June 28, 2011

Recommended Update of *Sample Zoning for Wind Energy Systems*

Introduction

On April 16, 2008, a document titled *Sample Zoning for Wind Energy Systems* was published by the state of Michigan. That document is attached as an appendix. Recent contacts with Michigan state government offices revealed that the state has no current plans to update the guideline. Consequently, we prepared this report in an attempt to inform the public and assist municipalities and counties that are responsible for developing zoning for wind energy systems. We strongly recommend that the state of Michigan consider our recommendations in adopting an official revision of its earlier guideline on the siting of onshore, utility-scale wind turbines.

We have been guided by the belief that wind turbines will benefit our state by offering a viable source of alternative energy, but also by the knowledge that the public must be protected from any known risks to safety and health.

Individuals responsible for this update are William MacMillan, Electrical Engineer (Ret.), Consumers Energy; Jerry Punch, Professor of Audiology, Department of Communicative Sciences and Disorders, Michigan State University; and Kenneth Rosenman, Chief, Division of Occupational and Environmental Medicine, Michigan State University. The proposed revisions were developed through regular meetings, consultation with experts in acoustics and wind turbine design, reviews of the existing scientific literature and the review of currently adopted siting guidelines of states and foreign countries.

The four issues addressed in this report are physical safety, noise limits, limitations on shadow flicker and the conflict resolution process. The regulation of noise levels is the most contentious issue related to the siting of wind energy systems. The proposed revision includes the rationale for our recommendations, based on the premise that municipalities need to consider these rationales when making their siting decisions.

Physical Safety

Setbacks are recommended to protect the physical safety of residents. Mechanical or catastrophic failure of wind turbines during the operational phase of any utility-scale wind project may result in threats to public health and safety due to turbine collapse, thrown blade fragments, or thrown ice.

The minimum setback distance of each wind turbine from both the nearest residential structure and the residential property line where the turbines are constructed should be the height of the tower plus height of the blade in its vertical position. Some zoning guidelines and ordinances are more protective and have specified the setback to be

1.1-1.5 times that distance. Ice throw and blade failure in large-scale turbines have been shown to be a threat at greater distances (Palmer, ND). Turbines should be sited to minimize risk to human safety to a negligible level. If the minimum setback distance is insufficient to protect persons who are not restricted from access to where a blade fragment or thrown ice could fall, a safety analysis should be performed by an independent engineer to determine whether a physical barrier should be put into place to protect such persons.

The recommendation regarding the property line was stipulated in the 2008 sample zoning guideline. We recommend that the same minimum setback distance also be applied for any inhabited residences. Specifically, for on-site wind energy systems and anemometer towers over 20 meters high, setbacks should be specified with reference to property lines of the respective zoning district; property lines of non-leased properties or lease unit boundaries; and road rights-of-way.

It is also recommended that participating property owners be allowed to waive any setback limits exceeding the height of the tower plus height of the blade in its vertical position.

Limitations on Noise

We recommend that municipalities base their decisions about noise limitations on the best available, peer-reviewed scientific evidence. There is sufficient evidence to support a link between audible sound produced by wind turbines and both sleep disturbance and annoyance. Regarding infrasound, however, we believe that a causal link between infrasound and adverse health impacts is not established, despite numerous anecdotal accounts and a growing literature showing the biological plausibility of such a link. It is also important to recognize that there is no published, peer-reviewed literature showing the absence of a link. This issue should be periodically revisited by interdisciplinary experts as future peer-reviewed evidence becomes available.

Michigan's 2008 zoning guideline specifies a fixed level of 55 dBA at property lines or lease boundary area (whichever is farther from the noise source) as the maximum-allowable noise level. We believe that a level of 55 dBA or higher presents unacceptable health risks.

In their deliberations regarding zoning issues, municipalities should be cognizant of the special characteristics of wind turbine noise. Evidence from several studies indicates that wind turbine noise, specifically amplitude-modulated noise, which is characteristic of the noise produced by wind turbines, is more easily perceived and more annoying than sounds having a constant level (Bradley, 1994; Bengtsson et al., 2004; Persson Waye, 2004; Pedersen et al., 2009). In addition, sounds that are unpredictable and uncontrollable are more likely to be annoying than constant, regularly occurring sounds (Geen & McCown, 1984; Hatfield et al., 2002), nighttime sounds are generally more

likely to be annoying than daytime sounds (van den Berg, 2004), and nighttime wind turbine noise is likely to be as much as 15 dB higher in level than the daytime level because of higher wind speeds that prevail at nighttime (van den Berg, 2004).

Rationale for Selecting 40 dBA (nighttime, outdoors). Exposure to noise at night has been established as causing adverse health effects. The WHO (2009) states that repeated exposures to a level of 40 dBA at night, averaged on an annual basis, lead to long-term adverse health effects such as cardiovascular disease, while shorter-term exposures of 40 dBA are associated with sleep disturbances. That organization has maintained for decades that there is a close relationship between annoyance and health (WHO, 2009, 2011). These health effects include increased heart rate, hypertension, cardiovascular disease, changes in sleep stages, increased awakening, an increase in body movement during sleep, self-reported sleep disturbance, increased use of sleeping pills, self-reported health problems, and insomnia-like symptoms (van Kempen et al., 2002; WHO, 2009). Shortened sleep duration is associated with an increased risk of high blood pressure and cardiovascular disease (Nagai et al., 2010). There is limited evidence that sleep disturbance causes fatigue, increased accidents, reduced performance, depression and other mental illness (WHO, 2009).

As already stated, there is no published, peer-reviewed evidence that directly links noise from wind turbines with the adverse health effects listed above. The studies conducted on noise have involved airport and road traffic noise. There is no reason to suspect that wind turbine noise will have less of a harmful effect than noise from road traffic or airplanes and, therefore, it is not unreasonable to regulate noise exposure from wind turbines based on the health studies showing adverse effects from traffic and airplane noise.

These observations could be the basis for a municipality to adopt the World Health Organization (WHO, 2009) recommendation to limit nighttime environmental noise exposure to 40 dBA. According to the WHO, limiting exposure to this level would protect the most vulnerable populations, including young children, the elderly and the chronically ill. Limiting wind turbine noise to 40 dBA is consistent with the *Precautionary Principle*, which states that public policy should err on the side of caution until scientists can provide a clearer picture of the relationship between policy actions and potential risks to society or to the environment.

Studies that have been performed on the health effects of noise from wind turbines have examined whether nearby residents are annoyed by the wind turbines (Pedersen et al, 2009). These studies show that annoyance from wind turbines increases with increasing noise levels. Examples of such results are shown in Figures 1 and 2.

The study by Pedersen et al. (2009) summarized survey data on annoyance from wind turbines in the Netherlands and Sweden, with annoyance being specified at four intervals of noise measured outside of dwellings. In both populations, the majority of

respondents could see at least one wind turbine from their dwellings. The responses for the Dutch population were reported only for those individuals who were not benefiting economically from the turbines (Figure 1). Dutch and Swedish respondents who were either annoyed or very annoyed (very annoyed are included in the annoyed group) with wind turbine noise were in substantial agreement for the lowest sound level intervals. For the 35-40-dBA interval, the Dutch respondents were annoyed to an extent that was statistically greater than for the Swedish respondents. No differences between Dutch and Swedish respondents were found when the percentages of very annoyed respondents were compared. Most importantly, 25% or more of all respondents were annoyed by levels of 40-45 dBA, while about 18-20% were very annoyed by those levels. According to Figure 2, a total of 18% found outdoor levels of 35-40 dBA to be *rather annoying* or *very annoying* outdoors and 8% found those levels to be *rather or very annoying* indoors. For outdoor levels of 40-45 dBA, 18% and 16% were *rather or very annoyed* outdoors and indoors, respectively.

Conclusions that can be derived from these data are that individuals who do not benefit economically from wind turbines are more likely to be annoyed by noise at relatively low levels and that the level of annoyance increases with increasing noise levels. (The latter finding was also supported by Pedersen and Persson Waye, 2004.) Communities that are tolerant of these levels of annoyance may wish to adopt 45 dBA as the maximum allowable noise level, but, in our view, non-participating residents are more likely to have complaints about noise levels when outdoor noise levels reach or exceed 45 dBA.

Measurement of Noise Levels. A practical approach is needed to assess whether existing noise levels are within the municipality's allowable limit. We recommend that the average nighttime noise level (dB L_{Aeq}) over several 10–minute periods during the hours of 10:00 p.m.-7:00 a.m. be used to determine if noise levels are within a municipality's allowable limit. To address sleep disturbance, nighttime noise limits should be measured at the façade of the residence, under normal operating conditions. Reasonable precautions, including the application of relevant noise measurement standards, should be taken to ensure that measurements are reliable and valid.

Waivers. If a municipality adopts a noise level less than 55 dBA, the municipality should consider including a provision that allows a home owner to waive the requirement of the specified noise limits below 55 dBA. It is not recommended that municipalities allow a waiver of levels of 55 dBA and above because of the increased incidence of adverse cardiovascular effects from noise exposure at those levels.

Areas with High Background Noise Levels Prior to Construction of Wind Turbines. For communities whose background noise levels before placement of wind turbines are already above the noise level adopted by those communities for wind turbines, we recommend that the allowable noise level be LA_{90eq}(nighttime, outside) plus 5 dB.

Limitations on Shadow Flicker

Shadow flicker occurs when the rotating blades of a wind turbine are positioned directly between the light of the sun and a reference point. Typically, shadow flicker is defined as changes in light intensity caused by shadows cast on the ground and stationary objects, such as a window at a dwelling, by the moving blades. No shadow flicker will be cast when the sun is obscured by clouds or fog or when the blades are not rotating. The occurrence of flicker depends on the sun's visibility at the receptor's location, the sun's movement with respect to the earth, hub height, rotor diameter, and wind speed and direction. Most of these factors vary seasonally. For a given location, the number of hours of shadow flicker per year can be predicted with a reasonable degree of accuracy by computer models. The input needed for such predictions include the turbine and receptor coordinates, a topographic map of the U. S. Geological Survey (USGS), rotor diameter and hub height, a frequency distribution of wind speed and direction, and average monthly sunshine hours. Municipalities wishing to impose limitations on the siting of wind turbines based on shadow flicker should acquire these data or consult with an independent expert who can provide them.

Some municipalities, including some in Michigan, impose a specific annual limit on shadow flicker, typically ranging from zero tolerance to 30 hours. Hourly limits on flicker can best be implemented by requiring a flicker analysis by an independent expert and a zero-tolerance rule can best be implemented by requiring the installation of flicker sensors on turbines that subject people to flicker. Site plans and other documents and drawings should specify mitigation measures to minimize potential impacts from shadow flicker, as identified by any shadow flicker impact analysis.

This is not a substantive change from Michigan's 2008 sample zoning guideline. Residents should be allowed to waive the specified limitations on shadow flicker.

Conflict Resolution

To help minimize costly disputes at the local community level, in 2011 the Bureau of Energy Systems began to work with the Community Dispute Resolution Program (CDRP) in Michigan to provide communities with contact information for individuals with specific expertise in wind-related community dispute resolution, as well as information on the CDRP. In many jurisdictions throughout Michigan, courts are making citizens aware of the availability of mediation as an alternative to litigating many types of disputes.

Community dispute resolution is a voluntary process in which two or more parties meet with a trained neutral mediator and together find a resolution to their problem. Mediators have no decision-making authority and they do not render case evaluations as in the MCR 2.403 case evaluation process. Instead, mediators are trained to assist the parties in generating options that result in a mutually acceptable resolution of their conflict.

The Alternative Dispute Resolution (ADR) Section of the Michigan State Bar houses a number of mediators who have mediated gas/oil, land use and various additional siting-type issues, including wind farm issues. Other trained individuals work in government, private industry, the non-profit sector and academia. Some individuals have training specifically related to wind energy. Michigan also has a network of CDRP centers that offer mediation. The centers, supported in part with funding from the Michigan Supreme Court, are available to provide mediation in a wide variety of dispute types. (See: http://courts.michigan.gov/scao/dispute/ for information on the Community Dispute Resolution Program.)

To assess whether wind turbine facilities are in compliance with a municipality's regulations, including noise limits, a municipality should consider requiring the wind turbine developer to put money into a municipality escrow account that can be used for periodic monitoring and/or complaints. This will allow the municipality to hire someone who is independent of any wind turbine developer and who has sufficient expertise to conduct the evaluation. The results of any such evaluation will be useful to ensure compliance with a municipality's zoning regulations and to provide facts to be used in any conflict resolution proceedings held by a mediator.

Local Community Wind Projects and Community Dispute Resolution. Many local municipalities are incorporating a provision for wind-specific dispute resolution processes in their Community Engagement, Planning Process and Local Zoning Ordinances associated with the planning, implementation and operation stages of local wind farms. In the interest of minimizing the number of pre- and post-construction complaints and disputes, the local municipalities may also wish to consider some community engagement process and/or preventive measures that might reduce the need for formal dispute resolution processes or litigation. For example, provisions might address requiring wind companies to include good-neighbor payments to non-participants who are located within a pre-determined distance of a utility-scale wind turbine. Another consideration for municipalities that wish to minimize disputes may be to limit wind energy projects only to areas of low residential density. Overlay districts may be useful in encouraging the siting of wind turbines in certain areas, in addition to encouraging continued use of those areas for agricultural purposes. In more industrialized areas, wind energy overlay districts could be identified to encourage placement of wind turbines in areas zoned as industrial.

Finally, within the context of community engagement, local municipalities may wish to explore ways to enhance opportunities for local business development associated with wind energy. For example, community economic development specialists may wish to explore ways to help existing manufacturers become suppliers (i.e., raw material, component, sub-system, total-system suppliers) to Original Equipment Wind Manufacturers, especially those that supply the local turbines. Communities may also wish to explore ways to enhance and integrate local Science, Technology, Engineering and Math (STEM) curricula with the wind energy projects. Related to this, local community organizations may wish to explore ways to provide college scholarships to local students who pursue careers related to wind-energy development. Finally, in the

context of Economic Gardening, local communities may also wish to explore business incentives for local students who major in entrepreneurship at a Michigan university/college and return to their home communities to launch new wind-related ventures.

Individuals with Expertise in Wind-related Community Dispute Resolution. Additional information about the Community Dispute Resolution Program (CDRP) program, including a list of mediation centers across the state, can be found at: http://courts.michigan.gov/scao/resources/other/cdrpcenters.pdf. Individuals can also discuss any potential additional alternative dispute resolution options with staff of the Office of Dispute Resolution, Michigan Supreme Court (Contact: Doug Van Epps, Director, 517-373-4840, vaneppsd@courts.mi.gov). Finally, the Bureau of Energy Services has identified the following individuals as having specific expertise in wind-related community dispute resolution and wind energy:

1. David Bidwell, 336-416-1644, bidwell2@msu.edu
2. John Sarver, 517-290-8602, johnsarver3@gmail.com
3. Dan Cherrin, 313-300-0932, dcherrin@fraserlawfirm.com; and,
4. Richard J. Figura, 231-326-2072

References

Bengtsson, J., Persson Waye, K., & Kjellberg, A. (2004) Sound characteristics in low frequency noise and their relevance for the perception of pleasantness. *Acta Acustica*, *90*, 171–180.

Bradley, J. S. (1994). Annoyance caused by constant-amplitude and amplitude-modulated sound containing rumble. *Noise Control Engineering Journal*, *42,* 203–208.

Geen, R. G., McCown, E. J. (1984). Effects of noise and attack on aggression and physiological arousal. *Motivation and Emotion*, *8*, 231–241.

Hatfield, J., Job, R. F., Hede, A.J., Carter, N.L., Peploe, P., Taylor, R., et al. (2002). Human response to environmental noise: the role of perceived control. *Journal of Behavioral Medicine*, *9*, 341–359.

Nagai M, Hoshide S, & Kario K. (2010). Sleep duration as a risk factor for cardiovascular disease – a review of the recent literature. *Current Cardiology Reviews*, *6*, 54-61.

Pedersen, E., van den Berg, F., Bakker, R., & Bouma, J. (2009). Response to noise from modern wind farms in The Netherlands. *Journal of the Acoustical Society of America, 126, 634-643.*

Palmer W. K. G. (ND). Assessment of Kent Breeze Renewable Energy (Wind) Project Impact on Serious Harm to Human Health. Legal brief prepared for Hearing of Environmental Review, Tribunal, Case No. 10-121 / 10-122. Paisley, ON N0G 2N0.

Pedersen, E., & Persson Waye (2004). Perception and annoyance due to wind turbine noise—a dose-response relationship. *Journal of the Acoustical Society of America*, *116*, 3460-3470.

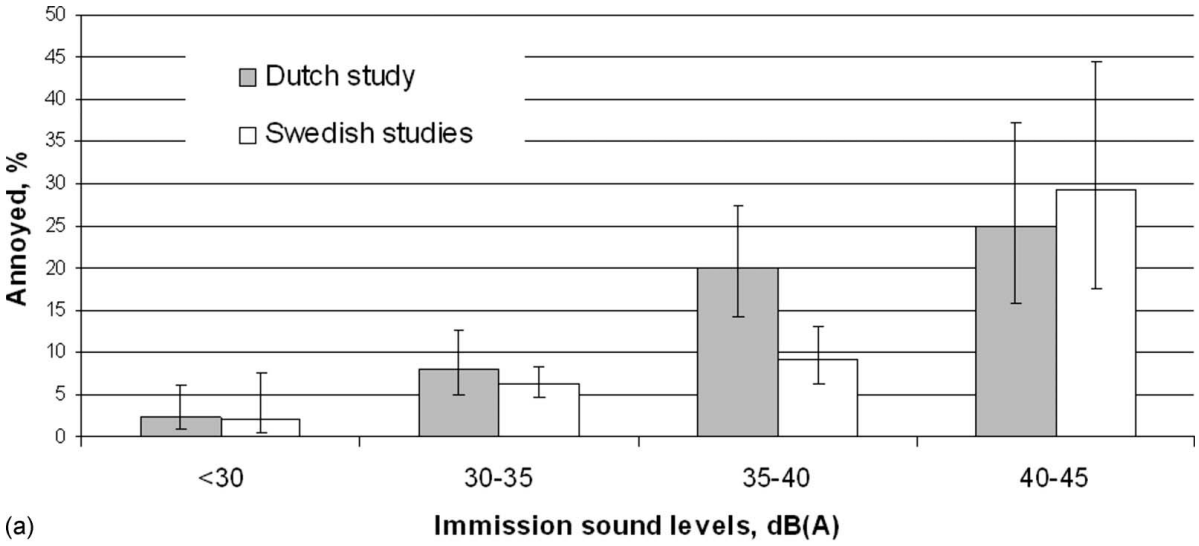
Pedersen, E., van den Berg, F., Bakker, R., & Bouma, J. (2009). Response to noise from modern wind farms in The Netherlands. *Journal of the Acoustical Society of America*, *126*, 634-643.

van den Berg, G. P. (2004). Effects of the wind profile at night on wind turbine sound. *Journal of Sound and Vibration*, *277*, 955–970.

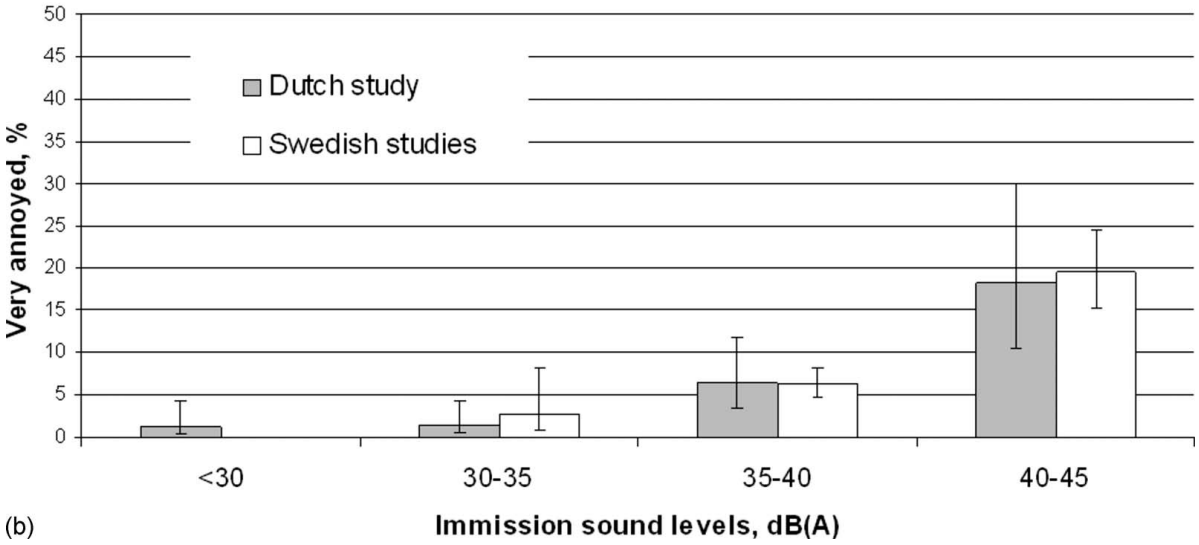
van Kempen, E. E, Kruize, H., Boshuizen, H. C., Ameling, C. B., Staatsen, B. A., & de Hollander, A. E. (2002). The association between noise exposure and blood pressure and ischemic heart disease: a meta-analysis. *Environmental Health Perspectives*, *110*(3), 307-17.

World Health Organization (2009). Night Noise Guidelines (NNGL) for Europe: Final Implementation Report. World Health Organization, Regional Office for Europe, Bonn Office. Accessed January 14, 2011 at:http://www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf.

World Health Organization (2011). Burden of Disease from Environmental Noise: Quantification of Healthy Life Years Lost in Europe. The WHO European Centre for Environment and Health, Bonn Office, WHO Regional Office for Europe.

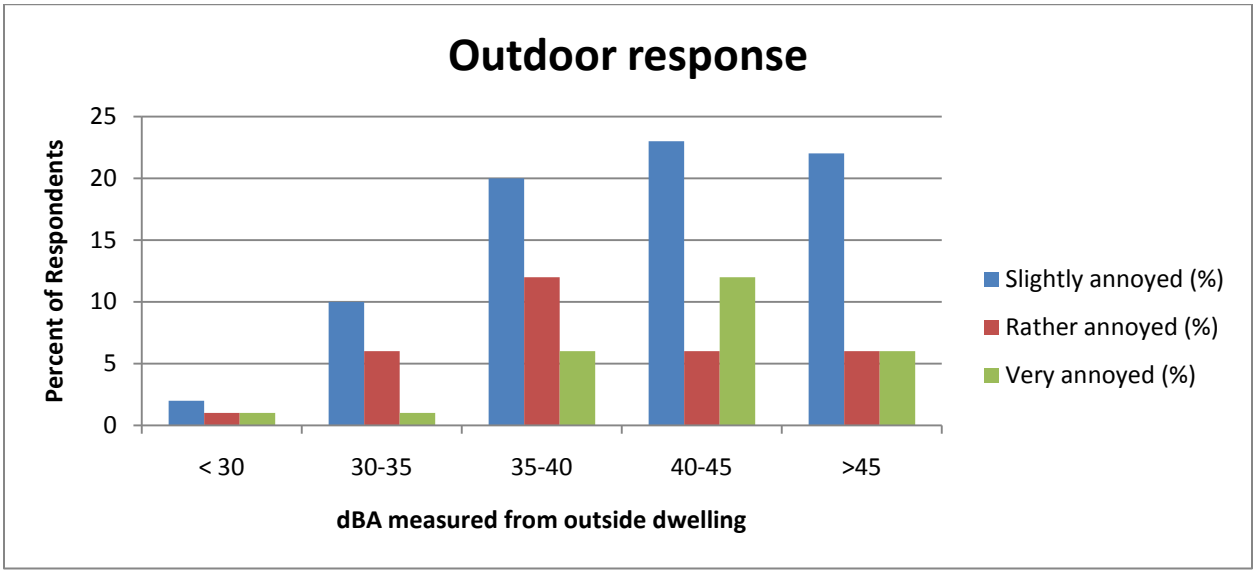


(a)



(b)

Figure 1. Proportions of respondents annoyed (a) and very annoyed (b) by wind turbine noise outside their dwellings in four sound level intervals in the Dutch study (only respondents who did not benefit economically, *n*=586) and the Swedish studies (*n*=1095), with 95% confidence intervals (Reproduced from Figure 2 of the article by Pedersen, van den Berg, Bakker, & Bouma, 2009).



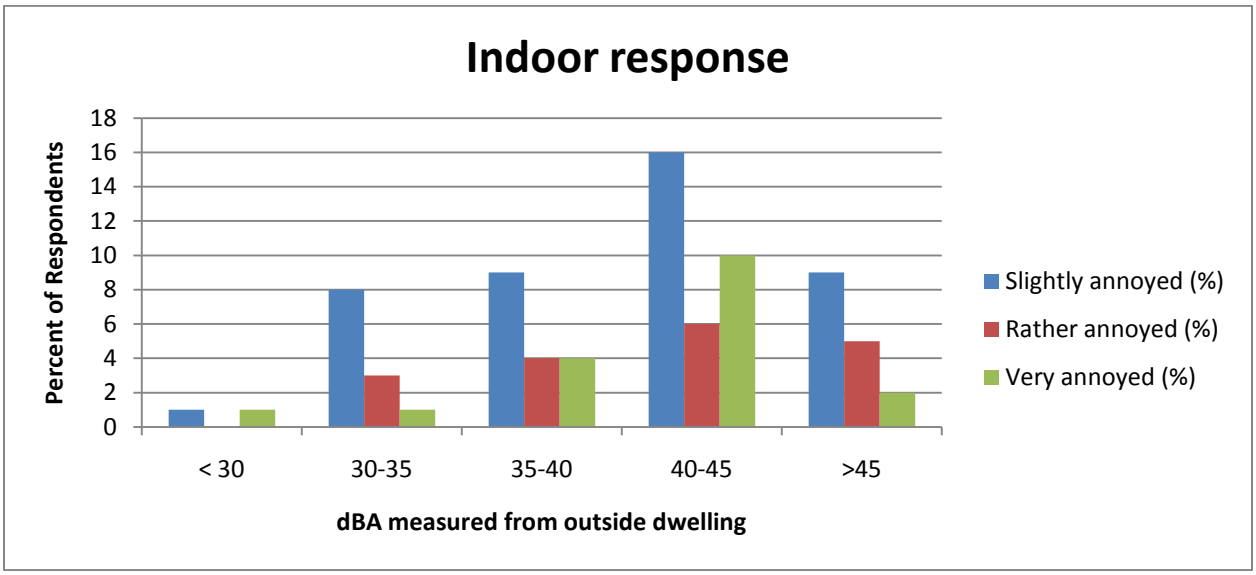


Figure 2. Percentage of respondents reporting various levels of annoyance, indoors and outdoors, to wind turbine noise, in 5-dBA sound level intervals. (Adapted from Table II of the article by Pedersen, van den Berg, Bakker, & Bouma, Pedersen et al., 2009).

Appendix I

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Sample Zoning for Wind Energy Systems

April 16, 2008

Introduction

These guidelines have been developed by the Energy Office, Michigan Dept. of Labor and Economic Growth (DLEG) to assist local governments to develop siting requirements for wind energy systems. This material is not intended to apply in urban areas. These guidelines have been developed with the intention of striking an appropriate balance between the need for clean, renewable energy resources and the necessity to protect the public health, safety, and welfare. The guidelines represent recommended zoning language for local governments to use if they amend their zoning ordinance to address wind energy systems. The Energy Office, DLEG has no authority to issue regulations related to siting wind energy systems.

Electricity generation is responsible for 36% of carbon dioxide pollution, 64% of sulfur dioxide pollution, 26% of nitrogen oxide pollution, and 34% of mercury pollution in the United States. Electricity generation from clean, renewable energy resources will reduce air pollution, increase the fuel diversity of our electric system, save natural resources, and provide a hedge against increases in the price of fossil fuels used for electric generation.

Different requirements are recommended for On-site Use (generally small) and Utility Grid (generally large) wind energy systems. On-site Use wind energy systems are sized to primarily serve the needs of a home, farm, or small business. Usually there is a single turbine – in contrast to a large, utility-scale wind farm that may include dozens or even hundreds of turbines. Utility Grid wind energy systems are sized to provide power to wholesale or retail customers using the electric utility transmission and distribution grid to transport and deliver the wind generated electricity. On-site Use wind energy systems can have towers up to 40 meters and Utility Grid wind energy systems can have towers up to 90 meters.

The guidelines have been developed with input from members of the Michigan Wind Working Group. The members of the Michigan Wind Working Group have not endorsed these guidelines. Professor Robert Fletcher, Ph.D. and Daniel Alberts, graduate student from Lawrence Technological University helped in the development of these guidelines by providing briefings on technical issues related to siting. Mr. Alberts also helped by conducting a modified Delphi study related to wind energy siting issues. For the Delphi study final report see:
http://www.ltu.edu/engineering/mechanical/delphi_wind.asp .

The guidelines were placed in typical sample zoning ordinance language by Kurt H. Schindler, Regional Land Use Educator with Michigan State University Extension.

Comments or questions are welcome and should be directed to John Sarver, Energy Office at 517-241-6280 or sarverj@michigan.gov.

Sample Zoning Amendments for Wind Energy Systems

The following is offered as sample zoning amendment language. It is intended as a starting point for a community to use when considering this issue.

- **If zoning exists:** If this is being done in a city, village, township, or county with its own existing zoning, then these provisions must be adopted pursuant to the Michigan Zoning Enabling Act.[1] A step-by-step checklist of procedures to amend the zoning ordinance is available from Michigan State University Extension's *Land Use Series*: "Checklist # 4: For Adoption of a Zoning Ordinance Amendment (including some PUDs) in Michigan" is available from www.msue.msu.edu/lu.
- **Township with county zoning:** If this is being done in a township that relies on county zoning, then the township must work with the county planning commission so these provisions are placed in the county's zoning ordinance pursuant to the Michigan Zoning Enabling Act.[2]
- **Zoning does not exist:** If this is being done in a township, village or city where zoning does not exist, then it is not possible to adopt these regulations concerning wind energy systems without first adopting zoning.

There are many different ways for a zoning ordinance to deal with the issues outlined here. The sample provided here is just one. It is written with the following assumptions:

1. The municipality already has site plan review in its zoning ordinance.
2. The section numbering system follows the standard system of codification presented in Michigan State University Extension's *Land Use Series:* "Organization and Codification of a Zoning Ordinance", available from www.msue.msu.edu/lu.
3. The municipality's attorney will review any proposed amendments before they are adopted.

Following are the sample zoning amendments with commentary.

Definitions

Add the following definitions to Section 503 (the section of the zoning ordinance for definitions of words).

> ANEMOMETER TOWER means a freestanding tower containing instrumentation such as anemometers that is designed to provide present moment wind data for use by the supervisory control and data acquisition (SCADA) system which is an accessory land use to a UTILITY GRID WIND ENERGY SYSTEM.
>
> AMBIENT means the sound pressure level exceeded 90% of the time or L_{90}.
>
> ANSI means the American National Standards Institute.

[1] P.A. 110 of 2006, as amended, (being the Michigan Zoning Enabling Act, M.C.L. 125.3101 *et seq.*)

[2] P.A. 110 of 2006, as amended, (being the Michigan Zoning Enabling Act, M.C.L. 125.3101 *et seq.*). A step-by-step checklist of procedures to amend the zoning ordinance is available from Michigan State University Extension's *Land Use Series*: "Checklist # 4: For Adoption of a Zoning Ordinance Amendment (including some PUDs) in Michigan" is available from www.msue.msu.edu/lu.

dB(A) means the sound pressure level in decibels. It refers to the "a" weighted scale defined by ANSI. A method for weighting the frequency spectrum to mimic the human ear.

DECIBEL means the unit of measure used to express the magnitude of sound pressure and sound intensity.

IEC means the International Electrotechnical Commission.

ISO means the International Organization for Standardization.

LEASE UNIT BOUNDARY means boundary around property leased for purposes of a Wind Energy System, including adjacent parcels to the parcel on which the Wind Energy System tower or equipment is located. For purposes of setback, the Lease Unit Boundary shall not cross road right-of-ways.

The IEC is the leading global organization that prepares and publishes international standards for all electrical, electronic and related technologies.

ISO is a network of the national standards institutes of 156 countries.

ON SITE WIND ENERGY SYSTEM means a land use for generating electric power from wind and is an accessory use that is intended to primarily serve the needs of the consumer at that site.

ROTOR means an element of a wind energy system that acts as a multi-bladed airfoil assembly, thereby extracting through rotation, kinetic energy directly from the wind.

SHADOW FLICKER means alternating changes in light intensity caused by the moving blade of a wind energy system casting shadows on the ground and stationary objects, such as but not limited to a window at a dwelling.

SOUND PRESSURE means an average rate at which sound energy is transmitted through a unit area in a specified direction. The pressure of the sound measured at a receiver.

SOUND PRESSURE LEVEL means the sound pressure mapped to a logarithmic scale and reported in decibels (dB).

UTILITY GRID WIND ENERGY SYSTEM means a land use for generating power by use of wind at multiple tower locations in a community and includes accessory uses such as but not limited to a SCADA TOWER, electric substation. A UTILITY GRID WIND ENERGY SYSTEM is designed and built to provide electricity to the electric utility grid.

WIND ENERGY SYSTEM means a land use for generating power by use of wind; utilizing use of a wind turbine generator and includes the turbine, blades, and tower as well as related electrical equipment. This does not include wiring to connect the wind energy system to the grid. See also ON-SITE WIND ENERGY SYSTEM and UTILITY GRID WIND ENERGY SYSTEM.

WIND SITE ASSESSMENT means an assessment to determine the wind speeds at a specific site and the feasibility of using that site for construction of a wind energy system.

General Provisions

Add to Article 10 subpart 107 (a part of the general provisions of the zoning ordinance dealing with structures and accessory structures) the following provisions for small wind energy systems with short towers as a use by right. That means a special use permit is not required.

1074. On-site Use Wind Energy Systems and Anemometer Tower.

An On-site Use wind energy system is an accessory use which shall meet the following standards:

A. Designed to primarily serve the needs of a home, farm, or small business.

B. Shall have a tower height of 20 meters or less.

C. Property Set-back: The distance between an On-site Use wind energy system and the owner's property lines shall be equal to the height of the wind energy system tower including the top of the blade in its vertical position. The distance between an anemometer tower and the owner's property lines shall be equal to the height of the tower. No part of the wind energy system structure, including guy wire anchors, may extend closer than ten feet to the owner's property lines, or the distance of the required setback in the respective zoning district, whichever results in the greater setback.

D. Sound Pressure Level: On-site Use wind energy systems shall not exceed 55 dB(A) at the property line closest to the wind energy system. This sound pressure level may be exceeded during short-term events such as utility outages and/or severe wind storms. If the ambient sound pressure level exceeds 55 dB(A), the standard shall be ambient dB(A) plus 5 dB(A).

Commentary: Another way to differentiate between On-Site Use and Utility Grid wind energy systems is size of the generators. Early drafts of this sample language made a distinction between a small wind energy system which has a rated capacity of not more than 300 kW and a large wind energy system greater than 300 kW. It was decided that use rather than size was a better way to classify wind energy systems for siting purposes.

Commentary: The property set-back requirement is designed to protect neighbors in the unlikely event of a tower failure. A setback equal to the tower's height should be adequate, but some communities require 1½ times the tower height as the setback.

Commentary: Normal conversation is in the range of 50-65 dB(A). There is more commentary under the Utility Grid section of this document.

E. Construction Codes, Towers, & Interconnection Standards: On-site Use wind energy systems including towers shall comply with all applicable state construction and electrical codes and local building permit requirements. On-site Use wind energy systems including towers shall comply with Federal Aviation Administration requirements, the Michigan Airport Zoning Act (Public Act 23 of 1950, MCL 259.431 *et seq*.), the Michigan Tall Structures Act (Public Act 259 of 1959, MCL 259.481 *et seq*.), and local jurisdiction airport overlay zone regulations. An interconnected On-site Use wind energy system shall comply with Michigan Public Service Commission and Federal Energy Regulatory Commission standards. Off-grid systems are exempt from this requirement.

F. Safety: An On-site Use wind energy system shall have automatic braking, governing, or a feathering system to prevent uncontrolled rotation or over speeding. All wind towers shall have lightning protection. If a tower is supported by guy wires, the wires shall be clearly visible to a height of at least six feet above the guy wire anchors. The minimum vertical blade tip clearance from

Commentary: Safety issues are addressed by reference to state construction and electrical codes and federal and state requirements related to towers. Safety issues are also addressed by provisions related to property set-backs, lowest point of blade, wind energy system controls, lightning protection, guy wire visibility, and interconnection standards.

grade shall be 20 feet for a wind energy system employing a horizontal axis rotor.

Special Use Standards

Add a section to Article 16 (the part of the zoning ordinance for specific special use permit standards).

1609. Utility Grid Wind Energy System, On-site Use Wind Energy System over 20 meters high, and Anemometer Towers over 20 meters high.

An Utility Grid Wind Energy System, On-site Use Wind Energy System over 20 meters high, and Anemometer Towers over 20 meters high shall meet the following standards in addition to the general special use standards (section 8608 of this ordinance):

A. Property Set-Back:

1. Anemometer Tower setback shall be the greater distance of the following:
   a. The setback from property lines of the respective zoning district;
   b. The setback from the road right-of-way; and
   c. A distance equal to the height of the tower from property lines or from the lease unit boundary, which ever is less.
2. Utility Grid and On-site Use Wind Energy System setback shall be greater distance the following:
   a. The setback from property lines of the respective zoning district;
   b. The setback from the road right-of-way; and
   c. A distance equal to the height of the tower including the top of the blade in its vertical position from property lines or from the lease unit boundary, which ever is less.
3. An Operations and Maintenance Office building, a sub-station, or ancillary equipment shall comply with any property set-back requirement of the respective zoning district. Overhead transmission lines and power poles shall comply with the set-back and placement requirements applicable to public utilities.

Background: Prior to construction of a Utility Grid wind energy system, a wind site assessment is conducted to determine the wind speeds and the feasibility of using the site. Installation of anemometer towers is considered a Special Land Use in this sample.

Commentary: Utility Grid wind energy systems may be treated as Special Land Uses under local zoning ordinances. Local governments may also decide to enter into a "Development Agreement" with a wind energy company that also incorporates suitable conditions or may develop a "Wind Overlay Zone" as an addition to or amendment of their existing zoning ordinances. For example, Huron County has developed a Wind Energy Conversion Facility Overlay Zoning Ordinance.

Commentary: The property set-back requirement is designed to protect neighbors in the unlikely event of a tower failure. A setback equal to the tower's height should be adequate, but some communities require 1½ times the tower height as the setback.

B. Sound Pressure Level: The sound pressure level shall not exceed 55 dB(A) measured at the property lines or the lease unit boundary, whichever is farther from the source of the noise. This sound pressure level shall not be exceeded for more than three minutes in any hour of the day. If the ambient sound pressure level exceeds 55 dB(A), the standard shall be ambient dB(A) plus 5 dB(A).

Commentary: Safety issues are addressed by reference to state construction and electrical codes and federal and state requirements related to towers. Safety issues are also addressed by provisions related to property set-backs, lowest point of blade, interconnection standards, falling ice, access doors, and handling of materials.

C. Safety: Shall be designed to prevent unauthorized access to electrical and mechanical components and shall have access doors that are kept securely locked at all times when service personnel are not present. All spent lubricants and cooling fluids shall be properly and safely removed in a timely manner from the site of the wind energy system. A sign shall be posted near the tower or Operations and Maintenance Office building that will contain emergency contact information. Signage placed at the road access shall be used to warn visitors about the potential danger of falling ice. The minimum vertical blade tip clearance from grade shall be 20 feet for a wind energy system employing a horizontal axis rotor.

D. Post-Construction Permits: Construction Codes, Towers, and Interconnection Standards: Shall comply with all applicable state construction and electrical codes and local building permit requirements.

E. Pre-Application Permits:
   1. Utility Infrastructure: Shall comply with Federal Aviation Administration (FAA) requirements, the Michigan Airport Zoning Act (Public Act 23

Commentary: Noise issues are complex and many communities do not have any detailed noise standards. Normal conversation is in the range of 50-65 dB(A). Noise standards may consider the potential for bodily injury, long term health effects, interference with speech and other activities, and sleep disturbance. EPA and World Health Organization documents indicate that 55 dB(A) is too low to produce hearing loss or long-term health effects.[1&2] Related to speech interference, would 55 dB(A) interfere with speech at the property line? EPA has estimated that the distance between persons would have to be 4 meters before there would be any interference.[1] Related to sleep disturbance, the World Health Organization notes that "80-90% of the reported cases of sleep disturbance in noisy environments are for reasons other than noise originating outdoors" and "habituation to night-time noise events occurs."[2] EPA has noted that the typical sound level reduction of buildings in cold climates is 17 dB (windows opened) and 27 dB (windows closed) so 55 dB outdoors would be reduced to no more than 28-38 dB indoors.[1]

References:

1. EPA, 1974. Protective Noise Levels: Condensed Version of EPA Levels Document.
2. World Health Organization, 1999. Guidelines for Community Noise.

The guidelines recommend basic standards for sound pressure levels. The standards can be more detailed and sophisticated. Separate standards can be developed for infranoise and low-frequency sound pressure levels. Separate standards can be developed for residential and non-residential areas. Sound pressure levels characterized as tonal can have lower limits. For example, the Huron County ordinance reduces their standard by 5 dB(A) in the event audible noise from the wind energy system contains a steady pure tone. Local governments who desire a more refined standard may want to consider developing a noise ordinance that would cover all generators of sound pressure levels not just wind systems in a fair and consistent manner.

of 1950 as amended, M.C.L. 259.431 *et seq*.), the Michigan Tall Structures Act (Public Act 259 of 1959 as amended, M.C.L. 259.481 *et seq*.), and local jurisdiction airport overlay zone regulations. The minimum FAA lighting standards shall not be exceeded. All tower lighting required by the FAA shall be shielded to the extent possible to reduce glare and visibility from the ground. The tower shaft shall not be illuminated unless required by the FAA. Utility Grid wind energy systems shall comply with applicable utility, Michigan Public Service Commission, and Federal Energy Regulatory Commission interconnection standards.

2. Environment:
   a. The site plan and other documents and drawings shall show mitigation measures to minimize potential impacts on the natural environment including, but not limited to wetlands and other fragile ecosystems, historical and cultural sites, and antiquities, as identified in the Environmental Analysis.
   b. Comply with applicable parts of the Michigan Natural Resources and Environmental Protection Act (Act 451 of 1994, M.C.L. 324.101 *et seq*.) (including but not limited to:
      i. Part 31 Water Resources Protection (M.C.L. 324.3101 *et seq*.),
      ii. Part 91 Soil Erosion and Sedimentation Control (M.C.L. 324.9101 *et seq*.) ,
      iii. Part 301 Inland Lakes and Streams (M.C.L. 324.30101 *et seq*.),
      iv. Part 303 Wetlands (M.C.L. 324.30301 *et seq*.),
      v. Part 323 Shoreland Protection and Management (M.C.L. 324.32301 *et seq*.),
      vi. Part 325 Great Lakes Submerged Lands (M.C.L. 324.32501 *et seq*.), and
      vii. Part 353 Sand Dunes Protection and Management (M.C.L. 324.35301 *et seq*.))
      as shown by having obtained each respective permit with requirements and limitations of those permits reflected on the site plan.

> Commentary: Environmental issues are complex. These guidelines identify areas that should be addressed in an Environmental Impact Analysis, but do not specify how the analysis should be conducted. Site specific issues should determine which issues are emphasized and studied in-depth in the analysis. There are a number of state and federal laws that may apply depending on the site.

F. Performance Security: Performance Security, pursuant to section 8611 of this Ordinance,shall be provided for the applicant making repairs to public roads damaged by the construction of the wind energy system.

G. Utilities: Power lines should be placed underground, when feasible, to prevent avian collisions and electrocutions. All above-ground lines, transformers, or conductors should comply with the Avian Power Line Interaction Committee (APLIC, http://www.aplic.org/) published standards to prevent avian mortality.

H. The following standards apply only to Utility Grid Wind Energy Systems:
   1. Visual Impact: Utility Grid wind energy system projects shall use tubular towers and all Utility Grid wind energy systems in a project shall be finished in a single, non-reflective matte finished color. A project shall be constructed using wind energy systems of similar design, size, operation, and appearance throughout the project. No lettering, company insignia, advertising, or graphics shall be on any part of the tower, hub, or blades. Nacelles may have lettering that exhibits the manufacturer's and/or owner's identification. The applicant shall avoid state or federal scenic areas and significant visual resources listed in the local unit of government's Plan.
   2. Avian and Wildlife Impact: Site plan and other documents and drawings shall show mitigation measures to minimize potential impacts on avian and wildlife, as identified in the Avian and Wildlife Impact analysis.
   3. Shadow Flicker: Site plan and other documents and drawings shall show mitigation measures to minimize potential impacts from shadow flicker, as identified in the Shadow Flicker Impact Analysis.
   4. Decommissioning: A planning

Commentary: These guidelines identify areas that should be addressed in an Avian and Wildlife Impact Analysis but do not specify how the analysis should be conducted. Site specific issues should determine which issues are emphasized and studied in-depth in the analysis. To assist applicants to minimize, eliminate, or mitigate potential adverse impacts, the U.S. Fish and Wildlife Service has developed Interim Guidance on Avoiding and Minimizing Wildlife Impacts from Wind Turbines which can be found at http://www.fws.gov/habitatconservation/wind.pdf. If the local government desires more structure to the analysis requirements, the Potential Impact Index developed by the U.S. Fish and Wildlife Service provides a framework for evaluating a project's impact on wildlife.

Applicants must comply with applicable sections of the federal Endangered Species Act and Michigan's Endangered Species Protection Law. The applicant should be aware that taking of these species is prohibited by State and/or Federal law unless the proper permits or exemptions are acquired. Early coordination with state and federal agencies is recommended. The applicant or the applicant's impact analyst should contact the U.S. Fish and Wildlife Service's East Lansing Field Office regarding federally-listed species and the Michigan Dept. of Natural Resources for state-listed species.

Commentary: Visual impact issues are difficult to address. Individuals seem to either like or dislike the look of wind energy systems. These guidelines try to address visual impact issues by providing some design standards and by restricting commercial advertising.

commission approved decommissioning plan indicating 1) the anticipated life of the project, 2) the estimated decommissioning costs net of salvage value in current dollars, 3) the method of ensuring that funds will be available for decommissioning and restoration, and 4) the anticipated manner in which the project will be decommissioned and the site restored.

5. Complaint Resolution: A planning commission approved process to resolve complaints from nearby residents concerning the construction or operation of the project
6. Electromagnetic Interference: No Utility Grid wind energy system shall be installed in any location where its proximity to existing fixed broadcast, retransmission, or reception antennae for radio, television, or wireless phone or other personal communication systems would produce electromagnetic interference with signal transmission or reception unless the applicant provides a replacement signal to the affected party that will restore reception to at least the level present before operation of the wind energy system. No Utility Grid wind energy system shall be installed in any location within the line of sight of an existing microwave communications link where operation of the wind energy system is likely to produce electromagnetic interference in the link's operation unless the interference is insignificant.

Zoning Districts

Add, where appropriate, to each land use district's list of possible special land uses the following:

1. Anemometer Tower over 20 meters high.
2. Utility Grid Wind Energy System.
3. On-site Use Wind Energy System over 20 meters high.

Site Plan Review

Add a section to Article 94 (the part of the zoning ordinance covering what is included in a site plan) to include additional items which should be shown on a site plan, and included in supporting documents for wind energy systems.

9407. Site Plans for Anemometer Tower, Utility Grid Wind Energy System, and On-site Use Wind Energy System.

In addition to the requirements for a site plan found in sections 9404, 9405, and 9406 of this Ordinance, site plans and supporting documents for Anemometer Tower, Utility Grid Wind Energy System, and On-site Use Wind Energy Systems which are over 20 meters high shall include

Comment: As indicated earlier, this sample is written with the assumption the requirement for site plans is already a requirement in the zoning ordinance. Further, that the site plan and/or permit application already requires basic information such as applicant identification; parcel identification including boundaries; scale; north point, natural features, location of structures and drives (existing and proposed); neighboring drives, buildings, etc.; topography; existing and proposed utilities; open spaces, landscaping, buffering features; soils data; and so on.

Also it is assumed the zoning ordinance requires all other applicable permits to be obtained prior to submission of the site plan, or at least the site plan prepared as will be required by other permitting agencies (when concurrent permitting will take place).

Finally it is assumed the ordinance already provides for an application fee and a site plan review fee in an amount specified in a published fee schedule adopted by the legislative body of the local unit of government. As with all fees, the amount must be set to cover anticipated actual cost of the application review.

the following additional information:

A. Documentation that sound pressure level, construction code, tower, interconnection (if applicable), and safety requirements have been reviewed and the submitted site plan is prepared to show compliance with these issues.
B. Proof of the applicant's public liability insurance for the project.
C. A copy of that portion of all the applicant's lease(s) with the land owner(s) granting authority to install the the Anemometer Tower and/or Utility Grid Wind Energy System; legal description of the property(ies), Lease Unit(s); and the site plan shows the boundaries of the leases as well as the boundaries of the Lease Unit Boundary.
D. The phases, or parts of construction, with a construction schedule.
E. The project area boundaries.
F. The location, height, and dimensions of all existing and proposed structures and fencing.
G. The location, grades, and dimensions of all temporary and permanent on-site and access roads from the nearest county or state maintained road.
H. All new infrastructure above ground related to the project.
I. A copy of Manufacturers' Material Safety Data Sheet(s) which shall include the type and quantity of all materials used in the operation of all equipment including, but not limited to, all lubricants and coolants.
J. For Utility Grid Wind Energy Systems only:
    1. A copy of a noise modeling and analysis report and the site plan shall show locations of equipment identified as a source of noise which is placed, based on the analysis, so that the wind energy system will not exceed the maximum permitted sound pressure levels. The noise modeling and analysis shall conform to IEC 61400 and ISO 9613. After installation of the Utility Grid wind energy system, sound pressure level measurements shall be done by a third party, qualified professional according to the procedures in the most current version of ANSI S12.18. All sound pressure levels shall be measured with a sound meter that meets or exceeds the most current version of ANSI S1.4 specifications for a Type II sound meter. Documentation of the sound pressure level measurements shall be provided to the local government within 60 days of the commercial operation of the project.
    2. A visual impact simulation showing the completed site as proposed on the submitted site plan. The visual impact simulation shall be from four viewable angles.
    3. A copy of an Environment Analysis by a third party qualified professional to identify and assess any potential impacts on the natural environment including, but not limited to wetlands and other fragile ecosystems, historical and cultural sites, and antiquities. The applicant shall take appropriate measures to minimize, eliminate or mitigate adverse impacts identified in the analysis, and shall show those measures on the site plan. The applicant shall identify and evaluate the significance of any net effects or concerns that will remain after mitigation efforts.
    4. A copy of an Avian and Wildlife Impact Analysis by a third party qualified professional to identify and assess any potential impacts on wildlife and endangered species. The applicant shall take appropriate measures to minimize, eliminate or mitigate adverse impacts identified in the analysis, and shall show those measures on the site plan. The applicant shall identify and evaluate the significance of any net effects or concerns that will remain after mitigation efforts.

        (Sites requiring special scrutiny include wildlife refuges, other areas where birds are highly concentrated, bat hibernacula, wooded ridge tops that attract wildlife, sites that are frequented by federally and/or state listed endangered species of birds and bats, significant bird migration pathways, and areas that have landscape features known to attract large numbers of raptor.)

        (At a minimum, the analysis shall include a thorough review of existing information regarding species and potential habitats in the vicinity of the project area.. Where appropriate, surveys for bats, raptors, and general avian use should be conducted. The analysis shall include the potential effects on species listed under the federal

Endangered Species Act and Michigan's Endangered Species Protection Law.)

(The analysis shall indicate whether a post construction wildlife mortality study will be conducted and, if not, the reasons why such a study does not need to be conducted.)

5. A copy of a shadow flicker analysis at occupied structures to identify the locations of shadow flicker that may be caused by the project and the expected durations of the flicker at these locations from sun-rise to sun-set over the course of a year. The site plan shall identify problem areas where shadow flicker may affect the occupants of the structures and show measures that shall be taken to eliminate or mitigate the problems.
6. A second site plan, which includes all the information found in sections 9404, 9405, and 9406 of this Ordinance, and shows the restoration plan for the site after completion of the project which includes the following supporting documentation:
   a. The anticipated life of the project.
   b. The estimated decommissioning costs net of salvage value in current dollars.
   c. The method of ensuring that funds will be available for decommissioning and restoration.
   d. The anticipated manner in which the project will be decommissioned and the site restored.
7. A description of the complaint resolution process developed by the applicant to resolve complaints from nearby residents concerning the construction or operation of the project. The process may use an independent mediator or arbitrator and shall include a time limit for acting on a complaint. The process shall not preclude the local government from acting on a complaint. During construction the applicant shall maintain and make available to nearby residents a telephone number where a project representative can be reached during normal business hours.

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