimental effect on health produced by psychological or psychosomatic factors such as negative expectations of treatment or prognosis.



“If symptom expectations are at the heart of symptom expression, current proposals to address health concerns, such as increasing minimum set back distances for wind turbines from residences, may do little to alleviate health complaints and related opposition to wind farm development.”¹¹

The Crichton paper led to another by Renzo Tonin and others in Australia 2016.¹² This study was designed to replicate that of Crichton et al. The size of the study was increased to 72 participants. The study first subjected volunteers to one of two films, the first designed to heighten the perception that infrasound is harmful and the second to reduce this perception. They then asked volunteers to listen to acoustic headphones that were either producing real infrasound or no sound at all. For those subjected to infrasound, the sound pressure level and waveform were set to simulate “an environment allegedly causing residents to have experienced severe adverse health effects.”¹³ The investigators found that volunteers who viewed the film designed to heighten the perception that infrasound is harmful generally reported more symptoms and higher intensity of symptoms than those who viewed the film designed to reduce this perception, regardless of whether or not they had actually been exposed to infrasound. Investigators believe that this supports the hypothesis of a nocebo effect and that perception, and no direct physical effect, may influence reported symptoms.

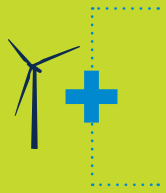
The McCunney review shows economic benefit, or lack of benefit, is another confounding factor for the presence or absence of annoyance. The review found evidence that residents who receive compensation for living near wind turbines are less likely to report adverse health effects than those who live nearby but do not receive economic benefit. Another of the studies notes that receiving benefit is a personal choice and consequently a matter of control over one’s environment.

One of the reviewers of our statement reminded us of a well-known study by Paul Slovic about how people estimate hazard and risk.¹⁴ If people believe that they are not in control of a technology, that it is applied without their consent, and that potential risks are not shared equitably, they might perceive the technology as more of a danger. Slovic categorizes these as “dread factors.” This may help explain the gap in reported impacts between people who are compensated for turbine siting and those who are not.

In addition, if a technology is not fully understood by laypersons or if potential effects are invisible to human perception, a person’s estimate of the hazard may also be elevated. This is termed the “unknown factor.” Technologies that combine both factors, like a wind development, may be seen as more risky and tend to draw opposition from neighbors.

To the extent that these perception factors are at work, increasing the distance of wind farms from residences might do little to reduce annoyance. However, finding ways for residents to have more control over exact location of individual turbines or be compensated for the loss of their former viewscape might have an effect.

The literature on these confounders helps explain the conclusion of an earlier report in a U.S. environmental journal in 2011.¹⁵



“To date, no peer reviewed scientific journal articles demonstrate a causal link between people living in proximity to modern wind turbines, the noise (audible, low frequency noise, or infrasound) they emit and resulting physiological health effects ... ”

The authors further concluded, “Given that annoyance appears to be more strongly related to visual cues and attitude than to noise itself, self-reported health effects of people living near wind turbines are more likely attributed to physical manifestation from an annoyed state than from infrasound. This hypothesis is supported by the peer-reviewed literature pertaining to environmental stressors and health.”¹⁶

CONCLUSION

There is no authoritative evidence that sound from wind turbines represents a risk to human health among neighboring residents. The only causal link that can be identified is that wind turbines may pose an annoyance to some who live near them. However, annoyance is likely influenced by a person’s feelings about the impacts of wind turbines on viewsheds, whether they get an economic benefit from the turbines, whether they have had a say in the siting process, and attitudes about wind power generally.

Given the evidence and confounding factors, and the well-documented negative health and environmental impacts of power produced with fossil fuels, we conclude that development of electricity from wind is a benefit to the environment. We have not seen evidence that wind turbines pose a threat to neighbors. We conclude that wind energy should result in a net positive benefit to human health.

GLOSSARY

Nocebo — a detrimental effect on health produced by psychological or psychosomatic factors such as negative expectations of treatment or prognosis.

Confounding Factor — A confounding factor in a study is a variable which is related to one or more of the variables defined in a study. A confounding factor may mask an actual association or falsely demonstrate an apparent association between the study variables where no real association between them exists. If confounding factors are not measured and considered, bias may result in the conclusion of the study.

Critical Review — Critical review articles are articles written by content experts to evaluate the state of the science and weigh the evidence regarding a particular hazard.

Viewshed — the view of an area from a specific vantage point.

Causal — relating to or acting as a cause.

Infrasound — sound waves with frequencies below the lower limit of human audibility.

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- 1 Global Wind Energy Council. Global statistics 2017. <http://gwec.net/global-figures/graphs/>.
 - 2 Ibid.
 - 3 American Wind Energy Association. Wind Capacity by State. 2017. <https://www.awea.org/wind-101/basics-of-wind-energy/wind-facts-at-a-glance/>.
 - 4 Council of Canadian Academies, 2015. *Understanding the Evidence: Wind Turbine Noise*. Ottawa (ON): The Expert Panel on Wind Turbine Noise and Human Health, Council of Canadian Academies.
 - 5 Ibid. Page 52.
 - 6 Ibid. Page 74.
 - 7 Ibid. Page 59.
 - 8 McCunney, RJ, Mundt, KA, Colby, WD, Dobie, R, Kaliski, K and Blais, M. *Wind Turbines and Health: A Critical Review of the Scientific Literature*. JOEM Vol 56, Number 11, November 2014.
 - 9 Ibid. Page 125. Referencing Thibault, B., Angen, E., & Weis, T. (2013). *Survey of Complaints Received by Relevant Authorities Regarding Operating Wind Energy in Alberta*. Calgary (AB): The Pembina Institute.
 - 10 Crichton, Fiona et al. Can Expectations Produce Symptoms from Infrasound Associated with Wind Turbines? *Health Psychology* 2014. Vol. 33, No. 4, 360-364.
 - 11 Ibid. Page 364.
 - 12 Tonin, Renzo; Brett, James; Colagiuri, Ben. The effect of infrasound and negative expectations to adverse pathological symptoms from wind farms. *Journal of Low Frequency Noise, Vibration and Active Control* 2016, Vol. 35(1) 77–90 (2016).
 - 13 Ibid. Page 79.
 - 14 Slovic, Paul. "Perception of Risk." *Science*, vol. 236, no. 4799, 1987, pp. 280–285. JSTOR, www.jstor.org/stable/1698637.
 - 15 Knopper, LD and Ollson, AC. Health effects and wind turbines: A review of the literature. *Environmental Health* 2011;78. <https://ehjournal.biomedcentral.com/track/pdf/10.1186/1476-069X-10-78>.
 - 16 Ibid. Page 8 of 10.



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