From: Jamin Hübner [redacted]
Sent: Wednesday, June 27, 2018 2:49 PM
To: PUC-PUC <PUC@state.sd.us>
Subject: [EXT]

Greetings,

My name is Dr. Jamin Hubner and I am submitting a bibliography document regarding wind turbines and adverse health effects to be posted on the PUC comments site for Prevailing Winds application EL18-026 .

Jamin Hubner
[redacted]
Rapid City, SD 57701

thanks!
jamin h
--
Dr. Jamin Hübner
Christian Studies Program Director
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ὁ κύριος Ἰησοῦς

A Partial Bibliography of Academic Literature Demonstrating Adverse Health Effects of Industrial Wind Turbines

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Originally compiled in April of 2015

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On Method of Determining Risk of Harm

Studies and Publications Supporting Adverse Health Effects

Publications and Associations covered: *Audiology Today, Noise and Health, Environmental Health, Nature and Society, Environmental Health Perspectives, The Journal of the Acoustical Society in America, The Bulletin of Science, Technology, and Society, Canadian Family Physician, National Health and Medical Research Council, Acoustical Society of America*

On Methodology and the Misleading Demands for Unrealistic Proofs

"The gold standard for proving causality of an exposure is the randomized clinical trial. But when it comes to testing the health effects of noise exposure on humans, such a study design is likely to be not only impractical and difficult to implement, but also unethical. The next-best evidence would come from longitudinal field research…Most of the studies performed to date around both transportation and wind-farm sources have been cross-sectional, which makes it impossible to assess causality. That's because investigators cannot establish whether the potential cause precedes the potential effect." Nate Seltenrich. "Wind Turbines: A Different Kind of Noise?" *Environmental Health Perspectives*. 122:1. A20. 2014. //ehp.niehs.nih.gov/wp-content/uploads/122/1/ehp.122-A20.pdf

"Because cases in a case series study are often self-identifying and population controls are lacking (as in this study), it is difficult to investigate and measure exposure-outcome relationships, and it is impossible to extrapolate results to the general population as selection bias is always a concern. That said, **case reports (or case series) often provide the first indicators in identifying a new disease or adverse health effect from an exposure**." Carmen Krogh. "A Self-reporting Survey: Adverse Health Effects, Industrial Wind Turbines (IWT) and the Need for Vigilance Monitoring." *Bulletin of Science, Technology, and Society*. 31:334. 2011. // bst.sagepub.com/content/31/4/334

"In a search of the literature, no studies were found which come close to replicating the long-term exposures to low level infrasound experienced by those living near wind turbines. So, to date, **there are no published studies showing that such prolonged exposures do not harm humans**." Alec Salt and James Kaltenbach. "Infrasound from Wind Turbines Could Affect Humans." *Bulletin of Science, Technology, and Society.* 31:4:296-302. 2011. //bst.sagepub.com/content/31/4/296

"Large-scale wind turbines are a relatively recent innovation, so the body of peer reviewed research addressing the potential impacts of their unique brand of sound is sparse and particularly unsettled. Anecdotal evidence strongly suggests a connection between turbines and a constellation of symptoms including nausea, vertigo, blurred vision, unsteady movement, and difficulty reading, remembering, and thinking.24 The polarizing issue of wind-turbine noise is often framed one of two ways: Turbines are either harmless, 25 or they tend to have powerful adverse effects, especially for sensitive individuals.26 According to Jim Cummings, Executive director of the nonprofit Acoustic Ecology Institute in Santa Fe, New Mexico, most of the reports to date that have concluded turbines are harmless examined "direct" effects of sound on people and tended to discount "indirect" effects moderated by annoyance, sleep disruption, and associated stress. But **research that considered indirect pathways has yielded evidence strongly suggesting the potential for harm**." Nate Seltenrich. "Wind Turbines: A Different Kind of Noise?" *Environmental Health Perspectives*. 122:1. A20. 2014. //ehp.niehs.nih.gov/wp-content/uploads/122/1/ehp.122-A20.pdf

"**There is overwhelming evidence that wind turbines cause serious health problems in nearby residents, usually stress-disorder-type diseases, at a nontrivial rate**. The bulk of the evidence takes the form of thousands of adverse event reports. There is also a small amount of systematically gathered data. The adverse event reports provide compelling evidence of the seriousness of the problems and of causation in this case because of their volume, the ease of observing exposure and outcome incidence, and case-crossover data. Proponents of turbines have sought to deny these problems by making a collection of contradictory claims including that the evidence does not "count," the outcomes are not "real" diseases, the outcomes are the victims' own fault, and that acoustical models cannot explain why there are health problems so the problems must not exist. These claims appeared to have swayed many nonexpert observers, though they are easily debunked. Moreover, though the failure of models to explain the observed problems does not deny the problems, it does mean that we do not know what, other than kilometers of distance, could sufficiently mitigate the effects. There has been no policy analysis that justifies imposing these effects on local residents. The attempts to deny the evidence cannot be seen as honest scientific disagreement and represent either gross incompetence or intentional bias." Carl Phillips. "Properly Interpreting the Epidemiologic Evidence About the Health Effects of Industrial Wind Turbines on Nearby Residents." *Bulletin of Science, Technology, and Society.* 31:4. 2011. p 303-315. //bst.sagepub.com/content/31/4/303

"Dr. William H. Stewart, the former Surgeon General of the United States, in a keynote talk to a 1969 Conference on Noise as a Public Health Hazard stated the following: "Must we wait until we prove every link in the chain of causation. In protecting health, absolute proof comes late. To wait for it is to invite disaster or to prolong suffering unnecessarily." Arline Bonzaft. "The Noise from Wind Turbines: Potential Adverse Impacts on Children's Well-Being." *Bulletin of Science, Technology and Society.* 31:291. July 20, 2011. //bst.sagepub.com/content/31/4/291

Misguided Methodology in Data Collection of Noise Evaluation

"For wind-turbine noise, the A-weighting scale is especially ill-suited because of its devaluation of the effects of low-frequency noise. This is why it is important to make C-weighted measurements, as well as A-weighted measurements, when considering the impact of sound from wind turbines. Theoretically, linear-scale measurements would seem superior to C-scale measurements in wind turbine applications, but linear-scale measurements lack standardization due to failure on the part of manufacturers of sound-level meters to agree on such factors as low-frequency cutoff and response tolerance limits. The Z-scale, or zero-frequency weighting, was introduced in 2003 by the International Electro-technical Commission (IEC) in its Standard 61672 to replace the flat, or linear, weighting used by manufacturers in the past." Jerry Punch, Richard James, and Dan Pabst. "Wind Turbine Noise: What Audiologists Should Know." *Audiology Today*. July-August 2010. P 27.
//windturbinesyndrome.com/img/WindTurbineNoise.pdf

"A-weighting corrects sound measurements according to human hearing sensitivity (based on the 40 phon sensitivity curve). The result is that low frequency sound components are dramatically de-emphasized in the measurement, based on the rationale that these components are less easily heard by humans. An example showing the effect of A weighting the turbine sound spectrum data of Van den Berg (2006) is shown in Figure 4. The low frequency components of the original spectrum, which resulted in a peak level of 93 dB SPL at 1 Hz, are removed by A-weighting, leaving a spectrum with a peak level of 42 dBA near 1 kHz. A-weighting is perfectly acceptable if hearing the sound is the important factor. A problem arises though when A-weighted measurements or spectra are used to assess whether the wind turbine sound affects the ear. **We have shown above that some components of the inner ear, specifically the OHC, are far more sensitive to low frequency sounds than is hearing. Therefore, A-weighted sounds do not give a valid representation of whether wind turbine noise affects the ear or other aspects of human physiology mediated by the OHC and unrelated to hearing**." Alec Salt and James Kaltenbach. "Infrasound from Wind Turbines Could Affect Humans." *Bulletin of Science, Technology, and Society.* 31:4:296-302. 2011. //bst.sagepub.com/content/31/4/296

The Need for More Scientific Study to Ensure Safety of Wind Turbines

"Assessing the effects of wind turbines on human health is an emerging field and conducting further research into the effects of wind turbines (and environmental changes) on human health, emotional and physical, is warranted." Loren Knopper and Christopher Ollson. "Health effects and wind turbines: A review of the literature." *Environmental Health*. 2011. 10:78. //ehjournal.net/content/10/1/78

"Results of this study suggest an underlying relationship between [Industrial Wind Turbines] and adverse health effects and support the need for additional studies." Carmen Krogh. "A Self-reporting Survey: Adverse Health Effects, Industrial Wind Turbines (IWT) and the Need for Vigilance Monitoring." *Bulletin of Science, Technology, and Society*. 31:334. 2011. P 15-16. //bst.sagepub.com/content/31/4/334

"Further research is needed to determine at what distances risks become negligible, as well as to better estimate the portion of the population suffering from adverse effects at a given distance." Michael Nissenbaum, Jeffrey Armanini, Christopher Hanning. "Effects of industrial wind turbine noise on sleep and health." *Noise and Health*. 14:60. 2012. P 237-243.

"…it seems obvious to me that there is a **very urgent need to study disease rates and death rates in the areas near wind farms and in controlled areas more than 10 km away**. There is also an urgent need to organise clinical and epidemiological studies to seek further evidence of the diseases and pathology described in the studies of industrial Vibro Acoustic Disease. There is similarly a very urgent need for veterinarians and ecologists to follow up the reports from farmers all around the world of abnormalities in farm animals near current large wind turbines, as with chickens that are hatching with crossed beaks and other abnormalities, and stock of

many types being born with unusual abnormalities. Above all I feel that there is an **urgent need to study the epidemiology of organisms that live in the soil and water around wind farms**. These organisms are known to communicate by low frequency vibration. All of this must be correlated with precise measurements of noise and vibration associated with wind turbine operation. Such measurements must be made on the turbine towers, on surrounding soils and on surrounding buildings out to at least 10 km." Max Whisson. "Wind Power and Ecology." *Nature and Society.* November-October 2011. //docs.wind-watch.org/Nature-Society-Nov-2011.pdf

General Health Problems (headache, dizziness, stress, sleep) **and Recommendations for Setbacks**

"We report a cross-sectional study comparing the health-related quality of life (HRQOL) of individuals residing in the proximity of a wind farm to those residing in a demographically matched area sufficiently displaced from wind turbines. The study employed a nonequivalent comparison group posttest-only design. Self-administered questionnaires, which included the brief version of the World Health Organization quality of life scale, were delivered to residents in two adjacent areas in semirural New Zealand. Participants were also asked to identify annoying noises, indicate their degree of noise sensitivity, and rate amenity. Statistically significant differences were noted in some HRQOL domain scores, with residents living within 2 km of a turbine installation reporting lower overall quality of life, physical quality of life, and environmental quality of life. **Those exposed to turbine noise also reported significantly lower sleep quality, and rated their environment as less restful. Our data suggest that wind farm noise can negatively impact facets of HRQOL**." Daniel Shepherd, David McBride, David Welch, Erin Hill. "Evaluating the impact of wind turbine noise on health-related quality of life." *Noise and Health*. 13:54. 2011. P 333-339. //noiseandhealth.org/text.asp?2011/13/54/333/85502

"**Industrial wind turbines can harm human health if sited too close to residents. Harm can be avoided if IWTs are situated at an appropriate distance from humans**. Owing to the lack of adequately protective siting guidelines, people exposed to IWTs can be expected to present to their family physicians in increasing numbers. The documented symptoms are usually stress disorder–type diseases acting via indirect pathways and can represent serious harm to human health." Roy Jeffrey, Carmen Krogh, Brett Horner. "Adverse Health Effects of Industrial Wind Turbines." *Canadian Family Physician*. 59:5. 2013. //ncbi.nlm.nih.gov/pmc/articles/PMC3653647/

"**Industrial wind turbine noise is a further source of environmental noise, with the potential to harm human health. Current regulations seem to be insufficient to adequately protect the human population living close to IWTs. Our research suggests that adverse effects are observed at distances <u>even beyond 1 km</u>**." Michael Nissenbaum, Jeffrey Armanini, Christopher

Hanning. "Effects of industrial wind turbine noise on sleep and health." *Noise and Health*. 14:60. 2012. P 237-243. //noiseandhealth.org/text.asp?2012/14/60/237/102961

Cf. Amanda Harry. "Wind Turbines, Noise and Health." 2007. Unpublished Study. //windturbinesyndrome.com/wp-content/uploads/2012/11/Amanda-Harry-Wind-Turbines-Noise-and-Health-2007.pdf

Vibro-Acoustic Disease

"…some researchers are referring to these effects as Vibroacoustic Disease, or VAD (Castelo Branco, 1999; Castelo Branco and AlvesPereira, 2004). VAD is described as occurring in persons who are exposed to high-level (>90 dB SPL) infra- and **low-frequency noise (ILFN), under 500 Hz, for periods of 10 years or more. It is believed to be a systemic pathology characterized by direct tissue damage to a variety of bodily organs and may involve abnormal proliferation of extracellular matrices**." Jerry Punch, Richard James, and Dan Pabst. "Wind Turbine Noise: What Audiologists Should Know." *Audiology Today*. July-August 2010. P 24. //windturbinesyndrome.com/img/WindTurbineNoise.pdf

"Much of what has been discovered over the last three decades is reported by Mariana Alves-Pereira and Nuno Castelo Branco of Portugal. **These extensive studies report numerous serious illnesses and, yes, many deaths, mainly from unusual cancers. A particularly characteristic finding is a thickening of the fibrous sheath surrounding the heart, the pericardium. Diseases such as type I diabetes and epilepsy developing late in life were also found and unusual malignant tumours were seen in the lungs, colon and brain.** Rage attacks occurred in some individuals and sudden attacks of nonconvulsive mental defects were seen. These illnesses were caused by low frequency vibrations and developed slowly over many years, with deaths usually occurring after five years of exposure. The low frequency induced disease complex is called Vibro Acoustic Disease, or VAD and is thought to be the result of disruption of the fine fibres that connect the cells of the body. This disease complex is not yet widely recognised clinically or legally and this has seriously delayed diagnosis. Detailed experimental studies of VAD pathology have been reported. A characteristic finding is the production of excess collagen in the absence of an inflammatory response. This results in the thickening of blood vessel walls and abnormal gas flow in the lungs. Other findings in the experimental studies were unusual cell death without the usual cell suicide mechanism of apoptosis." Max Whisson. "Wind Power and Ecology." *Nature and Society.* November-October 2011. //docs.wind-watch.org/Nature-Society-Nov-2011.pdf

Sleeping Complications

"**At high levels of wind turbine sound (more than 45 dBA) interruption of sleep was more likely than at low levels**. Higher levels of background sound from road traffic also increased the odds for interrupted sleep. **Annoyance from wind turbine sound was related to difficulties with falling asleep and to higher stress scores**." E. Pederson, et. al.

"WINDFARMperception: Visual and acoustic impact of wind turbine farms on residents." University of Gothenburg. 2008. P 4. //docs.wind-watch.org/wfp-final-1.pdf

"…it is acknowledged that noise from wind turbines can be annoying to some and associated with **some reported health effects (e.g., sleep disturbance), especially when found at sound pressure levels greater than 40 db(A)…"** Loren Knopper and Christopher Ollson. "Health effects and wind turbines: A review of the literature." *Environmental Health*. 10:78. 2011. ehjournal.net/content/10/1/78

"In total, **seventy two percent of participants reported either increased symptoms of anxiety, stress, or depression since the start of their local wind project (Table 1)… Among study participants, the most common adverse health outcomes reported included sleep disturbance, excessive tiredness, and headaches.**" Carmen Krogh. "A Self-reporting Survey: Adverse Health Effects, Industrial Wind Turbines (IWT) and the Need for Vigilance Monitoring." *Bulletin of Science, Technology, and Society*. 31:334. 2011. P 14. //bst.sagepub.com/content/31/4/334

"**Exposure to wind turbines does seem to increase the risk of annoyance and self-reported sleep disturbance in a dose-response relationship**." Jesper Schmidt and Mads Klokker. "Health Effects Related to Wind Turbine Noise Exposure: A Systematic Review." *PLoS One*. 2014; 9(12). //ncbi.nlm.nih.gov/pmc/articles/PMC4256253/

"**We conclude that the noise emissions of IWTs disturbed the sleep and caused daytime sleepiness and impaired mental health in residents living within 1.4 km of the two IWT installations studied**." Michael Nissenbaum, Jeffrey Armanini, Christopher Hanning. "Effects of industrial wind turbine noise on sleep and health." *Noise and Health*. 14:60. 2012. P 237-243.

General Noise Concerns

"From this and previous studies it appears that sound from wind turbines is relatively annoying: at **the same sound level it causes more annoyance than sound from air or road traffic. A swishing character is observed by three out of four respondents that can hear the sound and could be one of the factors explaining the annoyance. Sound is therefore an important and negative feature of wind farms and we recommend that, in the planning of wind farms, the negative impact of the sound and sound reduction should be given more attention**." Petersen, Eja, et. al. "WINDFARMperception: Visual and acoustic impact of wind turbine farms on residents." University of Gothenburg. 2008. P 5, cf. section 8.1 //docs.wind-watch.org/wfp-final-1.pdf

"**Six studies assessed the association of annoyance with exposure to estimated wind farm or proximity to a wind farm. The studies all reported an association between annoyance and higher estimated levels of wind farm noise or living closer to a wind farm**." Australian *National Health and Medical Research Council*. "Information Paper: Evidence on Wind Farms and Human Health." February, 2015. P 18.

"**Wind turbines are noisy and cause annoyance in about 20% of residents living within a distance considered acceptable by regulatory authorities. For many of this 20% the annoyance and sleep disturbance leads on to adverse health effects**. This is a far larger proportion than for those living with traffic and industrial noise at the same level. The annoyance and adverse health effects are attributable to the character of turbine noise and to deficiencies in noise regulations." John Harrison. "Wind Turbine Noise." *Bulletin of Science, Technology, and Society*. 31:256. 2011. P 12. //bst.sagepub.com/content/31/4/256

Low-frequency/InfraSound Concerns in General

"…the effects of low frequency noise among 439 employees working in offices, laboratories, and industries were also evaluated in another study. **It was shown that there was a relationship between fatigue and tiredness after work and increasing low frequency noise**. There were no employees that were exposed to low frequency noise with C-A differences greater than 20 dB (Schust M. 2004; Tesarz M. et al. 1997). Ising et al. conducted a study that examined the effect of low frequency nighttime traffic noise by measuring saliva cortisol concentrations in children. Based on a previous study, the authors stated that the full spectrum of truck noise in the children's bedroom was at a maximum of 100 Hz (Ising H. et al. 2004; Ising H. and Kruppa B. 2004). It was found that the children under high noise exposure (8h = 54-70dB(A)) had a significantly increased morning saliva cortisol concentration compared to a control population, which indicated an activation of the hypothalamus-pituitary-adrenal (HPA) axis (Ising H. et al. 2004). This endocrine change was found to be an indication of restless sleep and a further aggravation of bronchitis in the children. Finally, in 2000, a multidisciplinary group of clinicians and researchers called the Study Group on Neonatal Intensive Care Unit (NICU) Sound and the Expert Panel gathered and reviewed over 50 studies on the effects of sound on the fetus, newborn, and preterm infants. Upon the completion of review, the panel recommended that women should avoid prolonged exposure to low frequency sound levels (< 250 Hz) above 65 dB(A) during pregnancy (Graven SN. 2000). This recommendation was based on research that was conducted on sheep fetuses, which determined that after sustained periods of intense low frequency sound, the fetuses experienced injury to the hair cells of cochlea (Graven SN. 2000)" Roberts, Mark. Et. Al. "Evaluation of the Scientific Literature on the Health Effects Associated with Wind Turbines and Low Frequency Sound." Prepared for Wisconsin Public Service Commission. 2009. P 35-36. //maine.gov/dhhs/mecdc/environmental-health/documents/wind-turbine-wisconsin-assessment.pdf

Inaudible Sound (Infra Sound) Problems and Amplitude Modulation

"**Our research has suggested a number of mechanisms by which low-frequency noise could bother individuals living near wind turbines: causing endolymphatic hydrops, exciting subconscious pathways, and amplitude modulation of audible sounds**. Here we focus on the latter mechanism, amplitude modulation… **Our results suggest that that infrasound generated by wind turbines may cause amplitude modulation of audible sounds**, which is often the

basis for complaints from those living near wind turbines." Lichtenhan, Jeffry, and Alec Salt. "Amplitude modulation of audible sounds by non-audible sounds." *Proceedings of Meetings on Acoustics*. Published by Acoustical Society of America. Vol 19. 2014. //oto2.wustl.edu/cochlea/LichtenhanAMASA.pdf

"Studies carried out in Denmark, The Netherlands, and Germany (Wolsink and Sprengers, 1993; Wolsink et al, 1993), a Danish study (Pedersen and Nielsen, 1994), and two Swedish studies (Pedersen and Persson Waye, 2004, 2007) collectively indicate that wind turbines differ from other sources of community noise in several respects. **These investigators confirm the findings of earlier research that amplitude-modulated sound is more easily perceived and more annoying than constant-level sounds** (Bradley, 1994; Bengtsson et al, 2004) and that sounds that are unpredictable and uncontrollable are more annoying than other sounds (Geen and McCown, 1984; Hatfield et al, 2002)." Punch, Jerry, Richard James, and Dan Pabst. "Wind Turbine Noise: What Audiologists Should Know." *Audiology Today*. July-August 2010. P 23. // windturbinesyndrome.com/img/WindTurbineNoise.pdf

"…given the amplitude modulation, the allowed intrusion above ambient is far too high; there is no account taken of uncertainty in the prediction of noise at a home; there is no account taken for the excess noise caused by turbulent inflow, both natural and up-wind turbine wake; and **the lack of compliance testing leaves the adverse health effects to compound from one completed wind farm to the next one being designed**." John Harrison. "Wind Turbine Noise." *Bulletin of Science, Technology, and Society.* 31:256. 2011. P 12. //bst.sagepub.com/content/31/4/256

How Low-Frequency Noise Directly Affects the Human Ear

"Todd et al (2008) demonstrated that the resonant frequency of the human vestibular system is 100 Hz, concluding that the mechano-receptive hair cells of the vestibular structures of the inner ear are remarkably sensitive to low-frequency vibration and that this sensitivity to vibration exceeds that of the cochlea. **Not only is 100 Hz the frequency of the peak response of the vestibular system to vibration, but it is also a frequency at which a substantial amount of acoustic energy is produced by wind turbines**." Jerry Punch, Richard James, and Dan Pabst. "Wind Turbine Noise: What Audiologists Should Know." *Audiology Today*. July-August 2010. P 25. //windturbinesyndrome.com/img/WindTurbineNoise.pdf

"Measurements made within the endolymphatic system of the cochlea show responses that become larger, relative to measurements made in perilymph, as frequency is lowered. This suggests that endolymphatic responses to infrasound are enhanced in some manner. For high-frequency sounds, acoustic stimuli in the ear are summed. In contrast, the inner ear's responses to infrasound are suppressed by the presence of higher frequency stimuli. **The complexity of the ear's response to infrasound leads us to the conclusion that there are many aspects that need to be better understood before the influence of wind turbine noise on the ear can be dismissed as significant**." Alec Salt, and Jeffery Lichtenhan. "Responses of the Inner Ear to

Infrasound." Fourth International Meeting on Wind Turbine Noise." Rome, Italy. April 2011. // oto2.wustl.edu/cochlea/saltlichtenhan.pdf

"Anatomic studies show that the sensory hairs of the OHC are attached to the overlying tectorial membrane and electrical measurements from these cells show their responses depend on the displacement, rather than the velocity of the organ of Corti. As a result, their responses do not decline to the same degree as IHC as frequency is lowered. Their calculated sensitivity is shown as the "OHC sensitivity" curve in Figure 3. It is important to note that the difference between IHC and OHC responses has nothing to do with frequency-dependent effects of the middle ear or of the helicotrema (the other two of the three components mentioned above). For example, any attenuation of low frequency stimuli provided by the helicotrema will equally affect both the IHC and the OHC. So the difference in sensitivity shown in Figure 3 arises purely from the difference in how the sensory hairs of the IHC and OHC are coupled to the overlying tectorial membrane. The important consequence of this physiological difference between the IHC and the OHC is that the OHC are stimulated at much lower levels than the IHC. In Figure 3, the portion of the wind turbine sound spectrum within the shaded region represents frequencies and levels that are too low to be heard, but which are sufficient to stimulate the OHC of the ear. This is not confined to infrasonic frequencies (below 20 Hz), but in this example includes sounds over the range from 5 Hz to 50 Hz. **It is apparent that the concept that "sounds you can't hear cannot affect you" cannot be correct because it does not recognize these well-documented physiologic properties of the sensory cells of the inner ear. Stimulation of OHC at inaudible, low levels can have potentially numerous consequences…**" Alec Salt and James Kaltenbach. " Infrasound from Wind Turbines Could Affect Humans." *Bulletin of Science, Technology, and Society.* 31:4:296-302. 2011. //bst.sagepub.com/content/31/4/296

Low-Frequency Noise/Infrasound and Wind Turbines

"…**there is increasingly clear evidence that audible and low-frequency acoustic energy from these turbines is sufficiently intense to cause extreme annoyance and inability to sleep, or disturbed sleep, in individuals living near them**. Jung and colleagues (2008), in a Korean study, concluded that low-frequency noise in the frequency range above 30 Hz can lead to psychological complaints and that infrasound in the frequency range of 5–8 Hz can cause complaints due to rattling doors and windows in homes." Jerry Punch, Richard James, and Dan Pabst. "Wind Turbine Noise: What Audiologists Should Know." *Audiology Today*. July-August 2010. P 24. //windturbinesyndrome.com/img/WindTurbineNoise.pdf

"…**there are now numerous reports (e.g. Pierpont 2009; Punch et al, 2010) discussed extensively in this journal that are highly suggestive that individuals living near wind turbines are made ill,** with a 10 plethora of symptoms which commonly include chronic sleep disturbance. The fact that such reports are being dismissed on the grounds that the level of infrasound produced by wind turbines is at too low a level to be heard appears to totally ignore

the known physiology of the ear. Pathways from the OHC to the brain exist by which infrasound that cannot be consciously perceived could influence other subconscious functions." Alec Salt and James Kaltenbach. " Infrasound from Wind Turbines Could Affect Humans." *Bulletin of Science, Technology, and Society.* 31:4:296-302. 2011. //bst.sagepub.com/content/31/4/296

"Our present understanding of inner ear physiology and of the nature of wind turbine sounds demonstrates that low level infrasound produced by wind turbines can be transduced by the 9 OHC of the ear and this information transmitted to the cochlear nucleus of the brain via type II afferent fibers. We therefore conclude that **statements such as "there is no significant infrasound from current designs of wind turbines" are undoubtedly false.** The fact that infrasound dependent information, at levels that are not consciously heard, is present at the level of the brainstem provides a scientific basis for the possibility that such sounds can have influence on people. The possibility that low frequency components of the sound could contribute both to high annoyance levels and to other problems that people report as a result of exposure to wind turbine noise cannot therefore be dismissed out of hand." Alec Salt and James Kaltenbach. "Infrasound from Wind Turbines Could Affect Humans." *Bulletin of Science, Technology, and Society.* 31:4:296-302. 2011. //bst.sagepub.com/content/31/4/296

"**In conclusion, wind turbines must not be sited less than 5 km (3.1 miles) from all habitation, because of the risks produced by infrasound**." A translated summary of the French study by Marjolaine Villey-Migraine. "EFFETS DE L'EOLIEN INDUSTRIEL SUR LA SANTE DES HOMMES." Université Paris II-Panthéon-Assas. 2004. //waubrafoundation.org.au/wp-content/uploads/2015/01/villey-migraine_eoliennesinfrasons.pdf

How Infra-Sound is Worse in Larger Turbines

"**The relative amount of low-frequency noise is higher for large turbines (2.3–3.6 MW) than for small turbines (≤ 2 MW), and the difference is statistically significant**. The difference can also be expressed as a downward shift of the spectrum of approximately one-third of an octave. A further shift of similar size is suggested for future turbines in the 10-MW range. Due to the air absorption, the higher low-frequency content becomes even more pronounced, when sound pressure levels in relevant neighbor distances are considered." Pedersen, C., and Henrich Moller. *Journal of Acoustical Society in America*. 129:3727. 2011.

"**The increased size of these multi-MWatt turbines, especially the blades, has been associated with complaints of adverse health effects (AHEs) that cannot be explained by auditory responses alone**." Punch, Jerry, Richard James, and Dan Pabst. "Wind Turbine Noise: What Audiologists Should Know." *Audiology Today*. July-August 2010. P 26. //windturbinesyndrome.com/img/WindTurbineNoise.pdf

Visual Pollution and Shadow Flicker

"Visibility of wind turbines enhances their potential to cause noise annoyance." Petersen, Eja, et. al. "WINDFARMperception: Visual and acoustic impact of wind turbine farms on residents." University of Gothenburg. 2008. P 5. //docs.wind-watch.org/wfp-final-1.pdf

"People exposed for short periods to simulated wind turbine shadow flicker in a laboratory have shown some evidence of impaired cognition and a physiological stress response.50" Australian *National Health and Medical Research Council*. "Information Paper: Evidence on Wind Farms and Human Health. February, 2015. P 23.

Attempted Denials and Their Political Context

Summary: Pro-wind associations (e.g., Canadian and American Wind Energy Association) hire experts to review the literature and summarize it in a way so as to downplay (or completely deny) all of the above health effects of wind turbines.

Case Study 1: "In particular, the panel considered "wind turbine syndrome" and vibroacoustic disease, which have been claimed as causes of adverse health effects. The evidence indicates that "wind turbine syndrome" is based on misinterpretation of physiologic data and that the features of the so-called syndrome are merely a subset of annoyance reactions. The evidence for vibroacoustic disease (tissue inflammation and fibrosis associated with sound exposure) is extremely dubious at levels of sound associated with wind turbines." W. David Colby, Robert Dobie, Robert McCunney, et. al. "Wind Turbine Sound and Health Effects, An Expert Panel Review 2009, Prepared for American Wind Energy Association and Canadian Wind Energy Association. //canwea.ca/pdf/talkwind/Wind_Turbine_Sound_and_Health_Effects.pdf

Case Study 2: "(1) Infrasound sound near wind turbines does not exceed audibility thresholds. (2) Epidemiological studies have shown associations between living near wind turbines and annoyance. (3) Infrasound and low-frequency sound do not present unique health risks. (4) Annoyance seems more strongly related to individual characteristics than noise from turbines." W. David Colby, Robert Dobie, Robert McCunney, et. al. "Wind Turbines and Health: A Critical Review of the Scientific Literature." *Journal of Occupational and Environmental Medicine*. 56:11. 2014.
//motiva.fi/files/9664/Wind_Turbines_and_Health_A_Critical_Review_of_the_Scientific_Literature.pdf

Unsurprisingly, a wind energy advocate and associate (Ivan Pineda) responded to the above study by saying, "These results should lay to rest any concerns that some citizens may have with regard to living near wind turbines."

The Inefficacy of These Denials

"**The dismissal of the adverse effects of noise on residents living with wind turbine noise has largely come from the wind power industry who have supported this claim with reports by acousticians, doctors and engineers whom they have hired to write on the noise/health relationship**." Arline Bonzaft. "The Noise from Wind Turbines: Potential Adverse Impacts on Children's Well-Being." *Bulletin of Science, Technology, and Society.* 31:291. July 20, 2011. //bst.sagepub.com/content/31/4/291

"In a New York Times article (Zeller, October 6, 2010), Mr. Zeller gives voice to residents who have had their quality of life diminished by nearby wind turbines, but then adds that: "For the most extreme claims, there is little independent backing." Unfortunately, the only studies he cites are those from American Wind Energy Association, a trade group, and its Canadian counterpart, which concluded that "there is no evidence that the audible and sub-audible sounds emitted by wind turbines have a direct adverse physiological effects." Arline Bonzaft. "The Noise from Wind Turbines: Potential Adverse Impacts on Children's Well-Being." *Bulletin of Science, Technology, and Society.* 31:291. July 20, 2011. //bst.sagepub.com/content/31/4/291

"Much of the answer as to why the wind industry denies that noise is a serious problem with its wind turbines is because holding the noise to 30 dBA at night has serious economic consequences. The following quotation by Upton Sinclair seems relevant here: "It is difficult to get a man to understand something when his salary depends upon his not understanding it" (Sinclair, 1935,reprinted 1994, p. 109). In recent years, the wind industry has denied the validity of any noise complaints by people who live near its utility-scale wind turbines. Residents who are leasing their properties for the siting of turbines are generally so pleased to receive the lease payments that they seldom complain. In fact, **they normally are required to sign a leasing agreement, or gag clause, stating they will not speak or write anything unfavorable about the turbines. Consequently, complaints, and sometimes lawsuits, tend to be initiated by individuals who live near property on which wind turbines are sited, and not by those who are leasing their own property**. This situation pits neighbor against neighbor, which leads to antagonistic divisions within communities." Punch, Jerry, Richard James, and Dan Pabst. "Wind Turbine Noise: What Audiologists Should Know." *Audiology Today*. July-August 2010. P 26. //windturbinesyndrome.com/img/WindTurbineNoise.pdf

"The contrasting position from the wind industry and its advocates (including many people supporting renewable energy) is that there isn't an issue concerning noise and vibration. The parallel with a sound akin to that of a refrigerator is made, for example. Consider the comments to the Senate committee (submission no. 204) from Dr Mark Diesendorf, Deputy Director of the Institute of Environmental Studies, University of New South Wales: cNoise is rarely a problem beyond a distance of 500m and very few dwellings in Australia are within 400m of a large wind turbine. Licence conditions for wind farms should, and mostly do, set objective, measurable noise limitsd. Similarly, a National Health and Medical Research Council (NHMRC) Rapid

Review of the evidence in July 2010 acknowledged that while a range of effects such as annoyance, anxiety, hearing loss, and interference with sleep, speech and learning have been reported anecdotally, there is no published scientific evidence to support adverse effects of wind turbines on health. However, there are good grounds for questioning the above. An NHMRC Scientific Forum on Wind Farms and Human Health held in June 2011 (a year after its Rapid Review) had four presentations from those regarded as experts in the area. Of significance is the wide divergence in the assessments presented. Those challenging the wind industry position included Dr Bob Thorne, whose expertise is in noise assessment and monitoring. In contrast to the wind industry position that there are no adverse impacts on people from wind farms, Dr Thorne stated that there is already peer-reviewed research on the deleterious effects of wind farm noise on people. Complaint histories to regulatory authorities are another form of evidence. For example, in the period April 2009 to March 2010, 906 complaints were made to Wellington City Council, New Zealand concerning the noise from the wind farm at Makara. The Te Rere Hau wind farm in New Zealand recorded 378 complaints over an 11-month period, and is the subject of a legal review of its compliance (Thorne, 2011)." Murray May. "Wind Power Controversy." *Nature and Society*. November-October, 2011. //docs.wind-watch.org/Nature-Society-Nov-2011.pdf

"**Proponents of turbines have sought to deny these problems by making a collection of contradictory claims including that the evidence does not "count," the outcomes are not "real" diseases, the outcomes are the victims' own fault, and that acoustical models cannot explain why there are health problems so the problems must not exist. These claims appeared to have swayed many nonexpert observers, though they are easily debunked**. Moreover, though the failure of models to explain the observed problems does not deny the problems, it does mean that we do not know what, other than kilometers of distance, could sufficiently mitigate the effects. There has been no policy analysis that justifies imposing these effects on local residents. The attempts to deny the evidence cannot be seen as honest scientific disagreement and represent either gross incompetence or intentional bias." Carl Phillips. "Properly Interpreting the Epidemiologic Evidence About the Health Effects of Industrial Wind Turbines on Nearby Residents." *Bulletin of Science, Technology, and Society.* 31:4. 3022. p 303-315. //bst.sagepub.com/content/31/4/303

Arguments that Claims of Adverse Health Affects are Actually Only "In Your Head"

"Where noise problems are acknowledged, some academics such as Professors Simon Chapman at the University of Sydney and Keith Petrie at the University of Auckland subscribe to the mass hysteria ideas promoted by controversial British psychiatrist Simon Wessely. Such assessments primarily implicate people's fears and anxieties about new technologies to explain noise complaints and sleeping difficulties that appear in conjunction with wind farm developments. [I am not persuaded by such arguments, given the seriousness of some of the adverse health effects observed.]" Murray May. "Wind Power Controversy." *Nature and Society*. November-October, 2011. //docs.wind-watch.org/Nature-Society-Nov-2011.pdf

"Symptom expectations were created by viewing information readily available on the Internet, indicating the potential for symptom expectations to be created outside of the laboratory, in real world settings. Results suggest psychological expectations could explain the link between wind turbine exposure and health complaints." Crichton, Fiona; Dodd, George; Schmid, Gian; Gamble, Greg; Petrie, Keith. "Can expectations produce symptoms from infrasound associated with wind turbines?" *J. Health Psychology*. 33:4, Apr 2014, 360-364. //psycnet.apa.org/?&fa=main.doiLanding&doi=10.1037/a0031760

Responses to the "It's Just in Your Head" Excuse

"The turbine nocebo effect gained currency worldwide following the March 2013 release of two Australian reports claiming to offer evidence that people who expect adverse effects of turbines—in part as a result of activism by groups such as Australia's Waubra Foundation—are more likely to report having them. In Cummings' estimation, the two new studies are not as definitive as they purport to be.36 One, a paper published at the University of Sydney,37 considered no explanation of health effects other than nocebo. The other, a peer-reviewed study published in Health Psychology, 38 reported expectations to have, at most, a very small effect on either the number or severity of reported symptoms.36." Nate Seltenrich. "Wind Turbines: A Different Kind of Noise?" *Environmental Health Perspectives*. 122:1. A20. 2014. //ehp.niehs.nih.gov/wp-content/uploads/122/1/ehp.122-A20.pdf

Impact/Review Assessments Affirming Adverse Health Effects

"Impact Assessment for Waubra Farm." //windturbinesyndrome.com/wp-content/uploads/2010/08/the-dean-waubra-wind-farm-report-july-201011.pdf

Barbara Frey and Peter Hadden. "Wind Turbines and Proximity to Homes: The Impact of Wind Turbine Noise on Health." January, 2012. //windvigilance.com/Frey_Hadden_WT_noise_health_01Jan2012.pdf

Changes of Views That Have Been Subsequently Refuted

"Leventhall (2006) changed his position, stating that although wind turbines do produce significant levels of low-frequency sound, they do not pose a threat to humans—in effect reverting to the notion that what you can't hear can't hurt you." Punch, Jerry, Richard James, and Dan Pabst. "Wind Turbine Noise: What Audiologists Should Know." Audiology Today. July-August 2010. P 26. //windturbinesyndrome.com/img/WindTurbineNoise.pdf