Bibliography for the NEWEEP Webinar: Understanding the Impacts of Wind Turbine Sound

http://www.windpoweringamerica.gov/filter_detail.asp?itemid=2679&pga=ne_forum

Journal Articles and Books

Peer Reviewed

Sources appearing in the peer-reviewed section are identified as such by (a) cross referencing them with the publications they appear in to identify them as academic peer-reviewed, or (b) because specific verification that the source publication uses a process of rigorous academic peer-review has been submitted to NEWEEP staff. If we cannot verify that a publication meets the academic peer-reviewed standard, we have placed the article from that publication in the "Unknown Review Process" category.

- Jakobsen, J., 2005. Infrasound Emission from Wind Turbines. Journal of Low Frequency Noise, Vibration and Active Control, 24(3), 145-155.

- Keith, S., Michaud, D. & Bly, S., 2008. A proposal for evaluating the potential health effects of wind turbine noise for projects under the Canadian Environmental Assessment Act. Journal of Low Frequency Noise, Vibration and Active Control, 27(4), 253-265.

- Leventhall, G., 2006. Infrasound from Wind Turbines – Fact, Fiction or Deception? Canadian Acoustics, 34(2), 29-36.

- Pedersen, E., Hallberg, L. & Waye, K., 2007. Living in the vicinity of wind turbines: a grounded theory study. Qual Res Psychol, 4(1-2), 49-63.

- Pedersen, E. & Perrson, W.K., 2008. Wind turbines: low level noise sources interfering with restoration? Environ Res Lett., 3(015002). Available at: http://www.iop.org/EJ/article/1748-9326/3/1/015002/erl8_1_015002.pdf.

- Pedersen, E. & Persson Waye, K., 2007. Wind turbine noise, annoyance and self-reported health and well-being in different living environments. Occupational and Environmental Medicine, 64(7), 480-486. Available at: http://www.ncbi.nlm.nih.gov/pubmed/17332136 [Accessed May 10, 2010]. **Abstract:** OBJECTIVES - To evaluate the prevalence of perception and annoyance due to wind turbine noise among people living near the turbines, and to study relations between noise and perception/annoyance, with focus on differences between living environments. METHODS: A cross-sectional study was carried out in seven areas in Sweden across dissimilar terrain and different degrees of urbanisation. A postal questionnaire regarding living conditions including response to wind turbine noise was completed by 754 subjects. Outdoor A-weighted sound pressure levels (SPLs) were calculated for each respondent. Perception and annoyance due to wind turbine noise in relation to SPLs was analysed with regard to dissimilarities between the areas. RESULTS: The odds of perceiving wind turbine noise increased with increasing SPL (OR 1.3; 95% CI 1.25 to 1.40). The odds of being annoyed by wind turbine noise also increased with

increasing SPLs (OR 1.1; 95% CI 1.01 to 1.25). Perception and annoyance were associated with terrain and urbanisation: (1) a rural area increased the risk of perception and annoyance in comparison with a suburban area; and (2) in a rural setting, complex ground (hilly or rocky terrain) increased the risk compared with flat ground. Annoyance was associated with both objective and subjective factors of wind turbine visibility, and was further associated with lowered sleep quality and negative emotions. CONCLUSION - There is a need to take the unique environment into account when planning a new wind farm so that adverse health effects are avoided. The influence of area-related factors should also be considered in future community noise research.

- Pedersen, E. et al., 2009. Response to noise from modern wind farms in The Netherlands. The Journal of the Acoustical Society of America, 126(2), 634-643. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19640029 [Accessed May 10, 2010]. **Abstract:** The increasing number and size of wind farms call for more data on human response to wind turbine noise, so that a generalized dose-response relationship can be modeled and possible adverse health effects avoided. This paper reports the results of a 2007 field study in The Netherlands with 725 respondents. A dose-response relationship between calculated A-weighted sound pressure levels and reported perception and annoyance was found. Wind turbine noise was more annoying than transportation noise or industrial noise at comparable levels, possibly due to specific sound properties such as a "swishing" quality, temporal variability, and lack of nighttime abatement. High turbine visibility enhances negative response, and having wind turbines visible from the dwelling significantly increased the risk of annoyance. Annoyance was strongly correlated with a negative attitude toward the visual impact of wind turbines on the landscape. The study further demonstrates that people who benefit economically from wind turbines have a significantly decreased risk of annoyance, despite exposure to similar sound levels. Response to wind turbine noise was similar to that found in Sweden so the dose-response relationship should be generalizable.

- Pedersen, E. & Waye, K.P., 2004. Perception and annoyance due to wind turbine noise--a dose-response relationship. The Journal of the Acoustical Society of America, 116(6), 3460-3470. Available at: http://www.ncbi.nlm.nih.gov/pubmed/15658697 [Accessed May 10, 2010]. **Abstract:** Installed global wind power increased by 26% during 2003, with U.S and Europe accounting for 90% of the cumulative capacity. Little is known about wind turbines' impact on people living in their vicinity. The aims of this study were to evaluate the prevalence of annoyance due to wind turbine noise and to study dose-response relationships. Interrelationships between noise annoyance and sound characteristics, as well as the influence of subjective variables such as attitude and noise sensitivity, were also assessed. A cross-sectional study was performed in Sweden in 2000. Responses were obtained through questionnaires (n = 351; response rate 68.4%), and doses were calculated as A-weighted sound pressure levels for each respondent. A statistically significant dose-response relationship was found, showing higher proportion of people reporting perception and annoyance than expected from the present dose-response relationships for transportation noise. The unexpected high proportion of annoyance could be due to visual interference, influencing noise annoyance, as well as the presence of intrusive sound characteristics. The respondents' attitude to the visual impact of wind turbines on the landscape scenery was found to influence noise annoyance.

- Pedersen, E. & Larsman, P., 2008. The impact of visual factors on noise annoyance among people living in the vicinity of wind turbines. Journal of Environmental Psychology, 28(4), 379-389. Available at: http://www.sciencedirect.com/science/article/B6WJ8-4RY6WWF-1/2/eda6ba2c72af9d1436f8044b05a2f699 [Accessed May 10, 2010]. **Abstract:** Wind turbines are highly visible objects and the response to wind turbine noise is possibly influenced by visual factors. In this study, visibility of the noise source, visual attitude and vertical visual angle (VVA) in different landscapes were explored. Data from two cross-sectional field studies carried out among people living near wind turbines (n=1095) were used for structural equation modelling. A proposed model of the influence of visual attitude on noise annoyance, also comprising the influence of noise level and general attitude, was tested among respondents who could see vs. respondents who could not see wind turbines from their homes, living in flat vs. hilly/rocky terrain, and living in built-up vs. rural areas. Visual attitude towards the noise source was associated with noise annoyance to different degrees in different situations. A negative visual attitude, more than multi-modal effects between auditory and visual stimulation, enhanced the risk for noise annoyance and possibly also prevented psychophysiological restoration possibilities. Aesthetic evaluations of the noise source should be taken into account when exploring response to environmental noise.

- Pedersen, E. et al., 2010. Can road traffic mask sound from wind turbines? Response to wind turbine sound at different levels of road traffic sound. Energy Policy, 38(5), 2520 - 2527.

- van den Berg, G.P., 2004b. Effects of the wind profile at night on wind turbine sound. Journal of Sound and Vibration, 277(4-5), 955-970. Available at: http://www.sciencedirect.com/science/article/B6WM3-4BJ7683-3/2/1e86256c8a95ea4f983ef723893bd5ea [Accessed May 10, 2010].

- van den Berg, F., 2009. Wind turbines: Why they are noisy and what to do about it. The Journal of the Acoustical Society of America, 125(4), 2623. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19355085 [Accessed May 10, 2010]. **Abstract:** Sound from modern, tall wind turbines is related to sleep disturbance and is, per decibel, more annoying than sound from common sources such as road or air traffic. Surveys among residents indicate that there are several reasons for this: the swishing character of the sound, the intrusiveness at night, and the visibility of the wind turbine(s). Residential reaction is also determined by the attitude towards wind turbines in the landscape and by economical benefits. From acoustical research different explanations have arisen as to why the sound is amplitude modulated. For a distant observer it is the result of the change in trailing sound level due to the change in wind that the revolving blades encounter. High night-time sound levels are due to an increase in rotor height wind speed simultaneously with a decrease in near-ground wind speed. Wind turbine design has been directed to higher yields per turbine. Less attention has been given to low noise blades and rotor speed reduction. Low noise design could also include a reduction in the modulation amplitude and more sophisticated speed reduction; viz., at high annoyance conditions. Also, involving residents in wind farm planning may have a high potential to reduce annoyance.

- van den Berg, G.P., 2004b. Effects of the wind profile at night on wind turbine sound. Journal of Sound and Vibration, 277(4-5), 955-970. Available at: http://www.sciencedirect.com/science/article/B6WM3-4BJ7683-3/2/1e86256c8a95ea4f983ef723893bd5ea [Accessed May 10, 2010]. **Abstract:** Since the start of the operation of a 30 MW, 17 turbine wind park, residents living 500 m and more from the park have reacted strongly to the noise; residents up to 1900 m distance expressed annoyance. To assess actual sound immission, long term measurements (a total of over 400 night hours in 4 months) have been performed at 400 and 1500 m from the park. In the original sound assessment a fixed relation between wind speed at reference height (10 m) and hub height (98 m) had been used. However, measurements show that the wind speed at hub height at night is up to 2.6 times higher than expected, causing a higher rotational speed of the wind turbines and consequentially up to 15 dB higher sound levels, relative to the same reference wind speed in daytime. Moreover, especially at high rotational speeds the turbines produce a [`]thumping', impulsive sound, increasing annoyance further. It is concluded that prediction of noise immission at night from (tall) wind turbines is underestimated when measurement data are used (implicitly) assuming a wind profile valid in daytime.

Unknown Review Process

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- Pierpont, N., 2009. Wind turbine syndrome: a report on a natural experiment [pre-publication draft], Santa Fe, NM: K-Selected Books. Available at: http://www.windturbinesyndrome.com/wp-content/uploads/2009/03/ms-ready-for-posting-on-wtscom-3-7-09.pdf.

- Punch, J., James, R. R., & Pabst, D. (2010). Wind-turbine noise: What audiologists should know. *Audiology Today*, *JulAug2010*.

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Non-Profit and Academic Reports

- Alberts, D.J., 2006. Primer for Addressing Wind Turbine Noise, Lawrence Technological University.

- Archives and Collections Society, 2004. Some health aspects of wind driven industrial turbines, Picton, ON: Archives and Collections Society. Available at: http://www.aandc.org/research/wind_community_health.html.

- Bajdek, C., 2007. Communicating the Noise Effects of Wind Farms to Stakeholders. In Reno, Nevada: Harris Miller Miller & Hanson, Inc. **Abstract:** State and local agencies may lack applicable noise criteria and standards for the assessment of noise impact from

wind farms used for the production of electricity, and many decision-makers, as well as the general public, have limited experience with the noise effects of modern wind farms. Although largely viewed as environmentally friendly, the wind energy industry does have its detractors. Some of the information posted on the Internet concerning the noise effects of wind farms can be misleading. This paper explores several innovative approaches or strategies to communicate the noise effects of wind farms to decision-makers and the general public including audibility analyses, Virtual Soundscapes and supplemental metrics.

- Bajdek, C., 2005. Noise Issues and the Siting of Facilities. North American Wind Power, (April 2005). **Abstract:** This article reviews the basics of sound and decibels for the uninitiated, discusses some actual measurement results from a case study, provides an overview of recent research into community reaction to noise, and outlines some methods for dealing with the noise issue.

- Bass, J. et al., 2005. Low Frequency Noise and Wind Turbines, The British Wind Energy Association. **Abstract:** Concerns have been raised in the UK that noise radiated from wind turbines contains sufficiently high levels of low frequency energy that may pose a threat to human health. It was suggested that symptoms included nausea, headaches and anxiety. This document, issued by the British Wind Energy Association (BWEA), provides information on the issue of low frequency noise and wind turbines, based on current knowledge.

- Chatham-Kent Public Health Unit, 2008. The health impact of wind turbines: a review of the current white, grey, and published literature, Chatham, ON: Chatham-Kent Municipal Council. Available at: http://www.wind-works.org/LargeTurbines/Health%20and%20Wind%20by%20C-K%20Health%20Unit.pdf.

- Colby, W.D. et al., 2009. Wind Turbine Sound and Health Effects: An Expert Panel Review, American Wind Energy Association & Canadian Wind Energy Association. **Abstract:** Wind energy enjoys considerable public support, but it also has its detractors, who have publicized their concerns that the sounds emitted from wind turbines cause adverse health consequences. In response to those concerns, the American and Canadian Wind Energy Associations (AWEA and CanWEA) established a scientific advisory panel in early 2009 to conduct a review of current literature available on the issue of perceived health effects of wind turbines. The panel undertook extensive review, analysis, and discussion of the large body of peer reviewed literature on sound and health effects in general, and on sound produced by wind turbines. Following review, analysis, and discussion of current knowledge, the panel reached consensus on the following conclusions:

    - There is no evidence that the audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effects.

- The ground-borne vibrations from wind turbines are too weak to be detected by, or to affect, humans.

- The sounds emitted by wind turbines are not unique. There is no reason to believe, based on the levels and frequencies of the sounds and the panel's experience with sound exposures in occupational settings, that the sounds from wind turbines could plausibly have direct adverse health consequences.

- Cummings, J., 2010. Wind Farm Noise: 2009 in Review - Research, public concerns and industry trends, Acoustic Ecology Institute. **Abstract:** The key messages of this report can be boiled down to four themes. First, it is clear that many people, in all parts of the country, have been dramatically impacted by the noise of wind farms near their homes. To dismiss all these people does a disservice to constructive public discourse, and short circuits our opportunities to learn from their experiences as we continue to develop new wind farms. Second, it is clear that wind farm noise is truly not that bothersome to most people who hear it or live near it, and that the vast majority of wind farms never generate any substantial ongoing noise issues. Concerns that dominate public discourse and activist web sites can seem to accentuate the hardest to quantify issues (such as direct health effects, especially of low frequency noise), while magnifying the extent of problems as communities consider new wind developments. Third, the nature of the sounds made by wind turbines make it especially difficult to rely on reassuring "noise limits" as proposed by states, counties, or townships. And fourth, and perhaps most important yet least appreciated: we are facing some social choices that may be difficult to make. While broad-brush studies report no simple cause-effect between wind farm noise and various measures of impact (health, annoyance, property values), it is also clear that a minority of those nearby do often experience dramatic, negative impacts.

- Hoen, B., Eckholdt, H., & Wiser, R. (2010). Assessing the Impacts of Reduced Noise Operations of Wind Turbines on Neighbor Annoyance: A Preliminary Analysis in Vinalhaven, Maine (No. LBNL-3562E). Office of Energy Efficiency and Renewable Energy Wind & Hydropower Technologies Program U.S. Department of Energy Washington, D.C.: Lawrence Berkeley National Laboratory. Retrieved from http://eetd.lbl.gov/EA/EMP. **Abstract**: Neighbors living near the 3 turbine, 4.5 MW Vinalhaven, Maine wind power facility, which began operations in late 2009, have complained that the noise from the turbines is unwelcome and annoying. Fox Islands Wind, the owner of the facility, hypothesized that implementing a Noise Reduced Operation (NRO) for the turbines, which effectively limits the turbines' maximum rpm and power output, would reduce the sound levels produced by the turbines, and therefore might also reduce the degree to which the neighbors report being annoyed by those sounds. To test this hypothesis in a preliminary fashion, a pilot study was conducted in early 2010, the results of which are the subject of this brief report.

- Kalinski, K., 2008. Understanding Turbine Sound Impact Studies. North American Wind Power, (May 2008). **Abstract:** Wind turbines make noise, or, more accurately, sound. Whether this sound as it reaches its neighbors is inaudible or unbearable depends on a

number of factors, including the level and pitch of the sound generated by the turbine, the distance to its neighbors, meteorology and the intervening terrain. Given this information, the amount of noise generated by a wind farm can be predicted fairly well before the first shovel of a wind energy project hits the ground.

- Leventhall, G., Pelmear, P. & Benton, S., 2003. A review of published research on low frequency noise and its effects. Department for Environment, Food and Rural Affairs. Available at: http://westminsterresearch.wmin.ac.uk/4141/ [Accessed May 10, 2010]. **Abstract:** Low frequency noise causes extreme distress to a number of people who are sensitive to its effects. Such sensitivity may be a result of heightened sensory response within the whole or part of the auditory range or may be acquired. The noise levels are often low, occurring in the region of the hearing threshold, where there are considerable individual differences. There is still much to be done to gain a fuller understanding of low level, low frequency noise, its effects, assessment and management. This present study considers some properties of low frequency sounds, their perception, effects on people and the criteria which have been developed for assessment of their effects. Proposals are made for further research, to help to solve the continuing problems of low frequency environmental noise.

- Pedersen, E., 2007. Human response to wind turbine noise: perception, annoyance and moderating factors, Göteborg, Sweden: Göteborgs Universitet, Sahlgrenska Acedemy, Department of Public Health and Community Medicine. Available at: http://gupea.ub.gu.se/dspace/bitstream/2077/4431/1/gupea_2077_4431_1.pdf.

- Phillips, C., 2010. An Analysis of the Epidemiology and Related Evidence on the Health Effects of Wind Turbines on Local Residents, Wisconsin: Brown County Citizens for Responsible Wind Energy.

- Ramikrishnan, R., 2007. Wind turbine facilities noise issues, Toronto, ON: Queen's Printer for Ontario. Available at: https://ozone.scholarsportal.info/bitstream/1873/13073/1/283287.pdf.

- Rideout, K., Copes, R. & Bos, C., 2010. Wind turbines and health, Vancouver: National Collaborating Centre for Environmental Health. Available at: http://www.ncceh.ca/files/Wind_Turbines_January_2010.pdf.

- Rogers, A., Manwell, J. & Wright, S., 2006. Wind Turbine Acoustic Noise, Renewable Energy Research Laboratory - University of Massachusetts at Amherst. **Abstract:** Wind turbines generate sound via various routes, both mechanical and aerodynamic. As the technology has advanced, wind turbines have gotten much quieter, but sound from wind turbines is still an important siting criterion. Sound emissions from wind turbine have been one of the more studied environmental impact areas in wind energy engineering. Sound levels can be measured, but, similar to other environmental concerns, the public's perception of the acoustic impact of wind turbines is, in part, a subjective determination.

In almost all cases, the sound levels associated with wind turbines large & small only produce subjective effects such as annoyance, or interference with activities such as speech, sleep, and learning. Modern turbines typically only produce annoyance. More serious affects associated with sounds from industrial plants and around aircraft include physiological effects such as anxiety, tinnitus, or hearing loss. Whether a sound is objectionable will depend on the type of sound (tonal, broadband, low frequency, or impulsive) and the circumstances and sensitivity of the person (or receptor) who hears it. Because of the wide variation in the levels of individual tolerance for noise, there is no completely satisfactory way to measure the subjective effects of noise or of the corresponding reactions of annoyance and dissatisfaction. Operating sound produced from wind turbines is considerably different in level and nature than most large scale power plants, which can be classified as industrial sources. While noise may be a concern to the public living near wind turbines, much of the sound emitted from the turbines is masked by ambient or the background sounds of the wind itself. The sound produced by wind turbines has diminished as the technology has improved. In the following paper, after a short summary of the basic principles of sound and its measurement, a review of sound generation from wind turbines, sound propagation, as well as sound prediction methods is given.

- Schomer, P., 2009. Background Sound Measurements and Analysis in the Vicinity of Cape Vincent, New York, Champaign, Illinois: Schomer and Associates, Inc. **Abstract:** The acoustic consulting engineering firm Hessler Associates, Inc., Haymarket, Virginia produced two sound level assessment reports for two wind projects proposed for Cape Vincent, New York: the first report in 2007 for BP and the second report in 2009 for AES-Acciona. Because there were concerns early on among local citizens that the BP report was misleading, the Wind Power Ethics Group (WPEG) contracted with Schomer and Associates, Champaign, Illinois to conduct an independent background sound survey of Cape Vincent. Hessler's BP study for the Cape Vincent Wind Power Facility appears to have selected the noisiest sites, the noisiest time of year, and the noisiest positions at each measurement site. Collectively, these choices resulted in a substantial overestimate of the a-weighted ambient sound level, 45-50 dB according to Hessler. This study was designed to address a number of flaws noted in Hessler's BP study. Our study found that: 1. The Hessler position at a measurement site systematically and significantly yields higher sound levels than does the Community position. 2. The sound levels measured in this study show Cape Vincent to be a quiet rural area, much as depicted by the data for Hessler's study. 3. Measurements, such as those conducted at Hessler's study, are not indicative of the noise environment of typical residences in the Cape Vincent area. 4. Failure to remove insect noise in Hessler's study violated his own recommended survey and analytical techniques and substantially misrepresented typical ambient sound levels. 5. In assessing potential noise impacts from wind turbine development, rather than using 45-50 dB A-weighted levels as suggested by Hessler, a more accurate level would be 30 dB, which is the average value for the daytime, evening and nighttime L90 sound levels observed at both the "Hessler" and Community positions for sites A and B in this study. Arguably, the level should be down at 20 to 25 dB, since an A-weighted L90 of 20 dB occurs during the quietest nighttime hours, and the A-weighted L90 for the whole 9-hour night is 25 dB.

- van den Berg, F. et al., 2008. Project WINDFARMperception: Visual and acoustic impact of wind turbine farms on residents, University of Groningen - Faculty of Mathematics and Natural Sciences. **Abstract:** This report gives the results of the EU financed study WINDFARMpertception on how residents perceive a wind farm in their living environment as far as sound and sight are concerned. The study includes a postal survey among Dutch residents (n = 725, response rate: 37%) and an assessment of their aural and visual exposure due to wind farms in their vicinity.

- Whitford, J., 2008. Model wind turbine by-laws and best practices for Nova Scotia municipalities: final report, Halifax, NS: Union of Nova Scotia Municipalities. Available at: http://www.sustainability-unsm.ca/our-work.html.

- World Health Organization, 2009. Night noise guidelines for Europe, Geneva, Switzerland: WHO Regional Office for Europe. Available at: http://www.euro.who.int/document/e92845.pdf.

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- Alves-Pereira M, C.B.N., 2007b. In-home wind turbine noise is conductive to vibroacoustic disease. In: Proceedings of the 2nd International Meeting on Wind Turbine Noise. In Lyon, France.

- Alves-Pereira M, C.B.N., 2007c. Public health and noise exposure: the importance of low frequency noise. In: Proceedings of the Inter-Noise Congress. In Istanbul, Turkey.

- Alves-Pereira M, C.B.N., 2007d. The scientific arguments against vibroacoustic disease. In: Proceedings of the Inter-Noise Congress. In Istanbul, Turkey.

- van den Berg, G.P., 2004a. Do wind turbines produce significant low frequency sound levels? In In: Proceedings of the 11th International Meeting on Low Frequency Noise and

Vibration and its Control. Maastricht, Netherlands: University of Groningen – Science Shop for Physics. **Abstract:** Wind turbines produce low frequency sounds, but it has not been shown this is a major factor contributing to annoyance. Sound from wind turbines involves several sound production mechanisms related to different interactions between the turbine blades and the air. Low frequency sound is predominantly the result of the displacement of air by a blade and of turbulence at the blade surface. An important contribution to the low frequency part of the sound spectrum may be the result of the sudden variation in air flow the blade encounters when it passes the tower: the angle of attack of the incoming air suddenly deviates from the angle that is optimized for the mean flow. This effect probably has not been considered important as the blade passing frequency is of the order of one hertz where human hearing is very insensitive. This argument however obscures a very relevant effect: the low blade passing frequency modulates well audible, higher frequency sounds and thus creates periodic sound. This effect is stronger at night because in a stable atmosphere there is a greater difference between rotor averaged and near tower wind speed. Measurements have shown that more turbines can interact to further amplify this effect. The effect is confirmed by residents near wind turbines who mention the same common observation: often late in the afternoon or in the evening the turbine sound changes to a more 'clapping' or 'beating' sound, the rhythm in agreement with the blade passing frequency. It is clear from the observations that this is associated to a change to a higher atmospheric stability. The increased annoyance has not been investigated as such, although there are indications from literature this effect is relevant. It is of increasing relevance as the effect is stronger for modern (that is: tall) wind turbines.

White Papers, Essays & Other

- Acoustic Ecology Institute Special Report: Wind Energy Noise Impacts, November 2009

- Cota, H.M. et al., 2008. Now Hear This! What All Environmental Engineers Should Know About Noise Control. Available at: http://digitalcommons.calpoly.edu/cenv_fac/115 [Accessed May 10, 2010]. **Abstract:** Noise is an is an that affects almost everyone. And even though environmental engineers are often called on to deal with noise-related problems, most of them receive little or no academic training in noise control. This primer suggests why all environmental engineers should know something about noise control, what they need to know, and where they can find the necessary information.

- Environmental Protection Agency, Office of Water, 2007. Auxiliary and supplemental power fact sheet: wind turbines, Washington, DC: Environmental Protection Agency. Available at: http://www.epa.gov/owm/mtb/wind_final.pdf.

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- Harry, A., 2007. Wind turbines, noise, and health., Wind Watch. Available at: http://www.wind-watch.org/documents/wp-content/uploads/wtnoise_health_2007_a_harry.pdf.

- Kamperman, G.W. & James, R.R., 2008. The "How-To" Guide to Siting Wind Turbines to Prevent Health Risks from Sound, Windaction.org. **Abstract:** As a part of the widespread enthusiasm for renewable energy, state and local governments are promoting ”Model Ordinances” for siting industrial wind farms which establish limits for noise and other potential hazards. These are used to determine where wind projects can be located in communities, which are predominantly rural and often extremely quiet during the evening and night. Yet, complaints about noise from residents near existing industrial wind turbine installations are common. This raises serious questions about whether current state and local government siting guidelines for noise are sufficiently protective for people living close to the wind turbine developments. Research is emerging that suggests significant health effects are associated with living too close to modern industrial wind turbines. Research into the computer modeling and other methods used to determine the layout of wind turbine developments, including the distance from nearby residences, is at the same time showing that the output of the models may not accurately predict sound propagation. Current information suggests the models should not be used for siting decisions unless known errors and tolerances are applied to the results. This essay expands upon an earlier paper and includes information to support the findings and recommended criteria. We are proposing very specific, yet reasonably simple to implement and assess criteria for audible and non-audible sound on adjacent properties and also present a sample noise ordinance and the procedures needed for pre-construction sound test, computer model requirements and follow-up tests (including those for assessing compliance). The purpose of this paper is to outline a rational, evidence-based set of criteria for industrial wind turbine siting in rural communities.

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- Ontario. Ministry of the Environment, 2008. Noise guidelines for wind farms: interpretation for applying MOE NPC publications to wind power generation facilities, Toronto: Queen's Printer for Ontario. Available at: http://www.ene.gov.on.ca/publications/4709e.pdf.

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